Text and references to accompany Nevada Bureau of Mines and Geology Map 171

Geologic Map of the Northern Pequop Mountains, Elko County, Nevada

by

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INTRODUCTION

The Pequop Mountains form a tilted cross section through the Mesozoic to early Tertiary crust and display a complex network of Mesozoic metamorphic and contractional features and overprinting Cenozoic extensional structures. Precambrian and Paleozoic miogeoclinal strata and Tertiary volcanic and clastic rocks are exposed within the range. Structurally, these rocks form an east-tilted footwall block bounded on the west by a west-dipping normal fault.

During the Mesozoic the Pequop Mountains occupied a position in the hinterland of the Sevier fold and thrust belt and miogeoclinal strata within the range strikingly display the effects of hinterland shortening and metamorphism. Locally, the Pequop Mountains are situated in, and form the eastern margin of, a terrain of miogeoclinal strata that underwent regional Barrovian metamorphism, which peaked during the Late Cretaceous (Camilleri and Chamberlain, 1997). This terrain includes the Wood Hills and East Humboldt Range–Ruby Mountains to the west (fig. 1). The Pequop Mountains form the lowest grade (non-metamorphosed to lower amphibolite facies), structurally shallowest part of the terrain; ranges to the west expose progressively higher grade and structurally deeper rocks (Camilleri and Chamberlain, 1997; fig. 1). In addition to displaying the effects of Mesozoic metamorphism, the Pequop Mountains also provide a rare, superb cross section through two hinterland thrust faults.

This paper focuses on the description and relative ages of structures, whereas more regional tectonic and structural interpretations of the Pequop Mountains have been presented elsewhere (e.g., Camilleri and Chamberlain, 1997; Camilleri and McGrew, 1997; Camilleri, 1998; Camilleri, 2009). The structure within miogeoclinal strata in the Pequop Mountains is geometrically complex. The most salient structures are a low-angle fault called the Pequop fault and two thrust faults called the Independence and unnamed thrusts (fig. 2). The Pequop fault is the most important structure because it divides Paleozoic strata within the range into two plates that have different structural and metamorphic characteristics. An unmetamorphosed Paleozoic section is present in the hanging wall of the Pequop fault (shown shaded in fig. 2), and a predominantly metamorphosed, ductiley deformed section forms the footwall. Despite the foregoing differences, Paleozoic strata in both the hanging wall and footwall are cut by thrust faults: the Independence thrust in the footwall and the unnamed thrust in the hanging wall (fig. 2).

For simplicity, the structure of the Pequop Mountains is described in four parts. The first part describes structure in the footwall of the Pequop fault; the second, structure of the Pequop fault and its hanging wall; the third, high-angle faults; and fourth, range-bounding normal faults.

PREVIOUS WORK AND METHODS

The first detailed geologic study of the Pequop Mountains was by Thorman (1970). He mapped, defined, and correlated Paleozoic stratigraphy and mapped parts of the Independence and unnamed thrusts and the Pequop fault. Thorman (1970) also delineated a sequence of metamorphosed strata that were unique at the time of his work; they were stratigraphically unlike any previously defined Precambrian-Paleozoic stratigraphic units in eastern Nevada and therefore could not be correlated. He suspected that the metamorphosed strata were Paleozoic in age and tentatively suggested they were Ordovician to Devonian (Thorman, 1970, p. 2432). Thorman was correct in that the rocks are Paleozoic in age and are stratigraphically unique to northeastern Nevada. However,

