DEPARTMENT OF THE INTERIOR
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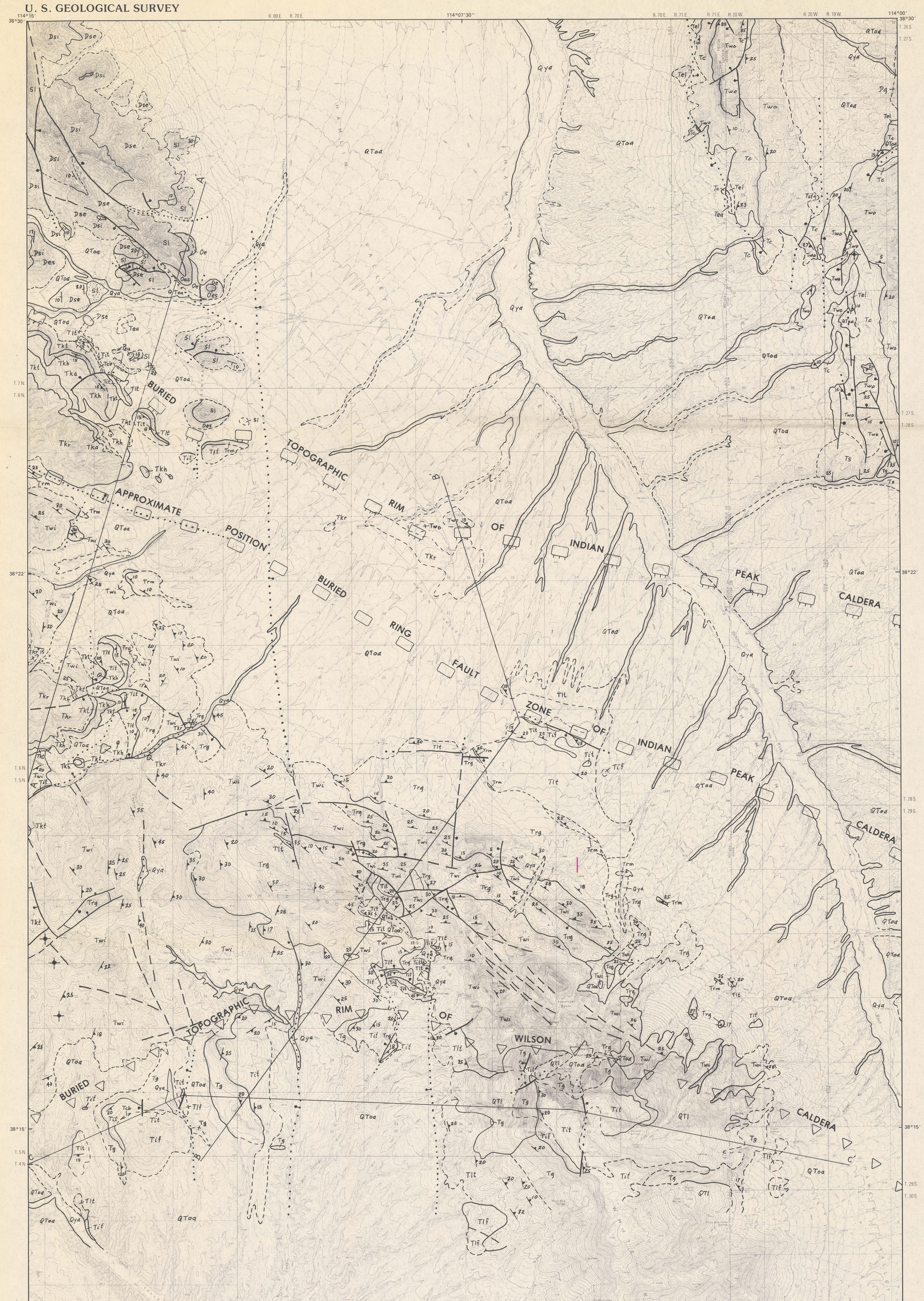
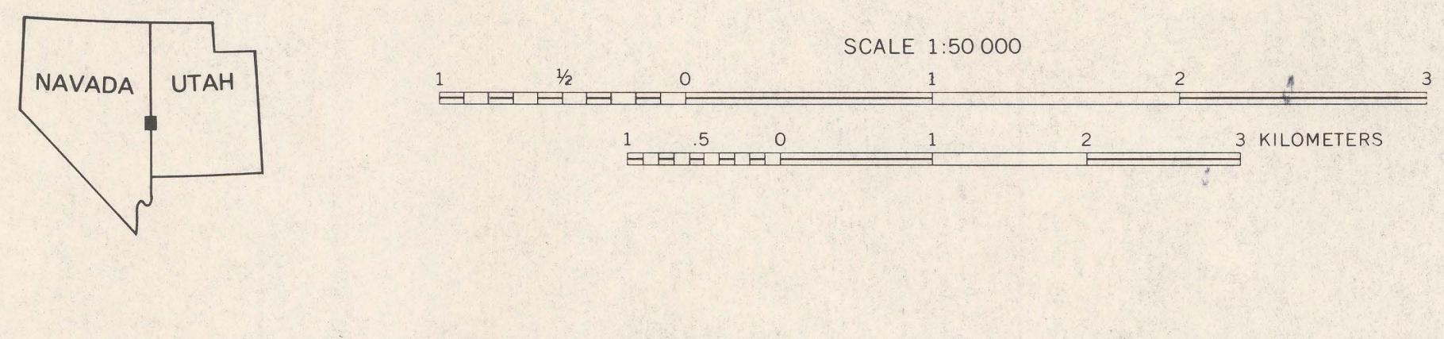
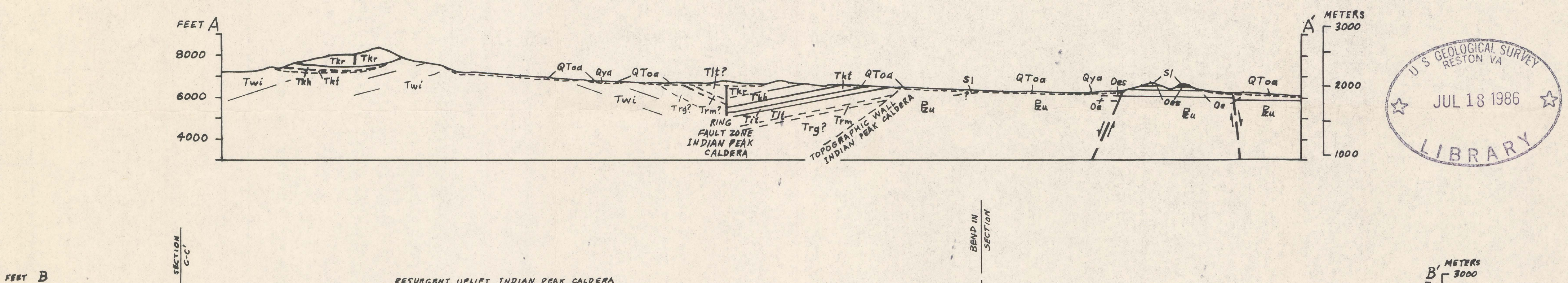
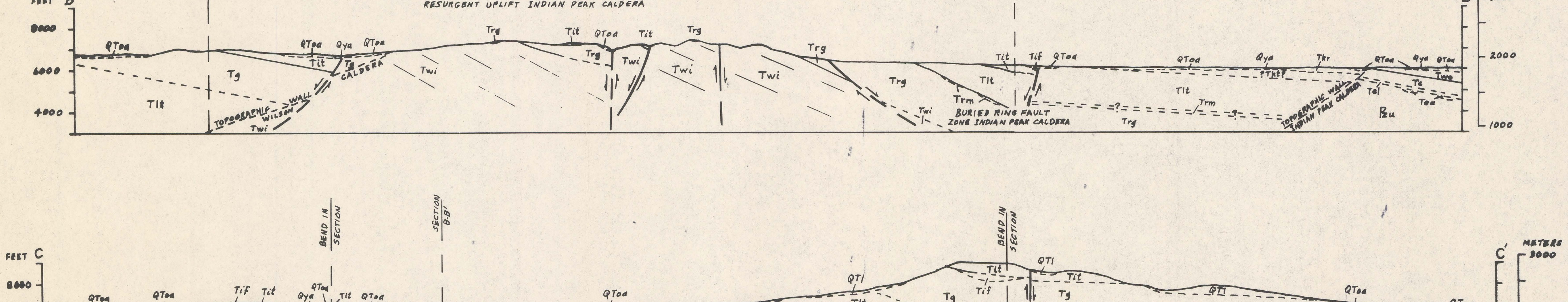


