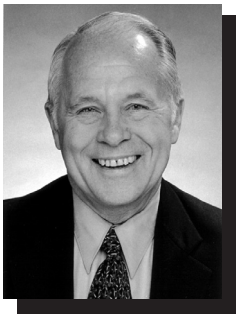
The Washington Division of Geology and Earth Resources

Geology in the Public Interest

WASHINGTON STATE DEPARTMENT OF
Natural Resources
Doug Sutherland - Commissioner of Public Lands
Ron Teissere - State Geologist

Washington's complex geology gives rise to many geologic hazards—earthquakes, active volcanoes, landslides, tsunamis, and abandoned mines. As Washington's geological survey, the Division of Geology and Earth Resources contributes to the safety and economic well-being of Washington's citizens by informing the public, government, and industry about the consequences of unpredictable geologic events and the nature of the land around us, including the availability of important resources such as aquifers and sand and gravel. The Division has provided this information at very low cost to the taxpayer, supplementing its budget with more than $1 million in grants over the last ten years to help finance this work. Studies have shown that providing geologic information to the public more than pays for itself over time. For example, a benefit/investment analysis done for Oregon's geological survey showed that for every tax dollar spent, they brought in or saved the state about $235.



Doug Sutherland
Commissioner of Public Lands

The Division of Geology provides:

- Evaluation of geologic hazards and advice on their mitigation
- Disaster response and damage assessment
- Surface and subsurface geological mapping
- Inventory and regulation of mineral and oil and gas resources
- Technical support for environmental and forest protection
- A complete library collection on the geology of Washington
- Publications on Washington geology

GEOLOGIC HAZARDS

Division geologists actively identify, assess, and map geologic hazards using modern geotechnical and geophysical methods. Our hazard maps are critical for land-use and emergency-management planning, disaster response, and building-code amendment. As our population grows, there is increasing pressure to develop in hazardous areas. Delineation of these areas has never been more important.

Massive landslide on Perkins Lane along Magnolia Bluff in Seattle, one of the areas hardest hit during the winter storms of 1996–97. Photo by Hugh Shipman.

In response to the Growth Management Act's mandate to use the 'best available science', our geologists meet with local governments and townspeople in at-risk communities to educate them about geologic hazards and ensure that these hazards are taken into account in growth-management and disaster planning.

The Division is also among the first responders to disasters, helping staff the State Emergency Operations Center at Camp Murray and later documenting damage in the field.

Landslides. Landslides are a continuing problem along our hillsides, shorelines, and roadways. Just since 1996, landslides have caused hundreds of millions of dollars of damage in Washington.

The Division is a leader in landslide hazard identification, mitigation, and emergency response. Our geologists responded to landslide emergencies in Seattle in 1997, in Olympia and Grand Coulee in 1998, and in Snohomish County in 2002. We have mapped Cowlitz County's landslide hazard areas to assist with growth-management planning. The county's Aldercrest landslide, which damaged 138 homes, was declared a federal disaster area. Damage to public facilities and private property is estimated in excess of $30 million.

Landslide hazard maps can help prevent this kind of loss to property by showing those areas that are unsafe for building. To this end, additional landslide mapping projects are currently planned for Thurston and Clark Counties.

Division geologists are also studying large ancient landslides that may record prehistoric earthquakes to help document the recurrence intervals for mega-quakes, which could be devastating to western Washington.

Earthquakes. Geologic evidence suggests that most of Washington is at risk from large earthquakes. In 1700, a mega-quake occurred on the Cascadia subduction zone just off the coast of Washington. The largest quake since European settlement was in a sparsely populated area east of the Cascades in 1872. Puget Lowland earthquakes in 1946, 1949, and 1965 killed 15 people and caused more than $350 million in property damage, and the Nisqually

Debris from a parapet failure on the south side of the Washington Federal Savings building in downtown Olympia caused by the Nisqually earthquake of February 2001. Photo by Joe Dragovich.

earthquake in 2001 caused more than $2 billion in damage.