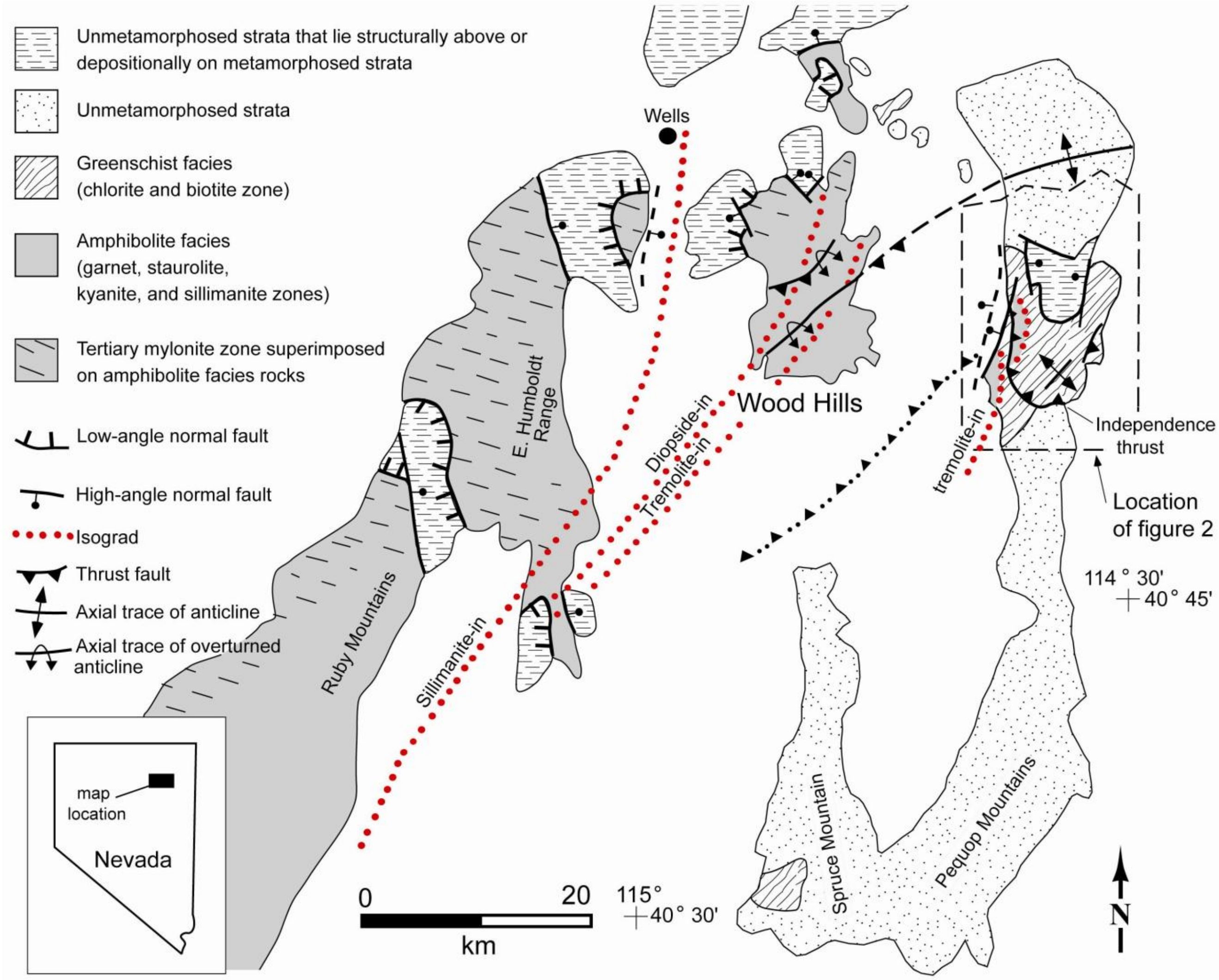

Figure 1. Metamorphic map of the Pequop Mountains and environs. Map is modified after Camilleri and Chamberlain (1997). Diopside- and tremolite-in isograds are for calc-silicate rocks and the sillimanite-in isograd is for metapelite.

the metamorphosed strata are Cambrian-Ordovician in age rather than Ordovician-Devonian; in fact, the metamorphosed sequence constitutes nearly the entire Cambrian section. It was not until a little more than twenty years after Thorman's work that new, unique Cambrian formations in ranges due east of and adjacent to the Pequop Mountains were named and type sections delineated by McCollum and Miller (1991). The work of McCollum and Miller (1991) allowed naming and correlation of mappable metamorphosed units in the Pequop Mountains with undeformed Cambrian units to the east. Consequently, recognition of a new stratigraphy has resulted in a new structural and stratigraphic picture of the Pequop Mountains, which is presented herein.

Mapping of the Pequop Mountains was conducted from 1988 to 1992. U.S. Geological Survey 1:24,000-scale topographic quadrangles served as base maps. Tertiary units and Quaternary surficial units were mapped principally by using 1:24,000-scale color aerial photographs.

STRATIGRAPHY

Rocks in the Pequop Mountains are divisible into three general groups: 1) Proterozoic and Paleozoic strata in the hanging wall and footwall of the Pequop fault, 2) Eocene volcanic rocks and Miocene Humboldt Formation, and 3) Tertiary to Quaternary surficial deposits. The three groups are briefly discussed here; more detailed lithologic descriptions are given in the description of map units.

Rocks in both the hanging wall and footwall of the Pequop fault consist predominantly of carbonate with lesser siliciclastic strata, but they differ with respect to metamorphism and stratigraphy. Strata in the hanging wall range in age from Ordovician to Permian, are unmetamorphosed, and lack ductile deformation. Strata in the footwall are Proterozoic to Permian with Mississippian and older strata being predominantly metamorphosed and ductiley deformed. In addition to the metamorphic contrast across the Pequop fault, there are also a few stratigraphic

