

Table SI-1. Level Data Results (1988-1967)							
Latitude (degrees Noth)	Longitude (degrees East)	Vertical* (mm/yr)	Uncertainty† (mm/yr)	Latitude (degrees Noth)	Longitude (degrees East)	Vertical* (mm/yr)	Uncertainty† (mm/yr)
39.877500	-123.719722	2.01	0.97	40.766667	-124.216944	-2.85	0.43
39.878333	-123.725000	2.13	0.97	40.766944	-124.216389	-2.58	0.42
39.889444	-123.746111	1.69	0.96	40.779722	-124.207222	-2.45	0.41
39.902778	-123.749722	1.92	0.95	40.785556	-124.180278	-1.73	0.40
39.904722	-123.756111	2.15	0.95	40.791389	-124.176667	-1.57	0.40
39.916111	-123.763333	2.17	0.94	40.796389	-124.195556	-2.05	0.40
39.919444	-123.764167	2.09	0.94	40.801667	-124.162778	-1.26	0.38
39.924167	-123.757222	2.11	0.94	40.802500	-124.167222	-1.44	0.38
39.943611	-123.779444	2.38	0.93	40.804722	-124.153333	-1.14	0.37
39.950833	-123.778889	2.01	0.93	40.804722	-124.146667	-0.82	0.37
39.953889	-123.774444	1.15	0.93	40.805000	-124.140556	-1.58	0.37
39.960278	-123.778056	2.06	0.92	40.805278	-124.195000	-3.05	0.39
39.963333	-123.786944	2.60	0.92	40.806111	-124.115000	-0.31	0.38
39.968056	-123.798056	1.21	0.92	40.818333	-124.180278	-2.15	0.37
39.976944	-123.800556	1.61	0.92	40.822222	-124.175278	-2.05	0.37
40.000833	-123.785833	1.49	0.91	40.828611	-124.171389	-1.33	0.37
40.010278	-123.789444	1.68	0.90	40.830556	-124.081111	0.24	0.41
40.016944	-123.789722	2.01	0.90	40.843611	-124.080278	0.21	0.42
40.021111	-123.790833	1.78	0.90	40.851944	-124.161389	-1.39	0.39
40.034444	-123.774722	2.33	0.89	40.856389	-124.088056	-0.18	0.43
40.036111	-123.788056	0.75	0.89	40.864444	-124.151944	-1.58	0.40
40.041111	-123.778611	2.15	0.89	40.866111	-124.091111	-0.22	0.43
40.057778	-123.785000	1.81	0.88	40.867222	-124.083333	0.35	0.44
40.061389	-123.777500	2.20	0.88	40.868056	-124.106667	-1.43	0.43
40.068056	-123.789444	2.09	0.87	40.868611	-124.085000	0.28	0.44
40.092500	-123.790556	2.61	0.86	40.891667	-124.079444	0.35	0.46
40.099722	-123.795278	2.02	0.86	40.905278	-124.086111	-0.38	0.47
40.101111	-123.793611	2.71	0.86	40.916111	-124.091389	0.31	0.47
40.105833	-123.794167	2.53	0.86	40.921944	-124.095833	-2.62	0.48
40.106667	-123.793889	2.35	0.86	40.931111	-124.100000	0.54	0.48
40.116389	-123.799167	2.22	0.85	40.951667	-124.100000	-0.01	0.50
40.126111	-123.821944	2.90	0.84	40.963611	-124.099444	0.58	0.50
40.131389	-123.816389	2.24	0.84	40.988333	-124.108611	0.55	0.52
40.135556	-123.814167	1.76	0.84	40.995278	-124.111389	0.40	0.52
40.141944	-123.806667	1.12	0.84	41.008056	-124.108611	0.70	0.53
40.167778	-123.780556	0.73	0.83	41.020833	-124.105833	0.13	0.54
40.181944	-123.774722	1.77	0.82	41.028611	-124.106389	0.23	0.54
40.193056	-123.766111	1.62	0.81	41.035278	-124.110833	1.55	0.54
40.203333	-123.776667	1.58	0.81	41.046111	-124.116944	2.64	0.55
40.209722	-123.784444	1.31	0.81	41.051667	-124.122222	1.53	0.55
40.219444	-123.809722	1.45	0.79	41.061667	-124.136944	1.00	0.56
40.220278	-123.784167	1.12	0.80	41.086389	-124.148056	1.05	0.57
40.223333	-123.799722	1.44	0.80	41.096389	-124.155833	0.73	0.58
40.236944	-123.822778	1.60	0.79	41.141111	-124.136111	1.95	0.60
40.249167	-123.821667	1.16	0.78	41.152500	-124.131944	1.37	0.61
40.259167	-123.839444	0.71	0.77	41.157778	-124.122500	1.16	0.61
40.266667	-123.868333	1.40	0.75	41.163056	-124.108889	0.11	0.62
40.267778	-123.847222	1.05	0.77	41.251667	-124.087500	2.39	0.67
40.271389	-123.863611	1.38	0.76	41.262778	-124.095833	2.05	0.67
40.273333	-123.877500	0.98	0.75	41.277500	-124.093056	0.34	0.68
40.279167	-123.861667	1.08	0.76	41.287222	-124.081944	1.55	0.68
40.280833	-123.885556	1.47	0.75	41.308611	-124.044167	1.86	0.70
40.282222	-123.855556	0.92	0.76	41.323056	-124.036944	2.21	0.71
40.287500	-123.893889	2.01	0.74	41.365000	-124.018611	2.40	0.73
40.294167	-123.892500	1.84	0.74	41.376389	-124.013056	2.37	0.73
40.299167	-123.890833	1.97	0.74	41.406667	-124.028611	2.01	0.75
40.305278	-123.899722	1.18	0.73	41.420556	-124.032778	2.02	0.75
40.313611	-123.910833	1.99	0.73	41.434722	-124.038056	2.03	0.76
40.321667	-123.920000	1.94	0.72	41.453889	-124.041944	1.28	0.77
40.334444	-123.928611	2.28	0.72	41.460278	-124.046111	2.55	0.77
40.344722	-123.930833	1.76	0.71	41.464167	-124.041667	2.44	0.77
40.367778	-123.923333	2.01	0.70	41.472222	-124.041389	2.41	0.77
40.376667	-123.924722	1.28	0.70	41.482222	-124.048611	2.44	0.78
40.396667	-123.935833	2.31	0.69	41.497222	-124.040278	3.55	0.78
40.396944	-123.947500	1.79	0.69	41.506111	-124.031111	2.01	0.79
40.407778	-123.957222	2.47	0.68	41.514722	-124.028889	1.32	0.79
40.413889	-123.966389	2.46	0.68	41.520278	-124.031111	-3.07	0.79
40.428056	-123.982222	2.37	0.67	41.524167	-124.033611	0.75	0.80
40.435000	-123.986944	1.76	0.66	41.539722	-124.047778	1.66	0.80
40.440278	-124.025000	2.16	0.65	41.539722	-124.047778	1.86	0.80
40.441389	-124.036389	2.08	0.65	41.569444	-124.068056	1.65	0.81
40.443889	-124.013333	1.55	0.65	41.604722	-124.099722	1.30	0.83
40.457222	-124.066389	1.87	0.63	41.606667	-124.096389	3.39	0.83
40.483056	-124.101111	3.79	0.61	41.645833	-124.116389	0.24	0.84
40.494444	-124.101111	3.45	0.61	41.651389	-124.113611	1.88	0.85
40.499722	-124.105000	3.17	0.60	41.660556	-124.114722	2.23	0.85
40.526111	-124.149722	3.15	0.58	41.666944	-124.111389	1.36	0.85
40.538611	-124.144722	2.38	0.58	41.676389	-124.111389	2.22	0.86
40.553611	-124.144444	1.57	0.57	41.692778	-124.108056	1.91	0.86
40.567500	-124.147222	1.44	0.56	41.704167	-124.122778	2.17	0.87
40.570833	-124.148056	0.94	0.56	41.706389	-124.128889	2.09	0.87
40.582222	-124.149722	0.89	0.55	41.711389	-124.127500	1.95	0.87
40.592222	-124.153333	0.65	0.55	41.719722	-124.136111	1.75	0.88
40.597500	-124.157500	0.43	0.54	41.744167	-124.170000	2.09	0.89
40.601944	-124.169167	0.32	0.54	41.745556	-124.200278	2.50	0.90
40.605278	-124.177500	-0.07	0.53	41.745833	-124.200556	2.43	0.90
40.612222	-124.189444	-0.36	0.53	41.745833	-124.200833	2.54	0.90
40.621389	-124.208889	-0.66	0.52	41.745833	-124.200833	2.53	0.90
40.642222	-124.208611	-0.31	0.50	41.746111	-124.182500	2.52	0.89
40.680278	-124.199722	-3.33	0.48	41.748611	-124.200000	2.30	0.90
40.695833	-124.201944	-4.03	0.47	41.748611	-124.200000	2.06	0.90
40.706667	-124.205833	-3.86	0.46	41.749722	-124.198056	1.65	0.90
40.725278	-124.213056	-1.94	0.45	41.750556	-124.196389	2.53	0.90
40.736667	-124.207778	-2.09	0.44	41.752222	-124.184722	2.45	0.90
40.744722	-124.195556	-1.82	0.44	41.752778	-124.191667	2.36	0.90
40.766667	-124.216667	-2.87	0.43	41.756667	-124.203333	2.35	0.91

