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Paleozoic and Mesozoic rocks of the Almanor 15' quadrangle, Plumas County, California

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Text to accompany Paleozoic and Mesozoic rocks of the Almanor 15' quadrangle, Plumas County, California

INTRODUCTION

The first geologic studies of the Lake Almanor area were published in the late eighteen hundreds by Diller (1892, 1895) and Turner (1898). Subsequent work by McMath (1958, 1966) and by Eldridge Moores and his students including Robinson (1975), D'Allura and others (1977) and Hannah (1980) established much of the stratigraphic and structural framework represented on this geologic map (Figure 1), although significant reinterpretation of some of the earlier recognized features and units has resulted from this investigation. The geology shown on the quadrangle map was mapped during the course of this investigation with the exception of parts of sections 13 and 18, T27N and R8E, which were compiled from Hanna (1980). Field studies were conducted during June to September of 1985, September of 1986, June and July of 1987, and October of 1988.

The Almanor quadrangle straddles part of the geographic and geologic boundary between the Sierra Nevada range on the south and the Cascade Range on the north. The terrain is generally mountainous and heavily forested (by conifers) with elevations ranging from 2,300 feet near Gansner Bar in the southwest corner of the quadrangle to 7,400 feet on Dyer Mountain in the northeast corner of the quadrangle. The best exposures are commonly along road cuts and more rarely in drainages and along ridges.

GEOLOGIC FRAMEWORK

The Almanor quadrangle consists of an upper Cenozoic cover of volcanic extrusives and alluvium that locally blankets deformed and metamorphosed Paleozoic and lower Mesozoic rocks of oceanic, arc, and continental affinity. The Cenozoic volcanic rocks consist of mafic flows and silicious ash flow tuffs that are part of the southernmost extent of the Cascade Range volcanic province which principally lies to the north of the quadrangle. Most alluvial deposits are younger than the volcanic rocks and tend to blanket the volcanic and older deposits. Many areas within the quadrangle, in particular Rush Hill, Rush Creek Hill, Onion Flat and areas southwest of Onion Flat, are presently topographically high but have geomorphic and weathering characteristics suggestive of an older dissected erosional surface.

The Paleozoic and lower Mesozic basement rocks of the quadrangle represent parts of three major geologic belts that occur in the northern Sierra Nevada. From west to east they are: the Central belt, the Feather River peridotite belt, and the northern Sierra terrane (also referred to as the Eastern belt) (Day and others, 1985; Harwood, 1988). In addition to these regional belts, a narrow belt of rock with a more restricted volume and regional distribution, here referred to as the Soda Ravine block, occurs between the Feather River peridotite belt and the northern Sierra terrane (Figure 2) . This block may represent a fragment of disrupted eastern Klamath terrane. The Central belt in the Almanor quadrangle consists of a mixture of radiolarian chert, argillite, and greenstone of oceanic affinity and is characterized by a melange structure. The unit has yielded Triassic (Irwin, 1976), Late Pennsylvannian to Early Permian, and Mississippian to early

Pennsylvanian radiolarian faunas (Table 1). The Feather River peridotite belt in this area consists of fairly homogeneous serpentinized peridotite and dunite of unknown tectonic affinity or age. Radiometric dating of rocks from this belt have yielded ages that range from the Middle Devonian to the Late Triassic (Saleeby and Moores, 1979; Standlee, 1978; and Weisenberg and Lallemant, 1977).

The northern Sierra terrane includes most of the metamorphic rocks in the map area and consists of a continentally derived basement complex, the Shoo Fly Complex (DOsf), which is overlain by a middle and upper Paleozoic volcanic rocks, volcanic-clastic rocks and radiolarian chert (McMath, 1966; Harwood, 1988). The radiolarian chert (PMpc) was deposited in a quite marine basin from the Early Mississippian into the Middle(?) Pennsylvannian. Chert deposition was preceded and followed by episodes of arc related volcanism and sedimentation that occurred during Late Devonian and Early Mississippian (Dsb, MDt, and Mpl) time and again during the late Early and early Late Permian (Pa and Pr) (McMath, 1966; Durrell and D'Allura, 1977; Harwood, 1983; 1988).

In general, the contacts between units within the the northern Sierra terrane are rarely exposed due to heavy vegetation and colluvium. The contact between the Upper Devonian Sierra Buttes Formation (Dsb) and the Shoo Fly Complex (DOsf) is interpreted as a depositional contact based on an unconformable contact exposed south of the Almanor area (Durrell and D'Allura, 1977). The contact between the Shoo Fly Complex and the Sierran Buttes Formation (Dsb) was mapped at the first appearance of volcanic rock, tuff, or quartz-bearing volcanic detritus that overlie quartzose sandstone. The contact between the Sierra Buttes Formation and the Taylor Formation (MDt) was placed at the first appearance of pyroxene-bearing metaandesite or pyroxene-bearing clastic rocks.

