

Limitations of rupture forecasting exposed by instantaneously triggered earthquake doublet

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<i>Source</i>	<i>Latitude</i>	<i>Longitude</i>	<i>Strike</i>	<i>Dip</i>	<i>Rake</i>	<i>SV</i>	<i>Depth</i>	<i>M₀ (Nm)</i>	<i>Magnitude</i>
ISC	29.961°	68.202°	-	-	-	-	34 km	-	<i>M_s</i> 6.9
EHB	29.979°	68.165°	-	-	-	-	35 km	-	<i>M_w</i> 7.1
GCMT	29.74°	68.13°	298°	15°	122°	175°	15 km	5.2 × 10 ¹⁹	<i>M_w</i> 7.1
NEIC body wave	29.976°	68.208°	334°	7°	145°	188°	7 km	4.0 × 10 ¹⁹	<i>M_w</i> 7.0
NEIC W-phase	29.78°	68.21°	291°	16°	107°	183°	12 km	4.3 × 10 ¹⁹	<i>M_w</i> 7.0
This study [fixed strike]	29.856°	68.185°	315°	14°	140°	176°	13 km	2.5 × 10 ¹⁹	<i>M_w</i> 6.9
			290°	11°	115°	175°	13 km	2.4 × 10 ¹⁹	<i>M_w</i> 6.9

Supplementary Table 1: Mainshock source parameters from seismology. Source parameters of the Harnai earthquake (27 February 1997, 21:08 UTC) from the International Seismological Centre bulletin (ISC), the updated Engdahl, van der Hilst & Bulland catalogue⁴⁹ (EHB), the Global Centroid Moment Tensor project (GCMT), the USGS National Earthquake Information Center (NEIC), and from our own seismological analysis. All of the catalogues list a single event, whereas we recognize two distinct sub-events. However, the focal mechanism and centroid depth we obtain using long-period body waveform modelling represent the initial mainshock only – the two solutions shown are for free and fixed strike, respectively – and we were unable to determine a mechanism or depth for the +19 second aftershock using seismology. *Latitude* and *Longitude* refer to the epicentre coordinates, except for the GCMT and NEIC W-phase solutions, in which they instead represent the centroid coordinates. *SV* is the slip vector for the NNE-dipping nodal plane, which we assume represents the faulting for reasons explained in the text.

	Fault	Strike	Dip	Rake	SV	Slip	Eastings	Northings	Length	Top	Bottom	Centre	M ₀ (Nm)	M _w	RMS	Fig.
Model A	F1	290°	22° NE	103°	186°	3.00 m	389.9 km	3276.2 km	39.4 km	13.7 km	16.9 km	15.3 km	32.2 × 10 ¹⁸	6.9	2.19 cm	Suppl. 2a
	F2	303°	31° NE	81°	230°	2.00 m	425.3 km	3261.8 km	25.2 km	6.8 km	10.8 km	8.8 km	12.5 × 10 ¹⁸	6.7		
	F3	290°	18° NE	85°	205°	0.33 m	400.0 km	3290.0 km	20.0 km	0.1 km	2.4 km	1.3 km	1.59 × 10 ¹⁸	6.1		
Model B	F1	290°	22° NE	102°	187°	3.00 m	389.9 km	3276.2 km	39.2 km	13.8 km	16.8 km	15.3 km	31.9 × 10 ¹⁸	6.9	2.18 cm	Suppl. 2c
	F2	124°	58° SW	122°	344°	2.00 m	438.0 km	3277.2 km	27.3 km	5.8 km	15.5 km	10.7 km	18.2 × 10 ¹⁸	6.8		
	F3	290°	18° NE	85°	205°	0.33 m	400.0 km	3290.0 km	20.0 km	0.1 km	2.4 km	1.3 km	1.59 × 10 ¹⁸	6.1		
Model C	F1	107°	63° SW	90°	017°	3.00 m	406.0 km	3318.3 km	38.7 km	12.4 km	20.1 km	16.3 km	32.6 × 10 ¹⁸	6.9	2.18 cm	Suppl. 2e
	F2	304°	31° NE	73°	234°	2.00 m	425.3 km	3261.8 km	26.2 km	6.7 km	10.7 km	8.7 km	12.8 × 10 ¹⁸	6.7		
	F3	290°	18° NE	85°	205°	0.33 m	400.0 km	3290.0 km	20.0 km	0.1 km	2.4 km	1.3 km	1.59 × 10 ¹⁸	6.1		
Model D	F1	107°	63° SW	90°	017°	3.00 m	406.0 km	3318.3 km	38.6 km	12.6 km	20.4 km	16.5 km	32.7 × 10 ¹⁸	6.9	2.18 cm	Suppl. 2g
	F2	125°	57° SW	119°	350°	2.00 m	437.5 km	3277.1 km	27.0 km	5.7 km	13.8 km	9.8 km	17.1 × 10 ¹⁸	6.8		
	F3	290°	18° NE	85°	205°	0.33 m	400.0 km	3290.0 km	20.0 km	0.1 km	2.4 km	1.3 km	1.59 × 10 ¹⁸	6.1		

Supplementary Table 2: Fault plane parameters from InSAR modelling. Uniform slip models A to D represent the four possible combinations of model fault F1 and F2 dip direction. *SV* is the slip vector, and *Eastings* and *Northings* are UTM Zone 42N coordinates of the up-dip surface projection of the fault centre. *Top*, *bottom* and *centre* are the top, bottom and centre depths of the model fault plane and *RMS* is the root mean square error between observed and model displacements. Parameters written in italics were fixed during the inversion.

Date	Time (UTC)	Lat.	Lon.	Magnitude			Relative Location Uncertainty				
				Source	Type	M	1 st semi axis		2 nd semi axis		Area (km ²)
							Az. (°)	L (km)	Az. (°)	L (km)	
27.02.97	21:08:00	29.851	68.185	ISC	M_s	6.9	89	0.78	179	1.32	3.2
27.02.97	21:08:19	29.502	68.539	-	-	-	291	2.53	21	7.85	62.4
27.02.97	21:17:24	29.660	68.329	ISC	m_b	5.1	292	1.33	22	2.57	10.8
27.02.97	21:19:48	29.704	68.371	ISC	m_b	4.5	300	2.06	30	4.81	31.1
27.02.97	21:21:35	29.850	68.425	ISC	m_b	4.4	309	5.55	39	9.03	157.3
27.02.97	21:27:32	29.704	68.238	ISC	m_b	4.3	298	2.33	28	4.96	36.2
27.02.97	21:30:35	29.923	67.956	ISC	M_s	6.4	275	0.73	5	1.43	3.3
27.02.97	21:42:18	29.573	68.227	ISC	m_b	4.0	310	4.96	40	11.73	182.8
27.02.97	21:44:00	29.829	67.916	ISC	m_b	4.4	280	2.71	10	5.04	42.8
27.02.97	21:44:23	29.841	68.390	ISC	m_b	4.4	311	4.62	41	11.02	159.8
27.02.97	21:47:27	29.969	67.930	ISC	m_b	4.3	271	3.13	1	7.57	74.3
27.02.97	21:51:53	30.002	68.161	ISC	m_b	4.2	50	2.18	140	4.22	28.9
27.02.97	22:00:38	30.154	68.101	ISC	m_b	4.1	289	3.66	19	5.65	64.9
27.02.97	22:12:23	29.871	68.180	ISC	m_b	4.0	273	5.23	3	11.32	186.1
27.02.97	22:17:40	29.913	68.096	ISC	m_b	4.3	82	2.19	172	5.53	38
27.02.97	22:20:19	29.990	67.951	ISC	m_b	4.2	87	2.73	177	7.42	63.7
27.02.97	22:30:59	30.099	68.103	ISC	m_b	3.9	82	2.44	172	4.81	36.8
27.02.97	22:36:53	29.875	68.098	ISC	m_b	3.7	320	5.43	50	13.6	232.1
27.02.97	22:39:48	29.627	68.546	ISC	m_b	4.5	291	1.74	21	3.91	21.4
27.02.97	22:41:57	29.545	68.316	ISC	M_s	5.2	283	1.33	13	2.15	9
27.02.97	22:49:11	29.577	68.282	ISC	m_b	4.1	282	2.36	12	2.95	21.9
27.02.97	22:56:44	29.926	67.898	ISC	m_b	3.6	313	2.98	43	6.69	62.7
27.02.97	23:36:38	29.832	67.766	ISC	m_b	3.9	317	4.97	47	10.22	159.5
27.02.97	23:39:08	29.928	67.984	ISC	m_b	4.0	283	2.63	13	4.42	36.5
27.02.97	23:46:07	29.997	68.083	ISC	m_b	3.7	319	3.76	49	6.33	74.7
27.02.97	23:54:13	29.314	67.871	ISC	m_b	3.8	296	7.24	26	10.99	250.1
28.02.97	00:09:20	29.520	68.406	ISC	m_b	3.9	317	6.28	47	11.11	219.1
28.02.97	00:12:15	29.593	68.393	ISC	m_b	3.8	307	4.84	37	8.66	131.8
28.02.97	00:28:01	29.968	68.116	ISC	m_b	3.8	306	3.55	36	5.77	64.3
28.02.97	00:33:49	29.833	68.092	ISC	m_b	4.0	307	3.01	37	5.51	52.1
28.02.97	00:36:11	29.549	68.697	ISC	m_b	4.2	304	2.94	34	4.1	37.8
28.02.97	00:45:08	29.919	67.840	ISC	m_b	3.6	73	4.66	163	12.55	183.7
28.02.97	01:04:08	29.579	68.588	ISC	M_s	4.4	277	2.56	7	4.23	34
28.02.97	01:13:12	29.680	68.326	ISC	m_b	3.6	318	6.19	48	12.73	247.3
28.02.97	01:26:20	29.867	68.259	ISC	m_b	3.7	317	5.39	47	9.76	165.4
28.02.97	01:46:24	29.644	68.249	ISC	M_s	4.3	89	0.86	179	1.6	4.3
28.02.97	01:49:25	29.884	67.894	ISC	m_b	3.9	314	3.1	44	6.77	66
28.02.97	02:05:27	29.901	68.112	ISC	m_b	3.8	75	5.59	165	10.16	178.5
28.02.97	02:11:13	29.597	68.334	ISC	M_s	4.3	273	2.14	3	3.21	21.6
28.02.97	02:22:03	29.862	67.759	ISC	M_s	4.0	46	1.9	136	3.22	19.3
28.02.97	02:28:07	29.567	68.759	ISC	m_b	3.9	315	4.9	45	12.83	197.4
28.02.97	02:43:12	29.567	68.525	ISC	m_b	3.8	311	4.23	41	5.43	72.1
28.02.97	02:51:57	29.709	68.590	ISC	M_s	4.0	87	7.93	177	10.06	250.8
28.02.97	03:03:14	29.585	68.610	ISC	m_b	3.9	312	5.9	42	8.59	159.2
28.02.97	03:12:08	29.997	68.187	ISC	m_b	4.1	310	3.2	40	5.83	58.6
28.02.97	03:17:34	29.609	68.560	ISC	M_s	4.4	277	1.26	7	2.04	8.1
28.02.97	03:20:24	30.052	68.271	ISC	m_b	4.2	311	4.79	41	9.78	147.1