The Division produces earthquake hazard maps for at-risk urban areas. These maps show areas where earthquake damage from amplification of earthquake waves or soil liquefaction can be expected to be high. Damage can then be mitigated by either reinforcing structures in these areas or not building there at all.

Five detailed liquefaction maps and one ground-shaking map have been published by the Division to date. Our Olympia map was tested by the Nisqually earthquake and successfully predicted the areas of greatest damage. A federally funded statewide reconnaissance map of ground-shaking and liquefaction susceptibility was completed in 2004 and is available on our website (see http://www.dnr.wa.gov/geology/hazards/hmgp.htm).

Division geologists hold workshops to show cities and counties how to use these maps for land-use and emergency-management planning.

Mount St. Helens from the Pumice Plain, about one mile north of the mountain, on April 16, 1983. Photo by Pat Pringle.

Volcanoes. In the past 12,000 years, Washington's five active volcanoes have erupted more than 200 times, producing ash, lava, and massive mudflows. The 1980 eruption of Mount St. Helens killed 57 people, blanketed eastern Washington with ash, and caused more than $1 billion in damage.

Mount Rainier is our most dangerous volcano because of the large population close to the mountain. Previous lahars (mudflows) from Mount Rainier inundated Puget Lowland valleys as far as current-day Renton, Tacoma, and Olympia. The Division has mapped and determined the age of many of these events to present a much clearer picture of their frequency and magnitude.

In the past, lahars from Glacier Peak have flowed through the Skagit Valley all the way to La Conner. Recent mapping in Skagit and Whatcom Counties has identified previously unrecognized, young lahars from Glacier Peak that would obliterate small towns such as Darrington and destroy sections of Interstate 5, should they occur today.

The Division collaborates with the U.S. Geological Survey's Cascades Volcano Observatory to produce volcano hazard maps and develop response plans for each volcano. We assist at-risk communities with their land-use, evacuation, and emergency-management plans and hold open meetings in at-risk communities to present the danger and allow citizens to ask questions and voice concerns.

Tsunamis. The coast of Washington is at risk from tsunamis of both local and distant origin. These destructive waves are most commonly caused by submarine earthquakes. In 1964, the Washington coast suffered $600,000 damage from a tsunami caused by the great Alaska earthquake in Prince William Sound. Our current technology gives us plenty of warning for tsunamis produced by distant quakes. An

Damage to the State Highway 109 bridge over the Copalis River near Copalis Beach caused by a distant tsunami from the 1964 Alaska earthquake. Photo courtesy of the *Daily World*, Aberdeen, Wash.

earthquake on the Cascadia subduction zone—like the 1700 event or the Indian Ocean earthquake of 2004—could generate a tsunami that would strike our coast with great force within a few tens of minutes.

The Division is on the front line in disseminating information about tsunamis. To date, we have produced five tsunami hazard maps showing projected areas of inundation for much of our outer coast, where more than 40,000 residents and $1.5 billion in property are at risk. We hold informational meetings in coastal communities and help local governments develop evacuation and emergency-management plans.

We also participate in the National Tsunami Hazard Mitigation Program to help improve tsunami warnings, inundation modeling, and dissemination of tsunami research. Our librarian, under a grant from the NTHMP, prepares and publishes *TsuInfo Alert*, a newsletter that links tsunami scientists, emergency responders, and community planners to the latest tsunami research.

Coal Mine Subsidence. Abandoned coal mines underlie at least 50,000 acres in King, Kittitas, Lewis, Pierce, Skagit, and Whatcom Counties. Some of these mines are near the surface and pose a risk to buildings or other structures from mine collapse. Information about the location and condition of coal mines is necessary to identify hazardous areas. Our extensive coal mine map collection

The main adit at the Lockwood Pyrite mine, showing acid mine drainage with dissolved metals. Photo by Mac McKay.

and staff expertise are invaluable in guiding development in these areas. We work with local governments to accurately locate mines and interpret mine maps. We also respond to collapses in urban areas.

