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STEWART L. UDALL, *Secretary*

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Geology and Mineral Deposits of the Twin Crags Quadrangle Idaho

By ARTHUR B. CAMPBELL and STANLEY E. GOOD

CONTRIBUTIONS TO ECONOMIC GEOLOGY

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A descriptive report on the geology of a quadrangle at the southwest corner of the Coeur d'Alene mining district

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GEOLOGY AND MINERAL DEPOSITS OF THE TWIN CRAGS QUADRANGLE, IDAHO

By Arthur B. Campbell and Stanley E. Good

ABSTRACT

The 7½-minute Twin Crags quadrangle in the panhandle of Idaho includes parts of Shoshone, Kootenai, and Benewah Counties. It was mapped in 1948 to 1950 as part of a study of the general geology of the Coeur d'Alene mining district, which extends eastward from the quadrangle.

The area is underlain by low-grade metasedimentary rocks of the Precambrian Belt series, and by a few lamprophyre and diabase dikes that probably are of early Tertiary age. The Belt series is represented by five formations, from oldest to youngest: the Prichard formation, Burke formation, Revett quartzite, St. Regis formation, and Wallace formation. These formations consist principally of argillite and quartzite, but include a very few impure limestone and dolomite beds. Tertiary(?) to Recent unconsolidated sediments cover a few small areas in the quadrangle.

The sedimentary rocks of the quadrangle are part of a southward-dipping homocline that has been interrupted and deformed locally by faulting and folding. The structural pattern is coarse grained and simple compared to that of the Coeur d'Alene district. Faults generally are steeply dipping to vertical; folds are broad and open, and plunge at low angles. Direction of movement on fault planes is in many cases indeterminate owing to the thick stratigraphic units involved and the lack of key horizons.

The known mineral deposits of the quadrangle consist of barren siderite veins; quartz and siderite veins that locally contain galena, sphalerite, pyrite, pyrrhotite, and chalcopyrite; and stibnite-bearing veins. The only recorded mineral production from the quadrangle is one small shipment of antimony ore in 1916. All accessible mine workings were mapped during the course of this study.

INTRODUCTION

Geologic mapping of the Twin Crags quadrangle was begun in 1948 as part of a study of the general geology of the Coeur d'Alene mining district. Stanley E. Good was in charge of the work during the summers of 1948 and 1949 and was assisted by Arthur B. Campbell. Campbell, assisted by George E. Becraft, completed the fieldwork in 1950.

The structural framework and stratigraphy of this area, which is near the principal mineralized part of the Coeur d'Alene district, are different in some respects from those of the greater part of the district. A comprehensive report on the general geology of the Coeur d'Alene district currently being prepared by S. W. Hobbs, A. B. Griggs, R. E. Wallace, and A. B. Campbell considers matters of geologic interpretation for the entire district, including the Twin Crags quadrangle. Thus, the present report is in general restricted to a description of the geologic features of the quadrangle.

LOCATION, CULTURE, AND ACCESS

The Twin Crags quadrangle is in the Coeur d'Alene Mountains of northern Idaho, about 55 miles airline east-southeast of Spokane, Wash. (fig. 1). The 7½-minute quadrangle is an area of about 51 square miles in Shoshone, Benewah, and Kootenai Counties bounded by parallels 47°22′30″ and 47°30′ and by meridians 116°15′ and 116°22′30″.

Only about 50 people maintain permanent residence in the quadrangle; most of them live in the valley of Pine Creek. Some of these people are engaged in logging operations, in farming, and in prospecting, but the economy of the area depends mainly on mining activity in the neighboring Coeur d'Alene district.

Access to the quadrangle is from the northeast or south. From the northeast the quadrangle may be reached by traveling westward on U.S. Highway 10 from Kellogg, Idaho, to the village of Pinehurst, then south up the valley of Pine Creek. The roads along Pine Creek, West Fork, Middle Fork, and Calusa Creek provide access to much of the northern three-quarters of the quadrangle. The southern part of the quadrangle is accessible from secondary roads that follow Reeds Gulch, Falls Creek, and Mineral Creek. These secondary roads join the St. Maries-Avery road in the St. Joe River valley. Parts of the area are served only by unimproved dirt roads, many of which are blocked by fallen timber and slumped banks. Few foot trails are maintained, so most travel after leaving the roads is through brush and second-growth timber.

The largest stream in the area, which flows northward from sec. 13, T. 47 N., R. 1 E. (pl. 1), is known locally as the West Fork of Pine Creek. The topographic map of the quadrangle, however, shows that part of the stream as the main channel of Pine Creek and uses the name West Fork only for the part west of sec. 13, T. 47 N., R. 1 E.

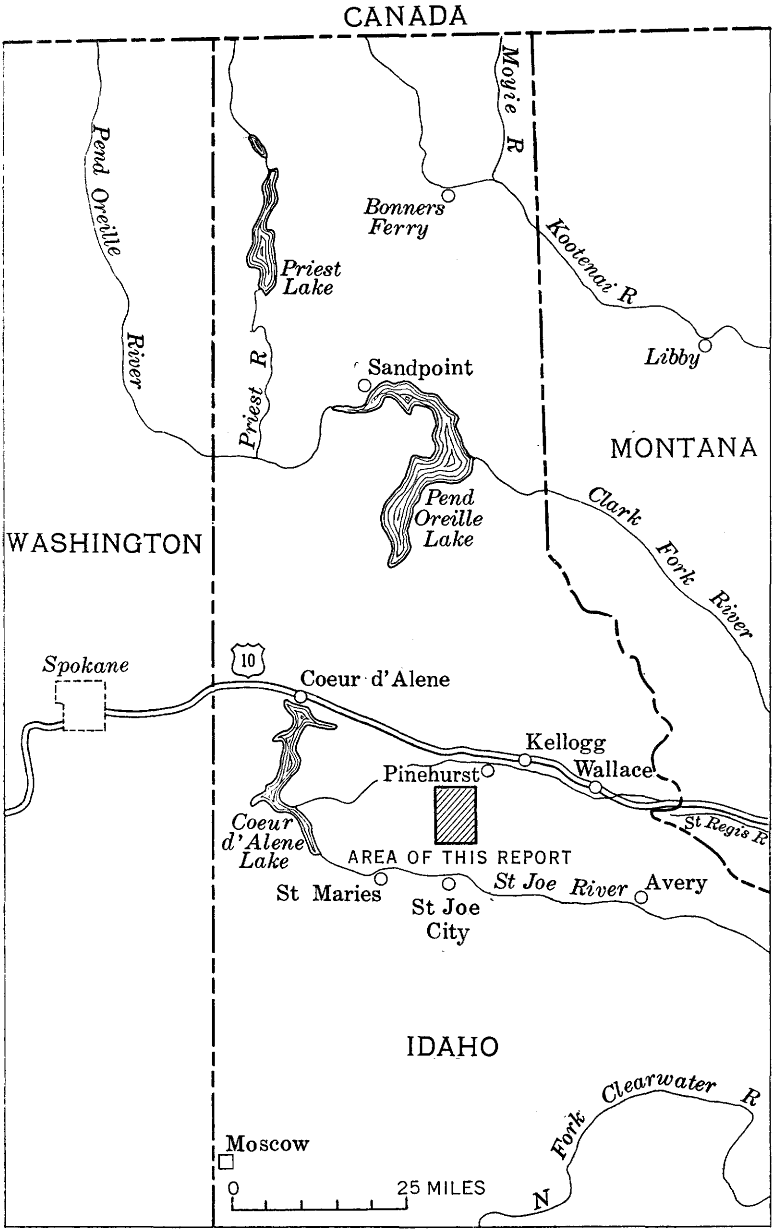

FIGURE 1.—Index map showing location of Twin Crags quadrangle.

The stream names used in this report are those used on the topographic map.

PREVIOUS WORK

Previous geologic work in parts of the Twin Crags quadrangle has all been of a reconnaissance nature. Jones (1919) and Umpleby and Jones (1923) described the geology of the part of the quadrangle in Shoshone County. Anderson (1940) mapped the part of the quadrangle in Kootenai County and described the siderite veins at the Palisade mine. His report includes a sketch map of the workings at the Palisade mine accessible in 1937. These references are the only known record of the geology of several prospects that were inaccessible to us.

Although the mapping of Calkins (Ransome and Calkins, 1908) did not extend into the Twin Crags quadrangle, his interpretation of the stratigraphy of the Belt series in the Coeur d'Alene district helped immeasurably in our work.

ACKNOWLEDGMENTS

We are grateful to Theodore Schmidt and family for their many kindnesses during the work in and near the Palisade mine and for the information they provided concerning prospects in the area.

Most of the mapping in the quadrangle was done by Stanley E. Good. His many friends received with deep sorrow the news of his accidental death in October 1949. Although only 30 years old at the time of his death, he had proved himself to be a teacher and field geologist of unusual competence. His diligence and singleness of purpose were an inspiration to his fellow workers, and his pleasant disposition endeared him to all.

GEOMORPHOLOGY

The mapped area (pl. 1) is in the Coeur d'Alene Mountains in the Northern Rocky Mountains physiographic province. The maximum relief of almost 4,000 feet is from Latour Peak, which has an altitude of 6,408 feet, to the bottom of the Pine Creek valley which has an altitude of about 2,420 feet, near the northeast corner of the area. The area has been dissected by stream erosion to a stage in which the valley walls rise steeply to long narrow, nearly flat-topped ridges and the valley floors nowhere exceed 1,000 feet in width.

