PROVISIONAL GEOLOGIC MAP OF THE TINTIC MOUNTAIN QUADRANGLE, JUAB AND UTAH COUNTIES, UTAH

by

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INTRODUCTION

Location, Methods, and Prior Work

The Tintic Mountain quadrangle is located in central Utah about 6 miles (10 km) south of Eureka near the central part of the East Tintic Mountains. The quadrangle is on the east margin of the Basin and Range Physiographic Province.

Because the quadrangle is partly within the East Tintic mining district, numerous geologic studies have been done on the area. Morris and Lovering (1979) prepared the most comprehensive report on the district; other examples are listed in the references in this open-file report. U.S. Geological Survey geologist H.T. Morris (1975) previously mapped the geology of the Tintic Mountain quadrangle. Subsequent mapping occurred in the west (Hannah and MacBeth, 1990) and northeast (Keith and others, 1989, 1991) parts of the quadrangle. This map focuses on the Tertiary volcanic rocks, and relies on geochemical, geochronologic, and stratigraphic data from Moore's M.S. thesis (1993) supervised by J.D. Keith. The stratigraphy of the Tintic Mountain Volcanic Group has been revised from that of Morris and Lovering (1979) with a mix of formal and informal rock unit names. The quadrangle was remapped in an effort to update and build upon the prior mapping and geologic studies of H.T. Morris.

This open-file report is based primarily on mapping completed in 1991-1993; parts of the quadrangle were mapped by coauthors Hannah, Cannan and MacBeth (1991-1992), Keith and Moore (1991-1992), Moore (1991-1992), and Tingey (1993), as depicted on the index to areas of responsibility for geologic mapping (figure 1). Age determinations were conducted by S.T. Nelson. The map was compiled by T. Pulsifer under the direction of J.D. Keith and D.G. Tingey. Moore and others (2007) subsequently discussed petrogenesis of the East Tintic volcanic field based on Moore (1993).

This geologic map focuses on the Tertiary igneous rocks in part of the East Tintic Mountains, and supercedes the reports of Morris (1975), and Hannah and MacBeth (1990). The revised stratigraphy of the Tintic Mountain Volcanic Group in this open-file report was partly shown in Keith and others (1989, 1991) and Hintze (1988, chart 32, p. 149). The surface geology of the Tintic Mountain area is extremely complex and we recognize that some inconsistencies have not been resolved. Notably, the correlation chart is not fully compatible with the mapping and isotopic ages. Some isotopic age data do not match the physical stratigraphy and sample locations and units sampled are uncertain. Also, thicknesses shown on cross sections do not match those on nearby maps. A structural or stratigraphic explanation is needed to explain why map unit Trp is exposed on both sides of the range. Age ranges for Trp and some other map units may be longer than shown in the correlation chart. Not all units are named on the basis of their geochemistry. Geochemical and geochronologic research are ongoing.

Inferred Calderas and Geologic History

The Tintic Mountain quadrangle is characterized by exposures of Eocene and Oligocene volcanic, sedimentary, and intrusive rocks that lie unconformably upon faulted lower Paleozoic sedimentary rocks

(Cambrian to Devonian?). Volcanic eruptions produced three nested calderas that are incompletely delimited, but likely extend into the adjacent Eureka, Furner Ridge, and McIntyre quadrangles. Eruption of the Fernow Quartz Latite (map symbol Tf) created the oldest of the three calderas (Fernow caldera), and severely altered the Herkimer Limestone (Ch) and Fish Haven Dolomite (Ofh) near the caldera wall in the southwest part of the map area. The caldera is dated at 34.71 ± 0.19 Ma or older, based on the presumed correlation with the Packard Quartz Latite by Moore (1993).

Subsequent eruption of the lava flows of Rattlesnake Peak (Trp) created a second caldera (Rattlesnake Peak caldera), destroying the northern extent of the Fernow caldera. Collapse of the caldera walls following eruption resulted in the entrainment of large blocks of Paleozoic rocks, most notably the Tintic Quartzite (Ct), within the lava flows. This caldera location is crudely comparable to the Tintic caldera proposed by Morris (1975) and mostly encompasses unit Trp.