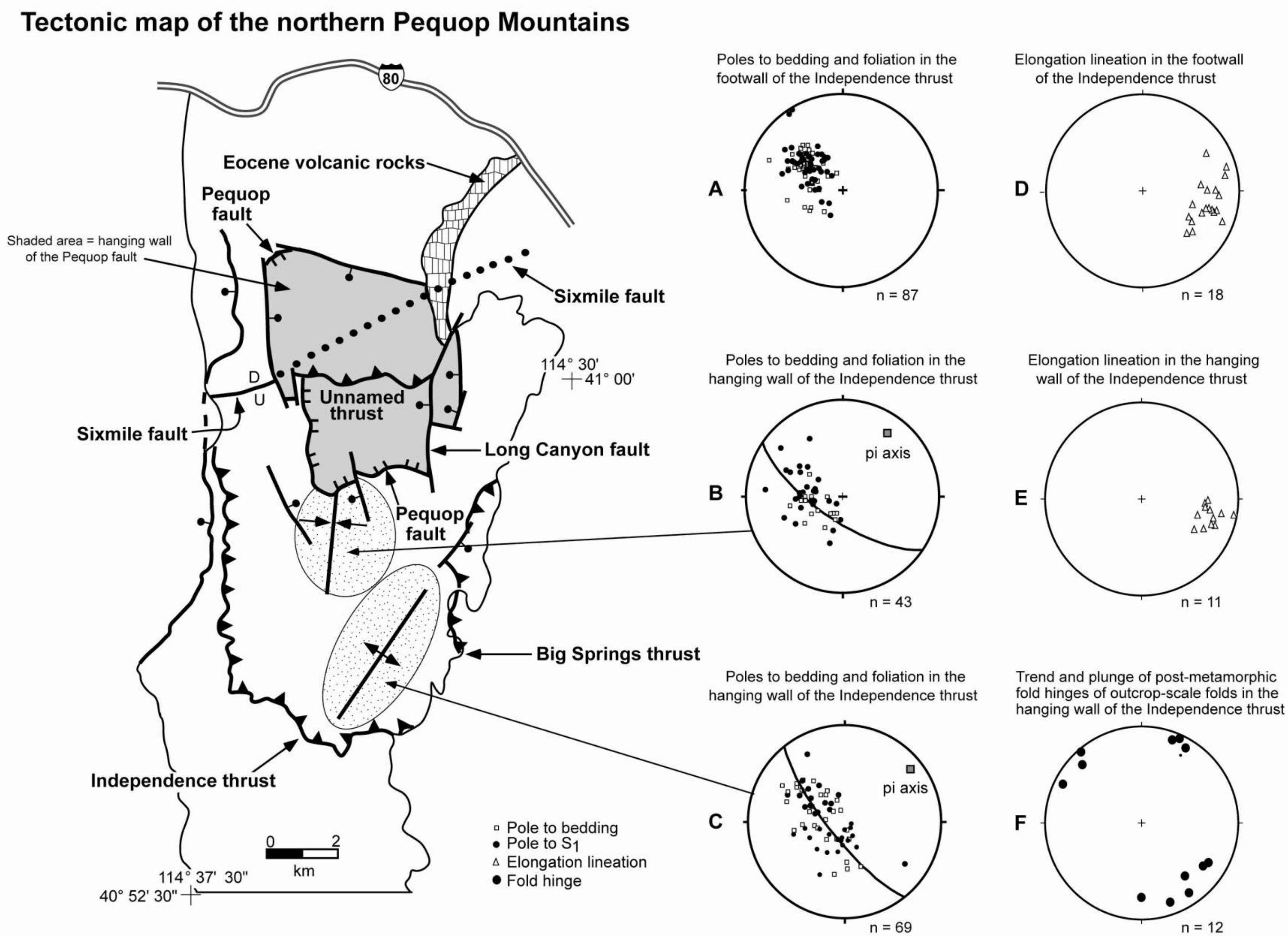

Figure 2. Simplified map of the Pequop Mountains depicting major faults and stereograms of structural and fabric elements. Stereograms B and C are pi diagrams that depict the hinge line of map-scale folds that fold foliation in the hanging wall of the Independence thrust. Attitude data presented in stereograms B and C are derived from the domains represented by the stippled areas. Stereogram F depicts hinge lines of outcrop-scale folds that fold foliation in the hanging wall of the Independence thrust.

differences. The most salient difference is the presence of an eastern dolomitic facies of the Silurian Roberts Mountains Formation in the footwall and the presence of a western platy limestone facies of the Roberts Mountains Formation in the hanging wall (Thorman, 1970; Berry and Boucot, 1970; Sheehan, 1979). Another contrast is the occurrence of sparse, very small Late Jurassic to Cretaceous (?) felsic to intermediate composition intrusions that are restricted to the footwall. The intrusions, although sparse, are mostly in Cambrian strata, but a few cut Ordovician rocks. Intrusions were not found in Silurian and younger rocks.

