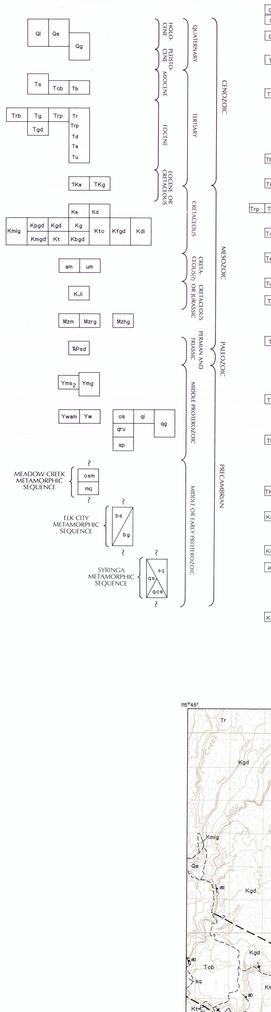
CORRELATION OF MAP UNITS



DESCRIPTION OF MAP UNITS

Qa ALLUVIAL DEPOSITS (HOLOCENE)—Stream deposits in modern drainages.

Qg LANDSLIDE DEPOSITS (HOLOCENE)—Unconsolidated deposits of landslide origin.

Ql GLACIAL DEPOSITS (HOLOCENE AND PLEISTOCENE)—Poorly sorted and poorly stratified, unconsolidated deposits principally of glacial origin. Includes till in lateral and ground moraines as well as outwash and alluvium.

Ts SEDIMENT (MIOCENE?)—Unconsolidated, poorly sorted sediment, primarily clay, sand, and silt, that locally contains cobbles. Sediment lies beneath, within, and above **Tcb** unit, but is only mapped separately in a few localities in the western part of the area.

Tcb COLUMBIA RIVER BASALT GROUP (MIOCENE)—Dark greenish brown, aphyric, subhorizontal flows 10-30 m thick. Columnar jointing is common. Local clay interbeds and palagonite-rich (water-induced?) breccia. Mapped by V.E. Camp as Grande Ronde Formation (R. and N.), overlain in places by the basalt of Wieppe and the Asotin Member of the Saddle Mountains Basalt (Swanson and others, 1979; Camp, 1981). Includes overlying unconsolidated sediment (**Ts** unit) in the northwest part of the area southwest of Chamook Ridge.

Tb BASALT DIKES (MIOCENE?)—Black, aphanitic, tabular dikes, typically 1-3 m thick, that consist principally of plagioclase, augite, glass, and opaque oxides. Most likely related to Columbia River Basalt Group.

Tr RHYOLITE DIKES (EOCENE)—Tan-weathering, aphanitic to very fine-grained phenentic rock that contains less than 10% potassium feldspar and quartz phenocrysts.

Trp, Trp RHYOLITE PORPHYRY PLUGS, DIKES, AND DIKE SWARMS (EOCENE)—Highly porphyritic rock consisting of about 40% phenocrysts of quartz, alkali feldspar, and plagioclase in an aphanitic groundmass.

Tg DACITE DIKES (EOCENE)—Dark to medium gray, nonfoliated, porphyritic dikes that contain plagioclase and hornblende phenocrysts up to 1 cm long.

Ta ANDESITE DIKES (EOCENE)—Dark gray, nonfoliated dikes characterized by sparse hornblende and plagioclase phenocrysts in an aphanitic groundmass. Plagioclase phenocrysts are more elongate than those in **Td**.

Tu UNDIVIDED DIKES (EOCENE)—May include any of the types of dikes described above, but most are either rhyolite (**Tr**) or dacite (**Td**).

Trb RHYOLITE BRECCIA (EOCENE)—Intrusive(?) breccia consisting of angular to subrounded, matrix-supported clasts of gray siliite and quartzite and buff-colored rhyolite ranging in size from 5 mm to 5 cm enclosed in a matrix of light gray, aphyric to porphyritic rhyolite. Termed the Crooked Fork plug by Nold (1968, 1974).