28.02.97	04:59:33	29.836	68.154	ISC	m_b	4.1	83	2.56	173	3.14	25.3
28.02.97	05:28:36	29.925	67.944	ISC	m_b	4.1	271	3.93	1	7.84	96.7
28.02.97	05:34:40	29.480	68.520	ISC	M_s	4.0	307	3.76	37	6.89	81.4
28.02.97	06:25:46	29.622	68.209	ISC	M_s	4.5	39	1.91	129	3.03	18.2
28.02.97	06:44:52	29.872	68.093	ISC	m_b	3.9	270	2.37	0	3.15	23.5
28.02.97	06:47:16	29.477	68.113	ISC	m_b	3.8	315	5.95	45	15.09	282
28.02.97	07:52:08	29.686	68.220	ISC	M_s	4.3	311	2.24	41	4.19	29.5
28.02.97	08:27:37	29.613	68.265	ISC	m_b	4.0	331	4.21	61	5.69	75.2
28.02.97	08:33:56	29.572	68.382	ISC	m_b	3.9	321	3.76	51	4.73	55.8
28.02.97	09:47:09	29.704	68.168	ISC	m_b	3.5	318	3.59	48	8.28	93.5
28.02.97	10:12:31	29.331	68.200	ISC	m_b	3.8	327	3.73	57	6.56	76.8
28.02.97	10:24:39	29.901	67.736	ISC	m_b	3.6	319	2.93	49	6.11	56.3
28.02.97	10:36:50	29.746	68.164	ISC	M_s	3.9	311	2.62	41	4.45	36.6
28.02.97	13:59:19	29.793	68.079	ISC	m_b	3.7	329	4.71	59	8.13	120.4
28.02.97	14:46:38	29.422	68.448	ISC	m_b	3.5	329	7.86	59	12.26	302.9
28.02.97	15:17:24	29.618	68.271	ISC	M_s	3.8	307	4.27	37	6.71	89.9
28.02.97	16:14:35	29.997	67.896	ISC	M_s	3.7	299	3.5	29	5.93	65.3
28.02.97	21:12:09	29.587	68.563	ISC	m_b	3.8	44	2.94	134	4.08	37.6
28.02.97	22:15:00	29.934	68.169	ISC	M_s	3.7	88	1.88	178	3.36	19.9
28.02.97	22:58:46	29.966	68.103	ISC	M_s	3.9	275	1.47	5	2.62	12.1
01.03.97	00:42:06	29.608	68.364	ISC	M_s	4.4	88	1.18	178	2.23	8.3
01.03.97	00:57:06	29.521	68.253	ISC	m_b	3.7	300	6.26	30	10.91	214.4
01.03.97	01:35:49	29.948	67.903	ISC	m_b	3.9	304	3.61	34	6.45	73.1
01.03.97	01:39:07	29.904	67.846	ISC	M_s	3.7	67	3.57	157	4.15	46.6
01.03.97	02:06:26	30.054	67.869	ISC	m_b	3.9	88	2.51	178	3.57	28.1
01.03.97	02:36:13	29.837	67.744	ISC	m_b	3.6	335	6.26	65	9.18	180.4
01.03.97	05:35:49	29.854	68.207	ISC	m_b	3.7	320	3.97	50	7.6	94.9
01.03.97	06:31:25	29.808	68.048	ISC	m_b	4.0	86	3.07	176	4.12	39.7
01.03.97	07:44:31	29.864	67.888	ISC	m_b	3.9	271	2.11	1	3.3	21.8
01.03.97	07:55:23	30.142	67.777	ISC	m_b	3.8	329	6.34	59	10.17	202.5
01.03.97	08:13:32	29.619	68.317	ISC	m_b	4.2	87	2.58	177	3.52	28.4
01.03.97	08:25:35	30.403	67.388	ISC	m_b	3.7	283	5.35	13	8.48	142.5
01.03.97	09:10:24	29.832	68.240	ISC	m_b	3.8	276	4.4	6	9.01	124.4
01.03.97	13:17:41	29.808	68.150	ISC	m_b	3.9	315	5.14	45	10.18	164.4
01.03.97	19:02:46	29.950	67.738	ISC	m_b	3.5	9	6.6	99	7.79	161.5
01.03.97	20:23:31	29.873	68.006	ISC	M_s	3.8	271	2.27	1	3.69	26.4
01.03.97	21:23:51	29.940	68.167	ISC	m_b	4.1	289	3.32	19	5.35	55.8
02.03.97	03:58:23	29.614	68.182	ISC	m_b	4.1	83	2.49	173	3.76	29.4
02.03.97	05:27:09	29.767	68.212	ISC	m_b	4.3	84	1.63	174	2.75	14
02.03.97	08:43:51	29.917	68.103	ISC	m_b	3.9	307	4.51	37	7.13	101.1
02.03.97	12:01:47	29.837	68.136	ISC	m_b	3.8	308	2.5	38	5.1	40
02.03.97	12:33:05	29.522	68.338	ISC	m_b	3.6	313	4.31	43	7.83	106.1
02.03.97	23:54:24	29.592	68.259	ISC	m_b	3.6	332	3.68	62	5.67	65.6
03.03.97	02:25:20	29.978	67.961	ISC	m_b	4.2	287	2.32	17	3.52	25.7
03.03.97	02:28:31	29.541	68.515	ISC	M_s	4.7	275	1.24	5	2.14	8.3
03.03.97	02:31:29	29.480	68.642	ISC	m_b	4.1	36	3.84	126	9.5	114.7
03.03.97	06:51:09	30.246	67.936	ISC	m_b	3.8	306	6.74	36	9.61	203.3
03.03.97	13:06:53	29.899	67.797	ISC	m_b	4.1	316	3.02	46	5.27	50.1
03.03.97	13:22:53	29.617	68.165	ISC	m_b	3.9	312	4.79	42	6.45	97.1
03.03.97	19:42:42	29.588	68.244	ISC	M_s	4.4	86	1.9	176	3.59	21.4
04.03.97	02:49:33	29.611	68.341	ISC	M_s	4.5	273	1.75	3	2.9	15.9

