A reassessment of outer-rise seismicity and its implications for the mechanics of oceanic lithosphere
Supplementary Material

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1 Deflection profiles and seismcity

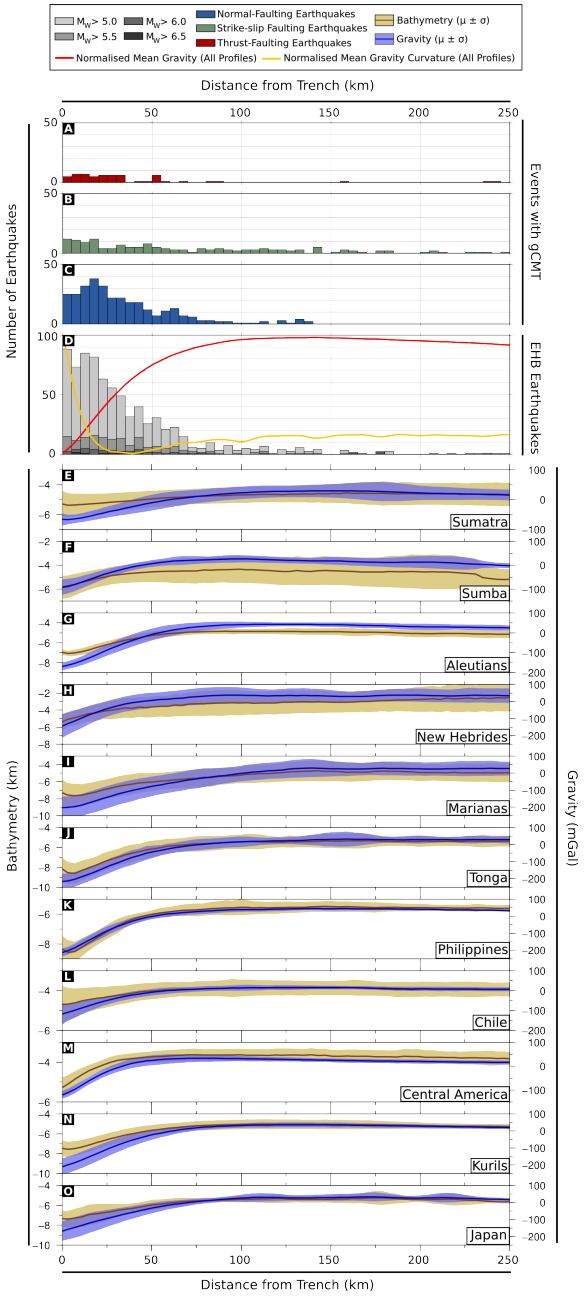

Figure S1: **Profiles of outer rise seismicity and morphology.** (a-d) Earthquakes as a function of distance from the trench. As depth is not a concern when considering the horizontal distribution of events, the gCMT catalogue, rather than that compiled in this study, is used, to maximise the number of events available. (a) Compressional earthquakes (gCMT catalogue). (b) Strike-slip earthquakes (gCMT catalogue). (c) Extensional earthquakes (gCMT catalogue). (d) All earthquakes (EHB catalogue). Normalised mean gravity profile (red) and curvature (yellow). (e-o) Bathymetry (brown) and gravity (blue) profiles from individual trenches.

2 Waveform modelling solutions

This section contains waveform modelling results for the 1964 deep thrust event from Chile, previously modelled by Chinn and Isacks (1983) using only *P*-waves. Remodelling here includes *SH* waves, and lengthens the soruce-time function to a more realistic 4 second duration, rather then the 1 second duration used in the original study. These changes alter the depth of the source from 41 km beneath the seafloor to 36 km beneath the seafloor.