Tg GRANITE (EOCENE)—Fine to coarse-grained, equigranular to slightly porphyritic granite that contains equant to bipyramidal smoky quartz, white to pinkish feldspar, biotite, and sparse amphibole. Contains miarolitic cavities, which are most common in associated aplite dikes. Pegmatite is rare. Contacts sharp and discordant. Weathers to form pink rounded outcrops and spires. Includes the Lolo Hot Springs batholith mapped by Nold (1968, 1974) and the Horsethoe Lake stock (Lewis and others, 1992).

Tgd HORNBLENDE-BIOTITE GRANODIORITE (EOCENE?)—Light gray, medium- to fine-grained, porphyritic hornblende-biotite granodiorite and granite that contain small (4-8 mm) phenocrysts of potassium feldspar. Biotite and hornblende are concentrated in diffuse clots. Exposed in a small stock southeast of Stanley Hot Springs, the northern part of which is dioritic.

Tkg PORPHYRITIC BIOTITE GRANITE (EOCENE OR CRETACEOUS)—Light gray, medium-grained, porphyritic biotite granite. Contains phenocrysts of potassium feldspar 5-15 mm long. Like **Tg**, it weathers to smooth rounded outcrops, contains smoky quartz, and has high background radioactivity. However, it contains less magnetite than **Tg** and lacks the miarolitic cavities that are characteristic of **Tg**.

Tka ANDESITE DIKES, UNDIVIDED (EOCENE OR CRETACEOUS)—Dark gray, sparsely porphyritic to equigranular fine-grained dikes of uncertain age. Equivalent to either the **Ta** or **Ka** units.

Ka ANDESITE DIKES (CRETACEOUS)—Dark gray, sparsely porphyritic to equigranular fine-grained dikes that consist primarily of plagioclase, biotite, quartz, and hornblende. Distinguished from **Ta** by a weak to moderate foliation and by cross-cutting pegmatite of probable Cretaceous age.

Kd DIORITE DIKES (CRETACEOUS)—Fine-grained, equigranular (± pyroxene)-biotite-hornblende diorite and quartz diorite dikes.

Kg MUSCOVITE-BIOTITE GRANITE (CRETACEOUS)—Medium-grained, equigranular muscovite-biotite granite and granodiorite. Muscovite is in books that are up to 1 cm in diameter in the eastern part of the area. The mass south of Mex Mountain in the western part of the area is biotite-poor and contains abundant hematite. Includes part of the Grave Peak pluton of Toth (1987).

Kgd BIOTITE GRANODIORITE (CRETACEOUS)—Medium to fine-grained, equigranular to porphyritic biotite granodiorite and granite. Grades(?) into biotite tonalite on the southwest side of the Bitterroot lobe of the Idaho batholith, southwest of Old Man Creek. Associated pegmatite and aplite dikes and sills are common. Zircon U-Pb dates of 71 ± 9 Ma and 75 ± 5 Ma from samples along the Lochsa River (Toth and Stacey, 1992) are the best estimates of the age of this unit. Includes the Skookum Butte, White Sand Creek, and Brushy Fork stocks of Nold (1968, 1974), part of the Grave Peak pluton of Toth (1987), and the Tom Beal Park granite of Williams (1977).

Kfgd PORPHYRITIC BIOTITE GRANODIORITE (CRETACEOUS)—Medium-grained biotite granodiorite and granite that contains euhedral phenocrysts of alkali feldspar 1-3 cm long.

Ktc TONALITE OF COOLWATER RIDGE (CRETACEOUS)—Strongly foliated, fine-grained biotite tonalite that occurs in a single homogenous elongate body spanning Coolwater Ridge and the Selway River. Pronounced foliation, fine grain size, and ribboned quartz indicate deformation of intrusion during(?) and after emplacement. Includes minor, indistinct, intermediate-composition autoliths or xenoliths and some long and thin bodies of tourmaline-garnet schist and amphibolite. Planar fabric is locally folded about shallow to steep eastward-plunging axes. A U-Pb zircon date of 94 ± 1.4 Ma was obtained from a sample near Lowell (Toth and Stacey, 1992). Includes Coolwater Ridge orthogneiss of Morrison (1968).

