

**Alexandre Brongniart (1770-1847):
Kinship, Natural History, and
the Invention of Ceramic Science**



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Short Abstract:

In this thesis, I examine the life of Alexandre Brongniart, whose career in natural history paralleled a forty-seven-year directorship of the Sèvres Porcelain Manufactory. Critically, I show that Brongniart created a coherent science for “the arts of the Earth,” for which he established the term “*la céramique*.” Brongniart placed the study of the ceramic arts firmly within the context of natural history as well as that of expansive, geological time. As a case study, Brongniart’s lifetime highlights the transitions in the study of natural history that took place between the Enlightenment and the mid-nineteenth century. Brongniart was born into a family centred in artisanal and noble networks, where Enlightenment views were often admired and upheld. Shared kinships, guild ties, and social networks strengthened families and expanded financial interests, while marriages frequently established or enlarged alliances. Surrounded by prominent *savants*, artists, and artisans, Brongniart inherited significant advantage, but he also actively shaped his own education and career. Brongniart’s early education took place amid the chemical revolution – learning chemistry from Lavoisier himself. By his early career, Brongniart had begun the kinds of analysis and categorization that were instrumental in establishing scientific disciplines such as biology, palaeontology, geology, and mineralogy out of the study of natural history. By the end of the eighteenth century, all-encompassing, cosmological “systems” fell into disfavour, as a focus on facts, experimentation, analysis, measurement, and observation became indispensable to the practice of science. Both Brongniart, and his famous associate and friend, Georges Cuvier, sought to record observations with restricted emphasis on theory, and both considered that precise nomenclature was a key component of the practice of natural history and science. My discussion traces Brongniart’s successful and unsuccessful contributions to expanding scientific disciplines and to scientific language, including words such as *Jurassic*, *Jovienne*, *Saturnienne*, and, perhaps most importantly, *la céramique*.

Long Abstract:

In this thesis, I examine the life of Alexandre Brongniart, whose career in natural history paralleled a forty-seven-year directorship of the Sèvres Porcelain Manufactory. Critically, I show that Brongniart created a coherent science for “the arts of the Earth,” for which he established the term “*la céramique*.” I trace Brongniart’s contributions to numerous fields of study, such as geology, mineralogy, applied chemistry, and the ceramic arts. This thesis seeks to expand the discussion of Brongniart’s wide-ranging studies and to show that Brongniart’s contributions to ceramic science belong to the domain of the history of science as well as to the study of the arts. Brongniart has received limited attention in the literature of the history of science, where he often appears as a supporting actor, whilst his contributions to the science of ceramics have largely been overlooked. Likewise, specialists in fine arts and in the ceramic arts have done considerable study on his work in porcelain making but have typically viewed his ceramics work separately from his work in natural history. However, as I show, Brongniart’s efforts across fields grew out of his understanding of natural history and chemistry.

As a case study, Brongniart’s lifetime highlights the transitions in the study of natural history that took place between the Enlightenment and the mid-nineteenth century. He was born into a family centred in artisanal practices and networks, where Enlightenment views were often admired and upheld. Among artisanal networks, shared kinships and guild ties strengthened families and expanded financial interests, while marriages frequently established or enlarged alliances. As I show, Parisian artisans of all types were supported by noble patronage and used shared assets to benefit the entire community. To some extent these reciprocal acts of cooperation were familial, and others were legislated, either internally, by the rules of the guilds, or externally, by the laws of Paris. By tracing genealogies, I illustrate the networks of the Brongniart family and demonstrate that several families in eighteenth- and

nineteenth-century natural history – several which have often been termed “dynasties” – were interrelated by marriage as well as by trade or profession. Importantly, as an architect, Brongniart’s father, Théodore Brongniart, was able to offer and to receive patronage from within this interconnected and interdependent society. These well-established patronage networks continued to balance Brongniart’s experience throughout his lifetime.

Surrounded by prominent *savants*, artists, and artisans, Brongniart was born to significant advantage, but he also actively shaped his own education and career. His birth coincided with the Lavoisierian chemical revolution – as I show, Brongniart’s family members, such as his uncle, Antoine Louis Brongniart, and his cousin, Antoine Fourcroy were among Lavoisier’s earliest supporters and Brongniart was ideally positioned to take advantage of Lavoisier’s discoveries. Brongniart’s first efforts at public lectures took place in the family salon, where he instructed his audience of family members and close friends in the new oxygen-based chemistry, as Lavoisier himself looked on. Archived notes and outlines show his process of self-instruction, as well as how he expanded the course between 1786-89.

Brongniart’s independent travel also shaped his education and his natural history practice. During the first of many trips, an educational journey to England in 1790, Brongniart demonstrated his adept social skills and his qualifications in natural history, as he quickly developed contacts and resources in England, including Joseph Banks, Jonas Dryander, Matthew Baillie, William Blizard, John Francillon, James Lee, John Sibthorp, Ferdinand Bauer, and White Watson. Importantly, a project on the chemistry of enamel processes and colours marked Brongniart’s first formal study of artisanal practices related to ceramics. It culminated in his first major published memoir, “L’Art d’émailleur sur métaux,” which appeared in the *Annales de Chimie* in 1791. Additionally, in Summer 1791, Brongniart joined the naturalist José Bonifácio de Andrada on a journey through France, during which he began to sharpen his focus on the nature of the earth. I show that these two major trips mark the

beginning of Brongniart's interest not only in ceramics, but also in fieldwork and the study of the distinct characteristics of the Earth's layers.

Brongniart's efforts at building and maintaining a community for shared scholarship can be seen through the efforts he put into the Société Philomathique, which he founded with fellow students and family associates, such as François Silvestre. Brongniart's efforts toward the Société shed light on his approach to the practice of natural history as an exchange of information and effort, rather than as a purely individual pursuit. By his early career, Brongniart had begun the kinds of analysis and categorization that were instrumental in establishing scientific disciplines such as biology, palaeontology, geology, and mineralogy out of the study of natural history. These increasingly specialized fields led to the mid-nineteenth century emergence of the figure of the scientist. By the end of the eighteenth century, all-encompassing cosmological "systems" had fallen into disfavour, as a focus on facts, experimentation, analysis, measurement, and observation became indispensable to the practice of science. Both Brongniart, and his famous associate and friend, Georges Cuvier, sought to record observations with restricted emphasis on theory, and both considered that precise nomenclature was a key component of the practice of natural history and science. My discussion traces Brongniart's successful and unsuccessful contributions to scientific language, including words such as *Jurassic*, *Jovienne*, *Saturnienne*, and, perhaps most importantly, *la céramique*. Following Brongniart's publication of *Traité des Arts céramiques* in 1844, the term was soon translated into English as both *ceramic* and *keramic*, and into German as *Keramic*, becoming both indispensable and widely used.

Not only was Brongniart's work critical to the science of ceramics, he was a major contributor to geological, mineralogical, and palaeontological practice. A key study on the geology of the Paris Basin, co-authored with Cuvier, *Essai sur la géographie minéralogique des environs de Paris: avec une carte géognostique, et des coupes de terrain*, demonstrated

that a well-ordered collection of fossils could be used to identify individual strata and to establish the relative ages of the layers of the earth. Often, this early-career event has been recorded as Brongniart's most significant achievement in the sciences. His later contributions debuted with less sensation, but his geological, mineralogical, and paleontological work remained highly regarded and influential throughout his career.

In 1829, with *Tableau théorique de la succession et de la disposition la plus générale en Europe des Terrains et Roches qui composent l'écorce de la Terre, ou exposition graphique du Tableau des Terrains*, Brongniart charted a history for the earth that spanned from present-day conditions to the volcanic formation of the first layers of granitic rocks. Brongniart's annotated cross-section appeared shortly before Charles Lyell's outspoken support of expansive geological time in his 1830 publication of *Principles of Geology*. Brongniart's *Tableau des Terrains* depicted a stratigraphical succession of the earth's layers based on what Brongniart had compiled for the European continent. While less direct than Lyell's *Principles* regarding the age of the earth, both Brongniart's schematic image and its accompanying text, *Tableau des terrains qui composent l'écorce du globe, ou essai sur la structure de la partie connue de la terre*, gave clues to Brongniart's ideas of the long expanses of time required for geological process to have occurred. While he believed geological time to have been substantially long, Brongniart expected the age of the earth to be quantifiable, once the right knowledge could be traced, such as information on successive generations and variations of trilobites. Brongniart's belief in some form of geological "deep" time was directly influential to his discussion on the human history that could be witnessed through both archaeological and global ceramic practices, while he demonstrated that archaeological knowledge could illuminate geological questions.

Brongniart's life interests merged seamlessly, and his career efforts sought to integrate study of the mineralogical and biological productions of nature with study of the productions

of humankind. It was a vast undertaking, requiring extensive fieldwork, as well as broad access to materials, global specimens, and a lifetime of scientific dialogue and inquiry. Brongniart used his considerable social capital and social skills to establish himself as a key scientific contact at the Muséum d'Histoire naturelle, at his personal cabinet in St. Germain, and at Sèvres. He also acted to improve French mining and industry. Largely on the basis of his expertise and merit, Brongniart's career was remarkably stable over long periods of successive revolutions, political transitions, and social changes, which enabled his ambitious undertakings in both natural history and in the ceramic arts to be fully realized. Since his summative late-life publications appeared, the field of ceramics has had a permanent foundation by which it could be universally understood. Many of Brongniart's categories and methodologies have remained intact and have served as a basis for research in ceramic science, history, and connoisseurship into the present-day.

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LIST OF ABBREVIATIONS

AMMNS - Archives, Manufacture et Musée national du céramique de Sèvres

AN - Archives Nationales

BMHN - Bibliothèque Muséum nationale d'Histoire Naturelle

BNF - Bibliothèque Nationale de France

BMR - Bibliothèque municipale de Rouen

Note: All translations are my own unless otherwise indicated.

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Your eyes go out toward the water, and the waves rise;
your hands go out to the earth and the seeds swell;
you know the deep essence of water and the earth,
conjoined in you like a formula for clay.

-from *Odes to Common Things*

XXXIV (You are the daughter of the sea)

Pablo Neruda

INTRODUCTION
Alexandre Brongniart (1770-1847):
Kinship, Natural History, and the Invention of Ceramic Science

“In everything that nature makes, nature records how it was made. In the rock is a record of how it was made. In man is the record of how man was made. When we are conscious of this, we have a sense of the laws of the universe. Some can reconstruct the laws of the universe from knowing just a blade of grass. Others have to learn many, many things before they can sense what is necessary to discover that Order which is the universe.”¹

- Louis Kahn

When Louis Kahn spoke these words in the late 1960s, his words, in part, reflected the poetry of Walt Whitman, “. . . a leaf of grass is no less than the journey-work of the stars,” and that of William Blake, “to see a World in a Grain of Sand.” Kahn could easily have been referring directly to Alexandre Brongniart, the subject of this thesis, and to his close associate, the naturalist Georges Cuvier (1769-1832).² In the early nineteenth century, it was popular knowledge that Cuvier could identify the complex characteristics of an animal on the basis of a limited number of fossil bones, such as a skull or a jawbone.³ As Cuvier explained, “every organized being forms a whole, a unique and closed system, the parts of which mutually correspond and contribute to the same definitive action by reciprocal reaction. None of these parts can change without the others changing too; and, by consequence, each of them, taken separately, indicates and gives all the others.”⁴ By the features of a single part, the animal’s

¹ John Lobell, *Between Silence and the Light* (Boston, 2008), 12.

² Walt Whitman and Harold Bloom, *Walt Whitman’s Leaves of Grass* (New York, 2005). William Blake, “Auguries of Innocence,” *The Pickering Manuscript* (New York, 1972), 13-14.

³ M. J. S. Rudwick, *Worlds Before Adam* (Chicago, 2010), 20; M. J. S. Rudwick, *Bursting the Limits of Time* (Chicago, 2007), 356-363.

⁴ Georges Cuvier, *Discours sur la théorie de la terre* (Paris, 1821), 178-9.

size and environment could be surmised, for example, as well as whether it was an herbivore or a carnivore, and its relationship to animals of similar types could be established.

However, it was no instantaneous feat; Cuvier's intuition was developed after long, careful study, extensive comparison, and record keeping, as was the case with Brongniart, whose energy was dedicated to knowledge gathering in both the natural and manufactured worlds, and to the development of their order and organisation. His time was spent unravelling the recorded stories within nature that Kahn later poeticised. Brongniart pursued research across multiple fields of study, using observation of subtle distinctions and minute characteristics to clarify natural orders and species and to understand the physical structure of the Earth. Across its wide scope, Brongniart's work emphasised that the essential nature of an object or a body revealed its composition, origins, or history.

On the basis of his prolific and varied publications, Brongniart's contributions have often been viewed through the lenses of specialists in either geology or in the ceramic and decorative arts. However, in this thesis I argue that his actions and recorded thoughts often meshed seamlessly together, and no single discipline or field defined his career. Alongside holding the directorship of the porcelain manufacture at Sèvres for more than four decades, Brongniart conducted important geological studies; he made major contributions to biology, palaeontology, taxonomy, and mineralogy, and performed valuable research in ceramic chemistry. No author has yet taken on the daunting task, which I attempt here, of bringing together these diverse interests and contributions within a single study. As I demonstrate, Brongniart's ability to construct a foundation for ceramic science depended upon his mastery of a number of different arts and sciences, including painting, sculpture, and architecture; industry and its technology; and, most critically, natural history.

Throughout his career, Brongniart collected specimens of every sort, and was involved in the applied arts both as a patron and as a practiced draftsman, capable of illustrating his own

publications. He also held prominent teaching posts in mineralogy and natural history, including at the Muséum d'Histoire naturelle, the École des Mines, and the École Centrale des Quatre Nations.⁵ Frequently, Brongniart observed an object, a specimen, or a material from multiple perspectives, and continuously rearranged and reinterpreted the data he collected. For example, a porcelain object could at once be interesting for its chemical and material content, its method of production, its use, its design, and its artistic merit. His active scientific observation influenced information-rich decorative schemes at Sèvres, in which he created realistic views of the world and its inhabitants, including both local and global scenes, in sets such as the *Service Encyclopédique* (1806), the *Service des Départements* (1827), and the *Service Arts Industriels* (1820-35), (see Figures 0.1-0.3).⁶

In a pioneering joint-study with Cuvier, *Essai sur la géographie minéralogique des environs de Paris*, first published in 1811, Brongniart and Cuvier paired geological and biological knowledge to establish innovative and precise methodology for *geognosy*, a discipline that had a narrow focus on the Earth's surface.⁷ They published the first biostratigraphic analysis of a geographic region to clarify the positions of the layers of the Earth alongside an extensive analysis of both mineral content and representative fossil specimens. Taking advantage of the rich fossil collections of the Muséum, many of which had been categorised by Lamarck, and using their knowledge of comparative anatomy, Cuvier and Brongniart ordered the data found in each layer systematically. They enumerated characteristic fossils and minerals and included an illustrated cross-section that established the positions of geological formations. The divisions represented distinct chronological and *geognostic* eras

⁵ Derek E. Ostergard, *The Sèvres Porcelain Manufactory* (New Haven, 1997), 25-37.

⁶ Anne Dion-Tenenbaum and Tamara Préaud, *Le service encyclopédique* (Paris, 2011); Ostergard, *Sèvres Porcelain Manufactory*, 367-70; P. Ennès and A. Prévert, "An Encyclopaedia for Dessert," *La Revue du Louvre et des Musées de France* 4 (2003).

⁷ Georges Cuvier and Alexandre Brongniart, *Essai sur la géographie minéralogique des environs de Paris* (Paris, 1811). A Wernerian term, *geognosy*, a precursor to the English term *stratigraphy*, comprised the study of the Earth's layers and their relationship to one another.

and provided a system of relative dating. This early career achievement has often been used to define Brongniart's geological research, although he continued to generate ideas and observations in geology for decades thereafter.⁸

The 1807 *Traité de minéralogie avec des applications aux arts* and the 1825 handbook, *Introduction à la minéralogie*, both provided a set of resources for understanding the mineral character and structure of the Earth.⁹ Supplemental information was included for understanding the ceramic arts, as well as earthen materials and their practical uses. Brongniart's publications formed a connection between practical and theoretical geological and mineralogical research with his synthesising work in the ceramic arts. After a career of extensive research and publication, including articles on ceramics, clays, and mineralogy that appeared as entries in the serially produced *Dictionnaire des sciences naturelles*, Brongniart created a clear timeline of the Earth's geological past, the *Tableau des terrains qui composent l'écorce du globe*, which he illustrated in the *Tableau théorique de la succession et de la disposition la plus générale en Europe des Terrains et Roches* of 1829 (see Figure 7.10).¹⁰ The schematic drawing of the layers of the Earth and its corresponding geologic time scale drew upon Brongniart's biological, palaeontological, geological, and mineralogical studies, connecting several of his career efforts. It also depended upon his earliest lessons in architecture and drafting. He followed the deep-time oriented *Tableau des terrains* with a study

⁸ See, for example, Frank Dawson Adams, *Birth and Development of the Geological Sciences* (New York, 1954): 165-7; David Oldroyd, *Thinking about the Earth: A History of Ideas in Geology* (Cambridge, MA, 1996): 102, 114-17; Rachel Laudan traced some of Brongniart's contributions to geological ideas throughout his active years in the field, see: *From Mineralogy to Geology* (Chicago, 1993); Gabriel Gohau also provided an expanded view of some of Brongniart's ideas in *A History of Geology* (New Brunswick, NJ, 1991). Jean Gaudant edited a series of essays on the development of French geology, including an essay by Philippe Grandchamp which details Brongniart's geology course of 1812, "Deux courses de géologie professées en France," in *L'essor de la géologie française* (Paris, 2009): 227-74.

⁹ Alexandre Brongniart, *Traité élémentaire de minéralogie* (Paris, 1807); *Introduction à la minéralogie* (Paris, 1825).

¹⁰ Alexandre Brongniart, *Tableau des terrains* (Paris, 1829); *Tableau théorique* (Paris, 1829).

of the human history of ceramics. In 1844, Brongniart published his path-breaking *Traité des arts céramiques*, a set of two comprehensive text volumes plus an *Atlas* of plates and diagrams.¹¹ It was followed, in 1845, by the publication of the two-volume catalogue raisonné, *Description méthodique du Musée céramique de Sèvres*.¹² Taken as a whole, these publications formed a continuous exposition of the Earth's history, including a comprehensive study of the ceramic arts.

Brongniart's publications on ceramics reached the scale of the great systems of Buffon and the detail of the *Encyclopédie méthodique* that he had read in his youth.¹³ He established a clear and openly accessible science of ceramics that ranged from questions of basic chemistry, mineralogy, and geology through a survey of the known methods of ceramic processing, production, firing, and decoration. In addition, through the *Musée céramique* and its collections, Brongniart provided a global history of ceramic objects. Utilising his skills across disciplines, all of which supported a specific mastery of ceramics that had taken a lifetime to build, his collective efforts and major publications formed a bridge between the all-encompassing systems of the savants and the antiquarians of his youth and the specialised disciplines of the scientists of his late career.

Brongniart employed his singular position as one of the most powerful and well-connected porcelain manufacturers of his day, as well as his characteristic emphasis on the organisation and classification of facts and information. He established a clear science out of what were generally disparate pieces of local knowledge and arcane practices typical of the limited canon related to "the arts of the Earth." Using chemical and mineralogical knowledge,

¹¹ Brongniart, *Arts céramiques*, 1844.

¹² Alexandre Brongniart, *Traité des arts céramiques*, 2 vols. and *Atlas* (Paris, 1844); Alexandre Brongniart and Denis Désiré Riocreux, *Description méthodique du Musée céramique* (Paris, 1845).

¹³ Denis Diderot and Jean le Rond d'Alembert, *Encyclopédie, ou dictionnaire raisonné des sciences, des arts et des métiers* (Lausanne, 1778).

Brongniart analysed and classified clay and colouring materials, and using geological knowledge, he located and identified useful mineralogical sources for ceramic production. Most critically, he used his practical and scientific knowledge to develop a methodology for others to study and to understand pottery and porcelain making through multiple perspectives, including chemical, mineralogical, technological, and cultural. Although Brongniart centred his work around ceramics, his classificatory systems offered an origin point on which to build studies of other artforms, such as textiles, metals, architecture, design and pattern, painting, and sculpture. As I have shown elsewhere, in the decade after Brongniart's death, the architect Gottfried Semper drew directly upon his research at Sèvres to plan his own history of metals, as well as to articulate his own comprehensive history of style.¹⁴ While Semper has been credited with the foundation of the scientific approach to art history, his achievements in this field depend to a large extent upon the foundation laid by Brongniart.¹⁵

The word “ceramic,” now commonplace and indispensable, owes its usage to Brongniart. Taken from the Greek *Keramos*, “*céramique*” was defined in print by Brongniart in *Arts céramiques* as an all-encompassing term that described clay- and mineral-based products or processes, including tile, bricks, pottery, porcelain, glass, and the like. Importantly, he extended this definition to the physical and electrical properties of ceramic materials.¹⁶ Before Brongniart's writings on the ceramic arts, there was no widely understood, collective term for the field, nor were there any open, comprehensive guides to its processes. *Arts céramiques* was immediately recognised as a definitive resource that formed a foundational study of the diverse field. However, apart from the appreciation of specialists in ceramics,

¹⁴ Gottfried Semper and Peter Noever, *The Ideal Museum* (Wien, 2007); Gottfried Semper and Harry Francis Mallgrave, *Style* (Los Angeles, 2007); Julia Carr-Trebelhorn, *From Geology to Art History* (Lexington, KY, 2014).

¹⁵ Carr-Trebelhorn, *From Geology to Art History*, 3-4.

¹⁶ Brongniart's used the term “la céramique” as a component of the name for the museum at Sèvres in 1824, but he did not regularly use it in print until 1830. I discuss the etymology and creation of the term in Chapter Four.

Brongniart's impact on ceramic production and technology, archaeology, and art history is less well-known. Although his geological research has received extended analysis, his treatise on ceramics remains only marginally connected to the domain of the history of science.¹⁷

In the first half of this thesis, I examine the familial and intellectual matrices in which the young Brongniart was brought up and educated. His father, Théodore, was a close student of the architect Étienne Boullée, becoming his chosen successor as the resident architect at Les Invalides in 1782.¹⁸ Brongniart's earliest training included receiving technical instruction from his father; here he learned the necessary skills of architecture, including drafting and the nature of artistic creation. However, he was also exposed to exciting developments in the emerging sciences, and at the same time as he acquired technical prowess in the fine arts, he grew more engaged with natural history, chemistry and pharmacy, as both his father and his uncle, Antoine Louis Brongniart (1742-1804), had done in their youth.¹⁹ Beginning his career as a mining engineer with the Agence des Mines in 1794, Alexandre wrote to his father that his work was "fifty-percent architecture, twenty-five percent geology, and twenty-five percent chemistry," explaining that he spent much of his time drawing scale elevations of the interior structure of the mines as well as drafting accurate floor plans.²⁰ Brongniart applied his architectural and representational skills throughout the remainder of his career, including the development of a continuous record of visual documentation, most importantly as cross-sections or elevations of the Earth's surface (see Figures 0.4-0.5, 3.3, 6.2-6.5, 7.2-7.4, 7.6-7.7, 7.10). The lessons he

¹⁷ It was initially translated into English as both *keramic*, from the Greek, and as *ceramic*, following the French. In German, *Keramic* became the favoured usage.

¹⁸ For an overview of Boullée's work, see Emil Kaufmann, *Three Revolutionary Architects: Boullée, Ledoux, and Lequeu*, (Pennsylvania, 1952), 436-473.

¹⁹ I discuss the family history and the family pharmacy in Chapter One.

²⁰ Alexandre Brongniart, Correspondance Active (1791-1825), Correspondance de Famille, Lettres à son père, 1793-95, 9 Octobre 1795, AN 668 AP /1, 74.

gleaned from his father would contribute greatly to his scientific activities for the rest of his career.

The study of natural history lay at the heart of Brongniart's early intellectual endeavours. The topic, which acquired unprecedented prestige in late eighteenth-century France, provided a method for organising and classifying activities in multiple sciences, and it encouraged a particular way of observing and reducing complexities into smaller, more coherent segments. Nevertheless, Brongniart retained the lessons and skills from architecture throughout his lifetime and architecture provided insights that were useful for his scientific work, notably in the area of mineralogy. As he turned his attention from the columns, orders, and proportions of architecture to natural history, he relied upon the ordering of parts and compositions among collections of fossils, minerals, and anatomies. In his *Introduction à la minéralogie* of 1825, Brongniart described organic beings as having rounded, "somewhat cylindrical" features, which rarely appeared with regular angles or flat planes. Contrastingly, minerals could be broken down into rectilinear forms, planes, and observable angular relationships (see Figure 6.2).²¹ Previously, in 1807, he had described the study of nature as the "scattered pieces of an immense edifice" which the naturalist sought to reassemble in order to re-establish the structure ("*rétablir l'édifice*"). He explained that physics and chemistry provided the instruments by which nature could be examined in all its facets, while they helped students to understand the alterations that natural objects had undergone.²²

Brongniart's study of both architecture and natural history informed his interests in ceramics, including pottery and porcelain, which he classified and organized in a similar way to the analysis he gave to natural history collections. In an unpublished essay entitled "Architecture, essai sur l'art," Boullée had considered the macroscopic properties of nature,

²¹ Brongniart, *Introduction à la minéralogie*, 5-6.

²² Brongniart, *Traité élémentaire de minéralogie*, 2.

including framed vistas, aisles of trees that could be paired with the proportions of constructions, or the interplay of carefully channelled natural light across architectural surfaces. He noted that “if there is an art which enables us to avail ourselves of nature, then it is unquestionably the most worthy of all the arts.”²³ Boullée’s words could apply equally to pottery, porcelain, and ceramics, which, despite appearances of artifice, are inextricably bound by nature and by the understanding and recreation of natural processes. Likewise, during the late eighteenth century, the related craft of *menuiserie*, or furniture carpentry, was viewed as small-scale architecture. *Menuiserie*, like pottery, relied upon an understanding of physics, chemistry, and the behaviours of natural materials of all types.²⁴

In practice, architecture, furniture, and pottery remain separate domains. Nonetheless, there were areas of connection, including the use of ceramic materials as technology, structure, and decoration within the construction of buildings or as adornment and surface treatments for furniture (see Figures 0.6-0.7a-b). The fourth century BCE philosopher, Diogenes, was said to have used a massive clay pot for a home. In the *Atlas to Arts céramiques*, Brongniart included a depiction of the bare-chested philosopher stretching forward, animal-like, out of a monumental terra cotta jar turned on its side (see Figure 0.8). Two other illustrations from the same plate depicted the production of similarly sized pots in Africa, and a Brazilian burial jar, respectively.²⁵ Most would not consider Diogenes’ abode either as suited to Boullée’s “Architecture” or as meeting the standards for the Vitruvian “art of building.” Nonetheless, abstractly, the forms of architecture and pottery vessels share a common relationship, each

²³ Helen Rosenau, *Boullée & Visionary Architecture: Including Boullée’s ‘Architecture, Essay on Art’* (London, 1976), 93.

²⁴ Leora Auslander, *Taste and Power*, 110-2. As an industry related to both ceramic production and architecture, I consider the networks of *menuisiers* and related trades in Chapter One.

²⁵ Brongniart, *Arts céramiques*, Plate XIX. The image, following Winckelmann, was taken from a relief at the Villa Albani in Rome. Giovanni Battista Casanova, engraver, and Johann Joachim Winckelmann, “Alexander Conversing with Diogenes,” *Monumenti antichi inediti*, vol. 1 (Rome, 1767), pl. 174.

having walls that create the enclosure of space. In the *Book of Tea*, Okakura Kakuzō, citing Laotse (Lao Tzu), observed:

the reality of a room, for instance, was to be found in the vacant space enclosed by the roof and walls, not in the roof and walls themselves. The usefulness of a water pitcher dwelt in the emptiness where water might be put, not in the form of the pitcher or the material of which it was made.²⁶

While this frequently quoted passage from Okakura tends toward the philosophical rather than the practical, the similarity between pottery and architectural forms as containers, objects for protection, for ceremony, or for burial, among countless functions, is readily apparent.²⁷ The art of both pottery and architecture lies within the creation of space. Likewise, both found their origins in organic forms, such as animal horns used as drinking vessels, re-envisioned by the Greeks in metals or clay as the *rhyton* (see Figure 0.9); leaves used as containers; or natural caves and shelters made of materials such as animal hides, bamboo, wood, grass, and adobe. Setting aside differences of scale and complexity, and following on from Boullée, an essential point is that the related forms of both pottery and architecture derive from nature in material and in conception.

Boullée was not the only eighteenth-century voice to include the man-made in his view of nature. In 1751, Denis Diderot linked natural history to the “mechanical arts,” calling upon natural historians to include the experiments of artisans within their studies:

. . . it would be most advantageous to link the arts to the products of nature. An exact enumeration of these products would give rise to many arts that are as yet unknown. A detailed examination of the different aspects from which the same product can be studied would lead to the discovery of still other arts. The first of these possibilities demands a very extensive knowledge of natural history and the second, great dialectical ability. Consequently, a treatise on the arts, as I envisage it, cannot be the work of an ordinary man... I have already pointed out that the history of nature is incomplete

²⁶ Okakura, Kakuzō, *The Book of Tea: Classic Edition* (Rutland, VT, 1997), 45.

²⁷ Frank Lloyd Wright cited Okakura as an influence, and Okakura may have been reciprocally influenced by Wright. Thomas S. Hines, “The Search for Frank Lloyd Wright: History, Biography, Autobiography,” *Journal of the Society of Architectural Historians* 54, 4 (1995): 475.

without the history of the arts.²⁸

Brongniart's nineteenth-century science of ceramics was drawn from the natural history that he had studied at the end of the eighteenth century. When he began his education in the 1770s, there were three all-encompassing kingdoms of natural history, as described by Linnaeus: Animal, Vegetable, and Mineral.²⁹ The eighteenth century saw these fields grow increasingly precise.³⁰ His career occurred during the period Foucault considered "Classical" natural history, roughly outlined as the seventeenth to nineteenth centuries. Foucault showed that knowledge in natural history was intimately tied to both classification and language.³¹ As Foucault argued, there could be no study of biology until the end of the eighteenth century, as there was no concept of "life" at any time prior, "only living beings."³² Neither could there be a science of pottery making.

The natural history of the Renaissance had been based on "associations and similitudes as ordering principles."³³ Natural historical knowledge of the seventeenth and early eighteenth centuries included fictional and mythological references, as well as practical ones. In a description of the natural history of the fox, Conrad Gesner (1516-65) combined drawings, records of the habits of the fox, related folklore, and even words, such as "crafty, sly, cunning" and so on, linked to classical quotations.³⁴ Although Brongniart sought scientific precision in his classifications, *Arts céramiques* was situated at the end of this long tradition of natural history. Brongniart's writing was broad and inclusive, touching on subjects such as the ancient

²⁸ Denis Diderot, "Art," *The Encyclopedia of Diderot & d'Alembert Collaborative Translation Project*, translated by Nelly S. Hoyt and Thomas Cassirer (Ann Arbor, MI, 2003).

²⁹ Dan H. Nicolson, "Stone, Plant, or Animal," *Taxon* 51, 1 (2002): 1.
<https://doi.org/10.2307/1554958>.

³⁰ See Susannah Gibson, *Animal, Vegetable, Mineral? How Eighteenth-century Science Disrupted the Natural Order* (Oxford, 2015).

³¹ See Foucault, *Order of Things*, 78-124.

³² Michel Foucault, *The Order of Things* (London, 2010), 175.

³³ William B. Ashworth, "Emblematic Natural History of the Renaissance," in *Cultures of Natural History*, eds. N. Jardine et al. (Cambridge, 1996): 36.

³⁴ Ashworth, "Emblematic Natural History," 36.

uses and understanding of ceramic objects, as seen through literary accounts and archaeology. But it was also centred in the Lavoisierian chemical revolution, including chemical and geological studies with Lavoisier himself. Thus, Brongniart was able to relate key chemical understanding such as the importance of *oxidation* and *deoxidation* (reduction) and electrical processes to the complex production and firing requirements of pottery and porcelain technology.³⁵ While Brongniart's writing followed in a long tradition of descriptive natural histories, it was also at the forefront of scientific discovery and practice.

In *Ways of Knowing*, John Pickstone argued that in the eighteenth century, the study of natural history benefitted from an expanded perspective that included objects of material culture.³⁶ Brongniart constructed "*la céramique*" out of natural history's expansive mineral kingdom, and his analysis of ceramics considered extrinsic characteristics, such as style and pattern, but also the internal – chemical, mineralogical, and structural. The former was an existing way of thinking about pottery that had much in common with seventeenth-century natural history that had focussed on the external characteristics of animals; the latter paralleled the kinds of analysis and classification necessary for not only the dissections of biology and comparative anatomy, but also the microscopic and gravimetric analyses required by physics, chemistry, and mineralogy. The "arts of the Earth," a phrase describing the craft and art of pottery making, had been used in the sixteenth century by Palissy, and remained popular until the mid-nineteenth century, when Brongniart introduced the term "*la céramique*" to a broad audience.³⁷ As I show below, Brongniart adopted "*la céramique*" as a substitution and a simplification for the phrase "arts of the Earth," and as a way of defining the field within the related sciences of natural history. The study and knowledge of the Earth were integral to the

³⁵ See Chapter Five for a full discussion of Lavoisier's relationship to the technology at Sèvres, and of Brongniart's integration of chemistry knowledge with porcelain technology.

³⁶ John V. Pickstone, *Ways of Knowing* (Chicago, 2001).

³⁷ Bernard Palissy, *Discours admirable de l'art de terre, de son utilité des esmaux et du feu* (Geneva, 1863).

study of pottery and porcelain, just as much as knowledge of high-temperature reactions and physical chemistry were integral to understanding the Earth's formation and history.

Centring Influences and Connections

Brongniart's advantages included well-positioned family connections that were intertwined with prominent intellectual and artisanal networks. Although their financial circumstances were precarious by the mid-eighteenth century, the Brongniart family had been ennobled during the early seventeenth century, and they continued to maintain substantial social capital.³⁸ The family had direct connections to the select group of artisans surrounding the court at Versailles, as well as to the retinues of both the House of Orléans and the Prince de Condé.³⁹ Mutually reinforcing networks offered (and required) an ambitious young man like Brongniart opportunities from patronage and shared resources. To succeed as an individual, there were social and political expectations to meet – in Brongniart's case, youthful efforts such as the chemistry lectures he gave in the family salon and the group excursions he organized during his youthful education acted both as self-instruction and public performances. They were meant not only to share knowledge, but also to entertain an audience.⁴⁰

Dorinda Outram's important 1984 study of Georges Cuvier, Brongniart's close associate, is a touchstone for the present study.⁴¹ Brongniart's close friendship with Cuvier makes comparison with Outram's work necessary, but their situational and personal differences are what make the contrast relevant and interesting. Outram's discussion showed that both Cuvier's administration-focussed formal education and his self-fashioning aided his ambitions to leadership positions. She sought to balance the prevailing image of Cuvier, who was often

³⁸ Monique Mosser, *Alexandre-Théodore Brongniart* (Paris, 1986), 15.

³⁹ Mosser, *Alexandre-Théodore Brongniart*, 16.

⁴⁰ I discuss his early education in Chapter Two.

⁴¹ Dorinda Outram, *Georges Cuvier* (Manchester, 1984).

seen as “the unquestioned dominant figure in the French life sciences.” She argued that Cuvier’s authority was a highly variable individual resource that he was at pains to maintain. Thus, Cuvier’s patronage-bound scientific career “lacked the power to produce universally agreed or accepted research programmes or methods of procedure in science. It was the nature of patronage, in other words, to produce controversy rather than consensus in science.”⁴² Outram described Cuvier’s power as inherently dependent and emotionally tied, rather than a consequence of an accepted institutional or academic authority, a situation which forced Cuvier to expend efforts to maintain his influence. This was a constant process, which Outram saw as diminishing Cuvier’s true effectiveness in shaping the practices of natural history.

Where Cuvier needed to create nearly all his patronage relationships in Paris, Brongniart’s life presents a contrasting case in which both inherited and constructed networks formed a flexible matrix in which he could build a career. These long-established networks and families had variable amounts and types of power, and members benefitted from the accumulation of diversified financial, social, political, and intellectual resources over several generations. From his earliest years, Brongniart’s personal efforts relied upon and contributed back to his inherited milieu, where patronage was frequently, if not always, reciprocal. In times of great political and social turmoil, the stability provided by these networks provided significant advantage to his early career, and he actively returned patronage and support to other network members as well as to close acquaintances, such as Cuvier. Outram considered this type of patronage to be “informal”, and crucially, much of it was familial. As I show in Chapters Three and Four, although they were cousins, Brongniart treated his relationship with the chemist and Revolutionary politician Antoine François de Fourcroy (1755-1809) with care and protection, recognizing the patronage Fourcroy offered as something that could be diminished or even lost. Fourcroy guided Brongniart’s early education in chemistry,

⁴² Outram, *Cuvier*, 7.

encouraged the development of his presentation skills, determined which courses Brongniart would teach at the Lycées from the 1790s forward, including a key chemistry course in early 1800 that supported Brongniart's candidacy at Sèvres the same year. Brongniart responded to Fourcroy's professional requests without hesitation, and it was not a relationship that he or his family could take for granted. Nevertheless, with nepotism increasingly put under the spotlight of the Revolution, merit became a factor in the eye of the public, and traditional familial and artisanal patronage relationships could come under suspicion.⁴³

As I discuss in Chapter One, the artisanal networks that shaped Brongniart's experience were interdependent, both by nature and by regulation, and relied on the give-and-take of their membership. Individuals, such as an architect or an artisan, could (and should) excel, as this had the potential to benefit or to raise the prominence of other contributors to the network as well. From the late seventeenth century forward, the Brongniart family followed in the long-established patterns of French artisanal and bourgeois families to promote the interests of their families, both as a unit and as individuals.⁴⁴ Combined assets included political and social power, as well as financial and educational resources. The Brongniart dynasty, like many longstanding Parisian families, constantly reinforced ties through the cross-promotion of family members and they were able to share access to educational resources such as instructors, ideas, libraries, and collections.

Brongniart used his collections for his personal research, but also as a teaching tool for his children, alongside his many students, fellow natural historians, and invited guests. Cuvier and Brongniart both instructed their children in natural history.⁴⁵ Thus, it was possible to plan for the pursuit of similar or parallel careers, much as Parisian families who had ties to a

⁴³ At the Muséum, changes were put in place to distribute offices and power more evenly. See, Outram, *Cuvier*, 162-3. See also John Carson, *The Measure of Merit* (Princeton, NJ, 2007).

⁴⁴ I have discussed this previously in the Introduction and Chapters One and Four.

⁴⁵ On multigenerational families at the Jardin, see Outram, *Cuvier*, 173-174; Maurice Crosland, *Science under Control*, (Cambridge, 2002), 179-86.

particular guild or profession had commonly done. Consequently, the careers of both Cuvier and Brongniart could be benefitted by the assistance of their children, who worked as trained support personnel in addition to building their own careers. Brongniart's network also protected its members in the face of adversity. For example, Fourcroy's education was supported by other family members and associates after his father suffered a financial and professional downturn. Later, as I describe in Chapter Three, during the Revolution the extended family networks, including Fourcroy, were mobilized to obtain Brongniart's release from imprisonment on two separate occasions.

In contrast to Cuvier's education at the strict Carolinian Academy at Stuttgart and his early career as a tutor, Brongniart's patronage relationships rarely imposed harsh ideological limitations on his scientific career.⁴⁶ Rather, his familial network provided a platform for personal development within a relatively open arena. Network members such as Brongniart's parents and Fourcroy guided his early education, with the content slanted towards familial assets and interests, such as pharmacy and the arts, as well as towards his personal goals in chemistry and natural history. Later, as I discuss in Chapter Two, Brongniart took responsibility for his own education, and sought the company and input of other well-instructed naturalists and artisans.

Where Cuvier's formal training at Stuttgart was focussed on the management of external factors and the skills needed for public administration, Brongniart's education and network assets allowed him to focus on self-management skills, self-control, and relationship-building. Throughout his career, He marshalled both internal and external resources while focussing on the consolidation of information and knowledge, particularly on natural history and ceramics. His personal and intellectual authority was not used to provoke controversy but rather to defuse it; he focussed on establishing general principles and determining *consensus*

⁴⁶ Outram, *Cuvier*, 21-9.

within scientific disciplines such as mineralogy, palaeontology, geology, and, particularly, the ceramic arts. Indeed, much of this authority arose from his ability to consolidate, synthesize, and share knowledge, whether in print or through personal contact. As I show in the second half of this thesis, Brongniart believed that this kind of approach was best suited to lead to scientific agreement and accepted procedures. Critically, he used his familial advantages, institutional resources, and personal skills to construct a platform for articulating and launching his new science of ceramics.

Outram saw Cuvier's authority as owing much to what she called 'powerful marginality': "although science at least at (Cuvier's) élite level, was an occupation of considerable public prestige, it was also one in itself marginal to the exercise of real power in his society, the sort of power that collects taxes, gathers armies, and administers provinces."⁴⁷ However, knowledge and political capital were often interchangeable. High-ranking Parisian savants often wielded broader political powers, including in the pre-Revolutionary era, that of the tax-gatherer and gunpowder administrator Lavoisier, or, post-Revolution, roles as lawmakers and political leaders, such as Gaspard Monge, Claude Louis Berthollet, and Fourcroy, diplomats such as the statistician Charles Etienne Coquebert de Montbret, or provincial administrators, such as the artisan and mathematician Louis Costaz. Brongniart's role at Sèvres was not statecraft, but the manufactory had a significant role to play in the development of French industry, particularly under Brongniart's initiatives to create open educational resources and a museum on site. Brongniart's power was often expressed through forms of soft power, based on attraction rather than coercion.⁴⁸ The fact that Brongniart could use his work to benefit and to expand French industry meant that he was also shaping his

⁴⁷ Outram, *Cuvier*, 9.

⁴⁸ Joseph S. Nye, *Soft Power* (New York, 2004).

society through exercises of what Outram termed “real power.”⁴⁹

When Cuvier came to Paris in 1795, he brought no small amount of intellectual competition and companionship to Brongniart, while Brongniart could offer Cuvier an immediate place in the social and scientific networks he both inhabited and continued to build. Cuvier offered exactly the kind of intellectual interaction that Brongniart had hoped the Société Philomathique, a scientific society which he cofounded as a young naturalist, would foster.⁵⁰ Their friendship was based on mutual respect and gave benefits to each from its onset. Cuvier was often seen as an outsider by contemporary witnesses, such as Charles Lyell and Alexander Humboldt. For Humboldt, Cuvier’s lack of noble status was a real problem in his quest for scientific credibility. Additionally, he was a protestant, which went against the prevailing Catholicism of France and had the potential to create social and political divisions.⁵¹ To some extent, Cuvier was positioned as someone who needed to fend for himself, whereas Brongniart was deeply rooted in a community that buffered his experience. While their social situations were in stark contrast, the two naturalists’ interests were so close that, as I discuss in Chapter Three, they often simultaneously reached similar conclusions during the early years of their collaboration together.

Drawing from both artisanal workshops and the salon culture of Paris, Brongniart’s childhood education was shaped by close familial relationships with prominent French intellectuals, savants, politicians, and artists. Critically, his success was aided by his privileged status, but was not determined by it. Brongniart was unusually fortunate to have interacted frequently with some of the stars of Parisian intellectual life from his earliest youth. This provided an uncommon set of connections for the developing natural historian, but it was

⁴⁹ Outram, *Cuvier*, 9; Nye coined the term soft power in the late 1980s, after the publication of Outram’s work on Cuvier, but her work hinted at the distinction between coercive power and attractive power. See Nye, *Soft Power*, 2004.

⁵⁰ I discuss the Société Philomathique’s origins and membership in Chapter Three.

⁵¹ Charles Lyell, *Life, Letters, and Journal of Charles Lyell*, vol.1 (London, 1881), 127-8.

Brongniart's skills in making full use of this network that shaped his outlook. He easily gained access to the most exclusive levels of society, including royalty, but was equally comfortable transitioning to travelling with the army, and working in remote French mines. Brongniart spent time exploring geographical formations and mountains across Europe, but was well-versed in painting, sculpture, and architecture. Although his inherited milieu was a determinant, his career was shaped by his capacity to successfully confront adversity and political circumstance. As I show throughout this thesis, his adaptability and thoughtful balancing of resources enabled him to marshal his own intellectual authority in the natural sciences and the arts.

In *Paris Savant*, Bruno Belhoste depicts the vibrant society of *ancien régime* Paris, the “Capital of Science,” where Enlightenment ideals circulated and savants and scholars met with one another through institutions such as the Academies, libraries, and laboratories.⁵² Developing knowledge was an important personal and social act. Salons provided an arena for discussion, display, and connection among the invited guests, and they allowed for rapid transfer of ideas, fashions, and gossip.⁵³ The lycées encouraged education of all sorts, with emphasis on the study of nature, science and languages.⁵⁴ Belhoste describes a city whose residents of all classes intermingled side-by-side when they did not fully integrate.⁵⁵ Accessible to a broad public, ballooning was one of the marvels that captured the city's imagination.⁵⁶ In his twenties, Brongniart frequently strolled through or lingered in the Palais Royal, which Belhoste described as a stimulating environment that held every sort of attraction, from the lectures at the Lycée, to wax model displays, gambling tables, natural history cabinets, luxury

⁵² Bruno Belhoste, *Paris Savant* (Oxford, 2019), 1-44.

⁵³ Belhoste, *Paris Savant*, 95-98; on the function of salons, see also: Steven D. Kale, *French Salons* (Baltimore, 2004); Antoine Lilti, *The World of the Salons* (Oxford, 2015).

⁵⁴ Belhoste, *Paris Savant*, 113-5.

⁵⁵ Belhoste, *Paris Savant*, 24-30; 109-13; 125-6.

⁵⁶ Belhoste, *Paris Savant*, 130-3; on ballooning, see also Marie Thébaud-Sorger, *L'aérostation au temps des lumières* (Rennes, 2009).

boutiques, houses of prostitution, and cafés.⁵⁷

Importantly, as I discuss in Chapter Three, Brongniart's family was part of the administration of the Lycée and was connected by kinship or professional ties to many members of the Academy.⁵⁸ Brongniart's networks would become involved in carrying these projects forward; these included the Jardin des Plantes, the artisanal quarters of Paris, the artist studios of the Louvre, and the chemical laboratories of Lavoisier at the Arsenal.⁵⁹ Friends and allies were involved in designing and supervising a number of public works, such as fresh water supplies, improved sewage systems, and safer cemeteries.⁶⁰ Importantly, in 1804, Théodore Brongniart was charged with the design and construction of the new Père Lachaise cemetery to the east of the faubourg Saint Antoine. Throughout this period in Paris, there were countless opportunities to observe, to learn, and to participate, as well as to build a career and to create an identity. I demonstrate how Brongniart and members of his extended network operated within Paris from the *ancien régime* through the mid-nineteenth century, and functioned successfully throughout the series of revolutions that marked his lifetime. I consider Paris and its multiple institutions not only as important locations for science, but also as key components of Brongniart's life in the capital of French cultural, political, and scientific power.

Brongniart in Context

Throughout this thesis, I demonstrate that Brongniart used his singular social advantages to build a coherent science of ceramics out of what had been arcane and traditional practices, and I establish that his work as ceramist grew directly from his mastery of several scientific fields, in particular the theory and practice of natural history. The interdisciplinary

⁵⁷ Belhoste, *Paris Savant*, 127-30.

⁵⁸ Belhoste, *Paris Savant*, 1-22.

⁵⁹ Belhoste, *Paris Savant*, 24-5; 32-35; 57-62, 199-203.

⁶⁰ Belhoste, *Paris Savant*, 169-94.

nature of the ceramic arts has often left its study disaggregated and split between the various literatures concerned with scientific practice, art and art history, connoisseurial appreciation, or the history of science and technology. I argue that a synthetic approach is necessary to understand the emergence of ceramic science in early nineteenth-century France. The study of Brongniart's life provides a case for the examination of the cultural and social factors surrounding natural history, scientific practice, and the ceramic arts in late eighteenth- and early nineteenth-century France. More broadly, his career was formed in, and was made possible by a series of dramatic political transformations and social transitions. Brongniart's familial structures were relatively stable across a period of great change, which enabled him to find advantage among the expanding opportunities made possible by revolutionary developments in both the sciences and in political structures. Although the Revolution allowed the elevation of all types of citizens, large, well-established families such as the Brongniart and Coquebert sustained their social and intellectual power and operated customary forms of patronage throughout the ensuing political turmoil.

I have followed three contextual factors throughout this thesis: political, scientific, and social. Within each of these arenas, Brongniart was a close witness to the influences that shaped both Parisian and international science in the late eighteenth and early nineteenth century. His life ran in parallel with the monumental political transformations of the late eighteenth century through the mid nineteenth century, and his early education and career were deeply affected by the aftermath of the French Revolution. Strategically, Brongniart showed support for the Revolution, but in general he avoided voicing strong political opinions. This was a conscious political stance, a carefully crafted response to an environment in which the wrong words or sentiments expressed at an inopportune moment could lead to disastrous, if not fatal, consequences. At the start of the Revolutionary Wars, as a trained pharmacist, Brongniart was

able to support military efforts while continuing to develop his education and interests.⁶¹ After the Revolution, his mature career found its footing at the commencement of the Napoleonic era, thrived following the Restoration of the Bourbon family to the throne in 1815, and remained intact in 1830 when the July Revolution brought the House of Orléans into power. Under his direction, Sèvres supplied each successive government with legitimacy imagery, tableware, and objects, while Brongniart remained invested in the development of the mining, pottery, and porcelain industries of France. Alongside Brongniart's role at the manufactory, his career as a mining engineer and geologist, begun in 1794 with appointments as a mining engineer at the Agence des Mines and a teaching post alongside René Just Haüy at the École des Mines, led to the role of Chief Mining Engineer by 1815 and to his election to the Chair of Mineralogy at the Muséum in 1822.

When Brongniart arrived at Sèvres in 1800, Napoléon sought to re-establish the manufactory's prominence, insisting on artistic and technical perfection.⁶² The manufactory was also to become an art school.⁶³ Brongniart strove to make Sèvres a model for emulation whose production was to be unrivalled.⁶⁴ By the end of the empire in 1814, Brongniart was widely seen to have been successful in the improvements at Sèvres and was highly respected for his integrity and careful attention to the financial aspects of the manufactory.⁶⁵ Throughout his career, he continued to seek innovation and to maintain the high quality of production at the institution. Indeed, his accomplishments and expertise helped to stabilize the manufactory

⁶¹ See, for example, BMHN MS3357, "Journal du Voyage aux Pyrénées, 1-15 Septembre 1793," 54. Brongniart's travel as a military pharmacist began in September 1793, and lasted until late summer 1794.

⁶² Tamara Préaud, "Brongniart as Administrator," in Derek E. Ostergard, *Sèvres Porcelain Manufactory* (New Haven, 1997): 43-8; and "The Nature and Goals of Production at the Sèvres Manufactory," In *Sèvres Porcelain Manufactory*, 75.

⁶³ Préaud, "Brongniart as Administrator," 43.

⁶⁴ Préaud, "Nature and Goals of Production at the Sèvres Manufactory," 75.

⁶⁵ Préaud, "Brongniart as Administrator," 45-8.

through the series of regime changes of the early nineteenth century.⁶⁶ When Louis-Philippe rose to power in 1830, Brongniart was pleased that the new king was already familiar with the processes, artists, and production of Sèvres. From 1830 to 1847, a period that coincided almost exactly with Louis-Philippe's rule, Brongniart was able to pursue the research and writing for *Arts céramiques* and the *Description méthodique du Musée céramique de Sèvres*, which he completed shortly before his death. In 1846, nearing the end of his career, Brongniart stepped down in favour of his successor, Jean-Jacques Ebelman. However, Louis-Philippe demonstrated his appreciation by retaining Brongniart at full salary, acknowledging that his experience and knowledge were still of great benefit to the manufactory.⁶⁷

The second contextual factor concerns the new scientific practices and disciplines that appeared in the late eighteenth and early nineteenth century, marking a shift away from the broad study of natural philosophy. In the Anglosphere at least, these changes culminated in the creation of the figure of the "scientist."⁶⁸ This transition occurred alongside the Chemical Revolution anchored by the transformational research of Antoine Lavoisier, whose new system – focussed on the presence of the newly discovered element, oxygen – recast chemical understanding. Brongniart was a direct witness to and indeed a participant in these events, learning chemistry from major figures within his family networks, among whom were Lavoisier and his earliest supporters.⁶⁹

Newly developing fields, such as crystallography, biology, geology, and comparative anatomy forced changes in the ways in which the broadly-focussed intellectual figure of the

⁶⁶ For a detailed discussion on Brongniart's stable career at the manufactory, see Préaud, "Brongniart as Administrator," 45-9.

⁶⁷ Préaud, "Brongniart as Administrator," 46.

⁶⁸ Sydney Ross, "Scientist: The Story of a Word," *Annals of Science* 18, 2 (1962): 65-85.

⁶⁹ Bernadette Bensaude-Vincent and Isabelle Stengers, *A History of Chemistry* (Cambridge, MA, 1996), 39-50; Bernadette Bensaude-Vincent, *Lavoisier* (Paris, 1993), 283-340; Jonathan Simon, *Chemistry, Pharmacy, and Revolution in France, 1777-1809* (Aldershot, 2005), 85-86.

eighteenth-century *savant* was viewed.⁷⁰ Increasingly specialised knowledge meant that the generalised and inclusive study of natural philosophy, still prominent in the mid-to-late eighteenth century, became difficult or impossible to maintain by the early nineteenth century. No longer could a savant expect or need to create a comprehensive study as Georges Le Clerc, Comte de Buffon had done with the forty-four volumes of *Histoire Naturelle*.⁷¹ Increasingly specialised scientific subjects were characterised by the emergence of new societies, and by the appearance of new journals, terminology, and academic standards, while close attention was paid to novel kinds of phenomena that flowed into European capitals from laboratories, instruments, and expeditions. Most authors could only expect to illuminate an increasingly restricted segment of the developing picture of the natural world.

The third contextual factor relates to the importance of the familial and correspondence networks that Brongniart inherited, maintained, and expanded. His personal networks were embedded in the (sometimes literal) construction and reconstruction of Paris, and senior members of these groups played central roles in the reinvention of French government and society that began with the Revolution. Members of the Brongniart family networks were also actively engaged in the sciences, the arts, and in the development of French education. For many of the individuals discussed in this thesis, reciprocal patronage relationships, strategic and supportive marriages, long term loyalties, and thoughtful self-promotion all formed indispensable contributions to what were simultaneously individual and public achievements. As I discuss in Chapters One and Four, marriages were frequently used to solidify family ties and to retain or strengthen family fortunes, and many were arranged with an overpowering

⁷⁰ On the role of the savant through the eighteenth century, see J. B. Shank, “Les Figures du Savant,” in *Histoire des sciences et des savoirs: De la Renaissance aux Lumières*, t. 1, eds. Dominique Pestre and Stéphane van Damme (Paris, 2015), 43-65.

⁷¹ Thirty-six volumes were completed before his death in 1788, and the remaining eight volumes were completed by his associates as of 1804. Georges Louis Leclerc, comte de Buffon, *Histoire Naturelle, générale et particulière* (Paris, 1749-1804).

degree of familial intervention. Without family support, financial prospects, or social advantages, marriage options could be limited or non-existent, while some matches were formed out of purely practical arrangements. With Brongniart's life as a case study, I examine the participants in the overall picture, not only within Parisian and global natural history, but also the society and politics in which they acted.

Hidden in Plain Sight: Locating and Defining Ceramics

Because it became the chief focus of Brongniart's otherwise disparate interests, I concentrate on his central role in constructing what became known as ceramic science. The discipline did not – as many accounts have it – begin only in the twentieth century, with heightened interest in superconductors or silicon technologies. Neither had it begun during the countless centuries of development of pottery, porcelain, brick, tile, and other functional clay-based objects, which originated alongside human civilisation. Indeed, there was no accepted or formal body of chemical or mineralogical knowledge about the materials that constituted ceramics when the race for European porcelain development fostered widespread innovation in pottery making during the eighteenth century. Literature on the subject was sparse, and often factually incorrect or misleading.⁷² Although he drew upon the input of a broad community of savants and scientists, Brongniart was the first author to give the study of ceramics shape, order, and an appropriate nomenclature. He ensured that the outcomes he demonstrated in print were

⁷² As I discuss in Chapter Eight, through the eighteenth century, the canon related to pottery and porcelain making was sparse. In the late-eighteenth and early-nineteenth century, the encyclopaedias contained articles on pottery processes, but the information was incomplete. For example, see "Fayencerie," *Encyclopédie ou Dictionnaire raisonné des sciences*, vol. 4 (Paris, 1765); Henry Louis Duhamel du Monceau, *L'art du potier de terre* (Paris, 1773); and Charles René Fourcroy de Ramecourt, *Art du chauffournier* (Neuchatel, 1776). In 1765, the research of Didier d'Arclais de Montamy appeared posthumously as *Traité des couleurs pour la peinture en émail et sur la porcelaine* (Paris, 1765). Some early-nineteenth century authors made attempts to illuminate manufacturing processes, such as Jacques Fourmy, who self-published *Recueil de mémoires relatifs à l'art céramique* (Paris, 1804).

repeatable processes that anyone could perform independently. When a process or a subject presented new questions, his printed work clearly depicted what understanding he had gained, and he allowed others to debate the foundations or implications of new findings in the field. Although he cannot be credited with all or even most of the process of developing the “arts of the Earth,” Brongniart played a key role in shaping the ways in which the ceramic arts were defined, categorized, and practised throughout the nineteenth century.

In 1847, nearly at the end of his accomplished life, Brongniart was satirised as “le vieux porcelainier” by Bertrand Isidore Salles (de Gosse) (1821-1900), in a critique of the professors of the Muséum titled *Histoire naturelle drolatique et philosophique des professeurs du Jardin des Plantes*.⁷³ The phrase “old porcelainier” pointed to an important truth – that porcelains (and ceramics) could be viewed as existing apart from both the traditional and the developing scientific fields of ceramic production. Not only that, but they were outmoded. Salles’ satire appeared only three years after Brongniart’s *Art céramiques* appeared in print, but it had been more than eighty years since a series of prominent debates on porcelain making, which I discuss in Chapter Five, had drawn the attention of most of the savants of Paris. At the time of its publication, the caricatures fell flat. Further, Salles had written with only a superficial understanding of most of his subjects, including Brongniart. The publication remained rare and obscure until the twentieth century, when it was picked up by authors hoping to sketch the culture of the Muséum and its savants, including the character of Brongniart.⁷⁴

The positioning of Salles as a reliable witness has led to a flawed view of how Brongniart was perceived by his close contemporaries. The satire described Brongniart as “arrogant, imperious, skilful to take advantage of every talent and every opportunity to arrive

⁷³ See Isidore Salles and Frédéric Gérard, *Histoire naturelle drolatique* (Paris, 1847).

⁷⁴ See Jules Gay, *Le Bibliophile fantaisiste* (Turin, 1869), 265-6; and Fernand Drujon, *Étude de bibliographie critique et analytique pour servir à l'histoire littéraire*, (Paris, 1888): 465-7.

at his own ends,” while everyone at the Muséum “bows to his despotic sway.”⁷⁵ Salles arrived in Paris and began working as a journalist only in 1840, at age nineteen.⁷⁶ He had little experience or training in natural history, had lived in Paris only a relatively few years, and had been present only during the final years of Brongniart’s career. However, his co-contributor, Frédéric Gérard (1806-1857), who was terminated from his position as editor of Charles Dessalines d’Orbigny’s *Dictionnaire universel d’Histoire Naturelle* in 1844, likely held grudges against many of the natural historians working in Paris.⁷⁷ Their accounts cannot be taken as accurate characterizations of any of their subjects, including Brongniart, but instead might be viewed as characteristic of the social and political dissent which led to the February Revolution of 1848.⁷⁸ Interestingly, after the Revolution removed Louis-Philippe I from office, Salles himself became a civil servant, heading the Press Office for Alexandre-Auguste Ledru-Rollin, the new Minister of the Interior.⁷⁹

As I show in Chapter Seven, upon its publication in 1844, *Arts céramiques* immediately set the standard for the science of ceramics, a position it held into the early twentieth century. Brongniart’s ideas and classifications rapidly became integral to understanding in ceramics at every level, including industry, production, historical analysis, and scientific practice. Although his work remained foundational, by the mid-twentieth century, as the language of science changed from French to English, his untranslated French texts ceased to reach most

⁷⁵ As quoted in Toby A. Appel, *Cuvier-Geoffroy Debate* (Oxford, 1987), 284n109. See also: *Cuvier-Geoffroy Debate*, 193-201, 283fn96, 284fn108-9.

⁷⁶ Franck Bourdier, “Trois siècles d’hypothèses sur l’origine et la transformation des êtres vivants (1550-1859),” *Revue d’histoire des sciences* 13, 1 (1960): 1-44.

⁷⁷ Charles Dessalines d’Orbigny, *Dictionnaire universel d’histoire naturelle* (Paris, 1849). On the personality of Gérard and his relationship with the natural historians of Paris, see, Franck Bourdier, “Geoffroy Saint-Hilaire Versus Cuvier: The Campaign for Paleontological Evolution,” in Cecil J. Schneer, *Toward a History of Geology* (Cambridge, MA, 1969), 37.

⁷⁸ C. Schnitter, “Le développement du Muséum national d’histoire naturelle de Paris au cours de la seconde moitié du XIX^{ème} siècle,” *Revue d’histoire des sciences* 49, 1 (1996): 57-8.

⁷⁹ Drujon, *Étude de bibliographie critique*, 465-7.

English-speaking scientists.⁸⁰ Nonetheless, the classificatory structures Brongniart had defined and the processes that he had revealed and clarified remained intact and, to date, continue to be an integral part of the practice of ceramics at all levels.

The ceramic arts and ceramic science can be prohibitively complex. Often, neither makers nor historians have cause to reach far beyond their specialisation or styles. W. David Kingery has been one exception, writing both as a researcher and an educator in ceramic science, and as a historian of ceramic objects and production. Kingery merged his knowledge of materials with applications in the fine arts, creating studies that ranged from the analysis of historical glazes to applications in archaeology and archaeometry, in a joint study with Pamela Vandiver in *Ceramic Masterpieces: Art, Structure, and Technology*.⁸¹ In 1999, nearly 150 years after Brongniart's *Arts céramiques* appeared, Kingery claimed that his 1960 textbook, *Introduction to Ceramics*, "provided a vision of ceramic science as a tool for purposeful ceramic technology. It helped move ceramics along the path from empirical craft to becoming a science-based activity."⁸²

Yet, almost a century earlier, a similar declaration had been made for Brongniart's 1844 *Arts céramiques*. As the ceramist Louis Marc Emmanuel Solon wrote in 1910:

If one single book had to be selected to represent ceramic literature in a miscellaneous library, if a student of pottery manufacture had to part with all of his technical works save one, we have no hesitation in saying that the choice should fall upon Brongniart's *Traité des arts céramiques*. Before Brongniart gave to the learned world a treatise which was to raise the potter's art to the level of a science, nothing but desultory attempts had been made to gain that end.⁸³

Kingery was a powerful voice, and despite his interest in historical ceramics, he believed ceramic science belonged to the late twentieth century and not before. He described his

⁸⁰ Michael D. Gordin, *Scientific Babel: How Science Was Done Before and After Global English* (Chicago, 2015).

⁸¹ W. David Kingery and Pamela B. Vandiver, *Ceramic Masterpieces* (New York, 1986).

⁸² W. David Kingery, "The Science and Technology of Made Things," *Inamori Foundation Kyoto Prize Commemorative Lecture* (1999), 4; *Introduction to Ceramics* (New York, 1960).

⁸³ Louis Marc Emmanuel Solon, *Ceramic Literature* (London, 1910), 58.

personal contributions as having helped to take “ceramics” away from “empirical craft.”⁸⁴ His 1998 article, ‘The Transition of Ceramics from Craft to Science-Based Industry,’ traced the “craft of ceramic manufacture” from the early sixteenth century to the end of the twentieth.⁸⁵ Kingery placed Cipriano Piccolpasso’s 1557 manuscript, *Three Books of the Potters Art*, as “one of the earliest books that can be properly described as ceramic science.”⁸⁶ However, Piccolpasso’s book remained in manuscript form until 1857 – more than a decade after Brongniart’s *Arts céramiques* appeared – and was not based on first-hand knowledge, but the unreliable testimony of artists wishing to protect their secrets.

Kingery explained that science was “most simply defined as organized knowledge.” He then established a three-part definition for science: first, “discovery and description”; second, “explanation” or the “search for operational principles explaining how things and processes work”; and third, “a way of thinking” that defined questions “subject to testing by experiment or experience.”⁸⁷ Kingery placed most of the studies of the seventeenth through nineteenth centuries in his discussion within the first category of discovery and description. On Brongniart, he wrote:

. . .traces of the same role of science as a describer of ceramic materials and processes appear in Alexandre Brongniart’s *Traité des arts céramiques* published in 1844. In the description of many products and processes very different from one another, Brongniart attempted to ‘classify them in a rational manner.’⁸⁸

Kingery did not discuss Brongniart further and did not explicitly place *Arts céramiques* wholly within his definition of science, claiming that the “maturing of various strands of the science of materials” led to the creation of materials science and engineering.⁸⁹ He did not relate any

⁸⁴ Kingery, “Science and Technology of Made Things,” 4.

⁸⁵ W. David Kingery, “The Transition of Ceramics from Craft to Science-Based Industry,” *Qualicer* 98, (1998): 3-9, 3.

⁸⁶ Kingery, “Transition of Ceramics,” 4.

⁸⁷ Kingery, “Transition of Ceramics,” 4-5

⁸⁸ Kingery, “Transition of Ceramics,” 13.

⁸⁹ Kingery, “Transition of Ceramics,” 14.

real sense of the contributions Brongniart had made to ceramic science, or, in Brongniart's terminology, to the "ceramic arts."⁹⁰

Biographical Historiography

Until the deposition in 2008 of Brongniart's journals at the Bibliothèque of the Muséum d'Histoire naturelle and a collection of personal papers at the Archives Nationales, the primary insight into his personal writings was available via the 1940 family biography of Louis de Launay, *Les Brongniart*.⁹¹ Using a collection of private family papers, Launay covered in one volume the lives of several generations of family members, including Brongniart's father, Théodore; his uncle, Antoine Louis (1742-1804); his son Adolphe (1801-1876); and the architect Michel-Barthelémy Hazon (1722-1822), the grandfather of his wife Cécile Coquebert de Montbret (1782-1866).⁹² The scale of the publication left little room for in-depth analysis of Brongniart's career, and bizarrely, while *Les Brongniart* provided a reliable source of facts and dates, Launay utilised a portion of the family documents to create a separate, fictional memoir, based on Brongniart and Cécile's journals from early in their marriage, *Un mariage sous le Directoire*, in which Brongniart was disguised as Augustin Aumont.⁹³ Now that his source materials for the fictional memoirs are available in public archives, this period can be traced with greater clarity.⁹⁴ However, other family journals, such as those written by his daughters, Herminie and Mathilde, which have the potential to expand the picture of

⁹⁰ Kingery, "Transition of Ceramics," 14.

⁹¹ Louis Auguste Alphonse de Launay, *Les Brongniart: une grande famille de savants* (Paris, 1940).

⁹² Charles Étienne Coquebert de Montbret and his wife, Nicole Charlotte Hazon, (1760-1832) were first cousins, so the architect Hazon was the maternal grandfather of Cécile as well as her great-uncle.

⁹³ Louis de Launay, "Un mariage sous le Directoire," *La Revue de France* (15 October 1933).

⁹⁴ Philippe Lejeune, "'Et le cahier?,' Journaux en famille: les Coquebert de Montbret." <https://www.autopacte.org/11Et%20le%20cahier.pdf>

Brongniart's primary relationships, as well as the personal journal materials cited by Launay from Brongniart's later years, remain in private collections.⁹⁵

In *Les Brongniart*, Launay offered glimpses into Brongniart's life via a narrow selection of quotations. These were often pulled from several journal entries, written days apart, to create a single episode in the biography.⁹⁶ Despite the large volume of journal materials now in archives, *Les Brongniart* remains the only source of information on Brongniart's private writing after 1802, leaving it as the primary window into Brongniart's personal thoughts over the last forty-five years of his life.⁹⁷ Launay quoted selectively from Brongniart's entries, but the quotations gave little idea of the overall balance of Brongniart's ideas, the frequency with which events occurred, or how Brongniart's private journal writing changed as his career progressed.

Additional histories of the Brongniart family can be found in Sylvestre de Sacy's 1940 biography of Brongniart's father, and a 1986 Musée Carnavalet catalogue of an exhibition devoted to his father's work.⁹⁸ Vigée-Le Brun's *Souvenirs* and Gita May's *Elisabeth Vigée-Le Brun* shed light on the Brongniart family's social connections and intimate experience.⁹⁹ Other publications have clarified the nature of the extended family network. These include biographies of Fourcroy by Georges Kersaint, Alain Queruel, and Bill Smeaton; studies of Lavoisier by Bernadette Bensaude-Vincent, Arthur Donovan, Henry Guerlac, and Jean Pierre Poirier; and Michelle Sadoun-Goupil's biography of Claude Louis Berthollet. The youthful

⁹⁵ Lejeune, "Et le cahier?," 2-3; see, for example, Launay, *Les Brongniart*, 93-7.

⁹⁶ See, for example, the series of entries on Brongniart's teaching in Paris in 1793 and on his response to the hiring of Geoffroy at the museum, which I discuss further in Chapter Three. Launay, *Les Brongniart*, 57-9.

⁹⁷ Nearly all of Brongniart's numbered travel journals have been deposited in public archives, primarily at the BMHN. From the 1790s, Brongniart kept his travel journals (*Journaux des Voyages*) distinct from his daily journals (*Journaux Sédentaires*).

⁹⁸ Jacques Sylvestre de Sacy, *Alexandre-Théodore Brongniart* (Paris, 1940). Monique Mosser, *Alexandre-Théodore Brongniart: architecture et décor* (Paris, 1986).

⁹⁹ Gita May, *Elisabeth Vigée-Le Brun* (New Haven, 2005); Marie Louise Elisabeth Vigée-Le Brun, *Souvenirs de Mme Vigée-Le Brun* (Paris, 1926).

journals of Brongniart's son-in-law, Jean-Victor Audouin, edited by Jean Théodoridès as *Journal d'un étudiant*, contain an invaluable account of Brongniart's scientific teaching at his personal cabinet in Saint Germain.¹⁰⁰ Philippe Taquet has written two volumes on the life of Cuvier, *Georges Cuvier: Naissance d'un génie*, and *Georges Cuvier: Anatomie d'un naturaliste*, which describe the early life and career of Cuvier as well as his relationships with Parisian savants, covering the period 1770-1804.¹⁰¹ As co-author with Brongniart on the subjects of geology and palaeontology, Cuvier's career provides a fascinating comparison with that of Brongniart's across the period of 1790-1830.

Natural History, Porcelain Making, and Ceramic Science

Brongniart's achievements in geology and mineralogy have received more extensive and more serious attention. Martin Rudwick has written cogently on Brongniart's connection to the geological debates of the early-nineteenth century and has placed his work within the larger picture of contemporary British and Continental geology. While Rudwick examined in detail the shared geological research of Cuvier and Brongniart that resulted in the publication of the Paris Basin Survey of 1811, he paid less attention to the remainder of Brongniart's role in ongoing geological discussions. Significantly, in Rudwick's brief biographical entry on Brongniart written for the *Complete Dictionary of Scientific Biography* he followed a lengthy discussion of Brongniart's geological research with a cursory reference to the topic of ceramic

¹⁰⁰ Georges Kersaint, *Fourcroy* (Paris, 1963); Alain Queruel, *Antoine de Fourcroy* (Paris, 2009); William Arthur Smeaton, *Fourcroy* (London, 1962); Bernadette Bensaude-Vincent, *Lavoisier* (Paris, 1993); Arthur Donovan, *Antoine Lavoisier* (Oxford, 1993); Henry Guerlac, *Lavoisier – the Crucial Year* (Ithaca, 1961); Jean Pierre Poirier, *Lavoisier* (Philadelphia, 1998); Michelle Sadoun-Goupil, *Le chimiste Claude-Louis Berthollet* (Paris, 1977); Jean-Victor Audouin and Jean Théodoridès, *Journal d'un étudiant* (Paris, 1965).

¹⁰¹ Philippe Taquet, *Georges Cuvier: Naissance d'un génie* (Paris, 2006); *Georges Cuvier: Anatomie d'un naturaliste* (Paris, 2019).

technology.¹⁰² Although mention was made of *Arts céramiques* and *Minéralogie*, Rudwick overlooked the *Atlas* – published as the third volume of *Arts céramiques* – and omitted the two-volume “catalogue raisonné,” the *Description méthodique*.¹⁰³ His scant discussion of ceramics in a volume related explicitly to scientific biography implicitly positioned the field outside the domain of the sciences. Underscoring the distinction further, Rudwick included a lengthy but select bibliography of “Brongniart’s principal writings,” in which no entry on ceramics appeared.¹⁰⁴

Some of the most insightful writing about Brongniart and his work has come from the long-time Sèvres archivist Tamara Préaud. Two late-twentieth-century publications provided a framework for Préaud’s vital discussions on Brongniart’s work on porcelain. These were the 1998 catalogue from the Bard Graduate Centre exhibition, co-edited with Derek V. Ostergard, and contributions to *Refinement & Elegance: Early Nineteenth-Century Royal Porcelain from the Twilight Collection, New York*, the catalogue of an exhibition held at the Schloss Charlottenburg, Berlin in 2007.¹⁰⁵ Préaud drew upon Brongniart’s papers related to ceramics and the documents and objects created during his career at Sèvres. Her focus has not been limited to Brongniart alone but includes the history of the Sèvres Manufactory and its production. However, these two collections did not investigate other aspects of Brongniart’s career and life, including the major research he did in both mineralogy and geology.

Préaud wrote that Brongniart was without experience in ceramics prior to coming to the manufactory, stating:

¹⁰² M. J. S. Rudwick, “Brongniart, Alexandre,” in *Dictionary of Scientific Biography*, (Detroit, 2008), 493-497.

¹⁰³ Brongniart, *Description méthodique du Musée de Sèvres*, 1845.

¹⁰⁴ Rudwick, “Alexandre Brongniart,” 2008.

¹⁰⁵ Derek E. Ostergard and Tamara Préaud, *The Sèvres Porcelain Manufactory: Alexandre Brongniart and the Triumph of Art and Industry, 1800-1847*, (New Haven, 1997); Tamara Préaud, “Alexandre Brongniart and the German Manufactories: Exchanges and Travels,” in Samuel Wittwer, ed. *Refinement & Elegance* (Munich, 2007): 97-119.

the appointment to such a prestigious post of a young man – Brongniart had just turned thirty – who also lacked experience in financial matters, personnel management, and even ceramics was typical of the period. Given the factory’s disastrous state at the time, however, the decision was quite daring.¹⁰⁶

This statement was later echoed in her remark that the young Brongniart had *no knowledge at all* of ceramics.¹⁰⁷ However, in this dissertation I show that understanding of natural history, including chemistry and mineralogy, formed a necessary component of ceramic mastery, especially at the high level of manufactories such as Sèvres. Brongniart was always close to the scientists working in support of the porcelain and chemical industries, and he learned chemistry under their supervision. Further, his architectural studies provided translatable skills in the development of visual representation, three-dimensional designs, and decoration schemes. While he may have focussed on a career in chemistry and natural history, rather than architecture, when the opportunity at Sèvres arose, his skills were well-suited to the immediate needs of the manufactory.

My thesis ties together Brongniart’s scientific study and knowledge of the arts, highlighting the qualities that made him the ideal candidate for the directorship at Sèvres in 1800. The path to mastery in ceramics is often revered as lifelong, and no one direction can be seen as better than another in achieving a place of balance between the science and art of the medium. In the case of Josiah Wedgwood (1730-1795), numerous life narratives favour the from-the-ground-up transition from *potter* to industrialist.¹⁰⁸ Indeed, Wedgwood’s experience reflected the common way into mastery of most artisanal fields, where a student learned the most basic aspects of a craft or *métier* from the lowest rungs first, beginning as early as childhood. In pottery and porcelain making, this meant materials preparation, cleaning duties, or other unskilled but necessary tasks. Gradually, after long periods of immersion in the craft,

¹⁰⁶ Préaud, “Brongniart as Administrator,” 43.

¹⁰⁷ Préaud, “Alexandre Brongniart and the German Manufactories,” 97.

¹⁰⁸ Particularly, see Brian Dolan, *Josiah Wedgwood: Entrepreneur to the Enlightenment* (London, 2004); Eliza Meteyard, *The Life of Josiah Wedgwood* (London, 1865).

new skills were learned. However, Brongniart also developed interests in the arts as a young student and was introduced to the properties of clay materials at least by the time he modelled for the terra cotta portrait by Houdon in 1777 (Fig. 1.3). Importantly, Brongniart had extensive training in drawing and painting, as well as in the practices of both enamelling and faïence, alongside extensive study of chemistry and mineralogy, long before entering the porcelain industry at the top of its ranks. Brongniart's education was in some ways like those of Josiah Wedgwood's three sons (his near contemporaries), all of whom were potentially groomed for the management of the Etruria works built by their father.¹⁰⁹ Notably, an important difference between Wedgwood and Brongniart is that Wedgwood was an entrepreneur who sought to create a business and a personal fortune, while Brongniart pursued a career in state-supported institutions, such as the Bureau des Mines, the Muséum, and Sèvres with a focus on the production of knowledge and pedagogy, as well as on technological improvement for the industry as a whole.

While Brongniart was greatly assisted by his place in an influential familial network in the achievement of the directorship at Sèvres, it was a critical component of Wedgwood's career that he was a member of a longstanding artisanal family. Wedgwood had numerous influences and assets which allowed him the flexibility of making his own start as a pottery manufacturer. Although he was not a firstborn son and was not entitled to a large property inheritance, as Brian Dolan has stressed, Wedgwood was not entirely without means. For example, he was able to draw upon family resources, including the fairly-priced rental of an intact and comfortably large pottery and residence.¹¹⁰

While Brongniart could not be considered a porcelain master when he arrived at Sèvres in 1800, many of the elements in his training that were absent fell within the areas of specialised

¹⁰⁹ Dolan, *Wedgwood*, 383-390.

¹¹⁰ Dolan, *Wedgwood*, 72-7.

artisanal skill. What took Wedgwood years to accomplish, as he gradually became focussed on research and worked to achieve a stable environment from which to dedicate his time to pottery chemistry, Brongniart achieved in his first efforts at the manufactory. I refer here to the introduction of new colours and newly reformulated clays and glazes. Even if Brongniart practiced his own skills at hands-on formation techniques such as wheel-throwing or mould-making (which was certainly possible, although no evidence shows his exact course of study in the field prior to 1800), these tasks at Sèvres were completed by masters of the processes. As a trained potter, Wedgwood was skilled at formation techniques, but Dolan has suggested that his physical limitations, administrative efforts, and research kept him from working directly in the studios.¹¹¹ Wedgwood's training gave him ready skills in formation techniques to such an extent that he could innovate styles based on his practical understanding. However, while he needed to teach himself the chemistry of pottery making in order to develop this level of mastery, Brongniart could apply his knowledge of mineralogy and Lavoisierian chemistry to porcelain making from his arrival at the manufactory. Another difficulty for Wedgwood was that he worked at a distance from his markets, and often had to rely on others to suggest style ideas and to negotiate sales to the highest-ranking households.¹¹² Brongniart, by contrast, understood the interests of wealthy and royal clients from lifelong immersion in an elite milieu, and could encourage new designs based on his own aesthetic understanding.

I seek to characterise the language available to describe the status of Brongniart and others who sought mastery in pottery and porcelain making. In the process, I hope to demonstrate the variety of ways by which ceramic mastery may be understood. Natural historians and savants of an earlier generation, such as Pierre Macquer, could be taken as an authority in several different scientific fields, including the chemistry of pottery and porcelain,

¹¹¹ Dolan, *Wedgwood*, 44-8, 200-3.

¹¹² Dolan, *Wedgwood*, 128-30, 164-5, 206-9.

fabric dyeing, and medicine. Educated within this tradition, Brongniart had training in anatomy and pharmacy, as well as in chemistry. As I discuss in Chapter Two, his chemical and material studies allowed for quick understanding of enamel colour chemistry during a brief period of instruction at the London workshop of Pierre Hubert Desvignes. His mid-1790s visits to study at the Faïencerie Ollivier, which I discuss in Chapter Three, centred around the production of pharmaceutical jars, which were decorated with a white glaze and oxide colourants, using processes that were approximately similar to enamelling on metal. Thus, each field supported and informed the others, sometimes in unexpected ways. As a practicing natural historian, his skills in these areas were acquired at the same time as he gained expertise in the earth sciences, such that his study of mineralogy and geology, and a combination of these, led to his foundational work in palaeontology.

At Sèvres, Brongniart became an “administrator,” a term which fell short of expressing his actions in research, museum collecting, historical studies, porcelain designs, and chemistry. Nevertheless, he had acquired a substantial reputation as a geologist and mineralogist by the time of his acceptance as a corresponding member of the Institut in 1807. The word *paléontologie* appeared in 1822 in the work of Henry Ducrotay de Blainville, with *paléontologiste* following shortly thereafter.¹¹³ Unlike the term palaeontologist, which was applied with increasing precision to describe practitioners of emergent scientific practices, the term *ceramist*, which emerged in the wake of Brongniart’s late-career publications, was comprehensive and synthetic. The term aptly described the science that he had envisioned from his earliest days at the manufactory, as well as its practitioners. It was simultaneously exclusive to specialists in pottery and porcelain making and inclusive of the many paths to mastery of – and ways of practicing within – the expansive, multifaceted field.

¹¹³ It was made known in English by Charles Lyell in 1833. See Alain Rey, *Dictionnaire historique de la langue française* (Paris, 1992).

The Path from Savant to Scientist

Although I deal in detail with the various themes and subjects that formed key elements of Brongniart's labours, my narrative broadly follows the chronology of his life. Part One concerns Brongniart's family networks, early education, and his early career efforts. These chapters draw on the vast output of Brongniart's near-daily journal practice during the 1790s, which include several travel journals. Alongside his letters, these documents offer a vivid picture of his links to contemporary political and scientific events. Part Two examines Brongniart's mature career after 1800, when he was named director at Sèvres. The four chapters making up this section contain discussions on ceramics, mineralogy, palaeontology, and geology, and they focus primarily upon Brongniart's publications. Although the shift in the narrative from Part One to Part Two moves from the closely internal to the public, there were continuous threads between Brongniart's later public writings and his early journals of the 1790s. The latter were often written as a chronicle of observations, of meetings with people, and of the generation of ideas. They were frequently intended to be shared semi-publicly.¹¹⁴

In Chapter One, I focus on Brongniart's familial and intellectual networks, while tracing his extensive family connections. I describe the roots of Brongniart's experience and discuss several important figures who aided in the experience and the promotion of the Brongniart family. I also demonstrate ways that this network could foster mutually supporting enterprises and businesses. In the second chapter I trace Brongniart's early education and discuss his study of chemistry and natural history. His studies were initially guided by his family, but in time he himself directed his education towards natural history and the practical sciences. I discuss his moves toward intellectual independence, following him as he took part in the practice of the Grand Tour, with an extended visit to England. I show that, while in

¹¹⁴ For example, see Silvestre and Brongniart, *Letters*, BMHN MS 1989/ 873-888 and MS2351/C, 1794.

England, he developed fruitful connections with a large network of important figures, including Joseph Banks, Matthew Baillie, Samuel Pepys Cockerell, and James Lee.

In Chapter Three, I examine the struggles Brongniart underwent as a young naturalist. Over this period, even as Revolutionary tensions increased to the point of the Terror, Brongniart worked to develop his network, to create publications, and to research within several fields. He also began to eliminate certain career paths, such as medicine or faraway exploration, from consideration. As I show, Brongniart's network was instrumental in protecting his interests and those of his closest associates. In Chapter Four, I discuss Brongniart's early career, notably the role in its development that was played by his delivery of both paid and unremunerated teaching throughout Paris. He sought a stable and adequate income, a quest that was supported in a number of ways by members of the extended Brongniart family network. Senior members had key positions in French politics and their support of Napoléon reaped rewards for many individuals, not least Brongniart himself.

Part Two begins with Chapter Five, in which I explore of the state of porcelain making in 1800 – the point where Brongniart entered the field. It includes the eighteenth-century background of Brongniart's early networks, as the French competed to create a native hard-paste porcelain. I provide an overview of the understanding and technology at the end of the eighteenth century, particularly as it related to Brongniart's first few years at the manufactory. I examine his early publications in the field as well as his introduction of new colour chemistry. The information, acquisition, and management practices that he developed at Sèvres, including the *Enquête des Préfets*, a survey of the French pottery and porcelain industry, are central to my analysis, and in the same vein I discuss Brongniart's plans for the development of a museum at Sèvres.¹¹⁵

¹¹⁵ Michel Dubus and Béatrice Pannequin, *La céramique française sous l'Empire* (Paris, 1999).

In Chapters Six and Seven, I focus on Brongniart's mid-career works on mineralogy, geology, geognosy, and palaeontology. Chapter Six features a discussion on his 1807 textbook, *Traité de Minéralogie*.¹¹⁶ I discuss Brongniart's relationship with Georges Cuvier, and roots of their joint research project on the geognosy of the Paris Basin. Importantly, I consider the ways in which Brongniart and Cuvier shaped their identities and I discuss the emergence of the scientist as both an identity and a vocation. Chapter Seven continues the subject of geology, including a discussion on the Paris Basin publications, and a discussion of Brongniart's summary works in the field. These include the geognostic and palaeontological study of 1829, *Tableau des terrains* and the related illustration, *Tableau théorique*, which gave full expression to Brongniart's views on the nature of the Earth and on deep time.¹¹⁷ He followed these publications with *Arts céramiques* and those of the related museum catalogue, *Description méthodique du Musée céramique de Sèvres*, which I discuss in Chapter Eight.¹¹⁸ Taken together, Brongniart's nineteenth-century publications form a natural history that spans from the origins of the Earth to the arts of human production in Brongniart's lifetime. I follow up with a brief conclusion, in which I bring together the various strands of Brongniart's multifaceted career. I show that the most significant of Brongniart's activities – including geology, mineralogy, palaeontology, archaeology, chemistry, and the arts – were interlinked, culminating in his efforts to develop a science of ceramics that fit seamlessly within the context of a natural history of the Earth. The Appendix contains biographical information and family

¹¹⁶ Brongniart, *Traité de minéralogie*, 1807.

¹¹⁷ Alexandre Brongniart, *Tableau des terrains qui composent l'écorce du globe*, (Paris, 1829); *Tableau théorique de la succession et de la disposition la plus générale en Europe des Terrains et Roches* (Paris, 1829).

¹¹⁸ Alexandre Brongniart, *Traité des arts céramiques*, 2 vols. and Atlas, (Paris, 1844); Alexandre Brongniart and Denis Désiré Riocreux, *Description méthodique du Musée céramique* (Paris, 1845).

trees, an annotated map of Paris, maps highlighting relevant networks, sites, and institutions, and a timeline.

PART ONE

CHAPTER ONE: Vital Networks

Brongniart and his two younger sisters were born into a family whose privilege and well-established connections provided access to the intellectual and artistic elite of *ancien régime* Paris, as well as to the artisanal networks of the city and its surrounding faubourgs. As children, they were in constant company of noble patrons, often on terms of near-intimacy. In such a milieu, Brongniart and his siblings enjoyed a remarkable childhood during which, by their representation in numerous artworks, they became figures of public interest and reputation – visual (and, in private, practical) examples of Rousseau’s ideal children. Alexandre’s wide-ranging interests as an adult, which subsequent chapters of the thesis explore, testify to the creative and intellectual breadth of this milieu, whilst his later capacity to navigate shifting political regimes may be attributed to the social and professional skills inculcated and infused by his background.

Within this chapter, I first map the complex ties that provided the Brongniart family with a secure position within a network that actively built and protected its collective interests. Secondly, I explore the social, intellectual, and artisanal communities in which they participated. The members of this interwoven and mutually-supporting community possessed specialised material skills and knowledge, and successfully mentored multiple generations, while facilitating their professional success. Lastly, I demonstrate the importance of these family networks in securing aristocratic and elite patronage, which extended beyond material commissions to providing spaces, such as salons and workshops, in which further connections and influence could be built.

Using the family history and networks as a starting point, I explore the carefully calculated risks taken by Théodore Brongniart to advance and promote his own architectural work. I show that the contributions of his younger brother, Antoine, alongside other members of the extended kinship, including Antoine François de Fourcroy, continuously reinforced and

aided the collective family status. Although the family experienced highs and lows, the position, education, and ambition of various members, alongside their associated networks, fostered the creation of grand projects and ambitious efforts. Tight alliances helped to buffer either momentary or prolonged setbacks of individual members, while promoting the long-term success and stability of the whole.

Parisian Connections and Family Beginnings

Alexandre Brongniart's grandfather Ignace Théodore Brongniart (1707-1765) was the first of the Brongniart family to be based in the French capital.¹ Upon his arrival, Ignace made his home at no. 6, rue faubourg Saint Antoine, in a neighbourhood of artists, furniture makers, *marchand merciers*, and artisans. He studied pharmacy with Nicolas (II) de Fourcroy (ca. 1670- before 1737), one of several members of the Fourcroy family employed as a *marchand apothicaire*. It was a relationship from which Ignace would gain everything he needed to establish his life in Paris. Nicolas owned a pharmacy and residence in the rue de la Harpe, *au Flambeau Royal*, which had come to him through the family of his wife, Marie Madeleine Langlois (1680-1704). In 1737, the death of Nicolas left the long-held family business without guidance. During this critical year, Ignace completed his *maîtrise* and married Nicolas' daughter, Louise Geneviève de Fourcroy (1701-1775).² With the marriage, the pharmacy was transferred to Ignace, giving the couple a stable livelihood.

The circumstances of the marriage, and the inheritance of the pharmacy, solidified the financial security and social position of Ignace. Likely, his noble status was a contributing

¹ See Family Trees, Appendix 1 and Annotated Maps, Appendix 3-5. As with much genealogical research, some branches are well-known, and others are more challengingly incomplete. For Brongniart and Fourcroy family genealogies, see Georges Kersaint, *Fourcroy* (Paris, 1963); Monique Mosser, *Alexandre-Théodore Brongniart* (Paris, 1986); Jacques Silvestre de Sacy, *Alexandre-Théodore Brongniart* (Paris, 1940); Léon-Honoré Labande, *Causeries du Besacier* (Paris, 1895).

² Mosser, *Alexandre-Théodore Brongniart*, 155.

factor in the alliance. However, the relationship between the two families prior to this union remains unclear. Ignace and Louise Geneviève raised their two sons, Théodore (II) and Antoine, in the Left Bank neighbourhood of the pharmacy.³ From 1758, establishing himself among the highest ranks of his profession, Ignace taught chemistry at the nearby *Collège de Pharmacie*. As the eldest son, Théodore had initially followed his family's wishes by studying medicine and pharmacy.⁴ While there was a varied background of artisanry in the Brongniart kinship, particularly among the Langlois family, as I discuss in detail below, the expectations that young Théodore would act on his advantages by assuming a role within the family business kept him from pursuing any kind of early apprenticeship outside of medicine. Nonetheless, his ultimate career choice was likely influenced by his proximity to the classes of Jacques François Blondel (1705-1774), which took place a few doors down from the family pharmacy.⁵

After completing his medical studies, as well as courses in Blondel's atelier, Théodore moved on to study with the prominent architect Étienne Louis Boullée, a residential architect who later became known for his extravagant, future-oriented designs.⁶ Théodore competed for several academic prizes, with notable successes, and began his private architectural practice soon afterwards. In 1767, he married Anne Louise Degremont (1741-1829), the owner of a lingerie boutique near the rue du Temple, whose efforts, as later chapters show, were a factor in the family's careful positioning and protection during periods of crisis. The 1770s were foundational years in establishing Théodore's reputation and career as an architect, and Alexandre was born in 1770 to young parents eager to build upon their resources and to

³ No longer extant, the pharmacy building was located at the corner of the former rue Poupée. Mosser, *Alexandre-Théodore Brongniart*, 15; Eugène-Humbert Guitard, "Les Brongniart: Robert Anchel, in *Revue des spécialités*, 1933," in *Revue d'histoire de la pharmacie* 83 (1933).

⁴ Silvestre de Sacy, *Alexandre-Théodore Brongniart* 5, 12; Mosser, *Alexandre-Théodore Brongniart*, 15.

⁵ Many of these classes were offered without charge to artisanal guild members. Richard Cleary, "Romancing the Tome," *Journal of the Society of Architectural Historians*, 48, 2 (1989).

⁶ Silvestre de Sacy, *Alexandre-Théodore Brongniart*, 11-12.

improve their social standing.

Continued Legacy: “au Flambeau Rouge” and the pursuit of Chemistry in Paris

As Théodore moved forward with his career in architecture, in 1765, the rue de la Harpe pharmacy passed to his younger brother, Antoine, who had interests in medicine and chemistry. This move kept the management of the pharmacy stable and provided opportunities in the careers of both brothers.⁷ Inheritor of an artisanal métier in origin and practise, Antoine continued to use his research and industry to expand the family’s fortunes. He also took on his father’s teaching post in chemistry at the *Collège de Pharmacie*, becoming chair in 1777. In a glimpse at the active, and often reciprocal, patronage within the family, René Charles de Fourcroy de Guillerville (1717-1799), a cousin, promoted the rue de la Harpe shop of Antoine as the only reliable pharmacy to provide versions of the formulas printed in his book on childcare, itself a reflection of Rousseauian principles, *Les Enfants élevés dans l’ordre de la nature*.⁸

In addition to his other responsibilities, Antoine was actively involved with the most important chemists of Paris. He had served as demonstrator to Pierre Macquer, chemist at Sèvres and les Gobelins, and professor at the Jardin du Roi. In 1779, Antoine established himself as first apothecary to the king, Louis XV. This was a purchased title, which provided an elevation in status and opportunities for increased income.⁹ As Antoine increasingly spent time at Versailles, the pharmacy in the rue de la Harpe was transferred in 1784 to his student,

⁷ Silvestre de Sacy, *Alexandre-Théodore Brongniart*, 5, 12; Mosser, *Alexandre-Théodore Brongniart*, 15.

⁸ Jean-Louis de Fourcroy de Guillerville, *Les enfants élevés dans l’ordre de la nature*, (Paris, 1775), 394.

⁹ Maurice Bouvet, “Les apothicaires royaux,” *Bulletin de la Société d’histoire de la pharmacie* (Paris, 1928).

François Edmé Regnault (1755-1807), yet another member of the Langlois family.¹⁰ At Versailles, Antoine taught chemistry classes, and among a long list of notables, the Abbé Sieyès (1748-1836), was one of his registered attendees.¹¹ An influential teacher during Alexandre's youth, Antoine François de Fourcroy was a younger cousin to Théodore and Antoine. Like the Brongniart family, there were several generations of the Fourcroy family who practised as apothecaries, or in similar capacities. Fourcroy and his Brongniart cousins traced their common ancestor to the father of Nicolas (II), Fourcroy's great-grandfather, another Nicolas (I) (d.c.1727). Nicolas (I) was a *marchand épicier* (spice dealer), a trade related to that of the apothecary. Fourcroy's grandfather, Pierre (b.c.1680-after 1710), brother to Nicolas (II), was the first generation to act as *marchand apothicaire* to Louis-Philippe II, duc d'Orleans.¹² Fourcroy's father, Jean-Michel (1710-1783), followed his father, Pierre, in the titular role through *survivance*, in which lifelong appointments could pass directly from father to son.¹³

As a young student, from age nine to age fourteen, Fourcroy was enrolled at the Collège d'Harcourt, near the rue de la Harpe pharmacy (now run by Antoine), where he attended as a day pupil. Given its location, it is likely that the pharmacy served as a periodic, or even regular, haven during Fourcroy's years as a student nearby. A childhood friend, Ambroise Marie François Joseph Palisot, Baron de Beauvois, recalled that Fourcroy's youthful interests tended to involve theatre and the arts, memorising passages from his favourite authors (particularly Molière, a famous member of the Fourcroy and Langlois family tree) to recite to his classmates – all skills which later contributed to his reputation as a compelling speaker. Palisot later

¹⁰ Jean Flahaut, "Lavoisier et les pharmaciens parisiens de son temps," *Revue d'histoire de la pharmacie*, 83^e année, 307 (1995): 356 and Laborde, "Louis Cellot," *Répertoire alphabétique, Cau-Chamo* XXVI (Paris: Gallica, 1801-2000), 141.

