QM-10

PLATE 1

STATE OF OREGON

DEPARTMENT OF GEOLOGY AND MINERAL INDUSTRIES

704 Lewis Building, Portland, Oregon

EARL K. NIXON, Director

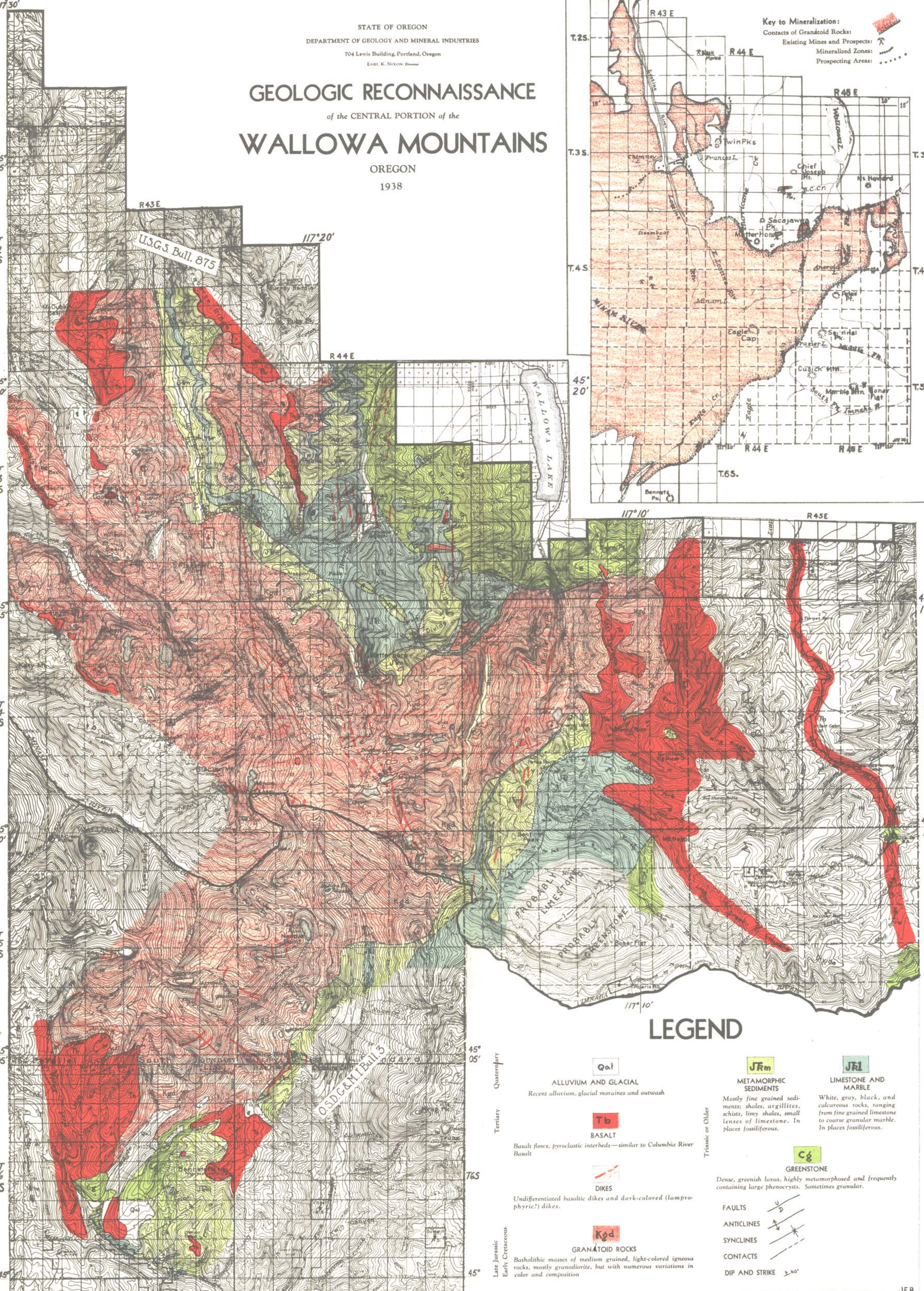
GEOLOGIC RECONNAISSANCE

of the CENTRAL PORTION *of the*

WALLOWA MOUNTAINS

OREGON

1938



LEGEND

Quaternary

Qal — ALLUVIUM AND GLACIAL

Recent alluvium, glacial moraines and outwash

Tertiary

Tb — BASALT

Basalt flows, pyroclastic interbeds—similar to Columbia River Basalt

DIKES

Undifferentiated basaltic dikes and dark-colored (lamprophyric?) dikes.