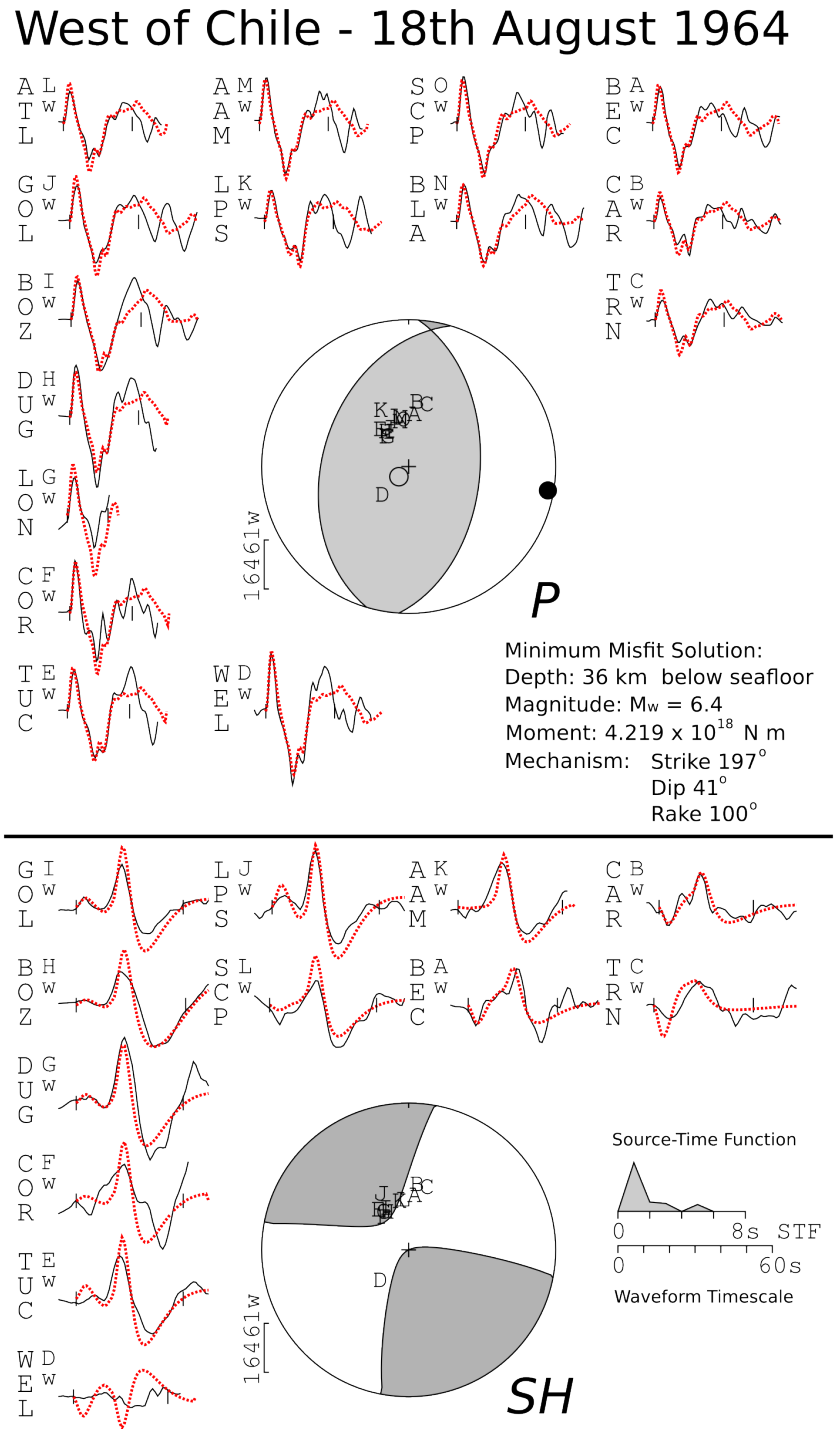

Figure S2: **New waveform modelling solution for the 18th August 1964 Chilean Earthquake.** An M_W 6.4 earthquake at -26.4°S, -71.7°W. Source-side water depth is ≈ 7 km. This earthquake was previously modelled by Chinn and Isacks (1983) using ony P-waves, with a shorter (1 second) source time function, and a centroid depth 5 km deeper.

