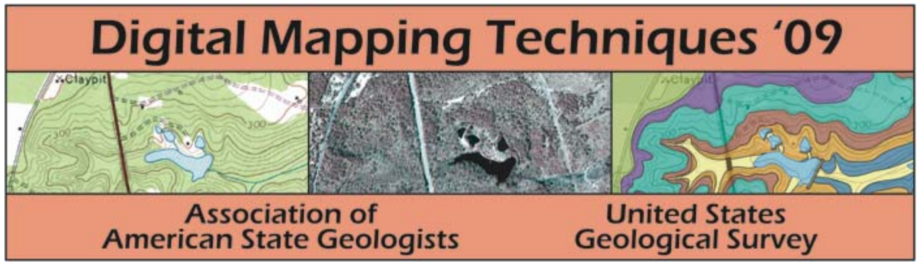

The following was presented at DMT'09
(May 10-13, 2009).

The contents are provisional and will be
superseded by a paper in the
DMT'09 Proceedings.

See also earlier Proceedings (1997-2008)
http://ngmdb.usgs.gov/info/dmt/

Feature Extraction from High-Resolution Lidar | The Next Generation of Base Maps

The Oregon Department of Geology and Mineral Industries (DOGAMI) Mapping Group

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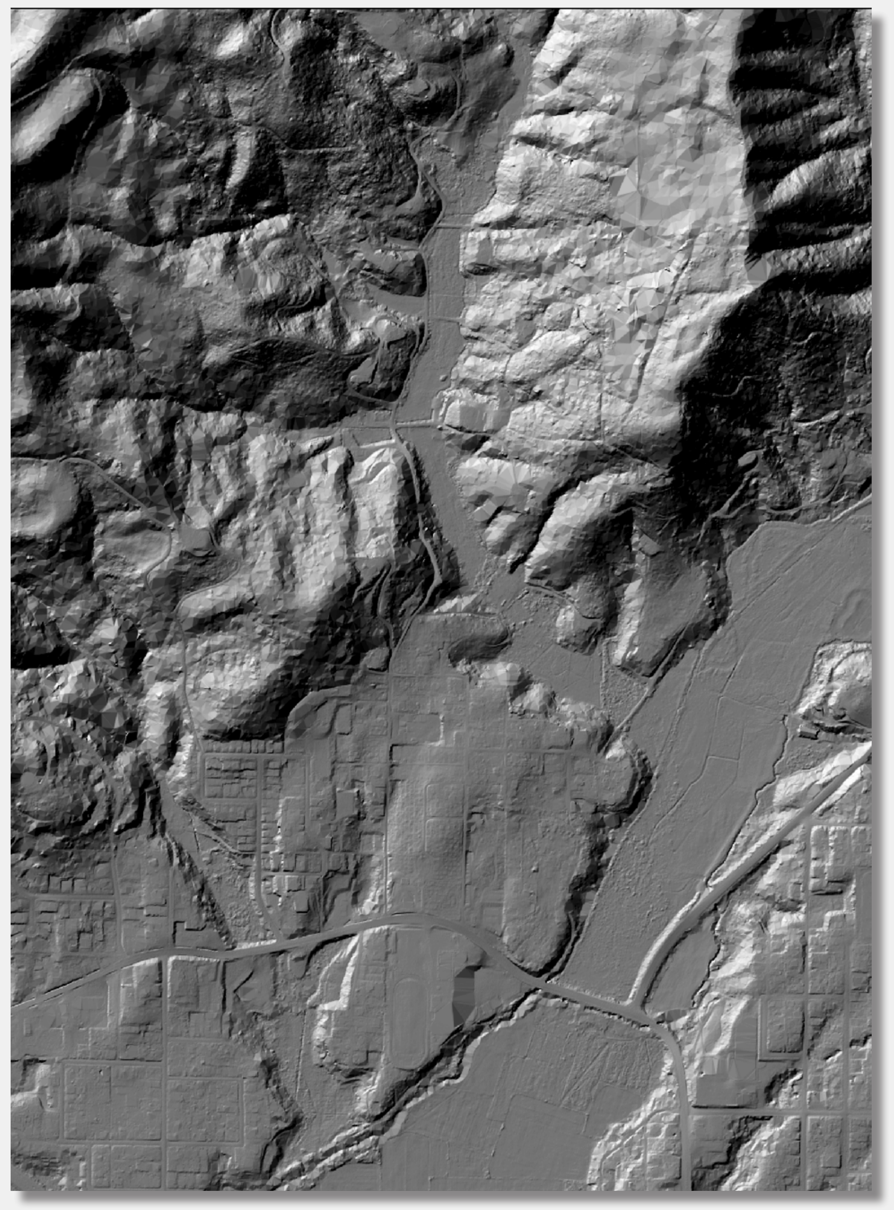
Bare Earth Model