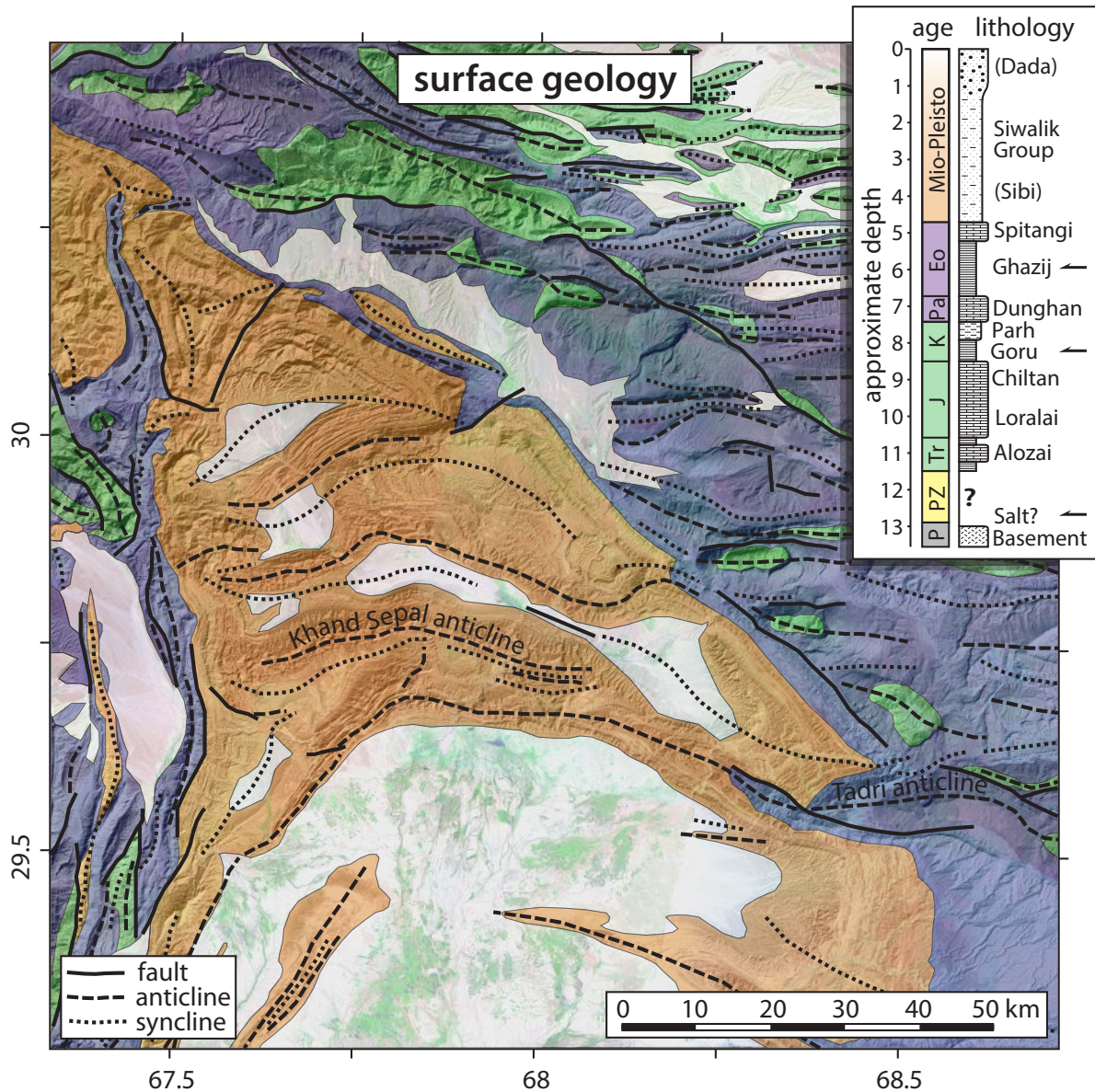
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04.03.97	13:03:46	29.346	68.754	ISC	M_s	5.8	278	1.01	8	1.79	5.7
04.03.97	14:06:50	29.664	68.273	ISC	m_b	4.0	307	4.39	37	5.75	79.3
04.03.97	20:33:18	29.524	68.703	ISC	m_b	3.8	35	4.46	125	6.17	86.5
05.03.97	04:15:56	29.530	68.176	ISC	m_b	3.5	313	3.56	43	6.06	67.8
05.03.97	08:40:50	29.782	68.206	ISC	m_b	4.0	289	3.8	19	4.43	52.9
05.03.97	16:42:06	29.537	68.307	ISC	m_b	3.8	30	3.35	120	3.89	40.9
05.03.97	19:31:52	29.805	68.131	ISC	m_b	3.6	351	4.92	81	7.17	110.7
07.03.97	13:52:48	29.921	67.797	ISC	m_b	3.8	314	4.1	44	8.31	107
08.03.97	14:58:50	29.492	68.629	ISC	M_s	3.7	24	4.8	114	7.11	107.2
09.03.97	06:07:45	29.724	68.133	ISC	m_b	4.2	89	1.98	179	3.27	20.3
09.03.97	06:47:57	29.344	68.821	ISC	m_b	3.9	309	4.8	39	5.21	78.5
09.03.97	18:50:03	29.665	68.174	ISC	m_b	3.8	303	3.4	33	5.08	54.3
10.03.97	06:08:44	29.665	68.153	ISC	m_b	4.3	279	2.1	9	2.79	18.4
10.03.97	22:49:39	30.219	68.004	ISC	m_b	3.7	87	5.99	177	12.12	227.9
11.03.97	00:15:46	29.708	68.205	ISC	m_b	3.5	314	3.93	44	5.53	68.2
11.03.97	23:54:37	29.919	68.033	ISC	m_b	3.5	77	5.53	167	10.84	188.4
13.03.97	01:25:55	29.854	67.888	ISC	m_b	3.7	75	2.73	165	3.39	29.1
13.03.97	01:42:00	29.991	68.120	ISC	m_b	3.6	318	4.31	48	7.48	101.2
13.03.97	01:53:25	29.839	68.193	ISC	M_s	3.4	90	2.46	180	3.06	23.6
13.03.97	10:48:59	29.620	68.223	ISC	m_b	3.9	307	5.85	37	7.33	134.7
13.03.97	13:22:25	29.926	68.146	ISC	M_s	3.9	78	2.06	168	4.2	27.2
13.03.97	20:38:12	30.106	67.833	ISC	M_s	4.2	87	1.12	177	2.26	7.9
13.03.97	23:42:41	29.962	68.003	ISC	m_b	3.8	326	2.47	56	3.87	30
14.03.97	05:30:23	29.572	68.487	ISC	m_b	3.9	314	4.08	44	8.12	104.1
17.03.97	08:31:41	29.886	68.048	ISC	m_b	4.0	63	3.78	153	5.33	63.3
19.03.97	11:15:48	30.274	67.903	ISC	M_s	4.2	88	1.59	178	2.41	12
20.03.97	00:47:29	30.132	67.993	ISC	M_s	4.1	274	1.32	4	2.25	9.3
20.03.97	03:30:15	29.887	67.931	ISC	m_b	4.0	315	4.52	45	12.84	182.4
20.03.97	05:00:43	29.927	67.745	ISC	M_s	3.4	72	5.59	162	16.35	287.3
20.03.97	08:50:39	30.144	68.022	ISC	M_s	5.7	276	0.74	6	1.34	3.1
20.03.97	09:03:12	30.048	68.028	ISC	m_b	3.7	318	3.62	48	7.07	80.3
20.03.97	09:35:34	30.109	67.925	ISC	m_b	4.3	277	2.28	7	4.01	28.8
20.03.97	10:16:47	30.267	68.052	ISC	m_b	3.6	78	7.47	168	15.01	352.4
20.03.97	11:17:18	30.079	67.980	ISC	M_s	4.3	273	1.66	3	3.11	16.3
20.03.97	12:46:18	30.071	68.062	ISC	M_s	4.2	288	1.81	18	2.29	13
20.03.97	13:11:23	30.418	67.943	ISC	m_b	3.6	315	4.7	45	10.05	148.6
20.03.97	15:59:33	29.964	67.988	ISC	m_b	3.7	317	2.79	47	5.39	47.2
20.03.97	19:09:57	30.144	67.970	ISC	m_b	4.1	90	1.47	180	2.59	11.9
21.03.97	04:50:47	30.167	67.957	ISC	M_s	3.9	273	2.27	3	3.57	25.5
21.03.97	15:46:33	30.150	67.934	ISC	M_s	4.0	293	2.2	23	2.84	19.7
22.03.97	06:19:51	30.129	67.950	ISC	M_s	4.5	271	0.94	1	1.96	5.8
22.03.97	12:36:49	30.146	67.966	ISC	m_b	3.8	313	3.35	43	6.23	65.6
22.03.97	12:53:49	29.806	67.763	ISC	M_s	3.7	276	1.76	6	3.06	17
22.03.97	23:48:49	30.114	67.943	ISC	m_b	3.8	315	3.96	45	8.36	104.1
23.03.97	02:40:20	30.102	67.916	ISC	M_s	3.4	311	5.37	41	9.79	165
25.03.97	20:19:48	29.772	67.758	ISC	m_b	3.7	319	6.95	49	14.25	311.3
28.03.97	21:52:24	30.007	68.001	ISC	m_b	4.0	78	1.45	168	2.6	11.9
28.03.97	22:27:38	30.200	68.013	ISC	m_b	4.0	81	2.96	171	4.64	43.2
29.03.97	17:43:40	29.547	68.674	ISC	M_s	3.5	292	2.22	22	2.68	18.7
17.06.97	11:18:39	30.070	68.023	ISC	M_s	4.7	276	1.17	6	1.93	7.1

24.08.97	13:15:20	30.069	67.975	ISC	M_s	5.3	281	0.88	11	1.61	4.5
07.09.97	10:15:23	29.971	67.804	ISC	M_s	5.2	276	0.74	6	1.43	3.3
09.12.08	22:52:37	30.398	67.408	ISC	M_s	5.6	284	0.89	14	1.6	4.5