3 Earthquake data tables

Waveform modeling Results

Date			Time		Lat/°	Long/°	z_{SL}	z_P	M_W	Focal Mechanism			Region
yyyy	mm	dd	hh	mm			km			Strike/°	dip/°	Rake/°	
1964	08	18	04	44	-26.387	-71.668	43	36	6.7	195	41	99	Chile
1990	03	06	13	30	-11.221	117.334	22	16	5.6	084	56	-065	Sumba
1990	04	06	14	57	15.215	147.622	18	10	6.3	055	73	-068	Marianas
1990	09	14	07	00	51.493	-164.073	15	10	5.6	293	78	-018	Aleutians
1991	05	07	13	09	39.471	144.700	27	21	6.0	282	32	-101	Japan
1992	05	28	21	24	47.631	155.469	19	13	5.7	075	55	-049	Kurils
1992	07	08	16	04	50.210	-176.276	10	4	5.0	298⋆	41⋆	-051⋆	Aleutians
1992	08	19	00	57	50.498	-174.917	17	10	6.2	262	51	-083	Aleutians
1992	08	31	04	39	-11.406	118.306	36	30	5.3	082	58	-120	Sumba
1992	10	01	08	18	-39.187	-75.238	27	23	5.5	035⋆	42⋆	-051⋆	Chile
1993	03	17	04	36	-37.691	-75.010	14	9	5.6	224⋆	30⋆	-037⋆	Chile
1993	04	02	08	04	-17.387	-171.834	11	6	6.0	192	55	-061	Tonga
1993	04	14	05	58	51.072	-168.810	15	10	6.0	076	51	-073	Aleutians
1993	06	16	06	59	-21.786	-173.710	38	30	5.3	160⋆	45⋆	090⋆	Tonga
1993	06	29	03	46	-11.042	118.384	25	20	5.6	261	61	-087	Sumba
1993	11	11	00	28	50.207	-177.433	29	23	6.0	290	37	-071	Aleutians
1994	03	15	03	36	11.106	-88.117	7	4	6.2	107	52	-114	Chile
1994	04	27	09	23	-21.501	-173.554	48	40	6.3	000	33	089	Tonga
1994	04	28	16	44	-39.487	-75.157	11	7	5.5	225⋆	51⋆	-044⋆	Chile
1994	05	04	11	47	51.449	-168.560	15	8	5.3	064⋆	44⋆	-088⋆	Aleutians
1994	07	04	21	36	14.890	-97.305	12	9	6.3	154	46	-104	Chile
1994	08	11	20	42	-21.607	-173.674	49	41	5.9	347	30	083	Tonga
1994	09	05	22	13	46.807	155.189	15	8	5.8	075	56	-072	Kurils
1994	11	05	10	52	10.702	141.419	21	16	5.6	094	43	-075	Marianas
1995	05	16	20	12	-22.935	170.004	23	19	7.6	285	42	-097	New Hebrides
1995	05	22	03	45	-22.698	170.131	10	6	6.3	268	35	-108	New Hebrides
1995	06	19	00	57	44.002	150.434	16	9	5.1	034⋆	36⋆	-118⋆	Kurils
1995	07	19	00	24	-22.684	169.886	13	9	6.1	128	47	-106	New Hebrides
1995	11	10	22	30	16.607	148.189	18	12	5.2	205	30	-089	Marianas
1996	02	12	09	08	-11.124	118.647	10	4	6.2	070	41	-094	Sumba
1996	02	19	07	10	-42.158	-75.421	16	12	5.9	192	36	-099	Chile
1996	07	06	11	56	15.493	147.771	18	11	5.6	033	31	-093	Marianas
1996	10	01	00	52	51.902	-166.536	14	8	5.2	222⋆	54⋆	-134⋆	Aleutians
1996	11	15	15	29	10.340	127.430	10	4	5.8	341	41	-086	Philippines
1996	11	20	19	42	10.300	127.430	12	6	5.8	320	47	-114	Philippines
1997	02	12	05	19	52.099	171.283	16	12	5.6	112	46	-098	Aleutians
1997	07	10	14	53	-11.259	117.940	37	30	5.3	070	57	-129	Sumba
1997	11	10	19	04	12.364	145.723	47	40	5.5	339	39	072	Marianas
1998	04	01	22	42	-40.414	-75.037	10	7	6.6	217	45	-072	Chile
1998	08	30	01	48	17.106	148.236	12	5	6.3	015	43	-072	Marianas
1999	01	16	10	44	56.218	-147.299	27	22	6.0	262	39	036	Aleutians
1999	05	05	22	41	14.316	-94.765	6	2	6.1	309	48	-089	Chile
1999	06	09	07	07	49.401	158.311	19	12	5.2	083⋆	33⋆	-014⋆	Kurils
1999	08	22	09	35	-40.615	-75.112	16	12	6.4	201	40	-081	Chile
1999	10	25	07	29	31.984	142.247	16	7	5.7	036	58	-079	Japan
2000	05	02	15	03	17.423	147.603	12	7	5.8	031	53	-024	Marianas
2000	12	19	13	11	11.735	144.877	16	10	6.2	063	46	-086	Marianas
2001	04	09	09	00	-32.748	-73.218	8	4	6.7	231	50	-073	Chile
2001	08	30	08	12	-22.943	169.889	18	14	5.8	132	23	-059	New Hebrides
2001	09	20	02	01	-11.398	114.942	10	5	5.6	070	52	-113	Sumba
2002	01	10	08	36	-17.669	-172.255	16	9	5.8	012	56	-118	Tonga
2002	11	30	21	50	-15.109	-172.392	12	7	5.5	167	46	-085	Tonga
2002	12	01	14	37	-11.232	117.164	31	25	5.6	245	42	-115	Sumba
2002	12	28	09	36	51.441	-168.577	14	8	5.6	245	35	-104	Aleutians
2003	01	18	19	50	33.923	137.221	19	17	5.6	193	28	074	Japan
2003	05	01	00	14	17.704	147.884	16	8	5.4	000	41	-060	Marianas
2003	06	24	08	33	43.102	149.605	13	7	5.4	227	36	-107	Kurils
2003	11	15	07	10	-17.274	-172.229	15	8	5.9	009	52	-103	Tonga