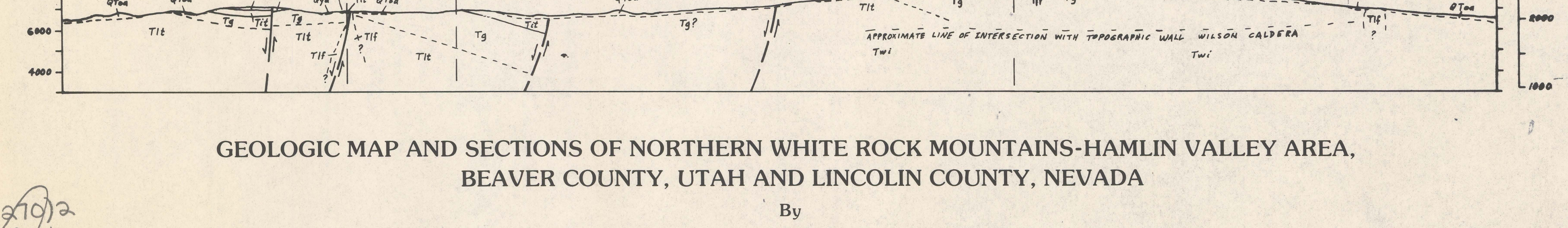
Base from U. S. Geological Survey, 1:24 000, Rosencrans Knolls, Hamlin Well, Miller Canyon, Gleason Basin, Buckwash Well, White Rock Peak, 1972