Although the major geomorphic features are the result of stream erosion, some of these features have been modified slightly by alpine glaciation. Glacial features do not occur as extensively in this area as in some parts of the Coeur d'Alene Mountains, but such features as cirques, cirque lakes, faceted spurs, and glacial striae are present in some places. Undoubtedly morainal deposits and other glacial features have been destroyed or obscured by subsequent fluvial erosion.

The long, nearly flat-topped interstream divides, which range in altitude from about 5,000 feet to about 5,800 feet, appear to be remnants of a dissected erosion surface that was called the "Summit Peneplain" by Anderson (1929, p. 751). The several high peaks of the quadrangle rise above this surface as monadnocks. The flat ridges are controlled by neither structure nor lithology, inasmuch as they are underlain by moderately to steeply dipping beds of all formations. No gravel deposits were found on any of these ridges. Estimates of the age of this upland surface range from Cretaceous (Anderson, 1929, p. 758–761) to late Tertiary (Blackwelder, 1912, p. 410–414). No evidence bearing on the age of the surface was found in this quadrangle, but in areas to the east there is evidence to suggest that it was formed in early to middle Tertiary time, probably during the Eocene epoch (Pardee, 1950, p. 366).

The St. Joe divide, which extends irregularly across the southern part of the area, separates the watersheds of the Coeur d'Alene River to the north and the St. Joe River to the south. This divide forms a natural boundary between areas to the north and south and has a marked effect on commerce, industry, and culture. The drainage from most of the area is into Pine Creek, which flows northward into the Coeur d'Alene River. The drainage into Pine Creek has primarily a trellis pattern modified in the headwaters of each tributary by a dendritic pattern. Most of the tributaries enter the major streams at nearly right angles, and a few tributaries are barbed, where the drainage has been controlled by a fault. The gradient of the West Fork and of that part of Pine Creek within the quadrangle averages 114 feet per mile.

Many gravel-capped terraces along the north side of the West Fork and the west side of Pine Creek reflect a pause in the downcutting of the stream. These terraces are probably related to the "broad valley stage" as described by Calkins (Ransome and Calkins, 1908, p. 76) and may reflect a major interruption in the downcutting cycle when the river was dammed downstream by the Miocene basalt flows of the Columbia River Plateau. The effects of rejuvenation after this dam was breached are still apparent near the headwaters of the West Fork. There, in the NW¼ sec. 15, T. 47 N., R. 1 E., a nickpoint about 200 feet high is working headward into a large undissected remnant of gravel deposited during the broad-valley stage.

GEOLOGY

Most of the quadrangle is underlain by a thick sequence of metasedimentary rocks of the Belt series of Precambrian age. Only small parts of the area are underlain by igneous dike rocks, probably of early Tertiary age, and by Tertiary(?), Quaternary, and Recent unconsolidated sediments. The metasedimentary rocks form part of a southward-dipping homocline that has been modified by northwestward-trending open folds and broken by a series of northwestward- and northward-trending faults.

METASEDIMENTARY ROCKS

The metasedimentary rocks of the Belt series are largely argillite, quartzose argillite, fine-grained argillitic quartzite, and fine-grained quartzite, which Calkins (Ransome and Calkins, 1908), in his study of the Coeur d'Alene area, divided into the following six formations in order of decreasing age: Prichard formation, Burke formation, Revett quartzite, St. Regis, Wallace and Striped Peak formations. All but the Striped Peak are represented in the Twin Crags quadrangle. The gross lithology of each of these formations is fairly distinctive, but because the range of rock types is rather narrow and because the detailed lithology of parts of each formation is very similar to the lithology of parts of others, identification of the formations is difficult, especially in areas of sparse exposure. Furthermore, the contacts between the formations are somewhat arbitrarily placed because the predominant rock type of one formation grades into that of another through a stratigraphic interval or transition zone, that may be a few tens of feet thick or as much as several hundred feet thick.

PRICHARD FORMATION

The Prichard formation, which is the oldest unit exposed in the area, is composed predominantly of thin-bedded dark quartzose argillite and white quartzite that crop out only in the northeast part of the quadrangle. The Prichard is not generally confused with other formations of the Belt series because it is distinctively dark gray to dark greenish gray. Good exposures are rare because of the ease with which the argillite weathers, but exposures may be seen in the drainage basin of Sourdough Gulch and in sec. 31, T. 48 N., R. 2 E., where the Prichard is in contact with the overlying Burke formation.

The dominant rock type of the Prichard in the quadrangle is medium- to dark-gray or greenish-gray argillite, although beds of light-gray to white fine-grained argillitic quartzite are present throughout the formation and tend to increase in number and thickness toward the upper contact. Because argillitic parts of the formation commonly contain small disseminated crystals of pyrite, many weathered exposures are stained by limonite. A few units of white vitreous quartizite, each as much as 60 feet thick, were distinguished from the rest of the formation near the northeast corner of the quadrangle (fig. 1). Quartzite beds within each unit are as much as 3 feet thick and commonly are cut by veinlets of milky quartz. These quartzite units are a part of a 2,100-foot thick zone of interbedded argillite and quartzite immediately northeast of the Twin Crags quadrangle (Campbell, 1953).

Generalized stratigraphic section of upper part of Prichard formation and lower part of Burke formation in NW¼NW¼ sec. 6, T. 47 N., R. 2 E.

	Feet
Burke formation:	
Mostly covered; float of light-gray impure quartzite; several small exposures of light-gray vitreous quartzite; beds 3 to 6 inches thick	136
Mostly covered; much float of light-gray impure quartzite and nearly white vitreous quartzite; a few exposures of vitreous quartzite with greenish-gray shaly partings; thin dark-gray laminations in quartzite	63
Covered	74
Quartzite, impure, light-gray, thin-bedded (½ to 3 inches), many very thin black laminations parallel to bedding; rock weathers to greenish gray with limonitic stain	38
Quartzite, impure, light-gray, thin-bedded (½ to 4 inches); abundant greenish-gray shaly partings; a few shaly beds as much as 3 inches thick; quartzite commonly spotted by small segregations of carbonate minerals	53
Quartzite, impure, pale greenish-gray, thin-bedded; shaly partings and thin interbeds of greenish-gray argillite increase toward bottom	79
Prichard formation:	
Quartzite (75 percent), impure, medium-gray; some spots of carbonate minerals; a few shaly partings; numerous (25 percent) dark-gray argillite beds ½ to 3 inches thick; more argillitic near bottom	55
Quartzite (60 percent), impure, light greenish-gray, thin-bedded, interbedded with dark-gray thin-bedded argillite (40 percent). Partly covered	90
Quartzite, subvitreous, light-gray; 2- to 6-inch beds; many thin black laminae parallel to bedding: abundant sericite on bedding planes	55
Quartzite (60 percent), impure, light-gray; interbedded with dark-gray argillite (40 percent); beds generally ¼ to ½ inch thick, some quartzite beds as much as 2 inches	43
Quartzite, vitreous, white: 3- to 8-inch beds	28
Quartzite (30 percent), impure, dark-gray, thin-bedded; interbedded with dark-gray argillite (70 percent)	25
Quartzite (70 percent), impure; spots of carbonate minerals; 2- to 6-inch beds, interbedded with dark-gray argillite (30 percent) in beds 1/16 to ½ inch thick	56
Total	795

Bedding in the argillite is generally quite regular and pronounced. Most beds range in thickness from 1 to 6 inches, although some may be as much as 12 inches thick. Commonly the rock appears varved; silty and fine-grained sandy sediments alternate in layers ranging in thickness from about 1 mm to 5 mm. Bedding in the impure quartzite is generally similar to that in the argillite.

Sedimentary features are rare in the Prichard, but a few mud cracks and some graded bedding were seen near the upper contact, and small-scale preconsolidation slump structural features are present in a few places. Such slump features have been misinterpreted by some workers in the region as being organic in origin.

The thickness of the Prichard exposed in the quadrangle, though known to be only a small part of the total thickness, cannot be estimated reliably because the exposures are poor and contain no marker beds, and the rocks are folded and faulted. Calkins (Ransome and Calkins, 1908, p. 29) reported a thickness of more than 3,000 feet in the Coeur d'Alene district, where the base is not exposed. Gibson (1948, p. 10) reported a minimum thickness of 9,700 feet in the Libby quadrangle, about 50 miles to the northeast, where again the base of the formation is not exposed. Wallace and Hosterman (1956, p. 579) estimated a partial thickness of nearly 17,000 feet for the Prichard in western Montana.

The Prichard is overlain conformably by the Burke formation, but there is not a sharp lithologic break between the two. Instead, they grade into one another through an 800-foot transition zone composed of interbedded dark-gray impure quartzite, white vitreous quartzite, and dark-gray, generally thinly laminated quartzose argillite. We placed the contact at the top of the uppermost dark-gray argillite unit, above which the rocks are predominantly impure quartzite with argillitic partings and thin interbeds of greenish-gray argillite.

BURKE FORMATION

Rocks assigned to the Burke formation, characteristically sericitic quartzite and quartzose argillite, are exposed throughout much of the northern half of the quadrangle and along both sides of the valley north and west of the junction of Pine Creek and West Fork. Outcrops of the formation are generally small and are widely scattered.