The northern Sierra terrane consists of three lithotectonic blocks, the Genesee, Hough, and Butt Valley blocks. The two northernmost lithotectonic blocks, the Genesee and Hough blocks, were first recognized by McMath (1966) and further described by D'Allura and others (1977). The third structural block, herein referred to as the Butt Valley block, is the westernmost and the the least well constrained stratigraphically. The Genesee block consists of Shoo Fly Complex overlain by Sierra Buttes and Taylor Formation in stratigraphic succession although depositional contacts are not exposed. The lower member of the Peale Formation was not recognized above the Taylor Formation in this block and only a small part of the chert member of the Peale Formation is exposed from under an alluvial cover. The lower member of the Peale Formation may, in part, be faulted out in this area. The highest stratigraphic unit that is exposed in the Genesee block is the Arlington Formation. Both units are faulted against the underlying section along a zone that is locally characterized by sheared rock and(or) gouge that is several meters to tens of meter wide.

The stratigraphic section from the basal Shoo Fly Complex through the Arlington Formation are present in the Hough block. In general, the Devonian volcanic and volcaniclastic rocks decrease in unit thickness and grain size from east to west. In addition, the relative proportion of volcanic to volcaniclastic rock decreases from east to west across the block boundaries in both the Devonian and Permian units. The western exposures of the chert member of the Peale Formation thins considerably towards the southeast probably in part due to erosion prior to deposition of the overlying Permian strata (Harwood, 1983, 1988) although tectonic thinning cannot be excluded.

The Butt Valley block consists of a thin sliver of serpentinite and Sierra Buttes Formation which is overlain by pyroxene-bearing metaandesite that is tentatively correlated with the Taylor Formation. The upper part of the Paleozoic section including the Peale and Arlington Formations are not present in the Butt Valley block and are inferred to have been eroded prior to deposition of the Late Triassic strata. The conglomerate which overlies the Taylor (?) Formation of the Butt Valley block contains lenses of limestone which have yeilded Late Triassic conodonts (Table 1)

Upper Triassic limestone and conglomerate and Jurassic volcaniclastic rocks of the Sailor Canyon Formation unconformibly overlie Paleozoic volcanic rocks of the northern Sierra terrane at the North Fork of the American River (Clark and others 1962; Harwood, 1983;). Similar Upper Triassic limestone and conglomerate (TRls and TRc) occur in the Butt Valley block. These rocks are tentatively correlated with the Triassic limestone and conglomerate of the Sailor Canyon Formation at the North Fork of the American River. The limestone and conglomerate of the Butt Valley area are associated with poorly dated, probably Upper Triassic and Lower Jurassic volcaniclastic rocks (JTRs). The Upper Triassic limestone of the Almanor area has been correlated previously with the Hosselkus Limestone of the Taylorsville area (Robinson, 1975). The Jurassic and(or) Triassic volcaniclastic and volcanic rocks, and the Upper Triassic limestone and conglomerate which underlie them in the Butt Valley area, were originally named the Cedar Formation by Diller (1895). Robinson (1975) and D'Allura and others (1977) subsequently assigned rocks of the Butt Valley and Soda Ravine blocks to the Arlington Formation which they concluded was Permian and Triassic in age. The type Arlington and related rocks have subsequently been shown to be exclusively Permian in age, probably late Early Permian (Harwood, 1983; 1988) therefore the volcaniclastic rocks of the Butt Valley block are probably not equivalent in spite of some litholigic similarities.

A sliver of undated slate and adjacent argillaceous sedimentary rock, the Soda Ravine block, that contains blocks of Permian and Triassic bioclastic limestone lies along the westernmost edge of the northern Sierra terrane. The Permian limestone block has yielded Early Permain fusulinids of probable McCloud Zone A affinity (C.H. Stevens, written commun., 1985), and the Triassic limestone blocks have yielded Late Triassic (late Carnian and Norian) fossils equivalent to those in the Hosselkus Limestone (Diller, 1892; Harwood, in prep) as well as slightly older late Middle and (or) early Late Triassic (Ladinian-Carnian) fauna (Table 1). The associated slate unit (p) is lithologically similar to the Pit Formation of the eastern Klamath terrane. The Permian limestone has closer faunal and lithologic affinity to McCloud Limestone of the eastern Klamath terrane than to Permian rocks of the northern Sierra terrane as has been noted by previous workers (D'Allura and others, 1977). Similar tectonic slivers of Permian and Triassic (?) rock have been reported from the same structural position along the Melones fault south of the Almanor quadrangle (McMath, 1958; D'Allura and others, 1977; Harwood and others, 1988).