Abandoned Metal Mines. There are more than 3800 abandoned metal mines in Washington. The mines were worked and abandoned before there was a requirement for reclamation and cleanup. Mine hazards include water quality degradation from high concentrations of heavy metals, and physical hazards such as vertical pits, caving shafts, and collapsing underground workings. These hazards have obvious and significant liability problems for land owners, the public, and government. Other states have found that it only takes one accident to create a headline in every newspaper in the state.

We are currently cataloging and investigating these sites for the Inventory of Inactive and Abandoned Mine Lands. The Division was awarded a U.S. Forest Service grant for this work because of our technical expertise and the extensive collection of reports and data about these mines in our library. We are publishing our findings on each mining district as the site investigation work is done.

GEOLOGIC MAPPING

Geologic maps show the types and ages of rocks that occur at or near the Earth's surface. They show the locations of faults and folds, landslides, glacial deposits, and other regional or local features, depending on the scale of the map. Geologic maps are the most fundamental and important tool of earth scientists.

Most geologic mapping done by companies and universities is for a specific purpose and covers a small irregular area. Our job as the state survey is to produce maps that cover whole areas of the state at various scales. We compile mapping done by others and add our own mapping to complete the coverage.

Our geologic maps are used for a broad range of practical applications, including growth-management planning, dam safety, hazard and risk assessment, water-resource appraisals, resource use and protection, education, recreation, and scientific research.

Virtually every Environmental Impact Statement (about 50 each year) begins with a geologic map. Without our geologic maps, EIS originators would be required to generate their own information at significant cost.

Recent storm-water runoff mitigation in the West Plains area of Spokane was based on findings of our geologic mapping program, which discovered permeable rock into which storm water could be drained, thus preventing frequent flooding.

Our current mapping focuses on 7.5-minute quadrangles at a scale of 1:24,000. This work is partially supported by grants from the U.S. Geological Survey STATEMAP Program. A state geologic mapping advisory committee, with members from industry, government, and the geotechnical consulting community, directs our mapping to areas of highest need.

Subsurface Mapping. Sometimes Division geologists can gather enough subsurface data to create maps and cross sections that can be used for ground-water resource planning and evaluation. For instance, our subsurface mapping of the Spokane aquifer was critical in planning new development to make the best use of available water. Subsurface mapping also aids in hazard assessment and environmental cleanup.

Resource Mapping. Washington has an $800 million per year mineral industry that includes sand and gravel, crushed stone, coal, metals, and industrial minerals such as diatomite, clay, silica, and olivine. Industry uses our maps and publications, along with other reports from our library, to help find new resources.

In the past, the Division has done many mineral and other resource inventories. Recent emphasis has been on locating the sand, gravel, and quarry rock resources needed for highway and infrastructure construction. We have produced sand and gravel resource maps that are useful for guiding zoning decisions and balanced resource planning at the local level. To date about 10 percent of the state has been mapped for sand, gravel, and crushed rock resource potential.

RESOURCE REGULATION

Surface Mine Reclamation. There are about 1200 active surface mines in Washington, primarily sand and gravel operations. The Department of Natural Resources is the agency that oversees surface mine reclamation. The Division monitors the operation of these mines to ensure current environmental protection and future beneficial use. Mines are often reclaimed for fish and wildlife, grazing, forestry, wetlands, and commercial and industrial uses.

The Division has produced a 'best management practices' manual for surface mining to educate miners in the art and science of reclamation. We also hold workshops to train miners on

particular aspects of reclamation. Both of these efforts are aimed at reducing the cost to the State of cleaning up after badly managed mines.

Oil and Gas Regulation. The oil and gas regulatory program supervises exploration and drilling and ensures that these activities are done in a manner that protects the environment and conserves resources, including ground-water resources.

About 600 oil and gas wells have been drilled in Washington, although there has been no large-scale commercial production. The gas storage project at Jackson Prairie in Lewis County has been the state's most beneficial oil and gas project. Jackson Prairie is the world's third-largest natural gas storage field and stores enough natural gas to ensure uninterrupted supplies to our region.

