STATE OF WASHINGTON
DEPARTMENT OF NATURAL RESOURCES
BRIAN J. BOYLE, Commissioner of Public Lands
ART STEARNS, Supervisor

DIVISION OF GEOLOGY AND EARTH RESOURCES
RAYMOND LASMANIS, State Geologist

REPORT OF INVESTIGATIONS 28

TIN, TUNGSTEN, AND MOLYBDENUM GEOCHEMISTRY OF PARTS OF STEVENS AND SPOKANE COUNTIES, WASHINGTON

by

Bonnie B. Bunning

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COVER PHOTO

The Germania mill in Stevens County, Washington. During the 1930's and 1940's, the Germania mine and mill supplied tungsten concentrate to General Electric Company, for use in manufacturing light bulbs. Today the tungsten vein system at Germania is worked out, but the old mine still holds high potential as an exploration target for porphyry molybdenum mineralization.

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TIN, TUNGSTEN, AND MOLYBDENUM GEOCHEMISTRY OF PARTS OF STEVENS AND SPOKANE COUNTIES, WASHINGTON

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Bonnie B. Bunning

ABSTRACT

One hundred and thirty-one rock samples were collected from 51 mines and prospects in Stevens and Spokane Counties during the field seasons of 1981 and 1983. The samples were analyzed for tin, tungsten, and molybdenum. Pulps from an additional 21 rock samples and 13 stream sediment samples taken by the U.S. Forest Service were analyzed for tin.

Twelve prospects in the study population carried anomalously high values of tin, including two prospects, the Young America and the Daisy-Tempest mines, both of which assayed more than 100 ppm tin. One new occurrence of scheelite, molybdenite, and chalcopyrite was discovered, and two former tungsten mines were found to have high potential as porphyry molybdenum targets.

Eight areas are recommended for further study.

INTRODUCTION

LOCATION AND GEOGRAPHIC SETTING

The study area encompasses all of Stevens County and parts of Spokane County lying southeast and northwest of the City of Spokane (fig. 1). In addition to 161 samples taken from this area, 3 were also collected from Pend Oreille County at the Stevens County border, and a fourth was taken from the Romulus mine in Ferry County. Sample descriptions and analytical results for the four extra samples are included in appendix A.

The area is located primarily within the Okanogan Highlands physiographic province, which is characterized by rugged mountains of moderate relief and flat valleys filled with glacial debris (Franklin and Dyrness, 1973). To the south, thick basalt flows of the Columbia Basin province lap northward and eastward onto the mountainous terrain, leaving isolated high points as remnants of the former topography.

The climate is characterized by hot, dry summers and cold, wet winters. Vegetation in the hills ranges from open pine woodlands to dense, brushy forests with local stands of fir and cedar. Grasslands or agricultural crops prevail in the valley bottoms.

GENERAL GEOLOGY

The oldest rocks in the study area are gneissic rocks of the Priest River crystalline complex (also referred to as the Selkirk crystalline complex, Kaniksu-Spokane dome, and Spokane dome) which crop out on Mount Spokane, in the northeast corner of Spokane County. Part of the complex — Hauser Lake Gneiss — has recently been dated at 2.9 billion years (Harms, 1982), an age similar to gneissic rocks in the

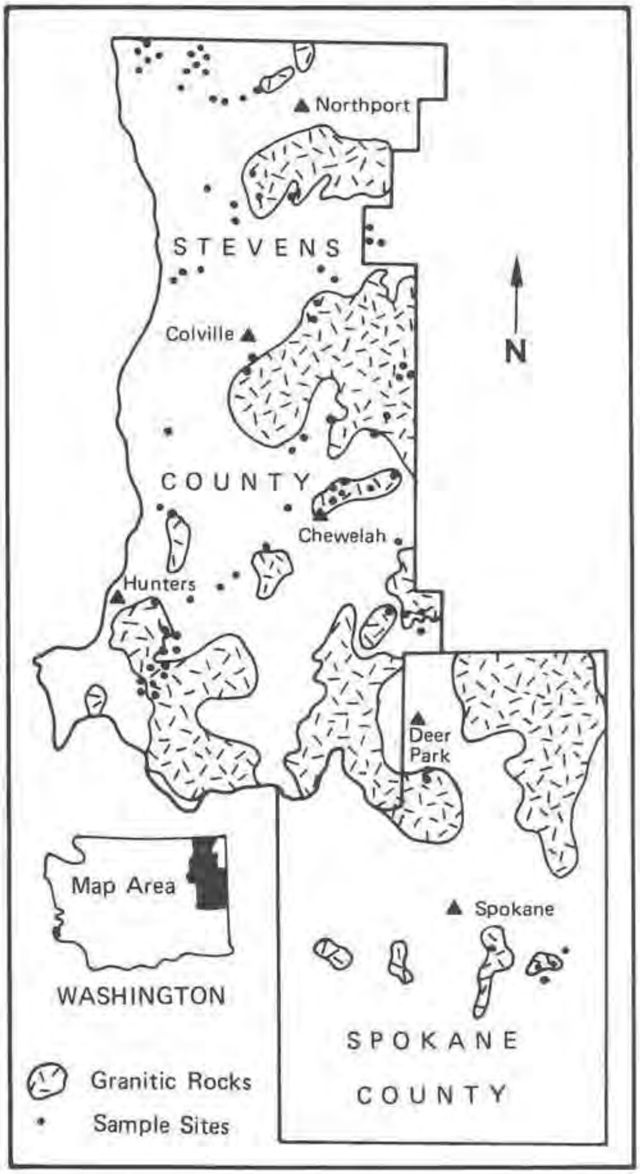

Figure 1. — Location map of the study area, Stevens and Spokane Counties, Washington.

Priest River, Idaho area. These rocks predate the metasedimentary and metavolcanic rocks of the Belt Supergroup and the Deer Trail and Windermere Groups of middle to upper Proterozoic age which are exposed in eastern and central Stevens County.

Upper Precambrian to Jurassic rocks in the area are exposed within the Kootenay Arc, a northeasterly trending tectonic belt of folded and faulted sediments and volcanics welded onto the continent during the Mesozoic Era. Rocks of the Kootenay Arc record as many as three periods of deformation.

The area is extensively intruded by Cretaceous granitic rocks and to a lesser extent by Eocene dikes and plugs. Eocene tuffs and pyroclastic and andesitic flows are of local importance throughout the area. To the south, all lithologies disappear beneath Miocene basalt flows of the Columbia Plateau. Pleistocene deposits and loess of the Palouse Formation are regionally extensive.

OBJECTIVES AND SCOPE OF STUDY

In 1981, the Washington Division of Geology and Earth Resources (WDGER) initiated a geochemical sampling program for tin, tungsten, and molybdenum in parts of Stevens and Spokane Counties. The objectives of the study were to locate areas with geologic potential for tin, tungsten, or molybdenum deposits, and to reevaluate old mines and prospects for occurrences of tin, tungsten, or molybdenum that had been overlooked or unrecognized in the past.

High-grade samples were taken from prospects that (1) reportedly contain tin, tungsten, molybdenum, or copper; (2) are found near the reported occurrences; or (3) are geologically favorable for tin, tungsten, or molybdenum deposits. Sites identified as anomalously high by 1981 field work were revisited in 1983. At that time, the 1981 samples were duplicated (to the extent possible), and additional samples were taken to trace the source of the anomaly.

Mine sampling of high-grade material provided a quick look at the untested potential of known properties in the area. A more detailed evaluation of the geology, alteration, veining, and ore mineralogy at each site supplemented the sample results.

One hundred and thirty-one samples were taken by WDGER, and pulps from an additional 21 rock samples and 13 stream sediment samples were obtained from the U.S. Forest Service and analyzed for tin.

STUDY METHODS

Eighty-five rock-chip samples from 51 mines and prospects were collected in 1981. Samples consisted of one to two pounds of the most highly mineralized rocks available in outcrops or on the mine dumps. A reference suite of hand specimens was also collected at each site. Sample descriptions are recorded in appendix A, table A-1.

Ten prospects found to be anomalous in either tin or tungsten were revisited during the 1983 field season (appendix A, table A-2). Repeat high-grade samples were collected as a check on the 1981 data. Rock-chip samples of the wall rocks, host rocks, or single minerals were also collected to help characterize the anomalously high deposits. Forty-four samples were collected in 1983.

To extend coverage to northern Stevens County (not originally included in the WDGER field area), sample pulps from a geochemical study of the Colville National Forest (Grant, 1982) were acquired from the U.S. Forest Service. Thirty-four samples (21 rock and 13 stream sediment), shown as anomalously high in tungsten or molybdenum in the 1982 report, were split and analyzed for tin. The results showed three samples with anomalously high tin values. Sample descriptions listed in appendix A, table A-3, are taken from the U.S. Forest Service report.

The 1981 samples were prepared by the U.S. Bureau of Mines in Spokane. Following standard digestion procedures, splits of the minus 100-mesh fraction were analyzed for molybdenum at Eastern Washington University, and splits for tin and tungsten were analyzed at Silver Valley Laboratories, in Osburn, Idaho. Tin and molybdenum were analyzed by atomic absorption spectroscopy (detection limits of 2 ppm and 1 ppm, respectively); tungsten was determined colorimetrically (detection limit of 10 ppm). All 1983 samples were processed by Silver Valley Laboratories. Pulps of the U.S. Forest Service samples are stored at the Early Winters U.S. Forest Service camp, near Mazama, Washington.

Statistical analysis of the total population and smaller populations within the total was attempted without success. The failure is attributed to the small population size and to the diversity of the samples. A collection of high-grade mine samples from different geologic settings cannot be treated meaningfully as a single population. Anomalously high values were determined subjectively.

Analytical results were plotted on mylar overlays of 1:250,000-scale quadrangle maps. A set of reduced-scale sample location maps is included in this report (appendix B, figs. B-1 through B-8).

ACKNOWLEDGMENTS

The author appreciates the assistance of Mohammed Ikramuddin who analyzed the 1981 samples for molybdenum at Eastern Washington University. Thanks are also extended to personnel of the U.S. Bureau of Mines in Spokane, who prepared the 1981 samples for analysis; and to Hawley Woolschlager of the U.S. Forest Service in Okanogan for facilitating the acquisition of U.S. Forest Service sample pulps for tin geochemistry.

GEOLOGIC MODELS

Copper, molybdenum, tungsten, and tin deposits are commonly, but not exclusively, associated with granitic rocks of quartz diorite to alkali granite composition. Granite-hosted deposits of copper, molybdenum, tungsten, and tin are each found under a relatively restricted range of geologic conditions, which together overlap along a continuum described by magmatic differentiation and tectonic proximity to the continental margin (fig. 2). Copper deposits and tin deposits form the respective end members in this comparison. Differences in deposit type are partly controlled by the source pluton's composition, origin, cooling history, and tectonic setting. Ideal deposit types have been classified by numerous workers and were used as models for this study; their general characteristics are summarized below (Taylor, 1979; Westra and Keith, 1981; Hobbs and Elliott, 1973; Einaudi and others, 1981).

TIN DEPOSITS

Primary tin deposits are almost exclusively associated with granite or biotite-granite source rocks. Most tin granites originated in the crust and were formed from pre-existing rocks by ultrametamorphism. Some tin-bearing granites are thought to have originated in the upper mantle, acquiring their peraluminous composition through crustal assimilation during emplacement. Tin-bearing granites occur within the continental portion of a convergent plate boundary, or within zones of crustal extension.

Tin granites are enriched in fluorine, boron, bismuth, tungsten, lithium, beryllium, rubidium, and molybdenum and are notably depleted in strontium and barium. Ratios of strontium 87 to strontium 86 are characteristically high. Granites which host tin deposits may or may not be geochemically enriched in tin outside of the

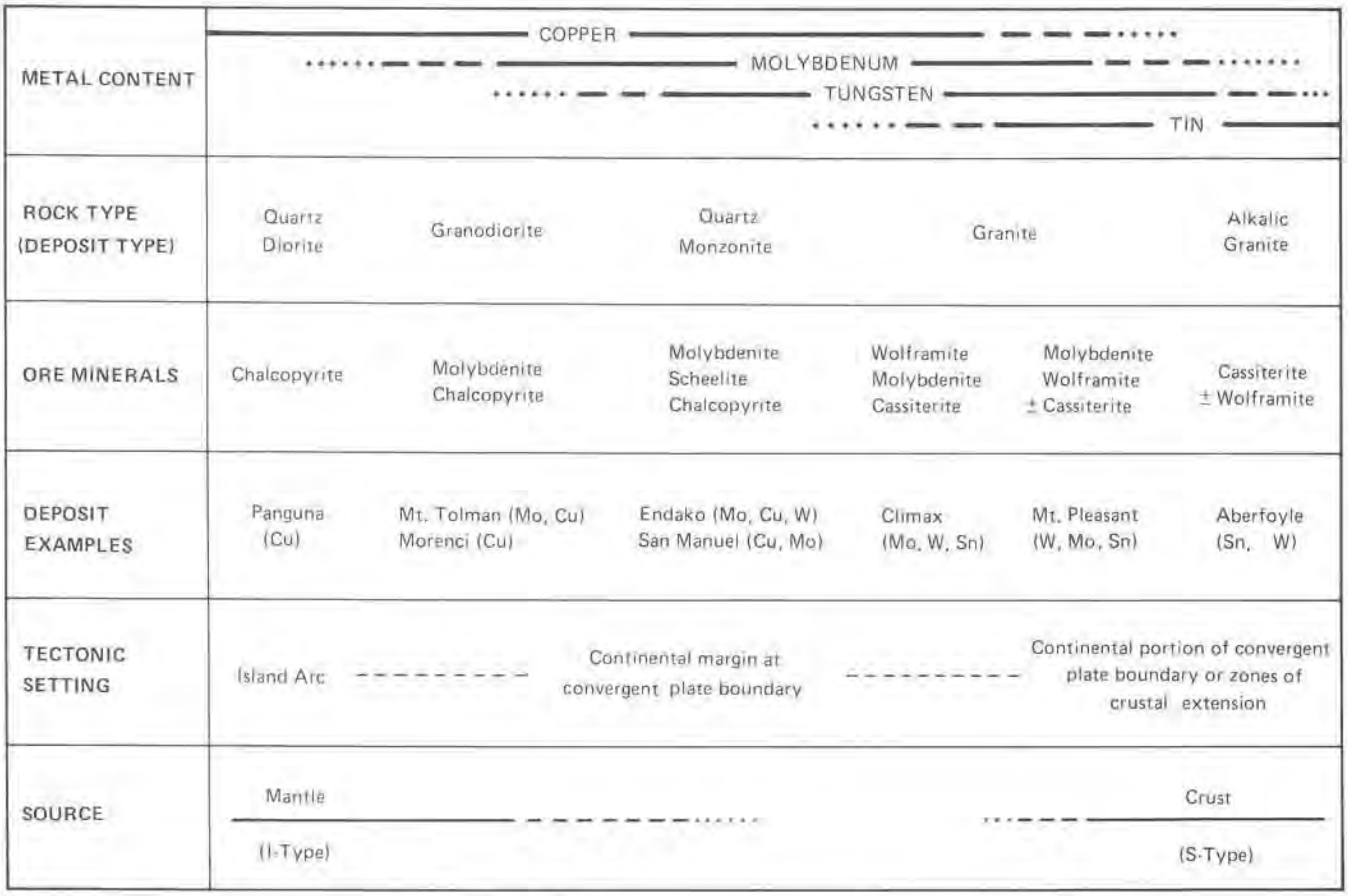

Figure 2. — Relationships of tin, tungsten, molybdenum, and copper deposits in granitic rocks

deposit area. The peraluminous composition of tin granites is indicated by the common presence of muscovite, garnet, cordierite, topaz, and corundum. Tin granites are often found in regions of high-grade regional metamorphism and are emplaced passively by stoping rather than by brittle fracture. Tin granites fit into the S-type granite classification of Chappell and White (1974) and into the ilmenite series granitoids of Ishihara (1981).

Deposits of tin are known from the Precambrian to the Tertiary, but are especially concentrated in Paleozoic and Cretaceous orogenic belts. The deposits take the form of veins, disseminations, and pegmatites within granite, as contact and replacement deposits in reactive rocks adjacent to granite, or less commonly, as zoned veins and fracture fillings in subvolcanic sulfide deposits.

Kaolinization and greisenization consisting of quartz and muscovite with topaz, fluorite, tourmaline, and beryl are common alteration types of granite-hosted deposits. Cassiterite (SnO_2) and stannite (Cu_2FeSnS_4) are the principal ore minerals.

MOLYBDENUM DEPOSITS

Molybdenum ore deposits occur in rocks of granodiorite to granite composition, most commonly in quartz monzonite porphyry or granite. Those with composition in the granodiorite to quartz monzonite range (calc-alkaline deposits) are closely associated with porphyry copper deposits with copper-to-molybdenum ratios approaching 1:1 in some cases (Mount Tolman). Those at the granite end of the spectrum (granite or Climax-type deposits) are generally of higher grade, are enriched in tungsten and tin, and are relatively depleted in copper. Tungsten is a common associate of molybdenum, occurring as scheelite or powellite in the calc-alkaline porphyry molybdenum deposits, and as huebnerite or wolframite in granite stockwork deposits. In some cases, as at the Ima mine in Idaho, tungsten-quartz vein deposits emanate from a stockwork molybdenum system. Tin is found in trace amounts in granite molybdenum systems and is produced as a byproduct of molybdenum mining at the Climax mine, in Colorado.

In contrast to tin deposits, which occur at the tops of passively emplaced sheetlike or batholithic-scale plutons, molybdenum deposits occur in small, more or less cylindrical stocks derived from an underlying batholith, and are emplaced at a high level above the parent body. The small stocks show forceful intrusion, evidenced by doming, ring dike complexes, breccia pipes, and stockwork fracturing.

Granitic rocks which host molybdenum deposits are differentiated phases of more mafic magma, most likely derived from the mantle. Molybdenum deposits are found at convergent plate boundaries and areas of crustal extension. The stocks are commonly emplaced high enough in the crust to have had an associated volcanic phase. Calc-alkaline molybdenum deposits are enriched in copper, tungsten, and fluorine, while granite-hosted deposits are anomalously high in tungsten, tin, fluorine, bismuth, and uranium. Molybdenite (MoS_2) is the only important ore mineral, and is carried in quartz veins and veinlets, or as a "paint" on fracture surfaces. Tungsten in veins and stockworks is commonly associated with molybdenum. In some molybdenum districts, peripheral late base-metal/silver veins associated with the molybdenum system have also been mined.

Alteration patterns in molybdenum deposits are approximately concentric, reflecting convective cooling around the stock. The four most common stages of alteration are as follows:

1. Potassic: Veinlets and pervasive replacement by potassium feldspar and biotite associated with the ore horizon.

2. Quartz-sericite-pyrite (phyllic): Pervasive stockwork alteration in a halo concurrent with and extending beyond the ore zone.

3. Argillic: Alteration of feldspars to clay minerals and sericite to varying degrees extending beyond the ore zone.

4. Propylitic: Alteration of mafic minerals and plagioclase to chlorite, epidote, calcite, and clay minerals at a distance from the orebody.

TUNGSTEN DEPOSITS

As demonstrated in figure 2, tungsten occurs in geologic environments ranging from calc-alkalic molybdenum-type to granite-hosted tin-type settings. Tungsten is a common byproduct of tin and molybdenum mining. Conversely, some tungsten deposits, such as the Mount Pleasant deposit in Canada, produce secondary molybdenum, while others, like Panasquiera, Portugal, produce secondary tin.

Granite-hosted tungsten deposits are found in the apical portions of granite batholiths, or in late-phase stock complexes where residual, tungsten-bearing fluids collected and were among the last phases to cool. The parent rocks are commonly S-type, peraluminous granites enriched in tungsten, tin, bismuth, fluorine, molybdenum, and rubidium, or quartz monzonite enriched in copper, molybdenum, and fluorine. Tungsten deposits associated with tin are found in granite batholiths emplaced passively into high-grade metamorphic rocks. Those deposits more closely related to molybdenum systems are found in granitic stocks emplaced forcefully by multiphase intrusion. Both types are found at convergent plate boundaries or continental zones of extension.

Tungsten as wolframite, $(Fe,Mn)WO_4$, and as scheelite, $CaWO_4$, occurs in veins, veinlets, and disseminations accompanied by greisen-type alteration consisting of quartz and muscovite with topaz, fluorite, and tourmaline. Cassiterite and molybdenite are common secondary ore minerals, along with bismuth, bismuthinite, stannite, and, less commonly, chalcopyrite, tetrahedrite, arsenopyrite, galena, and sphalerite.

Tungsten-bearing skarns are economically the most important sources of tungsten. They occur near coarsely crystalline, batholithic-scale intrusions of granodiorite to quartz monzonite composition and are often associated with calc-alkalic volcanics in a continental margin tectonic setting. Tungsten skarns were formed in a deeper and hotter (300° C to 600° C) environment than other types of calcic skarn deposits.

Tungsten skarns typically replace impure, argillaceous carbonates, developing a stratiform appearance within one or more favorable beds of limited thickness. Tungsten skarns are enriched in tungsten, molybdenum, and copper, as well as zinc and bismuth in some cases. Scheelite, the predominant tungsten mineral, is often accompanied by pyrrhotite, chalcopyrite, pyrite, molybdenite, sphalerite, magnetite, bismuth, bismuthinite, arsenopyrite, and galena.

Alteration in the source intrusive (endoskarn) is limited to a narrow zone of clinopyroxene, plagioclase, and epidote, or, in some cases, quartz, plagioclase, pyroxene, and muscovite. Skarn minerals in the exoskarn are formed in both prograde and retrograde events which in some cases improve tungsten grade. Prograde, high-temperature minerals which may form in the stratiform skarn are hedenbergite, grossularite-andradite garnet, wollastonite, plagioclase, and idocrase. As the system cools, retrograde alteration takes place, forming hornblende, biotite, plagioclase, apatite, and chlorite, with clinozoisite, sphene, tremolite, fluorite, and muscovite.

PAST PRODUCTION IN THE STUDY AREA

TIN (SILVER HILL MINE)

PRODUCTION

The most significant occurrence of tin in the study area is the Silver Hill deposit, 11 miles southeast of Spokane in secs. 23 and 24, T. 24 N., R. 43 E. (fig. 3). The area was first prospected for graphite in graphitic schists, and later for silver, when a quartz vein bearing argentiferous galena was discovered. Cassiterite was identified in 1906, and mining began the following year (Collier, 1907). One hundred and twenty-five tons of ore grading 3 to 6 percent tin was mined from the deposit, but none of the ore was shipped, and no new ore has been developed by intermittent prospecting efforts since the first years of operation. Only one outcrop has produced all the tin ore presently stockpiled at Silver Hill. In the early 1940's, the U.S. Bureau of Mines and the U.S. Geological Survey evaluated the prospect for its strategic metals potential, concentrating their efforts on the several tungsten veins and one occurrence of beryl on the property (Page, 1942).