¹¹ Derek E. Ostergard, *Sèvres Porcelain Manufactory* (New Haven, 1997), 27.

¹² See Appendix 2, Succession of the House of Orléans.

¹³ "Biography of Fourcroy," *Analectic Magazine*, vol. 2, 2nd ed. (July-December 1813), 329.

considered that Fourcroy had not yet demonstrated a strong inclination toward medicine and chemistry.¹⁴

In 1770, the same year that Alexandre was born, Fourcroy's father, Pierre, had his titular position as *marchand apothicaire* revoked in the face of objections from the apothecary guild. Fourcroy's education was disrupted, and he was forced into a less certain path. Crucially, he lost the opportunity for his own expected *survivance* to employment as an apothecary to Louis-Philippe.¹⁵ At age fifteen, with an incomplete education, he was forced to take a paid position as a copyist. By itself, the situation offered a disappointing outlook. In his late life, Fourcroy recalled that the support of his father's acquaintance, the physician Félix Vicq d'Azyr (1748-1794) – later a mentor to Alexandre and the Société Philomathique – helped him to return to medical study and protected him from a less fulfilling future that might otherwise have followed.¹⁶

Alongside continued studies in chemistry and medicine, including significant financial and political struggles to obtain his medical diploma and status as “regent doctor” (which was never accorded to him), Fourcroy joined Antoine Lavoisier at his Arsenal laboratory as an assistant, just as Lavoisier began to produce his most important works on chemistry and the nature of oxygen.¹⁷ Antoine Brongniart, Claude Louis Berthollet, Louis Bernard Guyton de Morveau, Jean Henri Hassenfratz, Pierre Auguste Adet, and Fourcroy were among the first to confirm and to promote Lavoisier's paradigm-shifting theories in chemistry. Members of the close-knit group supported Lavoisier's research as co-authors of *Méthode de nomenclature chimique* in 1787. This vital publication, which I discuss in the following chapter, introduced

¹⁴ Ambroise Marie François Joseph Palisot de Beauvois, *Éloge historique de M. Fourcroy* (Paris, 1810).

¹⁵ Guitard, “Les Brongniart,” 133-134; Georges Cuvier, “Account of the Life and Labours of the Count de Fourcroy,” *Belfast Monthly Magazine* 12, 69 (30 April 1814).

¹⁶ Kersaint, *Fourcroy*, 14.

¹⁷ I discuss Lavoisier's discoveries further in Chapters Three and Five.

Lavoisier's antiphlogistic theories, ushering in a radical reform of the approach to the science of chemistry.¹⁸

Wider Networks and the Strategy of Continuity

While the connection between the Fourcroy and Brongniart families is well known, the importance of other large family networks is less so. In addition to the practice of pharmacy and chemistry that continued within both the Brongniart and Fourcroy families, the Langlois were artisans, including printers, engravers, and publishers. The family was established at the turn of the seventeenth century, headed by the engraver François Langlois, known as Chartres (or Ciartres) (1588-1647). His most noted publication was the 1620 natural history volume *Livre des fleurs*, which presented a series of charming but, importantly, near-realistic depictions of tulips and related flowers alongside a variety of birds (see Figure 1.1).¹⁹ This book marked an early achievement in the Brongniart and Langlois family's long involvement in parallel pursuits of natural history and the arts. It set an early standard for illustration, categorisation, and publication that later generations, including Brongniart, either directly or indirectly, continued to expand upon. Into the eighteenth century, the Langlois family held enterprises in the Left Bank, in a region demarcated by the rue de la Harpe and the rue Saint Jacques. These neighbourhoods were close knit spaces for local interactions as well as market sites that drew a larger clientele from other locales.

An important dynasty of *marchand merciers* and *drapiers*, the Brochant were related to the Brongniart, Fourcroy, and Langlois families through the well-known engravers and art

¹⁸ Louis-Bernard Guyton de Morveau and Bernadette Bensaude-Vincent, *Méthode de Nomenclature Chimique* (Paris, 1994).

¹⁹ "Langlois, François," *Benezit Dictionary of Artists* (2011); Maxime Préaud, "Langlois, François," *Oxford Art Online* (2003); François l'Anglois, *Livre des fleurs* (Paris, 1620).

dealers of the Mariette family.²⁰ The wealthy clan descended from Mathurin Brochant in the early seventeenth century and were active merchants in Paris over the course of several generations. The alliance between the families was formed in 1745, with the marriage of Angélique-Geneviève Mariette (1727-1808), daughter of Pierre Jean Mariette (1694-1774), to Claude Jean Baptiste Brochant des Tourterelles (d.1792). She was provided with a 100,000-livre dowry, while her husband brought 120,000 livres of his own to the match.²¹ Such a marriage enabled families to protect their children's futures, as well as their assets, as they sought to assure the stability of future generations.

In a related marriage, the Mariette family sought status through a connection with the Geoffroy family. Several members of the Geoffroy family had been apothecaries, beginning in the sixteenth century. The brothers Étienne François Geoffroy (1672-1731) and Claude Joseph Geoffroy (1685-1782), were both pharmacists and chemists, as well as members of the Académie.²² The 1752 marriage of Claude Joseph's son, the apothecary and chemist Claude François Geoffroy (1729-1753) to Geneviève-Thérèse Mariette (b.1723), younger sister of Angélique-Geneviève Brochant (née Mariette) formed the alliance between the Geoffroy and Mariette families. Like her sister, Geneviève-Thérèse had a 100,000-livre dowry. These sums represented a significant investment in marriages that brought social advantage and prestige to the Mariette family.²³ The Brochant family also boasted of several marriages to the wealthy Le Couteulx family of bankers and *marchand merciers*.²⁴

²⁰ There are several families in Brongniart's kinship that are often referred to as "dynasties." I use this term to denote a family that had several successive generations that maintained prominence and sustained financial and social capital. Four generations of the Mariette family, beginning with Pierre (I) Mariette (1596-1697) were active in the arts and publishing through the eighteenth century. Amy L. Walsh, "Mariette family," *Grove Art Online* (2003).

²¹ Kristel Smentek, *Mariette and the Science of the Connoisseur* (London, 2017), 27.

²² Paul Dorveaux, "Apothicaires membres de l'Académie royale des Sciences," in *Revue d'histoire de la pharmacie*, 20^e année, 79 (1932).

²³ Smentek, *Mariette*, 27.

²⁴ R. Flamein, "Mobilités sociales et capitalisme: une approche comparée entre Rouen et

The Brochant kinship brought about numerous central relationships in the story of the Brongniart family, particularly for Alexandre. These included Brongniart's close associate in mineralogy, André-Jean Marie Brochant de Villiers, and both the Coquebert de Montbret and the Geoffroy families.²⁵ As I show throughout this thesis, the Brongniart family was closely acquainted with several members of the Coquebert de Montbret family well before the marriage of Alexandre to Cécile in 1800. Brongniart shared interests in natural history with the three Coquebert de Montbret brothers: entomologist Antoine Jean (1753-1828), diplomat and engineer Charles Étienne (1755-1831), and naturalist and military officer Romain (1767-1829). A descendant of the less-affluent junior branch of the Brochant family established near Mantes-la-Ville, the mineralogist André Jean François Marie Brochant de Villiers (1772-1840) shared a close relationship with both Alexandre and Charles Étienne Coquebert de Montbret, dating from at least 1794, when he settled in Paris. After studying mineralogy with Abraham Werner in Freiburg during the Revolution, Brochant de Villiers was the first student to be enrolled in the newly reorganized École des Mines when it reopened its doors in 1794, just as Alexandre began his teaching career there.²⁶

As I discuss in Chapter Six, Charles Étienne Coquebert de Montbret and his wife, Geneviève Eugénie de Hazon (1725-1827); Alexandre, Cécile and their children; plus Brochant de Villiers and his family, all lived in the same Saint Germain residence during the 1800s.²⁷ The building, originally belonging to the Hazon family, was owned by Charles Étienne

Paris (1600-1825),” *Annales de Normandie*, 66 (2016); N. Lyon-Caen, “‘Au Petit Paradis,’ des Brochant: transmission et reproduction familiale chez des marchands drapiers parisiens,” in A. Bellavitis, *Mobilité et transmission dans les sociétés de l’Europe moderne* (Rennes, 2009).

²⁵ The Brochant family was related to the Coquebert de Montbret family through the marriage of Marie Catherine Hazon to Pierre Paul Brochant in 1711. Laurence Croq, “Les édiles, les notables et le pouvoir royal à Paris, histoire de ruptures (XVIIe-XVIIIe siècles),” (2019): 23.

²⁶ École Polytechnique, *Livre du Centenaire*, t. 3 (Paris, 1897), 112-3.

²⁷ Ostergard, *Sèvres Porcelain Manufactory*, 32; Jean-Victor Audouin and Jean Théodoridès, *Journal d’un étudiant* (Paris, 1965).

Coquebert de Montbret from 1802.²⁸ The related households of 71 rue Saint Dominique, became a locus for natural history research for both the natural history collections and the libraries held there.²⁹ The members of this family group, including Alexandre, Brochant de Villiers, and Coquebert de Montbret, pursued a series of related, mutually-supporting projects in mineralogy and mapmaking.³⁰

At the Muséum, Alexandre's contemporary and a rival naturalist from the 1790s, Étienne Geoffroy Saint-Hilaire (1772-1844), was also a distant cousin, from a branch of the Geoffroy family living in Troyès.³¹ Intended for the clergy, Geoffroy came to Paris in the 1780s on a scholarship to the Collège de Navarre, where, alongside his other preparatory work, he studied natural history with Mathurin Jacques Brisson (1723-1806). Geoffroy saw that natural history offered greater opportunities for himself than did a career in the church. To satisfy his father's wishes, he moved to the Collège du Cardinal-Lemoine to complete an additional degree in the law, which he finished by 1790. Legal studies gave Geoffroy cause to remain in Paris, during which time he simultaneously pursued natural history. At the College du Cardinal-Lemoine, Geoffroy studied with René Just Haüy (1743-1822), and, at the Jardin des

²⁸ From 1791 to 1802, Charles Étienne rented a nine-room apartment in the rue de Tournon, where Brongniart stayed following his marriage to Cécile (in addition to accommodations at Sèvres). Jane Conroy And Barbara Wright, "France and Ireland in the Late Eighteenth Century: The Correspondence of Charles Coquebert de Montbret and Andrew Caldwell, 1791-1803," *Analecta Hibernica*, 49 (2018): 158.

²⁹ Alexandre Brongniart, *Catalogue des livres composant la bibliothèque scientifique de feu M. Alexandre Brongniart* (Paris, 1858); Isabelle Laboulais-Lesage, "Reading a Vision of Space: The Geographical Map Collection of Charles-Etienne Coquebert de Montbret (1755-1831)," *Imago Mundi* 56, 1 (2004).

³⁰ Laboulais-Lesage, "Reading a Vision of Space", 57-61.

³¹ The exact connection to the family of Étienne Geoffroy Saint-Hilaire is unclear. Pierre Flourens (1794-1867) confirmed the relationship in his *Éloge* for Geoffroy Saint-Hilaire, as did Jean-Baptiste Dumas when remembering Isidore Geoffroy Saint-Hilaire. The connection is probably a distant one, likely dating to either the sixteenth century or the seventeenth century, with either the apothecary Estienne (I), or his son, Estienne (II). Pierre Flourens, *Éloge historique d'Étienne Geoffroy Saint-Hilaire* (Paris, 1852); Jean-Baptiste Dumas *Éloge historique de Isidore Geoffroy Saint-Hilaire* (Paris, 1873).

Plantes, took classes with Louis Jean Marie Daubenton (1716-1800) and Fourcroy.³²

It appears unlikely that Alexandre met Geoffroy prior to the 1790s, and perhaps did so only in 1793, after Geoffroy's appointment to the professorship at the Muséum. Although Alexandre recorded a member of the Geoffroy family as a participant in a series of guided nature walks he led for close associates and family between 1788-90, this was probably René Claude Geoffroy de Villeneuve (1767-1831) or his brother, Étienne Matthieu (c.1767-after 1804), both sons of the physician Étienne Louis Geoffroy de Villeneuve (1725-1810).³³ The kinship relationship between Brongniart and Geoffroy has not been demonstrated elsewhere, and was perhaps less influential in the relationship between the two naturalists than was their common bond through natural history and membership in the *Société Philomathique*. This, founded by Brongniart and his associates in 1788, was joined by Geoffroy in 1795. As I discuss in Chapter Three, Geoffroy was instrumental in bringing Georges Cuvier to Paris that same year. Cuvier immediately became one of Brongniart's closest research associates and was also a good friend to Geoffroy upon his arrival in the French capital. The dynamics of the relationships between the three men have drawn the attention of several scholars, with the partnership of Cuvier and Brongniart often set parallel to the debates between Cuvier and Geoffroy during the 1820s.³⁴

The Fourcroy, Langlois, Brochant, Mariette, and Brongniart families were large, with

³² Flourens, *Geoffroy Saint-Hilaire*, 1852.

³³ Brongniart wrote to his father that Geoffroy Saint-Hilaire was not the same Geoffroy that his father knew, but was a "young unknown." I discuss their early relationship in Chapter Three. See: Papiers provenant d'Alexandre Brongniart, Journaux et papiers se rapportant aux voyages d'Alexandre Brongniart, "Courses et voyages dans le bassin de Paris, par ordre chronologique," "Promenades zoo-phyto-lythologiques aux environs de Paris par Alex. Brongniart," BMHN MS 2350/1; Alexandre Brongniart, Correspondance Active (1791-1825), Correspondance de Famille, Lettres à son père, 1793-95, 21 Juin 1793, AN/668/1/18. On the nature walks, see Chapter Two. See also: "Promenades zoo-phyto-lythologiques aux environs de Paris par Alex. Brongniart," BMHN MS 2350/1.

³⁴ In particular see: Toby Appel, *The Cuvier-Geoffroy Debate* (Oxford, 1987); Dorinda Outram, *Georges Cuvier* (Manchester, 1984).

multiple generations having numerous descendants. As such, it is difficult to factor how much this wide-ranging kinship factored in patronage relationships on a regular basis; at the very least, this large family and network of artisans and merchants formed a background rich in aesthetic understanding and artistic creation. Throughout this thesis, I highlight the influence, presence, and actions of an extensive group of networks, many of which are centred in these longstanding family connections. Alexandre's position within this milieu offered access to the best possible resources Paris could offer a young student, and, as I show throughout, he intentionally preserved and built upon his personal and professional connections throughout his lifetime. His networks were particularly important as assets in the collection of global data and the development of informational resources. Without them, Brongniart's comprehensive projects and publications in geology and ceramics could never have been accomplished.

The Value of Artisanal Networks

Théodore's professional connections often related back to merchants, artists, and artisans (including apothecaries), frequently those working in the faubourg Saint Antoine, or in the studios provided for artisans at the Arsenal, such as Jean François Leleu, Jean François Oeben, and Jean Henri Riesener, or the chemistry laboratory and residence of Lavoisier. An architect not only created a plan, but also coordinated the efforts of a large group of contributors, each chosen for their expertise and skill. Architects such as Théodore not only served their client, but they also relied on reciprocal patronage relationships of many types. Artisans and merchants provided furnishings, artworks, and fixtures, and other craftsmen and engineers were employed for construction.

The work of craftsmen and artists formed a substantial investment in the construction of a *hôtel particulier*. Furnishings such as tables, chairs, commodes, candelabras, sconces, wall and window coverings, and decorations could amount to three times the cost of basic

construction. The architect's plan included furniture with luxurious marquetry surfaces, upholstery, porcelain vases, gilded clocks, sculptures, paintings, mirrors, curtains, and tapestries, often from prestigious makers such as Sèvres, Saint Gobain, and les Gobelins. Further, an architect would offer multiple fabric schemes based on seasonal changes and assumed redecoration after a brief period.³⁵ As an example of one artisanal system involved in the complex plan of an elite residence, furniture workshops could command extraordinarily high prices for a single object. A conservative estimate for the work of Jean Henri Riesener (1734-1806), *ébéniste du roi* from 1774, indicates that he earned 900,000 livres in commissions over a ten-year period from Louis XVI.³⁶ While these sums represent the very top of the market, they demonstrate that substantial amounts of money could be made in the furnishing of a new residence. In Paris, the creation of a piece of furniture often required several workshops, each controlled by separate guilds.

Master *ébénistes* (artisanal woodworkers) required the contributed expertise of metalsmiths, lacquer specialists, carpenters, and material suppliers, as well as artists, who worked across multiple styles. Sometimes, an *ébéniste* might also be considered a *menuisier*, by which is meant more generally a 'carpenter.' The two terms denoted separate kinds of woodworking, although both operated from within the same guild. Carpentry workshops, which could build the basic furniture, had a different set of skills and production requirements than the lacquer workers or varnishers. The creation of chemical finishes such as lacquers, or metallic inlays, such as silver or bronze called upon a specific material mastery. Ormolu (gilt bronze) mounts came from the *ciseleur-fondeurs* (chaser-founders, or metal sculptors), who

³⁵ Michael Stürmer estimates that an architect would offer a noble client a budget with seventy five percent of the investment value of a newly constructed residence going to its furnishings, rather than to the construction itself. Stürmer suggests that redecoration was planned for an interval of perhaps six years. Stürmer, "An Economy of Delight: Court Artisans of the Eighteenth Century," *Business History Review* 53, 4 (1979): 496.

³⁶ Stürmer, "Economy of Delight," 523.

often independently created a variety of set styles to be sold as applied pieces of decoration. The most complex and refined work was done by specialists in marquetry, either of inlaid pieces of cut wood veneers, or of highly polished black lacquered furniture such as desks or cabinets with intricate inlaid metal decorations.³⁷ Many of the artisans involved were skilled mathematicians, geometricians, chemists, *porcelainiers*, *faïenciers*, and metallurgists who possessed extensive material knowledge.³⁸

Although the guild structure defined much of the Parisian furniture trade, the workshops of the faubourg Saint Antoine were not required to maintain guild memberships. Thus, the faubourg was open to greater diversity in its workforce and community.³⁹ The loosened restrictions of the faubourg allowed foreign-born artisans to practise their craft alongside the French makers, increasing both competition and innovation. With more freedom to act independently, the lines between *menuisier*, *ébéniste*, and *marchand mercier*, among other distinctions, were often blurred. The high concentration of workshops and dealers in the faubourg Saint Antoine fostered a creative environment and an active marketplace in which large, protective family networks benefitted their members and associates.⁴⁰

Often, for individual artisanal workshops, a *marchand mercier* would negotiate commissions and sales, combining multiple types of work, including upholstered goods, marquetry and case goods, metal works, and porcelain within a single showroom. These merchants were not guild members but worked cooperatively among them and were active

³⁷ Vincent Charles Bastien, *La fabrique du luxe* (Paris, 2018); André Charles Boulle (1642-1732), *Ébéniste du Roi*, was known for his use of exotic materials such as tortoiseshell, brass, and pewter. He was highly influential, and his name is now given to the techniques he practised, called Boulle marquetry, or Boulle work. Jean Nérée Ronfort, *André Charles Boulle* (Paris, 2009).

³⁸ On the artistic, technological, chemical, and mathematical knowledge required by *ébénistes* and *menuisiers*, see Leora Auslander, *Taste and Power* (Berkeley, 2006), 110-120.

³⁹ Jean-Baptiste Minnaert, *Le faubourg Saint-Antoine* (Paris, 1998); Raymonde Monnier, *Le faubourg Saint-Antoine* (Paris, 1981), 8, 33-4, 38-9, 52-77.

⁴⁰ Auslander, *Taste and Power*, 92-8.

participants in design creation, nonetheless. In addition to fabrics and furniture, rare objects, including natural history specimens, minerals, shells, corals, sculptures, as well as Asian and European porcelains could also be found among their inventories.⁴¹ The best *marchands merciers* could command large sums of capital that could enable the front-end financing of special commissions.⁴² Districts such as the faubourg Saint Antoine, with numerous related workshops in close proximity, offered vital meeting grounds in which an architect could both offer beneficial patronage and receive it (see annotated Paris map, Appendix 3).

Networks and Architecture: l'hôtel de Montesson, Parisian Nobility, and Patronage

Beginning in the 1770s, Théodore Brongniart was commissioned to construct several homes for the Parisian bourgeoisie and nobility. The Marquise de Montesson, born Charlotte-Jeanne Béraud de La Haye de Riou (1738-1806), became an active supporter of his work. Numerous patronage relationships and close familial relationships of the Brongniart family were centred in the social networks surrounding Mme de Montesson and the duc d'Orléans. Her early patronage helped to establish his professional and artistic reputation. It was a fortunate, if not critical, relationship for the young architect, as she continued to employ him on other projects and to promote his work to those in her acquaintance. Having been widowed by Jean-Baptiste de Montesson (1687-1769) while still young, the thirty-one-year-old marquise possessed both a strong social standing and financial independence. Meanwhile, she had already caught the attention of her future husband, becoming the mistress of Louis-Philippe, duc d'Orléans (1725-1785), known as "the Fat."⁴³ The duke sought permission from Louis XV (1710-1774) to marry her, a negotiation that took several years to complete. The king's

⁴¹ Pierre Verlet, "Le commerce des objets d'art et les marchands merciers à Paris au XVIIIe siècle," *Annales* 13, 1 (11 March 1958): 18.

⁴² Stürmer, "Economy of Delight," 522; Bastien, *La fabrique du luxe*, 32, 148; Sarah Kane, "Merchants and Luxury Markets," *Journal of Design History* 9, 4 (1996), 298.

⁴³ See Appendix 2, Succession of the House of Orléans.

reluctant approval came with rigid stipulations that included restricting the marquise from presentation at court. This prohibition motivated the creation of a new pair of residences and an active social network centred around the duke and his new wife, distant from the court at Versailles.

In 1770, Mme Montesson chose a building site in the Chaussée d'Antin, on land secured by a long-term lease from the Mathurins, arranged through the partnership of Théodore and his associate, Jean François Letellier. In 1773, following the completion of the new residence, the *hôtel de Montesson*, the duc d'Orléans and Mme de Montesson held their secret wedding ceremony in its new chapel. That same year, Théodore designed another large residence on an adjacent street for Louis-Philippe, on a property that abutted that of his wife. This second residence and its gardens were completed and altered over a period of years. Eventually the two houses were linked together by a private path through a folly in the garden.⁴⁴

Théodore benefitted substantially from the relationship he established with Mme de Montesson. The partnership with Letellier, too, seems to have been instrumental, but there is little on record to indicate the nature of its formation. There is limited biographical information concerning Letellier, although he probably studied architecture alongside Théodore.⁴⁵ He shared a close connection to Théodore and his wife, as the couple chose Letellier to act as godfather to Alexandre at his baptism on 6 February 1770.⁴⁶ It is unclear from the extant records how much of the partnership and the land deal with the Mathurins relied upon the legal and financial advantages of Letellier. In the sale documents, he was described as an *entrepreneur du bâtimens du roi*, a term that most often referred to a master mason, who might both provide initial financing and manage the daily aspects of the construction in partnership

⁴⁴ Mosser, *Alexandre-Theodore Brongniart*, 34-5.

⁴⁵ Jacques Silvestre de Sacy, *Alexandre-Théodore Brongniart* (Paris, 1940) 141-3; Fiske Kimball, "A Louis XVI Room," *Bulletin of the Pennsylvania Museum* 28, 150 (1932), 3-7.

⁴⁶ *Alexandre Brongniart, Papiers Personnels (1770-1835)*, AN668-AP1.

with an architect.⁴⁷

The Brongniart family became a part of the social life of Mme de Montesson's Chaussée d'Antin residence, where the marquise created a special social environment, holding frequent salons and theatre performances at her home, and writing several of her own plays. Théodore designed a theatre on her property, and the architect became a favourite actor in her productions, one of which earned a visit from Voltaire.⁴⁸ Théodore's debut under her patronage set his career on a high plane from its start. Although it was a providential relationship for the young architect, the association with Mme Montesson had deep roots, as the Brongniart and Fourcroy families were associated with the milieu of the succession of the House of Orléans for generations. In whatever way this early commission was conceived and structured, it marked the beginning of thirty-year-old Brongniart's ascendant career.

Other members of the society surrounding the Chaussée d'Antin became important influences and patrons for the Brongniart family. Jean-Étienne Guettard (1715-1786) was prominent in eighteenth-century French mineralogy and geology, and his influence during Alexandre's early education was significant. Guettard had begun his career as a student of Bernard de Jussieu and had also acted as assistant to René Réaumur (1683-1757), where he oversaw Réaumur's cabinet. From 1747, he served as *médecin-botaniste* to Louis (I) duc d'Orleans, where he became the keeper of his cabinet of mineralogy and natural history. As I discuss in detail in Chapter Two, in 1746, Guettard presented a memoir to the academy on his mineralogical survey of France, which he then published in 1751, alongside two maps. Although summary in its contents, his publication was the first attempt at a mineralogical map

⁴⁷ Archives Nationales; Cote MC/ET/XLVI/405 - MC/ET/XLVI/529, MC/RE/XLVI/7 - MC/RE/XLVI/8 - MC/RS//853. For details of the sale, see Mosser, *Alexandre-Théodore Brongniart*, 29-31. See also Allan Graham, *Architecture of the French Enlightenment* (London, 1989), 219; "Le Tellier, Jean Francois," *Dictionnaire des journalistes 1600-1789* (Oxford, 1999).

⁴⁸ Mosser, *Alexandre-Théodore Brongniart*, 30.

of a country.⁴⁹ Following Louis' death in 1752, Guettard retained his position under his son, Louis-Philippe, as well as apartments at the Palais Royal. From at least 1763, Guettard, a friend of Lavoisier's father, guided Lavoisier's early natural history study, including mineralogy and geology. Subsequently, both Guettard and Lavoisier contributed to the ideas and education of Brongniart. It is likely that Alexandre frequently visited the natural history collections under Guettard's care, beginning with his earliest interests in the field. Into his late-life publications, Alexandre demonstrated considerable respect for Guettard's efforts and achievements.⁵⁰

Another valuable member of the Brongniart family networks, the chemist Claude Louis Berthollet, was introduced to the Brongniart and Fourcroy families through his association with the two Chaussée d'Antin households. Berthollet had received a degree in medicine from Turin in 1770, and upon arriving in Paris in 1772, was employed as Mme Montesson's personal physician. During this time, he studied chemistry under Macquer, while also working with Antoine Brongniart and Fourcroy. When Lavoisier's ideas about oxygen forced a change in the understanding of chemistry, Berthollet joined as co-author of *Méthode de nomenclature chimique* in 1787, helping to clarify and promote the developments.⁵¹ Deepening his connection to Mme Montesson's circle, in 1779, Berthollet married Marguerite-Marie Baur, a harpist and lady's maid employed in the Hôtel Montesson.⁵² This marriage strengthened Berthollet's bonds with his friend and colleague, the mathematician Gaspard Monge, as the two had married into the same family.⁵³ As I discuss in Chapter Four, both

⁴⁹ Rhoda Rappaport, "Geological Atlas of Guettard, Lavoisier, and Monnet," in *Toward a History of Geology*, ed. C. J. Schneer (Boston, 1969), 272-287; Josef W. Konvitz, *Cartography in France* (Chicago, 1987), 84-9.

⁵⁰ I discuss this relationship in Chapter Two.

⁵¹ I discuss this landmark publication in Chapter Two. Guyton de Morveau and Bensaude-Vincent, *Nomenclature chimique*, 1994.

⁵² Marie Louise Elisabeth Vigée-Le Brun, *Souvenirs* (Paris, 1926), 81; François Pairault, *Gaspard Monge* (Paris, 2000), 52.

⁵³ I examine this relationship further in Chapter Five. Michelle Sadoun-Goupil, *Berthollet* (Paris, 1977), 20; Maurice P. Crosland, *Society of Arcueil* (Boston, 1967), 97.

Berthollet and Monge joined the Egyptian Expedition of the late 1790s before returning to Paris to elevate Napoléon to power through the Coup of 18 Brumaire. With their shared and respective powers in the Napoleonic government, Monge and Berthollet provided indispensable aid in the early career of Alexandre.

In 1777, Théodore was made a member of the *Académie royale d'architecture* and continued to draw wealthy clients throughout Paris. In a near parallel to Mme de Montesson, but across the Seine, he formed another beneficial relationship with the princesse de Monaco. Mistress of the prince de Condé since 1760, for whom she left her husband in 1769, she asked Théodore to build a house for her near the Palais Bourbon. Soon afterwards, in 1782, the daughter of the prince de Condé, the unmarried princesse Louise-Adelaïde de Bourbon Condé, hired Théodore to construct the Hôtel Bourbon Condé nearby, at 12 rue Monsieur.⁵⁴ The commissions for the competing House of Bourbon did not affect his relationship with the House of Orléans, and Mme Montesson continued to support and to employ him. During the years 1780-1782, she commissioned Théodore to design the impressive Couvent des Capucins d'Antin in the 9th Arrondissement. This building was preserved during the Revolution, and later repurposed as one of the Écoles Centrales (now the Lycée Condorcet).⁵⁵ Théodore's ability to balance the interests of the two competing potential heirs to the throne set an example for Alexandre to follow in his later career.

Théodore continued to create a series of homes for wealthy Parisian families, developing an extensive list of private clients, including work on Maupertuis, the estate of the marquis de Montesquiou-Fézensac. Elisabeth Vigée-Le Brun recorded her country visits to the Château de Morfontaine, the home of Louis Pelletier de Morfontaine, alongside guests such as Théodore, the artist Hubert Robert, and Étienne Vigée, who excelled at playing charades and

⁵⁴ Silvestre de Sacy, *Alexandre-Theodore Brongniart*, 51-5.

⁵⁵ Silvestre de Sacy, *Alexandre-Theodore Brongniart*, 46.

were left to consider themselves at home.⁵⁶ Her memoirs point to the larger social sphere of the Brongniart family which existed within or at least, alongside, an extraordinary network of patronage relationships. This world included numerous artists and artisans who existed as relative equals among one another, all of whom were recipients at some level of patronage from their hosts, who, in turn, were largely members of the nobility. Sometimes, these personal and social acts took on a very public form that verged on the self-promotional or self-celebratory. For instance, Vigée-Le Brun nostalgically recalled the surprise for her engineered by Théodore and his wife on an opening night at the Vaudeville Theatre in 1783. In the production, *The Assembling of the Arts*, a character that symbolised the concept of ‘painting’ was modelled after Vigée-Le Brun herself, shown at work on a portrait of Marie Antoinette. The entire production had been kept a secret from her until it was revealed during the performance.⁵⁷ The incident drew both Vigée-Le Brun and Théodore into the public spotlight.

As Théodore’s reputation and profile grew, so did the success of his architectural practice. While the original family residence was on rue St Marc, in the ninth arrondissement on the Right Bank near the Chaussée d’Antin, in 1781, Théodore completed construction of the *Maison Brongniart*, at the corner of the Boulevard des Invalides and rue Plumet (now Oudinot) (see Figure 1.2).⁵⁸ Its situation was at the front corner leading into rue Monsieur, which he had designed and opened. The street-facing lot gave Théodore a forum to demonstrate his skill as an architect to the passing public. His architectural efforts and artistry led to an official position that stabilised his career, a pattern that Alexandre later followed. Although the *Maison Brongniart* was completed in 1781, by 1782, Théodore had succeeded to Boullée’s post at Les Invalides, where the family then took up residence.⁵⁹ Meanwhile, the nearby *Maison*

⁵⁶ Vigée-Le Brun, *Souvenirs*, 105-6.

⁵⁷ Vigée-Le Brun, *Souvenirs*, 46.

⁵⁸ Silvestre de Sacy, *Alexandre-Theodore Brongniart*, 56.

⁵⁹ The family was provided apartments at Les Invalides, which they kept until the Revolution. Mosser, *Alexandre-Théodore Brongniart*, 311-2.

Brongniart served as a prominent display of Théodore's creative work as an architect.

Embodying Ideals: The Strategy of Representation and the Creation of Style

Alongside his two sisters, Louise (1772-1845) and Émilie (1780-1847), Alexandre's childhood was depicted in a series of portraits. As is demonstrated by the portraits, as well as the youthful journals of Alexandre, Théodore and Anne-Louise took an active hand in their children's lives.⁶⁰ The portraits, often exhibited at the Salon, ensured that their children were among the most visibly celebrated in Paris, and the images and objects highlighted the children's individuality and youthful curiosity. The artists Jean Antoine Houdon, Jean Louis Couasnon, Elisabeth Vigée-Le Brun, Jean-Baptiste Greuze, Henri François Riesener, and François Gérard all contributed portraits to the family's collections. The collective sculptures and paintings illustrated the unusual experience of the Brongniart family. In particular, the pair of terra cotta busts by Houdon of Alexandre and Louise presented a model for the period of childhood romanticised by Rousseau in the novel, *Émile*, of 1763 (see Figure 1.3). The pair of sculptures of Louise and Alexandre were exhibited together at the salon of 1777 and were immediately popular in the culture of late eighteenth-century Paris.⁶¹ The Brongniart children, through the serial reproduction of these portrait busts, became iconic representations of childhood in late eighteenth-century France, continuing to appear in reproductions throughout their lifetimes and into the present day.

These images were created at one level as family mementos, but they also shaped the family's public image. Few bourgeois or noble families could boast of so many portraits created by such a diverse and noted group of artists. To sit for a professional portrait was a major event that had the potential for social interaction, in which friends and associates might

⁶⁰ Alexandre Brongniart, *Journaux de voyage et journaux intimes*, BMHN MS3357-58.

⁶¹ Dominique Poulot, *Une histoire des musées de France* (Paris, 2013), 130.

stop by to observe the artist at work and to be entertained by the sitter at the same time. However, it could also be a substantial effort in time spent seated at home or in a studio and was often a large financial investment.⁶² Particularly, portraits by artists such as Houdon and Vigée-Le Brun were frequently confined to the ranks of the political, social, or creative elite. Houdon often created work for a public market alongside private commissions, where subjects for his work included Voltaire, Denis Diderot, Benjamin Franklin, the Marquis de Lafayette, Thomas Jefferson, and George Washington, while Vigée-Le Brun was frequently employed by Marie Antoinette.⁶³

Only a rare client could be positioned in such a way as to access this kind of attention for a family portrait. Théodore had a close working relationship with many sculptors and painters, and his associations were often based on deep friendship as well as mutual professional support. He was often able to specify the artworks that would be placed in his constructions. In some cases, sculptors were called upon to create monumental friezes, or massive architectural installations, such as (Claude Michel's) Clodion's relief sculptures for the Hôtel Bourbon-Condé.⁶⁴ The clients and collaborators of Théodore often became social connections and close friends, and he amassed a large personal collection of their artworks, with notable sculptures by Clodion.⁶⁵

This network of sculptors, artists, artisans, and clients was based on reciprocity, with mutually beneficial outcomes. Théodore acted as patron, client, and agent, but he also derived social and personal benefit as an architect from his connections with many of the best artists in

⁶² On French portraiture during the late eighteenth century, see: Sébastien Allard et al. *Portraits Publics/ Portraits Privés 1770-1830*, (Paris, 2006); Amy Freund, *Portraiture and Politics in Revolutionary France* (University Park, PA, 2014).

⁶³ On Houdon's portraiture, see Anne L. Poulet, *Jean-Antoine Houdon* (Washington, DC, 2003).

⁶⁴ Mosser, *Alexandre-Théodore Brongniart*, 82-3.

⁶⁵ Auguste Jal, "Pajou, Augustin," *Les dictionnaires historiques d'après des documents authentiques inédits* (Paris, 1867); "Pajou, Augustin," *Grove Art Online* (Oxford, 1996); Ostergard, *Sèvres Porcelain*, 376.

Paris. Many of these people were linked with Théodore from the earliest days of their careers. Both as a group and as individual innovators, they continuously defined the trends and styles active in late eighteenth-century Paris. Théodore could promote the sculptors' and painters' work to his elite audiences, either his clients, or those who were welcomed to the family salon to see his private collections. However, the artworks themselves, and their high quality, had the effect of highlighting the Brongniart family, making them a sought-after force in the creation and embodiment of style.

The artists and intellectuals who populated the houses of the aristocracy such as Mme Montesson's were more than just commissioned workers. They became a part of the social atmosphere and came together often as colleagues and even friends. Berthollet travelled extensively with Mme Montesson and the duc d'Orléans, to the point of becoming a special confidant. Berthollet was supported by Louis-Philippe (I) for over a decade, from his arrival in Paris until he was appointed to Macquer's post at the Gobelins tapestry works in 1784. While a member of the Orléans household, Berthollet received a laboratory and funding for his use, and was otherwise encouraged in his scientific pursuits and experiments.⁶⁶

Witnessing the last Days of the *Ancien Régime*

When Brongniart was fifteen, in 1785, Louis-Philippe (I) died and the active society that surrounded his home in the Chaussée d'Antin came to an end. The king forbade Mme Montesson to dress herself or her residence in mourning, forcing her to close her home to mourn in the Convent of the Assumption.⁶⁷ Those artists who were reliant upon her patronage, such as Joseph Bologne, Chevalier de Saint-Georges (1745-1799), who served as music director for her theatre, had to find other support to continue their work. In the case of Saint-

⁶⁶ Sadoun-Goupil, *Berthollet*, 20-5; Aleksander Sztejnberg, "The Eminent French Chemist Claude-Louis Berthollet," *Substantia* 4, 2 (2020): 139-49.

⁶⁷ Henriette Lucie de La Tour du Pin and Felice Harcourt, *Memoirs* (New York, 1971), 87.

Georges, for a period, he moved to the Palais Royal to live with the next duc d'Orléans, Louis-Philippe II (1747-1793), who soon became enmeshed in revolutionary politics, adopting the name l'Égalité.⁶⁸ In the summer of 1789, Louis-Philippe II switched his membership in the Assembly from the ranks of the nobility to the Third Estate. He became a popular figure among the restless crowds, and the Palais Royal served as a central location for revolutionaries to gather.⁶⁹

As the close-knit world of celebrity and nobility of the *ancien régime* was upended, the dynamics and the power structures of the network changed, but the loyalties frequently did not. Notably, in the autumn of 1789, when Vigée-Le Brun felt threatened by the growing resentment of the Parisians, including crowds that gathered near her home, she stayed for several days with the Brongniart family, until her own residence was again safe.⁷⁰ Berthollet and Monge also remained close to the Brongniart family, and, as I show in Chapter Four, were valuable allies. Brongniart was born just as his father's architectural career gained momentum. He entered a world that offered him a set of open-ended opportunities and rare privilege, and an intellectual and artistic milieu into which he threw himself with exceptional energy.

⁶⁸ "Louis-Philippe-Joseph, duc d'Orléans," *Encyclopedia Britannica*, 2020; Gabriel Banat, *The Chevalier de Saint-Georges* (Hillsdale, NY, 2006), 52.

⁶⁹ Although he voted for the death of Louis XVI, Louis-Philippe did not survive the Revolution. Darrin M. McMahon, "The Birthplace of the Revolution: Public Space and Political Community in the Palais-Royal," *French History*, 10, 1 (1996).

⁷⁰ Gita May and Louise-Elisabeth Vigée-Le Brun, *Elisabeth Vigée-Le Brun* (New Haven, 2005).

CHAPTER TWO: The Progress of an Education, 1786-90

Born into such surroundings, Alexandre Brongniart had an unusually fortunate set of instructors and mentors in both natural history and in the arts. He developed a precocious, enduring interest in natural history and in chemistry, and acquired an artistic understanding that was both theoretical and practical in its focus. In this chapter, I trace the steps Alexandre took toward a broad education during the final years of the *ancien régime* and the early French Revolution. I show that his activity in these years served as a foundation for further pursuits; indeed, every enduring theme in his lifetime of work is represented during this period, including chemistry, mineralogy, anatomy, architecture, and the fine arts. Among the accomplished teachers to whom he and his sisters had access were his uncle Antoine, his cousin Antoine-Louis Fourcroy, Antoine Lavoisier, and Pierre-Joseph Macquer, as well as the painters Jacques-Louis David and François Gérard. These figures held influential political and professional positions, from which, when called upon or needed, they shared their influence or support.

Like many noble and bourgeois families of the *ancien régime*, Brongniart was instructed and guided by his parents and family, with much of his earliest study occurring within the family home. As Alexandre entered his teenage years, he took initiatives toward self-education as well as attending courses at public institutions. As he gained independence, he built and reinforced his personal contacts and developed his networking skills both in France and internationally. Although he was clearly focussed on natural history and chemistry, his options remained open for a career in medicine, or even architecture. Alexandre's education was suitable for many possible careers and paths and was adaptable to the changing political and social landscape. As I demonstrate throughout this thesis, Brongniart's personal relationships and his cultivation of politically and intellectually powerful networks created opportunities that made possible the full expression of his efforts.

Youthful Education in a Privileged Sphere

There is little evidence surviving concerning the content of Alexandre's education during his earliest years, but it was evidently focussed on the development of basic skills such as reading, writing, and mathematics. From a relatively early age, he learned to hunt, ride horses, use firearms, practise taxidermy, and mount the specimens he gathered.¹ He also had a collection of small animals, including guinea pigs, to which he referred as his "menagerie."² He probably took part in the amateur theatricals, observing the staging of plays and attending the performances.³ Alexandre's childhood and teen years coincided with a period of prolific architectural commissions for Théodore. Witnessing the design, construction, and furnishing of the large residences and institutions provided evidence to Alexandre of his place in the world, and of the potential to shape the city and the country in which he lived.

As a young child, Alexandre had a close view of the creative processes of the artists who created the family's portraits. Houdon's terra cotta busts were completed as Alexandre turned seven years old and were exhibited at the salon that same year.⁴ Such a rare experience provided allowed him to observe painting techniques, as well as the use of earthen materials such as clays and plaster of Paris, with which he would be surrounded for most of his adult life. Alexandre studied architecture, drawing, and drafting alongside his father, while exploring a variety of other subjects, including natural history. His education appears to have been guided nearly as much by his uncle Antoine and his cousin Fourcroy as it was by his father, Théodore. In addition to family members, the mathematician François Peyrard (1760-1822) became

¹ Alexandre Brongniart, *Correspondance Active (1791-1825), Correspondance de Famille, Lettres à son père, 1793-95*, AN/668/1, 17-21.

² Alexandre Brongniart to Mme Brongniart, 11 August 1791, *Alexandre Brongniart Papiers personnels*, AN 668/AP/1, 8.

³ While travelling with the Pharmaceutical Corps in 1793, he and some companions wrote and performed their own play. Brongniart, *Lettres à son père, 1793-95*, AN/668/1, 17-21.

⁴ Guilhem Scherf, *Houdon* (Paris, 2006), 156-163, cat. 29.

Alexandre's personal tutor from 1785 to 1787.⁵ As I discuss in detail below, Lavoisier's critical ideas in chemistry had coincided with Alexandre's birth. By the time of the Houdon portraits, Lavoisierian chemistry had become the new paradigm for Brongniart's teachers within the family sphere, including Fourcroy, although it had yet to be known elsewhere. Chemistry would become a primary subject that linked together many of Brongniart's interests and expectations, including mineralogy, medicine, and pharmacy.⁶

In 1786, sixteen-year-old Brongniart began the three-year program at the recently established École des Mines, where he studied under Balthazar Sage.⁷ By 1789, he had also enrolled in courses at the Faculté de Médecine, studying with Théobald Nizon.⁸ Brongniart received his *maître-ès-arts* from the Sorbonne in 1789. He attended Fourcroy's lectures at the Jardin du Roi and worked as his assistant, particularly on topics in chemistry that he could only have learned in the company of Fourcroy, his uncle Antoine, and Lavoisier himself.⁹ While Théodore hoped that his son would undertake a lucrative and creative career in the arts, Mme Brongniart preferred him to take up a medical career. However, both allowed for flexibility in his education and preparation for the future.¹⁰ Although he had plans to return to medical school, as I discuss below, in 1790-91, the unfolding events of the Revolution coincided with a year of study that included independent educational travel to England and to the south of

⁵ Janis Langins, "Histoire de la vie et des fureurs de François Peyrard, bibliothécaire de l'Ecole polytechnique de 1795 à 1804 et traducteur renommé d'Euclide et d'Archimède," *Bulletin de la Société des Amis de la Bibliothèque de l'École Polytechnique* 3 (1989).

⁶ By his late teens, Brongniart was still exploring a wide range of other subjects, including geology. I discuss this further below and in Chapter Four.

⁷ From its founding in 1783, the École des Mines offered a three-year course. Claude Guillemin and Jean-François Poullen, "Deux siècles de minéralogie à l'École des Mines de Paris," *Bulletin de Minéralogie* 107, 1 (1984).

⁸ Louis de Launay, *Les Brongniart : une grande famille de savants*, (Paris: Rapilly, 1940), 52.

⁹ De Launay, *Les Brongniart*, 51. On chemistry instruction in Paris in the late eighteenth century, see: John Perkins, "Chemistry Courses, the Parisian Chemical World and the Chemical Revolution, 1770-1790," *Ambix* 57, 1 (2010).

¹⁰ Jean Julien d'Omalius d'Halloy, *Notice biographique sur Alexandre Brongniart, lue à la séance du 19 mars 1860 de la Société géologique de France* (Paris: L. Martinet, 1860), 1.

France.

The Legacy of Guettard: Lavoisier as Student and Teacher

Lavoisier was a key figure in Alexandre's education, as was Lavoisier's earliest teacher in natural history, Jean Étienne Guettard (1715-86). Lavoisier was twenty in 1763, when Guettard, a friend of Lavoisier's father, began to provide him with instruction in natural history.¹¹ Formerly an assistant to René Réaumur, Guettard had published an early version of a large scale geological map of France in 1746 (see Figure 2.1).¹² From 1747, he was employed as a *médecin-botaniste* and as the keeper of the cabinet of Louis, duc d'Orleans (1703-52).¹³ Guettard's post gave him substantial freedom to travel across France, collecting mineralogical samples and studying the landscape. Critical to the scientific study of several members of Alexandre's network, as well as to French porcelain development, in 1751, Guettard was the first to locate a French source of kaolin, a necessary component for porcelain production.¹⁴ Guettard's discovery was held back from direct publication, at first, out of the interests of the duc d'Orléans, and then by his untimely death in 1752.¹⁵ Problematically for Guettard, the secret was maintained until 1765, when, with the permission of the late Duke's son, Louis-Philippe I, Guettard was finally released to present a memoir at the Academy. The 1765 memoir drew the notice of the minister Henri Bertin (1720-92), a former investor in the French East Indies Company who was, at the time, responsible for the French mining industry. Bertin recognised the importance of such a discovery, as well as the political and economic value of Guettard's maps, providing funding to Guettard in 1766 for the completion of a comprehensive

¹¹ Henry Guerlac, "Lavoisier's Scientific Education," *Isis* 47, 3 (1956): 211, 215.

¹² J. E. Guettard, *Mémoire et carte minéralogique* (Paris, 1746).

¹³ See Appendix 2, Succession of the House of Orléans.

¹⁴ I discuss Guettard's significant contributions to porcelain research in Chapter Five. "Guettard, Jean-Étienne," *Complete Dictionary of Scientific Biography* (Detroit, 2008).

¹⁵ Guettard compiled the series of memoirs and the public arguments in a comprehensive publication, *Mémoires sur différentes parties des sciences et des arts* (Paris, 1768), 117-226.

mineralogical atlas of France.¹⁶

Twenty-three-year-old Lavoisier joined Guettard in the research and fieldwork for the *Atlas*, which lasted over a decade.¹⁷ Lavoisier drew geological sections depicting the strata he observed, which he planned for the margins of each map. By 1780, the first edition of the *Atlas* was published, with each page depicting a particular region in France. However, the edition omitted Lavoisier's planned cross-sections.¹⁸ That same year, the minister Bertin was replaced by Antoine-Grimoald Monnet (1734-1817), with whom Lavoisier was at odds. Lavoisier ceased his official involvement in the map but continued to support the work of Guettard privately. However, Guettard's death in 1786 meant that the incomplete publications were left to be finalized by Monnet.¹⁹

The geological map was not the only study of critical importance to Lavoisier over this period. In 1765, he also presented his first memoir to the Academy, on the chemical behaviour of plaster of Paris, a subject which was probably suggested by Guettard.²⁰ At the same time, he continued to experiment in chemistry, and was elected to the Academy in 1768. Guettard's research in kaolin had spurred vital developments in porcelain-making and in Lavoisier's chemical researches. Lavoisier published his personal research on the geology of the Paris Basin, including a study of the distinct strata, in 1789, the same year that he published his ground-shifting discoveries in chemistry.²¹ The memoir, "General observations on the recent

¹⁶ "Guettard," *Scientific Biography*, 577-9.

¹⁷ Rhoda Rappaport, "Lavoisier's Geologic Activities, 1763-1792," *Isis* 58 (1967).

¹⁸ Josef W. Konvitz, *Cartography in France* (Chicago, 1987), 87.

¹⁹ Rhoda Rappaport, "Early Disputes between Lavoisier and Monnet, 1777-1781," *British Journal for the History of Science* 4, 3 (1969); Jean-Étienne Guettard and Antoine Grimoald Monnet, *Atlas et description minéralogiques de la France* (Paris, 1780).

²⁰ Guerlac, "Lavoisier's Scientific Education," 215.

²¹ Antoine Lavoisier, "Observations générales sur les couches modernes horizontales," *Mémoires de l'Académie Royale des Sciences* (1789); Albert V. Carozzi, "Lavoisier's Fundamental Contribution to Stratigraphy," *The Ohio Journal of Science* 65, 2 (March 1965); Rhoda Rappaport, "Lavoisier's Theory of the Earth," *British Journal for the History of Science*, 6, 3 (1973); Rappaport, "Lavoisier's Geologic Activities," (1967).

marine horizontal beds,” contained ideas generated during Lavoisier’s research on Guettard’s *Atlas* but included observations that went beyond the scope of mapmaking.²² As the plate *Coupe des Bancs Littoraux et Pélagiens* demonstrated, Lavoisier proposed an explanation for successive layers of overlapping sediments (see Figure 2.2). He sought to explain the long-term actions of the ocean tides and levels versus the deposition of sand, shells, and finer particles. While Lavoisier considered the uppermost beds to be “modern” – that is, the result of present-day actions – he also considered that the layered strata gave indications that they were formed by a “very slow oscillating movement” that took place over “several hundreds of thousands of years.”²³ Cross-sections of the exposed beds located at three sites in the Paris Basin included explicit notes on the presence or absence of marine or freshwater shells, as well as notes on the location of petrified wood and amber (see Figure 2.3). Unpublished manuscripts by Lavoisier also contain extensive notations on fossils as mineralogical indicators of specific strata.²⁴

Of course, Lavoisier’s most important achievement was the discovery of the presence and behaviours of oxygen and the dismantling of phlogiston-based chemistry. His chemical experiments took place across the 1770s and came to fruition in the 1780s, a period that corresponded with Alexandre’s education in natural history. The *Méthode de nomenclature chimique* written by Guyton de Morveau, Lavoisier, Berthollet, Fourcroy, Hassenfratz, and Adet, was published in 1787, just as Alexandre began formal study of mineralogy and medicine.²⁵ At one level, the group sought to restructure the inherited naming systems of chemistry, many of which had alchemical origins, and which were often unclear. However, the

²² Lavoisier’s memoir was summarised by Nicolas Desmarests in 1795. Desmarests, *Encyclopédie méthodique: Géographie-physique* (Paris, 1795), 783-91.

²³ Desmarests, *Encyclopédie méthodique*, 787.

²⁴ Carozzi, “Lavoisier’s Fundamental Contribution” (1965), 71-2.

²⁵ Louis-Bernard Guyton de Morveau and Bernadette Bensaude-Vincent, *Méthode de Nomenclature Chimique* (Paris, 1994).

system, based on Linnaean ideals, primarily served as a vehicle for promoting Lavoisier's anti-phlogiston chemistry, of which his co-authors were its earliest proponents. In 1789, Lavoisier published his epoch-making *Traité élémentaire de chimie*, which made his ideas available to a much larger, European audience of chemists.

Brongniart learned chemistry from his uncle Antoine and his cousin Fourcroy, as well as from Lavoisier himself. Macquer was close enough to the Brongniart family that he kept a copy of Houdon's portrait of Alexandre in his home in Gressy-en-France.²⁶ Antoine Augustin Parmentier (1737-1813) who had a laboratory at Les Invalides near the family residence, and Berthollet, whose laboratory was supplied by the duc d'Orléans, were also influential on Brongniart's intellectual development. Seventeen when *Nomenclature chimique* appeared, it is likely that Alexandre was among the first students to be introduced to a purely oxygen-based chemistry, without initially being exposed to standard phlogiston theories.²⁷ Likewise, Lavoisier's 1789 article on "recent marine horizontal beds," was published during a critical period in Alexandre's geological studies, and he was almost certainly aware of the publication, if he had yet to comprehend its full importance.

Chemistry Lessons & Salon Lectures: A Teacher in Training

Beginning in 1786, Brongniart precociously embarked on a transition from student to teacher, presenting a series of courses in chemistry and natural history at his family's residence at Les Invalides.²⁸ Much like a poetry performance, a private theatre production of a play written and performed by household members, or an emulation of the prestigious childhood salon recitals of Mozart, Alexandre's salon lectures became a part of the cultural landscape of

²⁶ Ostergard, *Sèvres Porcelain Manufactory*, 26.

²⁷ Papiers provenant d'Alexandre Brongniart, Cours et enseignements divers à l'Hôtel des Invalides, au Lycée républicain, à l'Ecole centrale et au Muséum, Chimie, BMHN MS 2322.

²⁸ Théodore Brongniart was resident architect at Les Invalides from 1782 to 1792, and the family lived on site. Mosser, *Alexandre-Théodore Brongniart*, 310-4.

ancien régime for his close circle of acquaintances.²⁹ Modelling himself after Fourcroy, whose early interest in theatrical performances led to his famously eloquent lecturing style, or his father Théodore's renowned skill at acting, Brongniart's education emphasized not only the content of his thoughts, but also their presentation.³⁰ These courses provided an opportunity for the young savant to gather his ideas on his previous education and research, as well as to allow him to develop skills in presenting a topic to a diverse audience. No records exist regarding attendance at Brongniart's salon chemistry classes, and it is likely they were limited to the family and their friends. Importantly, Lavoisier himself watched on from the shadows of the family salon on at least one occasion.³¹

Archives indicate that Brongniart began with a three-lesson course in the fall of 1786, and a larger, eight-lesson course the following year on elastic fluids, expanding this to twelve lessons in October 1788. By January 1789, it had grown to twenty lessons.³² The notes for the actual classes of 1786 are not included in the file Alexandre kept, but each of those from 1787 is present. From these eight lessons, the proximity Alexandre had to the novel chemistry of the late eighteenth century can be readily seen. Alexandre's lesson on the nature of fire was derived directly from Lavoisierian chemistry.³³ Attendees of Alexandre's youthful courses were privileged to receive instruction that reflected the most advanced thinking of the day, and Brongniart emphasised that the concept of phlogiston was useless and even fanciful. On this topic he noted:

²⁹ Ilias Chrissochoidis, "London Mozartiana: Wolfgang's Disputed Age & Early Performances of Allegri's Miserere," *Musical Times* 151, 1911 (2010): 83-89.

³⁰ I discuss the family's interest in acting and performance further in Chapter One. Later, in 1795, Cuvier also began to use this approach, basing his lecturing style on the theatrical work of François-Joseph Talma. Theodore Wells Pietsch, *Cuvier's History of the Natural Sciences* (Paris, 2018), 25.

³¹ Paul-Antoine Cap (Gratacap), *Le muséum d'histoire naturelle* (Paris, 1854), 125.

³² Brongniart, Cours et enseignements divers à l'Hôtel des Invalides, BMHN MS 2322.

³³ Antoine Laurent Lavoisier, *Traité élémentaire de chimie*, (Paris, 1789); Guyton de Morveau and Bensaude-Vincent, *Nomenclature Chimique*; Robert Siegfried, "From Elements to Atoms: A History of Chemical Composition," *Transactions* (Philadelphia, 2002).

A few details about Phlogistics: Phlogiston and the manner of which it is spoken must be regarded as an imaginary being, and that the phenomena which it explains should be rejected, being explained in a much more satisfactory manner by the fixing of the base to the air in the body during combustion.³⁴

In Lesson One of his small chemistry classes, Alexandre marked out his knowledge and demonstrated his support of Lavoisier's recently developed theories on which several of his instructors had collaborated. Alexandre began his 1787 course with an overview of the three classes of natural history as defined by Linnaeus: animal, vegetable, and mineral.³⁵ The second lesson focussed on the mineral kingdom, for which he showed two divisions based on the property of combustibility. The first of these ("*les incombustibles*") was divided into "salts" and "earths" and the second ("*les combustibles*") contained "diamond, hydrogen gas, sulphur, metals, bitumen."³⁶ Thus, within the very first lessons, Alexandre brought his own chemical discussion directly into the life of the salon by connecting it to the properties of earthen materials, and by discussing their applications in "*les poteries de terre*" and porcelain, and to the material understanding of precious objects, such as diamonds, (as well as, later, to gold and platinum).

Significantly, Alexandre included diamonds at the head of his discussion of combustible materials. As I discuss in depth in Chapter Five, the research on the combustion and nature of diamonds was conducted in part at Sèvres using the furnaces there under Macquer's supervision, and continued with Lavoisier during the late 1770s using a large glass lens and concentrated sunlight.³⁷ It is likely that Alexandre had some indirect knowledge and understanding of the experiments that had taken place. In addition to the discussion on the combustion of diamonds, he incorporated into his courses the ideas of a number of chemists of his acquaintance, including Parmentier, whose laboratory was housed at Les Invalides, near

³⁴ Brongniart, *Cours et enseignements divers à l'Hôtel des Invalides*, BMHN MS 2322.

³⁵ Dan H. Nicolson, "Stone, Plant, or Animal," *Taxon* 51, 1 (February 2002): 7-10.

³⁶ Brongniart, *Cours et enseignements divers à l'Hôtel des Invalides*, BMHN MS 2322.

³⁷ Christine Lehman, "Pierre-Joseph Macquer," *Osiris* 29, 1 (2014).

the family residence, and Berthollet, whose laboratory was supported by Louis-Philippe, duc d'Orléans. In lesson five, Alexandre addressed organic compounds and fabric dyes, a specialty of both Macquer and, later, Berthollet, both of whom held the post as director of dyes and dyeing at Les Gobelins.³⁸

The 1787 class followed the three kingdoms entirely, demonstrating a breadth of knowledge across the newest research in French chemistry, but it also engaged the audience with the chemistry and properties of ordinary things. Although dyes, porcelains, and diamonds were prestigious applications and areas of exploration in chemistry, they were also intimately connected with the household. Alexandre listed materials and solutions from across diverse categories, often highlighting luxury items such as alcohols, perfumes, chocolate, scented oils, and olive oil. Likewise, he offered examples of medicinal items such as emetics and opium. It reflected the applied chemistry practised by those around him, but it was also a way of engaging his audience with items from their everyday lives. The final two lessons revolved around organic compounds that derived from animals, such as blood, urine, milk, fat, and bile, thus bringing his view of chemistry into the biological, living world. Overall, it was a general survey of the chemical aspects of the natural world.³⁹

His third course of twelve lessons, given during October 1788, covered elastic fluids (gasses), as did his fourth and final class at Les Invalides, given in January 1789. These courses in the behaviour of gasses were taken from the very latest discoveries in Chemistry, and Alexandre pointed to an era of the previous seventeen years, or from 1772 forward, as being the most important in shaping the understanding of this topic. Indeed, 1772, which Henry Guerlac named the “crucial year,” had marked the beginning of Lavoisierian chemistry.⁴⁰ By

³⁸ Lehman, “Macquer”, 250-3; Barbara Whitney Keyser, “Between science and craft: The case of Berthollet and dyeing,” *Annals of Science* 47, 3 (1990).

³⁹ Brongniart, *Cours et enseignements divers à l'Hôtel des Invalides*, BMHN MS 2322.

⁴⁰ Henry Guerlac, *Lavoisier – the Crucial Year* (Ithaca, NY: CUP, 1961).

his fourth year of teaching a class in the family salon, Alexandre had developed his presentation skills as well as his scientific knowledge. At the outset he acknowledged his debt to his cousin, mentor, and teacher, writing:

a distinguished Professor, whose student I am honoured to be, has paved the way for me, which I will try to follow as best I can, however difficult it may be. This course is only an attempt to imitate that of M. de Fourcroy.⁴¹

The first lesson contained a brief history of landmarks in the history of chemistry from 1750, just up to 1772, with the work of the English chemist Joseph Priestley and “finally M. de Lavoisier, etc.” The addition of “etc.” may indicate a discussion of the scientists Alexandre knew personally, such as Macquer, Berthollet, and his uncle, who were all connected with Lavoisier from the early 1770s.⁴² The timeline and the specific reference to the previous seventeen years made clear that Alexandre believed that both Priestley’s work and that of Lavoisier heralded pivotal changes in chemistry. It was from the basis of their work that he began his lessons.

Alexandre’s final two classes described a series of experiments on gasses designed by Cavendish, Priestley, and Lavoisier, among others. Alexandre stated his dual goal of public instruction and self-education in an early draft of the 1788 lectures, writing, “this course being rather an object of utility and instruction for me than for those who do me the honour to listen to me.”⁴³ The repeated and expanded course of twenty lessons demonstrated that he had achieved a significant degree of mastery over the material by January 1789. This course was the first of many in Alexandre’s early career, in which he taught subjects that served to clarify and to organize his own understanding.

⁴¹ In an early draft, concerning Fourcroy, Brongniart had written “disciple” before editing the text to read “élève”: “I am honoured to be a ~~disciple~~ pupil...” Brongniart, *Cours et enseignements divers à l'Hôtel des Invalides*, BMHN MS 2322.

⁴² Brongniart, *Cours et enseignements divers à l'Hôtel des Invalides*, BMHN MS 2322. Priestley visited Paris and met Lavoisier in 1774; see: American Chemical Society, *Antoine-Laurent Lavoisier: The Chemical Revolution* (Paris, 1999), 2.

⁴³ Brongniart, *Cours et enseignements divers à l'Hôtel des Invalides*, BMHN MS 2322.

Alexandre's early classes doubled as a form of self-cultivation, in which he challenged himself to master new material and to further his skills while developing his reputation as a professor. As Stephen Greenblatt demonstrated, social contexts, mores, and politics influenced and constrained the process of self-fashioning. Notable personalities often consciously developed their characters and public personas in view of these circumstances.⁴⁴ From the start, Alexandre's life was embedded in the regulated manners and customs of a deeply socially-conscious bourgeois and noble milieu. Among the personal character traits to which he aspired were civility and intellectual respect, self-confidence (but not conceit), sociability, verbal adeptness, awareness, observation, perception, thoughtfulness, honesty, fair exchange, individual achievement, and personal expertise. He viewed the members of his network, including his father, Fourcroy, and Lavoisier as models for behaviour, comportment, and achievement. The series of salon lectures provide an early window into Alexandre's personality and his intentional processes towards self-development.

Exploration and Knowledge-Seeking Travel

Throughout the 1780s, Alexandre's education continued to centre around activities within his family sphere, although his scientific network was rapidly expanding. On 11 September 1786, Alexandre, his mother, and two younger sisters travelled to Dieppe for a two-week stay. Sixteen-year-old Alexandre began a journal for the trip, writing steadily as the trip progressed, noting the landscape, the terrain, and the natural environment that his group encountered as their carriage rolled northwest from Paris to the coast.⁴⁵ He thoughtfully recorded the atmosphere and weather alongside the family's personal experiences, and he

⁴⁴ Stephen Greenblatt, *Renaissance Self-Fashioning* (Chicago, 2005).

⁴⁵ Alexandre Brongniart, "1st Voyage, from Paris to Dieppe, 1786: Relation of a trip from Paris to Dieppe made by Al. Brongniart, his mother, and his two sisters, 11 September 1786," BMHN MS 2336, 1.

found objects to add to his natural history collections. On the return to Paris, the family stopped overnight in Vaudreuil. Up in the middle of the night to care for an ailing Émilie, his mother was terrified to find a black-faced but bright-eyed goat resting in an armchair in front of the fireplace. Amusedly and tellingly, Alexandre wrote “her fear was about the same as Robinson’s when he discovered a cave in his isle.”⁴⁶ For Alexandre, travel was not just a diversion from his daily life in Paris, it was an adventure and an inquiry, in which an unfamiliar but ordinary interior could evoke far away and mysterious lands. The trip was the first time he created a complete narrative of his experience during the progress of a particular life event, and it was to be one of many separate small notebooks in which he recorded his diverse travels.

Alexandre’s journal keeping continued with the documentation of a local series of walks entitled “Promenades Zoo-Phyto-lythologiques aux environs de Paris par Alexandre Brongniart, 1788, 1789, 1790, 1791.”⁴⁷ Within these pages he recorded a series of nature walks taken with family associates, friends, and natural historians.⁴⁸ These excursions occurred during the same period as the chemistry courses in the family salon at Les Invalides, and included a mix of family friends, young naturalists, and savants.⁴⁹ Notes included the names of the people who participated, while categories of observations included the duration and location of the outings, the weather, and the types of natural specimens encountered. A long list of associates and naturalists took part, including MM. Vauquelin (frères), MM. Desvignes (frères), MM. Rousillon et Amfroy, Mde Bailly, d’Antic, Olivier, d’Orsi père et fils, Grand-Maison, de Jussieu, Renaud, Laurent, de Bondi, Mallet, Geoffroy, Riche, Silvestre, and DuPont. At times, Alexandre travelled alongside a large class of students, such as the

⁴⁶ Brongniart, “1st Voyage, from Paris to Dieppe, 1786,” BMHN MS 2336.

⁴⁷ Alexandre Brongniart, “Zoo-Phyto-lythological walks around Paris,” BMHN MS 2350/1.

⁴⁸ Brongniart later included these small notebooks in a comprehensive file he labelled “Courses et Voyages dans la Bassin de Paris,” thus placing them at the start of his field work for his mature research. BMHN MS 2350/1.

⁴⁹ Brongniart, *Journaux et papiers se rapportant aux voyages*, BMHN MS 2350/1.

“l’herborisation de M. Perille” or that of M. Jussieu, numbering as many as thirty to eighty people.⁵⁰ Trips were made to the forest of Bondy, Versailles, the bois de Montmorency, Sèvres, Fontainebleau, and Montmartre among other locations.⁵¹ Some of the excursions were extended overnight trips into neighbouring villages or into the countryside. On one trip, Alexandre returned from the countryside and Versailles in Lavoisier’s carriage. Although Alexandre recorded little of their conversation, Lavoisier’s gesture of esteem and familiarity was significant enough that he included it in the often-spare personal narrative of his journals.⁵²

Both educational and social, Alexandre’s notations in his accounts of the excursions became increasingly complex over the course of the four years in which he recorded them. In the final two years, he was more frequently in the company of academicians, and he extended his interests from insects and plants to note the mineralogical character of the region. Early notes on the “fruits of the walk” included “some insects” or “a lot of plants and some insects” while, in 1790, he recorded finding “selenite (crystals) and some aquatic insects” or “lenticular gypsum and a *charançon* (weevil).”⁵³ Often, they were both herborizing and hunting trips, in which he gathered specimens for his collections. Gradually, these brief walks gave way to larger trips and expeditions across France, including a lengthy course for young naturalists at Fontainebleau, which he organized for his associates several years in a row. These courses, which I discuss further in Chapter Three, remained semi-private in character, but were centred on fieldwork practices and specimen collection.

⁵⁰ See Appendix 4 for a map and information on the participants.

⁵¹ On at least three occasions, Brongniart recorded stopping for dinner at Sèvres, but no entry reveals if he means he visited the manufactory itself or simply the village and countryside nearby. Brongniart, *Journaux et papiers se rapportant aux voyages*, BMHN MS 2350/1.

⁵² Brongniart, *Journaux et papiers se rapportant aux voyages*, BMHN MS 2350/1.

⁵³ Brongniart, *Journaux et papiers se rapportant aux voyages*, BMHN MS 2350/1.

An Educational Journey to England during the Early Years of the Revolution

The year that passed after the fall of the Bastille on 14 July 1789 saw periods of continued unrest, including a march on Versailles that ended in a deadly riot. Led by a group of Parisian women angry over the soaring prices of bread, the “October Days” of 1789 showed that the population remained both anxious and agitated three months into the Revolution.⁵⁴ Soon thereafter, Louis XVI and Marie Antoinette were relocated from Versailles to the Tuileries, and the National Assembly created a makeshift hall from the royal riding arena, the *Salle de manège*. An uneasy balance existed between the monarchy and the new government, while the latter sought to create a constitution that would establish citizens’ rights and a constitutional monarchy. Additionally, efforts were underway to limit the power of the clergy, and to claim church property for the state.⁵⁵ On 14 July 1790, one year after the fall of the Bastille, during the Festival of the Federation at the Champ de Mars, an increasingly powerless Louis XVI had sworn a declaration to uphold the new constitution. He had not been able to contribute to the document in any way and had no power of veto over it. While significant numbers of the nobility felt the situation in France distressing enough to emigrate, the goals of reform and reorganization found widespread acceptance, including support among the nobility.⁵⁶

During the early phases of the Revolution, the Brongniart family remained in their residence at Les Invalides. The Palais Royal, which was home to the Lycée, became a centre of political activity and information exchange.⁵⁷ Louis-Philippe II was seen as a more liberal potential alternative to Louis XVI, supporting the reforms and engaging in revolutionary

⁵⁴ Jeremy Popkin, *A New World Begins* (New York: Basic Books, 2019), 176-80.

⁵⁵ Popkin, *New World Begins*, 223-5; Simon Schama, *Citizens* (London, 2004), 267.

⁵⁶ Popkin, *New World Begins*, 213-4; Schama, *Citizens*, 262-3.

⁵⁷ Schama, *Citizens*, 114-6, 139, 396; William Doyle, *The French Revolution* (Oxford, 2001), 104-7.

politics.⁵⁸ Alexandre was still young enough to be able to prioritize his education rather than becoming involved in Revolutionary politics, and, temperamentally, was not inclined toward vocal activism. However, like many of his acquaintance and class, he was open to reform measures. He showed interest in the efforts of the Assembly and was positive about the potential for the new government.⁵⁹ There was widespread public anxiety in the first year of the Revolution, but there is little sign that Brongniart found the political events an obstacle to his education. In the summer of 1790, he left Paris for London on his first independent, long-distance trip, as well as his first outside the borders of France. The voyage would enable him to experience British culture and to learn from the best of the savants of London. He began a new journal that displayed the combination of purposefulness and effort that he had first demonstrated in his writings on the 1786 family trip to Dieppe. Alexandre's interests were rooted in the examination of the world around him, whether constructed and artfully designed, technological, or natural.⁶⁰

Dorinda Outram has shown that Cuvier followed a similar course of travel and self-education between 1789-95. Cuvier moved from Stuttgart to Caen, where he was employed as a tutor in the household of the Marquis and Marquise d'Héricy. He was initially expected to take his pupil, Achille, on an educational tour throughout Europe in 1792, although the trip did not materialize.⁶¹ While in Caen, Cuvier consistently supplied highly detailed and informative letters to support and sustain the natural history society he had formed with his friends in Stuttgart.⁶² In addition, he actively cultivated intellectual contacts in Paris and at the Muséum.⁶³ The Revolution altered his travel plans, but his situation also gave him time to focus more

⁵⁸ Popkin, *New World Begins*, 110, 123, 126; Doyle, *French Revolution*, 128.

⁵⁹ Alexandre Brongniart, *Journaux de voyage et journaux intimes, Journal 1790-1795, de Paris à Londres*, "1790, Voyage No 1, Angleterre," BMHN MS 3357, 1-51.

⁶⁰ Brongniart, "1790, Voyage No 1, Angleterre," BMHN MS 3357.

⁶¹ Outram, *Cuvier*, 33.

⁶² Outram, *Cuvier*, 31.

⁶³ Outram, *Cuvier*, 42-4.

closely on his research in natural history.⁶⁴ Neither Cuvier nor Brongniart found the revolutionary years an overwhelming obstacle to the development of their knowledge base and the acquisition of research skills.

For Alexandre, crossing the English Channel in early August 1790 was as much an investigation as it was a passage. He made his way through London, forging relationships with artisans, botanical artists, savants, physicians, and other notables. The network he created in London stemmed from the introductions of his Parisian contacts and mirrored the privileged access to the elite world of his Parisian experience. He visited workshops, factories, engineering marvels, and architectural landmarks, as well as collections and cabinets. Rather than a casual vacation, Alexandre completed an educational tour over the course of nearly three months of nearly independent travel, much of which was in the company of family associates or alongside newly acquired English contacts.⁶⁵

In travelling to England, Alexandre was participating in the practice of educational and formative tours commonly taken by elite young men during the late eighteenth century.⁶⁶ These trips were organized to provide intellectual and personal development, and to enable a young student to gain first-hand experience of people and places outside his customary sphere. Although the typical educational trip was intended to provide a rounded experience, they were as diverse as those who had the advantage of participating in the practice. Educational tours were not always successful. In 1781, for example, Georges Louis Leclerc, Comte de Buffon (1707-88) had sent Jean Baptiste Lamarck (1744-1829) as a companion and guide for his son, Georges Louis Marie Leclerc de Buffon (1764-94). Throughout the tour, Buffon's son behaved badly, treated Lamarck with disdain, and took little interest in the educational aspects of the

⁶⁴ Outram, *Cuvier*, 37.

⁶⁵ Brongniart, "1790, Voyage No 1, Angleterre," BMHN MS 3357.

⁶⁶ See Brian Dolan, *Exploring European Frontiers* (London, 2000); *Ladies of the Grand Tour*, (London, 2015).

trip.⁶⁷

By contrast, in 1785 the la Rochefoucauld brothers, François (1765-1848) and Alexandre (1767-1841) accompanied their tutor, Maximilien de Lazowski, on a tour of England.⁶⁸ On this voyage of three-and-a-half months, the brothers and de Lazowski travelled by private carriage throughout the country, assiduously recording the sights they saw, including factories, industrial innovations, and farming methods. Many of the commercial concerns the brothers visited might have been off-limits to those seen as potential competitors, but since the trio was young and on an educational tour, they were often given extraordinary access to industrial areas.⁶⁹ On other occasions, such as at the cotton mills at Manchester, they were seen as potential threats to the business, and were refused entry.⁷⁰ Here, François was disappointed as he wished to compare the factories to those he had seen in Derby. He did, however, report in detail about the fabrics and threads he was shown. He also wrote knowledgeably about the action of the looms in a factory that made tapes, ribbons, and garters.⁷¹ The information the brothers and their tutor collected included the differences between British and French large-scale operations such as factories and farms, as well as the social attitudes and behaviours of the people they met, the quality of roads, and the kinds of accommodations available. The knowledge they sought was general and the trip also had a social orientation, although each of the young men worked to include as many overtly useful observations as possible.⁷²

Alexandre inhabited much the same world as the Rochefoucauld family, living comfortably in the seventh arrondissement in Paris, albeit with a difference in outlook based

⁶⁷ The experience, to Lamarck, was one of lasting distress and disappointment. Richard W. Burkhardt, *Spirit of System* (Cambridge, MA, 1977), 10.

⁶⁸ Their extensive, letter-style journals to their father, the duc de Liancourt (1747-1827), have been compiled and translated into English. Norman Scarfe, *Innocent Espionage* (Woodbridge, Suffolk, 1995).

⁶⁹ Scarfe, *Innocent Espionage*, xix.

⁷⁰ Scarfe, *Innocent Espionage*, 62.

⁷¹ Scarfe, *Innocent Espionage*, 66.

⁷² Scarfe, *Innocent Espionage*, 1-9.

on a considerably smaller fortune. The Brongniart family residence at Les Invalides and the recently constructed Maison Brongniart were in the same general neighbourhood as that of the Rochefoucauld family. The living arrangements of the Brongniart family suggested a high status, but Théodore's architectural projects were often created in partnerships that involved a financial risk, rather than coming from the protective basis of a large fortune. Although Théodore had numerous clients and sufficient income in the period prior to the Revolution, the Brongniart family position was highly dependent on the patronage and employment provided by wealthy contacts.⁷³ Alexandre's voyage to England reflected the transitional nature of his family's status, being both noble in status but tied to bourgeois concerns of business and artisanship. He could easily connect with elite politicians or nobles, but was likewise comfortable in the company of artisans, painters, and tradesmen. Rather than travelling by private carriage, or even by coach, and without a chaperone or a tutor, he frequently walked across the countryside and consciously conserved expenditures.⁷⁴

During Alexandre's stay in England, he met another young traveller, Thomas Christie (1761-96), who was recommended by the physician Matthew Baillie as someone who could help Alexandre plan his visit to Derbyshire.⁷⁵ Christie had spent six months on a trip through Great Britain in 1787, and in early 1790 had taken a further six-month voyage in France. Christie's travels across the two countries of France and England led him to become a political activist and commentator, publishing his thoughts in favour of the reforms of the Revolution in 1791.⁷⁶ The two young explorers had much in common, including natural history and medical study, but Alexandre was moving very quickly in order to arrange his trip, and wrote

⁷³ Mosser, *Alexandre-Théodore Brongniart*, 27-30.

⁷⁴ Brongniart remained in the company of his friend, Pierre Desvignes, for most of his journey in England. Brongniart, "1790, Voyage No 1, Angleterre," BMHN MS 3357.

⁷⁵ Brongniart, "1790, Voyage No 1, Angleterre," BMHN MS 3357.

⁷⁶ Thomas Christie, *Letters on the Revolution of France* (London, 1791).

little of their conversations.⁷⁷ Christie had also planned to publish the story of his own voyage, which he had written in a series of letters, but died before he was able to do so.⁷⁸ Clearly, however, record keeping either for personal use or for publication was a ritual part of the educational journey for each of these young men.

Alexandre's travel companions included members of the Desvignes family, who worked in both France and England, but claimed British citizenship. Peter (Pierre) Hubert Desvignes (c.1737-c.1793) was a chemist, jeweller, and goldsmith working in London from at least the early 1770s. He was accompanied in London by his two sons: Peter (Pierre) Hubert Desvignes (c.1770-1813) and Elise Hubert Desvignes (c.1771-1844).⁷⁹ In the late 1780s, the Desvignes brothers studied natural history with Alexandre in Paris and participated in Alexandre's nature walks between 1788 and 1791.⁸⁰ Like Alexandre, the brothers were interested in architecture and the decorative arts. Alexandre shared a room with the eldest brother, Peter, and the pair travelled together throughout the summer. On one of the first nights, Alexandre joined his companions for dinner in an inn frequented by the community of French jewellers working in London.⁸¹ It is impossible to know if this was merely a matter of circumstance as a travelling companion to the Desvignes family or if it was intentional networking based on Alexandre's plans for the weeks ahead.

An association with French diplomats made his stay in London easier and gave him a different kind of social outlet. On 12 August 1790, Alexandre made his way to the home of the ambassador, Armand-Marc, comte de Montmorin (1745-92). He became a frequent guest, in

⁷⁷ Rev. Alexander du Toit, "Christie, Thomas (1761–1796)," in *Oxford Dictionary of National Biography* (Oxford, 2004).

⁷⁸ du Toit, "Christie, Thomas (1761–1796)."

⁷⁹ Several references to the Desvignes family appeared in Brongniart's journals between 1789-96. Biographical details of the Desvignes family are limited. See Desvignes Family Tree, Appendix 1.

⁸⁰ Brongniart, "Promenades zoo-phyto-lythologiques aux environs de Paris," BMHN MS2350/1.

⁸¹ Brongniart, "1790, Voyage No 1, Angleterre," BMHN MS 3357.

addition to receiving and sending mail and packages via the ambassador. Alongside the comte de Montmorin were his son, Calixte de Montmorin Saint-Hérem (1771-94), and his daughter, Victoire Montmorin de la Luzerne (1765-94) as well as César Guillaume, comte de la Luzerne (1763-1833).⁸² A business errand provided an alternate motivation for Alexandre's trip to London, and he paid several visits to the home of the exiled Controller-General of Finances Charles Alexandre de Calonne on behalf of his father. In the end, Alexandre's visits appear to have been productive, and Brongniart was assured of a forthcoming payment of some amount owed to Théodore.⁸³ Having succeeded in his efforts, Alexandre did not make social visits to Calonne during the remainder of his trip.⁸⁴ However, he did return at the end of the summer with a message from his father, which suggests that some precaution was being taken by the Brongniart family to carry the messages to Calonne personally rather than through the post.⁸⁵

Applications in Chemistry: A Memoir on Enamelling

Alexandre dedicated himself to a major project in applied art and chemistry while in London, working alongside the elder Desvignes. Desvignes was described as a chemist by the Communal Assembly of Paris, of which he was an elected representative.⁸⁶ In London, he produced fine silver tableware, candlesticks, and domestic objects, as well as enamels, crafts

⁸² Mosser, *Alexandre-Théodore Brongniart*, 15; Their relationship was relatively close, and during his travel through Oxford, Brongniart was entrusted with an undisclosed errand for Mme de la Luzerne at Blenheim Palace. Brongniart, "1790, Voyage No 1, Angleterre," BMHN MS 3357.

⁸³ Brongniart, "1790, Voyage No 1, Angleterre," BMHN MS 3357, 9.

⁸⁴ Brongniart, "1790, Voyage No 1, Angleterre," BMHN MS 3357, 225. In 1788, Calonne married Mme de Harvelay (born Anne-Rose de Nettine), tentatively identified by Georges Kersaint as a Fourcroy cousin. See Kersaint, *Fourcroy* (Paris, 1963), 23-4.

⁸⁵ Brongniart, "1790, Voyage No 1, Angleterre," BMHN MS 3357, 9.

⁸⁶ Haim Burstin, *Une révolution à l'oeuvre: Le Faubourg Saint-Marcel, 1789-1794* (Seyssel, 2005), 255, 972. The Communal Assembly of Paris was formed in 1790 to reform the city's administration. Gary Kates, *The Cercle Social, the Girondins, and the French Revolution* (Princeton, 2014), 34.

that represented applied chemistry in cohesion with artistry (see Figure 2.4).⁸⁷ Metalcrafts, enamelling, and silversmithing required a knowledge of mechanics, alloys, tooling, heat treating, interactions between materials, and the chemistry of mineral colours. Painted and fired enamels could have a functional role as an applied component that added heat protection or acted as a cover for a joint or structural element, or they might be purely a decorative object on their own. Desvignes' expertise gave Brongniart an opportunity to practice applied chemistry and to study material behaviours first-hand.

At Desvignes' London studio, Alexandre began with observation and drawings, before working on his own projects. Given that he had been associated with the Desvignes family for some time, and that there were several jewellery workers, gemmologists, and artisans among his acquaintance in London, it is likely that this was a planned study. Although he worked in Desvignes' workshop for several days, Alexandre wrote only brief entries on the efforts in his journals. However, at the end of this busy month in London, he speedily wrote a memoir on the craft, its colours, and its chemical processes. Before leaving, he sent the article, his first significant memoir, to Paris and published it in the writings of the Société Philomathique.⁸⁸

The enamel project relied upon a synthesis of artistry, material understanding, and chemistry, and Alexandre's study of enamel colouring and firing benefitted from his

⁸⁷ William Chaffers, *Gilda Aurifabrorum* (London, 1883), 194; Mary Cooke Antiques, *An important & extremely rare George III Adam Oil & Vinegar Cruet made in London in 1776 by Peter Desvignes* (2022). <https://marycooke.co.uk/british-silver-1760-1830/an-important-extremely-rare-george-iii-adam-oil-vinegar-cruet-made-in-london-in-1776-by-peter-desvignes>.

⁸⁸ Brongniart, "1790, Voyage No 1, Angleterre," BMHN MS 3357, 16. The memoir on enamels was included in an early publication of the Société Philomathique in 1790. However, the 1790 *Bulletin des Sciences* was made by a copyist (Marie Aimée Steck, née Guichelin), for limited circulation. Brongniart published a brief entry on his trip to England in the August 1791 *Bulletin* (No.2). When the society's memoirs were published as a collection in 1799, the edition began with the 1791 *Bulletin* (No.2). The enamelling memoir also appeared in the *Annales de Chimie* in 1791. Alexandre Brongniart, "Voyage de Paris à Bakewell," *Bulletin Société Philomathique* 2 (August 1791); Société Philomathique de Paris, *Bulletin des sciences, de Juillet 1791 à Ventôse An 7* (Paris, 1799), 3; Alexandre Brongniart, "l'Art d'émailleur sur métaux," *Annales de Chimie* 9 (Paris, 1791), 192-214.

understanding of Lavoisierian chemistry. The process for enamelling included using equipment such as the blowpipe, an instrument that was also used by Lavoisier and others for the study of the chemical properties of minerals (see Figure 6.2, #16).⁸⁹ Although Alexandre specifically discussed metalworking processes, enamelling on metal was related to processes in glass, porcelain, and pottery decoration. Crucially, the reactions central to colour development in firing processes were much more effectively understood with the knowledge of the actions of oxygen than was possible with the Stahlian phlogiston theories still heavily in use.⁹⁰ Alexandre described the use of metal oxides to apply colours to metal surfaces, noting which colours the oxides could make, such as iron oxide to make red or lead oxide to make yellow. He detailed the process of firing the colours and of polishing them with a common clay often found at an *épiciier*, that had been carefully levigated to remove impurities and silica until “pure.”⁹¹

Alexandre related his work in London to the experiments and techniques described in *l’Art de la verrerie de Neri, Merret et Kunckel* but updated its seventeenth-century language to match the new nomenclature of Lavoisierian chemistry.⁹² He noted the difficulty of creating new colours for enamelling, and recognized that many colours were kept as secret processes, although basic techniques were well known.⁹³ He discussed the questions related to the behaviour of the various colours and metal when exposed to fire, but had, at such an early stage in his investigations, not yet arrived at a satisfactory answer. However, his research questions

⁸⁹ Marco Beretta and Paolo Brenni, *The Arsenal of Eighteenth-Century Chemistry* (Leiden, 2022), 35-40. I discuss Brongniart’s use of the blowpipe further in Chapter Seven.

⁹⁰ Oxidation-reduction reactions, which depend upon the removal or addition of chemically bound oxygen molecules, were a cornerstone of Lavoisierian chemistry. I discuss this further in Chapter Five.

⁹¹ Brongniart, “l’Art d’émailleur,” 192-214; 202.

⁹² Antonio Neri, *Art de la verrerie de Neri, Merret et Kunckel* (Paris, 1752). The adoption of Lavoisierian nomenclature was not immediate in all places. For example, as Matthew Eddy had indicated, in 1798, John Walker wrote that, although he respected Lavoisier’s scientific achievements, he found fault with their system of nomenclature. *Language of Mineralogy* (London, 2016), 194.

⁹³ Brongniart, “l’Art d’émailleur,” 194.

were directed at the role of oxygen. It was useful that his research centred on enamel applied to three metals: gold, silver, and copper, as gold reacted the least, while both silver and copper reacted visibly with oxygen.⁹⁴ His study, while limited, was one of the earliest to examine methods of artisanal practice in updated, Lavoisierian terms, and it demonstrated his mastery of its concepts at an early stage in the use of the new principles.

Valuable Introductions and Associations

As Alexandre added to his acquaintances in London, he further expanded his potential for new contacts. He was supplied with letters of introduction by the prominent naturalist Pierre Marie Auguste Broussonnet (1761-1807), who had travelled extensively in England and France, working with a number of naturalists including the President of the Royal Society, Joseph Banks (1743-1820) in London, and John Sibthorp (1758-96) in Oxford.⁹⁵ Brongniart visited Banks early in his stay, where he was introduced to Jonas Dryander (1748-1810), Banks' assistant and librarian.⁹⁶ Alexandre was given access to Banks' collections where he examined the various specimens in the botanical collection and took note of their preservation techniques. Additionally, he studied the engravings and drawings for the *Florilegium*, a botanical book Banks had hoped to publish based on his travels on the *Endeavour*. The engravings for the *Florilegium* were based on several hundred preliminary drawings by Sydney Parkinson (1745-71), who had died while on the voyage.⁹⁷ Brongniart particularly admired the illustrations of Franz Bauer (1758-1840), whom Banks had hired as botanical illustrator at Kew. He became a regular visitor to the collection during his London stay.⁹⁸ Alexandre's

⁹⁴ Brongniart, "l'Art d'émailleur," 214-5.

⁹⁵ Keir B. Sterling, "Sibthorp, John (1758–1796), botanist," *National Biography* (23 September 2004).

⁹⁶ Edwin Rose, "From the South Seas to Soho Square: Joseph Banks's Library, Collection and Kingdom of Natural History," *Notes and Records of the Royal Society of London* 73, 4 (2020).

⁹⁷ Joseph Banks et al., *Joseph Banks' Florilegium* (London, 2017.)

⁹⁸ Brongniart, "1790, Voyage No 1, Angleterre," BMHN MS 3357.

privileged access to Banks's cabinet and library was a mark of both his social status and of his merit in his knowledge of natural history.

On the recommendation of Broussonnet, Brongniart also visited Sir James Edward Smith (1759-1828), a wealthy botanist who had recently purchased the personal library of Carl Linnaeus (1707-78) and founded the Linnaean Society of London.⁹⁹ Smith showed Alexandre books from the collection and provided him with a letter for London physician Matthew Baillie (1761-1823), who practised privately and also served as physician to George III.¹⁰⁰ With Baillie, Alexandre visited both his cabinet and his hospital, St George's, in London. Another physician who welcomed Alexandre was Sir William Blizard (1743-1835), who founded the medical school at the London Hospital, the first institution of its kind.¹⁰¹ Both Blizard and Baillie took Alexandre with them on their daily visits around the two hospitals. Alexandre recorded the high number of amputations that took place at the London hospitals, attributing the increase, relative to Paris, to the atmosphere and weather of England. He observed the cleanliness, the use of iron beds, and the overall lack of unpleasant odours. At the London Hospital, he described the operating theatre, the laboratories for chemistry and for dissection, as well as the "anatomy museum."¹⁰² With Baillie, he watched an operation that required an incision that Alexandre surmised had succeeded very well.¹⁰³ In all, he considered that the medical procedures were done carefully, but there was, at this stage in his education, little depth to his observations on specific procedures. Although medicine was an enduring interest, and,

⁹⁹ A. T. Gage, *Linnean Society of London* (London, 1938); Linnaean societies were developed elsewhere, including one founded by Broussonnet in Paris, which met from 1787 to 1793, but was disbanded during the Revolution. Pascal Duris, "Les Sociétés linnéennes françaises et le culte de Linné (1780-1830)," *Bulletin de la Société Botanique de France* 136, 3 (1989), 179-185.

¹⁰⁰ "Baillie, Matthew," *Scientific Biography* (Detroit, 2008).

¹⁰¹ Michael Bevan, "Blizard, Sir William (bap. 1744, d. 1835)," *National Biography* (Oxford, 2004).

¹⁰² Brongniart, "1790, Voyage No 1, Angleterre," BMHN MS 3357, 14,16.

¹⁰³ Brongniart, "1790, Voyage No 1, Angleterre," BMHN MS 3357, 14.

at the time, a course of study, these visits were general tours of the facilities and brief overviews of the methods.

Other prominent physicians and naturalists provided patronage by way of letters of introduction. Dr. Samuel Foart Simmons (1750-1813) became a supportive contact, facilitating Alexandre's access to more cabinets, including a letter for Dr. Edward Whitaker Gray (1748-1806), keeper of the natural history collections of the British Museum.¹⁰⁴ Simmons offered willing assistance in locating other contacts, as well as sharing his medical knowledge. One such contact was John Francillon, (1744-1814), who worked as a naturalist, as well as a lapidary and gemmologist. He had a notable cabinet and sold prints and drawings related to natural history.¹⁰⁵ Alexandre wrote at length of Francillon's collection of insects and butterflies.¹⁰⁶

Francillon took Alexandre to the Hammersmith residence and nursery of James Lee (1715-95). The nursery, called "the Vineyard" was one of the most important in Europe, supplying exotic plants to both Kew and gardens in France.¹⁰⁷ Here, Alexandre was given the opportunity to examine the insect collection of Lee's recently deceased daughter, the botanical artist Ann Lee (1753-90).¹⁰⁸ Although Alexandre visited and spent prolonged hours working in cabinets, including drawing at Francillon's cabinet, he made few detailed descriptions of their holdings. However, he did learn methods for the preparation, organisation, and display of

¹⁰⁴ Simmons practised in London, specializing in treatment for the mentally ill. In 1804, Simmons was appointed to care for George III. Helen Brock, "Simmons, Samuel Foart," *National Biography* (2004). Edward Whitaker Gray was Keeper of the British Museum's natural history collection until his death in 1806. Anita McConnell, "Gray, Edward Whitaker," *National Biography*, 2004.

¹⁰⁵ F. Farges, "French Blue and the New Hope," *Gems and Gemology* 45, 1 (2009).

¹⁰⁶ Brongniart, "1790, Voyage No 1, Angleterre," BMHN MS 3357, 10.

¹⁰⁷ A second partner was Lewis Kennedy (1721-1782). E. J. Willson, *James Lee and the Vineyard Nursery, Hammersmith* (London, 1961).

¹⁰⁸ Ann Lee studied botanical drawing with Sydney Parkinson (c.1745-1771). A. M. Lysaght, "Banks' Artists and His Endeavour Collections," *Captain Cook and the South Pacific*, ed. T. C. Mitchell, (Canberra, 1979): 15.

objects. Late in his stay, he visited James Parkinson's (1755-1824) cabinet in Albion Street, with which he was highly impressed. Having seen many collections during his voyage, he now saw how natural specimens could be treated with better care and organization.¹⁰⁹ Additionally, he examined methods of illustration and made a series of drawings throughout his trip. Drawing was a skill Alexandre practised frequently, creating illustrations for his own research, including animal dissections, earth formations, machine and mine diagrams, architectural sketches, and projected designs. His journals of the 1790s are often illustrated much in the manner of a lab notebook, with small sketches in the margins. It is likely that he learned much more from visiting collections and botanical artists than he was able to record in his journals.¹¹⁰

Parallel Worlds of Contemporary Architecture

Early in his London stay, like most tourists, Alexandre made a visit to St Paul's Cathedral to take in the view from the top. Rather than being swept away by wide views of London and the Thames, or marvelling at the engineering feats of the cathedral, Brongniart instead examined the detail of its material structure. He did not mention the workmanship or the fineness of the surfaces, but instead their content, material, and function. Unlike the romantic detail of his 1786 journal, in which he enjoyed the sudden changes in landscapes that revealed expanded vistas, his record of the visit to St Paul's was that of a thoughtful investigator. Alexandre observed that the London ironwork was problematically subject to rust, and as a result, that many surfaces were clad in lead. Moving from the metals, he examined the stonework. However, here his interest once again drew itself to the mineralogy, observing that the stone was full of marine life and shells, which had degraded less than the surrounding

¹⁰⁹ Brongniart, "1790, Voyage No 1, Angleterre," BMHN MS 3357, 34.

¹¹⁰ Brongniart, "1790, Voyage No 1, Angleterre," BMHN MS 3357, 1-38.

Alexandre Brongniart, "Observations pour servir à la myologie des singes, par Alexandre Brongniart. Paris, 15 germinal an IV," in *Papiers de Georges Cuvier, Travaux d'anatomie comparé*, BMHN MS 607.

rock.¹¹¹ His observations revealed the tendency toward both separation and synthesis within the nature of his thinking – every whole returned back to a complex system of parts, and the intrinsic properties of the materials defined their behaviour. The rusting away of the iron could be countered by the protective nature of lead.¹¹² The naturally occurring composite materials, such as the building blocks of the cathedral, were made up of a soft, non-impervious limestone that could be contrasted with the more durable fossils it contained. The architecture of the cathedral was an example of the intermingling of organic materials and inorganic structural elements. Alexandre’s view moved between the composites and the components, while constantly seeking their reciprocal effects.¹¹³

The architect Samuel Pepys Cockerell became one of Alexandre’s most important contacts in London. Cockerell, whose most notable building project was Admiralty House, Whitehall (built between 1786 and 1788), held professional positions very similar to those of Théodore, including serving as Surveyor of the Foundling Hospital of London.¹¹⁴ Although not all his ambitious plans were implemented, Cockerell worked on several urban projects and designs. Alexandre saw Cockerell frequently during his stay, joining him for dinners at his home, or drawing and reading architectural books in his library. They took various architectural sightseeing tours together – first with a tour of Cockerell’s residence, then of London landmarks and current projects.

