Earthquake Hazard Mapping for Oregon Communities

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Annual Technical Summary

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Investigations Undertaken

To date our work on this project has consisted of building three-dimensional geologic models for the 29 Oregon urban areas (Figure 1) that are the subject of the project, and collecting in-situ shear wave velocity measurements at each of the study areas.

The geologic models were constructed using existing geologic mapping, air photo interpretation and subsurface data from approximately-located water well logs. Quaternary deposits were isopached for each area, down to a maximum depth of 30m. The resultant models consist of 50 m grids of thickness values for the various Quaternary and bedrock units at each area down to a depth of 30 m. The geologic models are complete, and are currently being reviewed by geologists familiar with the local geology.

SH-wave data was collected using a 12-channel Bison 5000 seismograph with 8-bit instantaneous floating-point and 2048 samples per channel. The data was recorded at a sampling rate between 0.025 and 0.5 ms, depending upon site conditions. The energy source for SH-wave generation was a 1.5 m section of steel I-beam struck by a 4.5-kg sledgehammer horizontally. The geophones used for recording SH-wave data are 30-Hz horizontal component Mark Product geophones. Spacing between the geophones is 3.05 m (10 ft). The walkaway method (Hunter et al., 1984), in which a group of 12 in line geophones remained fixed, and the energy source is "stepped out" through a set of predefined offsets. Depending upon site geological conditions, the offsets of 3.05 (10 ft), 30.5 (100 ft), 61.0 (200 ft), 91.5 (300 ft), 122 (400 ft), and 152.4 m (500 ft) are used. In order to enhance the SH-wave and reduce other phases, 5 ~20 hammer strikes in each site of the steel I-beam are staked and recorded for each offset.

The SH-wave data are processed on a PC computer using the commercial software SIP (Rimrock Geophysics, Inc., 1995). The key step for data process is to identify the refractions from different horizons. Figure 2 shows the composited SH-wave refraction profile generated using VISTA 7.0 (Seismic Image Software Ltd., 1995), from the individual offset records, at site McM03 near Dayton, Oregon. Four refractions, R1, R2, R3, and R4 were identified in the profile. Arrival times of the refractions are picked interactively on the PC using BSIPIK module in SIP. The arrival time data picked from each offset record are edited and combined to generate a data file for velocity model deduction using SIPIN module. Figure 3 shows the arrival times for the refractions identified in the profile. The shear-wave velocity model is generated automatically using SIPT2 module. Figure 4 shows shear-wave velocity model derived from the refraction data at site McM03.