GEOLOGY AND MINERALIZATION

According to Page (1942), three types of tin-bearing pegmatites — sillimanite-andalusite pegmatite, feldspar-quartz pegmatite, and massive quartz pegmatite — are arranged in four en echelon zones trending approximately N. 25° W. across Silver Hill. Shattered cassiterite crystals up to several inches long are most abundant in the sillimanite-andalusite pegmatite of zone one, where chip sampling has shown an average grade of 3.6 percent metallic tin. Feldspar-quartz pegmatite and associated sillimanite-andalusite pegmatite of zones two through four carry disseminated cassiterite of a much lower grade. The principal gangue minerals are sillimanite, andalusite, orthoclase, and quartz. Plagioclase, microcline, muscovite, tourmaline, garnet, biotite, and corundum are less common constituents. Fluorite, beryl, and columbite-tantalite have also been reported (Page, 1942). Scheelite pseudomorphs of wolframite occur in quartz veins, quartz pegmatite, and schist. At least eight separate tungsten-bearing veins have been found.

Figure 3. — Location map of past producers of tin, tungsten, and molybdenum.

Biotite-tourmaline pegmatites in the area are younger than the tin-bearing pegmatites and are not mineralized.

Host rocks for the pegmatite pods are biotite, tourmaline, graphite and sillimanite gneisses, and quartzite of the Priest River crystalline complex. Similar gneissic rocks near Newport, Washington, have recently yielded ages of 2.9 billion years (Harms, 1982). Granite in the mine area displays moderate foliation and is considered by Weiss (1968) to be a product of ultrametamorphism of Precambrian sediments. Predominantly unfoliated aplite, alaskite, and two-mica granite extensively intrude the metamorphic complex in the Mount Spokane area. Those rocks are all believed to be Cretaceous in age, and at least partly derived from the Precambrian rocks by partial anatexis during Cretaceous time.

The tin-bearing pegmatites of Silver Hill most likely formed from high-temperature metamorphism of Precambrian crystalline rocks in a manner similar to the intrusive rocks on Mount Spokane, and were brought near the surface by extensional tectonics during the Eocene. Additional references on the Silver Hill deposits and surrounding geology can be found in Anderson (1923), Tabor (1941), and Griggs (1966, 1973).

TUNGSTEN (GERMANIA AND GERMANIA CONSOLIDATED MINES)

HISTORY AND PRODUCTION

The Germania mine has had a complex and colorful history since J. S. McClean located the first claims in 1894. Serious development of the mine began when the Germania Mining Company, controlled by German interests and managed by Wilhelm Scheck, came on the scene in 1906. The mine began producing a year later and up until World War I wolframite concentrates from the mine were shipped to the Krupp gun works in Essen, Germany. Production continued until war broke out abroad. In 1914 the last wolframite shipment was taken out of the U.S. on the submarine Deutschland, and the Alien Property Custodian impounded the Germania mine and mill. Before the property was seized, however, a "mysterious" fire destroyed the mill buildings and word circulated that the mine workings had been caved. Correspondence from outraged creditors in Germany indicates that Wilhelm Scheck successfully borrowed money using, as collateral, the claim that he had been offered three million dollars by the German government to destroy the mine and keep it out of "enemy" hands.

The Alien Property Custodian took over what was left of the property in 1914, but lost it in 1923 to the American Tungsten Company (a consortium of McClean family members and former mine employees) for $250 in unpaid taxes. American Tungsten Company operated the mine until the panic of 1929. A year later, in 1930, the mine was purchased by a dairy farmer and sometime miner from Chehalis, Washington, named J. B. Scollard. Scollard operated the mine profitably under the name Tungsten Producers, Inc., selling $600,000 worth of tungsten concentrates to General Electric Co. between 1931 and 1936. He sold the mine to GE's Incandescent Lamp Division in 1936. GE increased the mill capacity, and produced wolframite for internal use off and on until 1943. During that time the Germania mine was the country's leading producer of wolframite.

In 1943 R. H. Mills of Spokane bought the Germania from GE, sold off the mining equipment and leased out the property to James Miller. The mine was inactive until 1951 when Tungsten Mining and Milling Co. acquired the property. The company received a loan grant from the Defense Minerals Exploration Administration (DMEA) in 1952 to help finance new milling equipment. Tungsten Mining and Milling sold the mine to Penticton Mines Ltd. of Canada a year later and minor production continued. When radioactivity was found on the property in the mid-1950's, Penticton Mines reorganized as Tungsten-Uranium Company and explored around the site for uranium. The last recorded production from the Germania mine was in 1955.

During the late 1930's and early 1940's scattered mining operations were in progress on the south end of the vein system, but no production from that time is recorded. One of the operators, Industrial Tungsten Corp., consolidated the properties into Germania Consolidated Mines, Inc., modernized the mill, and began shipping in 1951. The Germania Consolidated continued to produce until 1955 and remained active until 1957 when an influx of foreign tungsten caused prices to plummet from $55 per ton to $12.50. The Germania Consolidated mill burned to the ground in 1960, finally closing a chapter of Washington's mining history. Between 1904 and 1955 the two mines produced approximately 1,028 tons of WO_3.

GEOLOGY

The Germania system is a series of parallel quartz veins that strike N. 29° E. and dip 70° to 80° to the southeast. The veins crosscut metasediments of the Precambrian Togo Formation and granitic rocks of the Cretaceous Loon Lake batholith. The granitic rocks vary widely in texture and composition, ranging from rhyolite to granodiorite. Most of the phases are quartz monzonite with variations in quartz and biotite content, and in nature and style of phenocrysts. According to Du (1979), the mineralization at Germania Consolidated is hosted by quartz monzonite, while at the Germania porphyritic biotite quartz monzonite serves as the host.

MINERALIZATION

Although mineralization is found in several of the veins, almost all production came from the main vein which is described below.

Wolframite (var. ferberite), molybdenite, scheelite, pyrite, arsenopyrite, and galenobismutite are carried in a gangue of quartz with clusters of bright green mica (identified by X-ray diffraction as biotite altering to chlorite). Fluorite and tourmaline have also been reported as gangue minerals. Small, individual crystals of wolframite and molybdenite are found throughout the length of the vein, but ore-grade material is unevenly distributed in large crystal aggregates located in the wider portions of the vein. Scheelite is pseudomorphous after wolframite and also occurs as veinlets crosscutting wolframite crystals.

Molybdenite is found throughout the vein but has never been recovered from the deposit. It is most abundant in the Germania Consolidated workings and on the lowest level of the Germania mine. In both mines, molybdenum replaces tungsten with depth as the major ore metal, vein contacts become gradational, and the wall rocks become pervasively altered and mineralized with pyrite, molybdenite, and wolframite.

ALTERATION

Alteration in the upper levels of the Germania mine is restricted to greisen selvages along quartz veins. Granitic rocks appear nearly fresh, with only minor chloritic alteration. More extensive alteration is reported in the lower Germania workings and at Germania Consolidated, where pervasive bleaching and clay alteration of feldspars is noted. Examples of sericitic alteration of feldspars, silica-molybdenite stockwork veins, and quartz-sericite-pyrite flooding can be found in specimens from the dumps.

The geologic setting, style of mineralization, and alteration are reminiscent of tungsten-molybdenum systems found throughout the western United States. It is quite possible that the mined-out tungsten veins are the upper expression of a porphyry molybdenum system hidden at depth. Additional references on the Germania area can be found in Bancroft (1909, 1914), Purdy (1954), Howd (1956), and Becraft and Weiss (1963).

MOLYBDENUM [DEER TRAIL MONITOR (MONITOR) MINE]

PRODUCTION

Only 17.5 tons of molybdenum concentrate have been produced from the study area. All of the production came from the Deer Trail Monitor (Monitor) mine in the northwest corner of sec. 24, T. 30 N., R. 37 E., near the town of Fruitland (fig. 3). The mine was operated by a small Spokane company between 1936 and 1941.

GEOLOGY

The mine is developed in a band of calc-silicate hornfels skarn interbedded with argillite and argillaceous limestone. The limestone and argillite are mapped by Campbell and Raup (1964) as the Old Dominion Limestone, defined by Weaver (1920). Recent workers (Snook and others, 1981) correlate the Old Dominion Limestone with the Metaline Formation of Middle Cambrian age. The limestone overlies Lower Cambrian Addy Quartzite which crops out to the east. Cretaceous(?) hornblende-biotite granodiorite is exposed to the west and was intersected in the mine workings. Frequent faulting displaces the ore zones.

MINERALIZATION

The ore is confined to contact-metamorphosed limestone bands that carry molybdenite, pyrite, chalcopyrite, pyrrhotite, sphalerite, and galena. Large crystals of molybdenite are commonly associated with coarsely crystalline garnet, epidote, calcite, and actinolite in the metamorphosed zone. It also occurs with sparse pyrite and chalcopyrite disseminated throughout the recrystallized limestone. Galena and sphalerite found in dump material are not closely associated with molybdenite mineralization.

Ore grading 0.28 to 0.46 percent MoS_2 was mined from the deposit in the late 1930's (Huntting, 1956). More than 3,000 feet of workings on three levels exploited the mineralized zone.

FAVORABLE PROSPECTS

TIN

SPOKANE COUNTY

FREEMAN CLAY PIT

NE¼NW¼NW¼ sec. 1, T. 23 N., R 44 E.
Sample numbers: 81-1B, 81-2B, 81-3B, 81-42B, 81-43B, 81-44B, 81-45B, 81-46B, 81-47B, 81-48B, 81-49B

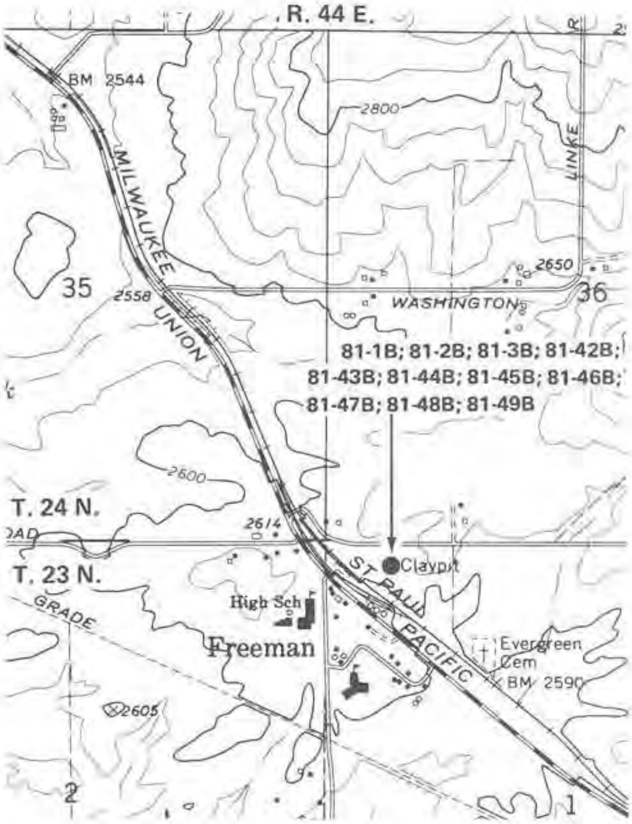

Figure 4. — Sample location map — Freeman clay pit (from USGS Freeman 7.5-minute quadrangle map).

The Freeman clay pit (fig. 4) is reported to carry accessory amounts of zircon, ilmenite, magnetite, cassiterite, topaz, lepidolite, monazite, rutile, and tourmaline in the heavy-mineral fraction of kaolinized dikes (Goodspeed and Weymouth, 1928; Wilson, 1934). The mineral assemblage suggested to early workers that the deposit was of hydrothermal origin. Subsequent workers considered the kaolinite to be a saprolite of pre-Tertiary metamorphic rocks, developed during the subtropical-to-temperate climatic period of the Eocene and Miocene Epochs (Hosterman and others, 1960; Hosterman and others, 1964; Hosterman, 1969).

The intrusive rocks in the Freeman pit are granitic, varying in texture from aplite to pegmatite. All of the granite has been altered to kaolinite, quartz, and sericite. In some areas, fractured lavender quartz or books of muscovite can be found. The granitic rocks intrude paragneiss and quartzite which also have been altered to kaolinite, quartz, and sericite. Quartz, minor coarse muscovite, and various accessories are the only residual minerals. Minor iron-oxide staining can be found in the coarse-grained granite and metasediments, but the deposit as a whole is notable for its bright whiteness and lack of iron oxide.

Three types of dikes and veinlets have been identified. These are (1) granite or pegmatite dikes, (2) quartz-kaolinite veins, and (3) veins of kaolinite with little or no quartz. In at least two cases, the relatively pure kaolinite veins crosscut granite dikes. Selvages of kaolinite in the wall rocks border both kaolinite and quartz-kaolinite vein types. The granite and pegmatite dikes have sharp contacts with no selvage development. In places, quartz-kaolinite and kaolinite veinlets follow bedding in the metasedimentary host rocks.

The Freeman clay pit was studied because of its similarity to the primary tin-kaolin deposits at Cornwall, England. Greisen-bordered tin-tungsten-quartz veins at Cornwall are temporally and spatially associated with kaolinization of biotite-muscovite granite of Late Carboniferous age (Bray and Spooner, 1983). At Cornwall the kaolinite is of primary, hydrothermal origin, characterized by the lack of weathered profiles, halloysite clays, and iron-oxide staining, and by the fact that kaolinization is deep and complete, without intervening areas of unweathered rock.

At Freeman, kaolinization of granite and metasedimentary rocks is also deep and complete, preserving original rock textures. Wilson and Goodspeed (1934) report that a well drilled in the bottom of the pit penetrated 285 feet without striking hard rock. They also note the lack of secondary silica and relict feldspar in the kaolinite of the dikes, and conclude the kaolinite in the dikes is of primary origin. Kaolinite and quartz-kaolinite veins with kaolinite selvages were observed to crosscut all other rock types in the pit. While the depth and style of kaolinization at Freeman match the criteria outlined for hydrothermal kaolinite at Cornwall, strong evidence of tropical weathering in other rocks from the Freeman area argues for a secondary origin.

Kaolinite and quartz-kaolinite dikes are common in the pit, but none were observed to be mineralized, and no stockwork or sheeted veining is present. Sample 81-42B carried 28 ppm tin in kaolinized granite, the highest reading in the pit area (no kaolinite-quartz dikes were isolated for analysis). Twenty-eight ppm tin is well above the crustal average of 3-5 ppm for granitic rocks and within the range 20-40 ppm for some tin-rich granites in which deposits are known to occur (Taylor, 1979). That relatively high value, and the presence of trace amounts of cassiterite, topaz, tourmaline, and lepidolite, make the Freeman pit area an attractive exploration target.

STEVENS COUNTY

HUCKLEBERRY MOUNTAIN AREA

Six ore samples in the range of 38 to 64 ppm tin were taken from four dolomite- or limestone-hosted deposits on the western side of the Huckleberry Mountains. The anomalously high values were obtained from the Deer Trail Monitor (Monitor) mine, the Read prospect, the Togo mine, and the Cleveland mine during both the 1981 and 1983 field seasons. All but the Cleveland mine are located at the contact of Precambrian or Paleozoic carbonate rocks with a hornblende-biotite granodiorite pluton (presumably of Cretaceous age). No direct evidence of an intrusive source is found at the Cleveland mine, but the ore occurs in brecciated carbonate rocks.

According to Nekrasov (1971), many skarn-forming minerals contain significant concentrations of tin. The high values obtained in this study most likely reflect the higher "background" content of skarns, and do not necessarily indicate potential for economic concentrations of tin.

READ PROSPECT

SW¼SE¼ sec. 11 and NW¼NW¼ sec. 14, T. 30 N., R. 37 E.

Sample numbers: 81-98B, 83-12B, 83-13B, 83-14B, 83-15B, 83-16B, 83-17B, 83-18B

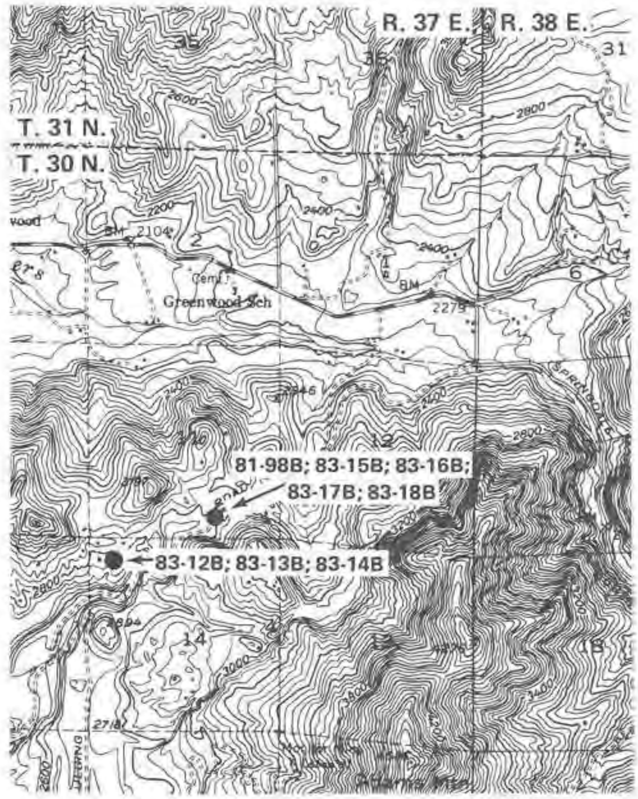

Figure 5. — Sample location map — Read prospect (from USGS Hunters 15-minute quadrangle map).

The Read deposit (fig. 5) is a magnetite-bearing magnesian skarn located at the contact of Cambrian dolomite (Metaline formation?) and granodiorite presumably of Cretaceous age. Prospecting for magnetite and tungsten along the contact zone dates from the early 1900's. No commercial production has been recorded from the property, though a few tons of magnetite were reportedly smelted in Fruitland during the early days.

The mineralogy of the deposit has been discussed in detail by Bennett (1962) and Schaller and Vlisidis (1962). Their combined studies record the minerals listed in table 1.

Two sites along the contact zone were sampled in 1981 to verify and characterize the reported occurrence of scheelite. A sample (81-98B) of magnetite, quartz, garnet, tremolite, wollastonite, and malachite carried only 20 ppm tungsten and 5 ppm molybdenum, with 64 ppm tin. Samples of the granite, dolomite, and magnetite taken in 1983 (83-12B through 83-18B) failed to duplicate the high tin value. The highest value of the 1983 samples was 12 ppm tin from a sample (83-16B) of dolomite at the contact with granodiorite. Sample 83-17B was taken from a

TABLE 1. —*Mineralogy of the Read prospect* *

MINERALS	ABUNDANT	LESS ABUNDANT	MINOR CONSTITUENTS AND ACCESSORY METALS
Metallics	Magnetite	Chalcopyrite Pyrite Pyrrhotite	Scheelite Sphalerite Powellite Tin Titanium Manganese (Molybdenum?)
Nonmetallics	Diopside Ludwigite Forsterite	Almandite Andradite Hedenbergite Wollastonite	Spinel Epidote Tremolite Quartz Potassium feldspar (sanidine) (orthoclase) Plagioclase feldspar (labradorite) Apatite Clinohumite? Tourmaline? Chondrodite Serpentine Calcite Dolomite Fluorite Chlorite

* From Bennett (1962).

garnetiferous zone at the contact to check for the presence of tin-bearing garnet. The garnet was isolated and analyzed by X-ray diffraction, but no tin was found. Stannian ludwigite (a magnesium-iron borate), which selectively replaces forsterite, was identified from this deposit in 1945 (Broughton, 1945). The ludwigite carried 0.2 percent tin within its crystal structure and is probably responsible for the one high value sampled at the prospect in 1981.

DEER TRAIL MONITOR (MONITOR) MINE

NW¼NW¼ sec. 24, T. 30 N., R. 37 E.
Sample numbers: 81-102B, 83-51B, 83-52B

The Deer Trail Monitor (Monitor) mine (fig. 6) is located on Adams Mountain, 1½ miles southeast of the Read prospect. The Deer Trail Monitor (Monitor) mine is a calcic skarn developed in a Cambrian limestone unit along the eastern border of the same hornblende-biotite granodiorite intrusion that forms the Read deposit. At the Monitor, fine-grained molybdenite is disseminated

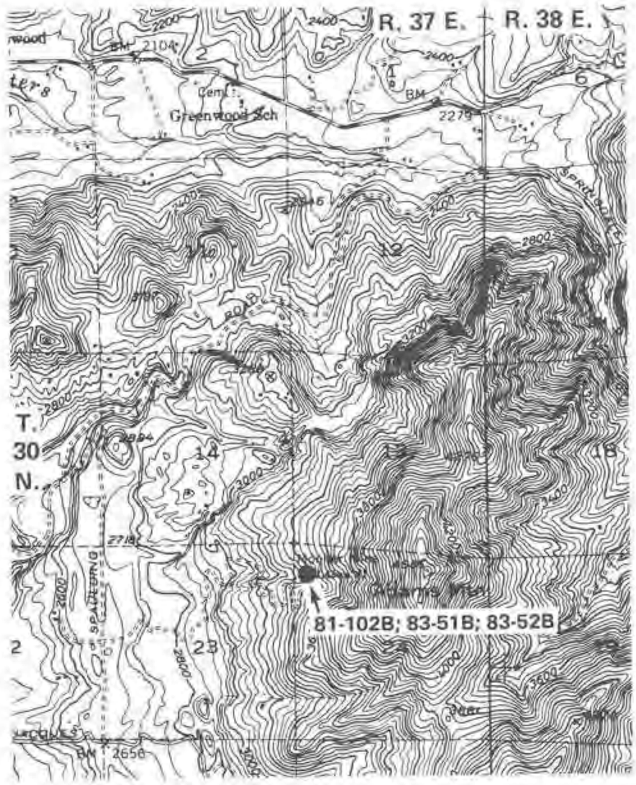

Figure 6. — Sample location map — Deer Trail Monitor (Monitor) mine (from USGS Hunters 15-minute quadrangle map).

in light-green silicified limestone. Large flakes of molybdenite are found in crystal aggregates of garnet, calcite, and epidote. Pyrite, pyrrhotite, and minor chalcopyrite, galena, and sphalerite are the accessory sulfides. A coating of small scheelite crystals was identified on one sample. The workings are presently caved, and outcrops of the contact zone are limited to road exposures in the SE¼NW¼NW¼ sec. 24, T. 30 N., R. 37 E.

At the Deer Trail Monitor (Monitor) mine, euhedral cinnamon-brown crystals of grossularite garnet are selectively developed along the silty partings of tightly folded gray limestone. More intensely contact-metamorphosed limestone is composed of massive green and brown calc-silicate hornfels with pods of coarse crystalline calcite, epidote, green andradite garnet, brown grossularite garnet, and molybdenite. Grossularite shows distinct zoning in thin sections from the calc-silicate hornfels zone. Manganese in the form of pyrolusite is common, especially associated with pink clinozoisite developed at the contact of the limestone and a biotite-granite dike. Abundant sphene was found in thin sections of the granite dike. An extremely fine-grained siliceous rock (quartzite?), cut by quartz-tourmaline veins, that crops out in the mine area is presumed to be the Addy Quartzite which forms the eastern contact of the deposit.

