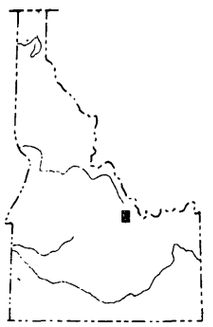
MAP GQ-733

DEPARTMENT OF THE INTERIOR
UNITED STATES GEOLOGICAL SURVEY

GEOLOGIC QUADRANGLE MAPS OF THE UNITED STATES

GEOLOGIC MAP OF THE LEADORE QUADRANGLE LEMHI COUNTY, IDAHO

By
Edward T. Ruppel



QUADRANGLE LOCATION

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TO ACCOMPANY MAP GQ-733

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By Edward T. Ruppel

DESCRIPTION OF ROCK UNITS

Qal ALLUVIUM--Recent gravel, sand, silt, and clay associated with present drainage.

DEPOSITS FORMED BY MASS WASTING:

Qc CREEP AND SOLIFLUCTION DEPOSITS--angular fragments of bedrock of source area, typically less than 1 ft in diameter, in soil or till; characterized by stepped or hummocky topography.

Qls LANDSLIDE DEPOSITS--angular fragments of bedrock in source area of slide mixed with soil; characterized by irregularly hummocky topography.

Qt TALUS--angular fragments of waste rock at the base of cliffs.

Qp PROTALUS RAMPARTS AND ROCK STREAMS--angular fragments of waste rock at the base of cliffs and talus, and forming lobes that are characterized by flow wrinkles.

ALLUVIAL FANS:

Qfy RECENT ALLUVIAL FANS--subangular to subrounded fragments of rock as much as 3 ft in diameter mixed with alluvial sand, silt, and clay, in fans being formed by present streams.

Qfo OLD ALLUVIAL FANS--subrounded fragments of rock, typically less than 1 ft in diameter, and associated finer clastic material; extensively planed by northward-shifting streams during valley tilting.

GLACIAL DEPOSITS (Ruppel and Hait, 1961; Dort, 1962):

Qmc DEPOSITS IN UNDISSECTED MORAINES--till containing nearly unweathered quartzite, limestone, dolomite, and volcanic and granitic rocks. Includes cirque moraines in a few high sheltered cirques.

Qmb DEPOSITS IN ROUNDED AND DISSECTED MORAINES--till containing rocks similar to those in unit Qmc, but with fewer fragments of carbonate and igneous rocks; coarse-grained rocks deeply weathered.

Qma VENEERS OF COARSE GRAVEL--abundant fragments of little-weathered Kinnikinic Quartzite and sparse deeply weathered Precambrian quartzite.

Qac ALLUVIAL GRAVELS--probably outwash deposits derived from rocks similar to those in unit Qmc; sand, silt, and clay.

Qab ALLUVIAL GRAVELS--probably outwash deposits derived from rocks similar to those in unit Qmb; sand, silt, and clay.

Qaa ALLUVIAL GRAVELS--probably outwash deposits derived from rocks similar to those in unit Qma; sand, silt, and clay.

TUFF AND TUFFACEOUS CONGLOMERATE:

Tt TUFF, TUFFACEOUS CONGLOMERATE, AND LIMESTONE--mainly very light gray friable vitric well-sorted tuff in beds as much as 3 ft thick; interbedded very light grayish brown medium-grained tuff and tuffaceous conglomerate and very light gray very finely crystalline to aphanitic limestone in beds 1-3 ft thick. Unit commonly is veneered with lag gravel of angular chips of vitreous quartzite derived from tuffaceous conglomerates and from sparse quartzite fragments scattered through tuffs.

Ttg TUFF AND TUFFACEOUS CONGLOMERATE--mainly yellowish-gray to very light gray medium-grained friable calcareous tuff that contains abundant sand and silt derived from sedimentary rocks; abundant interbeds and lenses, as much as 3 ft thick, of tuffaceous conglomerate that is composed of angular to well-rounded fragments, as much as 1 ft in diameter, of locally derived sedimentary rocks.