Late Jurassic Early Cretaceous

Kgd — GRANITOID ROCKS

Batholithic masses of medium grained, light-colored igneous rocks, mostly granodiorite, but with numerous variations in color and composition

Triassic or Older

JTRm — METAMORPHIC SEDIMENTS

Mostly fine grained sediments; shales, argillites, schists, limy shales, small lenses of limestone. In places fossiliferous.

JTRl — LIMESTONE AND MARBLE

White, gray, black, and calcareous rocks, ranging from fine grained limestone to coarse granular marble. In places fossiliferous.

Cg — GREENSTONE

Dense, greenish lavas, highly metamorphosed and frequently containing large phenocrysts. Sometimes granular.

FAULTS

ANTICLINES

SYNCLINES

CONTACTS

DIP AND STRIKE

JEA

Base: United States Forest Service
Forest Atlas, Wallowa and Minam Folio Sheets.
Surveyed 1912-1917

SCALE

1 0 1 2 3 4 Miles

Contour Interval—100 Feet

Geology by Warren D. Smith; Assisted by
Ray C. Treasher — John Eliot Allen
Lloyd Ruff — Wayne Lowell

GEOLOGIC RECONNAISSANCE

of the Central Portion of the

WALLOWA MOUNTAINS, OREGON

INTRODUCTION

Purpose

A geologic reconnaissance of the central portion of the Wallowa Mountains was carried out by the State Department of Geology and Mineral Industries in order to determine the areas or zones most suitable for prospecting; to definitely eliminate certain localities as being unfavorable prospecting ground; to prepare a reconnaissance geologic map illustrating the conclusions; and to carry northward the data published by this Department as Bulletin no. 3, "The Geology of a Part of the Wallowa Mountains, Oregon", by Clyde Ross.

Extent of the Survey

Five geologists and four student assistants spent five weeks in July and August, 1938, plus an additional week by two geologists and two student assistants. Geologic contacts and belts of mineralization were studied in some detail. Rocks and formations were classified by field methods. The map and data must be regarded as strictly preliminary, and conclusions may be modified by further work.

Personnel

The survey parties were directed by Earl K. Nixon, Director of the State Department of Geology and Mineral Industries, who kept in close touch with the progress of the work by correspondence and field inspection. Warren D. Smith was geologist in charge of field parties, assisted by Ray C. Treasher and John Eliot Allen of the State Department of Geology and Mineral Industries, and Lloyd Ruff and Wayne Lowell, geologists. Fred Hoffstead, Wilbur Greenup, James Weber, and Herbert Harper were student assistants, with Forrest Landeen as cook.

Acknowledgements

The topographic base was supplied from the Forest Atlas of the United States Forest Service; sheets 8, 9, 12, and 13 of the Wallowa National Forest, and sheets 4, and 5 of the Minam Division of the Whitman National Forest were used. While the topography is reconnaissance, these topographic maps made it possible to cover the area effectively. Special mention is made of the cooperation of Mr. C. J. Buck, Regional Forester; Mr. J. F. Erwin, Supervisor of Wallowa National Forest; Mr. Lester Moncrief, Supervisor of Whitman National Forest; Mr. V. H. Flack, in charge of Maps and Surveys; as well as many of the staff.

Mr. Clint Haight, editor of the Joseph Herald, Mr. G. T. Green, Mr. Jos. La Gore, Mr. Jack Baxter, and Mr. Charles Seeber gave invaluable assistance. The merchants of Lostine, Enterprise, and Joseph contributed greatly to the administration of the field parties.