* Rate of vertical land motion between landmark surveys conducted in 1968 and 1988. Positive values denote upward motion and negative values denote downward motion.

† Uncertainty in millimeters per year.

TABLE SI-2. Global Navigation Satellite System (GNSS) Data												
Site Name	Source [*]	Latitude	Longitude	Beginning Observation	End Observation	Span (yrs)	North [†] (mm/yr)	Uncertainty (mm/yr)	East [‡] (mm/yr)	Uncertainty (mm/yr)	Vertical [#] (mm/yr)	Uncertainty (mm/yr)
P179	USGS	42.098970	-123.685570	6/12/2007	11/28/2022	15.5	-3.48	0.34	-1.08	0.36	0.76	0.70
P734	USGS	42.076640	-124.293260	10/10/2007	11/28/2022	15.1	-1.93	0.18	1.71	0.19	2.59	0.36
P786	USGS	41.845480	-123.980770	8/21/2008	11/28/2022	14.3	-2.56	0.19	0.36	0.21	1.59	0.39
P154	USGS	41.807080	-123.360050	5/11/2007	11/28/2022	15.6	-3.89	0.17	-1.71	0.19	0.91	0.33
PTSG	USGS	41.782740	-124.255220	1/1/2003	11/27/2022	19.9	-0.83	0.16	2.70	0.18	2.36	0.35
CACC	USGS	41.745600	-124.184300	9/27/2011	12/29/2021	10.3	-1.63	0.25	1.40	0.26	2.60	0.54
P316	USGS	41.559130	-124.086140	7/1/2006	11/27/2022	16.4	-2.05	0.33	-0.03	0.34	-1.06	0.81
P155	USGS	41.272440	-123.188790	9/19/2007	11/28/2022	15.2	-4.19	0.18	-3.66	0.20	0.20	0.38
P325	USGS	41.151670	-123.882610	10/25/2006	11/28/2022	16.1	-1.67	0.36	-0.66	0.37	3.17	0.84
TRND	USGS	41.053890	-124.150870	11/16/1999	11/27/2022	23.0	4.08	0.17	2.33	0.18	-0.39	0.37
P343	USGS	40.887130	-123.334210	6/21/2007	11/28/2022	15.4	-3.89	0.18	-4.98	0.20	0.76	0.37
P058	USGS	40.876310	-124.075370	11/10/2005	11/28/2022	17.1	-0.14	0.27	1.33	0.28	0.78	0.65
P169	USGS	40.791150	-123.967650	5/27/2004	11/28/2022	18.5	16.84	0.20	-1.99	0.21	3.68	0.49
P331	USGS	40.732920	-123.324140	6/21/2007	11/28/2022	15.4	3.36	0.18	-5.97	0.20	0.56	0.37
P162	USGS	40.691110	-124.237040	9/11/2004	11/28/2022	18.2	-4.09	0.21	2.04	0.22	-1.03	0.50
P168	USGS	40.668640	-123.881460	9/15/2005	11/28/2022	17.2	8.98	0.25	-1.15	0.26	5.13	0.60
P161	USGS	40.637360	-124.213090	5/7/2005	11/28/2022	17.6	2.65	0.21	0.50	0.22	-0.83	0.51
P326	USGS	40.575320	-123.698930	5/19/2006	11/28/2022	16.5	7.60	0.30	-6.57	0.32	2.30	0.71
P160	USGS	40.551250	-124.133270	5/5/2005	11/28/2022	17.6	-2.40	0.22	-2.48	0.23	1.14	0.54
P167	USGS	40.543710	-123.880180	9/17/2005	11/28/2022	17.2	8.76	0.25	-3.99	0.26	1.81	0.59
P159	USGS	40.504790	-124.282780	10/26/2006	11/28/2022	16.1	3.62	0.37	-2.73	0.38	-0.49	0.90
327P	USGS	40.478860	-123.573060	4/30/2008	11/28/2022	14.6	13.84	0.22	-7.67	0.23	0.76	0.50
CME6	USGS	40.441400	-124.396330	10/12/2007	9/3/2019	11.9	-2.82	0.26	-6.25	0.27	-2.79	0.65
166P	USGS	40.435180	-123.862830	11/2/2005	11/28/2022	17.1	19.20	0.26	-5.83	0.28	0.72	0.61
P324	USGS	40.256840	-123.655740	5/17/2006	11/28/2022	16.5	3.60	0.12	-10.71	0.19	0.60	0.43
157P	USGS	40.247550	-124.308070	5/11/2006	11/28/2022	16.6	9.54	0.30	-19.50	0.31	1.49	0.67
P165	USGS	40.245550	-123.853270	6/9/2006	11/28/2022	16.5	1.87	0.20	-11.44	0.22	2.03	0.47
P163	USGS	40.219570	-124.057290	6/7/2006	11/28/2022	16.5	20.17	0.30	-14.72	0.32	1.83	0.69
P164	USGS	40.119260	-123.693340	8/10/2004	11/28/2022	18.3	5.68	0.19	-14.75	0.20	0.56	0.44
P156	USGS	40.024440	-123.906120	6/9/2006	9/2/2022	16.2	11.92	0.11	-20.02	0.15	-1.91	0.39
FISH	USGS	42.046190	-124.268050	8/20/1993	6/28/2005	11.9	3.49	0.87	3.12	0.87	3.07	2.61
GORD	USGS	41.986120	-123.937350	8/20/1993	6/29/2005	11.9	11.72	1.94	2.64	-2.42	2.64	-1.51
HP13	USGS	41.932540	-124.158380	7/19/2001	6/27/2005	3.9	-0.05	0.86	2.77	0.86	1.50	2.57
H111	USGS	41.521750	-124.033220	7/18/2001	6/26/2005	3.9	-3.38	1.18	3.79	1.18	16.88	3.53
SCHL	USGS	41.153410	-123.881960	5/7/1992	6/29/2005	13.2	-2.02	0.65	1.81	0.65	2.80	1.96
HP19	USGS	40.975040	-124.117390	9/30/1993	6/22/2005	11.7	-1.91	0.65	4.05	0.65	0.60	1.95
O1RE	USGS	40.943850	-123.622510	7/21/2004	6/23/2005	0.9	-2.58	0.67	-3.62	0.67	-1.83	2.00
O1RD	USGS	40.896350	-123.772430	10/25/1993	5/23/2001	7.6	-1.10	0.88	-4.63	0.88	0.80	2.65
HORS	USGS	40.874720	-123.732950	5/7/1992	6/23/2005	13.1	3.26	0.66	-3.58	0.66	2.35	1.99
KNEE	USGS	40.726640	-123.974830	6/13/1992	6/24/2005	13.0	-0.01	0.65	-7.87	0.65	1.84	1.94
SIS3	USGS	40.715440	-124.201970	5/7/1992	7/24/2004	12.2	-0.55	0.72	-52.88	0.72	-2.15	2.14
IAQ2	USGS	40.668970	-123.882620	5/8/1992	7/29/2004	12.2	4.73	0.69	-1.41	0.69	0.19	2.08
TAB3	USGS	40.630110	-124.193730	7/14/2001	7/23/2004	3.0	-2.13	1.43	2.02	1.43	-2.14	4.28
O1PA	USGS	40.588970	-124.255600	11/16/1999	6/21/2005	5.6	-1.63	0.95	1.49	0.95	5.63	2.85
SHW1	USGS	40.578940	-123.697530	5/8/1992	7/25/2004	12.2	-0.05	0.72	-6.63	0.72	2.25	2.15
HP16	USGS	40.460220	-123.235000	8/18/1993	7/25/2004	10.9	-3.13	0.70	-14.86	0.70	0.58	2.09
GRSH	USGS	40.306380	-123.977840	5/6/1992	7/19/2004	12.2	309.00	0.70	-63.32	0.70	2.75	2.09
COOS	USGS	40.256810	-124.266030	6/1/1993	7/24/2004	11.2	8.41	0.72	-18.76	0.72	4.57	2.16