CHALLIS VOLCANICS AND RELATED INTRUSIVE ROCKS:

Tcl LATITIC AND ANDESITIC ROCKS--predominantly flow rocks, medium-light-gray to medium-dark-gray, grayish-red to very dusky red, and grayish-blue to dusky-blue; typically porphyritic, with very fine grained to aphanitic groundmass; porphyritic varieties contain phenocrysts of glassy feldspar (sanidine?) in euhedral to subhedral crystals 1-3 mm long, of hornblende in euhedral to subhedral crystals 2-3 mm long that commonly are corroded and chloritized, of very sparse glassy quartz in rounded grains 1 mm in diameter, and of plagioclase in euhedral to subhedral crystals 2-3 mm long that typically are altered to clay. Unit includes a few 5- to 50-ft-thick interbeds of tuff, lapilli tuff, and tuff breccia, and near the base includes lenticular flows, as much as 200 ft thick, of dark-gray very fine grained partly scoriaceous basalt. Maximum exposed thickness of unit is about 5,000 ft. Top concealed by younger tuffaceous rocks and surficial deposits.

Tcb BASALTIC ROCKS--mainly basalt and interbedded pyroclastic rocks. Basalt is typically medium dark gray to dark gray, fine grained, and porphyritic, contains phenocrysts of olivine as subhedral to anhedral crystals 2-3 mm in diameter, of plagioclase feldspar, now altered to clay, as relict subhedral crystals up to 1 cm long, and of hornblende as subhedral to euhedral crystals 1-2 mm long; much of basalt is vesicular to scoriaceous; flow breccias are widespread. The pyroclastic rocks include tuff, lapilli tuff, tuff breccia, and agglomerate. The rock fragments in the coarse-grained rocks are mainly basalt, but include a small percentage of andesitic and latitic rocks in places. The basaltic unit thickens rapidly south of Grove Creek by addition of thick pyroclastic units, principally basaltic agglomerate, and by addition of thick lenticular flows of latitic and andesitic rocks similar to Tcl except that they contain abundant biotite phenocrysts as much as 5 mm in diameter. The maximum thickness of the unit, in its southernmost exposures along Big Timber Creek, is about 3,200 ft.

Tct TUFF--medium-light-gray, medium- to coarse-grained, well-bedded; interbedded in Tcl and Tcb; is darker gray and more poorly bedded as percentage of lithic fragments increases.

Tci BASALTIC INTRUSIVE ROCKS--similar to extrusive basalt, but very fine to fine grained. Typically in dikes 3-10 ft thick, less commonly 50-100 ft thick; dikes less than 25 ft thick could not be shown at scale of map.

PARK CITY FORMATION:

Ppg GRANDEUR MEMBER--dolomite, dolomitic limestone, and limestone; very light gray to medium-light-gray, weathering same color, very fine to fine grained; thin-bedded, platy; basal 25 ft vuggy and massive. Contact with underlying Quadrant Formation is gradational through a thickness of about 75 ft, and contact is placed at highest bed of Quadrant-like sandstone. Exposed thickness about 250 ft; top of formation not exposed in quadrangle.

Pq QUADRANT FORMATION--quartzitic sandstone, dolomite, and limestone; includes three lithologic units, not mapped separately in this study; total thickness about 1,300 ft.

UPPER UNIT--predominantly slightly to moderately calcareous quartzitic sandstone, with thin and inconspicuous interbeds of similarly colored cherty sandy dolomite. Sandstone is pale yellowish brown to light brownish gray and medium light gray to light gray, weathering same colors to light brown and moderate yellowish brown; fine grained (0.2-0.3 mm), clean, in beds 10-30 ft thick; in lower part of unit some beds are conspicuously crossbedded. Top 75 ft of unit contains two 20- to 25-ft-thick layers of dolomite that are light gray to medium light gray (weathering to same color), very fine to fine grained, in beds 0.5-0.8 ft thick, partly containing abundant chert in irregular nodules 0.1-0.2 ft in diameter. Total thickness about 450 ft.

MIDDLE UNIT--gradationally underlies upper unit; is mostly limestone and dolomite with a few thin interbeds of black shale and mudstone. Carbonate rocks are medium gray to medium light gray (weathering to same color), thin to medium bedded; some beds contain much dark-gray chert in nodules and thin interbeds; about 400 ft thick.