Geology mapped in 1984-85; modified in part from mapping by students in Brigham Young University summer geologic field courses









GEOLOGIC MAP AND SECTIONS OF NORTHERN WHITE ROCK MOUNTAINS-HAMLIN VALLEY AREA, BEAVER COUNTY, UTAH AND LINCOLIN COUNTY, NEVADA

By

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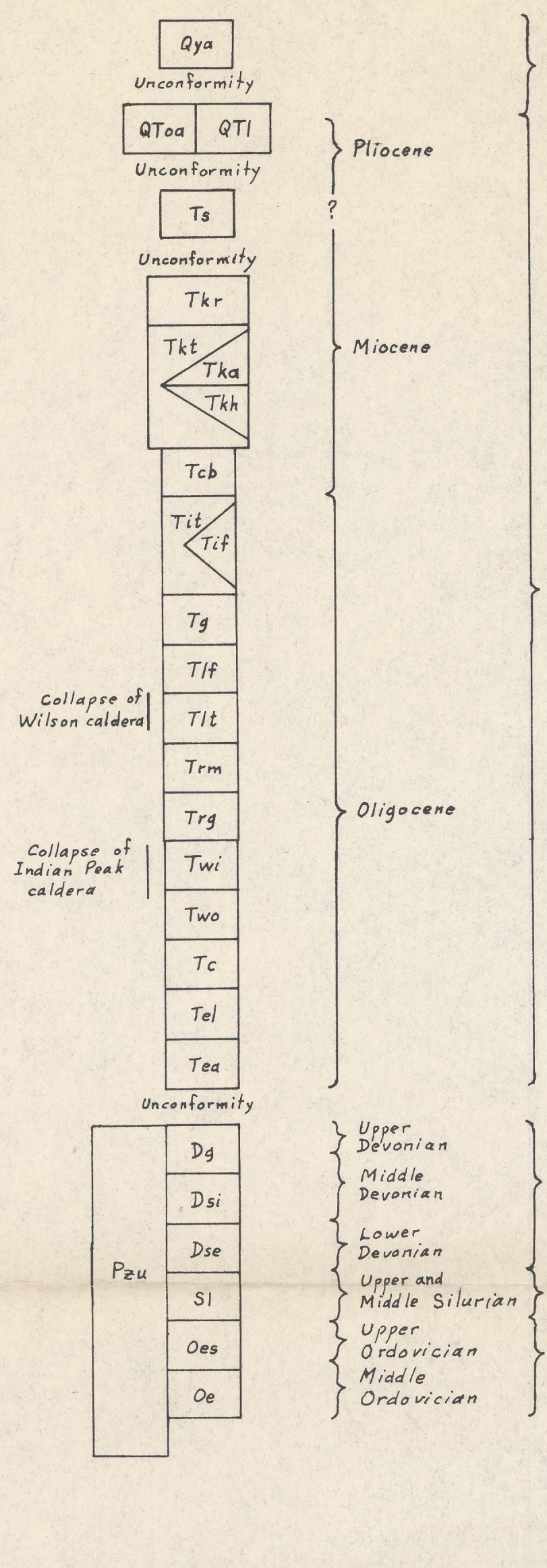
1986

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

CORRELATION OF MAP UNITS



——— CONTACT--Dashed where approximately located or inferred

——— FAULT--Bar and ball on downthrown side; dashed where approximately located or inferred from lineament on aerial photographs; dotted where concealed

┴ STRIKE AND DIP OF BEDS

STRIKE AND DIP OF COMPACTION FOLIATED IN WELDED TUFF

▲ Inclined

● Horizontal

░ SILICIFIED ROCKS

▭ BURIED TOPOGRAPHIC RIM OF INDIAN PEAK CALDERA

▭ BURIED RING FAULT ZONE OF INDIAN PEAK CALDERA

▽ BURIED TOPOGRAPHIC RIM OF WILSON CALDERA

SUMMARY OF GEOLOGY

The geologic history of the map area can be separated into three episodes: deposition of Paleozoic rocks, Oligocene-Miocene volcanism, and late Cenozoic faulting and sedimentation.

Paleozoic rocks are exposed in the Limestone Hills in the northern part of the map area. There, they compose a sequence of orthoquartzites, dolomites, and minor limestones deposited from the Middle Ordovician to Upper Devonian. This sequence is cut by northwest-striking high-angle faults probably of late Cenozoic age, but shows no evidence of the folding and thrusting resulting from the late Cretaceous Sevier Orogeny that is manifest in neighboring ranges.

