UNITED STATES DEPARTMENT OF THE INTERIOR

GEOLOGICAL SURVEY

Geology of the Boiling Springs and Garden Valley 15-minute quadrangles, Boise and Valley Counties, Idaho

By

Paul L. Weis[1]

Open-File Report 84-0784

1984

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

[1] Spokane, Wash.

CONTENTS

ILLUSTRATIONS

ABSTRACT

The Boiling Springs and Garden Valley 15-minute quadrangles form the southwest corner of the Challis $1^{o}x2^{o}$ quadrangle. They are underlain mostly by subequal masses of comagmatic granite and granodiorite of the Idaho batholith. In the southeastern corner of the Garden Valley quadrangle the batholithic rocks were intruded by many dikes and small, irregular plutons that are a part of the dike swarm of Anderson[1]. The hypabyssal intrusives range from andesite to rhyolite in composition, and appear to be genetically related to the gold, silver, copper, molybdenum, lead, and zinc deposits of the Boise Basin district and its vicinity.

Tertiary faulting produced a number of large structural basins in this region, including Garden Valley in the Garden Valley quadrangle and Round and Long Valleys, parts of which are present along the west margin of the Boiling Springs quadrangle. These valleys contain Tertiary and Quaternary sediments that probably reach thicknesses of several thousands of feet.

Glaciation during Pleistocene time affected only the highest parts of the area, mostly in a few square miles at and north of Scott Mountain, in the northeastern part of the Garden Valley quadrangle.

General statement

The Garden Valley and Boiling Springs 15-minute quadrangles are in the southwestern corner of the Challis $1^{o}x2^{o}$ quadrangle, 30 to 60 miles northeast of Boise. Virtually the entire area is underlain by granite and granodiorite of the Idaho batholith, but surficial rocks of Quaternary and possible Tertiary age occur in many of the valleys (plate 1). A small area in the southeastern part of the Garden Valley quadrangle contains a wide variety of dikes and small plutons that were intruded into the batholith. Field mapping in the Garden Valley and Boiling Springs quadrangles (plate 1) was carried out over a period of about 6 man-months during the summers of 1979 and 1980, as part of an integrated study of the Challis $1^{o}x2^{o}$ quadrangle. Although the present field work included some detailed studies, much was necessarily of a reconnaissance nature. The descriptions of the rocks that follow combine information from field observations, studies using the petrographic microscope, examination of panned concentrates from stream sediments, and semiquantitative spectrographic analyses of stream sediments and selected rock samples.

Metamorphic rocks

Gneiss (Gn).--An apparent xenolith about 250 to 300 feet in diameter is exposed along the Middle Fork Payette River immediately north of the mouth of Wet Foot Creek, Boiling Springs quadrangle (plate 1). Country rock is biotite granodiorite of the Idaho batholith. The contacts are not exposed. The xenolith is coarse-grained (>1/8 in.) quartz-feldspar-biotite granodiorite orthogneiss. Gneissic layering is the result of segregation of biotite, with

---

[1] Anderson, A. L., 1947, Geology and ore deposits of Boise Basin, Idaho: U.S. Geological Survey Bulletin 944-C, p. 119-319.

layers containing 15 to 20 percent biotite alternating with layers containing 1 percent biotite or less. Biotite-rich layers are foliated, with subparallel orientation of the biotite flakes. Most layers are compressed and deformed into migmatite-like structures. Post-deformation quartz-feldspar-biotite pegmatites as much as 2 feet thick cut the gneiss. No other xenoliths are known within 10 miles of this point.

Igneous rocks

Idaho batholith

The major units of the Idaho batholith in the area were first mapped and named by Schmidt (1964), in areas immediately north and northeast of the Boiling Springs quadrangle. These rocks, which he named the Granodiorite of Gold Fork and the Quartz Monzonite of Warm Lake extend south from the area he studied and together occupy most of the Boiling Springs and Garden Valley quadrangles. In the Challis $1^{o}x2^{o}$ quadrangle the rocks have been found to extend far beyond the limits of Schmidt's study (Fisher and others, 1983), and in this and other reports related to the Challis project they are referred to as Kgd (Cretaceous granodiorite) and Kg (Cretaceous granite) respectively.