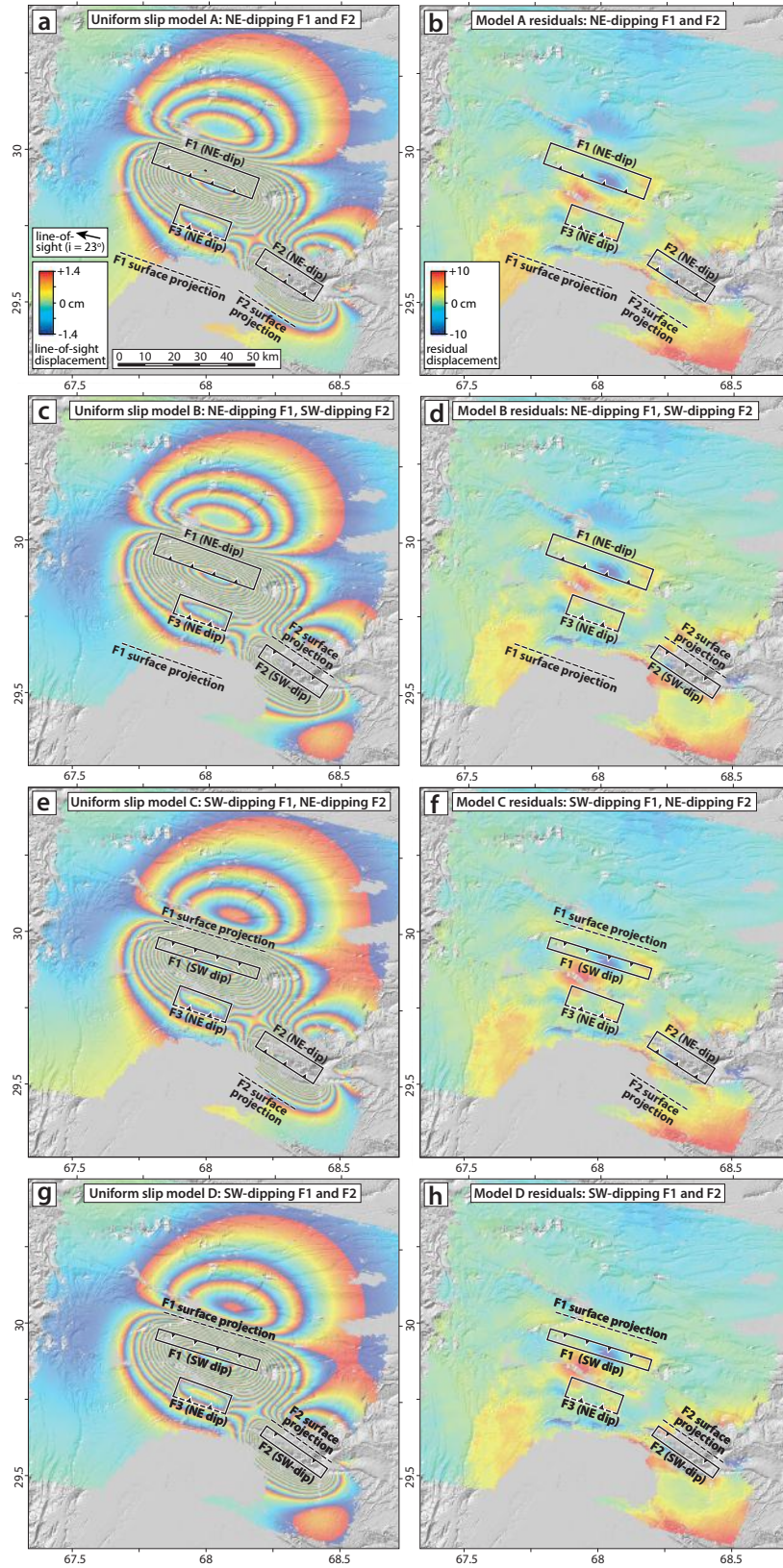
Supplementary Table 3: Relocated epicentres of the Harnai sequence. Epicentre and origin time have been calibrated using the centre of an InSAR-derived model fault for the 9 December 2008 Ziarat earthquake²⁵. The 90% error ellipses are given as the azimuth (clockwise from north) and length of the two semi-axes. The entire catalogue could be shifted by as much as 6.5 km parallel to the NE-SW strike of the Ziarat fault (see Methods).

<i>Date</i>	<i>Time</i>	<i>Lat.</i>	<i>Lon.</i>	<i>Strike</i>	<i>Dip</i>	<i>Rake</i>	<i>SV</i>	<i>Depth</i>	<i>M₀ (Nm)</i>	<i>M_w</i>	<i>Fig.</i>
04.03.97	13:03	29.344°	68.752°	52°	87°	2°	52°	8 km	3.5 × 10 ¹⁷	5.6	S10
20.03.97	08:50	30.144°	68.020°	328°	12°	158°	170°	21 km	3.0 × 10 ¹⁷	5.6	S11
17.06.97	11:18	30.073°	68.023°	230°	27°	62°	171°	18 km	3.4 × 10 ¹⁶	5.0	S12
24.08.97	13:15	30.070°	67.975°	253°	17°	71°	183°	16 km	2.6 × 10 ¹⁷	5.5	S13
07.09.97	10:15	29.975°	67.806°	321°	18°	139°	181°	19 km	9.5 × 10 ¹⁶	5.3	S14

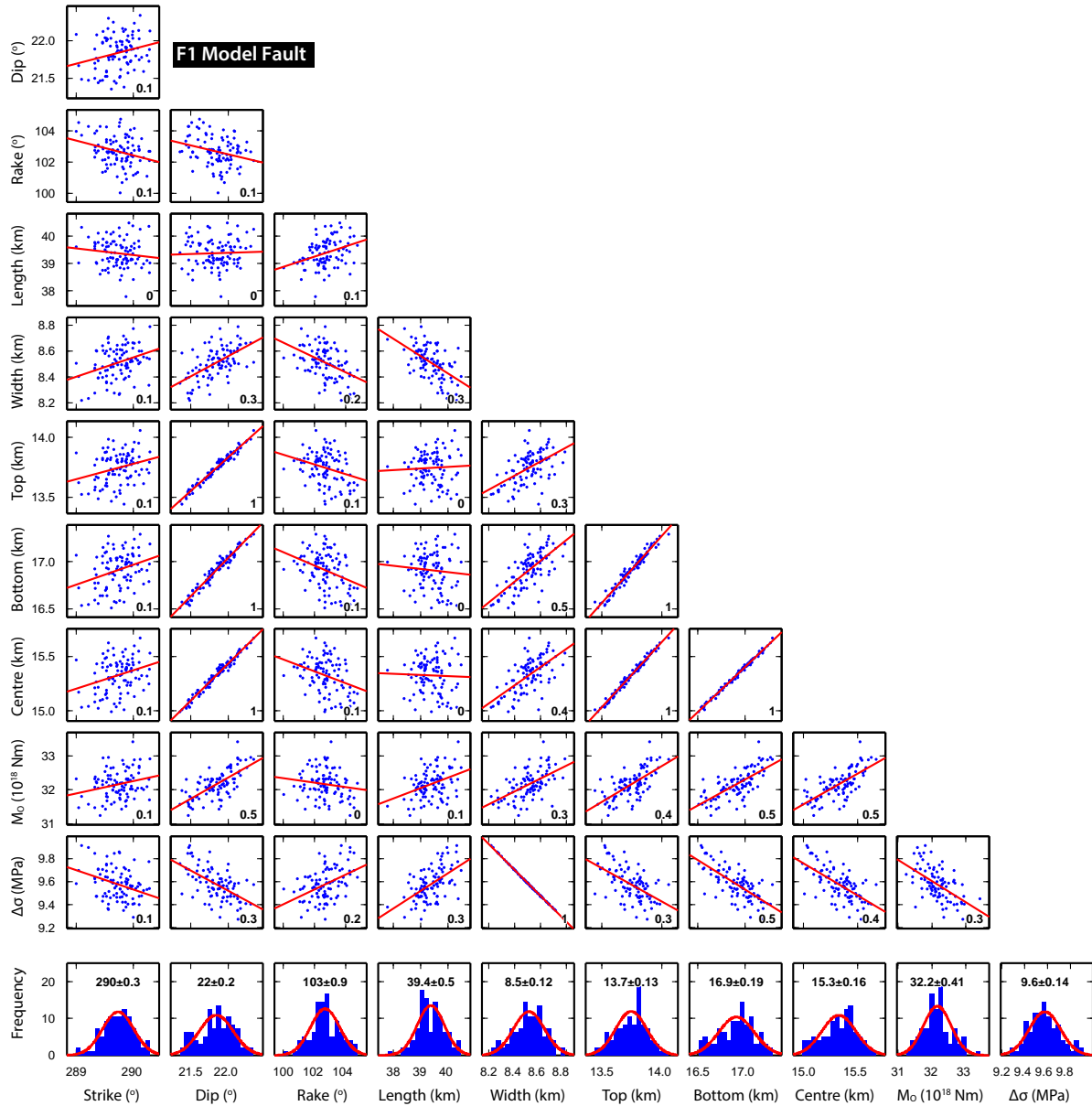
Supplementary Table 4: Focal mechanisms of major aftershocks from body waveform modelling. Relocated epicentre latitudes and longitudes are taken from Supplementary Table 3.