The bare earth elevation model is a representation of the Earth's surface stripped of man-made objects and vegetation. This is achieved through post-processing of lidar point data, where the sheer density of elevation points collected -- in this case, upwards of 8 points per square meter -- allows for the recognition of high-precision (sub-meter) ground trends. Within the geology community, bare earth elevation models have proven revolutionary in their ability to reveal the subtleties of terrain, shedding light on previously unidentified features, such as alluvial fans, landslides, and historic channel beds. The power of the bare earth elevation model to aide in understanding terrain is further examined here through various strategies in geovisualization.

Customized Hillshading

Hillshading brings an elevation model to life. However, every terrain is unique, so why light them all the same way? In this example we shift the light source from its standard 315 degrees azimuth and 45 degrees declination (as seen at left) to 345 and 60, respectively. Also, we exaggerated the vertical by a factor of 5. This landscape is dominated by northwest trending drainages. Bumping the light source northward better defines their features. Exaggerating the elevation in an area with such high relief also helps to bring out its nuances.

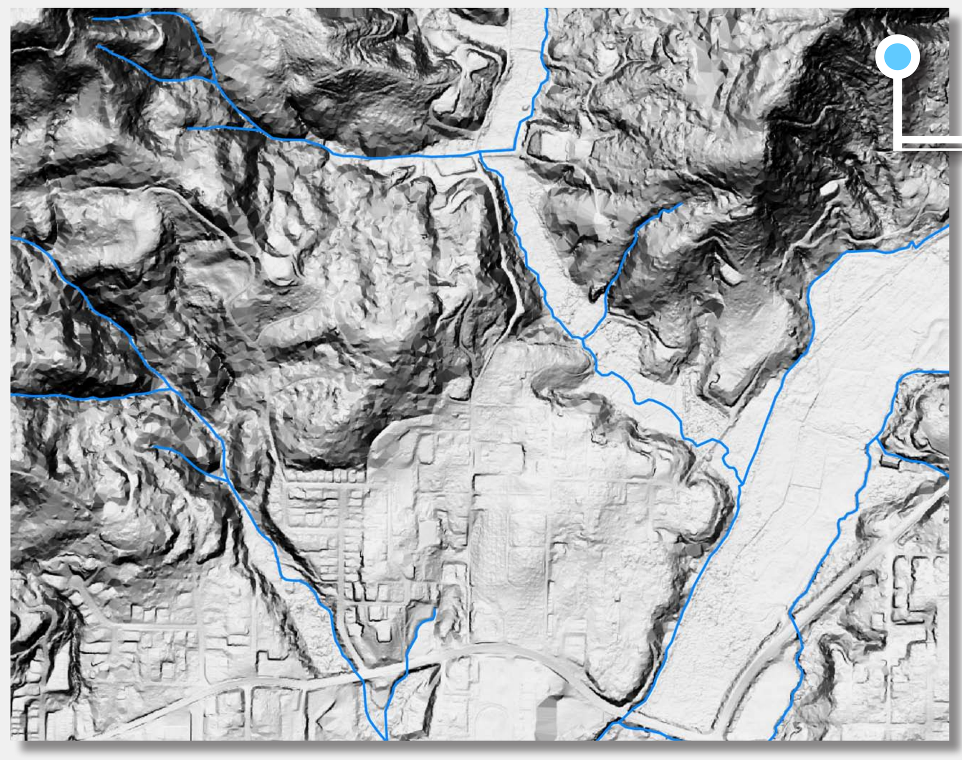
Smoothed Contours

Contours take all the guesswork out interpretting elevations. With lidar its possible to effectively contour a terrain with 2 foot contours. At smaller scales, though, such exquisite detail becomes a visual liability. To massage out some of this detail and produce more appealing and appropriate contours, try smoothing your bare earth elevation model by averaging its values over a set radius, and then build your contours from there. These contours have an interval of 20 feet with indices every 100 feet.