* USGS GPS data sourced from https://earthquake.usgs.gov/monitoring/gps/NCalifornia_SGPS, https://earthquake.usgs.gov/monitoring/gps/NCalifornia_SGPS_ITRF2014, and https://earthquake.usgs.gov/monitoring/gps/Pacific_Northwest_ITRF2014

† Rate of north-south motion relative to ITRF2014. Positive values denote northward motion and negative values denote southward motion.

‡ Rate of east-west motion relative to ITRF2014. Positive values denote eastward motion and negative values denote westward motion.

Rate of vertical motion relative to ITRF2014. Positive values denote upward motion and negative values denote downward motion.

GNSS Site Offsets Used by the USGS to Calculate Geodetic Rates. These Discrete Offsets Include Coseismic Earthquake Motion.											
Station or Date*	Decimal date†	N offset‡ (mm)	N uncertainty§ (mm)	E offset¶ (mm)	E uncertainty# (mm)	U offset‡ (mm)	U uncertainty‡ (mm)	Type‡	Earthquake magnitude	Earthquake information	Distance from epicenter** (km)
CACC	Decimal date	N offset (mm)	N uncertainty (mm)	E offset (mm)	E uncertainty (mm)	U offset (mm)	U uncertainty (mm)	Type	Earthquake magnitude	Earthquake information	Distance from epicenter (km)
3/10/2014	2014.1862	-4.85	1.47	-0.82	1.38	3.35	4.74	earthquake	6.8	nc72182046	129.2
12/8/2016	2016.9363	1.35	0.52	1.49	0.5	-3.71	1.59	earthquake	6.6	us20007z6r	221.5
12/20/2021	2021.9665	-0.6	0.66	-0.62	0.61	3.38	2.34	earthquake	6.2	nc73666231	166.7
P734	Decimal date	N offset (mm)	N uncertainty (mm)	E offset (mm)	E uncertainty (mm)	U offset (mm)	U uncertainty (mm)	Type	Earthquake magnitude	Earthquake information	Distance from epicenter (km)
1/10/2010	2010.0246	-2.43	0.49	-1.08	0.46	-1.29	1.45	earthquake	6.5	nc71338066	161.7
11/3/2012	2012.8405	0.91	0.49	-1.8	0.46	-4.32	1.47	antenna			
3/10/2014	2014.1862	-4.28	0.49	0.04	0.46	1.81	1.47	earthquake	6.8	nc72182046	155.4
6/2/2016	2016.4189	-0.38	0.49	2.83	0.46	-1.63	1.51	antenna			
12/8/2016	2016.9363	0.41	0.49	0.48	0.47	-2.65	1.51	earthquake	6.6	us20007z6r	240.5
P786	Decimal date	N offset (mm)	N uncertainty (mm)	E offset (mm)	E uncertainty (mm)	U offset (mm)	U uncertainty (mm)	Type	Earthquake magnitude	Earthquake information	Distance from epicenter (km)
8/26/2008	2008.6517	3.3	1.74	1.02	1.24	6.05	6.47	antenna			
9/6/2008	2008.6817	3.51	1.33	1.35	1.65	-11.4	4.87	antenna			
1/10/2010	2010.0246	-2.91	0.49	-0.94	0.47	0.4	1.47	earthquake	6.5	nc71338066	145.4
3/10/2014	2014.1862	-2.99	0.49	0.91	0.47	-0.19	1.49	earthquake	6.8	nc72182046	148.5
12/8/2016	2016.9363	0.22	0.49	1.02	0.47	-3.1	1.49	earthquake	6.6	us20007z6r	241.6
3/25/2020	2020.23	6.38	0.69	-2.34	0.68	-1.22	1.83	antenna			
12/20/2021	2021.9665	0.85	0.49	-0.24	0.46	0.85	1.47	earthquake	6.2	nc73666231	182.6
P179	Decimal date	N offset (mm)	N uncertainty (mm)	E offset (mm)	E uncertainty (mm)	U offset (mm)	U uncertainty (mm)	Type	Earthquake magnitude	Earthquake information	Distance from epicenter (km)
1/10/2010	2010.0246	-2.54	0.5	-1.31	0.47	1.83	1.54	earthquake	6.5	nc71338066	181.5
6/27/2013	2013.4846	-0.06	0.49	1.06	0.47	-0.02	1.49	antenna			
3/10/2014	2014.1862	-2.11	0.49	0.97	0.46	-0.43	1.49	earthquake	6.8	nc72182046	185.8
12/8/2016	2016.9363	0.18	0.5	0.44	0.47	-3.44	1.51	earthquake	6.6	us20007z6r	278.4
P154	Decimal date	N offset (mm)	N uncertainty (mm)	E offset (mm)	E uncertainty (mm)	U offset (mm)	U uncertainty (mm)	Type	Earthquake magnitude	Earthquake information	Distance from epicenter (km)
1/10/2010	2010.0246	-2.24	0.49	-0.67	0.46	-1.24	1.45	earthquake	6.5	nc71338066	170.1
3/10/2014	2014.1862	-1.24	0.49	1.42	0.46	-1.75	1.46	earthquake	6.8	nc72182046	184
7/1/2016	2016.4983	-1.25	0.49	0.4	0.46	0.11	1.51	antenna			
12/8/2016	2016.9363	0.3	0.49	0.24	0.47	-4.45	1.52	earthquake	6.6	us20007z6r	281.4
PTSG	Decimal date	N offset (mm)	N uncertainty (mm)	E offset (mm)	E uncertainty (mm)	U offset (mm)	U uncertainty (mm)	Type	Earthquake magnitude	Earthquake information	Distance from epicenter (km)
6/15/2005	2005.4518	-3.44	1.61	1.84	1.34	-2	4.48	earthquake	7.2	usp000dt25	151.8
2/4/2009	2009.0931	-0.28	0.69	-1.58	0.66	-1.55	2.09	antenna			
3/19/2009	2009.2108	2.66	0.53	-0.73	0.49	0.77	1.78	antenna			
1/10/2010	2010.0246	-2.93	0.49	-0.65	0.46	-0.16	1.46	earthquake	6.5	nc71338066	130.8
3/10/2014	2014.1862	-3.98	1.42	-0.79	1.34	3.88	4.63	earthquake	6.8	nc72182046	129
7/1/2015	2015.4956	-1.25	0.59	-1.8	0.56	1.01	1.78	antenna			
1/21/2016	2016.0548	1.22	0.7	0.95	0.68	-3.3	1.98	antenna			
12/8/2016	2016.9363	1.07	0.49	0.65	0.46	-1.55	1.46	earthquake	6.6	us20007z6r	219.7
12/20/2021	2021.9665	0.03	0.48	-0.32	0.46	3	1.45	earthquake	6.2	nc73666231	169.1
P316	Decimal date	N offset (mm)	N uncertainty (mm)	E offset (mm)	E uncertainty (mm)	U offset (mm)	U uncertainty (mm)	Type	Earthquake magnitude	Earthquake information	Distance from epicenter (km)
1/10/2010	2010.0246	-2.72	0.49	-1.02	0.47	0.35	1.5	earthquake	6.5	nc71338066	112.9
10/12/2011	2011.7746	4.01	0.64	-2.36	0.62	-1.01	1.77	other			
3/10/2014	2014.1862	3.82	1.54	-2.76	1.43	6.84	5.03	earthquake	6.8	nc72182046	119.6
8/18/2014	2014.627	11.1	0.67	-8.09	0.57	3.55	1.74	other			
12/8/2016	2016.9363	-0.36	0.49	-0.18	0.47	1.55	1.52	earthquake	6.6	us20007z6r	215.6
3/9/2019	2019.3504	3.86	0.95	-0.27	0.96	-3.83	2.43	antenna			
12/20/2021	2021.9665	0.19	0.49	0.16	0.47	2.8	1.51	earthquake	6.2	nc73666231	149.8