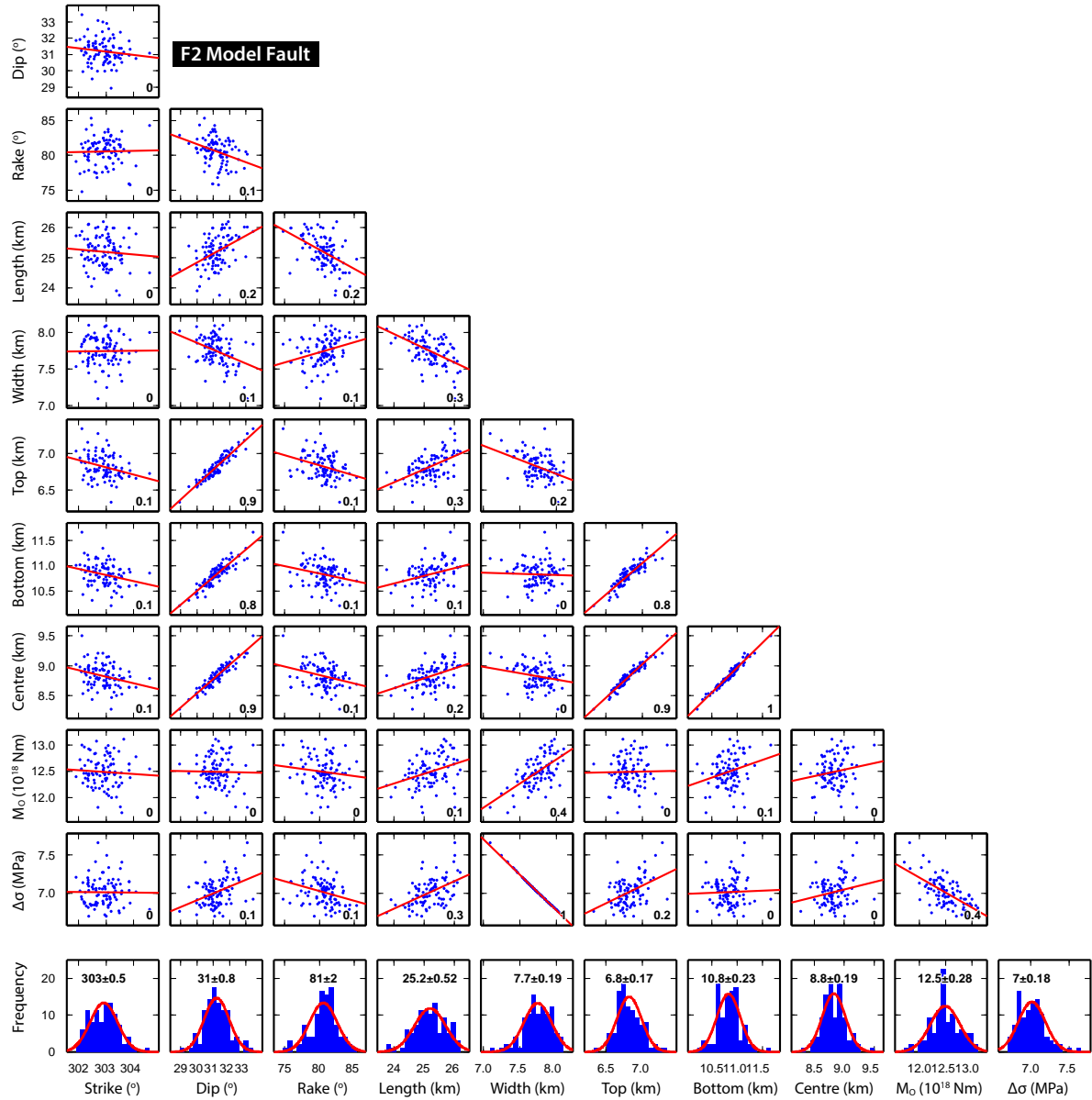
Supplementary Figure 1: Surface geology of the epicentral area, overlain on Landsat image. Named anticlines are those mentioned in the main text. Inset depicts a generalized stratigraphic column with approximate unit thicknesses and potential detachment horizons.



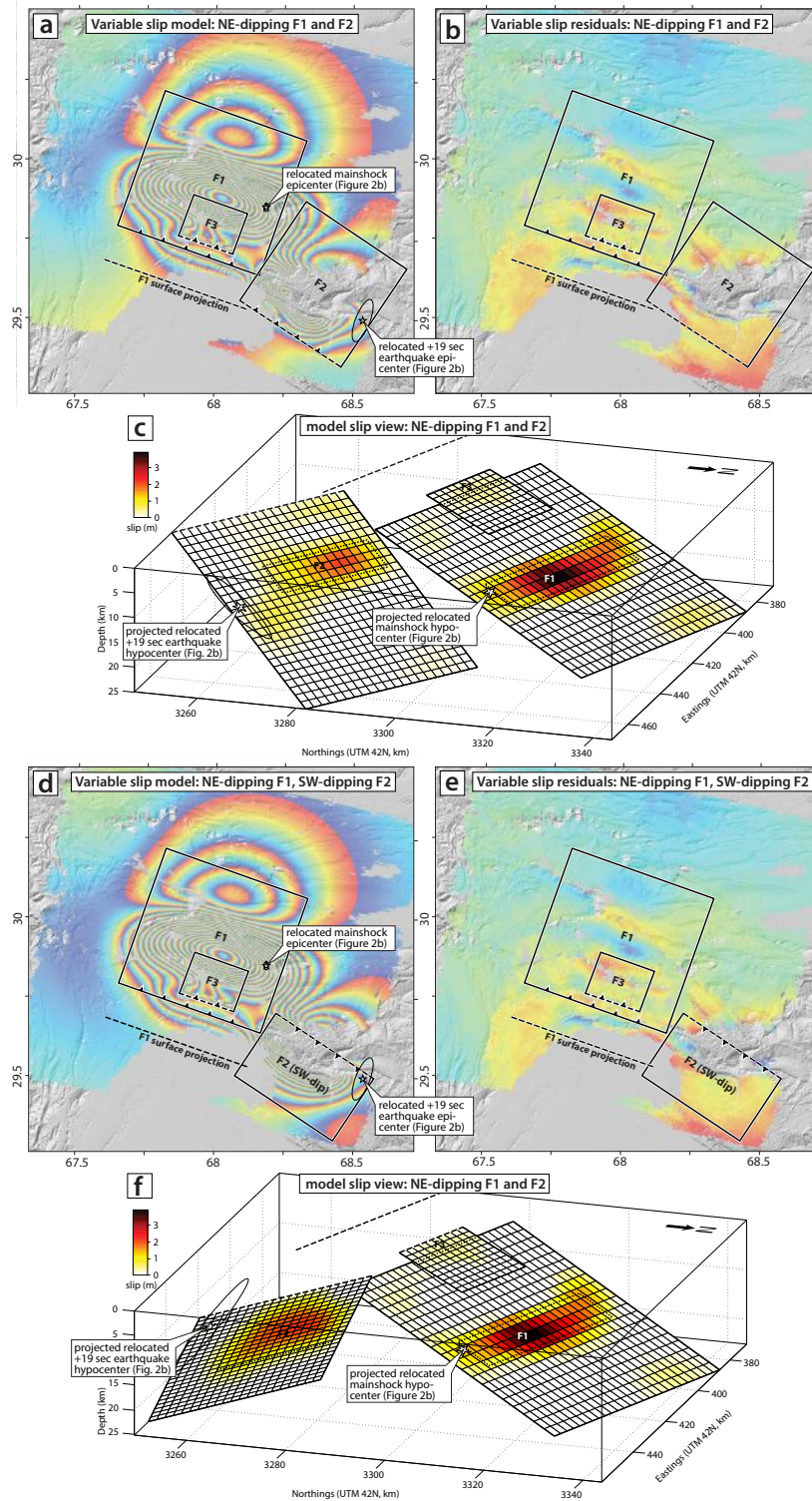
Supplementary Figure 2: Model interferograms (left) and residual displacements (right) for uniform slip InSAR models. Model parameters are given in Supplementary Table 2.



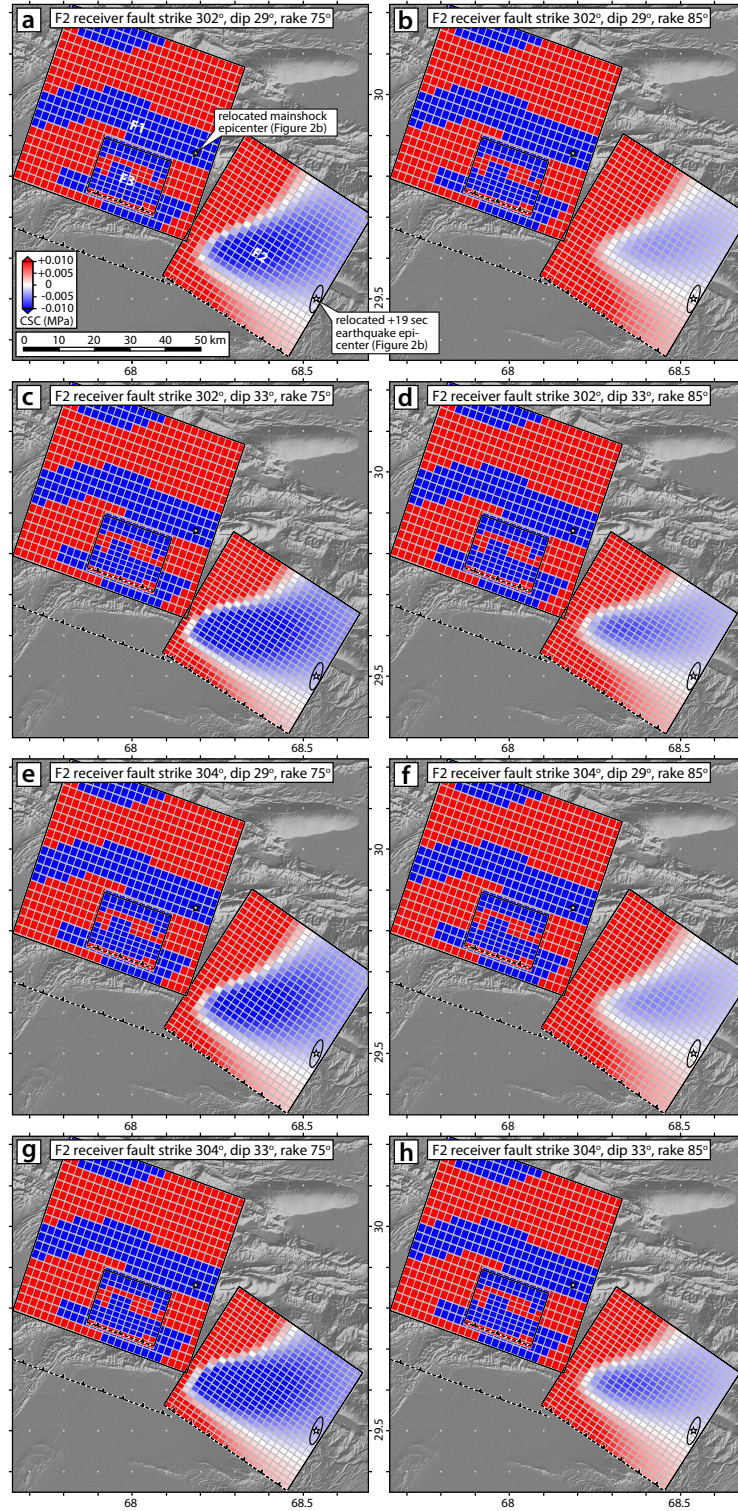
Supplementary Figure 3: Parameter uncertainties and trade-offs for the F1 InSAR model fault. Each panel in the first nine rows shows the uniform slip fault plane parameters obtained by inverting 100 datasets perturbed with realistic noise (see Methods). The red line indicates a linear regression through these points, with the correlation coefficient plotted in the lower-right corner of each panel. Histograms in the tenth row show the distribution in values for each parameter. The numbers represent the mean value and 1σ error, determined by fitting a normal distribution (red curve) to each histogram.