One site he recorded was the house of the third Duke of Portland, William Cavendish-Bentinck. During the 1790s, Cockerell was working on a survey of the Portland family estate at Soho, but it is unclear from the journal if Alexandre was referring to a townhouse the duke

¹¹¹ Brongniart, “1790, Voyage No 1, Angleterre,” BMHN MS 33578, 8.

¹¹² Giorgio Torraca, *Lectures on Materials Science for Architectural Conservation* (Los Angeles, 2009), 138-40.

¹¹³ Brongniart, “1790, Voyage No 1, Angleterre,” BMHN MS 3357, 8.

¹¹⁴ Michael W. Fazio, Benjamin Henry Latrobe, and Patrick Alexander Snadon, *Domestic Architecture of Benjamin Henry Latrobe* (Baltimore, 2006), 23-81.

held in Whitehall, or the grand family home of his wife, Devonshire House, in Piccadilly. The Adam brothers, (Robert, John, and James) had created designs in the 1770s for a large London residence for the duke to be called Portland House, on Cavendish Street, near Mansfield Street, a street previously laid out by the Adam brothers. Although the streets were created and the site established, the house itself was never built. This type of urban planning and speculation would have interested Alexandre deeply, as it directly mirrored the kinds of works his own father created in Paris. Additionally, Cockerell took Alexandre to see the speculative project of the Adams brothers called the Adelphi Buildings (built during 1768-1784). These were a mixture of residencies that were constructed along the Thames as a part of a multipurpose development. The plan for the Adelphi Buildings was an urban solution to upgrading an undesirable neighbourhood. The basement and ground level floors along the Thames were warehouse spaces, stables, shops, and covered roads, while the upper floors consisted of a variety of residences integrated into one site, all situated on only three acres of land.¹¹⁵ Additionally, Alexandre and Cockerell visited the residence of the Prince of Wales, George Augustus Frederick (1762-1830) – presumably Carlton House – which was then undergoing elaborate remodelling (lasting from 1783-96).¹¹⁶

On another tour, Cockerell and Alexandre visited the home of James Pitt, Earl of Chatham (1756-1835) on which Cockerell had done work on the interior. From there, they went to the banks of the Thames near Blackfriars Bridge to see Albion Mills, at the time the largest and most important mill in London.¹¹⁷ Newly built, it was an engineering feat, containing numerous steam-operated milling machines. Moving by boat to London Bridge, Cockerell and Alexandre stopped to look at the Bank of England, before taking another ride

¹¹⁵ Colin Thom, “How Diocletian’s Palace Inspired Robert Adam’s Most Audacious Development – the Adelphi,” in *Robert Adam and Diocletian’s Palace in Split*, eds. Joško Belamarić and Ana Šverko, (Zagreb, 2017).

¹¹⁶ Fazio, *Latrobe*, 172-6.

¹¹⁷ A. W. Skempton, “Samuel Wyatt and the Albion Mill,” *Architectural History* 14 (1971).

down the Thames to Greenwich. The Greenwich Hospital was similar to Alexandre's own residence and surroundings at Les Invalides in Paris and was no doubt a compelling location for him. If these outings were, in ways, social events and typical tours of London architecture and houses, they were atypical in that the two men were so intimately connected with the process of planning and overseeing large construction projects, including urban planning, and residences of the nobility.¹¹⁸ Alexandre did not record the details of their conversations, nor are there any publicly archived letters to his father from this summer trip, but there was very likely a beneficial and reciprocal exchange of ideas between Alexandre and Cockerell.

Beyond London: English Natural History, Industry, Mineralogy, and Landscape

Toward the end of their summer, Alexandre and his travelling companion, Peter Desvignes, set out to spend two weeks touring England. In Oxford, they stopped to visit the botanist John Sibthorp, another contact provided by Broussonnet.¹¹⁹ Not finding Sibthorp, the pair located Ferdinand Lucas Bauer (1760-1826), a botanical artist who was the younger brother of Franz, the artist at Kew whose work Alexandre had admired so much on his first visit to Cook's library. In addition to seeing a few colleges, they visited the botanical garden, the Ashmolean Museum, and the Sheldonian Theatre.¹²⁰ Much like the tour of the la Rochefoucauld brothers, this was to be a series of visits to prominent sites in natural history and in industry. As he added to his geological knowledge, his mind focussed on the land around him and he recorded the soil types he saw, their composition, and the terrain in which they were located. He preferred walking across the countryside to take in the environment, and the

¹¹⁸ On the architectural commissions of Cockerell see Fazio, *Latrobe*; for Théodore Brongniart, see, Mosser, *Alexandre-Théodore Brongniart*; Silvestre de Sacy, *Alexandre-Théodore Brongniart*.

¹¹⁹ Broussonnet had done fieldwork with Sibthorp in France in the 1780s. Sidney Lee and Georges Simonds Boulger, *Dictionary of National Biography*, vol. 52, *Shearman-Smirke*. (London, 1897), 189-91: 189.

¹²⁰ The "old Ashmolean" on Broad Street, now the Oxford Museum of the History of Science.

pair walked from Oxford and Blenheim to Birmingham. Nearing Birmingham, he noted that the ground contained large deposits of grey clays, and that there was a corresponding industry of brickmaking nearby, as well several coal mines in the region. With these observations, he drew a natural correlation between environment and industry, as well as to the geological relationship of adjacent clay and coal deposits.

Throughout his stay in England, Alexandre visited various factories to see the processes and innovations. One of the first of these was a factory in Deptford that also served as a foundry for copper and iron, which he visited with la Luzerne. He concerned himself with the mechanisms and how they worked, noting the intricate details of the complex systems of pulleys and wheels. At Deptford, his written account was limited to the outer impression that this factory produced. Likely, the works were too complicated to sort out with only a casual first viewing. It was more a visit to satisfy a question of curiosity than one of thoughtful understanding. At Birmingham, Alexandre and Peter went to a factory run by Samuel Hands that made metal buckles that could be attached to shoes and slippers with hooks. These were mass-produced and low-cost versions that mimicked the handmade silver buckles favoured by the wealthy. At Hands' factory, they observed the mechanical processes for cutting and stamping metal.¹²¹ Both travellers were fascinated by the metalworking techniques of the factory, which was particularly useful to Peter, who followed in his father's silversmithing trade by becoming a watchmaker and metal artisan.¹²²

For one outing, the two travellers rented a horse for the purpose of riding to a coal mine near Denby.¹²³ By now, Alexandre's interests in the nature of the Earth were beginning to

¹²¹ In 1793, The Universal Magazine announced the bankruptcy of Samuel Hands along with his partners Robert Burton Cooper and Thomas Wright, "buckle-makers." Maxine Berg, *Luxury and Pleasure in Eighteenth-Century Britain* (Oxford, 2005); *Universal Magazine of Knowledge and Pleasure* (London, 1793), 237.

¹²² G. H. Baillie, *Watchmakers and Clockmakers of the World* (London, 2013), 84.

¹²³ Denby is now the site of a notable stoneware and porcelain manufacturer, founded in 1809. See Llewellynn Jewitt, *Ceramic Art of Great Britain* (London, 1878), 129.

coalesce into solid practical understanding, beneficial both for developing his geological ideas and for mineral identification and exploitation. At the mine, Alexandre carefully noted its exterior features as well as the simple mechanisms by which it operated. There was no steam pump, but instead a horse-driven system was used to pull the coal out of the mine. The mine was 100 feet deep, and the miner who led the way gave them each a loose-fitting coat to protect their regular clothing. Alexandre was last behind Peter and the miner as the three worked their way slowly down by holding onto a rope, each secured partially by a chain and a board that passed behind them. On their way down, Alexandre noted the character of the shaft, the types of rock or material around him, and the way in which it was constructed. In his descent into the mine, he noted “the limestone from the mine was grey and contained shell remains, especially near the part closest to the Earth’s surface.”¹²⁴ Later, they visited a second mine, and in both places, Alexandre was able to see the extraction processes up close, and to understand the working conditions. He also had the chance to explore the hidden interior of the Earth and view the clear structure of the strata below the surface.¹²⁵ The close inspection of mining operations was valuable not only for his access to the minerals *in situ*, but also for the geological revelations it uncovered.

For their visit to the town of Bakewell, Alexandre had a letter of introduction for White Watson (1760-1835).¹²⁶ Watson was a geologist and mineralogist, as well as a stone worker and craftsman.¹²⁷ Alexandre and Peter viewed his collections and cabinet, and Alexandre noted that Watson was keenly interested in botany. Watson created artworks and tableaux using local stones, including using layers of samples as a literal and descriptive illustration of geological strata. The small plaques were proportional, and directly representational of the Earth’s

¹²⁴ Brongniart, “1790, Voyage No 1, Angleterre,” BMHN MS 3357, 28.

¹²⁵ Brongniart, “1790, Voyage No 1, Angleterre,” BMHN MS 3357, 28.

¹²⁶ Brongniart, “1790, Voyage No 1, Angleterre,” BMHN MS 3357, 30.

¹²⁷ Mick Cooper and Ian Thomas, “Geology of Chatsworth House, Derbyshire,” *Mercian Geology* 17 (2008).

composition, as Brongniart recorded “he had printed a small book on the mineralogy of this province to which he had attached a marble table containing a proportionate sample of the different layers of the land.”¹²⁸

Alexandre may have seen a manuscript or an early draft, rather than a final copy, as a projected 1790 book to be published jointly by Watson and his partner, William Martin, failed to receive enough subscribers to be printed.¹²⁹ In 1793, without consulting Watson, Martin published the drawings he had made of both his and Watson’s fossil specimens as *Figures and Descriptions of Petrifications, Collected in Derbyshire*.¹³⁰ Since Watson and Martin had planned a much larger, integrated study connecting characteristic fossils with descriptions of the strata, when possible, Martin noted the typical location of certain fossils. For example, he described *Lythophyllum fillicus*, a type of fern, as “sometimes met with in the coal-shale,” but “abounding in the *way-boards*, or thin beds of indurated clay which generally separate the different strata of coal and grit-stone.”¹³¹ However, much of the analysis was dependent on Watson’s research, some of which Brongniart had seen. In 1811, well after Brongniart’s own work with Cuvier in the Paris Basin was established, Watson’s ideas were collected in *A Delineation of the Strata of Derbyshire*. Watson paired his text with a tablet of stone cross-sections that he had created, probably similar or identical to the one he had shown Alexandre and Peter during their visit. As he had intended from at least 1790, Watson matched his geological cross-section with a description of the characteristic fossils the strata of his region in England.

Watson took Alexandre and Peter on walks where he pointed out regional geological

¹²⁸ Brongniart, “1790, Voyage No 1, Angleterre,” BMHN MS 3357, 30-31.

¹²⁹ White Watson, *Delineation of the Strata of Derbyshire* (Sheffield, 1811).

¹³⁰ Watson, *Strata of Derbyshire*, ii-iii; William Martin et al., *Figures and descriptions of petrifications, collected in Derbyshire* (Wigan, 1793). In 1809, Martin published a more complete version, again without Watson’s knowledge. William Martin, *Petrificata Derbiensia* (Wigan, 1809).

¹³¹ Martin, *Petrifications*, Pl. 10.

formations. Alexandre recorded what he learned:

in all Derbyshire the first layer of the high hills was formed by sand clumped together in the bottom which was pink and had the appearance of granite. But it does not contain feldspar. The second was of petrosilex. The third was of very hard limestone, containing a multitude of fossils and taking a very fine polish. The third layer was a stone of a singular nature called “tolstone” by the English, of a greenish colour and containing cores of calcareous spar.¹³²

It is likely that Alexandre had seen Lavoisier’s geologic memoir of the previous year, “Observations générales,” which described the horizontal beds (strata) that remained from the sea that once covered the region around Paris, and had seen Lavoisier’s drawings illustrating the locations of specific types of seashells, which he had described by size, and by the type of water, either marine or fresh, in which they were formed (see Figure 2.3).¹³³ Like Lavoisier, Watson was constructing a method for displaying the Earth’s strata and the characteristic fossil contents of each layer.

In his tour of the countryside with Watson and his visits into the interior of the mines, Alexandre was able to examine the exposed strata of the Earth, to discuss the various land formations with local experts, and to purchase samples of local minerals for his collections.¹³⁴ He recorded the terrain as he travelled from London to Dover, and in the few hours he had to spend in Kent town, he examined its striking geology. After crossing the Channel, he continued his observations at Calais, making comparisons. Here, he had the time to walk far down the beaches, gaining a sense of the composition of the exposed cliffs. He noted the strong similarities between the two coastlines, observations which would continue to inform his geological ideas thereafter.¹³⁵

¹³² Brongniart, “1790, Voyage No 1, Angleterre,” BMHN MS 3357, 31.

¹³³ Lavoisier, “Observations générales,” 1789.

¹³⁴ Brongniart, “1790, Voyage No 1, Angleterre,” BMHN MS 3357, 30-32.

¹³⁵ Brongniart, “1790, Voyage No 1, Angleterre,” BMHN MS 3357, 30-32. In *Époques de la nature*, Buffon argued that land masses and continents, such as England and France, had once been attached to one another. Georges-Louis Leclerc, comte de Buffon, *Epochs of Nature*, Chicago, 2018), 101-117. See also Tjeerd H. van Andel and J. Brendan Murphy, “plate

Alexandre's Parisian world was built on a lifetime of associations, but he recreated a parallel network in London in a matter of weeks. He established connections with a group of people that mirrored nearly every sort of person and type of intellect he knew in France. Across an impressively broad range of activities, he gained scientific and technical knowledge, while his geological and mineralogical expertise increased dramatically. Thanks to his social skills, elite status, and education, as well as his personal contacts, Alexandre deftly transitioned from one social or intellectual setting to another. During his trip, he worked on topics across all his varied interests, laying the groundwork for his lifetime of research and publications. From the mid-1780s to 1790, Alexandre had transitioned from a young student in the salons of Paris to an active naturalist engaged in fieldwork and research. That so many English naturalists of high rank offered time and assistance, as well as additional references, showed that Brongniart was already accepted as a serious, if still developing, naturalist.

Throughout the summer of 1790, Alexandre's daily journals show that he pursued intellectual activities whenever possible and sought out the best collections or resources he could. As a learning trip, it worked across all disciplines. The study of enamelling and gemmology opened numerous disciplines as potential fields of employment. His research worked equally toward developing his knowledge of mineralogy. Although he worked in enamelling with Desvignes, which was similar in its underlying practice and science to porcelain glazing and decoration, Alexandre seems not to have worked directly in any sort of metalsmithing. The ceramic and enamel processes were, perhaps, more technically interesting to Alexandre and allowed for a concise research program, although he did visit forges and metalworking facilities. At the same time, he worked equally to observe medical facilities, collections, hospitals, and medical practices. The walk across the Cotswolds and in the Peak

tectonics," Encyclopedia Britannica, 8 December 2022, <https://www.britannica.com/science/plate-tectonics>. Accessed 4 January 2023.

District gave him an extended opportunity to examine the flora and fauna, visit Oxford, Blenheim, and Chatsworth for collections and architecture, and, particularly, to examine land use and geology.

The voyage allowed Alexandre to pursue the full range of his interests, and there was a seamless continuity to his intellectual environments. His associates could be antiquarians who were also makers of elegant objects, collectors who published the work of others, or physicians working to benefit public health. Exploring a mine with working miners was experienced as enthusiastically as tours of architectural landmarks of London with one of the city's premiere architects. Alongside medical observations and visits to prominent natural history cabinets, Alexandre actively learned the process of enamelling metals. Significantly, among all his efforts and experiences, with naturalism and medicine commonly noted to be his core interests, only the enamelling project resulted in an immediately published memoir.

A Second Expedition: Exploring the Natural History of French Terrain

The following year, on 1 August 1791, Alexandre and the Brazilian naturalist and statesman José Bonifácio d'Andrada e Silva (1763-1838) set out on a three-week naturalising trip that focussed on the terrain between Paris and Montcenis, including stops in Auxerre, Tonnerre, Dijon, Beaune, and Le Creusot. D'Andrada had come to Paris to study mineralogy and mining engineering at the École des Mines and he studied chemistry with Fourcroy at the Jardin des Plantes.¹³⁶ He had been commissioned by the Portuguese government to undertake a "philosophical journey," seeking information on new techniques in science, mining, and industry.¹³⁷ Although barely into his twenties, Brongniart was a seasoned traveller and researcher who could act as a local guide. For Brongniart, this relationship was very fortunate,

¹³⁶ José Augusto Pádua, "Nature conservation and nature building in the thought of a Brazilian founding father: José Bonifácio (1763-1838)," (Oxford, 2004).

¹³⁷ Pádua, "José Bonifácio," 5-6.

as d'Andrada was a dedicated natural historian with similar interests in both mining and geology. Unlike his travels in 1790 with Desvignes, alongside d'Andrada Alexandre was able to focus on the geological and mineralogical character of the region. As he wrote to his mother:

you know my enthusiasm for natural history and you know it hardly needs to be prompted. So imagine how great it must be now, with a very educated colleague who makes observations with as much enthusiasm as me, and more habitually. So, I believe that nothing escapes us. . . I am now writing my journal in much more order, accuracy, and detail.¹³⁸

Although they travelled between towns by coach, Alexandre walked for much of the journey, while d'Andrada, less accustomed to the effort, sought the aid of a horse or a donkey to carry their belongings and to make the trip more comfortable. Although Brongniart was content on foot, as he continuously added rocks to his collection of specimens, having an animal to help carry his travel box was a welcome relief.¹³⁹ The pair must have realized how eccentric they looked, as Alexandre wrote to his father, “my jacket, my pants, my hairstyle, my red hat, and my great sabre make me look just like Crispin, especially my shadow, because of its darkness.”¹⁴⁰

Although Brongniart's description of his hat was restricted to the colour and the effect it produced in his shadow, variations of the Phrygian cap, or “*bonnet de la Liberté*,” appeared as early as 1789, and grew popular in Paris by 1791, before being adopted more widely in 1792.¹⁴¹ Brongniart may have worn an early style of the “*bonnet rouge*,” or his clothing may have signified his membership in the National Guard for the district des Jacobins-Saint-

¹³⁸ Alexandre Brongniart to Mme Brongniart, 4 Août 1791, Correspondance Active, 1791-1825, AN 668/AP/1, 4.

¹³⁹ Alexandre Brongniart to Théodore Brongniart, 8 August 1791, AN 668/AP/1, 5.

¹⁴⁰ Alexandre Brongniart to Théodore Brongniart, 8 August 1791, AN 668/AP/1, 6. Crispin was a comedic character in the French theatre during the seventeenth and eighteenth centuries, with origins in the Commedia dell'arte character, Scaramouche. See “Crispin,” in *Concise Oxford Companion to Theatre*, eds. Phyllis Hartnoll and Peter Found, (Oxford, 1996).

¹⁴¹ Jennifer Harris, “Red Cap of Liberty: Dress Worn by French Revolutionary Partisans 1789-94,” *Eighteenth-century Studies* 14, 3 (1981): 283-312; R. Wrigley, “Transformations of a Revolutionary Emblem: The Liberty Cap in the French Revolution,” *French History* 11, 2 (1997): 131-69, 134.

Dominique, which he had joined in 1789.¹⁴² It is likely that he chose his travelling attire for both practical and political reasons. The sword Brongniart wore may have long been considered a necessity of travel, but, for the first time, Revolutionary laws allowed a broader segment of the population to carry weapons, and citizens were encouraged to join militias to play a peacekeeping role in the new National Guard.¹⁴³

Optimism still surrounded the Revolution at this stage. Although there had been violent episodes, the 1789 Declaration of the Rights of Man and the ongoing work of the Constitutional Assembly provided substantial hope for many members of the French population during the summer of 1791.¹⁴⁴ However, the King and Queen had become increasingly aware that the restrictions on their powers and movements were a form of imprisonment, out of which they could not negotiate. On 20 June 1791, they attempted a nighttime escape from France before being recognized and apprehended at Varennes early the following morning. They were returned to Paris under guard and remained imprisoned in the Tuileries thereafter. The flight made it clear that Louis XVI did not fully support the reform measures and, in fact, had been coerced to sign the documents related to the New Assembly and the Constitution.¹⁴⁵

Brongniart and d'Andrada's three-week trip took place only weeks after this incident occurred. Like many of his fellow natural historians and savants, Brongniart maintained focus on his intellectual interests, but also participated in the newly constructed societies and social forms of the Revolution.¹⁴⁶ His letters during this trip drew attention to his participation in pro-

¹⁴² BNF MS 1212, vol.1 fol. 101. <https://ccfr.bnf.fr/portailccfr/ark:/06871/004b1945539>.

¹⁴³ Popkin, *New World Begins*, 136, 156-7; Doyle, *French Revolution*, 112-3; François Furet, *Revolutionary France: 1770-1880* (Oxford, 1997), 67-8.

¹⁴⁴ Popkin, *New World Begins*, 157-69.

¹⁴⁵ Doyle, *French Revolution*, 151-2; Schama, *Citizens*, 475-7.

¹⁴⁶ On the use of scientific practice as a personal focus to endure the hardships of the Revolution, see Dorinda Outram, "The Ordeal of Vocation," *History of Science* 21, 3 (1983): 251-73.

Revolutionary efforts, including his support of the Société des amis de la Constitution.¹⁴⁷ He joined a meeting of a local chapter in Auxerre, where everyone in attendance left their arms at the front entrance. He “was charmed by the tranquil and sage patriotism” of the society. Brongniart’s writing style, much like his scientific style, focussed on the facts without prolonged commentary, but it shone light on the political and social landscape. Thus, he described the day’s news, in which the members of the town of Auxerre, who had a “pure and enlightened patriotism” had learned that eight young local men had sworn to do everything possible to return the king to power.¹⁴⁸

This group, while known to be “strong enemies of the Revolution,” had not previously been aggressive or problematic, and had been generally left alone by the pro-Revolutionary majority of the town. However, the citizens of Auxerre were indignant upon reading that these eight men had written that the town would be “charmed to give the first mark of its attachment” to the king. The Auxerrois arrested five of the men immediately and planned to capture the other three.¹⁴⁹ Brongniart also reported that he and d’Andrada had dined that same evening with a priest he had met at the meeting of the Société, whom Brongniart described as a “very hot (*bien chaud*) patriot.” On 12 July 1790, the National Assembly had created the Civil Constitution of the Clergy, which demoted the status of the church. Priests were required to swear an oath to the constitution. Although the legislation was condemned by the Vatican in April 1791, a significant number of French clergy, including those in smaller towns and rural areas, opted to adopt (or, at least, not to resist) the regulations.¹⁵⁰ While Brongniart must have been aware of the contradictions faced by the clergy during the Revolution, like many others,

¹⁴⁷ In 1792, the *Société des amis* was renamed the *Société des Jacobins, amis de la liberté et de l’égalité*, also called the Jacobin Club. François Furet and Mona Ozouf, *Critical Dictionary of the French Revolution* (Cambridge, MA: 1989), 704-710.

¹⁴⁸ Alexandre Brongniart to Théodore Brongniart, 2 August 1791, AN 668/AP1, 3.

¹⁴⁹ Alexandre Brongniart to Théodore Brongniart, 2 August 1791, AN668/AP1, 3.

¹⁵⁰ Popkin, *New World Begins*, 224-6.

he had seen that that every public act, including letter-writing or the choice of dinner companions, could be questioned by anyone, and that the wrong sentiments could have disastrous results. As he travelled through the countryside, he took special care to demonstrate his alignment with the Revolution and its new government.

On their route, the two companions stopped frequently to create drawings or examine exposed cuts in the landscape, and they set aside at least two hours a day for writing.¹⁵¹ Alexandre made numerous observations on the geology, the mineralogy, and the agriculture of the regions through which they travelled. His observations included cross sections of the Earth, including the separate strata and their contents. This was his first opportunity to voyage beyond the vicinity of Paris with the specific goal of geological study. He began with the uppermost beds, numbering them in order as he described each subsequent layer. He gave approximate measurements and retrieved samples of shells, such as molluscs, sea urchins, and oysters. He observed mineralogical characteristics, such as the presence of calcareous earth (i.e., calcium carbonate, either from limestone or chalk) and the colour of each bed, as well as the clay content, noting the presence of other minerals, such as selenite crystals (a crystalline variety of gypsum).¹⁵²

Alexandre's descriptions of the fossil and mineral contents demonstrated that he was already looking at the exposed layers of the Earth in much the same way that he later examined the Paris Basin alongside Cuvier. Similar to Lavoisier's 1789 essay, "Observations générales sur les couches modernes horizontales," Alexandre was already focussed on the distinctions within the chalk of the Tertiary strata.¹⁵³ His observations included the structure or example, of a "small mountain . . . whose cut southern flank presented alternately banks of argillaceous

¹⁵¹ Alexandre Brongniart to Mme Brongniart, 4 August 1791, AN 668/AP/1, 4-5; Journal du Voyage de Paris à Dijon, Montcenis, et autres lieux, 4 August 1791, BMHN MS 2337, 2-3.

¹⁵² Brongniart, Journal du Voyage de Paris à Dijon, Montcenis, et autres lieux, BMHN MS 2337, 2-3.

¹⁵³ Carozzi, "Lavoisier's Fundamental Contribution," 71-85.

limestone . . . and white gypsum. The gypsum was sometimes in small veins intertwined in a clay and calcium bearing stone.¹⁵⁴ Clay and gypsum, as I discuss further in Chapter Five, were of particular interest to applications in the arts, and Lavoisier had focussed his early geological memoirs on the mineralogy and chemistry of gypsum (plaster of Paris).¹⁵⁵ Brongniart's notations on the typical building stone of a region, including its ability to take a high polish, which gave a relative sense of its hardness, demonstrated the type of quarries nearby. Harder, more dense stones could be polished in the manner of marbles, while the surface of less dense stones remained pitted after polishing and were more subject to destruction by the elements or by mechanical means. In turn, the appearance of the stone and the quarries provided clear evidence of their geological nature.

Upon arrival in Dijon, Alexandre and d'Andrada met with several naturalists, including some prominent members of the broader Brongniart family network. Their first contact was Jean Joseph Antoine Bosc (1764-1837), the brother of Louis Augustin Bosc d'Antic (1759-1828), one of the founders of the Linnaean Society of Paris in 1787. Bosc was involved in the factories of Dijon, and a close associate of the city's naturalists. He accompanied Alexandre and d'Andrada on visits throughout the local area. They met with Louis Bernard Guyton de Morveau (1737-1816), an early supporter of Lavoisier's chemical principles, whose ideas on nomenclature had been the basis for *Nomenclature chimique* in 1787.¹⁵⁶ Additionally, they met the physician François Chaussier (1746-1828), an exponent of nomenclatural reform in medicine, the botanist Jean-François Durande (1732-94), and the naturalist Claudine Picardet (1735-1820), a translator and author in natural history, as well as a collaborator with Lavoisier.¹⁵⁷ This was an important connection for the study of mineralogy, as in 1790, Mme

¹⁵⁴ *Argillaceous*: clay-containing.

¹⁵⁵ Antoine Laurent Lavoisier, *Oeuvres*, t.3 (Paris, 1862), 106-144.

¹⁵⁶ Louis Bernard Guyton de Morveau et al., *Méthode de nomenclature chimique* (Paris, 1787).

¹⁵⁷ Following the death of her husband, Claude Picardet, in 1796, she married Guyton de

Picardet had completed the first French translation of Abraham Gottlob Werner's *Traité des caractères extérieurs des fossiles*.¹⁵⁸ In addition, Alexandre and d'Andrada visited local enterprises such as the *blancherie de toile* directed by Bosc, which used muriatic acid to whiten fabrics, and toured the Jardin de l'Arquebuse. They also visited the mineralogy cabinet of Jacques Pierre Champy (1744-1816) and attended the chemistry class of Chaussier.

Throughout the trip, Alexandre recorded diverse observations, including weather, temperature measurements, agricultural crops and methods, construction materials, descriptions of the quality of stone, the applied colours of houses, and the types of paving stones used for the roads and streets. They visited mines and manufactures, particularly Buffon's forge. Although he did not specify the factory by its original name, *La cristallerie de la Reine Marie-Antoinette*, they visited the glass factory at Creusot. Begun at Sèvres in 1727 as a glass factory, it was relocated to Creusot in 1787 for the purpose of making crystal. He was received by the factory's director, Jean-Henry de Gazeran, whom he knew through connection with Antoine Brongniart.¹⁵⁹ Alexandre considered that the objects he saw at Creusot rivalled the British crystal wares he had seen the previous year.¹⁶⁰

While the 1790 trip to England had shown Brongniart which intellectual subjects were of highest significance to him, having an accomplished companion who shared his interests enabled him to focus analytically on the details of the Earth around him, and on the flora and fauna they encountered. The entries in his 1791 travel notebooks were concentrated on geology, geognosy, and mineralogy, as well as on broader interests such as construction

Morveau in 1798. "Picardet, Claudine," Complete Dictionary of Scientific Biography, *Encyclopedia.com* (2021).

¹⁵⁸ I discuss the translation and Werner's mineralogy further in Chapter Six. Abraham Gottlob Werner and Claudine Picardet (née Pouillet) Guyton de Morveau, *Traité des caractères extérieurs des fossiles* (Dijon, 1790).

¹⁵⁹ Alexandre Brongniart to Théodore Brongniart, 2 August 1791, 11; *Mémoires de la Société Éduenne* (Autun, 1894), 267-8.

¹⁶⁰ Alexandre Brongniart to Théodore Brongniart, 2 August 1791, 11; *Mémoires de la Société Éduenne*, 267-8.

materials, agriculture, and industry. Meanwhile, he continued to create new contacts and to develop his social and scientific networks. The London trip of 1790 had included the study of several subjects across the arts and natural history. By contrast, in 1791, Alexandre's attention was centred on chemistry, geology, mineralogy, earthen materials, and industrial production. While the 1790 trip had allowed him to explore broad choices, including architecture and applied arts, the 1791 version allowed him to develop his mineralogical and geological ideas, and to clarify his future plans.

Sèvres in the Revolutionary Spotlight

In 1790, as Alexandre studied enamelling, he almost certainly had no thought of ascending to the directorship at Sèvres. However, like many other chemists of his acquaintance, he was familiar with the manufactory and its technology, and he was interested in colour chemistry. It is probable that opportunities in mineralogy and chemistry were among the myriad of options for which Alexandre was preparing himself. After his return to Paris in the autumn of 1791, Alexandre continued to go on naturalising expeditions, and pursued chemical, mineralogical, and anatomical study. At the same time, the Revolution continued to shift the balance of power throughout France. In 1791, for example, Prussia denounced the Revolution with the *Declaration of Pilnitz*, affirming the support of Prussia and the Holy Roman Empire for Louis XVI. In April 1792, France declared war on Austria, marking the start of over two decades of conflict between France and its European neighbours.¹⁶¹

For the first two years of the Revolution, as the country waited for the reforms of the Constitutional Assembly to be enacted, the leadership at Sèvres remained in place, guided on site by Antoine Régnier.¹⁶² Through the summer of 1792, the production at Sèvres remained

¹⁶¹ Popkin, *New World Begins*, 272-5; Schama, *Citizens*, 497-502

¹⁶² Alexandre Brongniart, "Art d'émailleur sur métaux," *Annales de Chimie* (1791); E. J.

active. However, when the king ordered all copies of a memoir by Mme Lamotte on Marie Antoinette to be burned in the Sèvres kilns on 26 May 1792, the controversy drew attention to the manufactory. The academic advisors to Sèvres, including Jean Darcet, Louis Claude Cadet de Gassicourt, Nicolas Desmarests, Jean-Jacques Bachelier, Jean-Jacques Lagrenée, and Louis-Simon Boizot, were all removed from their posts at once. The internal reshuffling of personnel destabilized the manufactory by putting a less capable, but pro-Revolutionary, worker in the position of director.¹⁶³ The events of 26 May reflected the desperate situation of Louis XVI and Marie Antoinette, as they attempted to protect themselves from personal attacks at every level. The reaction of the National Assembly was yet another demonstration of how much the King's powers had dissipated – he had ordered the use of the equipment in a manufactory that had once been his personal property, an act which led directly to the manufactory's reorganization.

In 1792, the nearly two-year period of relative domestic calm ended when violence broke out in an insurrection led by the National Guard at the Tuileries on the 10 August 1792, bringing an end to the monarchy. This event was soon followed by the September Massacres, so named for the systematic killing of nearly all the prison population of Paris, which I discuss in the following chapter. The insurrection and further violence made clear that Louis XVI's situation in France was dire. On 11 December, the King was indicted for treason, and on 15 January 1793, he was found guilty by the members of the convention. He was executed six days later.¹⁶⁴ In October 1793, the creation of the Revolutionary Tribunal brought a new horror and momentum to the Revolution. Executions increased in number, and trials, whose

Richardson, *Unlikely citizens? The Manufacturers of Sevres porcelain and the French Revolution*. (London, 2007), 85, 146.

¹⁶³ Richardson, *Unlikely citizens*, 145-6; Antoine d'Albis, "The Creation of Hard-Paste Porcelain Production at Sèvres," *Metropolitan Museum Journal* (2002): 269.

¹⁶⁴ Schama, *Citizens*, 579-84; "French Revolutionary Wars," *Oxford Reference* (2012). <https://www.oxfordreference.com/view/10.1093/acref/9780191737817.timeline.0001>.

judgements were final, were often used for political and personal retribution. Following Darcet's arrest, he was targeted by Robespierre, who had risen to power with the creation (and manipulation) of the Tribunal.¹⁶⁵ It was through the efforts of well-connected allies, such as Fourcroy, that Darcet was able to escape trial and execution in 1793.¹⁶⁶

As revolutionary tensions heightened, Alexandre could not remain a casual supporter of reform. Utilizing his education and network to advantage, in August 1793, he became a member of the French pharmaceutical corps, a post that allowed him to continue to develop his skills while aligning himself with French military efforts. Additionally, as a military pharmacist, the distance from Paris during the increasingly violent Revolution offered an amount of protection. Nine years after his London summer, Alexandre's memoir on enamelling would prove to be a key factor in his appointment to the directorship at Sèvres, which badly needed reorganization by that time.¹⁶⁷

¹⁶⁵ Charles Coulston Gillispie, *Science and Polity in France: Revolutionary and Napoleonic Years* (Princeton, 2014), 325.

¹⁶⁶ Claude Viel, "Fourcroy et les Lycées," in *Revue d'histoire de la pharmacie*, 98e année, 369 (2011): 27-8; Michel Jean Jérôme Dizé, *Précis historique sur la vie et les travaux de Jean d'Arcet* (Paris, 1802), 23-5.

¹⁶⁷ I discuss the factors surrounding his appointment to Sèvres in Chapter Four.

CHAPTER THREE: The Growth of a Profession in Natural History

Throughout the turbulence of the Revolution and its aftermath, Brongniart navigated skilfully, and with some amount of good fortune, through political and social obstacles. His uncertainty about the direction his future could take was complicated by the political climate of revolutionary France, as the world of his childhood gave way to a newly reshaped society. Many of the Brongniart family's patronage relationships grew problematic as noble status became a liability. However, some members of the extended family network, such as Fourcroy, David, Berthollet, and Monge became deeply involved in revolutionary and post-revolutionary politics.¹ Their emergent political clout had the effect of smoothing the various social and political storms that surrounded the Brongniart household.

Many members of the elite and wealthy society linked to Brongniart's immediate family, such as Elisabeth Vigée-Le Brun, Lucie de la Tour du Pin, and François Alexandre Frédéric, Duc de La Rochefoucauld-Liancourt (1747–1827), were forced to abandon their property and homes in France. The Brongniart family remained in France, showing support for reforms that would establish a constitutional monarchy. Although the Revolution presented dangers and difficulties, Brongniart made few references in his journals to day-to-day politics or to any negative effects his family experienced. This omission was strategic and intentional; he was keenly aware of the need to demonstrate his support for the revolutionary government, but he also understood that he needed to avoid defences or criticisms of any political position that he might later regret. Brongniart used his revolutionary-era travel journals and letters to communicate information to his family circle, and to members of the Société Philomathique, particularly from 1793 when he began extended periods of travel within the military

¹ Charles Coulston Gillispie, *Science and Polity in France: Revolutionary and Napoleonic Years* (Princeton, 2014).

pharmaceutical corps.² Often, he entrusted his youngest sister, Émilie, to read and to share the journals openly with friends and family, and to ensure their safe return. He intended them to be semi-public and expected that anyone might read them at any given opportunity.³

By 1791, Brongniart's basic formal education was complete, and he turned to higher-level studies. He continued to pursue medical interests, and he improved his knowledge of geology, mineralogy, biology, anatomy, chemistry, and pharmacy, while expanding his network of associates. Not yet at a point where he could pull together his ideas into a prominent publication, Brongniart was building an impressive body of knowledge across several fields, particularly within natural history and the arts. Through rigorous habits and an anchoring commitment to record keeping, including the events and intellectual practices of each day, self-organisation became a purposeful and indispensable way of channelling and fostering his ideas. What emerged through these diverse activities was not a lack of clarity or purpose, but instead the extension and integration of Brongniart's increasingly varied intellectual pursuits.

Knowledge of a broad range of subjects was a requirement of traditional natural history. In the eighteenth century, the publications of Georges Louis Leclerc, Comte de Buffon (1707-1788) not only outlined a comprehensive natural history, but they also demonstrated the potential reach of an individual savant.⁴ Buffon's *Histoire naturelle* consisted of thirty-six volumes published over a period of forty years during his lifetime, with eight more published between 1789 and 1804. It covered all aspects of natural history in an encyclopaedic system, beginning with a theory of the Earth and its origins, history, and composition, before compiling descriptions of animals, man, birds, fish, and minerals.⁵

² Silvestre and Brongniart, *Letters*, 27 septembre 1793-4 messidor an II (27 septembre 1793-22 juin 1794), Recueils d'autographes de divers personnages, BMHN MS 1989/ 873-888.

³ For example, see Silvestre and Brongniart, *Letters*, BMHN MS 1989/ 873-888 and BMHN MS2351/C, 1794.

⁴ Buffon was assisted in his work by Louis Jean Marie Daubenton as well as his cousin Edmé-Louis Daubenton.

⁵ Georges Louis Leclerc, comte de Buffon, *Histoire Naturelle* (Paris, 1750).

When Cuvier decried system-making in the “Preliminary discourse” of his *Recherches sur les Ossements fossiles* in 1812, he targeted the work of seventeenth-century rationalists such as René Descartes and Gottfried Leibnitz, as well as Benoît de Maillet, who had each created theoretical systems that attempted to account for the Earth’s history without consistent, factual foundations.⁶ Cuvier included Buffon in his criticisms. In addition to a factual natural history of animals, birds, minerals, and plants, Buffon offered a theory of the Earth’s formation, and worked to calculate its age.⁷ In the view of many eighteenth-century authors, Buffon’s work was not fully tied to empirical fact.⁸ As Cuvier noted sarcastically:

Buffon's system is merely a development of Leibnitz's, only with the addition of a comet which by a violent shock caused the sun to emit the liquid mass of the Earth at the same time as all the planets. From this theory one result is firm dating. For, by the present temperature of the Earth, we can know how long it has been cooling. And since the other planets left the sun at the same time as the Earth, we can calculate how many centuries the large ones still have to cool and at what point the small ones were already frozen.⁹

Cuvier openly criticised the work of eighteenth-century natural historians, including James Hutton and Déodat Gratet de Dolomieu, whom he believed had stretched limited observations and knowledge into sweeping theories based on supposition.¹⁰ The effect of Buffonian natural history lingered far longer in the psyche not only of the public, but also in that of many practicing naturalists. In particular, the ambitious grandeur of his system continued to exert an influence on his readers, Brongniart included. While Brongniart, like Cuvier, was not a system-builder, he did seek expertise in an extraordinarily wide range of topics in natural history from the earliest days of his career, seeking to account for a wide range of phenomena, including the

⁶ Georges Cuvier, *Ossements fossiles*, vol. 1 (Paris, 1812).

⁷ Georges Louis Leclerc, comte de Buffon, *Barr's Buffon: Buffon's Natural History*, v. 1, (1807), 1-114; Cuvier, *Ossements fossiles*, vol. 1, 37.

⁸ For example, see Thierry Hoquet, “Buffon’s Natural History” in *What Does It Mean to Be an Empiricist* Siegfried Bodenmann and Anne-Lise Rey-Courtel, eds. (Geneva, 2018), 140-1, 147-8.

⁹ Cuvier, *Ossements fossiles*, 27; translated as *Discourse on the Revolutions of the Surface of the Globe* (Philadelphia, 1831), 29.

¹⁰ Cuvier, *Ossements fossiles*, 37.

history of the Earth.¹¹

The world Brongniart entered as a young savant coincided with the ongoing scientific and chemical revolutions of the late eighteenth century. Within this chapter, I trace the transition in natural history as its three Linnaean classifications (animal, vegetable, mineral) were transformed into a variety of distinct sciences such as biology, mineralogy, and comparative anatomy.¹² A concentration upon information-gathering, empirical analysis and the increasing use of quantification highlighted the flaws of old-fashioned conjectural or theoretical systems. Nevertheless, while Brongniart was conscientiously empiricist, he retained a sense of the importance of situating scientific disciplines within the wider scope of natural history.

Additionally, I trace the ways in which Brongniart interacted with various Parisian intellectual communities, notably those connected to the field of natural history. As I showed in the previous chapter, while still in his teens, he co-founded the Société Philomathique, an organisation intended to support the work of young natural historians. Through this group, Brongniart and his friends were able to publish the results of their studies, as well as to create a digest of other research occurring in Paris. However, in 1793, an arrest over a naturalising expedition to Fontainebleau led Brongniart to suspend his medical study and to enlist in the military efforts as a pharmacist. He was sent to Bayonne, where he remained until mid-1794, when he was arrested a second time, with the more serious accusation that he had aided his friend, the naturalist Broussonnet, to escape over the mountains into Spain. As before, Fourcroy and other allies in Paris were a key factor in protecting him from further trouble.¹³

¹¹ Georges Cuvier, Robert Jameson, and Robert Kerr, *Essay on the Theory of the Earth*, (Edinburgh, 1817), 39-59.

¹² Dan H. Nicolson, "Stone, Plant, or Animal," *Taxon* 51, 1 (2002).

¹³ Bernard Druène, *L'Aventure pyrénéenne d'Alexandre Brongniart* (Pau, 1980).

Revolutionary Politics and an Unexpected Appointment

The rapid social and political change of the Revolution closed old pathways and created unexpected new ones. Some institutions, such as the Académie des Sciences, were dismantled, while others simply received new names and nominal alterations. The Jardin du Roi, long a site for public instruction, retained its essential character even as it was reorganized into the Jardin des Plantes and the Muséum d'Histoire naturelle.¹⁴ These changes paralleled and complemented the creation of new public schools, and they provided a variety of resources for comprehensive education throughout Paris. Brongniart was at an ideal age and status to benefit from the teaching and research opportunities that were opening in these changing and developing institutions.

Many major figures in Brongniart's scientific orbit enjoyed influential pedagogical positions in these institutions. Fourcroy had taught chemistry at the Jardin du Roi from 1784, while Antoine-Louis Brongniart acted as his demonstrator and taught classes there between 1777-93.¹⁵ Over these years, Alexandre was a frequent participant in the classes, both as a student, and, later, as an assistant to both his uncle and cousin.¹⁶ His interests in natural history were well-established. As I discuss below, in creating the Société Philomathique in 1788, he proved his commitment to the field while displaying his wide range of interests. By 1793, he had completed most of his formal studies (apart from medicine, which was still an open possibility), and was hopeful for an appointment at the Jardin, positioning himself as a potential candidate in natural history.¹⁷ In March 1793, a rare and unexpected opportunity had opened

¹⁴ On the changes at the Jardin des Plantes, see, particularly, E. C. Spary, *Utopia's Garden: French Natural History from Old Regime to Revolution* (Chicago, 2000) and Pietro Corsi, *Age of Lamarck* (Berkeley, 1989), 1-40.

¹⁵ Jonathan Simon, *Chemistry, Pharmacy and Revolution in France* (London, 2017), 101-3; Spary, *Utopia's Garden*, 24.

¹⁶ See Brongniart, *Journals*, BMHN MS 3357-58.

¹⁷ Alexandre Brongniart to Théodore Brongniart, 21 June 1793, AN 668/1, 18.

at the Jardin; in order to avoid arrest, Bernard Germain de Lacépède (1756-1825), had resigned from his post as demonstrator for the Cabinet d'Histoire Naturelle at the Jardin and left Paris. Without allowing for public notice of the vacancy, on the recommendation of René Just Haüy, Étienne Geoffroy Saint-Hilaire received an appointment as demonstrator, serving under Daubenton. It was a post for which Brongniart was well-prepared, and well-qualified, and for which Geoffroy's direct qualifications were clearly less appropriate.¹⁸

More shocking was the fact that a little over three months later, on 14 June, the Museum underwent a reorganisation and Geoffroy was given the chair of the newly established discipline of zoology. Brongniart had been associated with the Jardin through much of his life and had spent time assisting Daubenton in the Cabinet. Brongniart indicated to his father that a post within the cabinet of the Jardin was the post he desired most, and he believed it would be a high honour. When he related the events to his father on 21 June 1793, he considered Geoffroy as both unknown and unproven, whose interests had turned to natural history only recently. Dissatisfied and dismayed, he wrote "why have we been fighting, then, if the abuses of despotism still exist?"¹⁹ The sudden promotion of Geoffroy created a stir among Parisian naturalists, both within and on the periphery of the Jardin. Although Fourcroy was opposed to the decision, his arguments, along with the protests of other savants of the Jardin, were not successful. A few weeks later, Brongniart updated his father on events at the Jardin, saying that the Comité d'Instruction publique received the complaints from the professors at the Jardin despotically "and they went so far as to say that if this youth knew nothing, he would learn it."²⁰ Brongniart believed that most Parisian naturalists were against the decision to uphold Geoffroy's appointment, but there was little else to be done.

As Pietro Corsi has argued, the appointment to the post for the newly created field of

¹⁸ Appel, *Cuvier-Geoffroy Debate*, 21; Corsi, *Lamarck*, 13-4.

¹⁹ Alexandre Brongniart to Théodore Brongniart, 21 June 1793, AN 668/1, 18.

²⁰ Alexandre Brongniart to Théodore Brongniart, 21 June 1793, AN 668/1, 18.

zoology would have been a challenge for any nominee.²¹ What was not well-known at the time, was that Geoffroy, formerly a theological student, had been studying law at the Collège du Cardinal Lemoine, where he also studied mineralogy with Haüy. On 10 August 1792, when the priests of his college had been rounded up and imprisoned, Geoffroy recognised the gravity of the situation and immediately sought help from Daubenton and others, obtaining Haüy's release on 14 August. However, the other priests remained captive at Saint-Firmin, and, in September, the situation became dire as the revolutionaries began to massacre their prisoners.²² On 2 September, the first of what stretched into five days of extreme violence, Geoffroy returned to the prison and helped twelve additional priests climb out of a window to safety, very likely sparing them from violent deaths at the hands of a murderous group of volunteer National Guard members and sans-coulottes.²³ During the September Massacres, half of the prison population of Paris – more than fourteen hundred people – many of whom had been imprisoned under flimsy pretexts, were killed systematically.²⁴ While Haüy knew and could vouch for Geoffroy as a naturalist, it was his loyalty and courage that were rewarded by Haüy and Daubenton in naming him as demonstrator, and again in elevating him to chair during the reorganisation.

An Arrest at Fontainebleau

Disappointed, but undeterred, Brongniart continued to work toward his goals. He continued to host the nature walks he had organized for several years, even amid extreme political tensions. In August 1793, he arranged an overnight naturalist trip to Fontainebleau for several participants, an occasion that he had originally planned as an annual event two years

²¹ Corsi, *Lamarck*, 13-14.

²² Popkin, *New World Begins*, 288-93.

²³ Gillispie, *Science and Polity: Revolutionary and Napoleonic Years*, 181.

²⁴ Schama, *Citizens*, 528-39; *The Westminster Review*, v.5 (London, 1854), 163-4.

earlier. Although the group, led by Brongniart, planned to hunt and carried their own provisions, after camping overnight, they decided to enter the small town of Recloses for a meal. The presence of a group of unknown young men from noble backgrounds, very likely armed with hunting knives, sabres, and firearms, was met with fear and suspicion.²⁵ After their breakfast, the group was surrounded by locals and interrogated before being arrested. The young naturalists had travelled with their citizen cards, but without additional passports, as those were far more difficult to arrange. In ordinary days, this might have been enough, but during the summer of 1793, the situation had escalated. They remained under arrest for five days, until letters could be sent back and forth to Paris. Brongniart explained to his father that he had written to Fourcroy and to other professors of the Natural History Museum, following which they quickly received two letters from the Marie de Paris for their release.²⁶

The arrest was a signal that was impossible to ignore. Brongniart could not continue his independent and free path in Paris within the prevailing political atmosphere. His uncle, Antoine Louis Brongniart, had responded quickly to the Revolution, taking on a leadership position as a military pharmacist in 1792.²⁷ Almost immediately after the Fontainebleau incident, it was decided that Brongniart should act similarly, by joining the pharmaceutical corps as an *apothicaire-élève*. He received and passed his examination on the 23 August, just weeks after his arrest, and by September, was on his way to Bayonne. He planned to use the time to continue his explorations and was advised by Fourcroy to keep up with his teaching by organising new classes among his associates and acquaintances while he was away from Paris.

²⁵ In addition to the outfit he described in August 1791, which I described in Chapter Two, Brongniart described his customary gear elsewhere. In 1794, while in the Pharmaceutical Corps, he asked his family to send him a pistolet and a bayonet from his collection. In 1795, during his travels with the Corps des Mines, he carried a large gun, a small pistol, and a sword. Alexandre Brongniart to Theodore Brongniart, 13 Avril 1795, AN 668/1.

²⁶ Alexandre Brongniart to Théodore Brongniart, 19 August 1793, AN 668/1, 24.

²⁷ Maurice Bouvet, "Brongniart, pharmacien en chef de l'hôpital militaire d'instruction de Rennes (1800-1802)," *Revue d'histoire de la pharmacie*, 124 (1949): 497-500, 497.

This strategic manoeuvre allowed him to travel across France, thereby sharpening his pharmaceutical and chemical knowledge, while it provided opportunities for continued research and education in various topics in natural history, including geology and biology.²⁸

As I discussed in Chapter Two, Brongniart was careful with the political thoughts he included in his journals and letters. In his journals of 1793 and later, he omitted political stances almost entirely, although in other ways he continued to demonstrate support for the main goals of the Revolution, adopting its newly instituted social forms and its calendar at once. The radical transformation of French culture and its political structures, particularly during the extreme violence of 1793 to 1795, had a major effect on everyone in Brongniart's world, no matter how close to the revolutionary government their family was positioned. As quickly as the political balance shifted, particularly in the panic-driven era of the Terror, few were guaranteed security or peace of mind. His family was caught in sometimes contradictory positions. His father was seen as too closely connected to the nobility while his cousin, Fourcroy, became a powerful central figure in revolutionary politics.²⁹ Indeed, his father lost his position at Les Invalides in 1793 and with it, both income and the family's residence. The recently-constructed Maison Brongniart was sold, and Théodore's renowned art collections were auctioned to raise capital and pay down debts.³⁰ He had little hope for architectural commissions in Paris, and at the end of 1793, he accepted a project for the construction of a theatre in Bordeaux, where he remained until 1795.³¹ The theatre was a legitimate reason to leave Paris that enabled him to live with less fear of retribution for his perceived position as a wealthy royalist.³²

²⁸ See, for example, BMHN MS3357, "Journal du Voyage aue Pyrenées, 1-15 Septembre 1793," 54.

²⁹ Mosser, *Alexandre-Théodore Brongniart*, 308-14.

³⁰ Mosser, *Alexandre-Théodore Brongniart*, 312.

³¹ Sylvia Pressouyre, "Brongniart à Bordeaux et à La Réole (1793-1795)," *Bulletin Monumental*, 124, 1, (1966).

³² The theatre itself was never realized. Mosser, *Alexandre-Théodore Brongniart*, 312.

The rest of the Brongniart family moved from Les Invalides to their former residence on rue Saint Marc, near the Chaussée d’Antin, where the living quarters were tight.³³ With Théodore at Bordeaux, the family members who remained in Paris – including Brongniart, Émilie, and their mother, plus nineteen-year-old Aimée (Steck) Guichelin (1776-1821), and a household servant – moved into cramped quarters in a small section of the residence. Guichelin, Émilie’s companion and instructor, was the daughter of a master *menuisier* at Versailles. Her mother, a linen worker, had died in 1787.³⁴ The family repurposed the existing spaces, maintaining a cabinet and laboratory for Brongniart, in which he also slept, as well as a painting studio for Émilie.³⁵ Extras and luxuries, such as horses and carriages, were sold off. The economies of the Parisian household were coordinated by Mme Brongniart, whose business skills had been honed in the lingerie shop she had owned.

These straitened circumstances did not dramatically shift Brongniart’s personal objectives as he built his career. He had long displayed self-reliance and self-motivation and continued to work on intellectual subjects throughout the adverse period. He displayed a characteristic tendency toward financial caution, in contrast to the large expenditures and speculative risks often taken by his father. He had begun teaching in Paris already, and was, at the time, expecting to continue his medical studies. As Brongniart left for the pharmaceutical corps, he planned to return to Paris to resume teaching. He remained actively engaged in

³³ See Annotated Map, Appendix 3. The residence, which Luc and Edmée Delambre have called an “immeuble de rapport,” was purchased by Théodore Brongniart in 1778. On the building, see Luc Delambre and Edmée Delambre, *Servir la France napoléonienne à Washington* (Paris, 2020), 29. On the purchase, see Mosser, *Alexandre-Théodore Brongniart*, 309.

³⁴ Silvestre and Brongniart, *Letters*, BMHN MS 1989/ 873-888; For biographical details see C. J. Seth “Au carrefour des cultures: Marie-Aimée Steck-Guichelin,” *Swiss Society for the Study of the 18th Century* xviii, 8 (2017).

³⁵ As I discuss below, Brongniart was away from the residence for several months, travelling first with the army during 1793-4, then with the Corps de Mines during 1794-6. On the household arrangements, see Alexandre Brongniart to Théodore Brongniart, 29 Septembre 1794, AN/668/1, 73.

discourse with other savants and teachers at the Parisian institutions while away.³⁶

The Société Philomathique

When they met on the tenth of December 1788, just on the eve of the Revolution, Brongniart and his associates were thinking of more ordinary projects. Augustin François Silvestre (1762-1851), Claude Antoine Gaspard Riche (de Prony) (1762-1797), Jacques Joseph Audirac (d.1791), Charles de Broval (died or emigrated, 1791), Marc Antoine Petit (1766-1811), and Brongniart, teamed up to create the Société Philomathique. As we have seen, the society was dedicated to communicating the work of natural historians, intended particularly for those naturalists not yet fully accepted into official institutions.³⁷ The young savants joined together to read papers that had been recently published or read at the Académie des Sciences, the Société d'Histoire Naturelle, and elsewhere, and to discuss current research. It was a forum for sharing information and for providing an avenue to discuss mutual interests.

Brongniart, Silvestre, and Riche were the most visible members during the first few years. The early membership drew from the close family circle, several of whom were connected with the circle of the duc d'Orleans. Others were young physicians or medical students, which reflects the fact that Brongniart was engaged in medical study at the time. Silvestre became one of the most active of the group and was perhaps the closest to Brongniart – the pair were often together in family and social situations. Silvestre was expected to inherit the role of drawing instructor to the Enfants de France through *survivance*. However, he was instead made librarian to Monsieur, the comte de Provence (1755-1824).³⁸ Having spent his early years in study of fine art, Silvestre later sought expertise across a variety of subjects,

³⁶ See Silvestre and Brongniart, *Letters*, BMHN MS 1989/ 873-888; Brongniart, *Journal 1790-1795*, BMHN MS 3357; and Alexandre Brongniart Papiers Personnels, Correspondance Active, (1770-1835), AN 668 AP/1.

³⁷ Gillispie, *Science and Polity*, 2004, 193-4.

³⁸ The future Louis XVIII, who ruled during the Bourbon Restoration, from 1815-1824.

including natural history.³⁹ His background in both the arts and in natural history, coupled with a similar societal position, matched the interests and social status of Brongniart, and he became a trusted companion. Their relationship was founded in longstanding familial ties, but the two shared similar sensibilities that fostered a working partnership that benefitted and solidified the foundations of the Société Philomathique.

The membership of the Société in its first years was challenged both by the circumstances of the Revolution and by the (in some cases, tragic) loss of four of its members. In 1788, Petit had lately arrived in Paris to study medicine. By 1790, he had returned to study at Montpellier en route to establishing himself at Lyon.⁴⁰ Charles de Broval (d.1792), a mathematician, was the son of Nicolas François de Broval (1756-1834), the private secretary of Louis Philippe, duc d'Orleans, (1773-1850). Charles emigrated from France alongside his father in 1791.⁴¹ Audirac, a physician who had been educated at Montpellier, died in 1791, shortly after receiving his medical license.⁴² Claude Riche de Prony (1762-1797, called Riche) was the younger brother of the mathematician and engineer Gaspard Riche de Prony (1755-1839, called Prony). Riche had studied medicine at Montpellier, and had arrived in Paris in 1788, where he began working with Félix Vicq d'Azyr (1748-1794).⁴³ Riche was an active member of the society in its first four years, until he left Paris to serve as a naturalist under Bruni d'Entrecasteaux on a voyage to Africa and Australia. His travels lasted until 1796, when he returned to France due to illness. In the following year, he passed away. As secretary, Riche

³⁹ Denis I. Duveen, "Augustin François Silvestre and the Société Philomathique," *Annals of Science* 10, 4 (1954).

⁴⁰ Philibert Parat, *Éloge historique de Marc-Antoine Petit* (Lyon, 1812).

⁴¹ André Tuilier, "Les débuts de la Société Philomathique de Paris et le contexte idéologique," *Société Philomathique de Paris* (2019); and Fonds de Chevalier de Broval (1798-1850), AN 224AP/1.

⁴² Sources differ, giving both 1790 and 1791 as the year of his death. The date is recorded as 1790 in Pierre Claude François Daunou, *Journal des Savants*, (France, 1888).

⁴³ "Claude Antoine Gaspard Riche de Prony," *Biographie universelle classique* (Paris, 1829), 2559. On the early membership lists of the Société philomathique, see *Rapports Généraux des Travaux de la Société Philomathique de Paris*, v.1 (Paris, 1792).

figured prominently in the earliest memoirs of the group. The earliest of these were hand-copied and distributed among the small circle of members; Mlle Guichelin often performed this task.⁴⁴

The group planned to compile and disseminate information, as much for their own use as for the later benefit of readers outside their sphere. They gathered information from institutional sources and personal ones, covering a catholic selection of topics and ideas. Although membership declined in the earliest years, it grew from 1789 onwards. The November 1789 induction added the chemist Louis Nicolas Vauquelin (1763-1829), plus the physicians Guilbert⁴⁵ and J. F. Bellot.⁴⁶ Although he was not in the initial group, some sources consider Vauquelin to be a founding member.⁴⁷ Vauquelin had a close relationship with the Brongniart and Fourcroy families, and he was a student of Fourcroy, as well as, later, his assistant and research partner.⁴⁸ Vauquelin was an active member, collaborating on experiments and contributing to publications.⁴⁹ Through dedication and consistency in the publication of memoirs, the young naturalists established themselves as vocal participants in the scientific community of Paris. They worked to make their society an indispensable resource, eventually drawing other accomplished authors into their midst. From 1790 to April

⁴⁴ See Silvestre and Brongniart, *Letters*, BMHN MS 1989/ 873-888. A collection of the first decade of memoirs was published in 1798 as *Rapports généraux des travaux de la Société philomathique depuis son installation au 10 déc. 1788 jusqu'à 23 frimaire de l'an VI de la République* (Paris, 1792).

⁴⁵ Probably Julien Marie Guilbert, a surgeon and later a military health officer. *Annuaire statistique, civil, maritime, et commercial, du département du Morbihan* (Morbihan, 1804), 189.

⁴⁶ Florent Joseph Bellot de Busy, later, *Médecin en Chef des Armées* (1768-1834). Société Philomathique de Paris, *Bulletin* (Paris, 1889), xiii-xv; Société Philomathique de Paris, *Bulletin* (Paris, 1898), 16-24.

⁴⁷ Henri Bonnemain, "Vauquelin et la Société Philomathique," in *Revue d'histoire de la pharmacie*, 52^e année, 183 (1964), 149-154.

⁴⁸ Elizabeth Martin, "Vauquelin, Louis Nicolas," *The New Oxford Dictionary for Scientific Writers and Editors* (2009).

⁴⁹ Société Philomathique de Paris. *Rapports généraux des travaux* (Paris, 1792-1799): 229-272.

1793, a further twenty-one members, including correspondents, were added.⁵⁰

Early on, the society circulated collections of reports on various subjects, creating a digest based on the recent submissions to the Académie des Sciences and elsewhere. These publications were intended to increase access to information dispensed via more official pathways, such as presentation at the Académie des Sciences or the Société d'Histoire Naturelle. One of the first submissions to the memoirs authored by Brongniart centred on his 1790 trip to Bakewell and London.⁵¹ Combining the group members' mutual interests, the publications supported the members own education and provided a means of disseminating the latest scientific ideas to a broad audience. The contents initially were brief entries, often based on restating the work of established savants, such as a report Brongniart made on the recent work of Parmentier, whose permission Brongniart solicited before publishing his summaries.⁵² As Brongniart and his youthful associates became more engaged with their careers, and other naturalists joined the group, the memoirs aspired to rigorous standards, which were increasingly focussed on personal research.

An important submission to the *Bulletin* by Brongniart in 1793 was a manuscript of Antione Romain Coquebert de Montbret, on which Brongniart had acted as a consultant.⁵³ Active in natural history, Romain joined the Société Philomathique in 1791, along with his eldest brother, Antoine. In 1792, the third Coquebert brother, Charles-Etienne, returned to France after serving in a political post in Ireland from 1789-92, and joined the group. Romain's 1791 manuscript, "Observations sur quelques Coquilles du genre des Strombes," on characteristic fossil conch shells, examined the major anatomical and physiological differences

⁵⁰ Société Philomathique de Paris, *Extraits des Procès-verbaux des séances*, 1854.

⁵¹ Alexandre Brongniart, "Voyage de Paris à Bakewell," *Bulletin Société Philomathique et ses correspondants* 2 (August 1791).

⁵² Silvestre and Brongniart, *Letters*, BMHN MS 1989/ 873-888 and Alexandre Brongniart Papiers Personnels, Correspondance Active, (1770-1835), AN 668 AP/1.

⁵³ Jean-Michel Pacaud, "Sur un manuscrit inédit d'Antoine Romain Coquebert de Montbret," *Bulletin d'Information des Géologues du Bassin de Paris* 51, 2 (2014): 4-24, fig. 1-10, pl. 1-3.

between the adult and the juvenile forms of the shell, which had not previously been studied.⁵⁴ Critically, his and Brongniart's entry in the July 1793 *Bulletin* showed that Romain, Brongniart, and their associates had begun to analyse and characterise shells using methods of comparative anatomy. This article, published through Brongniart's efforts, was one of a limited number of natural history studies by Romain, who was otherwise occupied by the demands of military service.⁵⁵

In late summer of 1793, Brongniart took his place in the pharmaceutical corps, reaching Bayonne in September, and remaining there through the winter. In addition to his duties, he planned to continue to pursue his interests in natural history and set a goal of working on comparative anatomy projects with Victor Broussonnet (1771-1846), the younger brother of his friend and mentor, Auguste.⁵⁶ That autumn, writing to Silvestre from Bayonne, Brongniart expressed his hopes and expectations for the Société Philomathique, wanting to maintain a well-balanced, active, and engaged membership.⁵⁷ On 8 August 1793, the Academies were suppressed, and its members were displaced. Days later, on 11 August, Lavoisier spoke to a group of former members of the Academy who had assembled at the Lycée des Arts. Recognising the finality of the rupture, Lavoisier called the period following the official closure of the Academy a "deplorable interval" that would exist until the work of

⁵⁴ Pacaud, "Sur un manuscrit inédit,"; Jean-Michel Pacaud & Bruno Caze, "Une espèce nouvelle de Rostellariidae" *Cossmanniana* 13 (2011); Romain Coquebert and Alexandre Brongniart, "Extrait d'une mémoire sur la formation de la coquille du strombus fissurella, et sur deux espèces analogues à celle-ci," *Bulletin des Sciences par la Société Philomathique* (July 1793): 5.

⁵⁵ Romain's military career was brief due to a series of events that included his arrest and capture by the English in autumn, 1793. After his return to France, he suffered mental issues that kept him from continuing a career in either the military or natural history. On his life, see: Sheila Kennedy, "Coquebert de Montbret in Search of the Hidden Ireland," *The Journal of the Royal Society of Antiquaries of Ireland* 82, 1 (1952): 66; Général Herlaut, "Les négociations de Custine avec l'ennemi (Décembre 1792-Mai 1793)," *Annales Historiques de La Révolution Française* 9, 54 (1932): 523.

⁵⁶ Alexandre Brongniart, "Bayonne," 14-19 October 1793, BMHN MS3357, 76-80.

⁵⁷ Silvestre and Brongniart, *Letters*, BMHN MS 1989/ 873-888.

“learned societies” (i.e., the Academy) could be re-established.⁵⁸ However, the members were not forbidden from meeting in a “voluntary and open society.”⁵⁹ The meeting at the Lycée des Arts opened the way to the introduction of the Société Philomathique as a potential solution for the Academicians. In the last four months of 1793, the Société gained eighteen additional members: Berthollet, Lavoisier, Fourcroy, Vicq d’Azyr, Hallé, Ventenat, and Lefèvre-Gineau on 14 September; Leroy, Lamarck, and Lelièvre on 21 September; Monge, Prony, and Jumelin on 28 September; Laplace, Darcet, Deyeux, Pelletier, and Richard on 13 November; Lacroix and Lévillé on 13 December.⁶⁰ These eminent academicians sought the Société as a potentially useful haven for communication and a resource for publication, and thereby transformed its reputation and status.

On 6 October, Silvestre wrote to Brongniart that his letters were read at Société Philomathique, where they were enjoyed. The letters also demonstrated Brongniart’s continued participation in the affairs of the group. Of the new associates drawn from the ranks of the Academy, only two, Lamarck and Hallé, were among the attendees, and Silvestre noted that both men had attended every meeting of the group following their inductions.⁶¹ Despite the limited attendance of the larger group of former academicians, Brongniart was wary of the danger of allowing the membership to grow too quickly and with too much of an open-door policy. As he explained to Silvestre on 27 November:

between you and me, I find that we are going so quickly that we are taking everyone indiscriminately, without regard to character – remember that the charm of our meetings had come in ~~large~~ part from the great union that had reigned between us. Let’s be careful not to be too many. I have observed some receptions of highly educated people that, nevertheless, did not give me great pleasure. The Society, my dear friend, the Society is losing its character, it is losing it entirely.⁶²

⁵⁸ Poirier, *Lavoisier*, 334.

⁵⁹ Poirier, *Lavoisier*, 334.

⁶⁰ Société Philomathique de Paris, *Extraits des Procès-verbaux des séances*, (1854): 1-2

⁶¹ Silvestre and Brongniart, *Letters*, BMHN MS 1989/ 873-888.

⁶² Silvestre and Brongniart, *Letters*, BMHN MS 1989/ 873-888.

Nevertheless, by joining the Société Philomathique, the displaced academics made a public gesture of unification with the younger group of naturalists. The move helped to solidify the interactions between the younger naturalists and the established academics at a time when the academies were viewed with distrust.

It is significant that the first of the former members of the Academy to join the Société Philomathique were Fourcroy, Berthollet, and Lavoisier, as well as others who were already closely associated with Brongniart, Silvestre, and Vauquelin. Seeking membership of the Société was not purely a self-serving gesture on the part of the academics but was a public acquiescence to the reordering of the academic system as whole. It may also have been an active attempt at keeping a positive face on the part of the Academicians in view of their elimination – they had been free to create their own new group and had been encouraged to do so. Instead, they joined the Société Philomathique. In the process, they moved toward the unification of the community of Parisian science, rather than maintaining an isolated stance. However, the letters from Silvestre indicate that the most prestigious members such as Lavoisier, Fourcroy, and Monge often missed the meetings, as they were greatly preoccupied with other responsibilities. In the case of Lavoisier, the dire circumstances that began with his arrest on 24 November 1793 prohibited him from further involvement.⁶³ Nonetheless, by joining the younger group, the displaced academicians could easily justify their continued activity together, while their actions simultaneously strengthened the importance of the newly established Société Philomathique.

With the influx of academicians, the subscribed numbers of the group nearly doubled, and a new set of qualifications for membership, presentation, and publication was discussed.⁶⁴ It was agreed that the style of publications and their acceptance into the memoirs was to be

⁶³ Roger Hahn, *Anatomy of a Scientific Institution: The Paris Academy of Sciences* (Berkeley, 1971), 265-268.

⁶⁴ Silvestre and Brongniart, *Letters*, BMHN MS 1989/ 873-888.

closely modelled on that of the Academy. At one point, it was proposed that the unpublished Academy memoirs should be issued by the society. Given the more pressing circumstances of the Revolutionary Terror that was just beginning, these big projects did not come to fruition.⁶⁵ With many of the members occupied by different matters, such as new roles in the revolutionary government, there were few who could contribute regularly to the memoirs. This was the case for Brongniart, who was far from Paris in late 1793. Of the Philomaths, in addition to Lavoisier's arrest in November, Jean Darcet and Aubin Louis Millin de Grandmaison were also imprisoned that autumn.⁶⁶

In their letters, alongside membership questions and issues of structure, Silvestre and Brongniart adeptly switched between subjects such as the dissection of the Versailles Rhinoceros, chemical experiments, and questions of agriculture.⁶⁷ Although their exchanges remained focussed on future plans related to natural history, and to the vitality of the Société, the political situation was ever present. On the back of the last page of a letter from Silvestre written on 14 November, three sketches survive in a style characteristic of Brongniart – who often made small sketches in the margins of his letters, (see Figure 3.1). The first, the profile of a woman with high, billowing hair, facing left, was scratched through. Additionally, the drawing furthest to the right, the common Revolutionary symbol of a Phrygian cap atop a pike, was again marked out. Both drawings that were marked through had been done so lightly, as if the tentative sketches were unsatisfactory or imperfect. The middle drawing, which remained intact, was a of a wooden structure holding three objects. Drawn with minimal detail, the objects of the middle sketch suggest the ghastly souvenirs of the guillotine (or, possibly, their symbolic replacements) that had been placed on display.

One possibility is that the sketch of the woman depicted Marie Antoinette, who was

⁶⁵ Hahn, *Anatomy of a Scientific Institution*, 265-268.

⁶⁶ A. L. Millin, *Magasin encyclopédique*, t. 3 (Paris, 1808), 164-165.

⁶⁷ Silvestre and Brongniart, *Letters*, BMHN MS 1989/ 873-888.

executed 16 October 1793. However, the profile bears a stronger similarity to that of Mme Roland, particularly in comparison with the 1787 portrait by Adélaïde Labille-Guiard (see Figure 3.2). Active in revolutionary politics, Roland was viewed as a threat by Robespierre, and her execution had taken place on 10 November 1793, shortly before Silvestre's letter was written. Early in the Revolution, Mme Roland's salon had been popular with members of the Linnaean Society, including Bosc d'Antic and Guillaume-Antoine Olivier.⁶⁸ Whether or not the sketch on the letter represents her portrait, or that of someone else, there were countless reminders of the lives of men and women lost to the Terror.⁶⁹

Roger Hahn has viewed its lack of publications as a failure of the Société Philomathique to capitalise on the moment and uphold the Academy in new terms as a *société libre*. Yet he also acknowledged that the Société was struggling to publish full issues of its journal during the period between 1793 and 1795. In part this was because there was an extraordinary difference in stature between the former academicians and the youthful membership of the Société Philomathique. This imbalance alone was a disadvantage for large, expensive projects such as the publication of Academic memoirs. The demands of the political climate were such that extraneous plans in all areas were suspended. Brongniart and Silvestre were enthusiastic about the potential of these ventures, but the projects needed more support and involvement than the membership could provide in the difficult years of 1793 and 1794.⁷⁰ While not an instantaneous transformation, the adoption of the Société by senior members of the Parisian scientific community did have a lasting effect. New members, such as Lamarck and Hallé, remained involved and active. In the decade that followed the first admission of the academics, prominent naturalists continued to join the society, including Bosc, Olivier, Jean-Antoine

⁶⁸ Gillispie, *Science and Polity: Revolution and Napoleonic Years*, 169.

⁶⁹ See Hubertus Kohle and Rolf Reichardt, *Visualizing the Revolution* (London, 2008), 28, 43; James A. Leith, *Symbols, Myths and Images of the French Revolution* (Regina, 1998), 32, 42.

⁷⁰ Hahn, *Anatomy of a Scientific Institution*, 267.

Chaptal, René Just Haüy, Louis Jean Marie Daubenton, and Bernard Germain Lacépède.

Surviving the Terror

During 1793-4, when the Jacobins rose to power under Robespierre, political or personal carelessness or inattention could and frequently did have disastrous effects. Brongniart's August 1793 arrest was minor and fortunately surmountable. Joining the pharmaceutical corps gave him a way of distancing himself from the worst years of revolutionary violence in Paris and kept him out of direct military combat. There were, of course, bigger events that could not be controlled or slowed. As tax-collecting *fermiers générales*, both Lavoisier and his father-in-law, Jacques Paulze (1723-94), were arrested in November 1793. On 8 May 1794, Lavoisier was guillotined, alongside the other twenty-seven other members of this detested group, including Paulze. While Lavoisier's early biographers, such as Edouard Grimaux, criticized Fourcroy and other politically influential associates of Lavoisier for failing to act, there is evidence that Fourcroy argued for Lavoisier's release in front of the Tribunal, before recognising that he would only further endanger himself by persisting against an implacable Robespierre.⁷¹ There was no way to single out and to save any of the tax farmers, no matter what their other contributions to society or their future potential were.⁷²

As painful a blow to Brongniart's personal networks as Lavoisier's execution was, there is nothing in his journals or letters to indicate a reaction or acknowledgement of any sort. Surviving the Terror often required not only abiding by the new regulations and demonstrating

⁷¹ Édouard Grimaux, *Lavoisier* (Paris, 1896), 311-12.

⁷² Gillispie cited evidence drawn from the account of André Laugier, Fourcroy's cousin through his mother, Jeanne Laugier. Gillispie, *Science and Polity: Revolutionary and Napoleonic Years*, 324-5; See also Claude Viel, "Fourcroy et les Lycées," in *Revue d'histoire de la pharmacie*, 98e année, 369 (2011), 27-8. For a thorough retelling of Lavoisier's arrest and its contexts, see Madison Smartt Bell, *Lavoisier in the Year One* (New York, 2006), 166-86.

support for the aims of the government, but also finding ways to conceal emotional responses and to detach oneself from its horrors. For many, such as Félix Vicq d'Azyr, who collapsed from an illness while standing on the Champ de Mars at the Festival of the Supreme Being on 8 June 1794, this was an impossible task. Vicq d'Azyr remained bedridden until 20 June. His last days were filled with nightmares and hallucinations of the executions of his friends, particularly Lavoisier, the astronomer Jean Sylvain Bailly (1736-93), and the mathematician Nicolas de Condorcet (1743-94).⁷³ Others, such as Louis Augustin Guillaume Bosc (1759-1828) and Bernard Germain de Lacépède (1756-1825) put their efforts more fully into their work as naturalists.⁷⁴ As Lacépède wrote, "I loved to think of the wonderful effects of the power of nature, and of its sublime laws . . . I forgot the world, and saw only the universe."⁷⁵

In Bagnères, where Brongniart had moved after his stay in Bayonne, he was seen to be busy with a local public festival that took place on 9 May, just one day after the loss of his important teacher and mentor. If he was distressed by the events of the Revolution or disagreed with the actions of the prevailing Montagnard faction within the Jacobin party, Brongniart showed little public reaction. Instead, he maintained a general and consistent support for the new government, with which his future was deeply intertwined. By 1794, there had been thousands of executions in the name of the Revolution, including many from Brongniart's extended family. His cool temperament and an evident ability to navigate the difficult political demands that were constantly surfacing would be crucial assets for forging a major career in the capital.⁷⁶

In the summer of 1794, a major incident would again test the family networks. A little

⁷³ André Parent, "Félix Vicq d'Azyr (1748–1794)," *Parkinsonism & Related Disorders* 13, 4 (2006).

⁷⁴ Outram, "Ordeal of Vocation," 256-7.

⁷⁵ Outram, "Ordeal of Vocation," 257.

⁷⁶ "Terror" in *Critical Dictionary of the Revolution*, eds. François Furet and Mona Ozouf, (Cambridge, MA, 1989), 137-54.

more than a week before the overthrow and execution of Robespierre on 28 July, Brongniart went on an excursion in the Pyrénées in the company of a guide and two friends: a colleague named Treffenscheidl, *apothicaire en chef* of the hospital at Barèges, and the naturalist Pierre Marie Auguste Broussonnet (1761-1807).⁷⁷ On 19 July, taking advantage of the relaxed atmosphere that surrounded the group of young naturalists, Broussonnet, anxious over his personal safety during the Terror, distanced himself from the group and disappeared over the border into Spain.⁷⁸ The other members of the party, including Brongniart and Treffenscheidl, were accused of helping Broussonnet escape and were arrested and imprisoned.⁷⁹ For the second time, the Brongniart family called upon Fourcroy's help, which came as quickly as could be arranged. In the meantime, the Jacobin excesses had reached their limit, and Robespierre was arrested and guillotined. As the balance of power shifted, post-Thermidorian political changes also aided Brongniart's release and subsequent return to Paris, where he had been offered a position on the Commission for Weights and Measures alongside Coquebert.⁸⁰

Educational Institutions: The Lycées and l'Écoles centrales

The sudden heightened stature of the Société Philomathique in 1793 was just one of several pivotal intellectual events for Brongniart. He continued to develop his interests in natural history, to study medicine, and to enlarge his teaching experience, particularly in the

⁷⁷ Treffenscheidl (also Treffencheidl, Trefenscheidl, or Treffenscheidt), close in age to Brongniart, was probably a descendant of apothecary Jean Treffenscheidl, an emigré from Vienna to Paris. See "Notoriété portant renonciation à la succession de Eve Marguerite Rosenzweig, épouse de Jean-Baptiste Treffenscheidl," 1781, AN MC/RE/LIV/14; Jean Treffenscheidl, *Essence de vie, composée par le sieur Jean Treffenscheidl* (Paris: 1753). For a retelling of the incident, see Bernard Druène, *L'Aventure pyrénéenne d'Alexandre Brongniart* (Pau, 1980).

⁷⁸ An early supporter of the Revolution, Broussonnet had witnessed the brutal death of his patron, Berthier de Sauvigny, at the hands of an angry mob. This act changed his sentiments toward the Revolution. On de Sauvigny's death, see Schama, *Citizens*, 378-9 and "Broussonnet," *Biographie universelle, ancienne et moderne* (France, 1834), 638.

⁷⁹ Brongniart, *Journal*, BMHN MS3357, 150.

⁸⁰ Gillispie, *Science and Polity: Revolutionary and Napoleonic Years*, 458-62.

newly created public teaching institutions. One of the first and most prominent of these had been founded in 1781 as “Le Musée” by Jean-François Pilâtre de Rozier and known informally as the “Musée de Monsieur” after its relation to Monsieur, Le Comte de Provence, brother to Louis XVI. It was a resource for the general population of Paris, a place where anyone, including women, could enrol in classes on a wide variety of topics. From 1784, the Musée was relocated into a permanent home in a theatre at the Palais Royal, near the Comédie Française.⁸¹ After de Rozier died in a ballooning accident in 1785 the Musée was renamed, simply, the “Lycée”; it was immediately reorganized with new financing, drawing heavily upon noble patrons.⁸²

Fourcroy, still young and still in the early stages of his career, became one of the most well-admired professors of the Lycée. From 1786, his public chemistry class there had been based on Lavoisierian principles, and he taught chemistry with the aim of instructing the general population in complexities of the developing science.⁸³ However, by 1789, the Lycée was losing financial support in the face of the Revolution, as a significant number of the members found themselves at odds with the new government and were beginning to emigrate or suffer financial downturns. In 1790, a second reorganisation took place, this time in an effort headed by the Abbé de Sieyès and Fourcroy. To pay off the original debts of the Lycée and garner operating capital, subscribers paid a set fee to be established as founders of the newly reformed institution. Among the founding patrons were Lavoisier and Théodore Brongniart. The Brongniart and Fourcroy families became active participants in the life of the Lycée, either teaching or attending courses on a variety of topics. In the mid-1790s, Brongniart’s youngest sister, Émilie attended public courses, often accompanied by her mother, and became an avid

⁸¹ For a history of the Lycées, see Claude Viel, “Fourcroy et les Lycées,” in *Revue d’histoire de la pharmacie*, 98e année, 369 (2011), 13-30; and W. A. Smeaton, “The Early Years of the Lycée and the Lycée des Arts,” *Annals of Science* 11, 3 (1955).

⁸² Viel, “Fourcroy et les Lycées,” 13-30; Smeaton, “Early Years of the Lycée,” 257-267.

⁸³ Viel, “Fourcroy et les Lycées,” 3, 16, 20, 27.

student. It also served as a continued learning and teaching arena for Brongniart, whose first major courses in natural history were given there.⁸⁴ In 1793, it became necessary to further clarify the identity of the institution and to demonstrate its alignment with the political changes under the new revolutionary government. Thus, it was again renamed, this time as the Lycée Républicain.

In addition, from 1793, the newly created Lycée des Arts, also located at the Palais Royal, received extensive support from Fourcroy and Silvestre.⁸⁵ Fourcroy became the Lycée des Arts' first president, and Lavoisier was briefly its second. Brongniart took on additional teaching responsibilities in natural history there.⁸⁶ Founded by a former toymaker and engineer, Charles Emmanuel Gaillard-Desaудray – who had spent time in the manufacturing centre of Birmingham – the focus of the Lycée des Arts was practical, providing a place for artists and artisans to train, particularly in the making of luxury objects.⁸⁷ The Lycée des Arts was intended to be complementary to the Lycée Républicain, and Desaудray planned an institution in which the arts and the sciences could come together, with courses offered at no charge to the students.⁸⁸

By 1794, new public schools, intended to provide the technical education desired by the military and the state, were established through an initiative of the revolutionary government. Here, the role of the savants in reshaping French society had an immediate and lasting effect. Fourcroy was again among the most influential of the politicians working to establish the framework. There were five schools that comprised the Écoles Centrales in Paris

⁸⁴ Louis de Launay, *Les Brongniart*, 53-4.

⁸⁵ Viel, "Fourcroy et les Lycées," 2011; Gillispie, *Science and Polity: Revolutionary and Napoleonic Years*, 213-214.

⁸⁶ Bruno Belhoste, *Paris Savant* (Oxford, 2019), 239.

⁸⁷ Michel Régis, "L'art des Salons," in *Aux armes et aux arts*, eds. Pierre Arizzoli-Clémentel and Philippe Bordes (Paris, 1985), 75-6.

⁸⁸ Bernadette Bensaude-Vincent and Christine Blondel, *Science and Spectacle in the European Enlightenment* (Aldershot, 2008).

– one of which was located in the Couvent des Capucins, which Théodore Brongniart had built in 1780-2 for Mme de Montesson in the Chaussée d’Antin.⁸⁹ Brongniart was called upon to teach natural history at the École Centrale des Quatres-Nations, while continuing with his other teaching responsibilities.⁹⁰

Prior to his first arrest in 1793, Brongniart had taught zoology at both the Lycée and the Lycée des Arts. He had asked for the classes, believing they would not occur all at once, and he told his father that it was Fourcroy who had pushed him to give them: “You will see that it was impossible for me not to do them.”⁹¹ The workload benefitted his ethos of self-cultivation; in keeping with his earlier position that teaching courses was the best way to learn and to organize knowledge, at the end of the courses, he wrote to Théodore to say that he had expanded his knowledge on the subject matter dramatically.⁹² Fourcroy continued in his role as teacher and mentor, even over the tension-filled years of the Terror, and Brongniart continued to pursue research. Beginning his teaching career just prior to the creation of the École Polytechnique in 1795, Brongniart was one of the last of the Parisian savants to begin working without the specifically tailored education it was designed to offer. However, he had long benefitted from studying and working with many of the most prominent professors of Paris, including Fourcroy in chemistry, Haüy in mineralogy, and François Peyrard in mathematics, and his work reflected the high standards of these educators.

Old and New: The Bureau des Mines and the Muséum d’Histoire naturelle

Following his return to Paris in late summer 1794, Brongniart could turn again to developing his career. In addition to his previous teaching positions at the Lycées, which had

⁸⁹ See Annotated Map, Appendix 3.

⁹⁰ The École Centrale was located on the current site of the Institut de France.

⁹¹ Alexandre Brongniart to Théodore Brongniart, 21 June 1793, AN 668/1, 18.

⁹² Alexandre Brongniart to Théodore Brongniart, 21 June 1793, AN 668/1, 18.

been held open for him, he had new options for immediate employment. With Fourcroy's help, he had a position waiting for him with the newly organized Council on Weights and Measures. Charles-Étienne Coquebert de Montbret had already taken a post there and asked Brongniart to join him.⁹³ A second opportunity, as an engineer with the Agence des Mines, also opened up. The former was a bureaucratic position that did little to satisfy Brongniart's specific interests, but it would have been a very good opportunity if no other had existed. However, the latter option offered increased travel and exploration, as well as further training in geology and mineralogy. Brongniart wrote to his father saying that he knew it would give him much more experience in both fields, and that it was an opportunity for a young man who had not yet made his place in the world. He made his choice quickly, and was soon travelling again, spending Autumn 1794 travelling through Normandy as a mining engineer.⁹⁴

Working for the Agence des Mines gave Brongniart a way of utilising his skills and building upon them. As I have discussed in the introduction, Brongniart told his father that his architectural training was as valuable to his work as an engineer as chemistry and mineralogy were. Meanwhile, in the field, he was now able to study natural formations and to develop first-hand knowledge of the terrain throughout France. As his travel journals in 1790 and 1791 demonstrated, Brongniart was already looking at geological formations and their characteristic seashells and other fossils by this time.⁹⁵ Another advantage was the ability he now had to see the state of French industries up close, and to meet other mineralogists and naturalists.

Teaching in Paris and Travel with the Agence des Mines

In a move that put the 1793 controversy over the zoology chair aside, Geoffroy was

⁹³ Alexandre Brongniart to Théodore Brongniart, 6 Août 1794, AN/668/1, 62-67.

⁹⁴ Alexandre Brongniart to Théodore Brongniart, 13 Septembre 1794, AN/668/1, 70.

⁹⁵ Brongniart, *Voyage no 2, 1791*, Journaux et papiers se rapportant aux voyages d'Alexandre Brongniart, Voyages de Paris à Dijon, BMHN MS 2337/2.

welcomed into the Société Philomathique on 13 January 1795. That spring, Geoffroy invited Georges Cuvier (1769-1832) to Paris and on 23 March, Cuvier, too, joined the Société. Brongniart and Cuvier, born six months apart, shared common interests in anatomy, and they almost immediately began working on jointly prepared dissections of various animal specimens. Likewise, when Cuvier began teaching, Brongniart showed his support and his curiosity in attending his classes whenever possible. While the Parisian natural history community had the potential for directly competitive relationships to emerge, there is little sign that Brongniart felt overly displaced by Cuvier. Importantly, by 1795, Brongniart had already consciously begun to move beyond medicine and anatomy to focus on the increasingly attractive disciplines of geology and mineralogy.⁹⁶ Unlike Cuvier, who had a limited network when he arrived in Paris, Brongniart had a longstanding and relatively secure footing in the politics, society, and academic structures of the city. Although there were key areas where their skills evidently overlapped, neither was positioned to overshadow the other completely. It is clear from Brongniart's journal entries that, from their earliest acquaintance, they rapidly began to work alongside one another and had a mutually supportive exchange of ideas.

Brongniart shared his energies and interests openly with other scholars, notably in his dissemination of results from his examination of collections. He worked on the private papers and specimens of Jean Gigot d'Orcy (1733-93), and he also participated actively in the classification and the publication of the items sent back from the expeditions of Guillaume Antoine Olivier (1756-1814).⁹⁷ This work was joined by other naturalists, particularly other

⁹⁶ Philippe Taquet has hinted that Brongniart's personal goals were affected by being bested by Cuvier in anatomy and in his public lecture style. However, evidence that Brongniart was either overly jealous or adversely affected by Cuvier's arrival is limited. See Philippe Taquet, "Les contributions respectives de Georges Cuvier et d'Alexandre Brongniart à l'élaboration de l'Essai sur la géographie minéralogique des environs de Paris, d'après les manuscrits retrouvés d'Alexandre Brongniart," *Travaux du Comité français d'Histoire de la Géologie* 23 (2009).

⁹⁷ Alexandre Brongniart, *Correspondance Active* (1791-1825), *Correspondence de Famille*, *Lettres à son père*, 1793-95, 16 Mai 1793, AN/668/1/14.

members of the Société Philomathique. By 1795, Brongniart had begun working with Haüy, becoming his teaching assistant at the École des Mines. Although his career had yet to solidify and he had not found a well-paid, career-defining post such as a teaching chair, Brongniart sought out and remained in demand for various ongoing projects and responsibilities. His active social engagement and his efforts to cultivate a community of young, working savants made him a popular ally and a desirable contact. In 1795, while he was away travelling during the warmest months of the year with the Corps des Mines, he maintained a central position at the centre of the social and intellectual networks of Parisian natural history.⁹⁸

Brongniart was clearly enthusiastic about the skills he was learning and the insights he drew out of his first full year's work as a mining engineer. In the spring and summer of 1795, he was assigned to assess mines in the Alps. Brongniart led a group of three students from the École des Mines, as they hiked with their equipment, throughout countryside. In August and September, Brongniart was invited to join the party of Déodat Gratet de Dolomieu (1750-1801) on an extended tour of Mont Blanc. Having lost his fortune during the Revolution, Dolomieu took a post as chair of natural history for the Écoles centrales, alongside Horace Bénédict de Saussure (1740-99) and was also assisting the Agence des Mines.⁹⁹ They were joined by the Genevan naturalists Pierre François Tingry (1743-1821), and Marc-Auguste Pictet (1752-1825). The group took two trips, each two weeks long, hiking in the mountains with Geneva as a base of departure.¹⁰⁰ Thus, Brongniart was able to study the Alps in detail alongside some of the region's most-qualified experts.

The professional activities Brongniart performed under the auspices of the Agence des

⁹⁸ The Agence des Mines became the Conseil des Mines on 22 October 1795. Laboulais, Isabelle, et Jakob Vogell, "Construction du métier d'ingénieur des Mines," *Annales historiques de la Révolution française* 385, 3 (2016): 57.

⁹⁹ F. G. B.-L. Jan, "Déodat de Gratet de Dolomieu (1750–1801), Vie et œuvre d'un géologue Européen, naturaliste et lithologiste," *Comptes rendus de l'Académie des Sciences* II, A (2000): 88.

¹⁰⁰ Alexandre Brongniart to Théodore Brongniart, 24 Aout 1795, AN/668/1, 101.

Mines allowed him to develop his ideas in natural history and in industry. Although his nascent career was taking shape, his personal life reflected the aftermath of the financial and emotional upheavals brought on by the Revolution. He spent much of the course of 1795 isolated from his family and frequently alone, and he repeatedly wrote to his family in distress over their difficulties and disagreements, as well as about financial matters and living arrangements. The family was forced to make significant changes to their lifestyle, and Brongniart was even prepared to sell his copies of Buffon and the *Encyclopédie*, sacrifices he both regretted and felt a responsibility to make.¹⁰¹

The separation of his parents, initially undertaken for political reasons, had become deeply personalised by the summer of 1795. At the same time, their eldest daughter, Louise, had begun to have both financial and marital difficulties.¹⁰² While Brongniart spent much solitary time away from Paris, two resolutions grew from his personal reflections. The first was that he would likely no longer study medicine, feeling that he had been too far removed from his studies to resume it.¹⁰³ Rather, he would prefer to become a pharmacist “in the style of Pelletier,” meaning a pharmacist by employment in his own enterprise, but who also concentrated on chemistry and research.¹⁰⁴ The second, perhaps much grander resolution, was that he would no longer entertain hopes of travel to far away destinations, such as Africa, which he seems to have already discussed as a possibility. Instead, he intended to focus on travel throughout France and Europe.¹⁰⁵ Similarly, in January 1796, when offered a job as a professor

¹⁰¹ Alexandre Brongniart, *Lettres à son père*, April-November 1795, AN/668/1, 9-116, particularly 108.

¹⁰² See, for example, Alexandre Brongniart to Théodore Brongniart, 27 Septembre 1794, AN/668/1, 72.

¹⁰³ Alexandre Brongniart to Théodore Brongniart, 23 Juillet 1795, AN/668/AP/1, 96; 26 Septembre 1795, AN/668/AP/1, 106.

¹⁰⁴ He had been working with Bertrand Pelletier as a member of the pharmaceutical corps, and his close example may have been partially influential over this decision. Alexandre Brongniart to Théodore Brongniart, 26 Septembre 1795, AN 668 AP 1, 106.

¹⁰⁵ Alexandre Brongniart to Théodore Brongniart, 23 Juillet 1795, AN/668/AP/1, 96.

in Grenoble, which would have offered opportunities to do fieldwork beyond the Paris region, he deferred because he had been named a professor of natural history at the École Centrale des Quatres-Nations.¹⁰⁶ Thus he chose local opportunities over the chance to travel or to live outside of Paris.

After 1795, Brongniart did not travel on long expeditions in the field as a mining engineer. His life in Paris resumed with a return to his focus on the Société Philomathique, teaching responsibilities, and other research. He was also engaged in the arts, with regular attendance at the Salon, visits to artists' studios, the theatre, and discussions with his family. On 31 March 1796, he went with his father to the faubourg Saint Antoine, where they visited the faience factory of Louis François Ollivier (1734-1808).¹⁰⁷ Brongniart returned several times to study with Ollivier, and he collected samples of clays and pottery.¹⁰⁸ Ollivier's processes in the construction of hygienic heating furnaces were the subject of a memoir of Berthollet and Guyton de Morveau in 1785, and the two chemists may have been another resource for Brongniart in his work with Ollivier.¹⁰⁹ Since Ollivier manufactured faience apothecary jars and porcelain, and also refined both white clay for faience and lead for glazing and other applications, Brongniart likely focussed on the chemical aspects of faience and porcelain making during his time there. In the evenings, he read the articles on faïence in the encyclopaedia.¹¹⁰ Whatever the long-term motivation behind these projects might have been, this episode shows that Brongniart had begun to work on topics that were related to pottery and porcelain making by the mid-1790s.¹¹¹

¹⁰⁶ Brongniart, *Journaux Sédentaires*, BMHN MS 3358, 21, 27.

¹⁰⁷ Régine de Plinval de Guillebon, "Une manufacture de faïence à Paris," In Sèvres: *Revue*, 27 (2018): 44-63.

¹⁰⁸ Brongniart, *Journaux Sédentaires*, BMHN MS 3358, 23-25, 33.

¹⁰⁹ Jules François F. Fleury-Husson, called Champfleury, *Bibliographie céramique* (Paris, 1881), 243-4. Brongniart, *Journaux Sédentaires*, BMHN MS 3358, 25.

¹¹⁰ Champfleury, *Bibliographie céramique*, 243-4.

¹¹¹ Brongniart, *Journaux Sédentaires*, BMHN MS 3358, 56-7.

Brongniart's interest in the arts and the unusual advantages of his position led to an extraordinary event in the Brongniart household in January 1797. Using Brongniart's personal laboratory at rue Saint Marc, he and Silvestre teamed up with the anatomist and surgeon (and Philomath), Robillard, to teach a private anatomy class to female artists, who otherwise would not have had the opportunity for this kind of study.¹¹² On one occasion they brought in a cadaver and prepared it for anatomy and drawing lessons. It remained in Brongniart's laboratory for nearly a week, and each day, a group of women that included Silvestre's wife, the artist Constance Garre, painted it through the daylight hours and then returned to work in the evenings by lamplight.¹¹³ The fact that Brongniart and Silvestre organized this private class shows the high level of effort they believed was valuable in developing understanding for the sake of the arts, for instruction, and for self-cultivation. Their efforts allowed the female students to learn directly from nature, adding deeper understanding to their artworks.