Waveform modelling Results - Continued from previous page

Date			Time		Lat/°	Long/°	z_{SL}	z_P	M_W	Focal Mechanism			Region
yyyy	mm	dd	hh	mm			km			Strike/°	dip/°	Rake/°	
2004	03	14	16	30	-17.314	-172.196	14	7	6.0	204	39	-078	Tonga
2004	05	13	17	34	11.772	144.340	32	25	6.0	208	85	171	Marianas
2004	06	29	07	01	10.680	-87.116	9	5	6.2	323	50	-079	Chile
2004	07	13	19	51	-24.267	-174.832	14	7	5.5	047	50	-068	Tonga
2004	08	07	09	30	51.630	-166.307	10	5	6.0	228	39	-116	Aleutians
2004	09	06	23	29	33.226	137.294	14	11	6.7	084	43	087	Japan
2004	09	07	18	36	33.266	137.161	14	12	5.6	249	35	084	Japan
2004	09	08	14	58	33.198	137.233	9	6	6.2	259	38	069	Japan
2004	09	10	02	05	33.101	136.558	9	6	5.6	353	79	173	Japan
2004	09	13	03	00	44.019	151.416	11	5	6.0	048	55	-125	Kurils
2005	01	17	10	50	10.984	140.846	25	20	6.1	155	34	-039	Marianas ✠
2005	01	17	10	50	10.984	140.846	28	23	6.1	159	45	-091	Marianas ✠
2005	02	10	16	53	-23.091	169.263	14	13	6.3	273	41	-080	New Hebrides
2005	04	08	11	38	-23.148	169.284	6	4	6.0	278	29	-071	New Hebrides
2005	05	04	04	38	11.720	143.855	19	11	5.5	279	28	-052	Marianas
2005	11	14	21	38	38.101	144.931	18	13	7.0	024	47	-072	Japan
2006	04	29	04	06	-11.260	118.371	37	32	5.8	223	34	-119	Sumba
2006	06	24	23	43	43.539	150.037	15	8	5.1	053⋆	44⋆	-102⋆	Kurils
2006	06	26	01	59	50.190	-176.140	33	28	5.3	254⋆	42⋆	-110⋆	Aleutians
2006	07	16	11	42	-28.710	-72.498	12	7	6.2	351	48	-117	Chile
2006	07	27	01	01	10.407	142.064	37	3	2 5.5	124	88	003	Marianas
2006	08	02	14	45	-11.189	116.845	30	24	6.0	133	33	-087	Sumba
2006	08	04	07	45	52.089	171.090	16	10	5.4	335	59	-054	Aleutians
2006	09	28	06	22	-16.590	-171.976	20	13	7.0	359	43	-101	Tonga
2006	11	15	11	40	46.486	154.731	13	7	5.6	068	63	-077	Kurils
2006	11	16	06	20	46.329	154.506	13	6	6.0	033	40	-093	Kurils
2006	11	17	06	33	47.001	155.529	11	5	5.5	239⋆	45⋆	-090⋆	Kurils
2006	11	18	10	05	11.090	-87.821	8	4	5.6	294	42	-101	Chile
2006	11	28	08	01	46.689	155.551	13	8	5.3	044⋆	39⋆	-090⋆	Kurils
2006	12	07	19	10	46.137	154.411	18	11	6.5	055	40	-080	Kurils
2007	01	13	17	37	46.883	156.288	21	16	6.1	294	47	-046	Kurils
