

Supplementary materials for  
**Refining Heterogeneities Near the Core-Mantle Boundary Beneath East Pacific Regions: Enhanced Differential Travel Time Analysis Using USArray**

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Event ID	Date	Latitude (°)	Longitude (°)	Depth (km)	Mw	LF	HF
200704050356A	2007-04-05-03:56:50	-24.62	37.31	14	6.34	Y	
200707211534A	2007-07-21-15:34:52	-65.78	-22.15	289.5	6.42		Y
200708020321A	2007-08-02-03:21:42	-179.97	51.31	21	6.73	Y	
200708041424A	2007-08-04-14:24:51	-105.41	-4.8	10	6.07		Y
200708152022A	2007-08-15-20:22:11	-177.55	50.32	9	6.46		Y
200708202242A	2007-08-20-22:42:29	-39.25	8.04	10	6.54	Y	Y
200710050717A	2007-10-05-07:17:52	179.46	-25.19	509.4	6.49		Y
200710162105A	2007-10-16-21:05:43	179.53	-25.77	509.3	6.6	Y	
200711271150A	2007-11-27-11:49:58	162.15	-10.95	16	6.56	Y	Y
200712160809A	2007-12-16-08:09:17	-70.18	-22.95	45	6.71	Y	
200802041701A	2008-02-04-17:01:31	-70.04	-20.17	43.5	6.33		Y
200802080938A	2008-02-08-09:38:14	-41.9	10.67	9	6.94	Y	
200802141009A	2008-02-14-10:09:22	21.67	36.5	29	6.85	Y	
200802161445A	2008-02-16-14:45:11	-68.39	-21.35	130.1	6.07	Y	
200802210246A	2008-02-21-02:46:17	18.57	77.08	10	6.07	Y	Y
200805231935A	2008-05-23-19:35:34	-34.9	7.31	9	6.47		Y
200805291546A	2008-05-29-15:46:00	-21.01	64	10	6.29	Y	Y
200807150326A	2008-07-15-03:26:34	27.86	35.8	52	6.39		Y
200807190239A	2008-07-19-02:39:28	142.21	37.55	22	6.91	Y	
200807190927A	2008-07-19-09:27:01	164.49	-11.04	11	6.57	Y	Y
200807192239A	2008-07-19-22:39:52	-177.31	-17.34	391	6.41	Y	Y
200807231526A	2008-07-23-15:26:20	141.46	39.8	108	6.79	Y	
200807240143A	2008-07-24-01:43:16	157.58	50.97	27	6.21		Y
200808262100A	2008-08-26-21:00:36	-74.38	-7.64	154	6.38	Y	
200808270135A	2008-08-27-01:35:32	104.16	51.61	16	6.29	Y	Y
200809081852A	2008-09-08-18:52:07	166.97	-13.5	110	6.92	Y	
200809101308A	2008-09-10-13:08:14	-38.72	8.09	10	6.61	Y	Y
200809110020A	2008-09-11-00:20:50	143.75	41.89	25	6.77		Y
200809180141A	2008-09-18-01:41:02	-106	-4.55	10	6.01		Y

