

Attachment I-1: Seismic Information

APPENDIX C UNIFORM BUILDING CODE SEISMIC ZONE MAP

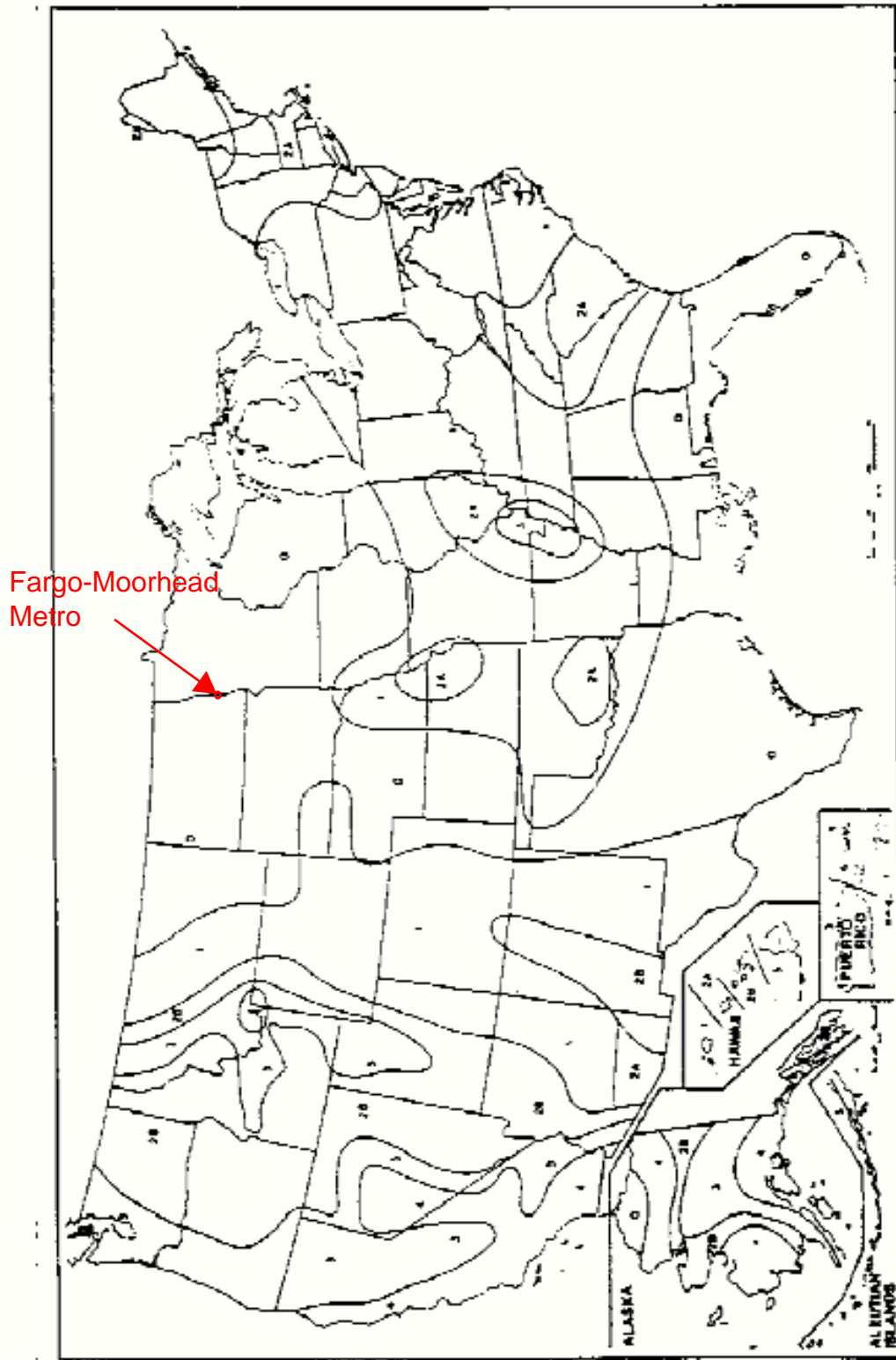
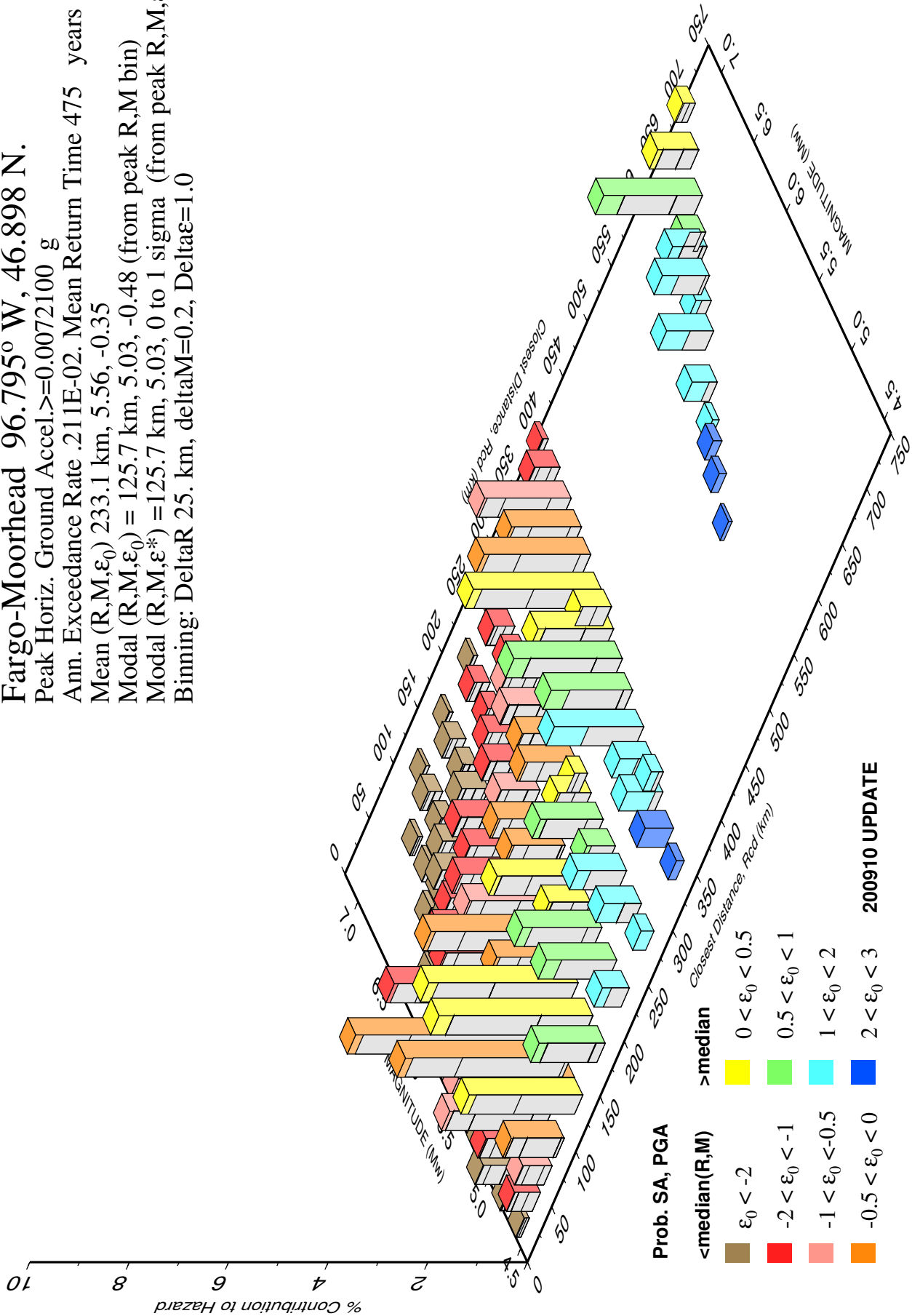
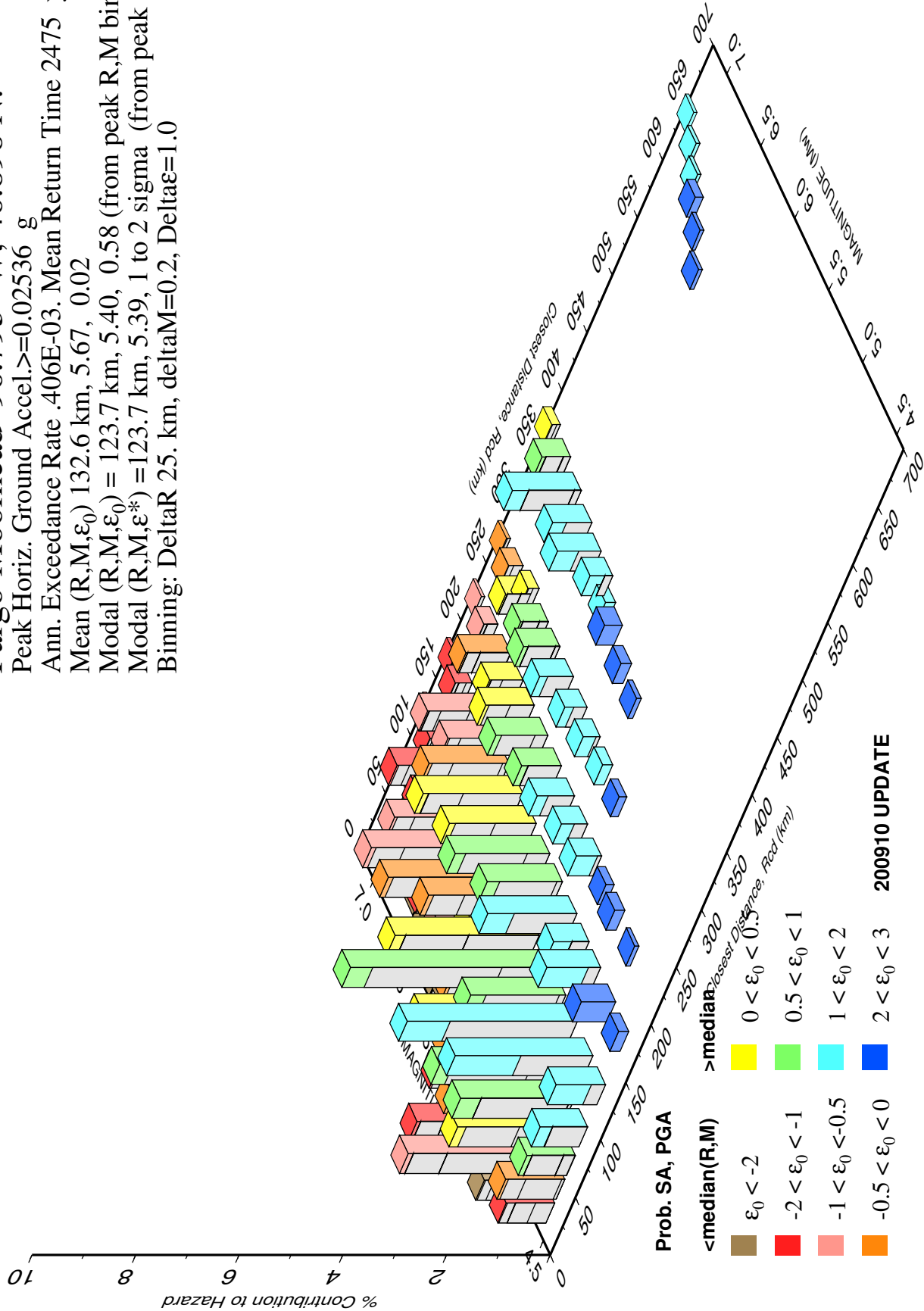