The two oldest Cenozoic units in the Pequop Mountains are a sequence of Eocene (41–39 Ma; Brooks et al., 1995) volcanic rocks in the northeastern part of the range and the Miocene Humboldt Formation in the hanging wall of a normal fault on the western flank of the range. The Eocene volcanic rocks are rhyolitic to andesitic, and they depositionally overlap Paleozoic strata in the hanging wall and footwall of the Pequop fault. The Humboldt Formation is composed of clastic and volcaniclastic rocks deposited on metamorphosed Cambrian and Ordovician strata belonging to, and offset from, metamorphosed strata in the hanging wall of the Independence thrust. Clasts within the Humboldt Formation appear to be largely derived from Paleozoic strata (Thorman, 1970) in the hanging wall of the Independence thrust. Some of the clasts are quite large, as much as ~ 250 m long, and hence mappable (see map). Mappable clasts are commonly fractured and are predominantly derived from the Ordovician-Cambrian Notch Peak Formation.

Quaternary and Tertiary surficial units mantle Miocene and older rocks within the range. These units include modern alluvium (unit “Qa”), alluvium and sedimentary rocks (i.e., older alluvium) undivided (unit “Qu”) and pluvial deposits and alluvium undivided (unit “Qla"). Pluvial deposits are present on the west and east flanks of the Pequop Mountains. These deposits are depositional remnants of separate lakes that once occupied Independence and Goshute valleys. On the east flank of the range, the contact between units “Qla” and “Qu” is actually the approximate trace of a well-defined shore line representing the high stand of the lake once occupying Goshute Valley. The high-stand shoreline of the lake once occupying Independence Valley was not mapped because of poor definition of shore lines on the west flank of the range.

STRUCTURE OF THE FOOTWALL OF THE PEQUOP FAULT

There are three major structural features in the footwall of the Pequop fault: a prograde metamorphic fabric, the Independence thrust, and the Sixmile fault. The metamorphic fabric is the oldest feature, and it is transected by the Independence thrust. The Sixmile fault (fig. 2) is inferred to be younger than the Independence thrust.

Metamorphism

The Proterozoic-Paleozoic rocks in the footwall of the Pequop fault range from unmetamorphosed to lower amphibolite facies (fig. 3) and metamorphic grade increases with stratigraphic depth. Metamorphism is Barrovian style, but deformation accompanying metamorphism was partitioned such that the rocks range from unstrained to deformed. Consequently, the metamorphic rocks display both regional and static metamorphic fabrics, albeit static fabrics are scarce. The age of metamorphism is bracketed between 154 and 84 Ma (Camilleri and Chamberlain, 1997). The older age bracket represents the age of a premetamorphic dike that is deformed by the metamorphic fabric and the younger age bracket represents a U-Pb metamorphic sphene age from the Toano Limestone that is inferred to represent the time of peak metamorphism (Camilleri and Chamberlain, 1997). The thermochronologic data indicate that the peak of metamorphism was in the Late Cretaceous but that metamorphism may have begun in the Late Jurassic.

Metamorphic Grade and Isograds

The distribution of metamorphic assemblages in metapelite in the footwall of the Pequop fault allows placement of biotite- and garnet-in isograds and a boundary between unmetamorphosed and metamorphosed rocks (figs. 3 and 4). In addition, calc-silicate assemblages in siliceous dolomite allow placement of a tremolite-in isograd, which coincides approximately with the garnet-in isograd. The distribution of isograds and facies in the footwall and hanging wall of the Independence thrust is discussed separately below.

The transition zone between metamorphosed and non-metamorphosed rocks in the footwall of Independence thrust is placed between the last appearance of shale and the first appearance of phyllite, which is between the Mississippian Chainman Shale/Diamond Peak Formation and the Ordovician Kanosh Shale (see cross section in fig. 3). The Chainman Shale/Diamond Peak Formation is largely texturally unmetamorphosed, consisting of shale, argillite, siltstone, and conglomerate. In contrast, the Kanosh Shale is an argillite or a Q-SER-CHL phyllite and therefore lies within the chlorite zone (see fig. 4 for mineral abbreviations). The first appearance of biotite in metapelite occurs below the Kanosh Shale but above the upper Cambrian Dunderberg Shale. Consequently the biotite-in isograd is placed just above the Dunderberg Shale, which has a typical assemblage of BI-MU-CHL-TOUR-ALL-PL-Q $\pm$ CC/EP. The garnet-in isograd for metapelite lies below the Dunderberg Shale but above the Precambrian-Cambrian Prospect Mountain Quartzite.

