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Reported Historic Asbestos Mines, Historic Asbestos Prospects, and Other Natural Occurrences of Asbestos in Oregon and Washington

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Introduction

This map and the accompanying dataset (***asbestos_sites.xls***) provide information on 51 natural occurrences of asbestos in Washington and Oregon, using descriptions found in the geologic literature. Data on location, mineralogy, geology, and relevant literature for each asbestos site are provided in the aforementioned digital file. Using the map and digital data in this report, the user can examine the distribution of previously reported asbestos occurrences and their geologic characteristics in the northwestern United States. This report is part of an ongoing study by the U.S. Geological Survey to identify and map reported natural occurrences of asbestos in the United States, which thus far includes reports of similar format for the Eastern United States (Van Gosen, 2005), the Central United States (Van Gosen, 2006), the Rocky Mountain States (Van Gosen, 2007a), and the Southwestern States (Van Gosen, 2008). These reports are intended to provide Federal, State, and local government agencies and other stakeholders with geologic information on natural occurrences of asbestos.

The file ***asbestos_sites.xls*** was compiled through a systematic search of the geologic literature. Although this asbestos dataset represents a thorough study of the published literature, it cannot be construed as a complete list. An asbestos site was included only when the literature source specifically mentioned asbestos and (or) described the commonly recognized asbestos minerals as occurring in the asbestiform crystal morphology. No attempt was made to infer the presence of asbestos if asbestos was not explicitly described. The user should refer to the references cited for each asbestos site entry for descriptions of these occurrences. These asbestos occurrences were reported to exist in outcrop exposures or rock exposed by exploration and mining operations. Note that these site descriptions apply to the time of each report's publication. No field verification of the sites was performed, nor were evaluations of potential exposure made at these sites. Many of the sites are likely to have been subsequently modified by human activities since their description. For example, since the time that the source literature was published, there may have been remediation of the site or it may have been either exposed or covered by recent development.

What is Asbestos?

The history of asbestos discovery and usage is at least 5,000 years old, extending back to the ancient civilizations in Greece and what is now Italy (see Ross and Nolan, 2003). Historically, asbestos is a generic commercial-industrial term used to describe a group of specific silicate minerals that form as long, very thin mineral fibers, which can form bundles. When handled or crushed, asbestos bundles readily separate into individual mineral fibers. The special properties of commercial-grade asbestos—long, thin, durable mineral fibers and fiber bundles with high tensile strength, flexibility, and resistance to heat, chemicals, and electricity—have made it well suited for a number of commercial applications (Bowles, 1955; Ross, 1981; Zoltai, 1981; Cossette, 1984; Ross and others, 1984; Skinner and others, 1988). Asbestos has been primarily used for its insulating and fire-resistant properties in many types of products (see Virta, 2006; Ross and Virta, 2001).

Currently, most commercial and regulatory definitions of asbestos include chrysotile, the asbestiform member of the serpentine group, and several members of the amphibole mineral group, including the asbestiform varieties of (1) riebeckite (commercially called crocidolite), (2) cummingtonite-grunerite (commercially called amosite), (3) anthophyllite (anthophyllite asbestos), (4) actinolite (actinolite asbestos), and (5) tremolite (tremolite asbestos). Other amphiboles are known to occur in the fibrous and (or) asbestiform habit (Skinner and others, 1988), such as winchite, richterite (Wylie and Huggins, 1980; Meeker and others, 2003), and fluoro-edenite (Gianfagna and Oberti, 2001; Gianfagna and others, 2003).

Historically, chrysotile has accounted for more than 90 percent of the world's asbestos production, and it presently accounts for over 99 percent of the world production (Ross and Virta, 2001; Virta, 2002). Mining of crocidolite and amosite deposits accounts for most of the other asbestos production, and small amounts of anthophyllite asbestos have been mined in Finland and the United States in the past (Ross and Virta, 2001; Van Gosen, 2005). Asbestos is no longer mined in the United States, since the last U.S. asbestos operation closed in 2002; this mine worked a large chrysotile deposit in the Coalinga district of central California.

Mounting evidence throughout the 20th century indicated that inhalation of asbestos fibers caused respiratory diseases that have seriously affected many workers in certain asbestos-related occupations (Tweedale and McCulloch, 2004; Dodson and Hammar, 2006). Airborne exposures to asbestos have been linked to a number of serious health problems and diseases, including asbestosis, lung cancer, and mesothelioma. Information on the health effects of asbestos is available online at http://www.epa.gov/asbestos/ and http://www.atsdr.cdc.gov/asbestos/.