Kmig BIOTITE-RICH GRANODIORITE (CRETACEOUS)—Medium-grained, equigranular, hornblende-biotite granodiorite and quartz diorite. Contains conspicuous books of euhedral biotite as thick as 4 mm and subhedral hornblende up to 6 mm long. Weathers to a coarse-grained grus.

Kmgd FOLIATED GRANODIORITE (CRETACEOUS)—Composite unit of foliated, medium-grained biotite granodiorite and tonalite, variably deformed megarynotic biotite granodiorite (**Kmgd**), and minor hornblende-biotite tonalite (**Kt**). Typically associated with abundant aplite and pegmatite. Occurs in thin and irregular bodies situated between metamorphic rock units where intrusion and deformation likely were fault controlled. Also mapped as border facies of **Kt**z unit.

Kmgd MEGACRYSTIC GRANODIORITE (CRETACEOUS)—Foliated, coarse-grained, porphyritic (± hornblende)-biotite granodiorite and tonalite containing potassium feldspar megacrysts up to 8 cm long. Megacrysts commonly form augen with rapakivi texture. In part equivalent to "Proterozoic" augen gneiss at Badger Creek described by Toth and Stacey (1992).

Kt TONALITE (CRETACEOUS)—Medium-grained, equigranular, massive to well-foliated hornblende-biotite tonalite, quartz diorite, and quartz monzodiorite. Distinguished by stubby hornblende crystals that locally define a linear fabric parallel to that in the nearb rock.

Kdi HORNBLENDE DIORITE (CRETACEOUS?)—Fine- to medium-grained, equigranular (± pyroxene)-biotite-hornblende diorite and quartz diorite, and minor hornblende-biotite granodiorite. Includes hornblende- and pyroxene-rich gabbros and diorites having a cumulate texture at the mouth of Bald Mountain Creek along U.S. 12. Commonly has complex interdigitating and locally gradational contacts with **Kgd** unit. Also occurs as inclusions (or intrusions?) too small to map in **Kgd**.

Kmg MIGMATITE (CRETACEOUS)—Areas where metamorphic rocks are intruded by 30-70% granitic rocks and intermixed at a scale of centimeters to decimeters.

um ULTRAMAFIC ROCK (CRETACEOUS?)—Small podiike bodies of medium- to coarse-grained pyroxenite and dunite. Dunite, altered to actinolite, talc, and chlorite, crops out at the confluence of Swiftwater Creek and the Selway River. Pyroxenite occurs north of Lowell, and pyroxenite and dunite occur south of Stillman Point.

am AMPHIBOLITE (CRETACEOUS? OR PROTEROZOIC?)—Fine- to medium-grained plagioclase-hornblende rock. Interpreted to have an igneous protolith on the basis of uniform composition and texture and apparent cross-cutting relations at many places. May include some Proterozoic mafic bodies, but a Cretaceous age is probable for most. One such dike cross-cuts a deformed pluton of suspected Cretaceous age along Kelly Creek, north of the map area (Lewis and others, 1992).

Ki,l INTRUSIVE ROCKS OF THE ACCRETED TERRANES (CRETACEOUS OR JURASSIC)—Principally well-foliated, locally mylonitic, biotite-hornblende quartz diorite, but includes more felsic phases (granodiorite) as well as hornblende gabbro. Unit is exposed along U.S. 12 west of the mouth of Sutter Creek and is similar to quartz diorite exposed near Greer, northwest of the map area. Initial $^{87}Sr/^{86}Sr$ ratios are less that 0.704 (Armstrong and others, 1977; Criss and Fleck, 1987).

Mzm MARBLE (MESOZOIC?)—Light gray, medium-grained, pure calcite marble is exposed along the West Fork of Clear Creek in the southwest part of the map area. Interbedded with fine-grained, diopside-bearing, calcareous quartzite. Marble is also exposed along strike to the north, in a small outcrop northeast of the Middle Fork of the Clearwater River. There it is medium gray and highly deformed. Both masses probably represent inclusions of marble of the Riggins Group within younger plutonic rocks.