Most of the exposed rocks in the map area are regionally extensive ash-flow tuff units deposited during the latter half of the Oligocene. Sources of the oldest tuff sheets--the 32-m.y.-old rhyolite Lamerdorf Tuff Member of the Escalante Desert Formation (unit Tel) and the 30.6-m.y.-old dacite Cottonwood Wash Tuff (unit Tc)--lie to the southeast and north of the map area, respectively. Northern sectors of source calderas of two younger dacite sheets are well exposed in the map area (fig. 1). Eruption at 29.5 Ma of the 2,000 km^3 of the dacite outflow tuff member of the Wah Wah Springs Formation (unit Two) that now covers an area of about 20,000 km^2 in Utah and Nevada led to collapse of the Indian Peak caldera. Continued eruptions filled the caldera with the closely similar intracaldera tuff member of the Wah Wah Springs Formation (unit Twi). The northern topographic rim of this large depression can be located closely along the south side of the Limestone Hills and Rosencrans Knolls and its largely buried extension trends east-southeast across the map area. The exact location of the ring fault is obscured by younger deposits and faulting, but is believed to lie about 3 km to the south of the topographic rim. The position of the ring fault is more clearly expressed immediately to the west of the map area where landslide deposits of shattered Ordovician quartzites and dolomites that sloughed off the topographic wall lie upon intracaldera tuff. The major area of exposure of the intracaldera tuff member of the Wah Wah Springs Formation, from Miller Canyon on the northwest to Gleason Basin on the southeast, marks the resurgently uplifted, block-faulted core of the caldera. Significant topographic relief formed on this resurgent core so that thin 26-m.y.-old ash-flow tuffs of the Isom Formation (unit Tit) lie unconformably upon either intracaldera tuff (unit Twi) or on two younger, post-caldera pre-Isom tuffs--the Greens Canyon Tuff Member of the Ryan Spring Formation (unit Trg) and the tuff member of the Lund Formation (Tlt). A deep, probably fault-bounded basin within the resurgent uplift, centered around the head of Cobb Creek, was filled with the Greens Canyon Tuff Member; this basin fill may be as much as 1,400 m thick.

North of The Hermitage, a part of the moat of the Indian Peak caldera lying between its resurgent core and topographic wall is filled with 1 km of tuffs of the Ryan Spring and Lund Formations. Source of the several hundred cubic kilometers of rhyolite tuff of the Ryan Spring Formation has not been definitely located, although the large area of thick exposure to the west of the map area around Mt. Wilson is a possible candidate.

The second major dacite ash-flow tuff unit, the 27.9 Ma tuff member of the Lund Formation, has a volume of thousands of cubic kilometers in Utah and Nevada. The northern topographic rim of the Wilson caldera that collapsed upon eruption of the Lund tuff trends east-west across the resurgent dome of the older Indian Peak caldera and is marked by the northern pinchout of the tuff of Ripgut Springs (unit Tg) against the intracaldera member of the Wah Wah Springs Formation. About 750 m of the Ripgut and overlying Isom Formation filled the Wilson caldera in the map area, whereas north of the caldera the Isom is generally a thin and impersistent sheet and the Ripgut is absent. A series of three porphyry and flow-layered vitrophyre bodies (unit Tlf) along the southern margin of the map area may mark the position of the structural margin of the Wilson caldera.

The source of the Isom tuffs, another voluminous sheet in Utah and Nevada, has not been clearly defined but probably does not lie far southeast of the map area because large, intensely flattened and ptygmatically folded pumice blocks are found around White Rock Peak.

Beginning in the early Miocene about 24 m.y. ago, the character of volcanism changed from catastrophic eruptions of enormous volumes of dacite and rhyolite ash with concurrent development of huge calderas, to much smaller eruptions of a bimodal association of rhyolite tuffs and lava flows and trachyandesite lava flows (units Tkt, Tkh, Tka, Tkr) from many local centers without caldera development. Only one of these rhyolite tuffs, the tuff member of Headwaters Spring of the formation of Rosencrans Knolls (unit Tkh), is welded; its source may be a small trap-door structure west of the map area.

Block faulting in late Cenozoic time led to erosion of rock debris off the emerging highlands which was deposited as extensive, poorly sorted alluvial fan deposits in adjacent basins. An older, semi-consolidated and tilted sequence (unit Ts) is exposed along the east margin of the map area. The thick section of highly porous tuff of Ripgut Springs and overlying Isom Formation around White Rock Peak has sloughed into flanking valleys in several landslides. Younger alluvial deposits of several ages (units QToa and Qya) underlie a wide area of the present intermountain basins.