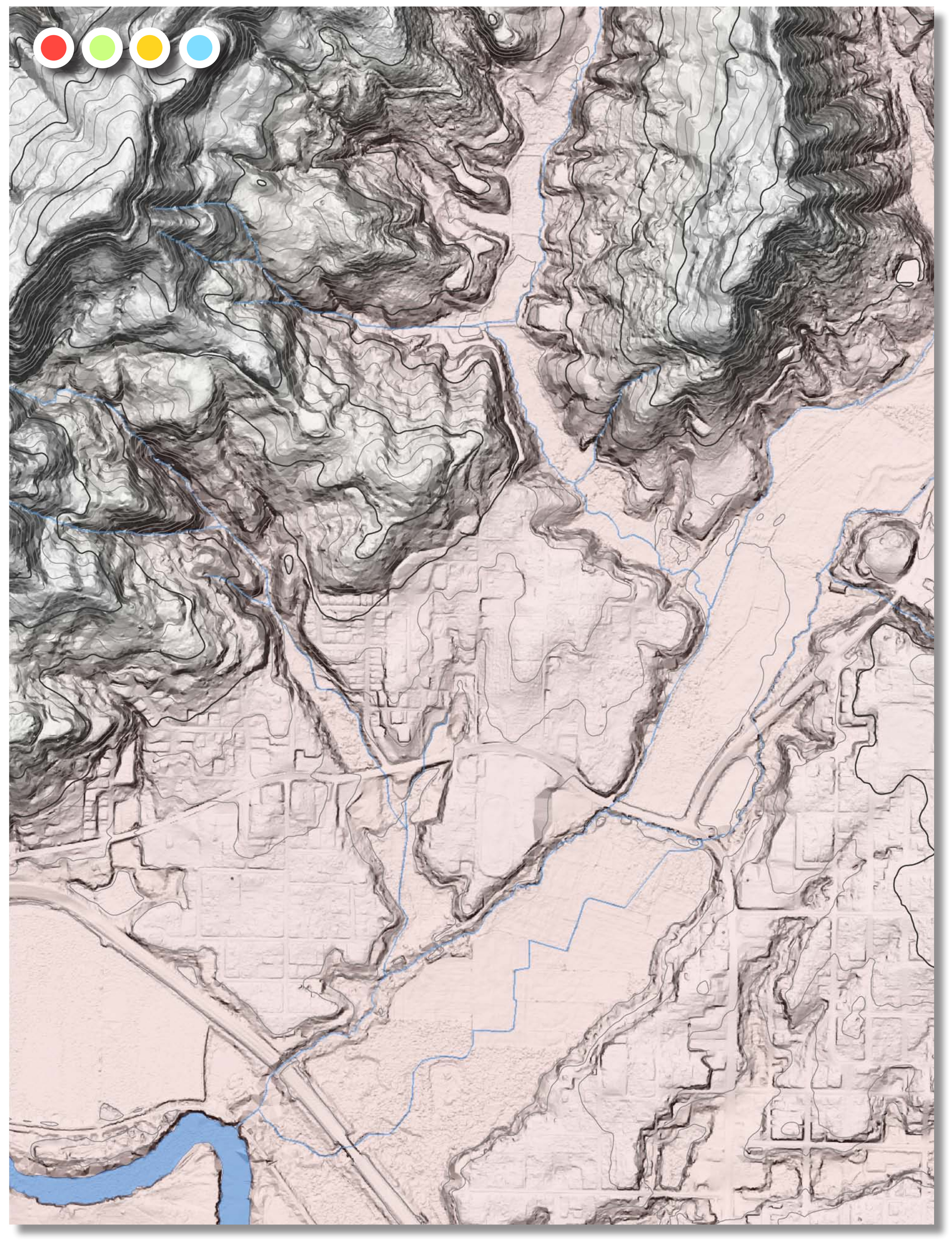
Defined Slopes

While hillshading is truly essential for visualizing terrain, its inherent directional biases often shroud useful detail in shadow. An effective method for accenting all slopes is by draping a semi-transparent hillshade over a slope layer, where the highest slope values are represented by a dark color. It is also useful to exclude low slope values when classifying your slope layer, since they are not especially useful and have a tendency to muddy up the look of your map.

Hydrology Delineation



Numerous valiant attempts have been made toward automating the extraction of hydrologic features from lidar. Nonetheless, we find that there is no substitute for the trained eye and some steady