Mzrg RIGGINS GROUP (MESOZOIC?)—Fine-grained, garnetiferous biotite-hornblende schist and diopside-bearing quartzite. Unit contains beds of marble to the south in the area east of Harpster (Myers, 1982). Probably correlative with the Squaw Creek schist exposed to the south near Riggins (Hamilton, 1963).

Mzhg HORNBLENDE GNEISS (MESOZOIC?)—Medium- to fine-grained garnet-biotite-hornblende gneiss, hornblende-biotite schist, and calc-silicate quartzite exposed west of Woodrat Mountain. Calc-silicate quartzite contains variable amounts of plagioclase, hornblende, diopside, epidote, and garnet. Unit may be correlative with Riggins Group (**Mzrg**) exposed to the west.

TPsd SEVEN DEVILS VOLCANIC GROUP (TRIASSIC AND PERMIAN)—Mylonitic, fine- to medium-grained chlorite-actinolite-epidote schist containing stringers of quartz, plagioclase, and epidote interlayered with lens-shaped pods of unsheared andesite tuff. These schistose rocks were probably derived from andesitic, pyroclastic, and sedimentary rocks containing abundant dikes of plagioclase. Correlated with similar rocks of the Seven Devils Volcanic Group exposed to the southwest (Myers, 1982).

Ymg MISSOULA GROUP, UNDIVIDED (MIDDLE PROTEROZOIC)—Unevenly laminated and microlaminated siltite and argillite, and subordinate fine-grained quartzite. Biotite-grade metamorphism and magnetite impart a characteristic gray color. Siltite and quartzite beds are normally graded and generally capped by black argillaceous layers. Argillaceous beds commonly contain grayish white scapolite(?) crystals 5 mm in diameter. Assignment to the Missoula Group is based on similarity to parts of the Snowdy and Shepard Formations of the Missoula Group as mapped to the northeast in Montana by Harrison and others (1986).

Ymag MOUNT SHIELDS FORMATION AND MEMBER 2 (MIDDLE PROTEROZOIC)—Light gray, fine-grained quartzite in tabular, decimeter- to meter-thick beds. Locally contains coarse (1 mm) rounded grains in an otherwise fine-grained quartzite. Correlated with member 2 of the Mount Shields Formation mapped by C.A. Wallace (pers. commun., 1990) along Fish Creek north of Lolo Hot Springs, Montana.

Yw WALLACE FORMATION (MIDDLE PROTEROZOIC)—Gray to brown calcareous siltite and argillite showing centimeter-scale graded and swell bedding. Locally contains ripple marks and mud cracks. At higher metamorphic grades is banded green (diopside and actinolite) and white (plagioclase and quartz). Diopside is replaced by hornblende adjacent to intrusive bodies of **Kgd**. Irregular dissolution cavities are common. Layers of breccia (open triangles) consist of angular to subrounded clasts up to 10 cm long of white quartzite and darker siltite and argillite in an amphibole-rich matrix. Correlative with the middle and possibly lower members of the Wallace Formation exposed to the north in the Wallace 1° by 2° quadrangle (Harrison and others, 1986).

Ywam AMPHIBOLITE, WALLACE FORMATION (MIDDLE PROTEROZOIC)—Black, layered, lensiike amphibolite bodies interbedded with diopside gneiss of the Wallace Formation. Composed of subequal amounts of hornblende and plagioclase with accessory sphene, epidote, magnetite, and garnet. Although interpreted as orthoamphibole by Nold (1968, 1974) and as a layered mafic intrusion by Jens (1972, 1974), in gradational character with surrounding diopside gneiss and its close association with biotite granodiorite suggest an origin by replacement of diopside by hornblende.

cs CALC-SILICATE GNEISS (MIDDLE PROTEROZOIC)—Includes centimeter-scale layered hornblende-diopside-quartz-plagioclase gneiss, light-colored diopside quartzite, amphibolite, quartzite with more than 5% garnet, and minor amounts of garnet-biotite schist and gneiss. Compositional layering or variation in grain size of amphibolite distinguishes it from the more homogeneous rock of the metaigneous amphibolite (**am**). The unit probably was derived from carbonate-bearing lower and middle members of the Wallace Formation, but is too highly recrystallized to assign a formational name.