DESCRIPTION OF MAP UNITS

Qya	YOUNGER ALLUVIUM AND STREAM DEPOSITS (QUATERNARY)--Thin, unconsolidated deposits of gravel, sand, and silt probably deposited by Holocene fluvial processes; floodplain accumulations of clay occur locally in Hamlin Valley Wash
QToa	OLDER ALLUVIUM (QUATERNARY TO PLIOCENE)--Unsorted unconsolidated to semi-consolidated deposits of coarse gravel to sand that form coalescing alluvial fans on flanks of mountain ranges and smaller patches of thinner colluvium in ranges. Includes topographically high remnants of alluvial fans that are possibly Pliocene as well as Pleistocene in age. Older fans east and northeast of White Rock Peak contain mostly clasts of the Isom Formation, whereas older fans near head of Wood-McCullough Creek contain clasts of rhyolite lava-flow member of formation of Rosencrans Knolls (unit Tkr). May be several hundred meters thick in Hamlin Valley
QTl	LANDSLIDE DEPOSITS (QUATERNARY TO PLIOCENE)--Hummocky terrain underlain chiefly by Isom Formation although some tuff of Ripgut Springs appears locally; ranges from mappable coherent fault-bounded slabs to chaotic rubble. Extensively covered by soil and vegetation. Age is uncertain but may be as old as Pliocene
Ts	SANDSTONE AND CONGLOMERATE (PLIOCENE OR MIOCENE)--Poorly sorted and stratified, loosely consolidated fluvial and alluvial deposits made of clasts as large as boulder size of rocks of the Isom Formation and older units. Exposed only east of Hamlin Valley where a tilted sequence of beds may be as much as 1,300 m thick
	FORMATION OF ROSENCRANS KNOLLS (MIOCENE)--Biomodal association of trachyandesite lava flows and rhyolite tuffs and lava flows with potassium-argon ages of 24 to 23 m.y. (Willis, 1985)
Tkr	Rhyolite lava-flow member--Lava flows, domes, and small intrusions of generally flow-layered, gray, pink, or lilac, weakly to strongly porphyritic rhyolite. Phenocrysts are combinations of sanidine (locally iridescent), clear to smoky quartz, plagioclase, and minor biotite. Lithophysae, spherulites, and vapor-phase topaz in vugs are locally conspicuous. Margins of some bodies are vitrophyre. As much as 300 m thick
Tkt	Tuff member--Heterogeneous, generally poorly exposed sequence of rhyolite ash-flow tuff, surge deposits, and water-lain tuff and volcanic debris flows. Tuffs are weakly consolidated, tan, yellow, or gray, and commonly have conspicuous lapilli of white pumice and of dark-colored fragments of older volcanic rock units and of rhyolite flow rock; phenocrysts of quartz, sanidine, plagioclase, and biotite make up less than 10 percent of the tuffs. Debris flows contain angular clasts as much as 0.5 m across of older rock units and of rhyolite flow rock in a sandy, tuffaceous matrix. As much as 120 m thickness exposed in map area
Tka	Trachyandesite lava-flow member--Sequence of gray, black or red-brown vesicular lava flows that range from aphyric to strongly porphyritic. Some flows contain as much as 15 percent phenocrysts of zoned, corroded plagioclase as much as 4 cm long and lesser olivine, augite, and hypersthene that are 1-2 mm in diameter. Aphanitic matrix consists of plagioclase, pyroxene, and iron-titanium oxides. Flows are chemically uniform (2.3 weight percent K_2O, 4.2 percent Na_2O, 50-52 percent SiO_2). Thickness about 80 m
Tkh	Tuff member of Headwaters Spring--Moderately welded, compound cooling unit of gray, tan, brown, orange, or purple high-silica rhyolite ash-flow tuff. Phenocrysts make up 25-30 percent of the tuff and include smoky bipyramidal quartz, slightly iridescent sanidine, plagioclase, and minor biotite. Lapilli of pumice are inconspicuous; lapilli of dark-colored volcanic rock diminish upwards in the unit. Generally forms a prominent cliff. Potassium-argon age on sanidine is 23.9±0.9 m.y. (Willis, 1985). Thickness as much as 150 m
	CONDOR CANYON FORMATION (MIOCENE)
Tcb	Bauers Tuff Member--Densely welded gray, orange, or red lapilli ash-flow tuff containing less than 15 percent small (less than 1 mm) phenocrysts of plagioclase, sanidine, and biotite. Exposed in only three places along west side of map area. A few meters thick. Average potassium-argon age is 22.3 m.y. (Fleck and others, 1975; age adjusted for new decay constants)
	ISOM FORMATION (OLIGOCENE)
Tit	Tuff member--As many as three cooling units of densely welded lapilli ash-flow tuff that are gray, red, orange, brown, or purple where devitrified and black where a basal vitrophyre. Plagioclase phenocrysts make up about 5 percent of lowest cooling unit and about 10 percent of upper unit; augite, hypersthene, and magnetite phenocrysts make up only a few percent of the tuffs. Around White Rock Peak compacted pumice blocks are as much as 40 cm long and are locally ptygmatically folded owing to secondary flowage after deposition. Unit typically forms ledges or cliffs and weathers to coarse grus. Unit is not everywhere present; ranges upward in thickness to 10 to 20 m north of topographic rim of Wilson caldera and to more than 150 m inside it. One kilometer south of Delmue Ranch in southwestern corner of map area unit includes a thin lava flow (Tif). Average potassium-argon age of unit is 26.0 m.y. (Fleck and others, 1975; age adjusted for new decay constants)