The granite and granodiorite are in gradational contact. Plagioclase comprises 50 to 80 percent of the total feldspar in these rocks and is typically white or very light gray. Accurate estimation of plagioclase-potassium feldspar ratios, and thus accurate placement of the granite-granodiorite contact, cannot be made with confidence in the field, so it was necessary to select another criterion for field use.

Limited thin section study suggested that plagioclase-potassium feldspar ratios are closest to 2:1, the granite-granodiorite boundary, in those rocks that contain about 1/2 percent to 1 percent muscovite by volume. As the muscovite content is much easier to estimate in the field than the plagioclase-potassium feldspar ratio, it was decided that a muscovite content of 1/2 to 1 percent (estimated) would be used as the basis for separating the two rock types (<1/2 percent indicating granodiorite, 1/2 to 1 percent or more indicating granite). It should be noted, however, that the muscovite content and the feldspar ratios are not precisely equivalent in all examples; thus it is highly likely that some rocks mapped as granite are actually muscovite-rich granodiorite and some rocks mapped as granodiorite are really muscovite-poor granite.

Granodiorite (Kgd).--Approximately half the area is underlain by coarse-grained (>1/8 in.) white to light-gray, locally porphyritic granodiorite. The rocks are composed of plagioclase, potassium feldspar, quartz, and biotite, with accessory magnetite, garnet, monazite, apatite, and zircon. Texture is typically coarse and equigranular, but locally is porphyritic, with potassium feldspar phenocrysts 1 to 2 1/2 inches long that make up 1 to 30 percent of the rock. The porphyritic facies forms a poorly defined northwest-trending belt 2 to 4 miles wide and about 6 to 8 miles long (plate 1), extending from the head of Little Gallagher Creek (about 1 mile northeast of Gallagher Guard Station) in the southeastern part of the Garden Valley quadrangle to the mouth of Lightning Creek in the northwest quarter of the Garden Valley quadrangle; elsewhere its distribution appears to have no particular pattern.

In many places the granodiorite is cut by simple quartz-feldspar-mica pegmatites a few inches to as much as 3 feet thick and as much as 50 feet in length. The mica in most of the pegmatites is biotite, but in some areas, and particularly in areas within a few miles of the granite, the mica is muscovite. Aplite dikes, typically 2 to 36 inches thick and a few tens of yards long are also present in places. They commonly contain sugary quartz, feldspar, and scattered muscovite flakes, and bands of tiny red garnet crystals are characteristic of some. The aplites commonly grade into pegmatitic material that makes up some 10 percent of the dikes. Aplites are most abundant in the Boiling Springs quadrangle.

Plagioclase (An 25-28) makes up 50 to 80 percent of the total feldspar in the granodiorite; thus the map unit actually contains local patches of granite. Plagioclase occurs exclusively as anhedral, interstitial grains, only a few of which are zoned, and in places shows a dusting of sericite, but in most places it is relatively fresh. Potassium feldspar occurs both as euhedral phenocrysts and as anhedral grains. It is commonly poikilitic, locally perthitic, and in places has microcline grid twinning. Quartz typically makes up about 20 percent of the rock. It is commonly interstitial, and also occurs in many places in myrmekitic intergrowths with plagioclase. Biotite, generally about 5 or 6 percent, occurs mostly as fresh, strongly pleochroic, ragged flakes, but in places it is altered to chlorite and magnetite. Muscovite, as fresh, ragged to euhedral flakes, is present in places in amounts of 1/2 percent or less.

Accessory minerals vary widely in abundance. Monazite is abundant only in the watersheds of Clear Creek and Big Creek in the northwestern part of the Boiling Springs quadrangle. Garnet is abundant in the upper half of the Middle Fork Payette River and its tributaries in the Boiling Springs quadrangle, and locally in smaller areas in the Garden Valley quadrangle. Zircon ranges from sparse to absent. Apatite is also very sparsely present in most places. Magnetite appears to be the least variable of the accessory minerals but it, too, is variable to some extent.

The granodiorite typically occurs in relatively modest exposures, rarely occupying as much as 10 percent of the area. In most places it shows incipient to substantial disaggregation into grus. Fresh, hard outcrops are almost totally absent.