A Decade of Change

The 1790s were a time of exploration and self-discovery for Brongniart. He worked to build mutually supportive networks and actively sought to accumulate and disseminate knowledge through teaching, publications, and professional organisations. As I have shown, from his youth, Brongniart had built relationships with other naturalists easily, and had maintained them throughout times of intense conflict. Following the Revolution, the Société Philomathique he had co-founded became recognized as an important scientific society. Some of the members who had joined in response to the closure of the Academy, such as Lamarck

¹¹² Robillard was a member of the Société Philomathique from 1791, and a surgeon at Les Invalides. Silvestre, *Rapport général des travaux de la Société Philomathique de Paris*, 1799, viij.

¹¹³ Brongniart, *Journaux Sédentaires*, BMHN MS 3358, 56-7. Other attendees were: Mme Chaudet, née Jeanne Élisabeth Gabiou (d.1832), portrait painter; her sister-in-law, Marie-Élisabeth (Lemoine) Gabiou (1761-1811); Marie Denise Villers (1774-1821); and Marie-Victoire Lemoine (1754-1820).

and Fourcroy, remained associated with the group, and the membership remained active. Although Brongniart had been born into fortunate circumstances, his situation had been radically altered by the political events of the Revolution. Nonetheless, his focus on scientific studies remained intact, and by the end of the 1790s, he was a well-respected professor whose ideas on natural history had begun to take shape as a wide-ranging, comprehensive study. He also worked as a mining engineer, expanding his field experience in both mineralogy and geology. In this capacity, Brongniart began to combine the interests of the state and industry with natural history, as he identified and recommended ways of managing French mineral resources. As I discuss in Chapter Four, his efforts in all these domains gave him many of the skills needed to direct the manufactory at Sèvres.

CHAPTER FOUR: By Nature and Design – A New Role in Industry

The end of the eighteenth century marked a transition for France politically and culturally, as the Revolution came to an end and Napoléon rose to power. On 26 October 1795, a new constitution eliminated the Convention and established the Republic.¹ It was not a popular government, but one that was preferable to the recent alternatives – either a monarchy, or Jacobin excess and Terror. The new government included the five-person Directorate, the Conseil des Cinq-Cents, and the Conseil des Anciens. Fourcroy remained active as a senator in the latter until 1797.² In 1798, after completing successful military campaigns in Italy, twenty-eight-year-old Napoléon was too young for a place in the Directory, for which the minimum age had been set at forty. Nor could the rules be suspended to allow an exception for him.³ Instead, he continued in his military career with an expedition to Egypt, taking with him a group of savants, including Berthollet, Monge, and Dolomieu. The expedition increased Napoléon's political power and earned the support he needed to eliminate the Directory during the Coup of 18 Brumaire (9 November 1799).⁴ As I discuss in this chapter, the Egyptian expedition benefitted the careers of several savants, including those with close ties to the Brongniart family.

Longstanding family and professional relationships, as well as careful strategies, continued to buffer Brongniart's experience. He did not join the Egyptian expedition, preferring to concentrate on the teaching posts he held at the lycées and at the École centrale des Quatre-Nations. Within this chapter, I examine the skills and mindset that made Brongniart

¹ David P. Jordan, *Napoleon and the Revolution* (Basingstoke, 2014), 29.

² "Fourcroy, Antoine François de," *Complete Dictionary of Scientific Biography*, *Encyclopedia.com* (24 January 2022); William Doyle, *Oxford History of the French Revolution*. 2nd ed. (Oxford, 2002), 319.

³ Jordan, *Napoleon and the Revolution*, 49-50.

⁴ Jordan, *Napoleon and the Revolution*, 49-61.

suited for the directorship at Sèvres, while placing him within the context of the changing social, artistic, and scientific landscapes of France. I also examine the importance of Brongniart's family and patronage relationships in providing the social and intellectual conditions for his placement at Sèvres. Brongniart's appointment benefitted from the culmination of a series of complex political movements involving various members of the Parisian savant community, including the Egyptian Campaign and the Coup of 18 Brumaire.

The Origins of a Career

In the aftermath of the Revolution, and particularly from 1795 under the government of the Directory, young savants were provided with increasing opportunities to establish themselves and to promote their research. As I have discussed in Chapter Three, the reorganisation of existing institutions, as well as the creation of new education centres, such as the lycées and the Écoles centrales, brought opportunities for instruction in the latest scientific ideas to a diverse public, with courses that offered both specialised technical skills and topics of general interest.⁵ Brongniart's own teaching career, the preparation for which came in part from the carefully planned chemistry lectures given in the family salon at Les Invalides from 1787-90, was developed alongside the growth of the lycées and the creation of new national standards for education. He continued to manage the collections in his personal laboratory, while building a botanical specimen garden for the École centrale des Quatre-Nations and assisting in the organization of the collections of Guillaume Antoine Olivier, who travelled extensively around the Middle East and Persia from 1792-98.⁶

⁵ I discuss the lycées in Chapter Three; see also William Smeaton, "The Early Years of the Lycée and the Lycée Des Arts" *Annals of Science* 11, 4 (1955); Margaret Bradley, *Gaspard Clair François Marie Riche De Prony* (Lewiston, NY, 1998); Hervé Guénou, "Musées et Lycées Parisiens (1780-1830)," *Dix-Huitième Siècle* (1986).

⁶ Guillaume Antoine Olivier, *Voyage dans l'empire Othoman, l'Égypte et la Perse* (Paris, 1801); Alexandre Brongniart, *Journal Sédentiare*, 24 March 1799, BMHN MS3358, 222.

As I have shown in Chapter One, Brongniart had grown up close to the circle of Louis Philippe I, duc d'Orleans and his morganatic wife, Mme Montesson. The Brongniart family had a longstanding association with the artisanal and bourgeois class that surrounded the Parisian elite and nobility.⁷ These social relationships were also professional ones, in which the Brongniart family provided necessary services, such as pharmaceutical advice, or luxuries, in the form of architectural design. As before, Brongniart seldom, if ever, demonstrated a vocal political stance that would jeopardise his relationships or social position. However, like many of his associates and intimates, while he played a background role in the political context of the Revolution, he demonstrated his support for intellectual and institutional reform throughout.⁸ Over years and decades, he continued to benefit significantly from associations with those members of his family network, including David, Fourcroy, Berthollet, and Monge, who featured prominently in both the Revolution and the Napoleonic Empire.⁹

The Egyptian Campaign: A Defining Moment of Change

In 1798, Napoléon, while personally seeking a path to political power, publicly supported the expansion of French powers, proposing himself as leader for a campaign in Egypt.¹⁰ While the campaign was a large military effort, he sought to add a group of engineers, chemists, and natural historians, along with artists and students. Berthollet and Monge, sworn to secrecy about the destination, organized the group of savants on the promise that the outcome

⁷ Monique Mosser, *Alexandre-Théodore Brongniart: architecture et décor* (Paris, 1986), 14-32.

⁸ Augustin Pyramus de Candolle and Jean-Daniel Candaux, *Mémoires et souvenirs (1778-1841)* (Geneva, 2003), 97.

⁹ William Arthur Smeaton, *Fourcroy: chemist and revolutionary* (London, 1962), 38-67, 90-91; Alain Queruel, *Antoine de Fourcroy* (Paris, 2010), 67-132; Michelle Sadoun-Goupil, *Berthollet*, (Paris, 1977); Louis de Launay, *Monge* (Paris, 1933); on David and the Revolution, see Edouard Pommier, *L'art de la liberté* (Paris, 1991), 20, 34-7, 115-7, 174-82 and Jean-Pierre Poirier, *Lavoisier* (Philadelphia, 1996), 334.

¹⁰ David P. Jordan, *Napoleon and the Revolution* (Basingstoke, 2014), 49-51.

would be worthwhile. The participants could benefit both financially and personally, with numerous research opportunities as well as the potential for elevation in status and power. Those with permanent posts in France would be protected in their careers, retaining their seniority, and receiving an increase in pay.¹¹

As we have seen, by the time these preparations began Brongniart held multiple teaching posts. While he was enthusiastic about the possibilities of the expedition, he nevertheless remained in Paris.¹² Unlike the professors of the Muséum, such as Geoffroy Saint-Hilaire, who were to receive benefits for their participation, Brongniart did not have the same kind of incentive or guarantee, having yet to receive a stable appointment of any kind. Cuvier declined his invitation on the grounds that he was already busy performing comparative anatomy in Paris.¹³ Cuvier preferred his Parisian laboratory work to fieldwork, seldom venturing far for his research.¹⁴ Brongniart could have obtained a place had he sought one. He remained eager to voyage throughout Europe, and possibly beyond, and he had already travelled extensively with Déodat Gratet de Dolomieu, another of the expedition's savants.¹⁵ However, while his preferences for reading travel diaries, expedition collections, and adventure stories indicated an admiration for distant exploration, Brongniart stood to gain less than he risked at this stage in his career. Like Cuvier, he had several laboratory-based and location-specific projects to continue.

From Brongniart's close family circle, the students Alexandre Gérard (younger brother

¹¹ Charles Coulston Gillispie and Michel Dewachter, *Monuments of Egypt* (Princeton, NJ, 1987); J. Christopher Herold, *Bonaparte in Egypt* (London, 1963); Jordan, *Napoleon and the Revolution*.

¹² Dena Goodman, "Gender of Fieldwork" *Journal of the Western Society for French History* (Ann Arbor, MI, 2018): 16.

¹³ Gillispie and Dewachter, *Monuments*, 6.

¹⁴ Dorinda Outram, *Georges Cuvier* (Manchester, 1984), 60-62; Philippe Taquet, "Les contributions respectives de Georges Cuvier et d'Alexandre Brongniart à l'élaboration de l'Essai sur la géographie minéralogique des environs de Paris," *Travaux du Comité français d'Histoire de la Géologie* 3, 23 (2009): 8.

¹⁵ See Chapter Three for a discussion of Brongniart's travel in the Alps alongside Dolomieu.

of the painter, François) and Ernest Coquebert de Montbret joined the Egyptian expedition, as did Hippolyte Victor Collet-Descotils (1773-1815),¹⁶ Brongniart's student and companion during his excursion in the Alps in 1795.¹⁷ For these individuals, the expedition was an educational voyage that could lead to future opportunities. Although early rumours indicated that the savants would be travelling to Egypt, it was only at Malta that the final destination became clear.¹⁸ By this time, Coquebert de Montbret and his fellow student, Jean-Marie Dubois-Aymé (1779-1846) had indicated their wish to turn back, but were convinced otherwise, while Dolomieu felt that he been betrayed and used for his status as a Knight of Malta in the French conquest.¹⁹

During their stay in Egypt, all the young engineering students from the École Polytechnique earned their diplomas, just as if they had continued their work in Paris.²⁰ The intellectual and scientific aspects of the expedition were undertaken with care and speed, despite the often-uneasy relations between the military and the civilians. The savants had good reason to be frustrated, disappointed, or even angry with the situation they found, including the shortage of provisions. The military often showed resentment toward the large contingent of civilians, including denying them rations, lodging, or even transport.²¹ Additionally, shortly after landing, most of their belongings, including the scientific equipment, was lost during the battle with the British fleet at Abukir Bay in August 1798.²² The savants continued to find resources on their own and records of the Institut d'Égypte, organized by Monge and Napoléon,

¹⁶ Isabelle Laboulais, "Notre métier est de décrire," *Études sur le XVIIIe siècle* (Brussels, 2015): 8.

¹⁷ Charles C. Gillispie, "Scientific Aspects of the French Egyptian Expedition," *Proceedings of the American Philosophical Society* 133, 4 (1989): 452-3, 464.

¹⁸ Augustin Pyramus de Candolle and Alphonse de Candolle, *Mémoires et souvenirs* (Geneva, 1862), 55-6. Gillispie, "Scientific Aspects," 452-3, 464.

¹⁹ Gillispie and Dewachter, *Monuments*, 7.

²⁰ Gillispie and Dewachter, *Monuments*, 10.

²¹ Gillispie and Dewachter, *Monuments*, 6, 8; Herold, *Bonaparte in Egypt*, 73, 214.

²² Jordan, *Napoleon in Egypt*, 55.

show continuous activity, research, and discovery.²³

Brongniart's decision was in many ways a fortunate one. Unlike the mid-eighteenth-century voyage of Charles Marie de la Condamine; the ill-fated 1785 expedition of La Pérouse; or the six-year expedition of Olivier and Jean Guillaume Bruguière (1792-1798) – for which knowledge gathering was a prominent factor – the Egyptian Campaign was, at a primary level, a military endeavour under the harshest of circumstances.²⁴ The goal was to interfere with British shipping and trade interests, while taking control of Egypt and re-establishing its prominence.²⁵ Working alongside more than 30,000 soldiers, 150 savants were charged with gathering information about Egypt, while the military fought the Marmeluk military regime then in power. Napoléon sought to enjoin the Egyptians and the Ottoman Sultan by claiming that he had come to liberate Egypt, all the while seeking French control.²⁶ While Napoléon could point to successes such as the Battle of the Pyramids, there were also heavy losses.²⁷

On balance, the military efforts to conquer Egypt were a failure. Nelson destroyed the French fleet soon after its arrival, and, among other setbacks on land, a protracted battle at Acre produced a vast number of casualties.²⁸ In addition, French soldiers were exposed to the plague, with many, including Ernest Coquebert de Montbret, succumbing to the disease.²⁹ After winning a land battle at Aboukir on 25 July 1799, Napoléon secretly left the otherwise

²³ Herold, *Bonaparte in Egypt*, 164-200; Jean-Edouard Goby, *Premier Institut d'Égypte* (Paris, 1987).

²⁴ Studies and memoirs of these journeys include G. Helferich, *Humboldt's Cosmos* (New York, 2005); Alexander von Humboldt, *Personal Narrative of a Journey to the Equinoctial Regions of the New Continent* (London, 1995); Paul Murdin, *Full Meridian of Glory* (New York, 2009); Guillaume Antoine Olivier, *Voyage dans l'empire Othoman, l'Égypte et la Perse* (Paris, 1801).

²⁵ Doyle, *French Revolution*, 332; Jordan, *Napoleon and the Revolution*, 60; C. Gordon Smith et al., "Egypt," *Encyclopedia Britannica* (2 November 2021).

²⁶ Jordan, *Napoleon and the Revolution*, 51-2.

²⁷ Herold, *Bonaparte in Egypt*, 95-100.

²⁸ Jordan, *Napoleon and the Revolution*, 55; Herold, *Bonaparte in Egypt*, 111-21, 295-310.

²⁹ Gillispie, "Scientific Aspects," 453; "Notice historique sur A.F.E. Coquebert de Montbret, lue à la séance générale de la Société philomathique le 12 brumaire an XII (4 novembre 1803)," épitaphe en vers de la main d'Alexandre Brongniart, BMHN MS2352/4/b.

precarious situation in Egypt accompanied by Monge, Berthollet, Denon, and several other senior savants and officers.³⁰ Upon his arrival in France, he quickly claimed victory, before news of the failures and losses in Egypt could be spread.³¹

Resolutions and Foundations

Writing in his journal during the week of the expedition's departure and having said goodbye to several close associates and friends, Brongniart reaffirmed his own interests, and outlined a set of goals for sustaining and prioritising his diverse activities.³² His public life during the 1790s followed a conscious, if slow-burning plan that included further scientific research, aspirations toward publications, and visions of a major public position. Meanwhile, to his great distress his personal life remained unsettled.³³ Nearing his thirtieth birthday, Brongniart recorded anxieties over his options. It did not seem likely that any significant post, such as a permanent chair at the Muséum d'Histoire naturelle, would be available to him soon; without an inheritance or a suitable income, he was conscious of his limited choices. The consequences of marrying someone who was also without a fortune were worrisome to Brongniart and his family, and he was aware that any potential bride with a stronger financial footing would in turn be concerned about his own lack of financial security. His strict work habits provided a focus for his time while he continued to establish and expand his research and teaching, and he resolved to continue without expectation of marriage.³⁴

It was during these years that Brongniart began an affair with the married composer and singer Sophie Gail, who was a member of the intimate circle of the Brongniart, Silvestre,

³⁰ Jordan, *Napoleon and the Revolution*, 61.

³¹ Jordan, *Napoleon and the Revolution*, 60-1.

³² Alexandre Brongniart, *Journals de Voyage & Journaux Sédentaires*, BMHN MS 3358, 122-3.

³³ See Brongniart, *Journals*, 1798-1799, BMHN MS 3358.

³⁴ See Brongniart, *Journals*, BMHN MS 3358, 164-304.

and Coquebert de Montbret families.³⁵ The difficulties he experienced in managing this clandestine relationship shattered his typically steady character. His evening reading changed abruptly from accounts of travel and expeditions, natural histories, and encyclopaedia entries to Pierre Choderlos de Laclos' *Les liaisons dangereuses*, whose anti-hero Vicomte de Valmont he found to be a "horrible rogue."³⁶ Brongniart's personal struggles adversely affected his public life, and he fell behind in his studies and missed some teaching duties. This change in his personality was also picked up by others, including, as Brongniart wrote in his journal, his close friend and colleague Charles Étienne Coquebert de Montbret.³⁷

For Brongniart, the years 1798 and early 1799 marked the end of nearly a decade of efforts to create a prominent professional life from small projects, research, teaching, and, with the Corps des Mines, fieldwork across France. In November of 1798, he proudly recorded in his journal that he had just been named a professor of mineralogy at the Conseil des Mines, where he had served as assistant to Haüy from 1795.³⁸ The professorship made teaching the course explicitly his own responsibility, although he had already assumed many of Haüy's teaching duties. In addition to mining engineering, Brongniart had learned state-of-the-art mineralogy and crystallography as one of Haüy's closest assistants.³⁹ Although not yet one of the coveted spots at the Muséum, it was a clear step towards making him a potential candidate for a post in the future.

Alongside delivering his courses in natural history at the École Centrale des Quatres-

³⁵ Brongniart's marital anxieties and affair with Gail took place during late 1798 through mid-1799. Gail (née Garre) was the sister-in-law of Augustin François Silvestre through his wife, Constance Garre, a painter. Silvestre and Garre divorced in 1802. D. Goodman and E. Talbot, "Documenting Art, Writing Biography: Construction of the Silvestre Family History, 1660–1868," *Journal of Family History* 40, 3 (2015): 280.

³⁶ Brongniart, *Journals*, 6 March 1799, BMHN MS 3358, 208. Pierre-Ambroise-François Choderlos de Laclos and Michel Delon, *Les liaisons dangereuses* (Paris, 2018).

³⁷ Brongniart, *Journals*, 20 March 1799, BMHN MS 3358, 221.

³⁸ Jean-François Guillemin Claude Poullen, "Deux siècles de minéralogie à l'Ecole des Mines de Paris," in *Bulletin de Minéralogie*, 107 (1984), 5.

³⁹ I discuss this critical relationship further in Chapter Six.

Nations, Brongniart had been actively cataloguing and building a botanical garden there.⁴⁰ At the Lycée Republicain, he taught natural history to a popular audience. He had also been asked to contribute an essay on entomology to a new edition of Buffon's *Histoire Naturelle*, based on his work on the collections sent back to Paris by Guillaume-Antoine Olivier.⁴¹ Despite this acclaim, and his appointment at the Conseil des Mines, financial stability seemed unobtainable. Brongniart knew that, without it, the status and security that would come with a marriage into an elite family seemed impossible to achieve.

Strategies of Marriage-Making

As I have discussed in the introduction and in Chapter One, marriages were frequently used to solidify family ties.⁴² For example, the families of Monge and Berthollet were interwoven by common professions, shared politics, and close marriages. In 1779, Berthollet had married Marie Marguerite Baur (c.1748-1828), a harpist from a family of musicians, who served as *femme de chambre* to Mme Montesson.⁴³ Her brother, Alexandre Barthélémy Baur (1751-1823), was also a musician. A testament to the close relationship of their families, in 1790, Barthélémy married Anne-Françoise Huart (1770-1852), likewise a musician and the younger sister to Catherine Huart (1747-1827), the wife of Gaspard Monge (m. 1777). Monge had come from an artisanal family of *marchand merciers* and *marchand quincaillers* (ironmongers), while Catherine, following the death of her first husband, had inherited a forge, and so their union offered financial and practical benefits to both partners.⁴⁴ Through

⁴⁰ Brongniart, *Journals*, BMHN MS 3358, 20-24 March 1799, 222-4.

⁴¹ Brongniart, *Journals*, BMHN MS 3358, 6 April 1799, 229.

⁴² Bruno Belhoste, "Gaspard Monge, un savant acteur de son temps," *Sabix*, 41 (March 1, 2007).

⁴³ Elisabeth Vigée-Le Brun, *Souvenirs de Mme Vigée Le Brun* (Paris, 1926), 145.

⁴⁴ As I discussed in Chapter One, *marchand merciers* were an important segment of the artisanal class. Often highly trained artisans, they were able to work outside the typical restrictions of the exclusive guilds. Pierre Verlet, "Le commerce des objets d'art et les

association with Jean Henri Hassenfratz, Monge recommended his brother-in-law, Alexandre Huart, for the directorship of a glass factory at Champroux.⁴⁵ These ties created a family network of artisans and industrial leaders with connections to the influential social circle of Mme Montesson. Additionally, the marriages reinforced the public relationship between Monge and Berthollet, and the two were known to frequently act in solidarity with one another.⁴⁶

Brongniart's reflections on marriage show that he understood strategy and position would be necessary for a good match, since without substantial wealth he had only his intellectual achievements and social position to offer a potential spouse.⁴⁷ This was the setting in late April 1799 when Mme Coquebert came to visit Brongniart's eldest sister, Louise. Mme Coquebert made it known that if Brongniart wished to marry their daughter, Cécile, a few months short of her seventeenth birthday, his lack of fortune would not stand in the way. Cécile had recently received a proposal of marriage, but she had already determined her preference for Brongniart, and the match was viewed as a suitable one by her mother.⁴⁸

Brongniart had been in the company of the Coquebert family for much of the previous decade and had expressed the hope that Cécile would find a good husband, as he rated her qualities and personality highly. However, his journal entries show that the direct offer of marriage to Cécile was entirely unexpected.⁴⁹ He recorded:

I find on my way back a note from my sister who tells me that she will be back early, that she has something important to tell me. It worries me and I can hardly do

marchands merciers à Paris au XVIIIe siècle," *Annales: Economies, Sociétés, Civilisations* 13, 1 (March 11, 1958).

⁴⁵ Belhoste, "Gaspard Monge," 8; Manuel Grison, *L'étonnant parcours du républicain J. H. Hassenfratz* (Paris, 1996), 28-30; 89-90.

⁴⁶ Herold has written that, in Egypt, the soldiers humorously called the two men by the single name "Mongéberthollet," (a play on the phrase "Monge et Berthollet"). Herold, *Bonaparte*, 173-4.

⁴⁷ Brongniart, *Journals*, BMHN MS BMHN MS 3358, 21 April 1799, 234.

⁴⁸ Coquebert de Montbret, Cécile, Bernard Poujeaux, and Pauline Poujeaux. *Journal (1799-1801)*. (Paris, 2007), xxiii-xxvi.

⁴⁹ Brongniart, *Journals*, BMHN MS 3358, 21 April 1799, 234.

anything. At 8 o'clock my sister comes back and, sitting down by my fire, she tells me that Mme Coquebert has come to see her in relation to me. Cécile has been asked to marry. Mme Coquebert and her husband, who have a great friendship for me, did not want to make up their minds without knowing my intentions, which they could reasonably suppose that I could hide out of delicacy. If I intend to marry, if I wanted to unite myself with Cécile, that the difference of fortune does not stop me. The whole family loves me enough to disregard this question. This is very abbreviated, what my sister told me. To express all the ideas that this announcement, as unexpected as it is flattering, has shown me, would be difficult. They present themselves in too great a number and too confusedly.⁵⁰

Coquebert had been an influential friend and a mentor to Brongniart, and the pair had common affinities, such as the Société Philomathique, and close familial connections.⁵¹ Still intimate with Gail, and uncertain about a future alongside Cécile, Brongniart confessed that “this badge of friendship, interest, confidence, good opinion” gave him a great deal of pleasure. A liaison like this would give him “invaluable rare advantages” but he noted that he would have to “accustom myself to the idea of leaving the independent life of a bachelor”. He recalled that he had long thought that if a “precious opportunity” such as the one that now presented itself ever materialized – “A young woman, pretty, educated, of a charming character. An extremely kind father and mother, and my best friends; a respectable, interesting, kind family, people I have known for a long time and all good, etc. etc.” – he should not waste it.⁵²

After brief hesitation and self-examination, he committed happily to the offer, but it soon caused new anxieties, as the marriage contracts were only slowly negotiated between the families. Although by April 1799 his personal relations with Gail had cooled (at least on her part), as Silvestre’s sister-in-law, Gail continued to be a member of the family circle. While her moods with him were variable, she continued to demand Brongniart’s time, energy, and loyalty. At the same time, Gail continued to pursue a series of liaisons, including those with Brongniart’s close friend, Amable Pelé, and Swiss naturalist Augustin Pyramus de Candolle

⁵⁰ Brongniart, *Journals*, BMHN MS 3358, 21 April 1799, 234.

⁵¹ Coquebert de Montbret, *Journal*, xxiii-xxvi.

⁵² Brongniart, *Journals*, BMHN MS 3358, 21 April 1799, 234.

(1778-1841). Regardless of the progress of his relationship with Cécile, Gail's behaviour continued to frustrate Brongniart throughout the summer.⁵³ Brongniart's proposed marriage to Cécile was not made open knowledge, and there were still barriers to be overcome with the financial terms of the contract. It was only in the late summer that Brongniart and Cécile spent increasing amounts of time together, and in September Brongniart joined her family at the home of the Hazons in Gisors.⁵⁴

The forthcoming marriage brought the question of Brongniart's mature career into the spotlight for both families, and it gave Brongniart the opportunity to consider his professional options in a broader, more public context. Coquebert had previously maintained a closely supportive relationship with Brongniart, but the promised union meant that, as Brongniart's father-in-law, Coquebert could become more deeply involved. Any assistance he gave Brongniart would directly benefit his own daughter, and it was in Coquebert's interests to see that the couple had a stable start to their lives together. One such project was the idea of returning to the Brongniart family's longstanding profession, by taking over an established pharmacy, or otherwise starting a new one. A pharmacy would give Brongniart financial independence and provide him with a laboratory and workplace. It was not the first time that he had investigated the possibility of such a path to independence. Brongniart had considered a shared enterprise with the adoptive son of the chemist Louis-Claude Cadet de Gassicourt, Charles-Louis Cadet de Gassicourt (1769-1821). In the end, the pair did not enter partnership, perhaps due to the necessity for Cadet de Gassicourt to complete his pharmacy studies, which he did only in 1800.⁵⁵

⁵³ Candolle, *Mémoires et souvenirs*, 73-4.

⁵⁴ Brongniart, *Journals*, BMHN MS 3358, 266.

⁵⁵ Charles-Louis Cadet de Gassicourt was the adoptive son of Louis-Claude Cadet de Gassicourt, and the natural son of Louis XV and Marie Thérèse Françoise Boisselet. As I discuss in Chapter Five, Louis-Claude Cadet de Gassicourt was instrumental in the combustion experiments pursued by Lavoisier and Macquer during the 1770s. Simone Flahaut, "Le

Brongniart and Coquebert researched locations and existing pharmacies in the Left Bank, and at the same time Brongniart spent time in research and study with the chemist Vauquelin and the pharmacist Pelletier.⁵⁶ Brongniart studied chemical processes at Pelletier's rue de la Jacob pharmacy, which Pelletier had taken over following the death of his teacher, the influential chemist, Guillaume François Rouelle. Presumably, with Pelletier, these were hands-on lessons in the operations of the pharmacy itself and in chemical preparations, but Brongniart did not record specifically what he worked on with Vauquelin.⁵⁷

On 16 October 1799, a group including Berthollet, Monge, and Denon returned from Egypt alongside a still triumphant Napoléon. Soon after their return, Berthollet and his family, as well as Vivant Denon, attended dinners at the Brongniart family home.⁵⁸ As the political setting changed once again, so events moved quickly for Brongniart. His family's proximity to Berthollet, Monge, and Denon meant that they were poised to benefit from changes within the administration and the power structures of France that Napoléon's return promised. After several years of military campaigns, Bonaparte was ready to assert his power on a much greater scale. Aided by the participation of his brother Lucien Bonaparte, Charles Maurice de Talleyrand-Périgord, the Abbé Sieyès, General Joachim Murat, Joachim Le Breton, and others, a successful coup took place on 18-19 Brumaire (9-10 November 1799). This action ended the rule of the five-person Directory and resulted in the creation of the Consulate, with power to be shared by three consuls. Three weeks after his return from Egypt, Napoléon continued to realize his ambitions with his appointment as First Consul, alongside Sieyès and Pierre Roger

Pharmacien Charles-Louis Cadet de Gassicourt, bâtard de Louis XV, et sa famille," *Revue d'Histoire de La Pharmacie* (1980).

⁵⁶ Brongniart, *Journals*, BMHN MS 3358, 15 August 1799, 263.

⁵⁷ Brongniart, *Journals*, BMHN MS 3358, August-October 1799, 263-75. During 1797, Vauquelin did significant research on the identification of the element chrome and its chemistry. Its use as a rich green ceramic colourant was later developed by Brongniart at Sèvres. Alain Queruel, "Vauquelin (1763-1829): un savant mêlé contre son gré aux turbulences de son époque," *L'Actualité Chimique* 224 (1999).

⁵⁸ Brongniart, *Journals*, BMHN MS 3358, 18 October 1799, 275.

Ducos.⁵⁹

While Brongniart's time in Paris during the period of the Egyptian campaign was productive, the early return of Napoléon and his closest advisors from the expedition brought swift change. Brongniart's journal entry for the day of 18 Brumaire was even more understated than usual, containing only an observation on "grands evenements."⁶⁰ Nonetheless, he understood that the day's events would have great consequences, not only for France, but also for the members of his network and for himself. He attended a series of dinners in the autumn of 1799, including one on 22 November at the Brongniart family home at which Fourcroy and Denon were guests, and a week later, at the home of Berthollet and his family. Berthollet remained close to Napoléon, and, along with Monge, was appointed as a senator under the new Consulate.⁶¹ Opportunities quickly reached Brongniart's intimate circle. On 9 January 1800, Coquebert was appointed Consul to Amsterdam, his departure hastening the marriage of Brongniart and Cécile. A month later, on 7 February, they signed the much-discussed contract, and within two days, the marriage formalities were complete, with their lives not having yet found a permanent footing. They did not have long to wait. On 24 March 1800, Brongniart wrote in his journal that Mme Berthollet had come to their home that morning, informing him that Berthollet wanted Brongniart to fill the position as director of Sèvres.⁶²

Although his appointment at Sèvres may seem to have been an extraordinary career leap, Brongniart had demonstrated his organisational skills and leadership from an early age. The Société Philomathique, which he founded and maintained, relied on his management and

⁵⁹ Jordan, *Napoleon and the Revolution*, 62-751; William Doyle, *Oxford History of the French Revolution* (Oxford, 1996), 374-5.

⁶⁰ Brongniart, *Journals*, BMHN MS 3358, 281.

⁶¹ R. Hahn, "Claude-Louis Berthollet," *Encyclopedia Britannica*, 5 December 2021. <https://www.britannica.com/biography/Claude-Louis-Berthollet>.

⁶² Brongniart, *Journals*, 24 March 1800, BMHN MS 3358, 305. Coquebert de Montbret, *Journal*, xxiii-xxvi.

sustained efforts, as did his numerous teaching assignments and projects such as the botanical garden at the École Centrale des Quatres-Nations. He had also supervised a number of groups of researchers and students during the Corps des Mines expeditions of 1794-5. As we have seen, late eighteenth-century France was a world of rapid change in which young men could rise quickly under the right circumstances, such as the appointment of the relatively unknown Geoffroy Saint-Hilaire to the high-ranking chair of zoology at the Muséum. Critically, for Brongniart, the practice of natural history and of porcelain making were closely linked, as I discuss in Part Two.

In 1800, Brongniart's relative youthfulness was not a drawback. Only recently, an older generation of politicians, including Monge, Berthollet, and Fourcroy, had backed twenty-nine-year-old Napoléon as a leader. By comparison, Brongniart's nomination to the post at Sèvres may be understood as a calculated wager in a France that had been shaped by young Revolutionaries. The appointment also showed that he had not acted in political ways that would keep him from serving under the new government represented by the Consulate and Napoléon. While Sèvres was plagued by financial difficulties and a lack of innovation throughout the revolutionary period, it possessed a strong foundation, as well as a well-established group of artisans who had remained in place from the days of Macquer's directorship. The manufactory needed to be steadied and improved, but it had retained many valuable assets throughout the Revolution.⁶³ Any new director would have the expertise of Sèvres technicians and artists to draw upon. Additionally, Brongniart had the advantage of a lifelong familiarity with processes and chemistry related to porcelain-making, including a familiarity with the laboratories of the manufacture itself.

⁶³ E. J. Richardson, *Unlikely Citizens? The Manufacturers of Sèvres Porcelain and the French Revolution* (London, 2007), 201-11.

Speculations of Future Potential

If Brongniart had ever held explicit intentions for an appointment to Sèvres they were unrecorded. However, his work in the 1790s showed more than a passing interest in ceramics, from his study within the silver and enamelling workshop of Pierre Hubert Desvignes, to the days spent working at Louis François Ollivier's faïencerie in the faubourg Saint Antoine.⁶⁴ Brongniart was keenly aware of the prospects for employment within natural history and industry in Paris. He recorded the active discussions that he had with other young naturalists, including Cuvier, André Marie Constant Dumeril (1774-1860), and Sylvestre-François Lacroix (1765-1843), particularly when it appeared that there might be vacancies appearing at the Muséum d'Histoire Naturelle in the imminent future.

In late December of 1799, the group of friends met and discussed the recent elections to the Senate of two chairs at the Muséum, Louis Jean-Marie Daubenton and Bernard Germaine de Lacépède. Thinking that the two men would have to depart from their posts at the Jardin des Plantes, Brongniart was aware that both he and Cuvier were eligible for that of Lacépède in Zoology (Reptiles and Fish).⁶⁵ Brongniart had taught this subject at the Lycée Republicain and at the Lycée des Arts. It is clear from his journal entries that Brongniart, along with his close associates, consistently thought strategically about the positions that would be available in the future. Brongniart knew already that competition would be tight for any lucrative posts at the Muséum, and he was aware of the similarity of interests between himself and Cuvier.⁶⁶ Brongniart had studied zoology and anatomy, and, as the 1793 letters regarding Geoffroy's

⁶⁴ I discussed these events in Chapters Two and Three.

⁶⁵ Brongniart, *Journals*, 22 December 1799, BMHN MS 3358, 288. However, Brongniart knew that the chair in mineralogy that belonged to Daubenton had other, more likely successors, including Dolomieu and Haüy, both of whom had seniority over Brongniart in the field. In any event, Lacépède did not resign from his post, and was only replaced in his daily activities by Dumeril in 1803.

⁶⁶ On Cuvier's positioning and patronage, which included the support of Fourcroy, see Outram, *Cuvier*, 54-57.

nomination to the zoology chair expressed, he had hoped for a spot at the Muséum based on this work. He saw in Cuvier a substantial match within the subject area.⁶⁷ But what Cuvier possessed in depth of study, Brongniart made up for in flexibility and a diverse understanding across the breadth of natural history, geology, mineralogy, and chemistry. They may both have wanted to make their mark at the Muséum, but Brongniart had long thought about other options he could take, such as a pharmacy or the production of publications in natural history. Additionally, he had already shown a strong interest in mineralogy and geology and would be qualified for more than one subject area at the Muséum. Moreover, writing to Silvestre in 1793, Brongniart had voiced enthusiasm for Aubin Louis Millin's contributions to the Société Philomathique on antiquarian questions, which he recognised as valuable for the study of natural history.⁶⁸

Earning a Place in Industry

Whatever political or social rationale lay behind his appointment at Sèvres, Brongniart, having close associations with the Sèvres chemists Macquer, Darcet, and Cadet de Gassicourt, had developed a skillset that was well suited to the manufactory. Sèvres was a well-known institution that – precisely because its directorship required an extensive and diverse social and educational background – attracted a much narrower field of candidates for its directorship than did the Muséum. Industrial positions, such as that of Berthollet's at Les Gobelins, or Darcet's at Sèvres, or the directorship of the glassworks at Saint Gobain, were acknowledged as among the best-compensated in Paris. In the 1780s, shortly after Macquer's death, Fourcroy remarked upon the distinct advantage the savants working in industry had over those working as professors at the Muséum. Mme Roland recalled that Fourcroy had argued for better

⁶⁷ Launay, *Les Brongniart*, 72-4.

⁶⁸ Silvestre-Brongniart Letters, BMHN MS 1989/ 873-888.

treatment of the natural history professors throughout Paris. Some scholars have interpreted her words as an indication of Fourcroy's jealousy over Berthollet's advantage in gaining the lucrative post, worth "2000 ecus," at Les Gobelins.⁶⁹ Regardless of the tone of his statement, Mme Roland's memoirs show that Fourcroy was alert to the value of a position at Sèvres. Brongniart, unlike many of his associates in the Société Philomathique, or the Société d'Histoire naturelle, had a long history with the manufactory, and had experience in both the arts and in chemistry, which was clearly useful, if not essential, in gaining the post.

The management at Sèvres had been disrupted during the Revolution, and its future was uncertain. While a number of workers remained in place, highly-skilled artists such as Etienne Charles Le Guay, his wife Marie Jacquotot, and the sculptor Louis-Simon Boizot transferred to private manufactories such as Dihl and Guerhard in Paris, where they were able to draw better incomes.⁷⁰ As I discussed in Chapter Two, in August 1793, several academicians who served as advisors to the manufactory, including the chemist Jean Darcet, had been dismissed for their involvement in the burning of Mme Lamotte's memoir of Marie Antoinette in the Sèvres kilns.⁷¹ Darcet was imprisoned for his royalist associations. Fourcroy helped to secure his release, but Darcet was could not return to his advisory role at Sèvres. In April 1794, the position of the minister of the Interior was abolished, and new committees took its place. Of those, Sèvres fell under the administration of the commission of Agriculture and Manufactures,

⁶⁹ Gillespie, without giving the quote, made this characterization assertively. Charles Coulston Gillispie, *Science and Polity in France: End of the Old Regime* (Princeton, 2004), 407. See also Sadoun-Goupil, *Berthollet*, 22. The relevant passage can be found in Roland, *Lettres de Mme Roland* (Paris, 1900), 374-5n; Fourcroy held numerous public posts that were believed to bring in as much as 24,000 livres combined, an amount that drew substantial criticism. However, Fourcroy had either been paid in *assignats*, or had not been paid at all, leaving him with almost no actual income. Smeaton, *Fourcroy*, 10-11, 74-5. At the time of the Revolution, ecús were valued at 6 livres/écu.

⁷⁰ Régine de Plinval de Guillebon, "La manufacture de porcelaine de Guerhard et Dihl dite du duc d'Angoulême," *French Porcelain Society IV* (1988): 10-1.

⁷¹ Antoine d'Albis, "Hard-Paste Porcelain Plates from Sèvres," *Metropolitan Museum Journal*, 37 (2002): 269.

of which Louis Costaz (1767-1842), and Claude-Louis Berthollet were important figures. Additionally, the younger brother to Louis Costaz, Claude-Anthelme (1769-1858), was named head of the Bureau des Arts and Manufactures.⁷²

At the end of the eighteenth century, the operations of Sèvres were not paramount among the concerns of most of the young naturalists of Paris. Its location was isolated from other Parisian laboratories, and although the manufactory had played a prominent role in Parisian chemistry during the 1770s, it was not a centre of research by the 1790s. However, as I discuss in depth in Chapter Five, it was familiar ground for Antoine Louis Brongniart, Fourcroy, and Berthollet. Sèvres possessed many assets, including chemistry laboratories and furnaces, that had proven valuable to these men, and their respective positions gave them authority to negotiate on its behalf and to protect it.

Unlike Sèvres, the teaching chairs at the Muséum, of which there were only a limited number, were under continuous observation by any number of candidates, who all hoped for indications of any change in circumstances. Few young savants had planned for an opportunity to forge a career at Sèvres or were openly competing for one. At the end of 1799, Fourcroy had insisted Brongniart take over his upcoming courses in chemistry at the Lycée, even if it meant that he had to pass his natural history course on to someone else. While this action provided Fourcroy with support for his class as his political life resumed, it also gave Brongniart a public opportunity to display his knowledge of chemistry. Whatever the background manoeuvres, Brongniart responded immediately, arranging to teach the courses.⁷³

Among his contemporaries, Brongniart's specific intellectual capacities – attention to

⁷² Harold T. Parker, "Two Administrative Bureaus under the Directory and Napoleon," *French Historical Studies* 4, 2 (1965): 149.

⁷³ Brongniart, *Journals*, 27 December, BMHN MS 3358, 288. Cuvier served as his replacement, which Brongniart had mixed feelings about, both disappointed about the loss, and at Cuvier's quick success in his place. See Brongniart, *Journals*, 12 January 1800, BMHN MS 3358, 291.

detail, academic leadership, and the ability to both systematise and teach complex bodies of thought – were well-known. In his memoirs Augustin Pyramus de Candolle (1778-1841) provided a first-hand view into the personality of Brongniart, drawing attention to his early management skills, such as the naturalisation trip to Fontainebleau of 1798. For more than a week, Brongniart led the group, which included Cuvier, Dumeril, Auguste-Henri de Bonnard (1781-1857), Eutrope-Barthélemy de Cressac (1777-1844), and Pierre François Marie Auguste Dejean (1780-1845). Brongniart divided the participants into sections for different types of searches, such as plants, insects, birds, or minerals, keeping everyone on schedule as they followed methods he had outlined in detail.⁷⁴ As De Candolle recalled:

I had left for this course, a little student, ignored and isolated; I returned having heard distinguished men discuss their studies, and I had gained something from their friendship. I had seen them observe nature and had thus learned from them, practically, the difficult art of observation. Nothing had been lost for me, neither herbalization, nor conversation, and it is still today to this course that I am tempted to relate my scientific life. Also, I have always conserved a special attachment to this ancient forest of Fontainebleau, and I never cross it without feeling a real emotion of memory and gratitude.⁷⁵

Likewise, Dolomieu, while held captive in 1799-1800, reflected on Brongniart's "very just mind, easy conception, very clear ideas and easy speech; and one does as much for the sciences, when one teaches them perfectly well, as when one advances by a short distance the limits which confine their career."⁷⁶

There were, of course, other Parisian savants who may have been strong candidates for various roles at Sèvres at this crucial juncture. Certainly, others had comparable or better skills as research chemists, such as Vauquelin, who was an expert in theoretical and practical knowledge of mineralogical materials and analytical chemistry.⁷⁷ However, Vauquelin

⁷⁴ Augustin Pyramus de Candolle and Alphonse de Candolle, *Mémoires et souvenirs de Augustin-Pyramus de Candolle* (Geneva, 1862), 67-8.

⁷⁵ De Candolle, *Mémoires et Souvenirs*, 67-8.

⁷⁶ Jean Gaudant, *Dolomieu et la géologie de son temps* (Paris, 2005), 146.

⁷⁷ Smeaton, *Fourcroy*, 34-35.

possessed neither Brongniart's broad skill set nor his ability to converse with elite echelons of Parisian society, both of which were necessary for the role of director. If the post Brongniart filled had been split into separate roles, Vauquelin might have been suited to a place as a consulting chemist, as Darcet had been. However, Vauquelin was occupied with the chemistry laboratory he shared with Fourcroy.⁷⁸

Jean Henri Hassenfratz (1755-1827) was another naturalist with training in chemistry and mineralogy alongside experience in applied arts that included carpentry, metalworking, glassmaking, and even pottery. Hassenfratz had connections to Lavoisier, Fourcroy, Berthollet, and Monge, among others. Additionally, he taught in the lycées, and was actively involved in public affairs. On his merits as a scientist, a case could have been made for Hassenfratz to take on a role at Sèvres, and Berthollet was aware of his diverse training and knowledge. However, there were other points in Brongniart's education that Hassenfratz could not rival – Brongniart's aesthetic training and polished social skills enabled his ease of negotiation within the elite milieu of Sèvres. Importantly, Hassenfratz had an outspoken political position in favour of the Revolution and the Republic, one which his biographer Emmanuel Grison suggests held him back in the Napoleonic era.⁷⁹

There were other ceramic manufacturers in Paris whose production rivalled that of Sèvres, such as that of Christophe Dihl (1752-1830). However, in 1800, there could have been little inducement for a porcelainier such as Dihl, who ran the manufactory alongside his wife, the widow Guérhard, to take on any role at Sèvres which would compromise his own lucrative factory in the rue du Temple.⁸⁰ Under Napoléon, Sèvres was expected to be unrivalled in

⁷⁸ Alain Queruel, "Vauquelin," *L'Actualité Chimique* 224 (1999), 48; *Vauquelin et son temps* (France, 1994), 91-2.

⁷⁹ Grison, *Hassenfratz*, 51-90, 205, 235-6, 248-9, 272-6.

⁸⁰ Louise Françoise Madeleine Croisé Guerhard (1751-1831). David Garrioch, *The formation of the Parisian bourgeoisie, 1690-1830* (Cambridge, 1996), 140. "Inventaire après décès de Christophe Erasmus Dihl, arrivé à Paris, boulevard des Italiens, no. 5. Louise François

excellence, and with particular emphasis (as previously outlined by the managing committee of the Convention) on developing its contribution to the promotion and preservation of French industry.⁸¹ The directorship required a dynamic and ambitious leader who could improve porcelain production on all fronts, while also expanding the industry as a whole. There was little inducement to draw management away from a working (and competing) manufactory. Rather, Sèvres needed a director who could promote its public interests while expanding the research base of its production process. Brongniart could readily apply his chemical, geological, and mineralogical knowledge, analytical thinking, artistic understanding, social skills, organizational and management skills, decisiveness, and efficiency in order to resume high quality production at Sèvres, to locate high-quality resources, and to implement production and processing changes that would solidify the manufactory's position as an industry leader and innovator.

A Special Envoy from Berthollet

As the members of his networks benefitted from the return of Napoléon and the organisation of the Consulat, Brongniart typically recorded with little reaction or commentary the announcement of big changes, such as Coquebert's new diplomatic post in Amsterdam. Although the choice of director for Sèvres was not entirely up to Berthollet, he was a close associate of and advisor to Louis-Claude Costaz an administrator in the Division des Arts et Manufactures, which maintained oversight of the manufactory's management during the Revolutionary period.⁸² Costaz was a trained menuisier who had joined the Egyptian campaign as a mathematician. He had returned to France with Napoléon, alongside Berthollet and

Madeleine Croisé, son épouse, demeurant rue Meslay, no. 8, (1830),” AN MC/RE/LXXXVI/19.

⁸¹ Richardson, “Unlikely Citizens?,” 208-210.

⁸² Richardson, “Unlikely Citizens?,” 186-7, 208-210.

Monge.⁸³ It was a personal gesture when Brongniart learned about the offer of the directorship at Sèvres. While Berthollet was on his way to his office, he sent his wife on an errand to Brongniart's home with the message of the appointment.⁸⁴

Although Brongniart wrote of the day's activities, there was no expression of shock at its arrival.⁸⁵ Nevertheless, Cécile Brongniart wrote that the gesture from Mme Berthollet was "maternal" in character when she arrived with the news and described Brongniart's anxiety and his quick calculations following the offer, even as he rushed out to give his positive reply. That day, Brongniart went immediately to Berthollet, then to see Fourcroy, before visiting Costaz and returning to confirm with Berthollet. His swift response suggests that whatever personal anxiety he felt about the post, it was not an entirely new idea when the offer was made.⁸⁶ However, he had to wait several weeks for the final decree from Lucien Bonaparte, then Minister of the Interior. The final decision, made official in late summer, 1800, was not based solely on Berthollet's opinion, but was a joint decision that included Costaz and Lucien Bonaparte.⁸⁷

As critical figures in both the education of Brongniart and in the hiring process for the manufactory, the association of Fourcroy, Antoine-Louis Brongniart, and Berthollet cannot be

⁸³ Louis-Claude Costaz (1767-1842) is probably the same L. Costaz who worked as an *ébéniste* prior to the end of the revolution, creating a limited number of pieces. His father, Claude Costaz (1717-1789), was a *marchand menuisier*. Louis Costaz also employed his younger brother Claude-Anthelme on the Bureau des Arts and Manufactures. See Parker, "Two Administrative Bureaus," 161-3; as Leora Auslander has noted, furniture makers, particularly those who built the underlying framework for load-bearing and structural objects, were often skilled mathematicians and geometers. Thus, the transition from furniture-maker to mathematician and policy maker followed a natural progression for Costaz. Auslander, *Taste and Power* (Berkeley, 1998), 78, 116.

⁸⁴ Berthollet had a close working relationship with his wife. Coquebert de Montbret, *Journal* xxiii-xxvi; Brongniart, *Journals*, 24 March 1800, BMHN MS 3358, 305.

⁸⁵ Brongniart, *Journals*, 24 March 1800, BMHN MS 3358, 305.

⁸⁶ Coquebert de Montbret, *Journal* xxiii-xxvi; Brongniart, *Journals*, BMHN MS3358, 24 March 1800, BMHN MS 3358, 305.

⁸⁷ As a member of the commission of arts and manufactures Louis Costaz had been involved in the reorganization of Sèvres. Richardson, "Unlikely Citizens," 186-7, 208-210.

discounted lightly, even if no direct evidence outlines a particular long-term plan. Brongniart's proven merits, experience, and ability were prominent factors in the appointment, but it was an education in which Fourcroy had a significant influence, even as late as 1800. In particular, Fourcroy had only recently arranged for Brongniart to teach a public chemistry class at the Lycée. The memoir, *L'Art d'émailleur sur métaux*, written during Brongniart's 1790 London summer voyage, was among the materials presented by Berthollet regarding Brongniart's suitability and training.⁸⁸ That Berthollet, as a close advisor to Napoléon, was willing to support Brongniart personally gives a strong indication of Brongniart's reliability and suitability for the post, both professionally and politically.

Brongniart's practical and theoretical mineralogical understanding provided him with the skills necessary to identify natural resources and to evaluate the material supplies using chemical analysis. Brongniart's close connection to Haüy indicated how well regarded his work on the subject was, and he had long considered the applications of mineralogy to the arts. Brongniart was linked to an entire network of experts in the arts, sciences, and industry, which would enable him to reach out for added insights and knowledge. More subtle, but defining, was Brongniart's ability to present his ideas and understanding visually, through accomplished draftsmanship and artistic skills cultivated with the influence and teaching of his father. Additionally, he had an excellent understanding of the kinds of machines and equipment in use in mines and factories throughout Europe, which would aid him in developing new technological approaches to the work at Sèvres.

Perhaps another influential factor in promoting Brongniart was that various indirect benefits from his appointment, in the form of design commissions at the manufactory, flowed to his father, who suffered financially following years of setbacks, while the manufactory

⁸⁸ Jean-Baptiste Dumas, *Éloge de MM. Alexandre Brongniart et Adolphe Brongniart*, (Paris, 1877), 21-2.

gained from his artistic input. Théodore Brongniart had shared a close connection with Berthollet through the household of Mme Montesson for nearly a decade prior to the Revolution. His career had been curtailed by the lack of architectural work during the years of destruction as well as political and social change. Théodore brought to the manufactory a deep aesthetic understanding and extensive experience in the creation of integrated design schemes, along with knowledge of drawing, sculpture, and interior design. It was a beneficial exchange, as Théodore's contributions included some of the most important designs of the Napoleonic era at Sèvres. The collaboration between Brongniart and his father both strengthened the manufactory and eased Brongniart's early transition and growth as its director.⁸⁹

Few could rival Brongniart's particular combination of social, scientific, connoisseurial, and artistic skills that brought him the post at Sèvres. Throughout his long career, and despite major political changes that could easily have shifted the balance to someone else's favour, few challenges were made to his expertise or his value to the manufactory. As I discuss in Chapter Five, directing the struggling manufactory was no small task, but Brongniart was not entirely alone in his first years at Sèvres. He relied on the input of experts and artists around him while quickly educating himself on all aspects of European ceramic production, using much the same approach as he had with natural history. He reorganized the manufactory at once, retaining or rehiring several employees while making significant changes in the production. Many of the employees had lived and apprenticed there with members of their extended family, going back generations. These workers held substantial institutional knowledge and their traditional training and input meant that styles and technologies did not undergo radical change. Early on, Brongniart was mentored by Denon, and he hired the artists and designers he knew, including his own father, along with François

⁸⁹ Ostergard, *Sèvres Porcelain Manufactory*, 82-3; Mosser, *Alexandre Théodore Brongniart*, 239-261.

Gérard, Jean Baptiste Isabey, among others. Meanwhile, he hired established painters from the wider artistic population of Paris, including those from competing manufactories, such as Dihl & Guérhard.⁹⁰

⁹⁰ Ostergard, *Sèvres Porcelain Manufactory*, 43-5, 78-80.

PART TWO

CHAPTER FIVE: Porcelain Making – Chemistry, Technology, and Information

Brongniart's appointment to Sèvres placed him at the centre of French industry, and gave him leadership over its chemistry laboratories, among the best in France. The need to restore the factory to prominence and to promote French industry as a whole spurred research and innovation almost immediately.¹ While the aesthetic refinements of Sèvres porcelain seem, at a glance, distant from the connection to the natural world, for Brongniart, ceramics and Sèvres were literally and figuratively a point of synthesis, where extensive knowledge of the arts, chemistry, mining, mineralogy, geology, and natural history all contributed to material mastery and excellence in design and production.²

In this chapter, I focus on Brongniart's directorship, and on his efforts to clarify what had been loosely structured and often hidden ideas. I consider the collections of objects, materials, and knowledge that he deliberately acquired and show that he used these efforts to improve pottery and porcelain manufacture, primarily, but not exclusively, within France. Importantly, he used French and global pottery collections, alongside visits to other manufactories, information gathered from savants and artisans, as well as extensive chemical analysis, material testing, and research at Sèvres, as guideposts in shaping a ceramic science that he hoped would be on level with disciplines such as mineralogy or physics.³ Brongniart made signal contributions to the study and the clarification of the complex physical properties and chemical behaviours of clays, and I show that his training and interests in a range of scientific practices directly benefitted the manufactory.

¹ Tamara Préaud, "Brongniart as Administrator," in *Sèvres Porcelain Manufactory*, Derek E. Ostergard and Tamara Préaud, eds. (New Haven, 1997), 43-5, 50.

² As I discuss in Chapter Eight, Brongniart's work was foundational to the science of ceramics. See Alexandre Brongniart, *Traité des arts céramiques* (Paris, 1844).

³ Brongniart, *Arts céramiques*, t.1 (1844), XI.

With the changes that the appointment to Sèvres brought to his life, Brongniart focussed his concentration on four main subject areas: chemistry, mineralogy, geology, and porcelain making, dividing his days between sites that included Sèvres, the Conseil des Mines, the lycées, and the Muséum d'Histoire naturelle. He regularly crossed Paris from East to West and remained connected to the active life of its salons, education and research centres, and public events, while also maintaining a global network of contacts.⁴ He pursued the latest information and research developments in areas such as chemistry, mining, and firing techniques, while establishing himself as a knowledge resource for savants and experts in both local and distant locations. From the earliest days of his directorship, Brongniart outlined sweeping projects at the manufactory. Meanwhile, he continued to be deeply involved with questions of mineralogy and geology. As I show in this and the following chapters, his knowledge of clays and materials for porcelain production was enhanced immeasurably by his geological and mineralogical knowledge, as well as by his earliest education in chemistry.

Founded at Vincennes in 1740, the Sèvres manufactory was a relative latecomer to the porcelain trade, but its royal patronage enabled it to quickly reach the top ranks of European producers of soft-paste porcelain. Critically, in 1771, Sèvres became the first French manufactory to establish hard-paste porcelain production, often considered to be the material standard for its hardness, whiteness, and translucency, its resistance to thermal shock, and its overall fineness.⁵ The manufactory's success in the achievement depended upon the actions of several crucial connections within Brongniart's familial and intellectual networks, including Guettard, Macquer, and Darcet. Importantly, these chemists and savants were not exclusively specialists in pottery and porcelain, but their research also encompassed questions related to

⁴ See Annotated Map, Appendix 3.

⁵ See Antoine d'Albis, "Creation of Hard-Paste Porcelain Production at Sèvres," *Metropolitan Museum Journal* (2002): 267-76.

chemical behaviour and mineralogy.⁶ The pursuit of porcelain production led to additional scientific discovery and knowledge, as I describe in this chapter.

Very often, the development of European porcelain has been told exclusively as a German story, with slim acknowledgement that the development of hard-paste porcelain developed independently elsewhere. German production began at Meissen in 1710, and Germany remained the sole European producer of hard-paste porcelain for most of the eighteenth century. In France, the path to hard-paste porcelain production required sixty additional years of effort.⁷ As the story is frequently told, the names of familiar Parisian savants, such as Macquer and Darcet, have been repeated together so often that they appear to have always acted in unison on porcelain research, when the case, as I show, is far different.⁸ The centuries-long race to create a French porcelain that could rival those made in China and, later, Germany, was contentious, with distinct groups of researchers protecting their discoveries from their rivals.

The final stretch in the French quest for hard-paste porcelain took place just before Brongniart's birth in 1770, while major developments in geology, mineralogy, and porcelain research, as well as the creation of Lavoisierian chemistry, occurred just as he began his formative education. Importantly, the laboratories at Sèvres were a key location for experiments in diamond-burning that interested Lavoisier at a critical moment in his research and helped inform his understanding, leading to the discovery of oxygen. Additionally, as I discuss in detail below, in 1771, kiln-firing techniques were revealed that could change the

⁶ Christine Lehman, "Pierre-Joseph Macquer: An Eighteenth-century Artisanal-scientific Expert," *Ann Sci* 69, 3 (July 2012); Georges Cuvier, "Éloge historique de Jean Darcet," in *Recueil des éloges historiques* (Paris, 1861), 99-114.

⁷ The story of Johann Friedrich Böttger at Meissen is well known. Janet Gleeson, *Arcanum* (New York, 1999); Suzanne L. Marchand, *Porcelain: A History from the Heart of Europe* (Princeton, 2020).

⁸ Charles Coulston Gillispie, *Science and Polity in France: End of the Old Regime*. (Princeton, 2004), 406-7.

results of a firing dramatically, creating a white porcelain from impure clay pastes.⁹ These methods were known only to a handful of manufacturers, who did not fully understand the mechanisms, or the chemistry involved. However, with the development of Lavoisierian chemistry, the firing techniques could be understood as “reducing” the oxygen from within the porcelain itself.¹⁰

The experiments at Sèvres, and the craft and scientific knowledge of the community of porcelain chemists and savants, directly influenced Lavoisier’s research. In turn, Brongniart’s chemistry and natural history education was based on the latest discoveries of this period, with contributions and mentoring from several of the participants, including Lavoisier, Fourcroy, Antoine Louis Brongniart, Berthollet, Macquer, Darcet, Louis Claude Cadet de Gassicourt, and Guettard. Significantly, the events which took place during the French race for hard-paste porcelain highlight the use of the laboratories at Sèvres for chemical discoveries that went beyond the scope of pottery production. Given the politics of the Revolution and the uncertainty of the manufactory’s future at the end of the eighteenth century, Brongniart’s place in this lineage was not assured. However, his success in acquiring the position of director was secured by his membership of elite networks and by luck, preparedness, and a sense of timing. At both an intellectual and practical level, his education among its laboratories and savants grounded and informed his early directorship.

Western Fascination with Porcelain

From its first European discovery by voyagers such as Marco Polo in the thirteenth century, through the end of the eighteenth century, the material porcelain represented one of

⁹ Henri Louis Duhamel du Monceau, “L’Art de faire les pipes à fumer le tabac,” *Descriptions des arts et métiers* 4, 1 (Paris, 1771).

¹⁰ I discuss this further below. On reduction firing, see Gregg Conway, “Pottery Reduction Firing with a Fuel-Burning Kiln,” *Leonardo* 9, 2 (1976).

the most compelling challenges across Europe, both for its importation and for its technological secrets.¹¹ The qualities of Chinese porcelain – whiteness, hardness, translucency, and fineness of decoration – were unknown among European pottery types, making them sought after among the highest ranks. Portuguese ships made their way to China in the early 1500s, opening trade in the blue and white porcelain that became known as *kraak* ware, after the merchant boats, called carracks. From the start, European porcelain importation was deeply intertwined with global shipping networks and warfare, both with nearby European neighbours and with Asian and African countries. The trade, which endured over centuries, was by no means straightforward or without extraordinary risks. Factors such as trade rivalries, warfare, outdated styles, lack of control over production, and restricted access to markets, contributed to the drive to create locally produced European porcelain.¹²

From the Medici forward, European rulers and their artisans desired to replicate Chinese styles and materials.¹³ Rulers invested in workshops and research efforts, beginning with a wide range of earthen and organic materials, including talc, seashells, bones, and pulverized glass, whose effects and properties seemed, at least superficially, to share the correct properties of hardness, whiteness, and translucency. The innovations achieved various sorts of soft-paste porcelain, which, while white and glassy, were susceptible to scratching and more easily broken than Chinese examples had been.¹⁴ Owing in part to the secrecy of Asian potters, and to the differences in material resources and technology, European hard-paste porcelain

¹¹ Lin Meicun and Ran Zhang, “A Chinese Porcelain Jar Associated with Marco Polo,” *European Journal of Archaeology* 21, 1 (2018): 39-56.

¹² On the trade in porcelain see: Robert Finlay, “The Pilgrim Art,” *Journal of World History* 9, 2 (1998): 141–87; Anna Jackson and Amin Jaffer, (London, 2004); Maxine Berg *Goods from the East* (Houndmills, 2015), 46-84; and Julie Emerson et al. *Porcelain Stories from China to Europe* (Seattle, 2000).

¹³ On economic aspects of the porcelain industry, and the development of European industries, see Maxine Berg, “From Imitation to Invention,” *Economic History Review* (2002), 1–30.

¹⁴ Edwin Atlee Barber, *Artificial Soft Paste Porcelain* (Philadelphia, 1907), 5-6.

production remained elusive until the early eighteenth century, when Dresden scientists working for Augustus the Strong succeeded in creating hard-paste porcelain in 1708.¹⁵

Through the early nineteenth century, nearly all aspects of pottery and porcelain manufacture had remained the property of skilled trades learned through apprenticeship in closed workshops and manufactories. There was little open or shared information related to the vast body of specialized understanding on faïence, stoneware, and porcelain making. At all levels, manufacturers and artisans had been engaged in efforts to create import substitution products, and their achievements were proprietary secrets. Governments and private interests, alike, participated in industrial espionage. Notably, the Jesuit priest François Xavier d'Entrecolles observed Chinese practices at Jingdezhen and sent letters back to France in 1711 and 1722 with critical information on the types of materials utilized. Through these efforts, combined with experimentation, Europeans attempted to reverse engineer Chinaware from goods brought from the far East.

By 1800, porcelain making was well-developed across Europe. The novelty of the once-elusive material had given way to increased production of high-quality pottery and porcelain. Consumers could see wares in shops and printed sources; there was more credit available to allow the middle orders to purchase goods that had previously been accessible to the elites, and new institutions of connoisseurship emerged to tell the world what good taste was – in pottery, as well as in other forms of art and gastronomy.¹⁶ Asian and European wares of all types had become a customary part of bourgeois and noble residences, and even the least affluent households might be expected to own at least a few items.¹⁷ Innovations in processes enabled

¹⁵ Robin Hildyard, *European Ceramics* (London, 1999), 46-49.

¹⁶ Maxine Berg, *Luxury and Pleasure* (Oxford, 2005), 21-5.

¹⁷ For an economic history of Asian porcelain see Maxine Berg, "From Imitation to Invention," *Economic History Review* (2002): 1–30; and "Britain's Asian century: porcelain and global history in the long eighteenth century," in Jan Laura Cruz De Vries and Joel Mokyr, eds., *Birth of Modern Europe* (Leiden, 2010).

a wider distribution of products, and consumer demand encouraged levels of distinction ranging from everyday products to categories that were exclusive to wealthier ranks.¹⁸ There were still elite objects that remained the exclusive province of the wealthiest connoisseurs, but the market was increasingly diversified, allowing envy, the desire for emulation, and clever advertising campaigns to drive consumer demand. In France, the Sèvres manufactory had several near rivals such as Dihl and Guerhard, Nast, and Dagoty, while among others, Wedgwood, Worcester, and Derby in England, KPM in Berlin, and Meissen in Saxony, all produced a high standard of wares.¹⁹

As high-quality porcelain became more common in the nineteenth century, its markets were changing. The state-supported manufactory of Sèvres needed to respond to the sharp competition from Parisian manufacturers such as Dihl and Guerhard or Nast through improvements in its products and artworks, while also responding to the broader needs of French industry. Although competition continued to encourage the protection of many proprietary processes, sharing basic knowledge benefitted the production of smaller potteries, and fostered widespread technological improvement. Further, educated consumers could better distinguish the quality of a given pottery type, which helped in turn to expand the markets for porcelain and pottery.²⁰ Objects of porcelain and pottery were of practical use, but were also objects of desire that could mark both status and refinement.²¹

¹⁸ See Berg, "From Imitation to Invention."

¹⁹ Régine de Plinval de Guillebon and Robin R. Charleston, *Porcelain of Paris* (New York, 1972), 34.

²⁰ For example, in 1804, Jacques Fourmy sought to educate his consumers to underscore the technological improvements of his own wares, see *Recueil de mémoires relatifs à l'art céramique* (Paris, 1804), 3-4.

²¹ Berg, *Luxury & Pleasure*, 49-50.

The Problem of Porcelain

In all types of pottery making, the limits on the quality and kind of finished object were determined by the initial choice of the materials, as well as by their preparation. Prior to the nineteenth century, these choices were largely determined by geographic location and accessibility. The materials available to a manufactory or individual maker influenced the final products, and they could vary by location or by depth within a particular mine or source, requiring constant awareness, testing, and analysis.²² Pottery created by similar, or even identical, methods depended on the technology that was applied to the earthen materials, or the efforts of chemists and makers, but most significantly, it was (and remains) inextricably dependent upon the mineral resources. These materials – clays, sands, and *spars* – in turn, were located and understood through geological, mineralogical, and chemical techniques.²³

In 1712, the letters of Père d'Entrecolles made the words *kaolin* and *petuntse* (*baidunzi*) known to a Western audience.²⁴ These were the elusive materials that, when combined, formed a hard-paste porcelain. Although attentive to detail, d'Entrecolles had little experience with the industry, which limited his ability to interpret the finer points of Chinese practice.²⁵ In 1722, samples he sent to France were examined by René-Antoine Ferchault de Réaumur (1683-

²² A discussion of the desirable qualities of porcelain and necessary processing factors appears in Antoine d'Albis, "Methods of Manufacturing Porcelain in France in the Late Seventeenth and Early Eighteenth Centuries" in *Discovering the Secrets of Soft-paste Porcelain*, ed. Bertrand Rondot (New Haven, 1999).

²³ Feldspars. French: *spath*.

²⁴ See Appendix 6, Network Map, and Appendix 7, Timeline, for an outline of significant dates and events related to porcelain development in Paris. Père d'Entrecolles, "Lettre du Père d'Entrecolles Missionnaire de la Compagnie de Jésus, Porcelaine, au Père Orry de la même Compagnie, 1 Septembre 1712," in *Recueil de voyages au nord* (Amsterdam, 1731); "Lettre du Père d'Entrecolle," in J.-B. du Halde, *Description géographique, historique, chronologique, politique, et physique de l'empire de la Chine et de la Tartarie chinoise* (Paris, 1735); A. M. Pollard, "Letters from China," *Ambix*, 62, 1 (2015): 50-71.

²⁵ His letters were published in limited distribution in 1717, and 1724, respectively, before being more widely circulated in 1735. Pounds, "Discovery of China Clay," 21; Pollard, "Letters," 57-9.

1757), but the great chemist received only small amounts of highly processed materials, which had undergone all the preparatory steps of levigation and refinement and were ready to be used in a clay paste. Numerous mineralogical clues had been removed before he could examine the samples.²⁶ As a result, Réaumur identified what we now know to be kaolin as composed of talc rather than alumina.²⁷ However, he had reasoned (justly) that porcelain was in a state of semi-vitrification, in which the translucent appearance came from glassy regions that vitrified, and which were supported by a substance that did not transform, even at high temperatures.²⁸ Réaumur established his own formula for “porcelain” in 1740, but the resulting material was neither a soft-paste nor a hard-paste porcelain. Instead, it was a slow-cooled glass that had turned opaque from the process of crystallisation.²⁹

Three critical, independent groups carried this research forward. The first included Louis, duc d’Orléans (1703-1752); the naturalist Jean Étienne Guettard; the duke’s *maitre d’hotel*, naturalist Didier François d’Arclais de Montamy (1702-1765); and a potter named Le Guay.³⁰ As we have seen, Guettard had been Réaumur’s student and assistant, as well as the keeper of the natural history cabinet of Louis, duc d’Orleans by 1741. Guettard had first-hand knowledge of Réaumur’s porcelain tests and, as I discussed in Chapter Two, was engaged in creating a mineralogical study and map of France. He immediately matched the Chinese samples with minerals he had collected on his travels around the country.³¹ Guettard determined that the clay beds at Maupertuis, in La Manche, approximately 40 miles southwest

²⁶ D’Albis, “Methods of Manufacturing Porcelain,” 39-40.

²⁷ Pollard, “Letters from China,” 58-9; René Antoine Ferchault de Réaumur, “Second mémoire sur la Porcelaine,” *Mémoires de l’Académie Royale des Sciences* (Paris, 1729), 326-7.

²⁸ D’Albis, “Methods of Manufacturing Porcelain,” 39-40.

²⁹ This was an experimental material that was never put into production. On Réaumur porcelain, see Henry Watts, *A Dictionary of Chemistry* (London, 1864): 843-4.

³⁰ George Lechevallier-Chevignard, *La manufacture de porcelaine de Sèvres* (Paris, 1908), 69-70.

³¹ Jean-Etienne Guettard, *Mémoires sur différentes parties des sciences et des arts*, t.1, (France, 1768), xvij-xlj, 91-272.

of Bayeux, had the necessary geologic composition. Like those at La Manche, the kaolin beds in China were known to be preceded by a bed of highly refractory red clay, which was useful in making refractory kiln bricks or protective *saggars*.³²

Guettard had become the first to discover a kaolin source in France. Further, the role of *petuntse*, he correctly intuited, could be filled by any number of the materials known as *spaths*, (*feldspaths*, or feldspars).³³ Guettard's discovery was kept quiet while the group carried out tests at the duke's property at Bagnolet. They succeeded in the manufacture of a series of small porcelain objects and in 1751, Guettard deposited a secret notice of his discovery with the academy, and Louis purchased a plot of land where the kaolin was located. While promising, this porcelain was never put into large-scale manufacture, in part because the early tests did not produce a pure white finished product. The duke's early death in 1752 prevented any further research from taking place at Bagnolet.³⁴

The second group was headed by Louis Léon Félicité de Brancas, comte de Lauraguais (1733-1824) who brought with him his personal physician and collaborator, Jean Darcet (1724-1801). Likely present for some of the experiments at Bagnolet, or otherwise having seen the research, the comte de Lauraguais and Darcet became interested in the pursuit of porcelain for themselves. The count set up a laboratory at his Left Bank residence, the hotel de Lassay.³⁵ He employed Le Guay, as well as Darcet's friend, the doctor Augustin Roux (1727-1776). Importantly, this was research that the count could only perform in the wake of Guettard's discovery – the comte de Lauraguais had, in fact, taken control of all the late duke's research,

³² Saggars are used to enclose wares in fuel-burning kilns, to protect the surface of the wares.

³³ Alexandre Brongniart, *Premier mémoire sur les kaolins ou argiles à porcelaine* (Paris, 1839), 40-1.

³⁴ Guettard, *Mémoires sur différentes parties des sciences et des arts*, t.1, xxj.

³⁵ Henry Guerlac, "Some French Antecedents of the Chemical Revolution," *Chymia* 5 (1959): 84-6.

notes, and materials on porcelain, including a set of fired samples, in a purchase from de Montamy, who substantially outranked Guettard in the household of the late duke.³⁶

Darcet and the count succeeded in making a porcelain paste that they claimed was equal in quality to Chinese porcelain. The count boasted of their status as the makers of the first French hard-paste porcelain, unaware of Guettard's sealed papers at the Academy. After fourteen years, Guettard was released from secrecy by the fourth duc d'Orléans, Louis-Philippe I, and was able to claim his priority over the discovery of French kaolin. Although Lauraguais possessed the samples from Guettard's research, he pretended not to know of them, and Le Guay denied any of the experiments at Bagnolet were successful. In 1765, following a year of public arguments, the sealed documents were opened to reveal Guettard's description of the processes by which the porcelain pastes were created at Bagnolet. This dispute, in which Guettard's primacy in the business was ultimately supported, brought about the first public discussions related to the mineralogical and chemical nature of hard-paste since those of Réaumur in the 1720s.³⁷ In 1844, Brongniart looked back upon the incident, championing Guettard's priority in the discovery of kaolin, noting that Lauraguais had fought against the reality of Guettard's achievement "in the crudest way, the furthest from what one would expect from the politeness of a man of that rank".³⁸

Although Guettard had produced the first real French hard-paste porcelain, only the third group of researchers, at Sèvres, was able to make long-term use of the results, if not of the kaolin sources located by either Guettard or Darcet.³⁹ Possibly benefitting from the public

³⁶ Friedrich Melchior Grimm, *Correspondance, littéraire, philosophique et critique par Grimm, Diderot, Raynal, Meister, etc* (Paris, 1878), 52-4.

³⁷ For the aspects of the story, see Gillespie, *Science and Polity: Old Regime*, 406-8; and Guerlac, "French Antecedents of the Chemical Revolution," 73-112.

³⁸ Brongniart, *Arts céramiques*, v. 2, 1844, 503.

³⁹ As I discussed in Chapter Two, Guettard's 1765 memoir to the Academy attracted the attention of the minister Bertin, who provided funding for Guettard to complete his mineralogical atlas of France as a result. This project, in turn, enabled Lavoisier and Guettard to travel together for geological fieldwork.

discussion of Guettard's discovery at Maupertuis and his detail-rich memoir, Macquer was notified by a pharmacist named Villaris of a kaolin deposit at Saint Yrieix in 1768.⁴⁰ Following a series of complex examinations of the raw materials, Macquer and his assistant, Étienne Mignot de Montigny (1714-1782) were able to create trials of a hard-paste porcelain at Sèvres. In 1769, Macquer presented a memoir and some pieces of porcelain to the Academy; although he did not reveal his exact procedures at this stage, his work soon led to the institution of the first native French manufacture of porcelain.⁴¹ According to Brongniart, the start of hard-paste production at Sèvres could be dated to 1771, with kiln improvements following shortly thereafter, in 1774.⁴² They also continued to make the soft-paste wares for which Sèvres had an established market.

Among other factors, this timing was likely influenced by the recent revelation of special firing techniques used by Charles Marie Roussel of Saint Omer. In 1730, Roussel, a French manufacturer of ceramic tobacco pipes, had discovered that a series of actions taken during various stages of firing could eliminate the reddish colouring brought on by the presence of iron in the clay and render the finished product white. In the key year of 1771, Roussel revealed his secret for the first time to Henri-Louis Duhamel du Monceau, which Duhamel published in "L'Art de faire les pipes à fumer le tabac."⁴³ The processes described in detail how Roussel closed off the kiln for brief periods of time during the firing, and, towards the end of the firing, loaded the kiln with a higher quantity of fuel (wood) than normal, firing this way for an hour.⁴⁴ Duhamel's memoir coincided with the commencement of hard-paste production

⁴⁰ Brongniart, *Arts céramiques*, v. 2, 1844, 503-4.

⁴¹ Brongniart, *Arts céramiques*, v. 2, 1844, 495.

⁴² Brongniart, *Arts céramiques*, v. 2, 1844, 504.

⁴³ Henri Louis Duhamel du Monceau, "L'Art de faire les pipes à fumer le tabac," *Descriptions des arts et métiers* 4,1 (France, 1771), 11-12; Brongniart, *Arts céramiques*, v. 2, 186-7.

⁴⁴ The actions described include those necessary to create a reducing (oxygen-deprived) firing atmosphere in the kiln. In reduction, the oxygen needed by the fire is drawn from the chemically bonded oxygen in the ceramic wares themselves, rather than from the air. This

at Sèvres, and would have been of particular interest to Macquer in his research, particularly as it provided a method for making use of less-pure sources of clay to create white porcelains. Two years later, in 1773, Macquer's brother, Philippe, included a discussion of Roussel's methods in the *Dictionnaire universel*.⁴⁵ That Roussel's methods were utilized at Sèvres is clear from Brongniart's description of the changes he later made to the firing processes, which eliminated an unnecessary set of intermediate steps described by Roussel.⁴⁶

From Porcelain to Diamonds: Lavoisier and the Discovery of Oxygen

Darcet's incidental research was arguably more influential than his work on kaolin. While the comte de Lauraguais had not succeeded in capitalising on the expensive kaolin research he pursued, Darcet had spent several years in research on porcelain, and other substances, including refractory minerals and combustibles. He drew his work into a memoir on porcelain presented to the Academy in 1768. The end of the memoir contained a startling notice regarding experiments in the burning of diamonds, which had previously been thought to be impervious to fire.⁴⁷ Experiments of this type were not entirely new, but the earlier trials were limited and not well-known, and the expense was largely prohibitive. It was an extravagance that was perhaps driven by the environment surrounding the laboratories of the comte de Lauraguais.⁴⁸ Darcet's experiments in the furnace at the Hôtel de Lassay and were sensational enough that Macquer was drawn in in disbelief.⁴⁹ In 1771, Macquer invited an

action can produce noticeable changes in the fired product. On reduction firing, see Gregg Conway, "Pottery Reduction Firing with a Fuel-Burning Kiln," *Leonardo* (Oxford) 9, 2 (1976).

⁴⁵ Philippe Macquer, *Dictionnaire raisonnée universel des arts et métiers* (France, 1773), 460-61.

⁴⁶ Brongniart, *Arts céramiques*, vol.1, pt.1 (1844), 228.

⁴⁷ Guerlac, "French Antecedents of the Chemical Revolution," 85-6; Christine Lehman, "What Is the 'True' Nature of Diamond?" *Nuncius* 31, 2 (2016).

⁴⁸ Pierre Rousseau, *Journal Encyclopédique* 31, 4 (July-December 1771): 331-3; Gillispie, *Science and Polity: Old Regime*, 407.

⁴⁹ On Guettard's observations, see Henry Guerlac, *Lavoisier – the Crucial Year* (Ithaca, NY, 1961), 81.

audience to the workshops at Sèvres in which a group of seventeen savants and officials, including Darcet, Antoine Louis Brongniart, Cadet de Gassicourt, Fourcroy, and Lavoisier, witnessed the repeat of Darcet's trials.⁵⁰ The group was amazed by the pyrotechnic display and the novelty of the experience, which opened up a new course of scientific inquiry.

The race for porcelain was not simply an industrial and commercial effort but the questions it raised directly factored into the research of Lavoisier, who had just begun independent work in natural history and chemistry. He did not yet have his famous laboratories at the Arsenal and was working in a more central location, probably near the Palais Royal.⁵¹ In 1765, only three years prior to the reading of Darcet's diamond memoir, Lavoisier had read his first memoir to the academy on the chemistry and properties of gypsum, which he then published in 1768.⁵² This topic, suggested to him by Guettard, allowed for study of the chemical behaviour of earthen materials, thus combining Lavoisier's twin interests of chemistry and geology. One aspect of his memoir included the calcination of the gypsum, a process that drives off the chemically bound water. Calcination enabled the functional properties of plaster of Paris, which, when recombined with water, hardened into a solid mass that could be used for mould-making, ornamentation, sculpted objects, and more.⁵³ This research gave Lavoisier the technical background to respond to the new set of questions brought about by Darcet's memoir.

Lavoisier became deeply interested in the diamond experiments, which contributed to his emerging understanding of oxidation processes and the atmospheric conditions which allowed the diamond to burn, or those which protected it. Diamonds exposed to the air, either

⁵⁰ On the series of experiments, see Antoine-Francois de Fourcroy, "Diamant," *Éléments d'histoire naturelle et de chimie*, t.2 (Paris, 1786), 379-392.

⁵¹ Viel, C. "Did Lavoisier Have a Laboratory Other than That of the Arsenal?" *Revue d'histoire de la pharmacie* 42, 307 (1995): 369-73.

⁵² Marco Beretta, "Lavoisier as a reader of chemical literature," in *Revue d'histoire des sciences*, t. 48, 1-2 (1995): 71-94.

⁵³ J. R. Partington, *History of Chemistry* (London, 2016), 378.

within an open crucible or encased in a protective crucible or *saggar* disappeared completely, and if pulled from the furnace while the transformation was in progress, could be seen to glow and to emit a colourful phosphorescence. Partially consumed diamonds that were left to cool had areas which had blackened. However, it was common practice among jewellers and lapidaries to heat flawed diamonds to improve their clarity. They did so by encapsulating the diamonds with protective layers, shielding them from the damaging effect of the air. Existing chemical knowledge could provide no explanation for the chemical basis of their practice.⁵⁴

Like Lavoisier's memoir on gypsum, which considered calcination and the release of chemically bound water, the burning of diamonds brought the presence of the atmosphere into the picture. It did so in such a way that the action of the fire could be seen in the effects that surrounded the diamond in mid-transformation. Like charcoal, it was possible to witness the diamond as it reacted with the atmosphere around it and then vanished. Famously, Lavoisier also realized that these effects could be measured to a high level of precision, and he devised special equipment to accomplish this task.⁵⁵

Just as Lavoisier was performing his early experiments, Roussel's firing techniques demonstrated that the atmosphere also played a role in the outcome of fired pottery. Much like the encased diamonds, Roussel's techniques prohibited the entry of fresh air to fuel the fire, which was the key to observable chemical and physical transformations that included whitening the porcelain paste. Both phenomena pointed to a similar mystery. In both cases, the kiln fuel and the diamonds were affected differently by the presence or the absence of air.

⁵⁴ Antoine-Francois de Fourcroy, "Diamant," *Éléments d'histoire naturelle et de chimie*, t.2 (Paris, 1786): 379-392.

⁵⁵ See Guerlac, *Crucial Year*, 76-113; Christine Lehman, "What Is the "True" Nature of Diamond?" *Nuncius* 31, 2 (2016): 361-407; Hunt, "Melting of Platinum," 79; In the following decade, Guyton de Morveau was the first to show that diamonds and charcoal had the same chemical composition; Lehman, "À la recherche de la nature du diamant: Guyton de Morveau successeur de Macquer et Lavoisier," *Annales historiques de la Révolution française* 383, 1 (2016).

Importantly, Roussel's methods were made known just before the start of what Henry Guerlac called "Lavoisier's Crucial Year" of 1772.⁵⁶ Lavoisier, Macquer, and Cadet de Gassicourt continued to experiment with the combustion of diamonds, and Lavoisier also experimented with phosphorus and sulphur, compounds which react strongly in the presence of oxygen. The combination of these efforts brought about Lavoisier's discovery of the role of oxygen, providing a foundation for modern chemistry.⁵⁷

When Brongniart began his directorship at Sèvres, he could call upon his earliest education in chemistry, which was centred on the work of Lavoisier and his discoveries of the 1770s. Brongniart was still very young when Macquer and Lavoisier performed the series of experiments that revealed the presence and interactions of oxygen, and they took place only a few years before Houdon sculpted his terracotta childhood portrait.⁵⁸ As I showed in Chapter Two, Brongniart's cousin, Fourcroy, and family associate, Berthollet, were among the very first supporters of Lavoisier's ideas, joining as co-authors of the *Méthode de nomenclature chimique* in 1787.⁵⁹ From 1786 to 1789, the sixteen-year-old Brongniart had been teaching the new Lavoisierian chemistry in his family salon, where Lavoisier himself looked on. In addition to porcelain, Brongniart's notes for the lectures included a featured discussion of the character of diamonds, and their combustibility.⁶⁰

⁵⁶ Guerlac, *Crucial Year*, 1961.

⁵⁷ In modern terms, *oxidation* and *reduction*, and in Brongniart's terminology, *oxyder* (to oxidize) and *désoxyder* (to de-oxidize). Brongniart, *Arts céramiques*, v. 2, 1844, 186-7.

⁵⁸ Exhibited at the Salon of 1777, I have discussed this portrait in detail in Chapter Two.

⁵⁹ I have discussed this publication in Chapter Two. Bernadette Bensaude-Vincent, Louis-Bernard Guyton de Morveau, Antoine Laurent Lavoisier, Claude Louis Berthollet, and Antoine François de Fourcroy, *Méthode de nomenclature chimique* (Paris, 1994).

⁶⁰ Paul A. Cap (Gratacap), *Le muséum d'histoire naturelle* (Paris, 1854), 125.

Colour Chemistry

When Brongniart arrived at Sèvres, he was tasked with restoring the manufactory's finances, which required adjustments to the production processes. A key decision by Brongniart was to eliminate soft-paste production, and to strategically focus the manufactory's efforts on hard-paste production.⁶¹ At the time, hard-paste was the prevailing fashion, as well as a well-researched and consistent product of the manufactory. Because the two types of paste differed so heavily from one another in processing, modelling, glazing, and decorating, this action meant the restructuring of personnel, research, and technology. Each type of paste required its own set of glazes and colours, as well as firing techniques. By limiting variables, Brongniart could focus and strengthen the manufactory's output, while innovating and refining within a consistent range of production.⁶²

The designs introduced during Brongniart's early directorship were complex, layered, and highly pictorial. They were often finished with additional applications of patterned gilding. The paintings, repeat motifs, borders, and patterns were dependent upon the smooth, even, durable surface provided by the hard paste, as well as upon reliable colours (see Figures 0.1-0.3, 0.9). Colour development became a major part of the research under Brongniart's directorship. As I have discussed in Chapter Two, the creation of fired colours using metallic oxides was familiar territory for Brongniart. His 1790 studies in London alongside chemist, enameller, and silversmith Pierre Desvignes, led to his first published memoir on metallic oxides.⁶³ Additionally, Brongniart's mid-1790s work at the faïencerie of Louis François Ollivier exposed him to principles of earthenware and stoneware manufacture, decoration,

⁶¹ See Antoine d'Albis, "Two Controversial Decisions by Alexandre Brongniart," in *Sèvres Porcelain Manufactory*, Ostergard and Préaud, eds., (New Haven, 1997): 149-56.

⁶² Antoine d'Albis, "Two Controversial Decisions," 150-2.

⁶³ Alexandre Brongniart, "L'Art d'émailleur sur métaux," *Annales de Chimie* IX (1791).

chemistry, and colouring. His earliest efforts at Sèvres drew upon this background.⁶⁴ By 1802, he had made several advances at Sèvres, and had formalised his ideas in the *Essai sur les couleurs obtenues des oxydes métalliques*, which he presented to the Institut that year.⁶⁵

With the memoir, Brongniart showed that he was working at the leading edge of the field. In 1797, Vauquelin had discovered a new element when experimenting with Siberian red lead. The element could exist in many differently coloured forms, which led Fourcroy and Haüy to suggest the name *chrome*.⁶⁶ Immediately following its isolation, research began towards its use in artistic pigments and in pottery making, but no manufactory had introduced a successful chrome-based colour before the start of the nineteenth century. Brongniart's earliest research at Sèvres developed a reliable chrome green for hard-paste porcelain.⁶⁷ Another of his experiments at Sèvres resulted in the use of titanium for glaze and colour compositions.⁶⁸

In the essay on colours, Brongniart addressed a 1798 publication in which Christophe Dihl, of the manufactory Dihl and Guerhard, claimed to have created an improved colour palette with unfired colours that appeared unaltered after vitrification. This task of maintaining the proper colour throughout the production process was problematic, since the original, unfired colours of minerals could change dramatically, such as cobalt carbonate, which could

⁶⁴ Jules François F. Fleury-Husson (called Champfleury), *Bibliographie céramique* (Paris, 1881), 243-4.

⁶⁵ Alexandre Brongniart, "Essai sur les couleurs obtenues des oxydes métalliques et fixées par la fusion sur les différens corps vitreux," *Journal des Mines* XII (1801-2).

⁶⁶ Louis Nicolas Vauquelin, "Sur une nouvelle substance métallique contenue dans le plomb rouge de Sibérie," *Annales de Chimie* 25 (19 January 1798). See also Marcel Delépine, "Conférence de M. le Professeur Delépine: ses œuvres chimiques," *Revue d'histoire de la pharmacie*, 51^e année, 177 (1963).

⁶⁷ This success was soon duplicated both at Nast and at Dihl and Guerhard. See Plinval de Guillebon, *Porcelaine de Paris*, 32.

⁶⁸ Brongniart, *Essai sur les couleurs*, 77.

turn from pale pink to vibrant blue based on chemical combinations and firing conditions.⁶⁹ Pottery colours generally required a substantial amount of experience for a painter to control. This made it more difficult for a painter trained using traditional media to adjust to porcelain painting. Fourcroy, Guyton de Morveau, and Darcet had been assigned to verify the statements made by Dihl. Fourcroy acknowledged that porcelain painters typically worked with two palettes, the actual one with which they were working, and a second, that of the finished results, that existed within their memory.⁷⁰ If stable colours could be manufactured, the initial palette colours could be viewed correctly throughout the production process, allowing the paintings to be fired with more reliability and consistency. Stable colours for artists throughout the working stages would be a major improvement in production. While the three savants were convinced by the results they were shown, the methods used by Dihl were not published.⁷¹

In his first two years of research at Sèvres, Brongniart identified and developed a palette of permanent colours that were unchanged after firing. Brongniart outlined a stable process that was distinct from the problematic practice of using vegetable, or organic, dyes to colour the unfired ceramic colours, which often left a permanent residue that damaged the appearance of the decoration or painting.⁷² Demonstrating one of his fundamental philosophies, he asserted that he felt it necessary, as a representative of Sèvres, to make his work known for the benefit of the industry. Regarding the 1798 memoir of Dihl, Brongniart noted that he had no privileged knowledge of any chemical processes that Dihl had kept secret, and if he had, he would not have shared anything that could be seen as proprietary chemical secrets publicly. Rather, it was

⁶⁹ Some oxides depend on the presence of either an oxidizing or reducing atmosphere during firing to produce desired colours, such as copper, which can produce either green or red. Emmanuel Cooper, *Potter's Book of Glaze Recipes* (London, 2004), 17-19.

⁷⁰ Antoine-François de Fourcroy, "Sur les couleurs pour la porcelaine du cit. Dihl," *Annales de Chimie* 25 (19 January 1798), 86-7.

⁷¹ Plinval de Guillebon, *Porcelaine de Paris*, 32; Fourcroy, "Sur les couleurs pour la porcelaine," 97-8.

⁷² Brongniart, *Essai sur les couleurs*, 3.

a straightforward practice to prefire the metallic oxides with their individually formulated fluxes or frits to drive the desired colour reactions in advance. These colours could then be ground into a powdered form suitable for application by artists. As Brongniart later wrote in *Arts céramiques*, many of the colours had already been in use among numerous makers, prior to Dihl's memoir on the subject.⁷³ Since the colours developed by this process could be maintained in the subsequent decorative firings, this method could create a powder that effectively matched the final fired results. Brongniart indicated that there were still numerous other colours that could not be made reliably stable, and that certain colours could be adversely influenced by both the combinations of materials and the firing conditions.⁷⁴

In a practical sense, Brongniart's memoir was a utilitarian description of the colours that could be made with various combinations of metals and glazes or pastes. Fired colours reacted differently depending on formulations, firing temperatures, and other conditions. Brongniart provided explanations of several regularly observed and reliable rules of thumb that would allow colours to develop correctly, including sharing the secret to Sèvres' method for creating black, a difficult colour to achieve, but which he noted depended on processing and application as much as chemistry. The most significant aspects of this memoir have as much to do with revealing Brongniart's general attitude towards scientific enquiry as they do for technical matters of pottery making. Additionally, Brongniart's focus on the difficulty of creating certain colours such as black, green, and pink elevated their commercial significance and heightened the desirability of the distinct colours and designs produced at Sèvres.

Brongniart considered that the complex issues of pottery chemistry had been neglected with regards to theory, and he noted that it was among the last material areas of the arts to take

⁷³ Plinval de Guillebon, *Porcelaine de Paris*, 32; Brongniart also clarified that Dihl had carefully selected the palette of stable colours, omitting many which could not be successfully treated as to be invariable after firing, *Arts céramiques*, t. 2, 597-9.

⁷⁴ Brongniart, *Essai sur les couleurs*, 21-2, 25, 27, 29-30.

advantage of the principles of Lavoisierian chemistry.⁷⁵ To begin with, he saw that artisanal knowledge could contribute to the understanding of chemical and physical behaviours of materials. He believed that under certain conditions the “arts” (in this case, colour chemistry, but also generally) could constitute a *science*, rather than a practical arena to which scientific knowledge was applied. His memoir was a declaration of his personal intent to draw the realm of the savant and the artisan closer together:

I thought that the precise knowledge of these facts, that the exposition of the principles which bind them, and which naturally lead to the explanation of a great number of them, might interest chemists, who, are occupied with more general research and more importantly, cannot know all the details of a very complicated art.⁷⁶

Brongniart provided a method for forming the basis of a science, which entailed establishing facts and general principles. He argued that the longstanding daily practice of pottery colour development could reliably be described and put in order in the manner of a science. Within the context of the essay, Brongniart suggested a clear framework, if not yet for pottery and porcelain making as a whole, at least for fired colours on pottery, enamels, and glass.

Brongniart and French Industry

Brongniart’s essay focussed on the intricate series of reactions and processes between the three distinct but interacting layers of a pottery or enamel object: the underlying surface (clay paste, glass, or metal), the glaze, and the applied colour.⁷⁷ By giving details of common practices particular to pottery making at Sèvres and elsewhere, Brongniart hoped to clarify the technical problems with which the chemists in his audience might not have been wholly familiar. Describing the fundamental principles that pottery artisans relied upon could aid and

⁷⁵ Brongniart, *Essai sur les couleurs*, 3.

⁷⁶ Brongniart, *Essai sur les couleurs*, 4-5.

⁷⁷ In the case of glass, there may only be two layers, those of the glass and the applied colour. A discussion of late nineteenth-century methods appears in Felix Hermann, *Painting on Glass and Porcelain and Enamel Painting* (London, 1897), 11-21.

encourage outside chemists in contributing insights and experience to benefit both industry and chemical theory. The improvement of French industry was one of Brongniart's guiding principles. While his initial goals included restoring the prominence of Sèvres' output, in some disorder as a result of the Revolution, his comprehensive plans also enabled the manufactory to use its considerable assets for the general benefit of French industry and education.⁷⁸ Sèvres occupied a place of high prestige and high expectation, and under Brongniart, it would become a leading institution in France for the improvement of industry, in step with Napoleon's broad initiatives for industrial improvement.

Brongniart envisioned Sèvres as an exemplar, not only for what it could produce, but also for the technical knowledge it could assemble and circulate. In the service of this aim, he became associated with the founders of the *Société d'encouragement pour l'industrie nationale* (SEIN) from its organisation in 1801, joining the chemistry committee as an *adjoint* in 1804.⁷⁹ This group was formed privately with the purpose of supporting the interests of French industry, with Jean-Antoine Chaptal, Minister of the Interior, serving as its first president.⁸⁰ The SEIN had several initiatives that included recognising and incentivising technological improvement and excellence. It also encouraged high-level technical education and developed a substantial research collection.⁸¹

From its formation, the SEIN was associated with the *Exposition des produits de l'industrie française*, and otherwise fostered innovations with awards. Brongniart frequently served as a juror for the purpose of determining prizes and recognising innovation. This was

⁷⁸ Ostergard, *Sèvres Porcelain Manufactory*, 31-2, 43.

⁷⁹ Société d'encouragement pour l'industrie nationale (SEIN), *Bulletin*, vol. 3-4, (Paris, AN XII [1804]), 55.

⁸⁰ Andrew Butrica has shown that SEIN had its roots within the Napoleonic administration, but that it had functioned independently since its founding, see "Creating a Past: The Founding of the Société d'Encouragement pour l'industrie nationale, Yesterday and Today," *The Public Historian* 20, 4 (1998).