qz IMPURE QUARTZITE (MIDDLE PROTEROZOIC)—Generally medium- to coarse-grained, impure, thin-bedded quartzite that contains abundant feldspar and biotite. Grades into quartz-rich biotite gneiss where migmatized; also contains up to 5% diopside, hornblende, or garnet and grades into calc-silicate gneiss. Unit probably correlates with quartzite-rich portions of the Wallace Formation, such as the Wallace gneiss unit of Hietanen (1963).

qtz QUARTZITE OF RAVALLI(?) GROUP (MIDDLE PROTEROZOIC)—Light gray, fine- to medium-grained quartzite and minor interbeds of muscovite schist. Bedding thickness is typically decimeters to meters, and cross laminations are common. Plagioclase is the principal feldspar. Includes rocks mapped as the Ravalli Group by Nold (1968, 1974).

sp QUARTZITE AND CALC-SILICATE GNEISS OF THE RAVALLI(?) GROUP AND WALLACE(?) FORMATION (MIDDLE PROTEROZOIC)—Composite unit of tightly folded and intermixed feldspathic quartzite and calc-silicate gneiss. Includes rocks probably equivalent to parts of qtz and **Yw**.

qtzsh QUARTZITE OF THE PRICHARD(?) FORMATION (MIDDLE PROTEROZOIC)—Quartz-muscovite-biotite schist exposed in the extreme eastern part of the area. Locally contains sillimanite. Generally coarse-grained with crenulated or multiply crenulated foliation.

MEADOW CREEK METAMORPHIC SEQUENCE

The Meadow Creek metamorphic sequence consists of micaceous quartzite (**mq**) and minor calc-silicate rocks (**csm**) exposed in the southern part of the area. The sequence is distinguished by the abundance of quartzite, particularly to the south of the map area where it includes the quartzite of Meadow Creek (Lewis and others, 1990).

csm CALC-SILICATE ROCKS OF MEADOW CREEK (MIDDLE OR EARLY PROTEROZOIC)—Dark gray, layered, amphibole-diopside-quartz gneiss.

mq MICACEOUS QUARTZITE (MIDDLE OR EARLY PROTEROZOIC)—Biotite-muscovite quartzite and quartz-rich schist. In locations adjacent to **csm**, these rocks include coarse-grained, crenulated, muscovite schist. In locations away from the **csm** contact, the mica grains are smaller and the schistose zones are separated by 1- to 2-cm-thick layers (or rods where more deformed) of fine-grained quartzite. Sillimanite is present locally. Calc-silicate rocks occur throughout.

ELK CITY METAMORPHIC SEQUENCE

The Elk City metamorphic sequence consists of biotite schist and biotite gneiss exposed in the southwestern part of the area. Map units are based on the predominance of schist (**bs**) or gneiss (**bg**). Sequence is distinguished by the abundance of gneiss and the scattered presence of cm-scale lenses of sillimanite and muscovite within the schist. Sequence is more widely exposed to the south near Elk City (Lewis and others, 1990).

bs BIOTITE SCHIST AND GNEISS (MIDDLE OR EARLY PROTEROZOIC)—Medium- to coarse-grained quartz-muscovite-biotite schist, medium-grained quartzofeldspathic gneiss, and dark micaceous quartzite; grades into biotite gneiss and schist (**bg**). Locally contains sillimanite and muscovite in lenses 1-4 cm in diameter that resemble flattened pebbles.

bg BIOTITE GNEISS AND SCHIST (MIDDLE OR EARLY PROTEROZOIC)—Fine- to medium-grained, quartz-feldspar-biotite (± muscovite) gneiss and muscovite-biotite-quartz schist. More schistose rocks locally contain sillimanite; garnet is rare.