Fine-grained granodiorite (Kgdf).--A local variation of the granodiorite was found in part of the Clear Creek watershed (plate 1) in the northern part of the Boiling Springs quadrangle, where it forms well-defined irregular to dike-like masses. The rock grades over short distances into more typical, coarser grained granodiorite or into equivalent fine-grained facies of granite. In this area it appears to be a late stage derivative of the normal batholithic rocks. Grain size is mostly about 5/100ths inch, with local euhedral biotite phenocrysts to 1/2 inch. Biotite is more abundant than in the typical granodiorite, generally about 8 percent or more.

Border facies granodiorite (Kgdb).--A variant of the granodiorite believed to represent border facies of the unit occurs in places along the western margin of the map area (plate 1). This facies typically contains mafic-rich xenoliths a few inches in diameter that make up a few percent to more than 50 percent of the rock. The granodiorite also contains biotite-rich bands and wisps that form schlieren a few inches to a few feet long, singly or as patches of more or less gneissic bands with parallel orientation. Areas where these rock types were noted are shown as border facies on the map.

Reconnaissance west of the study area showed the presence of biotite-hornblende quartz diorite and diorite gneiss in places within a mile or less from the study area boundary. Apophyses of granodiorite intrude diorite and diorite gneiss along the crest of the ridge due west of Crouch, Garden Valley quadrangle. The higher mafic mineral content of the diorite suggests the possibility that it is the source of the xenoliths in the border facies granodiorite. However, the quartz diorite is also characterized by abundant accessory sphene, whereas sphene was not noted in the granodiorite xenoliths.

Granite (Kg).--Approximately half of the study area is underlain by a batholith of muscovite-biotite granite that adjoins the granodiorite on the east (plate 1), and that also occurs as smaller patches that are probably outliers in the granodiorite. The rock is mostly white to light gray, coarse grained (>1/8 in.), locally porphyritic; with plagioclase, quartz, potassium feldspar, muscovite, and biotite. For the purpose of this study, batholithic rocks with more than 1/2 percent muscovite by volume (estimated) were mapped as granite. Accessory minerals include apatite, monazite, zircon, magnetite, and garnet.

Biotite-muscovite ratios and total mica in this unit show considerable variation. Total mica content ranges from about 4 to about 8 percent, but is mostly 4 to 6 percent. Biotite makes up 10 to 80 percent of the total mica present.

This unit is generally less porphyritic than the granodiorite, and appears to contain somewhat fewer pegmatite and aplite dikes as well.

Plagioclase/potassium feldspar ratios range from about 1:1 to as much as 3:1; therefore the map unit actually includes some granodiorite. Potassium feldspar in general is more abundant in facies where muscovite is more abundant than biotite. Plagioclase is oligoclase (An 22-28). It occurs both as anhedral and interstitial grains and rarely as nearly euhedral crystals with distinct zoning. Myrmekitic intergrowths with quartz are widespread and locally abundant. Plagioclase also occurs in poikilitic inclusions in potassium feldspar, commonly with parallel orientation of isolated grains.

Potassium feldspar is probably all microcline; most shows microcline grid twinning. It occurs as interstitial grains, euhedral crystals, in part as phenocrysts, and is perthitic in places. Much is poikilitic, with included grains of plagioclase or quartz, generally showing parallel orientation.

Accessory minerals are erratic in abundance, with garnet showing the widest variation. Zircon is sparse, and monazite was found only in small amounts on samples from upper Clear Creek, Boiling Springs quadrangle.

Exposures of granite range from sparse to spectacular. In much of the area outcrops comprise only 5 to 20 percent of the area, but in some places outcrops make up 50 to 75 percent of the area. Along the ridge separating the Middle Fork Payette River watershed on the west and the Deadwood River drainage to the east, roughly along the east boundary of the quadrangles from east of Scott Mountain to the headwaters of Rattlesnake Creek (plate 1), the granite crops out in broad, commonly steep, smooth slopes, monoliths, or irregular, highly varied shapes and forms. Examples of these features are particularly well developed at the head of Silver Creek.