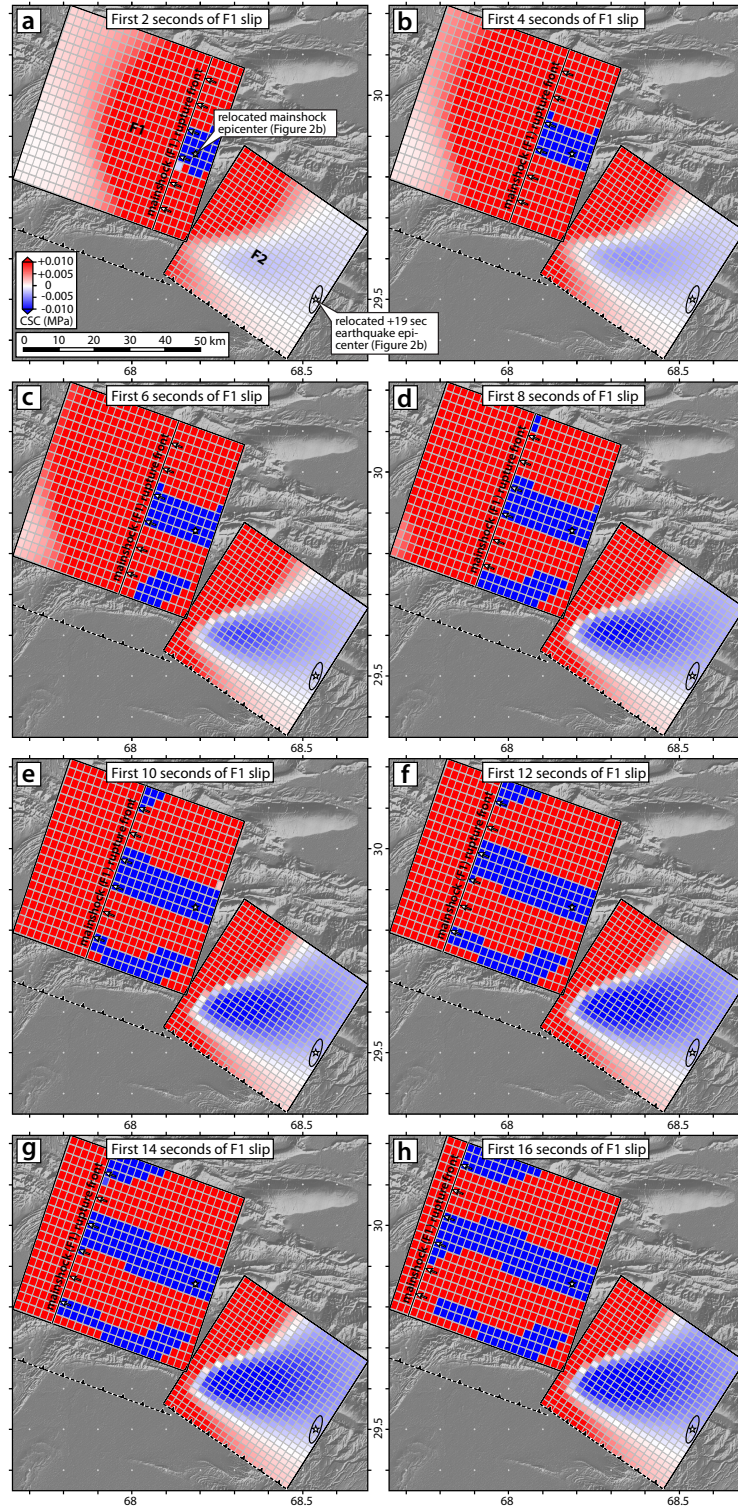
Supplementary Figure 4: Parameter uncertainties and trade-offs for the F2 InSAR model fault. Details are as in the previous figure.



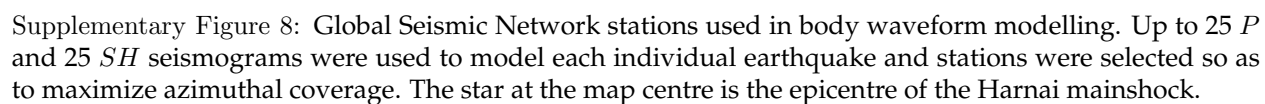
Supplementary Figure 5: Model interferograms, residual displacements and slip distributions for variable slip InSAR models. Our preferred model in which mainshock (F1) and +19 second aftershock (F2) faults both dip NE-wards is shown in (a) to (c); an alternative model in which the F2 fault dips SW-wards is shown in (d) to (f).



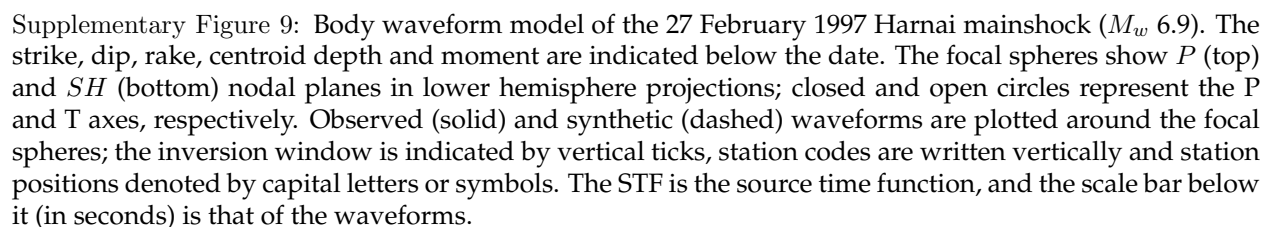
Supplementary Figure 6: Coulomb stress change (CSC) on F2 receiver faults with orientations perturbed according to realistic uncertainties in strike ($303^\circ \pm 1^\circ$), dip ($31^\circ \pm 2^\circ$) and rake ($80^\circ \pm 5^\circ$).



Supplementary Figure 7: Temporal progression in Coulomb stress change at the sub-event hypocentre resulting from each 2 second increment in accumulated F1 slip. Assuming a unilateral rupture propagating from SE to NW at 2.5 km/s, we add a new 5 km-long section of the F1 slip pattern for each 2 second increment.