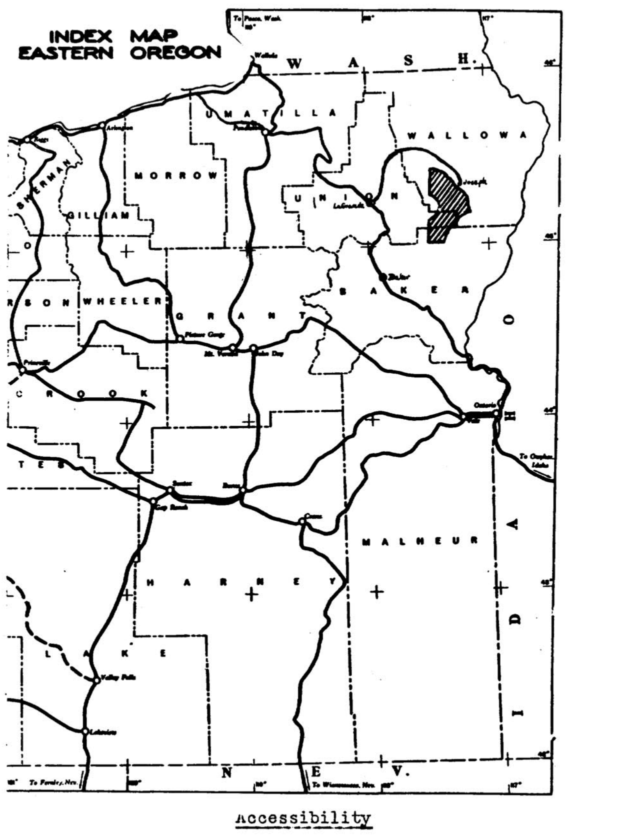
Previous Work

Published reports on the geology of the central portion of the Wallowa Mountains have been concerned with the limestone occurrences, (particularly the Black Marble & Lime Company's quarry in sec. 19, T. 2 S., R. 44 E.), with generalized statements as to the geology and some pertinent data on the physiography, glaciation and scenery, and a few reports on detailed areas or prospects. A selected bibliography is given at the close of this report.

GEOGRAPHY

Location

The central portion of the Wallowa Mountains covered by the map is located in southern Wallowa County, the extreme eastern extension of Union County, and a very small portion of Northern Baker County. It includes portions of T. 2, 3, 4, 5, & 6 S., R. 43, 44, & 45 E., in the extreme northeastern part of the State of Oregon. Its boundaries approximate those of the so-called Eagle Cap Primitive Area in the Wallowa and Whitman National Forests. It includes the drainage of Lostine River, Hurricane Creek, West and East Forks of Wallowa River on the north; and main Eagle Creek on the south.



Accessibility

The Wallowa Valley is served by a branch of the Union Pacific, LaGrande-Joseph branch, and by hard surfaced state highway 82. A Forest Service road extends up Lostine River 18 miles south of the town of Lostine. Good trails follow the east and west forks of Lostine River to the Lakes Basin and the summit of the range. Hurricane Creek is reached from either Enterprise or Joseph; a Forest Service road penetrates the Wallowa National Forest about two miles and an excellent trail follows the creek to its headwaters and into the Lakes Basin. Trails go up both forks of Wallowa River from Wallowa Lake; the trail up West Fork goes to the Basin and to the headwaters of Imnaha River, and the trail up East Fork passes Aneroid Lake and continues southeast across the Imnaha River to Cornucopia.

The south part of the area is reached by market and forest road through Keating and by a poor road up main Eagle Creek. Trails along the main streams penetrate to the high country.

Aside from the trails mentioned, there are few secondary trails or ways. Some lines of travel have been blazed by fishermen but for the most part it is a case of "follow your nose".

Physiography

The area has an average relief of 3000 feet and elevations ranging from 4500 feet to 10,000 feet. Hillside slopes of 30° are common, and the north-south ridges are fairly continuous. The late-youth topography is extensively modified by Pleistocene and Recent glaciation.

GEOLOGY AND STRATIGRAPHY

The following determinations and correlations are based on field methods and are tentative, subject to correction when laboratory work is completed on the rocks and fossils collected. A more detailed description of the area will be published by this Department as Bulletin no. 12, of which this map is a part.

Greenstones

Greenstones underlie the metamorphic sediments and marbles and are the oldest rocks mapped. Northeast of Point Joseph a sedimentary interbed at least 400 feet thick and several hundred feet below the top of the greenstone sequence, contains fossils that suggest a Triassic age determination. The northern series around Wallowa Lake must be at least 3000 feet thick as measured in two separate places. No section could be measured in the southern area on main Eagle Creek.

The greenstone of the northern area is a very hard, dense, tough, dark-green rock. A porphyritic phase contains lath-shaped feldspars that attain a length of five centimeters and occur in rosette-like groups in a dark, fine-grained matrix. The phenocrysts are thought to be secondary and the greenstones to be of extrusive rather than intrusive origin. 5/ Another common phase of the rock is a breccia of greenstone fragments imbedded in a matrix of green, fine-grained tuff or lava.