Fine-grained granite (Kgf).--Fine-grained facies of the granite, the exact counterpart of the fine-grained facies of the granodiorite, occur in contact with the fine-grained granodiorite in the upper part of Clear Creek valley in the northern part of the Boiling Springs quadrangle. They differ in that there are no porphyritic facies of the fine-grained granite. Contacts are generally gradational over a few inches with the fine-grained granodiorite, and over a few inches to a few feet with the granite. In most examples studied under the microscope, plagioclase was found to be 2 to 6 times more abundant than potassium feldspar; thus much of the muscovite-rich facies is actually fine-grained granodiorite or quartz diorite. Sphene was noted in one sample.

Border facies granite (Kgfb).--The granite contains some of the rocks believed to represent batholith border facies in the southwestern corner of the Boiling Springs quadrangle. There the granite contains mica-rich (mostly biotite) schlieren and bands in otherwise unfoliated and generally leucocratic muscovite-bearing rock. Limited exposures of these rocks probably represent zones of partial assimilation of the older granodiorite/granodiorite gneiss that bounds the Idaho batholith rocks to the west.

Relations of the granite and granodiorite

Even with the limitations in field criteria, it is possible to draw some general conclusions regarding the two units. Field relations of the Kg and Kgd suggest that they are comagmatic differentiates from a single source. It appears that emplacement and crystallization occurred over a considerable period, producing rocks of slightly different composition at different locations and times. In part of the area along and east of the Middle Fork Payette River, especially in the south half of the Boiling Springs quadrangle, as much as 4 miles separate typical end members of the two units. Elsewhere, as along part of Clear Creek in the northern part of the Boiling Springs quadrangle, gradational contacts extend over only a few tens of feet. In the fine-grained facies, gradations of only a few inches separate the two rock types.

Spatial relations and textural features do little to clarify the nature of their relationships, or the exact nature of a possible differentiation sequence. Where gradations appear to extend over the greatest distance, the rocks highest in muscovite are found along the highest ridges, but there the vertical distances involved (on the order of 3,500 feet) are so much smaller than the horizontal distances (as much as 20,000 feet) that no very clear-cut conclusions seem warranted. Along Clear Creek, where gradational zones are much narrower, no lineations or foliations are present which might indicate physical mixing of relatively advanced differentiates.

Similarly, composition and mineralogy fail to precisely define the genetic relationships. Plagioclase compositions cover essentially the same ranges both in rocks high in muscovite and rocks with little or no muscovite. Potassium feldspar content averages higher in the Kg, but even there it exhibits a considerable range. The potassium feldspar in the granite consistently shows microcline grid twinning, but some of the potassium feldspar in the granodiorite does, too; thus its presence or absence is not a reliable basis for separation. Chemistry of the two as shown in semiquantitative spectrographic analyses shows no differences in trace element content.

Hypabyssal igneous rocks

The southeastern part of the Garden Valley quadrangle contains a large number of dikes and small, irregular plutons that intrude the granodiorite of the Idaho batholith, and make up 25 percent to 95 percent of the rocks by volume. They are part of a northeast-trending belt of intrusives referred to as the dike swarm (Anderson, 1947) whose western limit is identified on plate 1. Trends of individual dikes range from about N. 20° E. to about N. 70° E. and dips are generally 70° to 90°. Scattered, generally small dikes are also sparsely represented along the south boundary of the quadrangle west of the main area of younger intrusives. In Anderson's (1947) study, he assigned intrusive rock names to the stocks and irregular plutons, and applied the terminology for extrusive rocks to the dikes. In this paper, his nomenclature was retained in order to avoid confusion where we both refer to the same bodies of rock.

In parts of the area individual intrusives are too small and too closely spaced to show at the publication scale. In part of the map area some are lumped into a single map unit that consists predominantly of dikes of closely similar composition. Elsewhere, the younger intrusives have too wide a variety of compositions to justify that treatment, but within all of the area shown as being part of the dike swarm and labeled Kgd on the map, a considerable volume of the rock is actually made of younger rocks.

A more detailed study of the dike swarm by Anderson (1947) includes a 1:24,000 scale map of that part which lies within the Garden Valley quadrangle. The dike swarm area of the present map is in part generalized from that work.