The rocks of the northern Sierra terrane have been regionally metamorphosed to the lower greenschist facies. All of the sedimentary rocks of the terrane have a well-developed schistosity. Schistosity is only sporadically developed in the more massive flows of the volcanic units in the Taylorsville sequence. Conodont alteration indicies (A.G. Harris, written commun., 1987) suggest the rocks of the Butt Valley area reached temperatures ranging from 300° to 350° C. Rocks of the Central Belt are generally less indurated and foliated than those in the northern Sierra terrane and consist primarily of argillite or phyllitic argillite rather than slate.

STRUCTURE

Northwest trending features that include faults, folds, and lithologic boundaries dominate the structural fabric of the metamorphic rocks. Major steep faults with unknown displacements seperate each of the main belts of the quadrangle. The Rich Bar fault forms the boundary between the Central belt and the Feather River peridotite belt (Hietanen, 1973). The Melones fault lies between the Feather River peridotite belt and the Soda Ravine block (Hietanen, 1973), and a steep fault, the Crablouse fault is inferred, to lie between the Soda Ravine block and the northern Sierra terrane.

Two major generally gently west-dipping faults (or fault zones) seperate the three lithotectonic blocks within the northern Sierran terrane. The Genesee Block is seperated from the Hough block by the Grizzly Mountain fault (McMath, 1958; D'Allura and others, 1977) and the Hough and Butt Valley blocks are seperated by the Clear Creek fault.

The Grizzly Mountain fault in the Almanor quadrangle is a broad zone, in places more than a kilometer wide, that is made particularly prominant by the occurrence of serpentinite within the fault zone. The Grizzly Mountain fault zone has had an early history of thrust faulting that is probably Mesozoic in age. It is also inferred to have been modified in part by normal faulting that is probably Cenozoic in age (McMath, 1958; D'Allura and others, 1977; Day and others, 1985). The eastern part of the fault zone in the Almanor area is characterized by repetition of section and imbricate thrust faulting of serpentinite, Shoo Fly Complex and the Sierra Buttes Formation. The Arlington and upper member of the Peale Formations are faulted against the Shoo Fly Complex, serpentinite and Sierra Buttes Formation along the western part of the fault.

The Clear Creek fault is gently to moderately west-dipping in the Rush Hill area but steepens towards the north where it is either folded into a more vertical position or modified by younger high-angle faults. Hydrothermal alteration of rocks has also occured locally along this fault, particularly towards the north where the the faults is more steeply dipping

West-dipping overturned folds with faulted-out east limbs occur in the eastern parts of the Butt Valley and Hough blocks (D'Allura and others, 1977). The overturned syncline of the Hough block is here referred to as the Canyondam syncline and the overturned anticline of the Butt Valley block as the Butt Valley anticline (Figure 1). Stratigraphic sections of both the Genesee and Hough blocks are generally west-dipping and east-facing.

Steep northwest-trending normal faults of Cenozoic (?) age showing down-to-the-west displacement and strong geomorphologic expression occur in the Genesee block of the Almanor quadrangle. These faults repeat the Upper Devonian Sierra Buttes Formation and Upper Devonian-Mississippian Taylor

Formation. An apparent down-to-the-east fault displaces the northern end of the Canyondam syncline in the Hough block.

Gold mineralization associated with hydrothermal activity has occurred in the northern part of the Grizzly Mountain fault. The gold and accessory minerals including silver and lead are localized in blocks of keratophyric rock most likely derived from the Sierra Buttes Formation that lie in the fault zone. Gold mining is presently occuring in the area at the time of this study. Placer gold deposits are also heavily worked along the headwaters of the North Fork Feather River.

INTRUSIVE ROCKS

There are two main domains of intrusive rock within the Almanor quadrangle. The Devonian Wolf Creek stock lies in the northeast part of the quadrangle and intrudes rocks of the Upper Devonian Sierra Buttes Formation (Saleeby and others, 1987). A sequence of Mesozoic dikes and larger plutonic bodies lies in the southwestern part of the quadrangle (Robinson, 1975). The Mesozoic intrusive rocks principally lie east of the Feather River peridotite belt and intrude rocks of the Soda Creek block, but several very small dikes also cut the Feather River peridotite belt and the Central belt. These intrusive rocks are characterized by weakly developed solution cleavage and a generally widespread overprint of low-grade metamorphic minerals including chlorite, albite, green amphibole, white mica, and biotite. The Mesozoic intrusive rocks show evidence of penetrative fabric development suggesting a pre-regional deformation time of intrusion and, in addition, are cut by steep faults and are locally overprinted by a cataclastic fabric adjacent to the Melones fault.