Figure C-1. Seismic zone map of the United States

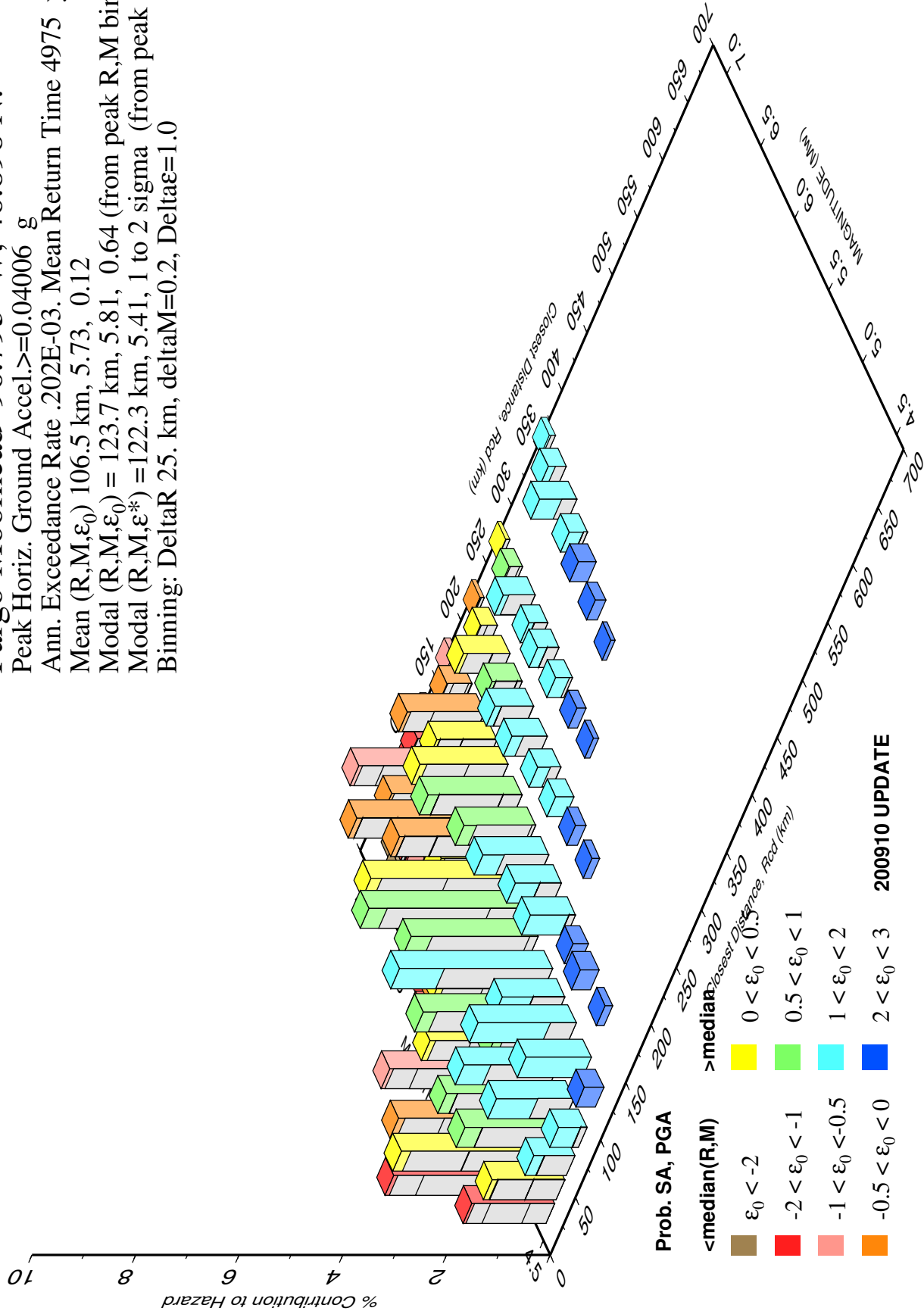
PSH Deaggregation on NEHRP BC rock
 Fargo-Moorhead 96.795° W, 46.898 N.
 Peak Horiz. Ground Accel. ≥ 0.0072100 g
 Ann. Exceedance Rate .211E-02. Mean Return Time 475 years
 Mean (R,M, ϵ_0) 233.1 km, 5.56, -0.35
 Modal (R,M, ϵ_0) = 125.7 km, 5.03, -0.48 (from peak R,M bin)
 Modal (R,M, ϵ^*) = 125.7 km, 5.03, 0 to 1 sigma (from peak R,M, ϵ bin)
 Binning: DeltaR 25. km, deltaM=0.2, Delta ϵ =1.0



PSH Deaggregation on NEHRP BC rock
 Fargo-Moorhead 96.795° W, 46.898 N.
 Peak Horiz. Ground Accel. ≥ 0.02536 g
 Ann. Exceedance Rate .406E-03. Mean Return Time 2475 years
 Mean (R,M, ϵ_0) 132.6 km, 5.67, 0.02
 Modal (R,M, ϵ_0) = 123.7 km, 5.40, 0.58 (from peak R,M bin)
 Modal (R,M, ϵ_0^*) = 123.7 km, 5.39, 1 to 2 sigma (from peak R,M, ϵ bin)
 Binning: DeltaR 25. km, deltaM=0.2, Delta ϵ =1.0



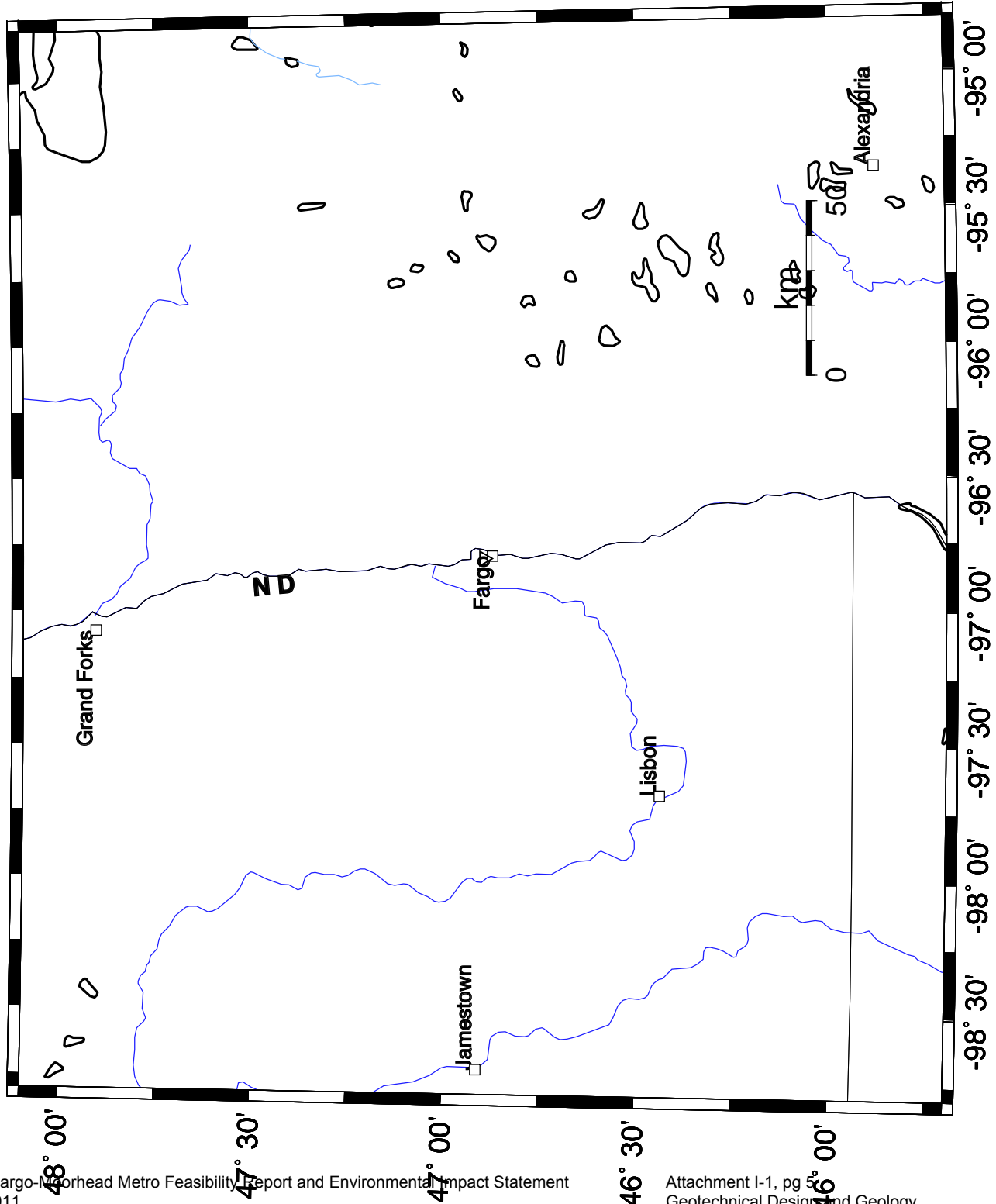
PSH Deaggregation on NEHRP BC rock
 Fargo-Moorhead 96.795° W, 46.898 N.
 Peak Horiz. Ground Accel. ≥ 0.04006 g
 Ann. Exceedance Rate .202E-03. Mean Return Time 4975 years
 Mean (R,M, ϵ_0) 106.5 km, 5.73, 0.12
 Modal (R,M, ϵ_0) = 123.7 km, 5.81, 0.64 (from peak R,M bin)
 Modal (R,M, ϵ^*) = 122.3 km, 5.41, 1 to 2 sigma (from peak R,M, ϵ bin)
 Binning: DeltaR 25. km, deltaM=0.2, Delta ϵ =1.0