TECHNICAL SUPPORT

The expertise of the Division is often sought on various environmental issues. For example, the Division:

- Participates in a study of mining effects on the Yakima River. Partners in the project are Yakima County, the Yakama Tribe, and the Washington Departments of Ecology and Fish and Wildlife. The emphasis of the project is on salmon recovery and developing better mining methods.
- Assists in environmental cleanups, including the Asarco smelter site and Elliot Bay. The Division lends its expertise in geology, mineralogy, and ground water.

The Geology Library can be a busy place. Many of the geologic reports in the collection cannot be found anywhere else. Photo by Karl Wegmann.

- Helps educate local government and citizens about beach erosion and effects of armoring coastlines.
- Helps ensure that submarine disposal of dredge spoils is done in a stable and safe manner by supplying expertise in slope stability.
- Assists the Department of Natural Resources in evaluating land-management practices, assessing land values for land trades or acquisitions, and identifying resources.
- Reviews State Environmental Protection Act (SEPA) and National Environmental Protection Act (NEPA) documents to ensure that geologic hazards and resources are considered.

GEOLOGY LIBRARY

Geologic research is expensive and time-consuming. Fortunately, research reports typically retain their value and utility for many years, providing an economic return to society of many times their original cost. To fully understand the geology of an area requires studies of its soils, surficial deposits, bedrock, stratigraphy, paleontology, mineralogy, geochemistry, geochronology, structural geology, hydrology, and geophysics (seismic, gravity, magnetic and other surveys), to name a few.

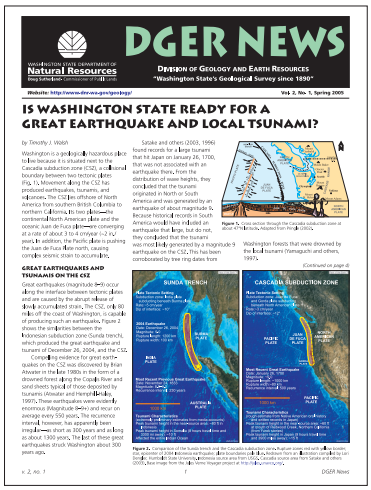
The Division's Geology Library has the state's largest collection about the geology of Washington, and more than 1000 items are added each year. Our librarian is knowledgeable and eager to help users find what they need. A full library catalog is online at http://www.dnr.wa.gov/geology/washbib.htm and the geologic map index is at http://www.dnr.wa.gov/geology/mapindex.htm.

The library has many unique and exhaustive collections. For example, the periodically updated U.S. Geological Survey topographic maps are invaluable for understanding river channel migration, landform changes, development patterns, and land use. We have the largest collection of Washington topo maps held anywhere. Master's and doctor's dissertations and theses are important original sources of geologic information but are usually held only by the originating university. The library has copies of *all* of these works about Washington geology—more than 2000 of them—from all universities, internationally.

As populations grow and land-use pressures increase, government and industry on all levels need quick access to geologic and geotechnical information to address growth-management issues and decide where to build roads and other public lifelines. The Growth Management Act's mandate to use the 'best available science' only increases this need. Our users often have very little time to do their studies and cannot afford to do original research. For them, time is money. They rely on existing reports, which they can find most efficiently through us. Their work would be much more difficult and expensive without ready access to our library.

PUBLICATIONS

Division cartographers and editors prepare the results of mapping and other research for publication. We also publish the online newsletter, *DGER News*, as well as occasional publications such as geologic road guides, best management practices for surface mining, and scientific papers. Our current goal is to make as many of our publications as possible available digitally on CD or on our website at http://www.dnr.wa.gov/geology/.


DGER NEWS

Division of Geology and Earth Resources
"Washington State's Geological Survey since 1890"

IS WASHINGTON STATE READY FOR A GREAT EARTHQUAKE AND LOCAL TSUNAMI?

GREAT EARTHQUAKES AND TSUNAMIS ON THE CSZ

SUNDA TRENCH

CASCADIA SUBDUCTION ZONE