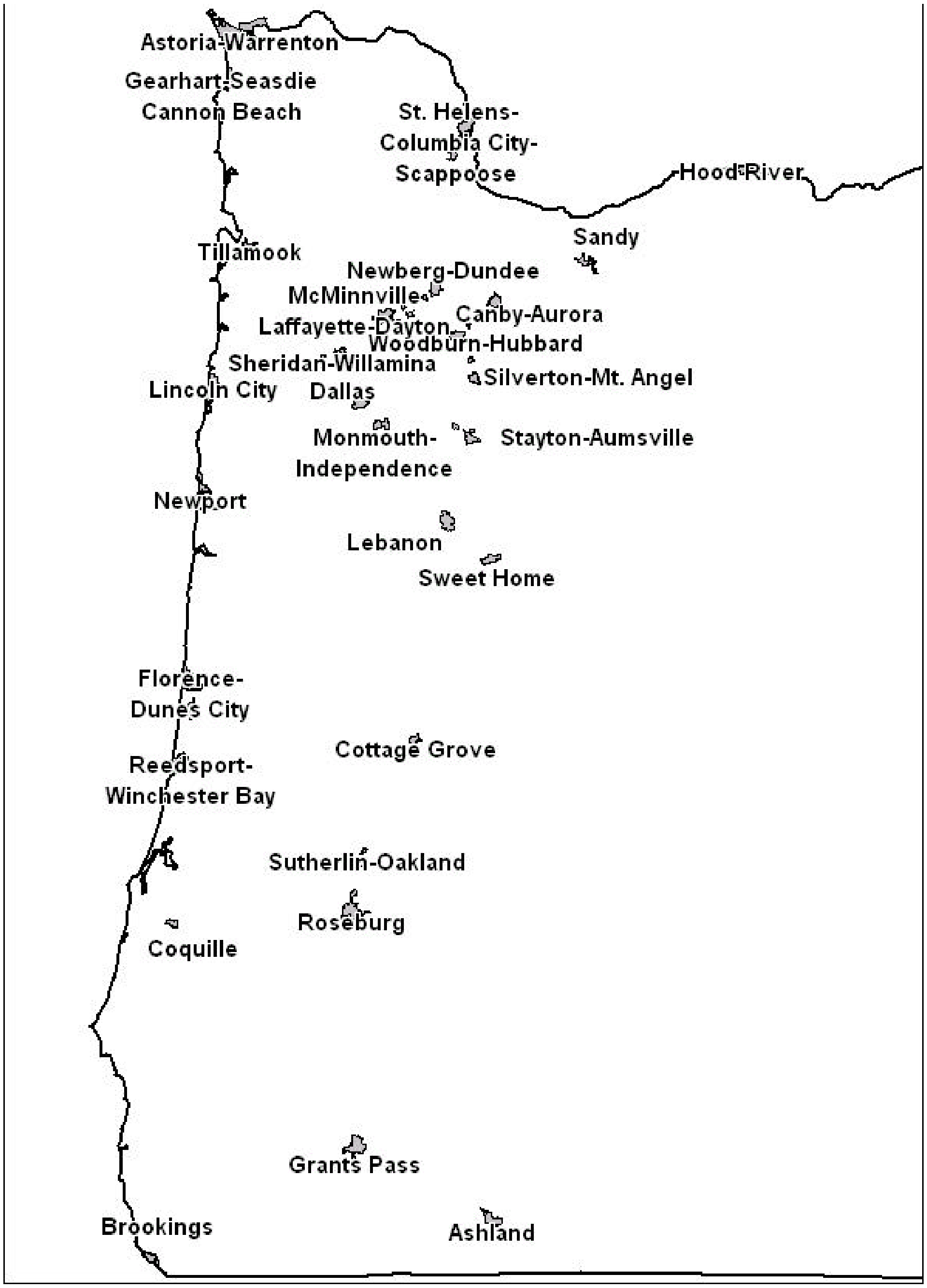

Figure 1. Study area locations.