The hypabyssal intrusives are believed to be entirely Tertiary in age (Anderson, 1947). They represent a virtually continuous gradation in composition from diorite to rhyolite, and wherever contacts are exposed and age relationships can be seen, it appears that relative ages follow the theoretical differentiation sequence as well. Earlier rocks are consistently more basic in composition, later rocks are more acidic. Groups of dikes of similar composition tend to be most numerous in particular parts of the dike swarm and also tend to strike more nearly parallel to one another and less nearly parallel to dikes of distinctly different composition. North of the South Fork Payette River the dikes also appear to be much more numerous near river level (about 3,300-3,500 feet elevation) than they are on the ridges to the north (7,500-8,000 feet elevation), and this, together with the relatively small size of many of the dikes, might be explained by a modest-sized source at no great depth below their present position.

The intrusives have been grouped into major lithologic types in the descriptions below. Their relative volumetric abundance was estimated in the field to be approximately: coarse andesite and diorite 40 percent; coarse porphyritic quartz latite 18 percent; rhyolite and rhyodacite 17 percent; hornblende-biotite-quartz porphyry 12 percent; fine-grained non-porphyritic quartz latite 8 percent; andesite 2 percent; dacite 2 percent; lamprophyres 1 percent. Lamprophyres are all in small, isolated dikes that were not mapped or studied separately, and are not included in the descriptions that follow.

Diorite (Td).--Diorite occurs as small dikes and irregular plutons of dark-gray or greenish-gray rock. Scattered white plagioclase phenocrysts as much as 2 inches long occur in the dikes. White plagioclase makes up as much as 50 percent of the rock in diorite plutons. One diorite body reportedly extends from outcrops along Grimes Creek on the east (in the southeast corner of the Garden Valley quadrangle, plate 1) to the vicinity of Quartzburg, about 8 miles to the southwest in the adjoining Placerville quadrangle (Anderson, 1947). Most plutons are much smaller. Diorite dikes are typically 6 to 20 feet thick, appear to have a strike length of about 100-150 feet, and have a very dense aphanitic chilled zone at their borders. Diorite dikes were not mapped separately in this study.

Under the microscope, many dikes and small plutons identified by Anderson (1947) as diorite were found to have a considerable range of textures and mineralogy. One contained plagioclase laths and interstitial potassium feldspar in a ratio of about 3.5:1, together with biotite and pyroxene.

Another was predominantly plagioclase, hornblende, and pyroxene, with about 50 percent mafic minerals. Large poikilitic pyroxene crystals were found in one dike, and 5 percent quartz was found in another. Plagioclase typically has pronounced trachytic texture, many dikes contain euhedral biotite, hornblende or pyroxene, or a mixture of them, and many show considerable alteration, especially chlorite after biotite, with anomalous blue interference colors, and abundant epidote(?) calcite, and sericite.

Granodiorite and andesite porphyry (Ta).--These rocks, in part including the "Birdseye" andesite of Anderson (1947), occur mostly as irregular masses up to 8 by 1 1/2 miles, and also as dikes 10 to 50 feet thick and up to several hundred yards long. These are typically dark-gray to pinkish-gray rocks with white feldspar phenocrysts 1/4 to 1/2 inch long, in a groundmass generally with less than 1/16 inch maximum grain size. Biotite and hornblende are in euhedral crystals 1/50th to 1/10th inch long, both as phenocrysts and in the groundmass. Quartz and potassium feldspar are present only in the groundmass, together with accessory magnetite, epidote, zircon, apatite, and sphene. Most of these rocks are andesite or granodiorite, with quartz content ranging from 8 to 25 percent, plagioclase (An 40-42) and potassium feldspar in ratios of 1.8 to 5 parts plagioclase to 1 part potassium feldspar. Mafic mineral content ranges from 8 to 18 percent of the rocks, plagioclase 46 to 67 percent, and potassium feldspar 13 to 25 percent.