ACKNOWLEDGMENTS

I have greatly benefited from discussions with D.S. Harwood throughout the coarse of this study and acknowledge helpful discussions with Norm Silberling and Judy Hannah. Bruce Wardlaw and Anita Harris kindly identified the conodonts in Table 1, and Bonnie Murchey kindly identified the radiolarians. Norm Silberling looked at the Pentacrinus-like-bearing samples and ammonites from Locality 1, Table 1.

DESCRIPTION OF MAP UNITS

Qal — ALLUVIAL DEPOSITS (QUATERNARY AND (OR) PLIOCENE?)--typically unconsolidated, subangular boulder- conglomerate and gravel deposits; clast types are representative of local rock types

Qrt — RIVER TERRACE DEPOSITS (QUATERNARY)-- Poorly sorted, unconsolidated mud, sand, gravel and boulder deposits along rivers and creeks, but generally higher than modern high-water levels

QTv — BASALTIC, ANDESITIC AND DACITIC VOLCANIC ROCKS UNDIFFERENTIATED (QUATERNARY AND (OR) TERTIARY)--basaltic, basaltic andesite and andesitic flows typically 2-8 m thick; flows include olivine phyric, plagioclase-pyroxene, and plagioclase phyric varieties; siliceous volcanic tuff and ash, commonly vuggy and vesicular, spheroidal weathering, whitish, buffy, pinkish and pale gray weathering, dark gray on fresh surface,

QTc — CONGLOMERATE (QUATERNARY AND (OR) TERTIARY)--Reddish weathering rounded and subrounded, poorly sorted conglomerate, with clasts generally smaller than 30 cm in diameter. Deposits presently sit about 1,200 feet above the present drainages and occur in the southwestern part of the quadrangle. Deposits include clasts of Shoo Fly Complex indicating derivation from the east prior to development of the present drainage systems

INTRUSIVE ROCKS--divided into:

mh — METAMORPHOSED HORNBLENDE PORPHYRY (TRIASSIC? OR YOUNGER)--porphyritic intrusive rock with abundant euhedral, coarse-grained hornblende phenocrysts in a fine-grained felsic matrix that is dominantly sericitic; locally tectonized with a cataclastic texture and overprinted by secondary alteration to fine-grained chlorite and sericite

mq — METAMORPHOSED QUARTZ PORPHYRY (TRIASSIC? OR YOUNGER)--thin dikes of porphyritic intrusive rock with coarse-grained quartz and albitized plagioclase phenocrysts in a matrix of white mica, chlorite, albite, and quartz, with accessory iron oxides

mp — METAMORPHOSED PLAGIOCLASE PORPHYRY (TRIASSIC? OR YOUNGER)--coarse plagioclase phenocrysts in medium-grained, flow banded felsic groundmass, with abundant accessory apatite and magnetite; cut by poorly developed solution cleavage with high concentration of opaque minerals,

md — METAMORPHOSED DIKE ROCK (TRIASSIC? OR YOUNGER)--includes plagioclase porphyry with fined-grained felsic groundmass, mafic minerals altered to chlorite, and minor accessory sphene, secondary solution cleavage defined by alignment of opaque minerals; and plagioclase hornblende porphyry with coarse euhedral plagioclase and finer, less abundant euhedral hornblende with a fine-grained felsic groundmass, secondary biotite, albite, sericite, pale green amphibole rimming igneous hornblende,

mi

METAMORPHOSED INTRUSIVE ROCK UNDIFFERENTIATED (TRIASSIC? OR YOUNGER)--generally medium grained, locally porphyritic, holocrystalline groundmass, with relict zoned plagioclase, minor euhedral hornblende and uralized clinopyroxene, accessory sphene, apatite and opaque minerals; metamorphic minerals include epidote and(or) clinozoisite, white mica, chlorite, calcite and biotite,

CENTRAL BELT--divided into:

cba

ARGILLITE (MISSISSIPPIAN TO TRIASSIC?)--predominantly black argillite, siliceous argillite, argillaceous chert and red, greenish, and black chert, rare greenstone and extremely rare garnet amphibolite, structurally chaotic with a melange fabric