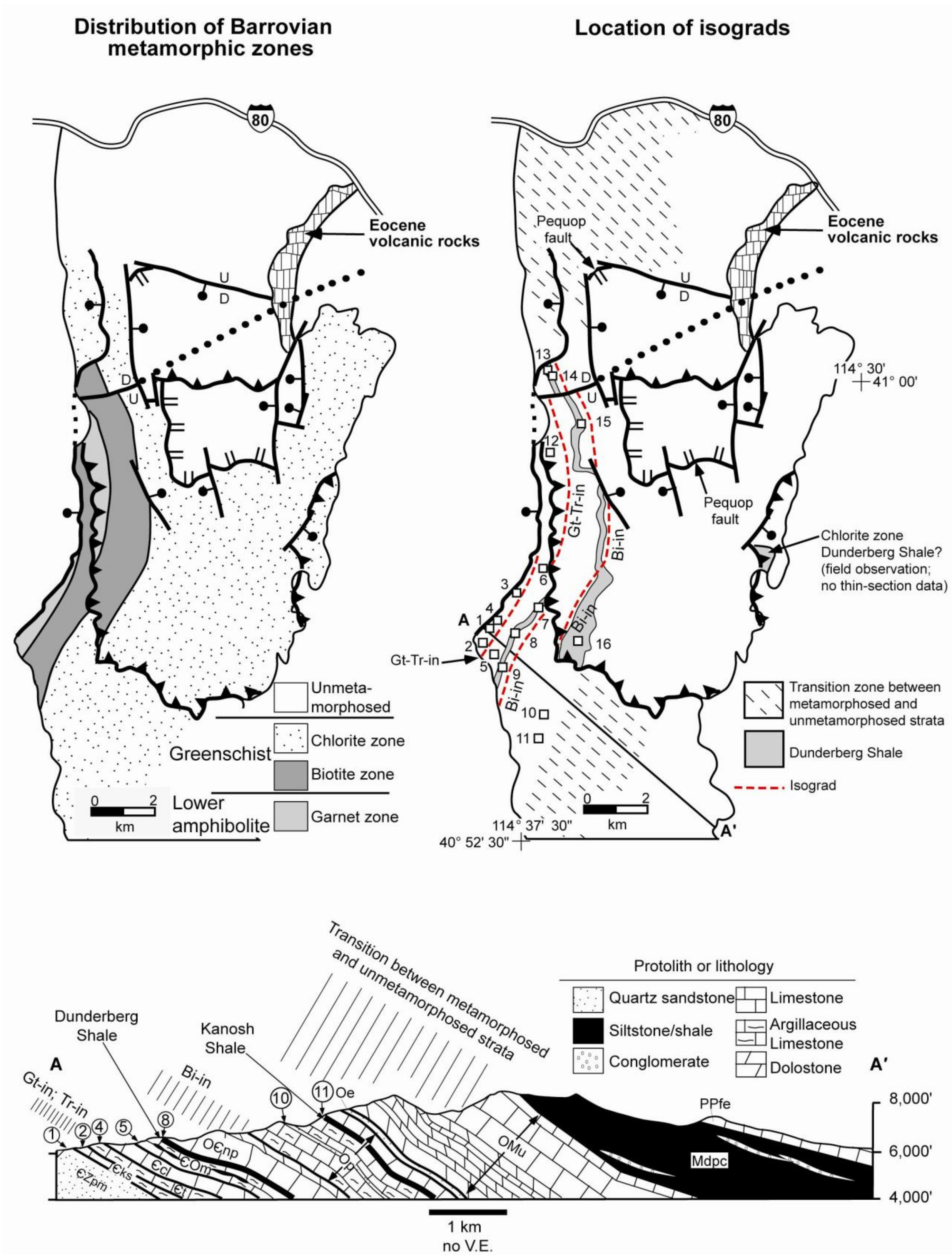

Figure 3. Metamorphic maps and cross section of the Pequop Mountains. The cross section is modified after Camilleri and Chamberlain (1997). The map on the right depicts sample locations (boxes) of metamorphic rocks whose assemblages are listed in figure 4. Unit symbols on the cross section are the same as on the geologic map with the exception of these: Op=Pogonip Group undivided and OMu=Joana Limestone, Guilmette Formation, Lone Mountain Dolomite, Roberts Mountains Formation, Laketown Dolomite, and Fish Haven Dolomite, undivided.

Assemblages in the footwall of the Independence thrust

Prospect Mountain Quartzite (metapelite)
- spl 1: Q-MU-BI-GT-PL-CHL (retrogressive rim around GT)

Killian Springs Formation (metacarbonate)
- spl 2: TR-TLC-CC-Q
- spl 3: TR-TLC-Q

Toano Limestone (metacarbonate)
- spl 4: BI-CC-HNB-Q-DO-CHL-SPH-ALL (rimmed by EP)

Oasis, Shafter, Decoy, and Morgan Pass Formations, undiv. (metapelite)
- spl 5: BI-MU-Q-CHL-PL-ALL-TOUR
- spl 6: BI-MU-Q-CHL-TOUR

Dunderberg Shale (metapelite)
- spl 7: BI-MU-Q-CHL-PL-ALL-TOUR
- spl 8: BI-MU-Q-CHL-PL-TOUR-CC-ALL (rimmed by EP)
- spl 9: BI-MU-Q-EP-CHL-PL-ALL-TOUR

Unit C of the Pogonip Group (metacarbonate)
- spl 10: CC-DO-Q

Kanosh Shale (metapelite)
- spl 11: SER-CHL-TOUR

Assemblages in the hanging wall of the Independence thrust

Toano Limestone (metacarbonate)
- spl 12: TR-CC-DO

Dunderberg Shale (metapelite)
- spl 13: BI-MU-Q-CHL-PL-CC-TOUR-ALL
- spl 14: BI-MU-Q-CHL-PL-ALL-TOUR
- spl 15: BI-MU-Q-CHL-pyrite-ALL-TOUR
- spl 16: Q-SER-CHL-PL (detrital?)