⁸¹ Daniel Blouin et Gérard Emptoz, "La Société d'encouragement pour l'industrie nationale et le Conservatoire des arts et métiers (1801-1811)," *Artefact* (October 2019).

not a wholly altruistic move on his part; exceptional products from Sèvres were put on display at the exhibitions, which both encouraged technical achievement industry-wide and promoted retail sales at Sèvres. The *Exposition* was first held in 1798 and continued to be held on a semi-regular basis until 1849. It was a showcase of the best works and innovations of French makers, providing awards as well as a forum for promotion. The SEIN could offer additional prizes, even in years when there was no exhibition. Sèvres, whose status kept it out of consideration for competition, sought to display extraordinary achievements, while Brongniart was frequently tapped to serve as juror. By 1807, the SEIN *Bulletin* recognised Sèvres as “still the top porcelain factory that exists in Europe.” Numerous Parisian manufactures received awards, including Dihl and Guerhard, Nast, and Dagoty.⁸²

The Institut de France also frequently sponsored competitions to foster industrial achievement. A pottery-making competition, held between 1797 and 1799, sought an inexpensive but vitreous ware that could withstand quick changes in temperature from hot to cold or vice versa. The physical criteria could be met by hard-paste porcelain, but the firing and production costs kept it out of reach for most common buyers. Ordinary pottery was generally porous, absorbing oils, foods, and odours. It chipped and broke easily and was less durable. Additionally, many potteries still used lead glaze, although its negative health effects were widely known.⁸³

A chemist, faïencier, and porcelainier from Nantes, Jacques Fourmy (1757-1832) entered the Institut’s contest, successfully winning the prize in 1799.⁸⁴ Fourmy sought control over the materials to an uncommon degree, and primary research was a driving force in his career. In addition to spurring material advancement, Fourmy’s knowledge and skills were

⁸² SEIN, *Bulletin*, vol. 5-6 (1806-7), 115-116.

⁸³ Jacques Fourmy, *Mémoire qui a remporté le prix proposé par l’Institut National* (Paris, 1800), vi-viii.

⁸⁴ Fourmy, *Mémoire qui a remporté le prix proposé*, viii.

precisely the kinds of traits that the industrial contests hoped to identify. Fourmy had arrived in Paris in 1798, having sold all his interests in the family faïencerie to his brother-in-law.⁸⁵ The Nantes faïencerie had provided lifelong training in pottery-making, and Fourmy had achieved a high level of mastery and knowledge by the time he turned forty. His scientific, and perhaps economic, interests led him to research porcelain production. In Nantes during the 1790s, working on mineralogy as well as porcelain, Fourmy had become acquainted with Haüy, for whom Fourmy was asked to create a set of porcelain crystallographic models.⁸⁶

Fourmy combined his entry with the proposal of another public competition. In 1784, the Academy of Toulouse offered a contest seeking to improve or to eliminate the unhealthy aspects of inexpensive pottery. Although he had not entered the Toulouse competition previously, after three calls for submissions had been made, Fourmy was the first to meet the challenge with his 1799 entry. In addition to being highly vitrified and therefore less susceptible to food contamination, Fourmy's ware had no unstable ingredients or known toxins such as lead. He submitted the details for his process to the Institut and his wares were displayed during the *Exposition* of 1801. The prize and the exhibition brought him into contact with Brongniart, who, as I discuss below, remained supportive of Fourmy's work thereafter.⁸⁷

A New Word for an Ancient Practice and a New Science

By 1800, Fourmy had established a manufactory in Paris to produce his newly developed pottery. He published a series of small essays on the science and technology of pottery, largely with the intent to promote his work.⁸⁸ At the suggestion of Haüy, Fourmy used

⁸⁵ Benjamin Fillon, *L'art de terre chez les Poitevins* (Niort, 1864), 3-4, 166-75.

⁸⁶ Fillon, *L'art de terre chez les Poitevins*, 171-3.

⁸⁷ Ostergard, *Sèvres Porcelain Manufactory*, 141, 161-2.

⁸⁸ Jacques Fourmy, *Mémoire sur les ouvrages de terres cuites, et particulièrement sur les poteries*, (Paris, 1802); *Essai sur les corps vitreux colorés par les métaux*, (Paris, 1804).

the novel term *hygiocérames* for his wares.⁸⁹ In giving credit to Haüy, Fourmy drew upon their relationship, simultaneously demonstrating his credibility within the Academic and scientific community.⁹⁰ Three years later, in 1805, Fourmy also used this nomenclature to coin *hydrocérames*, which referred to a type of earthenware pottery known to lower the temperature of the liquid it contained, found in the Americas, and elsewhere.

Haüy and Fourmy's 1802 neologism *hygiocérame* was admired by the author of a review in the *Paris Journal* as being prettier than the common name, *le poterie de santé*.⁹¹ In addition to the words "*hygiocérame*" and "*hydrocérame*," Fourmy included the use of the term "*céramique*" as an adjective to describe the collective body of pottery types, which only two years prior, he had described inexactly as the "pyrotechnic arts."⁹² By the end of 1804, Fourmy used the term more conspicuously, when he compiled all of his previously published memoirs in the *Recueil de mémoires relatifs à l'art céramique*. However, Fourmy was self-published, and reached only a limited audience. Although specialists and general readers alike might have found his publications informative, it is probable that the new term "*la céramique*" drew little notice within his relatively small audience, and had little traction, except for savants such as Brongniart and Haüy. In 1844, Brongniart remembered Fourmy as "the most educated man I have known in the theory and practice of the ceramic arts."⁹³ As I discuss below, Brongniart hired Fourmy at the manufactory, placing him in charge of the *Enquête de préfets* in 1805.

From the outset of his tenure at Sèvres, Brongniart had sought a term or phrase that would encapsulate the broader field that comprised pottery and porcelain making.⁹⁴ Few

⁸⁹ On Fourmy's biography, and his relationship with Haüy, see Fillon, *L'art de terre chez les Poitevins*, 171, 173.

⁹⁰ Fourmy, *Mémoire sur les ouvrages de terres cuites*, 92.

⁹¹ *Journal de Paris*, vol. 6 (27 August 1803): 2102.

⁹² Fourmy, *Mémoire sur les ouvrages de terres cuites*, 44, 62.

⁹³ Brongniart, *Arts céramiques*, t.2, 112fn.

⁹⁴ Joint credit for originating and promoting the new name must be given to Haüy, Fourmy, and Brongniart. However, Brongniart first used the term in a definitive way in 1824 as a part of the official name of the *Musée céramique et vitrique de Sèvres*, as I discuss further below.

outside his immediate sphere would have understood the use of the term *la céramique*, and in his letters and publications, he continued to use commonly understood phrases, such as “l’art de la poterie” or “l’art des terres.”⁹⁵ By 1824, when the museum was opened to the public, its name, the *Musée céramique et vitrique de la Manufacture royale de porcelaine et de peinture sur verre de Sèvres*, legitimised and defined the new term, *la céramique*, which was unique in encompassing the wide array of materials and objects in its collection.⁹⁶ In articles written for a broad audience, such as “Argille” in the *Dictionnaire des sciences naturelles* in 1816, which covered methods in pottery making in detail, or “Porcelaine,” for Courtin’s *l’Encyclopédie moderne* in 1830, Brongniart did not define or use “*la céramique*,” nor was it in common use elsewhere.⁹⁷ However, in 1830, in the entry for “Poteries,” which appeared in the *Dictionnaire technologique*, he utilised the term repeatedly, although without offering an explicit definition. It was only in 1844, with the publication of *Arts céramiques*, that he explicitly defined and introduced the term to a broad audience.⁹⁸ Although Brongniart had not invented the original term, his authority was crucial in establishing its place in everyday language to frame the new science he had delineated. From his discussion of vitrifiable colours in 1802 forward, Brongniart had insisted that the “arts of the Earth,” or *la céramique*, were capable of being

⁹⁵ This letter, dated 1^{er} Thermidor An 13 (19 July 1805), which described the function and intent of the survey, was likely influenced or drafted by Brongniart, prior to its distribution across France. Michel Dubus and Béatrice Pannequin, *La céramique française sous l’Empire à travers l’enquête des préfets, 1805-1810* (Paris, 1999), 104.

⁹⁶ Alexandre Brongniart and Denis Désiré Riocreux, *Description méthodique du Musée céramique de la manufacture royale de Porcelaine de Sèvres* (Paris, 1845), XV.

⁹⁷ Alexandre Brongniart, “Argille,” in Frédéric Georges Cuvier, *Dictionnaire des sciences naturelles*, t.3 (Strasbourg, 1816-45); “Porcelaine,” in *Encyclopédie Moderne*, t. 18 (Paris, 1830; “Poteries,” in *Dictionnaire technologique*, t.17 (Paris, 1830). That “céramique” was not a term in use as a reference to pottery production prior to 1802 is confirmed by data taken from Google Ngram Viewer, see

https://books.google.com/ngrams/graph?content=ceramique&year_start=1760&year_end=1850&corpus=19&smoothing=3

⁹⁸ Brongniart, *Arts céramiques*, 3.

defined as a science. What was missing was a concise, consistent language and a coherent classificatory system.⁹⁹

Brongniart's primary aim in establishing a science to describe and to understand the high-temperature firing processes and the complex mineralogical and chemical interactions of pottery and porcelain making was to clarify obscure practices and to ground a field that had, for most of its history, shielded its secrets from competition, and frequently depended upon tacit knowledge, trial-and-error, and accidental discovery. However, the complexity of the processes involved in pottery making was not the only reason that savants had not widely given their full attention to the field. As I discussed in the introduction, Diderot had pointed to the limited study of artisanal fields by savants, and had called for their inclusion in a comprehensive natural history. However, as I indicate in Chapter Six, Diderot saw this as part of a larger distinction between the work of the mind and the work of the hands, highlighting the widespread belief across eighteenth-century Europe that intellectual knowledge was a higher form of understanding than artisanal knowledge.¹⁰⁰

Myles Jackson has shown that, during the early nineteenth-century emergence of the discipline of physics, British natural philosophers such as John Herschel and Michael Faraday had believed that philosophical understanding would be enough to replicate the optical (lenses) work of Joseph Fraunhofer, despite their lack of Fraunhofer's well-practiced glassmaking skills and deep artisanal and scientific knowledge. The British would simply be able to instruct artisans in what they wanted to have made (Herschel) or they would be able to use chemistry to create identical lenses (Faraday). However, after years of effort, the British natural philosophers were forced to abandon the project after admitting to lacking the necessary skills and knowledge. Jackson's work demonstrates that the status of artisanal contributions to newly

⁹⁹ Brongniart, *Essai sur les couleurs*, 4-5; Brongniart, *Arts céramiques*, v.1, pt.1 (1844), X-XI.

¹⁰⁰ For an important discussion of eighteenth-century British thought on the distinction, see Steven Shapin and Barry Barnes "Head and Hand" *Oxford Rev. of Ed.* 2, 3 (1976): 231-254.

emerging scientific fields such as physics were part of an unsettled question during the early to mid-nineteenth century, while at the same time, it was increasingly made obvious that artisanal skill played a key part in generating scientific knowledge and advancement.¹⁰¹

Unlike many savants and natural historians, Brongniart – whose work in natural history had continuously relied upon the visceral and physical actions of not only his hands (performing dissections, taxidermy, care of living biological specimens and pets, catching specimens in nature, drawing, making displays of objects, and arranging collections), but also his body and his senses (tasting minerals for acidity or sweetness, climbing mountains, descending into wells or mines, smelling chemicals, organic matter, and minerals, examining objects under microscopes, observing colour, feeling electricity, and so on) – did not make a sharp distinction between the technological and intellectual demands of pottery making and those of other disciplines of natural history. Instead, he saw the intellectual effort of pottery and porcelain making to be parallel in its essence to fields such as mineralogy, geology, and physics. Brongniart's efforts in establishing *la céramique* were intended not only to form a clear science, but also to reshape the hierarchical beliefs regarding the status of both artisanal knowledge and the ceramic arts.

Towards a New Era: Building Knowledge in the Arts of the Earth

Brongniart's initiatives and collections at Sèvres were designed to create a landmark institution for porcelain and pottery knowledge, and he quickly formulated long-term plans for a research centre and museum to be housed at the manufactory. His approach was identical to

¹⁰¹ Myles W. Jackson, "Artisanal Knowledge and Experimental Natural Philosophers." *Studies in History and Philosophy of Science* 25, 4 (1994): 549–575; *Spectrum of Belief* (Cambridge, MA, 2000), 43–84.

that which he had employed and would continue to use as a mineralogist and a geologist. He sought to locate pottery styles, methods, materials, and objects throughout the world, and to link them to uses, cultures, geography, geology, mineralogy, and technology. No material or object was too humble for inclusion, including bricks, tiles, and basic earthenware.¹⁰²

Following the challenge Brongniart had publicly outlined in his 1802 memoir on colours both for himself and for the industry, as well as in his correspondence with Chaptal and others, he began a series of concrete steps toward establishing an underlying science for pottery and porcelain making. One of the biggest of these, in terms of its scale and reach, was *l'Enquête des Préfets*. This project was intended to collect information, as volunteered by individual potteries and manufacturers, concerning clays and pottery types in use across France, as well as to collect as many specimens as possible. The *Enquête*, which spanned from 1805 to 1812, was pursued jointly between Sèvres and the Statistics Bureau of the Ministry of the Interior. This survey amassed and organised a substantial amount of material and mineralogical knowledge as well as samples of pottery being manufactured across France.¹⁰³ Meanwhile, in his personal cabinets, whether at the Muséum, or at the Bureau des Mines, Brongniart systematically collected mineralogical samples from around the world. Beginning with a second trip to England in 1802, he carried out an intensive programme of research trips to manufactories across Europe, where he sought information concerning new styles, materials, and technologies. In the process, he established numerous long-term relationships that fostered exchange and open dialogue.¹⁰⁴

¹⁰² Ostergard, *Sèvres Porcelain Manufactory*, 75-7, 123-5; Richardson, “Unlikely Citizens,” 198-9, 227-8.

¹⁰³ Dubus and Pannequin, *La céramique française sous l'Empire*.

¹⁰⁴ For example, on Brongniart's relationship with Georg Frick at KPM, see Tamara Préaud, “Alexandre Brongniart and the German Manufactories,” in *Refinement & Elegance*, ed. Samuel Wittwer (Munich, 2008).

When Brongniart wrote to Chaptal on 28 July 1801 concerning ways to improve the French pottery industry, it was with two related goals in mind. The first was for permission to assemble the objects already held at Sèvres into one repository to form an organized collection. The second was to augment this collection, at minimal expense, with samples of both domestic and foreign pottery materials, and samples of all the known potteries and porcelains. He explained to Chaptal that the methodologically arranged collection would be useful as a record of the entire art of pottery making and its history. It would include objects necessary for both the art and the science of all types of pottery making, from the most basic to the most refined.¹⁰⁵

His long-range educational goals were clear: Sèvres would offer its visitors, both local and foreign, an opportunity to study the history of pottery making and the related applications of science.¹⁰⁶ The *Enquête* brought in a partial selection of raw materials from across France and sought to build a summary of pottery styles. It enabled Brongniart to understand levels of mastery and styles in pottery construction across France. Some manufacturers, at all levels of the industry, were proud to submit their works, while others declined to participate, likely fearing the loss of valuable competitive processes or material supplies.¹⁰⁷ The survey preserved a lasting record of a segment of the country's industry at the start of the nineteenth century and gave insight into the kinds of improvements from which the industry might benefit. Of equal significance, it augmented the geological and pottery knowledge Brongniart was accumulating both at Sèvres and at the Muséum.¹⁰⁸

Early on in his directorship, Brongniart sought to draw upon the knowledge and skills of the technical and chemical experts with which he was connected. Fourmy struggled to

¹⁰⁵ Dubus and Pannequin, *La céramique française sous l'Empire*, 27.

¹⁰⁶ Dubus and Pannequin, *La céramique française sous l'Empire*, 28.

¹⁰⁷ Béatrice Pannequin, "Clay, Pedagogy, and Progress: The *Enquête des Préfets* (1805-1810)," in *Sèvres Porcelain Manufactory*, Derek E. Ostergard and Tamara Préaud, eds. (New Haven, 1997): 162.

¹⁰⁸ Pannequin, "Clay, Pedagogy, and Progress," 162.

develop a market for his work, and otherwise seems to have been less fortunate with the business aspects of pottery production, but his artisanal, chemical, and material understanding was exemplary, and of evident use to Brongniart.¹⁰⁹ In 1805, he hired Fourmy with the dual purpose of researching economical hygienic wares for potential production at Sèvres, and to assist with the upcoming survey of French pottery. It was a beneficial arrangement, since he knew that Fourmy had an eye for distinctions of quality and for methods of production, understood mineralogy, and had a rare mastery of pottery and porcelain making. While Brongniart could offer support and patronage, he was in the position to benefit substantially from Fourmy's lifelong expertise.¹¹⁰

The collections which were formed by the *Enquête* offered a glimpse not only of the most treasured productions, but also those of ordinary quality that provided service to a broad population. The surveys also preserved the most quickly and inexpensively made potteries, intended for quick manufacture and temporary use, with a short lifespan. These kinds of objects were not intended to endure, and particularly were not intended for aesthetically-oriented collections. Frequently, pottery types such as these reached collections later, via archaeology, as examples of the quotidian or mundane in a forgotten past. The materials and objects from the *Enquête*, however, had a destination at the Sèvres museum. As a research museum, Brongniart understood the value of documenting the more ephemeral forms of artisanal practice as well as preserving the best and most enduringly admired objects. Alongside the pottery, he received mineralogical samples, and notes on skills and processes in use, as well as local market information. The *Enquête* was an anthropological and mineralogical study combined with a catalogue of technology. It could be used to highlight the kinds of instruction and improvements that would benefit French regions. However, it also recorded the

¹⁰⁹ Pannequin, "Clay, Pedagogy, and Progress," 162.

¹¹⁰ Brongniart continued to recognize Fourmy's contributions throughout his life. *Arts céramiques*, 2, 8, 112, 595, 671.

mineralogical aspects that could benefit or limit a region's output. Over time Brongniart incorporated the data he collected during the years of the *Enquête* into his research in other disciplines.

The *Enquête* took place in parallel with Brongniart's geological research on the Paris Basin and beyond, as well as his work as a mining engineer. The survey compiled geological information that could be beneficial to Sèvres and other manufacturers. For practical purposes, Brongniart's domestic pottery and Paris Basin surveys both shared common ground with the geological and mineralogical research begun by Guettard in the mid-eighteenth century. As I discuss in the following chapter, Guettard's plan for an atlas of the mineralogical deposits of France was explicitly intended to benefit French industry, but its course was interrupted before the monumental work could be completed. Not only did Brongniart draw upon Guettard's sweeping vision, but his close associate André Jean Marie Brochant de Villiers also returned to the project of a mineralogical survey and map of France in the 1820s.

CHAPTER SIX: Specialisation, Nomenclature, and Developing Fields

Although he had become director at Sèvres, Brongniart remained at the centre of Parisian natural history and participated actively in the local and global networks that the city's major scientific institutions, as well as numerous salons and intellectual societies, helped unite. Over the course of the first half of the nineteenth century, Brongniart worked at the forefront of new sciences, including mineralogy, geology, and palaeontology. As a mining engineer and a field researcher, he used systematised and localised studies to develop a practical understanding of the nature of the Earth, its land formations, and its structure, while collecting diverse materials and samples from around the globe.¹ He continued to build and to engage a large network of global researchers. His late-life publications grew from accumulated observations from almost half a century's research, and many of his ideas were expressed in the short format of a dictionary or encyclopaedia essay before they appeared independently, such as *Tableau des terrains* and *Traité des arts céramiques*.

Owing to its wide scope, I study Brongniart's work in geology and mineralogy across two chapters, before returning to the subject of ceramic science in the final chapter. As I discuss in Chapters Six and Seven, extensive research grounded Brongniart's publications, as he developed his understanding, defined natural mechanisms, and worked to establish and to define geology and palaeontology as sciences – efforts which, as I show in Chapter Eight, he also applied to the creation of a science that underpinned pottery making. While Brongniart's work has often been

¹ Brongniart's travels and fieldwork took him across France and Europe. He joined Dolomieu in the Alps, and travelled in England, Normandy, Brittany, Burgundy, Italy, Germany, Holland, and Sweden. A large collection of his travel journals, including those from his Paris Basin studies, are located in: Papiers provenant d'Alexandre Brongniart, "Journaux et papiers se rapportant aux voyages d'Alexandre Brongniart," BMHN MS2336-2351.

viewed in relation to single disciplines, his mineralogical, paleontological, and geological work was practised in tandem with his research and production in the arts. I argue that although Brongniart wrote about specific topics with a view to their individual distinctions, such as the chemical and physical properties of minerals or the biological characteristics of fossils, he held that these fields were connected in deep and varied ways. In this chapter, I look closely at Brongniart's discussions and publications in mineralogy, which underpinned most of his career works, especially those in geology and ceramics.

Brongniart was one of several naturalists who were invested in the reshaping of the broad Linnaean category of mineralogy into more precisely defined branches of natural history. Moreover, following the approach of Werner, Brongniart advocated for the separation of *geognosy*, or fact-gathering about the distinct terrains of the Earth, from *geology*, or the general theory of the history of the Earth, into discrete but related practices. I consider Brongniart's major contributions to both geology and mineralogy, published mainly as articles and essays, and his earliest contributions to the *Dictionnaire des sciences naturelles*, edited by Frédéric Cuvier (the younger brother of Georges). I also examine how scientific identities were being altered in response to new social, political, and intellectual contexts, and how Brongniart met with and propelled this change. Indeed, the complexity and the diversity of Brongniart's oeuvre serves as an example for how scientific practices changed across the span of his lifetime.

Brongniart's first major scientific publication appeared in 1807. A two-volume textbook, written for the French national *lycée* system, his *Traité élémentaire de minéralogie avec des applications aux arts* quickly became a respected reference for

working mineralogists that went beyond its immediate audience.² A second major publication, *Essai sur la géographie minéralogique des environs de Paris*, appeared in 1811, and was updated in 1822 under the title *Description géologique des environs de Paris*. These publications, which I discuss in Chapter Seven, were the result of a joint study with Georges Cuvier focussed on the geognosy of the Paris basin that began prior to 1804.³ Both *Minéralogie* and *Description géologique de Paris* highlighted Brongniart's reliance on multifaceted knowledge, his commitment to slow and methodical fact gathering, and his cautious approach to theorising. In the *Dictionnaire des sciences naturelles*, for example, he insisted that he was opposed to speculations or the creation of "systems," while his writings indicate the lingering influence of eighteenth-century Buffonian natural history in terms of their wide scope. As an author of numerous encyclopaedia articles, Brongniart drew upon forms such as the *Encyclopédie méthodique* of Diderot and d'Alembert and Pierre-Joseph Macquer's *Dictionnaire de chimie*, often retaining similar topic headings for his updated discussions.⁴ His approach to the creation and organisation of collections drew upon the work of his mentors and instructors, including Jean-Étienne Guettard, Balthazar George Sage, and René Just Haüy.

Before he published anything on mineralogy, Brongniart's early career interests in biology and anatomy had led to the publication of *Essai d'une classification naturelle des reptiles* in 1800, which played a significant role in the restructuring of biological classifications and the separation of amphibians from the class of reptiles. Biology

² Benjamin Silliman, "Obituary: Death of Alexandre Brongniart," *American Journal of Science and Arts* 2, 5 (1848): 142-4, 155-9.

³ Georges Cuvier and Alexandre Brongniart, *Essai sur la géographie minéralogique des environs de Paris* (Paris, 1811); *Description géologique des environs de Paris* (Paris, 1822, 1835).

⁴ See below for a discussion of Brongniart's encyclopaedia entries and their thematic similarities to Macquer's for example.

would be foundational to Brongniart's study of the Earth. Knowledge of fossils and their sedimentary position – the earliest form of biostratigraphy – contributed to essays such as *Sur les caractères zoologiques des formations* of 1821⁵ and *Histoire naturelle des crustacés fossiles, sous les rapports zoologiques et géologiques: savoir les trilobites*, published in 1822 with Anselme Gaëtan Desmarest (1784-1838), in which Brongniart paired several newly-categorized species of trilobite with information on their position within rock strata.⁶ Brongniart's writings shared a continuity of themes across diverse topics that included mineralogy, geology, chemistry, palaeontology, and ceramics. In what follows, I examine the interrelationships of Brongniart's research in various disciplines of natural history.

Between Paris and Sèvres

Although Brongniart's perspective constantly shifted across multiple facets of his research, the roughly ten-mile separation of Sèvres from the active hubs of Parisian natural history, such as the Muséum, formed a physical limitation to the kinds of work on which he could concentrate at a given moment. For example, questions of colour chemistry and the firing of porcelain were suited to the laboratories at Sèvres, as was a considerable amount of research on the behaviour of clays and pottery materials. For many early nineteenth-century Parisian savants and natural historians, especially those who lived where they worked, Brongniart's activities at Sèvres were out of active daily view, unlike the many closely linked cabinets, salons, lycées, cafés, and societies of central Paris that encouraged the exchange and circulation of information. However,

⁵ Brongniart, "Sur les caractères zoologiques des formations, avec l'application de ces caractères à la détermination de quelques terrains de craie," *Annales des Mines* 6 (1821), 8.

⁶ Alexandre Brongniart, *Histoire naturelle des crustacés fossiles, sous les rapports zoologiques et géologiques: Savoir des trilobites* (Paris, 1822).

French researchers, such as the mineralogist Cyprien Prosper Brard (1786-1838), and visitors from outside Paris, such as geologist Charles Lyell (1797-1875), often met with Brongniart both at Sèvres and at his salon and cabinet in central Paris.⁷ As Jean-Victor Audouin (1797-1841) recorded in 1817, Brongniart's courses at the Muséum included the mineralogy of pottery materials, in which the final classes took place at Sèvres. These efforts demonstrated that Brongniart worked to draw a stronger connection between the two research centres.⁸

Brongniart divided his weeks roughly equally between the two institutions, generally spending three days at Sèvres and three at the Muséum, with Sundays devoted to his family, his students, visitors to his cabinet, including an informal *souper* and a regular evening salon. With residences both at Sèvres and in Saint Germain by 1800, Brongniart did not seek additional housing at the Muséum prior to his promotion to the Chair of Mineralogy in 1822.⁹ No. 71 rue Saint Dominique, formerly inhabited by several generations of the Hazon family, was purchased by Charles Étienne Coquebert de Montbret in 1802. The site became the home of an extended family that included Alexandre, his wife Cécile, and their three children.¹⁰ Cécile's unmarried brother, Eugène, deaf, but nonetheless a specialist in languages, remained with the family,

⁷ Cyprien-Prosper Brard, *Minéralogie appliquée aux Arts*, t. 1 (Paris, 1821), 2-3; Charles Lyell, *Life, Letters and Journal of Charles Lyell*, vol.1 (London, 1881), 124, 132, 247.

⁸ Jean-Victor Audouin and Jean Théodoridès, *Journal d'un étudiant* (Paris, 1965), 22; Brongniart continued to teach similar classes into the 1820s. See also Brongniart, "Énumération et journaux des cours de minéralogie faits au Muséum d'Histoire naturelle, depuis 1823 inclusivement," Enseignement, BMHN MS 643.

⁹ Anne Lajoix, "Alexandre Brongniart: Scholar and Member of the Institut de France," in *Sèvres Porcelain Manufactory*, Derek E. Ostergard and Tamara Préaud, eds. (New Haven, 1997), 32-3.

¹⁰ Lajoix, "Alexandre Brongniart: Scholar," 32-3. The building is now numbered 3 and 5. Jacques Hillairet, *Connaissance de vieux Paris*, (Paris, 2017), 543.

where he helped to maintain the library.¹¹ One of the strengths of the Coquebert de Montbret clan had been their conscious effort to maintain close family relationships, and to retain family inheritances and properties, including by intermarriage. For example, Charles Étienne and his wife, Nicole Charlotte, were first cousins through the Hazon family, and his brother, Antoine-Jean, had also married a Coquebert cousin.¹²

By 1815, André Jean Marie Brochant de Villiers, a cousin to both the Coquebert de Montbret and Brongniart families, had also made his home at No. 71 rue Saint Dominique.¹³ Professor of mineralogy at the École des Mines since 1802, Brochant had relocated when Napoléon moved the school to Savoy.¹⁴ He returned to Paris mid-career, where he and Brongniart pursued similar work in mineralogy and industry. In a fascinating parallel to Brongniart at Sèvres, Brochant became the director of the glass and mirror factory, Saint-Gobain, in 1815 and was elected to the mineralogy section of the Académie des Sciences in 1816.¹⁵ Saint-Gobain, like Sèvres, relied upon the expertise of mineralogists and chemists for their material knowledge, and the glassworks employed members of the Brochant and Gérard families throughout the nineteenth century.¹⁶

¹¹ Stewart McCain, “Speaking like a state? Cultural imperialism, linguistic particularism and local officials in the Napoleonic enquiry into the patois, 1806–12,” *French History* 29, 4 (December 2015): 510, 512.

¹² See Family Trees, Appendix 1.

¹³ Audouin and Théodoridès, *Journal d’un étudiant*, 44.

¹⁴ Philippe Grandchamp, “Le cours de géologie professé par Brochant de Villiers à l’École des mines dans les années 1810,” *Travaux du Comité français d’Histoire de la Géologie* 3, 19 (2005), 4-5.

¹⁵ Grandchamp, “Le cours de géologie,” 13.

¹⁶ Yannick Lemarchand, “Un précurseur de la normalisation comptable: Brochant de Villiers et la comptabilité des sociétés anonymes, 1772-1840,” *Gérer et comprendre* (1994): 69-82; Additionally, Alexandre Sébastien Gérard (1779-1853) – the younger brother of François Gérard, and a former student of Brongniart – and his son, Alexandre Léon Sébastien Gérard (1817-96), were both officials at Saint Gobain during the nineteenth century. Augustin Cochin, *La manufacture des glaces de Saint-Gobain de 1665 à 1865* (Paris, 1865), 162.

The Saint Germain residence was ideally situated in the centre of Paris, midway between Sèvres and the Muséum. The pattern of Brongniart's schedule and the locations of his three primary work and living spaces served to balance his efforts, to widen his experience, and to organize his research. Both Brongniart and Brochant kept mineralogical cabinets at their residences, while Brongniart and Coquebert had extensive libraries.¹⁷ In his library, Brongniart collected important publications in geology, mineralogy, palaeontology, the mechanical arts, ceramics, chemistry, medicine, and so on.¹⁸ In 1831, the library of Coquebert comprised 13,000 volumes, largely to do with economic and political topics, as well as geography.¹⁹ In addition, it contained some 900 maps that were catalogued and annotated.²⁰

The related households of rue Saint Dominique became hubs of scientific and social activity that drew attention from young naturalists and well-connected foreign tourists alike.²¹ By 1839, *Galignani's New Paris Guide* listed the mineralogical cabinets of Brongniart and Brochant de Villiers among a number of well-known, private or semi-private Parisian sights and collections that required special

¹⁷ Audouin indicated that the mineralogical collections of Brochant were separate from those of Brongniart. Audouin and Théodoridès, *Journal d'un étudiant*, 44.

¹⁸ Brongniart's scientific library was auctioned in 1858, eleven years after his death, and four years prior to Cécile's. The auction catalogue had nearly two thousand entries. *Catalogue des livres composant la bibliothèque scientifique de feu M. Alexandre Brongniart* (Paris, 1858).

¹⁹ From 1831 to 1847, Eugène added a further 40,000 volumes. This library was transferred into the collections at the Bibliothèque de Rouen in 1849, following Eugène Coquebert de Montbret's death. Sven Ködel, "L'affaire du testament Montbret," *Coquebert de Montbret: Pratiques d'une bibliothèque savante autour de 1800* (10 Jan 2019).

²⁰ Isabelle Laboulais-Lesage, "Reading a Vision of Space: The Geographical Map Collection of Charles-Etienne Coquebert de Montbret (1755–1831)," *Imago Mundi* 56, 1 (2004).

²¹ Audouin and Théodoridès, *Journal d'un étudiant*, 44; A. Galignani, *Galignani's New Paris Guide* (Paris, 1839), 93; Léon Dufour, *Souvenirs d'un savant français* (Paris, 1888), 324.

introductions in order to visit.²² Additionally, Benjamin Silliman (1779-1864), in the first edition of his *American Journal of Science*, included a notice of Brongniart's request for samples of plant fossil specimens from the coal measures of the United States, in which Brongniart offered to pay the expenses for the shipment to his private Saint Germain address.²³ Thus, the professional and private activities of the residence opened up the Brongniart, the Brochant, and the Coquebert families to a wide population of scientists, diplomats, artists, and students on a continuous basis.

In *Paris Savant*, Bruno Belhoste illustrates the scientific worlds of *ancien régime* Paris, highlighting the interconnections and dynamic structures of the city of approximately 600,000 people. Belhoste records the life of a city whose structures, such as the academies and the patronage systems, were on the brink of collapse, brought on by the events of the Revolution. Yet, as the nineteenth century got underway, many of the institutions and systems that had seemed about to disappear had been reconfigured and re-established, albeit in new, or newly dressed, forms. From the Directorate of 1795 forward, French culture and politics sought distance from the excessive years of the Terror.²⁴

As we have seen, by 1794, stabilising reforms had led to the creation of new educational institutions including the Écoles Centrales, the École des Mines, and the École Polytechnique. In 1795, the Institut de France was created to replace the defunct academies and the Académie des Sciences was reformed with new membership.²⁵ The

²² Galignani, *New Paris Guide*, 92-3.

²³ The first edition of 1818 was reprinted in 1819. *The American Journal of Science* (Philadelphia, 1819), 71. Silliman reiterated the request a third time in 1821, *The American Journal of Science and Arts*, v.3 (Philadelphia, 1821), 7, 227.

²⁴ Antoine-Claire Thibaudeau, *Mémoires sur la Convention et le Directoire* (Paris, 1824), 124-5.

²⁵ Roger Hahn, *Anatomy of a Scientific Institution: Paris Academy of Sciences* (Berkeley, 1971), 286-312; Maurice P. Crosland, *Science Under Control: French Academy of Sciences, 1795-1914* (Cambridge, 2002), 50-8.

private Lycées sustained avid interest during the first half of the nineteenth century, drawing in a diverse group of auditors for classes on the sciences, literature, and the arts.²⁶ As the government-sponsored Lycées offered curricula to a large segment of the population, the term Lycée became closely identified with the government-sponsored schools.²⁷ In response, the Lycée Republicain underwent another series of name changes, becoming the Athénée de Paris in 1802, and, by 1814, the Athénée Royal de Paris. Likewise, the Lycée des Arts became the Athénée des Arts in 1803.²⁸ Both institutions drew instructors and speakers from the top ranks of Parisian scientists and experts. Cuvier delivered comparative anatomy lectures to a popular audience, Étienne Geoffroy Saint-Hilaire and his son Isidore taught zoology, and chemist Jean Baptiste Dumas began his Parisian career at the Athénée.²⁹

Salon culture, often seen as a critical part of *ancien régime* society, continued to maintain currency among the Parisian elite in the nineteenth century, providing a series of regular weekly events at which to share information, ideas, and experiences. On Sundays, Brongniart hosted a number of savants, intellectuals, and artists among whom were regular guests such as André Marie Ampère; Dominique François Arago; Étienne Arago; Alexander von Humboldt and his brother, Frédéric Marie; François Gérard; Eugène Delacroix; Jean-Baptiste Isabey; and foreign visitors such as Thomas Richard Underwood, Charles Lyell, Christian Leopold von Buch (1774-1853), George Bellas Greenough (1778-1855), and Roderick Murchison (1792-1871).³⁰ Émilie

²⁶ Barbara Haines, "The Athénée de Paris and the Bourbon Restoration," *History and Technology* 5, 2-4 (1988).

²⁷ Charles Dejob, *L'instruction publique en France et en Italie au XIXe Siècle* (Paris, 1894), 193-4.

²⁸ Dejob, *L'instruction publique*, 188-9.

²⁹ Haines, "Athénée de Paris," 262.

³⁰ John Challinor, "Some correspondence of Thomas Webster, geologist (1773-1844)-II," *Annals of Science* 18, 3 (1962); Léon Dufour, *Souvenirs d'un savant français*,

Brongniart and her husband, Louis André Pichon also hosted Lyell, as they both spoke English fluently and were conversant on natural history topics.³¹ A number of naturalists also held weekly gatherings, and Georges Cuvier had a popular and busy Saturday evening salon at the Jardin des Plantes, which met regularly until the death of his daughter, Clémentine (1805-1827).³²

Brongniart attended Cuvier's salon regularly. Among Cuvier's other guests were the author Henri Beyle, known as Stendhal (1783-1842), Sarah Bowdich Lee, and Alexander von Humboldt.³³ Lee, in her 1833 *Memoirs of Cuvier*, described Cuvier's salon, where "there passed in review, the learned, the talented, of every nation, of every age, and of each sex; all systems, all opinions, were received; the more numerous the circle, the more delighted was the master of the house to mingle in it . . . nothing was banished from this circle but envy, jealousy, and scandal."³⁴ She also described a conversation, following the Salon of 1819, in which a number of important guests took part in a discussion of the painter Anne-Louis Girodet de Roussy-Trioson's *Pygmalion and Galatea*:

when M. Brongniart (the celebrated mineralogist, and director of the Royal Manufactory of China at Sèvres) found fault with the flesh, which, he said, was too transparent; Baron de Humboldt (the learned Prussian traveller, who had lately been occupying himself with the chemical experiments of M. Gay-Lussac) objected to the general tone of the picture which he said looked as if lighted up with modern gas; M. de Prony (one of the mathematical professors of the École Polytechnique, and also director of the École des Ponts et Chaussées) found fault with the plinth

(Paris, 1888), 324; Lyell, *Life, Letters and Journal*, 124, 132, 247; Lajoix, "Alexandre Brongniart: Scholar," 33.

³¹ Lyell, *Life, Letters and Journal*, 132-3, 135, 140, 146; Isabelle Laboulais-Lesage, "From Sketches to Publication: The Genesis of the 'Essai d'une Carte Géologique' by Omalius d'Halloy and Coquebert de Montbret (1810-1823)," *Earth Sciences History* 26 (2007): 18.

³² M. Orr, "Keeping It in the Family: The Extraordinary Case of Cuvier's Daughters," *Geological Society Special Publication* 281, 1 (2007), 279-84.

³³ Edmond Pilon, "À propos d'un centenaire: Le salon de Cuvier au Jardin des Plantes," *Revue Des Deux Mondes (1829-1971)* 10, 2 (1932): 382-94.

³⁴ Sarah Bowdich Lee, *Memoirs of Baron Cuvier* (London, 1833), 166-7.

of the statue; and many gave their opinion in the like manner, each pointing out the faults that had struck him in this celebrated performance; after which, M. Cuvier said that the thumb of Pygmalion was not properly drawn, and would require an additional joint to those given by nature, for it to appear in the position selected by the painter. Upon this, M. Biot (the mathematician and natural philosopher, who had remained silent all the time,) with mock solemnity summed up the whole, showing that everybody had been more or less influenced by his particular vocation, or favourite pursuit; and concluded by saying that he had no doubt but that every one of them, if they met Girodet the next day, would congratulate him on the perfect picture he had produced (see Figure 6.1).³⁵

If Lee mixed nostalgia, idealism, and humour into her memoirs, they remain valuable as a document that shows the wide span of the identities and the interests of Cuvier's guests, as well as their general habits of conversational banter. Although each host had a characteristic group in attendance, salons across Paris often shared guests from within common networks. Much like Brongniart and Cuvier, Geoffroy Saint-Hilaire's guests included well-known scientific personalities such as Ampère and the Arago brothers. In addition, Geoffroy's salon became a favourite of nineteenth century authors including Victor Hugo, Georges Sand, Franz Liszt, Alfred de Musset, and Honoré de Balzac, who dedicated the novel *Père Goriot* to him.³⁶

From Savant to Scientist: Shaping Natural History and Shaping Identities

The *fin-de-siècle* witnessed the emergence of increasingly specialised scientific disciplines. New names, such as geology and zoology were created to reflect the development and separate identity of these sciences, and new institutions and requirements for membership appeared at the same time. Present day academic

³⁵ Anne-Louis Girodet de Roussy-Trioson (1767-1824) exhibited his painting, which was both sensational and controversial when it appeared, at the Salon of 1819. Anne Lafont, *Girodet* (Paris, 2005), 81-89

³⁶ John Tresch, *The Romantic Machine: Utopian Science and Technology after Napoleon* (Chicago, 2012), 362.

specialisation invites the possibility of committing historical anachronism, or of using constrictive descriptions, such as chemist, geologist, or mineralogist to describe who Brongniart was and how he worked. However, although aspects of his work can be captured by each of these roles, his identity was, instead, embedded in the integration of his broadly distributed actions, ideas, productions, and publications within natural history. As we have seen, like his eighteenth-century mentors and predecessors, including Buffon, Macquer and Lavoisier, Brongniart developed a comprehensive understanding of the natural and manufactured world which surrounded him. Taking on the directorship of Sèvres, perhaps paradoxically, allowed him to fulfil his personal expectations throughout natural history. In the following chapters, I argue that the mastery in pottery and porcelain making that Brongniart sought (and to some extent achieved) required input from and command of numerous contributing fields, including geology, mineralogy, chemistry, and crystallography.³⁷

In the eighteenth and nineteenth centuries, natural history could be pursued and understood at some level by a broad, popular audience drawn generally from both the upper and middle classes. As Cuvier wrote in his preface to the first volume of the *Dictionnaire des sciences naturelles* in 1816:

Natural history has reached in our days a degree of glory of which it was difficult to form an idea. It has been the object of the dominant taste. Powerful men have sought to distract themselves, by its study, from the troubles inseparable from greatness; the unfortunate, to forget through it the injustices of fortune; the fair sex itself, and the men happy enough to enjoy an independent fate, wise enough not to sacrifice their liberty to the lures of ambition or vain glory, have made it the charm of their leisure time. Finally, and this is undoubtedly its greatest triumph, these superior geniuses for whom meditation is a need, tired of the uselessness of abstract speculations, have come down from the heights of too general a philosophy, to seek the true laws of nature in the contemplation of its

³⁷ For a general background of global science in the long nineteenth century, see Dominique Pestre, Kapil Raj, and H. Otto Sibum, *Histoire des sciences et des savoirs: Modernité et globalisation* (Paris, 2015). On Parisian science at the *fin-de-siecle*, see Pietro Corsi, *Age of Lamarck* (Berkeley, 1989), particularly 1-39.

works, and preferred the study of the real world to the creation of an imaginary world; it is, in a word, in natural history that they drew the proofs of their doctrine or the subjects of their experiments.³⁸

Throughout the nineteenth century, nature walks in pursuit of unusual formations, exposed rocks, mountains, cliffs, and other sites were a social and aesthetic activity performed widely across Europe.³⁹ Although not every participant met these excursions with the same intellect or background, the practice fostered a public discussion among a rapidly developing group of specialists and societies, as well as casual participants whose venue was the salon, the cabinet, or the popular lycées. In her travelogue of 1835, *Paris and the Parisians*, the popular author Fanny Trollope considered the discussion of natural formations an ordinary part of salon conversation, saying “we might have passed the evening in talking of pictures, or music, or rocks and rivers, as of books.”⁴⁰

Serious naturalists set themselves apart from more casual participants, in part by establishing societies that could regulate the content and flow of information, and which could foster an informed discourse. In London, the Geological Society was founded in 1807, and in France, the Société Géologique was organized in 1830. Many of the societies, such as the Société d’Histoire naturelle, reestablished in 1822, had stringent entrance requirements, including age limits, that encouraged an engaged and well-instructed membership.⁴¹ As with the Société Philomathique, not all societies required professional status, but most expected their members to be capable of original

³⁸ Georges Cuvier, “Prospectus,” *Dictionnaire des sciences naturelles*, eds. Frédéric Cuvier and F. G. Levrault, t. 1 (Strasbourg, 1816), v.

³⁹ Noah Heringman has termed the relationship of poetry to natural history “aesthetic geology,” which he differentiated from the scientific practice of geology that emerged during the same time frame, see *Romantic Rocks, Aesthetic Geology* (Ithaca, NY, 2004). See also John Wyatt, *Wordsworth and the Geologists* (Cambridge, 1995).

⁴⁰ Frances Milton Trollope, *Paris and the Parisians in 1835*, vol. 1 (Paris, 1836), 44.

⁴¹ Société d’histoire naturelle de Paris, *Mémoires* 2, 1 (Paris, 1823), 1-18.

research. In particular, the Société d'histoire naturelle had regulations as to the attendance and participation of its members, which were in place to foster useful exchanges of information.⁴²

Names and Identifications

Eighteenth-century naturalists increasingly focussed on the identification and description of natural objects, and on devising methods of classification. By the nineteenth century, the formulation of robust systems of nomenclature had become a key component of natural history practice. As Cuvier observed in 1816:

Nomenclature is, after the observation of the facts and their methodical distribution, the fundamental part of natural history: it is only by an exact concordance of the names that one can avoid multiplying the beings, or creating monsters, by uniting on one species the properties which belong to several . . . Nomenclature is still the part which requires the most in-depth study, that which distinguishes the true naturalist from the compiler.⁴³

As naturalists had established consistent taxonomies, they also needed a new nomenclature, not just for the objects of study, but for the type of study itself. For example, in 1745, Charles Bonnet, unsure of the reception to the Greek derivation *entomologie* coined a second term, *insectologie*, which he gave as the title to *Traité d'insectologie, ou Observations sur les pucerons*.⁴⁴ Diderot adopted the term *géologie* in the *Encyclopédie* in 1751.⁴⁵ Likewise, Romé de l'Isle first used the term *cristallographie* to describe his 1772 study of crystal formations, *Essai de cristallographie*.⁴⁶ Lamarck was the first to use the term *biologie* in print in French, in

⁴² Société d'histoire naturelle de Paris, *Mémoires* 2, 1, 2-4.

⁴³ Cuvier, "Prospectus," xiv.

⁴⁴ Charles Bonnet, *Contemplation de la Nature* (Amsterdam, 1764), 279.

⁴⁵ Alan Charles Kors, *Encyclopedia of the Enlightenment* (Oxford, 2002); Gabriel Gohau, "Geology," *Encyclopedia of the Enlightenment* (London, 2001), 587, 590.

⁴⁶ Jean Baptiste de Romé de L'Isle, *Essai de cristallographie* (Paris, 1772).

Hydrogéologie, in 1802.⁴⁷ Each of these terms was subsequently applied to the savant specialists in each field; like chemists and mathematicians, entomologists, geologists, and biologists could then refer to themselves by a particular subject. The expansion of disciplines brought about the creation of new societies organized by specialty, such as the Société entomologique de France, founded in 1832.

Mineralogy received a trimmer definition, not a new term, as minerals already held a specific place as one of the three kingdoms of natural history. Until the late eighteenth century, mineralogy had encompassed everything in the non-organic world. With the appearance of geology and other fields, mineralogy lost its dominant meaning concerning the study of all things related to the Earth, including its history and its structures, such as oceans, mountains, and land formations.⁴⁸ Mineralogy became associated with the naturally occurring species that comprise the contents of the Earth's crust, such as chalk, alumina, feldspar, silica (sand), marble, quartz, basalt, and so on. By the 1790s, mineralogical knowledge in France was increasingly important to industry, giving rise to an important new class of *mineralogists* who were trained in chemistry, crystallography, geology, and fieldwork.

Categories of Actors

The terms used to describe experts in their respective fields inevitably changed

⁴⁷ Jean-Baptiste Pierre Antoine de Monet de Lamarck, *Hydrogéologie* (Paris, 1802), 8, 188; Frans A. Stafleu, "Lamarck: The Birth of Biology," *Taxon* 20, 4 (1971): 403.

⁴⁸ Roy Porter, *Making of Geology* (Cambridge, 1980), 53-61; David Oldroyd, *Thinking about the Earth* (Cambridge, MA, 1996), 59-85; M. J. S. Rudwick, "Minerals, strata and fossils," in Nicholas Jardine, *Cultures of Natural History* (Cambridge, 2005), 266-9. Several additional studies examine aspects of the development of geology and its distinction from mineralogy. See particularly, Rachel Laudan, *From Mineralogy to Geology* (Chicago, 1993); John G. Burke, "Mineral Classification in the Early Nineteenth Century," in *Toward a History of Geology*, Cecil J. Schneer, ed. (Cambridge, MA, 1969); Matthew Eddy, *The Language of Mineralogy* (London, 2016): 72-77.

alongside the novel classification of the sciences at the end of the eighteenth century. Earlier, intellectuals with a high level of knowledge of a particular subject were frequently designated as *savants*, while interested members of the gentry and nobility could develop an expertise in natural history or other subjects and become respectfully known as *amateurs* or *antiquaries*. These sweeping categories could overlap, and none yet had the pejorative resonance they would later acquire.⁴⁹ One could, and did, speak of many of these roles or activities as *careers* and *professions*.⁵⁰ Those who interested themselves in any aspect of the natural world were generally described as *natural historians*. At the end of the eighteenth century, Brongniart and other authors such as Cuvier, René Just Haüy, and Lamarck continued to refer to themselves as naturalists or natural historians, even as new, more specialised labels were emerging. Aware of the inadequacies of the old terms, in the *Discours préliminaire* of 1812, Cuvier called himself an “antiquary of a new species.”⁵¹ Brongniart’s lifetime spanned a transition between the generation of savants and artisans of the Enlightenment world and that of what William Whewell called the *scientist* in 1834.⁵²

In the historical literature, Brongniart’s wide interests have further complicated succinct description. He has been variously described as natural historian, geologist, chemist, mineralogist, savant, scientist, or, simply but ambiguously, *polymath*. Unlike other pottery and porcelain makers, Brongniart has not been seen as an *artisan*. As *administrator*, he spent less time working in the studios, kilns, and laboratories than he

⁴⁹ By the mid-nineteenth century, *amateur* and *antiquarian* increasingly drew criticism as terms applied to serious study. See Philippa Levine, *The Amateur and the Professional: Antiquarians, Historians, and Archaeologists in Victorian England, 1838-1886* (Cambridge, 2002).

⁵⁰ Maurice Rat, “Le vrai sens des mots,” *Revue des deux mondes* (1966), 447-9.

⁵¹ Georges Cuvier, “Discours préliminaire,” *Recherches sur les ossements fossiles de Quadrupèdes*, t. 1 (Paris, 1812), 1.

⁵² Sydney Ross, “Scientist: The Story of a Word,” *Annals of Science* 18, 2 (1962): 71.

did in oversight of the production, but he was directly involved with chemical, material, and process research as well as in the creation of new designs.⁵³ Contrastingly, Macquer, Brongniart's predecessor at Sèvres, has been viewed as an "artisanal-scientific expert," a term which recognizes the importance of Macquer's practical knowledge.⁵⁴

Into the nineteenth century, *artisans* occupied a position in a broader hierarchical scheme in which artists were widely considered to be those who worked with their intellect, while artisans worked with their hands. The *Hierarchy of Genres*, introduced by André Félibien in 1669, ranked artists by their subject matter, with history painting at the top, proceeding downward through portraiture, genre, landscape, animal, and still life.⁵⁵ The artistic guilds controlled the artists who were allowed to perform in each category, and, therefore, which were eligible for the most lucrative kinds of paintings. Artisans were members of their own guilds, separate from those of the artists.⁵⁶

There were occasions when individual craft artisans also pursued arts such as sculpture or painting, and vice versa. Many eighteenth- and nineteenth-century artists and artisans understood and contributed to sciences such as mathematics, chemistry, and physics.⁵⁷ Goldsmiths and horologists, few of whom had attended a university, often had interests in pure sciences such as chemistry, physics, or astronomy. For

⁵³ Ursula Klein, "Artisanal-Scientific Experts in Eighteenth-Century France and Germany," *Annals of Science* 69, 3 (2012): 321-3.

⁵⁴ Christine Lehman, "Pierre-Joseph Macquer an eighteenth-century artisanal-scientific expert," *Annals of science* 69, 3 (2012): 307-33.

⁵⁵ Paul Duro, "Giving up on history? Challenges to the hierarchy of the genres in early nineteenth-century France," *Art History*, 28, 5 (2005); On the academies of art and artisanal guilds, see Rafael Cardoso Denis and Colin Trodd, *Art and the Academy in the Nineteenth Century* (Manchester, 2000); Nikolaus Pevsner, *Academies of Art* (Cambridge, 1940).

⁵⁶ Michael P. Fitzsimmons, *From Artisan to Worker* (Cambridge, 2010).

⁵⁷ Peter Jones, *Industrial Enlightenment* (Manchester, 2008), 17.

example, in England, John Harrison occupied himself with the problem of establishing longitude by creating a timepiece that maintained accuracy on long sea voyages.⁵⁸ *Menuisiers*, especially those making load-bearing objects, or furniture with moving parts and concealed compartments, were often highly skilled mathematicians and geometricians.⁵⁹ Brongniart's enamelling and chemistry teacher Peter Hubert Desvignes was recorded as a chemist in France, but known as a goldsmith and silversmith in London, and his son, Peter, was employed likewise as both a goldsmith and horologist.⁶⁰

The highest ranks of eighteenth-century artisans and artists possessed substantial classical education, if for no other reason than the prominence of classical themes in artistic products. However, the position of the artisan in the hierarchy of the arts suggested that the artisan was not only separate from, but lower than, either the artist or the savant, as Diderot elucidated in 1751:

when men examined the products of the arts, they realized that some were primarily created by the mind, others by the hands. This is *part* of the cause for the pre-eminence that some arts have been accorded over others, and of the distinction between liberal and mechanical arts. This distinction, although it is quite justified, has led to bad consequences because it has given a low name to people who are very worthy and useful, and encouraged us in a certain natural laziness. We are all too inclined to believe that it is beneath the dignity of the human spirit to apply oneself diligently and continuously to specific and concrete experiments and objects, and that our mind forfeits its dignity when it descends to the study, let alone the practice, of the mechanical arts; the mind here stoops to questions in which research is laborious, reflection inglorious, and exposition difficult; such questions are dishonourable to deal with,

⁵⁸ Dava Sobel, *Longitude* (London, 1995).

⁵⁹ Leora Auslander, *Taste and Power* (Berkeley, 2006), 78, 111-2, 116-7.

⁶⁰ Haim Burstin, *Une Révolution à l'œuvre: le faubourg Saint-Marcel (1789-1794)* (Paris, 2005), 72, 914; Brian Loomes and G. H. Baillie, *Watchmakers and Clockmakers of the World* (London, 1976), 193; Arthur Grimwade, *London Goldsmiths 1697-1837* (Cambridge, 1935), 141; William Chaffers, *Gilda Aurifabrorum: A History of English Goldsmiths and Plateworkers* (London, 1899), 194. On the later history of the Desvignes family, see Godfrey Smith, *Hither Green: The Forgotten Hamlet* (London, 1997).

countless in number, and of scarcely any value.⁶¹

Academies and guilds promoted the hierarchical structure outlined by Félibien. As Diderot demonstrated, these hierarchies were ingrained by the mid-eighteenth century. As the artists of pre-revolutionary France, in particular Jacques Louis David, understood and vocalised, the sometimes-arbitrary rules that had created these demarcations existed to preserve the status of members with rank and patronage from competition from those outside the academy.⁶² The hierarchy of genres and the structures of the academies and guilds had their roots in a political system that often ignored or devalued the work of non-initiates, regardless of quality or content.

Importantly, the Académie des Sciences was closed in 1793, with the history painter David acting as one the most powerful voices for its dissolution.⁶³ While political motives were a primary factor, in eliminating the academies (as well as the guild system, which was abandoned in 1791), there was a public and systemic acknowledgement that their structure did not reflect either the existing or the desired social, artistic, and intellectual landscape.⁶⁴ While guild memberships could force loyalties or restrict production, in practice there had also been interconnected, interdependent, and reciprocally-supporting artisanal communities, particularly in locations such as the faubourg Saint Antoine, where guilds did not operate. Lines were blurred between categories, and there were hybrid identities and professions such as the

⁶¹ Denis Diderot, “Art,” *The Encyclopedia of Diderot & d’Alembert Collaborative Translation Project*, Translated by Nelly S. Hoyt and Thomas Cassirer (Ann Arbor, 2003); Originally published as “Art,” *Encyclopédie ou Dictionnaire raisonné des sciences, des arts et des métiers*, 1 (Paris, 1751): 713–717.

⁶² Edouard Pommier, *L’art de la liberté* (Paris, 1991), 34-7; Hahn, *Anatomy of a Scientific Institution*, 201, 239.

⁶³ Pommier, *L’art de la liberté*, 34-7; Hahn, *Anatomy of a Scientific Institution*, 201, 239.

⁶⁴ Liana Vardi, “The Abolition of the Guilds during the French Revolution,” *French Historical Studies*, 15 (1989).

marchand merciers, who not only sold artworks and artisanal objects, but also created their own wares.⁶⁵

Artisan and *artist* maintain utility as separate, if loose, categories, as they both call to mind certain ways of working, but neither can or should imply a particular way of thinking. The networks Brongniart maintained and took part in were continuously engaged in exchanges between disciplines. Natural historians and savants worked with an awareness of, but without strict obedience to, boundaries drawn by the academies. Common understanding and shared practise between disciplines was a factor, for example, in enabling the artisan and engraver Vivant Denon to achieve the political and administrative prominence that saw him develop the art collections of the Louvre or to consult on the porcelain production at Sèvres.⁶⁶ David, during the Revolution, maintained his status as a history painter of the highest rank, while also acting as a politician. Likewise, Berthollet, despite his position overseeing the dye processes at Les Gobelins and his professional similarity to Macquer, has often been viewed by historians as a savant and chemist, rather than an artisan or a textile dyer, but he acted as all these things.⁶⁷

A similar situation existed in England, where the entrepreneur, natural philosopher and industrial innovator Josiah Wedgwood (1730-1795) was commonly referred to as a *potter*. As he was trained in the craft by his father and brother, and began his career in a cottage industry, the term *potter* has fundamental accuracy regarding Wedgwood, but his transformation of a handcraft into an industry in England also rendered the description inadequate. Elsewhere, more specific references such as

⁶⁵ I have discussed this in detail in Chapter One.

⁶⁶ Andrew McClellan, *Inventing the Louvre* (Berkeley, 1999).

⁶⁷ See Michelle Sadoun-Goupil, *Le chimiste Claude-Louis Berthollet, 1748-1822* (Paris, 1977).

faïencier and *porcelainier* were in use, the latter of which applied directly to the work of Brongniart at Sèvres. Although he paralleled Wedgwood as an industry leader and could be seen to fit within the broadest definition of the term *potter*, Brongniart was not referred to as such.⁶⁸ In Louis Marc Solon's 1910 bibliography *Ceramic Literature*, for example, Solon described Wedgwood as "the greatest English potter" while he considered Brongniart "a consummate scientist" who was "the greatest ceramist of his day."⁶⁹

Between Comparative Anatomy and the Study of the Earth

As we have seen in Chapters Three and Four, although Brongniart had, from the earliest years of his education, desired a place at the Muséum, and demonstrated strong interest in the study of biology, including entomology and anatomy, he was also interested in the features of the Earth and practical applications of earthen materials. In his youth and early career, his choices were flexible, and he sought education across various subjects. His 1790s journals show that he was an avid collector and preparator of fish, bird, and insect specimens and was also occupied with the study of the complex behaviours of materials and the history and processes of the natural landscape.⁷⁰ Beginning with the first days of his acquaintance with Cuvier, the two had often performed anatomical studies together. They shared the dissections of various small animals, each comparing their respective observations.⁷¹

⁶⁸ Eliza Meteyard, *The Life of Josiah Wedgwood* (London, 1865), XIII.

⁶⁹ Solon, *Ceramic Literature*, 56, 228. I discuss the late nineteenth-century origins of the term "ceramist" in Chapter Seven.

⁷⁰ Alexandre Brongniart, 'Journaux de voyage et journaux intimes, Journal 1790-1802', BMHN MS3357-8. Luc Delambre and Edmée Delambre, *Servir la France Napoléonienne à Washington* (Paris, 2020), 55-6 and J. Delbourgo and N. Dew, *Science and Empire in the Atlantic World* (New York, 2008).

⁷¹ For example, see Alexandre Brongniart, "Observations pour servir à la myologie des

Since the 1940 biographical sketch of Louis de Launay, their similarities have been much discussed as a turning point for Brongniart in seeing the strong competition presented by Cuvier in the study of anatomy. This view was supported by a loose remark on a journal page where Brongniart concluded, after a day of work alongside Cuvier, that Cuvier had matched him equally in the work at hand. Brongniart, perhaps exasperated at the challenge, completed his day's entry with "j'abandonne ce travail." Realistically, although their skills in this area were similar, each had strengths that set them apart from one another. Brongniart had sufficient biological expertise to have become a prominent cabinet naturalist, had his interests not been varied and adaptable, including travel, fieldwork, architecture and drawing, chemistry, and mineralogy. This is shown by the small but influential article *Essai d'une classification naturelle des Reptiles*, which he published in 1800 as a report to the Société Philomathique.⁷² The text appeared just as Brongniart began his directorship at Sèvres, and it had a lasting effect in the biological sciences, proposing four orders of reptiles with entirely new names: Chelonia, Sauria, Ophidia, and Batrachia.⁷³ Brongniart noted that the last category, Batrachia, including frogs and salamanders, was distinctly different from other reptiles. The category was later separated out of Reptilia by Latreille, who established the category of Amphibia for the first time.⁷⁴ This essay, as well as a second

singes, par Alexandre Brongniart. Paris, 15 germinal an IV," in *Papiers de Georges Cuvier. Travaux d'anatomie comparé*, BMHN MS 607.

⁷² "Essai d'une classification naturelle des Reptiles," *Bulletin II* (Paris, 1800): 81-82, 89-91.

⁷³ Benjamin Silliman, "Obituary of Alexandre Brongniart, extract from a Discours pronounced by M. Elie de Beaumont at the funeral of Alexandre Brongniart, October 9, 1847," in Benjamin Silliman, *The American Journal of Science and Arts* 2, 5 (New York, 1848), 155-59.

⁷⁴ Edward Drinker Cope, *Batrachia of North America* (Washington DC, 1889): 16-7; M. J. S. Rudwick, "Brongniart, Alexandre," in *Complete Dictionary of Scientific Biography*, vol. 2 (Detroit, MI, 2008): 493-497; Anne Lajoix, "Alexandre Brongniart: Scholar and Member of the Institut de France," in *Sèvres Porcelain Manufactory*, Derek E. Ostergard and Tamara Préaud, eds., (New Haven, 1997), 29.

on a new species of insect, which appeared in the same *Bulletin*, were counterpoints to Brongniart's increasing expertise in the natural history of the inorganic world. Nevertheless, the two essays were his final publications on biology and marked a major change of focus in his work.⁷⁵

While Brongniart's article on reptiles was influential, he soon transferred his skills to the examination of fossil specimens found in the strata of the geological sites he studied. Brongniart relied on this knowledge, alongside the expansive collections at the Muséum, many of which had been catalogued and named by Lamarck, to aid in differentiating the distinct layers of the Earth.⁷⁶ His geological understanding increased his ability to determine the basic characteristics of the materials, as well as their probable locations and utility as industrial resources. This transition away from concentrated biological study was, of course, partially driven by his acceptance of the directorship at Sèvres, and by his continued work as a mining engineer and professor of natural history at the École des Mines, the Lycée Républicain (later, the Athénée de Paris), and the École Centrale des Quatres-Nations. Despite this move away from specialist research in the life sciences, biological knowledge informed his mineralogical and geological work and led to his participation in the development of palaeontology. Much of Brongniart's travel during the Napoleonic era was contained within the borders of France, perhaps as a reflection of the ongoing conflicts created by the Napoleonic wars, but particularly by his concentration on the geology of the Paris Basin and nearby regions, as I discuss below.⁷⁷

⁷⁵ Alexandre Brongniart, "Essai d'une classification naturelle des Reptiles," *Bulletin II* (Paris, 1800): 81-82, 89-91; "Sur un nouveau genre d'Insecte des environs de Paris (*Dasycerus sulcatus*)," *Bulletin II* (Paris, 1800), 115-116.

⁷⁶ Georges Cuvier and Alexandre Brongniart, *Essai sur la géographie minéralogique des environs de Paris* (Paris, 1811), ii-iii, 3, 11.

⁷⁷ A trip to England in 1802 and one to Germany in 1812 were exceptions to Brongniart's focus on domestic travel and research after during the Napoleonic era.

Brongniart's career was inevitably influenced by shifts within the practice of natural history. Vast resources, such as the expansive collections at the Muséum, were continually being developed, clarified, and enlarged, reshaping the scale of natural history. The number of new discoveries that were now being made on a regular basis meant that individuals needed to focus on narrower categories.⁷⁸ As Haüy observed in the introduction to *Traité de Mineralogie* of 1801, the Animal and Vegetable Kingdoms had drawn most of the attention of natural historians, making biology a highly competitive field among them.⁷⁹ In contrast, mineralogy required a particular kind of thinking that incorporated mathematics, spatial reasoning, applied chemistry, and fieldwork. The transformation of mineralogical understanding had only begun in the latter half of the eighteenth century, with the crystallographic work of Jean-Baptiste Romé de l'Isle and René Just Haüy in France, as well as the introduction of a clear system of mineralogical identification created by Abraham Gottlob Werner (1750-1817) in Germany.

Late eighteenth-century political developments slowed the development of mineralogical study in Paris. Although the École des Mines had been projected from the late 1760s, it did not open until 1783. Shortly thereafter, the Revolution disrupted the courses and, in 1791, the school was shuttered. It was reorganized in 1794 by the revolutionary government, alongside the establishment of the Corps des Mines.⁸⁰ The disruptions limited the number of qualified mineralogists just when France was eagerly

⁷⁸ Jardine, *Cultures of Natural History*, 266-76, 249-52; Paul L. Farber, "The Transformation of Natural History in the Nineteenth Century," *Journal of the History of Biology* 15, 1 (1982).

⁷⁹ René-Just Haüy, *Traité De Mineralogie*, (Paris, 1801).

⁸⁰ Isabelle Laboulais and Jakob Vogel, "La construction du métier d'ingénieur des Mines à l'épreuve du terrain pendant la Révolution et l'Empire," *Annales historiques de la Révolution française*, 3, 385 (2016): 47-66. URL: <https://www.cairn.info/revue-annales-historiques-de-la-revolution-francaise-2016-3-page-47.htm>

seeking mineral resources and understanding. In post-Revolutionary France, mineralogy offered diverse opportunities, particularly for those who sought travel and field experience as well as chemical knowledge. As I discussed in Chapter Four, Brongniart travelled with the Agence des Mines on lengthy expeditions during 1794-5. He remained active at the École des Mines as a professor and continued to work as an inspector thereafter. He resumed independent fieldwork in the early nineteenth century, beginning with the Paris Basin survey alongside Cuvier.⁸¹ Mineralogical analysis and identification skills informed his study of geology and underpinned his knowledge of palaeontology and stratigraphy. For Brongniart, the analysis of fossils as elements of a traceable record was a natural complement to his research as a mineralogist.

During the Revolution, there were few opportunities to study mineralogy, and indeed, great dangers for those students who remained in Paris. Brongniart's distant cousin André Jean Marie Brochant de Villiers studied in Freiburg under Werner from 1791-93. This move prevented his education from being disrupted and gave him an advantage over other students who could not find such an opportunity. As tensions eased, in 1794, Brochant returned to Paris to enrol in the newly reopened École des Mines as one of its first two inductees. Brongniart, having completed his study there prior to the Revolution, had just begun to teach mineralogy as a *suppléant* to Haüy.⁸² Brochant's three years in Germany immediately benefitted French mineralogy – he openly shared his notes, disseminating Werner's ideas among the close-knit group of Parisian mineralogists surrounding Haüy and, by 1797, had published a draft translation

⁸¹ In 1801, Brongniart and his wife Cécile welcomed their son Adolphe, and other major family changes took place, which may have slowed Brongniart's return to fieldwork outside the Paris region.

⁸² Philippe Grandchamp, "Brochant de Villiers et les Alpes," *Les scientifiques et la montagne, Actes du 116e congrès national des sociétés savants* (Paris: CTHS, 1993): 39-61.

of them.⁸³ In 1801 and 1808, respectively, Brochant's editions of *Traité élémentaire de minéralogie, suivant les principes du Professeur Werner* distributed Werner's ideas more widely.⁸⁴

Brongniart had the benefit of close association with Haüy alongside a careful understanding of the practices of Werner, perhaps developing as early as his trip to Dijon in 1791, where he met Claudine Picardet (née Poulllet).⁸⁵ The year before Brongniart's visit, Mme Picardet had completed the first French translation of Werner's publication, *Von den Äusserlichen Kennzeichen der Fossilien*, as *Traité des caractères extérieurs des fossils*, which included several updates that Mme Picardet had received in correspondence with Werner.⁸⁶ In Dijon, Brongniart would have had an early and uncommon opportunity to pair discussion of Wernerian mineralogy with Lavoisierian chemistry, which had yet to be adopted widely. Mme Picardet was a close associate (and later, the wife) of Louis Bernard Guyton de Morveau,⁸⁷ an important contributor to the *Nomenclature chimique* in 1787, the first publication to rely upon and to promote Lavoisier's restructured approach to chemistry.⁸⁸

Written in 1773, when Werner was twenty-five, *Von den Äusserlichen Kennzeichen der Fossilien* remained his most thorough and well-known publication.

⁸³ Haüy, *Traité de Mineralogie*, lv.

⁸⁴ André Jean-Marie Brochant de Villiers, *Traité élémentaire de minéralogie, suivant les principes de professeur Werner* (Paris, 1801); *Traité élémentaire de minéralogie*, 2nd ed. (Paris, 1808).

⁸⁵ I discuss Brongniart's visit to Dijon in detail in Chapter Two.

⁸⁶ Abraham Gottlob Werner and Claudine Picardet (née Poulllet) Guyton de Morveau, *Traité des caractères extérieurs des fossiles* (Dijon, 1790).

⁸⁷ Picardet married Louis Bernard Guyton de Morveau in 1798, following the 1796 death of her husband, Claude Picardet. "Picardet, Claudine," *Complete Dictionary of Scientific Biography* (20 December 2022).

<https://www.encyclopedia.com/science/dictionaries-thesauruses-pictures-and-press-releases/picardet-claudine>

⁸⁸ Louis-Bernard Guyton de Morveau, Antoine Laurent Lavoisier, Claude Louis Berthollet, Antoine François de Fourcroy, and Bernadette Bensaude-Vincent, *Méthode de nomenclature chimique* (Paris, 1994).

Werner was a member of a multi-generational mining family and took a practical approach to mineralogy. He studied mineralogy at the Bergakademie Freiberg and then followed up with legal studies at the University of Leipzig. In 1773, while at Leipzig, he wrote the manuscript, more in the manner of a field manual than as a theoretical discussion.⁸⁹ Rooted in longstanding practices of natural history and mineralogy, Werner used the word *fossil*, in the sense of “things dug from the ground,” to refer to inorganic mineral specimens, rather than in its later more-restricted usage referring to the preserved remains of organic beings.⁹⁰ He limited his discussion to mineral classification and description, which he called *oryctognosy*, one of five sections of mineralogy that he defined. The other branches of Werner’s mineralogy included *chemical mineralogy* (related solely to the chemical properties of minerals), *geognosy* (study of the mineral deposits and their relationship to one another in the Earth’s crust), *geographic mineralogy* (concerned with the mineral distributions of each country, as well as the physical features of a country), and *economic mineralogy* (concerned with the uses and applications of minerals).⁹¹ As I discuss below, Werner considered the field of *geognosy* as distinct from that of *geology* (which held discussion related to theories about the Earth), but the two categories were, in practice, poorly differentiated and vaguely understood.⁹²

⁸⁹ “Werner, Abraham Gottlob,” Complete Dictionary of Scientific Biography, *Encyclopedia.com*. (28 October 2022). <https://www.encyclopedia.com/science/dictionaries-thesauruses-pictures-and-press-releases/werner-abraham-gottlob-0>

⁹⁰ For a discussion of Werner’s mineralogical ideas, see Mott T. Greene, *Geology in the Nineteenth Century* (Ithaca, 1982): 19-45. Brochant de Villiers acknowledged Werner’s definition for “fossil,” but indicated a preference for the terms “minerals” and “mineral substances,” which better reflected the usage of the early-nineteenth century, *Traité élémentaire de minéralogie, suivant les principes de professeur Werner*, 25.

⁹¹ Brochant de Villiers, *Traité élémentaire de minéralogie*, 26.

⁹² For a discussion of Werner’s definitions of geognosy and geology, see Greene, *Geology in the Nineteenth Century*, 38-9.

By 1775, Werner had secured a teaching post at the Bergakademie, leaving the study of law behind. Although he was well-regarded for his teaching and for his masterful understanding of mineralogical materials, he did not publish prolifically.⁹³ While Werner knew that chemistry was a useful tool for describing and evaluating minerals, he believed that chemistry was generally too difficult for mineralogists in the field to apply and did not include its study within his work. Importantly, at the time of Werner's early publications, chemistry lacked the clarity that it would gain from the introduction of Lavoisierian chemistry and a revised nomenclature in the 1780s. By his late career, Werner recognized that the chemical and analytical methods of Swedish chemist Jöns Jacob Berzelius (1779-1848) were valuable tools.⁹⁴ Likewise, although Romé de l'Isle and Haüy made extensive use of crystalline structure in the identification of minerals, Werner never incorporated their developments into his actual practice. Despite his limited number of publications, Werner's expertise and his system for differentiating and identifying minerals became widely known and highly influential as his students, such as Brochant de Villiers, Alexandre von Humboldt, Benjamin Silliman, Robert Jameson, and others, popularized Werner's ideas and practical methods.⁹⁵

Werner's conception of the origin of the Earth was based on the sedimentation and crystallisation of solids from an aqueous solution. As such, Werner has often been associated with the separate, but overlapping, schools of neptunists (adherents to

⁹³ Henry Faul and Carol Faul, *It Began with a Stone* (New York, 1983), 95-8.

⁹⁴ Greene, *Geology in the Nineteenth Century*, 34. On Swedish mineralogy, see Brian Dolan, "Embodied Skills and Travelling Savants" in *Travels of Learning, Boston Studies in the Philosophy of Science* 233, A Simões, A. Carneiro, and M.P. Diogo, eds., (2003): 115-41; and "Governing Matters: The Values of English Education in the Earth Sciences 1790-1830," DPhil diss., (Cambridge, 1995).

⁹⁵ For example, see Brochant de Villiers, *Traité élémentaire de minéralogie*; Greene, *Geology in the Nineteenth Century*, 26-7, 34-5.

theories of the aquatic formation of the Earth) and catastrophists (who argued that the periodic occurrence of unknown but powerful catastrophic events could rapidly change the environment and living conditions on the surface of the Earth, as well as its structure). While his ideas were independent of the religious overtones frequently implied by those terms,⁹⁶ Werner's theories were useful to geologists for whom upholding biblical chronology was desirable, including the Irish geologist Richard Kirwan (1733-1812) and Swiss geologist Jean-André Deluc (1727-1817).⁹⁷

Although the debates between Neptunism and Plutonism (whose adherents argued for the role of volcanoes in the development of the Earth) were controversial in British and American geology, where neptunist ideas could be used to reinforce biblical narratives, the need to refer to Scriptural events did not have a similarly powerful place in French or German geology.⁹⁸ Werner (and continental Wernerians such as Brongniart and Brochant de Villiers) did not tie any events to the Noachian flood or consider biblical texts to be accurate geological evidence.⁹⁹ Werner's lifelong weak health prohibited prolonged expeditions, forcing him to rely upon the nearby Saxon landscape for information.¹⁰⁰ Thus, his primary fieldwork was related to sedimentary depositions, and he had little experience with volcanic terrains. These limitations, and not a strict adherence to biblical texts, were predominant factors in the development of Werner's ideas.¹⁰¹ Many of his students, including Humboldt and Jean-François

⁹⁶ Faul, *It Began with a Stone*, 97.

⁹⁷ Faul, *It Began with a Stone*, 111-12; Gillispie, *Genesis and Geology*, 49-61.

⁹⁸ For a brief survey of French geology in the eighteenth century, including the general outlook in France on religious questions in connection with natural history, see Faul, *It Began with a Stone*, 65-92.

⁹⁹ Greene, *Geology in the Nineteenth Century*, 38-9.

¹⁰⁰ On misconceptions regarding Werner's career, see Alexander M. Ospovat, "The Distortion of Werner in Lyell's *Principles of Geology*," *The British Journal for the History of Science* (1976): 191-3.

¹⁰¹ Faul, *It Began with a Stone*, 111-12.

d'Aubuisson de Voisins, sought broader evidence to show that Werner's suppositions were correct, but were forced to revise their beliefs in accordance with their travels and field observations of volcanic rock and activity.¹⁰²

A Synthesis of Continental Mineralogy

Like Brochant de Villiers, Brongniart had an early advantage in terms of access to the mineralogical ideas of both Haüy and Werner, and he quickly became one of France's top young mining engineers. Brongniart recognised early in his career that there were benefits to the differing approaches of both mineralogists. In 1807, he published his first major text, *Traité élémentaire de minéralogie avec des applications aux arts*. Although intended for use in the French national *lycées*, it became a useful resource for numerous French and foreign mineralogists and scientists.¹⁰³ For the development of an instructional text, Brongniart was in an ideal position as a Parisian professor working at the intersection of French, British, and German mineralogy. Critically, he was able to draw upon the input and ideas of both Werner and Haüy, alongside several other important naturalists, as well as his own laboratory research and field understanding. Like many teaching texts, Brongniart's *Minéralogie* demonstrated a synthesis of ideas, while informing his readers – both students and active professionals – how to determine the identity and value of mineralogical specimen, and how to apply numerous, often complex, approaches to mineralogical analysis. American mineralogists, such as Silliman and Parker Cleaveland (1780-1858), relied

¹⁰² Greene, *Geology in the Nineteenth Century*, 62-3.

¹⁰³ Benjamin Silliman, "Obituary: Death of Alexandre Brongniart," in Benjamin Silliman, *American Journal of Science and Arts* 2, 5 (New York, 1848), 141-3; "Obituary of Alexandre Brongniart, extract from a Discours pronounced by M. Elie de Beaumont at the funeral of Alexandre Brongniart, October 9, 1847," in Benjamin Silliman, *American Journal of Science and Arts*, 2, 5 (New York, 1848), 155-59.

upon the text as a resource and field guide. When Cleaveland sought to develop American mineralogy with the publication of *An Elementary Treatise on Mineralogy* in 1816,¹⁰⁴ he relied upon Brongniart's work as a foundation.¹⁰⁵

Although Werner acknowledged the value of chemical composition and crystalline structure, he created a methodology for field mineralogists and mining engineers that could be quickly applied without the application of chemical testing or mathematical analysis, concentrating on systematised descriptions of external characteristics such as colour, relative hardness, and texture. Conversely, Haüy's mineral characterisation was based on the integral molecule, as demonstrated by a system of measured angles and observed crystalline structure, coupled with chemical analysis. Haüy's work brought a mathematical basis to Romé de l'Isle's basic ideas of crystallography, and introduced recognisable mathematical relationships, including the *law of rational indices* of 1784.¹⁰⁶ Pulling from both French and German methods, Brongniart targeted crystal structure and chemical composition as the most important identification factors, along with observations on external characteristics such as density, colour, hardness (including notes on a material's ability to be polished), taste, and odour. Like Werner, Brongniart also considered the physical position of the mineral

¹⁰⁴ Parker Cleaveland, *An Elementary Treatise on Mineralogy* (Boston, 1816); "Cleveland, Parker," *Complete Dictionary of Scientific Biography*. *Encyclopedia.com*. (28 October 2022).

<https://www.encyclopedia.com/science/dictionaries-thesauruses-pictures-and-press-releases/cleveland-parker>

¹⁰⁵ Kennard B. Bork, "Correspondence as a Window on the Development of a Discipline: Brongniart, Cleaveland, Silliman, and the Maturation of Mineralogy in the First Decades of the Nineteenth Century," *Earth Sciences History* 18, 2 (1999): 198–245.

¹⁰⁶ The *law of rational indices* indicates that "crystal faces cut the crystallographic axes in simple, whole-number ratios. These ratios may be measured with reference to a unit plane having a ratio of 1:1:1 for three crystallographic axes and 1:1:1:1 for four crystallographic axes." See M. Allaby, "Law of rational ratios of intercepts," in *A Dictionary of Geology and Earth Sciences* (Oxford, 2013).

deposits (*geognosy*) as a factor in mineral identification.¹⁰⁷

Brongniart attempted to clarify Werner's term *geognosy* and to solidify its use in France. In his usage, as with that of Werner, *geognosy* consisted of factual information about the surface of the Earth, and its physical arrangement. It referred specifically to the study of the contents and layers of the Earth but did not include theorization on the origins of features or natural phenomena. By contrast, Brongniart defined *geology* as a forum for drawing theoretical insights together from broader kinds of observations, which he considered the overarching "system."¹⁰⁸ Similarly, British Wernerian geologists defined *geognosy* as "positive geology," and added the term *geogony*, or "speculative geology."¹⁰⁹ This separation of fields was intended to establish distance between the research-dominant geognostic work and the more speculative cosmologies and systems that were frequently associated with geology, but the distinction was cumbersome and vague. In practice, the Wernerian argument for the separation of the two terms was awkward, since the word *geology* was already widely used by natural historians, many of whom did not adopt Werner's restricted definition. With the introduction of the more literal term *stratigraphy* in the mid-nineteenth century, the word *geognosy* ceased to appear in regular use.¹¹⁰

While some of Brongniart's mineral descriptions included notes on the specific geological and geographic features of mineral deposits, *Minéralogie* did not include an

¹⁰⁷ Brongniart, *Traité de Mineralogie*, 1, 3, 24-7.

¹⁰⁸ I discuss this terminology further in Chapter Seven. Alexandre Brongniart, *Tableau des terrains qui composent l'écorce du globe, ou essai sur la structure de la partie connue de la terre* (Paris, 1829), 2.

¹⁰⁹ Edward Hitchcock, *Elementary Geology* (Amherst, 1840): 9.

¹¹⁰ See "Stratigraphie, Geognosie, 1800-1900," Books.google.com, *Google Ngram Viewer*, (2022). [online].

Available at: [https:// books.google.com /ngrams/graph?content= stratigraphie%2C +geognosie&year_start=1800&year_end=1900&corpus=30&smoothing=3&direct_ ur l=t1%3B%2CstratiCstrati%3B%2Cc0%3B.t1%3B%2Cgeognosie%3B%2Cc0](https://books.google.com/ngrams/graph?content=stratigraphie%2C+geognosie&year_start=1800&year_end=1900&corpus=30&smoothing=3&direct_url=t1%3B%2CstratiCstrati%3B%2Cc0%3B.t1%3B%2Cgeognosie%3B%2Cc0).

organized discussion of the Earth's structure. Rather, *Minéralogie* was planned as a work of *minéralogie oryctognostique*, in which simple minerals – those usually found in a homogenous mixture (*pâte*) – were ordered by character and composition. Brongniart found the individual branches of mineralogy established by Werner to be useful as separate areas of study. Thus, he explored the ideas of the structure of the Earth's surface in separate, *mineral geography* and *geognostic* studies, including the Paris Basin study he co-authored with Cuvier in 1811, *Essai sur la géographie minéralogique des environs de Paris: avec une carte géognostique, et des coupes de terrain*, which I discuss in Chapter Seven. Brongniart was not a strict Wernerian but considered his work alongside the research of French, British, and American scientists, while adding his own observations. He reacted authoritatively on issues where he found Werner in error, such as the gypsum of the Paris Basin, where he recognized that the evidence differed substantially from Werner's descriptions.¹¹¹ Throughout his lifetime, Werner held onto the belief that the Earth's crust was entirely formed in aqueous solution. He argued – erroneously – that basalt was not igneous but was also formed by the action of water. By contrast, Brongniart saw volcanic actions as a major factor in the development of the Earth.¹¹²

Brongniart had accepted the predominant influence on the history of the Earth of igneous materials and heat well before he began serious study of Werner's methodology. In his youth, he had studied the texts of Buffon, for whom volcanic activity and a fiery Earth were critical to the formation of land.¹¹³ Brongniart had also performed fieldwork and discussed geological issues with several French naturalists during the 1780s-90s, including Guettard, Dolomieu, Nicolas Desmarets (Desmarest)

¹¹¹ Brongniart, *Traité de Mineralogie*, 177.

¹¹² Faul, *It Began with a Stone*, 95-7.

¹¹³ Oldroyd, *Thinking About the Earth*, 89-92.

(1725-1815), and Barthélemy Faujas de Saint Fond (1741-1819), all of whom saw volcanic activity as an important geological force.¹¹⁴ While volcanic theory was viewed as controversial by some geologists well into the nineteenth century, by the time of James Hutton's publication of *Theory of the Earth* in 1795, Brongniart was already aware of the important geological evidence presented by volcanoes and igneous materials.¹¹⁵

Werner's insistence that basalt was sedimentary material was widely controversial, but persistent, as it had the potential of benefitting the arguments of both neptunists and scriptural geologists, while denying the role of volcanic heat promoted by French geologists such as Guettard and Desmarests, as well as the Scottish geologist Hutton, and other plutonists.¹¹⁶ In general, Brongniart omitted major theoretical discussion in *Minéralogie*, but he made an exception in asserting that basalt was undeniably igneous in nature.¹¹⁷ This was one area where his observations of the fusion of glass and porcelain materials at Sèvres particularly informed his insights. As he put it:

the lamellar structure of the basalts cannot be a proof of their aqueous origin, as was at first advanced. Several lavas of a known origin present this structure, and moreover the numerous observations of M. Fleuriau-de-Bellevue on the stony-looking products of the glassworks, the recent experiments of Hutton, and those of MM. Halles and Walt, prove that by melting basalts and other stones, and leaving them to cool very slowly, they lose the vitreous appearance which fusion gives them, to take on a lamellar or radiant texture and the appearance of a stone.¹¹⁸

¹¹⁴ Greene, *Geology in the Nineteenth Century*, 64-5.

¹¹⁵ James Hutton, *Theory of the Earth* (Edinburgh, 1795).

¹¹⁶ Greene, *Geology in the Nineteenth Century*, 27-31.

¹¹⁷ Brongniart, *Traité de Minéralogie*, 462-3, 469,

¹¹⁸ Brongniart, *Traité de Minéralogie*, 470; See also: Louis Benjamin Fleuriau de Bellevue, *Mémoire sur l'action du feu dans les volcans* (Paris, 1805); Hugh S. Torrens, "The geological work of Gregory Watt, his travels with William Maclure in Italy (1801-1802), and Watt's 'proto-geological' map of Italy (1804)," in Gian Battista Vai, W. Glen, and E. Caldwell, eds., *Origins of Geology in Italy* (Boulder, 2006).

Although Brongniart did not allude to his personal status or to personal observations at Sèvres, his understanding of the subject of vitrification and crystallisation was clear, and he was able to support the experimental evidence provided by a wide group of geologists without hesitation.

Minéralogie provided a foundation for the other texts Brongniart undertook to write, including the *Traité des arts céramiques*.¹¹⁹ He used chemical composition and crystal structure to help establish the mineral classifications, enabling comparisons globally, while seeking to clarify nomenclature.¹²⁰ He arranged his own collections, as well as those at the Bureau des Mines and at the Muséum according to the principles developed in the text. Brongniart could refer to some of the richest collections of mineral specimens available, linking and differentiating items from not only Europe, but from distant continents, such as jade from China, India, and the Americas. In addition, Brongniart accompanied his text with a collection of images designed to clarify concepts and technologies (see Figures 6.2-6.5).

While there were some hints of Brongniart's underlying theoretical ideas throughout *Minéralogie*, such as his stance on the role of volcanoes, he did not draw conclusions or describe a general conception of the Earth's history. Nor did he outline his views on the role that the timescale played in geological and mineralogical developments. However, several of his earliest sources, such as Buffon,¹²¹ Lavoisier,¹²² and Werner,¹²³ already had substantially long or unimaginable periods of time in mind,

¹¹⁹ Silliman, "Obituary of Alexandre Brongniart," 142-3.

¹²⁰ See Brongniart, *Traité élémentaire de minéralogie*, vi-xii, 1-2.

¹²¹ Oldroyd, *Thinking About the Earth*, 89-92; Jean-Paul Poirier, "About the Age of the Earth," *Comptes Rendus Geoscience* 349, 5 (2017): 223-5; Sally Newcomb, *World in a Crucible* (Charlottesville, VA, 2009), 139.

¹²² Desmarests, *Encyclopédie méthodique: Géographie-physique* (Paris, 1795), 783-91.

¹²³ "Abraham Gottlob Werner's Neptunist Stratigraphy," *Encyclopedia.com* (9 November 2022). <https://www.encyclopedia.com/science/encyclopedias-almanacs->

which Brongniart adopted.

Connections and Synthesis

In his first decade at Sevres, Brongniart made strenuous efforts to create and maintain social and scientific networks for information exchange, shared research, and pedagogic resources. In addition, he invested in shaping the practices of mineralogy, geology, and geognosy with an emphasis on classification. Brongniart's first full-length publication was a textbook in mineralogy, which provided a practical introduction to the science and offered a key to mineral identification. He carefully used the latest terms to separate categories and practices, making efforts to create distinctions between the theoretical (as in geological discussions) and the practical (as in geognostic studies). I examine Brongniart's efforts to shape fields within natural history in the following chapter, as well as his views on specific topics such as the timescale necessary for evident geological actions to have taken place. I also discuss his relationship with other naturalists, including Cuvier and Geoffroy, and show how Cuvier and Brongniart created the first comprehensive stratigraphical study of a region, based on the geology of the Paris Basin, which began in 1804 and ran through 1835.

In the introduction to *Minéralogie*, Brongniart announced his intention to create a separate publication for a broad approach to geognosy in the future.¹²⁴ As I discuss in Chapter Seven, by the time of Brongniart's mature career, the meaning of the word *geognosy* had blurred entirely. The word *geology* was widely used to describe both practical and theoretical ideas regarding the Earth's surface. Numerous articles and memoirs led to Brongniart's most complete work on the Earth, the 1829 study *Tableau*

transcripts-and-maps/abraham-gottlob-werners-neptunist-stratigraphy-incorrect-theory-advances-geological-sciences;

¹²⁴ Brongniart, *Traité élémentaire de minéralogie*, xi.

*des terrains qui compose l'écorce du globe.*¹²⁵ *Tableau des terrains* was a schematic illustration accompanied by a written description that was based on ascertainable facts, but it also served as insight into the ideas Brongniart accepted regarding the formation of the Earth and the nature of geological time, many of which were still controversial.

¹²⁵ Brongniart, *Tableau des terrains qui compose l'écorce du globe*, 1829.

CHAPTER SEVEN: Time and Place – Maps, Illustrations, and Schematics

While Brongniart was building a career through important teaching posts in mineralogy at the École des Mines and at the Muséum, as a mining engineer at the Agence des Mines, and as the director at Sèvres, he continued to carry out independent research elsewhere, correlating information across numerous subjects in natural history. In this chapter, I discuss Brongniart's publications in geognosy and geology, as well as his efforts in the developing field of palaeontology. This chapter provides a deeper look at Brongniart's personality and character, especially as witnessed through his interactions with Cuvier and other close associates. Additionally, it shows that Brongniart's active movement between locations in the Paris region and throughout Europe – whether on weekly trips between Sèvres, the family residence in St. Germaine, and the Muséum, or to further sites – formed a necessary basis for the fieldwork upon which his ideas in geology were founded. A key study with Cuvier, begun by 1804, utilized the fossil collections of the Muséum in combination with geognostic information collected throughout the Paris region. After preliminary presentations at the Academy in 1807-8, *Essai sur la géographie minéralogique des environs de Paris*, appeared in 1811, and was updated in 1822 under the title *Description géologique des environs de Paris*.¹ This study quickly became a benchmark for stratigraphical analysis. By combining comparative anatomical studies of fossil evidence with geognostic evidence gathered in the field, and by further taking into account the position and chemical environment of the depositions, Brongniart developed a more coherent and immensely sophisticated picture of the structure of

¹ Georges Cuvier and Alexandre Brongniart, *Essai sur la géographie minéralogique des environs de Paris* (Paris, 1811); *Description géologique des environs de Paris* (Paris, 1822, 1835).

Earth's surface. The approach enabled a three-dimensional view that could also illustrate chronological sequences. As I show, Brongniart indicated a flexible but expansive view of geological time in his research, which he hoped could eventually be correlated to verifiable evidence, such as fossil deposits, knowledge related to past species and their environments, as well as evidence on lifespans and extinction.

Several of Brongniart's publications were written for popular forums, such as encyclopaedia entries, which were informational texts rather than theoretical ones. In addition, he published short memoirs on specific topics in natural history. Although Brongniart remained focussed predominantly on mineralogy and geology, he also wrote selectively on questions of comparative anatomy. Particularly, a study on trilobites separated several distinct species for the first time, *Histoire naturelle des crustacés fossiles, sous les rapports zoologiques et géologiques: savoir les trilobites*, which allowed for accurate global comparisons.²

Brongniart resisted being drawn into early nineteenth-century debates over questions of evolution, even when public discussions between Cuvier and Geoffroy grew increasingly acrimonious, culminating in a series of debates at the Academy. Still, questions of species transformation raised by Lamarck and others were in the background of his geological and palaeontological research.³ Brongniart and Cuvier consulted zoological collections arranged and classified by Lamarck,⁴ retaining the names Lamarck had given them, but their joint study focussed primarily on geognostic

² Alexandre Brongniart and Anselme Gaëtan Desmarest, *Histoire naturelle des crustacés fossiles, sous les rapports zoologiques et géologiques* (Paris, 1822).

³ For a discussion of the scientific culture of the Muséum in the early nineteenth century, with an emphasis on questions of biological theories and transformism, see Pietro Corsi, *Age of Lamarck* (Berkeley, 1989).

⁴ Cuvier and Brongniart, *Essai sur la géographie minéralogique*, 1811, ij, 3.

information.⁵ Elsewhere, Cuvier was more outspoken, arguing vigorously against Lamarckian and other types of transformism.⁶ The fact that Brongniart remained close to both Cuvier and Geoffroy, among many others who concerned themselves with biology and transformism, has been held up as a mark of his capacity to maintain a position of diplomatic neutrality at moments of intense scientific disagreement.⁷ While this is true in general, I show that in this matter his attention was already stretched by his work at Sèvres and his publication commitments.

Brongniart's final formal work on the history of the Earth was the *Tableau des terrains qui compose l'écorce du globe* (see Figure 7.10). His illustration was developed as a cross-section of the Earth's layers that could be applied generally for Europe, if not yet globally. As I discuss towards the end of this chapter, he drew upon a lifetime of research in natural history, and gave full expression to the ideas he held on the formation of the Earth. By the act of recording the distinct layers, and by displaying the specific contents of the strata (as iconographic symbols) - while marking sharp divisions and the manner of deposition – open theoretical questions, such as species extinction or the volcanic formation of land masses, were displayed as incontrovertible facts.

Cuvier and Brongniart: Fieldwork in the Paris Basin

In 1804, Brongniart began a joint research project with Cuvier exploring the Paris region that integrated fossil collections of the Muséum and elsewhere. Although there are few records to indicate the details of the earliest discussions between them

⁵ See, for example, Cuvier and Brongniart, *Essai sur la géographie minéralogique*, 1811, 11-12.

⁶ Corsi, *Age of Lamarck*, 180-2, 209-10.

⁷ Dorinda Outram, *Georges Cuvier* (Manchester, 1984), 113, 174.

concerning the project, it is likely that they had both envisioned a study or collaboration with one another well before they were able to establish a clear objective and to begin their research.⁸ Highlighting the duration of his personal study of the Paris Basin, Brongniart organized a binder of journals related to his observations, most likely in the 1820s or later. By this time, he could view the collective research as complete. The collection contains ten small notebooks, beginning with “1788-1791; Promenades Zoo-phyto-lythologiques aux environs de Paris, par Alex. Brongniart.” He also included records of his annual “Cours de Fontainebleau,” which he led from 1793 to 1798.⁹ Numerous entries in his daily journals indicate excursions within an easy distance of Paris. In total, the Paris Basin journals span a period of thirty-three years, ending in 1821. The contents of these journals are highly simplified records of the events, but they mark the origins and the continuity of Brongniart’s research in the subject. From his earliest trips to the region around Sèvres and Versailles, or to the forest of Bondy, he recorded his observations on the entomology and the minerals and rocks. Over time, his observations gained in acuity, and he began to focus more intently on the mineral and geological features of the landscape. In all, the compilation of journals demonstrates the timeframe for Brongniart’s study as he worked toward the publication of the 1811 *Essai sur la géographie minéralogique des environs de Paris* and the subsequent 1822 & 1833 editions of the *Description géologique*.¹⁰

Another early journal in which Brongniart recorded his interests in geological

⁸ Cuvier and Brongniart, *Essai sur la géographie minéralogique; Description géologique des environs de Paris*.