P155	Decimal date	N offset (mm)	N uncertainty (mm)	E offset (mm)	E uncertainty (mm)	U offset (mm)	U uncertainty (mm)	Type	Earthquake magnitude	Earthquake information	Distance from epicenter (km)
1/10/2010	2010.0246	-1.44	0.49	0.49	0.46	-1.58	1.47	earthquake	6.5	nc71338066	144.2
3/10/2014	2014.1862	-1.27	0.49	1.83	0.46	0.98	1.48	earthquake	6.8	nc72182046	170.8
12/8/2016	2016.9363	0.5	0.49	0.82	0.46	-3.67	1.48	earthquake	6.6	us20007z6r	269.2
8/7/2019	2019.5969	2.03	0.82	2.12	0.82	-1.96	2.05	antenna			
12/20/2021	2021.9665	0.91	0.5	-0.18	0.48	1.98	1.05	earthquake	6.2	nc73666231	169.8
P325	Decimal date	N offset (mm)	N uncertainty (mm)	E offset (mm)	E uncertainty (mm)	U offset (mm)	U uncertainty (mm)	Type	Earthquake magnitude	Earthquake information	Distance from epicenter (km)
1/31/2007	2007.0821	0	0.8	2.51	0.76	4.02	2.41	antenna			
1/10/2010	2010.0246	0.76	1.44	0.11	1.36	5.21	4.61	earthquake	6.5	nc71338066	88
3/10/2014	2014.1862	-2.73	1.44	3.05	1.36	5.45	4.66	earthquake	6.8	nc72182046	111.2
12/8/2016	2016.9363	0.84	0.5	0.75	0.47	-3.29	1.52	earthquake	6.6	us20007z6r	209.9
4/25/2019	2019.3121	6.19	0.5	-8.1	0.47	1.71	1.53	antenna			
12/20/2021	2021.9665	0.26	0.49	-0.1	0.47	1.67	1.51	earthquake	6.2	nc73666231	119
TRND	Decimal date	N offset (mm)	N uncertainty (mm)	E offset (mm)	E uncertainty (mm)	U offset (mm)	U uncertainty (mm)	Type	Earthquake magnitude	Earthquake information	Distance from epicenter (km)
6/15/2005	2005.4518	-0.82	1.41	2.54	1.34	-3.35	4.47	earthquake	7.2	usp000dt25	153.5
1/10/2010	2010.0246	-1.76	1.4	-1.56	1.33	3.63	4.4	earthquake	6.5	nc71338066	63.9
3/10/2014	2014.1862	-0.44	1.4	7.18	1.33	-9.17	4.4	earthquake	6.8	nc72182046	86.5
12/8/2016	2016.9363	0.66	0.48	0.6	0.46	-1.6	1.45	earthquake	6.6	us20007z6r	184.9
2/14/2019	2019.1205	3.73	0.49	-1.16	0.47	-6.17	1.45	antenna			
12/20/2021	2021.9665	-0.66	0.48	0.1	0.46	2.89	1.45	earthquake	6.2	nc73666231	97.1
P343	Decimal date	N offset (mm)	N uncertainty (mm)	E offset (mm)	E uncertainty (mm)	U offset (mm)	U uncertainty (mm)	Type	Earthquake magnitude	Earthquake information	Distance from epicenter (km)
1/10/2010	2010.0246	-1.54	0.49	1.12	0.47	-2.68	1.49	earthquake	6.5	nc71338066	117.7
3/10/2014	2014.1862	-1.57	0.49	2.94	0.46	1.05	1.48	earthquake	6.8	nc72182046	151.9
12/8/2016	2016.9363	0.51	0.49	0.65	0.47	-4.77	1.48	earthquake	6.6	us20007z6r	246.6
7/31/2019	2019.5777	0.68	0.82	1.51	0.82	-1.52	2.05	antenna			
12/20/2021	2021.9665	0.49	0.49	0.63	0.46	1.6	1.46	earthquake	6.2	nc73666231	136
P058	Decimal date	N offset (mm)	N uncertainty (mm)	E offset (mm)	E uncertainty (mm)	U offset (mm)	U uncertainty (mm)	Type	Earthquake magnitude	Earthquake information	Distance from epicenter (km)
1/10/2010	2010.0246	-0.37	1.43	1.31	1.36	5.65	4.58	earthquake	6.5	nc71338066	57.8
3/10/2014	2014.1862	-3.05	1.43	8.15	1.36	5.85	4.62	earthquake	6.8	nc72182046	89.4
12/8/2016	2016.9363	0.54	0.49	0.67	0.46	-3.28	1.5	earthquake	6.6	us20007z6r	185.2
5/14/2020	2020.3669	4.67	0.49	0.45	0.46	-3.87	1.49	antenna			
12/20/2021	2021.9665	-0.47	0.49	0.22	0.46	1.73	1.49	earthquake	6.2	nc73666231	85.1
P169	Decimal date	N offset (mm)	N uncertainty (mm)	E offset (mm)	E uncertainty (mm)	U offset (mm)	U uncertainty (mm)	Type	Earthquake magnitude	Earthquake information	Distance from epicenter (km)
6/15/2005	2005.4518	-1.52	1.43	2.33	1.35	-6.06	4.59	earthquake	7.2	usp000dt25	176
1/10/2010	2010.0246	-0.25	1.43	4.95	1.37	-0.42	4.57	earthquake	6.5	nc71338066	63.2
3/10/2014	2014.1862	-2.3	1.43	6.66	1.35	-0.03	4.61	earthquake	6.8	nc72182046	98.5
12/8/2016	2016.9363	0.62	0.49	0.45	0.46	-2.53	1.47	earthquake	6.6	us20007z6r	192.1
7/4/2019	2019.5038	4.74	0.85	5.56	0.86	-2.04	2.13	antenna			
12/20/2021	2021.9665	0.18	0.49	0.6	0.46	2.73	1.47	earthquake	6.2	nc73666231	85.3
P331	Decimal date	N offset (mm)	N uncertainty (mm)	E offset (mm)	E uncertainty (mm)	U offset (mm)	U uncertainty (mm)	Type	Earthquake magnitude	Earthquake information	Distance from epicenter (km)
1/10/2010	2010.0246	-1.55	0.49	1.36	0.47	-1.93	1.48	earthquake	6.5	nc71338066	116.1
3/10/2014	2014.1862	-2.15	0.49	3.19	0.46	0.82	1.48	earthquake	6.8	nc72182046	153.2
12/8/2016	2016.9363	0.58	0.49	1.23	0.47	-4.28	1.48	earthquake	6.6	us20007z6r	244.9
8/1/2019	2019.5804	7.63	0.82	-1.42	0.83	0.15	2.05	antenna			
12/20/2021	2021.9665	0.84	0.5	1.25	0.47	2.91	1.53	earthquake	6.2	nc73666231	129.7
P170	Decimal date	N offset (mm)	N uncertainty (mm)	E offset (mm)	E uncertainty (mm)	U offset (mm)	U uncertainty (mm)	Type	Earthquake magnitude	Earthquake information	Distance from epicenter (km)
6/15/2005	2005.4518	-0.2	1.43	2.41	1.35	-8.25	4.55	earthquake	7.2	usp000dt25	181.4
1/10/2010	2010.0246	1.79	1.42	3.99	1.35	10.65	4.55	earthquake	6.5	nc71338066	74.5
3/10/2014	2014.1862	-2.97	1.42	4.88	1.35	0.12	4.55	earthquake	6.8	nc72182046	107.3
12/8/2016	2016.9363	-0.44	0.49	1.5	0.46	7.15	1.48	earthquake	6.6	us20007z6r	202.7
6/12/2020	2020.4463	-3.83	0.49	0.42	0.47	-15.5	1.47	antenna			
12/20/2021	2021.9665	0.47	0.49	0.42	0.46	-1.1	1.48	earthquake	6.2	nc73666231	98.4
P162	Decimal date	N offset (mm)	N uncertainty (mm)	E offset (mm)	E uncertainty (mm)	U offset (mm)	U uncertainty (mm)	Type	Earthquake magnitude	Earthquake information	Distance from epicenter (km)
6/15/2005	2005.4518	-2.61	1.43	2.59	1.35	-2.15	4.55	earthquake	7.2	usp000dt25	159.1
1/10/2010	2010.0246	1.2	1.43	12.11	1.35	5.29	4.55	earthquake	6.5	nc71338066	38.8
3/10/2014	2014.1862	-2.18	1.								