Quartz latite and quartz latite porphyry (Tq).--These rocks occur in small to large, locally irregular dikes. They are mostly gray, or greenish gray, with shades of pink, generally porphyritic with pinkish-gray phenocrysts up to 4 inches long. They are the only dike rocks in the area that consistently have an overall pink color. Phenocrysts are plagioclase, potassium feldspar, or quartz; largest phencocrysts are potassium feldspar. Occurrence of the phenocrysts is variable. One dike has no quartz phenocrysts; in another, 20 percent of the phenocrysts are quartz. In places plagioclase and potassium feldspars are subequal in phenocrysts; in others, only plagioclase and quartz phenocrysts are present.

Groundmass is fine grained (1/50th to 1/25th inch maximum) and variable in composition. Quartz ranges from 5 to 10 percent, and feldspar content is also variable. Biotite generally makes up 5-15 percent of the groundmass, and almost everywhere is altered to chlorite, magnetite/ilmenite, calcite, and epidote. Alteration is widespread in these rocks, with fine, unidentified mineral aggregates as radiating clumps and clots, mostly equidimensional, appearing to be pseudomorphous after single crystals. Aggregates of these kinds commonly show either a single extinction angle or radial extinction. Some contain small, clear, evenly spaced inclusions of plagioclase. Calcite, sericite, epidote, and fine opaque grains are abundant in the groundmass. Quartz, plagioclase, and potassium feldspar occur in graphic to subgraphic intergrowths in places, elsewhere as radial aggregates or as bands along margins of phenocrysts. Zircon and poikilitic, euhedral sphene are present in some of the dikes.

Hornblende-biotite granite (Thb).--This rock occurs as irregular plutons as much as a mile long. It is a gray, fine-grained rock, generally porphyritic, with prominent euhedral to subhedral white feldspar and gray quartz phenocrysts as much as an eighth of an inch long. Hornblende and biotite also occur locally as phenocrysts and crystal aggregates, generally about half the size of the feldspar and quartz phenocrysts. Most of the rock is granite, but in some places potassium feldspar makes up 1/4 to 1/20th of the total feldspar; thus in places the rock is granodiorite or tonalite. Many exposures are of considerably altered rock, with chalky feldspar phenocrysts and groundmass and bleached mafics. This is the principal host rock of the mineralized ground at the Cumo prospect south of Grimes Creek (plate 1).

Rhyolite (Tr).--On this map (plate 1), the unit also includes rhyodacite as the two are indistinguishable in the field. They occur mostly as closely spaced dikes 6 to 200 feet thick and as much as a quarter mile long, that were not mapped individually. On the map, areas are shown where rocks of this type make up an estimated 50 percent of the rock or more. The dikes are typically aphanitic, white or light gray, locally have thin wavy pink bands, in places have porcelaneous texture, and in part have porphyritic textures with euhedral to rounded quartz phenocrysts to 1/10 inch in size. One rhyolite has white feldspar phenocrysts and miarolitic cavities; another contains fine, uniformly distributed biotite, like ground pepper, on freshly broken surfaces. Most dikes are considerably altered and bleached to sericite, kaolinite, and calcite, with chlorite or iron oxides after biotite. Some of the altered rhyolite has a pisolite-like structure. Rhyodacites commonly are distinctly porphyritic, with easily discernible quartz phenocrysts and less obvious feldspars. Many rhyodacites are altered or weathered. Two appear to be fine-grained andesite porphyry, with feldspar phenocrysts and quartz present only in the groundmass. The rhyolite and rhyodacite dikes are in part host rocks for molybdenite at the Little Falls deposit, but do not contain sulfides at the Cumo deposit (plate 1).

Volcanic rocks

Basalt (Tcr).--A patch of basalt lava a few hundred yards across caps part of the ridge about 2 miles south-southeast of the town of Grimes Pass in the southwestern part of the dike swarm. It appears to be an outlying remnant of the extensive basalt flows that cover large areas of older rocks in the Banks quadrangle, west of Garden Valley. These flows are presumed to be Columbia River basalt, of Miocene age, but no attempts were made to identify the particular flow represented by the outcrop shown on the map.

