

## A summary of the La Grande quadrangle geology

For more detailed information please see the accompanying text and references.

### Geologic history

This area contains some of the oldest rocks in Oregon. Between 300 and 180 million years ago, fragments of the ancient sea bed and oceanic islands traveled slowly from faraway regions and docked onto the continent near here. Those pieces are today called terranes (for example, the Baker Terrane).

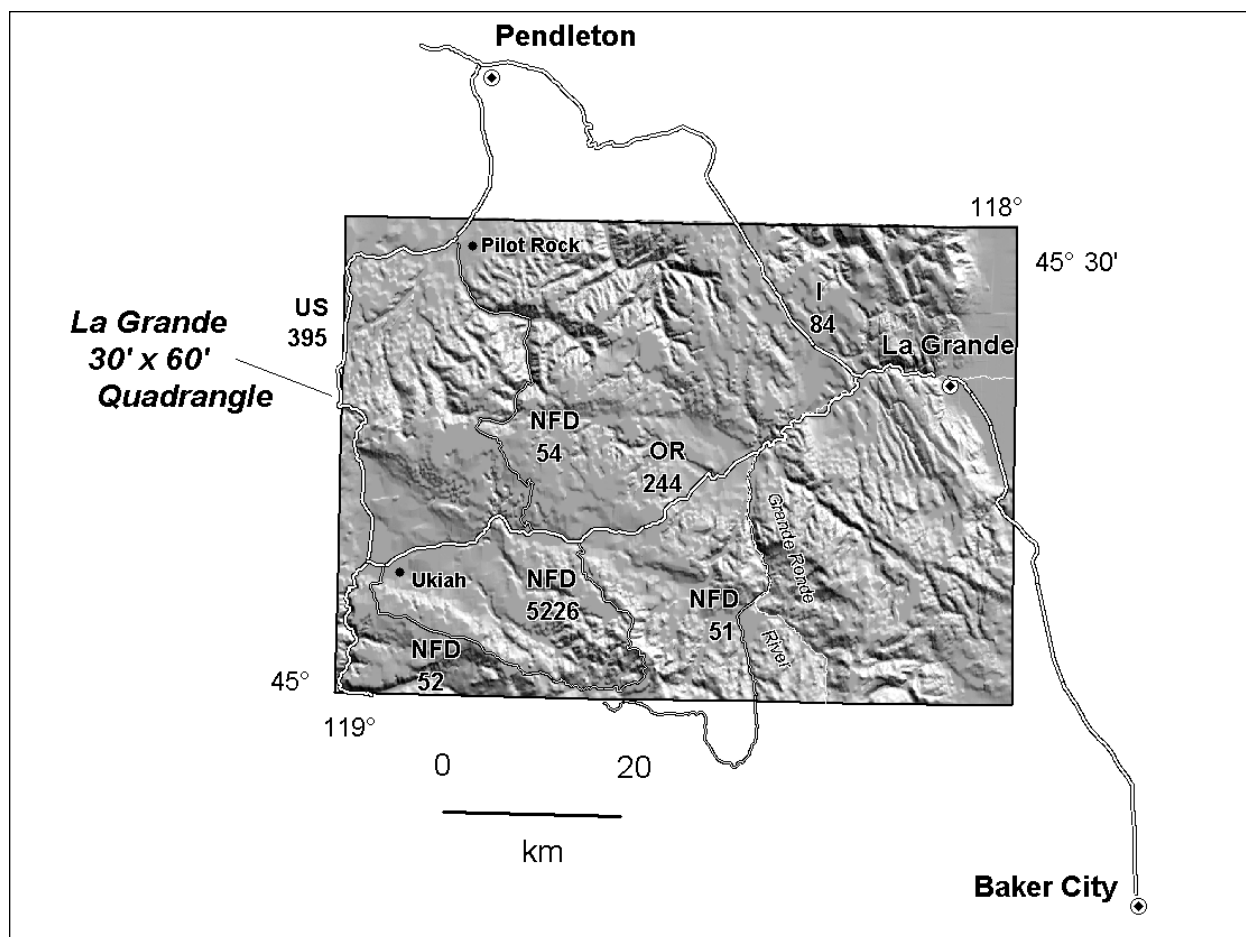
Since then, there have been periods of building, when volcanic and sedimentary rocks were deposited. There have also been periods of erosion and deformation, exposing granite that originally formed miles underground.