A number of United States governmental regulations address worker exposure to asbestos released during the handling of introduced asbestos–containing products, in shipbuilding and general construction sites, during building demolition or remodeling where asbestos containing materials ("ACM") may be encountered, and during the repair or replacement of commercial asbestos-based products, such as some brake components. There also are regulations governing the release and exposure of asbestos into the environment from manufacturing, mining, and other occupational sites. Federal regulations are listed in the Code of Federal Regulations (available online at http://www.gpoaccess.gov/cfr/).

Less straightforward is the regulation and management of the natural occurrences of asbestos, often referred to as "naturally occurring asbestos" (NOA). These natural asbestos deposits have gained the attention of regulatory agencies, health departments, and citizen groups. NOA includes minerals described as asbestos that are found in-place in their natural state, such as in bedrock or soils. Natural occurrences of asbestos are of concern due to potential exposures to microscopic fibers that can become airborne if asbestos-bearing rocks are disturbed by natural erosion or human activities (road building, urban excavations, agriculture, mining, crushing, and milling, as just a few examples). The geology of asbestos and its application to identifying and managing the natural deposits is explained in Van Gosen (2007b). Several examples of occupational and environmental exposures to natural asbestos occurrences are described in Churchill and Hill (2000), Nolan and others (2001), Clinkenbeard and others (2002), Gianfagna and others (2003), Peipins and others (2003), Ross and Nolan (2003), Burragato and others (2005), Meeker and others (2006), Sullivan (2007), and Horton and others (2008). United States Federal asbestos regulations do not *specifically* address occupational exposures to natural occurrences of asbestos, nor do they mention every variety of asbestiform amphibole.

The history and study of asbestos and its many complex issues are also discussed in Campbell and others (1977), Ross (1981), Stanton and others (1981), Zoltai (1981), Levadie (1984), Skinner and others (1988), Mossman and others (1990), Occupational Safety and Health Administration (1992), Guthrie and Mossman (1993), van Oss and others (1999), Virta (2002), Plumlee and Ziegler (2003), Dodson and Hammar (2006), and Fubini and Fenoglio (2007).

Natural Occurrences of Asbestos in the Northwestern United States

Oregon's asbestos deposits. All of the reported natural asbestos occurrences in Oregon appear to be related to the alteration of an ultramafic rock, specifically olivine-rich rocks (dunite, peridotite) that were serpentinized. As a result, the reported asbestos-bearing localities in Oregon occur where ultramafic rocks are most abundant, which are the east-central and southwestern regions of the State (Krevor and others, 2009).

Asbestos was once commercially produced on a small scale from three locations in Oregon—the Mount Vernon deposit in Grant County, the Raspberry Creek deposit in Jackson County, and the L.E.J. Asbestos mine in Josephine County.

The Mount Vernon chrysotile deposit (site number 14) was worked by the Coast Asbestos Company beginning in 1959, then again in 1961 and 1962 (inactive in 1960). The mine and its mill were located on Beech Creek, about 3 miles northeast of Mount Vernon in Grant County. The deposit consisted of thin, cross-fiber and slip-fiber chrysotile veins within a narrow, northeast-trending body of serpentinite (Bright and Ramp, 1965). Wagner (1963) describes in detail the pilot mill program that was operated on-site by Coast Asbestos Company; the fiber processing involved many steps and was designed to potentially reach a capacity rate estimated at 5,000 pounds of recovered fiber per 8-hour shift.

In 1943, along Raspberry Creek, Jackson County, a narrow lens of matted tremolite asbestos was mined from shallow trenches (site number 17). The workings were on the south side of Raspberry Creek, about a quarter mile to the west of the west fork of Evans Creek, Jackson County. Reportedly, that year the mine produced 600 pounds of fiber that was sold at $600 per ton (Bright and Ramp, 1965). The primary tremolite asbestos lens was described as no more than 1 foot in width, occurring in serpentinite near a contact with metavolcanic rocks.

The L.E.J. Asbestos mine (site number 21) was located on the southwest side of Bolt Mountain, about 6 miles southwest of Grants Pass in Josephine County. This mine produced a relatively small amount of tremolite asbestos from cuts and trenches; about 3 tons of hand-sorted ore was shipped in 1952 (Bright and Ramp, 1965). Slip-fiber tremolite associated with talc occurred in a northeast-trending fracture or sheer zone, 4 inches to 2 feet thick, within a serpentinite.