The greenstone of the southern area appears megascopically to be a dark-green, granular, gabbroid rock, composed mainly of pyroxene. It may represent a contact metamorphic phase of the sediments correlative with the Hummingbird Peak metamorphics. South of Bennetts Peak a large area of grey to greenish altered rocks, apparently of volcanic origin, was included with the metamorphic sediments.

Ross 5/ considers the greenstone to be Permian in the area to the southeast. Fossils from an interbed on Point Joseph may be Triassic. Therefore, the greenstone is provisionally considered to be Triassic, or older.

Metamorphic Sediments

The metamorphic sediments throughout the region mapped, conformably overlie the greenstones. Several horizons of marble and limestone are interbedded with these sediments. They tend to be highly calcareous near the marble contacts, and contain Triassic fauna. The argillitic portions of the group range from dark fossiliferous shale to dense, hard argillites or hornfels that are almost "basaltic" in appearance, and "clink" like a phonolite. Fine-grained disseminated pyrite appears in many of these. Banding is apparent even in the more altered types but slaty cleavage is seldom developed.

Where these sediments have been intruded by the granitoid rocks they are more or less altered and silicified, resembling graywacke. At Hummingbird Peak there is a contact zone up to 500 feet thick in which a great textural variety of hornblende-gneisses, schists, and hornfels have been developed and no definite contact can be drawn between the sedimentary and igneous rocks.

On the Hurwal Divide, near B. C. Basin, a series of argillites, hornfels, impure limestone and fossiliferous, calcareous shale more than 1000 feet thick overlies and grades downward into the grey marbles and limestones. Along Eagle Creek the shales are fossiliferous and include large lenses of marble. South of Bennetts Peak, several thousand feet of rocks of volcanic origin apparently overlie these shales, and are mapped with them.

Triassic fossils indicate Triassic age of these sediments.

Marbles and Limestones

The marbles and limestones are interbedded with the sedimentary series as relatively narrow bands that widen in many places to several hundreds of feet. Isoclinal folding within the largest marble masses greatly exaggerates their true thickness.

These rocks have frequently been called "limestone" but they have all undergone metamorphism and should properly be called marbles. Color varies from fine-grained black (Black Marble & Lime Co. quarry), to pink (Point Joseph), to yellow (Hurwal Divide). The more common coarse, granular and friable marble has individual crystals three millimeters in diameter, as in the areas of the Lostine, Hurricane, Wallowa, and Imnaha rivers. Argillaceous phases, grading into the sediments, are not common.

Well developed banding may be due to original bedding but probably resulted from intense metamorphism.

Sills and veins of igneous rock have often been broken and "stretched"; one occurrence gave conclusive evidence of having been "stretched" five times its original length. The once plastic marble flowed around these obstructions as indicated by contorted, folded, and squeezed banding.

Where the marble has been intruded by granitoid rocks, a tactite zone is often developed that will range from one inch to tens of feet in width. The more common metamorphic minerals are grossularite garnet, wollastonite, and epidote, as well as quartz, molybdenite, some scheelite, and secondary calcite. The contacts of basalt dikes with marble are sharp and unmineralized.

Stratigraphically, the marbles can probably be correlated with the "Martin Bridge Formation" 5/ which are Triassic. They have been traced continuously from the type locality at Martin Bridge northward to a point just south of Aneroid Lake. The marble areas of Lostine River and Hurricane Creeks and Hurwal Divide are all interconnected. Although they are separated from the southern area by about four miles of granitoid rocks on the two forks of Wallowa River, they are probably of similar age.

The marbles are fossiliferous in places, although the forms are not as well preserved as in the adjoining sediments. At the Black Marble Quarry, corals of several types, a few gastropods and possibly some brachiopods, were found.

Granitoid Rocks

Granitoid igneous rock is the predominate rock of the central portion of the Wallowa Range. The rock has many variations in composition and appearance and has been termed granodiorite, quartz diorite, diorite, biotite-quartz diorite, tonalite, "stock" rock, and others.

This rock is composed essentially of quartz, biotite, and plagioclase feldspar, sometimes with minor amounts of hornblende. Some phases range to muscovite-quartz granite and even alaskite to dark colored diorite. The portions containing the greatest quartz appear to be small intrusions separate from the main mass, as in B. C. basin and above Lapover on Lostine River. Aplite and pegmatite dikes were noted in several localities. Near the limestone contacts, tonalite phases appear. 7/ The argillite and greenstone contacts with the granitoid rock are usually without contact metamorphic minerals but considerable silicification frequently occurs.