LOWER UNIT--gradationally underlies middle unit; is interbedded quartzitic sandstone, dolomite, and limestone. Sandstone is mostly medium gray to medium light gray (weathering to light olive gray to moderate yellow brown), fine grained (0.1-0.2 mm), clean, well sorted, thick bedded to massive except for a few thin, thin-bedded units; some beds contain 0.1- to 0.2-ft-thick layers and irregular areas that are strongly calcareous and weather differentially. Dolomite and limestone are medium gray and medium dark gray (weathering to light olive gray to medium gray), finely to coarsely crystalline, partly bioclastic, partly sandy, fossiliferous, in beds 0.1-0.3 ft thick or thick bedded to massive; contain abundant medium-dark-gray to dark-gray (weathering to light gray) chert in nodules 0.2-0.5 ft in diameter, in nodular beds 0.5-1.5 ft thick, and in nodular lenses 0.3 ft thick and 5-10 ft long. Basal beds, about 50 ft thick, are irregularly interbedded calcareous and quartzitic sandstone, light-olive-gray (weathering to grayish orange to dark yellow brown), fine-grained, in beds 0.2-0.4 ft thick that weather differentially to produce a distinctive fretted surface. Total thickness about 450 ft.

Mb BIG SNOWY FORMATION--shale, siltstone, and limestone. Total thickness 850 ft.

UPPER THIRD--mainly medium-gray to medium-dark-gray thin- to thick-bedded fine- to medium-grained limestone; includes sparse brownish-gray, medium-gray, and yellowish-gray siltstone and mudstone interbeds 0.3-6.0 ft thick at top and in lower part.

MIDDLE THIRD--mainly pale-red, grayish-brown, and olive-gray limestone; includes sparse beds of olive-gray mudstone as much as 20 ft thick, a sequence of 0.5- to 1.0-ft-thick beds of brownish-gray to pale-red siltstone and interbedded medium-gray limestone about 90 ft thick in upper part, and two beds of

limestone pebble conglomerate 10-25 ft thick in middle part.

LOWER THIRD--grayish-red-purple, pale-brown to brownish-gray, and olive-gray to dark-gray mudstone and papery shale; includes a few 0.3- to 3-ft-thick beds of olive-gray and brownish-gray limestone in upper part.

Mm MADISON LIMESTONE--exposed only in small fault blocks and slices; complete lithology and thickness of unit is not known; thickness of exposed parts about 1,200 ft; actual original thickness perhaps about 2,500 ft.

UPPER PART--underlies shaly rocks of the Big Snowy Formation with apparent conformity; mainly medium-gray fine- to coarse-grained thick-bedded to massive limestone that is characterized especially by a bluish tint of medium light gray in weathered rocks. Some beds in uppermost 500 ft of exposed section are medium bedded to thick bedded, and contain abundant siliceous weathering crusts and dark-gray chert in nodules and thin beds. Prominent solution breccia zone, 40 ft thick, about 150 ft below top of formation. Some beds very fossiliferous, containing elements of Faberophyllum fauna of Late Mississippian age (J. T. Dutro, Jr., and W. J. Sando, written commun., 1962; Dutro and Sando, 1963, p. 1983). Exposed thickness of upper part of formation about 1,000 ft. Lithologic correlative of Mission Canyon Limestone, but includes rocks at top of unit that are younger than Mission Canyon rocks of southwestern Montana.

LOWER PART--gradationally overlies black shale of Milligen(?) Formation; limestone is medium gray (weathering medium light gray), finely crystalline, platy weathering, thin bedded (0.1-1.0 ft), contains abundant interbedded medium-dark-gray (weathering to yellowish gray) chert in irregular beds 0.1-0.3 ft thick. These rocks are lithologically similar to and occupy about the same stratigraphic position as the Lodgepole Limestone. In outcrops a few miles east of quadrangle, similar rocks contain fossils of Early Mississippian age characteristic of the Lodgepole in southwestern Montana (W. J. Sando and J. T. Dutro, Jr., written commun., 1960; E. R. Cressman, written commun., 1962). Only about 150-200 ft exposed in quadrangle.

MDmt MILLIGEN(?) AND THREE FORKS FORMATIONS--about 200 ft of platy limestone and black mudstone exposed only in Railroad Canyon. Upper 125 ft gradationally overlies platy limestone, and is black shaly to flaggy sooty carbonaceous mudstone with thin interbeds of dark-gray finely crystalline limestone; limestone is increasingly abundant toward top of unit as it grades into the lower part of the Madison (Lodgepole) Limestone; considered a correlative of Milligen Formation on basis of stratigraphic position and lithology. Lower 75 ft is medium-gray (weathering to yellowish orange, yellowish brown, and olive gray) very finely crystalline thin-bedded (1-3 ft) platy limestone with similarly colored interbeds of silty limestone and siltstone; considered a correlative of Three Forks Formation on basis of stratigraphic position and lithology; base not exposed.