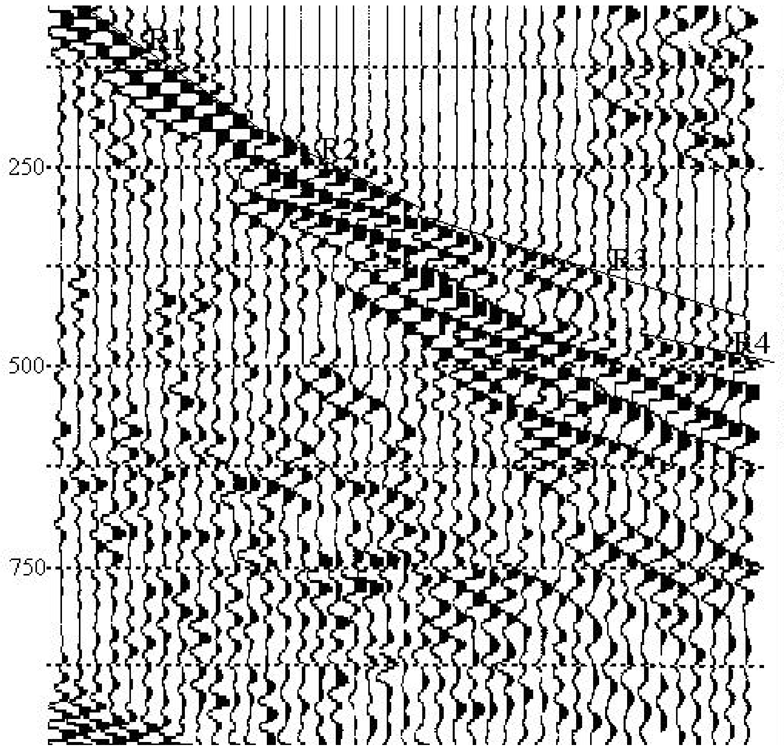

Figure 2. Composited SH-wave refraction profile at site McM03

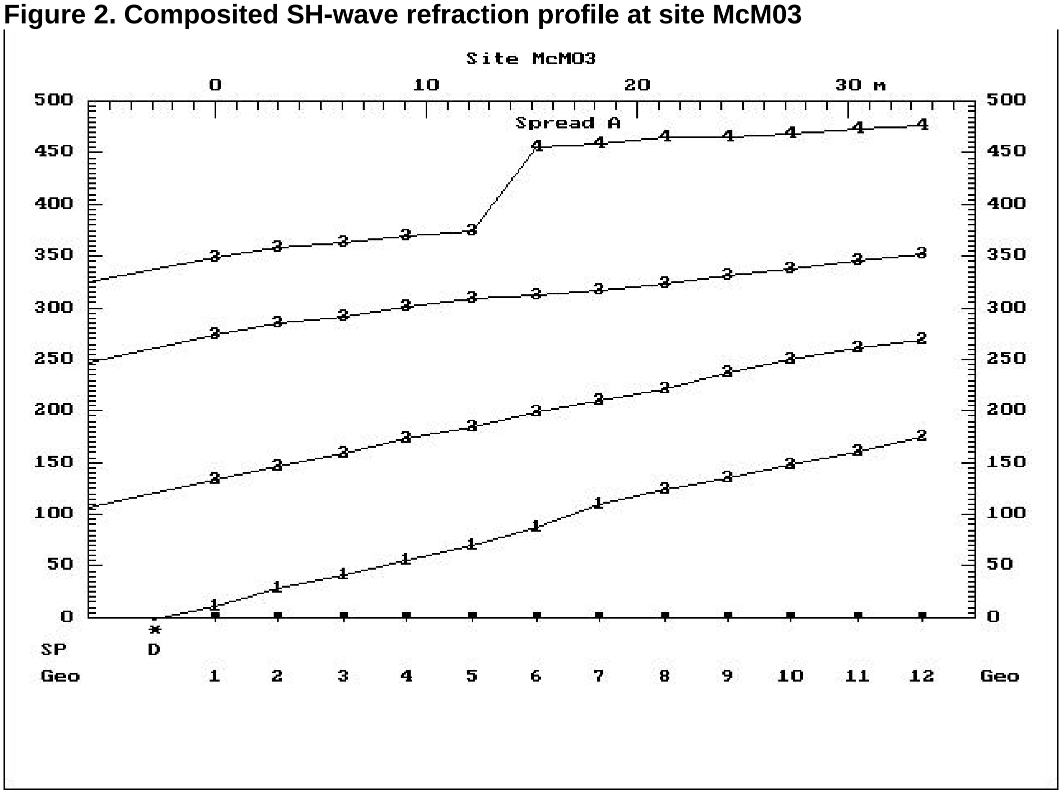

Figure 3. Arrival time curves of the refractions at site McM03.