The lithologic character of the Burke changes abruptly and repeatedly throughout a vertical section. All gradations exist within a series having as its end members pure vitreous quartzite and thin-bedded quartzose argillite. From 75 to 85 percent of the formation seems to be fine-grained quartzite of different degrees of purity. The quartzite contains abundant sericite in some beds and many bedding planes are covered with plates of the mica. The beds are generally quite thin; most range from 2 inches to 1 foot in thickness, and a few are as much as 3 feet thick. Many of the quartzite beds contain numerous brown spots as much as one-eighth inch in diameter and spaced ½ to 1 inch apart; the spots result from the weathering of small masses of ferroan dolomite crystals. Most of the quartzite is gray to light tan, but some is pale reddish purple and the very sericitic beds are commonly greenish gray. Many of the quartzite beds have extremely thin, widely spaced black laminations that appear much darker on weathered surfaces than on fresh rock. A dark reddish-brown rind develops on the weathered surfaces of some quartzite beds.

The quartzose argillite that constitutes the remaining 15 to 25 percent of the Burke formation is a thin-bedded gray to greenish-gray rock that is present throughout the formation but is more common in the lower half. Beds are commonly less than 3 inches thick, and bedding planes typically are coated with sericite. The argillite of the Burke is generally more sericitic and thinner bedded than argilllite of the Prichard, and green tints are more common in the Burke.

Mud cracks and ripple marks are common throughout the formation. Intraformational conglomerate and slump structures were seen in a few beds, particularly in the Burke-Revett transition zone.

No complete section of Burke rocks was found, but partial sections indicate a total thickness of about 3,000 feet. The apparent thickness northeast of Latour Baldy is about 5,000 feet, but this figure is questionable because of the possibility of undetected faults in this area of sparse bedrock exposures. Calkins (Ransome and Calkins, 1908, p. 32) reported a thickness of about 2,000 feet for the Burke formation about 30 miles northeast of the Twin Crags area. Anderson (1940, p. 11) estimated as much as 3,000 feet of Burke in southeastern Kootenai County, part of which is included in the Twin Crags quadrangle, and Shenon and McConnel (1939, p. 4) measured more than 3,500 feet a few miles northeast of the quadrangle.

The Burke formation appears conformable with both the underlying Prichard and overlying Revett formations. The Prichard-Burke contact has been described on page A8. The Burke-Revett contact is gradational and very difficult to map, for the impure quartzite of the Burke grades into the purer vitreous quartzite of the Revett through a poorly defined transition zone about 300 feet thick. The rocks in this zone are fairly pure subvitreous quartzite that ranges in color from buff to white and is soft enough to be scratched by the point of a geologist's pick. Beds are several inches to 3 feet thick, and crossbeds are common locally. A few 3- to 4-foot zones of thin-bedded quartzose argillite are in the transition zone, but they appear to pinch out laterally and could not be found in all exposures.

We placed the contact between the Burke and Revett formations at the top of the transition zone; hence, the Revett begins where buff impure quartzite is supplanted by white sugary-textured quartzite that is not easily scratched by a steel pick. This contact is difficult to locate, however, and Calkins (Ransome and Calkins, 1908, p. 33) stated the problem as follows: "Even where exposures are good, the line might not be drawn by a given observer precisely at the same horizon in different places and at different times, nor would two observers be apt to agree precisely as to where the boundary should be placed in a given section." One aid in the mapping of this contact in the Twin Crags area is the fact that the basal quartzite of the Revett commonly, although not consistently, turns reddish brown when weathered whereas the quartzite of the transition zone does not.

REVETT QUARTZITE

The Revett quartzite, distinctive because of its homogeneity, is composed chiefly of thick-bedded vitreous quartzite. It is resistant to weathering and is well exposed throughout much of its outcrop area. The quartzite supports massive cliffs and forms widespread taluses that are composed of large angular blocks. The formation crops out in a wide belt extending diagonally across the quadrangle, and in two areas south of Latour peak.

The Revett quartzite is composed largely of medium- to thick-bedded white, light-gray, and tan vitreous quartzite and of lesser amounts of sericitic quartzite and argillite. The weathered outcrops of certain quartzite beds, and the blocks of those beds in talus, commonly have a brick-red or brown rind about 1 to 2 inches thick. This red quartzite is particularly striking in contrast to the fresh white vitreous quartzite and, where found, is diagnostic of the formation. Groups of thin black laminations are present in many of the quartzite beds. The more sericitic quartzite beds show a faint greenish cast and may have a considerable amount of sericite and chlorite along bedding planes. A few beds of quartzite contain small spots of carbonate minerals which weather brown, but this feature is not as prevalent in the Revett of this area as it is farther east in the Coeur d'Alene district. Ripple marks are present in the thin-bedded sericitic quartzite but rarely in the thick-bedded vitreous quartzite.

Agillitic rocks occur throughout the section as shaly partings between quartzite beds and as distinct beds, but they do not constitute a major proportion of any part of the section.

The beds range from a few inches thick in the impure quartzite to as much as 4 feet thick in the purer quartzite. Bedding planes are well developed and regular in the thin-bedded rock but are quite indistinct in the thick-bedded rock. Cross-laminations are present in many of the quartzite beds. Most of the quartzite is composed of very fine to fine sand-size quartz, but some beds contain chiefly medium sandsize grains. The grains are generally equidimensional and angular with interlocking borders.

The Revett is about 1,800 feet thick in a complete section measured immediately east of the junction of Pine and Calusa Creeks. The formation apparently thickens to the west, for Anderson (1940, p. 12) reported as much as 3,000 feet in the southern part of Kootenai County. The formation is 1,000 to 1,200 feet thick at its type section 30 miles to the east (Ransome and Calkins, 1908, p. 35).

The Revett quartzite lies conformably between the Burke formation below and the St. Regis formation above. The Burke-Revett contact was described on page A9. The Revett-St. Regis contact, although gradational, is more distinct than the Burke-Revett contact. Mapping this upper contact may be troublesome, however, where structural relations are not clearly understood or where exposures are scarce. The top of the Revett has been placed at the horizon where there is a change from medium-bedded vitreous quartzite to thin-bedded argillitic quartzite that contain numerous brown specks and lenses of weathered carbonate minerals. A distinct zone of purple impure quartzite commonly is present within 75 to 100 feet above the base of the St. Regis.

Generalized stratigraphic section of upper part of Revett quartzite and lower part of St. Regis formation in sec. 13, T. 47 N., R. 1 E., and sec. 18, T. 47 N., R. 2 E.

	Feet
St. Regis formation:	
Quartzite, subvitreous to argillitic, white to medium-gray; some beds slightly purple; beds 8 to 30 inches thick with some shaly partings	65
Quartzite, sericitic, gray or tan; some beds slightly green; beds 2 to 6 inches thick; many iron oxide spots on weathered rock; ripple marks common	25
Quartzite, argillitic, purplish-gray to tan; some beds greenish gray; beds ½ to 4 inches thick; a few beds as much as 24 inches thick; few carbonate mineral lenses ⅛ inch thick and 12 inches long; ripple marks common	75
Revett quartzite:	
Quartzite, subvitreous to vitreous, tan, light-gray, or white; some rock has tan rind on weathered surface; beds 3 to 12 inches thick; thin black laminations several inches apart in vitreous quartzite; some greenish-gray shaly partings; cross-laminations in some thicker beds	165

Generalized stratigraphic section of upper part of Revett quartzite and lower part of St. Regis formation in sec. 13, T. 47 N., R. 1 E., and sec. 18, T. 47 N., R. 2 E.—Continued

	Feet
Revett quartzite—Continued	
Quartzite, mostly vitreous, light-gray, with brown-weathered rind; beds generally 1 to 3 feet thick but some beds as much as 6 feet thick	195
Quartzite, mostly subvitreous, light-gray or tan; beds as much as 3 feet thick; some beds show iron oxide spots on weathered surface; bedding planes commonly green from chloritic coatings; ripple marks common in lower part	200
Quartzite, mostly vitreous, white to light-gray, with brown-weathered rind; beds generally 1 to 4 feet thick, unit forms cliffs; some beds have thin black laminations; crossbeds common; a few thin beds of impure quartzite; few lenses and thin beds are carbonate bearing	195
Quartzite, argillitic, light-gray; beds 1 to 6 inches thick; many beds have iron oxide spots on weathered surface; many interbeds of vitreous quartzite	165
Quartzite, vitreous near top of unit to impure near bottom; white to light gray or tan, with brown-weathered rind; beds range from a few inches to 2 feet thick; unit forms cliffs; many beds have thin black laminations; sparse argillitic quartzite or quartzose argillite near bottom; carbonate spots in many beds; much sericite on bedding planes of impure quartzite; some crossbeds	580
Total	1,665

ST. REGIS FORMATION

The St. Regis formation, typically impure quartzite interbedded with a lesser amount of argillite, is exposed in about one-quarter of the quadrangle. Much of the headwater area of the West Fork is underlain by the St. Regis, and an outcrop band extends eastward from that area to the eastern edge of the quadrangle. Smaller areas of exposure are present in the southwestern corner of the quadrangle.