Breccia

Breccia pipe (Tb).--An area about 300 feet in diameter in the dike swarm area contains angular to rounded clasts of quartz latite and quartz latite porphyry (Tq), diorite (Td), hornblende-biotite granite (Thb), granodiorite (Kgd), and lamprophyre ranging from about 1/2 inch to as much as 2 to 3 feet in diameter. They are enclosed in a fine-grained dark-green matrix that contains small, scattered grains of pyrite. The pipe is identified on plate 1, about 1 3/4 miles north-northwest of the southeast corner of the Garden Valley quadrangle. This occurrence, first pointed out by Ora Rostad of AMAX (1979), was visited but not studied in detail during the course of this work. Its age is unknown.

Sedimentary rocks

Valley fill (Tertiary and Quaternary) (QT).--Garden Valley, Round Valley, Long Valley, and Boise Basin (to the southwest of the study area) are structural features that probably began to form in Mid-Tertiary time (Anderson, 1947, p. 151-172) and that have received sediments from the surrounding terrane since deformation began. Maximum thickness of fill in the valleys is not known, but Kinoshita (1962) provides evidence of 7,000 feet of fill in the part of Long Valley northwest of the Boiling Springs quadrangle. Schmidt and Mackin (1970) and Anderson (1947) report exposures of sediments of probable Miocene age in these settings in Boise Basin and Long Valley, and Kiilsgaard and Lewis discovered and mapped sediments near Warm Springs Creek, about 3 miles north of Crouch in the Garden Valley quadrangle (plate 1), that contain Miocene plant fossils (Fisher and others, 1983).

In most of the structural valleys of the region sedimentation was probably more or less continuous from the time deformation began, with pulses of more rapid deposition following each major episode of structural adjustment. As a result, most surface exposures consist of Late Pleistocene to Holocene alluvium and colluvium. It seems likely that relatively recent movement on a north-trending normal fault in Garden Valley is responsible for the exposures of older sediments along its upthrown (western) side (plate 1). Elsewhere, only younger material is known to be exposed at the surface.

Alluvium (Qal).--Recent alluvium is present in patches along all of the streams. Only the larger, thicker deposits are shown on the map.

Glaciation

No glacial deposits were mapped. Glaciation apparently occurred only in scattered, small areas in the extreme headwaters of Lightning Creek, Garden Valley quadrangle, at elevations of 8,000 feet or more. A typical example can be seen on the north side of Scott Mountain, at 8,215 feet elevation, the highest point in either quadrangle. There a cirque about 1/2 mile wide on the north side of the mountain contains two small lakes (not shown on plate 1). None of the glaciers appear to have extended below an elevation of about 6,500 feet.

Structure

Few structures were actually seen in outcrop in the two quadrangles. Strongly defined lineaments are apparent in aerial photographs, satellite photos, and topographic maps and are indicated as probable faults on the map. A particular effort was made to search for exposures where the presence of faults could be verified, but the only one found is a sheared zone about 40 feet wide on the west side of the Middle Fork Payette River at Tie Creek campground, Garden Valley quadrangle. This is in marked contrast to the locally spectacular exposures of thick, well-exposed, intensely sheared rock along faults that can be seen along the Deadwood River east of the Garden Valley quadrangle and elsewhere to the east (Kiilsgaard, oral commun., 1978, 1979, 1980).

Even though distinct sheared zones are not exposed in the map area, the linear features that are so evident in photographs are believed to represent faults and are mapped as such. In general they appear to trend either northerly or northeasterly. Topography suggests that the northward-trending faults are a part of the Basin and Range system recognized to the west and south, and are for the most part normal faults with the down-dropped side on the east. Northeasterly trending faults, which in places appear to merge with north-trending lineaments, rarely show relations that suggest directions of displacement, although a northeast-trending fault at the town of Cascade, northwest of the Boiling Springs quadrangle, clearly shows right lateral displacement (Schmidt and Mackin, 1970).

Measureable foliation was noted only in local areas along the west border of the study area. In places within the areas mapped as border facies, biotite schlieren exhibited recognizable attitudes, although where outcrops of more than a few square feet are present, attitudes in the northwestern part of the Garden Valley quadrangle commonly varied over a wide range. For example, at an outcrop at the head of Scriver Creek (plate 1), individual examples of foliation were found with a strike of N. 60° E., dip 85° NW.; N. 55° E., dip 65° SE.; N. 20° E., dip 65° N.; N. 40° E., dip 70° N. The majority of attitudes measured showed strikes of 20° to 60° east, and dips mostly steeper than 50°. No overall pattern was noted.