2007	01	13	23	40	46.696	156.652	16	11	5.2	103⋆	38⋆	-094⋆	Kurils
2007	05	08	05	31	-21.102	-173.640	16	8	5.0	028⋆	43⋆	-107⋆	Tonga
2007	08	15	20	22	50.283	-177.527	12	5	6.5	267	40	-090	Aleutians
2007	08	27	17	12	-17.295	-172.232	14	7	5.7	015	43	-122	Tonga
2007	10	25	13	50	46.008	154.239	32	25	6.2	129	69	021	Kurils
2007	12	13	15	51	-15.235	-172.321	18	12	6.1	149	45	-076	Tonga
2008	06	26	21	19	-20.801	-173.298	56	47	6.1	023	29	123	Tonga
2008	10	02	23	28	-23.026	169.925	19	16	5.9	138	25	-063	New Hebrides
2008	10	19	05	10	-21.849	-173.832	41	32	7.0	185	46	079	Tonga
2008	10	19	12	55	-21.963	-173.674	30	23	5.7	034	41	-083	Tonga
2008	10	25	19	24	-17.229	167.296	21	16	5.7	070	68	-033	New Hebrides
2008	12	24	09	11	-17.290	-171.894	12	6	6.0	002	53	-092	Tonga
2009	01	15	17	49	46.820†	155.185†	42	36	7.4	008	44	085	Kurils
2009	01	28	12	39	-16.973†	-172.068†	38	31	5.6	315	36	060	Tonga
2009	02	22	10	33	48.920†	158.078†	16	10	5.1	226	40	-102	Kurils
2009	07	06	14	53	50.435†	176.992†	35	29	6.1	262	38	-164	Aleutians
2009	08	27	20	10	45.496†	153.746†	16	10	5.4	029	56	-105	Kurils
2009	08	30	14	51	-15.223†	-172.571†	20	14	6.7	114	51	-091	Tonga
2009	10	19	22	49	-15.360†	-172.264†	30	23	6.0	280	42	-123	Tonga
2009	11	02	10	47	-24.121†	-175.173†	15	7	6.2	022	37	-097	Tonga
2009	11	22	22	07	-39.950†	-74.830†	11	8	5.8	204	44	-069	Chile
2010	02	22	05	08	-21.511†	-173.778†	50	41	5.7	167	60	092	Tonga
2010	03	01	08	58	-37.840†	-74.486†	11	6	5.0	204⋆	41⋆	-079⋆	Chile
2010	06	28	00	59	-37.910†	-75.038†	17	12	5.7	014	38	-072	Chile
2010	10	21	02	49	-34.737†	-73.726†	11	6	5.9	013	43	-126	Chile
2010	12	25	13	16	-19.670⋆	168.040⋆	23	17	7.0	348	72	-092	New Hebrides
2010	12	26	02	13	-19.580⋆	168.120⋆	19	14	5.9	203	25	-037	New Hebrides
2010	12	26	19	38	-19.610⋆	168.100⋆	21	16	5.5	187	27	-056	New Hebrides
2010	12	29	06	54	-19.660⋆	168.140⋆	24	18	6.5	189	18	-071	New Hebrides
2011	01	05	00	57	31.545†	142.177†	14	10	5.7	359	43	-093	Japan
2011	01	13	16	16	-20.630⋆	168.470⋆	20	14	6.8	329	49	-084	New Hebrides
2011	01	13	16	16	-20.630⋆	168.470⋆	35	29	6.8	278	44	-096	New Hebrides

