DEPARTMENT OF THE INTERIOR
UNITED STATES GEOLOGICAL SURVEY

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OPEN FILE REPORT
84-480

Base by U.S. Geological Survey, 1957

SCALE 1:48 000

1 ½ 0 1 2 3 4 5 MILES

1 .5 0 1 2 3 4 5 KILOMETERS

CONTOUR INTERVAL 80 FEET
DATUM IS MEAN SEA LEVEL

21° APPROXIMATE MEAN DECLINATION, 1975
TRUE NORTH
MAGNETIC NORTH

QUADRANGLE LOCATION

This report is preliminary and has not been reviewed for conformity with U. S. Geological Survey editorial standards and stratigraphic nomenclature.

PRELIMINARY GEOLOGIC MAP OF THE SPIRIT LAKE QUADRANGLE, WASHINGTON

by

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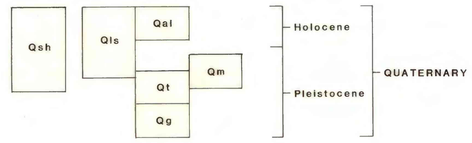
EXPLANATION

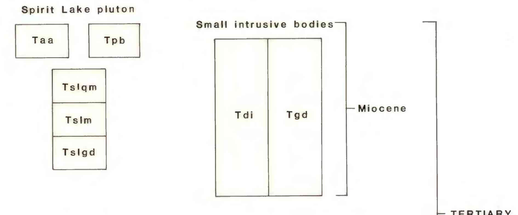
CORRELATION OF MAP UNITS

SURFICIAL DEPOSITS

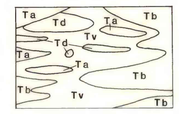


Unconformity

INTRUSIVE ROCKS



VOLCANIC AND SEDIMENTARY ROCKS



DESCRIPTION OF MAP UNITS

This map portrays the geology and topography of the Spirit Lake quadrangle as it existed prior to the cataclysmic eruption of Mount St. Helens on May 18, 1980. This eruption substantially modified the terrain in the southwestern part of the quadrangle. In particular, pre-1980 deposits of Mount St. Helens and some of the Tertiary bedrock along the North Fork of the Toutle River shown on this map are now buried beneath debris avalanche, mudflow, and pumiceous pyroclastic flow deposits produced by the eruptions that occurred on May 18, May 25, June 12, July 22, August 7, and October 16-18, 1980 (Lipman and Mullineaux, 1981). Quaternary deposits and Tertiary rocks in the bottom of South Coldwater Creek, the lower reaches of Coldwater Creek, and in Bear Cove at the north end of the west arm of Spirit Lake were also buried, and former exposures on the shore of Spirit Lake have been inundated as the level of the lake has risen to its current elevation of approximately 3,400 feet.

SURFICIAL DEPOSITS

Bedrock throughout much of the quadrangle is covered by unconsolidated and heavily vegetated surficial deposits. In addition to the mappable units described below, tephra from several major eruptions of Mount St. Helens during the past 40,000 years mantles the entire area (Mullineaux, Hyde, and Rubin, 1975). The thickness of the tephra blanket increases progressively from northwest to southeast within the quadrangle, commonly exceeding two meters in places east and northeast of Spirit Lake.

Qsh DEPOSITS OF MOUNT ST HELENS VOLCANO, UNDIFFERENTIATED (HOLOCENE AND PLEISTOCENE)--Unconsolidated pyroclastic, laharic, fluvial, and tephra deposits, and pyroxene andesite lava flows in the valley of the North Fork of the Toutle River

Qls LANDSLIDE AND DEBRIS FLOW DEPOSITS (HOLOCENE AND PLEISTOCENE)

Qal ALLUVIUM (HOLOCENE)--Unconsolidated stream deposits of silt- to boulder-size material. Locally includes accumulations of talus, reworked tephra from Mount St. Helens, and undifferentiated glacial deposits, especially in the drainage basins of Coldwater Creek, Clearwater Creek, Quartz Creek, and Green River

Qt TERRACE DEPOSITS (PLEISTOCENE)--Unconsolidated silt- to boulder-size detritus forming several levels of terraces along the Cowlitz and Cispus Rivers. Principally glacial outwash deposits of Hayden Creek and Evans Creek ages, but locally includes some Evans Creek till and postglacial alluvium (Crandell and Miller, 1974)

Qg GLACIAL TILL (PLEISTOCENE)--Weathered glacial till of Hayden Creek age (Crandell and Miller, 1974); bedrock not exposed

Qm MORAINES (PLEISTOCENE)--Unconsolidated poorly-sorted detritus forming lateral and end moraines, chiefly along the Cowlitz River, Green River, and Coldwater Creek

INTRUSIVE ROCKS

The Spirit Lake pluton, in the center of the quadrangle, is a complex, multiphase, epizonal body ranging in composition from quartz diorite to granite, here divided into three readily distinguishable phases. Widespread small intrusive bodies are more variable, and include mafic to intermediate hypabyssal dikes and sills compositionally similar to the volcanic rocks they intrude, as well as more silicic intrusions possibly genetically related to the Spirit Lake pluton; these latter are most abundant northeast and southeast of the pluton.