200810190510A	2008-10-19-05:10:33	-173.82	-21.86	29	6.9	Y	Y
200811070719A	2008-11-07-07:19:35	168.03	-14.83	13	6.37		Y
200812182119A	2008-12-18-21:19:28	-71.73	-32.46	18	6.13		Y
200902182153A	2009-02-18-21:53:45	-176.33	-27.42	25	6.96	Y	Y
200904060132A	2009-04-06-01:32:39	13.33	42.33	8.8	6.31	Y	
200904070423A	2009-04-07-04:23:33	151.55	46.05	31	6.87	Y	Y
200904170208A	2009-04-17-02:08:08	-70.48	-19.58	25	6.07	Y	Y
200904181917A	2009-04-18-19:17:58	151.43	46.01	35	6.6	Y	
200905100116A	2009-05-10-01:16:07	-85.17	1.39	6	6.1	Y	
200906050330A	2009-06-05-03:30:33	143.45	41.82	29	6.32		Y
200907071911A	2009-07-07-19:11:46	-72.45	75.35	19	6.03	Y	
200908122248A	2009-08-12-22:48:51	140.4	32.82	53	6.58	Y	
200908200635A	2009-08-20-06:35:04	0.94	72.2	6	5.99	Y	
200908301451A	2009-08-30-14:51:32	-172.57	-15.22	11	6.61		Y
200909072241A	2009-09-07-22:41:37	43.44	42.66	15	5.98		Y
200909122006A	2009-09-12-20:06:24	-67.92	10.7	10	6.36		Y
200910072052A	2009-10-07-20:52:13	119.53	81.57	8	5.81		Y
200910151748A	2009-10-15-17:48:21	-103.82	3.27	10	5.97	Y	
200911041841A	2009-11-04-18:41:44	-33.87	36.15	10	5.89	Y	
200911241247A	2009-11-24-12:47:15	-174.04	-20.71	18	6.74	Y	
201002180113A	2010-02-18-01:13:19	130.7	42.59	577.7	6.88	Y	Y
201003051147A	2010-03-05-11:47:06	-73.37	-36.67	18	6.6	Y	Y
201003070705A	2010-03-07-07:05:23	-115.3	-16.24	10	6.24	Y	
201003111439A	2010-03-11-14:39:44	-71.89	-34.29	11	6.85	Y	Y
201003140808A	2010-03-14-08:08:04	141.59	37.74	32	6.53	Y	
201003160221A	2010-03-16-02:21:57	-73.26	-36.22	18	6.64		Y
201004112208A	2010-04-11-22:08:12	-3.54	36.97	609.8	6.35	Y	Y
201004211720A	2010-04-21-17:20:29	-173.22	-15.27	35	6.08	Y	Y
201005241618A	2010-05-24-16:18:29	-71.56	-8.08	581.2	6.44	Y	Y
201007042155A	2010-07-04-21:55:52	142.37	39.7	27	6.28		Y
201010080326A	2010-10-08-03:26:13	-175.36	51.37	19	6.39		Y
201101010956A	2011-01-01-09:56:58	-63.09	-26.79	576.8	7.03	Y	Y
201101290655A	2011-01-29-06:55:26	-6.68	70.94	6	6.23	Y	
201102112005A	2011-02-11-20:05:30	-73.12	-36.47	27.6	6.84	Y	
201103010053A	2011-03-01-00:53:46	-111.98	-29.7	10	6.05		Y
201103220718A	2011-03-22-07:18:45	144	37.24	11	6.41	Y	Y
201105192015A	2011-05-19-20:15:22	29.1	39.15	7	5.89		Y
201106011255A	2011-06-01-12:55:22	-73.69	-37.58	21	6.34		Y