A 1981 sample (81-102B) of molybdenite, pyrite, magnetite, garnet, epidote, calcite, and malachite returned a value of 42 ppm tin with 150 ppm tungsten and 80 ppm molybdenum. A repeat high-grade sample in 1983 (83-52B) carried 3100 ppm molybdenum with no detectable tin. Sample 83-51B was a sample of green garnet isolated from the other minerals. It was analyzed for tin contained in the garnet structure, but none was found.

CLEVELAND MINE

Center NE¼ sec. 9, T. 30 N., R. 38 E. Sample numbers: 81-85B(a), 83-28B, 83-29B, 83-30B

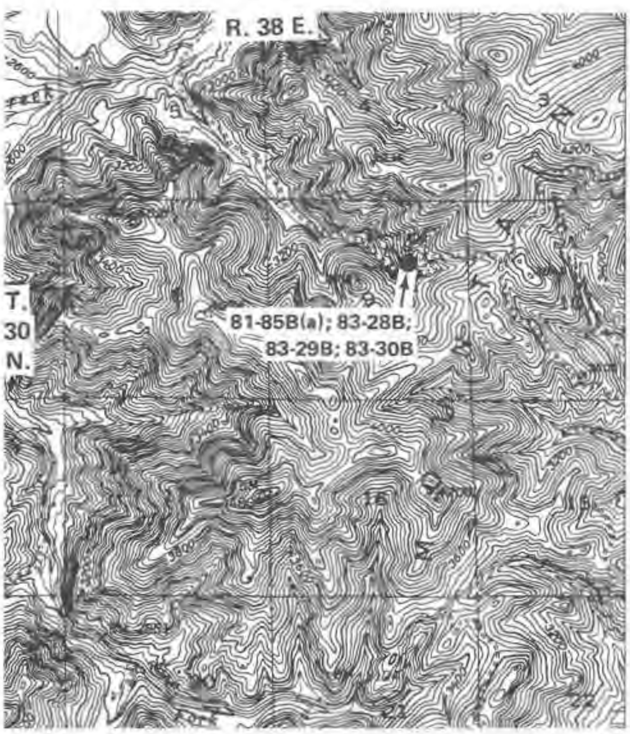

Figure 7. — Sample location map — Cleveland mine (from USGS Hunters 15-minute quadrangle map).

The Cleveland mine (fig. 7) produced lead, zinc, silver, and antimony intermittently from the 1890's to 1947. The ore is a complex of sulfides in brecciated dolomite pods of the Stensgar Formation, near its contact with argillite of the Buffalo Hump Formation. The contact is mapped as a fault in the mine area (Campbell and Raup, 1964). The ore consists of sphalerite, galena, tetrahedrite, boulangerite, stibnite, arsenopyrite, pyrite, cerussite, and anglesite in a gangue of quartz, mesitite (40 percent siderite and 60 percent magnesite), and dolomite. Sulfides are reported to be zoned both laterally and vertically in the deposit (Purdy, 1951). Sphalerite is carried in a calcite gangue, while the other sulfides are more commonly associated with quartz.

Sample 81-85B(a), comprised of galena, sphalerite, tetrahedrite, pyrite, stibnite, siderite, and quartz, assayed 52 ppm tin, 15 ppm tungsten, and 2 ppm molybdenum. Separate samples of sphalerite-, galena-, and pyrite-chalcopyrite-arsenopyrite-bearing ore were collected in 1983 to determine which fraction held the slightly elevated tin values found in 1981. The galena sample (83-28B) showed no detectable tin, while the sphalerite sample (83-29B) and pyrite-chalcopyrite-arsenopyrite sample (83-30B) assayed 56 and 39 ppm tin, respectively.

TOGO MINE

NW¼NW¼NE¼ sec. 6, T. 29 N., R. 38 E. Sample number: 81-84B

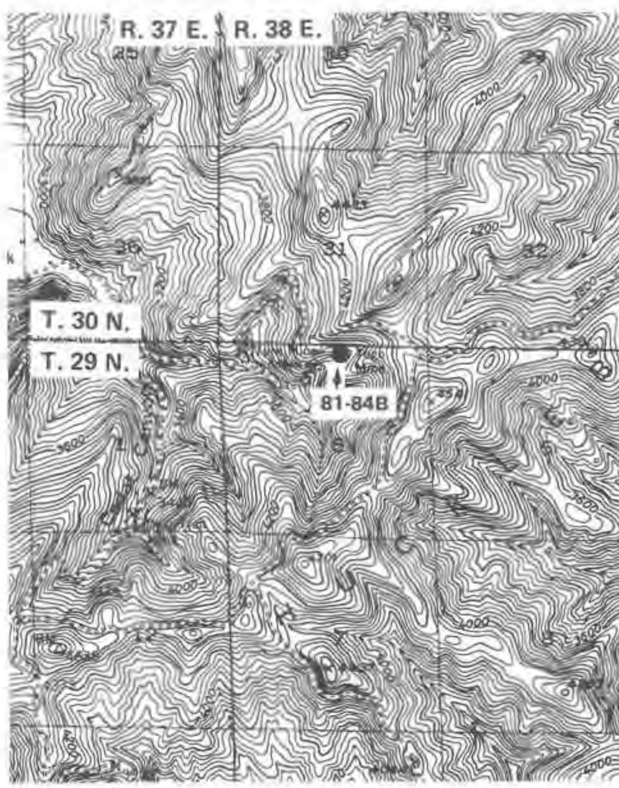

Figure 8. — Sample location map — Togo mine (from USGS Hunters 15-minute quadrangle map).

At the Togo mine (fig. 8) chalcopyrite, pyrite, arsenopyrite, malachite, and azurite are carried in quartz veins and disseminated in the calcareous argillite and dolomite host rocks.

Quartz, calcite, and tremolite are gangue minerals. One sample (81-84B) of tremolite with pyrite and chalcopyrite taken from the dump assayed 38 ppm tin. The sample had no detectable tungsten and only 3 ppm molybdenum.

DAISY AND TEMPEST MINES

NW¼SW¼ and NE¼NW¼NW¼ sec. 7, T. 33 N., R. 38 E.
Sample numbers: 81-57B, 81-58B, 81-59B, 81-60B, 81-61B, 83-42B, 83-43B, 83-44B, 83-45B, 83-46B

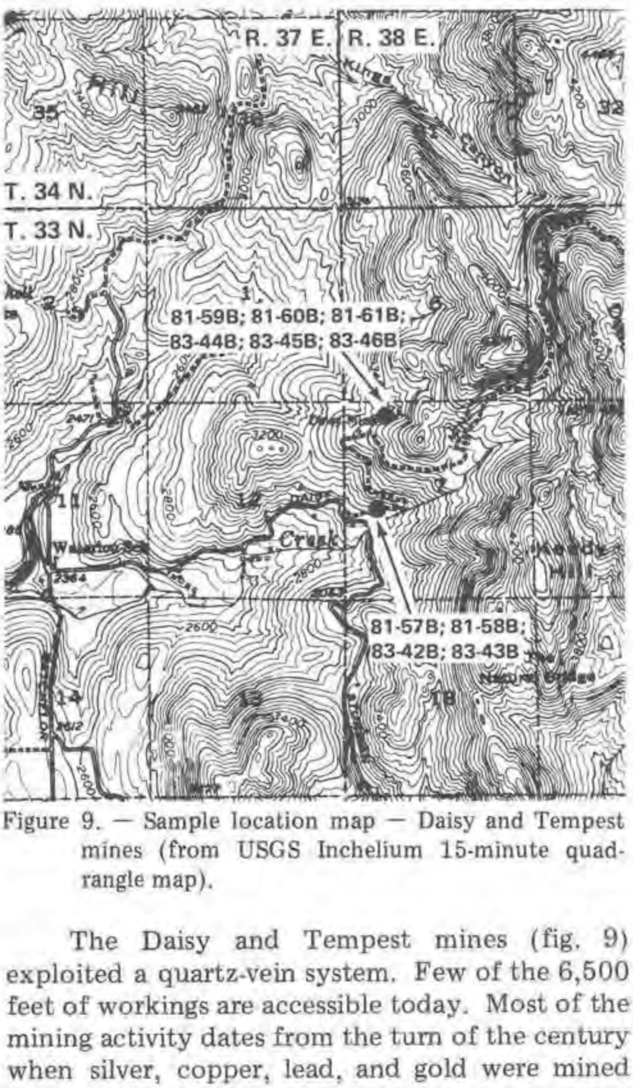

Figure 9. — Sample location map — Daisy and Tempest mines (from USGS Inchelium 15-minute quadrangle map).

The Daisy and Tempest mines (fig. 9) exploited a quartz-vein system. Few of the 6,500 feet of workings are accessible today. Most of the mining activity dates from the turn of the century when silver, copper, lead, and gold were mined from quartz veins carrying galena, chalcopyrite, sphalerite, tetrahedrite, arsenopyrite, pyrite, and scheelite. Nickel and cobalt are reported to occur in the ore (Huntting, 1956).

The mines were visited in 1981 to sample for tungsten. No anomalously high tungsten values were found, but the two mines were found to be significantly enriched in tin. Sample 81-58B, quartz vein and sulfide ore from the Tempest workings, carries 100 ppm tin. Sample 81-60B, siliceous granitic rock with disseminated arsenopyrite, contains 110 ppm tin. Repeat samples in 1983 in part confirmed the original findings. Sample 83-42B attempted to duplicate 81-58B, but no tin was detected. The silicified and sulfide-impregnated granitic rock sample (83-45B) did, however, confirm the 1981 results with 116 ppm tin. One sample of the sulfide-rich quartz vein from the Daisy dump (81-44B) was found to carry 232 ppm tin.

The quartz vein occurs near the contact of black pyritic slate and diorite. Outcrops of diorite near the Daisy workings are intensely altered to clay, goethite, quartz (less than 10 percent), and biotite in decreasing order of abundance. The diorite has no detectable tin. Dump samples at the Daisy also include a fine-grained silicified "granite" with quartz-orthoclase(?)-galena veinlets, and chloritized mafic minerals in the matrix (83-45B).

Except for the Young America mine, where 0.2 percent tin as stannite was already known to occur, the samples from the Daisy and Tempest mines contained the highest tin values of the total population of samples in the study. Further work is recommended.

YOUNG AMERICA MINE

NE¼NW¼ sec. 33, T. 38 N., R. 38 E.
Sample numbers: 81-40B, 81-41B, 83-8B, 83-9B

The Young America mine (fig. 10) was discovered in the 1880's and produced lead, zinc, gold, silver, and copper intermittently until 1954. At the mine, six adits have been driven into two parallel mineralized zones in brecciated limestone (Hundhausen, 1949). The upper, flat-lying zone, probably a fault, visited in 1981 and 1983, is 6 to 8 inches thick at the portal, and strikes N. 70° W., with a dip of 13° to the north. Early reports (Patty, 1921) describe the flat zone as bedding selectively replaced by ore-bearing solutions. However, Patty also describes the mineralized zone as plunging steeply downward within 35 feet of the cliff face, a feature he interprets as a fault. A shaft sunk on the steep part of the fault was reportedly filled with ore at the top, and gravel and boulders of ore below. The ore usually occurs in veins and lenses in sharp contact with unmineralized wall rock.

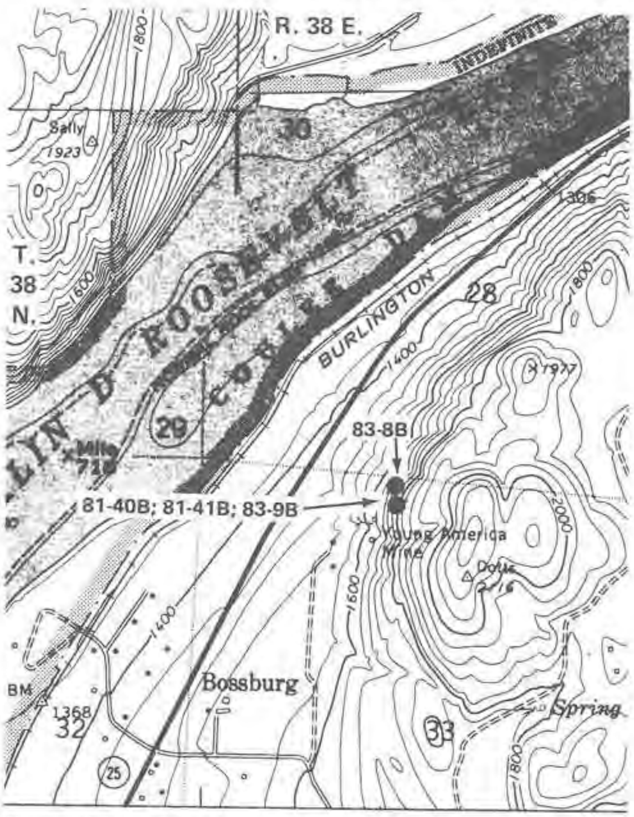

Figure 10. — Sample location map —Young America mine (from USGS Bossburg 7.5-minute quadrangle map).

The unmineralized breccia of angular limestone fragments cemented by quartz was found on the dump. The quartz, deposited concentrically around each fragment, suggests passive, open-space filling. The passive breccia filling, sharp contacts of ore with the wall rocks, and variable thickness and pitch of the ore zone, all indicate the ore was deposited in an open zone — most likely a fault — in the otherwise unaltered limestone.

Unoxidized ore carries sphalerite, galena, pyrite, geochronite, stibiconite, and stannite. Supergene portions of the ore body are composed of alternating bands of impure calcite, cerrusite, and smithsonite. The calcite is identified by its vivid red fluorescence in short-wave ultraviolet light. The cerrusite gives a pale blue color in short-wave, and pale yellow in long-wave ultraviolet light.

The Young America property was sampled in 1981 and 1983 to verify the presence of tin reportedly found as stannite there. Stannite was not positively identified in the ore samples; however, Sample 81-40B, of partly oxidized ore, returned a value of more than 1000 ppm tin — the highest tin value in the study area. The sample carried 15 ppm each of tungsten and molybdenum. Sample 81-41B, of unoxidized sulfides, was higher than average with 62 ppm tin. Tungsten and molybdenum assayed 10 ppm and 19 ppm, respectively. In 1983, Sample 83-8B was taken from a thin iron-oxide-rich fault zone in the shortest northern adit, but less than 2 ppm tin was found. Sample 83-9B, of silicified iron oxide from a flat fault exposed in the main mine area, returned a value of 199 ppm tin.

McMILLAN PROSPECT

NW¼NE¼NE¼ sec. 4, T. 34 N., R. 39 E.; SE¼SE¼ sec. 33, T. 35 N., R. 39 E.; and, NW¼ SW¼SW¼ sec. 34, T. 35 N., R. 39 E.

Sample numbers: 81-39B, 83-31B, 83-32B, 83-33B, 83-34B

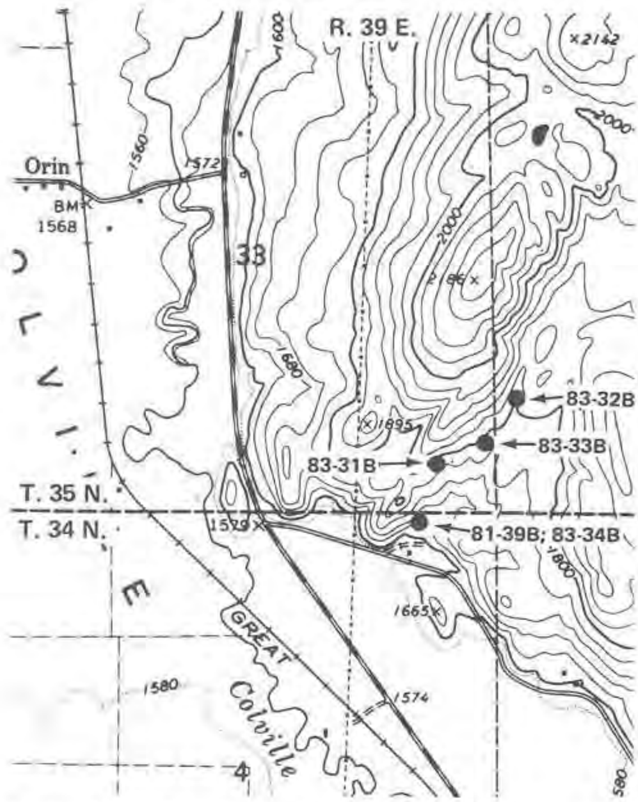

Figure 11. — Sample location map — McMillan prospect (from USGS Arden 7.5-minute quadrangle map).

The McMillan prospect (fig. 11) is reported as a scheelite occurrence in small tactite bodies near the contact of dolomite with granite (Huntting, 1956). Field work in the area in 1981 and 1983 failed to locate the tactite bodies, or any evidence of mining or prospecting. No scheelite was found in the samples with a black light; however, Sample 81-39B of blue dolomite with minor quartz, taken near its contact with hornblende- and biotite-bearing quartz monzonite of the Starvation Flat pluton (Cretaceous), was found to carry 24 ppm tin with only 5 ppm molybdenum and no detectable tungsten. A repeat sample from approximately the same location, of white recrystallized dolomite with rusty-weathering pyrite molds and an altered carbonate pebble, carried 14 ppm tin. A third sample (84-32B), taken from an outcrop of folded and recrystallized blue dolomite with irregular areas of cream-colored alteration, returned a value of 78 ppm tin. This range of values falls within the average range of tin values found in contact deposits and may not be indicative of particular tin enrichment.

All dolomite samples lie within 50 feet of the hidden contact with granite, but no contact metamorphic minerals were observed. The only sample of granite taken was from a pegmatite with euhedral pink feldspar crystals. No tin was detected in the granite sample.

U.S. FOREST SERVICE SAMPLE

SE¼NW¼ sec. 2, T. 32 N., R. 41 E.
Sample number: G-6/25 11R

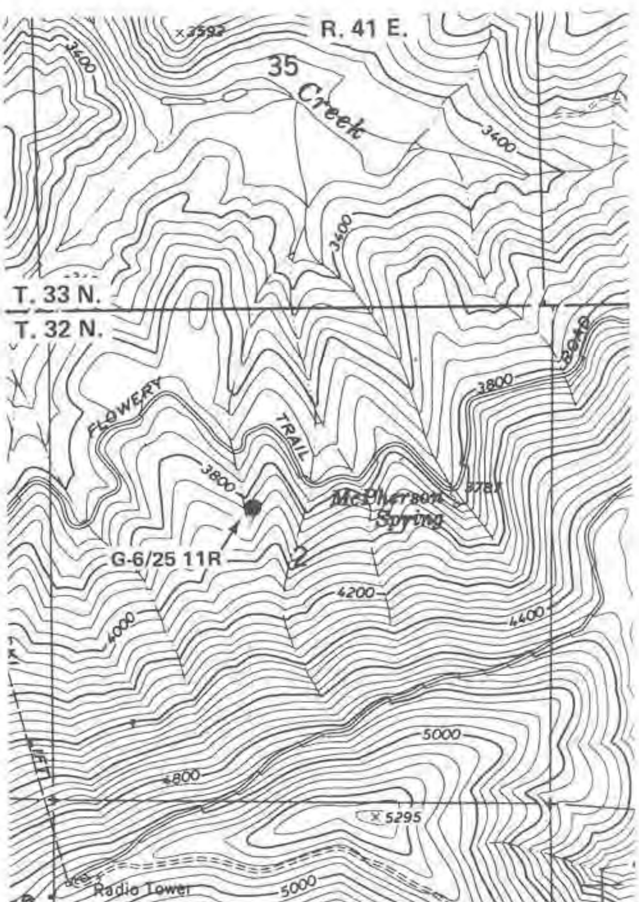

Figure 12. — Sample location map — USFS sample G-6/25 11R (from USGS Goddards Peak 7.5-minute quadrangle map).

Pulps from 21 rock and 13 stream sediment samples obtained from the U.S. Forest Service were analyzed in addition to WDGER samples. The original U.S. Forest Service work was done in 1981 as part of a study of the economic mineral potential of the Okanogan and Colville National Forests. Sample G-6/25 11R (fig. 12) was found to have a value of 71 ppm tin, in a rock described as "limonized and strongly quartz-sericite-altered granodiorite in a shear zone" (Grant, 1982). The granodiorite has been mapped as the Flowery Trail pluton of Triassic age (Miller and Clark, 1975). Contacts of this pluton with carbonate rocks a few miles to the southwest are mineralized with molybdenite, scheelite, and chalcopyrite. Further work in the altered portion described above is highly recommended.

U.S. FOREST SERVICE SAMPLE

SW¼SE¼ sec. 32, T. 35 N., R. 42 E.
Sample number: G-6/27 20R

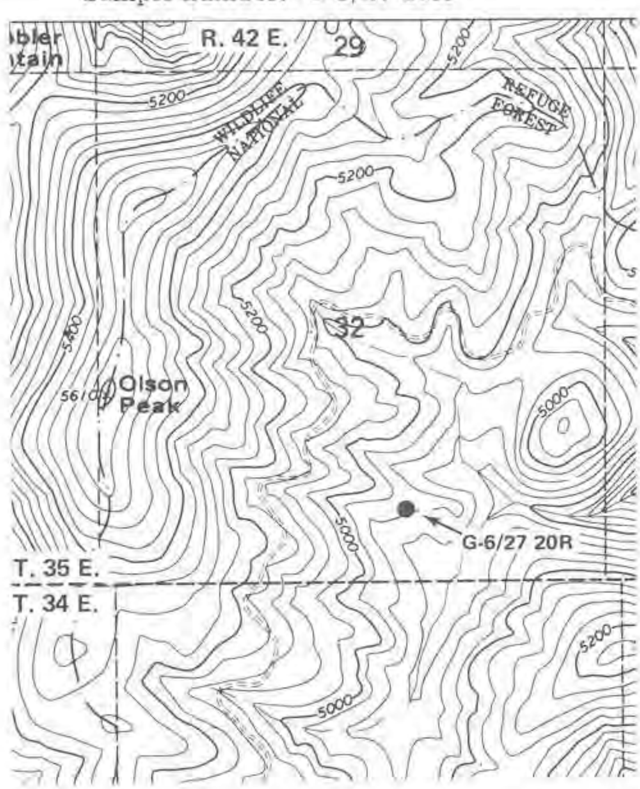

Figure 13. — Sample location map — USFS sample G-6/27 20R (from USGS Calispel Peak 7.5-minute quadrangle map).