⁹ Alexandre Brongniart, *Lettres et papiers se rapportant aux voyages d’Alexandre Brongniart*, “Courses et voyages dans le bassin de Paris, par ordre chronologique,” “Promenades zoo-phyto-lythologiques aux environs de Paris par Alex. Brongniart,” BMHN MS2350/1.

¹⁰ Cuvier and Brongniart, *Essai sur la géographie minéralogique*, 1811, and *Description géologique des environs de Paris*, 1822.

study was that of his 1791 trip with José Bonifácio de Andrada to Dijon and Montcénis. Early in their travels, on a hill east of Auxerre, Brongniart set the tone of the observations he would make throughout their trip: “on the top and on the surface of the Earth, (there was) a flat stone in rather large pieces, of an ochreous colour, containing a rather large quantity of detriments of shells and small crystals of carb. limestone. The ochreous earth also contained an immense quantity of chalk fragments.”¹¹ Brongniart recorded the colour of the Earth, and made observations on its mineral contents, as well as upon the presence of shells and their condition. In addition, he made cross-sections and included notes, and lettered keys to the drawings, on the position of the layers he observed.¹²

In 1808, Cuvier and Brongniart presented the first part of their preliminary findings to the Institut in *Essai sur la géographie minéralogique*,¹³ following up with a second presentation in 1809.¹⁴ Early versions of the essay were published in both the *Journal des mines* and in the *Annales du Muséum*, putting their initial results on record, and demonstrating their priority in systematically linking the fossil record to the layers of the Earth.¹⁵ They began by noting that mineralogical studies had, prior to their presentation, typically described the chemical and mineralogical character of successive strata, but ignored the fossil contents. Likewise, naturalists and others had

¹¹ Alexandre Brongniart, 1791 Voyage No. 2, Journal du voyage de Paris à Dijon, Montcenis, et Autun, BMHN MS 2337, 2.

¹² Brongniart, 1791 Voyage No. 2, BMHN MS 2337.

¹³ Anne Lajoix, “Alexandre Brongniart: Scholar and Member of the Institut de France,” in *Sèvres Porcelain Manufactory*, Derek E. Ostergard and Tamara Préaud, eds., (New Haven, 1997), 29.

¹⁴ Philippe Taquet, “Les contributions respectives de Georges Cuvier et d’Alexandre Brongniart à l’élaboration de l’Essai sur la géographie minéralogique des environs de Paris,” *Travaux du Comité français d’Histoire de la Géologie* 3, 23 (2009): 1-16.

¹⁵ Georges Cuvier and Alexandre Brongniart, “Essai sur la géographie minéralogique des environs de Paris” *Journal des mines* 23 (1808): 421–458; *Annales du Muséum d’histoire naturelle de Paris*, t. XI (1808): 293-326.

removed fossils from their place of formation without regard to their position. In the process, vital information for both fields was lost. Their study was an attempt to correlate the data of the zoologist with that of the field mineralogist, including the bones of unknown land animals, or the fossils of both marine and freshwater shells and creatures. The pair observed that the uppermost terrains of the Paris Basin were comprised of distinct sedimentary depositions which were created under successive chemically and physically different environments. They described the mineralogical contents of each terrain and added preliminary notes on the types of fossil contents present.¹⁶

Cuvier and Brongniart noted in 1808 that their study was work-in-progress, and they announced their intention to take the project further, based on more extensive fieldwork and analysis. A final draft of the *Essai sur la géographie minéralogique* was published in 1811, with cross-sections of several sites, alongside a hand-coloured map (see Figures 7.1-7.2).¹⁷ The following year, Cuvier included a copy of the essay with reproductions of the map and important cross-sections in his four-volume publication *Recherches sur les ossemens fossiles*.¹⁸ This publication more cohesively tied the fossil record to their descriptions of land formations in the *Essai sur la géographie minéralogique*.¹⁹ Additionally, the introduction to *Ossemens fossiles* gave Cuvier an opportunity to discuss his personal geological and palaeontological ideas.

In *Essai sur la géographie minéralogique*, Cuvier and Brongniart focussed on *geognosy*, distinguishing the different epochs that succeeded one another in the formation of the Earth. The pair sought to determine the relationships between fossil

¹⁶ Cuvier and Brongniart, “Essai sur la géographie minéralogique,” 1808.

¹⁷ Cuvier and Brongniart, *Essai sur la géographie minéralogique*, 1811.

¹⁸ Georges Cuvier, *Recherches sur les ossemens fossiles* (Paris, 1812).

¹⁹ Cuvier and Brongniart, *Essai sur la géographie minéralogique*, 1811.

remains and their geological position and order of deposition.²⁰ They cited Jean Honoré Robert de Paul de Lamanon (1752-1787) and his “Description de divers fossiles trouvés dans les carrières de Montmartre,” a 1782 essay concerning mineral composition, the location of fossils, and the characteristics of freshwater deposits versus those made in saltwater, as one of the few studies to correlate fossils with the site of deposition. Lamanon linked chemical composition to his descriptions of the strata. He also showed that chemical effects could account for the disappearance of bones in deposits left by saltwater, which was rich in *acide méphitique* (carbonic acid, H_2CO_3). Meanwhile the *acide vitriolique* (sulphuric acid, H_2SO_4) that was commonly found in freshwater, and found in gypsum, acted to destroy the carbonic acid of seashells, thus accounting for their disappearance in deposits where animal bones were located.²¹

Cuvier and Brongniart highlighted other natural historians who had recorded fossil information alongside information on terrains, including the research and maps of Guettard and the 1794 *Encyclopédie Méthodique: Géographie-physique* of Desmarests.²² Historians of science have pointed to an absence of references to Lavoisier in Cuvier and Brongniart’s discussion, but Desmarests’ *Encyclopédie Méthodique* included a summary of Lavoisier’s 1789 memoir, presented to the Académie, in which he had offered exploration and analysis of sedimentary beds, including their fossils and shells in the Paris Basin (see Figure 2.3). Lavoisier had

²⁰ For example, see Cuvier and Brongniart, *Essai sur la géographie minéralogique*, 9-13.

²¹ Robert de Paul de Lamanon, “Description de divers fossiles trouvés dans les carrières de Montmartre près Paris, et vues générales sur la formation des pierres gypseuses,” *Journal de Physique* (March 1782).

²² Cuvier and Brongniart, *Essai sur la géographie minéralogique*, 1811, iij-iv, 2-3, 9-11. Desmarests had also been a chemistry advisor to Sèvres in the pre-Revolutionary period. He was fired in 1793 along with Darcet and Louis Claude Cadet de Gassicourt. E. J. Richardson, *Unlikely citizens? The manufacturers of Sèvres porcelain and the French Revolution* (London, 2007), 150.

worked out a physical model for the breakdown and deposition of seashells and other matter as a regular function of the ebb and flow of the water, which Desmarests clarified and developed (see Figure 2.2).²³ Since the *Essai géographique* was presented to the Institut at a time when Brongniart was hoping for a successful appointment to the Faculté des Sciences, it is likely that Cuvier and Brongniart were politically careful in their acknowledgements. However, those savants who were versed in the geological discussions of the Paris Basin would have understood that the reference to Desmarests also implied the inclusion of the Lavoisier's 1789 memoir.²⁴

Brongniart and Cuvier drew attention to the layers of white chalk that many geologists had largely ignored, stating “the chalk has been considered by several geologists to be a very recent, indistinct, and unimportant formation. As a result of this false opinion, it has been badly characterised.”²⁵ Lavoisier's 1789 memoir had in fact described the white, calcium-bearing sediments, as well as the aquatic fossils they contained. Lavoisier considered these deposits to be “modern,” while also believing them to be “several hundreds of thousands of years” in the making.²⁶ Cuvier and Brongniart agreed, arguing that the chalk was far older than most geologists believed it to be, and that it was followed by a series of four or five “very distinct” formations.

²³ Nicolas Desmarests, “Notice sur un mémoire concernant les couches modernes horizontales et leurs dispositions,” *Encyclopédie méthodique, Géographie-physique*, t.1 (Paris, 1794), 783. Lavoisier's original title for the memoir was “Observations générales sur les couches modernes horizontales, qui ont été déposées par la mer, et sur les conséquences qu'on peut tirer de leurs dispositions, relativement à l'ancienneté du Globe terrestre.”

²⁴ M. J. S. Rudwick, *Bursting the Limits of Time: The Reconstruction of Geohistory in the Age of Revolution* (Chicago, 2007), 494-5.

²⁵ Cuvier and Brongniart, *Essai sur la géographie minéralogique*, 1811, 9. Here “recent” refers to what can be considered “modern-day,” or as belonging to the human historical period. However, Brongniart and Cuvier realized that the Tertiary Series was much older.

²⁶ Desmarests, “Notice sur un mémoire concernant les couches modernes horizontales et leurs dispositions,” 783-91.

Additionally, long periods of time had passed, and “big revolutions” had occurred between the time of the deposition of the chalk and the period in which the continents received the form they occupied in the present day.²⁷

The white deposits were seemingly homogeneous, and perhaps of only limited interest in a visual survey of land formations that contained multiple strata with more easily distinguished features. However, to the mineralogist or the chemist, the variations in depositions mattered critically.²⁸ In terms of artisanal applications, as Brongniart knew, the deposits that provided gypsum, used as plaster of Paris (CaSO_4), such as those found in the Montmartre quarries, were “very suitable for sculptural objects that are formed in moulds.”²⁹ Meanwhile, calcium carbonate (CaCO_3), which sometimes appeared as marbles with common names such as “marbre salin,” “marbre blanc,” or “marbre statuaire,” could be used for sculpture,³⁰ or it could act as a flux to lower the temperature at which a clay would melt.³¹ Often visually similar in their natural deposits, they derived from approximately similar circumstances of the sedimentation of calcium in lakes and seas.³²

Cuvier and Brongniart demonstrated that the Paris Basin had experienced successive periods of flooding and dry land, and they showed in detail how it was possible to use the fossil record to determine which of the strata were formed by saltwater, and which were formed by freshwater. For example, in Articles V & VI, they

²⁷ Cuvier and Brongniart, *Essai sur la géographie minéralogique*, 1811, 13.

²⁸ On the value of this knowledge for the arts, see Cuvier and Brongniart, *Essai sur la géographie minéralogique*, 19.

²⁹ Brongniart, *Minéralogie*, 183.

³⁰ Brongniart, *Minéralogie*, 193.

³¹ Brongniart, *Minéralogie*, 524, 531. The chalk (*craie*) formations are predominantly comprised of calcium carbonate; “chalk,” *Encyclopedia Britannica* (22 October 2013). <https://www.britannica.com/science/chalk>.

³² Melissa L. Stoudt and Frank R. Spellman, *Handbook of Geoscience* (Plymouth, 2013), 195.

described formations of gypsum laid down in freshwater, and listed a series of fossils that included mammals, birds, reptiles, fish, and molluscs. An adjacent layer was a marl with marine fossils that included fish, spirorbes, and shells (*huîtres*).³³ They noted that the characteristic fossils of each type of formation matched Lamanon's supposition that the acidic or basic character of the mineral deposits indicated the salinity of the water in which the sediments had originally been deposited. By comparing observations throughout the region, they determined similar lists of representative fossils for the strata (*terrain* or *couche*) and included notes on fossils that seemed particularly prominent in some locations but not others, such as at Liancourt. There, they listed seven fossil types that they believed were more abundant at that site than elsewhere.³⁴

Cuvier and Brongniart's research was the first cohesive and localised case study to use fossils coherently to demonstrate the conditions under which the Earth's layers were deposited. They created a model for geognostic record keeping and provided the groundwork for what would become the science of biostratigraphy. The pair based their findings on extensive fieldwork in the region around Paris, including, particularly, the mines of Montmartre. Their research took place over several years, and incorporated the carefully organized collections of the Muséum, many of which had been classified and described in detail by Lamarck.³⁵ While they generously acknowledged the value of Lamarck's contributions as a naturalist, they were careful not to subscribe to his radical theoretical interpretation of the data.³⁶

John Farey, an associate of William Smith, argued for the latter's priority in

³³ Cuvier and Brongniart, *Essai sur la géographie minéralogique*, 40-41.

³⁴ Cuvier and Brongniart, *Essai sur la géographie minéralogique*, 93.

³⁵ Rudwick, *Bursting the Limits of Time*, 478-9.

³⁶ Corsi has described the arguments of Cuvier against Lamarck. *Age of Lamarck*, 180-2, 209-10.

pioneering these studies.³⁷ Indeed, some authors have speculated that Brongniart had possibly seen the limited number of copies of Smith's early drafts of his geological map on his 1802 visit to London, an experience that became a motivating force behind his own and Cuvier's work on the Paris Basin.³⁸ However, even if he did see Smith's maps, they were unlikely to have illustrated ideas that were novel to Brongniart. In any case, while it is possible that drafts of the map were shown to him, or that there was discussion of Smith's ideas, there is no evidence that this was the case.

Certainly, the idea of a geological map, including one with cross-sections that recorded the locations of characteristic fossils, was not new to Brongniart. As I have discussed in Chapter Two, Guettard and Lavoisier collaborated on the mineralogical map of France, for which Lavoisier planned to include cross-sections of featured land formations, and Brongniart knew the two savants' ideas well. Charles Étienne Coquebert de Montbret's large map collection and his political interest in map-making were also direct influences. As for fossils, I showed in Chapter Three that Brongniart's co-authored paper with Coquebert's brother, Romain, in 1793, 'Extrait d'un mémoire sur la formation de la coquille de *Strombus fissurella*' was a comparative analysis of fossil shells that used techniques which he could later apply to fossils of all types.³⁹ As outlined above, from at least 1790, Brongniart's writing demonstrated that his interest in the analysis of geological features also included its fossil contents.

The Paris Basin proved to be an ideal location close at hand, with a rich catalogue of fossils to draw upon. Whether or not Smith's work was an influential factor

³⁷ John Farey, "Geological remarks and queries on Messrs. Cuvier and Brongniart's Memoir on the mineral geography of the environs of Paris," *Philosophical Magazine* 1, 35:142 (1810):113-139.

³⁸ See, particularly, Rudwick, *Bursting the Limits of Time*, 472.

³⁹ R. Coquebert and A. Brongniart, "Extrait d'un mémoire sur la formation de la coquille de *Strombus fissurella*, et sur deux espèces analogues à celle-ci," *Société Philomatique de Paris Bulletin des Sciences*, 1 (1793), 55-56.

in the timing of the Paris Basin study, the connection between the study of fossils and the study of landforms had been overlooked in the eighteenth century, but it could not be ignored by the early nineteenth. Cuvier benefitted from new insights as he developed the Chair of Comparative Anatomy at the Muséum and built upon the collections there, but individual specimen could not, by themselves, describe Earth's history or the life of the unknown animals represented by fossil remains. At the same time, Brongniart's mineralogical research had provided both chemical and physical evidence that showed the value of including notes on fossil remains in the description of terrains as a way of correlating factors such as position, relative age, and type of environment. As Rachel Laudan has argued, the field grew rapidly following these seminal publications of Cuvier and Brongniart.⁴⁰

Reflecting the expansion of their work beyond *mineral geography* and *geognosy*, Cuvier and Brongniart revised their original essay in 1822, retitling it as *Description géologique des environs de Paris*.⁴¹ By the time of its publication, Brongniart's son, Adolphe, had begun his own career in natural history. For the 1822 edition, twenty-two-year-old Adolphe contributed an essay on the characteristic fossil plants of the respective deposits, "Description des végétaux fossiles du terrain de sédiment supérieur," thus establishing himself in the creation of palaeobotany as well as a highly competent illustrator (See Figure 7.5).⁴² By this time, Brongniart was an acknowledged expert on the fossil characteristics of various geological deposits. His

⁴⁰ Laudan, *From Mineralogy to Geology*, 165-8.

⁴¹ Cuvier and Brongniart, *Description géologique des environs de Paris*, 1822. Although there was a name change following the 1808-1811 publication of *Essai sur la géographie minéralogique*, the 1822 publication *Description géologique* was considered the second edition of the earlier work. An 1835 edition was the third and final revision.

⁴² Adolphe Brongniart, "Description des végétaux fossiles du terrain de sédiment supérieur, cités dans la description du bassin de Paris," in Cuvier and Brongniart, *Description géologique des environs de Paris* (Paris, 1822), 353-72.

Sur les caractères zoologiques des formations, of 1821, described in detail the typical fossil contents of the chalk formations, including the observations of other geologists throughout Europe. He took the correlations outlined in the essay and looked forward to the increasing ability of linking global geological formations by similar points of identification.

In a similar vein, in 1822, Brongniart presented a decade of research on trilobites, an arthropod that lived during the Palaeozoic era, in *Histoire naturelle des crustacés fossiles, sous les rapports zoologiques et géologiques: les trilobites* (see Figure 7.8).⁴³ He had been teaching a class on natural history at the Faculté des Sciences in 1812 that featured a species that Linnaeus had called *Entomolithus paradoxus*.⁴⁴ In the process, Brongniart discovered that several distinct species had erroneously been described under this name, often without prior comparison to other specimens or reference to the location in which the fossils had been found. He retained the popular name, *trilobite*, as the family name, and established five separate species for the numerous specimens to which he had access. Brongniart had the advantage of being able to consult a wide range of trilobite fossils, many of which were held in private collections, including those sent to him directly by foreign naturalists.⁴⁵

Brongniart recognized that combining practices of zoology with geology could benefit both fields. Zoological techniques clarified the distinctions between the various species, and specific specimen information could provide evidence for geological deposits. By clarifying the record of the *Entomolithus paradoxus* and correcting the

⁴³ “Sur les caractères zoologiques des formations, avec l’application de ces caractères à la détermination de quelques terrains de craie,” *Annales des Mines* VI (1821): 537-572; Alexandre Brongniart and Anselme-Gaëtan Desmarest, *Histoire naturelle des crustacés fossiles, sous les rapports zoologiques et géologiques: Savoir les trilobites*, (Paris, 1822).

⁴⁴ Brongniart, *Savoir les trilobites*, 1.

⁴⁵ Brongniart, *Savoir les trilobites*, 8-46.

species identifications of other trilobites, as well as determining the geognostic and geographic occurrences of each species, trilobites could be used globally as reference fossils. For example, he confirmed that certain American trilobite specimens were identical to those found in England.⁴⁶ Brongniart's trilobite memoir was combined with a discussion of fossil crustaceans, *Les crustacées proprement dit*, written by his former student, Anselme-Gaëtan Desmarest (1784-1838).⁴⁷ Both essays illustrated the regular fossils of various geological terrains, in order to provide better identifications and to clarify the geological relationships.⁴⁸ The publication of *Histoire naturelle des crustacés fossiles* marked Brongniart's continued interest in the depths of the Earth and in deciphering what he considered to be a long but ambiguously-understood timescale, and he indicated that the ultimate goal was to determine relationships that could help determine the exact age of the Earth.⁴⁹ His 1822 publication provided scholars around the world with a systematic method for fossil comparison, and the presence of particular trilobite species has been recognized in the past two centuries as providing crucial evidence in global stratigraphical analysis.⁵⁰

Personal and Public Spaces: Teaching Cabinets and Laboratories

In July of 1822, following the death of René Just Haüy, Brongniart was elected to the chair of mineralogy at the Muséum. It was a distinction he had sought from his earliest days as a natural historian, nearly thirty years previously.⁵¹ Even for someone

⁴⁶ Brongniart, *Savoir les trilobites*, 58-9.

⁴⁷ Anselme-Gaëtan Desmarest was the son of Nicolas Desmarests. The spelling of his surname was changed during the nineteenth century.

⁴⁸ Brongniart and Desmarest, *Histoire naturelle des crustacés fossiles*, v-vii.

⁴⁹ Brongniart, *Savoir les trilobites*, 46.

⁵⁰ "Trilobite," *Encyclopedia Britannica* (29 September 2022).
<https://www.britannica.com/animal/trilobite>.

⁵¹ Paul-Antoine Cap (Gratacap), *Le Muséum d'histoire naturelle* (Paris, 1854), 73.

as well-positioned and renowned as he was, a chair at the Muséum was neither quick to materialize, nor guaranteed. In 1819, Brongniart, still serving as assistant to Haüy in mineralogy, had sought the geology chair upon the death of Faujas de Saint Fond, and had been rejected.⁵² Positions at the Muséum were frequently determined, not through public notice, but by promotion from within. Chairs often went to those who had been working in lower capacities for a substantial period, as in the case of Cuvier, who was passed over for his first nomination as preparator, but who became an assistant to Mertrud soon thereafter and, upon Mertrud's death, was promoted to the renamed chair of Comparative Anatomy.⁵³

Like the Abbé, Brongniart drew his students and young protégés around him. Often the site of the informal lessons and tutorials of Haüy, the second-floor apartment at the Hôtel de Magny, on the grounds of the Muséum, transferred to Brongniart with the new post (see Figure 7.9).⁵⁴ Brongniart could utilise the apartment as a separate residence, away from both Sèvres and rue Saint Dominique. As a practical matter, this additional space helped make room for his three children as they began their own families. In 1824, upon the death of André Thouin (1746-1824), Jean-Baptiste Dumas (1800-84), the husband of Brongniart's youngest daughter, Herminie, was allocated the apartment (also formerly that of Fourcroy) on the first floor of the Hôtel de Magny. Although he had not yet taken on a significant post at the Muséum, Dumas was well-regarded for his work with Thénard, his teaching at the Athenée de Paris, and elsewhere.⁵⁵ As numerous other families and employees of the Muséum appointees

⁵² Tamara Préaud, "Brongniart as Technician," in *Sèvres Porcelain Manufactory*, Ostergard and Préaud, eds., (New Haven, 1997), 63.

⁵³ Burkhardt, "Leopard in the Garden," 685-7.

⁵⁴ Launay, *Les Brongniart*, 93.

⁵⁵ Anton Moret, "La présentation des collections de minéralogie au Muséum national d'Histoire naturelle," *Art et histoire de l'art* (2014). On Dumas' career, see Cooke, *Scientific Culture*, 181-202.

lived on-site, the situation was not unusual. Alongside Brongniart and Dumas, the zoologist Achille Valenciennes (1794-1865) occupied the ground floor apartment until his death in 1865.⁵⁶ Valenciennes had been born at the Muséum and was a student of Cuvier and an intimate of the Brongniart household in Saint Germain.⁵⁷

Brongniart, like Haüy before him, was a patient teacher who worked closely with his students; he was well known for his organisational skills and his generosity with his time and knowledge, as well as with his collection.⁵⁸ When he took over as chair of mineralogy at the Muséum, he reorganized the collections in order to better reflect the order of his lectures, and where there were gaps, he filled them in with materials from his personal collection.⁵⁹ The households of the Hôtel de Magny and the rue Saint Dominique, and the workshops and laboratories of Sèvres became semi-public spaces that served as meeting grounds for numerous intellectuals, foreign visitors, and naturalists who held diverse, often differing, opinions and ideas about natural history. Brongniart was comfortably positioned at the centre of a vibrant community, which his efforts had built and maintained.⁶⁰ On a visit to Paris in 1829, Charles Lyell witnessed the fact that, like Cuvier, Brongniart had many assistants working individually on numerous ongoing projects in his cabinet but was “known to

⁵⁶ On the living arrangements at the Hôtel de Magny, see Alfred Lacroix, “La vie et l’œuvre de l’abbé Haüy,” *Bulletin de la Société française de Minéralogie: La célébration du deuxième centenaire de la naissance de l’abbé Haüy*. 67, 1-6 (1944): 66-7, 86.

⁵⁷ “Valenciennes, Achille,” Complete Dictionary of Scientific Biography, *Encyclopedia.com* (April 15, 2021). [Online.] <https://www.encyclopedia.com/science/dictionaries-thesauruses-pictures-and-press-releases/valenciennes-achille>.

⁵⁸ Cap, *Le Muséum*, 127; Benjamin Silliman, “Obituary: Death of Alexandre Brongniart,” *American Journal of Science and Arts* 2, 5 (New York, 1848), 141-3; “Obituary of Alexandre Brongniart, extract from a Discours pronounced by M. Elie de Beaumont,” *American Journal* 2, 5 (New York, 1848), 155-59.

⁵⁹ J. P. F. Deleuze, *History and Description of the Royal Museum of Natural History* (Paris, 1823), 584-85.

⁶⁰ Cap, *Le Muséum*, 127.

lose more time in organising this auxiliary force than he gain(ed) by their work.”⁶¹

Unlike the explicitly-trained assistants of Cuvier’s laboratories – which included his daughter, Clementine, and stepdaughter, Sophie Duvaucel – Brongniart’s students and assistants did not serve exclusively to simplify tasks. Rather, he positioned himself as a teacher and guide. Every Sunday, he was available for consultation at his cabinet on the rue Saint Dominique. This regular event in the relaxed atmosphere of his home nurtured an ongoing local and international network and made his residence a centre of information exchange. For example, in 1821, the British painter and naturalist Thomas Richard Underwood brought samples of shells from the collection of British geologist Thomas Webster for comparison with those in the cabinet, which Brongniart, Audouin, and several assistants examined and analyzed.⁶²

Louis Constant Prévost (1787-1856), a student of Brongniart’s who, in joining with Charles Lyell, created counter-arguments to Brongniart and Cuvier’s Paris Basin studies during the 1830s, nonetheless retained strong memories of his time spent at the rue Saint Dominique, and of Brongniart’s willingness to encourage discussion and disagreement:

how I was able to use and sometimes abuse this faculty! How much also did I profit from it in the years which followed, those of which I find it so difficult to abandon the memory! During more than twenty years devoted to the study of all branches of Natural History, the greatest pleasure I could find was to spend a great part of my leisure days in the collections of my old master and in his intimacy. How many happy and useful moments have thus passed! How many times did Desmarests, Leman, and I examine, determine, describe, and label the collections of mammals, birds, minerals, rocks, which Brongniart created and classified for the benefit and instruction of all.⁶³

⁶¹ Charles Lyell, *Life, Letters and Journal of Charles Lyell*, v.1 (London, 1881), 250.

⁶² John Challinor, “Some correspondence of Thomas Webster, geologist (1773–1844)-I,” *Annals of Science* 17, 3 (1961): 191-2.

⁶³ J. Gosselet, “Constant Prévost: Coup d’œil retrospectif sur la géologie en France,” *Annales de la Société Géologique du Nord*, t. 25 (1896): 6-7.

Audouin – Brongniart’s assistant, who later married his eldest daughter, Mathilde – recorded an incident in 1818, when a small group met at Brongniart’s cabinet as usual on Sunday and discussed a question raised by Henri Marie Ducrotay de Blainville (1777-1850) the previous evening at the Société Philomathique. Blainville had asserted that mammary glands always appeared in pairs of two.⁶⁴ The group looked through the specimens Brongniart had preserved in glass jars, where they located a species of marsupial that possessed an odd number – thus proving that Blainville’s assessment was in error.⁶⁵ Brongniart wrote a letter to Blainville that evening and sent it off, in order to speedily clarify the question.⁶⁶ This episode not only demonstrates Brongniart’s engagement and quick intellectual interest, but also the expansiveness of his collections. His cabinet continued to be useful across numerous disciplines and was not limited to the well-known mineralogical collection he possessed.

Cyprien Prosper Brard (1786-1838) was another of Brongniart’s students in mineralogy to lead a productive career in the field. Brard was a precocious student who, aged nineteen, had written and self-published *Manuel du minéralogiste et du géologue voyageur*, with the supervision of Haüy and Faujas de Saint Fond.⁶⁷ Although Brard held transformist views and, at times, challenged the work of Cuvier and Brongniart, he remained close to Brongniart throughout his career.⁶⁸ Brard wrote several books in mineralogy, including, in 1821, *Mineralogie appliqué aux arts*, in which he gave fulsome credit to Brongniart. He recalled that Brongniart had provided the initial knowledge he had acquired in mineralogy and had helped him “with his advice and by

⁶⁴ Audouin and Théodoridès, *Journal d’un étudiant*, 61.

⁶⁵ *Opossum didelphis*, (Virginia opossum); see Charles A. Long, “The Origin and Evolution of Mammary Glands,” *BioScience* 19, 6 (1969).

⁶⁶ Audouin and Théodoridès, *Journal d’un étudiant*, 61.

⁶⁷ Cyprien-Prosper Brard, *Manuel du minéralogiste et du géologue voyageur* (Paris, 1805).

⁶⁸ Corsi, *Age of Lamarck*, 208.

placing at my disposal the collection of useful minerals that he has gathered, either in his own cabinet, or in that of the Royal Manufacture of Sèvres.”⁶⁹

An Uncomfortable Balance: The Debates Between Cuvier and Geoffroy

Numerous authors have placed emphasis on the political power sought and wielded by Georges Cuvier during the early nineteenth century. These include Dorinda Outram, who saw Brongniart’s actions as part of a deliberate withdrawal from his relationship with Cuvier.⁷⁰ Charles Lyell (1797-1875) was an important witness to networks of Parisian naturalists during his visits in the 1820s, paying close attention to Cuvier. In 1823, the twenty-six-year-old Lyell wrote to his father that he had met several geologists at Cuvier’s salon, probably including Brongniart.⁷¹ After his first visit to the gathering, Lyell explained to his father that Alexander von Humboldt believed Cuvier was spending too much time in his political efforts, and that the Parisian savants had largely abandoned him. Lyell drew attention to their competitiveness: “we must not forget that Baron Humboldt and he are the two great rivals in science . . . Humboldt’s birth places him on the vantage ground and Cuvier perhaps tries to compensate this by a little political power.”⁷² Unlike Cuvier, Lyell believed Humboldt’s noble status buffered him from the repercussions of expressing a liberal viewpoint.⁷³

Cuvier’s interactions, politics, and scientific beliefs have often been contrasted

⁶⁹ Brard, *Manuel du minéralogiste*, t.3, 3.

⁷⁰ Outram, *Cuvier*, 113, 174; Toby A. Appel, *Cuvier-Geoffroy Debate* (Oxford, 1987), 67.

⁷¹ Lyell, *Life, Letters and Journal*, v.1, 125.

⁷² Lyell, *Life, Letters and Journal*, v.1, 128.

⁷³ Lyell, *Life, Letters and Journal*, v.1, 1.

with those of Geoffroy Saint-Hilaire.⁷⁴ The two were close friends in their early careers but became intellectual rivals as they reached their mature careers. The debates between Cuvier and Geoffroy are well-known, pitting Cuvier's commitment to the fixity of species against Geoffroy's transformism.⁷⁵ Both Outram and Toby Appel have addressed Brongniart's obvious predilection for occupying an intermediate position between the two men, and have queried why he did not venture into the arena in support of his close associate, Cuvier.⁷⁶ Brongniart's work and personal philosophy was, in general, in opposition to the open theorising of Geoffroy, and more in keeping with the slow and careful examination of large bodies of evidence preferred by Cuvier. However, by the time of the debates, both Cuvier and Geoffroy had been Brongniart's colleagues for more than thirty years. With extensive experience in the matters of personnel, including competition between artists, scientists, students, and others, Brongniart preferred to establish a stabilising neutrality, particularly among those he knew well. While the conflict between Geoffroy and Cuvier may have been personally uncomfortable, he did not often wade into contentious arguments without a clear professional purpose.

As Corsi has shown, Cuvier and Brongniart recognised that the fossil record they described was not continuous, showing instead wide gaps between the disappearance and emergence of species across sedimentary layers. However, as I

⁷⁴ Richard Somerset, "The Naturalist in Balzac: The Relative Influence of Cuvier and Geoffroy Saint-Hilaire," *French Forum* 27, 1 (2002): 81-111. Crosland, looking at a later period of the Academy, c.1840, wrote that "Arago and his friends" represented a liberal left, Thenard, Dumas and the Brongniart family were in the centre as moderates, and that the moderate-right included a group of Orléanists that included André de Jussieu and Mirbel, with the far right represented by Cauchy, see Crosland, *Science under Control*, 189.

⁷⁵ See Bourdier, "Geoffroy Saint Hilaire Versus Cuvier"; Appel, *Cuvier-Geoffroy Debate*; Edmond Perrier et al., "Debate between Cuvier and Geoffroy Saint-Hilaire," *Philosophy of Zoology before Darwin* (New York, 2009).

⁷⁶ Outram, *Cuvier*, 113, 174, 187; Appel, *Cuvier-Geoffroy Debate*, 67, 114, 157.

discussed above, their studies, as well as Lamanon's 1782 memoir "Description de divers fossiles," showed that the terrain they explored did not yield fossils in all conditions, and there was not yet enough evidence to create a continuous record of any sort.⁷⁷ Even Lamarck was unable to use the fossil series to show continuous links over time, as Cuvier noted.⁷⁸ Brongniart was cautious in accepting and espousing new theories but like many of those who frequented his salon and cabinet, he remained open to new interpretations of evidence and welcomed argument. Many of his students, including Brard, Audouin, and Henri Milne-Edwards (1800-85), were at least somewhat sympathetic to Geoffroy's views, but few fully adopted transformist theories.⁷⁹ Jean Baptiste Julien Omalius d'Halloy (1783-1875) was one of the members of this network who did argue for "successive transformation."⁸⁰ However, Brongniart gave little clue in his publications where his own thoughts on transformism stood, and it is likely that he held a cautious, but non-antagonistic, view on the subject.

Brongniart's theoretical caution likely mattered less during the debates than did his social sensitivities. As they occurred, the debates were a part of ordinary Academic discourse. Their importance was magnified in the eyes of the public well after they had ended, especially when Balzac declared victory for Geoffroy in his *avant-propos* of *Le Comédie humaine* in 1842.⁸¹ Brongniart displayed a steady-handed approach in contrast to Geoffroy's volatility. Audouin recorded an incident on 4 April 1818, in which he surmised that Geoffroy had sent a letter with his resignation from the Société Philomathique in the wake of a disagreement that Audouin did not specify. The

⁷⁷ Lamanon, "Description de divers fossiles trouvés dans les carrières de Montmartre."

⁷⁸ Corsi, *Age of Lamarck*, 160.

⁷⁹ Corsi, *Age of Lamarck*, 209; Appel, *Cuvier-Geoffroy Debate*, 114-118, 215.

⁸⁰ Corsi, *Age of Lamarck*, 213-14.

⁸¹ Somerset, "Naturalist in Balzac," 84-7; Honoré de Balzac, *La comédie humaine: Scènes de la vie privée*, (Paris, 1842), 18.

resignation was not accepted by the members in attendance, including Brongniart, Adolphe, Blainville, Desmarest, and Beaudant.⁸² Certainly, if this group had wished to suppress Geoffroy's ideas, they could have accepted his resignation. The action demonstrated that the membership took the identity of the *philomath* seriously, placing their values in upholding a space for academic disagreement rather than in the exclusion of controversial or opposing ideas. Geoffroy, for one, had been deeply connected to the group from its early years. Several of his letters to Cuvier from Egypt at the turn of the century were signed with thoughts of "nos excellens amis les philomates," expressing sentiments generally reserved for close friends and family.⁸³

In the publicly available archives, there are brief glimpses into the private thoughts of Brongniart during this period.⁸⁴ In one journal entry, Brongniart wrote that Cuvier had approached him and had asked about his inaction during the debates, at which Brongniart was surprised. Clearly, Cuvier was hoping for support from his corner, but Brongniart had remained neutral. In another incident, it was Geoffroy who criticised Brongniart for his absence from the debates. In all these cases Brongniart was reluctant to become embroiled in the controversy and sought a middle path, on one occasion reflecting that "these bitter debates between MM. Geoffroy and Cuvier always make these assemblies detestable for me."⁸⁵ For Brongniart, there was little to be gained by choosing sides. While Brongniart was, like Cuvier, averse to speculating beyond the available evidence, the subject matter of transformism was beyond the parameters of Brongniart's professional focus by 1830. However, Brongniart's lack of public support for Cuvier during his debate with Geoffroy has been cited as evidence of an increased

⁸² Audouin, *Journal d'un étudiant*, 82.

⁸³ Étienne Geoffroy Saint-Hilaire, *Lettres écrites d'Égypte* (Paris, 1901), 154.

⁸⁴ Launay, *Les Brongniart*, 97.

⁸⁵ Launay, *Les Brongniart*, 97.

distance in the relationship between them, rendering Cuvier an increasingly isolated figure.⁸⁶ Brongniart was evidently frustrated by Cuvier, but he also found Geoffroy's behaviour challenging, on one occasion (in October 1837) writing that there had been a scandalous scene with Geoffroy at the Academy.⁸⁷

Brongniart's numerous publications over this period suggest that the demands on his time were heavy enough without taking on some public role on the issues among his two colleagues. Three expansive entries for three different encyclopaedias: "Poteries," "Porcelaine," and *Tableau des terrains* (and its accompanying schematic illustration, *Tableau théorique*) were the resolution of several years of work, among which the *Tableau des terrains* appears to have been delayed more than once.⁸⁸ After completing most of his work for the *Dictionnaire des sciences naturelles*, he focussed on the research he had been accumulating for "les arts céramiques." In addition, on a personal level, Brongniart's mother, Anne-Louise Degremont, had passed away in November 1829.⁸⁹ These circumstances would have left Brongniart with little time and energy to spare on conflicts that fell outside of his responsibilities or personal research.

It is regrettable that few letters survive between Brongniart and Cuvier, or between Brongniart and Geoffroy, during the period in question. However, there is little evidence to indicate a true falling out between Brongniart and either of the two scientists. One of Brongniart's strengths was his general ability to resolve himself in his relationships to a careful and controlled response, regardless of the tensions present.

⁸⁶ Outram, *Cuvier*, 113, 174, 187.

⁸⁷ Launay, *Les Brongniart*, 97; Geoffroy's declining mental state in his later years has been noted by authors including Bourdier, who wrote "his body survived his mind for three of four years." It is unclear when Geoffroy's behaviour began to change due to his mental health. Bourdier, "Geoffroy Saint Hilaire Versus Cuvier," 59.

⁸⁸ I discuss his publications further below, including the delays in the appearance of the *Tableau des terrains*.

⁸⁹ Launay, *Les Brongniart*, 95-6.

Various sources show that Brongniart and Cuvier were still regularly in one another's company during the 1820s, either at Brongniart's cabinet, or at Cuvier's Saturday evening salons.⁹⁰ Following the second edition of the Paris Basin study in 1822, the pair were also still engaged in further research, even though most of the field work and analysis was completed by Brongniart in its later years.⁹¹

Brongniart retained a life-long friendship with Geoffroy, and never ceased to participate in Cuvier's social and personal life, even if he sometimes acknowledged the difficulty of dealing with Cuvier's dominating personality.⁹² In May 1830, although their debates were only recently concluded, Cuvier had put aside his public and intellectual disagreements, visiting Geoffroy to share his condolences at the death of Geoffroy's nineteen-year-old daughter Anaïs.⁹³ However, Cuvier's trip to London in the summer of 1830 and his early death in 1832 allowed little time for either private or public repair between them.

Understanding the Earth: Travel, Geological Mapmaking, and Geognosy

The related households of 71 rue Saint Dominique continued to share common efforts during the 1820s. In 1811, while Brongniart and Cuvier were publishing the first results of their Paris Basin survey, Brochant de Villiers had reinvigorated the idea of a producing a complete geological map of France, a scheme that had been initiated by Guettard in the eighteenth century.⁹⁴ However, it was only in 1822 that the long-

⁹⁰ Audouin, *Journal d'un étudiant*, 56; Lyell, *Life, Letters and Journal*, v.1, 133; Sarah Bowdich Lee, *Memoirs of Baron Cuvier* (London, 1833), 166-7.

⁹¹ Philippe Taquet, "Les contributions respectives," 14-5.

⁹² Launay, *Les Brongniart*, 97.

⁹³ Le Guyader, *Geoffroy Saint-Hilaire*, 123.

⁹⁴ Jean Gaudant, "André Brochant de Villiers (1772-1840), concepteur de la Carte géologique de la France, dite de Dufrénoy et Élie de Beaumont (1841)," *Travaux du Comité français d'Histoire de la Géologie* 3, 23 (2009): 67-88.

envisaged project received official sanction. Brochant, and two of his students, Jean-Baptiste Élie de Beaumont (1798-1874) and Ours Pierre Armand Petit-Dufrénoy (1788-1857) travelled to England to study geology alongside English specialists, particularly with a view to learning novel map-making methodologies.⁹⁵ Also in 1811, Coquebert de Montbret and Omalius d'Halloy (1783-1875) had begun work on a geological and statistical map, which they based on existing cartographic sources coupled with independent research. Brongniart was a correspondent and contributor to their map from its onset, and one of the working copies was maintained in his library.⁹⁶ Omalius d'Halloy's *Essai d'une carte géologique de la France, des Pays-Bas et de quelques contrées voisines* was published in 1822.⁹⁷ The following year, two separate explanatory essays, one by Coquebert de Montbret and the other by Omalius d'Halloy also appeared in print.⁹⁸

Like Brochant de Villiers and Coquebert, Brongniart recognised the value of location-specific information and correlated geological data; indeed, he continued to update his travel journals for more than thirty years after his arrival at Sèvres. Sticking to his late 1790s decision to spend his efforts travelling throughout Europe, he visited sites in England, France, Sweden, Holland, Germany, Switzerland, and Italy. Brongniart also had access to the map collection of Coquebert and relied upon

⁹⁵ Josef W. Konvitz, *Cartography in France* (Chicago, 1987), 89.

⁹⁶ Isabelle Laboulais-Lesage, "From Sketches to Publication: The Genesis of the 'Essai d'une Carte Géologique' by Omalius d'Halloy and Coquebert de Montbret (1810-1823)," *Earth Sciences History* 26 (2007): 2, 6-8, 16, 18.

⁹⁷ A. Dufrénoy and L. Elie de Beaumont, *Explication de la carte géologique de la France* (Paris, 1841).

⁹⁸ Jean Julien de Omalius d'Halloy, *Essai d'une carte géologique de la France* (Paris, 1823); See also: Laboulais-Lesage, "From Sketches to Publication," 31-53; Laboulais-Lesage, "Reading a Vision of Space;" Pierre Savaton, "The First Detailed Geological Maps of France: Contributions of Local Scientists and Mining Engineers," *Earth Sciences History* 26, 1 (2007): 55-73; Gaudant, "André Brochant de Villiers;" Maurice Nicklès, "Le Service de la Carte géologique de la France," *Revue d'histoire des sciences et de leurs applications* 22, 2 (1969): 163-166.

Coquebert's input as well as that of explorers and travelling naturalists. He further requested mineralogical and fossil samples from around the world, having provided specific instructions on how to collect, to record, and to label the items.⁹⁹ In 1812, just after the eight-year survey of French pottery, the *Equête de Prefets* (which I discussed in Chapter Five), had come to an end, and following the publication of the first edition of the Paris Basin study, Brongniart and his student Prévost took a trip to Germany for the purpose of making mineralogical and geological observations and visiting porcelain manufactories. Brongniart visited Berlin, where he was joined by Georg Frick, the director of KPM, the royal porcelain manufactory at Berlin. Frick thereafter remained alongside Brongniart on his trip throughout the country, including a stay at Meissen.¹⁰⁰

As with much of Brongniart's travel and scholarship, he cultivated exchanges of porcelain samples to benefit the collections of the museums at Sèvres and, reciprocally, for the collections of the partner manufactories, such as KPM. In addition, he took notes on technical processes, kiln designs, and local materials.¹⁰¹ The 1812 visit to Germany was Brongniart's ninth major trip for which he created a journal, and the first outside France since 1802. From this point forward, Brongniart pursued fieldwork in France as well as throughout Europe, often taking Adolphe with him. He was frequently joined by his students, and among his destinations, in 1817 he travelled to the Jura mountains; in 1820 to Italy; in 1824 to Sweden; and in 1835 to Holland and Germany. In 1830, Brongniart had planned another trip to European manufactories,

⁹⁹ Benjamin Silliman, *American Journal of Science* 31 (January 1837): 134-7.

¹⁰⁰ However, Frick was not granted access to the manufactory at Meissen during Brongniart's visit. Tamara Préaud, "Alexandre Brongniart and the German Manufactories: Exchanges and Travels 1800-1847," in Samuel Wittwer, ed. *Refinement and Elegance* (New York, 2007), 97-113.

¹⁰¹ See Préaud, "Alexandre Brongniart and the German Manufactories."

including Germany, which he titled “Voyage céramique.” However, with the outbreak of the July Revolution, the journey was suspended.¹⁰²

Depicting the Surface of the Earth: *The Tableau de Terrains & Tableau théorique*

Brongniart sought to link his work with that of other geologists. He used global comparisons to create an expanded geognostic study, at least for locations for which there were correspondents and contributors, such as explorers, mineralogists, geologists, and amateurs. He proposed a text that would describe the layers of the Earth’s crust in detail, using an elaborate cross-section to illustrate the geognostic periods. The *Tableau des terrains*, alongside its engraved illustration, *Tableau théorique*, appeared in 1829 (see Figure 7.10).¹⁰³ True to his cautious methodology, he restricted the project to the information that he could verify, and his cross-sections depicted only the European region that he had studied in detail.

As we noted in the previous chapter, Brongniart’s publications of the 1820s concerned mineralogy, geology and palaeontology, along with the technological aspects of porcelain and pottery production. Many of his articles were written for encyclopaedias, which targeted a broad audience of both experts and general readers. His writing for the *Dictionnaire des sciences naturelles* was mapped according to a basic plan outlined for the reader by Cuvier in the prospectus for the series, which offered the reader concise entries that were organized by genre (and related synonyms),

¹⁰² On the voyages, see Alexandre Brongniart, *Journaux et papiers se rapportant aux voyages d’Alexandre Brongniart, Journaux, lettres et papiers de voyage*, Ms 2336-2351.

¹⁰³ Alexandre Brongniart, *Tableau des terrains qui composent l’écorce du globe* (Paris, 1829). Alexandre Brongniart, Stév.-F. Constant-Viguié, and Jacques Collon, *Tableau théorique de la succession et de la disposition la plus générale en Europe des Terrains et Roches qui composent l’écorce de la Terre, ou exposition graphique du Tableau des Terrains* (Paris, 1829).

then order, class, and kingdom. Since the *Dictionnaire des sciences naturelles* was published in an alphabetical series, Brongniart often referred the reader to entries in volumes that had not yet been produced. These references outlined the areas of study he intended to pursue from the start of the project, and between 1808 and 1830, he authored numerous essays on topics related to geology and mineralogy. His combination of expertise enabled him to create some of the first explanations of the nature of clays and their geological context. His articles on pottery and its materials began with ninety-five pages on clays under the entry for “*Argille*” in 1816.¹⁰⁴ In 1830, he wrote an eighteen-page article, “*Porcelaine*,” for Courtin’s *Encyclopédie moderne* and an almost three-hundred page article, “*Poteries*,” for the *Dictionnaire technologique*.¹⁰⁵ As I show in Chapter Eight, the articles on pottery and clays were comprehensive enough to have been published independently, but with initial publication in three different contemporary encyclopaedias, they brought Brongniart’s knowledge to a wide audience.¹⁰⁶

The year 1830 marked a turning point in Brongniart’s research and writing, as he began to shape his thoughts on the ceramic arts. The article “*Poteries*,” was the first time he used the phrase “*arts céramiques*” in print, and while he did not explicitly define it, the meaning was clarified by his usage.¹⁰⁷ The Paris Basin survey that he had begun with Cuvier would remain an active area of study for most of his career, but with Cuvier’s death in 1832 and the shift in his own focus towards ceramics, Brongniart

¹⁰⁴ “*Argille*,” *Dictionnaire des Sciences Naturelles*, t. 3 (Paris, 1816): 3-95.

¹⁰⁵ Alexandre Brongniart, “*Porcelaine*,” in Eustache Marie Courtin, *Encyclopédie moderne*, t.18 (Paris, 1830): 576-94; “*Poteries*,” in Anselme Payen et al., *Dictionnaire technologique*, t.17 (Paris, 1830): 46-337.

¹⁰⁶ Dictionary entries such as “*Argile*,” “*Kaolin*,” “*Marl*,” “*Poteries*,” and “*Porcelaine*,” supported or were partial drafts of sections in his late career publications in ceramics, which are the primary focus of the following chapter.

¹⁰⁷ Brongniart, “*Poteries*,” 46-337.

finalized his research on the topic with a third edition of the *Description géologique* in 1835.¹⁰⁸ In 1839 and 1841, respectively, he presented the *Premier* and *Second mémoire sur les kaolins ou argiles à porcelaine* to the Institut.¹⁰⁹ These were predominantly geological and mineralogical studies, but Brongniart included the role of clays in industry. The memoirs and the encyclopaedia entries were, in turn, partial drafts of *Arts céramiques*.¹¹⁰ From this point forward, Brongniart centred his writing on its completion, as well as on the *Description méthodique du Musée de Sèvres*.¹¹¹

Making Sense of Time: Geology, Geognosy, and the Nature of the Earth

Brongniart's geological and geognostic ideas can be traced through his articles in the *Dictionnaire des sciences naturelles*.¹¹² He consistently linked his articles by referring the reader to related subjects, although these subjects were a part of a long-term plan. In his introduction to the mineralogical sections, for example, he wrote that entries on geology and other related topics would appear in forthcoming articles.¹¹³ Brongniart had written of the need to write a separate study dedicated to geognosy as early as the 1807 introduction to *Traité de élémentaire de minéralogie*.¹¹⁴ These entries would explain the distinctions he made between the two sciences, while also explaining the underlying methodologies and ideas. He considered that this was the inconvenience of issuing articles in alphabetical order, that the underlying principles were not

¹⁰⁸ Cuvier and Brongniart, *Description géologique des environs de Paris*, 1835.

¹⁰⁹ Alexandre Brongniart, *Premier mémoire sur les kaolins ou argiles à porcelaine sur la nature, le gisement, l'origine et l'emploi de cette sorte d'argile* (Paris, 1839); *Second mémoire sur les kaolins ou argiles à porcelaine* (Paris, 1841).

¹¹⁰ Alexandre Brongniart, *Traité des arts céramiques* (Paris, 1844).

¹¹¹ Alexandre Brongniart and Denis Désiré Riocreux, *Description méthodique du Musée céramique de la manufacture royale de Porcelaine de Sèvres* (Paris, 1845).

¹¹² Frédéric Cuvier, *Dictionnaire des sciences naturelles*, 94 vols., (Strasbourg, 1816-1830).

¹¹³ Cuvier, *Dictionnaire des sciences naturelles* 1 (1816), xlij-xlvi.

¹¹⁴ Alexandre Brongniart, *Traité élémentaire de minéralogie* (Paris, 1807), xi.

accessible to the reader from the beginning of the project.

In “*Eau*,” which appeared in 1819, he again referred his reader to the forthcoming articles “*Geologie*” and “*Geognosie*.”¹¹⁵ However, when the volume slated to contain these two articles appeared in 1821, they were instead brief definitions of the terms, completed, not by Brongniart, but by Brard, who served as an additional contributor on topics in mineralogy and geology. While similar to Brongniart’s earliest descriptions in the *Traité élémentaire de minéralogie*,¹¹⁶ Brard’s definitions of 1820 clarified the distinction between geology and geognosy, and he claimed that as a science, geognosy had originated only with Saussure, Pallas, Werner, Dolomieu, Faujas, and Spallanzani.¹¹⁷ Its object was the knowledge of the Earth, and of its nature, disposition, and all of the “contours of (its) mineral masses.” The inductive practices of geognosy contrasted with geology in that, with the latter, arbitrary theories, based on generalities deduced by observation, had frequently been developed. Thus, according to Brard, the term geology had, at times, been associated with gratuitous suppositions and hypotheses.¹¹⁸

The scale of the task, and Brongniart’s thorough approach to the subject matter very likely contributed to the delay in the appearance of the planned theoretical discussion, which was moved to the entries for “*Terres*” and “*Terrain*,” both of which could be found in the 53rd volume (published in 1828).¹¹⁹ Again, the entry “*Terrain*” indicated that another forthcoming article, *Théorie de la structure de l’écorce du globe*,

¹¹⁵ Alexandre Brongniart, “*Eau*,” *Dictionnaire des science naturelles*, t.14 (1819), 48.

¹¹⁶ Brongniart, *Traité élémentaire de minéralogie*, xj.

¹¹⁷ Cyprien Prosper Brard, “*Geognosie*,” *Dictionnaire des science naturelles*, t.18 (1820), 358.

¹¹⁸ Cyprien Prosper Brard, “*Geologie*,” *Dictionnaire des science naturelles*, t.18 (1820), 437.

¹¹⁹ Alexandre Brongniart, “*Terrain*” and “*Terres*,” *Dictionnaire des science naturelles*, t.53 (1828), 153-4, 209-10.

would resolve the questions surrounding both geology and geognosy. The long-delayed and much-enlarged article appeared as an extraordinary 250-page text in the *Dictionnaire des science naturelles* in 1829, and was also published separately in its entirety, running 450 pages, under the title *Tableau des terrains qui composent l'écorce du globe*. It stood as one of the cornerstones of Brongniart's research across his career as a geologist and mineralogist.

With the *Tableau de terrains* and the *Tableau théorique*, Brongniart outlined his ideas on the Earth, in which he balanced his fact-oriented approach to research with theoretical ideas that grew out of close observation. As he drew conclusions from the evidence that he had accumulated over more than four decades, Brongniart's *Tableau théorique de la succession et de la disposition la plus générale en Europe*, which I discuss below, clearly depicted species extinction and concretized his view on the varying intensity of natural forces, such as the early role of volcanoes in the formation of the Earth's surface (see Figure 7.10). Brongniart altered his definitions from earlier statements, where he had described geognosy as purely factual, while geology had possessed a purely theoretical basis.¹²⁰ He now explained that geognosy was the *theory*, defined as the recognisable link that could be established between facts, while geology was the *system*, or the study of distant causes that could have acted to produce the visible facts and their correspondence. Thus, geognosy was the theory of the surface of the globe, and geology was the overarching theoretical description.¹²¹ Fundamental to the establishment of theory was the determination of the composition of the Earth, including the order of the layers, their unique situation, and local variations.¹²²

The contradiction between the previous definitions Brard and Brongniart had

¹²⁰ I have discussed these terms in Chapter Six.

¹²¹ Brongniart, *Tableau des terrains*, 2.

¹²² Brongniart, *Tableau des terrains*, 2.

given to *geognosy* and *geology*, where geognosy was held to be explicitly non-theoretical, and Brongniart's revisions of 1828, not only highlighted the difficulty of separating the two terms, but also reflected that the effort to establish a distinct, non-theoretical practice of geognosy had failed.¹²³ In 1828, Brongniart attempted to accommodate the ongoing, widespread usage of the term "geology" by shifting the definitions, but the change served only to make the picture less clear. Although Brongniart followed through on the structure that he had established between the date of his first publications of the *Traité de Minéralogie* in 1807 and the appearance of the *Tableau des Terrains* in 1829, the term geognosy, never convincingly clear, had fallen increasingly out of use. Werner's nomenclature for the separation of geology into multiple disciplines had not fully been accepted, and most geologists, especially in Britain, preferred to use *geology* with a broad reference that contained both theoretical and practical features.¹²⁴

In the *Tableau des terrains*, Brongniart described what he considered to be established facts of Earth's composition by examining each layered strata (*terrain*) in mineralogical and paleontological detail. He also explored the prominently circulating theories related to the Earth's history and the ways in which landforms were created. Brongniart illustrated *Tableau des terrains* with *Tableau théorique*, a cross-sectional cartographic representation of the Earth depicting the order and content of geological formations (see Fig. 7.10). The information of the *Tableau théorique* was organized as a cut-away landscape, drawn only for the European continent that Brongniart considered to be well-enough understood and documented. Left of the axis, Brongniart

¹²³ Brongniart, *Traité élémentaire de minéralogie*, xj; Brard, "Geognosie," *Dictionnaire des science naturelles*, t.18 (1820), 358; Brard, "Geologie," *Dictionnaire des science naturelles*, t.18 (1820), 437.

¹²⁴ R. J. Howarth, "Etymology in the Earth Sciences: From 'geologia' to 'geoscience'," *Earth Sciences History* 39, 1 (2020), 1-27.

depicted a cross-section of a layered earth formation that ranged from the uppermost layer of the present, down to a bed of granite and related minerals. To the right of the axis, he included a diagrammatic cross-section of an active volcano resting on terrains composed of igneous rock types. Brongniart differentiated each layer with stylised but descriptive patterns, while the classes were filled in with keyed colours. One layer after another was carefully labelled by *class* and *formation*, and marked out by distinctions in appearance, material, and organic matter. The organic remains, such as plants and fossils, as well as skeletal remains, were identified by simplified drawings that were featured in the terrains where they could be found. The layers with skeletons of complex creatures were sandwiched between those containing aquatic life, or those devoid of fossil contents entirely – each new *formation* represented a marked change from the previous.¹²⁵

The outer frame of the image listed the geological periods, read from oldest to newest, clockwise from the right – the ingenious design showed a prehistory where volcanoes were the primary feature of the Earth's surface, leading to a period in which granite and related materials (pegmatite, kaolin, *hyalomictes* (griesen), protogine, syenite, and diorite) formed, but the image could be read simultaneously as a landscape depicting present-day volcanic activity. Granitic materials were shown as the lowest-known solid layer of the Earth's crust. While the volcanoes were shown as the producer of the various igneous rocks, they were shown above the granite, alongside other strata which also rested upon granitic foundations. Importantly, a key feature of Buffon's eighteenth-century history of the Earth was that the globe had originally been a fiery mass, much like the sun. Although Brongniart did not reference Buffon, the idea had

¹²⁵ The single sheet image was engraved by Jacques Collon, Brongniart, *Tableau théorique*, 1829.

been in circulation in France for decades. Thus, both natural historians and general readers of the *Tableau des terrains* would have been familiar with the concepts behind the visual information of the *Tableau théorique*, reading it as a logical sequence that illustrated a chronological account of the Earth's history.

In *Tableau des terrains*, Brongniart drew upon the methodology of the ongoing Paris Basin study but sought to create a generalised explanation of each geognostic terrain, including reasons for the formation and disappearance of features. It demonstrated his mature conception of the nature of the Earth and the layers which composed its surface, in which he divided its timescale into two defining eras: the *Saturnienne*, or prehistoric, and the *Jovienne*, or historical, time periods. These two broad time periods reflected generally held ideas as to the division of time, including those of Buffon. Although Brongniart maintained that all historical accounts of massive floods were apocryphal, time (and history) was commonly referred to as being either “ante-diluvian” or “diluvian,” terms that were deeply ingrained in the common language. While he sought to divorce these terms from a literal meaning or from any Scriptural connotation, the division of time along approximately similar lines, as related to known human history, remained a useful construct. Additionally, although the terms he used were drawn from the previously-adopted vocabulary of geologists – including *Saturnienne* and *Jovienne* – he stressed that the terms were independent of hypothesis or theory, and explicitly distinguished their geological meanings from any classical mythological reference.¹²⁶

Brongniart indicated that the layers of the Earth had been created by the distinct depositions made during a long series of centuries and numerous physical actions. These layers could be seen as generally uniform in principal structures, even at far

¹²⁶ Brongniart, *Tableau des Terrains*, 17.

distances from one another. Although it was probable that the Earth's principal *terrains* (strata) had been developed similarly around the globe, as the entire surface of the globe was not well known there was no way of verifying this, and it remained an open question.¹²⁷ Thus, Brongniart's views of the deposition of strata and their order of succession were only discussed in relation to those places in which it could be established with accuracy. The *Tableau théorique* specifically referred to Europe, although he believed, based on the limited evidence provided by foreign naturalists, that it was directly comparable to the rest of the globe, at least in a general sense.¹²⁸

He described the two types of deposition noted by geologists – either one on top of the other, or those that existed side by side. The former was “in series” and the latter was “out of series.” The layers formed out of series had the potential to be formed either during the same epoch, or during vastly different ones. This fact pointed to the difference between geognostic epochs and chronological ones. The succession of time determined chronological epochs. Conversely, the limitations on geognostic epochs were created by *grand phenomena* that altered the surface of the Earth.¹²⁹

When Brongniart addressed grand phenomena, he did not connect them to the Noachian flood or to any other biblical event. He also stated clearly that there were no authentic written historical accounts of phenomena that could be shown to have occurred on the vast scale that was visible in the geologic record, especially those of the more dramatic *Saturnienne* period. No human account described an event that could have affected the entire surface of the globe, nor could any accounts even be compared to smaller phenomena typical of the *Jovienne*, or modern-day period.¹³⁰ Brongniart

¹²⁷ Brongniart, *Tableau des Terrains*, 6.

¹²⁸ Brongniart, *Tableau des Terrains*, 2-27.

¹²⁹ Brongniart, *Tableau des Terrains*, 8.

¹³⁰ Brongniart, *Tableau des Terrains*, 27-32.

wrote that the last giant “general catastrophe,” which brought an end to the *Saturnienne*, had put the continents in their actual forms, and the sea in its current basin.¹³¹ The catastrophe had acted differently in distinct locations on the globe, but shared a “common character” in both cause and time period.¹³² Hedging on the lengths of time necessary to reposition continents, Brongniart noted only that these unknown events could have happened over several centuries, or even a few years.¹³³

The divisions between geognostic epochs were obvious from the readily visible boundaries between distinct *terrains*. Importantly, it was apparent to Brongniart and Cuvier that events had occurred to alter the circumstances under which successive layers had been deposited, and elsewhere, Brongniart had acknowledged the extinction of certain species, such as the trilobite, about which he wrote *Histoire naturelle des crustacés fossiles* in 1822.¹³⁴ Additionally, Cuvier had argued that the presence of the bones of large tropical animals such as elephants found in the geological record of Italy or England pointed to various kinds of alterations in the living conditions of the Earth, and the dramatically different creatures indicated by the skeletal remains of creatures such as the Mosasaur, showed that some creatures had disappeared completely from the known living world.¹³⁵ Brongniart believed these climate changes and extinctions were often the result of large phenomena in some unknown way.¹³⁶

Brongniart’s explanations balanced the role of water with other potential forces

¹³¹ Brongniart, *Tableau des Terrains*, 121.

¹³² Brongniart, *Tableau des Terrains*, 122.

¹³³ Brongniart, *Tableau des Terrains*, 29.

¹³⁴ I discuss this article in Chapter Six. Alexandre Brongniart and Anselme Gaëtan Desmarest, *Histoire naturelle des crustacés fossiles* (Paris, 1822).

¹³⁵ M. J. S. Rudwick, *Georges Cuvier, Fossil Bones, and Geological Catastrophes* (Chicago, 1997), 54-8.

¹³⁶ Brongniart, *Histoire naturelle des crustacés fossiles*, 64-5; *Tableau des Terrains*, 4-9, 29-33, 64; Cuvier and Brongniart, *Description géologique des environs de Paris*, 2nd ed., 1-2.

and global movements. He distanced himself from Buffon and other authors, who argued that the irregularities on the surface of the Earth, such as mountains, had been constructed by the underwater movements of a vast ocean. He drew upon Pierre-Simon Laplace and Siméon-Denis Poisson's view that the violent waves at the surface of the ocean did not propagate with the same intensity at the bottom of the sea. Brongniart considered that it was probable that the moveable materials at the bottom of the sea were very near the same place they had been "since our continents took their configuration," although the phenomena and movements in the depths of the ocean remained completely unknown.¹³⁷

Although his view of geological time was explicitly in favour of a long, but as-yet incalculable, duration, Brongniart highlighted the magnitude and the potentially extraordinary behaviour of forces rather than any specific or even general amount of time in which they had acted. While he had an expansive view of time, he was not a strict uniformitarian or gradualist. He was not willing to concede that only observable, "present-day forces" had been able to create all the types of formations or features visible in the Earth's crust. He did not believe that the movement of pure water, acting alone, without being either frozen or by causing decomposition, for example, was responsible for building valleys or gorges.¹³⁸ For example, the chart *Tableau particulier des terrains* indicated that erratic blocks were "transported by ice."¹³⁹ In the accompanying text, Brongniart described the movement of these enormous blocks of rock, more ancient than the land upon which they were positioned, as the result of a "violent cause."¹⁴⁰

¹³⁷ Brongniart, "Eau," 60.

¹³⁸ Alexandre Brongniart, "Eau," *Dictionnaire des Sciences naturelles*, t. 14 (1819), 56-57.

¹³⁹ Brongniart, *Tableau des terrains*, 28.

¹⁴⁰ Brongniart, *Tableau des terrains*, 74.

Despite the explicit annotation in favour of the movement of ice that Brongniart made in the table, in the text he hedged over naming any of the several theories he described as offering a clear solution to the question of erratic blocks, including Giovanni Battista Venturi's theories of ice transport.¹⁴¹ Although Brongniart had, in fact, made a clear choice in the table, he was not yet willing to promote this complex and controversial theory over the others, at least in the context of the *Tableau des terrains*. In *Tableau des terrains*, Brongniart sought a balanced approach that utilised carefully organized data and its analysis, in which evidence could be traced to potential causes. For unsettled questions, he presented several potential explanations that were in circulation at the time of his publication, but often left them open-ended. Erratic blocks were a subject of much debate at the time of Brongniart's publication, and he deliberately sidestepped a lengthy discussion of the individual theories.¹⁴² He did, however, assert that, similar to de Buch's views, he believed the dispersion of the erratic blocks into their present positions was related to an event that came after whatever phenomenon had uplifted the Alps, which marked his stance on another key idea.¹⁴³

While Brongniart continued to resist what he saw as unnecessary disagreement, particularly with his former mentors or his associates, he clearly indicated his support for geological ideas such as the mechanical uplift of the Earth's surface. Critically, Brongniart pointed to the action of the movement of the continents into their current locations on multiple occasions, referring to it as the marker of the division between the *Saturnienne* and *Jovienne* periods.¹⁴⁴ Evidence demonstrated clearly that the continents had, in some unknown way, been moved or altered, both apart, and upwards,

¹⁴¹ Brongniart, *Tableau des terrains*, 76-7.

¹⁴² Brongniart, *Tableau des terrains*, 77.

¹⁴³ Brongniart, *Tableau des terrains*, 77.

¹⁴⁴ Brongniart, "Eau," 60; Brongniart, *Tableau des terrains*, 17.

and certain mountain ranges, such as the Alps, had obviously been raised by some significant but unknown force or forces.¹⁴⁵

In common with Buffon's eighteenth-century theories, Brongniart's *Tableau théorique* depicted an Earth that was once much hotter, where, in cooling, the continents and the atmosphere were formed. He wrote that the present-day geognostic epoch coincided with a state of "repose" that had emerged since the continents took on their current forms, the sea arrived at its current level and location, and the atmosphere reached its present temperature. These conditions permitted the growth of the animals with which we are familiar, as well as human life.¹⁴⁶ Brongniart demonstrated that the Earth's surface had been transformed many times, and that most of those actions had taken place prior to the evidence of human existence, such as the eras during which the trilobite was prolific. Not only were there previous geognostic periods, many of them had been populated by different kinds of creatures who did not resemble any in the living world of the *Jovienne*.¹⁴⁷

Brongniart considered that the three "classes" of the current geognostic era, the *Jovienne*, exhibited a calmer and/or more temperate set of present-day conditions than those of the six *Saturnienne* period classes he defined.¹⁴⁸ Importantly, the *Saturnienne* period was marked by catastrophes of phenomenal magnitudes that were unseen in the *Jovienne* period. Brongniart indicated that the layers of the Earth generally could be identified across the globe by their mineralogical character as well as by their general resemblance to one another, coupled with the fossil materials they contained. In places where other resemblances could not be established, characteristic fossils could help

¹⁴⁵ Brongniart, *Tableau des terrains*, 252.

¹⁴⁶ Brongniart, *Tableau de terrains*, 9, 31.

¹⁴⁷ M. J. S. Rudwick, *Meaning of Fossils* (Chicago, 1985), 127-32, 199.

¹⁴⁸ Brongniart, *Tableau des Terrains*, 27.

clarify terrains. Strata considered “in series” could be distinguished by the manner and patterns of stratification that typified them. “*Terrains stratifiés*,” or *Neptunien*, were laid down in liquid (i.e., sedimentary). The “out of series,” or *Typhonien*, terrains (*terrains massifs*), were formed by cooling or disordered crystallisation, appearing in tracks or veins, either perpendicular to or cutting across the sedimentary layers (i.e., igneous). Brongniart used these considerations to clarify the subdivisions of the *Saturnienne* period.¹⁴⁹

The deepest layer and thus the oldest class in his series were the *Terrains Agalysiens* (primordial terrains of crystallisation, also commonly called *terrains primitifs*).¹⁵⁰ Brongniart considered “the space of time during which granite appeared on all the part of the surface of the Earth, accompanied by the minerals it contained, was a remarkable geognostic period.”¹⁵¹ Again, this was an understatement, because, through everyday ceramic practice, Brongniart knew intuitively the force and heat necessary to melt and fuse rocks. He did not describe in detail what he meant by “remarkable” for his readers. However, the *Tableau théorique* illustrated that the lowest layers of Earth’s crust – at least in Europe, but presumably globally – had been shaped by volcanic activity, which continued to be a factor in the present period (see Figure 7.10).

As we have seen, Brongniart, in his studies with Cuvier, had recorded a sequence of periods when what were large land masses in the present-day had been covered by either the sea, or freshwater, in alternation. He pointed to the Great Lake region of North America as a present-day example of lakes of an identical size to those which filled the Paris Basin. However, he also considered that the continents had not

¹⁴⁹ Brongniart, *Tableau des terrains*, 27.

¹⁵⁰ Brongniart, *Tableau des terrains*, 317.

¹⁵¹ Brongniart, *Tableau des terrains*, 8.

always been structured and placed the way that they came to be in the *Jovienne* period. The movement of the continents into their current configuration, and the establishment of the current locations of the sea and its level, however long that *moment* took, were the defining characteristics of the beginning of the *Jovienne*.¹⁵² Brongniart was clear that these could have taken place at once, or could have occurred faster in one part of the globe than another:

The word *moment* should not be taken here in the restricted meaning that is ordinarily given to it; on the contrary, it must be given the amplitude required by all the great phenomena of nature; so when a tempest, a thunderstorm, a volcanic eruption ends, although we can say that the general phenomenon ended around such time of the month or such time of the day, we know very well that the partial phenomena have not all finished at the same time.¹⁵³

Brongniart was vague about the lengths of time at work, partly because of the limitations of the data, but also because he was convinced that certain periods witnessed forces that went beyond those of recorded experience. His emphasis was on the marked changes between subsequent strata and the obvious extinctions that had occurred on multiple occasions. Some of these extinctions seemed to have occurred relatively rapidly. He saw that there were instances when present-day actions could not account for the changes in the Earth's structure. It was an argument that could be applied to a "Catastrophic" or "Neptunist" view, but Brongniart was not limited to the short timescale of which the contemporary rhetoric of the Uniformitarians, led by Lyell, often accused those they labelled "Catastrophists."¹⁵⁴

Alistair Sponsel has recently argued that Darwin withheld his ideas on the transformation of species for several years, as he was reluctant to challenge prevailing thought with such a radical assertion and was concerned about a too hastily concocted

¹⁵² Brongniart, *Tableau des terrains*, 29.

¹⁵³ Brongniart, *Tableau des terrains*, 29.

¹⁵⁴ On the ideas of the "Uniformitarians" and the "Catastrophists" in England, see Walter F. Cannon, "The Uniformitarian-Catastrophist Debate" *Isis* 51, 1 (1960).

theory being overturned.¹⁵⁵ In Brongniart's case, while he may have considered geological time as expansive, or had ideas similar to the limitless time promoted by Charles Lyell in 1830, he had little to gain by boldly declaring a phenomenally long timescale to general readers of his work. Although he was scrupulous about maintaining his credibility as a natural historian by eschewing the publication of radical hypotheses, he continued to seek evidence that would clarify the question.

The Challenge of Catastrophism

Both Brongniart and Cuvier have, at times, been viewed as "Catastrophists." Cuvier, perhaps more frequently than Brongniart, has been seen as having related the various events that covered the Paris Basin with water to a biblical narrative and even to the Mosaic floods.¹⁵⁶ This belief is owed almost entirely to Robert Jameson's preface to *Essay on the Theory of the Earth*, the unofficial, but widely-read 1813 translation of Cuvier's "Preliminary Discourse" to *Ossomens fossils*. Jameson's additions and remarks were highly influential in later geological and historical thought.¹⁵⁷ He began his preface by noting that "although the Mosaic account of the creation of the world is an inspired writing, and consequently rests on evidence totally independent of human observation and experience, still it is interesting, and in many respects important, to know that it coincided with the various phenomena observable in the mineral kingdom." Jameson claimed that the structure of the Earth and its fossil contents directly confirmed scriptural accounts. Further down, he added: "the deluge, one of the

¹⁵⁵ Alistair Sponsel, *Darwin's Evolving Identity* (Chicago, 2018), 227-40.

¹⁵⁶ See Philippe Taquet, "Cuvier's Attitude Toward Creation and the Biblical Flood," *Geological Society Special Publications* 310, 1 (2009).

¹⁵⁷ M. J. S. Rudwick and Georges Cuvier, *Georges Cuvier, Fossil Bones, and Geological Catastrophes* (Chicago, 1997), xi; see also Taquet, "Cuvier's Attitude Toward Creation and the Biblical Flood."

grandest natural events described in the Bible, is equally confirmed, with regard to its extent and the period of its occurrence, by a careful study of the various phenomena observed on or near the Earth's surface."¹⁵⁸

Nevertheless, Cuvier's original arguments did not mention biblical accounts. The fact that there were different periods of freshwater and marine water that alternated in the Paris Basin was clear in the geological record and it was impossible to reconcile these with Scriptural accounts even if he had wanted to do so. Both Cuvier and Brongniart believed that various phenomena had triggered the changes to the environment that had periodically led to widespread extinctions, as with the trilobite, but these had taken place on multiple occasions.¹⁵⁹ Additionally, Cuvier believed that the evidence provided by the finds of well-preserved mammals encased in ice demonstrated that whatever the event was that had initially frozen them was massive and had occurred suddenly.¹⁶⁰

Lyell's three-volume *Principles of Geology* appeared in print between 1830 and 1832. A proponent of the kind of 'uniformitarian' approach first proposed by James Hutton, Lyell argued for present-day causes over the occasional actions of great forces, which he classed entirely as catastrophes.¹⁶¹ His work championed a "steady-state" Earth with cyclic changes, and an incalculably long timescale of, perhaps, millions of years.¹⁶² Lyell's work stated outright that the formation and development of the Earth had required vastly extended amounts of time. However, his denial of the occurrence of any extraordinary forces was an extreme position for many geologists, including

¹⁵⁸ Georges Cuvier, Robert Jameson, and Robert Kerr, *Essay on the Theory of the Earth* (Edinburgh, 1817), xvi.

¹⁵⁹ Brongniart, *Tableau des terrains*, 64.

¹⁶⁰ Georges Cuvier, "Discours préliminaire," *Recherches sur les ossemens fossiles de Quadrupèdes*, t. 1 (Paris, 1812) 10-1.

¹⁶¹ Charles Lyell, *Principles of Geology*, vol. 1 (London, 1830), 78-90.

¹⁶² Rudwick, *Earth's Deep History*, 169-171.

Brongniart.¹⁶³

Lyell attempted to downplay the role of the successive marine and freshwater flooding of the Paris Basin described by Brongniart and Cuvier, and generally treated Brongniart's views of powerful forces antagonistically when they ran contrary to his own theories of slowly-acting, present-day causes, such as rivers.¹⁶⁴ However, Brongniart's observations led him to recognize that there had been eras of time in which unknown changes had occurred on monumental scales, including a possibility that both ice and volcanoes had once been significantly more important factors and that previous eras were witness to stronger forces than humans had recorded during the *Jovienne*. Lyell hoped to discredit Brongniart's work for his readers, particularly with respect to volcanoes. Taking Brongniart's figurative description that, at earlier periods of the Earth's history, natural forces were present in "centuples" of the amounts observed in the present-day, Lyell calculated hypothetical volcanic forces based on the eruption of Skaptár Jokul in 1783, for which there was a general understanding of the area and scale. Lyell's calculations led directly back to the idea that a significant portion of the Earth was, in Brongniart's scheme, molten and volcanic – or, indeed, all of it, at least before the volcanic fires cooled enough to allow rock to solidify. As a fiery, volcanic Earth remained a controversial and even threatening idea, Lyell hoped that his calculations would seem absurd, suggesting that the earth's natural forces could never have acted such an extreme way.¹⁶⁵ On the contrary, Brongniart did not think that a fiery Earth was improbable but could see that the lowest visible layers of the Earth's surface – comprised almost entirely of granitic rocks – were products of fusion.¹⁶⁶

¹⁶³ Rudwick, *Earth's Deep History*, 170-2.

¹⁶⁴ Charles Lyell, *Principles of Geology*, vol. 3 (London, 1832), 243-8.

¹⁶⁵ Lyell, *Principles of Geology*, vol. 1 (London, 1830), 427-8.

¹⁶⁶ Brongniart, *Tableau des terrains*, 360.

Brongniart occupied a unique position among practising geologists since at Sèvres and elsewhere, he witnessed powerful chemical changes in large pottery kilns on a regular basis. These reactions, such as the melting of silica in the presence of added clays and minerals, and the subsequent cooling of the transformed porcelains, were, in fact, the melting, solidification, and crystallisation of earthen materials. From the eighteenth century forward, numerous geologists had considered the application of heat in their analysis of samples.¹⁶⁷ This was commonly accomplished with the concentrated heat of a blowpipe.¹⁶⁸ Brongniart instructed his students in the use of blowpipes as a part of standard field mineralogical testing.¹⁶⁹ However, blowpipe experiments functioned on a very small scale, and could be held in the experimenter's hand. On this scale they gave little sense of natural forces, as compared to the dramatic transformations witnessed with the room-sized scale of a pottery kiln or a forge, or likewise, a volcano. At Sèvres, the rapidly burning fires of wood or coal kilns, when heated to porcelain temperatures, were microcosms of the Earth's forces. Famously, Buffon had used the forges he owned near Montbard for experiments related to the age of the Earth. He melted iron samples of known masses and proceeded to gauge the time it took for the samples to cool and to solidify, to calculate a potential age for the

¹⁶⁷ Cyril Stanley Smith, "Porcelain and Plutonism," in *A Search for Structure: Selected Essays on Science, Art, and History* (Cambridge, MA, 1981); Cecil J. Schneer, *Toward a History of Geology* (Cambridge, MA, 1969); Sally Newcomb, "Contributions of British Experimentalists to the Discipline of Geology: 1780-1820," *Proceedings of the American Philosophical Society* 134, 2 (1990); Robert Bakewell, *An Introduction to Geology* (London, 1813), 318-319. Brian Dolan "Governing Matters: The Values of English Education in the Earth Sciences 1790-1830," DPhil diss., (Cambridge, 1995), 168-9.

¹⁶⁸ Brian Dolan, "Blowpipes and Batteries: Humphry Davy, Edward Daniel Clarke, and Experimental Chemistry in Early Nineteenth-Century Britain," *Ambix* 45, 3 (1998).

¹⁶⁹ Brongniart, *Mineralogie*, 38-9.

Earth.¹⁷⁰ When extrapolated to a global scale, the power of these fires, like the interior of active volcanoes, pointed to unimaginable (and unliveable) atmospheres.¹⁷¹

Although Brongniart was clear that some phenomena had acted powerfully enough to cause mass extinctions, he also had a long timescale in mind, and in many ways his views were similar to those of Lyell. In one site at the cove of Uddewalla, Sweden, Brongniart calculated that the “recent” formations of sedimentary strata had been exposed for “perhaps” thirty or to forty centuries.¹⁷² This estimate was echoed much later by Lyell, who wrote that these particular formations, which bore fossil remnants identical to still-living sea life, had been uplifted over a period of roughly 5000 years.¹⁷³ Brongniart’s estimate that it took 3000-4000 years to create the local exposure of the sedimentary layers – while the surrounding sea-life remained clearly unchanged – could only hint at the long time scales he believed to be at work. In terrains where there were consistent organic remains, such as the trilobite, Brongniart noted that the fossil record could be used to determine a relative and approximate time scale for a given epoch, if one knew the lifespan of the organism and could determine how many generations were present. He further stated that the *Jovienne* period timescale, if it could be determined, could serve as another comparison for guessing at the duration of other geognostic periods and, therefore, the relative age of the Earth.¹⁷⁴

¹⁷⁰ Jean-Paul Poirier, “About the Age of the Earth,” *Comptes Rendus Geoscience* 349, 5 (2017): 223-5; Sally Newcomb, *World in a Crucible* (Charlottesville, VA, 2009), 139.

¹⁷¹ For comparison, porcelain vitrifies in the range of 1200C to 1400C, while molten lava measured at Kilauea, in Hawaii, averages 1200C. Sonia Calvari and Lawrence H. Tanner, *Volcanoes: Windows on the Earth* (Albuquerque, 2012), 54.

¹⁷² Brongniart, *Tableau des terrains*, 89.

¹⁷³ Charles Lyell, *A Manual of Elementary Geology* (London, 1851), 114.

¹⁷⁴ Brongniart, *Tableau des terrains*, 28-33.

From the Saturnienne to the Jovienne

Brongniart's natural history studies were developed in coordination with a large community of savants and naturalists. His work with Cuvier was foundational to the practice of both stratigraphy and palaeontology. Brongniart built a layered picture of the Earth's formation and history, synthesizing elements from Wernerian geology with aspects of French and British understanding while avoiding extreme positions, such as Neptunism or strict uniformitarianism. The *Tableau des terrains* and the *Tableau théorique* brought together a collection of geological ideas, in which Brongniart's discussion outlined and synthesized prevailing theories, while pointing to significant geological or physical phenomena that were still cause for debate. It was the work of a teacher who sought to stimulate the reader's interest and to spur independent thought.

CHAPTER EIGHT: From Volcanoes to Kilns and Granite to Glaze

Brongniart's collective publications portrayed a vast and continuous history spanning the geology of the Earth's origins to the human historical era. His work at the porcelain manufacture at Sèvres exercised a key influence on the way that he conceptualized this history. The last years of Brongniart's life were dedicated to producing general, synthetic works on the twin sciences of geology and ceramics. In this Chapter, I show that Brongniart's publications in natural history were interwoven with his work in the arts. Brongniart often wrote on one narrow topic at a time, but he did so within a framework that enabled each fact, description, or definition, such as the mineral descriptions within the 1807 *Traité de minéralogie*, or the brief articles that appeared in encyclopaedias, to contribute to an expansive picture of the Earth, its history, its resources, and their uses. In this chapter, I argue that Brongniart's consistent efforts across several newly created scientific disciplines gave him the necessary understanding to establish a rigorous and open science for ceramics of all types.

As we have seen, Brongniart was, by his own design, situated within a prominent centre of information exchange not only for geology and mineralogy, but also for pottery and porcelain making.¹ From his arrival at Sèvres in 1800, he used its laboratories as a site for experiments that expanded scientific knowledge in the field. With the creation of the *Musée céramique* in 1824, he compiled information, objects, and materials for what he termed “*les arts céramiques*.” Brongniart followed the *Tableau des terrains*, which I discussed in Chapter Seven, with a final series of books that together formed the basis of a science of ceramics, beginning with *Traité des Arts céramiques*, published in 1844. *Arts céramiques* spanned two

¹ For a comprehensive study of nineteenth-century European porcelain, as well as on Brongniart's position among other porcelain makers, see Samuel Wittwer, *Refinement & Elegance* (Munich, 2007).

volumes of text (of approximately 1400 pages) and a third volume (the *Atlas*), which included charts and descriptions, along with 86 plates. Importantly, *Arts céramiques* contained accurate data that allowed for reproducible experiments and fired results, such as colour formulations, as well as a clear classification system for ceramic types. The plates depicted all facets of ceramic production, archaeology, and use, including ceramics from foreign or historical cultures alongside those of the contemporary, global porcelain industry.

In 1845, a catalogue raisonné, *Description méthodique du Musée Céramique*, was published as a complement to *Arts céramiques*. Co-authored by the museum's conservator, Denis-Désiré Riocreux (1791-1872), the catalogue included two volumes: the first compiled descriptions of objects in the museum's collection and the second included hand-coloured lithographic plates depicting each item in exacting detail.² The title echoed Romé de l'Isle's *Description méthodique d'une collection de minéraux*, Balthazar George Sage's *Description méthodique du Cabinet de l'École Royale des Mines*, and other, similar natural history publications.³ The plates of *Description méthodique* represented the collections of the Sèvres *Musée Céramique* as of the late 1840s, spanning the period supervised by Brongniart.⁴ Collectively, the series drew together the voluminous information he had compiled over his career, including experiments and analysis of materials.⁵

² Alexandre Brongniart and Denis Désiré Riocreux, *Description méthodique du Musée céramique*, 2 vols. (Paris, 1845).

³ Jean Baptiste Louis de Romé de L'Isle, *Description méthodique d'une collection de minéraux*, (Paris, 1773); Balthazar Georges Sage, *Description méthodique du Cabinet de l'École Royale des Mines* (Paris, 1777).

⁴ It was founded as the *Musée Céramique et Vitrique*, as I have discussed in Chapter Five. On the development of the museum and its importance, see Sophie Millasseau, "Brongniart as Taxonomist and Museologist," in Derek E. Ostergard and Tamara Préaud, *Sèvres Porcelain Manufactory* (New Haven, 1997), 122-48.

⁵ See further Julia Carr-Trebelhorn, *From Geology to Art History* (Lexington, KY, 2014).

The Arts of the Earth: An Incomplete Canon

Well into the nineteenth century, the literature on pottery and porcelain making was sparse and often deliberately misleading. For centuries, those who held the most knowledge, particularly those who ran potteries or manufactories, had little incentive to share what they knew, as they reasonably feared that, in so doing, they could benefit their competition. Only rare authors, who had somehow moved out of or existed beyond the traditional structures of private manufactories and workshops, were in a position to freely share their knowledge. The geologist Barthélemy Faujas de Saint Fond's 1777 edition of the *Œuvres de Bernard Palissy* revived interest in Palissy's geology, as well as his faïence. Palissy became a kind of hero, and he was mythologized during much of the nineteenth century for his natural history practice and his innovations in pottery-making.⁶ Yet, when Palissy wrote on his pottery experiments, as Brongniart noted, he deliberately withheld the details of his research.⁷ Until Brongniart created the *Musée céramique* at Sèvres, there had been no public repository or study collection into which common pottery objects could be placed, such as those in mineralogy or palaeontology at the Muséum. Much of the porcelain collected from Asia was deliberately manufactured for a European market, and few collections, either public or private, could boast of wares that demonstrated styles reserved for the Chinese domestic markets or for the Dynastic ruling classes. More basic wares often failed to catch the eye of European visitors, and few were brought back to Europe.⁸

⁶ An expanded edition of Palissy's works with biographical notes was published by Paul Antoine Cap in 1844. Cap was a student of Brongniart. Bernard Palissy and Paul Antoine Cap (Gratacap), *Oeuvres complètes de Bernard Palissy* (France, 1844).

⁷ Brongniart, *Arts Céramiques*, t. 2 (1844), 63-5.

⁸ This thesis is written from a Western perspective. However, few authors elsewhere, such as Asia or the Middle East, were able to create global histories of ceramics over the same time frame.

The encyclopaedias of the eighteenth and nineteenth centuries were a forum for information about pottery and porcelain where authors could clarify points of general knowledge and discuss themes in manufacturing or technology. Subjects included clays, faïence, pottery, porcelain, and so on. In Diderot and d'Alembert's *Encyclopédie*, the entry on "Fayencerie" covered basic aspects of pottery and porcelain.⁹ Didier-François d'Arclais de Montamy authored entries on porcelain and Chinese pottery making for the *Encyclopédie*, as well. Following his death in 1765, these were collected and published in a single volume as *Traité des couleurs pour la peinture en émail et sur la porcelaine*.¹⁰ Henri Louis Duhamel du Monceau (1700-1782) wrote numerous entries, on a broad array of topics, for the *Descriptions des Arts et Métiers*.¹¹ In 1763, he wrote *L'art du tuilier et du briquetier*, co-authored with Charles René Fourcroy de Ramecourt (1715-1791) and Jean Gaffin Gallon (1706-1775).¹² A second entry, *L'art du potier de terre*, appeared in 1773.¹³ Fourcroy de Ramecourt also authored an entry on the work of lime kilns, *L'art du chauxfournier*, in 1766.¹⁴

Memoirs presented to the Academy were another resource, but, as with the encyclopaedias, the information derived from the short list of savants amid its ranks or among its guests. As a guest of the Academy, Nicolas Christierne de Thy, comte de Milly (1728-1784),

⁹ "Fayencerie," *Encyclopédie ou Dictionnaire raisonné des sciences, des arts et des métiers*, vol. 4 (Paris, 1765).

¹⁰ Didier d'Arclais de Montamy, *Traité des couleurs pour la peinture en émail et sur la porcelaine* (Paris, 1765).

¹¹ Henry Louis Duhamel du Monceau and L. H. de La Marre, *Descriptions des arts et métiers* (Paris, 1761).

¹² Charles René Fourcroy de Ramecourt et Jean Gallon, *L'Art du tuilier et du briquetier*. (Paris, 1763).

¹³ Henry Louis Duhamel du Monceau, *L'art du potier de terre* (Paris, 1773). Fourcroy de Ramecourt, a military engineer, was a Fourcroy cousin and a member of the Académie des Sciences as a "free associate." Brongniart considered Fourcroy de Ramecourt to be the primary author of *L'art du tuilier*. See *Arts céramiques*, t.1, 322. On the biography of Fourcroy de Ramecourt, see Joseph Thomas, *Universal Pronouncing Dictionary of Biography and Mythology*, vol. 1 (London, 1905); and J. Fr. Michaud and Louis Gabriel Michaud, *Biographie universelle, ancienne et moderne* (Paris, 1843).

¹⁴ Charles René Fourcroy de Ramecourt, *Art du chauxfournier* (Neuchatel, 1776).

read a memoir on Saxon porcelain in 1771, which he had studied in detail during a decade in the service of Charles Eugene, duc de Wurtemberg (1728-93).¹⁵ This memoir, plus supplemental materials, subsequently appeared as an entry in *Descriptions des Arts and Metiers* as “L’art de faire la porcelain.” De Milly’s article was technical, offering “recipes” for various pastes and their uses, but also tactical, in that it offered general terms such as “quartz” and “clay” without specifying the actual minerals used to fill these roles, or the locations from which they were drawn. He did not name the manufactory where he learned about porcelain making, as he was describing technology that he noted was a guarded secret.¹⁶

Macquer wrote several entries on topics in pottery and porcelain in his *Dictionnaire de chymie*, first issued in 1778.¹⁷ Under “*porcelaine*,” he asserted that much knowledge had been generated over the course of years of intense experimentation and search, but that not much was generated in terms of public understanding.¹⁸ However, by 1788, Macquer could lose little by clarifying basic questions about porcelain making for an interested public. Much had already been established in the memoirs of de Montamy on enamel painting, as well as those of Jean-Étienne Guettard and Jean Darcet on porcelain in the 1760s, which I have discussed at length in Chapter Five. Nonetheless, Macquer was aware of the imbalance between the reserves of hidden knowledge and the limited number of open publications.¹⁹

Brongniart used the format of the encyclopaedias to organize and to promote his understanding of clay materials and pottery making. Like Macquer, he wrote articles covering the topics “*argille*,” “*poteries*,” and “*porcelaine*.” His 1816 article, “*argille*” (clay), in the *Dictionnaire des sciences naturelles*, spanned eighty-six pages and described not only the

¹⁵ Charles Coulston Gillispie, *Science and Polity in France: End of the Old Regime* (Princeton, 2004), 348.

¹⁶ Nicolas-Christiern de Thy, Comte de Milly, *L’Art de la porcelaine* (Paris, 1761).

¹⁷ Pierre Joseph Macquer, “Porcelaine” and “Poteries,” in *Dictionnaire de chymie*. (Paris, 1778), 211-41.

¹⁸ Macquer, “Porcelaine,” 211-2.

¹⁹ Macquer, “Porcelaine,” 211-2.

nature of clay minerals, but how these characteristics made them valuable to production. The entry included a lengthy description of pottery and porcelain making.²⁰ In 1830, he published a three-hundred-page entry, “*Poteries*,” in the *Dictionnaire technologique*.²¹ This entry, as well as two memoirs on kaolin and its complex mineralogy, presented at the Institut in 1839 and 1841, were drafts of material that later appeared within the three volumes of *Arts céramiques*.²² The treatise was published in conjunction with the two-volume catalogue of the Sèvres museum, *Description méthodique*.²³ Brongniart’s publications on ceramics were not only stylistically and thematically linked, they were deeply integrated and intended to work in tandem with one another. The text of *Arts céramiques* referred directly to the museum collection and the plates in the *Description méthodique*. Although the *Traité élémentaire de minéralogie* of 1807 was intended for use in the Paris lycées, the information in the two volumes readily contributed to subjects discussed within all the other books, and Brongniart referred the reader to its information.²⁴

The Construction of Ceramic Science

As director of Sèvres, Brongniart considered pottery and porcelain as artistic objects for modern production, as well as objects for study. Much of his ceramic research, both historical and scientific, was based on the objects in the collections he had built for the museum during his tenure at Sèvres. Ceramic objects provided evidence for both historical and geological questions, while reciprocally, geology, mineralogy, and chemistry could inform historians about the origins of ceramic objects. For palaeontologists and archaeologists, the history of the Earth and civilisation could be traced not only by the mineral remains of flora

²⁰ Alexandre Brongniart, “*Argille*,” *Dictionnaire des sciences naturelles*, t.3, 1816, 2-96.

²¹ Alexandre Brongniart, “*Poteries*,” *Dictionnaire technologique* (Paris, 1822).

²² Alexandre Brongniart, *Traité des arts céramiques*, 2 vols. and Atlas, (Paris, 1844).

²³ Brongniart and Riocreux, *Description méthodique du Musée céramique*.

²⁴ Brongniart, *Arts Céramiques*, t. 1, 17, 186.

and fauna, but also by the remnants of material culture, of which ceramics and metals were among the most enduring. Ceramics could thus be utilised in the same manner as fossils, providing information about the history of the Earth. In his writing on ceramics, Brongniart followed a carefully considered organisational scheme informed by his understanding of the arts, but in keeping with his ideas about scientific methodology.

Brongniart's writing was broad and inclusive, touching on subjects such as the ancient uses and understanding of ceramic objects, as seen through literary accounts and archaeology. In particular, Plate XIX of the *Atlas* depicts the Greek philosopher Diogenes alongside an American native burial jar, as well as a scene of women forming jars of a similar size (see Figure 0.08). Similarly, Plates I and II show the placement of pottery in tombs from Germany, Italy, and Greece (see Figures 8.2-8.3). These plates included aspects of anthropology, archaeology, historical, and cultural context. He used a wide collection of associations and comparisons to construct an order for global ceramics. However, he promoted its science in line with the efforts made for sciences such as mineralogy, geology, biology, and palaeontology during the early nineteenth century.

Brongniart described the origins, fabrication methods, contexts, content, forms, and uses, that is to say, the *life* of ceramics, much as natural historians and biologists described the life of species. His work also considered the ways in which the materials and techniques were related to, and reliant upon, chemical interactions, material behaviours, mineralogical characteristics, crystalline structures, and processing technology, particularly the action of applied heat. Brongniart recognised that discovery, context, purpose, and use were integral parts of understanding ceramic making and ceramic science. Contexts and similar features offered clues to the processing, materials, and uses of objects, whether historical or from widely different cultures.