SYRINGA METAMORPHIC SEQUENCE

The Syringa metamorphic sequence consists of schist, quartzite, and calc-silicate rocks exposed in the southwestern part of the area. Map units are based on the predominance of schist (**sq**), quartzite (**qtz**), or calc-silicate rocks (**qzsh**). Sequence is distinguished by the abundance of schist and the presence of thin layers of calc-silicate quartzite throughout.

qs SCHIST AND QUARTZITE (MIDDLE OR EARLY PROTEROZOIC?)—Consists of interlayered quartz-mica schist and variably micaceous quartzite. Schist has relatively abundant, medium- to coarse-grained muscovite and biotite, less abundant magnetite, and minor sillimanite and garnet. Quartzite is coarsely recrystallized (2-5 mm) and foliated. Partings are typically spaced 1- to 30-cm.

qtz QUARTZITE AND SCHIST (MIDDLE OR EARLY PROTEROZOIC?)—Impure quartzite and biotite schist. Compositional layering on the scale of decimeters is defined by thin layers of schist alternating with massive quartzite. Quartzite typically contains 10-20% feldspar (principally alkali feldspar) and about 10% mica. Quartz grains are commonly 0.25 to 1 mm in diameter but are as much as 5 mm in highly recrystallized rocks. Recrystallized quartzite is also highly strained and foliated. In places this unit includes calc-silicate quartzite similar to that of the **qzs** unit.

qzsh QUARTZITE AND CALC-SILICATE ROCKS (MIDDLE OR EARLY PROTEROZOIC?)—Diopside quartzite and hornblende gneiss; locally epidote-rich. Also contains subordinate amounts of biotite schist. The hornblende gneiss is presumed by its association with calc-silicates of this unit to have a sedimentary origin.

FAULTS

A significant structure in the western part of the map area is the fault boundary (suture zone) between Precambrian continental rocks and the accreted Blue Mountains volcanic arc complex. The exact location of this structure is uncertain because of cover by younger volcanic rocks (**Tcb**), correlation difficulties within the metasedimentary units, and intrusion of the suture zone by **Kgd** in many places. The **Ki,l**, **Ti Pzsd**, and **Mzrg** units are west of a mylonitic fault zone that crosses U.S. Highway 12 at Sutter Creek and reappears from beneath the **Tcb** in the extreme southwest corner of the map. This fault zone is coincident with an abrupt change in initial $^{87}Sr/^{86}Sr$ ratios in the plutonic rocks (Armstrong and others, 1977; Criss and Fleck, 1987). However, the **Mzm** and **Mzhg** units, which may correlate with **Mzrg** and therefore also be part of the accreted island arc complex, lie east of this fault.

A second important structure in the western part of the area is the northwest-trending Glade Creek fault, which marks the southwestern limit of known Belt Supergroup units. This fault is within the trans-Idaho discontinuity (Yates, 1968; Pitz, 1985), a 10-km-wide deformational zone that extends from Glade Creek southwest to Lowell. Extreme flattening across this zone precludes determination of original attitude or motion of the Glade Creek fault. Rocks southwest of the Glade Creek fault were assigned to three metamorphic sequences (Meadow Creek, Syringa, and Elk City). These sequences are of uncertain age and correlation, and their contact relations are poorly understood. The contact between the Meadow Creek and Syringa sequences is interpreted as a thrust fault because of increasing deformation toward the contact and the occurrence along it of deformed plutonic rocks. The Syringa sequence may be in fault contact with the Elk City sequence, but poor exposure and our limited time in the field prevented us from determining the contact relations.

An important structure in the eastern part of the area is the Spruce Creek mylonite zone, which dikes and sills of Eocene age dips west. Orientation of wr surfaces indicates top to the east motion. This zone appears to be the western flank of the Bitterroot dome described by Hyndman (1980).

Northeast- to north-south-trending high-angle normal faults such as the Papoose Saddle and Cedar Creek faults are present across the map area. Many have controlled emplacement of Eocene dikes and dike swarms.