Sample G-6/27 20R (fig. 13) was one of two U.S. Forest Service rock samples with geochemical values of 17 ppm tin, a relatively high value for non-mine rock samples. The sample was taken from "very coarse-grained muscovite pegmatite with smoky quartz in a muscovite granodiorite porphyry" (Grant, 1982). The rocks are part of the Phillips Lake Granodiorite, a large pluton with a significant component of granite and two-mica quartz monzonite dikes (Miller and Clark, 1975).

U.S. FOREST SERVICE SAMPLE

SW¼SE¼ sec. 35, T. 40 N., R. 37 E.
Sample number: K-7/12 10R

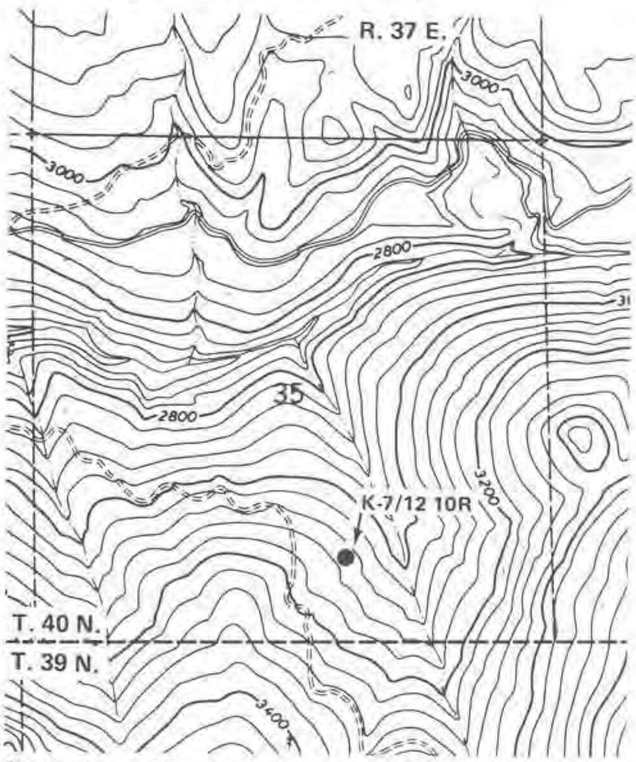

Figure 14. — Sample location map — USFS sample K-7/12 10R (from USGS Churchill Mtn. 7.5-minute quadrangle map).

This sample (fig. 14) was taken by the U.S. Forest Service from "strongly limonized, fine-grained, propylitized greenstone-diorite with quartz veinlets and approximately 1 percent pyrite" (Grant, 1982). The rock carries 17 ppm tin, a relatively high value for non-mine rock samples.

TUNGSTEN

STEVENS COUNTY

REGAL SERPENTINE QUARRIES

SE¼NW¼ sec. 7, T. 32 N., R. 41 E.
Sample numbers: 81-36B, 83-6B, 83-7B

The Regal Serpentine quarries (fig. 15) are developed in upper Paleozoic dolomite included

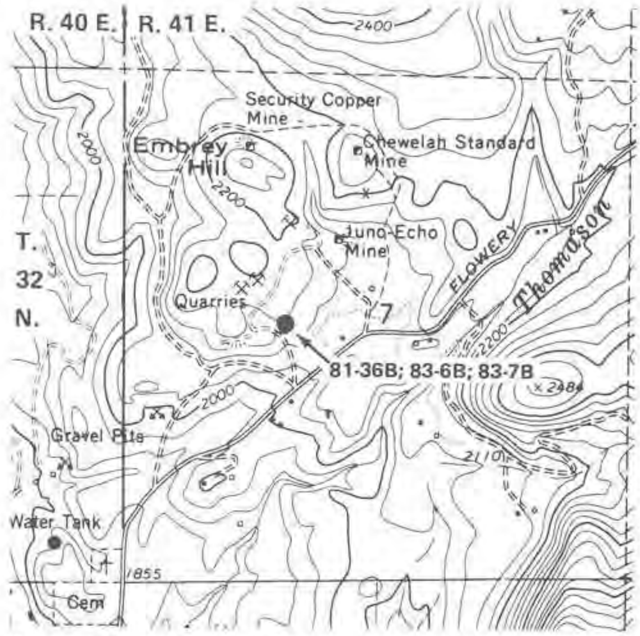

Figure 15. — Sample location map — Regal serpentine quarries (from USGS Chewelah 7.5-minute quadrangle map).

within the contact metamorphic aureole of the Flowery Trail Granodiorite of Late Triassic age. In the quarries, mafic minerals in the hornblende-rich granodiorite are altered to epidote and chlorite. Dolomite ranges in color from white to pink to light and dark green. Tremolite (both fibrous and massive varieties), calcite, and pyrolusite are common. Serpentine and fluorite can also be found. Silicification of the limestone is pervasive, and disseminated sulfides and narrow quartz-pyrite-chalcopyrite-bornite-molybdenite-scheelite veinlets are sparsely distributed. The area has been disturbed by numerous faults.

The Regal Serpentine quarries were formerly used as a source of terrazzo chips (Valentine, 1960). They were visited in 1981 as part of general reconnaissance around the Juno Echo, Chewelah Standard, and Security Copper molybdenum-copper-tungsten mines. At that time, the sulfide-quartz-scheelite veins in the quarries were discovered. One high-grade sample of the vein and disseminated sulfides assayed 26 ppm tin, 2260 ppm tungsten, and 1270 ppm molybdenum.

Two samples were taken in 1983. Sample 83-6B consisted of green dolomite with minor copper staining adjacent to the granodiorite intrusion. It was analyzed for tungsten, but carried less than 10 ppm. The second sample, 83-7B, was of fault gouge in granodiorite from the upper quarry. No tungsten was detected in the sample, and no scheelite was visible under ultraviolet light.

Several occurrences of copper, molybdenum, and tungsten have long been known to occur within the granodiorite northeast of the Regal Serpentine quarries. The presence of similar mineralization in the dolomite nearly doubles the area containing copper, molybdenum, and tungsten mineralization, and provides an interesting exploration target.

MOLYBDENUM

STEVENS COUNTY

GERMANIA AND GERMANIA CONSOLIDATED MINES

Secs. 13, 14, 23, and 26, T. 29 N., R. 37 E.
Sample numbers: 81-73B, 81-74B, 81-75B, 81-76B, 81-77B, 81-78B, 81-79B, 81-80B, 81-81B, 81-82B, 81-83B

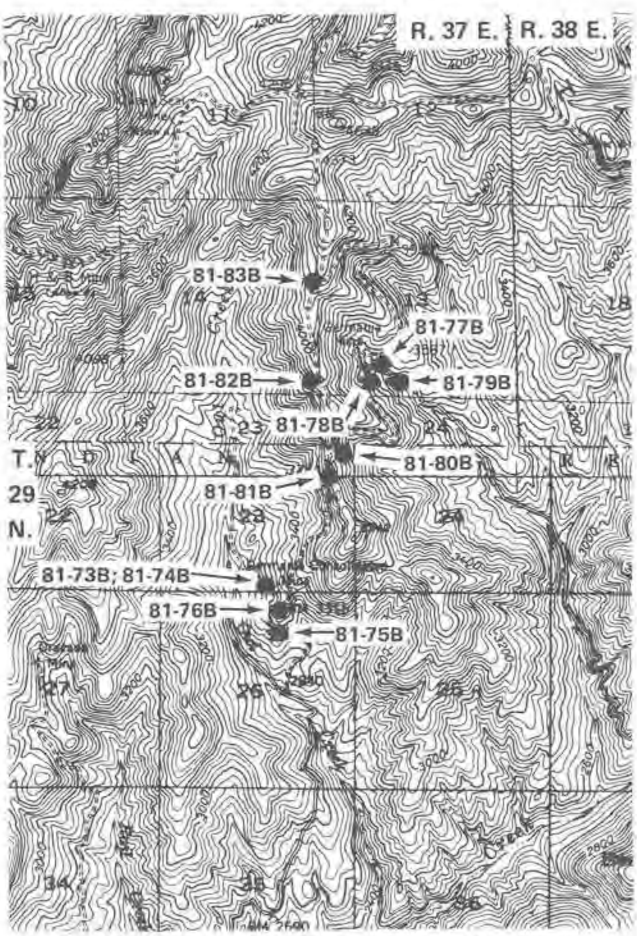

Figure 16. — Sample location map — Germania and Germania Consolidated mines (from USGS Turtle Lake 15-minute and Hunters 15-minute quadrangle maps).

The Germania and Germania Consolidated mine area (fig. 16) was sampled in 1981. A total of nine samples was collected from the mine dumps and altered wall rocks of the Germania and Germania Consolidated system, and from siliceous dikes and other tungsten prospects in the area.

The tin content of samples in the area ranges from 2 to 32 ppm. Samples of quartz-muscovite greisen are consistently higher in tin than samples of tungsten-molybdenum mineralization. The highest tin value was obtained on a sample of greisenized granite with silica-flooded fractures from the Green prospect located on top of the ridge between the Germania and Germania Consolidated mines (81-81B).

Tungsten in the samples ranges from 15 ppm in quartz-feldspar-porphyry dikes not associated with any mine (81-83B) to more than 5000 ppm in wolframite-bearing samples from the Keeth (81-75B) and Roselle prospects (81-80B). Of all samples taken, only those with visible wolframite carried anomalously high tungsten.

All samples from the Germania area were anomalously high in molybdenum with values between 6 and 1430 ppm. Samples from the Germania Consolidated mine and Keeth workings (81-73B, 60 ppm; 81-74B, 1430 ppm; 81-75B, 360 ppm; 81-78B, 50 ppm) were significantly higher than samples from the Germania mine (81-77B, 63 ppm; 81-78B, 13 ppm) and Green and Roselle prospects (81-81B, 18 ppm; and 81-80B, 32 ppm, respectively). In general, high values of molybdenum correlate with high values of tungsten in the ore samples.

The geochemical results cited above support the geological conclusion (discussed earlier in this report) that the Germania tungsten veins are the high-level expression of a porphyry molybdenum system similar to other molybdenum deposits in the western United States. The top of the molybdenum deposit is exposed in the Germania Consolidated mine, and on the deep levels of the Germania, where molybdenum mineralization increases and becomes distributed in silicified and pervasively altered host rocks. The Germania Consolidated area in particular is considered to be an excellent target for molybdenum exploration.

BLUE GROUSE MOUNTAIN AREA

Secs. 15 and 16, T. 30 N., R. 42 E.
Sample numbers: 81-27B, 81-28B, 81-29B, 81-30B, 81-31B (in sec. 18, not shown on fig. 17), 81-99B, 81-100B, 81-101B

Numerous tungsten prospects on Blue Grouse Mountain (sec. 16; fig. 17) date to the

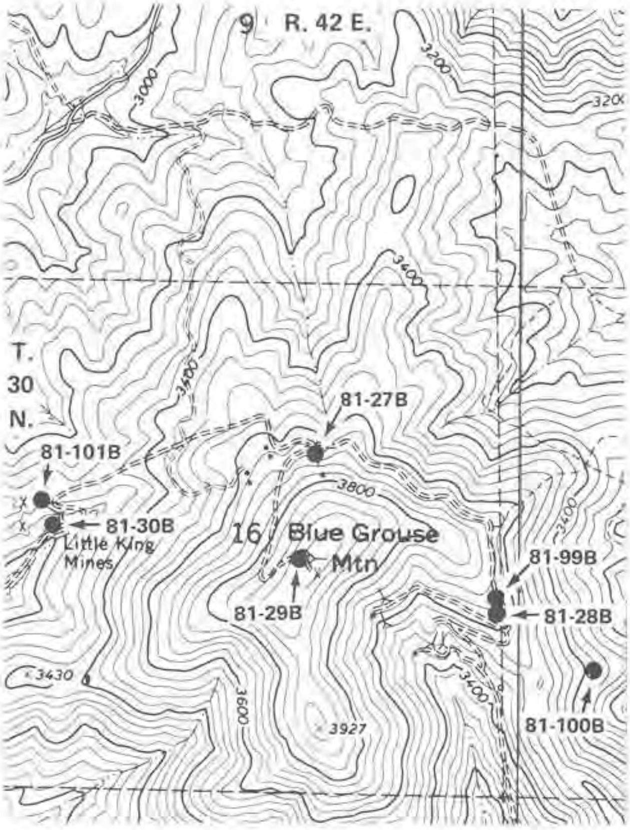

Figure 17. — Sample location map — Blue Grouse Mtn. area (from USGS Deer Lake 7.5-minute and Fan Lake 7.5-minute quadrangle maps).

early 1900's. While the properties have been intermittently active since that time, little production has been recorded. Altogether the properties have produced no more than 10 tons of WO_3.

GEOLOGY

Tungsten occurs in large huebnerite crystals and crystal clusters erratically distributed in quartz veins. A small amount of huebnerite is also disseminated in altered granite. The veins vary in width from a few inches to 5 feet. The quartz is predominantly white, but patches of smoky quartz have been noted. The veins strike northwest and more or less follow bedding in the metasedimentary host rocks of the Revett Formation. In at least one location, a vein occupies the contact between granitic rocks and metasediments. Minerals accompanying huebnerite are pyrite, argentiferous cosalite, and molybdenite (Culver and Broughton, 1945). However, no molybdenite or cosalite was identified in this study. Pyrite is common in the veins and in the adjacent sediments where large cubes are developed along bedding planes. Manganese oxide is ubiquitous in both granitic rocks and quartz veins.

The deposits occur near the contact of Revett Formation siltite with a muscovite-quartz monzonite pluton. The texturally uniform pluton characteristically carries 6 percent muscovite, with garnet, apatite, and zircon as accessories, with almost no mafic minerals (Miller and Clark, 1975). A smaller isolated body of the same composition is found two miles west in sec. 18, and similar rocks have been described from southern Stevens County and Pend Oreille County, south and east of Blue Grouse Mountain.

The Revett Formation has been recrystallized to quartz-mica schist within 50 feet of its contact with the quartz monzonite. Beyond that narrow aureole, the only contact effect is the development of large pyrite cubes along bedding in the siltite.

ALTERATION

According to Miller and Clark (1975) most of the muscovite in the pluton is primary. However, exposures near the Blue Grouse adit and Little King mine (Tungsten Products) on the north and west sides of the mountain are intensely hydrothermally altered. The granitic rocks in these areas are composed of little more than quartz and sericite with a minor amount of clay. In other outcrops, feldspar crystals are chalky, due to partial clay alteration. Greisen selvages commonly border small pegmatite dikes and quartz veins, and, in places, the granite-Revett contact is reported to be "greisenized with plumose masses of muscovite" (Culver and Broughton, 1945). No dikes or other plutons are mapped in the area, and all alteration is attributed to the quartz-monzonite pluton itself.

GEOCHEMISTRY

Concentrated ore from a small milling operation is reported to have carried 0.5 percent WO_3 and 0.2 percent tin (Huntting, 1956). Sample 81-30B, of crushed ore from a recent milling operation, assayed only 16 ppm tin, with 1430 ppm tungsten and 85 ppm molybdenum. These figures represent the highest values obtained for tin and molybdenum at Blue Grouse. Two other high-grade samples (81-28B and 81-29B) of huebnerite and quartz from the south side of the mountain, each ran more than 5000 ppm tungsten with insignificant tin and molybdenum.

Sample 81-27B of the greisen near the Blue Grouse adit showed no anomalous metal values, while a sample of greisen from the west side of the mountain (81-101B) ran 180 ppm tungsten and 39 ppm molybdenum. According to Culver and Broughton (1945), a small amount of disseminated tungsten was mined from the "west end workings." Sample 81-31B, from the Gaber farm in sec. 18, T. 30 N., R. 42 E. was also anomalously high, with 53 ppm molybdenum and 100 ppm tungsten.

The WDGER geochemical data suggest a correlation between the more intensely altered northwest side of the mountain and higher molybdenum values. According to the property owner, significant molybdenum values were intersected by deep drilling on the north side of the mountain, but apparently the core has since been lost (Wesley Butler, personal communication, 1983).

The intense and pervasive hydrothermal alteration of the north and west sides of Blue Grouse Mountain, the presence of huebnerite-quartz veins, and the high molybdenum values found in altered quartz monzonite all suggest that Blue Grouse has potential as a molybdenum target. Detailed geologic mapping and geochemical sampling would help evaluate this possibility.

SILVER SUMMIT (SUMMIT) MINE

Center sec. 33, T. 33 N., R. 38 E.
Sample numbers: 81-63B, 81-64B, 81-65B, 81-66B, 81-67B

The Silver Summit (Summit) mine (fig. 18) is located in a swarm of quartz-feldspar porphyry dikes intruding limestone and phyllite of early Paleozoic age. The dikes vary in composition and texture and can be distinguished on the basis of the size and number of quartz and feldspar phenocrysts, the percentage of biotite, and the degree of rock alteration. In all varieties, phenocrysts are carried in a siliceous matrix. Quartz phenocrysts are primarily clear, but may be light lavender. They are usually relatively large — up to 3/8 inch in diameter — and are both round and euhedral in cross section. One dike type is characterized by 30 percent feldspar phenocrysts. Another variety contains chalky green feldspars altered to clay. Some of the more leucocratic dikes are slightly propylitized by chlorite and epidote. One variant is composed of quartz, plagioclase, and fresh biotite, with magnetite as an accessory. No hornblende was seen in any of the dikes. Where the dikes contact limestone, epidote and garnet were formed. Stockworks of clear to lavender quartz veinlets were noted in a few outcrops.

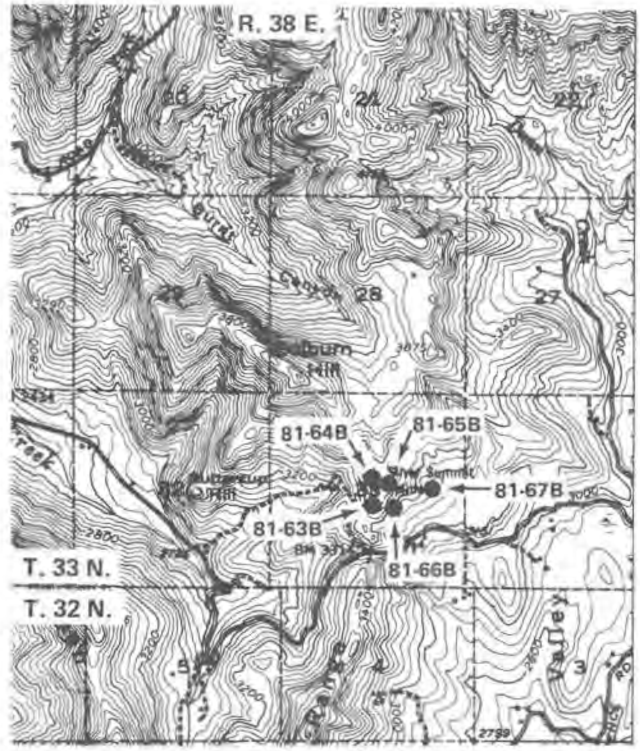

Figure 18. — Sample location map — Silver Summit (Summit) mine (from USGS Inchelium 15-minute quadrangle map).

The Silver Summit mine was active in 1890 and again in 1935. The several hundred feet of workings are developed on brecciated quartz-calcite veins carrying galena, pyrite, and anglesite. Scattered grains of scheelite and powellite are reported to occur (Moen, 1976), but none were noted in the field. The calcite in the vein fluoresces rose-red. Mineralization around a small shaft on the east side of the property consists of azurite and malachite with occasional grains of chalcopyrite.

In the five samples taken, the tin content ranged from less than 2 ppm in high-grade samples (81-65B, 81-67B) to 12 ppm (81-62B) in a quartz latite porphyry dike. Tungsten varied from less than 10 ppm in a quartz latite dike (81-66B) to 20 ppm in mineralized rocks around the shaft (81-64B). Molybdenite values ranged between 7 and 18 ppm. The highest value obtained was in the high-grade dump sample (81-65B).

The Silver Summit prospect is not considered to have high potential as a molybdenite prospect; however, the nature and composition of the dike swarm is geologically favorable for such mineralization, and as the extent of diking in the area is largely unknown, the area warrants a more detailed evaluation of its molybdenum potential.

SUMMARY

Much of Stevens County and northern Spokane County is underlain by Cretaceous granitic rock of the Loon Lake batholith. Quartz monzonite phases characterize most of the batholith, but rocks ranging from granodiorite to granite, including some muscovite-bearing and two-mica phases, are not uncommon. The muscovite-bearing rocks are part of a belt of peraluminous, S-type granites extending from Canada to Mexico. The plutonic belt coincides with the inferred margin of the Precambrian continental crust and with the metamorphic core complexes of the Cordillera (Miller and Bradfish, 1980). Small occurrences of tin are found along this trend, suggesting that such rocks may be a good exploration target for tin deposits of the type found in European two-mica granites. According to Mutschler (Mutschler and others, 1980; Felix Mutschler, personal communication, 1984), ternary plots of

$$Na_2O + K_2O \text{ vs. } MgO \text{ vs. } FeO + Fe_2O_3$$

on 214 whole-rock analyses of the Loon Lake batholith from the PETROS data bank are not significantly different from similar plots of stanniferous granites in other parts of the world. Contrary evidence suggests that the two-mica granites associated with metamorphic core complexes are formed in a different tectonic setting, are chemically different, and are consequently of lower potential than the highly tin-enriched two-mica granites of the Hercynian orogenic belt.

Of the prospects sampled in this study, only the Blue Grouse tungsten deposit is hosted by muscovite-bearing granitic rocks, and no anomalously high tin values were found there. On the whole, the peraluminous rocks of northeastern Washington remain an untested and slightly favorable target for tin exploration.

A second geologic environment with potential for tin is the Priest River crystalline complex in northeastern Spokane County and southeastern Stevens County. The complex exposes Archean gneisses intruded by Cretaceous two-mica quartz monzonite derived from the Precambrian rocks during the Cretaceous. Tin deposits of the pegmatite type are found in similar metamorphic rocks at Silver Hill and were probably "sweated" out of the crust in a manner similar to the aplite and alaskite of Mount Spokane. There is good potential for additional tin-bearing pegmatites to be found in the metamorphic rocks, but the deposits are likely to be small and probably sub-economic. Cassiterite also occurs at the Freeman clay pit, not far from Silver Hill, where the Precambrian metamorphic rocks and granite have been completely altered to kaolinite. Many similarities with the kaolinite and cassiterite deposits of Cornwall, England, suggest this area may also be an interesting target for greisen or stockwork-type tin-tungsten deposits.

Although parts of the Loon Lake batholith bear some similarities to granites from the tin-producing areas, the batholith as a whole is considered here to have a higher economic potential for deposits of tungsten and molybdenum. Two prospects examined during this study, the Germania and Blue Grouse Mountain areas, were found to be very favorable porphyry molybdenum targets. At the Germania and Germania Consolidated mines, wolframite-quartz veins were mined down to a zone containing more pervasive wall-rock alteration, disseminated mineralization, and higher molybdenum-to-tungsten ratios. At Blue Grouse, the muscovite-bearing quartz monzonite pluton which hosts wolframite-quartz veins has been widely altered to clay and sericite. Anomalously high molybdenum values were obtained from rock samples on the north side of Blue Grouse Mountain and were reported to have been intersected in drill core in the same area (Wesley Butler, personal communication, 1983). Both prospects represent good geologic targets for granite-type porphyry molybdenum deposits in the Loon Lake batholith.