Supplemental File SI-4 – Evaluation of Site and Monument Stability

Here we present our evaluation of the impact of the underlying geology type on vertical land motion rates. We also discuss the process we used to determine the confidence index for each geodetic site.

SI-4.1 Geology Type

We apply a geology type index to help us evaluate the potential for geological influence on VLM rate. One might expect a VLM site in a bay mud to subside more than a site installed in bedrock. The index is described below, with a list of the mapped lithologic units included in each geology type.

SI-4.1.1 Methods

We use published geologic maps to classify each geodetic site relative to 6 geology types, each with a potentially different effect on benchmark stability. Type 1 is presumably more prone to internal deformation and type 6 is presumably more internally stable. These assessments are qualitative.

For the Humboldt Bay / Eel River area, we utilize McLaughlin et al. (2000) geologic mapping. For geodetic sites to the north of this mapping extent, we utilize Delattre and Rosinski (2013). For areas in California not covered by McLaughlin et al. (2000) and Delattre and Rosinski (2013), we use Jennings et al. (2010). For areas in Oregon, we use Franczyk et al. (2020) statewide compilation and the 1:125k mapping from Moring (1983).

These are the following categories, ranked of increasing likelihood for stability.

Type 1: Later Holocene sediments such as bay sediment, river or creek sediments, etc. Units include: Q/Qal/Qa (Quaternary alluvial deposits – if really young), Qds (dune sand), af (Holocene artificial fill), Qm (Late Pleistocene to Holocene undeformed marine shoreline and aeolian deposits – if dunes), Qhc (latest Holocene stream channel deposits), Qht (Holocene young stream terrace deposits),

Type 2: Earlier Holocene to latest Quaternary sediments such as alluvial fans, fluvial terraces, etc. Units include: Qal (Quaternary alluvial deposits – if older), Qha (Quaternary alluvial deposits, undifferentiated)

Type 3: Late Tertiary sedimentary rocks. Units include: QTpc (Pliocene to Pleistocene Prairie Creek Formation), Qm (Late Pleistocene to Holocene undeformed marine shoreline and aeolian deposits – if marine terraces), Qmt₁₋₆ (Pleistocene marine terrace deposits), Qt (Pleistocene to Holocene undifferentiated nonmarine terrace deposits), Qf (Pleistocene to Holocene alluvial fan deposits), Qby (late Pleistocene Battery Formation), Qu (late Pliocene to Pleistocene undifferentiated marine and nonmarine overlap deposits),

Type 4: Tertiary Sedimentary Rock. Units include: QTw (Tertiary to Quaternary Wildcat Formation – marine to nonmarine sediments),

Type 5: Mesozoic Sedimentary Rock. Units include Jg (Jurassic Galice Formation – marine slate, metagraywacke, and greenstone) TK (Late Cretaceous to Pliocene

Franciscan Complex – Central Belt, marine sedimentary rock dominated by argillite), Ep (Paleocene to Eocene Franciscan Complex – Coastal Belt, Yager Terrane, mudstone, sandstone, lenses conglomerate), J (Jurassic marine sedimentary and metasedimentary rocks – Shale, sandstone, minor conglomerate, chert, slate, limestone), Kjfbf (Middle Jurassic to Early Cretaceous Franciscan Complex – Central Belt, Broken formation), Kjfrc (Middle Jurassic to Early Cretaceous Franciscan Complex – Central Belt, Redwood Creek Schist), cwr (Middle Jurassic to Early Cretaceous Franciscan Complex – Central Belt, White Rock Metasandstone),

Type 6: Mesozoic Bedrock. Units include: Kjfmc/Kjfs (Jurassic to Cretaceous Franciscan Complex – Eastern Belt, Blueschist and semi-schist), Mv (Paleozoic to Mesozoic Volcanic Rock), Pz/um (Jurassic Rattlesnake Creek terrane – volcanic rocks; Mesozoic ultramafic rock – serpentine, peridotite, gabbro, and diabase), Kjf/gs (Jurassic to Cretaceous Franciscan Complex – Central Belt, Cretaceous and Jurassic sandstone with smaller amounts of shale, chert, limestone, and conglomerate; includes Franciscan mélange, gs = greenstone block).