Figure 4. List of mineral assemblages in metamorphic rocks in the hanging wall and footwall of the Independence thrust. ALL=allanite, BI=biotite, CC=calcite, CHL=chlorite, DO=dolomite, EP=epidote, GT=garnet, HNB=hornblende, MU=muscovite, PL=plagioclase, Q=quartz; SER=sericite, SPH=sphene, TLC=talc, TOUR=tourmaline, TR=tremolite.

Micaceous layers within the Prospect Mountain Quartzite contain the prograde assemblage Q-MU-BI-GT-PL. The garnet-in isograd is inferred to coincide approximately with the tremolite-in isograd for siliceous dolomite (see GT-TR -in isograd in fig. 3). This inference is made because the first appearance of tremolite in siliceous dolomite (Toano Limestone) is in proximity of the first appearance of garnet in the Prospect Mountain Quartzite (see cross section in fig. 3).

The distribution of metamorphic facies and isograds in the hanging wall of the Independence thrust is very similar to that in the footwall but with a few minor differences. The Dunderberg Shale in the footwall, and in most of the hanging wall, is within the biotite zone and the biotite-in isograd lies stratigraphically above the shale. However, in the southern part of the hanging wall the biotite-in isograd transects the shale, and the shale is locally within the chlorite zone (fig. 3). The first appearance of tremolite in siliceous dolomite in the hanging wall occurs in the Toano Limestone, as it does in the footwall. Therefore, the tremolite-in isograd in the hanging wall is also placed just above the Toano Limestone. Moreover, although no metapelites are exposed beneath this isograd, it is inferred to coincide approximately with the garnet-in isograd as it does in the footwall.

In summary, metamorphic grade within the Proterozoic-Paleozoic section beneath the Pequop fault increases with stratigraphic depth. Rocks range from unmetamorphosed in middle Mississippian and younger strata to lower amphibolite facies in Proterozoic-Cambrian strata.

Metamorphic Fabric and Large-Scale Deformation Accompanying Metamorphism

Deformation during metamorphism accomplished variable attenuation of stratigraphic units and resulted in development of tectonites and large-scale pinch-and-swell structure (Camilleri (1998). Metamorphosed strata constitute rocks with a foliation only (S tectonite), rocks with a foliation and a lineation (S-L tectonite [S_1 and L_1]), and sparse rocks with a static fabric (no foliation or lineation). Foliation is parallel or at very low angle to bedding. Foliation that is at a low angle to bedding has a consistent geometric relation to bedding: if bedding is rotated to horizontal, foliation would consistently dip gently to the west. Lineation is defined by minerals or elongated grain aggregates with a dominant east to east-southeast trend (fig. 2 D and E). The metamorphic rocks also contain rare small-scale folds that are axial planar to S_1. These folds generally have amplitudes of a few centimeters, are upright, and lack vergence, although an easterly vergence was observed in few places. In addition, some of the higher-grade rocks contain sparse macroscopic pinch-and-swell structure and/or ptygmatically folded calcite veins that are normal or at a very high angle to foliation. Map-scale pinch-and-swell structure occurs only in higher-grade Cambrian rocks and is manifest as a gradational change in stratigraphic thickness along strike (see map).

The character and distribution of fabric in the metamorphic rocks changes with increasing metamorphic grade. The changes are similar in the footwall and hanging wall of the Independence thrust, with the exception of where the metamorphic fabric first appears. Foliation in the hanging wall of the Independence thrust first appears in Ordovician-Silurian dolomite (unit SOlf). Foliation in the footwall first appears in the Mississippian Joana Limestone. However, foliation in the Joana Limestone is restricted to the northernmost part of its mapped extent; to the south, the Joana Limestone is unfoliated and the first appearance of foliation occurs in the stratigraphically underlying Devonian Guilmette Formation. The predominant tectonite type in low-grade chlorite-zone rocks in both the hanging wall and footwall of the Independence thrust is an S tectonite whereas S-L tectonites are scarce. In these low-grade rocks, foliation is partitioned into sparse laterally discontinuous zones a few centimeters to several meters thick. The foliated zones are