hands. Using a slope layer supplemented by recent aerial photos produces accurate stream and water body delineations on the first try, with no clean-up of erroneous (and often ample) vertices.



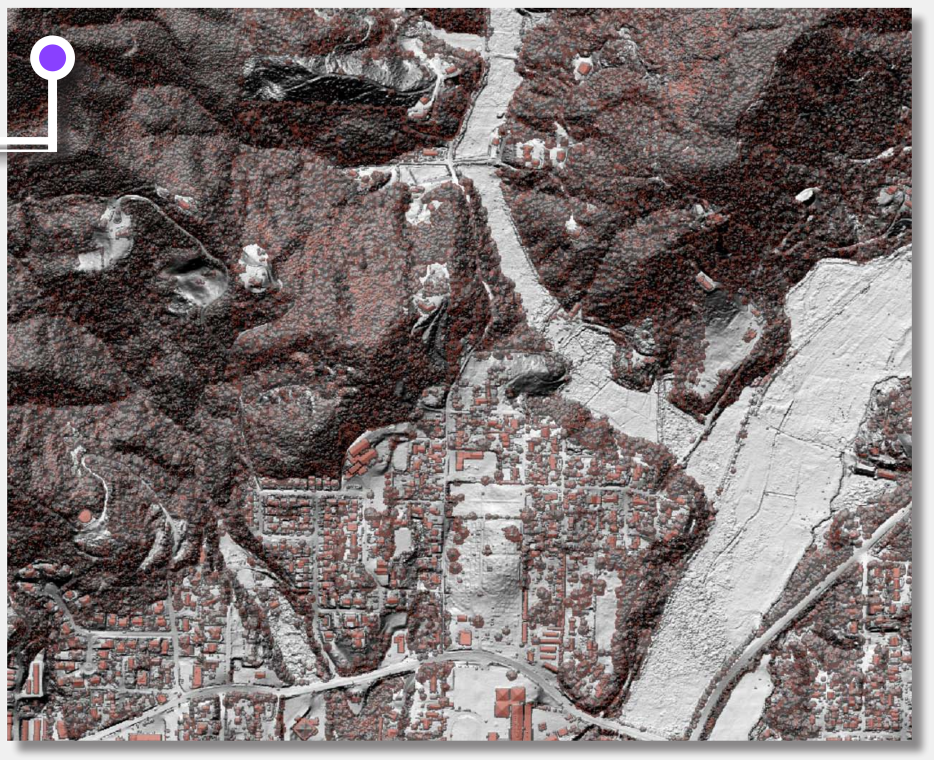
BARE EARTH COMPOSITE

Highest Hit Model

The highest hit elevation model is a representation of the full-featured landscape at the time of the lidar aerial survey. As opposed to the last-return (ground) illustrated by the bare earth elevation model, the highest hit is the first-return to the lidar sensor -- be it tree, car, skyscraper, or even people. Though not as immediately useful for applications in geology as the bare earth elevation model, it has many merits when it comes to feature extraction for base mapping.