RECOMMENDATIONS

Of the 15 prospects discussed in this report, 8 are considered worthy of further attention. They are as follows:

TIN

1. *Freeman clay pit*
   Greisen-type alteration in Precambrian ultrametamorphic granite; contains trace topaz and cassiterite.

2. *Young America mine*
Quartz-sulfide vein carries up to 0.2 percent tin in stannite; highest value in the study, +1000 ppm tin.

3. *Daisy-Tempest mine*
Complex quartz-sulfide vein ore with several +100 ppm tin analyses; one sample result was 232 ppm tin.

4. *USFS sample G-6/25 11R*
Limonitized and strongly quartz-sericite-altered granodiorite in a shear zone; carries 71 ppm tin.

TUNGSTEN

5. *Regal Serpentine quarry*
Small veinlets of quartz-scheelite-molybdenite in dolomite quarry nearly double the area known to contain some scheelite mineralization.

MOLYBDENUM

6. *Germania and Germania Consolidated mines*
Favorable rock types; increasing molybdenum:tungsten ratio with depth; more widespread mineralization and alteration suggest a molybdenum system beneath tungsten mine workings.

7. *Blue Grouse Mountain*
Sericite and clay alteration of muscovite quartz monzonite and high molybdenum values on the north side of Blue Grouse Mountain suggest a molybdenum system at depth.

8. *Silver Summit mine*
Stockwork veining and several dike phases, combined with the presence of minor molybdenite and scheelite mineralization, are characteristic of molybdenum systems; the area is considered to be a low-potential geologic target.

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APPENDIX A

SAMPLE DESCRIPTIONS AND ANALYTICAL RESULTS

TABLE A-1. — *Tin, tungsten, and molybdenum geochemistry of selected mines and prospects, Stevens and Spokane Counties, Washington (1981)*

Sample Number	Location (TRS)	Mine/Prospect Name	Topographic Quadrangle	Geologic Description	Results* (ppm)		
					Sn	W	Mo
81-1B	NE¼ NW¼ NW¼ sec. 1 T.23N., R.44E.	Freeman Clay Pit	Freeman, 7.5'	Coarse K-feldspar, quartz, muscovite pegmatite with muscovite crystals to 1.5-inch diameter; approximately 90% kaolinite; very minor iron- and manganese-oxide staining	6	40	3
81-2B	NE¼ NW¼ NW¼ sec. 1 T.23N., R.44E.	Freeman Clay Pit	Freeman, 7.5'	Heavy minerals in intermittent stream in bottom of clay pit	<2	<10	3
81-3B	NE¼ NW¼ NW¼ sec. 1 T.23N., R.44E.	Freeman Clay Pit	Freeman, 7.5'	Contact of metasediments with fine- to medium-grained granite; 1/4-inch quartz veinlets and pegmatite veinlets; white and yellow clay; shattered, lavender-colored quartz; <1% manganese oxide	N.A.	N.A.	N.A.
81-4B	SW¼ SE¼ NE¼ sec. 35 T.24N., R.44E.	Washington Road	Freeman, 7.5'	Weathered granite outcrop in road; iron-oxide staining is intense	4	<10	2
81-5B	SW¼ SW¼ NE¼ sec. 36 T.24N., R.44E.	East on Washington Road, right fork	Freeman, 7.5'	Two-mica pegmatite, unweathered; looks just like kaolinized rocks in Freeman Clay Pit	2	<10	10
81-6B	SW¼ NW¼ NW¼ sec. 31 T.24N., R.45E.	Washington Road	Freeman, 7.5'	Quartzite with tourmaline-quartz veining	8	<10	5
81-7B	sec. 18 T.24N., R.44E.	Tower Mountain	Spokane SE, 7.5'	Black sand in road drainage; weathered granite source rock	10	15	7
81-8B	NW¼ NE¼ sec. 10 T.36N., R.38E.	Vanasse Mine	Marcus, 7.5'	Quartz vein with small amount of galena and copper staining with manganese oxide and pyrite from dump	6	20	5
81-27B	SW¼ NE¼ sec. 16 T.30N., R.42E.	Blue Grouse Mountain Area	Deer Lake, 7.5'	Very white, altered (weathered?) granite consists of quartz, sericite, and clay with narrow quartz veinlets and 1.5-inch clots of manganese oxide? plus iron-oxide staining	<2	<10	1
81-28B	NE¼ SE¼ sec. 16 T.30N., R.42E.	Blue Grouse Mountain Area	Deer Lake, 7.5'	Small, high-grade sample of huebnerite-bearing quartz vein and contact-metamorphosed sediments at the contact; from open pit	2	>5000	<1
81-29B	NW¼ NW¼ SE¼ sec. 16 T.30N., R.42E.	Blue Grouse Mountain Area	Deer Lake, 7.5'	High-grade huebnerite and quartz from dump of upper adit on Blue Grouse Mountain	4	>5000	3

* N.A. = Not Assayed.

TABLE A-1. — *Tin, tungsten, and molybdenum geochemistry of selected mines and prospects, Stevens and Spokane Counties, Washington (1981) - Continued*

Sample Number	Location (TRS)	Mine/Prospect Name	Topographic Quadrangle	Geologic Description	Results* (ppm)		
					Sn	W	Mo
81-30B	NW¼ SW¼ sec. 16 T.30N., R.42E.	Blue Grouse Tungsten Mill	Deer Lake, 7.5'	Crushed chips from small tungsten mill; chips are pyritic sediments from zone adjacent to quartz-tungsten vein	16	1430	85
81-31B	SE¼ NE¼ sec. 18 T.30N., R.42E.	Gaber Farm	Deer Lake, 7.5'	Chips of quartz from old dozer cuts on ridge above Deer Lake	4	100	53
81-32B	NE¼ SE¼ NW¼ sec. 7 T.32N., R.41E.	Juno Echo Mine	Chewelah, 7.5'	High-grade dump sample; quartz vein with pyrite, chalcopyrite, molybdenite; molybdenite as "paint" on fractures; some copper and molybdenite disseminated in monzonite-granodiorite; scheelite?	8	1475	2500
81-33B	NE¼ NW¼ NW¼ sec. 7 T.32N., R.41E.	Security Copper Mine	Chewelah, 7.5'	Malachite and manganese oxide on tremolite in contact-metamorphosed dolomite	18	75	4
81-34B	SE¼ NE¼ NW¼ sec. 7 T.32N., R.41E.	Chewelah Standard Mine (Nellie S)	Chewelah, 7.5'	High-grade dump sample of vein quartz with pyrite, chalcopyrite, molybdenite, scheelite, bornite, malachite, and azurite	<2	1155	2800
81-35B	SE¼ NE¼ NW¼ sec. 7 T.32N., R.41E.	Prospect due south of Chewelah Standard Mine	Chewelah, 7.5'	High-grade dump sample of quartz, chalcopyrite, pyrite, and molybdenite; scheelite?	<2	1090	580
81-36B**	SE¼ NW¼ sec. 7 T.32N., R.41E.	Regal Serpentine Quarries	Chewelah, 7.5'	Large quarry nearest to the Juno Echo Mine; high-grade sample of quartz with chalcopyrite, bornite, pyrite, minor molybdenite; light-green, silicified dolomite carries very fine-grained specks of sulfide (?)	26	2260	1240
81-37B	Center NE¼ NW¼ sec. 5 T.32N., R.41E.	Blue Star Mine	Chewelah, 7.5'	Sample is of all rock types--mostly dolomite and limestone--found on the dump; includes disseminated pyrite in biotite-rich metasediment and quartz vein sample with a very small amount of molybdenite	2	35	79
81-38B	N½ NE¼ sec. 4 T.37N., R.39E.	Uribe Barite Property	Echo Valley, 7.5'	Fault zone in folded phyllite with pyrite and quartz	10	10	5
81-39B**	NW¼ NE¼ NE¼ sec. 4 T.34N., R.39E.	McMillan Prospect	Arden, 7.5'	Recrystallized "ice-blue" dolomite with minor quartz within 50 feet of the contact with granite; no scheelite under black light	24	<10	4

** Resampled in 1983 (Table A-2).

TABLE A-1. — *Tin, tungsten, and molybdenum geochemistry of selected mines and prospects, Stevens and Spokane Counties, Washington (1981) - Continued*

Sample Number	Location (TRS)	Mine/Prospect Name	Topographic Quadrangle	Geologic Description	Results* (ppm)		
					Sn	W	Mo
81-40B**	NE¼ NW¼ sec. 33 T.38N., R.38E.	Young America Mine	Bossburg, 7.5'	High-grade dump sample is of oxidized ore; cerussite, pyrite, malachite, smithsonite, galena, and sphalerite (minor); stannite(?)	>1000	<10	15
81-41B	NE¼ NW¼ sec. 33 T.38N., R.38E.	Young America Mine	Bossburg, 7.5'	Unoxidized ore; galena, sphalerite, stannite(?) in quartz with considerable pyrite; from lower dump	62	<10	19
81-42B	NE¼ NW¼ NW¼ sec. 1 T.23N., R.44E.	Freeman Clay Pit	Freeman, 7.5'	Kaolinized granite composed of 25% quartz, 25% muscovite (sericite?), 48% kaolinite, <1% manganese oxide, and moderate iron-oxide staining	28	45	3
81-43B	NE¼ NW¼ NW¼ sec. 1 T.23N., R.44E.	Freeman Clay Pit	Freeman, 7.5'	Kaolinized metasediments; 85% kaolinite; minor fine, rounded quartz grains; more-siliceous sediments are comprised of 75-85% quartz with clay and muscovite; veinlets of quartz and kaolinite show bleached (kaolinized) selvages along veinlets	14	10	4
81-44B	NE¼ NW¼ NW¼ sec. 1 T.23N., R.44E.	Freeman Clay Pit	Freeman, 7.5'	Coarse granite with crushed, lavender-colored quartz	18	10	2
81-45B	NE¼ NW¼ NW¼ sec. 1 T.23N., R.44E.	Freeman Clay Pit	Freeman, 7.5'	Kaolinized aplite; near 81-44B	14	<10	1
81-46B	NE¼ NW¼ NW¼ sec. 1 T.23N., R.44E.	Freeman Clay Pit	Freeman, 7.5'	Alaskite; 75% kaolinite, with quartz, sericite, and iron-oxide staining	10	25	2
81-47B	NE¼ NW¼ NW¼ sec. 1 T.23N., R.44E.	Freeman Clay Pit	Freeman, 7.5'	Kaolinized metasedimentary rocks crosscut by kaolinite veins	10	<10	2
81-48B	NE¼ NW¼ NW¼ sec. 1 T.23N., R.44E.	Freeman Clay Pit	Freeman, 7.5'	Alaskite; 15-20% quartz, 80% kaolinite, 5-10% sericite	12	35	N.A.
81-49B	NE¼ NW¼ NW¼ sec. 1 T.23N., R.44E.	Freeman Clay Pit	Freeman, 7.5'	Alaskite dike with lavender quartz selvages; crosscuts feldspathic metasediments	2	<10	N.A.
81-49(2)B	NW¼ NW¼ sec. 21 T.38N., R.39E.	Phalon Lake Prospect	China Bend, 7.5'	Fine-grained granite with quartz and biotite phenocrysts and minor pyrite	<2	<10	6
81-50B	NW¼ NW¼ sec. 21 T.38N., R.39E.	Phalon Lake Prospect	China Bend, 7.5'	Biotite granite(?) near argillite contact; unmineralized	8	<10	8

* N.A. = Not Assayed.

** Resampled in 1983 (Table A-2).

TABLE A-1. — *Tin, tungsten, and molybdenum geochemistry of selected mines and prospects, Stevens and Spokane Counties, Washington (1981) - Continued*

Sample Number	Location (TRS)	Mine/Prospect Name	Topographic Quadrangle	Geologic Description	Results* (ppm)		
					Sn	W	Mo
81-51B	NW¼ NW¼ sec. 21 T.38N., R.39E	Phalon Lake Prospect	China Bend, 7.5'	High-grade sample of rich molybdenite-quartz vein in granodiorite near contact with argillite; small adit; vein carries molybdenite and ferri-molybdite	2	450	5200
81-52B	NW¼ NW¼ sec. 21 T.38N., R.39E.	Phalon Lake Prospect	China Bend, 7.5'	Granodiorite walls in contact with quartz vein; some disseminated mineralization	2	40	82
81-53B	SW¼ SE¼ NW¼ sec. 18 T.36N., R.41E.	Longshot (Newland, Pioneer) Mine	Park Rapids, 7.5'	High-grade sample of galena, sphalerite, tetrahedrite	12	<10	11
81-57B**	NW¼ SW¼ sec. 7 T.33N., R.38E.	Daisy and Tempest Mines	Inchelium, 15'	Black slate with quartz and pyrite from lowest, relatively new adit	2	<10	18
81-58B**	NW¼ SW¼ sec. 7 T.33N., R.38E.	Daisy and Tempest Mines	Inchelium, 15'	High-grade sample of quartz vein with galena, pyrite, sphalerite, arseno-pyrite, chalcopyrite, tetrahedrite, pyrargyrite, and argentite(?); some slate is mineralized	100	355	54
81-59B**	NE¼ NW¼ NW¼ sec. 7 T.33N., R.38E.	Daisy Tunnel #3?	Inchelium, 15'	High-grade ore sample; quartz vein and sulfides; granitic rocks not included in sample	60	35	22
81-60B**	NE¼ NW¼ NW¼ sec. 7 T.33N., R.38E.	Daisy Tunnel #3?	Inchelium, 15'	Mineralized granitic rock (plagioclase, orthoclase, quartz); silicified and pyritized rock matrix	110	55	6
81-61B**	NE¼ NW¼ NW¼ sec. 7 T.33N., R.38E.	Daisy Tunnel #1 or #2?	Inchelium, 15'	Quartz-poor, argillized, and heavily iron-stained diorite(?); feldspars are "chalky"	20	20	5
81-63B**	Center sec. 33 T.33N., R.38E.	Silver Summit (Summit) Mine	Inchelium, 15'	Latite porphyry dike with feldspar and <10% quartz phenocrysts; matrix is siliceous and slightly propylitized; quartz phenocrysts are rounded, shattered and pale lavender in color	12	<10	9
81-64B	Center sec. 33 T.33N., R.38E.	Silver Summit (Summit) Mine	Inchelium, 15'	Porphyritic quartz monzonite from mine dump; has greenish feldspars, unaltered biotite; less siliceous matrix than 81-63B with more quartz phenocrysts; some quartz veinlets, silicification, pyrite	4	20	9

** Resampled in 1983 (Table A-2).

TABLE A-1. — *Tin, tungsten, and molybdenum geochemistry of selected mines and prospects, Stevens and Spokane Counties, Washington (1981) - Continued*

Sample Number	Location (TRS)	Mine/Prospect Name	Topographic Quadrangle	Geologic Description	Results* (ppm)		
					Sn	W	Mo
81-65B	Center sec. 33 T.33N., R.38E.	Silver Summit (Summit) Mine	Inchelium, 15'	High-grade dump sample; quartz, pyrite, bornite, galena, argentite, scheelite(?)	<2	15	18
81-66B	Center sec. 33 T.33N., R.38E.	Silver Summit (Summit) Mine	Inchelium, 15'	Quartz stockwork in quartz-feldspar latite porphyry dike with large euhedral and "square" quartz phenocrysts which are lavender near limestone-dike contact; trace of pyrite	10	<10	9
81-67B	Center sec. 33 T.33N., R.38E.	Silver Summit (Summit) Mine	Inchelium, 15'	High-grade dump sample from shaft east of previous samples; azurite, malachite, turquoise(?), and chalcopyrite in phyllite	<2	10	7
81-68B	SW¼ SW¼ SW¼ sec. 19 T.32N., R.38E.	Columbia Tungsten (Black Horse, Stockwell) Mine	Inchelium, 15'	Quartz monzonite with jarosite staining near narrow (4-inch) quartz vein	24	85	8
81-69B	SW¼ SW¼ SW¼ sec. 19 T.32N., R.38E.	Columbia Tungsten (Black Horse, Stockwell) Mine	Inchelium, 15'	High-grade sample of quartz with wolframite, pyrite, and molybdenite sparsely distributed	<2	4455	420
81-70B	S½ S½ sec. 19 T.32N., R.38E.	Washington Metals Prospect	Inchelium, 15'	Wolframite, tourmaline, and manganese oxide in quartz vein at contact with granite; sample is a composite of rocks from two trenches	<2	>5000	10
81-71B**	NW¼ NW¼ NW¼ sec. 6 T.29N., R.38E.	Turk Mine	Hunters, 15'	High-grade sample of chalcopyrite, pyrite, malachite, quartz, and barite from dump	14	20	1
81-72B	SE¼ SE¼ SW¼ sec. 1 T.29N., R.37E.	Deer Trail Mine Hoodoo Tunnel	Hunters, 15'	Sample of quartz monzonite-limestone intrusion breccia; some rhodochrosite, abundant manganese oxide; garnet, sphalerite, galena, and pyrite	15	20	3
81-73B	SW¼ SE¼ sec. 23 T.29N., R.37E.	Germania Consolidated Mine	Turtle Lake, 15'	Grab sample of crushed material on dump consists of flakes of molybdenite, silicified granite, and molybdenite-quartz veinlets	2	75	60
81-74B	SW¼ SE¼ sec. 23 T.29N., R.37E.	Germania Consolidated Mine	Turtle Lake, 15'	High-grade sample of mineralized quartz, wolframite, molybdenite, pyrite, arsenopyrite, and bismuthinite(?)	4	1680	1430
81-75B	NW¼ NE¼ sec. 26 T.29N., R.37E.	Keeth (Industrial Tungsten) Mine	Turtle Lake, 15';	High-grade sample of quartz-molybdenite-wolframite	4	>5000	360

** Resampled in 1983 (Table A-2).

TABLE A-1. — *Tin, tungsten, and molybdenum geochemistry of selected mines and prospects, Stevens and Spokane Counties, Washington (1981) - Continued*

Sample Number	Location (TRS)	Mine/Prospect Name	Topographic Quadrangle	Geologic Description	Results* (ppm)		
					Sn	W	Mo
81-76B	NW¼ NE¼ sec. 26 T.29N., R.37E.	Keeth (Industrial Tungsten) Mine	Turtle Lake, 15';	Sample of crushed rock from caved workings carries granite and quartz-molybdenite fragments	4	55	50
81-77B	Center S½ SW¼ sec. 13 T.29N., R.37E.	Germania Mine	Hunters, 15'	Ore minerals in quartz vein; high-grade sample; wolframite, molybdenite, pyrite	2	2790	63
81-78B	Center S½ SW¼ sec. 13 T.29N., R.37E.	Germania Mine	Hunters, 15'	Greisen assemblage with quartz and pyrite	16	40	13
81-79B	Center S½ SW¼ sec. 13 T.29N., R.37E.	Germania Mine	Hunters, 15'	Mill tailings from Germania Mine	10	385	N.A.
81-80B	NW¼ sec. 24 T.29N., R.37E.	Roselle Prospect	Hunters, 15'	Dump sample of slightly altered biotite granite; granite with quartz veinlets, and greisenized granite with wolframite-quartz veins; possibly molybdenite in greisen	18	>5000	36
81-81B	NE¼ sec. 23 T.29N., R.37E.	Green Prospect	Hunters, 15'	Trench float is greisenized (quartz and muscovite) granite with manganese oxide; wall rock adjacent to quartz veins is silicified	32	20	17
81-82B	SE¼ SE¼ SE¼ sec. 14 T.29N., R.37E.	Prospect on the ridge (no name)	Hunters, 15'	Quartz-feldspar porphyry with large feldspar phenocrysts and clear to lavender, shattered, rounded quartz phenocrysts; chloritized biotite; strong jarosite-goethite staining	9	50	N.A.
81-83B	Center N-S line between secs. 13 and 14 T.29N., R.37E.	Outcrops along road	Hunters, 15'	Aplite with quartz phenocrysts; quartz-feldspar porphyry with biotite; quartz-feldspar porphyry with euhedral quartz crystals and greenish feldspar	16	15	6
81-84B	NW¼ NW¼ NE¼ sec. 6 T.29N., R.38E.	Togo Mine	Hunters, 15'	Dump sample; tremolite with chalcopyrite and pyrite	38	<10	3
81-84B(a)	Center NW¼ sec. 29 T.31N., R.39E.	Denver Mine	Stensgar Mtn., 7.5'	Dump sample contains barite, quartz, chalcopyrite, and pyrite in dolomite	4	<10	3
81-85B	NE¼ NW¼ NW¼ sec. 36 T.31N., R.38E.	Wells Fargo Mine	Stensgar Mtn., 7.5'	Float sample from upper cut; barite, stibnite, and chalcopyrite	<2	25	1

* N.A. = Not Assayed.