201106222150A	2011-06-22-21:50:52	142.21	39.96	33	6.73	Y	
201107272300A	2011-07-27-23:00:30	-43.39	10.8	10	5.93	Y	Y
201108190354A	2011-08-19-03:54:26	-177	-16.52	407.9	6.24	Y	
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201109050952A	2011-09-05-09:52:01	-173.62	-15.3	37	6.22	Y	
201110232045A	2011-10-23-20:45:34	43.08	38.63	5	5.96		Y
201111221848A	2011-11-22-18:48:16	-65.09	-15.36	549.9	6.57		Y
201112271521A	2011-12-27-15:21:56	95.91	51.84	15	6.69	Y	
201202260617A	2012-02-26-06:17:19	95.99	51.71	12	6.65	Y	Y
201203050746A	2012-03-05-07:46:10	-63.29	-28.25	553.9	6.12	Y	
201203140908A	2012-03-14-09:08:35	144.94	40.89	12	6.95	Y	Y
201204100509A	2012-04-10-05:09:08	-13.97	-1.26	10	5.87		Y
201204170350A	2012-04-17-03:50:15	-71.36	-32.62	29	6.68	Y	
201205200203A	2012-05-20-02:03:51	11.23	44.9	8.3	6.09		Y
201205242247A	2012-05-24-22:47:46	5.71	72.96	10	6.26	Y	Y
201205280507A	2012-05-28-05:07:23	-63.09	-28.04	586.9	6.68	Y	Y
201205290700A	2012-05-29-07:00:03	11.07	44.82	9	5.87		Y
201206020752A	2012-06-02-07:52:54	-63.56	-22.06	527	5.98		Y
201208020938A	2012-08-02-09:38:30	-74.26	-8.41	144.6	6.04		Y
201208111223A	2012-08-11-12:23:18	46.83	38.33	11	6.45	Y	
201208301343A	2012-08-30-13:43:25	-10.62	71.44	14	6.74	Y	
201209262339A	2012-09-26-23:39:55	-178.29	51.59	16	6.48	Y	Y
201211141902A	2012-11-14-19:02:06	-71.19	-29.12	63	6.18	Y	Y
201301302015A	2013-01-30-20:15:43	-70.65	-28.09	45	6.77		Y
201302021417A	2013-02-02-14:17:35	143.09	42.77	107	6.93		Y
201302091416A	2013-02-09-14:16:07	-77.39	1.13	145	6.97	Y	
201302141313A	2013-02-14-13:13:53	142.51	67.63	11	6.67	Y	
201302281405A	2013-02-28-14:05:50	157.27	50.97	41	6.82	Y	
201303011253A	2013-03-01-12:53:51	157.45	50.9	33	6.37	Y	
201304300625A	2013-04-30-06:25:23	-24.91	37.59	10	5.81		Y
201306151611A	2013-06-15-16:11:02	25.02	34.4	10	6.32	Y	Y
201306242204A	2013-06-24-22:04:13	-42.59	10.7	10	6.46	Y	
201308120949A	2013-08-12-09:49:32	-81.93	-5.4	10	6.21		Y
201308301625B	2013-08-30-16:25:02	-175.36	51.61	33.5	6.97		Y
201309050401A	2013-09-05-04:01:36	-45.17	15.21	10	5.98		Y
201309111244A	2013-09-11-12:44:13	-104.82	-4.65	9.6	6.05	Y	Y
201310120210A	2013-10-12-02:10:27	-62.31	10.9	63	5.98	Y	Y
201310121311A	2013-10-12-13:11:53	23.25	35.51	40	6.76		Y