Between 17 and 15 million years ago, Columbia River Basalt erupted and covered most of the quadrangle, filling valleys and other low spots.

Over the next nine million years, the Powder River Volcanic Field between La Grande and Baker City was formed when a number of small volcanoes erupted.

In the last six million years, the Grande Ronde and Baker Valleys began forming. This continuing process is responsible for the geologic hazards (faults and landslides) that are most evident along the margins of the Grande Ronde Valley.

Two interesting features include leaf fossils found in 55 million year old sedimentary rocks south of Pilot Rock, and the Tower Mountain caldera. Tower Mountain is a 25-million-year-old volcanic complex that collapsed, leaving a hole, called a caldera, about 10 miles across.



*The 30' x 60' La Grande quadrangle in northeastern Oregon showing major roads. "NFD" indicates US National Forest Service roads.*

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## Geologic Resources

### Water

The zones of broken rock that separate individual Columbia River Basalt Group flows are often porous and make productive aquifers when buried beneath the regional water table.

### Aggregate and industrial minerals

Aggregate in the form of gravel, with smaller amounts of crushed rock, has been the major mineral resource mined in the La Grande quadrangle. Several types of volcanic rocks have also been used as road building sources. Sand and gravel suitable for aggregate occurs mainly as fluvial-fan and terrace surfaces in the Grande Ronde valley.

Other industrial-mineral resources in the quadrangle include perlite and rhyolite facing stone found around the Tower Mountain caldera. Laboratory reports of samples of perlite indicate that the quality is variable. Building stone has been locally quarried from the partially welded zones in ash-flow tuff. Some of the intrusions in the Bald Mountain batholith may hold promise for decorative building stone.

### Semiprecious gemstones

Opal and chalcedony have been found near the Tower Mountain caldera, Hideaway Creek, and around fault zones. There does not appear to be gem quality opal. Quartz-filled geodes and agate- and opal-filled thundereggs are also found in rhyolite in the Tower Mountain caldera, west of Sheep Creek, and along USFS road 5160.

### Metallic-mineral resources

Only a small part of the quadrangle has areas of rocks with gold, silver, copper, antimony, and mercury, but none of commercial quantity.

Placer mines at Camp Carson, China Diggings, and above the North Fork John Day River worked gravels around 1900 and in the 1940s. Other operations were generally small in size and of limited duration. The grade of the material mined was apparently low.

Silver, gold, and antimony have been produced in very small amounts from lode mines in and adjacent to the Bald Mountain batholith. Small, discontinuous lenses of silver-bearing galena and sphalerite were mined from altered Elkhorn pluton tonalite near the contact with the granite of Clear Creek. Narrow copper-gold veins have been explored in the amphibolite unit east of the Bald Mountain batholith, but no official records of copper or gold production from this area have been preserved.

### Geothermal energy

Three areas of the La Grande quadrangle are underlain by low-temperature geothermal water. Two recently drilled, deep water wells in the central part of the Grande Ronde Valley have encountered significant artesian flows of low-temperature geothermal waters. Moderately warm (approximately 20°C) water has been reported from both shallow and deep water wells near Pilot Rock.

### Fossil fuels

Potential for hydrocarbons in the La Grande quadrangle is low. Thin, low-quality peat or lignite coal seams are found near Ukiah and on Birch Creek. Potential for oil or natural-gas resources is restricted to the northwest quadrant of the quadrangle, and does not appear to be encouraging.

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## Geologic hazards

Geologic hazards are most evident along the active margins of the Grande Ronde Valley. The margins of the Grande Ronde valley are geologically unstable because of the active or potentially active faults, steep terrain, and a potential for dangerous landslides.

### Seismic hazards

The West Grande Ronde Valley fault zone may be active. Subtle topographic features indicate that there may have been earthquakes that broke through the ground surface as recently as the last 10,000 years. Previous studies indicate that the West Grande Ronde Valley fault zone is capable of

generating a magnitude 7 earthquake.

### Landslides

The most dangerous landslides in the area are fast-moving flows. These are particularly likely on the east flank of Mount Emily, where rapidly moving debris avalanches have cascaded down the face of the escarpment. In addition, flood events could be complicated by mudslides.

Many of the landslides in the immediate vicinity of La Grande are slow-moving, but buildings on these unstable surfaces are susceptible to damage from slope movement.

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