TABLE A-1. — *Tin, tungsten, and molybdenum geochemistry of selected mines and prospects, Stevens and Spokane Counties, Washington (1981) - Continued*

Sample Number	Location (TRS)	Mine/Prospect Name	Topographic Quadrangle	Geologic Description	Results* (ppm)		
					Sn	W	Mo
81-85B(a)**	Center NE¼ sec. 9 T.30N., R.38E.	Cleveland Mine	Hunters, 15'	Ore sample of galena, sphalerite, tetrahedrite, stibnite, and pyrite in siderite and quartz	52	15	2
81-86B	NE¼ NW¼ SW¼ sec. 11 T.29N., R.37E.	Queen and Seal Mine	Hunters, 15'	Dump sample with argentite, pyrite, galena, chalcopyrite, copper oxides in quartz with tremolite	4	25	25
81-87B	Center NE¼ sec. 15 T.29N., R.37E.	Aichan Bee (H&B) Prospect	Hunters, 15'	Pyrite and galena in vitreous black quartz vein, and disseminated in clear, vitreous quarzite of Buffalo Hump Formation(?)	<2	25	17
81-88B	Center S½ sec. 15 T.29N., R.37E.	Prospect in sec. 15	Hunters, 15'	Saccharoidal limestone, tremolite, basalt with small, pale-green striated, needle-like crystals and yellow-green colored coating surrounding black (manganese oxide?) clots; abundant manganese oxide; sample is of black clots surrounded by greenish coating and manganese oxide	14	<10	7
81-89B	SE¼ SW¼ sec. 5 T.37N., R.39E.	Pritchard & Harper Prospect	Echo Valley, 7.5'	Large area (several acres) of dark-colored quartzite carrying numerous white quartz veins; in some places, veins carry <1% pyrite in small cubes; several small adits	2	20	15
81-90B	W½ SE¼ NE¼ sec. 33 T.38N., R.39E.	Silver Trail Mine	China Bend, 7.5'	Galena, sphalerite, and pyrite in quartz veins, cutting Ordovician argillite near granite contact	2	<10	10
81-91B	E½ SE¼ NE¼ sec. 34 T.35N., R.39E.	Rocky Lake Prospect	Addy Mtn., 7.5'	Quartz plus aplite and granite with molybdenite and pyrite; dump sample from small decline is jarosite-stained; molybdenite occurs in rosettes in quartz and disseminated in silicified wall rocks; biotite "granite" is not very altered	<2	130	1000
81-92B	NE¼ SE¼ NE¼ sec. 17 T.36N., R.38E.	Prospect near Coyote - Grey Eagle Prospect	Kettle Falls, 7.5'	Dump sample of diorite and quartz with pyrite and siderite(?)	6	40	6

** Resampled in 1983 (Table A-2).

TABLE A-1. — *Tin, tungsten, and molybdenum geochemistry of selected mines and prospects, Stevens and Spokane Counties, Washington (1981) - Continued*

Sample Number	Location (TRS)	Mine/Prospect Name	Topographic Quadrangle	Geologic Description	Results* (ppm) Sn	W	Mo
81-93B	Center sec. 17 T.36N., R.38E.	Coyote - Grey Eagle Prospect	Kettle Falls, 7.5'	Pyrite, chalcopyrite, bornite, and malachite in quartz, quartzite(?), and totally argillized intrusive; some coarsely crystalline calcite veins cut argillized intrusives; also present is an argillite breccia cemented by quartz, and an altered igneous-rock breccia with hematite in numerous fractures; abundant manganese oxide	14	15	5
81-94B	SE¼ SE¼ NE¼ sec. 18 T.36N., R.38E.	IOU Claim	Kettle Falls, 7.5'	Galena and pyrite in quartz vein; also on the dump is fine, equigranular latite with 1% pyrite weathering to iron oxide, feldspars are argillized; some altered rocks look volcanic; sample contains unknown mineral (gray, metallic, looks like a cluster of small needles, soft with gray streak--silver?); quartz is either massive in veins, or as breccia matrix cementing volcanic fragments; minor calcite	2	30	26
81-95B	SW¼ SE¼ sec. 28 T.32N., R.36E.	Romulus Mine	Wilmont Creek, 15'	Massive galena and quartz crystals with pyrite and sphalerite; quartz and galena crystals intergrown; quartz crystals to 3 inches long; granite on the dump is sericitized alaskite with some manganese oxide	20	45	8
81-96B	SE¼ SW¼ SW¼ sec. 17 T.32N., R.40E.	Superior Copper Prospect	Addy, 7.5'	Sparse mineralization on dump; white quartz with minor chalcopyrite, azurite, malachite; other rocks include quartz-veined quartzite, silicified argillite, talc schist, plus Huckleberry greenstone with 2% pyrite	14	60	10
81-96(a)B	SE¼ SE¼ NE¼ sec. 11 T.31N., R.39E.	Dumbolten Prospect	Waitts Lake, 7.5'	Small prospect pit on east side of Douglas Mtn. in a quartz vein which cuts Huckleberry volcanics of Precambrian age; quartz vein contains minor chalcopyrite, malachite and an unknown, fibrous to acicular black crystal, submetallic luster (tourmaline?)	4	<10	12

TABLE A-1. — *Tin, tungsten, and molybdenum geochemistry of selected mines and prospects, Stevens and Spokane Counties, Washington (1981) - Continued*

Sample Number	Location (TRS)	Mine/Prospect Name	Topographic Quadrangle	Geologic Description	Results* (ppm)		
					Sn	W	Mo
81-97B	NE¼ SE¼ SE¼ sec. 2 T.29N., R.39E.	Gehrke Pit	Forest Center, 7.5'	Purple, fine-grained fluorite in "breccia veins" within saccharoidal dolomite near contact with the Loon Lake Batholith; lead-zinc-silver vein reported near granite contact; scintillometer kick in iron-oxide-rich areas of pit	26	<10	3
81-98B**	SE¼ SE¼ sec. 11 T.30N., R.37E.	Read Prospect	Hunters, 15'	Magnetite ore with minor pyrite or arseno-pyrite in calcium-rich granite at dolo-mite contact; granite is composed of chlorite, quartz, euhedral feldspar, garnet, and pyrite with minor magnetite veinlets; minor malachite staining	64	20	5
81-99B	NE¼ SE¼ sec. 16 T.30N., R.42E.	Blue Grouse Mountain Area	Deer Lake, 7.5'	Quartz with pyrite and dull-gray mineral (unknown) in altered granite of the Blue Grouse Adit	<2	20	18
81-100B	N½ SW¼ SW¼ sec. 15 T.30N., R.42E.	Blue Grouse Mountain Area	Fan Lake, 7.5'	Bedded sediments (Belt Supergroup) cut by small quartz veins and pegmatite with muscovite selvages; all iron-oxide stained with possible wolframite; peg-matite is comprised of potassium feldspar, quartz, and muscovite	4	<10	17
81-101B	SW¼ SW¼ NW¼ sec. 16 T.30N., R.42E.	Blue Grouse Mountain Area	Deer Lake, 7.5'	Near location of Little King Mines; altered and weathered granite contains 20% muscovite-sericite; grus is very, very white, with no mafic minerals; clots of iron, about 5%, are not related to pyrite or pervasive iron-oxide staining	<2	180	39
81-102B**	NW¼ NW¼ sec. 24 T.30N., R.37E.	Deer Trail Monitor (Monitor) Mine	Hunters, 15'	Calc-silicate hornfels near granite contact carries sphalerite, galena, molybdenite, pyrite, magnetite, chalcopyrite, epidote, actinolite, and calcite; molybdenite in greenish carbonate with garnet was not closely associated with galena and sphalerite	42	150	180

** Resampled in 1983 (Table A-2).

TABLE A-2. — *Tin, tungsten, and molybdenum geochemistry of selected mines and prospects, Stevens and Spokane Counties, Washington (1983)*

Sample Number	Location (TRS)	Mine/Prospect Name	Topographic Quadrangle	Geologic Description	Results* (ppm) Sn	W	Mo
83-1B	SW¼ NE¼ sec. 14 T.27N., R.42E.	Abandoned silica quarry	Dartford, 7.5'	Biotite, quartz, manganese oxide, and bluish druse with iron oxide from biotite-quartz veins in biotite granite	<2	15	13
83-2B	SW¼ NE¼ sec. 14 T.27N., R.42E.	Abandoned silica quarry	Dartford, 7.5'	Intensely weathered granite consists of clay, quartz, and muscovite	<2	<10	8
83-3B	SW¼ NE¼ sec. 14 T.27N., R.42E.	Abandoned silica quarry	Dartford, 7.5'	Very fine-grained granodiorite with hornblende, biotite and plagioclase; exfoliating on pit wall	15	<10	4
83-4B	SW¼ NE¼ sec. 14 T.27N., R.42E.	Abandoned silica quarry	Dartford, 7.5'	Hornblende-feldspar granodiorite porphyry; little quartz; euhedral hornblende crystals weather out into grus	<2	<10	3
83-5B	SW¼ NE¼ sec. 14 T.27N., R.42E.	Abandoned silica quarry	Dartford, 7.5'	Coarse pegmatite of massive feldspar, biotite, and quartz in granodiorite; heavily iron-stained	<2	45	279
83-6B	SE¼ NW¼ sec. 7 T.32N., R.41E.	Regal Serpentine Quarries	Chewelah, 7.5'	Green, calc-silicate hornfels adjacent to monzonite intrusive; minor copper staining	N.A.	<10	N.A.
83-7B	SE¼ NW¼ sec. 7 T.32N., R.41E.	Regal Serpentine Quarries	Chewelah, 7.5'	From upper quarry; tremolite is well developed; sample is of fault gouge zone in hornblende-biotite-bearing monzonite	N.A.	<10	N.A.
83-8B	NE¼ NW¼ sec. 33 T.38N., R.38E.	Young America Mine	Bossburg, 7.5'	Sample from oxidized fault zone in northernmost short adit; fault strikes N65°E, dips 15°S	<2	N.A.	N.A.
83-9B	NE¼ NW¼ sec. 33 T.38N., R.38E.	Young America Mine	Bossburg, 7.5'	Silicified, iron-oxide-stained fault at main portal; strikes N70°E, dips 13°N	199	N.A.	N.A.
83-12B	NE¼ NW¼ sec. 14 T.30N., R.37E.	Read Prospect	Hunters, 15'	Massive magnetite within recrystallized limestone	3	N.A.	N.A.
83-13B	NE¼ NW¼ sec. 14 T.30N., R.37E.	Read Prospect	Hunters, 15'	Garnet-diopside skarn; near dolomite outcrop	<2	N.A.	N.A.
83-14B	NE¼ NW¼ sec. 14 T.30N., R.37E.	Read Prospect	Hunters, 15'	Magnetite from prospect in limestone near old rotary drill holes	8	N.A.	N.A.

* N.A. = Not Assayed.

TABLE A-2. — *Tin, tungsten, and molybdenum geochemistry of selected mines and prospects, Stevens and Spokane Counties, Washington (1983) - Continued*

Sample Number	Location (TRS)	Mine/Prospect Name	Topographic Quadrangle	Geologic Description	Results* (ppm)		
					Sn	W	Mo
83-15B	SE¼ SE¼ sec. 11 T.30N., R.37E.	Read Prospect	Hunters, 15'	Same decline sampled in 1981 (81-98B); granodiorite footwall is silicified; actinolite, minor garnet, 0.5% pyrite with some chalcopyrite on fracture surfaces; sample is from granodiorite footwall	4	N.A.	N.A.
83-16B	SE¼ SE¼ sec. 11 T.30N., R.37E.	Read Prospect	Hunters, 15'	Dolomite hanging wall from same locality as 83-15B	12	N.A.	N.A.
83-17B	SE¼ SE¼ sec. 11 T.30N., R.37E.	Read Prospect	Hunters, 15'	Above decline; sample for garnet at dolomite-granodiorite contact; garnet is massive, flesh-colored, with feldspar and diopside(?)	<2	N.A.	N.A.
83-18B	SE¼ SE¼ sec. 11 T.30N., R.37E.	Read Prospect	Hunters, 15'	Magnetite and serpentine(?) above shaft	<2	N.A.	N.A.
83-22B	NW¼ NW¼ NW¼ sec. 6 T.29N., R.38E.	Turk Mine	Hunters, 15'	One-inch-thick zone of iron-oxide-stained clay with bright, bluish-black mineral that looks like specularite, but has black to gray streak	<2	N.A.	N.A.
83-23B	NE¼ sec. 36 T.30N., R.37E.	Unrecorded prospect	Hunters, 15'	Silicified Addy Quartzite with pyrite	<2	<10	4
83-24B	NW¼ NW¼ NW¼ sec. 6 T.29N., R.38E.	Turk Mine	Hunters, 15'	Actinolite, epidote, manganese oxide adjacent to quartz vein in fault zone from workings on west side of hill	2	N.A.	N.A.
83-25B	NW¼ NW¼ NW¼ sec. 6 T.29N., R.38E.	Turk Mine	Hunters, 15'	Silicified, brecciated quartz vein in fault; dominant fractures trend N84°E and dip 85°N	2	N.A.	N.A.
83-26B	NW¼ NW¼ NW¼ sec. 6 T.29N., R.38E.	Turk Mine	Hunters, 15'	Footwall side of quartz vein and fault zone is yellow-brown altered limestone with tremolite; abundant manganese oxide and malachite	4	N.A.	N.A.
83-27B	NW¼ NW¼ NW¼ sec. 6 T.29N., R.38E.	Turk Mine	Hunters, 15'	Silicified red and green dolomitic argillite with pyrite, chalcopyrite, and actinolite	<2	N.A.	N.A.

* N.A. = Not Assayed.

TABLE A-2. — *Tin, tungsten, and molybdenum geochemistry of selected mines and prospects, Stevens and Spokane Counties, Washington (1983) - Continued*

Sample Number	Location (TRS)	Mine/Prospect Name	Topographic Quadrangle	Geologic Description	Results* (ppm)		
					Sn	W	Mo
83-28B	Center NE¼ sec. 9 T.30N., R.38E.	Cleveland Mine	Hunters, 15'	Dump sample; high grade; predominantly galena	<2	N.A.	N.A.
83-29B	Center NE¼ sec. 9 T.30N., R.38E.	Cleveland Mine	Hunters, 15'	Dump sample; high grade; predominantly sphalerite	56	N.A.	N.A.
83-30B	Center NE¼ sec. 9 T.30N., R.38E.	Cleveland Mine	Hunters, 15'	Dump sample; high grade; predominantly pyrite, chalcopyrite, arsenopyrite	39	N.A.	N.A.
83-31B	SE¼ SE¼ SE¼ sec. 33 T.35N., R.39E.	McMillan Prospect area	Arden, 7.5'	White, crystalline dolomite about 50 feet from quartz monzonite contact	12	N.A.	N.A.
83-32B	NW¼ SW¼ SW¼ sec. 34 T.35N., R.39E.	McMillan Prospect area	Arden, 7.5'	Bluish, recrystallized dolomite with pods of cream- to rust-colored alteration; about 50 feet from quartz monzonite contact	78	N.A.	N.A.
83-33B	NE¼ SE¼ SE¼ sec. 33 T.35N., R.39E.	McMillan Prospect area	Arden, 7.5'	Pegmatite; quartz monzonite of varying grain size with euhedral pink (orthoclase?) phenocrysts; weakly foliated	<2	N.A.	N.A.
83-34B	NW¼ NE¼ NE¼ sec. 4 T.34N., R.39E.	McMillan Prospect area	Arden, 7.5'	Dolomite containing greenish-yellow pebble; dolomite is white, crystalline with rusty specks; near 1981 sample (81-39B)	14	N.A.	N.A.
83-35B	SE¼ SE¼ SW¼ sec. 1 T.29N., R.37E.	Deer Trail Mine	Hunters, 15'	Pod of garnet in chloritized schist with calcite veinlets, pyrite, and epidote in 5029 raise, left sub, Madre adit	12	<10	2
83-36B	SE¼ SE¼ SW¼ sec. 1 T.29N., R.37E.	Deer Trail Mine	Hunters, 15'	Vein material from muck in stope; above Madre adit	<2	<10	11
83-37B	SE¼ SE¼ SW¼ sec. 1 T.29N., R.37E.	Deer Trail Mine	Hunters, 15'	Pyritized wall rock; Madre adit 5028	<2	<10	2
83-38B	SE¼ SE¼ SW¼ sec. 1 T.29N., R.37E.	Deer Trail Mine	Hunters, 15'	Vein with galena, sphalerite, pyrite	<2	<10	2
83-39B	SE¼ SE¼ SW¼ sec. 1 T.29N., R.37E.	Deer Trail Mine	Hunters, 15'	DDH L-5; 75' to 80'; pyrite in argillite	<2	<10	5
83-40B	SE¼ SE¼ SW¼ sec. 1 T.29N., R.37E.	Deer Trail Mine	Hunters, 15'	DDH L-4; 294.8' to 295.8'; galena, sphalerite vein	<2	10	28

* N.A. = Not Assayed.

TABLE A-2. — *Tin, tungsten, and molybdenum geochemistry of selected mines and prospects, Stevens and Spokane Counties, Washington (1983) - Continued*

Sample Number	Location (TRS)	Mine/Prospect Name	Topographic Quadrangle	Geologic Description	Results* (ppm)		
					Sn	W	Mo
83-41B	SE¼ SE¼ SW¼ sec. 1 T.29N., R.37E.	Deer Trail Mine	Hunters, 15'	DDH L-5; 276' to 277'; galena-sphalerite vein	<2	55	23
83-42B	NW¼ SW¼ sec. 7 T.33N., R.38E.	Daisy and Tempest Mines	Inchelium, 15'	Ore from lower adit dump; pyrite, arsenopyrite, galena, sphalerite, bornite in quartz	<2	N.A.	N.A.
83-43B	NW¼ SW¼ sec. 7 T.33N., R.38E.	Daisy and Tempest Mines	Inchelium, 15'	Black pyritiferous slate from lower adit portal	<2	N.A.	N.A.
83-44B	NE¼ NW¼ NW¼ sec. 7 T.33N., R.38E.	Daisy and Tempest Mines	Inchelium, 15'	Quartz vein with sulfides from dump; northern adit	232	N.A.	N.A.
83-45B	NE¼ NW¼ NW¼ sec. 7 T.33N., R.38E.	Daisy and Tempest Mines	Inchelium, 15'	Pyritized, quartz-flooded granitic rock cut by pink veinlet (orthoclase?); quartz, fine-grained chlorite, and galena	116	N.A.	N.A.
83-46B	NE¼ NW¼ NW¼ sec. 7 T.33N., R.38E.	Daisy and Tempest Mines	Inchelium, 15'	Altered, weathered intrusive composed of goethite and clay near upper adit of Daisy Mine; <10% quartz	<2	N.A.	N.A.
83-50B	NW¼ sec. 24 T.30N., R.37E.	Roadcut	Hunters, 15'	Metamorphosed (Addy?) quartzite and siltite beds; quartzite is variable--recrystallized, coarse, fine; abundant manganese oxide; tourmaline crystals in bunches within quartzite; jarosite staining	<2	N.A.	N.A.
83-51B	NW¼ NW¼ sec. 24 T.30N., R.37E.	Deer Trail Monitor (Monitor) Mine	Hunters, 15'	Andradite garnet	<2	N.A.	N.A.
83-52B	NW¼ NW¼ sec. 24 T.30N., R.37E.	Deer Trail Monitor (Monitor) Mine	Hunters, 15'	High-grade molybdenite ore	<2	N.A.	3100

* N.A. = Not Assayed.

TABLE A-3. — *Tin geochemistry of rock and stream-sediment samples from the Colville National Forest*

Sample Number	Location (TRS)	Geographic Location of Stream-Sediment Samples	Topographic Quadrangle	Geologic Description of Rock Samples*	Results for Tin (ppm)
W-10/26 10S	SE¼ SE¼ sec. 22 T.37N., R.41E.	Upper Rocky Creek	Aladdin Mtn., 7.5'	Stream-sediment sample	<2
W-10/26 14R	SE¼ SE¼ sec. 22 T.37N., R.41E.	Rock sample	Aladdin Mtn., 7.5'	Moderately limonitized granodiorite porphyry	<2
W-6/25 4S	SE¼ NE¼ sec. 36 T.34N., R.41E.	Tributary to North Fork of Chewelah Creek	Calispell Peak, 7.5'	Stream-sediment sample	<2
2G-5/31 1R	SW¼ SW¼ sec. 31 T.34N., R.41E.	Rock sample	Cliff Ridge, 7.5'	Limonitized greenstone with 2% pyrite	4
2G-5/31 21S	NE¼ NE¼ sec. 20 T.33N., R.40E.	Tributary to Blue Creek	Addy, 7.5'	Stream-sediment sample	<2
2G-5/29 12S	NE¼ SW¼ sec. 5 T.31N., R.42E.	Tributary to Middle Fork of Calispell Creek	Nelson Peak, 7.5'	Stream-sediment sample	<2
2G-6/2 9S	NE¼ NW¼ sec. 11 T.36N., R.40E.	Tributary to Middle Fork of Mill Creek	Aladdin, 7.5'	Stream-sediment sample	4
2G-5/31 23S	SE¼ SE¼ sec. 9 T.33N., R.40E.	Tributary to North Fork of Chewelah Creek	Addy, 7.5'	Stream-sediment sample	<2
G-9/14 11AR	SE¼ SE¼ sec. 19 T.40N., R.37E.	Rock sample	Laurier, 7.5'	Silicified metavolcanics, dacite(?) with 10% pyrite	4
G-6/27 20R	SW¼ SE¼ sec. 32 T.35N., R.42E.	Rock sample	Calispell Peak, 7.5'	Very coarse-grained muscovite pegmatite with smoky quartz in muscovite granodiorite porphyry	17
G-6/27 22R	NW¼ SE¼ sec. 5 T.34N., R.42E.	Rock sample	Calispell Peak, 7.5'	Coarse-grained muscovite pegmatite in leucocratic granodiorite	4
G-6/27 12R	SW¼ NW¼ sec. 1 T.33N., R.41E.	Rock sample	Calispell Peak, 7.5'	Very coarse-grained two-mica pegmatite in weakly gneissic muscovite granodiorite porphyry	2
G-6/25 8S	NE¼ SW¼ sec. 31 T.33N., R.42E.	Tributary to Tenmile Creek	Goddards Peak, 7.5'	Stream-sediment sample	<2
G-6/25 11R	SE¼ NW¼ sec. 2 T.32N., R.41E.	Rock sample	Goddards Peak, 7.5'	Limonitized, strongly quartz-sericite-altered granodiorite in shear zone	71

* Geologic description of U.S. Forest Service samples taken from Grant, 1982.

TABLE A-3. — *Tin geochemistry of rock and stream-sediment samples from the Colville National Forest Continued*

Sample Number	Location (TRS)	Geographic Location of Stream-Sediment Samples	Topographic Quadrangle	Geologic Description of Rock Samples*	Results for Tin (ppm)
G-6/29 8S	SW¼ SW¼ sec. 26 T.36N., R.40E.	Robbins Creek	Park Rapids, 7.5'	Stream-sediment sample	4
G-6/30 1S	SW¼ SW¼ sec. 14 T.37N., R.41E.	Tributary to Rocky Creek	Aladdin Mtn., 7.5'	Stream-sediment sample	<2
G-6/28 29S	SW¼ SW¼ sec. 24 T.37N., R.41E.	Tributary to Rocky Creek	Aladdin Mtn., 7.5'	Stream-sediment sample	<2
G-10/26 14S	NW¼ SE¼ sec. 4 T.34N., R.42E.	Tributary to Tacoma Creek	Calispell Peak, 7.5'	Stream-sediment sample	2
K-7/16 28R	NW¼ SW¼ sec. 4 T.39N., R.38E.	Rock sample	Belshazzar Mtn., 7.5'	Strongly limonitized argillite/siltstone; quartz veinlets with 4% pyrite	7
K-7/15 17R	NE¼ SE¼ sec. 32 T.40N., R.39E.	Rock sample	Northport, 7.5'	Silicified metasedimentary wall rock adjacent to vein dump	<2
K-7/12 10R	SW¼ SE¼ sec. 35 T.40N., R.37E.	Rock sample	Churchill Mtn., 7.5'	Strongly limonitized, fine-grained propylitized greenstone-diorite with quartz veinlets and 1% pyrite	17
K-7/16 18R	NW¼ NW¼ sec. 29 T.40N., R.38E.	Rock sample	Churchill Mtn., 7.5'	Limonitized, fine-grained diorite(?)-andesite, <0.5% pyrite	<2
G-6/29 1R	NE¼ NW¼ sec. 2 T.35N., R.40E.	Rock sample	Park Rapids, 7.5'	Limonitized, coarse-grained two-mica granodiorite with quartz veinlets	<2
K-7/14 7AR	NW¼ SW¼ sec. 4 T.39N., R.39E.	Rock sample	Northport, 7.5'	Strongly limonitized crenulated slate/phyllite with quartz veinlets	<2
K-7/12 30R	SE¼ SW¼ sec. 8 T.40N., R.37E.	Rock sample	Laurier, 7.5'	Moderately limonitized (hematite) propylitized lithic volcanics, tuff, trace of pyrite	10
R-7/15 25R	SW¼ SE¼ sec. 7 T.40N., R.37E.	Rock sample	Laurier, 7.5'	Limonitized, hornfelsed metadacite, 2% pyrite	10
R-7/18 10R	SE¼ NE¼ sec. 7 T.40N., R.38E.	Rock sample	Churchill Mtn., 7.5'	Limonitized, hornfelsed siltstone, 1.5% pyrite	4
R-7/16 14R	SW¼ SW¼ sec. 24 T.40N., R.37E.	Rock sample	Churchill Mtn., 7.5'	Massive pyrite, pyrrhotite, chalcopyrite, magnetite (dump)	7
R-7/11 6S	NE¼ NE¼ sec. 17 T.40N., R.37E.	Deep Creek	Laurier, 7.5'	Stream-sediment sample	<2

* Geologic description of U.S. Forest Service samples taken from Grant, 1982.