Eruption of the tuff member of the Copperopolis Latite (Tct) created a third caldera (Copperopolis Latite caldera) approximately 7 miles (11 km) in diameter. Its location is based on: (1) the sub-circular distribution of several intrusive units, including the Silver City stock (Tsc) and a breccia pipe (Tbp), present exclusively within the proposed caldera; (2) the arcuate contact of the tuff member of the Copperopolis Latite (Tct) with the lava flows of Rattlesnake Peak (Trp); (3) the observation that tuff member thickness within the proposed caldera is ~425 feet (~130 m) thicker than the tuff outside the caldera (Hannah and others, 1991; Moore, 1993); (4) the presence of lacustrine strata (Tsu, Tsl) within the caldera.

The Copperopolis Latite caldera was later intruded by the Sunrise Peak Monzonite Porphyry (Tsp). Lacustrine shale clasts (Tsl) ripped up during the intrusion and related lava flows are visible in the agglomerates of Sunrise Peak (Tspf) (Lindgren and Laughlin, 1919; Keith and others, 1991). Overlying volcanoclastic sedimentary strata (Tse) record deposition in a terrain of high relief (Keith and others, 1991).

Several volcanic units and intrusions postdate the lacustrine and sedimentary units. Lava flows of the shoshonite of Buckhorn Mountain (Tbm) filled and overflowed the Copperopolis Latite caldera. The latite of Dry Herd Canyon (Tdh), latite of Little Dog Canyon (Tld), and the Latite Ridge Latite (Tlr) overlie these shoshonite lava flows in the center of the quadrangle. Volcaniclastic strata (Ts) are preserved only where overlain by the Latite Ridge Latite (Tlr) (Moore, 1993). Failure of the volcaniclastic strata (Ts) led to Quaternary-age landslides involving the Latite Ridge Latite (Tlr) in the southwest and south-central portions of the quadrangle. The latite of Rock Canyon (Trc) has $^{40}Ar/^{39}Ar$ ages of 33.72 $\pm$ 0.08 and 33.87 $\pm$ 0.13 Ma (Moore, 1993) and overlies the latite of Little Dog Canyon (Tld).

Several intrusive rock units occur in the quadrangle. A dike swarm at Paul Bunyans Woodpile (Tli) is one of the outstanding geologic features within the Tintic Mountain quadrangle. These biotite latite intrusions (Tli), here correlated with the latite of Dry Herd Canyon (Tdh) lava flows, occur exclusively within the proposed Copperopolis Latite caldera, as does the Silver City stock (Tsc). The intrusions of Keystone Springs (Tks), which ended at 34.03 ± 0.1 Ma (Moore, 1993), are recognized within the southern portion of the Copperopolis Latite caldera, as well as within the Rattlesnake Peak caldera. The monzonite porphyry of Silver City (Tsc), dated at 32.7 $\pm$ 0.2 Ma, is the largest intrusive body in the East Tintic Mountains and is associated with mineralization (Keith and others, 1991; Moore, 1993).

Tertiary alluvium (Ta) shed from the East Tintic Mountains contains Tertiary volcanic and Paleozoic sedimentary rock material and postdate volcanism. The Goshen fault (Jensen, 1984), which extends into the southeastern part of the quadrangle, has displaced the Tertiary alluvium, as well as the previously faulted Paleozoic units and Tertiary volcanic rocks.

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MAP UNIT DESCRIPTIONS

QUATERNARY SURFICIAL DEPOSITS

Qay **Younger alluvium** (Holocene) – Poorly consolidated deposits of stream alluvium incised into older alluvial deposits; mapped along most primary stream drainages, and also includes small areas of fan alluvium and colluvium; exposed thickness as much as 5 feet (2 m), total thickness unknown.