The dominant rock of the St. Regis formation in this area is a thin- to medium-bedded impure gray, greenish-gray, or purplish-gray quartzite that commonly is spotted brown on weathered surfaces from oxidation of ferroan dolomite crystals. Some of the thicker impure quartzite beds in the central part of the St. Regis section are quite similar to some beds in the Revett quartzite. Interbedded with the quartzite are gray, grayish-green, and purple argillitic rocks. More details of lithology are presented in the following stratigraphic section.

Generalized stratigraphic section of lower part of St. Regis formation in sec. 8, T. 47 N., R. 1 E.

	Feet
Top of exposed section.	
St. Regis formation:	
Quartzite, generally subvitreous, but some vitreous beds; light-gray to light greenish gray; a few beds slightly purple; beds range from 2 to 30 inches thick; many beds contain numerous iron oxide spots on weathered surfaces; a few thin apple-green argillite interbeds; few ripple marks	90
Quartzite, subvitreous, light- to medium-gray with pale-purple hues; most beds 12 to 36 inches thick, concentrations of chlorite on many bedding planes; thin dark-gray or purple laminations in some beds	135
Quartzite, similar to unit above but beds generally less than 20 inches thick, most less than 12 inches thick; some purple beds; some beds lenticular; minor spotted quartzite	165
Mostly covered; few exposures of thin-bedded (1 to 3 inches) interbedded grayish-green argillite and purplish-gray impure quartzite	55
Quartzite, impure, dominantly light to medium gray; many beds pale green or purple; beds as much as 24 inches thick but mostly 3 to 10 inches thick; chlorite concentrated on many bedding planes; spotted quartzite subordinate; mud cracks and ripple marks common	410
Quartzite, subvitreous with a few vitreous beds; dominantly greenish gray; a few greenish, more argillaceous beds; limonitic spots in many beds; most beds 3 to 24 inches thick but a few as much as 48 inches thick; some thick beds cross-stratified; many thin dark laminations through rock but concentrated near bedding planes; chlorite coating common on bedding planes; ripple marks and mud cracks present but not abundant. Much cover near top of this unit	310
Quartzite, like unit above but beds generally less than 12 inches thick; very little purple coloration; a few thin beds of gray-green argillite; some gray-green shaly partings between quartzite beds; many limonitic spots in some beds; dark laminations and ripple marks common	270
Quartzite, impure to vitreous, mostly greenish-gray; a few beds show purplish cast; quartzite beds 3 to 24 inches thick, interbedded argillite beds are thinner; many limonite spots and dark-gray laminations on weathered surfaces; few ripple marks; rocks grade downward into the more vitreous quartzite of the Revett	150
Total	1,585
Contact with Revett quartzite.	

Various shades of purple are a distinguishing characteristic of St. Regis rocks in other parts of the region, but the criterion is not as useful in the Twin Crags quadrangle, where purple and reddish-purple rocks constitute less than one-quarter of the formation. Apparently the general absence of purple coloration from much of the stratigraphic section around Twin Crags and the Palisade mine caused Anderson (1940, p. 55) to map those rocks as part of the Burke formation. The presence of argillitic interbeds, the generally more numerous iron oxide spots on weathered surfaces, and the purple coloration, if present, help distinguish the St. Regis.

Sedimentary structures, many of unknown origin, are common in the St. Regis. "Pseudoconglomerate" (Ransome and Calkins, 1908, p. 31) or mud-chip breccia is present in some of the impure quartzite, and small depressions, probably the result of raindrop impact, occur on the bedding surfaces of a few argillitic beds. Mud cracks and oscillation ripple marks are well preserved throughout the column. Some ripple marks in folded rocks appear to have oversteepened sides and sharp crests as a result of lateral compression.

No complete well-exposed section of the St. Regis was found for measurement, but a partial section about 1,600 feet thick was measured directly north of Twin Crags. The distribution and attitude of beds in the formation on the east side of the Middle Fork valley indicate a thickness of nearly 1,800 feet. Other workers' estimates of the thickness in nearby areas range from 600 feet (Wagner, 1949, p. 10) about 20 miles southeast of the Twin Crags quadrangle to about 2,000 feet (Anderson, 1940, p. 12) in the eastern part of Kootenai County. Anderson also noted a marked thickening of the formation toward the west.

The St. Regis lies conformably between the Revett quartzite and the Wallace formation. The Revett-St. Regis contact was discussed on page A11. Little is known of the rocks immediately above and below the St. Regis-Wallace contact in this quadrangle because the contact is everywhere covered by soil and vegetation. The lower part of the Wallace is calcareous or dolomitic and forms a light-brown fertile soil. Hobbs, Wallace, and Griggs (1950, p. 3) described the uppermost 150 to 450 feet of St. Regis near the eastern end of the Coeur d'Alene district as a light apple-green extremely fine grained siliceous argillite. A similar rock was seen in outcrop immediately below the St. Regis-Wallace contact a short distance east of the Twin Crags quadrangle in the Calusa Creek valley, and as float at several places within the Twin Crags quadrangle. The appearance of interbedded calcareous or dolomitic agrillite and quartzite marks the base of the Wallace. Although the St. Regis locally contains some carbonate-bearing beds, they are not as common as in the lower part of the Wallace. The contact can usually be located fairly accurately on the basis of the float and the contrast between the light-brown soil of the Wallace and the darker brown soil of the St. Regis.

WALLACE FORMATION

The Wallace formation comprises a thick sequence of quartzite and argillite, all more or less carbonate bearing, and a few beds of impure magnesian limestone. These rocks, which weather readily and consequently are not well exposed, are present in the southern part of the quadrangle immediately north and south of the St. Joe Divide. The best exposures are in the headwater areas of Reeds Gulch, Falls Creek, and Mineral Creek, all southward flowing tributaries of the St. Joe River.

The Wallace formation in and near the Coeur d'Alene area has been subdivided into members by several workers. Noteworthy among these efforts are Shenon and McConnel's (1939, p. 5) fourfold subdivision of the formation in the Silver Belt area and Wagner's (1949, p. 12–13) fivefold subdivision in the St. Joe Mountains southeast of the Twin Crags quadrangle. Although no members of the Wallace were mapped in this quadrangle, the stratigraphic column represented there approximates the lowest three members described by Wagner.

The Wallace is the most heterogeneous formation in the area, yet certain of its lithologic characteristics persist throughout the column and distinguish it. The abundance of carbonate minerals in much of the column is the most distinguishing lithologic feature of the formation, although the minerals are not necessarily present in all beds. The wide range of the carbonate mineral content in interbedded rocks results in differential weathering of adjacent beds. This weathering feature is best observed on outcrops of thinly interbedded carbonate-bearing quartzite and carbonate-free argillite, where a very hackly surface has been formed. The carbonate-bearing rocks weather to a light brown, owing to the presence of iron-rich dolomite, the most abundant carbonate mineral in the Wallace. The layered brown and black coloration on weathered exposures is typical and diagnostic of the formation.

Another feature unique to the Wallace is the crumpling of bedding caused by small-scale folding. The possibility of significant thickening of the formation as a result of the crumpling has been considered by Calkins (Ransome and Calkins, 1908, p. 39–40) and by Wagner (1949, p. 12). Mud cracks, very numerous in parts of the column, commonly have been distorted by this crumpling.

Rock types within the Wallace are similar to the quartzite and argillite in the older formations, except that the amount of carbonate minerals is significantly greater in the Wallace. There are few beds in the formation, however, that can be classed as limestone or dolomite. The lowest part of the Wallace consists chiefly of interbedded light-gray fine-grained quartzite and dark-gray to nearly black argillite, all more or less calcareous or dolomitic, with various mixtures of these rock types also represented. Most of the beds in these rocks are less than 12 inches thick, and many of the more argillitic beds are less than 2 inches thick. Mud cracks and graded bedding are exceptionally well formed and abundant in these rocks. Ripple marks and small-scale scour and fill features are present but not abundant.

Higher in the column the carbonate-bearing quartzite becomes thicker bedded, and single beds 2 to 4 feet thick are common. Some beds approach the composition of magesian limestone, although most are quartzose. The more limy beds commonly are cut by calcite veinlets and contain a few good examples of molar-tooth structure. Dark-gray to black argillitic rock is interbedded as in the lower part of the section but generally is noncalcareous.

The amount of argillitic rock increases higher in the section so that the youngest part of the Wallace exposed in the quadrangle is a noncalcareous black phyllite. Reconnaissance mapping south of the quadrangle indicated that more carbonate-bearing beds of the Wallace overlie the phyllite. This phyllite unit is probably correlative with Wagner's (1949, p. 13) third unit of the Wallace.

Only the lower part of the formation is represented in the Twin Crags quadrangle. Although there are indications of more than 5,000 feet of Wallace in the quadrangle, faulting, small-scale folding, and the lack of recognizable marker beds do not permit a reliable estimate of thickness. Wagner (1949, p. 12) estimated not more than 4,500 feet as the total thickness in the vicinity of Avery, Idaho. Shenon and McConnel (1939, p. 5) estimated the total thickness to be between 4,500 and 6,000 feet northeast of the quadrangle, and Anderson (1940, p. 12) reported not less than 5,000 feet to the west.

The Wallace, which is the youngest formation of the Belt series represented in the quadrangle, rests conformably on the St. Regis formation. The contact between these formations was described on page A14.