Dj JEFFERSON FORMATION:

PARTIAL SECTION EXPOSED IN VICINITY OF PURCELL SPRING--mainly medium-dark-gray to dark-gray finely to medium crystalline fetid dolomite. Lower 200 ft of formation typically is cyclic bedded, laminated, and sandy; base of formation is commonly marked by lenses as much as 30 ft thick of light-olive-gray and yellowish-gray fine- to medium-grained quartzitic sandstone, dolomitic sandstone, and sandstone, and sandy dolomite. Cyclic unit overlain by about 100 ft of light-olive-gray very fine grained thin-bedded dolomite, which in turn is overlain by a darker fetid dolomite. Exposed section about 800 ft thick; top of formation not exposed.

PARTIAL SECTION EXPOSED IN RAILROAD CANYON--mainly medium-gray to light-gray (weathering the same colors) partly laminated slightly sandy dolomite and dolomitic limestone in thin to medium beds, with interbeds as much as 3 ft thick of yellowish-gray medium-grained dolomitic sandstone; sandstone beds typically overlain and underlain by 0.1- to 0.2-ft-thick partings of fissile black shale. Basal 50 ft of formation made up of medium-gray to medium-dark-gray finely crystalline partly laminated thick-bedded to massive dolomite, which contains lenses of dolomitic sandstone. Exposed section about 200 ft thick; top removed by faulting.

Sl LAKETOWN DOLOMITE--dolomite, light-olive-gray to light-gray, with sparkling luster (weathering to light gray), finely to medium crystalline, vuggy, in beds 2-10 ft thick. Overlies older rocks on erosional unconformity. Thickness 0-200 ft.

Osm SATURDAY MOUNTAIN FORMATION--medium-gray to medium-light-gray finely crystalline thick-bedded to massive dolomite; partly fossiliferous; some beds contain irregular nodules of black chert, and some beds are irregularly mottled lighter gray; base of dolomite marked by 50-ft-thick unit that contains irregular network of hairlike wisps of white dolomite. Dolomite is underlain by basal unit about 50 ft thick of grayish-orange to olive-gray medium-grained sandstone, thin interbeds of grayish-red to dark-gray paper shale, and lenses of light-bluish-gray fine- to medium-grained quartzite. About 1,150 ft thick. Basal 100 ft of formation probably equiva-

lent to Lost River Member of Fish Haven Dolomite of Churkin (1962, p. 576). Age ranges from Middle Ordovician to Silurian(?) (R. J. Ross, Jr., and W. A. Oliver, Jr., written commun., 1961, 1962, 1964).

Ok KINNIKINIC QUARTZITE--white or light-gray fine- to medium-grained vitreous massive quartzite; partly mottled with irregular lenses and blebs, commonly a few centimeters long, of reddish-brown to reddish-orange sandstone cemented by ferrodolomite. About 2,000 ft thick. Fossils collected in other areas indicate Middle Ordovician age (R. J. Ross, Jr., written commun., 1966). Overlies Precambrian rocks with angular unconformity. Basal beds are locally conglomeratic, and in a few places have incorporated much sand derived from underlying Precambrian rocks.

PRECAMBRIAN ROCKS:

p€a UNIT A--pale-purple to grayish-pink medium- to coarse-grained quartzite in beds 3-6 ft thick; some beds prominently cross laminated; contains abundant hematite grains 0.5-1 mm in diameter; sand grains are well sorted and well rounded. Thickness ranges from 0 to about 1,000 ft, due to erosion before deposition of Kinnikinic Quartzite.

p€b UNIT B--medium-light-gray and light-brownish-gray to purplish-gray and grayish-red-purple quartzite, fine-grained to fine-medium-grained (0.3 mm), moderately to strongly feldspathic (5-40 percent, typically 10-25 percent); contains abundant magnetite in rounded grains scattered through rock and in laminae and cross laminae; some beds conspicuously laminated and cross laminated; thin bedded to medium bedded (1-4 ft). Unit homogeneous except for lower 1,000 ft that is gradational into unit below. In lower part, proportion of finer grained clastic material gradually increases, so that quartzite beds, which are 0.5-1 ft thick, become dirty appearing, medium gray to medium light gray, fine grained, feldspathic, and limonite speckled; siltite and argillite interbeds that are grayish red purple to medium dark gray and platy to pencilly become more common downward and form about 50 percent of the basal 200-300 ft of unit. Underlies unit A (p€a) conformably, or Kinnikinic Quartzite with angular unconformity; thickness, estimated from partial sections, is at least 6,000 ft.