It is assumed that this granitoid rock is a part of the Mesozoic batholith, probably upper Jurassic or lower Cretaceous age. Erosion must have proceeded for some time before later basalt was poured out, as an old prebasalt surface has been identified. It is characterized by a deep granitic soil, with occasional gravel beds composed of large boulders of quartzite, granite, andesite and other rocks. This terrane was gently rolling, and represented a late mature stage of topography.

Dikes

Dark-colored dikes, the so-called "iron dikes", are a prominent feature of the landscape, and they cut all types of rock. They appear to be predominately basaltic and represent the feeders to the later basalt flows. Where the basalt capping remains, these dikes may be seen passing through the granodiorite into and through the basalt flows.

Many dikes that appear to be basaltic are more properly classed as lamprophyric phases (complimentery dikes) of the granodiorite intrusion. One of these occurs just above Aneroid Lake. These dark-colored dikes are mapped as undifferentiated.

The dikes are most frequently seen in areas of granitoid rocks, where they are occasionally three miles long. Thickness varies from a few inches to 40 or 50 feet, with 20 feet being the more common. The trend is from 10° to 30° northwest in the Lostine River drainage and in the Lakes Basin; nearly north-south in the Hurricane and Wallowa drainage; and in three directions in the main Eagle drainage. The dips are almost vertical.

No mineralization along the contacts of the basaltic dikes with intruded rocks was noted. In fact, the contact is exceptionally sharp, as if the injected liquid was at low temperature and exerted little pressure during its intrusion. Many of the lamprophyric (?) dikes appear to have sharp contacts with little evidence of contact metamorphism, but further study is needed.

It is possible that economic minerals may be found in the dikes and along such contacts although none were found by this survey.

Basalt

The basalts are usually dense, dark grey to black, aphanitic lavas. Vesicular, scoriaceous, and porphyritic textures are not uncommon. The individual flows are usually about 20 feet thick, and columnar jointing is well developed although platy and blocky phases were observed. A highly magnetic, dense, black basalt was noted on Lookout Mountain, and elsewhere.

These basalt flows cap the ridges along the northern edge of the Wallowa Range. They underlie the Wallowa-Grande Ronde valley at an elevation of about 4500 feet and have a very flat dip. They next appear high on the crest of the ridges to the south at elevations of about 6000 feet and rise to 8500 feet before they disappear. Farther south and toward the west and east, the lava is several thousand feet thick and overlies all other formations at the lower elevations. On the south side of the range, only Bennetts Peak is capped with basalt (elev. 6000 ft.) but a few miles west and south, basalt becomes the predominant rock type.

The basalt is assumed to correlate with Columbia River Basalt and is therefore of middle Miocene age.

Alluvial and Glacial

Alluvium, or unconsolidated deposits, within the central Wallowa Mountains is glacial or derived directly from glacial deposits. The boulders are predominately granitoid, with minor amounts of greenstones and marbles. Size varies from rock flour to boulders 10 feet in diameter.

The great lateral and terminal moraine that impounds Wallowa Lake is undoubtedly one of the best preserved of its kind in the United States. The lateral moraine is 800 feet high at the upper end and its smoothly sloping sides strongly suggest an artificial embankment. The moraines at the mouths of Lostine River and Hurricane Creek are distinct physiographic features. They are well developed on the east side of Eagle Creek, and a small terminal moraine with two lobes impounds Two Color Lake, just south of Hummingbird Mountain. The tops of the lateral moraine ridges on Eagle Creek are 1000 feet above the valley floor. Granodiorite erratics found on the sides of the Lostine canyon 2500 feet above the stream bed are assumed to represent the depth of the Lostine glacier.

Recent alluvial wash within the valleys consists of sands and gravels derived from glacial debris. The wide and sometimes marshy flats along many of the streams are composed of sandy and bouldery material filled in behind glacial rock or morainal dams since the retreat of the ice.