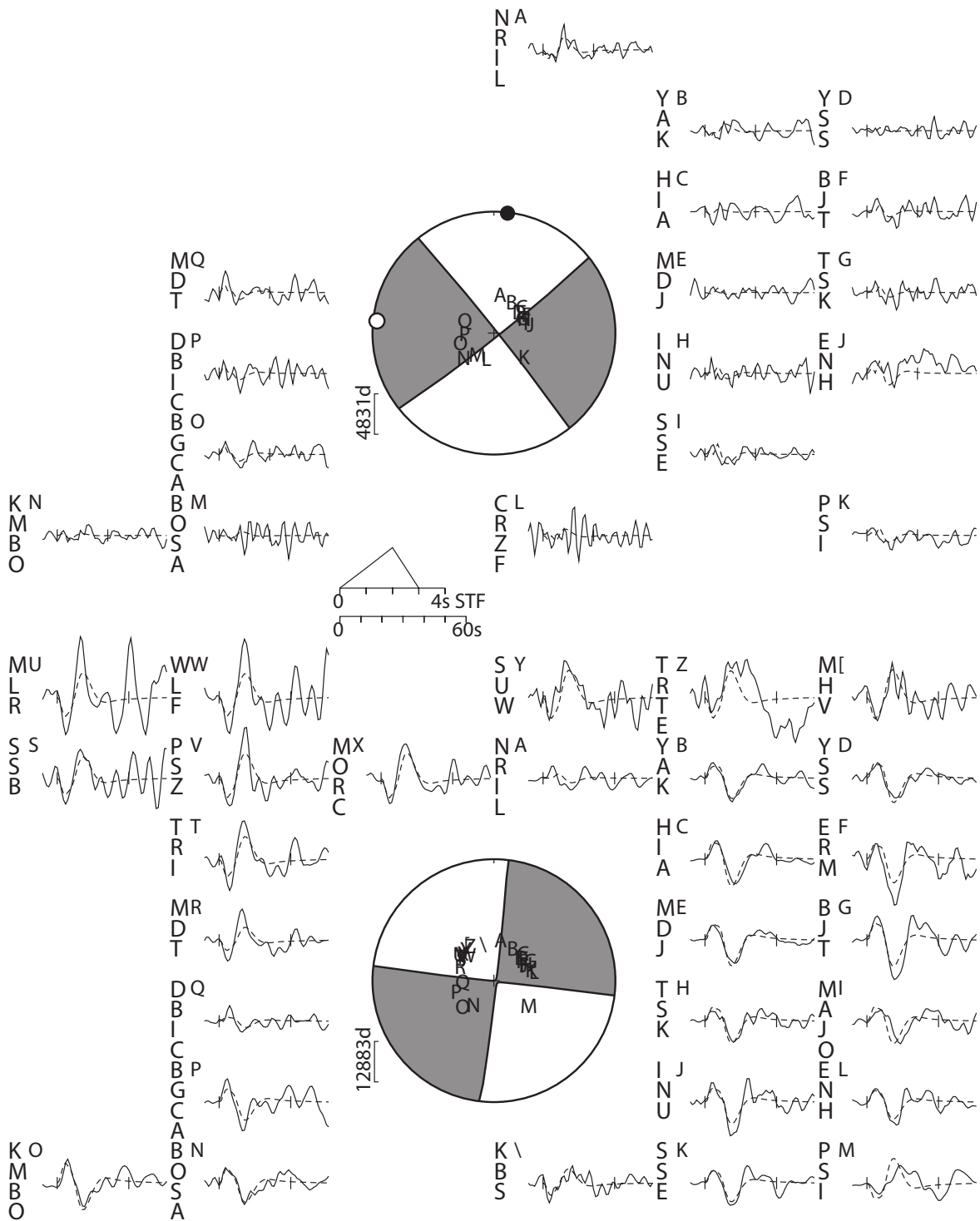


290°/11°/115°/13 km/2.4 x 10¹⁹ Nm

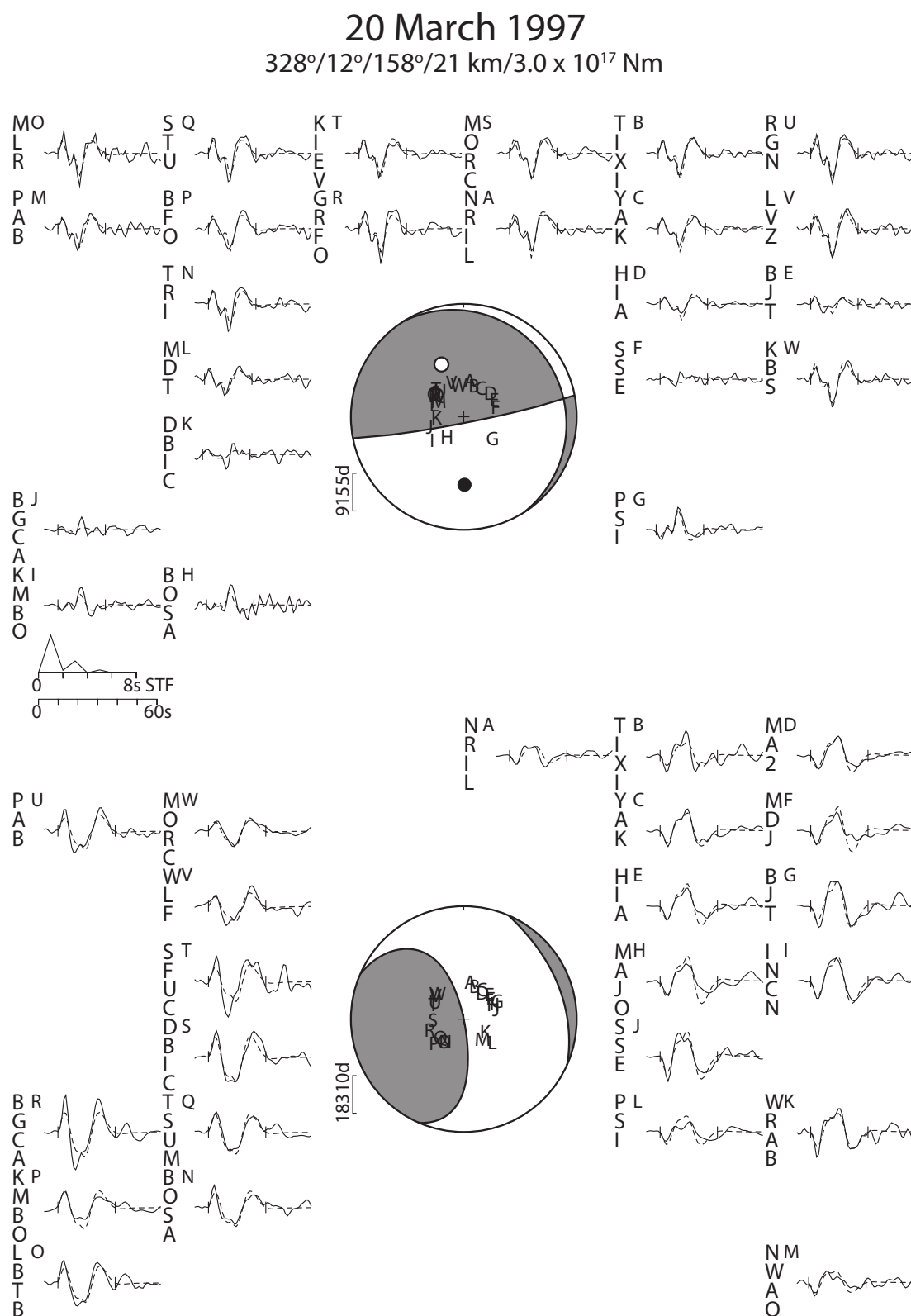


4 March 1997

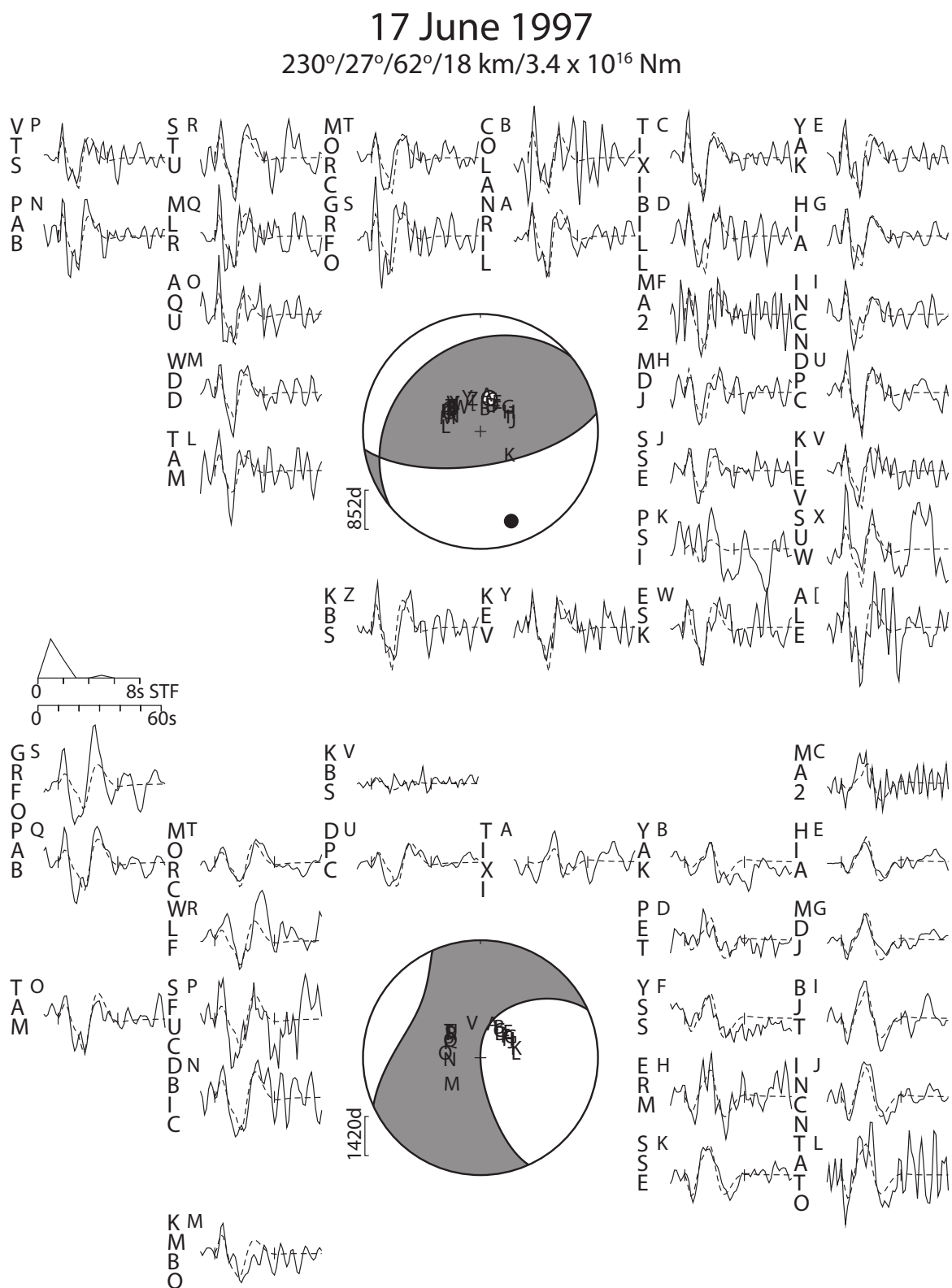
52°/87°/2°/8 km/3.5 x 10¹⁷ Nm



Supplementary Figure 10: Body waveform model of the 4 March 1997 aftershock (M_w 5.6). Layout is the same as in Supplementary Figure 9.