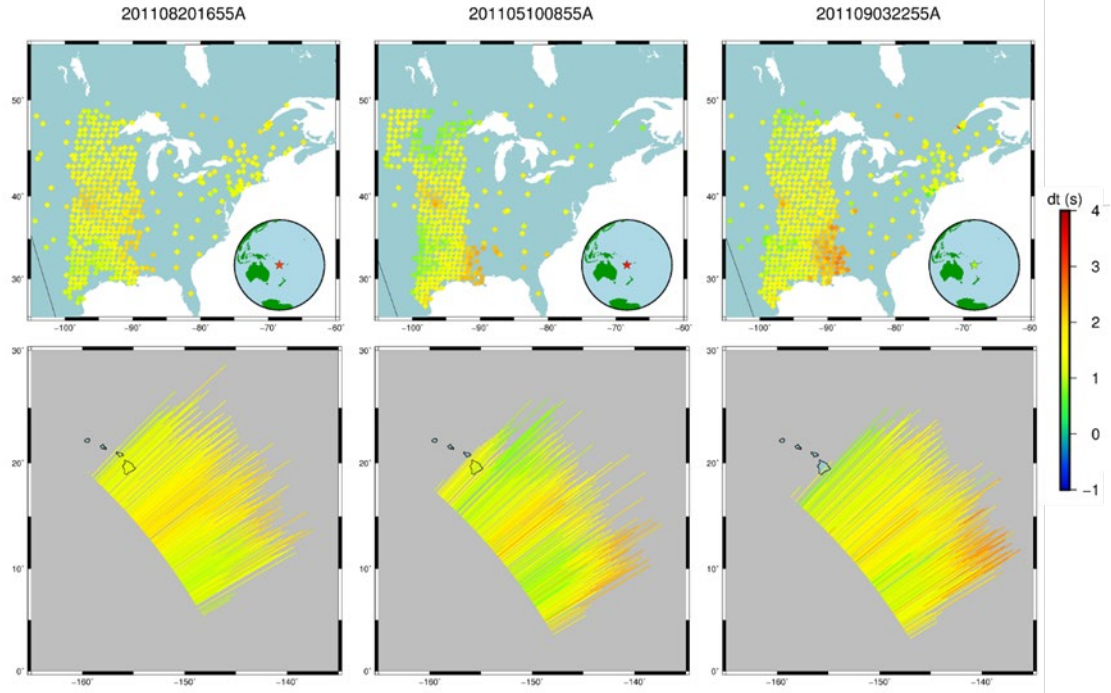
201310312303A	2013-10-31-23:03:59	-71.56	-30.3	29	6.49	Y	
201311021552A	2013-11-02-15:52:46	-112.59	-23.63	10	6.02	Y	Y
201402180927A	2014-02-18-09:27:13	-58.93	14.67	14.8	6.45	Y	
201402262113B	2014-02-26-21:13:40	-171.82	53.6	265	6.13		Y
201403100518A	2014-03-10-05:18:13	-125.13	40.83	16.6	6.91	Y	
201403162116A	2014-03-16-21:16:29	-70.7	-19.98	20	6.67	Y	
201404030158A	2014-04-03-01:58:30	-70.58	-20.31	23.6	6.59	Y	Y
201404040137A	2014-04-04-01:37:50	-70.65	-20.64	13.7	6.23		Y
201405240925A	2014-05-24-09:25:03	25.38	40.3	10	6.86	Y	
201405311153A	2014-05-31-11:53:46	-107.47	18.79	5	6.19		Y
201407201832A	2014-07-20-18:32:47	148.78	44.64	61	6.28	Y	
201407270128A	2014-07-27-01:28:37	-45.58	23.72	10	6.06	Y	Y
201408100343A	2014-08-10-03:43:17	142.13	41.16	41	6.11	Y	
201408180232A	2014-08-18-02:32:05	47.69	32.7	10.2	6.21		Y
201408241020A	2014-08-24-10:20:44	-122.31	38.22	11.2	6.07		Y
201410090214A	2014-10-09-02:14:31	-110.81	-32.11	16.5	6.95	Y	

**Table S1. Catalog of seismic events analyzed for direct P-waves in this study. Events utilized in each data period are marked with a "Y".**