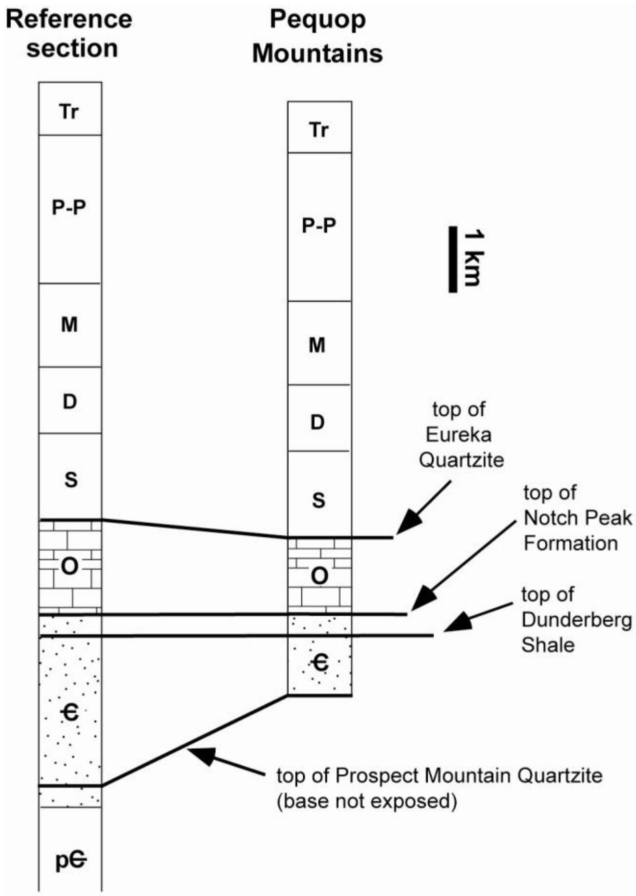

Figure 5. Comparison of minimum stratigraphic thicknesses of regionally metamorphosed and deformed Cambrian and Ordovician sections in Pequop Mountains with a standard, undeformed Paleozoic reference section. Both stratigraphic columns are hung on the top of the Upper Cambrian Dunderberg Shale for comparative purposes. The Mesozoic-Paleozoic reference section was constructed using data from undeformed sections in Pequop Mountains and nearby ranges (i.e., McCollum and Miller, 1991; D. M. Miller, 1984; Glick, 1987; Thorman, 1970; Robinson, 1961; and Fraser 1986). However, the thicknesses of the Cambrian and Ordovician sections in the reference column are derived from sections/type sections exposed in the Toano Range and described by Glick (1987) and McCollum and Miller (1991). The Toano Range is adjacent to, and due east of, the Pequop Mountains.

separated by domains of undeformed, texturally unmetamorphosed rock a few meters to tens of meters thick. In higher-grade biotite- and garnet-zone rocks, foliation is more penetrative, and although S tectonites are the predominant tectonite type, S-L tectonites are more abundant than they are in chlorite-zone rocks. The garnet- and biotite-zone rocks define map-scale pinch-and-swell structure with the swells being little deformed and the pinched parts being penetratively deformed. In the thickest (swell) parts of stratigraphic units, the distribution of fabric resembles that described above for chlorite-zone rocks. In contrast, fabric is most penetrative in severely attenuated (pinch) parts. In both pinch-and-swell regions, there are sparse static metamorphic fabrics attesting to the partitioning of deformation during metamorphism. Rocks with static metamorphic fabrics have the same prograde mineral assemblages as tectonites whose metamorphic minerals define lineation and/or foliation.

Development of the metamorphic fabric and pinch-and-swell structure accommodated up to 50 percent attenuation of stratigraphic section. This inference is based on comparison of stratigraphic thicknesses of metamorphosed Cambrian and Ordovician stratigraphic units with undeformed but correlative units in the Toano Range due east of the Pequop Mountains (fig. 5). The thickest parts of metamorphosed units are generally close to or comparable in thickness with the correlative but undeformed units to the east. However, a comparison of the thickness of the Cambrian-Ordovician section in the footwall of the Independence thrust, which is the most attenuated, with the thickness of the same but undeformed section to the east indicates a negligible amount of attenuation of Ordovician units and as much as 50 percent local attenuation of the Cambrian section (fig. 5). This suggests that the amount of attenuation increases with stratigraphic depth and metamorphic grade.

Independence Thrust and Related Structures

The Paleozoic section in the footwall of the Pequop fault is transected by the Independence thrust, which in map view juxtaposes rocks as old as Ordovician atop rocks as young as Mississippian. The thrust has an overall ramp geometry cutting footwall- and hanging-wall strata at a moderate angle, but locally it refracts to a higher angle where it cuts through more competent Upper Ordovician-Lower Devonian units in the footwall (i.e., units Opl, Oe, and DOu; see cross sections A–A' and B–B'). The thrust dips gently to the northeast, but locally it dips west where it refracts.