p€c UNIT C--grayish-green siltite; contains irregular streaks and lenses of grayish-pink to pale-brown very fine grained to fine-grained sandstone cemented by ferrodolomite, typically 1-2 cm thick and as much as 2 ft long, interbedded grayish-green very fine grained micaceous quartzite, and medium-gray to medium-dark-gray massive siltite. Unit grades into both overlying and underlying units as shown in upper 200 ft by increase of light-gray to light-brownish-gray fine-grained micaceous feldspathic quartzite in thin interbeds, and in lower few hundred feet by increase of light-brownish-gray fine-grained quartzite in thin interbeds. Estimated thickness about 1,500 ft.

p€d UNIT D--greenish-gray to light-gray quartzite (weathering nearly same color to light brownish gray), fine-grained, moderately to strongly feldspathic (10-30 percent), limonite-speckled and stained, locally sericitic, partly laminated and cross-laminated, in beds 0.5-3 ft thick to massive; upper half of unit tends to be thicker bedded than lower half except for uppermost 500 ft, which is thin to medium bedded. Unit is exceptionally homogeneous. A few beds, particularly in the upper part, contain argillite chips, and a few hundred feet of beds in middle part contain lenses similar to those in unit C of sandstone cemented by ferrodolomite. Unit D grades into overlying and underlying units; estimated thickness about 8,000 feet. Base not exposed in quadrangle.

gd QUARTZ DIORITE AND GRANODIORITE--medium-light-gray to medium-dark-gray fine- to medium-grained porphyritic rocks consisting of 12-23 percent quartz, 0-17 percent potassium feldspar, 45-57 percent plagioclase (An_{40-55}), and 15-25 percent combined biotite, hornblende, and, rarely, pyroxene. Phenocrysts include mafic minerals and plagioclase in crystals as much as 6 mm long. Rocks are in small stocks and sills and are homogeneous except in marginal zones, where they typically are fine grained to very fine grained and in places are choked with inclusions of wallrocks. Age somewhat uncertain but structural relations suggest probably early Tertiary, postthrusting but pre-Challis Volcanics.

gr GRANITE--moderate-pink to light-red (weathering same color to pale reddish brown) fine- to medium-grained (typically 0.2-1.5 mm) porphyritic rocks composed of 35-40 percent quartz, 30-50 percent potassium feldspar, and 10-25 percent plagioclase (albite) that commonly is moderately to completely saussuritized. Rocks typically are strongly fractured, partly granulated. Phenocrysts are quartz and potassium feldspar in subhedral to anhedral crystals as much as 10 mm long. Age of this rock is in doubt, for it is in fault contact with adjacent rocks everywhere in quadrangle. Radiometric age determinations on a sample (field No. 1S169) of granite from Railroad Canyon (NW¼ sec. 17, T. 16 N., R. 27 E.), analyzed by C. E. Hedge and F. G. Walthall, U.S. Geol. Survey, are as follows (Sr^{87}=radiogenic isotope):

Laboratory No.	Sample	Parts per million			Sr^{87}/Rb^{87}	Age, in millions of years	Sr^{87}/Total Sr^{87}
		Rb^{87}	Normal Sr	Sr^{87}			
347F	Potassium feldspar.	69.45	28.84	0.422	0.00608	410±60	0.177
347R	Whole rock	42.70	22.15	.255	.00597	405±40	.144

Ramspott and Scholten (1965) reported a potassium-argon age of 441±15 m.y. for biotite from similar rocks farther south in the Beaverhead Mountains. In the Leadore quadrangle, the Silurian age determined by radiometric methods cannot be confirmed by geologic evidence, and the age of the granite must remain in question until the effects of contaminants in the granitic magma, of pervasive alteration, and of extensive shearing and granulation can be evaluated.

ch CHERT BRECCIA--dark-gray to medium-dark-gray chert breccia and laminated chert in thrust faults. Has been formed apparently mainly by solution and squeezing out of limestone beds and partly by silicification only where rocks in thrust plate are thin-bedded and cherty lower part of Madison Limestone. Lamination parallels thrust surface. Thickness ranges from a few feet to about 100 ft.

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