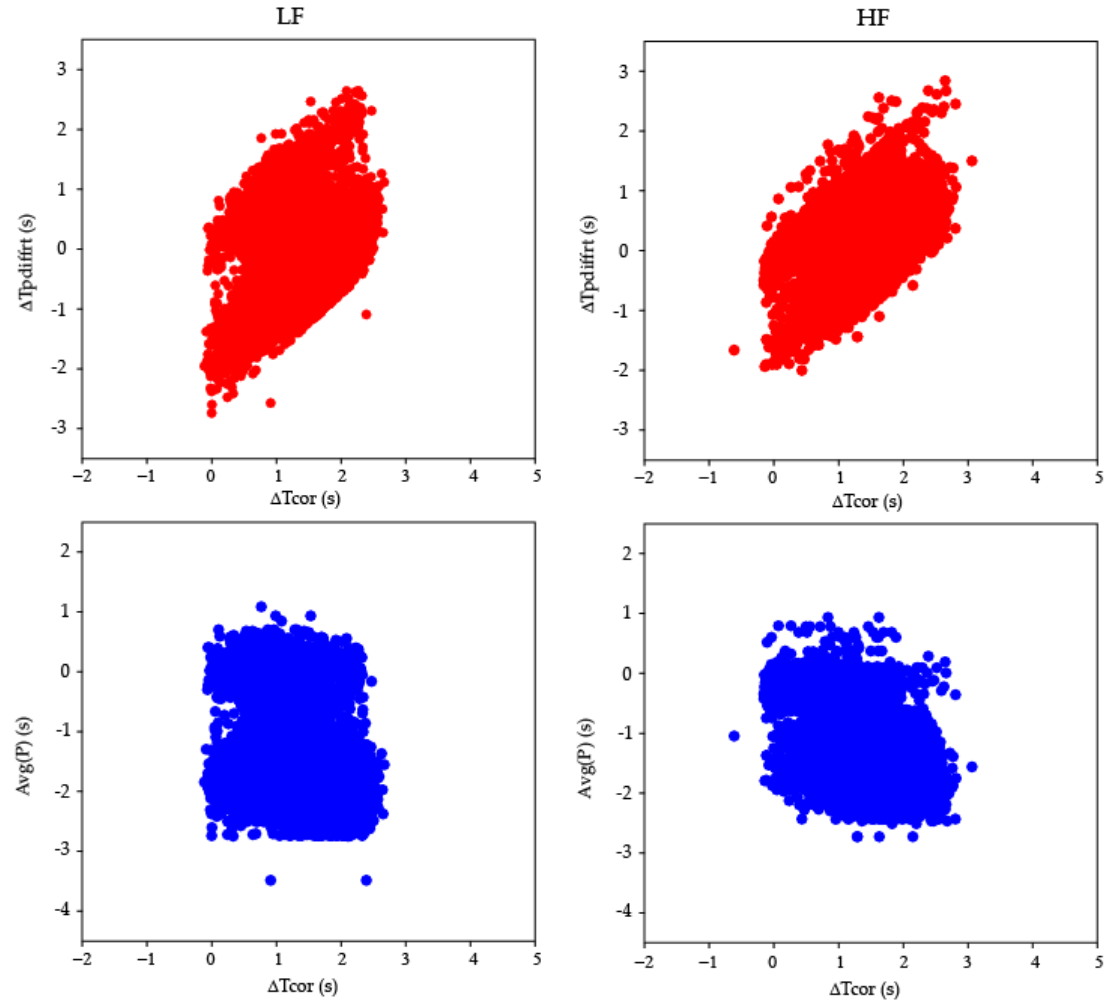
Event ID	Date	Latitude (°)	Longitude (°)	Depth (km)	Mw	LF	HF
201107061903A	2011-07-06-19:03:18	-176.34	-29.54	17	7.58	Y	Y
201108201655A	2011-08-20-16:55:02	168.14	-18.36	32	7.13	Y	Y*
201110211757A	2011-10-21-17:57:16	-176.24	-28.99	33	7.38	Y	Y
201101182023A	2011-01-18-20:23:23	63.94	28.78	68	7.23	Y	Y
201112140504A	2011-12-14-05:04:59	146.8	-7.56	140.9	7.08	Y	Y*
201109032255A	2011-09-03-22:55:40	169.72	-20.67	185.1	7.03	Y	Y
201101131616A	2011-01-13-16:16:41	168.47	-20.63	9	6.93	Y	
201103070009A	2011-03-07-00:09:36	160.77	-10.35	22	6.39	Y	Y
201110140335A	2011-10-14-03:35:14	147.88	-6.57	37	6.46	Y	
201109181240A	2011-09-18-12:40:51	88.14	27.72	50	6.9	Y	
201109030449A	2011-09-03-04:48:57	-26.85	-56.45	84	6.37	Y	Y
201104181303A	2011-04-18-13:03:02	179.87	-34.34	86	6.53	Y	Y
201111080259A	2011-11-08-02:59:08	125.62	27.32	224.9	6.91	Y	Y
201107290742A	2011-07-29-07:42:22	179.76	-23.78	523	6.72	Y	Y
201103241355A	2011-03-24-13:55:11	99.84	20.69	8	6.84	Y	
201105100855A	2011-05-10-08:55:08	168.23	-20.24	11	6.79	Y	Y*
201106160003A	2011-06-16-00:03:35	151.04	-5.93	16	6.34	Y	Y*
201107112047A	2011-07-11-20:47:04	122.17	9.51	19	6.5	Y	Y