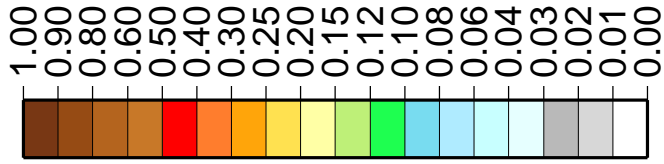
Probability of earthquake with M > 5.0 within 50 years & 50 km

U.S. Geological Survey 2009 PSHA Model

Site: -96.80 d E 46.90



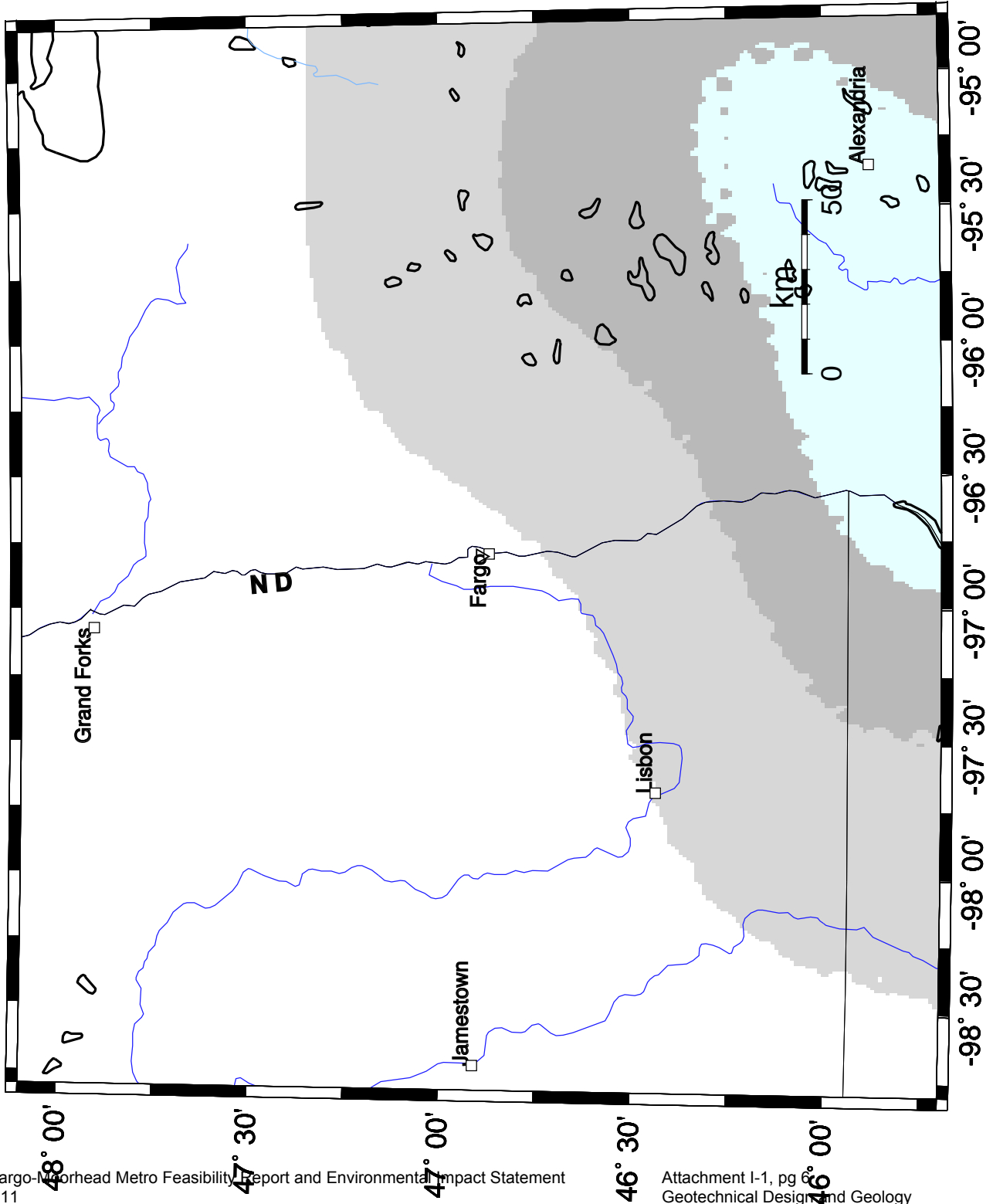
Probability



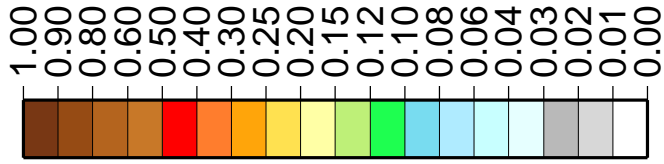
Probability of earthquake with M > 5.0 within 250 years & 50 km

U.S. Geological Survey 2009 PSHA Model

Site: -96.80 d E 46.90



Probability



Project: Fargo-Moorhead Metro Feasibility Study
 Subject: Significant Earthquake Events within 1000 Kilometers of Fargo-Moorhead
 Compiled By: KAH Revised By: KAH
 Date: 13-Aug Date Revised: 16-Aug

NEIC: Earthquake Search Results
 U. S. GEOLOGICAL SURVEY
 EARTHQUAKE DATA BASE
 FILE CREATED: Fri Aug 13 15:37:41 2010

Circle Search
 Circle Center Point Latitude: 46.898N Longitude: 96.795W
 Radius: 1000.000 km
 Catalog Used: USHS & PED
 Data Selection: Significant U.S. Earthquakes (USHS) & Historical & Preliminary Data (PED)
 Website: http://earthquake.usgs.gov/earthquakes/eqarchives/epic/epic_circ.php