FEATHER RIVER PERIDOTITE BELT--divided into:

fru

ULTRAMAFIC AND MAFIC ROCK (DEVONIAN TO TRIASSIC?)--predominantly massive homogeneous peridotite and serpentinized peridotite, with minor dunite and serpentinized dunite; dark-red weathering and dark blackish green on fresh surface; rocks are pervasively cut by randomly oriented faults and shear zones; includes fine-grained, hypidiomorphic granular gabbroic rock (gb)

SODA RAVINE BLOCK (EASTERN KLAMATH TERRANE ?)--divided into:

m

ARGILLITE MATRIX MELANGE (POST-LATE TRIASSIC-PRECENOZOIC)--tectonically disrupted zone that contains bioclastic limestone blocks (ls) which have yielded Late Triassic (Norian), late Middle to Late Triassic (late Ladinian to Carnian), Early Permian (Wolfcampian) faunas (Diller, 1892; Robinson, 1975; Table 1). The Early Permian limestone is probably of McCloud Zone A faunal affinity (Robinson, 1975; C.H. Stevens, written commun., 1985). The the melange consists dominantly of phyllite with subordinant lenses of chert pebble conglomerate, and quartzose- and chert-bearing sandstone, grit, and pebble conglomerate, also contains rare serpentinite lenses (s). Permmain limestone may be equivalent with the McCloud Limestone of the eastern Klamath terrane. Triassic limestone and associated roacks may in part be equivalent with the Pit Formation of the eastern Klamath terrane

p

PHYLLITE (TRIASSIC ?)--principally phyllitic slate and metasiltstone, commonly weathers buffy or pale gray with a bleached appearance; contains very minor fine-grained, greenish-weathering metagraywacke beds; unit may be equivalent to the Brock Shale of the eastern Klamath terrane (N.J. Silberling, oral commun., 1987)

NORTHERN SIERRA TERRANE--in this area divided into:

JTRs

METASEDIMENTARY ROCKS (JURASSIC AND (OR) TRIASSIC?)--dominantly greenish-gray volcanogenic-lithic metagraywacke and metasiltstone with prominent schistosity, lesser interlayered chert and siliceous volcanic pebble conglomerates and grits (cgl) with minor detrital quartzite, rare thin lenses of gray schistose limestone (l), and rare green and pinkish, aphanitic metatuff beds and lenses; clastic rocks are cut by small clinopyroxene-bearing intrusive dikes and (or) sills (mv). Metasedimentary rocks have yielded Middle Triassic to Lower Jurassic (inclusive) ammonites (reported in Robinson, 1975),

TRls

HOSSELKUS LIMESTONE (EARLY LATE TRIASSIC (LATE CARNIAN AND EARLY NORIAN))--grayish to whitish, schistose and semischistose crinoidal limestone with conodonts, typically recrystallized; conodont color alteration index indicates temperatures of approximately 300°-350° C were attained during metamorphism. Limestone is probably equivalent with the Hosselkus limestone of Diller, (1892)

TRc

CONGLOMERATE (EARLY LATE TRIASSIC (LATE CARNIAN AND EARLY NORIAN))--pale greenish in outcrop, pebble and cobble conglomerate with subrounded and subangular clasts, abundant detrital pale greenish and pinkish chert, siliceous volcanic clasts, and lesser mafic volcanic clasts

Pa

ARLINGTON FORMATION (PERMIAN)--dominantly lithic volcanogenic metasandstone, siltstone and phyllite with lesser intercalcalated chert, quartzite, and volcanic pebble conglomerate

Pr

REEVE FORMATION (PERMIAN)--occurs on the northeast slope of Keddie Ridge and consists of crystal-rich, plagioclase-rich, typically blocky, nonfoliated metatuff that weathers pale gray, and lavender or pinkish; includes a massive unfoliated plagioclase porphyry dike with very coarse-grained feldspar phenocrysts that intrudes fine-grained sediments of the Arlington Formation locally forming a dense black hornfels around the margin of the intrusion

PEALE FORMATION (PENNSYLVANIAN AND MISSISSIPPIAN)--divided into:

PMpc

CHERT MEMBER (PENNSYLVANIAN AND MISSISSIPPIAN)--thin-bedded, semischistose pale red to green, gray and black chert with lesser tuffaceous and shaley interbeds

Mpl

LOWER MEMBER (MISSISSIPPIAN)--dominantly dacitic and rhyodacitic metavolcanic tuff and flows; may have flattened whitish pumice fragments; typically massive, weathers to pale gray and pastel colors, also thin-bedded aphanitic, pale- and dark-green tuff and tuff breccia which may be platy; queried where uncertain