Qao **Older alluvium** (Holocene to Pleistocene) – Poorly consolidated deposits of stream alluvium and fan alluvium typically present above younger stream deposits; includes small areas of older stream alluvium and colluvium; mapped in Furner Valley, Little Dog Valley, Maple and Jims Springs area, Government Canyon area, and Tintic Valley; exposed thickness as much as 10 feet (3 m), total thickness unknown.

Qaf **Alluvial-fan deposits, undivided** (Holocene to Pleistocene) – Poorly consolidated deposits of coalescing fan alluvium in Goshen Valley; includes unmapped colluvium along valley margins; locally incised by younger alluvium of active streams; exposed thickness as much as 10 feet (3 m), total thickness unknown.

Qms **Landslide and slump deposits** (Holocene to Pleistocene) – Landslides and slumps developed on “weak” volcanic rock units; mapped near Kessler Spring, Riley Springs, Little Valley, and Jumpoff Spring areas; total thickness variable and unknown.

Unconformity

TERTIARY SEDIMENTARY AND VOLCANIC ROCKS

Ta **Tertiary alluvium** (Oligocene?) – High-level alluvial fans that are dissected and eroded; contains clay to gravel from Eocene-Oligocene volcanic rocks and Paleozoic units; age(s) uncertain but postdates volcanism; thickness is 0 to 250 feet (0-80 m).

Unconformity?

Trc **Latite of Rock Canyon** (Oligocene) – Black, gray to reddish brown latitic lava flows and vitrophyres with conspicuous phenocrysts of biotite and plagioclase in hand sample; clinopyroxene, titanomagnetite, and apatite are always apparent in thin section; orthopyroxene, amphibole, sanidine, and magmatic sulfide blebs present in some samples; informally named for exposures in the Eureka quadrangle; thickness is 0 to 1500 feet (0-460 m).

Tlr **Latite Ridge Latite** (Eocene) – White to reddish brown, trachytic, ash-flow tuff; the tuff is densely welded, eutaxitic, locally perlitic, and crystal poor; contains phenocrysts of plagioclase, biotite, and clinopyroxene; aphanitic-porphyritic, lapilli-sized lithic fragments and vitrophyric clasts of andesitic lava are also present; named by Morris and Lovering (1979) for exposures in the Eureka quadrangle; thickness is 0 to 500 feet (0-150 m).

Ts **Volcaniclastic strata** (Eocene) – Interbedded volcanic sandstone and conglomerate; strata are heterolithic, poorly sorted and stratified, and consist of angular, pebble- and cobble-size fragments of dark lava in a matrix of gray, biotite-bearing, volcanoclastic silt; clasts are much larger and more abundant in conglomerates; cross-stratification is common in the sandstones; thickness is 0 to 500 feet (0-150 m).

Tld **Latite of Little Dog Canyon** (Eocene) – Black, blue-gray, and gray-green, flaggy, porphyritic-aphanitic, felty, latitic lava flows; weathered surfaces are brown and subangular to smooth; forms a few poorly exposed outcrops; informally named for exposures in the Tintic Mountain quadrangle; thickness is 0 to 250 feet (0-80 m).

Tdh **Latite of Dry Herd Canyon** (Eocene) – Black, brown-black, and green vitrophyric and porphyritic-aphanitic lava flows; the flows are dense to scoriaceous, locally amygdaloidal, and contain phenocrysts of plagioclase, clinopyroxene, Fe-Ti oxides, and orthopyroxene; poorly exposed unit; commonly only cobble-size float is present; informally named for exposures in the Eureka quadrangle; thickness is 0 to 350 feet (0-110 m).

Tblu **Upper biotite latite flows** (Eocene) – Black to gray lava flows and vitrophyres with prominent biotite and plagioclase phenocrysts in hand sample; clinopyroxene, orthopyroxene, titanomagnetite, apatite, and magmatic sulfide blebs are also present, but are not obvious in hand sample; distinguished in the field from other biotite-latite flow units only on the basis of stratigraphic position; stratigraphically above the mafic flow sequence (unit Tbm); thickness is 0 to 350 feet (0-110 m).