**** Table sorted by largest earthquake to smallest**

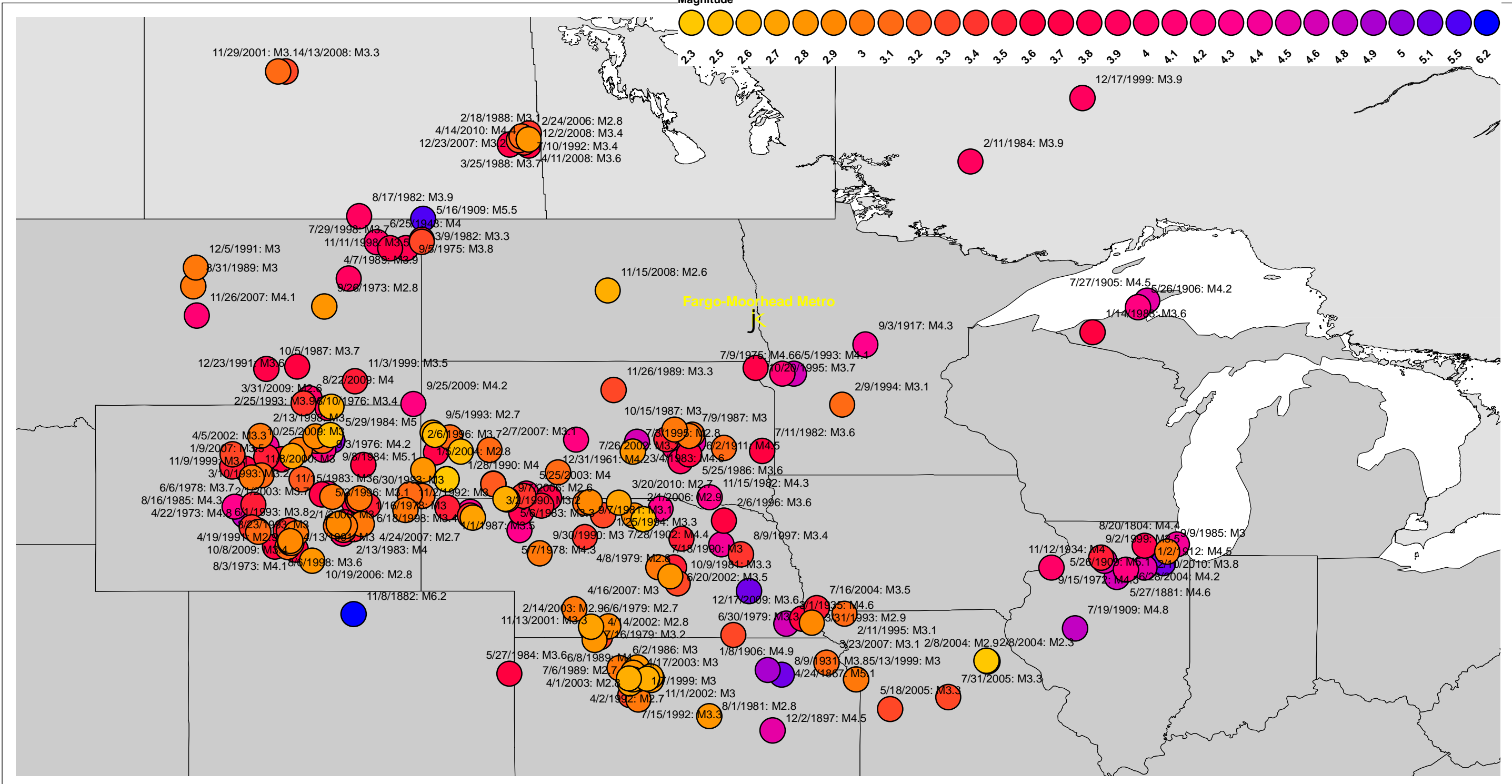
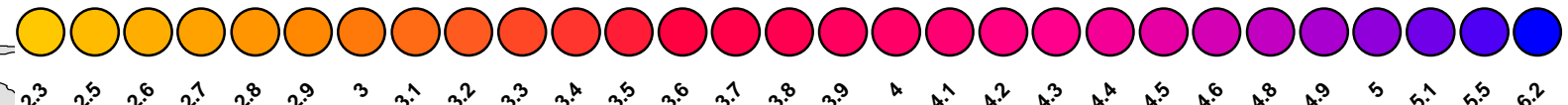
No.	Catalog Source	Date				Coordinates		Depth	Magnitudes	Type	Radial Dist	
		Year	Month	Day	Time	Lat	Long	(km)			(km)	(miles)
5	USHIS	1882	11	8	130	40.5	-105.5		6.2	FAKRK	997	620
12	USHIS	1909	5	16	415	49	-104		5.5	LgEPB	586	364
62	PDE	1984	10	18	153023.1	42.38	-105.72	33	5.5	MLGOL	867	539
2	USHIS	1867	4	24	2022	39.2	-96.3		5.1	FABAR	855	531
3	USHIS	1877	11	15	1745	41	-97		5.1	FASC	655	407
13	USHIS	1909	5	26	1442	41.6	-88.1		5.1	FASC	909	565
61	PDE	1984	9	8	5931.1	44.24	-106.02	20	5.1	mbGS	777	483
60	PDE	1984	5	29	201832.7	44.23	-105.96	18	5	mbGS	774	481
9	USHIS	1906	1	8	15	39.3	-96.6		4.9	FABAR	844	524
14	USHIS	1909	7	19	434	40.2	-90		4.8	FASC	923	574
28	PDE	1973	4	22	60712.4	42.63	-107.85	33	4.8	mbGS	993	617
4	USHIS	1881	5	27		41.3	-89.1		4.6	FASC	874	543
21	USHIS	1935	3	1	11	40.3	-96.2		4.6	FASC	734	456
34	PDE	1975	7	9	145415.1	45.67	-96.04	10	4.6	mbGS	148	92
55	PDE	1983	3	4	63218.69	44.21	-99.41	5	4.6	LgTUL	361	224
6	USHIS	1897	12	2	710	38	-96.5		4.5	FABAR	988	614
8	USHIS	1905	7	27	20	47.24	-88.45		4.5	FASC	634	394
15	USHIS	1911	6	2	2234	44.2	-98.2		4.5	FABAR	319	198
16	USHIS	1912	1	2	1621	41.5	-88.5		4.5	FASC	893	555
25	USHIS	1964	3	28	100846.5	43	-101.8	30	4.5	LgDG	586	364
27	USHIS	1972	9	15	52215.9	41.65	-89.37	11	4.5	LgDG	831	516
1	USHIS	1804	8	20	2010	42	-87.8		4.4	FASC	898	558
7	USHIS	1902	7	28	18	42	-97.6		4.4	FASC	547	340
32	PDE	1974	9	19	153611.4	44.11	-107.38	10	4.4	mbGS	882	548
219	PDE-W	2010	4	14	165346.6	50.83	-101.74	1	4.4	MLPGC	568	353
17	USHIS	1917	9	3	2130	46.3	-94.5		4.3	FASC	187	116
19	USHIS	1934	7	30	720	42.7	-103		4.3	FASC	676	420
40	PDE	1978	5	7	160619.6	42.3	-101.93	15	4.3	MLGS	652	405
53	PDE	1982	11	15	25822.93	43.01	-97.85	5	4.3	LgTUL	440	273
73	PDE	1985	8	16	60522.67	42.81	-108.06	10	4.3	MLGS	998	620
168	PDE	2002	11	3	204156.9	42.77	-98.9	5	4.3	LgGS	487	303
11	USHIS	1906	5	26	1442	47.1	-88.64		4.2	FASC	620	385
24	USHIS	1961	12	31	163605.8	44.25	-100.72	23	4.2	FASC	424	263
38	PDE	1976	9	3	41816.2	44.04	-106.15	10	4.2	MLGS	797	495
63	PDE	1984	10	18	155737.4	42.37	-105.81	33	4.2	MLGOL	873	542
141	PDE	1996	10	19	132758	43.09	-106.06	5	4.2	MLGS	843	524
181	PDE	2004	6	28	61052.17	41.46	-88.9	10	4.2	MwSLM	872	542
212	PDE-W	2009	9	25	151134.1	45.02	-104.21	4	4.2	MLBUT	611	380
23	USHIS	1946	7	23	645	44.1	-98.6		4.1	FASC	341	212
29	PDE	1973	8	3	214752	41.95	-106.8	0	4.1	mbGS	966	600
122	PDE	1993	6	5	12453	45.67	-96.29	10	4.1	LgOTT	141	88
202	PDE	2007	11	26	62732	46.92	-108.87	1	4.1	MLBUT	919	571