Spirit Lake pluton

Taa ARGILLIC ALTERATION (MIOCENE)--Areas of intense argillic and advanced argillic alteration in the northern part of the pluton. Rocks are brecciated and totally replaced by quartz, sericite or pyrophyllite, and limonite, with occasional minor alunite or diaspore. Protolith obscure, probably includes both plutonic and volcanic host rocks

Tpb PEBBLE BRECCIA (MIOCENE)--Bodies of pale green, poorly-sorted, coarse-grained breccia within Tslm near Ryan Lake. Composed of angular to subrounded clasts of porphyritic dacite and andesite in a fine tuffaceous matrix. Thoroughly altered to assemblages of carbonate and clay minerals. Probably postdates potassic alteration and mineralization of the Earl porphyry copper deposit (Hollister, 1979), dated by Armstrong and others (1976) at 16.2±0.6 m.y.

Tslqm QUARTZ MONZONITE PHASE (MIOCENE)--Light gray to pale pinkish gray, fine- to medium-grained, generally sparsely porphyritic and miarolitic pyroxene-hornblende quartz monzonite, granite, and aplite. In addition to areas shown on the map, small dikes and irregular bodies occur throughout the main phase of the pluton (Tslm). Phenocrysts are plagioclase, clinopyroxene, orthopyroxene, magnetite, and hornblende; groundmass is predominantly quartz and alkali feldspar with occasional minor biotite. Deuteric alteration is pervasive; primary mafic minerals are largely uralitized or chloritized and plagioclase is variably altered to albite, epidote, and sericite. Fine-grained black secondary tourmaline is widespread in this unit, and is particularly abundant in the vicinity of Mount Margaret, north of Spirit Lake

Tslm MAIN PHASE (MIOCENE)--Dark to light gray to pale pinkish gray, medium- to coarse-grained quartz diorite, quartz monzodiorite, granodiorite, and quartz monzonite. Consists of several texturally similar intrusive bodies having subtle, often gradational contacts. Typical rock contains phenocrysts of blocky plagioclase, to 1 cm, and prismatic augite and hypersthene in a groundmass of anhedral to granophyric quartz and alkali feldspar; minor late magmatic olive-brown hornblende and biotite occur sporadically. Coarse-grained hypidiomorphic granular textures predominate in the southwestern part of the unit and porphyritic textures are more common in the northern and eastern parts. Most of the rocks of this unit were moderately to extensively deuterically altered. Textures and alteration products are similar to those in the quartz monzonite phase except that secondary biotite is a common mineral in the main phase. A sample obtained on Hoodoo Peak (Sec. 21, T. 10 N., R. 5 E.) by R. W. Tabor (Engels and others, 1976) yielded a K-Ar age of 21.4±0.3 m.y.

Tslgd GRANODIORITE PHASE (MIOCENE)--A complex of dikes and irregular intrusions of fine-grained porphyritic to seriate pyroxene quartz diorite and granodiorite with minor screens of hornfelsed volcanic host rock. Extensive to complete deuteric alteration is characteristic. Contact with the main phase is poorly exposed, but dikes that are probably part of the main phase locally cut the granodiorite phase, indicating that the latter is older

Small intrusive bodies

Tdi DIORITE, DIABASE, AND GABBRO (MIOCENE)--Black to medium gray, orange-weathering, medium- to coarse-grained hypidiomorpic to subophitic rocks forming dikes and sills. Major occurrences are dikes on Huffaker Mountain and a large sill in the Smith Creek drainage. Composed of plagioclase, augite, orthopyroxene, and magnetite with or without olivine, ilmenite, minor interstitial quartz and traces of orthoclase. Range from unaltered (except for replacement of olivine by smectite minerals and carbonate) to extensively altered to zeolite, smectite, and carbonate

Tgd GRANODIORITE, QUARTZ DIORITE, QUARTZ MONZONITE, AND QUARTZ MONZODIORITE (MIOCENE)--Small epizonal dikes, sills, and irregular intrusive bodies peripheral to the Spirit Lake pluton. Mostly gray to light greenish or brownish gray, fine-to medium-grained porphyritic rocks with phenocrysts of plagioclase, augite, commonly orthopyroxene, and rarely hornblende in a fine-grained equigranular to granophyric groundmass of plagioclase, quartz, orthoclase, magnetite, pyroxene, and rarely hornblende and biotite. Moderately to extensively altered to assemblages of albite, epidote, calcite, sericite, chlorite, sphene, hematite, and smectite, with occasional pyrite, uralitic amphibole or zeolite