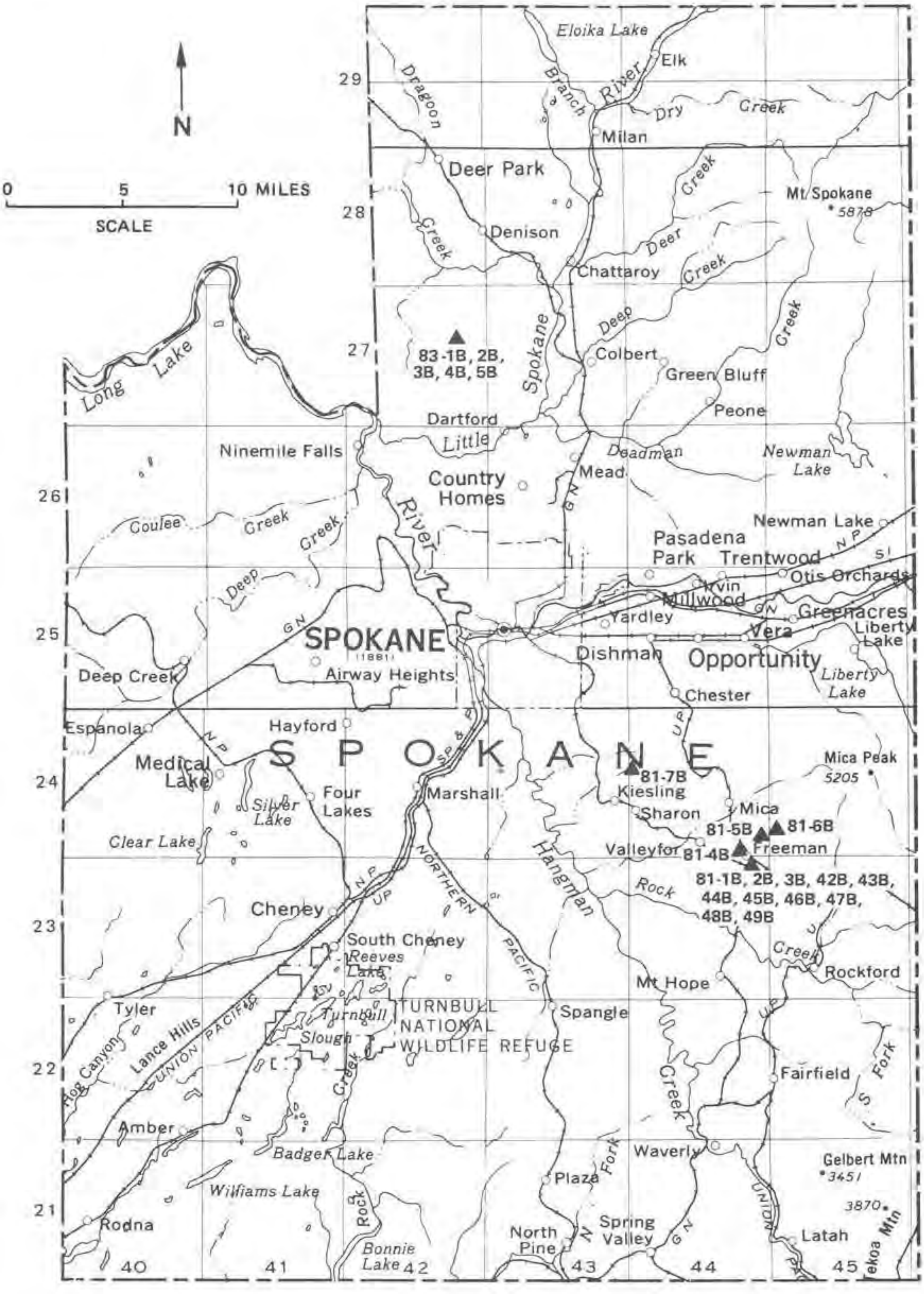
TABLE A-3. — *Tin geochemistry of rock and stream-sediment samples from the Colville National Forest Continued*

Sample Number	Location (TRS)	Geographic Location of Stream-Sediment Samples	Topographic Quadrangle	Geologic Description of Rock Samples*	Results for Tin (ppm)
R-7/18 28R	SW¼ NW¼ sec. 2 T.39N., R.38E.	Rock sample	Belshazzar Mtn., 7.5'	Limonitized, silicified, sericitized schist, 3% pyrite	<2
R-7/11 7S	SE¼ SE¼ sec. 9 T.40N., R.37E.	Camp Creek	Churchill Mtn., 7.5'	Stream-sediment sample	<2
R-7/17 27R	SW¼ NE¼ sec. 19 T.40N., R.38E.	Rock sample	Churchill Mtn., 7.5'	Limonitized, sheared granodiorite dike in metasediments (portal)	<2
R-7/18 6R	NW¼ NE¼ sec. 17 T.40N., R.38E.	Rock sample	Churchill Mtn., 7.5'	Limonitized, hornfelsed quartzite, 1% pyrite	<2
R-7/18 11R	SE¼ NE¼ sec. 8 T.40N., R.38E.	Rock sample	Belshazzar Mtn., 7.5'	Limonitized quartzite	<2

* Geologic description of U.S. Forest Service samples taken from Grant, 1982.

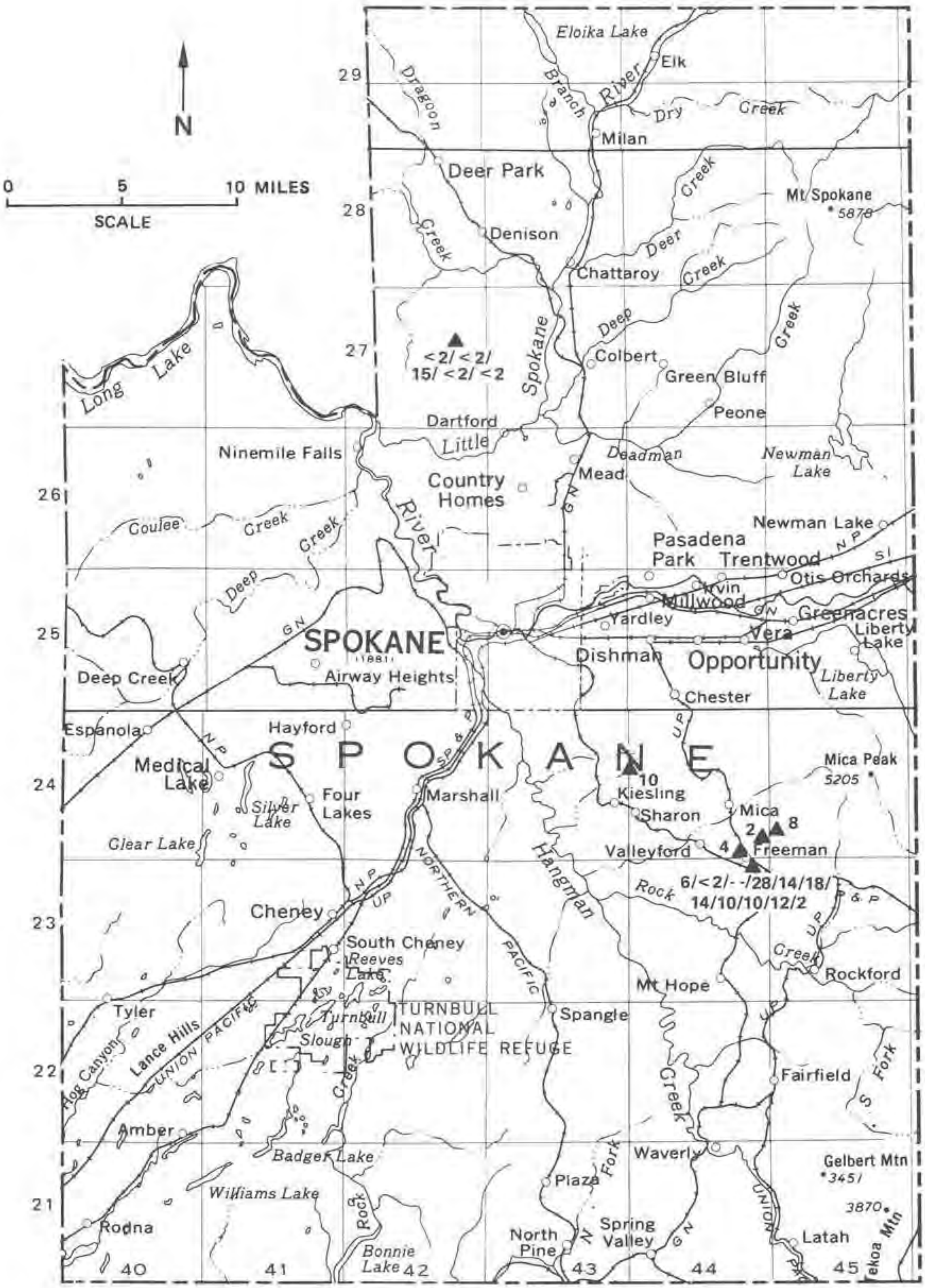
APPENDIX B

SAMPLE LOCATION AND GEOCHEMICAL MAPS



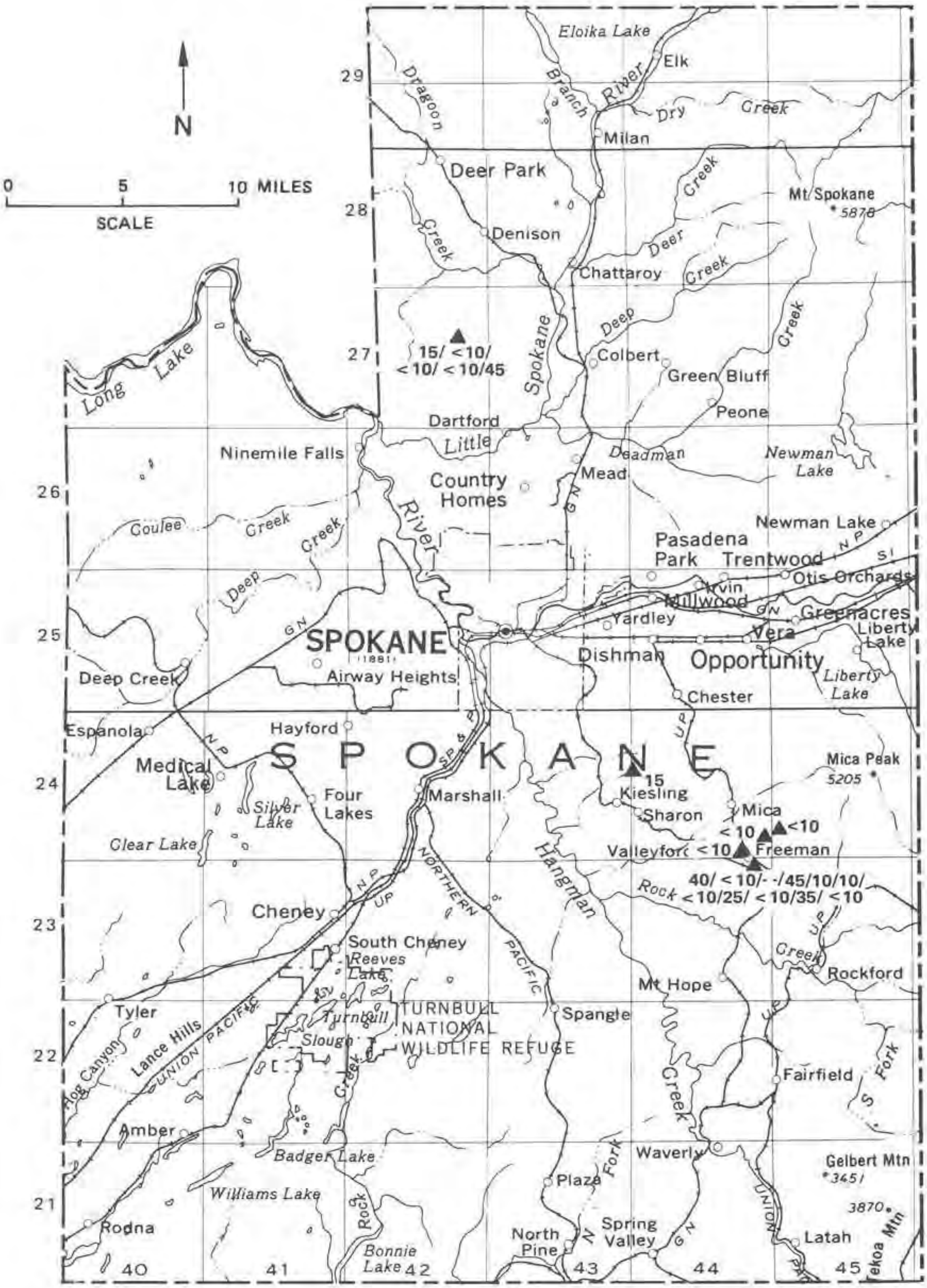
▲ WDGER rock sample location

Figure B-1. — Sample location map — Spokane County.



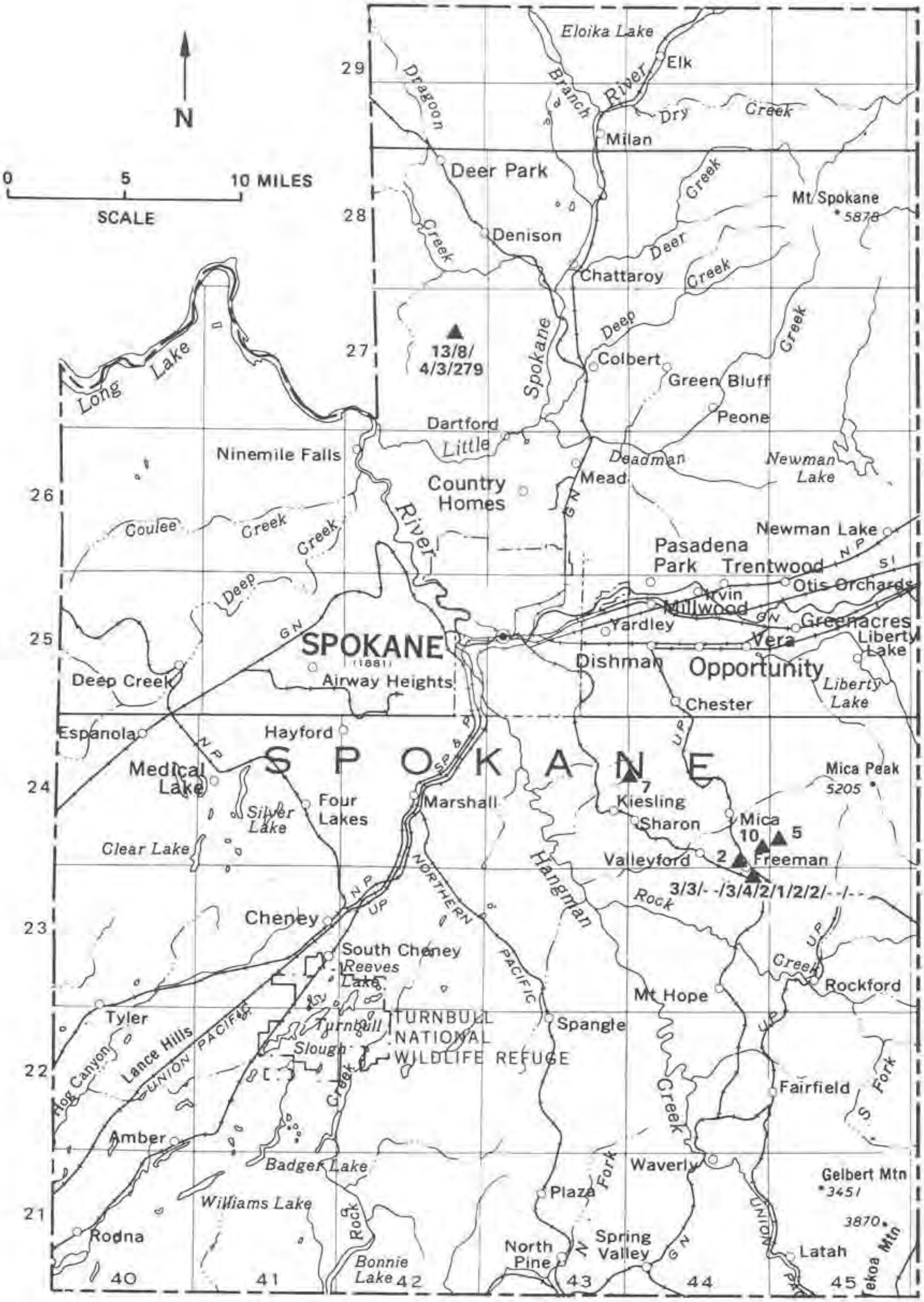
▲ WDGER rock sample location (results in ppm)

Figure B-2. — Tin geochemistry — Spokane County.



▲ WDGER rock sample location (results in ppm)

Figure B-3. — Tungsten geochemistry — Spokane County.



▲ WDGER rock sample location (results in ppm)

Figure B-4. — Molybdenum geochemistry — Spokane County.

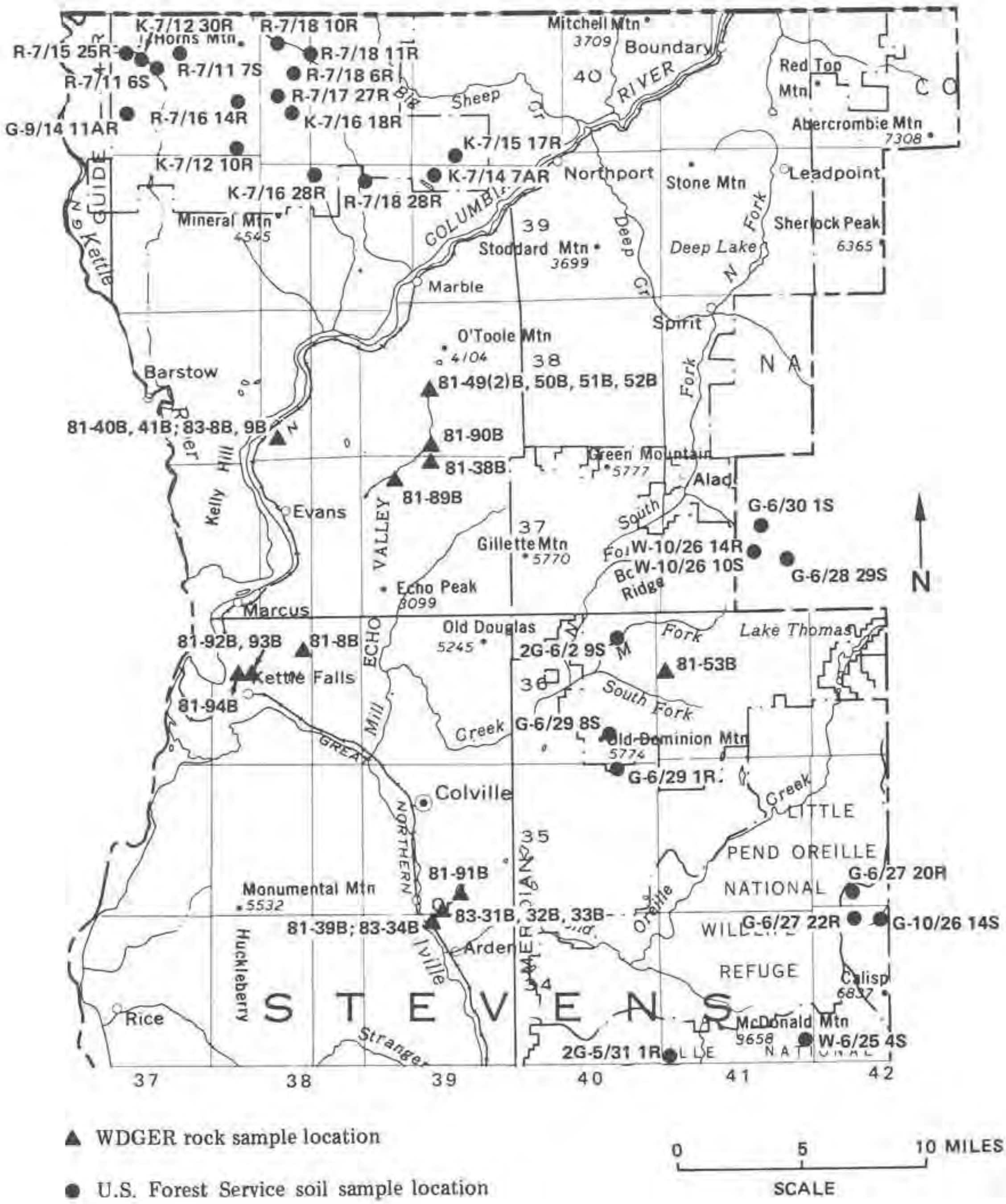


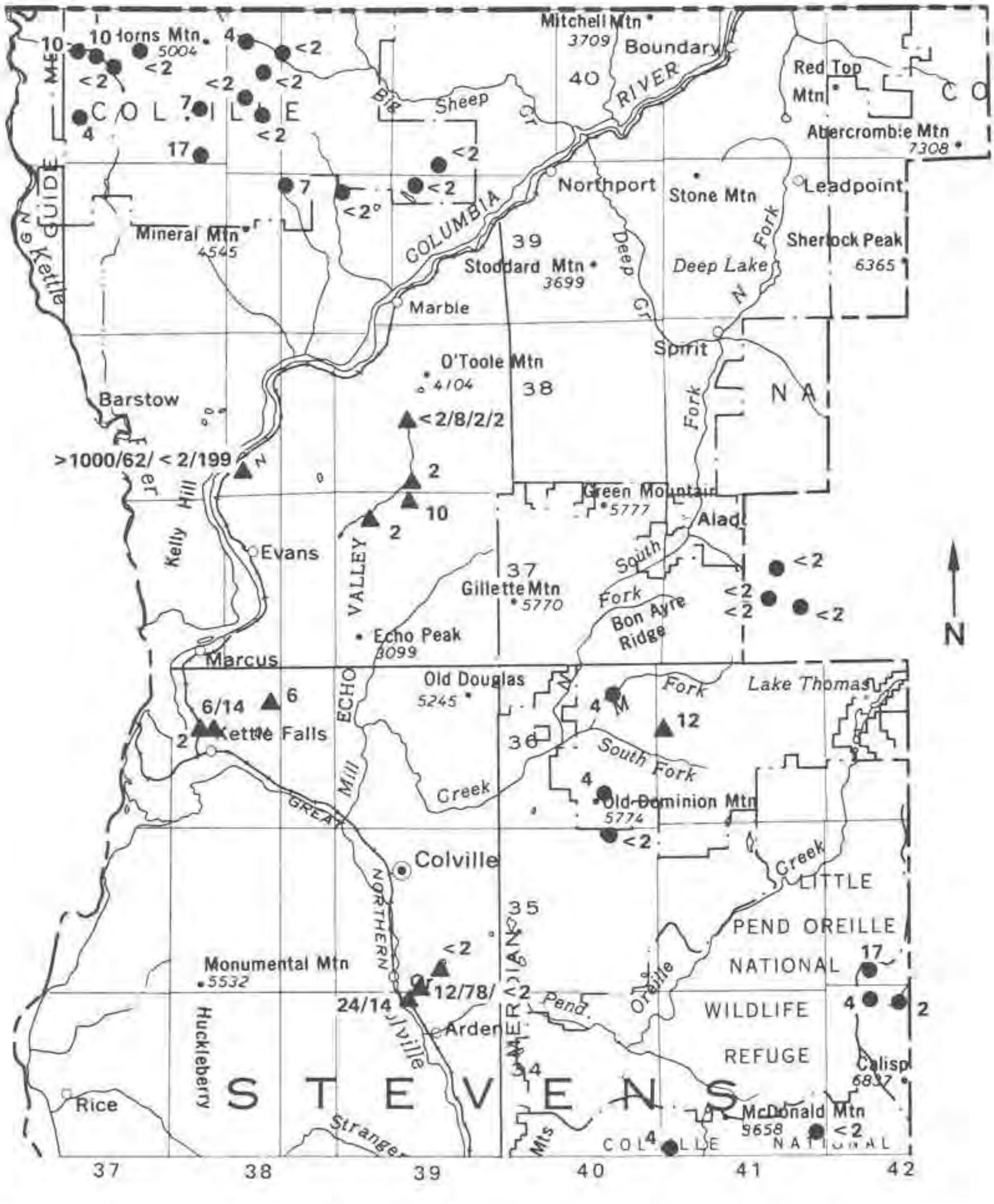
Figure B-5a. — Sample location map — Stevens County, north portion.