MDt

TAYLOR FORMATION (MISSISSIPPIAN AND (OR) DEVONIAN)--clinopyroxene-bearing andesitic volcanogenic sandstone, meta-andesite pillow lava, andesitic volcanic breccia. volcanic breccias are commonly clinopyroxene-bearing, locally amygdulodial with chalcedony filling vesicles; breccia fragments up to 20-30 cm across occur locally, particulary along Keddie Ridge. Volcanic rocks tend to form rusty colored soils. Unit includes lesser slate and siltstone, and minor small pods of black chert locally,

MDt? c

METAVOLCANIC ROCK (MISSISSIPPIAN ?)--dominantly schistose plagioclase phyric metatuff, with lesser intercalated clinopyroxene-bearing meta-andesite, tuff, pillow lava and pillow breccia present locally, local calcareous intercalations (c). Unit is interpreted as correlative with the Taylor Formation

Dw

WOLF CREEK STOCK (DEVONIAN)--granitic intrusive rock, coarse grained, hypidiomorphic granular with anhedral orthoclase, plagioclase and quartz, and subhedral biotite. Secondary alteration to chlorite after biotite, calcite after plagioclase; chalky weathering; U/Pb radiometric age from zircon is 378 +/- 5 Ma (Saleeby and others, 1987)

di Dsb cht

SIERRA BUTTES FORMATION (UPPER DEVONIAN)--predominantly quartz-bearing felsic volcanic rock including densely welded tuff, flows, siliceous metatuff, tuffaceous metasiltstone, and quartzose metasedimentary rocks; minor lenses of black chert commonly with pale grayish or whitish phosphatic nodules; resistant thin-bedded reddish or whitish metachert (cht), conglomerate with clasts of quartz-bearing volcanic rock, and minor quartz-phyric tuff, black slate, tuffaceous slate, and metasiltstone; cut by rare dioritic dikes (di). Unit has yielded one poorly preserved Middle? or Late Devonian radiolarian (Loc. 11) B.L. Murchey, oral communication, 1985)

DOsf ch

SHOO FLY COMPLEX (DEVONIAN? TO ORDOVICIAN)--predominantly micaceous, poorly sorted, well-rounded metaquartzite, slate, minor whitish metachert, common black, gray, and white chert (ch), pebble grit, pebble conglomerate and extremely rare limestone; sandstone and slate typically yellow-orange stained, and buffy weathering

sp

SERPENTINITE (AGE UNKNOWN)--sheared and serpentinized ultramafic rock

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Contact-- showing dip where measured; dashed where approximately located; dotted where covered

Fault-- Dashed where approximately located; dotted where concealed; queried where inferred; showing dip where measured

Thrust Fault-- Dashed where approximately located; dotted where concealed; teeth on upper plate

Normal Fault-- Dashed where approximately located; dotted where concealed; ball on down-thrown block of high-angle normal fault; hacher on down-thrown block of low-angle normal fault

Overturned syncline-- Axial trace approximately located

Overturned anticline-- Axial traace approximately located

Minor syncline-- Axial trace approximately located

Minor anticline-- Axial trace approximately located

Strike and dip of bedding:
- Inclined
- Vertical
- Overturned

Strike and dip of foliation:
- Inclined
- Vertical

Zone of sheared rocks, ellipes indicate the presence of tectonic blocks

Fossil Locality-- Numbers correspond to numbers on table one

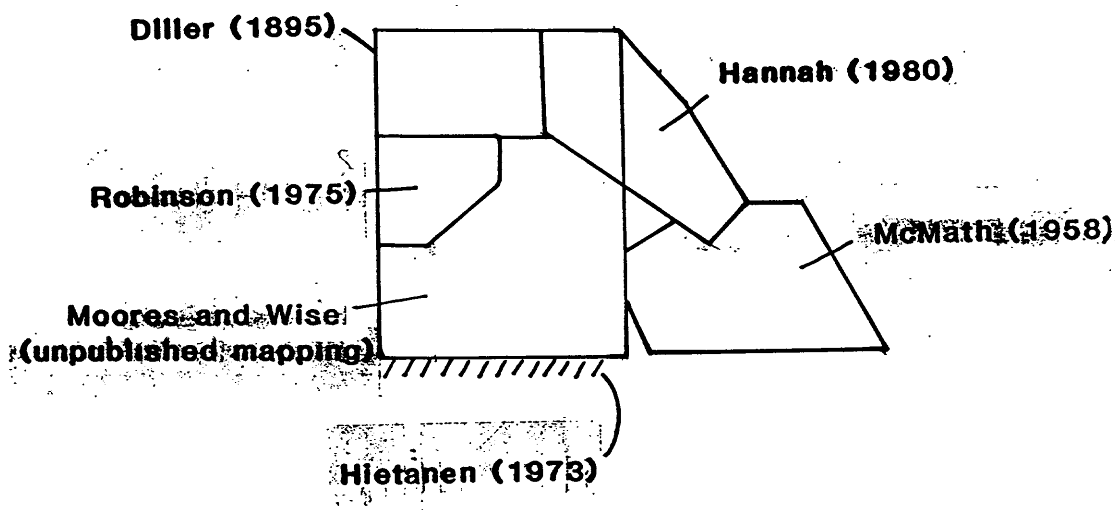

Figure 1. Map showing the location of previous mapping, Almanor quadrangle and adjacent area