Washington's asbestos deposits. Washington contains many known asbestos occurrences, many of which experienced past asbestos exploration. But, the State's asbestos production was modest, apparently limited to two small amphibole asbestos operations—at a site near Lyman in Skagit County and a mine near Alta Lake in Okanogan County.

In 1891 (possibly earlier), an amphibole asbestos deposit near Lyman, in Skagit County (site number 41), was "uncovered for a distance of 75 feet, and at the cropping is said to be eight feet in width"; it was described as a "wonderful asbestos deposit" and "of excellent quality, the fibers, fine as silk, being in some instances as much as 18 inches in length" (Engineering and Mining Journal, 1891, p. 362). Engineering and Mining Journal (1896, p. 135) records that the first shipment comprised 75 tons and noted "there are now 15 horses employed packing from the mine to the [Skagit] river and from there it is hauled on a wagon to the railroad." The precise location of this asbestos deposit is vague, described simply as near "Hamilton" across the Skagit River from Lyman. The property reportedly included 11 claims (Glover, 1936). The asbestos of this deposit is described as amphibole asbestos of unspecified variety. The geology of the deposit is also not reported. A geologic map (Tabor and others, 2003) of the area suggests the host rock is most likely greenschist.

Amphibole asbestos (unspecified type) was once mined from an open pit located about 1 mile from Alta Lake and 6 miles southwest of Pateros in Okanogan County (site number 37). Patty and Glover (1921, p. 107-108) describe active mining and processing of this material that occurred during 1921 by the Asbestomine Company: "This company grinds together short-fibred [sic] amphibole and diatomaceous earth and the resultant product is the base for both a fireproof and a cold water paint which they manufacture. Some of the material has also been made up into a plaster." Their brief description of the deposit indicates that the amphibole forms massive lenses, in part altered to talc, near the margins of granitic rocks. A geologic map (Gulick and Korosec, 1990) of the area suggests that the host rock may be an altered amphibolite.

In northern Whatcom County, the Sumas Mountain landslide (site number 51) deposits approximately 30,000 to 120,000 cubic yards of material annually into Swift Creek and the Sumas River. The landslide material comprises ultramafic rock boulders and disaggregated and weathered ultramafic rock, which each contain chrysotile. For several decades, landslide material has been dredged from Swift Creek to reduce local flooding. Some of the chrysotile-bearing, dredged materials have been used locally as fill material in construction projects, as road bedding, and other purposes. The U.S. Environmental Protection Agency has been sampling and studying the dredged landslide materials to evaluate the potential asbestos exposures to local residents and stakeholders and to seek solutions for managing this active, asbestos-generating natural system (Wroble, 2009).

Although it was not specifically described as an asbestos producer, noteworthy is a quarry that operated sometime in the 1930s on Burlington Hill, overlooking the town of Burlington in Skagit County (site number 56). According to Glover (1936, p. 14), "Asbestos-Talc Products of Washington, Inc., of Burlington, Skagit County, mines a somewhat fibrous soapstone-actinolite mixture that has developed in shear zones cutting greenstone. It is ground, mixed with asbestos and use [sic] for special cements."

The asbestos occurrences in Washington are not exclusively hosted by altered ultramafic rocks. As examples, (1) "serpentine" asbestos at the California gold-silver mine (site number 35) is hosted by metamorphosed volcanic rocks, and (2) chrysotile at the Coffin asbestos prospect (site number 40) occurs in thin serpentine veins within marble, which formed from the contact metamorphism of a dolomitic carbonate rock.

Fibrous Amphiboles in the Northwestern United States

During this study, several examples were noted in the geologic literature that mentioned the presence of fibrous amphiboles in developed mineral deposits (such as metal mines and prospects) or in undisturbed outcrops. These examples are shown on the map and described in a separate dataset (***fibrous_amphiboles.xls***). Amphibole asbestos was not specifically mentioned in the descriptions of these deposits. However, these sites indicate geologic settings with the potential to host asbestos. The geologic settings for these examples of fibrous amphiboles are similar to those that elsewhere form and host the reported asbestos. Thus, a discovery of asbestos in these areas would not be unusual from a geologic standpoint. Also, the distinction between "fibrous" amphibole and "regulatory" amphibole asbestos is often not clear-cut in natural amphibole-bearing deposits. The regulatory criteria for the analyses of commercial-grade amphibole asbestos do not always apply well to the natural occurrences of fibrous to asbestiform amphiboles; thus, these occurrences require site-specific detailed microscopic analyses (Meeker and others, 2006).