SI-4.1.2 Results

Figure 1 is a map showing the geodetic sites colored relative to geology type. We plot vertical land motion rates, south to north, with symbols relative to the geology type (**Figure 1B**).

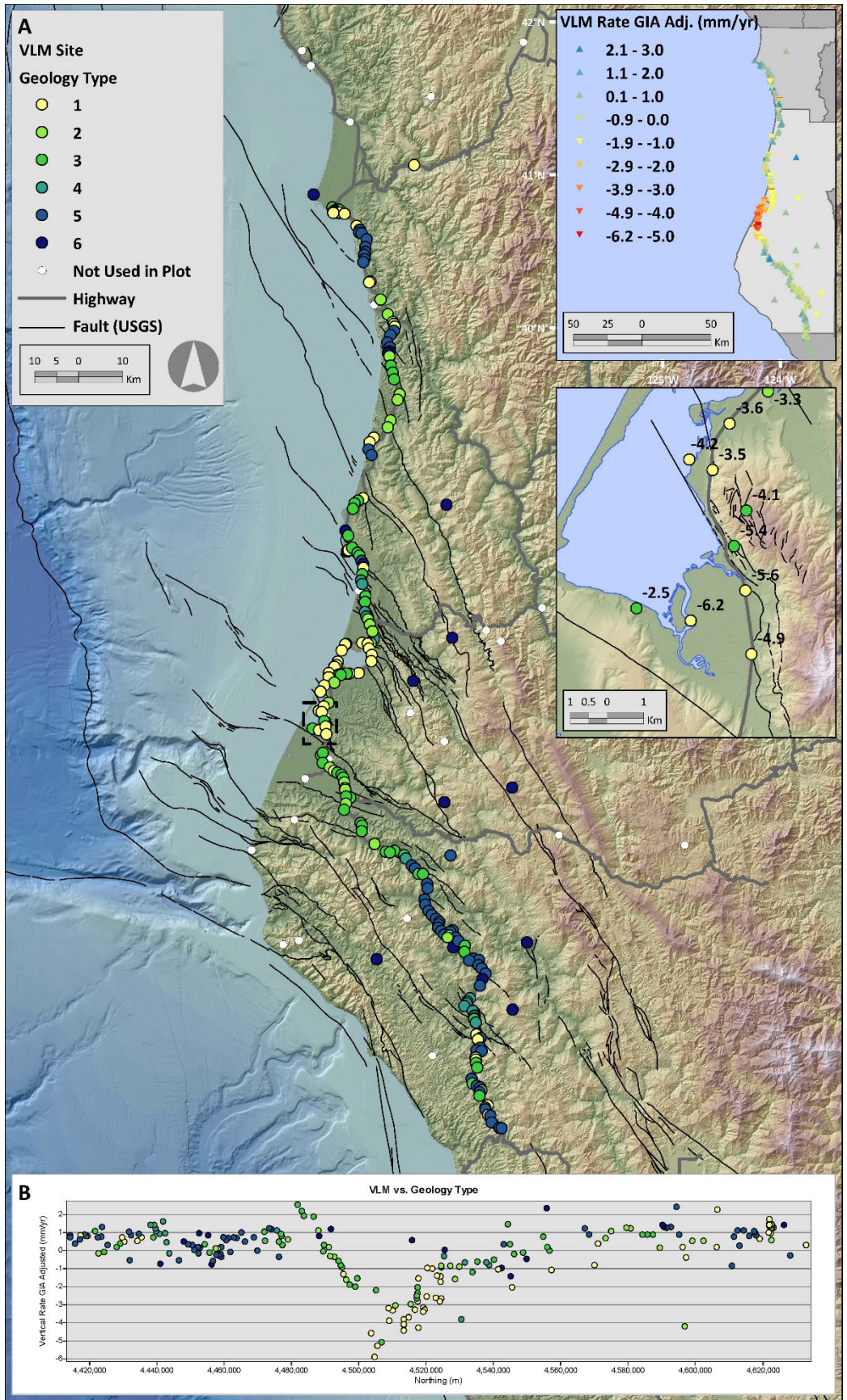


Figure SI-4-1. (previous page) Vertical Land Motion vs. Geology Type. (A) Map showing VLM sites plotted in Figure 5 colored relative to the geology type. (B) Sites plotted using colors from A are shown here with VLM rates on the vertical axis and Northing (meters) on the horizontal axis.

SI-4.1.3 Discussion

We present one comparison example. In the south Humboldt Bay region, there exist benchmarks along highway 101 (inset map, **Figure 1**). Some sites are located in areas mapped as Type 1: Quaternary sediments (e.g., estuarine mud) and some are located in areas mapped as Type 3: late Tertiary sedimentary rock (e.g., Wildcat Formation). In the inset map for this area, the benchmarks with VLM rates of -4.03 and -3.33 mm/yr are in Type 1 materials (bay mud) and the benchmark with the rate of -3.86 is in Type 3 materials (Wildcat Formation). There are two sites (-1.94 and -1.59 mm/yr) that are also in Type 3 materials, but they are on the hanging wall of the Little Salmon fault (LSF), while the site (-3.86 mm/yr) is in the footwall of the LSF.

SI-4.2 Confidence Index

We use the National Geodetic Survey (NGS) website to evaluate the confidence for each VLM site and create a confidence index (CI) from 0-14. Sites with lower numbers are in locations with lower confidence. These may include box or other

types of culverts. Sites with higher numbers are in locations with greater confidence, such as a bedrock knocker.

SI-4.2.1 Methods

The NGS assess all monuments for their relative stability using an index scale from 0-4, where 0 is least stable and 4 is more stable. We refine this stability index by considering the materials for which the monument is embedded, as well as the geological index from the previous section. As for the geological index, this confidence index is qualitative.

The confidence scale includes the following materials used to embed the monuments.

CI-0: campaign GPS sites (not really unstable, but the uncertainty is very large due to the paucity of observations)

CI-1-4: unknown material, catch basin, sign foundation, concrete slab, concrete post

CI-5: piling, concrete wall, concrete post, culvert headwall, concrete basin, runway foundation, concrete headwall

CI-6: pier piling, concrete post, concrete headwall, concrete wall, road curb, bridge curb, catch basin, concrete seawall, unknown, runway foundation

CI-7: bridge piling, steel rod, culvert headwall, bridge, catch basin, bridge abutment, bridge

CI-8: pier piling, concrete slab, unknown, bridge curb, culvert headwall, bridge, concrete post, concrete slab, unknown

CI-9: bedrock GPS, catch basin, culvert headwall, concrete slab, road curb

CI-10: bedrock GPS, bedrock, culvert headwall, bridge curb, bridge, boulder, culvert headwall, granite slab, concrete foundation, bridge abutment, concrete post

CI-11: bridge abutment

CI-12: bedrock GPS, bridge abutment, bridge, bedrock

CI-13: bridge abutment, bedrock

CI-14: bedrock GPS, bedrock

SI-4.2.2 Results

Figure 2 is a map showing the geodetic sites colored relative to confidence index.