Tif	Lava flow member--Porphyritic, gray, black, or brown lava flows containing less than 15 percent phenocrysts of plagioclase, augite, hypersthene, magnetite, and, locally, hornblende. Thickness as much as 100 m
Tg	TUFF OF RIPGUT SPRINGS (OLIGOCENE)--As many as three cooling units of crystal-poor, pumice-rich, rhyolite ash-flow tuff that range from densely welded, speckled black-brown vitrophyre at base to a porous, weakly consolidated lapilli-ash at top. Pumice clasts locally make up as much as a third of rock, are mostly of lapilli size, and are commonly varicolored black, gray, white, orange, and brown on a hand-sample scale. Phenocrysts less than 1 mm in diameter of plagioclase and biotite make up 5 percent of the rock. Locally, tuff contains clasts of Lund tuff as much as 10 cm in diameter. Base of unit in eastern half of sec. 36 in southwest corner of map area includes several meters of sandstone and conglomerate with clasts of older volcanic rock units. Unit pinches out northward against the topographic wall of the Wilson caldera but thickens southward in map area to 600 m
	LUND FORMATION (OLIGOCENE)
Tlf	Intrusive-lava vent member--Three bodies along southern margin of map area that are a flow-layered vitrophyre east of White Rock Peak, a slightly altered intrusive(?) porphyry southwest of the peak, and a vent complex in sec. 36 in southwest corner of map area. Wall rocks surrounding bodies are concealed beneath alluvium so age relations are unknown. However, phenocrystic composition of two western bodies is the same as tuff member of Lund Formation (Tlt). Eastern body has no quartz and more hornblende than biotite so resembles Wah Wah Springs magma composition, but presence of trace amount of sphene makes possible correlation with Lund magma. Western body has bedded surge(?) deposits at base grading upward into a tuff containing clasts as much as 1 m in diameter of Lund-composition vitrophyre and smaller clasts of granodiorite and feldspar-quartz-biotite-hornblende gneiss; massive Lund-composition vitrophyre caps the complex
Tlt	Tuff member--Dacite lapilli ash-flow tuff that is essentially a single cooling unit in map area but southward into its source caldera becomes a compound cooling unit. Ranges from a speckled gray-brown, densely welded vitrophyre at the base to a devitrified red-brown, densely welded tuff in middle to a porous gray tuff at top. Lapilli-size xenoliths of volcanic rock are rare; white pumice lapilli are typical. Phenocrysts make up about 40 percent of rock and include (in decreasing order of abundance) plagioclase, quartz, biotite, hornblende, pyroxene, and a trace of sphene. Unit pinches out locally over the resurgent dome of Indian Peak caldera but thickens to as much as 600 m in its moat north of The Hermitage and to over a kilometer just south of map area within Wilson caldera which was its source. Average potassium-argon age is 27.9 m.y. (Best and Grant, in press)
	RYAN SPRING FORMATION (OLIGOCENE)
Trm	Mackleprang Tuff Member--Densely welded, low-silica rhyolite lapilli ash-flow tuff that is mottled brown, orange, dark red, and purple. Dark-colored volcanic lapilli make up 5-10 percent of rock, phenocrysts of white plagioclase and lesser biotite 10-15 percent, and flattened, generally orange pumice lapilli about 10 percent. Generally forms a ledge. As much as 60 m thick
Trg	Greens Canyon Tuff Member--Crystal-poor, lithic, low-silica rhyolite, lapilli ash-flow tuff. Generally pale hues of gray, orange, red, or purple; white or yellow haloes surrounding weathered out, pea-sized inclusions are typical. Phenocrysts of plagioclase and biotite less than 2 mm in diameter make up less than 10 percent of rock. Densely welded basal zones form prominent ledges and have flattened orange and black pumice lapilli and locally abundant lapilli and small blocks of red tuff from Wah Wah Springs Formation. Above these basal vitrophyric zones, tuff is massive and forms slopes. Sequences of thinly bedded, tan to pale-yellow or green sandstone at mouth of Miller Canyon and on southeast side of Gleason Basin are included in unit. Similar sandstone overlies Greens Canyon tuff southwest of map area. At the head of Cobb Creek, in what is probably a fault-bounded basin on northern flank of resurgent uplift of Indian Peak caldera, five cooling units of tuff can be recognized; if faulting has not repeated section, thickness is about 1,400 m. Around The Hermitage thickness is about 600 m
	WAH WAH SPRINGS FORMATION (OLIGOCENE)