Both in his writings and in his inauguration of a museum and research centre for the purpose, Brongniart instituted a *natural history* of ceramics, a view that is of a piece with John Pickstone's claim that the nineteenth century was the 'age of 'scientific' museums,' where natural history collections were drawn together into national reference collections.²⁵ Brongniart's efforts at Sèvres were a part of broader nineteenth-century practices of natural history collection and classification, but also with a new approach. Cuvier insisted that animal classification required an understanding of the internal characteristics, and the relationships of one part to another, as well as of the species and its relationship to its environment. Similarly, Brongniart's analysis related the internal (chemical, mineral, and crystallographic) characteristics of ceramic wares to their external appearance, and to the types of applied technologies and cultural uses the wares experienced.²⁶ As Pickstone indicated "in the new zoology as in chemistry, the combinations and properties of elements served to explain both structure *and* process, variety *and* its classification" – we can readily see that this framework extends to Brongniart's approach to the study of ceramics.²⁷

In the introduction to *Arts céramique*, Brongniart explained that ceramic production could be grouped in Classes, Orders, and Suborders, just like the divisions created within branches of natural history. He consciously modelled his classifications of ceramics on those such as genus and species in biology, or in the related format for the geognostic divisions of the *Tableau des Terrains*. His first effort was to establish a system of classification for the broad range of ceramic production throughout history. Although many kinds of pottery had names or styles associated with them, they were often loosely used. Brongniart was the first to construct a broadly applicable, scientific classification. He considered that human production was too varied in output and unexpected in its innovations to establish a "natural classification"

²⁵ John V. Pickstone, *Ways of Knowing* (Chicago, 2001), 73-4.

²⁶ Pickstone, *Ways of Knowing*, 115-16.

²⁷ Pickstone, *Ways of Knowing*, 116.

that followed a strict system of varieties, species, and genres. Human production was noticeably idiosyncratic, and therefore it was more difficult to anticipate: “one can easily find how to form some groups, but when we want to introduce all of the productions, not only the ancient ones, but also the recent ones, we encounter many more obstacles than in the classification of natural productions.”²⁸ This was not a nod to the omnipotence of human production. Instead, it was a recognition that nature had the power of variation but was limited by the “actual state of nature.” That is, the living conditions of the Earth, along with the species present at any given moment, limited the range of possibilities. Human production did not always follow in a continuous progression, but instead created new, often dissimilar, genres which could challenge classification schemes. Likewise, objects that were separated by both distance and time could easily bear resemblances to one another that went beyond the superficial.²⁹

To accommodate both contemporary and ancient wares simultaneously, much as Brongniart treated mineral specimens, the first characteristic he utilised was the nature of the paste composition coupled with the approximate temperature to which it was fired, and the second was the type of glaze (if any). These were intrinsic chemical and physical characteristics of the pottery, rather than purely aesthetic or stylistic considerations. He established three classes of ceramic wares: *pâte tendre* (earthenware), *pâte dure* (stoneware), and *pâte dure, translucide* (porcelain), which were further divided into orders.³⁰ Brongniart placed material and technical differences ahead of chronology and geography in the construction of a classification system for world ceramics. Ceramic style, unlike that of paintings or metal objects, for example, was dependent upon definable, intrinsic characteristics of materials as

²⁸ Brongniart, *Arts Céramiques*, t. 1, xvi.

²⁹ Brongniart, *Arts Céramiques*, t. 1, xvi.

³⁰ I have described his organisational system in detail in *From Geology to Art History*, 2014, 15-23.

well as upon the available technology. Thus, in a single plate in the *Description méthodique*, (Pl. I, *Pâte Tendre, Plastique: Antique et Moderne*), Brongniart assembled a set of images that showed an ancient Egyptian object, a Roman object, and a South American example, all alongside architectural elements from European Renaissance buildings; these objects were chronologically and geographically out of sequence, but materially and technically they were all relevantly similar (see Figure 8.4). They shared a common state of applied technology, and each example demonstrated a heavily modelled figurative style. These earthenware objects all depended on a highly plastic clay that could withstand the deformations of sculptural modelling, and which matured at a low temperature.

Despite the vast differences in their origins and cultures, with a classification based on materials and technology, seemingly disparate objects could be grouped side by side. This embodied one of the premises of Brongniart's research: that ceramics had, to some extent, developed similarly (and progressively) around the globe, based on the properties of the clays and materials.³¹ However, the rates of development were not the same for all places. This was particularly true with porcelain, which developed in China at an early date, centuries before the first attempts to recreate it in Europe during the medieval and Renaissance periods³² Different cultures reached technological achievements at different times, sometimes centuries apart.

The Intersection of Mineralogy, Geology, and the Ceramic Arts

Between 1839 and 1840, Brongniart presented two memoirs to the Institut on kaolin, *Premier* and *Second mémoire sur les kaolins ou argiles à porcelaine*.³³ The first memoir

³¹ Brongniart, *Arts Céramiques*, t. 1, 10.

³² Brongniart dated Chinese porcelain and stoneware to “at least” as early as 1000 BCE, with the first pottery appearing there by 2000 BCE. Brongniart, *Atlas, Arts Céramiques*, Tabl. 1-2.

³³ Alexandre Brongniart, *Premier mémoire sur les kaolins ou argiles à porcelaine sur la nature, le gisement, l'origine et l'emploi de cette sorte d'argile* (Paris, 1839); *Second mémoire sur les kaolins ou argiles à porcelaine, sur la nature et l'origine de cette sorte d'argile* (Paris, 1841).

contained the results of the analysis of kaolin performed by the chemists Auguste Laurent (1807-53) and Faustino Malaguti (1802-78), as well as geological and physical descriptions of various samples of kaolin (see Figure 8.5). These studies brought clarity to what was otherwise a little-understood material. Brongniart sought to determine what characteristics were inherent in the kaolin clays from which porcelain was made, and to separate them from other, similar materials that could not be used to create high quality hard-paste porcelain.³⁴ His goal was to define kaolin as a proper mineral substance despite uncertainties regarding its formation, crystal structure, and behaviour, while making a distinction between “*terre kaolinique*” (kaolinite) and true “kaolin,” or the refined substance used to make porcelain.³⁵

In pottery and porcelain making, “empirical” compositions of kaolin were established using methods of levigation (*lavage*) to separate the “*terre kaolinique*” from the “*roche kaolinique*.” Brongniart considered this type of analysis as sufficient only for the practice of the ceramic arts, but not for science. “Empirical” analysis was contrasted with “rational” analysis – done by alternating dissolution by either alkaline or acidic solutions to isolate various compounds – as the method favoured by chemists, including at Sèvres. Rational analysis was the only method that could “make known as exactly as possible the true clay to which we must apply the name of kaolin.”³⁶ Rational analysis was capable of accounting for more specific materials, such as whether the calcium (*chaux*) component contained either potassium or sodium. However, as Brongniart sought to collate all the known material analyses, tables were provided for both types of analysis, shown alongside one another.³⁷

Brongniart considered that kaolins had lost their true mineral nature: “kaolinitic rocks come, in our opinion, from complete mineral species which have been more or less

³⁴ Brongniart, *Premier mémoire sur les kaolins*, 244.

³⁵ Brongniart, *Premier mémoire sur les kaolins*, 244.

³⁶ Brongniart, *Premier mémoire sur les kaolins*, 246.

³⁷ Brongniart, *Premier mémoire sur les kaolins*, 249.

decomposed, but they are no longer mineral species themselves. They have neither homogeneity nor crystalline form, the only characteristics which can, in our opinion, constitute, with the composition defined, a true mineral species.”³⁸ Brongniart followed the tables of analysis with a description of the known types of kaolin, as well as the geological location of known kaolin deposits.³⁹ Of these, he made notes of the merits and deficiencies of the kaolin varieties, relating material characteristics to various kinds of production, from fine pure-white porcelains that supplied manufactures such as Sèvres, to those, such as at Bayeux, which were more suited to sanitary and laboratory wares.⁴⁰

Brongniart determined, by their location, that kaolins were primary, granitic minerals that had decomposed due to the electrochemical effects of adjacent, feldspathic materials: “in geognostic terms, we say that the kaolinic rocks in place are from the epoch of the terrains of crystallization.” By this, he meant the earliest geognostic period, during which the molten surface of the Earth cooled enough for silica to solidify and to slowly crystallize as granite. Other deposits, not found *in situ*, but bearing some similarity to true kaolin, Brongniart described as “*kaoliniform*.” These had been transported from their place of origin and showed signs of disorder and of physical transformation.⁴¹ In the final section of the *Premier mémoire sur kaolin*, Brongniart included a *Tableau* for the geological distribution of kaolin beds, as well as related plates.

The *Second mémoire sur les kaolins* included a deeper discussion of the analysis of several samples of kaolin, in which Brongniart identified characteristic components, and

³⁸ Brongniart, *Premier mémoire sur les kaolins*, 252; The discovery of the crystalline form of kaolin required advances in microscopy and other methods of analysis capable of clarifying atomic arrangements. See Sterling B. Hendricks, “Lattice Structure of Clay Minerals and Some Properties of Clays” *The Journal of Geology* 50, 3 (1942).

³⁹ See Figure 8.1 for the illustration “Kaolin Quarry,” a preparatory illustration for a Sèvres porcelain service in 1816, by Jean-Charles Develly.

⁴⁰ Brongniart, *Premier mémoire sur les kaolins*, 273-80.

⁴¹ Brongniart, *Premier mémoire sur les kaolins*, 288.

worked to achieve a common chemical composition. However, the nature of the kaolin rock samples was variable, and the testing methods yielded slightly different results. Brongniart demonstrated the methods by which he and the Sèvres chemists had been able to derive a “definitive formula” for kaolin as $SA + 2Aq$.⁴² A key part of this valuable discovery was Brongniart’s access to a large collection of kaolin samples from known mines and manufactories. After a survey of hard-paste formulas, Brongniart analysed various soft-paste formulas, experimenting with material substitutions based on the presence of a consistent balance of elements. The series of experiments showed that material substitutions required more consideration than simply maintaining a consistent percentage of elements. While the Sèvres chemists were not entirely clear on the forces at work, Brongniart realized that it was necessary to consider the mineralogical circumstances of the ingredients in the clay paste, and their chemical structure.⁴³ For example, the substitution for calcium provided by one mineral source with another could alter the results of a fired product noticeably, sometimes detrimentally.⁴⁴

Brongniart applied the same style of discussion and scientific methodology in *Arts céramiques* but adapted it to a wider audience. He summarized the information derived from his kaolin research while referring his readers back to the original memoirs. He utilised the concepts and the geognostic eras he had defined in the *Tableau des terrains* to classify the specific deposits of kaolin included in the text. In both the *Premier mémoire sur les kaolins* and *Arts céramiques*, he indicated that the geological development of kaolinite was due to the decomposition of feldspars, aided by the action of iron, as well as water and carbonic acid.⁴⁵

⁴² “(Silica)(Alumina) + 2 waters.” This corresponds to the current chemical notation for the ideal formula for kaolin: $Al_2O_3 + 2SiO_2 + 2H_2O$. Brongniart, *Second mémoire sur les kaolins*, 229; *Arts céramiques*, 42.

⁴³ Brongniart, *Second mémoire sur les kaolins*, 294-300.

⁴⁴ Brongniart, *Second mémoire sur les kaolins*, 297-9.

⁴⁵ Carbonic acid: H_2CO_3 . Brongniart, *Premier mémoire sur les kaolins*, 291; *Second mémoire sur les kaolins* 283-7; *Arts céramiques*, 62.

Brongniart referred to experiments that he and Faustino Malaguti (1802-78) had performed on the decomposition of feldspars under the effects of electricity, which exploited the electrical properties of the materials and mimicked potential forces of natural decomposition.⁴⁶ Characteristically, in the *Premier mémoire sur kaolin*, he cautioned that “the time necessary to make (the experiments), their difficulty and their indispensable length have prevented me from taking them far enough to draw any conclusions from them that could satisfy wise and rigorous minds in matters of theory.”⁴⁷

Brongniart’s discussion of materials in *Arts céramiques* went beyond kaolin. He listed other plastic materials, including collyrite, cimolithe, and regular pottery clays, all of which were known to be “*silicates d’aluminium hydraté*” (alumino-silicates) with varying mineralogical impurities, including iron.⁴⁸ After establishing the basic clays that contributed to the composition of clay pastes, he could then proceed to develop the science related to pottery making.⁴⁹ Although many potters had used a system of recipes that utilised well-known materials, often created by trial and error, Brongniart used chemical analysis to derive rational formulas. He used this type of analysis throughout *Arts céramiques*, working to establish a universal system for expressing the results of experiments and enabling a common way to write formulas for clay bodies or glazes.⁵⁰

Arts céramiques provided both technical and historical information, while the museum catalogue illustrated a compendium of styles. Thus, the five volumes were a comprehensive

⁴⁶ Brongniart, *Second mémoire sur les kaolins*, 294-300.

⁴⁷ Brongniart, *Arts céramiques*, 55.

⁴⁸ Brongniart, *Arts céramiques*, 57.

⁴⁹ Brongniart, *Arts céramiques*, 58. *Clay pastes*: clay bodies, or mixtures of clays and other materials, which are combined to create a particular type of ceramic object.

⁵⁰ This could only be exploited appropriately once Amedeo Avogadro’s research established a constant for a mole of any given substance. This enabled Herman Auguste Seger to develop the unity molecular formula for glaze analysis and substitution. W. David Kingery, “The Transition of Ceramics from Craft to Science-based Activity,” *Qualicer* 98 (1996): 3-17; Matthew Katz et al., “The Reevaluation of the Unity Molecular Formula Limits for Glazes,” *Whitewares and Materials* 24, 2 (2009): 13-23.

manual for understanding all aspects of world ceramics, with an emphasis on a global perspective. *Art céramiques* was divided into three books: *First: Historic Introduction & General Considerations*, *Second: Classifications of Pottery*, and *Third: Coloration and Decoration*. Although the individual sections could be read out of sequence, generally the first book served as a foundation for the second book; reading *Arts céramiques* in sequence would have benefitted readers unfamiliar with the complex nature of ceramics. The *Atlas* included tables of collected data and illustrations of the concepts established within the text. It also provided examples related to archaeology and showed technical information.⁵¹

Description méthodique consisted of one volume of plates and another of tables and text descriptions of the illustrations. The plates depicted selections from the collection in the *Musée Céramique*. This included not only refined pottery types, but also bricks, tiles, and pottery fragments. Functional objects and common pottery wares were shown alongside religious objects or artistic ones, mirroring the categories defined in *Arts céramiques*. According to the organisational criteria for *Arts céramiques*, geography was less important than material composition, and all known world regions were treated on an equal basis. Contemporary ceramics from makers in France and examples of the recent production at Sèvres were included. Illustrations were carefully rendered to provide accurate, non-stylised depictions of the objects. The catalogue text provided supporting material and information on the provenance of all the objects in the collection.⁵²

Brongniart's discussion of ceramic production related directly to the geological time scale demonstrated in the *Tableau des Terrains*, and began, chronologically, with the transition from the *Saturnienne* to the present-day *Jovienne*. His writing and research provided a basis

⁵¹ I have described the format and content of both *Arts céramiques* and the *Description méthodique* in detail in Carr-Trebelhorn, *From Geology to Art History*.

⁵² Alexandre Brongniart and Denis Désiré Riocreux, *Description méthodique du Musée* (Paris, 1845).

for understanding global historical developments in relation to geological time, an as yet indeterminate period. The duration of the *Saturnienne* geognostic eras, at least, could be seen to have exceeded the relatively short periods of known historical record, or of human history. In *Arts céramiques*, Brongniart opted to refer to the divisions of time with the well-known terms *Antediluvian* and *Postdiluvian*, however.⁵³ This may have been a consideration for his audience, who were likely to be general readers, artists, or otherwise non-specialists in natural science, or it may have been in response to the poor reception of his invented terms by authors such as William Whewell, as I discuss below.

Brongniart used his discussion of the intersection between the two time periods to draw attention to the evidence of Gallic pottery that had been found alongside deposits of what were known to be ancient (“antediluvian”) animal bones. He wrote that some geologists aimed, by this evidence, to show the existence of humanity during the remote, Antediluvian period. He also cited large geological changes (particularly, the opening of the canal between the Île-de-Bréhat and the coast of Brittany), which archaeological evidence indicated had taken place during human historical periods.⁵⁴ Although Brongniart did not add further analysis on the extensive subject, he drew attention to the blurred distinctions between the historical period and the more distant past, indicating that historical ceramics would continue to play a role in shaping the views of both human and geological history and time.⁵⁵

Brongniart noted that geology informed the history of pottery in other ways. He observed that the most ancient potteries (except for Chinese porcelain) had drawn their materials from the uppermost (superficial), and therefore, most recent, deposits. By contrast, more recent pottery makers, particularly those from the eighteenth and nineteenth centuries,

⁵³ Brongniart, *Arts céramiques*, t. 1, 31.

⁵⁴ Brongniart, *Arts céramiques*, t. 1, 31; on the Ile de Bréhat, see Jean-Laurent Monnier, “Le gisement Paléolithique supérieur de Plasenn-al-Lomm (Ile de Bréhat, Côtes-du-Nord),” *Gallia préhistoire* 25, 1 (1982).

⁵⁵ Brongniart, *Arts céramiques*, t. 1, 31.

drew their materials from the most ancient deposits (*Terrains typhoniens*).⁵⁶ This paralleled developments in technical capacity and understanding, many of which depended upon advancements in mining, geology, and mineralogy. It also suggested a potential way of using the mineralogical composition of a pottery specimen to typify its relative age.

Local geology was a highly determinant factor in the style of pottery and could be used to define the pottery of a region or a people. For example, porcelain pastes could only be made from kaolins that were found in select deposits, but iron-bearing clays that produced earthenware and stoneware could be found readily. Even common clays had varying compositions and mineral characteristics. Brongniart consciously used the geological differences in materials to further his understanding of archaeology.⁵⁷ Within the laboratories at Sèvres, ceramic objects from the museum's collections were analysed for their chemical composition.⁵⁸ These analyses recreated the basic composition of a paste or a glaze. The information could then be used to differentiate between pottery types and origins, even those of visually similar styles.⁵⁹

The Importance of Materials

Brongniart placed a discussion of materials among the initial sections of the First Book of *Arts céramiques*. He assumed a general understanding of chemistry and mineralogy, and referred readers to other sources, such as his 1807 *Minéralogie*, or the *Traité de chimie, appliquée aux arts* written by Dumas.⁶⁰ Brongniart began by defining the geological and mineralogical factors related to the production of global ceramics. The unusual nature of clays,

⁵⁶ Brongniart, *Arts céramiques*, t. 1, 32.

⁵⁷ Brongniart, *Arts céramiques*, t. 1 (1844), xix; *Arts Céramiques*, t. 2 (1844), 480-4, 505, 521-22.

⁵⁸ Brongniart, *Arts céramiques*, 480-4.

⁵⁹ Brongniart, *Arts céramiques*, 462-4.

⁶⁰ Alexandre Brongniart, *Traité élémentaire de minéralogie* (Paris, 1807); Jean-Baptiste Dumas et al., *Traité de chimie, appliquée aux arts*, 8 vols. (Paris, 1828.)

whose plasticity and ability to be transformed by heat while retaining their structure, set them apart from other earthen materials. Brongniart sought to explain the characteristics and chemical nature of clays and clay minerals, and to identify the changes in composition which took place between mining, processing, and firing. He also sought to explain the geological origins of clays. Brongniart did not include full drafts of his presentations for the Institut, *Premier* and *Second mémoire sur les kaolins ou argiles à porcelaine*, but he summarized the material and referred to the original publications.⁶¹ His description of kaolin in *Arts céramiques* included the methods by which the mineral deposits (kaolinite) were refined into a pure clay that could be used in ceramic production.⁶²

Importantly, Brongniart described the experiments undertaken at Sèvres in detail. He used chemical analysis to determine clay formulas by the percent of the elements present, but also by the specific source. This meant that the data could be understood consistently. Additionally, he supplied tables indicating the chemical analysis of commonly-mined clay materials – Table V of the *Atlas* listed the characteristics, geological information, and analysis of various clays, and Table VI gave the results of analysis of common feldspars. In efforts to improve processes and to develop an understanding of the material behaviours of clays, Brongniart and the chemists at Sèvres performed tests on plasticity, providing fourteen kinds of clays, illustrating the range of applicable plasticities for each application.⁶³ Although it was a relative measurement, by replicating the processes he described, the list could be used comparatively in order to gauge the suitability of a clay body for a given process. Brongniart also experimented with the effects of firing on the expected shrinkage of clay pastes (*Atlas*, Table VII) and on the density of clays and clay pastes (*Atlas*, Table VIII).

⁶¹ Brongniart, *Arts céramiques*, 40-1.

⁶² On the distinction between kaolin and its mineral source, kaolinite, see the discussion in Chapter Five.

⁶³ Brongniart, *Arts céramiques*, t. 1, 252-8.

The First Book of *Arts céramiques* was not a “how-to” manual, although it had potential to improve industry and to expand the knowledge base. Rather, Brongniart described the historical development of practices of the ceramic arts through the mid-nineteenth century. More particularly, he demonstrated the science of the chemical, mineralogical and physical processes at work in ceramic production. He established a coherent and broadly applicable system of understanding ceramics based on quantifiable factors. He also connected the scientific understanding of ceramics to the diverse earth sciences that contributed to its knowledge. The *Second Book* applied the concepts and classification systems developed in the *First Book* to the various styles of ceramic production. The objects ranged from architectural materials, such as tile and bricks, to historical pottery styles and contemporary ones. In short, it was a scientifically-based historical survey of ceramics, covering ceramic production on a global scale.⁶⁴ Styles of all types were featured, including Western Antiquity, American native earthenware, Italian and French faïence, and European Porcelain. The *Third Book* returned to themes of practical information and scientific data, with an emphasis on colouring and decoration.⁶⁵ The *Third Book* was a synthesis of the scientific methodology developed in the *First Book*, and the historical styles categorised in the *Second Book*. Ceramic styles were used to describe colour development, artistic techniques, colour application, and firing methods. With ceramic materials, including colours, the style itself was dependent upon the materials and their treatment during processing. The *Third Book* presented information gathered by Brongniart over fifty years of research and writing on ceramic chemistry, which was informed by the tests of the chemists at Sèvres, and by the established methods of its artists and technicians.

⁶⁴ See Carr-Trebelhorn, *From Geology to Art History*, 19-23.

⁶⁵ Much of the material of the Third Book is similar to the scientific categories and methodologies developed by Brongniart in earlier sections of *Arts Céramiques*.

In all, Brongniart's *Arts céramiques* was intended to give shape to the science of pottery and porcelain making, and to expand its range to all manner of products derived from clays and clay materials. There was no previous publication, or set of publications, that came close to accomplishing what Brongniart's treatise did for the ceramic arts. He connected several sciences within the volumes and drew upon the contributions of many of his mentors, teachers, and associates. Among countless sources, Brongniart consulted the writings of authors of Western Antiquity, Chinese texts in translation, contemporary scientific debate across fields, the notebooks of explorers, and the opinions of experts throughout the world. Brongniart united as much information as possible related to the ceramic arts as it was practiced historically and globally, into one set of publications. Brongniart sought to build a clearly organized and structured process for collating and building knowledge. He further sought methods for quantifying complex procedures and looked for explanations to chemical and physical phenomena while providing paths to reproducible results in both experiments and production.

Brongniart's collected works on ceramics, including *Art céramiques*, could not inform a person how to become a potter, an artist, or an industry leader, but they provided several ways of thinking about ceramics that had not been demonstrated before. Prior to his publications, there was limited, unstructured information related to fields with uncertain parameters, vaguely labelled "pottery" and "porcelain." Expertise in the field of ceramics was difficult to come by. Brongniart's book levelled the playing field in a way that previous books had not done. His perspective as a teacher whose goal was to create open resources ran throughout the books – he hid nothing and shared processes without placing limits upon what his reader would need or want to know. His commitment to encyclopaedic and broadly applicable knowledge, to display, and to organisation made his publications enduringly relevant.

In 1854, Charles Russ Goodrich's *Science and Mechanism* contained the following observation: "Brongniart's *Les Arts céramique* is the great source of information for all

subsequent authors upon the history and practice of the ceramic art . . . we owe to him nearly all the accurate science we possess in reference to every point of porcelain manufacture.”⁶⁶

Following the appearance of the third edition of *Arts céramiques* in 1877, Jules François Felix Fleury-Husson (1821-89), known as Champfleury, an art critic and, in his later life, Chief of Collections at Sèvres, wrote in 1881:

The *Traité des arts céramiques* is still classic thirty-six years after its first edition; the whole of the work has remained standing by the scientific method which presided over it. Although this work was conceived in technical data, all the ceramic inventions are studied there; one finds there, with a history of the faience and porcelain factories of Europe, an outline of the work of the potters of antiquity.⁶⁷

Thirty years later, the 1911 *Encyclopaedia Britannica* listed the 1877 third edition of *Arts céramiques* at the top of a list of ten of “the best of the modern standard works dealing with the technical side of pottery production.”⁶⁸

The *Tableau des terrains*, along with *Arts céramiques* and the catalogue raisonné of the *Musée céramique* combined to create a history of the Earth from its origins and to trace human production through ceramic production. The framework Brongniart established with each of these publications was expandable and adaptable, enabling other natural historians, savants, and scientists to build upon the information Brongniart had collected and organized. He had provided a set of ways for thinking not only about the Earth, geology, and mineralogy, but also about ceramics of all types. In 1877, Albert Jacquemart began his *History of the Ceramic Art* by saying:

When treating on a special subject, the profound study of which requires an extensive acquaintance with the sciences of chemistry and geology, the only means of enlightening without fatiguing the reader, is to make use of a language so clear and so precise, as to dispense with endless repetitions. This language, which has long existed in ceramic art, was created by the talented Alexandre Brongniart, as first set forth in his valuable book, published in 1844.⁶⁹

⁶⁶ Charles Rush Goodrich, *Science and Mechanism* (New York, 1854), 188.

⁶⁷ Champfleury, *Bibliographie céramique* (Paris, 1881), 223.

⁶⁸ *Encyclopædia Britannica* (Cambridge, 1911), 760.

⁶⁹ Albert Jacquemart, et al., *History of the Ceramic Art* (London, 1873), 4.

Additionally, while Brongniart focussed exclusively on ceramics, his methodology provided a scheme for understanding and interpreting other human productions, including metalwork, textiles, design, and pattern, as in the 1863 publication of the architect Gottfried Semper (1803-79), *Style in the Technical and Tectonic Arts*.⁷⁰ Semper credited Brongniart and Riocreux with the development of collections that made possible the formation of a “technical and historical overview” of ceramics. In turn, Semper realized that a similar approach could be applied to textiles.⁷¹ In his study, however, Semper included not only textiles, but also ceramics and metallurgy. Interestingly, he ignored the specific meaning Brongniart had given to the term “la céramique,” claiming that, at least in German, no term existed to cover the arts “whose common material basis . . . is potter’s clay.”⁷² Of the word “ceramic” he argued that the Greek usage alluded only to the material (i.e., *clay*) to be treated. He claimed “we are perhaps justified here in assigning to the word a more general meaning than it had for the Greeks. For us it will encompass the whole art of making vessels, including vessels made from such other materials as metal, wood, ivory, glass, and stone.”⁷³ That Semper attempted to co-opt – in addition to his methodology – Brongniart’s recently established term is, in some way, a reflection of the utility and success of “*la céramique*.”

⁷⁰ Gottfried Semper, Harry Francis Mallgrave, and Michael Robinson, *Style in the Technical and Tectonic Arts or Practical Aesthetics* (Los Angeles, 2004). See Carr-Trebellhorn, *From Geology to Art History*, 2014.

⁷¹ Semper, et al., *Style*, 167.

⁷² Semper, et al., *Style*, 467. Semper was referring to his native language, as *Style* was first published in German. Although “la céramique” appeared in German texts following Brongniart’s publications, “Keramic” was not introduced in German until the late nineteenth century. See Google Ngrams, “Keramic” + “céramique,” German (2019). https://books.google.com/ngrams/graph?content=Keramic%2C+c%C3%A9ramique&year_start=1800&year_end=2019&corpus=31&smoothing=3

⁷³ Semper, et al., *Style*, 467.

Making New Words for New Frameworks

From his lifetime forward, Brongniart's efforts to establish the term "*céramique*" have not been well-documented.⁷⁴ The term's introduction to everyday language was both concrete – with the naming of the *Musée céramique* in 1824 – and subtle. Brongniart employed the word selectively at first, in both the encyclopaedia entry, "*Poteries*," and in the pair of kaolin memoirs at the Institut. He solidified these two decades of subtle effort with the explicitly-titled *Arts céramiques*, which provided a definitive and clear foundation for the word and the science, although he did not make a personal claim for establishing the term.⁷⁵ In 1857, Joseph Marryat (1790-1856), in *A History of Pottery and Porcelain*, included the etymology of the word "keramic," – as "*la céramique*" was frequently translated into English – with a preference given to the Greek origins of the word, rather than the French. Marryat's history was indebted to Brongniart's discussion in *Arts céramiques* and he stood out as a rare writer that recognised and acknowledged Brongniart's role in introducing the new term.⁷⁶

Whewell's criticism of 1834 may in part have encouraged Brongniart's initial caution in using the word. Whewell thought that the terms Brongniart introduced in *Tableau des terrains* were not "useful in enunciating geological truths" and found his system too complicated to be of any value: "it is evident that any portion of truth, which any author can have brought to light, may be conveyed by means of a much simpler apparatus. Such a nomenclature carries its condemnation on its own face." Whewell followed his critique with what Brongniart might have read, not as censure, so much as a suggestion for improved success: "I may remark, in general, that the only persons who succeed in making great

⁷⁴ As I indicated in Chapter Five, the term was first introduced, on the original suggestion of René Just Haüy, by Jacques Fourmy in 1804, in a self-published pamphlet. See Jacques Fourmy, *Recueil de mémoires relatifs à l'art céramique* (Paris, 1804).

⁷⁵ Brongniart, *Arts céramiques*, t.1, 3-4.

⁷⁶ Joseph Marryat, *History of Pottery and Porcelain* (London, 1857), 259-60.

alterations in the language of science, are not these who make names arbitrarily and as an exercise of ingenuity, but those who have much new knowledge to communicate; so that the vehicle is commended to general reception by the value of what it contains. It is only eminent discoverers to whom the authority is conceded of introducing a new system of names; just as it is only the highest authority in the state which has the power of putting a new coinage in circulation.”⁷⁷

In adopting the neologism “ceramic,” Brongniart also established the root *-cérame*, modifying such words as *grès* – which, in French, meant both stoneware pottery and sandstone – to clarify meanings. Thus, *grès-cérame* was explicitly a pottery type, and *grès* a sandstone. Although it was not applied during his lifetime, Brongniart’s root word *céram-* was eventually combined with Whewell’s preferred suffix, *-ist*, arriving at *ceramist*, a word that covered the work of pottery and porcelain makers of all types, from Wedgwood and Macquer to Brongniart, as well as to the chemists at Sèvres, Malaguti and Salvétat. By the turn of the century, it was a well-established term. Like Brongniart, a *ceramist* could be expected to rely upon knowledge in chemistry and physics, coupled with elements of geology, mineralogy, and crystallography.

⁷⁷ William Whewell, *Philosophy of the Inductive Sciences* (London, 1840), lxxx-lxxxi; Simon Schaffer, “The History and Geography of the Intellectual World: Whewell’s Politics of Language,” in *William Whewell: A Composite Portrait*, edited by Menachem Fisch and Schaffer (Oxford, 1991).

CONCLUSION: An Enduring Legacy

When he died on 7 October 1847, Brongniart left behind a legacy that has continued to influence scientific and artistic thought. His work developed key ideas in geology, biology, palaeontology, mineralogy, and ceramics. Brongniart was among the last of the *savants* of the eighteenth and early nineteenth century but was also included in the group of thinkers and experimenters for whom William Whewell promoted the term *scientist* in 1834.¹⁰⁴⁵ In the course of this thesis, which covers approximately eighty years, I have shown how it was possible for one individual to forge a career involving what appears to be greatly disparate elements across numerous political and cultural changes. Brongniart was known both for his knowledge of a wide range of subject areas and for his well-regarded expertise. Importantly, I showed that he created an intellectual and scientific structure for pottery and porcelain making that has been both effective and enduring.

As large a contribution as were Brongniart's efforts to create ceramic science, as director of Sèvres, Brongniart's research and writing were intertwined with the demands of making the manufactory an exemplary institution for France and Europe. Although Sèvres had been well supported prior to the Revolution, and had a strong position in the French and European markets, it was by no means an assured advantage by the time Brongniart was named its director in 1800. Over the course of forty-seven years, Brongniart worked to position Sèvres at the top, purposefully setting high standards and pursuing labour-intensive artistic schemes that pushed the boundaries of technical and aesthetic possibility. In fact, many of the more ambitious undertakings of

¹⁰⁴⁵ William Whewell, *Philosophy of the Inductive Sciences* (London, 1840), 118.

the manufactory relied on the fact that the objects and artworks produced were state-supported and had diplomatic or royal uses in mind, rather than purely commercial considerations.

In his efforts to return Sèvres to prominence in the early nineteenth century, Brongniart could rely upon his awareness, not only of artistic considerations, but material and mineralogical ones. As he travelled for the Agence des Mines, or studied the Paris Basin, he could also examine the distinctly characteristic types of clays found in France, from the deposits at St Yrieix first used by Sèvres, to those at Bayeux, for example. Some could make a fine porcelain with a true white, others a slightly off-white, and in the case of Bayeux, the kaolin was more suited to sanitary and laboratory wares than it was to tea services and dinner sets. His wide mineralogical and geological knowledge gave an advantage to the production at Sèvres, but it also allowed him to advise others to achieve better practices related their own manufacturing and production needs. These efforts contributed to the status of Sèvres as an international resource, including a school and a museum, but also continuously improved the production, making the manufactory's products highly desirable and coveted.

Critical to his success was an early access to the many of the leading savants of Paris during the eighteenth century. A multi-generational familial network of artisans and minor nobility anchored his life and career. Like the artisanal guild structures maintained by the apothecaries or the other artisans, the individual participants in the networks surrounding the Brongniart family, such as Ignace Brongniart, Théodore Brongniart, Antoine Louis Brongniart, and Antoine François Fourcroy, consciously supported the efforts of their family and close associates, behaviours which Brongniart later emulated and fostered. As I have shown, Brongniart's character and professional persona were based on the idea that reciprocity and thoughtful exchanges of dialogue,

information, and patronage were paramount, and an essential part of polite culture. From the beginning, his was a fortunate position, but one that required a great deal of personal effort to maintain, especially throughout the restructuring of society brought about by numerous political changes, including the French Revolution, the Napoleonic Empire, the Bourbon Restoration, and the July Revolution.

Brongniart's methodical canvassing of countless natural history specimens and geological formations of all types made him an authority throughout his career, and the Paris Basin study he began with Cuvier in the first decade of the nineteenth century firmly showed the value of a systematic pairing of a large body of well-organized fossils with observations of the Earth's strata over both localized and global regions. His research also contributed to numerous encyclopaedia entries that enriched the general knowledge of non-specialists. As I have shown, he collected vast amounts of information in a systematic fashion, with a view to its publication in works on mineralogy, geology, palaeontology, and ceramics. The directorship at Sèvres offered a starting point to build research facilities focussed on the collection, organization, and distribution of knowledge related to pottery and porcelain. Despite the extensive and potentially overwhelming amount of information he gathered, Brongniart was able to draw all his efforts together into several complete works before his death. It is a large body of work, which to date has received limited scholarly attention. It is a rich ground for continued study in both ceramics and in natural history.

Importantly, Brongniart's late-life synthesizing works on ceramics could not have been written without his earlier publications in natural history, which showed his great prowess in the fields of taxonomy, notably via his articulation of a new and – by most accounts – extraordinarily useful scientific nomenclature. Much as Brongniart's early mentors, including Lavoisier, Fourcroy, and Berthollet, as well as Guyton de

Morveau, had introduced Lavoisier's revolutionary chemistry through a focus on nomenclature, he embraced new words, and the ideas behind them, such as *geology* and *geognosy*, putting them to use rapidly. Likewise, he coined others, such as those necessary to describe his newly created classifications of *sauriens*, *batraciens*, *chéloniens*, and *ophidiens*. Brongniart's quick embrace of important new terms and well-supported ideas was tempered by his more cautious approach to the structuring of facts and information. In the end, his most profound contribution to language was the solidification of meaning he provided for "*la céramique*."

Although Brongniart and Cuvier decried the big-picture attempts of the "system-builders", the efforts of writers such as Buffon to capture all of nature in one all-encompassing theory retained a powerful influence over nineteenth-century natural history. Brongniart described a science of ceramic objects, similar to studies of mineralogical or biological specimens, and created a global picture with multiple methods of analysis, such as visual, physical, chemical, and geographic. As I have shown, there was no coherent ceramic science prior to the appearance of his nineteenth-century publications, particularly *Traité des Arts céramiques* and *Déscription méthodique du Musée de Sèvres*. By exploring the changes that took place in eighteenth- and early nineteenth-century natural history, as broad study turned toward specialization, I have shown how the emerging disciplines of geology, mineralogy, biology, physics, and palaeontology established the conditions for the emergence of a ceramic *science*. Key changes in longstanding ideas about natural history during the eighteenth and nineteenth centuries created a space suitable for thinking about new divisions, classifications, and methodologies for the ancient materials and practices of ceramics.

Brongniart demonstrated that artisanal and practical knowledge informed the

studies in natural history as well as scientific and technological inquiry. By defining a clear science for the ceramic arts, Brongniart placed artisanal practice on equal footing with philosophical and intellectual forms of inquiry. His work was a part of the broader picture of the expansion of the scientific disciplines of natural history. However, ceramics was distinct from sciences such as biology and mineralogy in that the objects of study were natural in origin, as minerals and inorganic materials, yet relied largely upon human intervention for their existence. Objects of inquiry in ceramics could be architectural, artistic, functional, decorative, historical, archaeological, anthropological, chemical, mineralogical, electrically-conducting, fragmentary, fugitive (as colour transitions, escaping gasses, melting, fluxing, and other liminal states of processing) and so on. Similar to biological nature, ceramic objects could be varied, but their varieties appeared in unpredictable ways, depending on the individual preferences and knowledge of the maker, culture, purpose, and countless other reasons. As a consequence of these widely-varied factors, ceramic science required a purposeful language and structure that was both concise and adaptable.

Most scientific disciplines had innumerable contributors and voices shaping nomenclature and classificatory structures. Contrastingly, in the case of ceramics, Brongniart's approach was largely reliant upon classifications and divisions based on the life, earth, and mineral sciences that he had explicitly defined for the first time. He did not work independently, but instead, at the heart of an extraordinarily diverse network of savants, artists, and specialists of all types; however, he had an unusual perspective as a contributor to the development of sciences such as geology, palaeontology, and mineralogy, in addition to porcelain manufacturing. His wide expertise made the critical difference in what he was able to accomplish towards the creation of a broadly accessible ceramic science. Still, he held back from making a

personal claim to priority, allowing his work to speak for itself. Most importantly, as he repeatedly demonstrated and voiced, knowledge for personal gain was not heroic – only shared knowledge had lasting value.

IMAGES



Figure 0.1: Sèvres, *Service Encyclopédique*,
painted by Jacques François Joseph Swebach, 1806.
Photo (C) RMN-Grand Palais / Martine Beck-Coppola



Figure 0.2: Sèvres, Plate from the *Service Des Départements*, 1827.
 Photo Credit: Metropolitan Museum (Open access)



Figure 0.3: Sèvres, *Service des Arts Industriels: la typographie*, painted by Jean-Charles Develly 1820-35.

Photo (C) RMN-Grand Palais / Martine Beck-Coppola

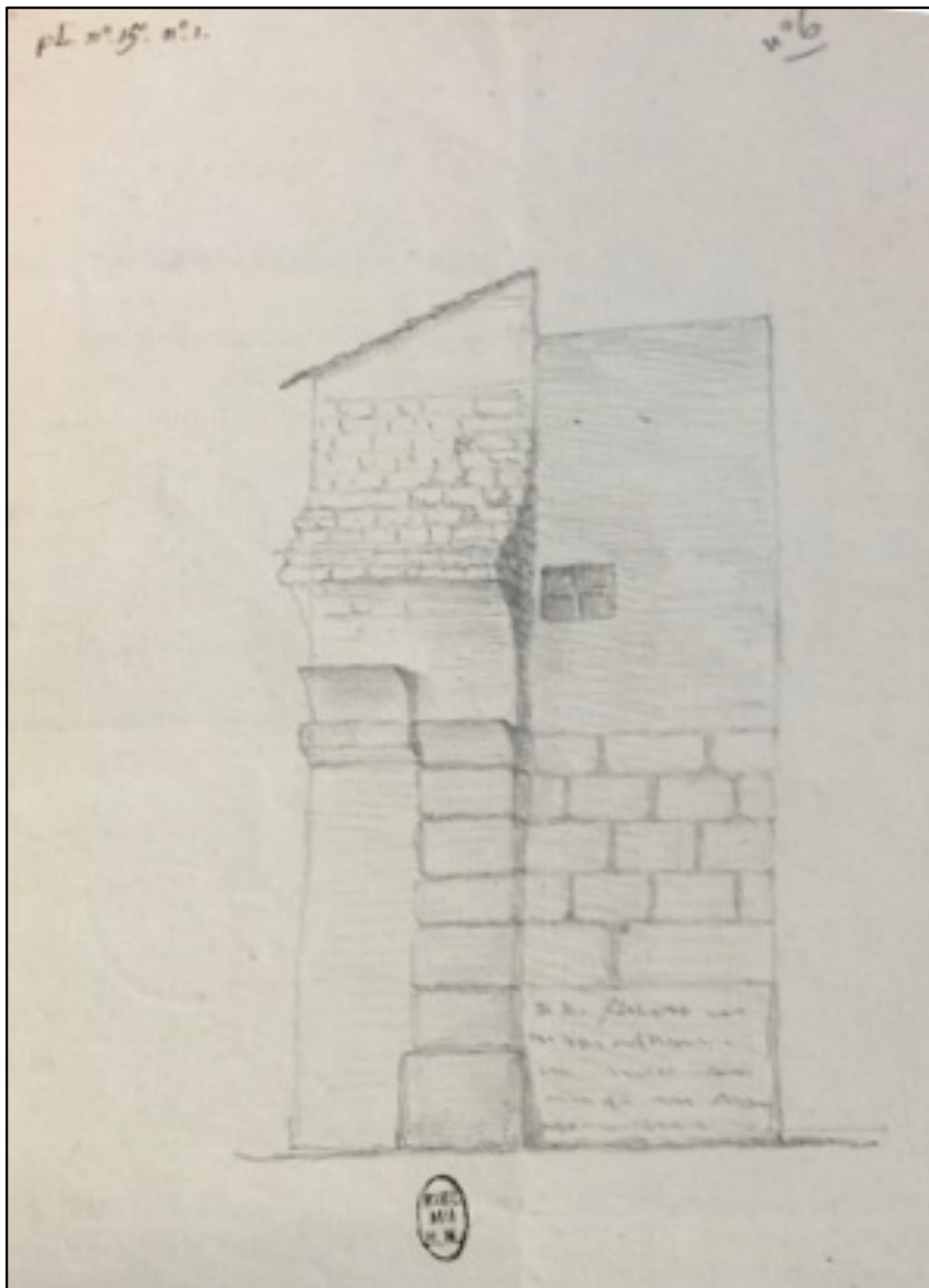


Figure 0.4: Alexandre Brongniart,
Building Cross-Section Depicting Stonework,
Journal de Voyage – Alpes, 1795.
Repository: BMHN, Paris
Photo: Carr-Trebelhorn, 2019

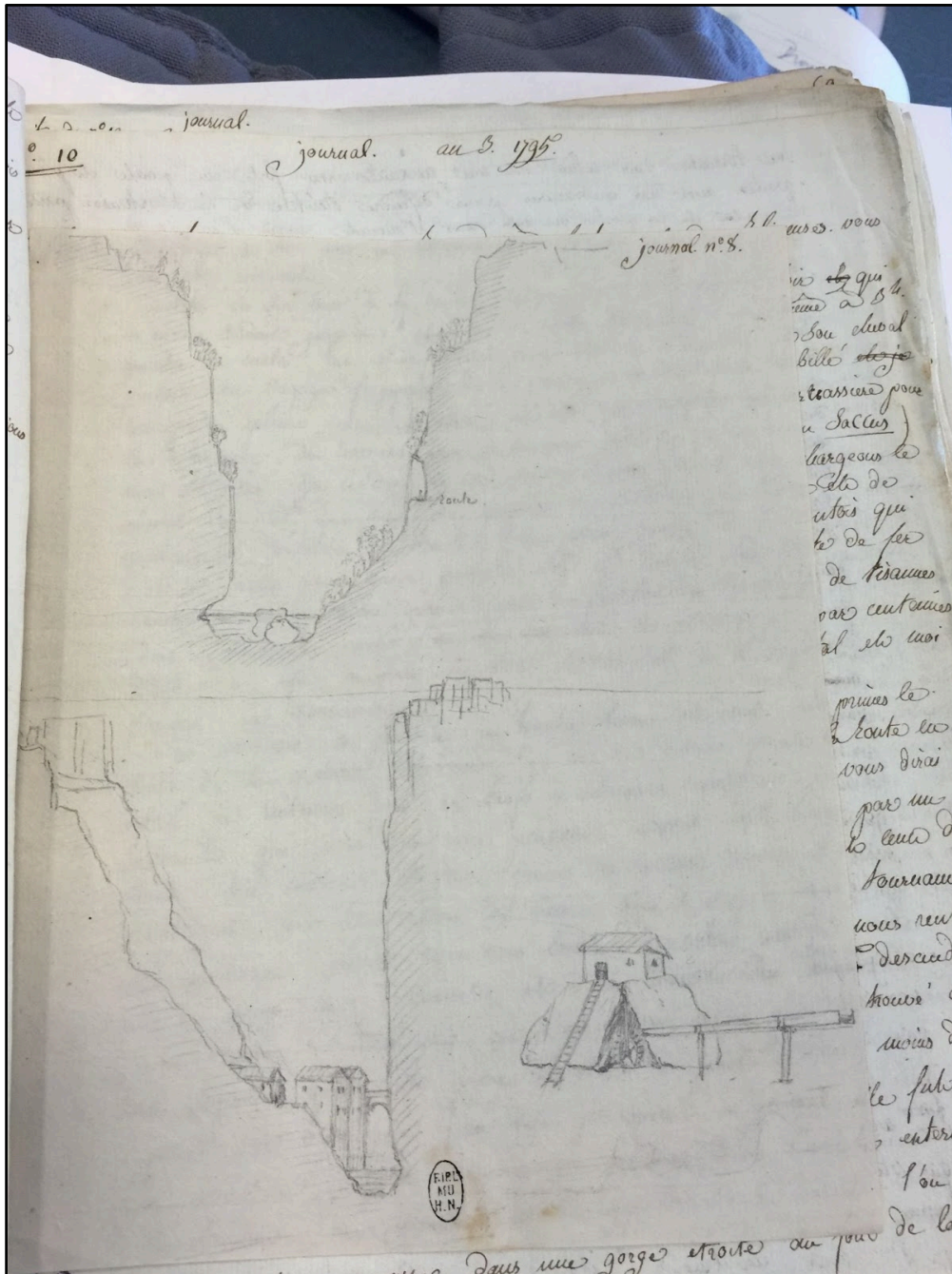
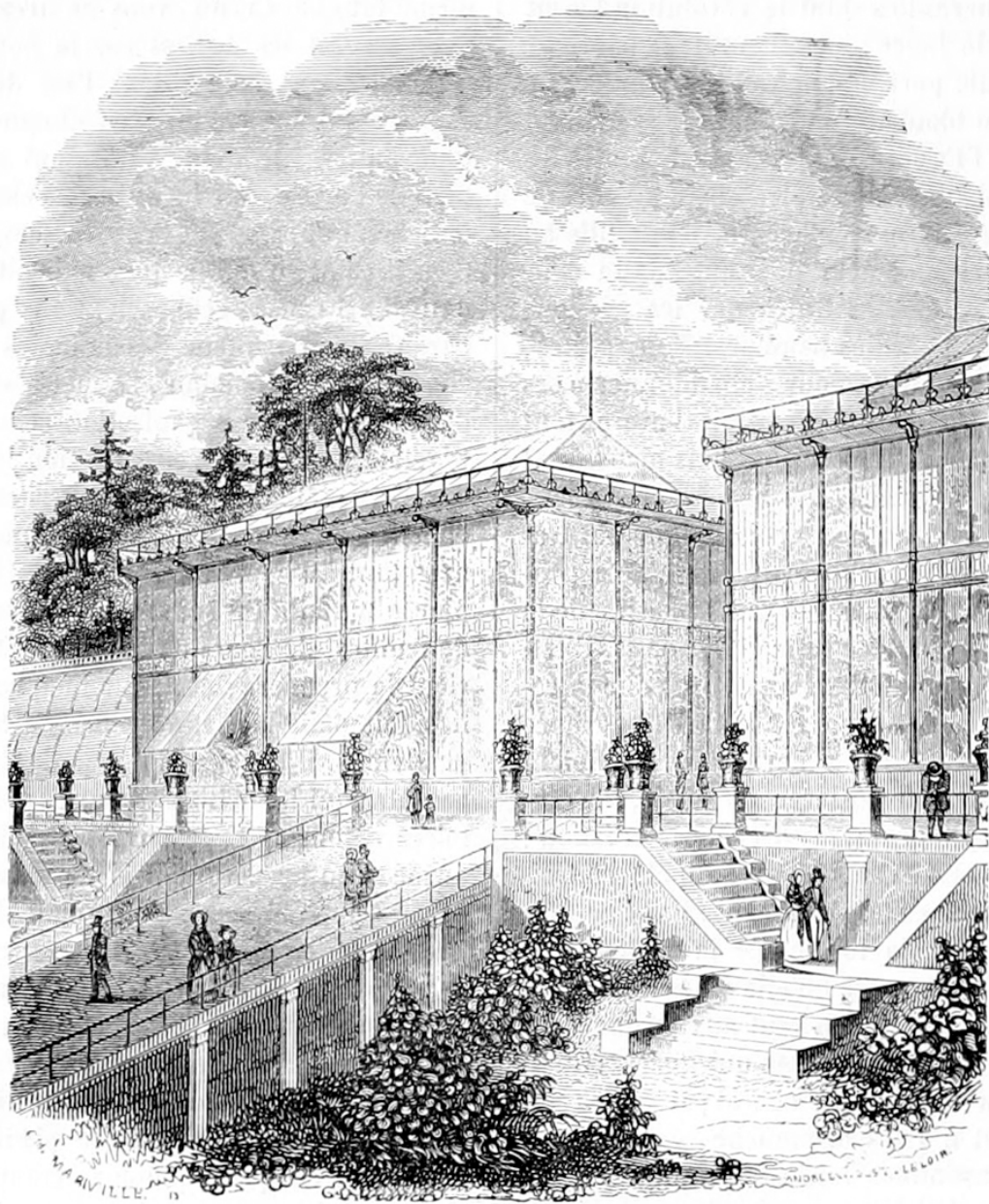


Figure 0.5: Alexandre Brongniart,
Elevations and Landscape Studies, Sketch of a Mill,
Journal de Voyage – Alpes, 1795
Repository: BMHN, Paris
Photo: Carr-Trebelhorn, 2019



Les grandes Serres.

Figure 0.6: Mariville, engraving,
Grandes serres du Jardin des plantes de Paris,
 in Pierre Boitard and Jules Janin,
Le Jardin des plantes: Description, (Paris: Barba, 1851).
 Designed by Charles Rohault de Fleury, built using Saint Gobain glass.
 Constructed between 1834-6.



Figure 0.7a: F. Leleu, *Secrétaire à cylindre*, c.1768-70, Sycamore, Rosewood, 26 Plaques of Sèvres Pâte Tendre, closed. Collection: Musée du Louvre, Département des Objets d'art du Moyen Age, de la Renaissance et des temps modernes



Figure 0.7b: F. Leleu, *Secrétaire à cylindre*, c.1768-70, open. Photos: Louvre Museum, Used with Permission

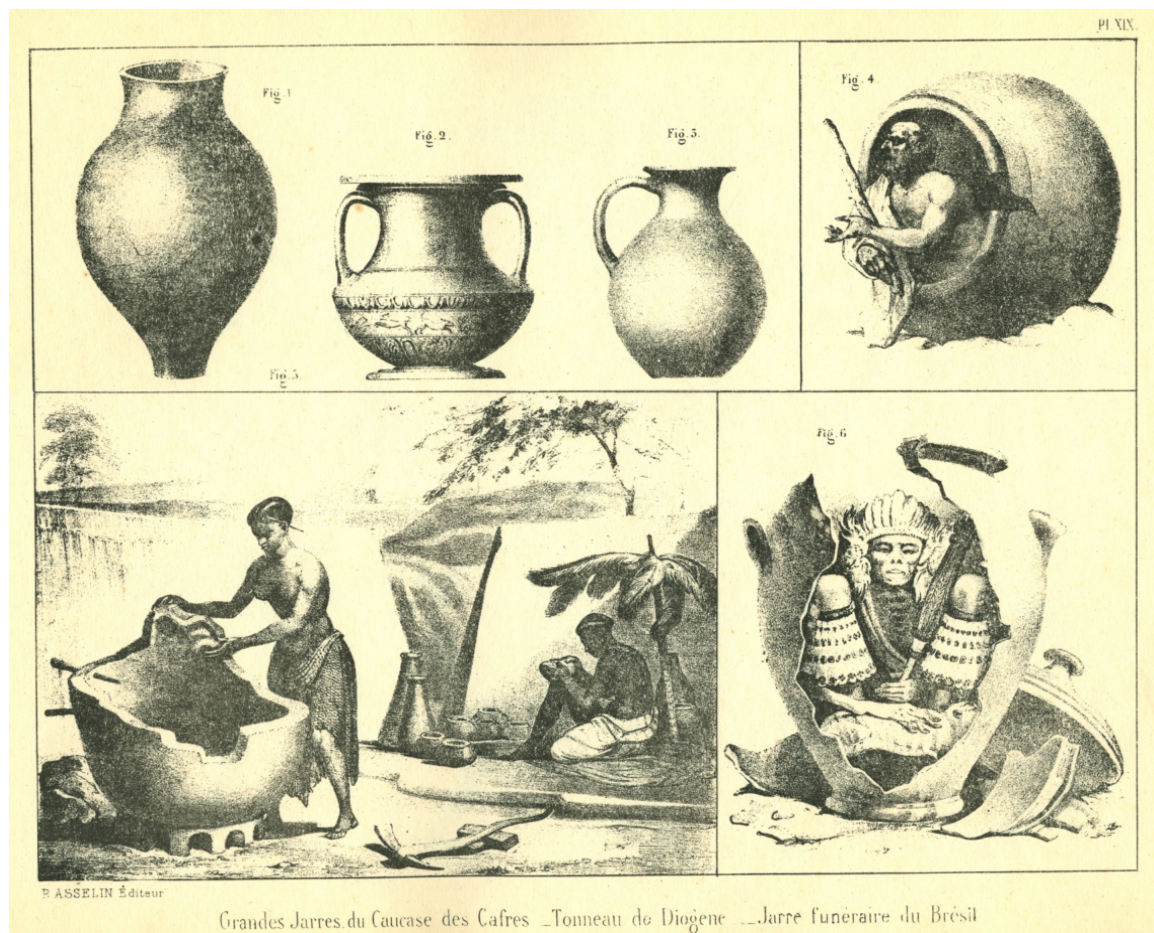


Figure 0.8: Cask of Diogenes, (Fig.4) Plate XIX,
Traité des Arts céramiques: Atlas, 1844.



Figure 0.9: Alexandre-Théodore Brongniart,
Vase “cornet antique” du Service olympique, Manufacture de Sèvres, 1807-1813.
Porcelain, Ceramic, Marble. 44 cm x 43.5 cm x 25 cm.
Photo: Louvre Museum, Used with Permission



Figure 1.1: François Langlois de Chartres,
Plate from *Livres des fleurs*, 1620, Paris.



Figure 1.2 - *Maison Brongniart*, Blvd des Invalides, Paris. Constructed 1781.
Alexandre-Théodore Brongniart.
Photo: J. Carr-Trebelhorn, 2016



Figure 1.3: Jean Antoine Houdon, *Portraits of Alexandre and Louise Brongniart*,
Terra Cotta and Marble, 1777.

Photos: Louvre Museum, Used with Permission



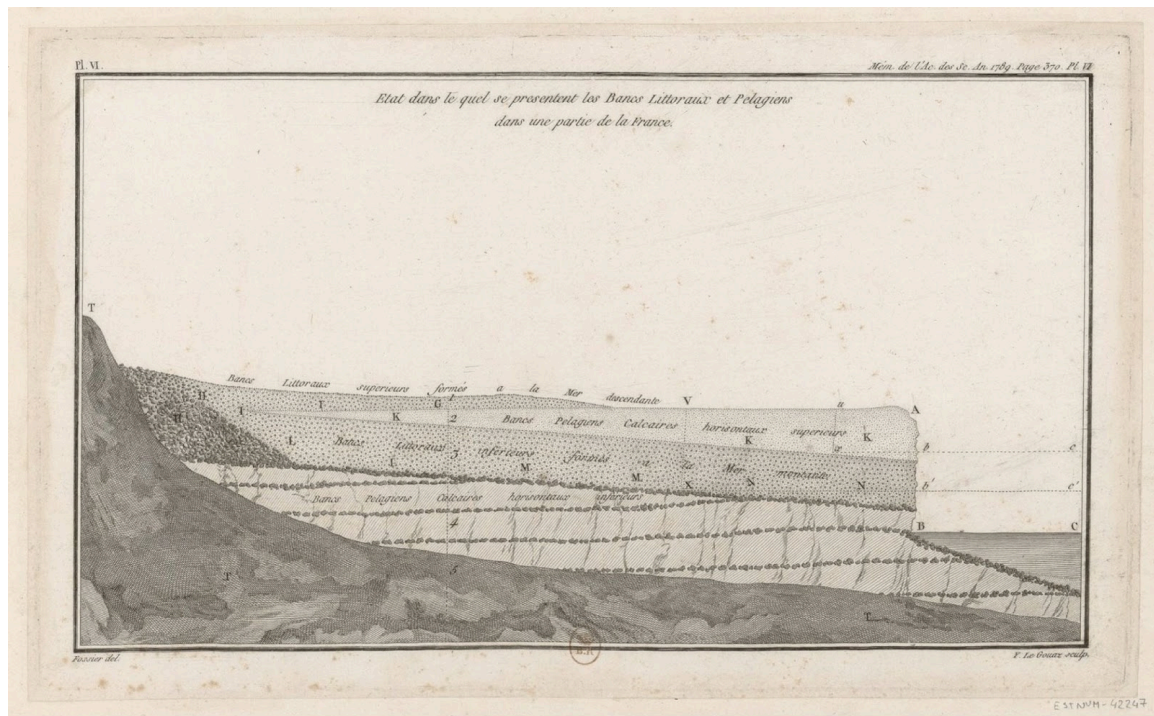
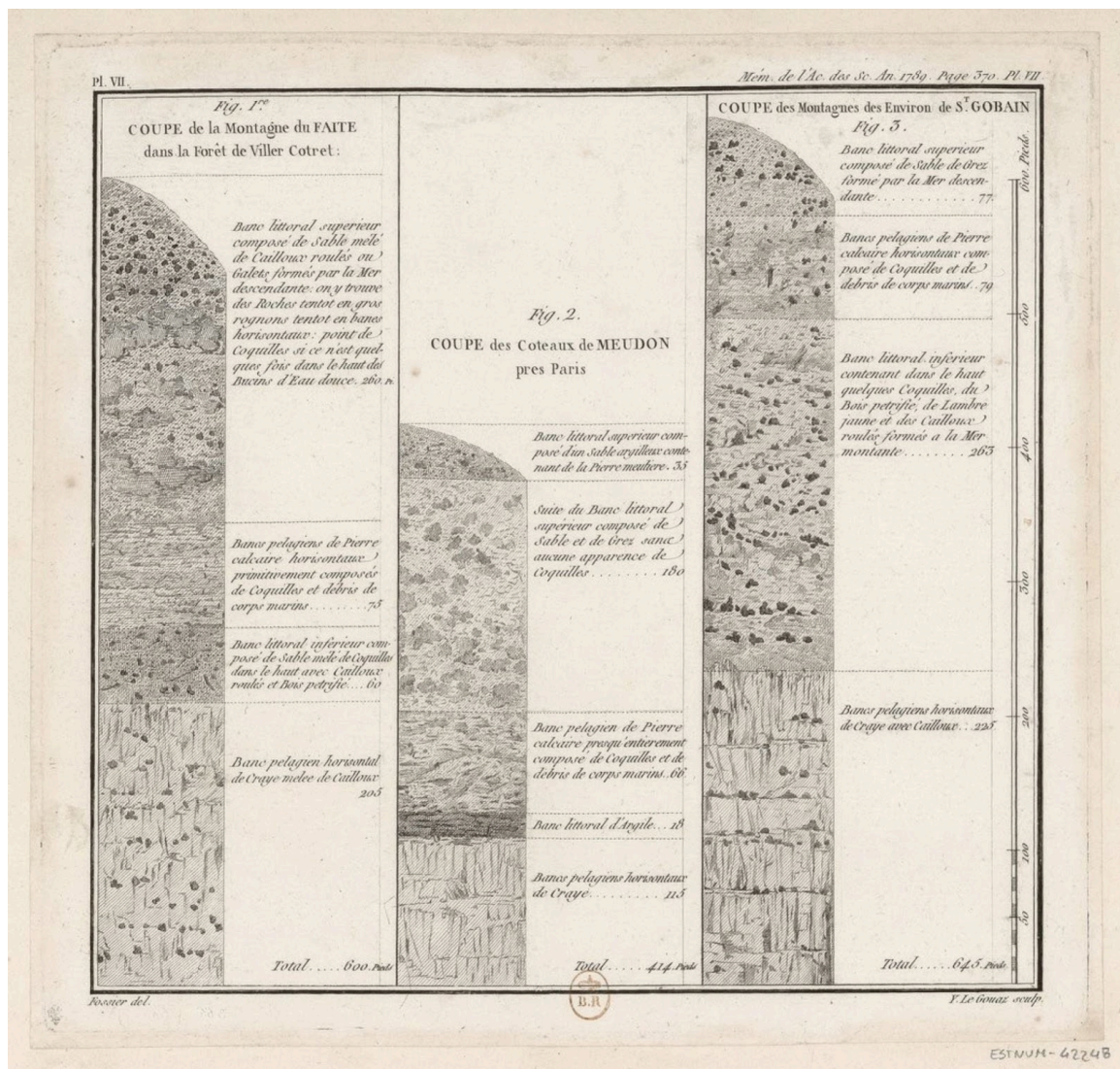


Figure 2.2 Antoine Lavoisier, *Coupe des Bancs Littoraux et Pélagiens*, 1789.



Source gallica.bnf.fr / Bibliothèque nationale de France

Figure 2.3 Lavoisier, *Coupes des environs de Paris*, 1789.



Figure 2.4 Pierre Hubert Desvignes, Silver Creamer, London, 1788-9.
Repository: RISD Museum, Acc. No. 67.228.
Photo: RISD/Public domain

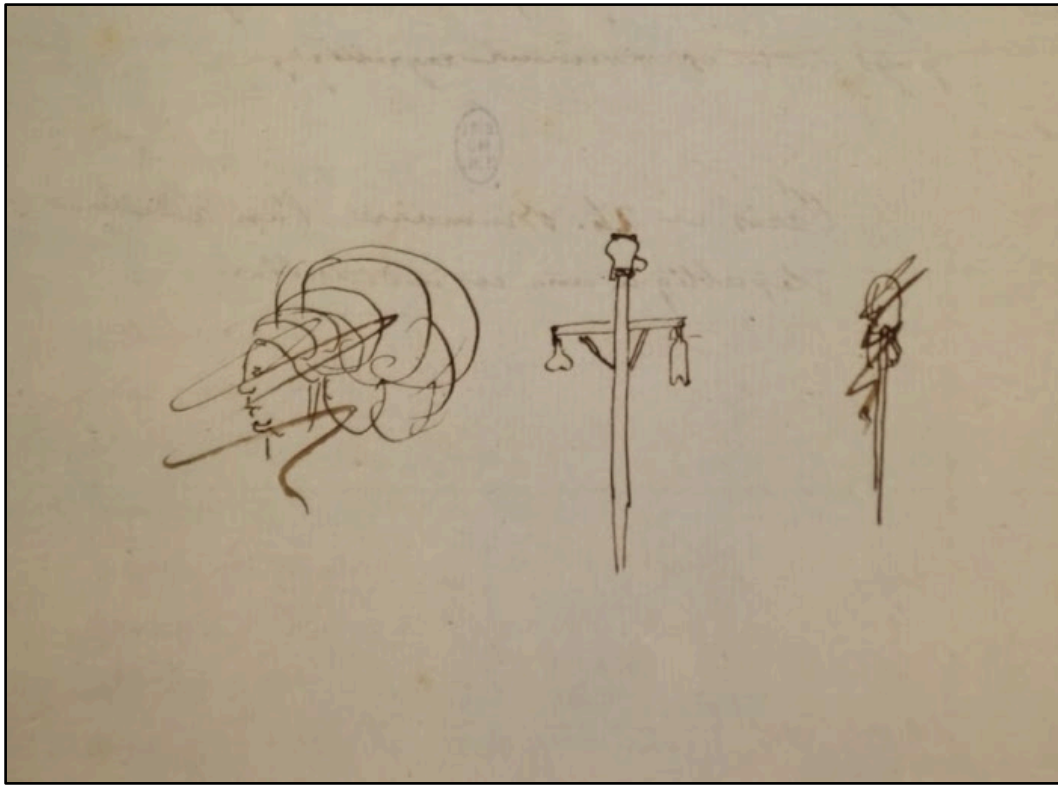


Figure 3.1 probably Alexandre Brongniart, Sketch on the back of a letter from François Silvestre, September 1793.

Repository: BMHN, Paris
Photo: Carr-Trebelhorn, 2019



Figure 3.2 Adélaïde Labille-Guiard (1749-1803),
Portrait of a Woman [Madame Roland], oil on canvas, c. 1787.
Photo: Musée des Beaux-Arts de Quimper, used with permission



Figure 3.3 Alexandre Brongniart, *Coupe de terre, Vallée d'Aspe*, Letter from Bayonne to his father in Bordeaux, 24 Germinal, An 2, République (14 April 1794), Repository: AN 668/AP/1. *Correspondance Active, 1791-1825*, 52.
Photo: Carr-Trebelhorn, 2015



Figure 6.1: Anne-Louis Girodet de Roussy-Trioson,
Pygmalion and Galatea, 1818, 8'4"x6'8", oil on canvas.
Photo: Louvre Museum, Used with Permission

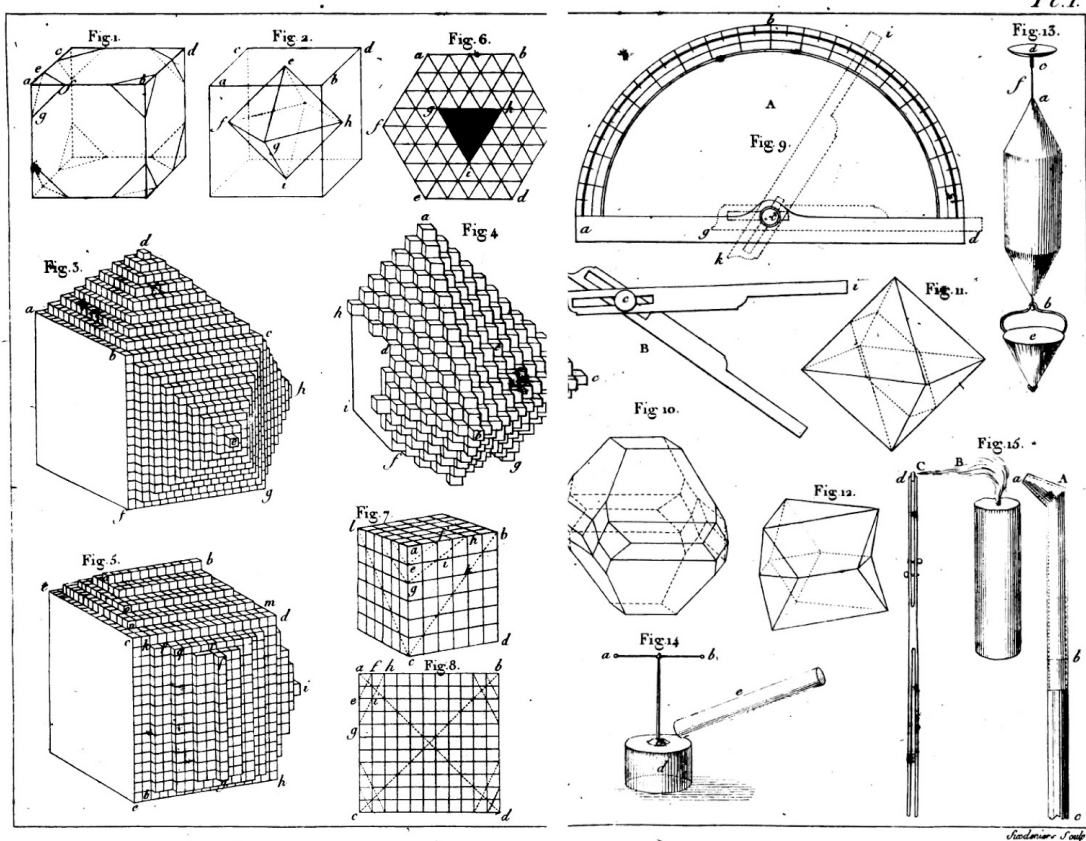


Figure 6.2 Alexandre Brongniart, *Mineralogie*, Plate I, 1807.

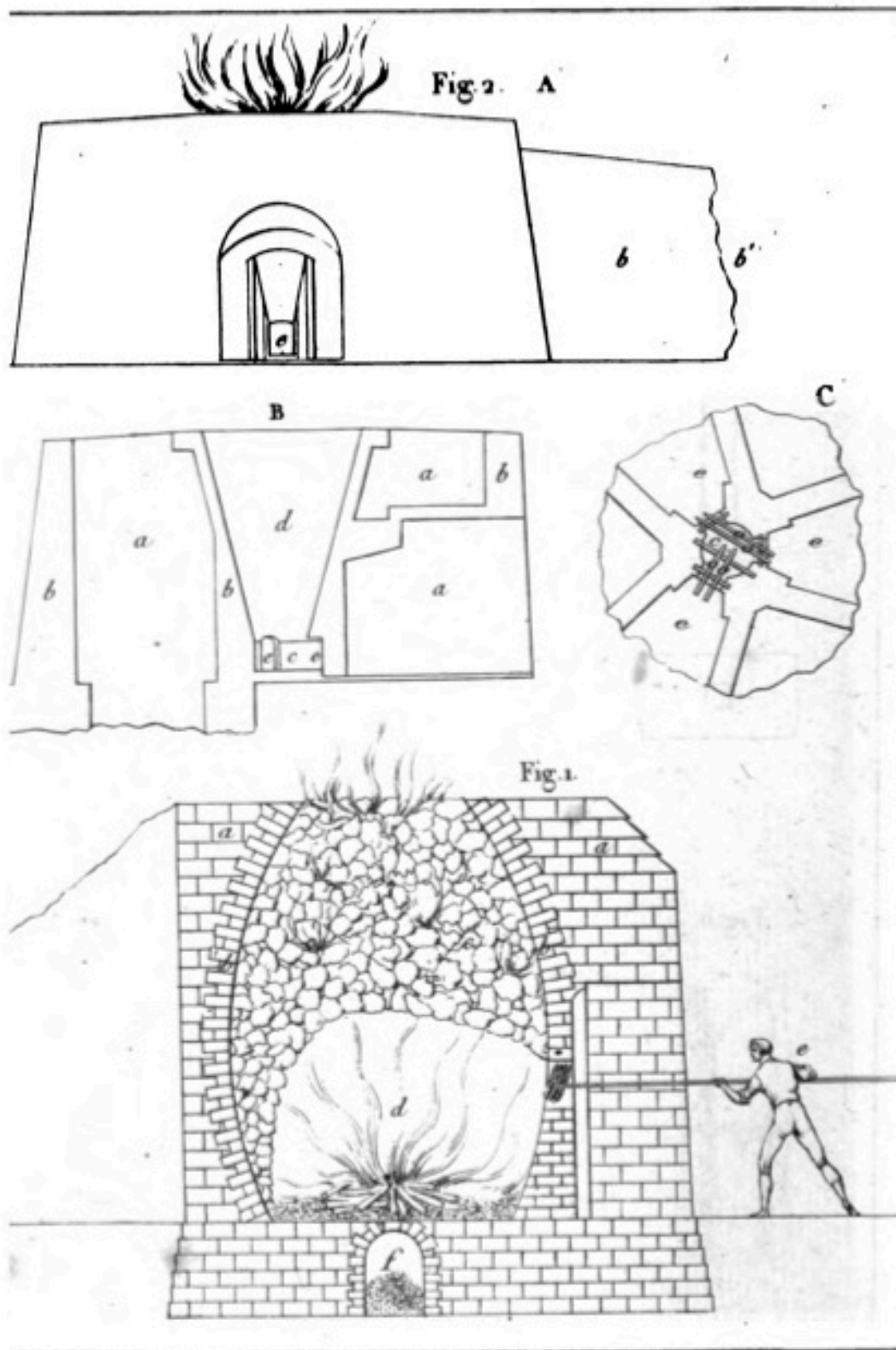


Figure 6.3 Alexandre Brongniart, *Mineralogie*, Plate V, left, 1807.

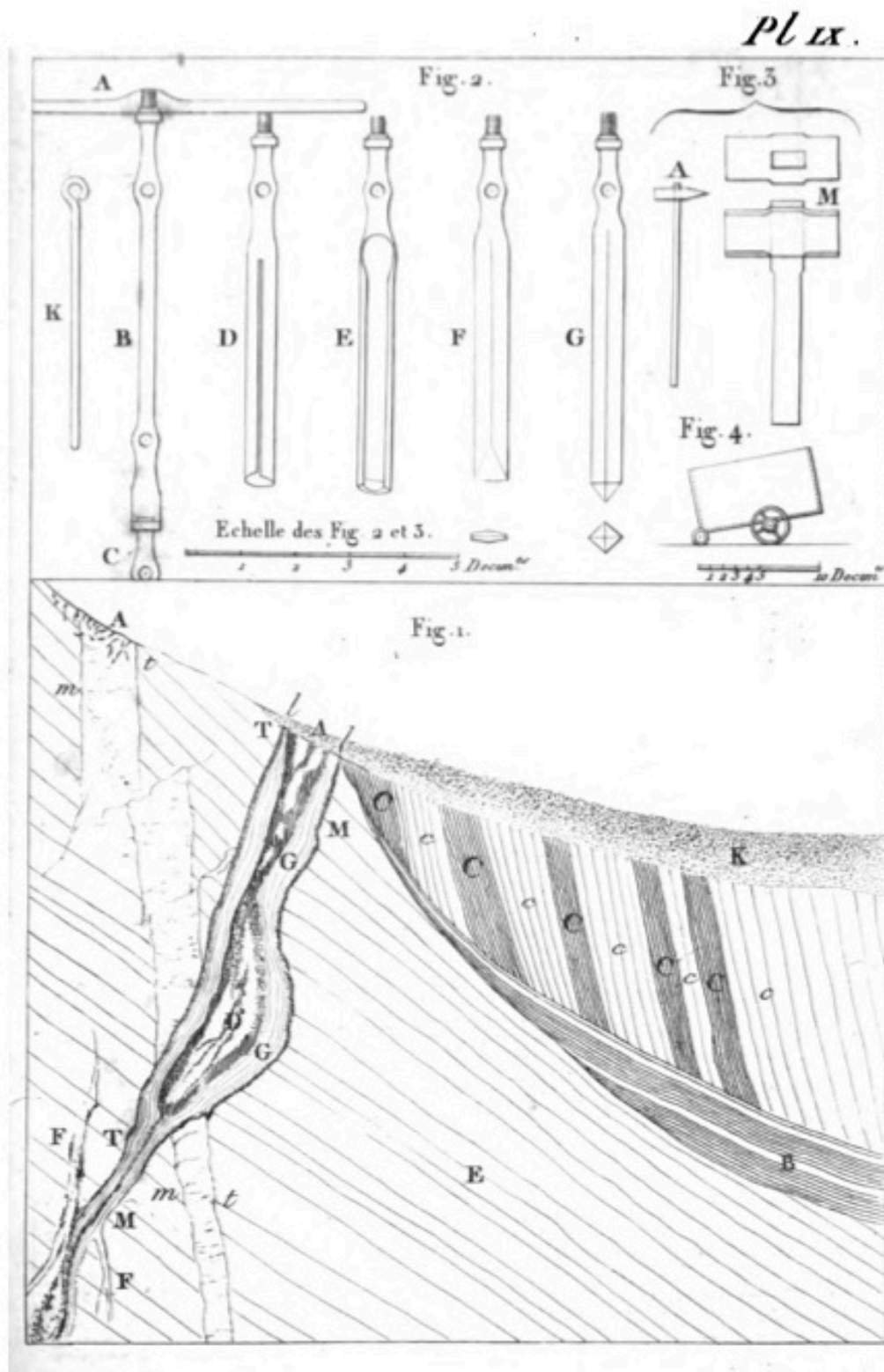


Figure 6.4 Alexandre Brongniart, *Mineralogie*, Plate IX, 1807.

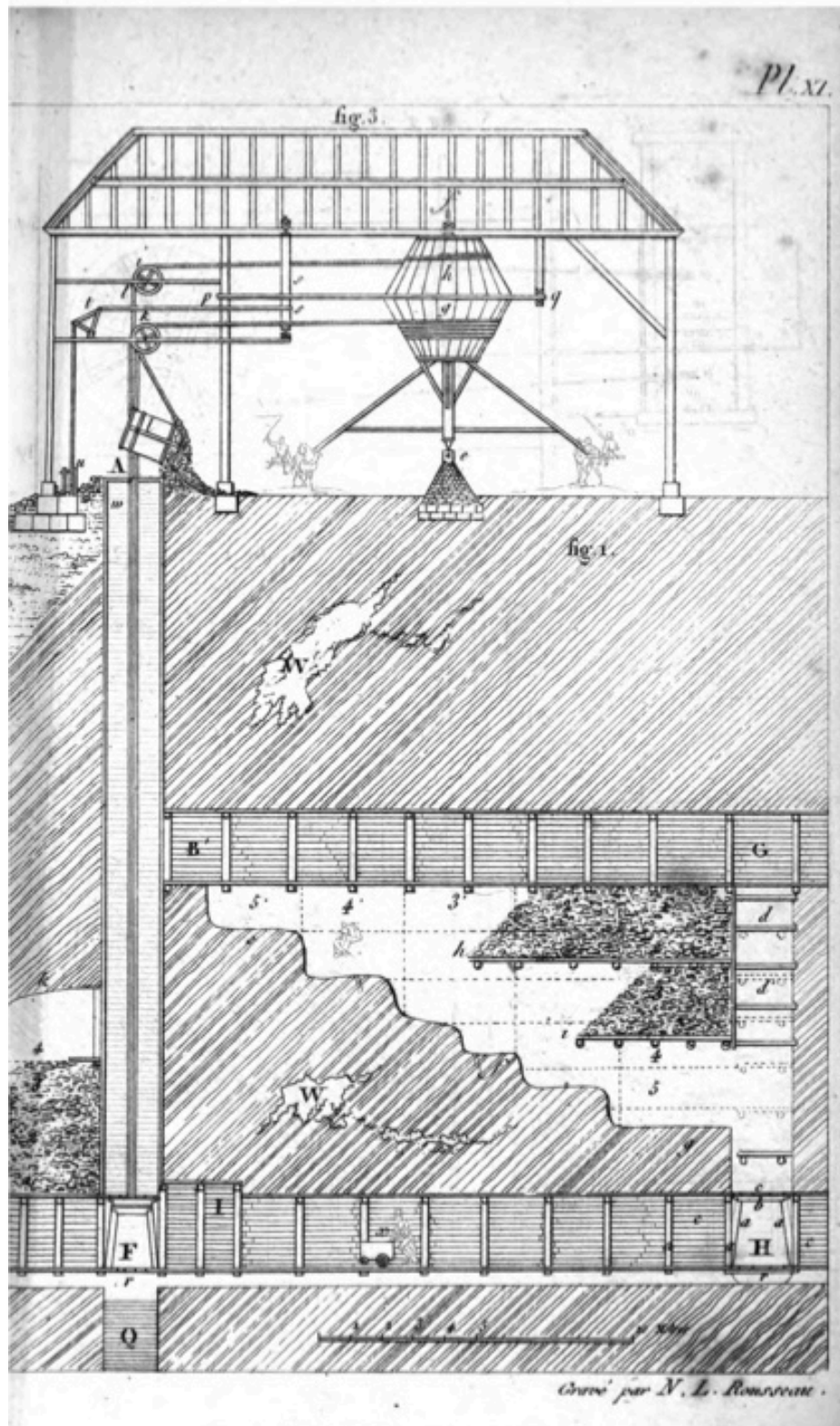


Figure 6.5 Alexandre Brongniart, *Mineralogie*, Plate XI, 1807.

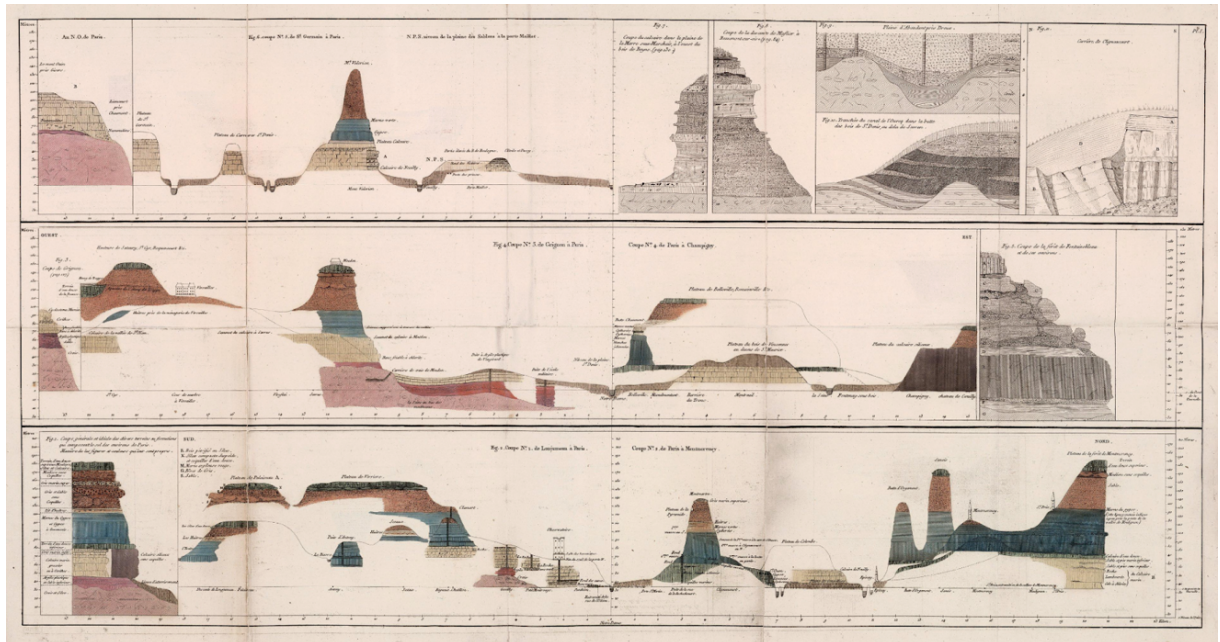


Figure 6.6: Hand-Colourled, Untitled Plate (Coupes de Terrain);
Essai sur la géographie minéralogique des environs de Paris, 1811.



Figure 6.7: Sèvres, Kaolin Quarry, painted by Develly, 1816.
 Image: Ostergard and Préaud, *Sèvres Porcelain Manufactory*



Figure 6.8: Sèvres, *Pug Mill*, painted by Develly, 1816.
Image: Ostergard and Préaud, *Sèvres Porcelain Manufactory*

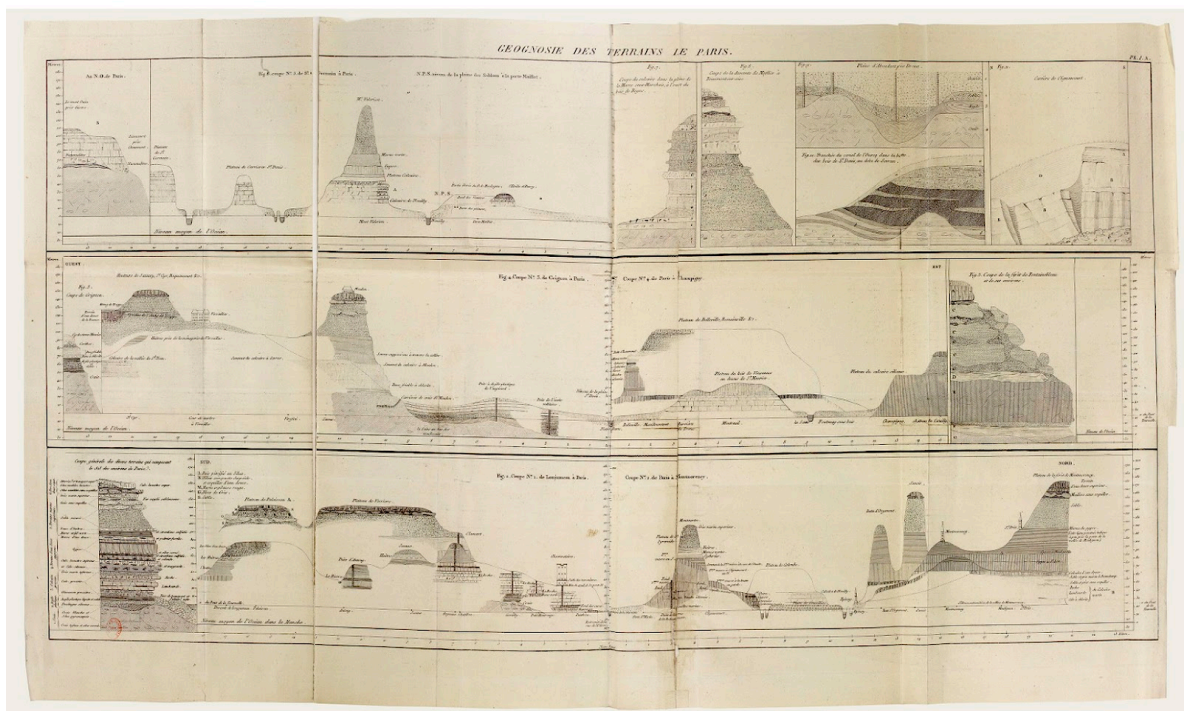


Figure 6.9: "Geognosie des Terrains de Paris,"
Description géologique, 1822.

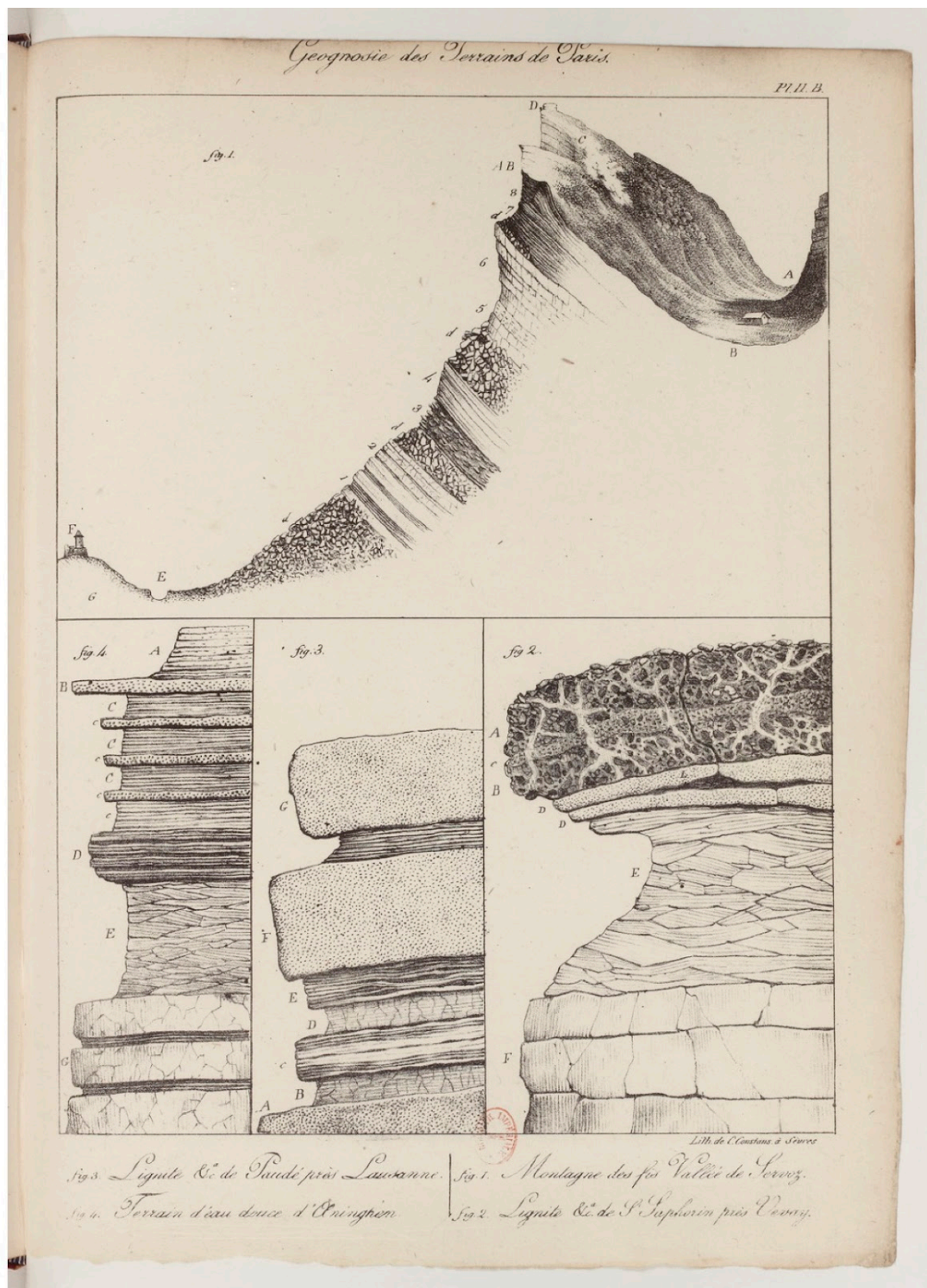
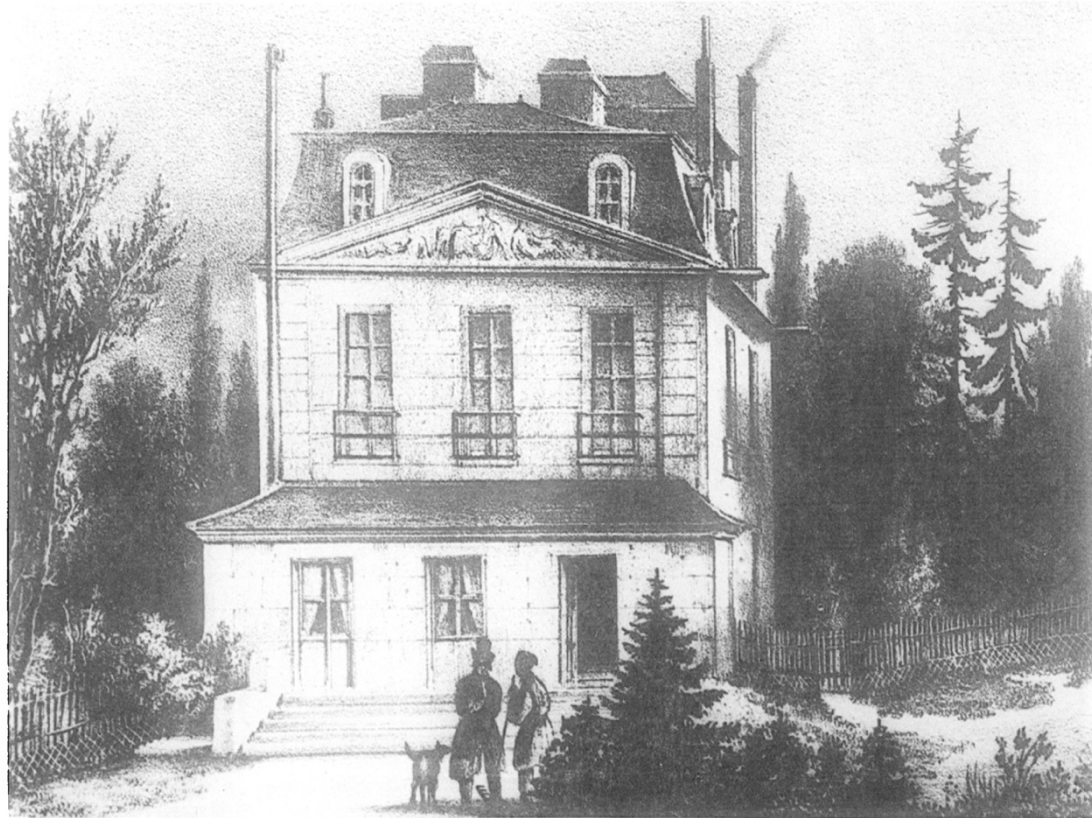


Figure 6.12: “Geognosie des Terrains de Paris,” Plate IIb,
Description géologique des environs de Paris, 1822.



Figure 6.13: Engraving by Develly after an original drawing by Adolphe Brongniart, “Sur les Végétaux Fossiles,” Plate III, 1821.



L'ancien hôtel de Magny du Muséum. L'appartement d'Haüy était au 2^m étage et celui de Fourcroy au premier.

Figure 7.1: Hotel Magny, on the Grounds of the Jardin des Plantes, Paris, depicted in Alfred Lacroix, "La vie et l'œuvre de l'abbé Haüy," 1918.

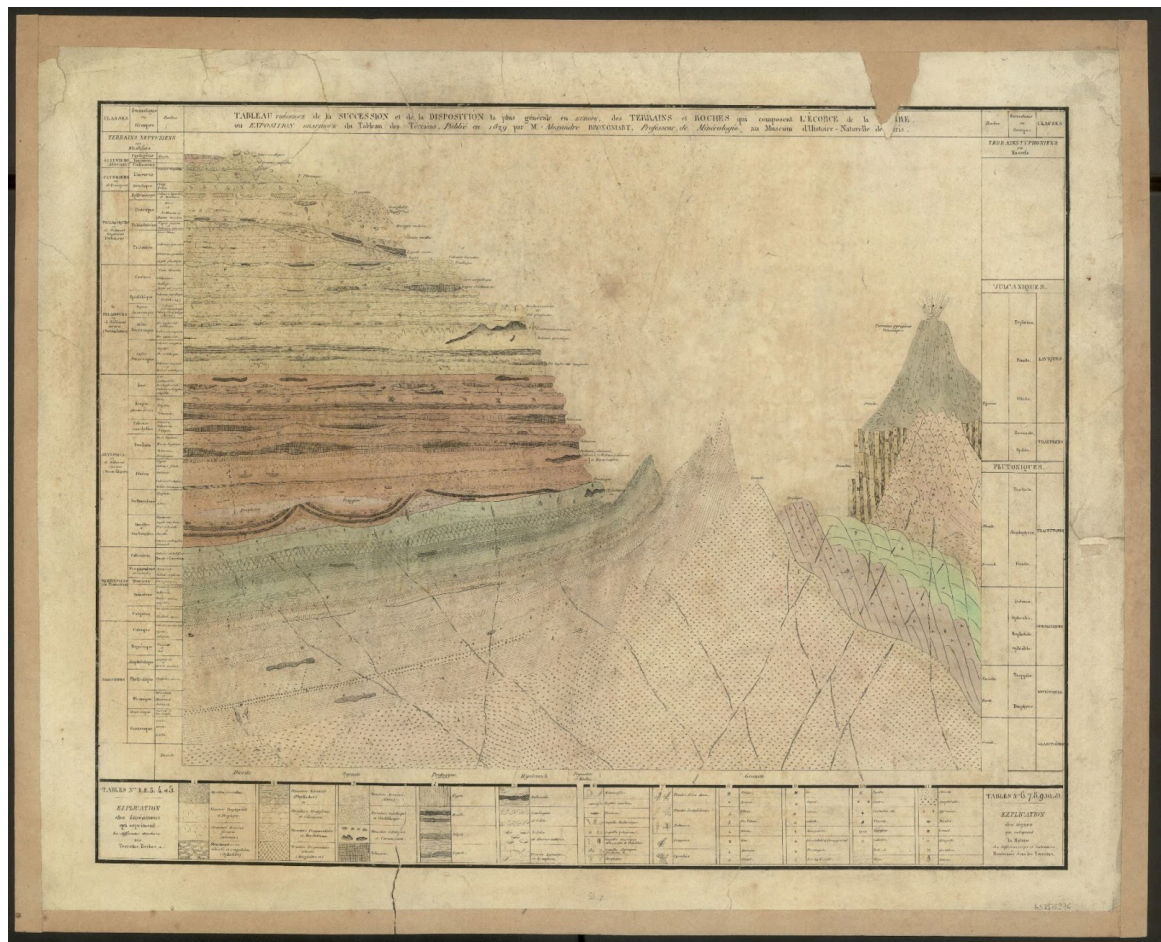


Figure 8.1: Alexandre Brongniart, *Tableau théorique de la succession et de la disposition la plus générale en Europe des Terrains et Roches qui composent l'écorce de la Terre*, 1829.