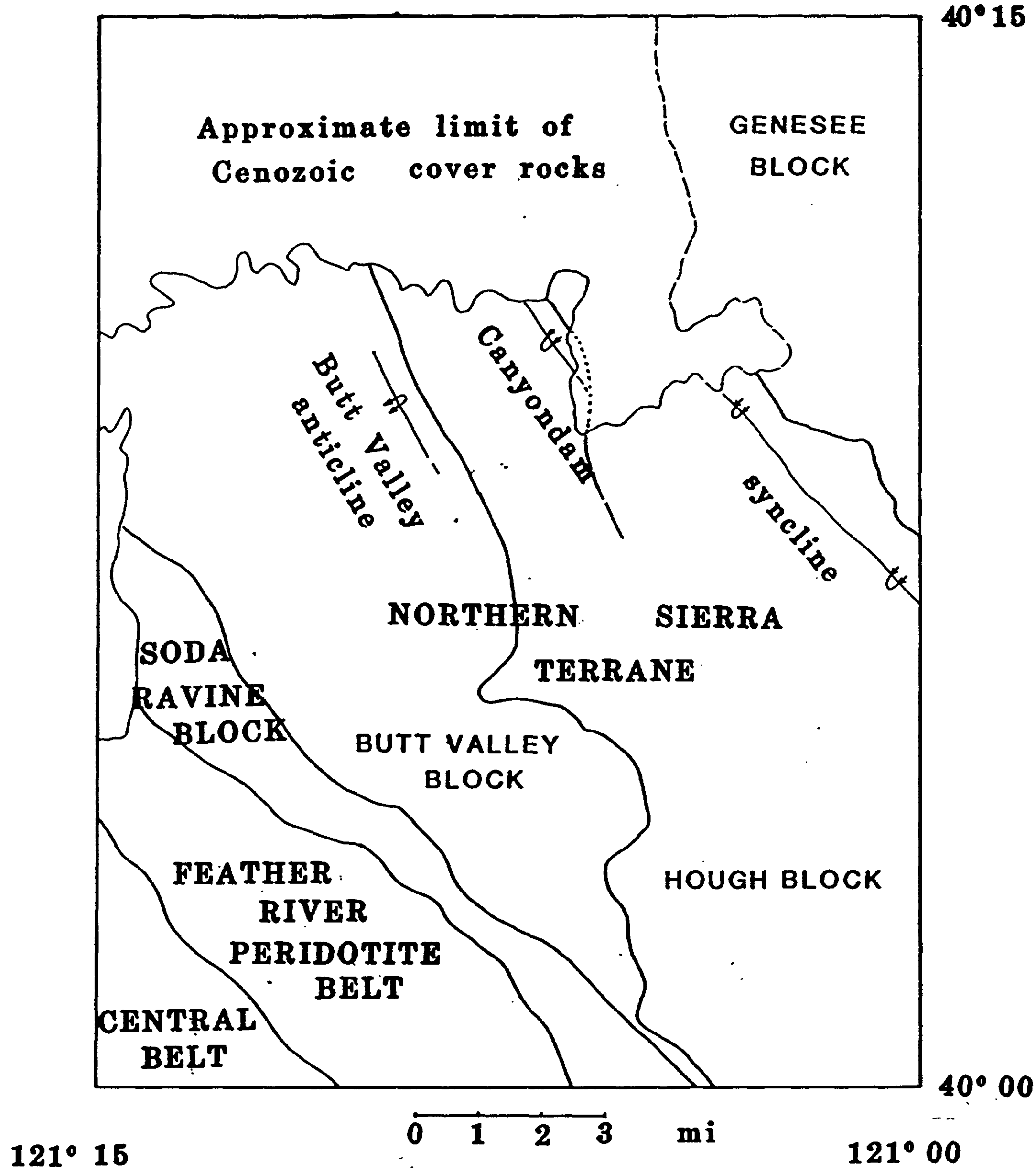

Figure 2. Map showing major tectonic units of the Almanor quadrangle

TABLE 1
FOSSIL LOCALITIES OF THE ALMANOR QUADRANGLE, PLUMAS COUNTY, CALIFORNIA

CONODONTS

MAP NO	FAUNA	AGE	LATITUDE	LONGITUDE	COLLECTOR
1.	Neospathodus homeri (Bender) Xaniognathus sp. indet. Ichthyoliths N. polygnathiformis	Ladinian to Carnian	40° 06' 53"	121° 13' 54"	this study
2.	Neogondolella navicula (Huckriede)	Late Carnian through Early Norian, early Late Triassic	40° 04' 05"	121° 07' 20"	this study
3.	Epigondolella abneptis (Huckriede) Xaniognathus sp.	Early Norian, early Late Triassic	40° 03' 35"	121° 07' 05"	this study
4.	Epigondolella primitia (Mosher) Neogondolella navicula (Huckriede)	Late Carnian through Early Norian, early Late Triassic	40° 02' 15"	121° 06' 40"	this study
5.	Epigondolella sp. Ichithyoliths	Late early to early middle Norian	40° 10' 06"	121° 09' 24"	this study
6.	Epigondolella sp.	Late early to early middle Norian	40° 10' 54"	121° 10' 11"	this study
7.	Epigondolella abneptis (Huckriede) Epigondolella sp	Early to middle Norian	40° 11' 05"	121° 10' 17"	this study
8.	indeter. denticle fragment	Ordovician-Triassic	40° 09' 20"	121° 09' 50"	this study

RADIOLARIANS

MAP NO	FAUNA	AGE	LATITUDE	LONGITUDE	
9.	Pseudoalbaillella elegan (Ishiya) Pseudoalbaillella u-forma (Holdsworth and Jones) Pseudoalbaillella sp.	Late Pennsylvanian to Early Permian (not younger than Leonardian)	40° 01' 47"	121° 13' 25"	this study
10.	Latentifistula impella (Ormiston and Lane Group)	Late Osagean to Chesterian or earliest Morrowan(?) Mississippian to Early Pennsylvanian	40° 00' 37"	121° 12' 27"	this study
11.	Spumellarian (large bladed spines)	Middle(?) to Late Devonian or younger	40° 09' 53"	121° 08' 21"	this study