Twi	Intracaldera member--A compound cooling unit of crystal-rich, lithic, dacite lapilli ash-flow tuff. Color generally shades of gray, orange, brown, and red but is white where locally hydrothermally altered in southwest part of map area. Contains as much as 10 percent lapilli and small blocks of a variety of sedimentary and volcanic rocks. Phenocrysts make up about 40 percent of rock and include, in decreasing order of abundance, plagioclase, hornblende, biotite, and lesser quartz and augite. Although tuff is typically densely welded, pumice lapilli are not everywhere conspicuously flattened. Thickness cannot be determined accurately because of faulting but is as much as 1 km
Two	Outflow tuff member--A simple cooling unit similar in composition to intracaldera member but contains only about half (i.e., 1-2 percent) as many quartz phenocrysts and no lithic fragments. Typically red brown with a black vitrophyre at base. Average potassium-argon age is 29.5 m.y. (Best and Grant, in press). About 600 m thick
Tc	COTTONWOOD WASH TUFF (OLIGOCENE)--A simple cooling unit of crystal-rich dacite lapilli ash-flow tuff. Generally red brown but locally has a speckled gray vitrophyre at base. About 40 percent phenocrysts of plagioclase, biotite (books as much as 8 mm in diameter), quartz (angular fragments as much as 5 mm and commonly stained red by hematite), hornblende (but inconspicuous in hand sample) and a trace of augite. About 200 m thick. Average potassium-argon age is 30.6 m.y. (Best and Grant, in press)
	ESCALANTE DESERT FORMATION (OLIGOCENE)
Tel	Lamerdorf Tuff Member--As many as three cooling units of crystal-poor, lithic, low-silica rhyolite lapilli ash-flow tuff. Mostly devitrified and pink, tan, orange, lilac, or white. A green vitrophyre occurs locally at base of cooling units. Phenocrysts less than 2 mm in diameter make up 10-15 percent of rock and include plagioclase and lesser biotite and hornblende. Less than 10 percent lapilli of dark-colored aphyric volcanic rock. In northwest quarter of sec. 30, R. 19 W., T. 27 S., the lower part of unit is tan, densely welded tuff, lacking lapilli, and contains small phenocrysts less than 1 mm across of plagioclase, quartz, biotite, and hornblende that together make up about one-third of rock; is probably the tuff of Sulphur Spring of Campbell (1978). Potassium-argon age on biotite from Lamerdorf Tuff on east flank of Wah Wah Mountains 45 km east of map area is 32.3±1.1 m.y. As much as 100 m thick
Tea	Andesite flow member--Poorly exposed, dark-brown lava flow containing sparse phenocrysts of plagioclase, pyroxene, and, locally, biotite. Found only along the Utah-Nevada State Line just south of Miller Mountain and near Rosencrans Knolls. Biotite phenocrysts in lava flows from west side of Limestone Hills immediately west of map area have a potassium-argon age of 31.8±1.2 m.y. (Best and Grant, in press)
Dg	GUILMETTE FORMATION (UPPER AND MIDDLE DEVONIAN)--Interbedded white to tan quartzite, light- to dark-gray to chocolate-gray dolomite, and minor gray limestone. Carbonate rocks are sugary to micritic and locally laminated. Crops out as alternating ledges and slopes. *Amphipora* are locally abundant. Only a few tens of meters exposed along margin of map area east of Miller Mountain; an incomplete section of about 400 m is exposed in the adjacent Lopers Spring map area to the east (Best, 1976)
Dsi	SIMONSON DOLOMITE (MIDDLE DEVONIAN)--Medium- to dark-chocolate-gray, medium- to thick-bedded, locally laminated, fine- to coarse-grained dolomite locally containing a few beds of light-gray dolomite. Fossils are generally sparse but many so-called "spaghetti beds" contain masses of *Amphipora*. Complete sections in Limestone Hills immediately north of map area are about 300 m thick
Dse	SEVY DOLOMITE (LOWER DEVONIAN)--Homogeneous, generally unfossiliferous, microcrystalline dolomite (Tschanz and Pampeyan, 1970). Weathers chalky white but is tan, gray, or pinkish gray on fresh surfaces. Medium bedded to massive and forms steplike slopes. Upper several tens of meters of unit are sandy and include pinkish-brown beds of orthoquartzite as much as 2 m thick. Unit is 200 m thick
Sl	LAKETOWN DOLOMITE (UPPER AND MIDDLE SILURIAN)--Light- and dark-gray, medium- to coarse-grained, medium- to thick-bedded crystalline dolomite. Generally darker gray dolomites lie above lighter gray. Locally fossiliferous and cherty. 200 m thick
Oes	ELY SPRINGS DOLOMITE (UPPER AND MIDDLE(?) ORDOVICIAN)--Medium-gray to black, medium- to coarse-grained, medium-bedded, cherty dolomite. Light-gray beds are locally present. About 100 m thick
Oe	EUREKA QUARTZITE (MIDDLE ORDOVICIAN)--White, tan, or light-gray, fine- to medium-grained thick-bedded orthoquartzite. Only upper 40 m is exposed in map area but is about 150 m thick in nearby areas (Tschanz and Pampeyan, 1970)
Pzu	PALEOZOIC ROCKS, UNDIVIDED--Small exposures west of Rosencrans Knolls along the topographic rim of the Indian Peak caldera are gray, highly silicified, locally brecciated, and probably Laketown or Sevy Dolomites