Tbm **Shoshonite of Buckhorn Mountain** (Eocene) – Dark to variably colored lava flows, breccias, and agglomerates with little or no biotite apparent in hand sample; these flows and breccias are commonly vesicular and mildly altered; clinopyroxene, plagioclase, orthopyroxene, titanomagnetite, apatite, traces of magmatic sulfides, and a few strongly resorbed and oxidized relict biotite crystals can also be found in thin section; informally named for exposures in the Tintic Mountain quadrangle; thickness is 0 to 500 feet (0-150 m).

Tblf **Lower biotite latite flows** (Eocene) – Light gray to red brown lava flows with conspicuous biotite and plagioclase phenocrysts in hand sample; clinopyroxene, titanomagnetite, apatite, and traces of amphibole and magmatic sulfide blebs can also be found in thin section; separated from other biotite lava flow units during mapping based on stratigraphic position beneath the shoshonite of Buckhorn Mountain; thickness is 0 to 200 feet (0-60 m).

Tse **Epiclastic strata** (Eocene) – Poorly stratified volcaniclastic sedimentary rocks, including conglomerate, near Government Canyon; original composition often obscured by intense alteration; rarely, angular clasts of Tintic Quartzite or lower Paleozoic carbonate units are present; thickness is 0 to 150 feet (0-50 m).

Tsu **Upper lacustrine strata** (Eocene) – Alternating beds of white limestone and dark-gray organic-rich shale containing abundant plant remains; generally, very poorly exposed; small pebble- and cobble-size fragments in float are typically the only clue to its presence; this unit represents deposits in a lake that formed in the Copperopolis Latite caldera; thickness is about 50 feet (15 m).

Tspf **Flows and agglomerates of Sunrise Peak** (Eocene) – Light-green to light-brown, slabby-weathering, latitic lava flows in which plagioclase phenocrysts are conspicuous in hand sample; other phenocrysts include biotite, clinopyroxene, titanomagnetite, and apatite; field relationships and composition suggest that the lava flows vented from the Sunrise Peak stock (and associated dikes); the agglomerate occupies the same stratigraphic position and contains the same phenocrysts except that biotite crystals are larger in size and more abundant in both fresh and altered outcrops; informally named for exposures in the Tintic Mountain quadrangle; thickness is 0 to 600 feet (0-180 m).

Tsl **Lower lacustrine strata** (Eocene) – Light-colored, fissile shale, with lesser amounts of mudstone and volcaniclastic sandstone; strata include ovoidal structures replaced by pyrite that may represent gastropods; unit weathers easily and, therefore, is poorly exposed; thickness is 0 to 350 feet (0-110 m).

Tct **Tuff member of Copperopolis Latite** (Eocene) – Thin- to very thick-bedded, vitrophyric, lithic, phenocryst-poor, ash-flow tuff and minor autobrecciated tuff; rare, unaltered tuff is moderately welded and eutaxitic; brecciated tuff consists of angular tuff blocks in a matrix of the same tuff; unit includes lapilli- and block-sized (up to 20 inches [50 cm] long) xenoliths that are commonly andesitic rocks (appear to be lava flows of Rattlesnake Peak); other included clasts are lower Paleozoic quartzite, limestone, and shale; named by Morris and Lovering (1979) for exposures near Copperopolis Canyon; thickness is 0 to 500 feet (0-150 m).

Tpf **Plagioclase-rich lava flows** (Eocene) – Massive and locally autobrecciated gray-green flows and overlying heterolithic breccia; phenocrysts include plagioclase and pyroxene in a non-lustrous, and aphanitic to microcrystalline groundmass; heterolithic breccia contains volcanic clasts, many from underlying flows, supported by a granular matrix; thickness is 0 to 400 feet (0-120 m).