VOLCANIC AND SEDIMENTARY ROCKS

Mid-Tertiary volcanic and volcaniclastic rocks in the Spirit Lake quadrangle constitute a structurally simple but stratigraphically complex, eastward-dipping, generally homoclinal sequence roughly six to eight kilometers thick. Although local unconformities have been observed, no major breaks have been recognized, and the section evidently represents the products of more or less continuous volcanism during late Oligocene and early Miocene time. On this map, the rocks are subdivided solely on the basis of lithology, and despite the complex intertonguing of rock types, it is apparent that basalts are most abundant in the lower part of the section in the western half of the quadrangle whereas andesites and more silicic rocks become dominant in the upper part. North of the Cowlitz and Cispus River, however, the entire sequence is basaltic. Few faults have been mapped in the Spirit Lake quadrangle, partly reflecting the limited bedrock exposure and the lack of distinctive marker beds. However, mapping done in the southern part of the quadrangle after the 1980 eruption of Mount St. Helens and subsequent erosion had removed the vegetation and surficial deposits from substantial areas, shows that faults are indeed rather uncommon, and those that have been noted are relatively minor, with offsets measured in tens of meters at most. Nevertheless, indications of an important underlying structure trending about N. 30° E. through the center of the map area are found in the orientations of faults west of Spirit Lake, of dikes and other intrusive bodies northeast of the Spirit Lake pluton, and the elongation of the pluton itself. The most prominant joint sets within the pluton are also oriented in a northeasterly direction. The marked contrast in stratigraphy across the Cispus River suggests that a significant fault may be buried beneath the alluvial deposits there, but no direct evidence for such a structure has been noted, and the northeasterly dike trend just described does not appear to be offset by the hypothesized fault.

Tb BASALT AND BASALTIC ANDESITE (OLIGOCENE AND MIOCENE)--Black to medium gray to green, aphyric to sparsely porphyritic, massive to vesicular basalt and basaltic andesite lava flows and flow breccia with interbedded mafic tuff, lahar, and minor sedimentary rocks. Crops out predominantly in the northern and western parts of the quadrangle. Porphyritic rock types consist of phenocrysts of plagioclase, olivine, and augite in intergranular to intersertal groundmasses of plagioclase, clinopyroxene, magnetite, and brown to green rare glass. Slightly to completely altered to zeolite or prehnite-pumpellyite facies assemblages. Within contact aureoles of the Spirit Lake pluton and some smaller satellitic intrusive bodies, these rocks have been recrystallized to fine-grained hornblende- and pyroxene-hornfels facies assemblages

Ta ANDESITE (OLIGOCENE AND MIOCENE)--Dark to light gray, green, and brown, generally porphyritic, pyroxene andesite flows and flow breccia; locally includes minor basalt and dacite flows and breccias and interbedded volcaniclastic rocks. Forms major accumulations at Tumwater Mountain, Strawberry Mountain, Bismarck Mountain, and Vanson Peak around the periphery of the Spirit Lake pluton; also found as individual flows and thin sequences of flows interbedded with dacite, rhyolite and volcaniclastic rocks in the southeastern part of the quadrangle. Andesite typically consists of plagioclase, augite, and hypersthene phenocrysts in a pilotaxitic groundmass of plagioclase, pyroxene, magnetite, quartz, and interstitial glass (usually altered to fine-grained smectite). Alteration variable, similar to that described above for basalt

Td DACITE AND RHYOLITE (OLIGOCENE AND MIOCENE)--White to light greenish gray, sparsely-phyric, commonly flow-banded dacite and rhyolite flows, and breccia. Forms major flow-dome complexes on Strawberry and Tumwater Mountains and isolated plugs and flow remnants scattered throughout the eastern half of the quadrangle. Typical samples contain less than 10 percent plagioclase phenocrysts and 5 percent pyroxene phenocrysts in a groundmass of devitrified glass which now consists of fine-grained granular to spherulitic quartz and feldspar. Hornblende is rare and biotite was not observed. Secondary alteration is more extensive in these silicic rocks than in andesite and basalt; such alteration probably results from supergene oxidation of minor but widespread pyrite

Tv VOLCANICLASTIC ROCKS (OLIGOCENE AND MIOCENE)--Continental pyroclastic and sedimentary rocks including andesitic to rhyolitic, typically lithic-rich, ash-flow and air-fall tuff, tuff breccia, volcanic siltstone, sandstone, conglomerate, minor coal beds, and many poorly-sorted volcanic breccia beds of uncertain origin. Pumiceous pyroclastic rocks are especially abundant in association with thick accumulations of dacite and rhyolite in the eastern part of the quadrangle. Original glassy debris has been entirely converted to smectite, quartz, feldspar, zeolites

CONTACT--dashed where approximately located, short-dashed where gradational or inferred, dotted where concealed

FAULT--dashed where approximately located, dotted where concealed

STRIKE AND DIP OF BEDDING OR EUTAXITIC FOLIATION IN TUFFS

HORIZONTAL BEDDING

STRIKE AND DIP OF PLANAR FLOW FEATURES IN VOLCANIC ROCKS

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