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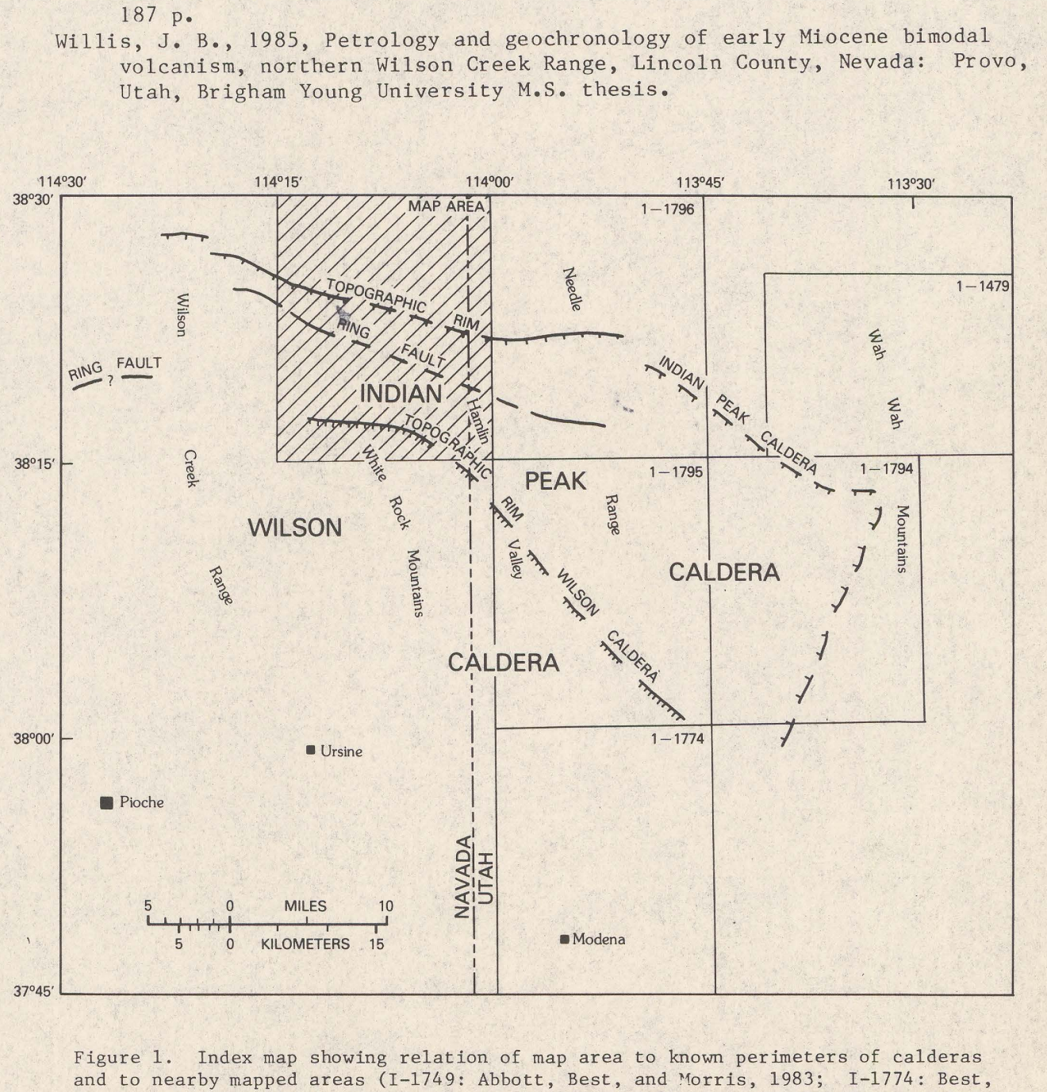

Figure 1. Index map showing relation of map area to known perimeters of calderas and to nearby mapped areas (I-1749: Abbott, Best, and Morris, 1983; I-1774: Best, in press; I-1794: Best, Morris, Kopf, and Keith, in press; I-1795: Best, Grant, and others, in press; I-1796: Best, Hintze, and Holmes, in press)