Trp **Lava flows of Rattlesnake Peak** (Eocene) – Blue-gray and green, generally massive and glomerophyric, latitic and andesitic lava flows and minor flow breccia; rocks in unit are vitrophyric and contain phenocrysts of plagioclase, clinopyroxene, orthopyroxene, Fe-Ti oxides, and biotite; iron-staining of plagioclase phenocrysts and of matrix along fractures is ubiquitous; flow-breccia clasts are cobble- to boulder-size, and the matrix is heavily altered; informally named for exposures in the Tintic Mountain quadrangle; thickness is 0 to 1000 feet (0-300 m).

Tf **Fernow Quartz Latite** (Eocene) – Blue-gray and white (when altered), very thick-bedded, rhyolitic, ash-flow tuff; unit is densely welded, eutaxitic, weakly spherulitic, and crystal rich; contains abundant (~ 48%), generally fragmented, phenocrysts of plagioclase, quartz, sanidine, biotite, and Fe-Ti oxides; locally, the tuff contains dark, glassy fiamme up to one foot (0.3 m) long and three inches (1 cm) thick; some fiamme are crystal rich while others are nearly aphyric; lapilli- and block-size, lithic fragments are present and are commonly andesitic in composition, implying a still older andesitic volcanic unit is present in the East Tintic Mountains; originally named the Fernow rhyolite by Tower and Smith (1899) and later the Fernow Quartz Latite by Morris (1957) for exposures near Furner Canyon (Fernow Canyon or Ferner Canyon on some maps) in the Tintic Mountain quadrangle; thickness is 0 to 1500 feet (0-460 m).

Intrusive contacts

TERTIARY INTRUSIVE ROCKS

Tbp **Breccia pipe** (Oligocene to Eocene) – Roughly 1 mile (2 km)-long, northwest-trending intrusion near Copperopolis Canyon; contains large blocks of quartzite up to 300 feet (100 m) long, and smaller blocks of carbonate and volcanic rocks; matrix is white, quartz-bearing, argillically altered igneous rock; cuts map units Tct and Trp, but youngest possible age uncertain; thickness is variable.

Tsc **Monzonite porphyry of Silver City** (Oligocene to Eocene) – Phenocryst-rich, amphibole-bearing monzonite porphyry with a seriate texture; some variations in size, abundance, and relative proportions of phenocrysts are typically present within the same dike or plug; quartz and amphibole are present in the more phenocryst-rich lithologies; clinopyroxene, biotite, plagioclase, and magnetite are early-formed crystal phases; orthoclase, apatite, sphene, and zircon are also present; hydrothermal alteration expressed as epidote, chlorite, and minor clay, sericite, and pyrite is almost ubiquitous; referred to as Silver City stock by Morris and Lovering (1979), largely present in the southwestern quadrant of the Eureka quadrangle, and extending into the adjacent Tintic Junction quadrangle; thickness is variable.

Tks **Intrusions of Keystone Springs** (Eocene) – Near-surface domes or intrusive plugs of light-colored, rhyolitic, feldspar porphyry; conspicuous large crystals of sanidine and plagioclase with much smaller, minor crystals of biotite, titanomagnetite, amphibole and traces of magmatic pyrrhotite; informally named for exposures in the Tintic Mountain quadrangle; thickness is variable.

Tli **Biotite latite intrusions** (Eocene) – Dark-colored, vent-facies dikes and plugs, uncommonly exhibiting columnar jointing inward from the walls of the dike; compositionally identical to the biotite latite lava flows (Tblu, Tblf), but correlated with the latite of Dry Herd Canyon (Tdh); comprises spectacular, horizontally oriented, columnar-jointed dikes of Paul Bunyans Woodpile near Riley Canyon in southwest part of the map area; thickness is variable.

Tsp **Sunrise Peak Monzonite Porphyry** (Eocene) – Distinctly porphyritic monzonite with a consistently fine-grained groundmass and fewer phenocrysts than the monzonite porphyry of Silver City; conspicuous phenocrysts include plagioclase, clinopyroxene, biotite, and magnetite; forms stock and smaller intrusions in northwest part of quadrangle; named by Morris and Lovering (1979); thickness is variable.