201108300657A	2011-08-30-06:57:41	126.76	-6.36	469.6	6.88	Y	Y
201103070009A	2011-03-07-00:09:36	160.77	-10.35	22	6.39	Y	Y
201110211757A	2011-10-21-17:57:16	-176.24	-28.99	33	7.38	Y	Y
201109032255A	2011-09-03-22:55:40	169.72	-20.67	185.1	7.03	Y	Y
201111080259A	2011-11-08-02:59:08	125.62	27.32	224.9	6.91	Y	Y
201107311434A	2011-07-31-14:34:47	171.58	-17.02	10	6.12		Y*
201109150753A	2011-09-15-07:53:18	-179.03	-35.31	10	6		Y
201105100855A	2011-05-10-08:55:08	168.23	-20.24	11	6.79	Y	Y
201106160003A	2011-06-16-00:03:35	151.04	-5.93	16	6.34	Y	Y
201107061903A	2011-07-06-19:03:18	-176.34	-29.54	17	7.58	Y	Y
201107112047A	2011-07-11-20:47:04	122.17	9.51	19	6.5	Y	Y
201108201655A	2011-08-20-16:55:02	168.14	-18.36	32	7.13	Y	Y
201101182023A	2011-01-18-20:23:23	63.94	28.78	68	7.23	Y	Y
201104181303A	2011-04-18-13:03:02	179.87	-34.34	86	6.53	Y	Y
201107290742A	2011-07-29-07:42:22	179.76	-23.78	523	6.72	Y	Y
201104230416A	2011-04-23-04:16:54	161.2	-10.38	79	6.82		Y
201109030449A	2011-09-03-04:48:57	-26.85	-56.45	84	6.37	Y	Y*
201103061432A	2011-03-06-14:32:36	-27.06	-56.42	87.7	6.54		Y*
201112140504A	2011-12-14-05:04:59	146.8	-7.56	140.9	7.08	Y	Y
201105142107A	2011-05-14-21:07:22	70.75	36.41	207.3	5.98		Y
201108300657A	2011-08-30-06:57:41	126.76	-6.36	469.6	6.88	Y	Y
201102211057A	2011-02-21-10:57:52	178.39	-26.14	558.1	6.53		Y
201109151931A	2011-09-15-19:31:04	-179.53	-21.61	644.6	7.32		Y

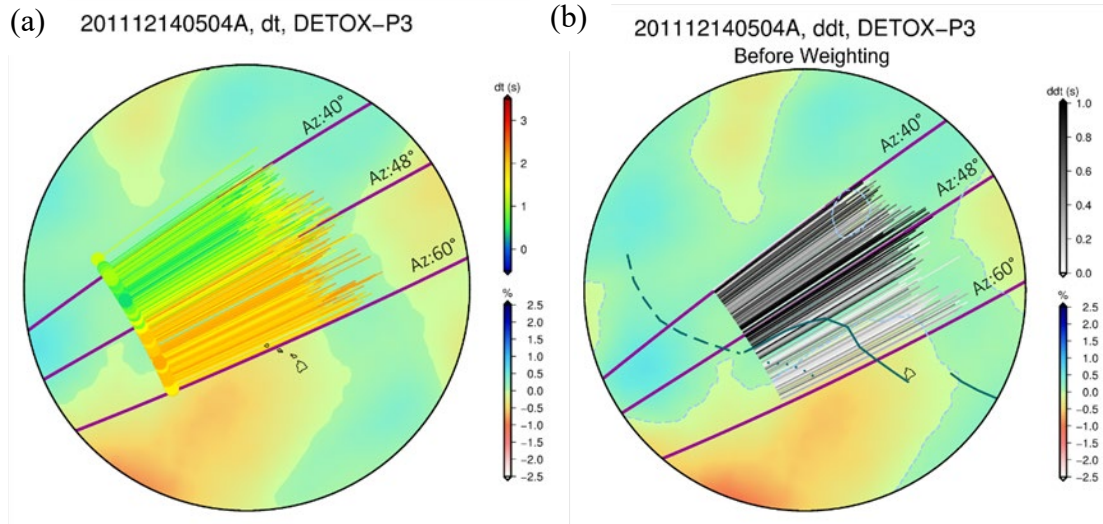
**Table S2. Catalog of seismic events analyzed for diffracted P-waves in this study. Events utilized in each data period are marked with a "Y".**