IGNEOUS ROCKS

Igneous rocks in the quadrangle are represented only by a few dikes of intermediate to mafic composition; the dikes were mapped as either diabase or lamprophyre. Dikes of the diabase group, which include some highly altered dikes of indeterminate composition, are present in sec. 36, T. 48 N., R. 1 E., and in secs. 2, 28, and 29, T. 47 N., R. 1 E.; they strike generally northwest to west-northwest. The lamprophyre dikes, which are clustered in the vicinity of the Palisade mine, strike generally north-northwest. Because of scale limitations, many small lamprophyre dikes and splits from the larger dikes are not shown on the geologic map (pl. 1). At least 11 lamprophyre dikes ranging from 1 to 30 feet in thickness are cut by the Palisade mine workings (pl. 2). Undoubtedly many dikes are present that were not seen in outcrop, for the dike rocks, especially the lamprophyre, weather more easily than the country rock and are generally obscured by overburden and vegetation.

The diabase dikes are dark green to nearly black and fine to medium grained, and commonly show some degree of chloritic alteration. The rock is composed predominantly of calcic andesine or labradorite, mostly saussuritized, and clinopyroxene, commonly altered to amphibole. The texture is ophitic or subophitic. Apatite and skeletal crystals of ilmenite are common accessory minerals.

The lamprophyre dikes are dark greenish gray to nearly black. Most are highly potassic, the texture is generally panidiomorphic-granular, and the plagioclase is largely andesine or labradorite. Many plagioclase laths are normally zoned from labradorite to sodic oligoclase. Subordinate amounts of carbonate minerals, chlorite, apatite, quartz, sericite, hornblende, augite, magnetite, and pyrite may be present in a given dike. The essential mineralogy of the rocks differs from dike to dike but most of the rocks can be classed as kersantite in which biotite, as phenocrysts, and plagioclase predominate The rocks in a few small dikes are spessartite, owing to the predominance of hornblende rather than biotite as phenocrysts, and one of the dike rocks examined microscopically is minette, because it contains sanidine as the principal feldspar in the groundmass and biotite as phenocrysts.

There is inadequate evidence in the Twin Crags quadrangle to indicate the relative age of the dikes, but interpretation of structural relations in the Coeur d'Alene district suggests an early Tertiary age for both the lamprophyre and the diabase. The lamprophyre dikes at the Palisade mine seem to be younger than the siderite veins that they intersect, for the veins are generally crosscut by the dikes (pl. 2). Two facts, however, suggest that the relation may be more complex: in at least one place the vein material extends along the wall of a dike as though controlled by it, and in several places veins widen abruptly where intersected by dikes.

UNCONSOLIDATED SEDIMENTS

Gravel deposits of Quaternary and probably in part Tertiary age are present at several places along Pine Creek and West Fork. These deposits generally cover terraces that range in altitude from about 2,600 feet near the northeastern corner of the quadrangle to about 4,000 feet near the headwaters of the West Fork. Dissection of some of these terraces and redistribution of the gravel by creep and mass movement have obliterated their original shapes.

The largest deposit of this older gravel is along the northward-flowing part of the West Fork. There the gravel extends down to the present level of the stream and, as shown on plate 1, includes some undifferentiated recent alluvial deposits. The fact that the upper reaches of the stream have not yet begun to dissect this area of older gravel was discussed in the section on "Geomorphology".

These older gravel deposits are composed of rounded poorly sorted material that ranges in size from silt to large cobbles and rare boulders. Most of the gravel has been derived from quartzitic units of the Belt series. No exotic gravel was found. A small area of conglomerate is near the junction of Ross and Sourdough Gulches (NW¼ sec. 30, T. 48 N., R. 2 E.) where the gravel has been cemented locally by limonite.

Deposits of Recent alluvium are in the valleys of Pine Creek and the West Fork and some of their major tributaries. Alluvial deposits along Falls Creek, which flows southward to the St. Joe River, extend a short distance into the southern part of the quadrangle. The alluvial material, which was derived from the formations of the Belt series and from the igneous bodies of the area, ranges from sand in the upper reaches of tributary streams to boulders in the main valley. Most of the larger fragments in the main valley are rounded, although much of the material along tributary streams is subangular to subrounded. Undoubtedly most of the alluvium in the main valley has been reworked from the higher terrace deposits of older gravel. The thickness of the alluvial deposits has not been determined.

STRUCTURE

The sedimentary rocks of the quadrangle are part of a southward-dipping homocline that has been interrupted and deformed locally by open folding and faulting. The structural pattern is coarse grained and simple as compared to that of the Coeur d'Alene mining district to the northeast. No fault of significant displacement or fold of large magnitude was found in the quadrangle excepting the Placer Creek fault near the northeastern corner of the quadrangle. Many small structural elements that were seen could not be shown at the scale of the geologic map but proved useful in structural and stratigraphic interpretations. Almost certainly many smaller folds and faults are present that were not recognized because of sporadic exposures and the lack of recognizable key beds in thick, fairly homogeneous formations.

FOLDS

The folds in the quadrangle are generally broad and rather poorly defined. Most of the folds trend northwestward and plunge gently to the southeast. Small-scale folds are present throughout the area and especially as drag folds along the major faults and within the Wallace formation. (See p. A15.) Some reverse-drag folds along faults have developed opposite to the orientation that would be expected from the known directional movement, probably as a result of a late reversal of movement due to relaxation of stress.

The Prichard formation in the northeastern corner of the mapped area is a part of the southern limb of the Pine Creek anticline (Forrester and Nelson, 1944; Campbell, 1953) that trends northwestward through the Pine Creek (Yreka) mining district, immediately northeast of the Twin Crags quadrangle. The axis of this anticline passes almost exactly through the northeastern corner of the quadrangle.

A fairly well defined anticline and syncline trend northwestward through the Pine Creek valley near its junction with Jackass Creek. Southeastward the syncline appears to pass into a fault of small displacement and the anticline dies out in the Burke formation. Because of lack of outcrop the folds could be traced northwestward only as far as the divide between Bear Creek and Ross Gulch.

An anticlinal axis through Latour Baldy and a synclinal axis to the north through Frost Peak both trend northwestward but are poorly defined because the folds are so broad. Both folds lose their identity southwestward in the valley of Langlois Creek where the Burke strata have the southerly regional dip.

The axial traces of several folds in the southern half of the quadrangle (pl. 1) can be located only within rather wide limits because the folds are so broad and open. With minor exceptions the fold axes trend northwestward and plunge gently southeastward.

FAULTS

Most of the faults in the quadrangle are vertical or very steeply dipping, as indicated by their almost straight traces shown on plate 1. The faults can be traced only with difficulty because of limited exposures and the great thicknesses and lithologic similarities of the formations involved. Thus, precise location of a particular fault trace is usually impossible, and continuity and linear extent are sometimes conjectural. Many of the faults were lost in areas where the same formation is present in both the hanging wall and the footwall. Many of the faults probably continue through the monoformational areas but lack surface expression.

The relative movement along individual faults is difficult to determine because key beds and horizons are lacking in formation of the Belt series. In general, the net slip seems to include components of both dip- and strike-slip movements. Most movement along fault planes was translational, but in certain areas only rotational movement can explain present stratigraphic and structural relations.

The faults in the quadrangle are divided in two groups on the basis of strike direction and structural relations: an older set of northwestward-trending faults and a younger set of northward-trending faults. This age relation is opposite to that found by Griggs (1952, p. 75) in the Canyon-Nine Mile Creeks area of the Coeur d'Alene district where a group of west-northwest-trending faults are younger than northward-trending faults.

NORTHWESTWARD-TRENDING FAULTS

Placer Creek fault.—The Placer Creek fault near the northeastern corner of the quadrangle has been traced for at least 25 miles along strike. Calkins (Ransome and Calkins, 1908, p. 63) stated that there is some evidence that the fault continues considerably farther than that. The generalized strike of the fault along its known length is about N. 80° W., but the segment present in the Twin Crags quadrangle strikes about N. 65° W. and is very nearly vertical. The south side of the fault in the quadrangle is relatively downthrown, for the upper part of the Prichard formation has been brought into fault contact with beds believed to be 5,000 to 7,000 feet lower in the Prichard. About 2 miles east of the Twin Crags quadrangle the axis of the Pine Creek anticline has been displaced about a mile horizontally by the Placer Creek fault. This displacement indicates right-lateral movement along the fault plane.

The trace of the fault is fairly well marked by slight topographic depressions, but these features are not nearly so well formed here as in the areas both to the east and the west. A zone of rather intensely sheared rock is partly exposed on the east side of the Pine Creek road immediately east of the quadrangle. Another zone of sheared rock is exposed along the road from Ross Gulch to Kingston.

Geb fault.—The Geb fault, which crosses Pine Creek just south of the junction with Langlois Creek, strikes about N. 40° W. and is nearly vertical. The trace of the fault east and west of Pine Creek forms an en echelon pattern believed to result from right-lateral offset along a younger northward-trending fault that is concealed in the Pine Creek valley by alluvium. This younger fault is exposed to the north in sec. 36, T. 48 N., R. 1 E. Southeast of Pine Creek there has been a right-lateral offset of the Burke-Revett contact along the Geb fault. There the horizontal stratigraphic separation, measured along the fault trace, is about 2,000 feet, and the south block is relatively downdropped. No evidence was found to indicate absolute direction or amount of movement along this fault.

The Geb fault was traced with relative ease southeast of Pine Creek where different formations constitute the hanging wall and footwall and where several exposures of brecciated Revett quartzite were found.