▲ WDGER rock sample location

● U.S. Forest Service soil sample location

0 5 10 MILES
SCALE

Figure B-5b. — Sample location map — Stevens County, south portion.



▲ WDGER rock sample location (results in ppm)

● U.S. Forest Service soil sample location (results in ppm)

0 5 10 MILES
SCALE

Figure B-6a. — Tin geochemistry — Stevens County, north portion.

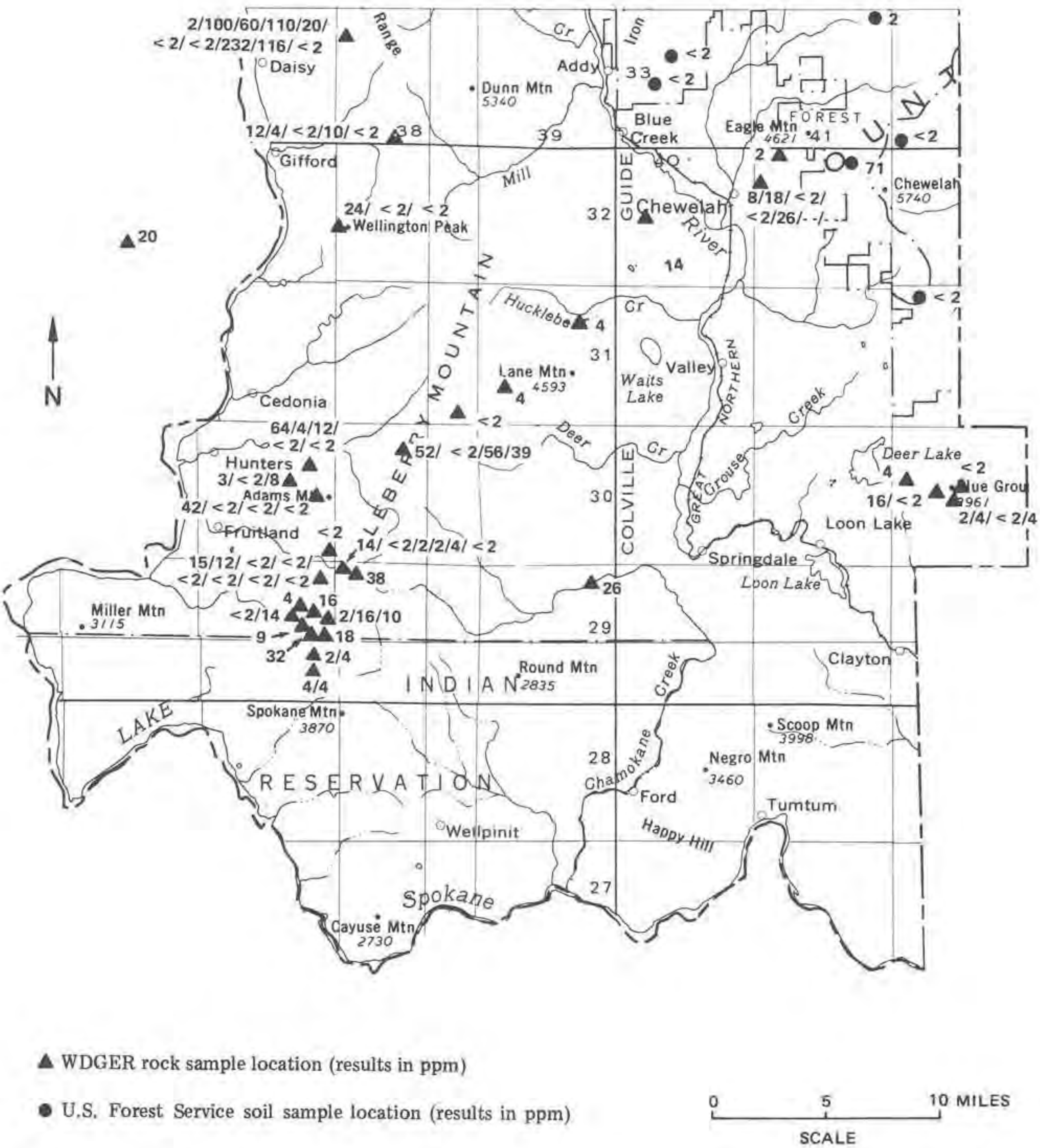
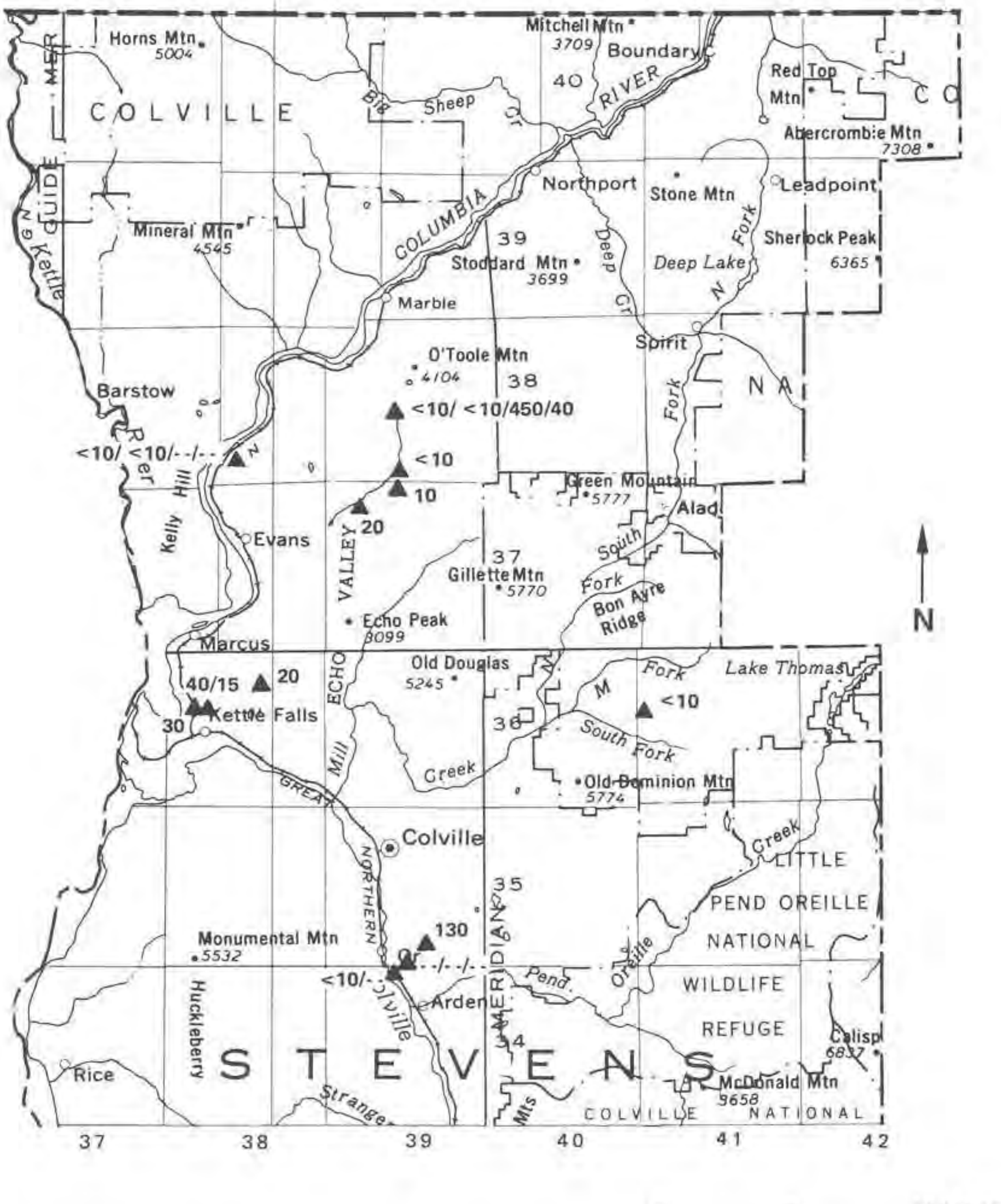
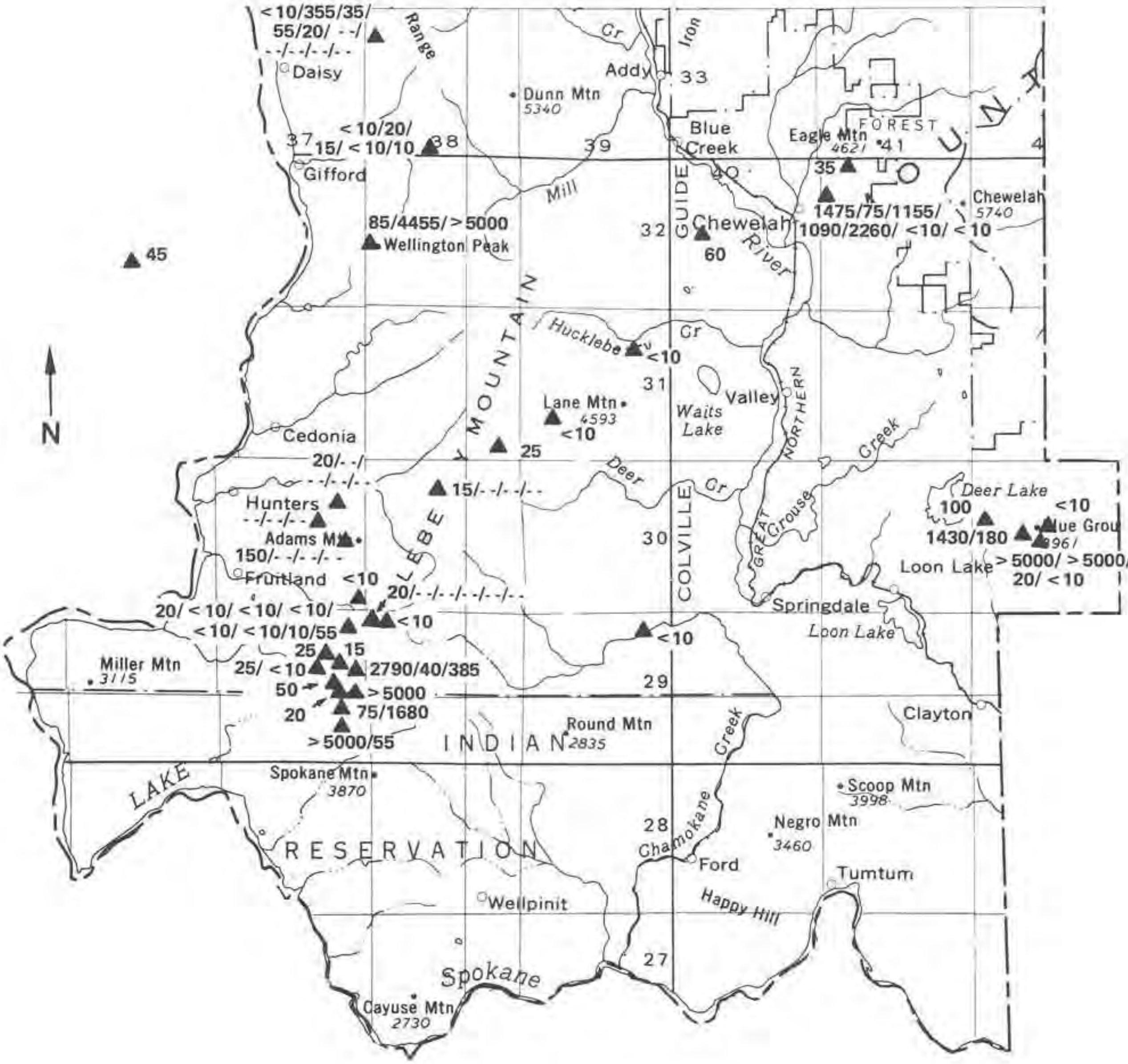


Figure B-6b. — Tin geochemistry — Stevens County, south portion.



▲ WDGER rock sample location (results in ppm)

Figure B-7a. — Tungsten geochemistry — Stevens County, north portion.



▲ WDGER rock sample location (results in ppm)

Figure B-7b. — Tungsten geochemistry — Stevens County, south portion.

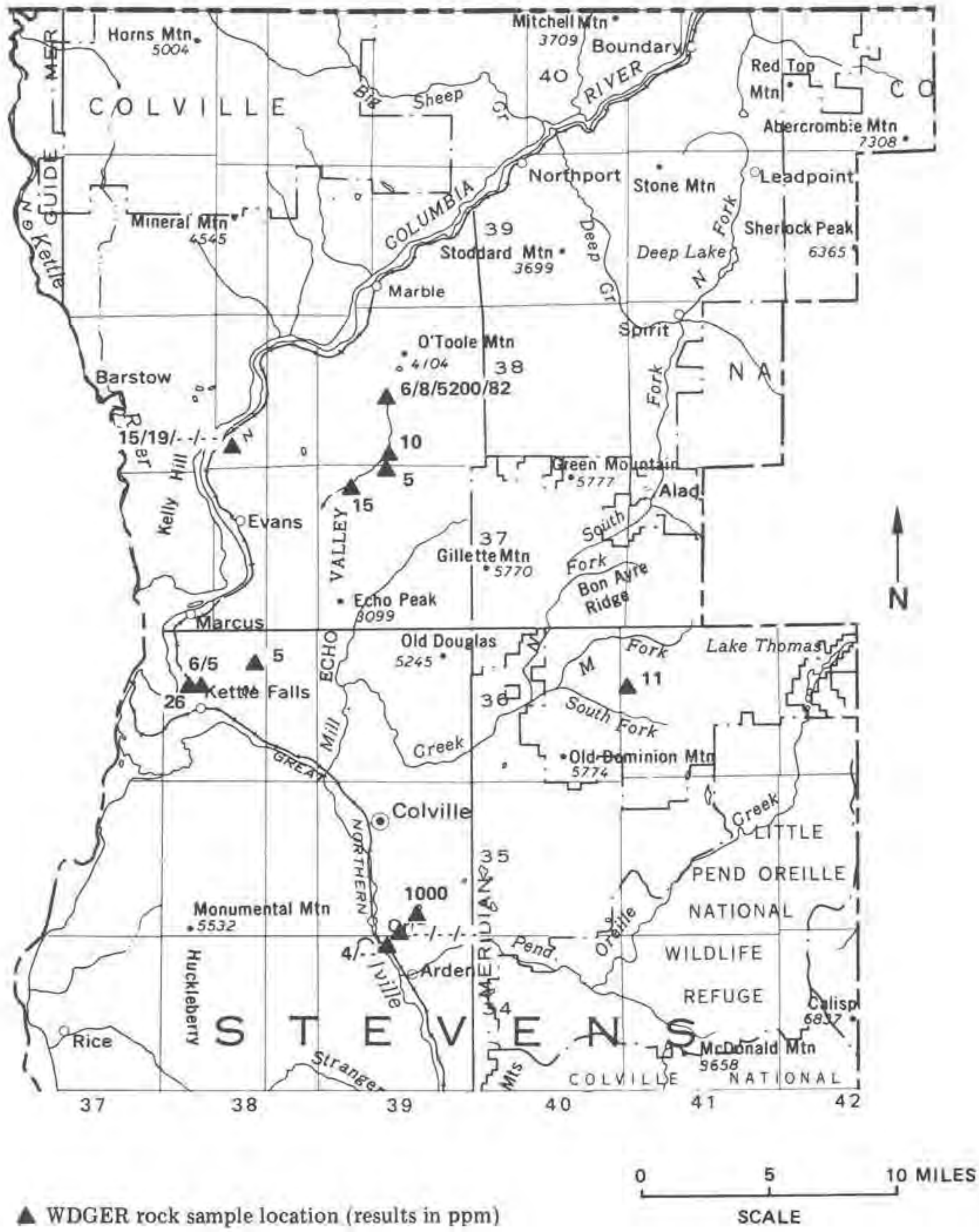


Figure B-8a. — Molybdenum geochemistry — Stevens County, north portion.

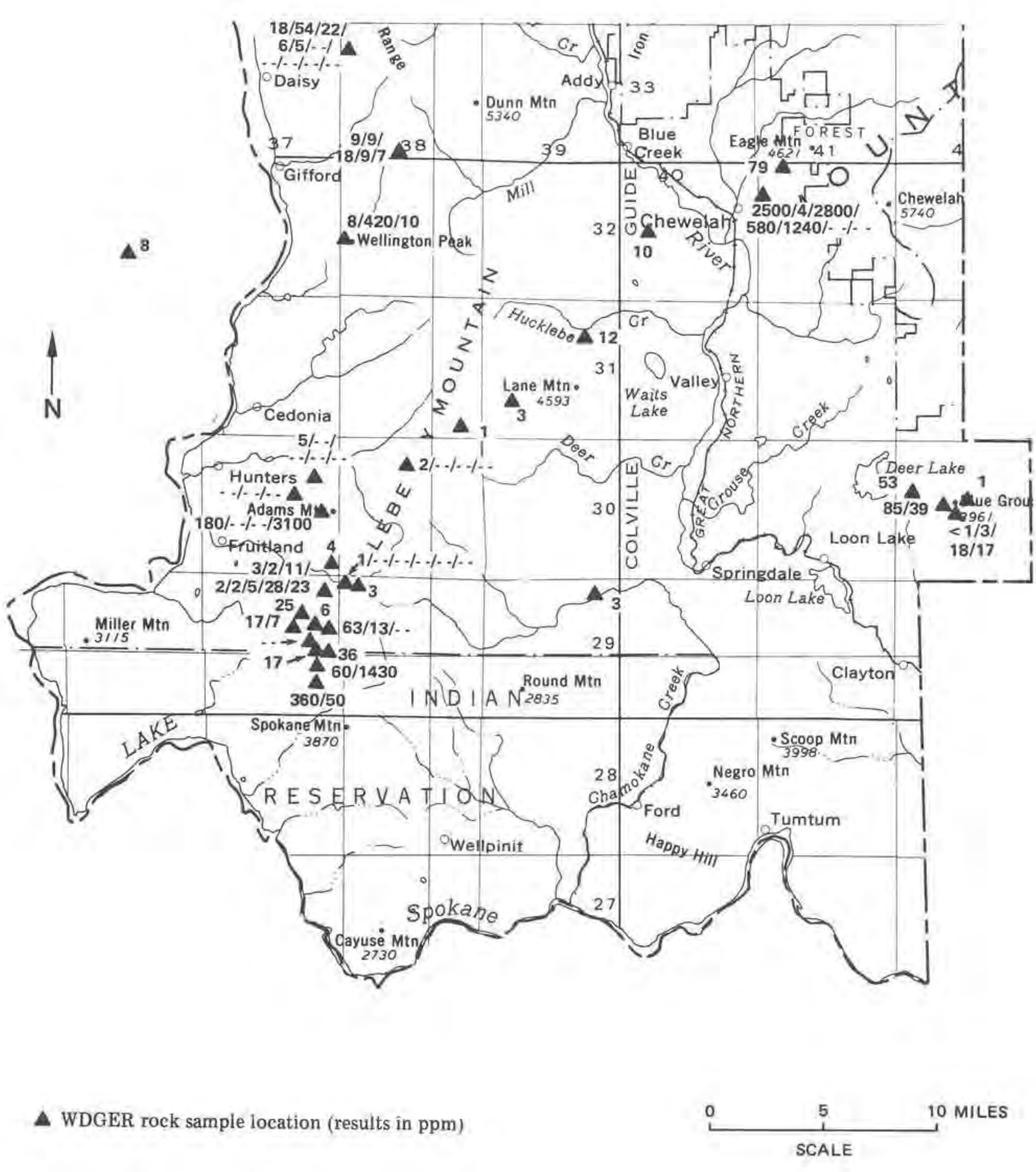


Figure B-8b. — Molybdenum geochemistry — Stevens County, south portion.