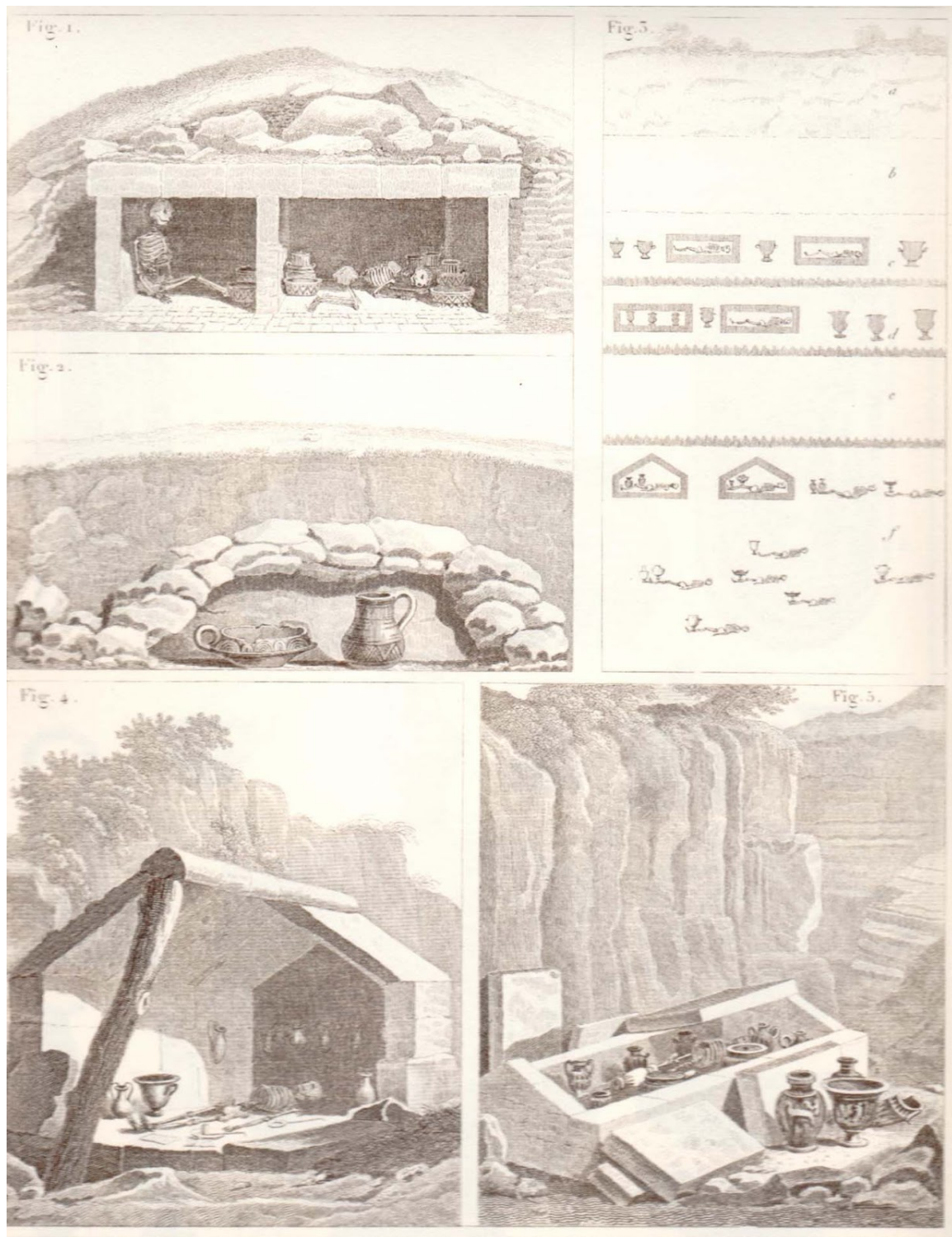


Figure 8.2: Alexandre Brongniart, Plate I, *Arts céramiques: Atlas*, 1844.



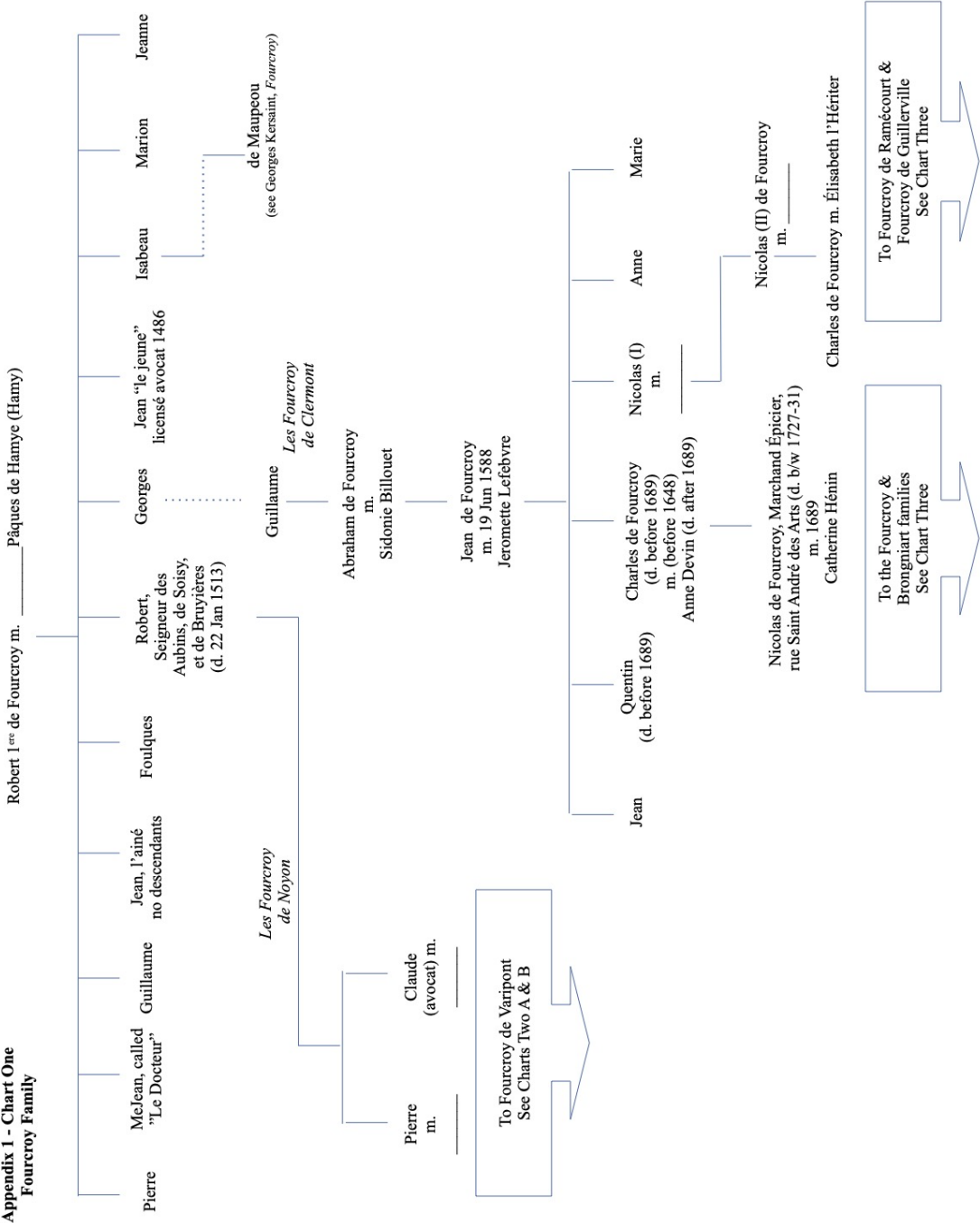
Figure 8.3: Alexandre Brongniart, Plate II, *Arts céramiques: Atlas*, 1844.



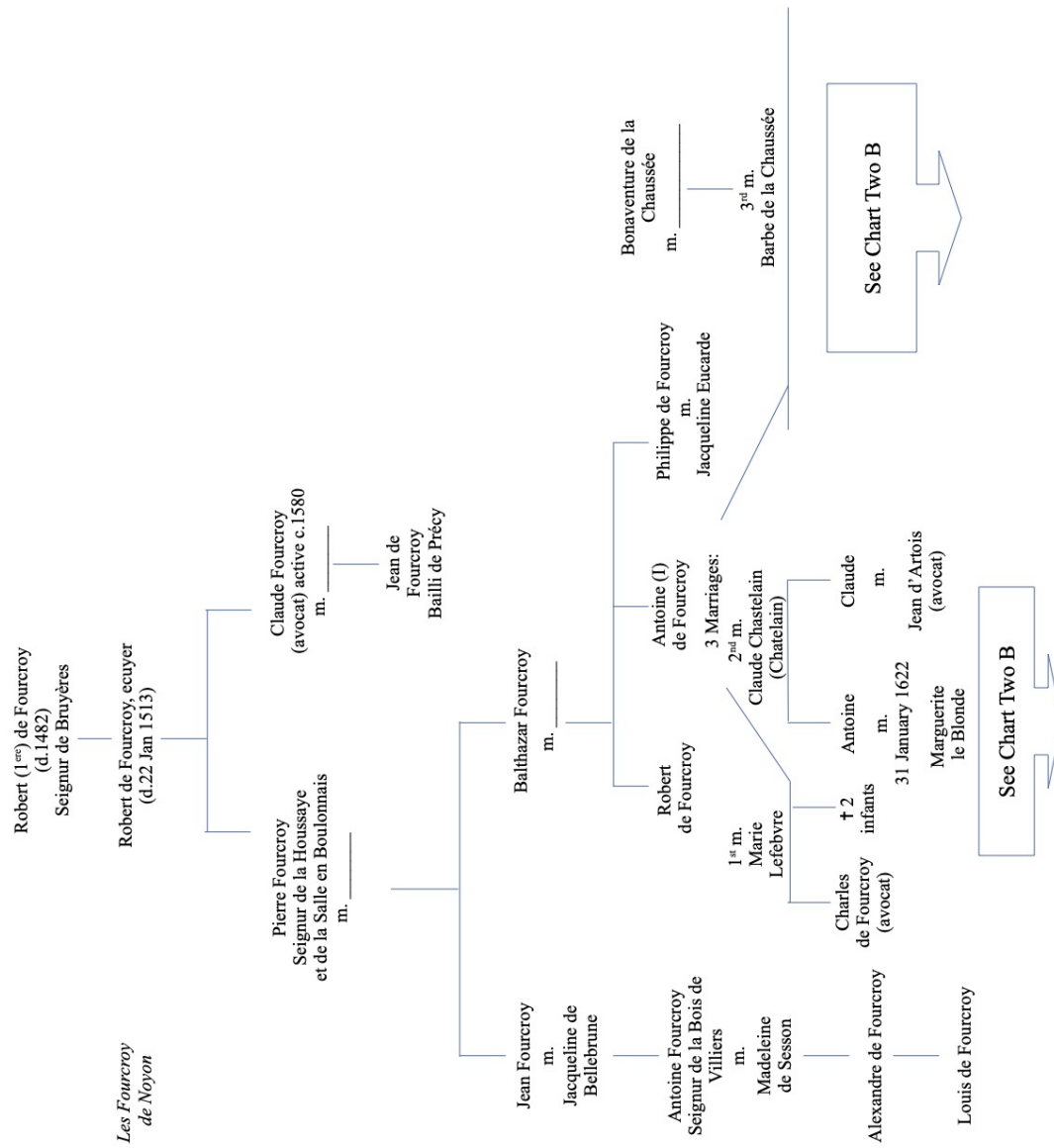
Figure 8.4: Plate I, *Déscription méthodique*, vol. 2

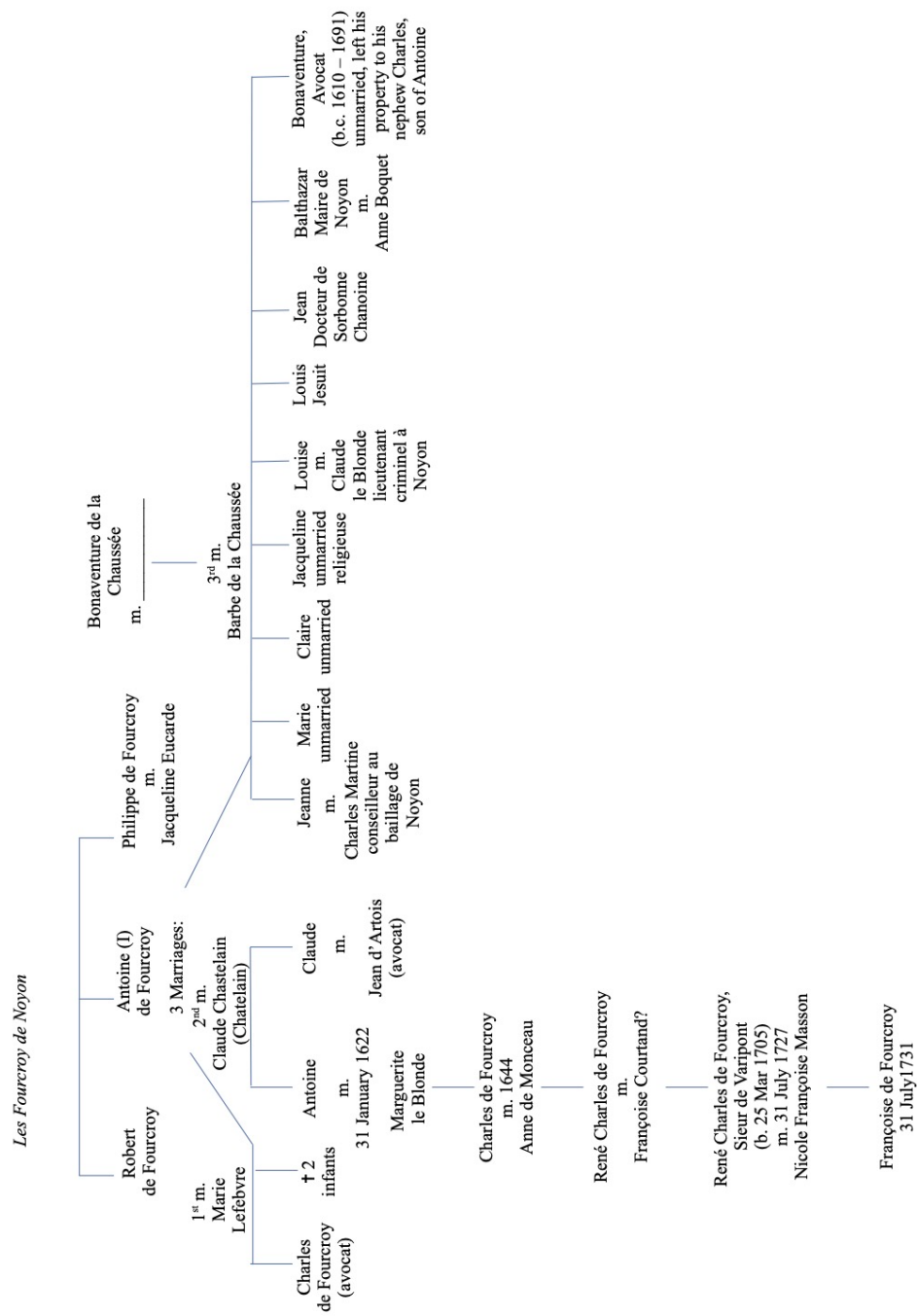
APPENDIX

Appendix One – Family Trees

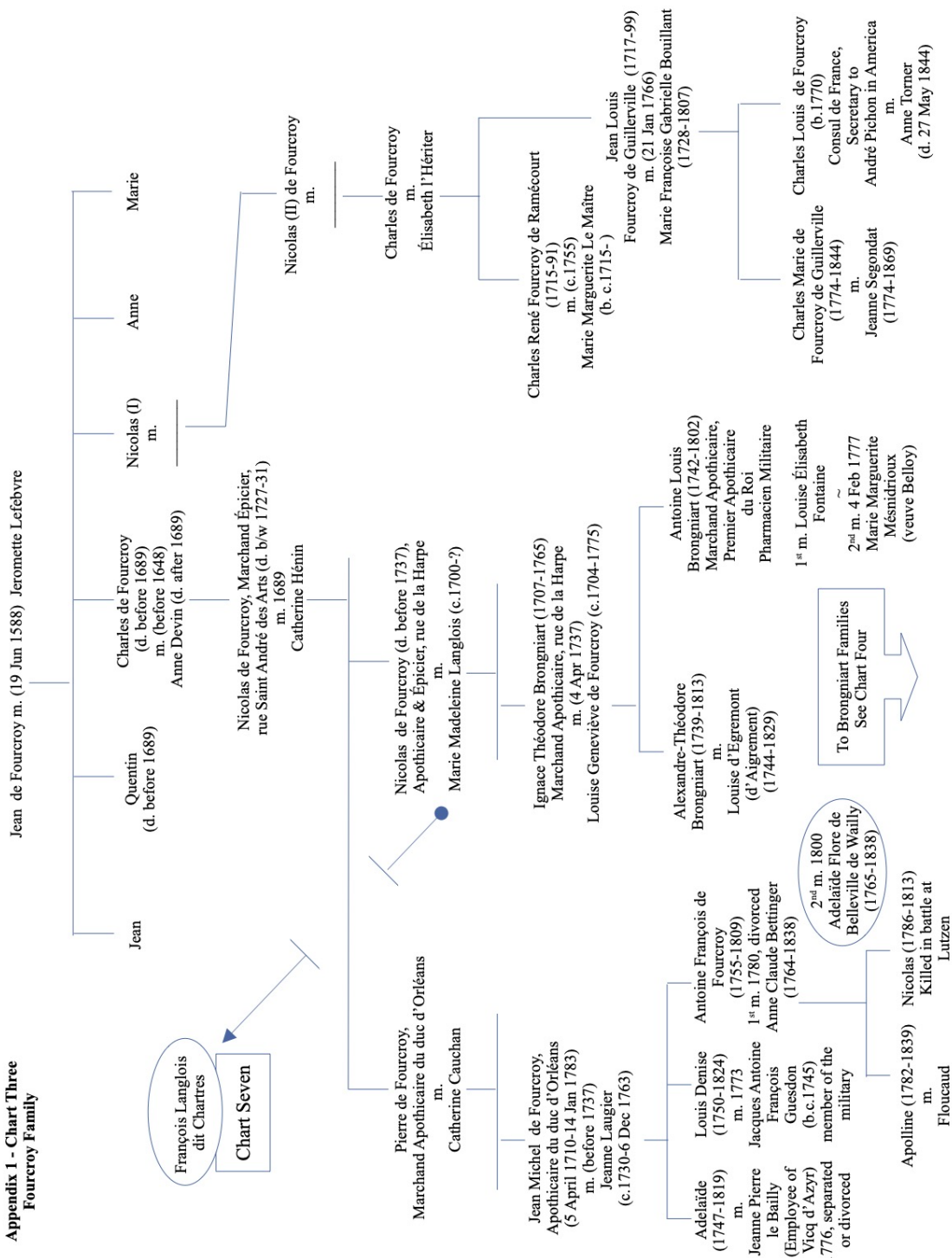


Appendix 1 - Chart Two A
Fourcroy Family

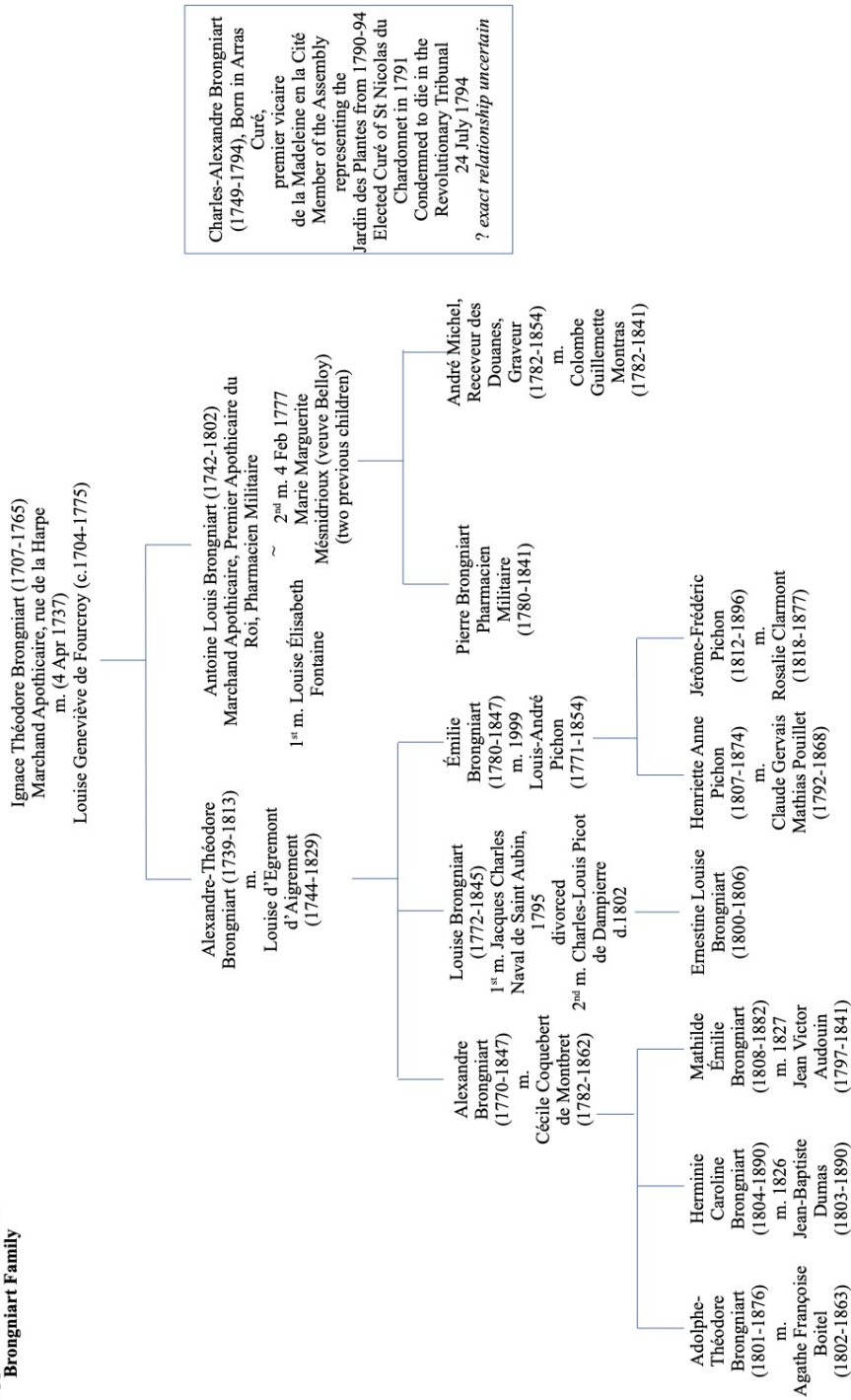




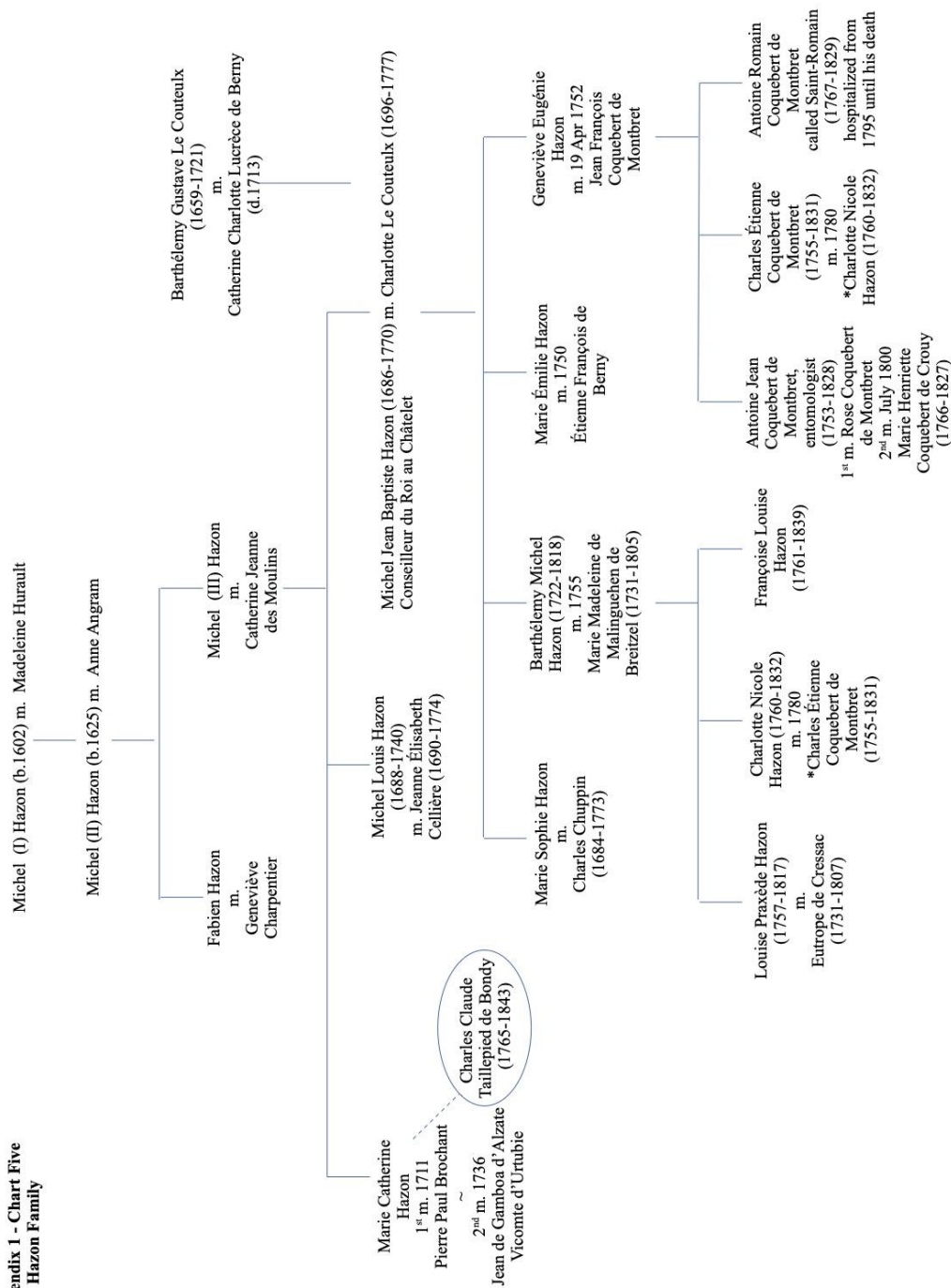
Appendix 1 - Chart Three
Fourcroy Family



Appendix 1 - Chart Four
Brongniart Family



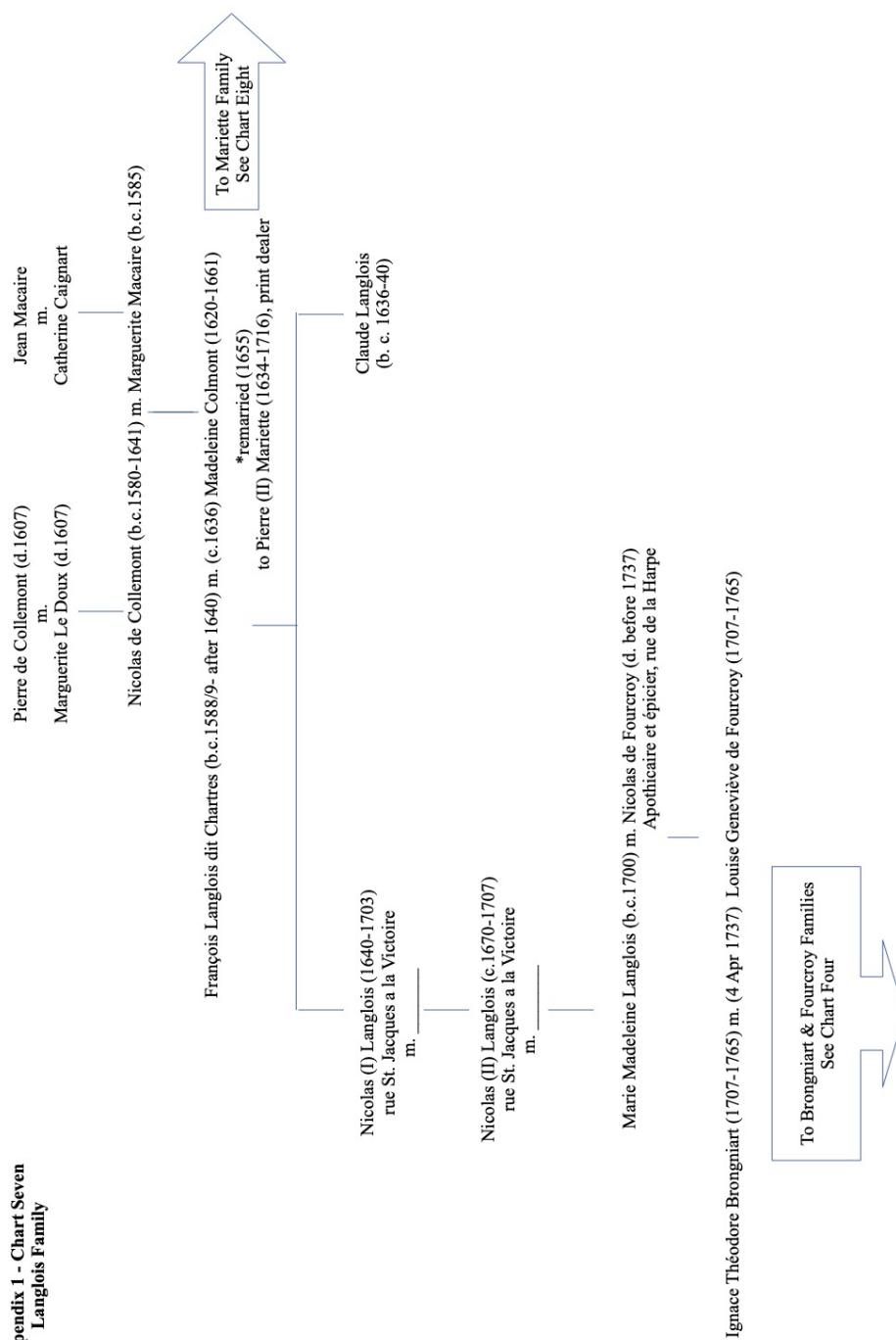
Appendix 1 - Chart Five
Hazon Family



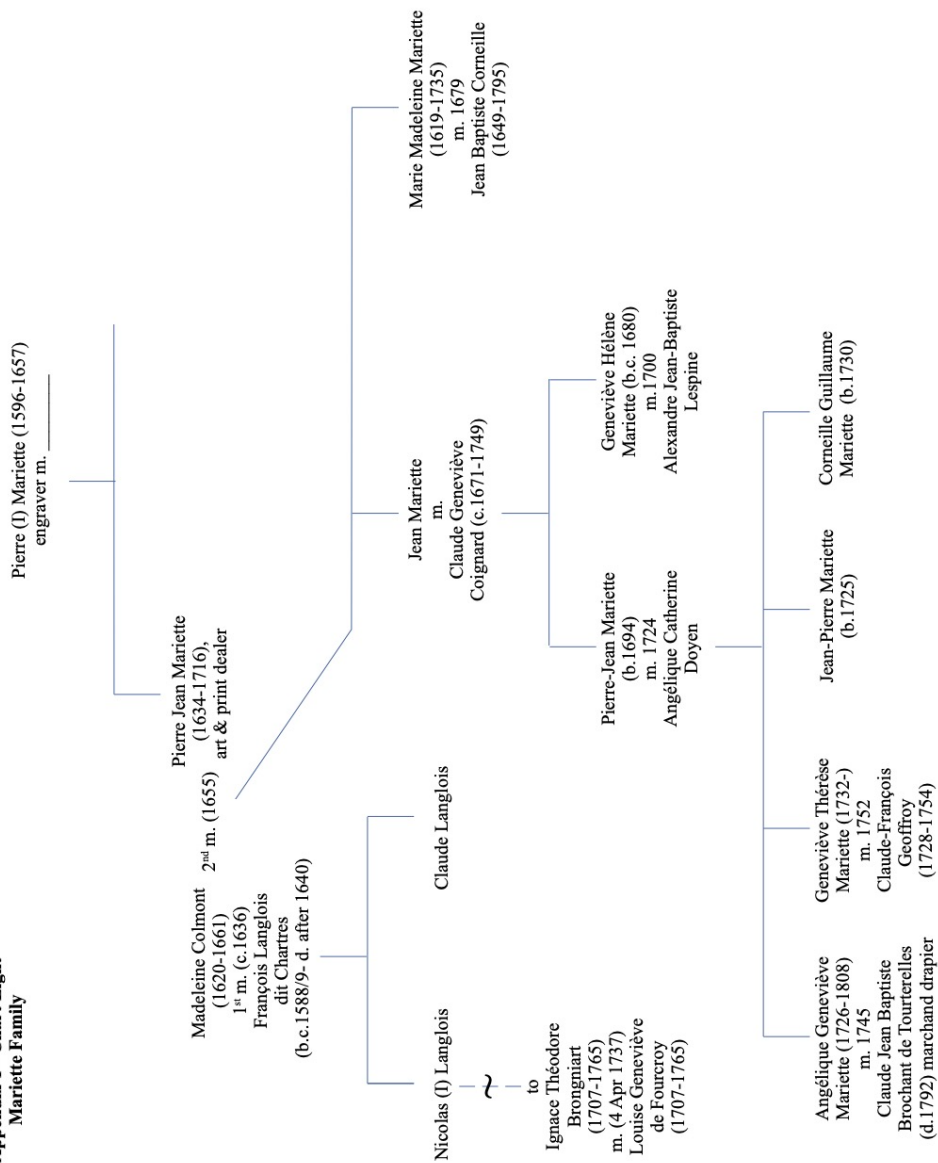
Barthélemy Michel Hazon (1722-1818)
m. 1755
Marie Madeleine de Malinguehen de Breitzel (1731-1805)



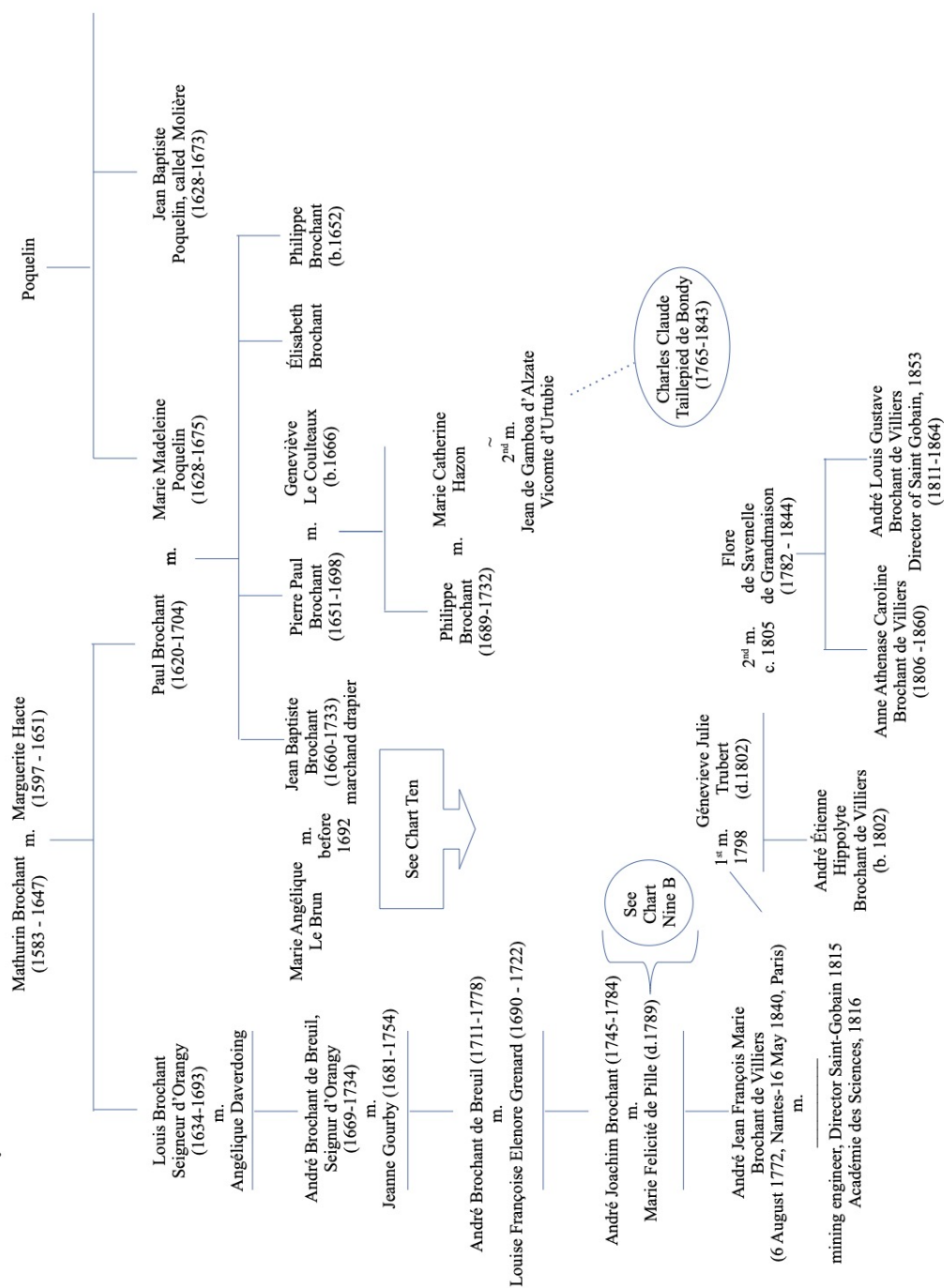
Appendix 1 - Chart Seven
Langlois Family



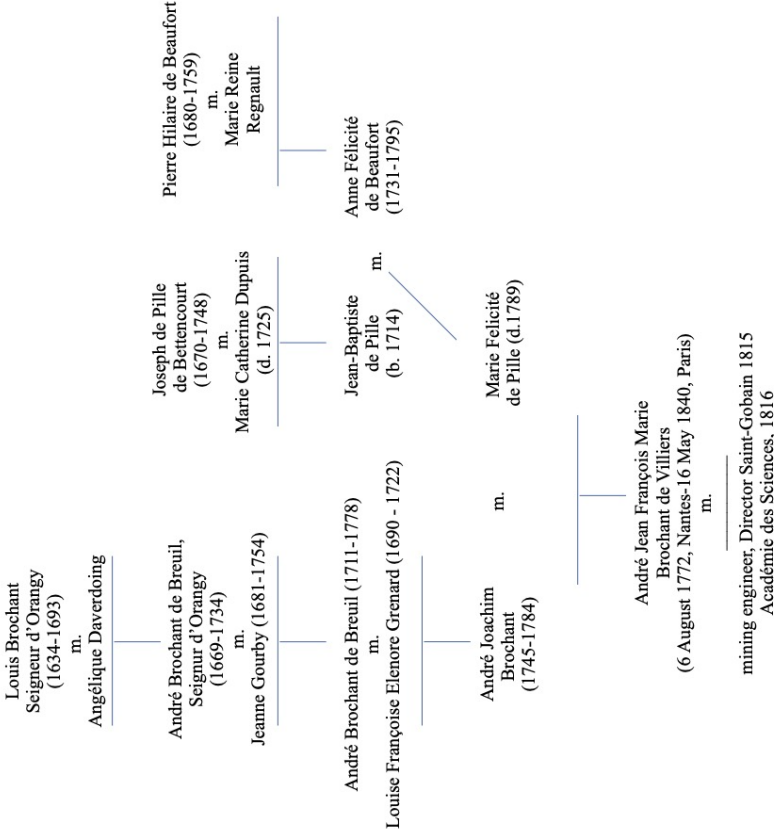
Appendix 1 - Chart Eight
Mariette Family



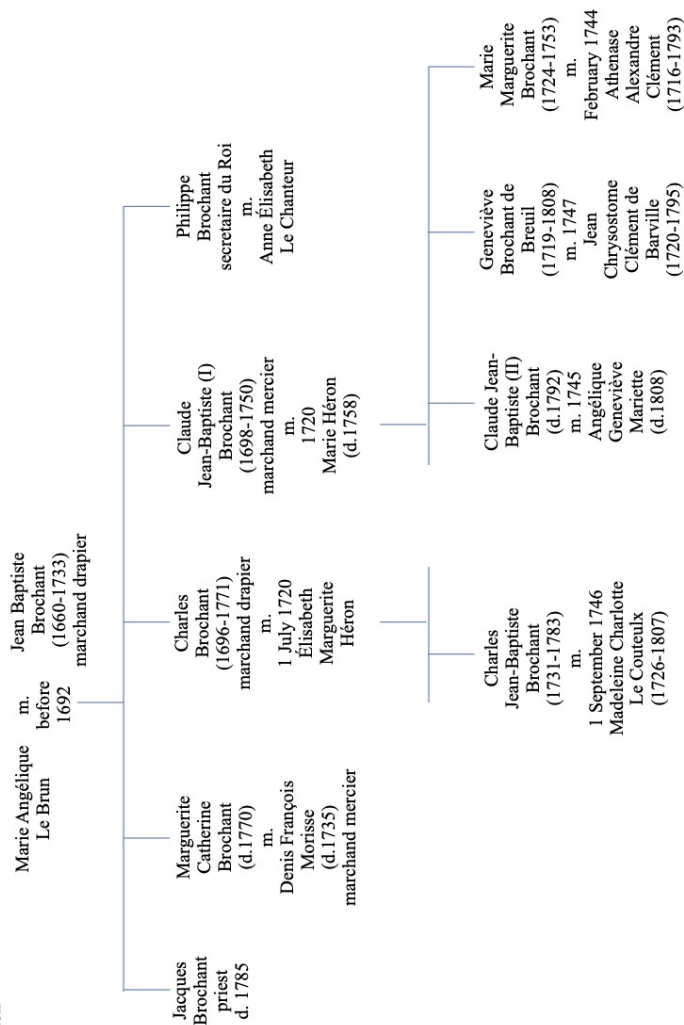
Appendix 1 - Chart Nine A
Brochant Family



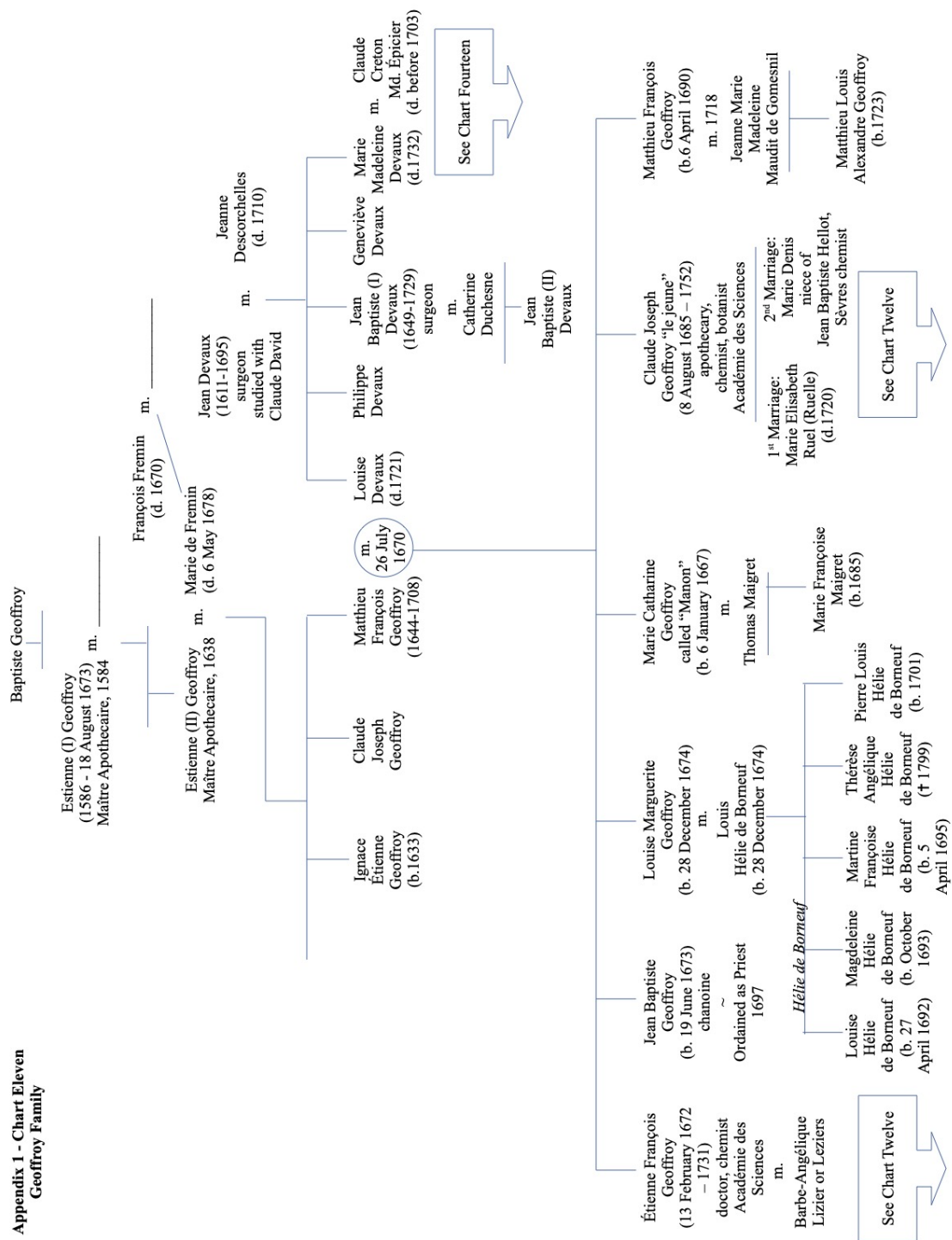
Appendix 1 - Chart Nine B
Brochant Family



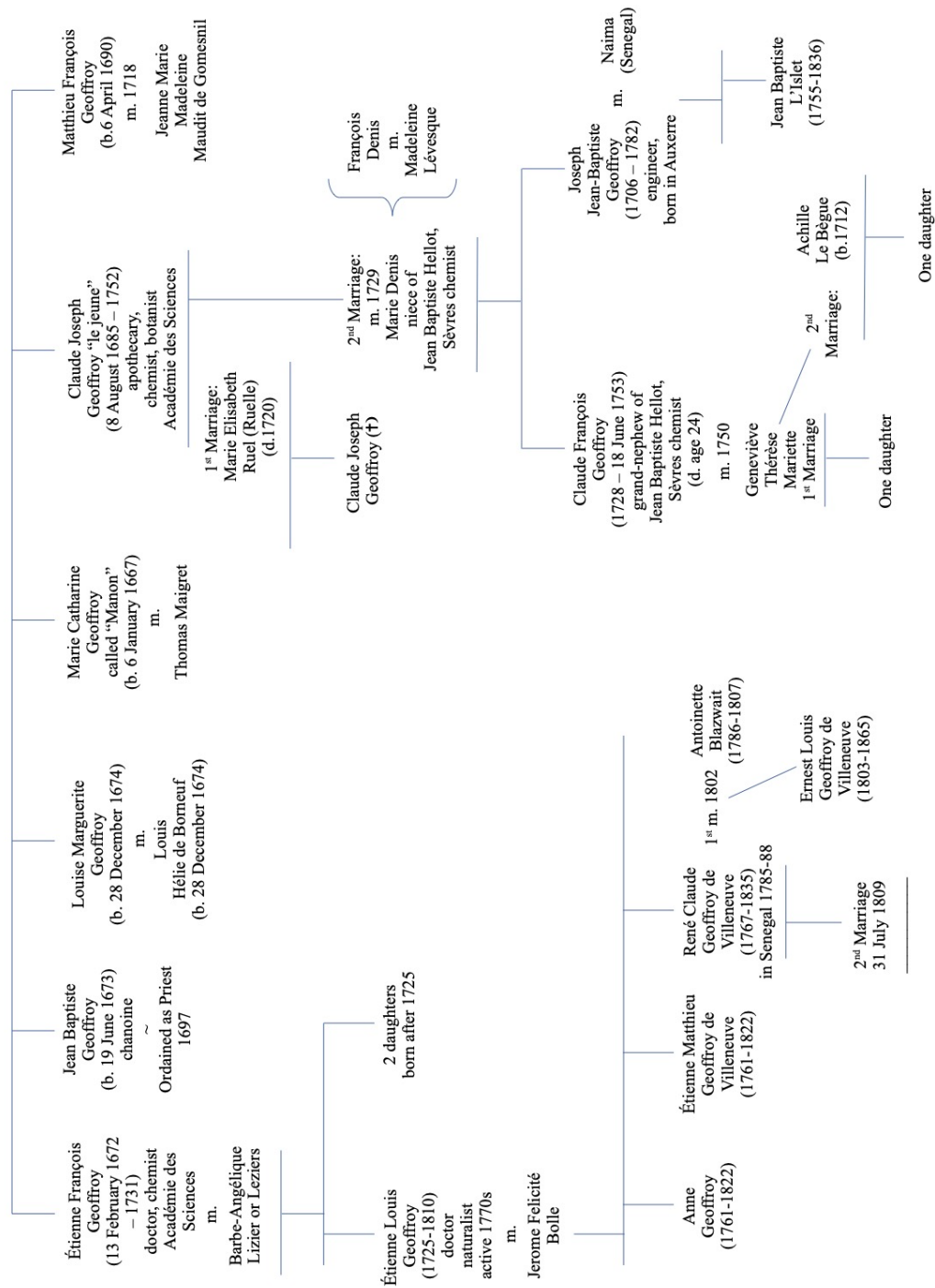
Appendix 1 - Chart Ten
Brochant Family



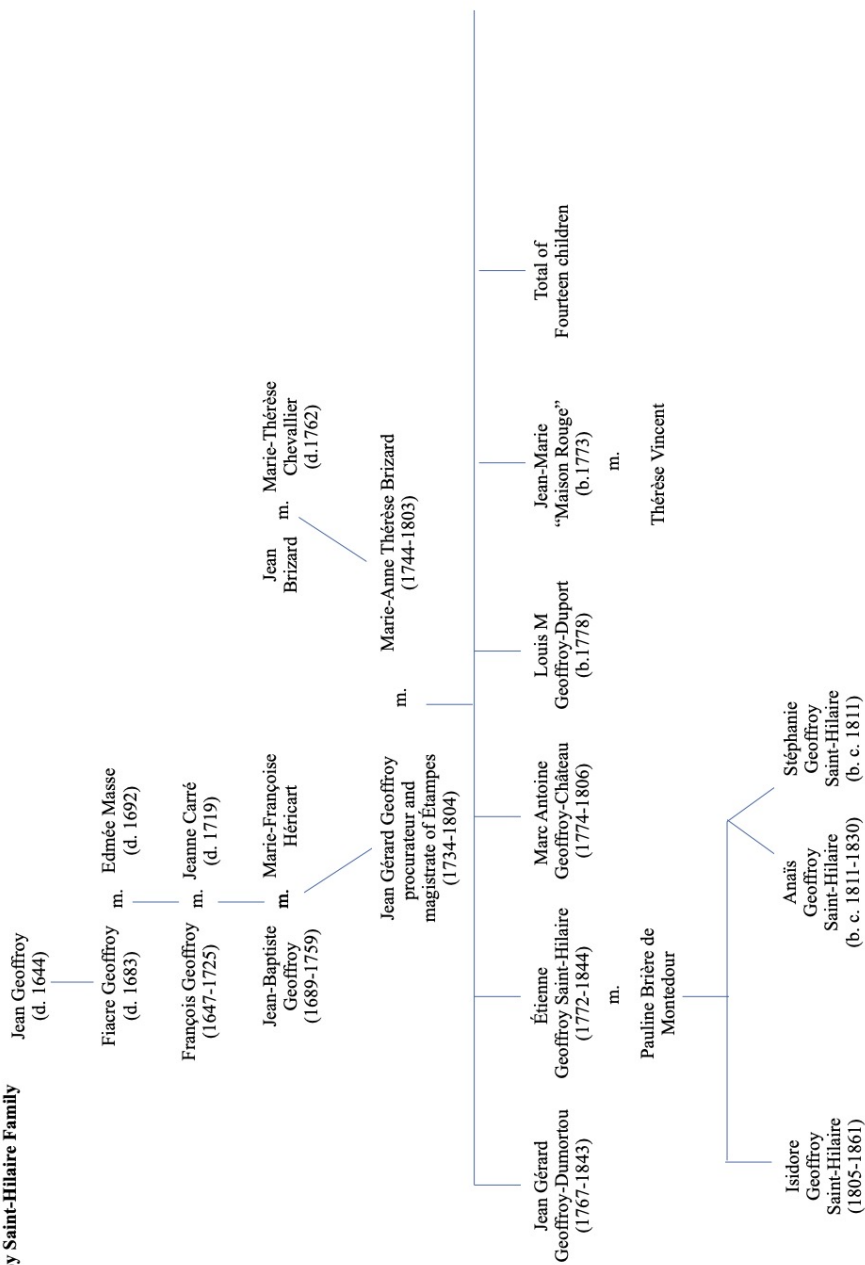
Appendix 1 - Chart Eleven
Geoffroy Family



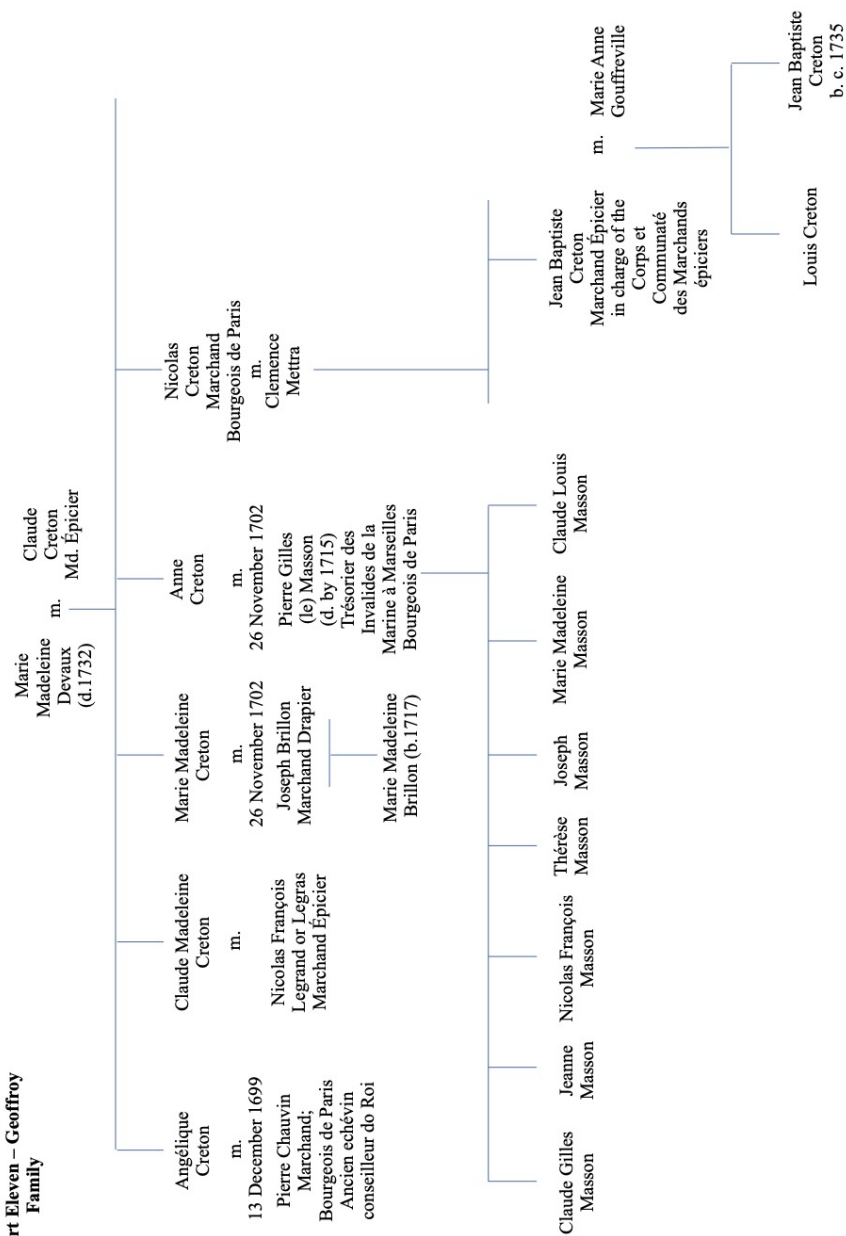
Appendix 1 - Chart Twelve
Geoffroy Family



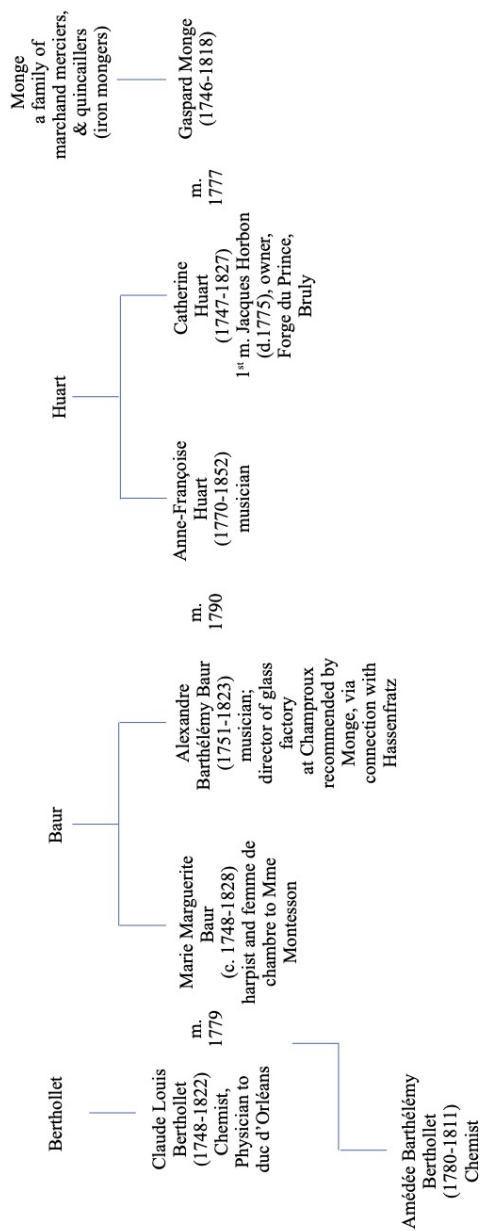
Appendix 1 - Chart Thirteen
Geoffroy Saint-Hilaire Family



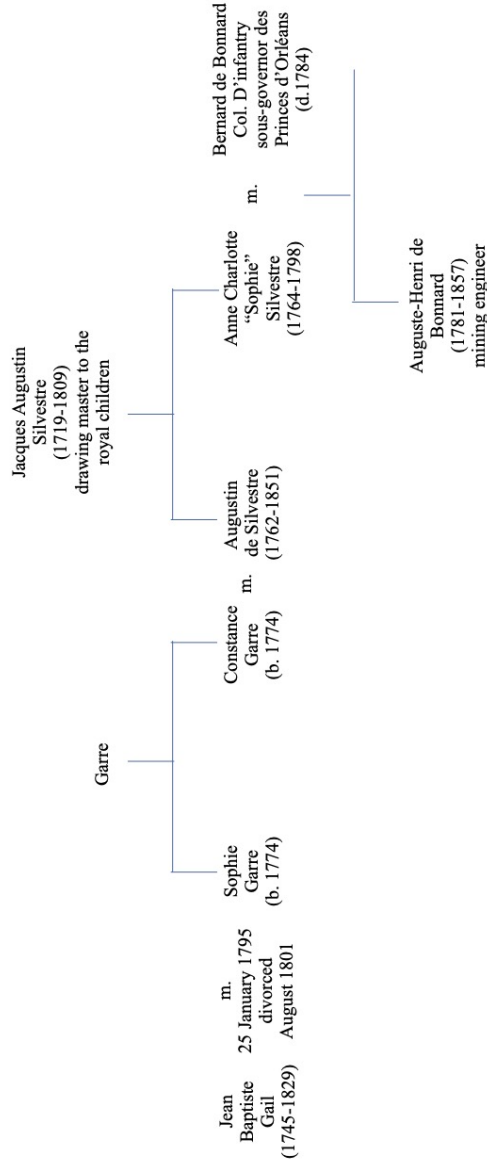
Appendix 1 - Quart Fourteen
Devaux/Creton/Masson
see Chart Eleven – Geoffroy
Family



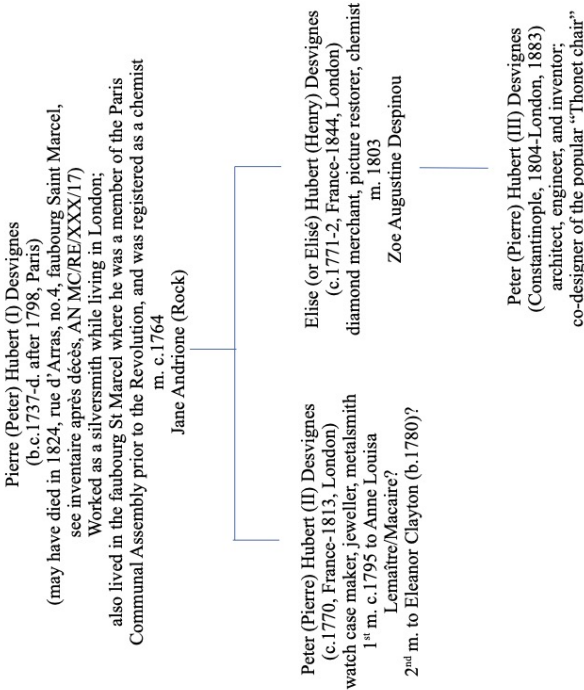
Appendix 1 - Chart Fifteen
Monge & Berthollet



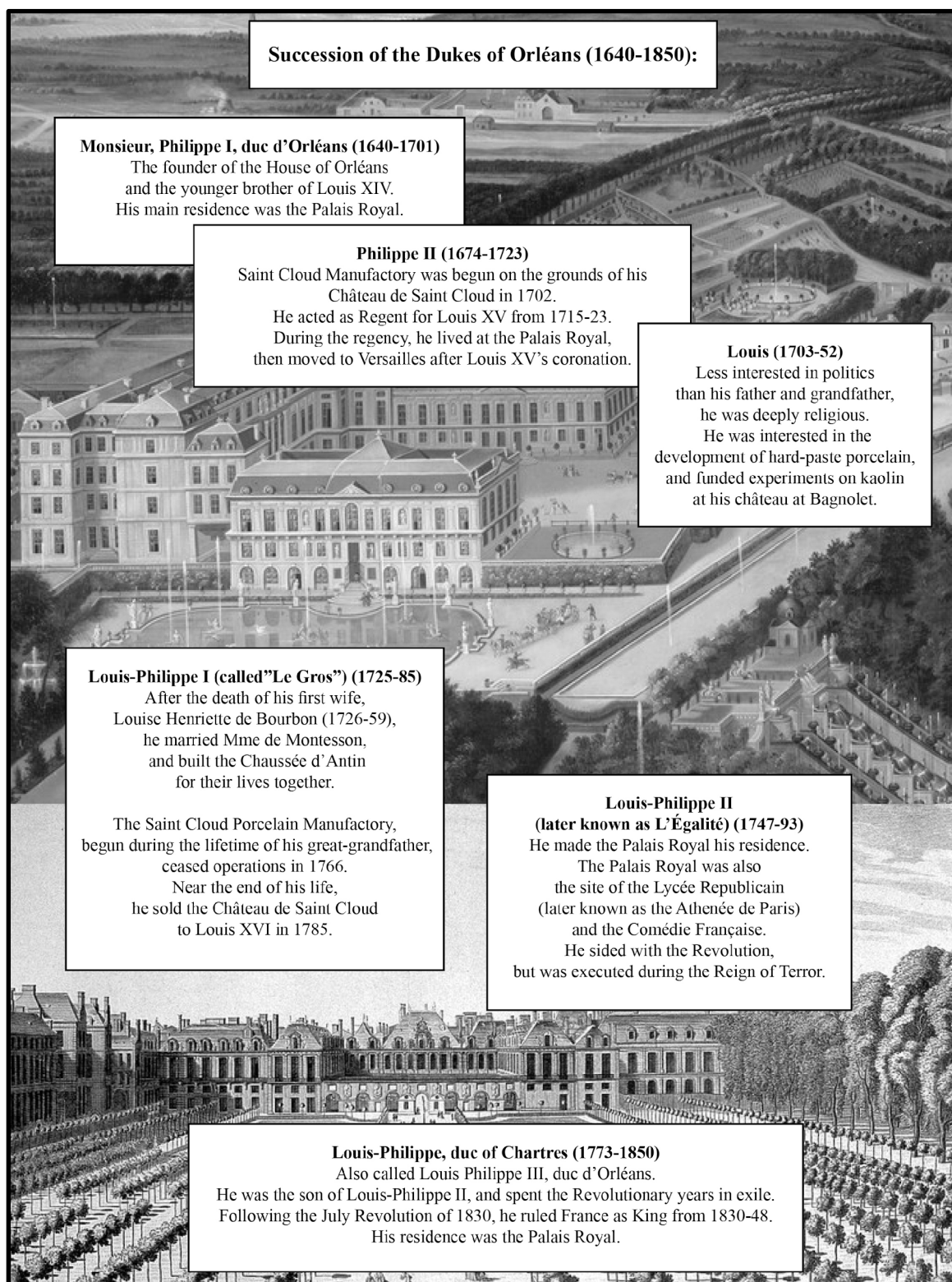
Appendix 1 - Chart Sixteen
Silvestre/Garre/Bonnard



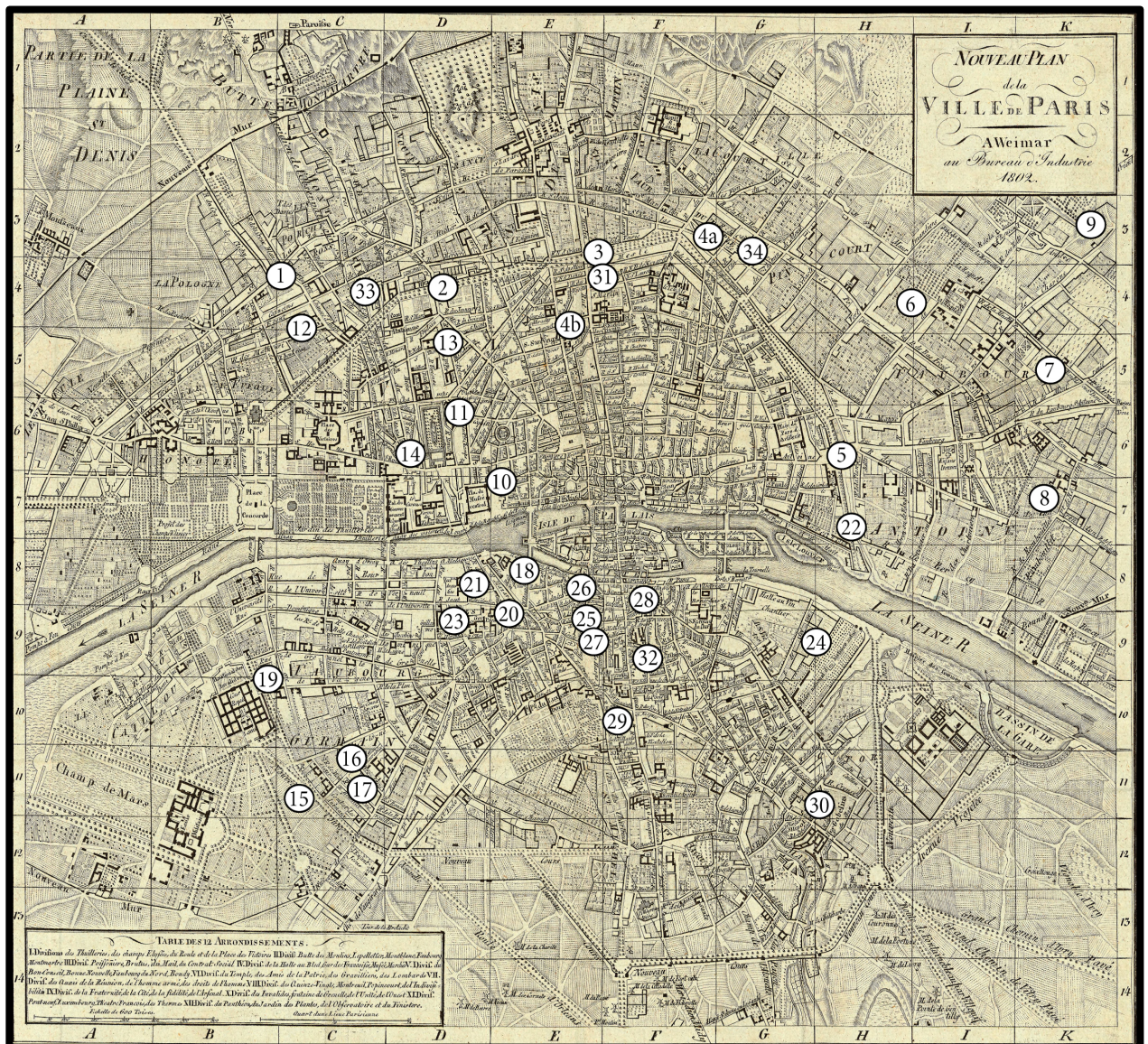
Appendix 1 - Chart Seventeen
Desvignes



Appendix Two – Succession of the Dukes of Orleans (1640-1850)



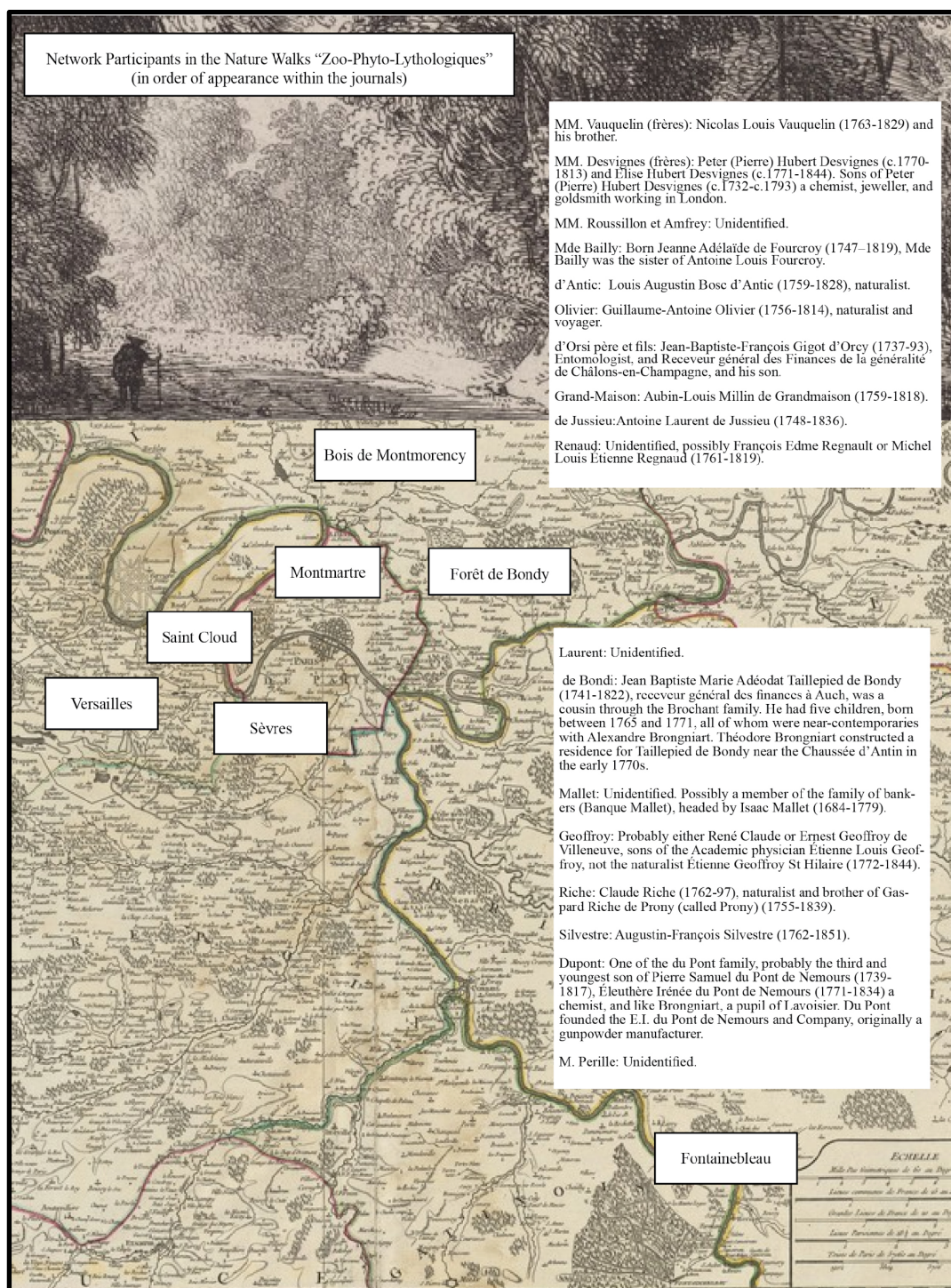
Appendix Three – Annotated Map of Paris



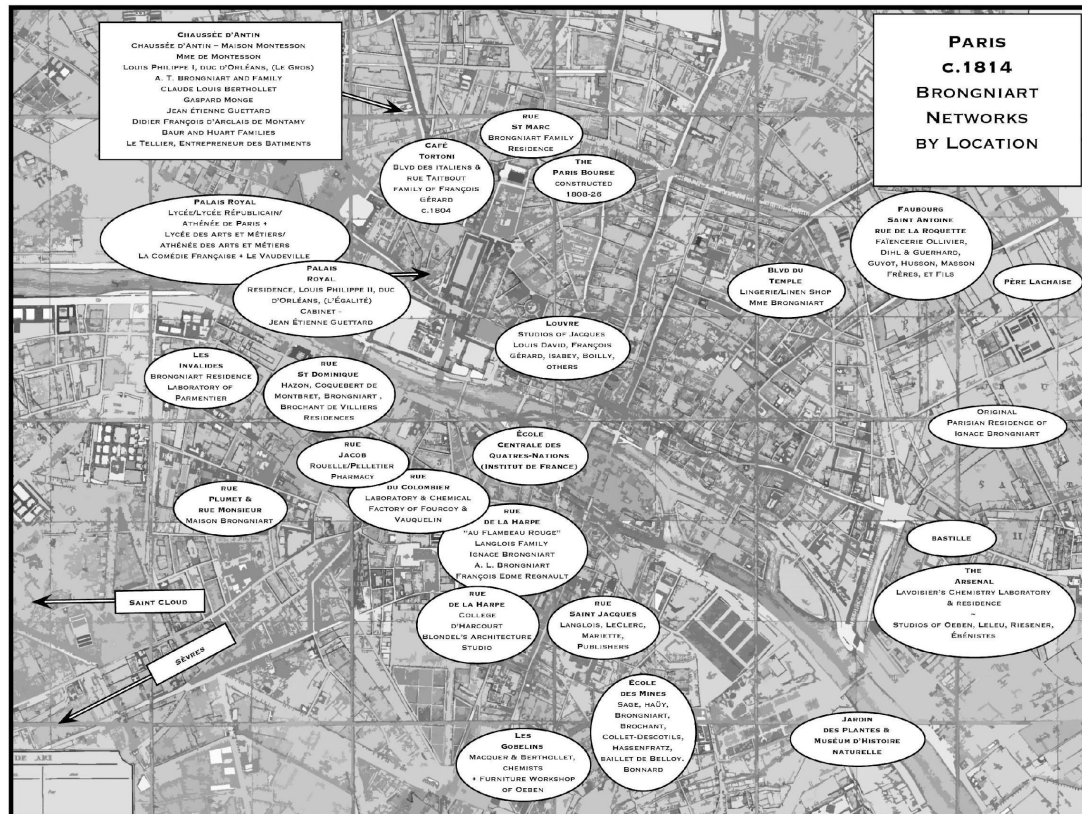
PARIS MAP KEY

- 1 - Chaussée d'Antin, location of the Hôtel Montesson, home of the Marquise de Montesson, adjacent to the home of Louis, duc d'Orléans (Cité d'Antin); site of Hôtel Necker, residence of Jacques Necker; residence of Lucie de la Tour du Pin, at the home of the Princesse Hénin
- 2 - rue Saint Marc, residence of the Brongniart family, (now ending at rue Favart to the West)
- 3 - rue Saint Denis, site of the shop of Charles de Fourcroy (marchand-épicer), spouse of Anne Devin (m. before 1648), mid-17th C.
- 4a - rue du Temple, neighborhood where the original ling rie/linen shop of Louise d' gremont, wife of Th odore Brongniart, was located
- 4b - rue Grenata, second location of the lingerie shop, and the location of the Brongniart residence in 1770
- 5 - La Bastille, prison, (destroyed in 1789); site of the laboratory of Lavoisier, as well as the workshops of Oeben, and later, Riesener.
- 6 - rue de la Roquette, site of numerous potteries and fa enceries, including Ollivier, Langlois, Masson, Husson, Nast, others.
- 7 - rue Faubourg Saint Antoine, artisanal district, workshops of numerous  b nistes, menuisiers, marchand merciers (Langlois, Leclerc, Lef vre); original Parisian residence of Ignace Th odore Brongniart
- 8 - Saint Gobain, Paris depot and warehouse, 20 rue Reuilly (later, the site of la caserne de Reuilly)
- 9 - P re Lachaise
- 10 - Louvre, during the late eighteenth century, location of the studios of Jacques Louis David, Isabey, Fran ois G rard, Louis Leopold Boilly, Fragonard, Marguerite G rard, others
- 11 - Palais Royal, Residence of Louis-Philippe II, duc d'Orl ans (1747-1793); site of the cabinet of the duc d'Orl ans; residence of Guettard; site of the Com die Fran aise, the Lyc e (R publicain, later l'Ath n e), and the Lyc e des Arts
- 12 - les Capucines, convent constructed by Th odore Brongniart for Mme Montesson, (1780-82); later used as one of the first five  coles centrales, now the Lyc e Condorcet
- 13 - The Paris Bourse, (now called the Palais Brongniart); Place de la Bourse, 16; designed by Th odore Brongniart in 1810, (built between 1811-36)
- 14 - Site of the "Lyc e" (from 1784); "Lyc e republicain" from 1793; renamed the Ath n e de Paris in April, 1802; rue de Valois, 2
- 15 - Maison Brongniart, constructed 1781, by Th odore Brongniart for his family, Blvd des Invalides & rue Plumet (now rue Oudinot)
- 16 - H tel Bourbon-Cond , constructed 1780-82, by Th odore Brongniart for Louis Ad la de de Bourbon, rue Monsieur, 12
- 17 - H tel Montesquiou, Constructed 1781, by Th odore Brongniart for Anne-Pierre de Montesquiou-F zensac, rue Monsieur, 20
- 18 - Coll ge de Quatre Nations, now the home of the Institut de France, Quai Conti, 23
- 19 - Les Invalides, Residence of the Brongniart family from 1782-1792
- 20 - Chemistry laboratory (usine) of Fourcroy, Vauquelin, et Le-Mercier; later Vauquelin et Cie.; rue du Colombier, 39; also a site for chemistry instruction, (Nicolas Zacharie Langlois, directeur de la fabrique)
- 21 - H tel Liancourt, residence of the La Rochefoucauld family
- 22 - Arsenal, residence & laboratory of Antoine Lavoisier
- 23 - Rouelle/Pelletier Pharmacy, rue Jacob
- 24 - Jardin du Roi/Jardin des Plantes & Mus um d'Histoire Naturelle
- 25 - rue de la Harpe, site of Ignace Th odore Brongniart's pharmacy - "le Flambeau Royal"
- 26 - College d'Harcourt, where Antoine Fran ois Fourcroy studied, rue de la Harpe
- 27 - architecture school of Blondel, where Th odore Brongniart first studied architecture, rue de la Harpe
- 28 - printing house of the engravers Nicolas (I) & Nicolas (II) Langlois; original home of Marie Madeleine Langlois, wife of Nicolas Fourcroy, (engraver/printer), rue Saint Jacques
- 29 - l' cole des Mines, since 1816, located in the H tel de Vend me
- 30 - Les Gobelins
- 31 - Pharmacy Treffenscheidl, original location, rue Saint Denis
- 32 - Pharmacy Treffenscheidl, later location, rue Saint Jacques
- 33 - Caff  Tortoni, coffee house run by the family of Fran ois Gerard, rue Taitbout
- 34 - Hotel de Lassay, home and laboratory of Louis Leon de Brancas, comte (later, duc) de Lauraguais
- 35 - Dihl and Guerhard, rue du Temple

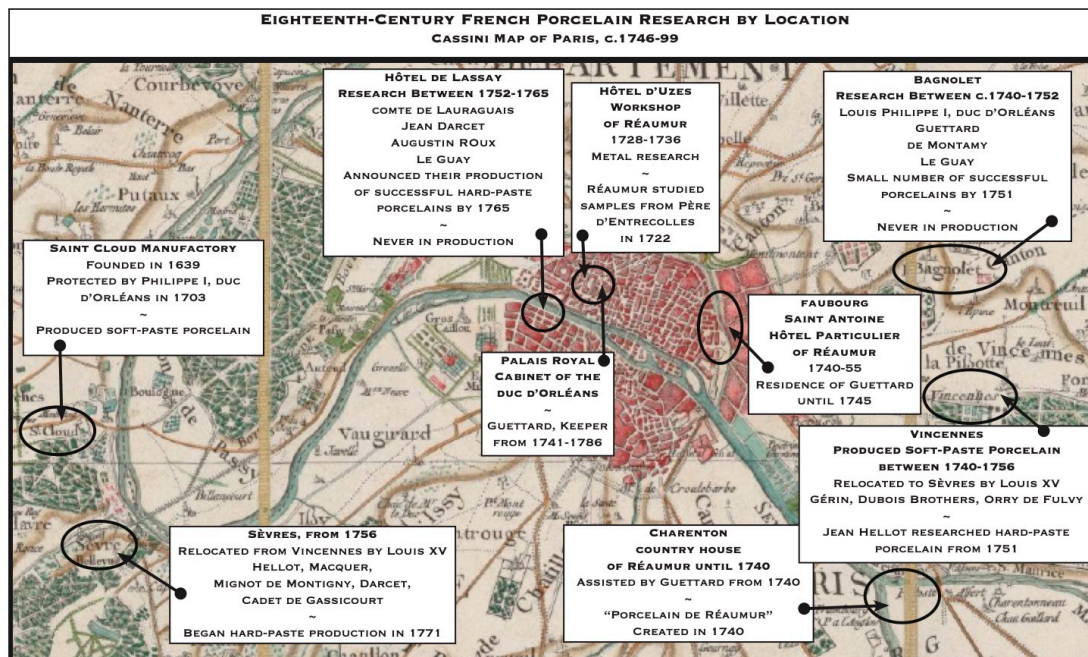
Appendix Four – Map of Nature Walks (1789-1800), with Biographical Information of Participants



Appendix Five – Map of Networks by Location



Appendix Six – Network Map of 18th-Century French Porcelain Research



Appendix Seven – Timelines

ALEXANDRE BRONGNIART: FROM SAVANT TO SCIENTIST
TIMELINES BY THEME—1620 TO 1850

BRONGNIART FAMILY	POLITICAL AND PUBLIC	DATE	SCIENCE AND NATURAL HISTORY	EUROPEAN POTTERY AND PORCELAIN
		1620	1620 Publication of the <i>Livre des Fleurs</i> by François Langlois, called Chartres	Saint Cloud Manufactory Founded in 1639 Protected by Philippe I, duc d'Orléans in 1703; produced a high-quality soft-paste porcelain, the first of its kind in France
		1639		
		1700	1707 Births of Georges-Louis Leclerc, Comte de Buffon, and Carl Linnaeus	
		1730	1735 First edition of Linnaeus' <i>Systema Naturae</i> appeared.	1710 The first European hard-paste porcelain was produced at Meissen for Augustus the Strong by Johann Friedrich Böttger and Count Ehrenfried Walther von Tschirnhaus. German porcelain technology did not transfer directly to other countries.
1737 Ignace Brongniart took over management of pharmacy on rue de la Harpe "au Flanbeau Royal"		1740	1739 Buffon named as director of the Jardin du Roi	
		1750	1746 Jean-Etienne Guettard published <i>Mémoire et carte minéralogique sur la nature et la situation des terrains qui traversent la France et l'Angleterre</i>	1753 De Montany published a translation of <i>La Lithogéognosie ou Examen des pierres et des terres</i> , by Johann Heinrich Pott. The discussion included clays, kaolins, and related earthen materials.
	1751-72 Publication of Diderot and d'Alembert's <i>Encyclopédie</i>	1770	1749 The first volumes of Buffon's <i>Histoire naturelle, générale et particulière</i> appeared (1749-88, 36 vols.)	1765 Death of de Montany. Posthumous publication of his <i>Traité des couleurs pour la peinture en émail</i>
1770 Construction of the Hotel Montesson in the Chaussée d'Antin	1762 Publication of Jean Jacques Rousseau's <i>Émile & The Social Contract</i>	1780	1763 Guettard, with Lavoisier as his student and assistant, continued the geological map of Paris he had begun in the 1740s.	1766 Closure of the Manufactory at Saint Cloud due to bankruptcy
5 February 1770 Birth of Alexandre Brongniart in Paris.		1787	1772 Lavoisier's experiments led to his discovery of the role of oxygen in chemical reactions	1775 Wedgwood Jasperware introduced
			1778 Death of Linnaeus	1782 Wedgwood's pyrometer
1781 Completion of the Maison Brongniart Blvd des Invalides & rue Plumet	1782 Publication of Pierre Choderlos de Laclos' <i>Les liaisons dangereuses</i>		1780 <i>Atlas et description minéralogique de la France</i> was published by Guettard and Monnet.	1782 Death of Mignot de Montigny. Jean Darcet hired to replace Montigny as assistant to Macquer at Sèvres.
	1782 Publication of Jean Jacques Rousseau's <i>Confessions</i>		15 February 1784 Death of Macquer	1784 Darcet replaced Macquer at Sèvres.
			7 January 1786 Death of Guettard	
			1787 Publication of <i>Méthode de nomenclature chimique</i>	

ALEXANDRE BRONGNIART: FROM SAVANT TO SCIENTIST
TIMELINES BY THEME—1620 TO 1850

BRONGNIART FAMILY	POLITICAL AND PUBLIC	DATE	SCIENCE AND NATURAL HISTORY	EUROPEAN POTTERY AND PORCELAIN
1788 Foundation of the <i>Société Philomathique de Paris</i>		1788	16 April 1788 Death of Buffon	
Summer 1789 Brongniart joined the National Guard	20 June 1789 Tennis Court Oath	1789	1789 Publication of Lavoisier's <i>Traité élémentaire de chimie</i>	
20 October 1789 Brongniart completed a <i>Maître des Arts</i> at the University of Paris, before continuing his scientific studies.	11 July 1789 Necker removed from office 14 July 1789 Storming of the Bastille			
27 July 1790–17 October 1790 Brongniart's Educational travel in England		1790		
1791 Brongniart published the memoir on enamelling written in England in 1790	2 March 1791 Dissolution of the artisanal guilds	1791		
Summer 1791 Brongniart travelled to Bourgogne with d'Andrada	10 June 1791 Louis XVI & Marie Antoinette Flight to Varennes 17 July 1791 Champ de Mars Massacre			
	25 April 1792 First use of the guillotine	1792	2–7 September 1792 September Massacres; Geoffroy Saint Hilaire intervened to save René Just Haüy and several other priests from probable execution	
August 1793 Brongniart's arrest while on an expedition at Fontainebleau.	21 January 1793 Execution of Louis XVI	1793	June 1793 Reorganization of the Jardin du Roi & the Cabinet du Roi into the Jardin des Plantes and the Muséum d'Histoire naturelle; Controversially, twenty-one-year-old Étienne Geoffroy Saint Hilaire was appointed as professor at the Muséum	1793 Arrest of Jean Darcet. Sèvres no longer had a director and several artists and technicians sought alternative employment. The manufactory came under the administration of a Revolutionary committee that included the trained menuisier and mathematician Louis Costaz.
23 August 1793 Brongniart's successful examination as pharmacist for the pharmaceutical corps; October 1793 departure for Bayonne	13 July 1793 Assassination of Marat 8 August 1793 Suppression of the Academies 16 October 1793 Execution of Marie Antoinette			

ALEXANDRE BRONGNIART: FROM SAVANT TO SCIENTIST
TIMELINES BY THEME—1620 TO 1850

BRONGNIART FAMILY	POLITICAL AND PUBLIC	DATE	SCIENCE AND NATURAL HISTORY	EUROPEAN POTTERY AND PORCELAIN
19 July 1794 In Bayonne, Pierre Marie Auguste Broussonnet went over the border into Spain; Brongniart & Treffenscheidl were imprisoned under suspicion that they had helped him	8 June 1794 Festival of the Supreme Being on the Champ de Mars	1794	8 May 1794 Execution of Lavoisier	
13 August 1794 letter acknowledging Brongniart's release arrived at his prison in Bayonne	28 July 1794 Overthrow and execution of Robespierre		20 June 1794 Death of Félix Vicq d'Azyr	3 Jan 1795 Death of Josiah Wedgwood
Autumn 1794 Brongniart gained a post with the Corps des Mines, travelling in order to document the mines and resources of France				
Late Summer 1795 Brongniart travelled with Dolomieu in the Alps	Salon 1795 François Gérard presented the portrait of Émilie, aged fifteen, launching his career	1795		
1796 Brongniart learned processes and researched at the Faïencerie Olivier in the faubourg Saint Antoine		1797		
1797 Brongniart nominated professor of natural history at the École Centrale des Quatre-Nations	Salon 1798 Gérard presented <i>Psyche and Cupid</i> , for which Émilie had modelled	1798	19 May 1798 Departure of Egyptian Expedition	
21 April 1799 Mme Coquebert suggested the possibility of a marriage between Brongniart and her daughter, Cécile, in the hopes that it could be arranged between the families; Summer 1799 period of unofficial engagement as the contracts were arranged	9-10 November 1799 Coup of 18-19 Brumaire established the three-person Consulate, with Napoléon as the First Consul	1799	1 July 1798 Napoleon's Egyptian Expedition arrived in Egypt	
9 February 1800 Marriage of Brongniart and Cécile Coquebert de Montbret	9 January 1800 Charles Étienne Coquebert appointed Consul to Amsterdam	1800	9 October 1799 Return of Napoléon from Egypt, accompanied by several savants, including Monge, Berthollet, Denon, & Costaz	
24 March 1800 Mme Berthollet's visit to announce the offer of the appointment of Brongniart as director of Sévres				

ALEXANDRE BRONGNIART: FROM SAVANT TO SCIENTIST
TIMELINES BY THEME—1620 TO 1850

BRONGNIART FAMILY	POLITICAL AND PUBLIC	DATE	SCIENCE AND NATURAL HISTORY	EUROPEAN POTTERY AND PORCELAIN
1802 Brongniart's 2nd voyage to London; taken for research on porcelain		1801	12 February 1801 Death of Jean Darcet	
	18 May 1804 Napoleon granted title "Emperor des Français"	1804		
	2 December 1804 Napoleon crowned Emperor, Josephine crowned Empress		13 October 1807 Founding of the Geological Society of London	1805 start of the <i>Enquête des Prefets</i> , a survey of French pottery making led by Brongniart
1807 <i>Traité Elementaire de Mineralogie</i> was published by Brongniart		1807	11 April 1808 Brongniart and Cuvier's preliminary research toward <i>Essai sur la géographie mineralogique des environs de Paris</i> presented to the Institut	
1807 Brongniart elected elected to the Collège de France in mineralogy	1808-1813 Palais de la Bourse (Paris Stock Exchange) designed and built by Alexandre-Theodore Brongniart. Construction, continuing under the supervision of Eloi Labarre, was completed by 1826.	1808	1811 Joint research by Brongniart and Cuvier <i>Essai sur la géographie mineralogique des environs de Paris</i> published with map	
1812 Brongniart travelled to Germany for the purpose of geological study as well as for pottery and porcelain research; he was accompanied by Constant Prévost	11 April 1814 Napoléon exiled to Elba after the Treaty of Fontainebleau	1811	1812 Cuvier's publication of <i>Recherches sur les ossements fossiles</i> .	
	3 May 1814-19 March 1815 First Bourbon Restoration, Louis XVIII named King	1814		
1815 Brongniart was elected a member of the Académie des Sciences in Mineralogy	20 March 1815 Napoléon returned from Elba and ruled during the "Hundred Days"			
	18 June 1815 Napoléon defeated at the Battle of Waterloo	1815		
	8 July 1815 Louis XVIII reinstated as King of France under a constitutional monarchy		1821 Re-establishment of the Société d'Histoire naturelle de Paris	
1818 Brongniart was appointed <i>ingénieur en chef des mines</i>	5 May 1821 Death of Napoléon	1820		

ALEXANDRE BRONGNIART: FROM SAVANT TO SCIENTIST
TIMELINES BY THEME—1820 TO 1850

BRONGNIART FAMILY	POLITICAL AND PUBLIC	DATE	SCIENCE AND NATURAL HISTORY	EUROPEAN POTTERY AND PORCELAIN
1822 Brongniart succeeded Haüy as professor of mineralogy at the Muséum		1822	1822 Deaths of Berthollet and Haüy	
			1822 Cuvier and Brongniart published <i>Description géologique de environs de Paris</i>	
	16 September 1824 Charles X replaced his brother, Louis XVIII, as King of France	1824	1824 Founding of the <i>Annales des sciences naturelles</i>	1824 Opening of the Musée céramique de Sèvres
	1829 Early works of Honoré de Balzac published; in 1832, he began work on the <i>Comédie humaine</i> ; 1830, Stendhal, <i>Le rouge et le noir</i>		1829 Publication of Brongniart's <i>Tableau des terrains qui composent l'écorce du globe</i>	
	2 August 1830 July Revolution Charles X removed from office; Louis Philippe (son of Louis-Philippe II, duc d'Orléans) was established as King of France	1830	1830 Cuvier-Geoffroy Debates at the Académie des Sciences	
	1831 Victor Hugo published <i>Notre-Dame de Paris</i>		17 March 1830 Founding of the Société géologique de France	
			13 May 1832 Death of Georges Cuvier	
1836 Visit by Brongniart to the Wedgwood factory at Etruria	1836 <i>Paris and the Parisians</i> by Fanny (Frances) Trollope published in English	1836		
	1844 Publication of Alexandre Dumas' <i>Les Trois Mousquetaires</i>	1844	19 June 1844 Death of Geoffroy Saint Hilaire	1844 Publication of Brongniart's <i>Traité des Arts céramiques</i>
	1844-46 Publication of Dumas' <i>Le Comte de Monte Cristo</i>			1845 Publication of Brongniart's <i>Description méthodique du Musée céramique de Sèvres</i>
1847 Death of Alexandre Brongniart	22-4 February 1848 February Revolution Louis Philippe removed from office; a provisional government established the Second French Republic	1847		1847 Brongniart succeeded by Jacques Joseph Ebelman at Sèvres
	1849 John Ruskin's <i>Seven Lamps of Architecture</i> published			
	1851 Great Exhibition of London; Crystal Palace built	1850	1859 Publication of Charles Darwin's <i>Origin of the Species</i>	

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