Northwest of Pine Creek, however, rocks of the Burke formation are poorly exposed in both walls of the fault, and the fault trace is difficult to locate.

Schmidt fault.—The Schmidt fault is a throughgoing northwestward-trending fault that approximately bisects the quadrangle. The fault strikes about N. 60° W. in the eastern part of the quadrangle and about N. 40° W. in the western part. The dip of the fault plane is from 80° SW. to 80° NE. in the few places where it could be measured. It is possible that this fault is the eastward extension of an unnamed fault traced by Anderson (1940, pl. 2) from the edge of the Columbia River basalt near Carlin, Idaho, nearly 20 miles eastward to the area between Latour Baldy Mountain and Mount Wiessner in the Twin Crags quadrangle. Anderson's unnamed fault is subparallel to the Placer Creek fault and to the Osburn fault, the major structural element of the Coeur d'Alene district. The Schmidt fault is probably genetically related to the set of northwestward-trending faults of which the Osburn and Placer Creek faults are members.

Movement along the Schmidt was right lateral and the south side was relatively downdropped. Strike-slip movement, significant along the Osburn and Placer Creek faults, could not have been great along the Schmidt fault, for the horizontal stratigraphic displacement measured along the trace of the fault near the eastern boundary of the quadrangle is not more than 2,500 feet. This amount of offset is not sufficient to explain the stratigraphic relations on opposite sides of the fault immediately northwest of its intersection with the West Fork fault where St. Regis rocks no lower than the middle of the formation are in fault contact with Revett rocks that must be very near the top of the formation. The stratigraphic offset of the fault in that segment must also reflect the result of movement along undetected faults either in the Revett north of the Schmidt fault or in the St. Regis south of the fault, or, less likely, rotational movement along the segment of the Schmidt.

Topographic lows and saddles are well formed along the Schmidt fault, especially in the western half of the quadrangle. Springs and sheared and brecciated rock were found at several places on the trace of the fault. A prominent escarpment in the Revett quartzite marks the south side of the fault zone on the spur ridge immediately southwest of the junction of the Middle and West Forks.

Benewah fault.—The Benewah fault, which crosses the West Fork near its headwaters, strikes generally N. 70° W. and is nearly vertical. Right-lateral movement has occurred along the fault. At the eastern end of the mapped trace of the fault where the St. Regis-Wallace contact has been offset, the horizontal stratigraphic separation is about 1,500 feet.

Latour fault.—The Latour fault, about 1½ miles northeast of the southwestern corner of the quadrangle, is another member of the northwestward-trending fault set. The fault appears to dip very steeply to the north and strikes about N. 50° W. The amount and direction of absolute movement on the fault are unknown, but slickensided quartzite in the St. Regis formation indicates that the last movement, at least, was mainly dip slip. The stratigraphic offset, however, suggests that the main movement along the fault was left-lateral strike slip.

The trace of the fault is marked in the central part of its mapped extent by an indistinct zone of sheared rock, by alined topographic depressions, and by distinct lithologic differences of rocks on opposite sides of the fault.

Reeds fault.—The Reeds fault, which cuts across the southwestern corner of the quadrangle, strikes about N. 50° W. and dips about 60° SW. There has been a significant amount of stratigraphic displacement along this fault, for rocks at least 1,000 feet below the upper contact of the Revett quartzite have been faulted into contact with basal units of the Wallace formation. This relation indicates a stratigraphic throw of at least 3,000 feet. The fault splits into two almost parallel segments near the northern boundary of sec. 32, T. 47 N., R. 1 E., and the throw may be divided between the two segments. No evidence was found to indicate whether movement was left-lateral strike slip, reverse dip slip, or a combination of the two.

Anomalous stratigraphic and structural relations and local topographic depressions on the shear zone mark the trace of the Reeds fault.

NORTHWARD-TRENDING FAULTS

A set of northward trending faults believed to be younger than the northwestward-trending faults include the following: the Higbee, West Fork, and Middle Fork faults, and the unnamed fault that underlies the alluvial deposits of Pine Creek near the mouth of Langlois Creek.

The trace of the West Fork fault indicates that the fault is nearly vertical to very steeply dipping westward and that it strikes nearly due north through much of its mapped extent. Although the west side of the fault has been downdropped relative to the east side, the amount of this movement is problematic. The fault cuts a previously folded and faulted terrane, so the apparent stratigraphic displacement varies from place to place along the fault.

The Middle Fork fault, which intersects the West Fork fault from the east, is also nearly vertical; its west side is downthrown relative to the east side. The apparent stratigraphic throw near the center part of the mapped extent of the fault is about 1,500 feet, but, as along the West Fork fault, the apparent displacement varies from place to place. The combined movements along the West Fork and Middle Fork faults have faulted out a segment of the older Schmidt fault near the southwest corner of sec. 11, T. 47 N., R. 1 E.

The Higbee fault, south of Latour Peak, and the unnamed fault in the Pine Creek valley, opposite the mouth of Langlois Creek, are both high-angle faults that strike northward and offset earlier northwestward-trending faults. There has been no significant movement along either of these faults.

MINERAL DEPOSITS

Prospecting and mining in the quadrangle have been sporadic, and few, if any, of the mining properties have yielded any appreciable amounts of ore. At the time of this investigation, work was being done only at the Palisade mine. Many of the old prospects and mines are partly or wholly inaccessible because of water and caved rock. Some of these now-inaccessible workings were described by Jones (1919) and Umpleby and Jones (1923).

Three general types of veins occur in the Twin Crags quadrangle: siderite veins, lead-zinc bearing veins, and antimony-bearing veins. The following descriptions include deposits of each type.

SIDERITE VEINS

PALISADE MINE

The Palisade mine, which is on the southeast flank of Twin Crags in the west-central part of the quadrangle, comprises about 2,700 feet of mine workings in four adits and an inclined shaft that expose several siderite veins in the St. Regis formation (pl. 2). The most persistent vein at the mine is exposed in the Blacksmith-shop workings and at the surface west of the Blacksmith-shop adit; three small veins at the Compressor-house workings are exposed in two short adits and a trench; and a moderately persistent vein can be traced for several hundred feet through several surface cuts and trenches near Schmidt cabin southeast of the Compressor-house adits. Three other siderite veins, all small, are exposed in prospect pits northwest of the Blacksmith-shop workings, and float indicates a vein is south of the Lower workings, which are about 4,000 feet southeast of the Blacksmith-shop workings.

The mine workings on the Blacksmith-shop vein include a 690-foot adit drift, a 40-foot inclined shaft that intersects the vein near its western end, and several small prospect pits.

The Blacksmith-shop vein is exposed in nearly continuous outcrop for 400 feet eastward from a point about 200 feet east of the Twin

Crags lookout tower and is known from surface and underground exposures to be nearly 900 feet long. Siderite float east of the Blacksmith-shop adit indicates the extension of the vein for an unknown distance farther in that direction. The vein apparently pinches out to the west, for no vein float was found on the west slope of Twin Crags.

In the Blacksmith-shop workings, the vein strikes approximately east and ranges in thickness from 3 to 48 inches. It has been offset along a bedding-plane slip and along several lamprophyre dikes that have intruded post-vein faults. The only significant offset occurs about 650 feet from the portal where one segment is offset about 90 feet to the northwest on the hanging-wall side of a large lamprophyre dike. This dike, which is 31 feet thick where cut underground, has been traced on the surface by outcrop and float for nearly 3,500 feet. It strikes about N. 10° W., and dips 80° to 85° SW. Five other smaller lamprophyre dikes were cut underground and are roughly parallel to the main dike.

Siderite is the principal vein mineral in the Blacksmith-shop vein, but other minerals are present locally. The western end of the vein, where seen in a prospect shaft, consists predominantly of barite with minor amounts of specularite, siderite largely altered to limonite, and quartz. The mineral content changes away from the barite prospect, for in the two prospect pits to the east siderite, magnetitie, and specularite are the chief constituents and barite is an accessory mineral. The vein in these two pits is 12 to 15 inches wide and is paralleled by numerous siderite stringers less than half an inch wide. In a road cut about 375 feet east of the barite prospect, the vein is exposed 175 feet lower, and it appears as two 3-inch branches that are weathered to a limonitic boxwork structure after siderite. In underground exposures of the vein, the chief mineral is siderite with minor amounts of pyrite, chalcopyrite, and quartz. Small amounts of sphalerite and galena were seen in vein material on the dump but none of these minerals was seen underground.

Two siderite veins are exposed in the road cut about 200 feet north of the exposure of the Blacksmith-shop vein (pl. 2). The northern vein is 3 feet wide, the southern one is 1 foot wide, and they are separated by 26 feet of unmineralized rock of the St. Regis formation. Both veins show much limonitic alteration.

Another siderite vein is exposed in a prospect pit 800 feet northwest of Twin Crags lookout. The exposure is poor, but the vein, which is not more than 6 inches wide, appears to strike N. 75° E. and to be vertical. The vein can be traced for a distance of 300 feet down the steep west slope toward Mirror Lake. It weathers to limonite and appears to be barren of sulfide minerals.