No.	Catalog Source	Date				Coordinates		Depth	Magnitudes	Type	Radial Dist	
		Year	Month	Day	Time	Lat	Long	(km)			(km)	(miles)
20	USHIS	1934	11	12	1445	41.5	-90.5		4	FASC	782	486
22	USHIS	1943	6	25	425	48.5	-105		4	LgEPB	640	398
54	PDE	1983	2	13	134444.1	42.23	-105.73	5	4	MLGS	877	545
91	PDE	1989	6	8	181843.4	39.17	-99.48	5	4	LgGS	886	551
97	PDE	1990	1	28	45959.19	43.31	-102.5	5	4	LgTUL	600	373
174	PDE	2003	5	25	73233.39	43.09	-101.79	5	4	LgGS	578	359
211	PDE-W	2009	8	22	154852	45.14	-106.45	13	4	MLBUT	772	480
52	PDE	1982	8	17	44925	49.06	-105.38	18	3.9	LgPGC	684	425
58	PDE	1984	2	11	112641	50.23	-92.24	18	3.9	LgOTT	500	311
90	PDE	1989	4	7	82648.91	47.72	-105.6	5	3.9	MLBUT	671	417
101	PDE	1990	10	25	62525.54	43.79	-98.47	5	3.9	LgTUL	369	229
118	PDE	1993	2	25	34415.54	44.93	-106.06	5	3.9	MLBUT	750	466
155	PDE	1999	12	17	210000.1	51.6	-89.84	18	3.9	LgOTT	727	452
18	USHIS	1931	8	9	61837	39.1	-94.7		3.8	FABAR	882	548
35	PDE	1975	9	5	204740.7	48.37	-104.38	5	3.8	MLLAO	593	368
64	PDE	1984	10	18	173827.4	42.41	-105.77	33	3.8	MLGOL	867	539
89	PDE	1989	2	9	51545.8	42.69	-101.9	5	3.8	LgGS	617	383
92	PDE	1989	6	16	145353.1	39.14	-99.46	5	3.8	LgGS	888	552
121	PDE	1993	6	1	213322.9	42.3	-107.57	5	3.8	MLGS	995	618
184	PDE	2004	8	29	184944.3	42.89	-105.49	5	3.8	MLGS	817	508
217	PDE-W	2010	2	10	95935.14	41.97	-88.5	10	3.8	MwSLM	857	533
10	USHIS	1906	5	10	27	43	-101.3		3.7	FASC	560	348
41	PDE	1978	6	6	212334.7	43.63	-107.83	5	3.7	MLGS	937	582
80	PDE	1987	10	5	185449.3	45.77	-107.38	5	3.7	MLBUT	824	512
84	PDE	1988	3	25	221400.6	50.6	-102.14	1	3.7	LgOTT	568	353
124	PDE	1993	7	23	63023.84	42.48	-105.7	5	3.7	MLGS	859	534
127	PDE	1993	10	10	41746.76	42.42	-105.87	5	3.7	MLGS	873	542
136	PDE	1995	10	20	155718.7	45.79	-96.86	5	3.7	LgOTT	123	76
138	PDE	1996	2	6	160836.8	43.98	-103.73	5	3.7	LgGS	631	392
139	PDE	1996	4	9	24808.19	43.07	-104.1	5	3.7	LgGS	715	444
147	PDE	1998	7	29	33158.93	48.37	-104.71	5	3.7	LgGS	616	383
170	PDE	2003	2	1	184411.5	43.08	-106.18	5	3.7	MLGS	852	529
30	PDE	1973	8	10	204728.6	41.89	-106.74	0	3.6	mbGS	966	600
51	PDE	1982	7	11	194228.5	44.01	-96.72	5	3.6	LgTUL	321	199
59	PDE	1984	5	27	233019.3	39.22	-102.15	5	3.6	MLGOL	957	595
75	PDE	1986	5	25	71322.13	43.94	-98.29	5	3.6	LgTUL	349	217
82	PDE	1988	1	14	172336.6	46.56	-89.62	5	3.6	LgGS	549	341
85	PDE	1988	4	14	93931.47	39.09	-99.15	5	3.6	LgGS	887	551
109	PDE	1991	12	23	203227.3	45.82	-106.71	5	3.6	MLBUT	772	480
114	PDE	1992	8	31	14014.21	43.83	-107.04	5	3.6	MLGS	871	541
117	PDE	1993	2	24	235217.6	43.71	-105.29	0	3.6	MLGS	753	468
137	PDE	1996	2	6	151028.3	42.51	-97.54	5	3.6	LgGS	490	304
148	PDE	1998	8	6	182207.1	41.95	-107.19	10	3.6	MLGS	992	616
204	PDE	2008	4	11	20029.68	50.58	-101.74	1	3.6	LgOTT	547	340
216	PDE-W	2009	12	17	25342.52	40.41	-95.86	5	3.6	LgGS	725	450
33	PDE	1975	5	13	75338.5	42.12	-98.45	10	3.5	LgSLM	547	340
36	PDE	1975	12	19	232619.5	42.85	-107.65	0	3.5	MLERDA	967	601
66	PDE	1984	10	20	115108.6	42.4	-105.87	33	3.5	MLGS	875	544
78	PDE	1987	1	1	80224.07	42.79	-103.48	5	3.5	LgGS	698	434
104	PDE	1991	5	30	220744	39.2	-99.4	5	3.5	LgTUL	880	547
116	PDE	1993	2	20	130810.2	42.83	-101.46	5	3.5	LgGS	583	362
128	PDE	1993	11	16	72604.03	43.88	-107.38	5	3.5	MLGS	893	555
129	PDE	1993	12	13	145103.1	42.33	-105.5	5	3.5	MLGS	856	532
149	PDE	1998	11	11	115937.6	48.55	-104.03	5	3.5	LgPGC	572	355
152	PDE	1999	9	2	161729.7	41.72	-89.43	5	3.5	LgGS	821	510
153	PDE	1999	11	3	132852	45.51	-105.47	10	3.5	MLGS	686	426
164	PDE	2002	6	20	42940.32	41.51	-98.62	5	3.5	LgGS	616	383
175	PDE	2003	11	21	10911.63	44.26	-98.78	5	3.5	LgGS	331	206
180	PDE	2004	2	15	31818.02	42.94	-105.4	10	3.5	MLGS	809	503
182	PDE	2004	7	16	121730.7	40.63	-95.55	5	3.5	MwSLM	703	437