Unconformity

Descriptions for Paleozoic rock units modified from Morris (1975). Unit thicknesses shown on cross section B-B" estimated from Hintze (1988) and sources cited therein.

DEVONIAN-SILURIAN-ORDOVICIAN SEDIMENTARY ROCKS

DSOb **Bluebell Dolomite** (Devonian, Silurian, and Upper Ordovician) – Dusky-gray coarse-grained dolomite with some beds of sublithographic creamy-white dolomite; includes curly laminated marker beds near middle; Hintze (1988, figure 31, p. 27, and chart 32, p. 149) puts Devonian strata (upper part of Bluebell of Morris and Lovering, 1961) in the Guilmette Formation; thickness of 750 feet (230 m) shown on cross section.

ORDOVICIAN SEDIMENTARY ROCKS

Ofh **Fish Haven Dolomite** (Upper Ordovician) – Dusky-gray, coarse-grained dolomite; includes cherty, mottled beds near base and in upper part; thickness of 500 feet (150 m) shown on cross section.

Unconformity

Oo **Opohonga Limestone** (Lower Ordovician) – Light blue-gray, thin-bedded, argillaceous limestone with many beds of flat-pebble conglomerate, and chert lenses at base; thickness of 1100 feet (340 m) shown on cross section.

CAMBRIAN SEDIMENTARY ROCKS

Caj Ajax Dolomite (Upper Cambrian) – Inferred to be present at depth, and appears on cross section only; thickness of 800 feet (240 m) shown on cross section.

Cop Opex Formation (Upper Cambrian) – Inferred to be present at depth, and appears on cross section only; thickness of 400 feet (120 m) shown on cross section.

Ccc **Cole Canyon Dolomite** (Middle Cambrian) – Dark-gray dolomite with bedded limestone higher in the unit; includes abundant worm burrows; the most widely exposed lower Paleozoic unit in the quadrangle; thickness of 2000 feet (610 m) shown on cross section.

Cb **Bluebird Dolomite** (Middle Cambrian) – Blue-gray, medium-grained limestone; thickness of 350 feet (110 m) shown on cross section.

Ch **Herkimer Limestone** (Middle Cambrian) – Blue-gray, medium-grained, argillaceous limestone; thickness of 450 feet (140 m) shown on cross section.

Cd **Dagmar Dolomite** (Middle Cambrian) – Creamy-white to gray, fine-grained, laminated, dolomitic limestone; thickness of 250 feet (80 m) shown on cross section.

Cte Teutonic Limestone (Middle Cambrian) – Inferred to be present at depth, and appears on cross section only; thickness of 350 feet (110 m) shown on cross section.

Co Ophir Formation (Middle Cambrian) – Inferred to be present at depth, and appears on cross section only; thickness of 400 feet (120 m) shown on cross section.

Ct **Tintic Quartzite** (Lower Cambrian) – Mostly tan-colored, medium- to fine-grained, prominently bedded quartzite with gray-green phyllite beds in upper 500 feet (150 m) and conglomerate zones in lower 1000 feet (300 m); exposed in the quadrangle as large blocks within Tertiary lava flows; it is inferred that these large blocks were included in volcanic units as landslides from caldera walls after voluminous pyroclastic eruption or as blocks rafted in the upper apophyses of intrusions; thickness of 2000+ feet (610+ m) shown on cross section.