STRUCTURAL AND HISTORICAL GEOLOGY

Great lava flows and tuff beds formed some time prior to middle Triassic time, probably in a manner similar to the Miocene basalts. The land area then began to sink, and it was covered by salt water in which were deposited limey and clayey sediments. These later became the metamorphic sediments with limestone interbeds, and fluctuating conditions of depth of water and source of material accounted for the changes in sediment. The shallow sea bottom swarmed with invertebrate life such as corals, and several types of shellfish.

Lack of Jurassic sediments indicates that the land emerged from the sea and the Triassic formations were folded. As folding progressed and the earth's crust was weakened, an underlying pool of molten rock (a magma) sought its way upward, making more progress through the less competent rocks by shoving them aside and folding them still more. Thus the limestones were squeezed until they became semi-plastic and the enormous thickening around the head of Lake and Hurricane Creeks was developed. The magma also advanced by stoping, as large blocks of the sediments are found completely isolated within the granitoid rock. This stoping or assimilation was better developed in the southern portion of the range where much of the granite itself eventually came to be made of more or less dissolved sediments. At no place, however, did the magma reach the surface, as nearly as can be determined from the present record. This magma was probably a part of the great late Jurassic or early Cretaceous granite batholiths that formed in the western Cordillera.

As the granodiorite cooled and contracted, it fractured and permitted numerous dikes of granodiorite-porphyry and aplite and lamprophyre to penetrate its upper portions and the cover of older rocks as well.

This now mountain range was then exposed to the agents of weathering and erosion and the overlying, highly folded rocks were stripped away, exposing the granite core. A rolling terrane developed, covered with a deep granitic soil and the major stream channels were floored with gravel.

Middle Miocene time saw the outbreak of another great lava flood. Through hundreds of fissures in the granite and folded sediments, liquid basalt welled to the surface and completely covered the land. This was a part of the great Columbia River Basalt series.

Erosion started its task of cutting through the basalt and underlying rocks and the valleys of the Wallowa, Minam, and Imnaha Rivers were initiated. Later the mountain range was again uplifted; it was raised as a great block, bounded on the sides by great fractures or faults along which the movement was localized. The most spectacular of the faults forms the precipitous northern part of the range. Other faults probably account for the Grande Ronde valley, a down faulted block of the earth's crust. Eagle Creek in part may flow along such a fracture.

The climate began a gradual change, and the annual mean temperature dropped to a point where it was possible for the winter's snow to remain until the next fall of snow. This snow was compacted into ice and the ice gradually moved down the already existing canyons. Soon the center of the range was covered by a great ice sheet. Rocks and debris were carried along by the glaciers as they gouged out their channels, giving the valleys a characteristic U-shaped profile, smoothing rock surfaces, hollowing out the multitude of basins now filled with lakes, and sculpturing the pinnacles and spires of the highest peaks. At the snouts of the glaciers which pushed onto the level Wallowa valley, great piles of debris were stacked to form the lateral and terminal moraines. Eventually the ice disappeared from all but one side of Eagle Cap, and water filled the ice scoured basins to form lakes. Lostine Lake, which formed behind its terminal moraine as Wallowa Lake was formed, has been destroyed by the stream cutting out the morainal dam. Wallowa Lake remains, an unique feature of the glacial activity, and is now protected by a man-made dam.

Recent geology includes the untiring work of the streams to reduce canyons and the canyon walls to a general flat plain. Much of the glacial debris has been reworked by these streams.

ECONOMIC GEOLOGY

The most favorable development of economic minerals usually occurs at or near granodiorite-limestone contacts in a tactite zone, particularly where limestone overlies granodiorite. The economic minerals are therefore of the contact-metamorphic type, of which molybdenite is of principal importance.

Major fracture zones are also mineralized to a certain extent, as the Lapover-Francis Lake-Twin Peaks zone.

Mineralization is also associated with some of the lamprophyric dikes. There are three general systems of dikes: an aplitic system with no associated mineralization and little contact-metamorphism; a lamprophyric system that may have followed the aplites with some mineralization; a much later basaltic system with no mineralization and practically no contact-metamorphism.

Gold and Silver

Gold and silver, in commercial quantities, have never been recovered within the area mapped so far as is known. Small amounts are reported from some of the prospects visited where most of the development work has been for copper. Such ores may carry gold values that will be recovered at a smelter but it is doubtful if gold or silver will be mined, as such.

Copper

Copper sulfides, silicates, and carbonates are found associated with dikes within the granodiorite and at or near limestone contacts. Many prospects have been opened at such occurrences, attention being attracted to them by copper stains. Results have not been encouraging, but the widespread occurrence of the copper minerals indicate that at some point, a sizeable deposit might be found, capable of being worked when the price of copper rises, and favorable transportation is developed in the area.