No.	Catalog Source	Date				Coordinates		Depth	Magnitudes	Type	Radial Dist	
		Year	Month	Day	Time	Lat	Long	(km)			(km)	(miles)
183	PDE	2004	8	13	11924.36	42.29	-106.96	5	3.5	MLGS	954	593
197	PDE	2007	1	9	101040.1	43.67	-108.11	5	3.5	MLGS	956	594
207	PDE	2008	11	3	131412.5	42.83	-105.18	5	3.5	MwRMT	801	498
37	PDE	1976	8	10	135457.5	45.03	-106.57	5	3.4	MLGS	785	488
48	PDE	1981	9	13	221629.7	43.04	-101.85	5	3.4	LgTUL	585	364
94	PDE	1989	7	13	183522.9	39.17	-99.47	5	3.4	LgGS	885	550
105	PDE	1991	8	26	114915.4	42.16	-100.53	5	3.4	LgTUL	604	375
112	PDE	1992	7	10	144443	50.64	-101.84	1	3.4	LgPGC	557	346
142	PDE	1996	12	11	35544	42.37	-107.69	5	3.4	MLGS	999	621
143	PDE	1997	8	9	174604	41.79	-97.18	5	3.4	LgGS	567	352
145	PDE	1998	6	18	162638.3	42.62	-103	5	3.4	LgGS	683	424
209	PDE	2008	12	2	102214.7	50.84	-101.73	1	3.4	LgPGC	568	353
213	PDE-W	2009	10	8	225558.1	42.3	-106.89	5	3.4	MLGS	948	589
44	PDE	1979	6	30	204639.3	40.05	-97.34	5	3.3	UKGS	762	473
49	PDE	1981	10	9	215427.9	41.17	-98.54	5	3.3	LgTUL	651	405
50	PDE	1982	3	9	131050.1	48.51	-104.03	18	3.3	LgPGC	571	355
56	PDE	1983	5	6	61446.95	42.96	-102.2	5	3.3	MLGS	611	380
65	PDE	1984	10	19	162904.4	42.41	-105.77	33	3.3	MLGS	868	539
70	PDE	1984	11	6	113852.5	42.31	-105.71	33	3.3	MLGS	871	541
72	PDE	1984	12	17	93132.24	42.36	-105.73	33	3.3	MLGS	869	540
96	PDE	1989	11	26	10614.67	45.32	-99.91	5	3.3	LgGS	297	185
113	PDE	1992	7	15	25640.75	38.76	-99.55	5	3.3	LgTUL	931	578
130	PDE	1994	1	25	24439.83	42.63	-100.14	5	3.3	LgGS	543	337
158	PDE	2000	4	13	181731.7	42.41	-105.81	5	3.3	MLGS	871	541
160	PDE	2001	11	13	15613.13	40	-100.21	5	3.3	LgGS	814	506
162	PDE	2002	4	5	11848.2	43.94	-108.1	5	3.3	MLGS	942	585
185	PDE	2005	5	18	195942.9	38.46	-93.97	5	3.3	LgGS	965	600
186	PDE	2005	7	31	70707.97	38.72	-92.72	5	3.3	LgSLM	967	601
205	PDE	2008	4	13	21028.1	52.17	-106.96	1	3.3	MLPGC	939	583
45	PDE	1979	7	16	347.3	40.18	-100.38	5	3.2	UKTUL	799	496
68	PDE	1984	10	24	90354.78	42.32	-105.72	21	3.2	MLGS	870	541
98	PDE	1990	3	2	41527	43.3	-102.5	5	3.2	MLGS	600	373
119	PDE	1993	3	10	35431.17	43.4	-106.62	5	3.2	MLGS	863	536
194	PDE	2006	8	29	114653.7	44.22	-106.29	5	3.2	MLGS	798	496
203	PDE	2007	12	23	155441.1	50.69	-101.95	1	3.2	LgPGC	566	352
26	USHIS	1966	6	26	115943.1	44.3	-103.43	2	3.1	LgBAR	592	368
47	PDE	1981	9	7	3809.12	42.89	-100.52	5	3.1	LgTUL	533	331
67	PDE	1984	10	22	111756.3	42.4	-105.88	33	3.1	MLGS	876	544
83	PDE	1988	2	18	52705.5	50.77	-101.89	0	3.1	LgOTT	570	354
108	PDE	1991	12	18	213647.9	41.94	-106.92	5	3.1	MLGS	975	606
131	PDE	1994	2	9	84535.58	45	-95	5	3.1	LgGS	252	157
134	PDE	1995	2	11	55410.16	40.51	-94.95	5	3.1	LgGS	725	450
140	PDE	1996	5	3	74751.53	43.04	-104.02	5	3.1	LgGS	712	442
146	PDE	1998	7	12	162849.6	43.55	-101.11	5	3.1	LgGS	502	312
154	PDE	1999	11	9	81741.19	43.48	-107.48	5	3.1	MLGS	920	572
161	PDE	2001	11	29	73526.36	52.17	-107.12	5	3.1	LgPGC	948	589
165	PDE	2002	7	26	83217.21	44.36	-98.22	5	3.1	LgOTT	302	188
187	PDE	2005	10	19	24346.14	44.08	-97.54	5	3.1	LgGS	318	198
190	PDE	2005	12	25	141508.7	42.27	-107.55	5	3.1	MLGS	995	618
193	PDE	2006	8	17	164058.3	44.22	-106.17	5	3.1	LgGS	789	490
198	PDE	2007	2	7	103558.7	44.03	-102.58	5	3.1	LgGS	552	343
199	PDE	2007	3	23	81549.84	39.46	-95.34	5	3.1	LgGS	834	518
206	PDE	2008	8	22	230131.8	43.08	-104.29	5	3.1	MLGS	727	452
39	PDE	1978	1	16	35001.7	42.44	-105.32	5	3	MLGS	837	520
57	PDE	1983	11	15	123312.2	43.02	-105.96	5	3	MLGS	840	522
74	PDE	1985	9	9	220631	41.85	-88.01	5	3	LgGS	896	557
76	PDE	1986	6	2	40405.2	39.34	-99.78	5	3	LgGS	873	542
77	PDE	1986	6	12	151434	42.4	-105.69	20	3	MLGS	864	537
79	PDE	1987	7	9	220645.5	44.33	-98.29	10	3	LgGS	308	191
81	PDE	1987	10	15	105433.8	44.47	-98.6	5	3	MLGS	304	189