The Compressor-house workings, a few hundred feet southeast of the Blacksmith-shop, include two short adits and a 30-foot trench. The lower adit, 175 feet long, trends west for 120 feet along an approximately 4-foot thick vertical vein and then is cut by a 2-foot lamprophyre dike that has weathered to a mudlike mass. The vein narrows beyond the dike and is 8 inches wide at the face about 50 feet farther west. The wallrock is sheared and altered along most of the length of the adit. The vein is predominantly siderite that is now weathered to limonite. No sulfide minerals were observed.

The upper adit is 90 feet northwest of the lower adit and 27 feet higher. It trends about S. 70° W. for 90 feet along a siderite vein that pinches and swells in width from 1 to 5 feet, and dips about 80° NW. The mineralogy of this vein is similar to that of the vein in the lower adit.

A third vein exposed in an old trench 40 feet west of the upper adit is a narrow siderite stringer that fingers out at the west end of the trench.

A siderite vein was exposed in bulldozer trenches dug near the Schmidt cabin in the fall of 1948. In one trench, below the cabin, the vein is 6 feet wide, strikes N. 45° W., and is vertical. This vein is on strike with another vein, 12 inches wide, exposed in a trench 600 feet to the northwest. Siderite is predominant, and outcrops are oxidized to a limonitic boxwork. Only a few minor occurrences of galena and sphalerite were observed.

The portal of the Lower workings (pl. 2) of the mine is about 2,000 feet southeast of the Schmidt cabin. The adit, which was driven to intersect at depth the veins exposed in the upper workings, is 940 feet long. The face of the adit in 1948 was at least 2,000 feet short of an intersection with the possible downward extension of the Blacksmith-shop and the Compressor-house veins.

The adit of the Lower workings trends northwestward for about 570 feet through St. Regis strata that have been sericitized much more here than elsewhere on the property. Four nearly vertical lamprophyre dikes, which strike about N. 10° W., were cut in this distance. Beyond the fourth dike, the adit turns northward and cuts this dike again, then follows along the dike to the face. A 1-inch carbonate veinlet was cut 645 feet from the portal. A 30-foot stub drift was driven to the west on a zone of quartz stringers 70 feet from the face.

A short distance south of the adit of the Lower workings, siderite vein material was traced by float and a few outcrops for nearly 3,000 feet along strike. The float distribution indicates the vein is nearly vertical and strikes about N. 60° W.

OTHER SIDERITE VEINS

The Big Iron vein has been traced for about 9,700 feet in secs. 22 and 23, T. 47 N., R. 1 E., by underground and surface exposures and by vein float. The vein is 30 to 40 feet wide where exposed by a short adit on the west side of the Middle Fork of Pine Creek; in outcrop it ranges from 3 to 30 feet wide along the known strike length. The vein strikes east-northeast and dips from 75° S. to vertical. The vein seems to cross both the Middle Fork and West Fork faults without offset and is believed to be younger than these faults. Siderite, largely altered to limonite, and quartz in sporadic veinlets constitute the mineralogy of the vein. The siderite is manganiferous in places, and local residents report that a small quantity of siderite was mined for its manganese content during World War I. Jones (1919, p. 35) reported an assay of 19 percent manganese. Exploration work on the vein consists of numerous prospect pits at intervals along strike and an adit about 175 feet long west of the Middle Fork. This carbonate vein and others nearby are exposed more than 3,000 feet lower than those near the Palisade mine, yet they contain no sulfide minerals.

Two siderite veins a short distance north of the Big Iron vein were each traced by float for about 2,000 feet along strike. Prospect pits on these two veins have exposed only limonite, derived from siderite, and quartz.

An adit in the SW¼ sec. 13, T. 47 N., R. 1 E., follows a narrow carbonate and quartz vein southeastward for about 925 feet. The vein strikes an average of N. 45° W. and dips 80° NE. The vein is irregular in width and at places consists only of thin seams of limonitic siderite in fractured Revett quartzite. No surface expression of this vein was seen.

LEAD-ZINC BEARING VEINS

Galena and sphalerite occur in small discontinuous veins in several prospects, but exploration has exposed no deposit of these minerals that even approaches commercial grade and tonnage. These sulfide minerals usually are associated with quartz and (or) siderite; pyrite, pyrrhotite, and chalcopyrite are present in some veins. All the lead-zinc bearing veins examined are in the Prichard formation.

INTERNATIONAL MINE

The portal of the workings at the International property is in sec. 31, T. 48 N., R. 2 E., on the east side of Pine Creek valley opposite the mouth of Jackass Creek. The workings (fig. 2), which have an aggregate length of about 2,400 feet, consist of an elaborate network of drifts and crosscuts, all within about 400 feet of the portal, a winze,

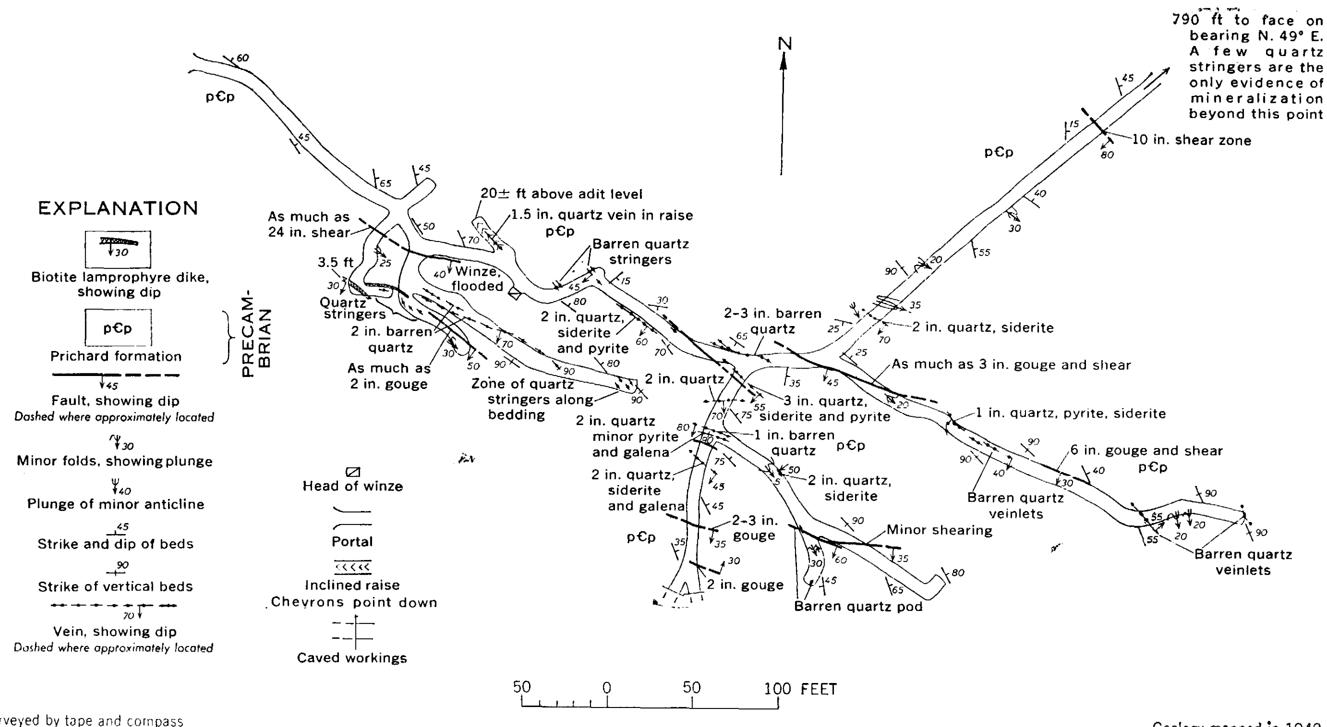

FIGURE 2.—Geologic map of the International mine.

now flooded and of unknown depth, and a 1,400-foot crosscut to the northeast from a point about 400 feet inside the portal.

The mine is in interbedded argillite and quartzite of the upper part of the Prichard formation. The workings do not follow any single vein or mineralized zone, but rather they have cut several small discontinuous quartz-siderite veins, some of which contain minor amounts of galena and pyrite. All these veins strike generally northwestward and, with few exceptions, are vertical or dip steeply to the southwest. None of these veins exceeds 3 to 4 inches in thickness and none has been traced for more than about 100 feet along strike.

The Prichard rocks strike somewhat east or west of north and dip to the east. Numerous minor folds present in the thin-bedded country rock plunge generally to the southeast at angles of from 5° to 35°. Faulting seems to have been minor. The numerous shear zones, few of which exceed 3 inches in width, strike generally northwestward and most dip to the southwest. An altered biotite lamprophyre dike and a small associated sill are exposed in a crosscut that trends southwestward from a point in the main adit about 150 feet from the portal.

K. C. PROSPECT

The K. C. prospect is in the SE¼ sec. 25, T. 48 N., R. 1 E. on the north side of Bear Creek. Two prospect adits have been driven in the Prichard formation to explore a zone of quartz veins that had been located by float. The lower adit (fig. 3), which has a total accessible length of about 425 feet, was driven northwestward for about 90 feet to intersect the main vein and then northward along the vein. The upper adit, about 75 feet west of the main adit, consists of about 100 feet of accessible workings. The upper adit was driven on a bearing of N. 15° W. for 85 feet and then it was split, one branch trending N. 53° W. for 20 feet then S. 70° W. for 27 feet and the other trending due north for an unknown distance. This northward-trending adit is caved 12 feet from the split in headings.