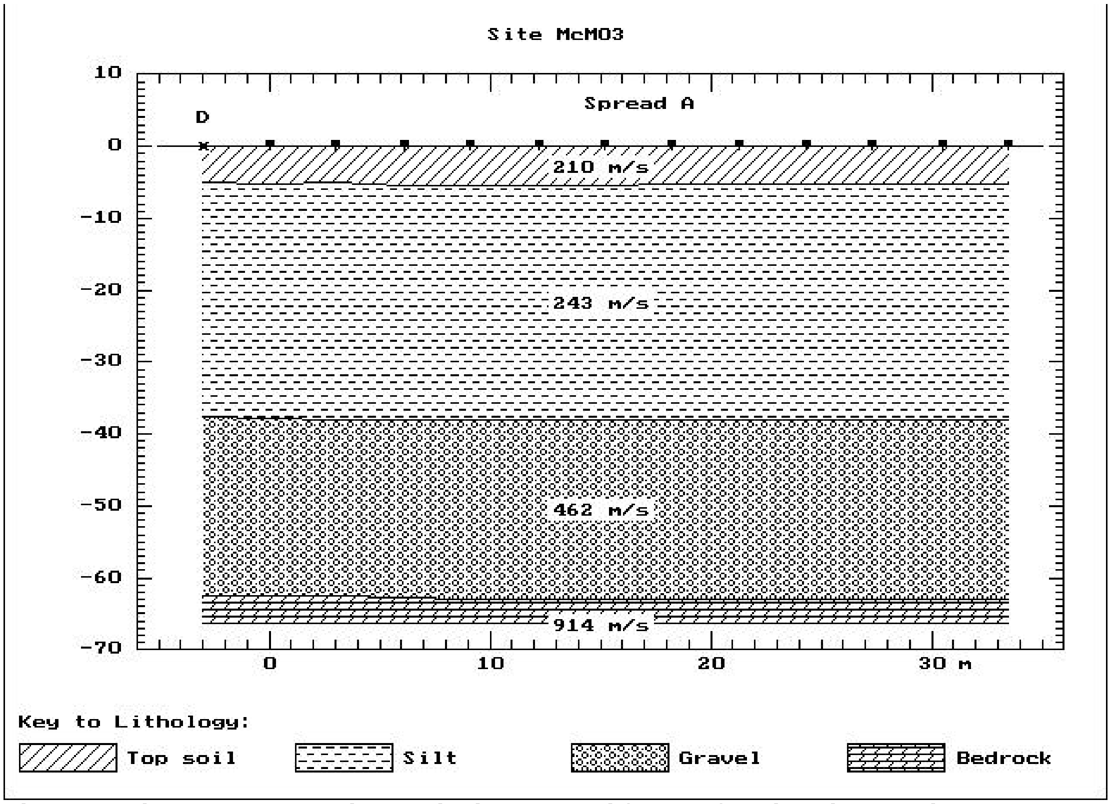

Figure 4. Shear-wave velocity model interpreted from refraction data at site McM03.

Measured shear wave velocities for the 29 sites are presented in Table 1.

Table 1. Measured Shear Wave velocity.

SITE NAME	Layer 1 Thickness	Layer 1 velocity	Layer 2 Thickness	Layer 2 velocity	Layer 3 Thickness	Layer 3 velocity	Layer 4 Thickness	Layer 4 velocity
Ashl01	2.00	59.83	6.20	222.05	0.00	376.25	0.00	0.00
Ashl02	8.50	100.85	13.50	197.38	0.00	313.03	0.00	0.00
Ast01	10.00	55.82	0.00	161.29	0.00	0.00	0.00	0.00
Ast02	5.00	21.59	0.00	41.02	0.00	0.00	0.00	0.00
War02	0.00	58.60	0.00	0.00	0.00	0.00	0.00	0.00
War01	5.50	29.30	0.00	64.76	0.00	0.00	0.00	0.00
Ast03	8.20	24.98	0.00	46.57	0.00	0.00	0.00	0.00
Brook01	0.00	56.44	6.00	148.34	0.00	361.44	0.00	0.00
Canb01	2.50	82.03	0.00	209.71	0.00	0.00	0.00	0.00
Canb02	3.50	49.34	0.00	202.62	0.00	0.00	0.00	0.00
Coquil01	9.50	58.90	0.00	118.73	0.00	0.00	0.00	0.00
Coquil02	27.00	46.57	0.00	181.65	0.00	0.00	0.00	0.00
Cottage01	3.40	67.54	0.00	300.07	0.00	0.00	0.00	0.00
Cottage02	3.60	57.67	0.00	391.67	0.00	0.00	0.00	0.00
Dalla01	3.40	50.89	0.00	232.84	0.00	0.00	0.00	0.00
Dalla02	2.70	53.66	0.00	240.55	0.00	0.00	0.00	0.00
Hoodr01	4.50	44.72	0.00	416.96	0.00	0.00	0.00	0.00