MAP SYMBOLS

Contact: dashed where approximately located; queried where uncertain

High-angle fault: dashed where approximately located; dotted where concealed; queried where uncertain; ball and bar on downthrown side

Thrust fault: approximately located; queried where uncertain; teeth on upper plate

Td Dikes

Areas of mylonitized rock

Strike and dip of compositional layering interpreted as bedding; ball indicates top direction was determined

Vertical bedding

Strike and dip of foliation: includes compositional layering of gneisses

Vertical foliation

Bearing and plunge of mineral lineation

Bearing and plunge of small fold axis

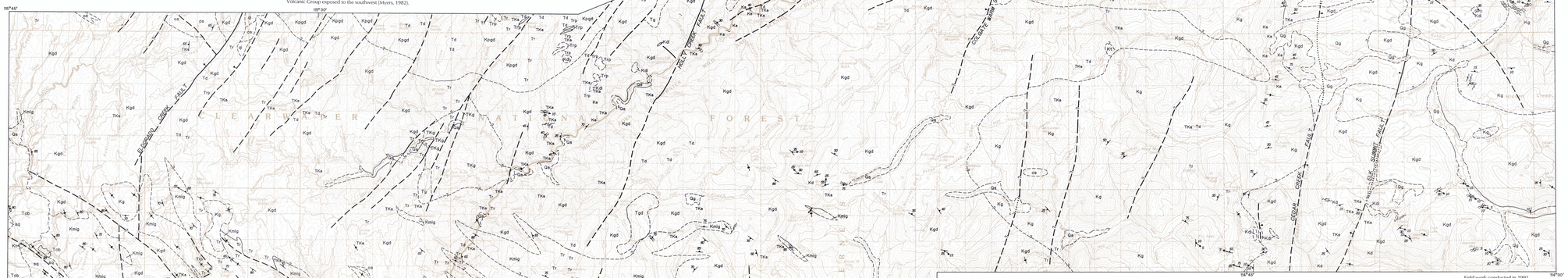
Bearing and plunge of crenulation lineation

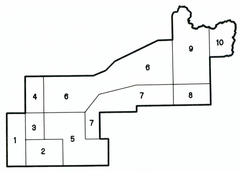
Bearing and plunge of asymmetrical small fold showing counterclockwise rotation viewed down plunge

Bearing and plunge of asymmetrical small fold showing clockwise rotation viewed down plunge

Sedimentary breccia

Quartz vein





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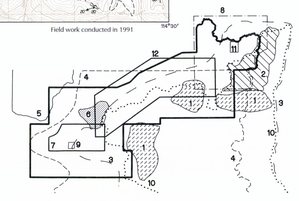

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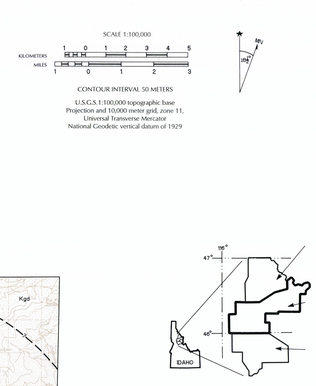

INDIVIDUAL MAP AREAS

1. Paul E. Myers and Robert W. Reynolds, assisted by L. Darlene Batatian, Lori D. Snyder, and David E. Stewart
2. Robert W. Reynolds, assisted by L. Darlene Batatian, Lori D. Snyder, and David E. Stewart
3. Reed S. Lewis, Paul E. Myers, and Russell F. Burmester, assisted by Louis J. Caputo, Virginia S. Gillerman, and Mark W. Thurber
4. Earl H. Bennett and Paul E. Myers
5. Russell F. Burmester, assisted by Bernard E. Dougan and Leon T. Sawyko
6. Reed S. Lewis, assisted by Louis J. Caputo, Virginia S. Gillerman, Keegan L. Schmidt, and Mark W. Thurber
7. Rolland R. Reid, Reed S. Lewis, and Russell F. Burmester, assisted by Keegan L. Schmidt and Mark W. Thurber
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GEOLOGIC MAP OF THE LOCHSA RIVER AREA, NORTHERN IDAHO

R.S. Lewis, R.F. Burmester, R.W. Reynolds, E.H. Bennett, P.E. Myers, and R.R. Reid

1992

Cartography by Loudon R. Stanford on a computer-aided cartographic system at the Idaho Geological Survey.
Map Reviewed by Tom Frost and Bill Bonnichsen.
Printed by Pikes Peak Litho., Colorado Springs, Colorado

Published and sold by the Idaho Geological Survey
University of Idaho, Moscow, Idaho 83843