Digital Databases

The asbestos database (***asbestos_sites.xls***) summarizes information found in geologic references examined by the author. The entries in the database are sorted by State and descending order of latitude (north to south). Each asbestos site entry in the database includes these data fields:

Site number

Number used to identify the dataset entries with their corresponding locations on the map.

State

The State in which the reported asbestos occurrence, prospect, or mine occurs, using the two-letter U.S. Postal Service abbreviation.

Site name as reported

The name of the former asbestos mine, former asbestos prospect, or reported occurrence, matching the nomenclature used in the source literature.

Development

This field indicates whether the asbestos site represents a former asbestos mine, former prospect, or an occurrence. "Past producer" indicates that the deposit was mined and produced asbestos ore for commercial uses sometime in the past. "Past prospect" indicates that the asbestos deposit was once prospected (evaluated) for possible commercial use, typically by trenching and (or) drilling, but the deposit was not further developed. "Occurrence" indicates that asbestos was reported at this site. The occurrence category includes (1) sites where asbestos-bearing rock is described in a geologic map or report; and (2) asbestos noted as an accessory mineral or vein deposit within another type of mineral deposit.

Latitude

The latitude of the site's location in decimal degrees, measured using the North American Datum of 1927. The number of significant figures following the decimal point indicates the believed accuracy of the location: (1) two significant figures (for example, 44.03) indicates an approximate location based on a general description, (2) three significant figures (for example, 44.094) indicates a fairly accurate location based on a detailed description or location shown on a small-scale map (1:50,000 scale or smaller), and (3) four significant figures (for example, 42.5586) indicates a precise location based on a detailed description or a location shown on a large-scale map (1:24,000 scale or larger).

Longitude

Longitude was calculated in the same manner as latitude.

Asbestiform mineral(s) reported

This field identifies the type of asbestos present as described in the source literature.

Associated mineral(s) reported

Minerals mentioned in association with the asbestos, as they were described in the source literature. The order in which each mineral is listed does not necessarily indicate its relative abundance in the deposit, but rather its order of mention in the source report.

Host rock(s) reported

The host rock(s) for the asbestos is (are) listed when available as described in the source literature.

References

The references used to compile the site information are listed in this field. The full reference citations are provided in the accompanying digital files ***References.pdf*** and ***References.xls.***

Another database, ***fibrous_amphiboles.xls,*** lists seven localities where fibrous amphiboles are described in the geologic literature. This database is organized in a manner similar to ***asbestos_sites.xls*** with the exception of two data fields:

(1) The data field "Site type" replaces the data field "Development."

(2) The data field "Fibrous amphibole(s) description" replaces the data field "Asbestiform mineral(s) reported." This field contains short excerpts of amphibole description, quoted directly from the geologic literature.

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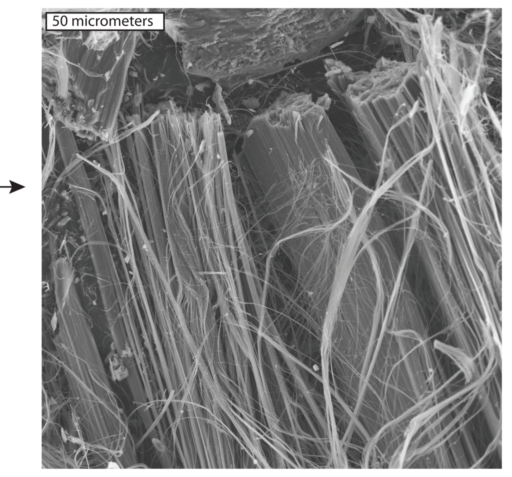
Number and Type of Reported Asbestos Sites in Oregon and Washington

State	Former asbestos mine	Former asbestos prospect	Asbestos occurrence
Oregon	3	7	12
Washington	2	7	20
	5	14	32

The Sumas Mountain landslide in northern Whatcom County, Washington. This earthflow carries chrysotile-bearing debris into Swift Creek below on a continual basis.