Hoodr02	1.00	42.87	6.00	83.58	38.00	116.27	0.00	306.86
Lebanon01	3.00	44.41	0.00	184.42	0.00	0.00	0.00	0.00
Lebanon02	4.90	75.25	0.00	205.09	0.00	0.00	0.00	0.00
McMin01	5.80	55.51	0.00	422.82	0.00	0.00	0.00	0.00
McMin02	7.00	61.99	0.00	85.43	0.00	0.00	0.00	0.00
McMin03	5.60	65.69	31.70	74.32	25.30	141.86	0.00	281.88
Monm1	2.30	52.12	15.00	100.23	29.10	169.62	0.00	350.96
Monm2	7.00	49.04	21.10	84.81	0.00	124.29	0.00	0.00
Reedp01	6.40	27.45	8.50	44.41	0.00	80.80	0.00	0.00
Reedp02	3.90	43.79	0.00	230.99	0.00	0.00	0.00	0.00
Roseb01	6.00	55.82	0.00	291.13	0.00	0.00	0.00	0.00
Sher01	3.40	38.55	0.00	230.99	0.00	0.00	0.00	0.00
Willa01	1.00	38.24	3.00	119.04	0.00	238.39	0.00	0.00
Mtag01	3.70	56.75	10.00	135.08	0.00	335.23	0.00	0.00
Silvert01	1.00	60.45	3.00	252.27	0.00	432.38	0.00	0.00
STH01	1.00	27.14	0.00	371.31	0.00	0.00	0.00	0.00
STH02	1.00	12.34	0.00	255.97	0.00	0.00	0.00	0.00
STH03	1.50	40.71	0.00	218.96	0.00	0.00	0.00	0.00
Stayt01	3.00	66.61	0.00	169.93	0.00	0.00	0.00	0.00
Stayt02	1.80	43.79	0.00	295.45	0.00	0.00	0.00	0.00
Sutherl01	5.00	131.38	0.00	259.67	0.00	0.00	0.00	0.00
Oakland1	9.10	61.06	0.00	332.76	0.00	0.00	0.00	0.00
Sweet01	6.10	62.61	0.00	263.68	0.00	0.00	0.00	0.00
Hub01	1.00	31.15	11.20	75.25	0.00	112.26	0.00	0.00
Wood01	6.10	76.17	33.50	105.16	0.00	122.13	0.00	0.00
Wood02	6.70	70.93	0.00	112.87	0.00	127.99	0.00	0.00
Wood03	4.50	65.07	0.00	93.45	0.00	97.76	0.00	0.00
Sandy01	4.50	88.20	0.00	188.12	0.00	0.00	0.00	0.00
Floren01	11.20	67.23	0.00	96.53	0.00	0.00	0.00	0.00
Floren02	4.40	74.32	0.00	114.42	0.00	0.00	0.00	0.00
DuneC01	4.00	53.66	0.00	177.64	0.00	0.00	0.00	0.00
Grandp01	2.40	79.26	0.00	156.05	0.00	0.00	0.00	0.00
Grandp02	1.50	41.33	7.00	114.42	0.00	285.27	0.00	0.00
Grandp03	0.60	99.00	2.10	170.85	0.00	267.69	0.00	0.00
Lincohn01	4.30	57.05	0.00	295.45	0.00	0.00	0.00	0.00
Lincohn02	0.00	86.97	0.00	0.00	0.00	0.00	0.00	0.00
Newb01	4.90	67.85	0.00	158.21	0.00	0.00	0.00	0.00
Newb02	7.90	49.96	0.00	101.77	0.00	0.00	0.00	0.00
Newp01	1.00	61.68	6.70	138.16	0.00	189.05	0.00	0.00
Newp02	17.00	99.92	0.00	129.22	0.00	0.00	0.00	0.00
Seas01	6.70	84.50	0.00	112.57	0.00	0.00	0.00	0.00
Seas02	12.20	52.43	0.00	80.80	0.00	0.00	0.00	0.00
Seas03	15.50	64.15	0.00	86.35	0.00	0.00	0.00	0.00
Tillam1	2.40	103.31	0.00	188.12	0.00	0.00	0.00	0.00
Tillam2	17.00	25.29	0.00	94.99	0.00	0.00	0.00	0.00
Tillam3	17.40	25.60	0.00	77.10	0.00	0.00	0.00	0.00

UBC-97 Soil Classification

After the geologic model for each site has been reviewed, and any adjustments resulting from the review have been made, we will use the following technique to map the relative earthquake hazard of the study areas.

The average shear-wave velocity (ν_s) over the upper 30 m of the soil profile will be calculated by assigning each isopached unit a velocity derived from the velocity measurements, then using (ICBO, 1997)

$$\nu_s = 30\text{m}/\Sigma\{d_i/\nu_{si}\}$$

Where: d_i = thickness of layer i in meters.
v_{si} = shear-wave velocity of layer i in m/s.

The UBC-97 soil classification map is generated using MapInfo^{tn} and Vertical Mapper^{tm}, based on the average shear-wave velocity and Table 2 (ICBO, 1997). Soil types S_E and S_F can not be differentiated from the average shear-wave velocity. S_E and S_F are differentiated based on geologic and geotechnical data, and engineering judgement.

Table 2. UBC-97 soil profile types

Soil Category	Description	Average shear-wave velocity
S_A	Hard rock	v_s>1500 m/s
S_B	Rock	760m/s<v_s<1500m/s
S_C	Very dense soil and soft rock	360m/s<v_s<760m/s
S_D	Stiff soil	180m/s<v_s<360m/s
S_E	Soil	v_s<180m/s
S_F	Soil requiring site-specific evaluation	

Non-Technical Summary

The goal of this project is to provide useful earthquake hazard maps for 29 small to medium sized Oregon communities. The maps will be based on existing geologic and geotechnical data, and will show areas that are subject to greater or lesser earthquake hazards based on local geology. The maps will allow users to determine which areas within a community are at greatest risk from earthquake shaking, and to compare hazards between communities. The maps are being made by combining information about the type and thickness of geologic deposits in the area with measurements of the stiffness of the deposits, to determine if there are “soft” areas of geology present that might enhance earthquake shaking.