Lead and Zinc

Lead and zinc minerals were not noted in the course of this survey although unconfirmed reports of lead and zinc from the B. C. Basin, east of Hurricane Creek, were received. Some further prospecting might be done in the B. C. Basin to determine the value of these deposits; otherwise it is suggested that a search for lead and zinc minerals be directed to more favorable localities.

Molybdenum

Molybdenite, the molybdenum sulfide, and molybdite, the molybdenum oxide, occur at many localities. They are found in the tactite which is a metamorphic assemblage of minerals formed at the contact of the granodiorite with limestone. This tactite is usually composed of grossularite garnet in large crystals, with lesser amounts of epidote, quartz, calcite, wollastonite, and sometimes minor amounts of pyrite and copper minerals. Molybdenite is less frequently finely disseminated within the tactite zone and may be associated with minute amounts of scheelite. Molybdenite and copper minerals seem to have some association, as flakes of molybdenite were noted at most of the copper prospects.

The general occurrence of molybdenite in the tactite should encourage further prospecting for this mineral. The contact zones and areas of mineralization shown on the small map may be considered as a guide to such localities. While the low price of copper does not permit the economic development of many of these prospects for copper, the higher priced molybdenite may stimulate the mining of a deposit from which copper could be recovered as a by-product and further the value of the property.

Tungsten

Tungsten, occuring as scheelite, the calcium tungstate, has about the same association as does molybdenite. The mineral is very difficult to identify in the field as it appears much like quartz. Only by panning, or by the use of the ultra-violet lamp, can it be readily determined. Many areas may prove to have scheelite deposits, and will be found only be detailed prospecting with a pan or lamp.

Limestone and Marble

Limestone and marble for use in cement manufacture, lime, building stone, and interior trim have been discussed in detail by Parks, 4/, Moore 3/, and Hodge 2/, the latter giving computed costs of quarring, shipping, and marketing. Analyses indicate that the quality is satisfactory for cement and lime purposes.

The black marble of the Black Marble & Lime Company's quarry, sec. 19, T. 2 S., R. 44 E., takes a beautiful polish, and the white calcite veinlets and replaced fossils relieve the monotony of the black color. Development of this natural resource should receive further study.

Granite for Building and Monumental Stone

Many granodiorite outcrops have resisted the action of weathering agents for untold centuries. The rock is formed principally of quartz, feldspar, black mica, and occasionally hornblende, of medium grain size. It presents a pleasing contrast, takes an excellent polish, and tends to break into large blocks. At present much of the better quality granodiorite is located unfavorably for development. This situation will probably be remedied in the near future when roads are constructed for recreational purposes.

Garnets for Abrasives

The tactite developed at the granodiorite-limestone contacts contains garnets that range from one-eighth to one inch in diameter, and has a calcareous matrix that is quite soft. Garnets also form solid masses up to 20 feet wide. Mining development along the tactite zones might permit the extraction of this garnet as an abrasive by-product material.

SUGGESTIONS TO PROSPECTORS

The maps presented herewith may be used as guides to efficient prospecting. The following points should be borne in mind:

1. Mineralization is associated with:
   - A. Granodiorite-limestone contacts
     - (1) where limestone overlies granodiorite
     - (2) in the tactite zone.
   - B. Major fault zones.
   - C. Lamprophyric dikes at certain places.
2. Mineralization, in decreasing order of importance, consists of:
   - A. Molybdenite
   - B. Scheelite
   - C. Copper
   - D. Lead and zinc, in B. C. Basin.
   - E. Gold and silver, associated with other ore minerals.

Molybdenite may be finely disseminated within the contact zones and tactites and such areas should be studied with extreme care. If molybdenite is suspected it may be advisable to have an assay before final decision is made. Scheelite is difficult to identify by "eye-ball assay" methods; it should be pulverized and panned and as the scheelite is heavier than quartz it will trail the quartz minerals in the pan. A more satisfactory, and incidently more expensive, method is to use an ultra-violet lamp outfit. Light from this instrument causes scheelite to glow or fluoresce but it must be operated in total darkness.

Certain nonmetallics such as marble, granite, and garnet may be developed as economic conditions justify. The prospector should collect data and specimens of these materials against the time when they will become economically important.

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