The veins exposed are small and discontinuous. Nowhere does vein width exceed 6 inches. The most persistent of the veins in the lower adit strikes N. 10° W. and dips 80° NE., and appears to follow a throughgoing narrow fault. Other small veins strike somewhat west or east of north and dip eastward. Quartz is the common gangue mineral associated locally with minor amounts of siderite. Minor amounts of sphalerite, galena, pyrite, and pyrrhotite are present in the veins. Specimens of high-grade lead and zinc ore on the dump of the upper adit may have come from the part of the working now caved, for no such sulfide-bearing vein material was seen in place.

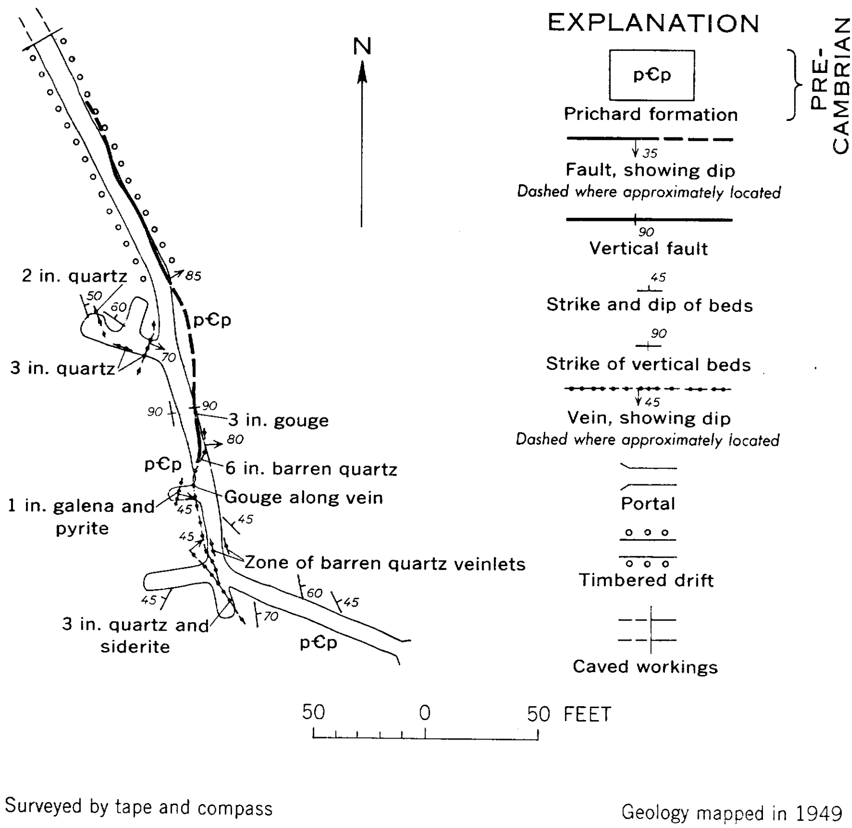

Figure 3.—Geologic map of the lower adit, K. C. prospect.

PATRICIA NO. 1 PROSPECT

The Patricia No. 1 prospect, in the Neglected group of claims, is in the SW¼ sec. 31, T. 48 N., R. 2 E. The workings at the prospect (fig. 4) consist of a single adit driven southeastward from Pine Creek. The cave-in about 200 feet from the portal occurred just before the prospect was mapped; three days earlier a paced distance to the true face of the adit indicated a total length of about 320 feet. The length of the adit beyond the cave-in is shown in figure 4, but the exact bearing of the extension is approximated. A caved raise of unknown length is on the south side of the audit about 150 feet from the portal.

All the workings are in thin-bedded argillite of the Prichard formation. The beds strike northeast and dip southeast. A shear zone, which ranges from 2 to 8 inches in width and which strikes N. 65° W. and dips 65° SW., was intersected about 45 feet from the portal and was followed for 70 feet southeastward along strike. Several quartz veins, some of which are offset along minor faults, were cut in

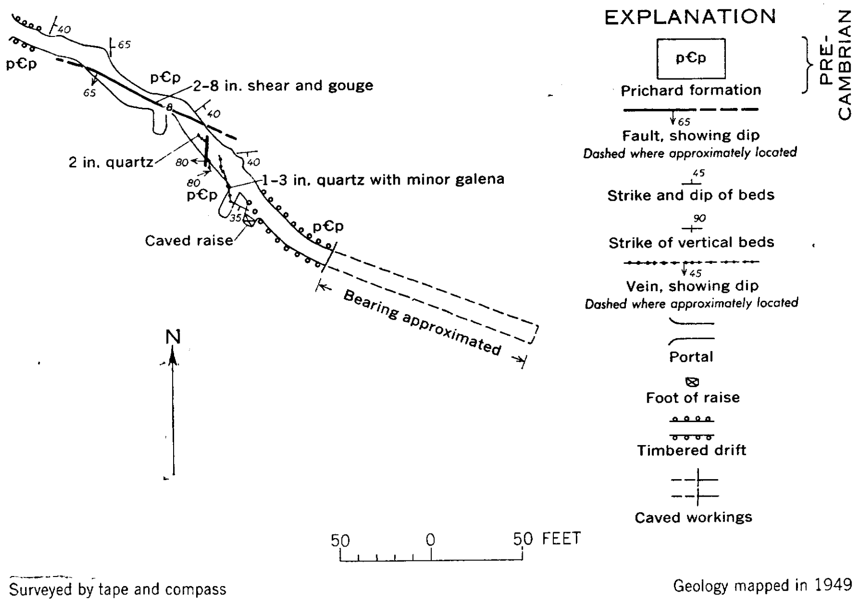

FIGURE 4.—Geologic map of the Patricia No. 1 prospect.

an area about 130 feet from the portal. The veins range from 1 to 3 inches in width and locally contain small amounts of galena. Small quartz veins seen beyond the caved area locally contain galena and sphalerite.

TIBERIUS PROSPECT

The Tiberius prospect is in sec. 24, T. 48 N., R. 1 E., near the head of Sourdough Gulch. Workings at the property (fig. 5) consist of a 225-foot crosscut, a 90-foot drift, and a flooded winze of unknown depth. The workings are all in thin-bedded argillite and quartzose argillite of the Prichard formation. A few thin beds of gray quartzite are interbedded with the argillite. The beds strike N. 35°–60° W. and dip 40°–55° SW. Several narrow shear zones exposed in the crosscut range in strike from N. 50° W. to due west. A schistose quartz-chlorite rock near the vein may be an altered dike but more likely is a zone of highly sheared and altered Prichard.

The Tiberius vein, which was intersected about 185 feet from the portal, strikes N. 30° W. and dips from 50° to 70° SW. The vein ranges in width from 2 to 5 inches and is persistent along strike.

Sphalerite is the chief sulfide mineral, but galena and pyrite are present in lesser amounts. Quartz and a minor amount of siderite constitute the gangue. Several small discontinuous quartz veins are parallel or subparallel to the main vein.

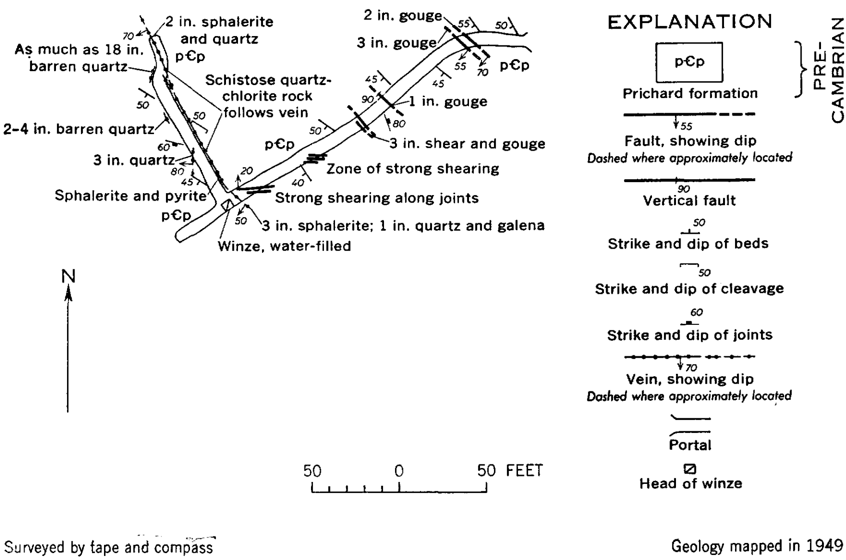

FIGURE 5.—Geologic map of the Tiberius prospect.

ANTIMONY-BEARING VEINS

Several prospects on antimony-bearing veins are in Sourdough Gulch both north and south of the Placer Creek fault. Two of the prospects, the Great Dunker and the Bluebird prospects, are shown on plate 1; other smaller antimony prospects in the vicinity are reported by local residents. Although none of the now-accessible workings exposes antimony-bearing veins, Jones (1919, p. 31–34) described such veins in two prospects in Sourdough Gulch. These two prospects, the Pearson and the Hannibal, probably are the same properties as those now known as the Great Dunker and the Bluebird, respectively. The ore mineral is stibnite which has replaced intensely sheared and altered rocks of the Prichard formation. Minor amounts of pyrite, galena, and sphalerite were seen on mine dumps. Jones reported a small shipment of antimony ore from the Pearson (Great Dunker) prospect in 1916, but none from the Hannibal (Bluebird) prospect.

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