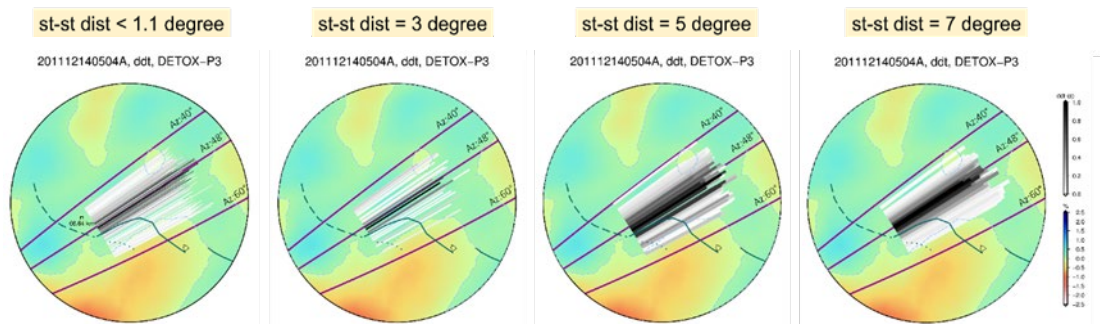
**Figure S1. Differential travel time anomalies across three earthquake events with comparable source characteristics.** The figure comprises two rows illustrating the spatial distribution and travel time residuals for three selected earthquake events. Top row illustrates travel-time residuals as observed directly at the stations, with the location of each station marked and the magnitude of the residual indicated by colors aligned with the color scale on the right. Bottom row illustrates travel-time residuals mapped along the diffractive paths from the earthquakes to the stations, providing insight into the path-dependent variability of the travel-time anomalies. The color coding remains consistent with the top row.



**Figure S2. The travel-time analysis of Pdiff and average P-wave travel time residuals for low- and high-frequency data.** Top panel displays scatter plots of Pdiff travel-time differences versus  $\Delta T_{cor}$ , offering insights into the consistency and variability of Pdiff measurements relative to  $\Delta T_{cor}$  across frequencies. Bottom panel illustrates the correlation between  $Avg(P)$  and  $\Delta T_{cor}$ , highlighting the broader implications of average travel-time adjustments on the differential travel-time analysis.



**Figure S3. The corrected travel-time differences and its spatial gradient for event 201112140504A.** (a) Displays the travel-time differences ( $\Delta T_{cor}$ ) along the diffractive path of the seismic event, employing a color scale located in the upper right for correlation. Dots signify the initiation points of diffraction. The background features deep mantle imaging from the DETOX-P3 model, with values aligned to the lower right color scale, offering insights into the underlying mantle structure influencing the observed residuals. Three azimuth angles critical to the analysis are highlighted with purple lines, delineating the directional dependencies of the diffractive path residuals. (b) Follows the structure and content of panel (a) but focuses on variability in travel-time difference between station pairs, whose intensity corresponds to a grayscale gradient on the right.



**Figure S4. Analysis of lateral travel-time variations by inter-station distance for event 201112140504A.** This figure demonstrates how varying inter-station distances affect the weighted travel-time differences observed for the seismic event 201112140504A. The distances are categorized into four groups: less than 1.1°, approximately 3°, 5°, and 7°. These categories are presented sequentially from left to right, with each category color-coded according to the scale in the top right corner. The underlying tomographic model used is DETOX-P3, with velocity perturbations



depicted in colors that correspond to the scale at the bottom right.