Mineral deposits

The Garden Valley quadrangle includes the northernmost edge of the Boise Basin mineralized area, known since the 1860's as a source of gold, silver, lead, and zinc. In 1979 and 1980 active work was underway at three properties (plate 1). Abella Resources, of Vancouver, B.C., carried out exploratory drilling at the Little Falls molybdenum property in sec. 33, T. 9 N., R. 6 E. In late 1980 they reported "geologically indicated" ore reserves of approximately 1 million tons containing 0.05 to 0.08 percent MoS_2, with local concentrations as high as 0.7 percent (Gerald Grant, oral commun., 1980). The ore is mostly in fracture coatings and disseminated grains in silicified and kaolinized Tertiary rhyolite and in adjacent granodiorite of the Idaho batholith.

Exploratory drilling was underway at the Cumo property during the field studies for this report. The Cumo deposit, in sec. 12, T. 8 N., R. 33 E., is owned by AMAX and reportedly contains copper sulfides in an upper zone and molybdenite in a lower zone, with most of the mineralization in or along the edges of a small stock of Tertiary hornblende-biotite granodiorite porphyry. Rhyolite dikes at and near the property show no mineralization. Grade and reserves data were not available (Ora Rostad, oral commun., 1980).

At the Missouri mine, sec. 27, T. 8 N., R. 5 E., work was underway to extend the main adit level along the principal vein structure. Mineralization, consisting principally of pyrite, argentiferous galena, and sparse sphalerite, is in part in intensely sheared clayey gouge.

No activity is known at other lode deposits in the area, but the owner of the Comeback mine, secs. 25 and 26, T. 8 N., R. 5 E., expressed interest in reopening the mine. Grab samples from one dump contained 70 ppm gold, 200 ppm silver, 5,000 ppm lead, 1,500 ppm copper, 7,000 ppm zinc, 1,000 ppm antimony, and more than 10,000 ppm arsenic.

A potential for placer gold was recognized in Garden Valley. Alder Creek, which joins the South Fork Payette River at the southeast edge of Garden Valley, was extensively placered for gold during the 1800's. Panned concentrates taken along the South Fork Payette River immediately downstream (west) from the mouth of Alder Creek contained a few scattered flakes of gold. During the 1979 and 1980 field seasons a gravel quarrying operation was underway on the north bank of the river in sec. 27, T. 9 N., R. 4 E. Although that gravel might contain too little gold to warrant working for that alone, it appeared that washing operations that were a part of the gravel processing might be modified sufficiently to constitute a potentially economic operation to recover gold derived from Alder Creek.

Monazite was recovered from placer gravels along Big Creek in the northwest corner of the Boiling Springs quadrangle (Schmidt and Mackin, 1970). Work there ended about 1960, and only the remains of the abandoned dredge and gravel tailings could be seen at the property in 1980. Panned concentrates from lower Clear Creek, about 5 miles to the south, contain a considerable quantity of monazite, but the quantity and economic value of that occurrence is not known.

References

Anderson, A. L., 1947, Geology and ore deposits of Boise Basin, Idaho: U.S. Geological Survey Bulletin 944-C, p. 119-319.

Fisher, F. S., McIntyre, D. H., and Johnson, K. M., 1983, Geologic map of the Challis $1^{o}x2^{o}$ quadrangle, Idaho: U.S. Geological Survey Open-File Report 83-523, scale 1:250,000.

Kinoshita, W. T., 1962, A gravity survey of part of the Long Valley district, Idaho: U.S. Geological Survey Open-File Report, 11 p.

Schmidt, D. L., 1964, Reconnaissance petrographic cross section of the Idaho Batholith in Adams and Valley Counties, Idaho: U.S. Geological Survey Bulletin 1181-G, p. G1-G50.

Schmidt, D. L., and Mackin, J. H., 1970, Quaternary geology of Long and Bear Valleys, west-central Idaho: U.S. Geological Survey Bulletin 1311-A, p. A1-A22.