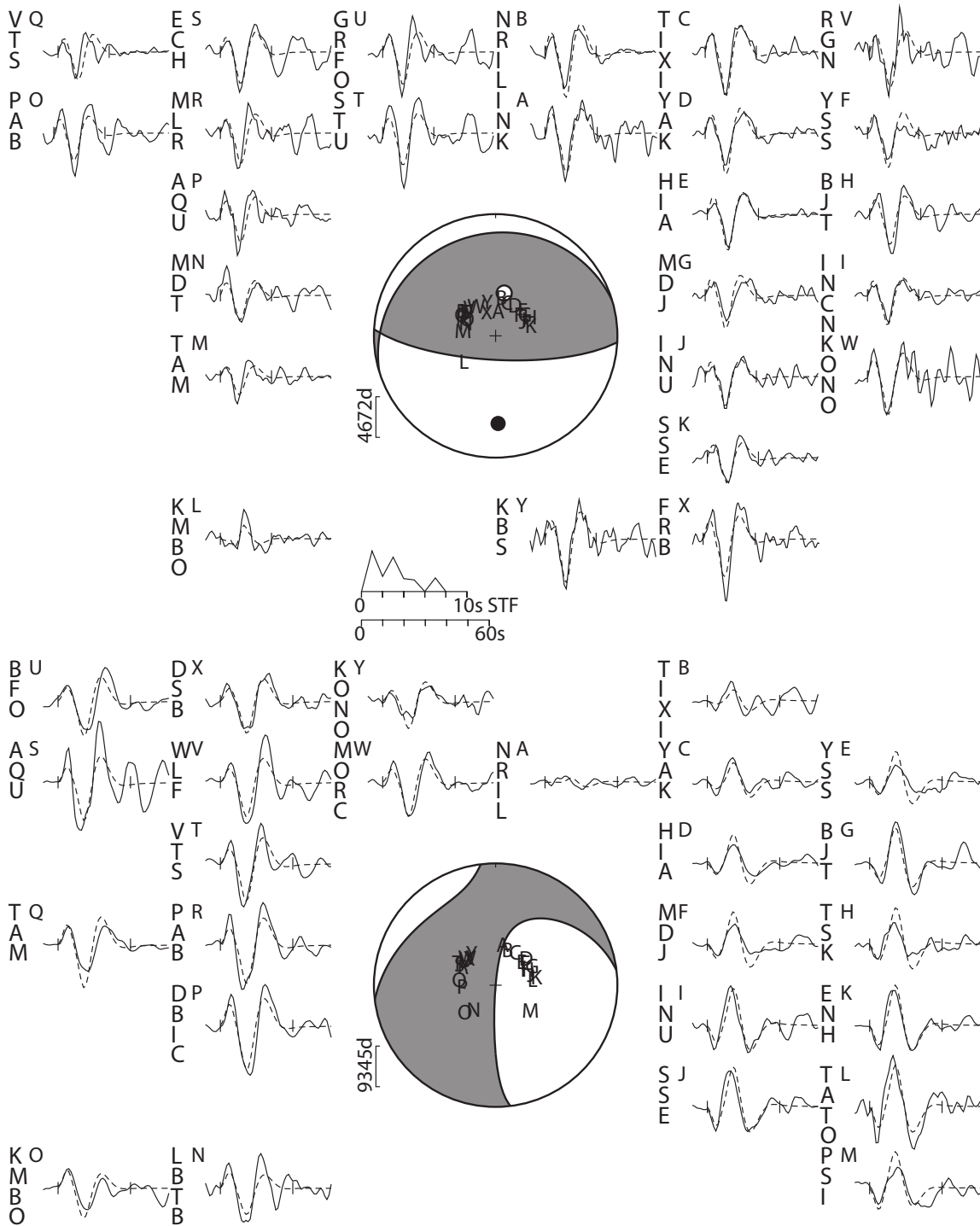


Supplementary Figure 11: Body waveform model of the 20 March 1997 aftershock ($M_w 5.6$). Layout is the same as in Supplementary Figure 9.



Supplementary Figure 12: Body waveform model of the 17 June 1997 aftershock (M_w 5.0). Layout is the same as in Supplementary Figure 9.

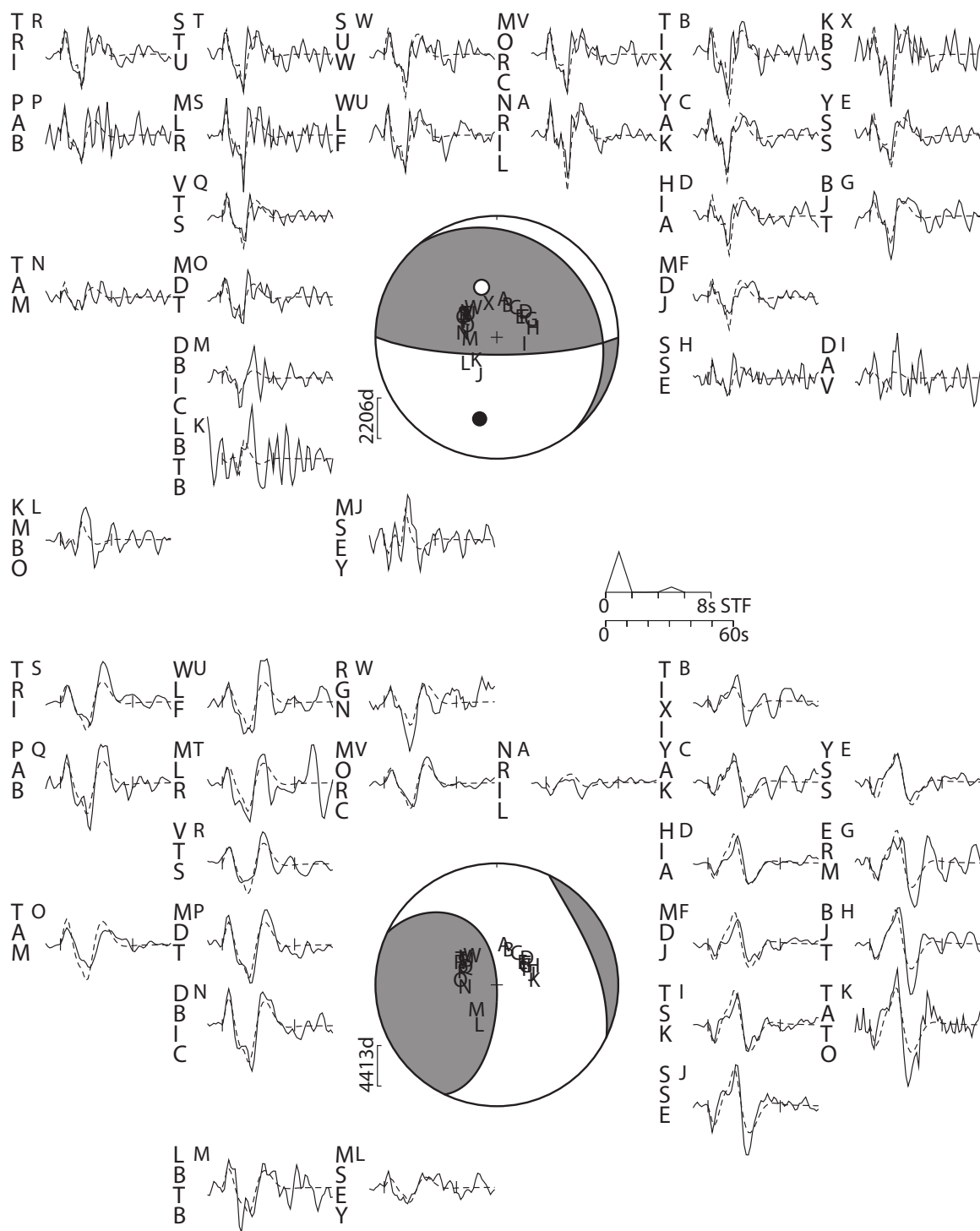
24 August 1997
 $253^{\circ}/17^{\circ}/71^{\circ}/16 \text{ km}/2.6 \times 10^{17} \text{ Nm}$



Supplementary Figure 13: Body waveform model of the 24 August 1997 aftershock (M_w 5.5). Layout is the same as in Supplementary Figure 9.

7 September 1997

321°/18°/139°/19 km/9.5 x 10¹⁶ Nm



Supplementary Figure 14: Body waveform model of the 7 September 1997 aftershock (M_w 5.3). Layout is the same as in Supplementary Figure 9.