Legend

Magnitude



US Army Corps of Engineers®

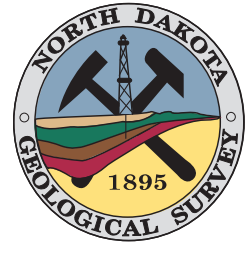
FMMFS_P3_seismic_2010-08.mxd
Printed on 16 AUG 2010

Fargo-Moorhead Metro Feasibility Study

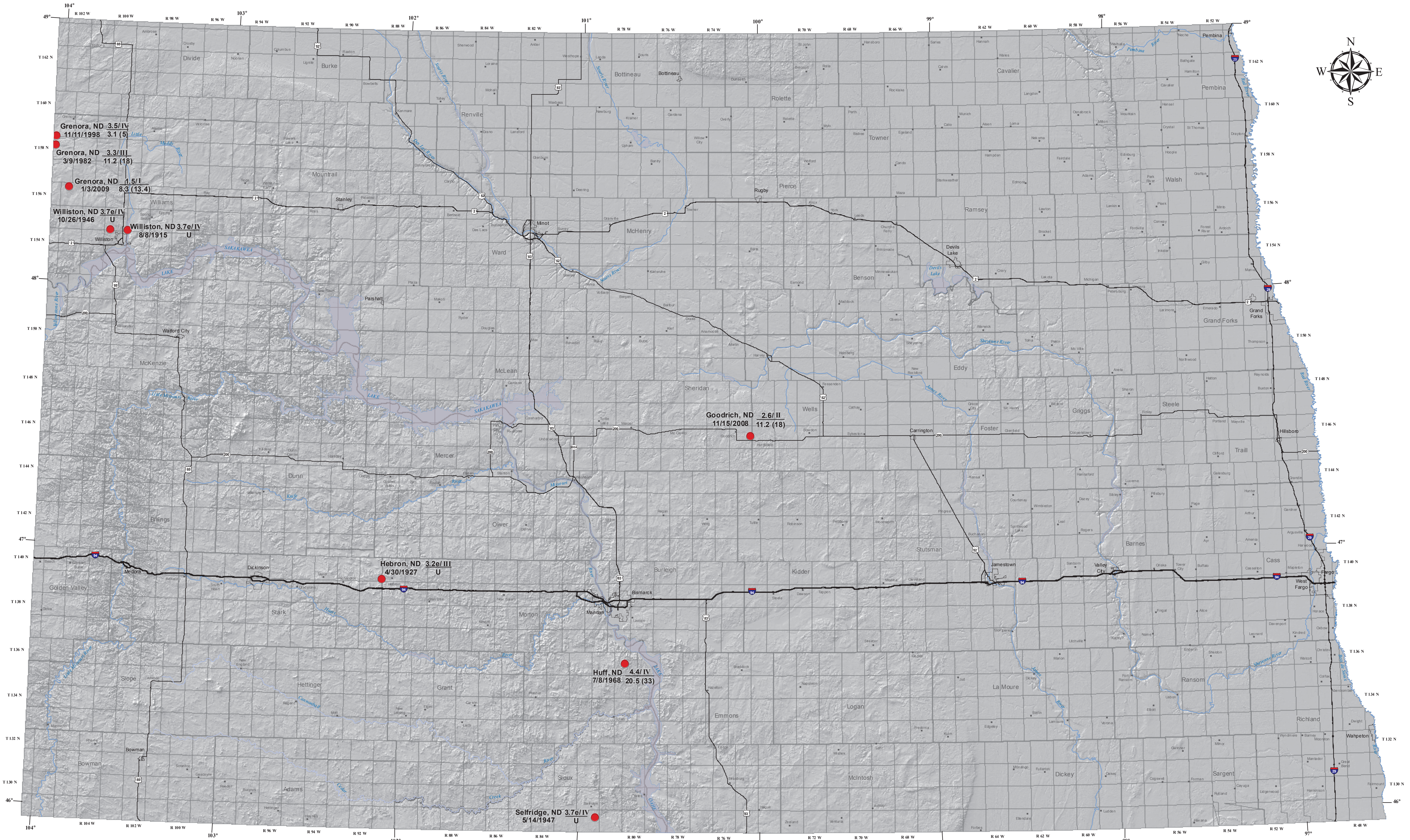
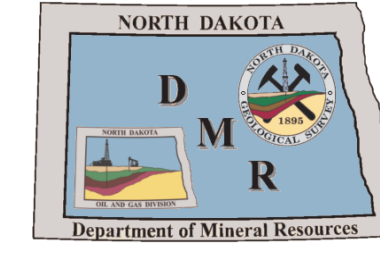
Seismic Events Located with 1000 kilometers of Fargo-Moorhead



1:9,504,000



EARTHQUAKES IN NORTH DAKOTA



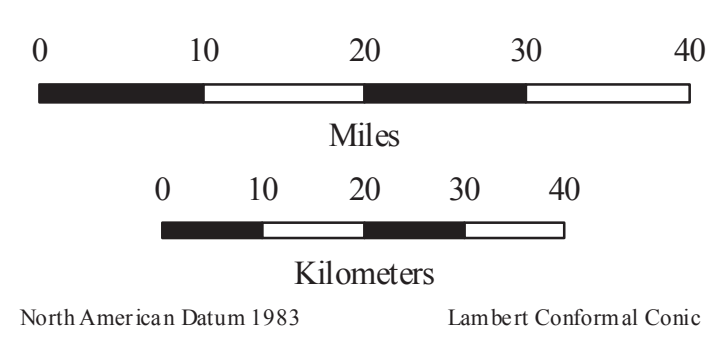
EXPLANATION

- Misc Symbols**
- Water
 - Selected Major Rivers or Creeks
 - County Boundaries
 - Township Boundaries
 - City/Town Boundaries
 - City/Town Locations
 - Interstate Highway
 - US Highway
 - Selected State Highway

EARTHQUAKE INFORMATION

- Nearest City or Town
- Date of Earthquake
- Approximate Location of Earthquake Epicenter
- Earthquake Magnitude Reported
- Modified Mercalli Earthquake Intensity value reported
- Calculated Depth of Earthquake reported in miles and (kilometers)
- U = Undetermined

Scale 1:750,000



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