12.	Radiolarians	Late Triassic	40° 01' 18"	121° 12' 52"	Irwin (1976)

OTHER FOSSIL LOCALITIES

MAP NO	FAUNA	AGE	LATITUDE	LONGITUDE	
13.	Triticidey Pseudofusulinella Schwagerinal	probably Early Permian	40° 05' 38"	121° 13' 54"	Diller (1892) Robinson (1975)
	Fusulinids reexamined this study: Triticites hermanni (Skinner and Wilde) Triticites brevis (Skinner and Wilde)	earliest Permian, "similarity to Klamath fusulinids is so close, I feel it belongs to the same biogeographic province" C.H. Stevens, written commun., (1985).			this study
14.	Ammonites Bellemnites Brachiopods Hallobia Bryazoe	Early Norian (Late Triassic)	40° 06' 36"	121° 13' 39"	Diller (1892)
15.	Pentacrinus Californicus	late Paleozoic to early Mesozoic	40° 10' 16"	121° 09' 47"	Reported in Robinson (1975)
16.	Ammonites	Middle Triassic to Early Jurassic, inclusive	40° 10' 25"	121° 10' 20"	Reported in Robinson (1975)
17.	Ammonites	Middle Triassic to Early Jurassic, inclusive	40° 11' 20"	121° 11' 01"	McMath (1960) Reported in Robinson (1975)
18.	Pentacrinus-like	late Paleozoic to early Mesozoic	40° 10' 21"	121° 09' 46"	this study
19.	Pentacrinus-like	late Paleozoic to early Mesozoic	40° 10' 30"	121° 09' 46"	this study
20.	Pentacrinus-like	late Paleozoic to early Mesozoic	40° 10' 30"	121° 09' 58"	this study
21.	Pentacrinus-like	late Paleozoic to early Mesozoic	40° 10' 21"	121° 09' 58"	this study
22.	Pentacrinus-like	late Paleozoic to early Mesozoic	40° 06' 45"	121° 13" 47"	Diller (1892)
1.	megaphyllites sp. undet. arcestids either clionititids or arpaditinid trachyceratids	late Middle to early Late Triassic, no younger than Carnian and no older than late Ladinian	see conodont locality 1.		Silberling (1987)
	Also from this locality: Pentacrinus Californicus (Clark)	late Paleozoic to early Mesozoic			Diller (1892)