We plot vertical land motion rates, south to north, with symbols relative to the confidence index (**Figure 2B**).

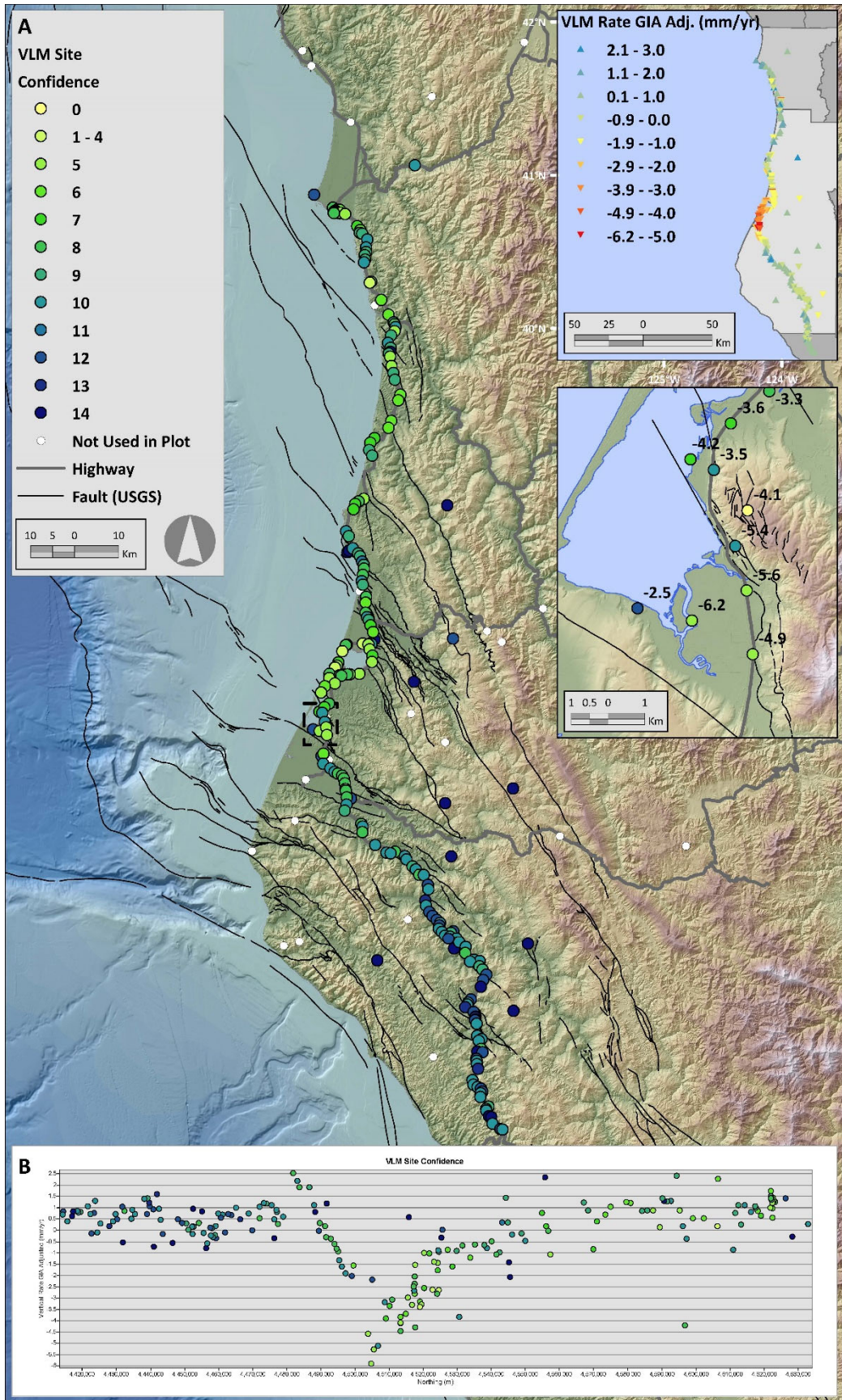


Figure SI-4-2. (previous page) Vertical Land Motion vs. Confidence Index. (A) Map showing VLM sites plotted in Figure 5 colored relative to the Confidence Index. (B) Sites plotted in colors used in A are shown here with VLM rates on the vertical axis and Northing (meters) on the horizontal axis, south to north.

SI-4.2.3 Discussion

Using the same site comparisons as we made for the geologic type, we present some observations in the southern Humboldt Bay area. The absolute CI value is not important as this is a qualitative index. If we consider that the sites with greater confidence are darker blue and the sites with less confidence are lighter green/yellow, we can see that the sites along highway 101 (inset map, **Figure 2**) with VLM rates of -4.03 and -3.33 mm/yr have lesser confidence than the site with the VLM rate of -3.86 mm/yr. While these sites have different confidence indices, the VLM rates don't differ significantly.

Conclusion

These assessments are qualitative. Our observations suggest that geology type and site stability do not appear to control VLM rates. However, our analysis was not comprehensive so that these factors may affect VLM rates.

When additional, more quantitative analyses are conducted using these data, a more quantitative assessment of the geological or site control on monument stability should be considered.