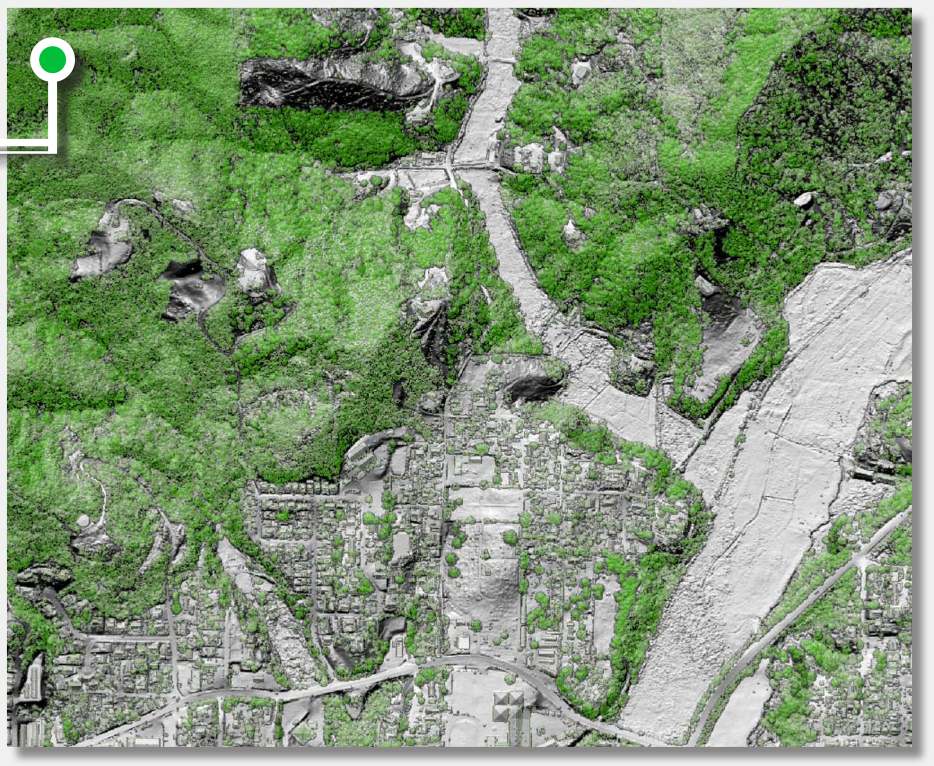
Structure Modeling

With some simple math we can approximate flat-topped structures (e.g. buildings). First we subtract bare earth from highest hit. This gives us the heights of all raster cells considered "non-ground." We can further refine this by taking the slope of our "non-ground" layer and isolating those areas with low slopes -- say below 25 degrees. In general, these areas will represent buildings and bridges. Additional tricks in symbology can be employed to reduce the appearance of non-buildings.