Waveform modelling Results - Continued from previous page

Date			Time		Lat/°	Long/°	z_{SL}	z_P	M_W	Focal Mechanism			Region
yyyy	mm	dd	hh	mm			km			Strike/°	dip/°	Rake/°	
2011	03	22	07	18	37.244†	144.003†	13	7	6.4	052	49	-070	Japan
2011	04	11	17	53	37.644†	144.450†	16	10	5.4	057	50	-079	Japan
2011	05	05	14	58	38.173†	144.040†	24	16	6.1	048	59	-050	Japan
2011	05	10	08	55	-20.240⋆	168.230⋆	19	14	6.7	349	54	-078	New Hebrides
2011	05	11	08	19	-20.300⋆	168.350⋆	12	6	5.8	333	53	-054	New Hebrides
2011	05	26	02	10	-17.676†	-172.217†	11	4	5.5	006	41	-084	Tonga
2011	06	03	00	05	37.285†	143.907†	24	17	6.2	205	42	-132	Japan
2011	07	01	13	18	13.117†	146.561†	49	42	5.7	298	51	057	Marianas
2011	07	15	00	55	-24.194†	-175.297†	12	5	5.3	052⋆	41⋆	-098⋆	Tonga
2011	08	17	11	44	36.765†	143.770†	11	5	6.2	062	51	-076	Japan
2011	08	22	06	04	-17.430⋆	167.270⋆	14	10	5.8	025	36	-114	New Hebrides
2011	10	08	08	53	-20.602†	-173.222†	14	8	6.0	033	38	-098	Tonga
2011	10	20	03	39	-29.972†	-176.298†	26	17	5.1	360⋆	45⋆	-100⋆	Tonga
2011	10	28	11	07	-28.677†	-176.096†	16	9	5.3	168⋆	35⋆	-120⋆	Tonga
2011	11	17	01	57	-1.702†	-81.546†	25	23	6.0	087	81	001	Chile
2012	02	02	13	34	-17.830⋆	167.130⋆	17	12	6.9	049	61	-051	New Hebrides
2012	02	03	03	46	-17.380⋆	167.280⋆	17	13	6.2	010	41	-085	New Hebrides
2012	02	05	16	40	-17.950⋆	167.230⋆	16	11	6.1	023	54	-081	New Hebrides
2012	03	14	09	08	40.894†	144.935†	13	8	6.9	256	43	-104	Japan
2012	08	31	12	47	10.819†	126.627†	44	35	7.6	009	41	078	Philippines
2012	08	31	23	37	10.405†	126.724†	14	5	5.6	001	63	-089	Philippines
2012	09	02	14	42	11.309†	126.647†	12	5	5.4	340⋆⋆	45⋆⋆	-090⋆⋆	Philippines
2012	09	04	09	58	10.483†	126.825†	15	7	5.4	161	32	-116	Philippines
2012	09	04	15	11	10.612†	126.711†	10	2	5.5	349	54	-090	Philippines
2012	12	07	08	18	37.889†	144.090†	57	50	7.2	025	37	106	Japan ✠
2012	12	07	08	18	37.889†	144.090†	23	16	7.1	057	49	-061	Japan ✠
2013	03	24	04	18	50.717†	160.162†	15	10	6.1	057	40	-073	Kurils

Table 1: **Waveform modeling results for outer rise earthquakes from this study.** Locations are taken from the updated catalogue of Engdahl et al. (1998), except those indicated by † which are from the NEIC catalogue, or by ⋆ which are from the gCMT catalgoue. Depth, moment and mechanism parameters are determined from waveform modeling. z_{SL} is the depth below sealevel. z_P is the depth below the top of the plate. Parameters marked ⋆ are taken from the gCMT catalgoue. Parameters marked ⋆⋆ assumed, consistent with observed waveforms. Events marked ✠ are double-source events.

References

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