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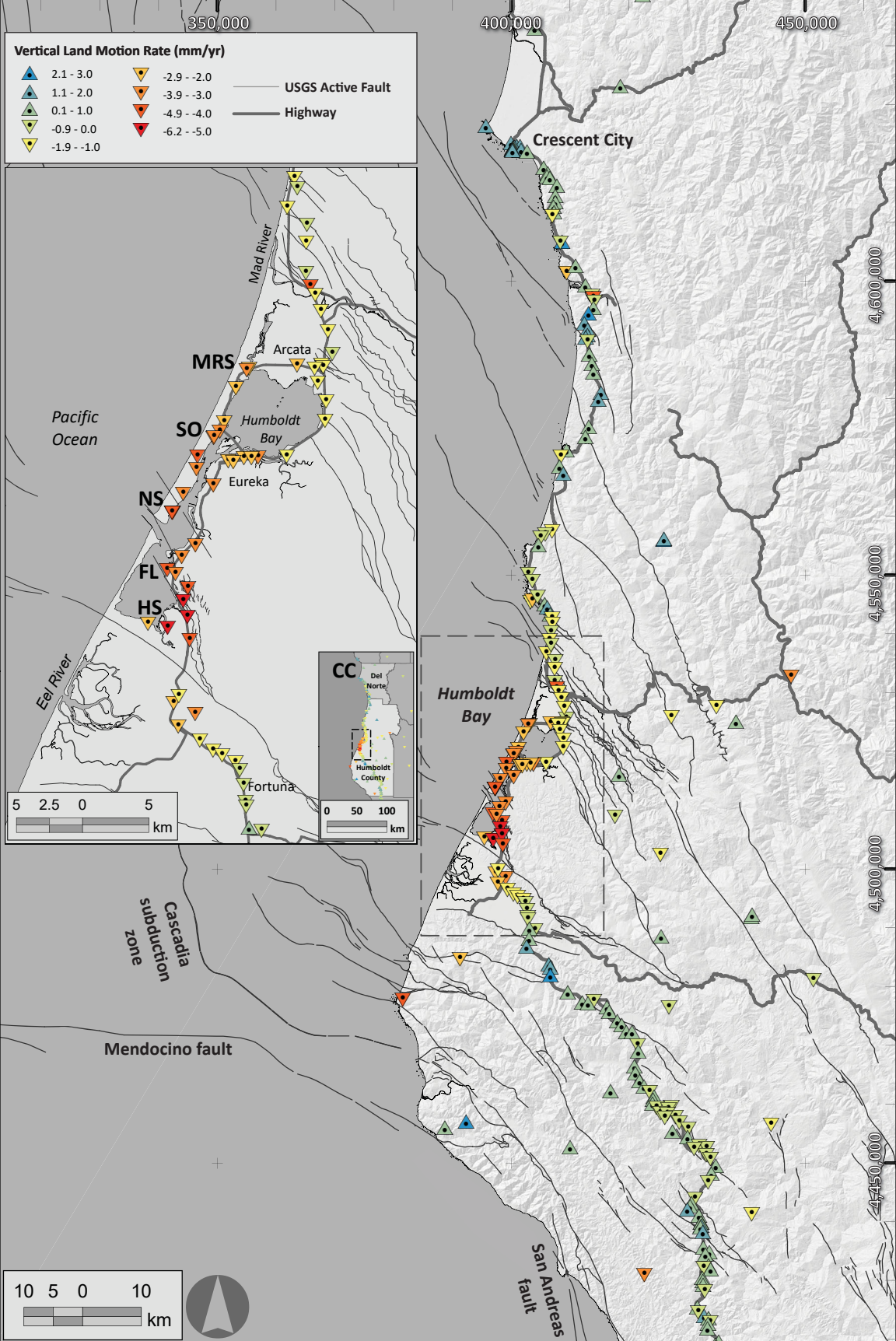
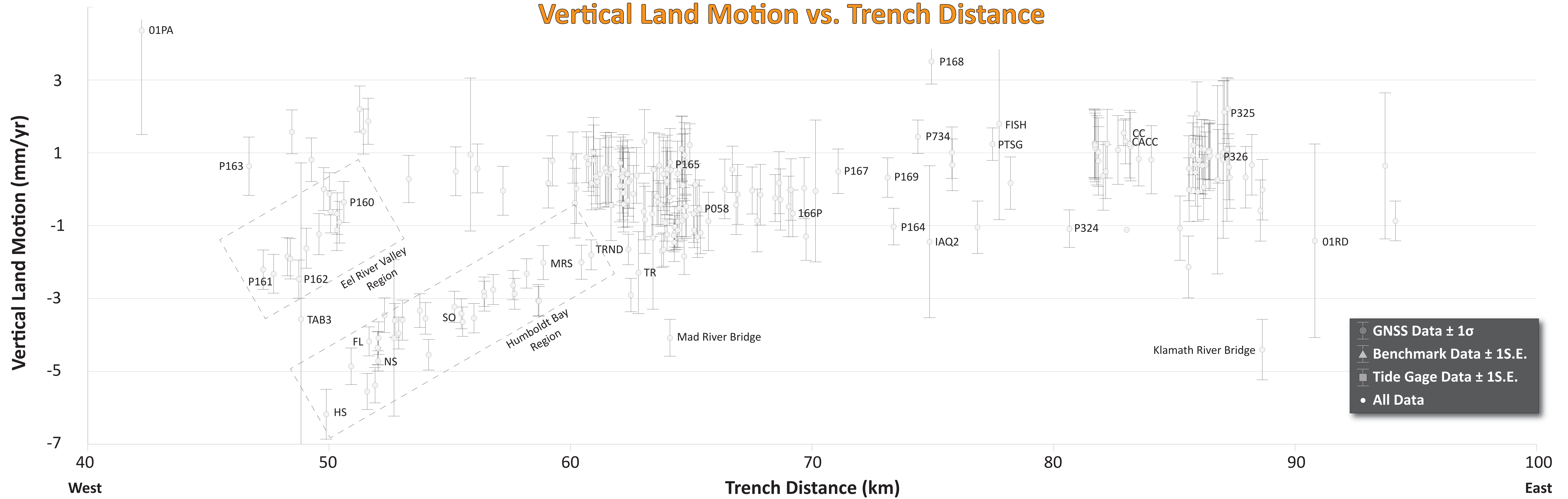


Figure SI-5. Geodetic Results. Vertical land-level change in coastal northernmost California. Vertical land motion rates are symbolized with color relative to rate magnitude. Inverted red triangles represent negative uplift and non-inverted blue triangles represent positive uplift. Northing and Easting coordinates are in the UTM NAD83 Zone 10N, meters, reference frame.

Vertical Land Motion vs. Trench Distance



Vertical Land Motion vs. Latitude

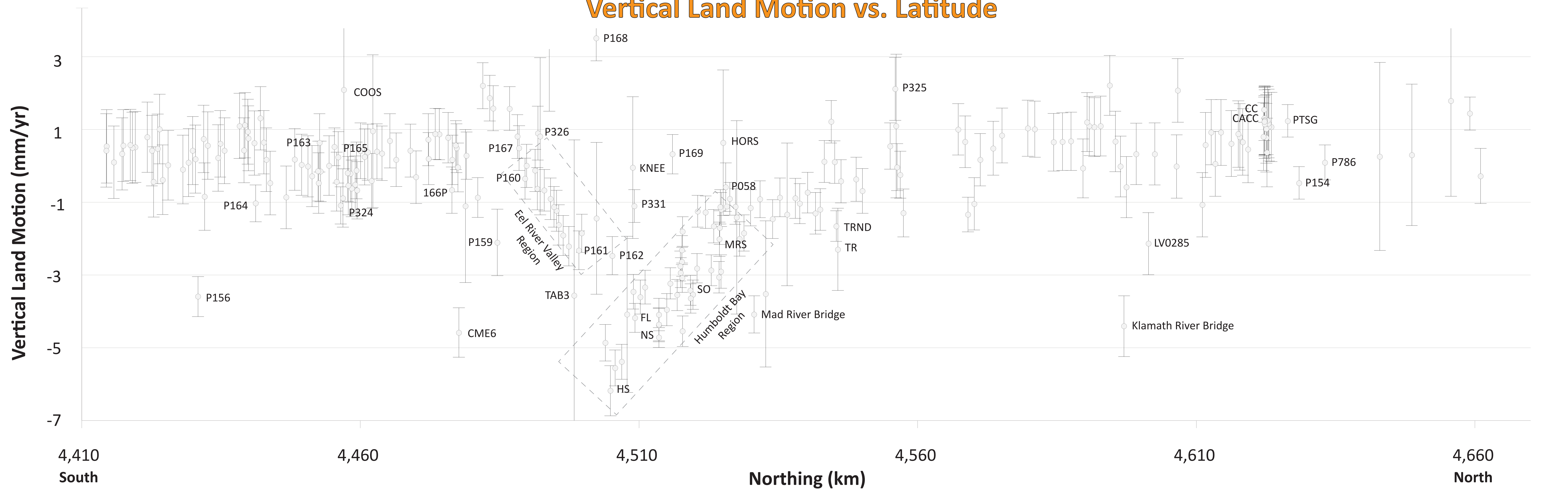


Figure SI-6. Spatial Variation in Vertical Land Motion. Summary of vertical land-level change in the coastal northernmost California plotted for GNSS, tide gage, and benchmark level sites. Standard error uncertainty is plotted for data used in these analyses. Sites with large uncertainty and sites that are not very close to Highway 101 are included. (A) VLM rates (mm/year) plotted relative to horizontal distance (in kilometers) to the CSZ trench, west to east. Only coastal GNSS data are included. Some geodetic sites are labeled. (B) VLM rates (mm/year) plotted relative to distance in kilometers (UTM NAD83 Zone 10 N), south to north.