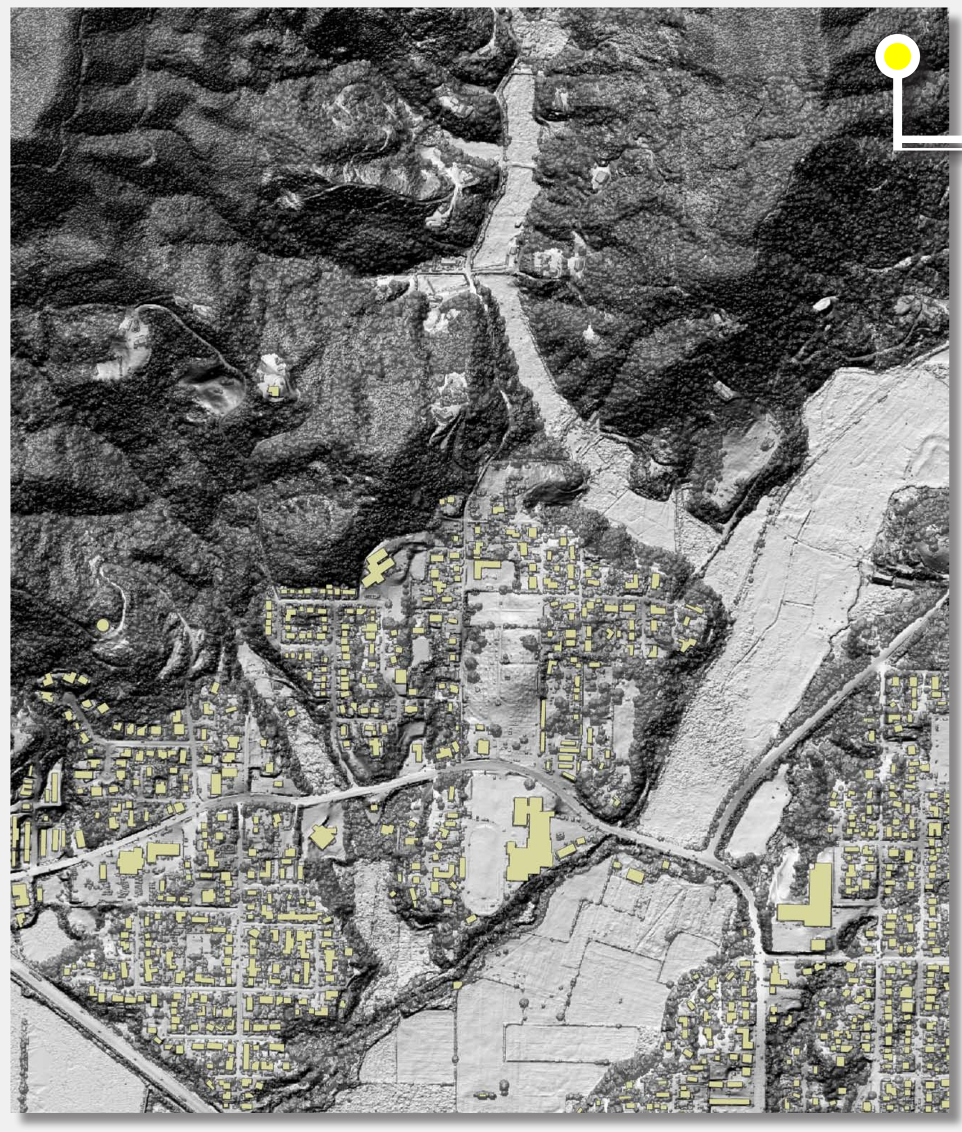


Canopy Modeling

Similar to structure modeling, using a "non-ground" layer we can approximate trees and other vegetation. This time we are interested in isolating features with a rather high slope. We can then take one step further by symbolizing "non-ground" height values from a light green (shrubs) to a dark green (tall trees). The result is a very visually appealing layer that illustrates the varying heights of trees in particularly well forested landscapes.



Building Extraction



We have taken structure modeling to the next level with true building extraction. With the help of Lidar Analyst software (by Visual Learning Systems) we can create polygons that accurately represent building footprints with very little or no editing. Lidar Analyst uses breaks in slope, recognition of angles, and your supervised classification to produce polygons are attributed with z-values -- very handy for 3D visualizations. This tool, in concert with structure and canopy modeling, creates an extremely realistic view of a landscape with no help from aerial photos.

It is worth noting that building extraction differs from hydrologic feature extraction in that the resultant vector layer is much less vertex-rich, and therefore less painstakingly edited.

HIGHEST HIT COMPOSITE

Additional Notes

These data were collected with a Leica ALS50 Phase II Lidar system (150 kHz). Pulse density is at least 8 points per square meter with vertical accuracies within 15 centimeters on flat surfaces. Raw data was gridded to 1-meter resolution. The town of Coquille, Oregon is feature in these maps. All maps are represented at a scale of 1:8,000. Maps projected in Universal Transverse Mercator (NAD 83) Zone 10 North. All geoprocessing was performed using ESRI ArcGIS products. Poster prepared by Jed Roberts. For more information, e-mail jed.roberts@dogami.state.or.us.

Reference: Burns, W.J., 2008. Regional Landslide Hazard Maps of the Southwest Quarter of the Beaverton Quadrangle, West Bull Mountain Planning Area, Washington County, Oregon. Oregon Department of Geology and Mineral Industries, Open File Report O-08-09.