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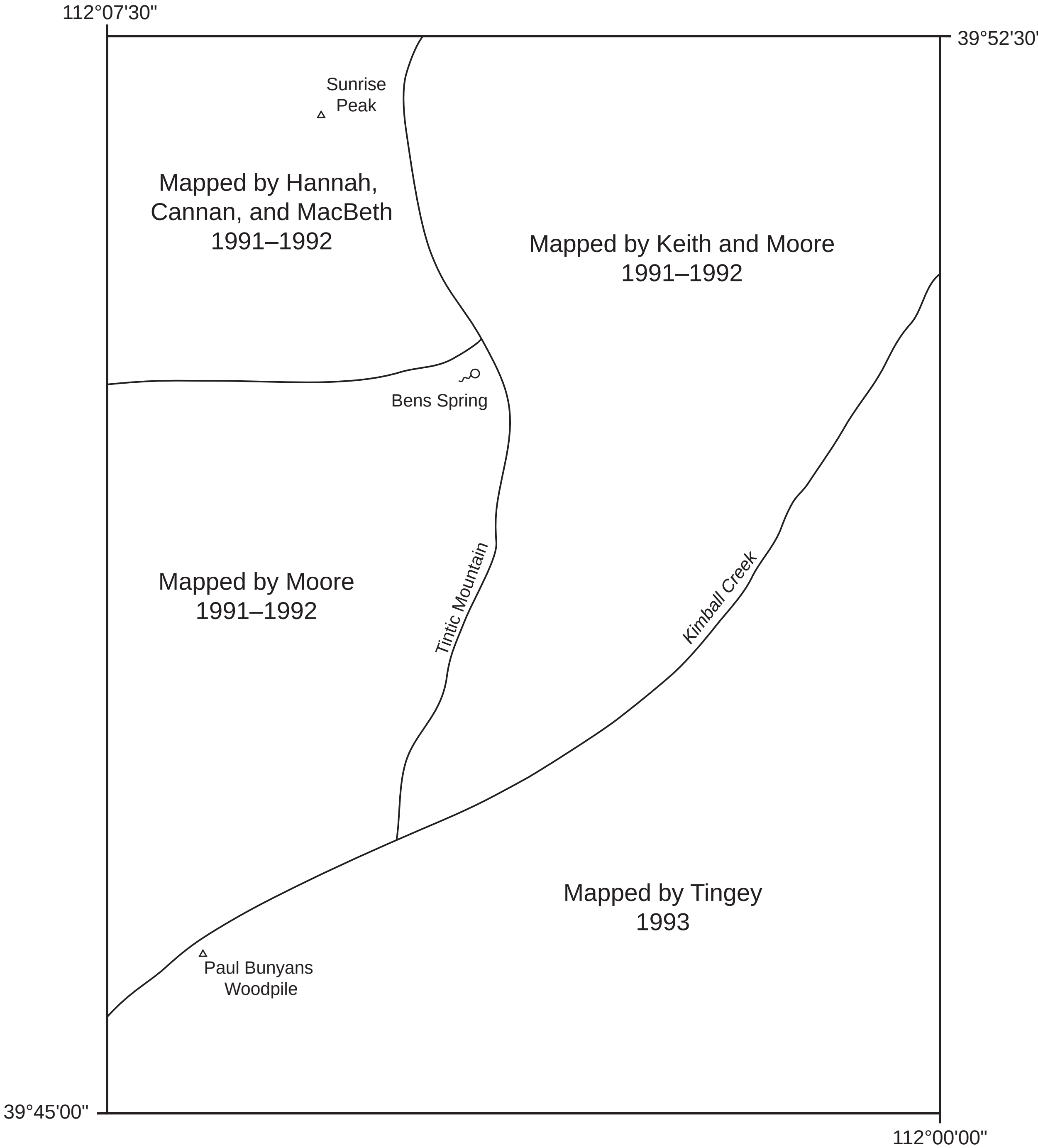
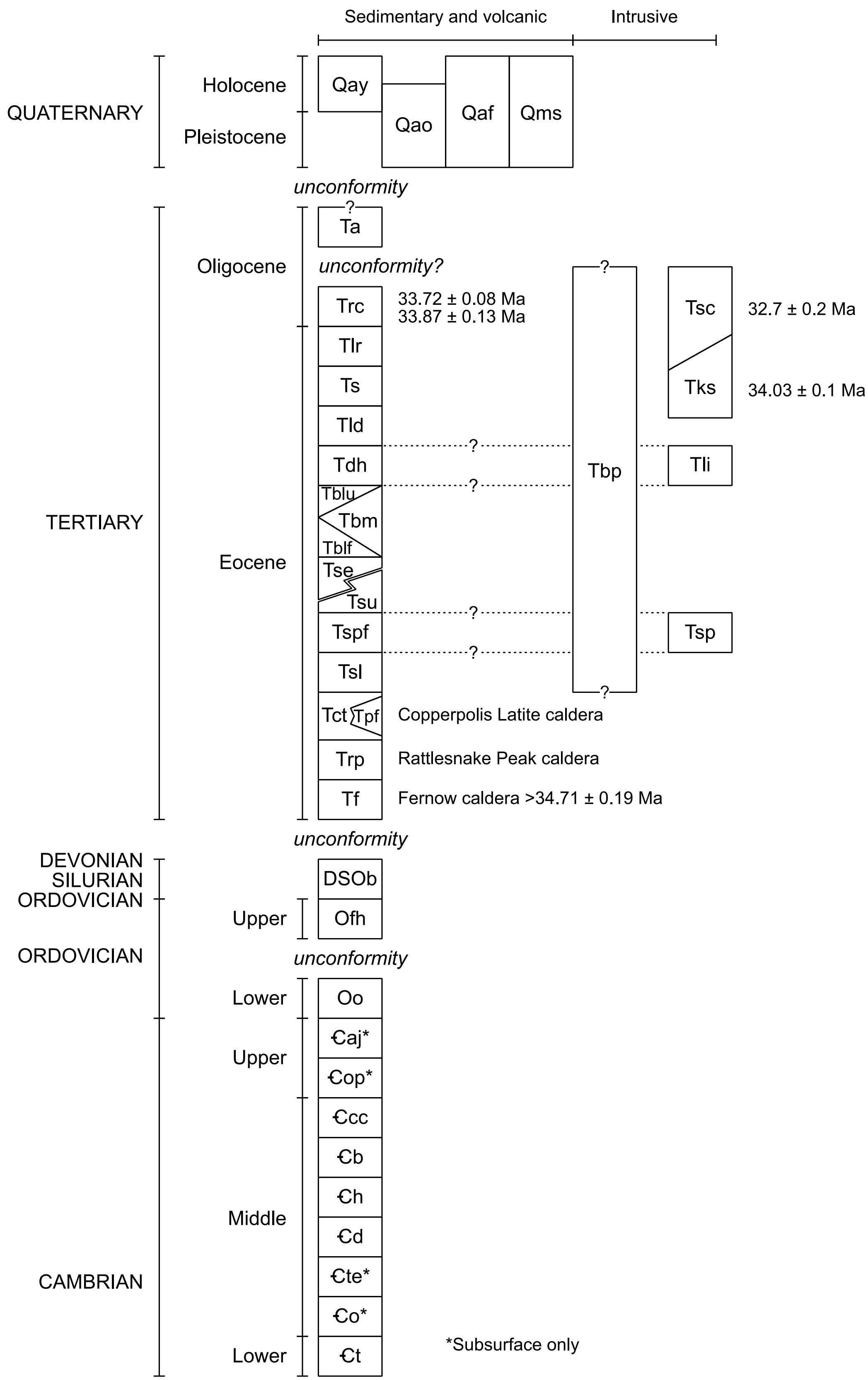


Figure 1. *Index to areas of responsibility for geologic mapping in the Tintic Mountain quadrangle.*

CORRELATION OF MAP UNITS



MAP SYMBOLS

Contact – Dashed where approximately located; queried where uncertain on cross sections

Steeply dipping fault – Dashed where approximately located, dotted where concealed and approximately located; bar and ball on downthrown side; arrows indicate relative displacement on cross sections

Scarp – Associated with landslide deposits

21 Strike and dip of beds in sedimentary rocks

34 Strike and dip of foliation or layering in volcanic rocks

Area of jasperoid alteration

A——A′ Line of cross section