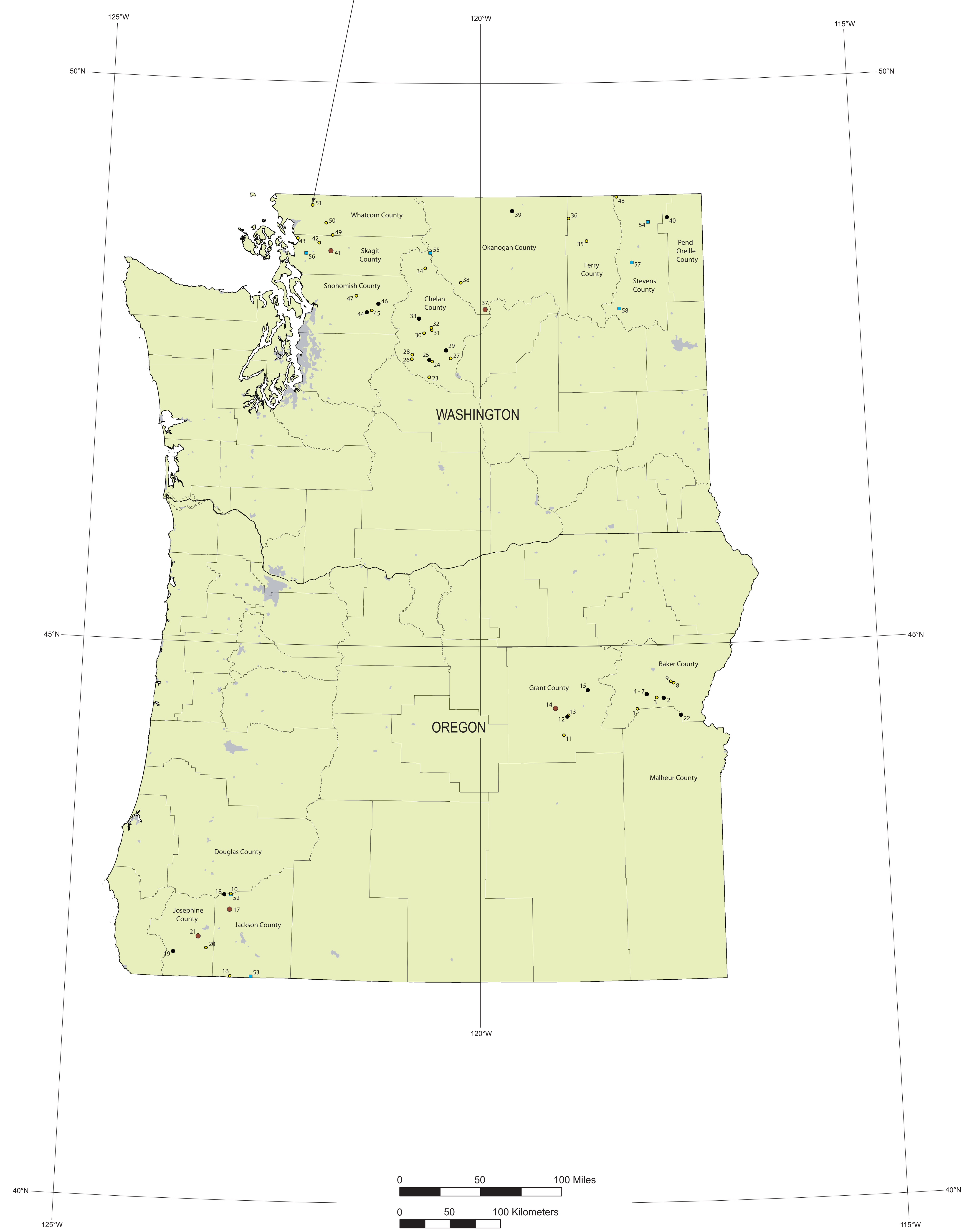


Scanning electron microscope microphotograph of chrysotile from the Sumas Mountain landslide (site number 51). Photograph by the U.S. Geological Survey Denver Microbeam Laboratory.

Reported Asbestos and Fibrous Amphibole(s) Occurrences in Oregon and Washington

EXPLANATION
[Site number corresponds to a specific entry in the dataset]

- Former asbestos mine
- Former asbestos prospect
- Reported asbestos occurrence
- Reported fibrous amphibole(s)
- Urban area



Projection: Lambert Conformal Conic
False Easting: 0.00000
False Northing: 0.000000
Central Meridian: -120.000000
Standard Parallel 1: 33.000000
Standard Parallel 2: 45.000000
Latitude of Origin: 0.000000
Datum: North American 1927