The geometry of stratigraphic units in the footwall and hanging wall of the thrust differ markedly. Stratigraphic units and S_1 in the footwall dip approximately 35° to 45° to the east (fig. 2A) with local dip variations reflecting gentle folding (e.g., see cross section in fig. 3). Stratigraphic units and S_1 in the hanging wall of the thrust are deformed by outcrop-scale folds, map-scale northwest-vergent back folds, and a back thrust called the Big Springs thrust (fig. 2). Hanging-wall folds are predominantly upright, have kink geometry, and in general lack an axial planar cleavage. The hinge lines of map-scale folds plunge gently to the northeast (see π axis in fig. 2B and 2C). One of the map-scale folds appears to be a fault-bend fold above Ordovician-Lower Devonian dolostone in the footwall (see hanging wall anticline in cross section B–B'). Hinge lines of outcrop-scale folds plunge gently in northerly and southerly directions, but their trends vary from north-northeast to northwest (fig. 2F). This variability in trend may be a manifestation of curved hinge lines. The geometries of outcrop-scale folds are diverse. Some appear

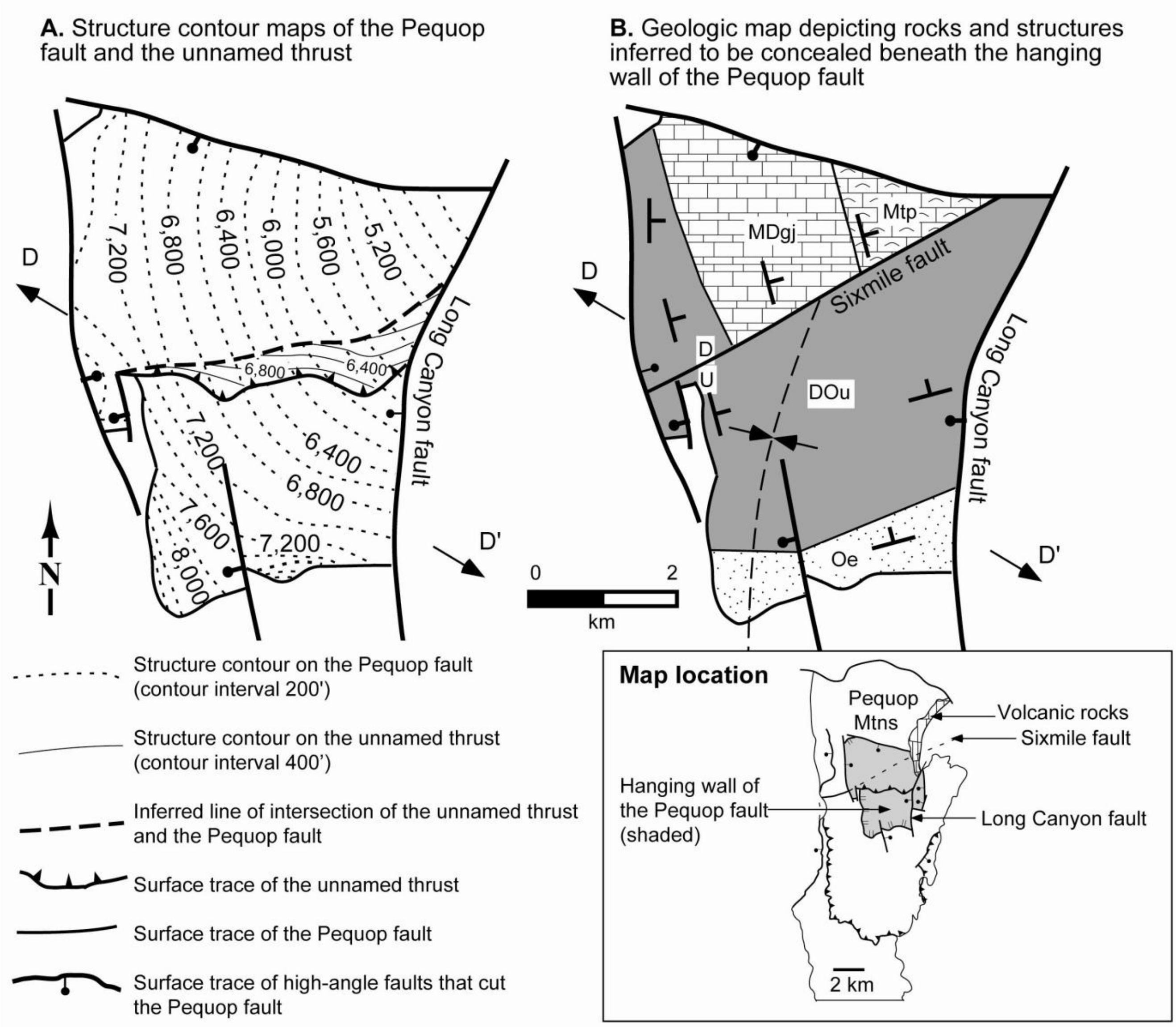

Figure 6. A) Composite structure-contour map of the Pequop fault and the unnamed thrust. The contours are only depicted to the west of the Long Canyon fault. The bold dashed line represents the approximate position of the line of intersection of the Pequop fault and the thrust, which corresponds to the cutoff of the thrust fault in the plane of the Pequop fault. Arrow indicates position of cross section D-D'. **B)** Map showing inferred geologic relationships beneath the hanging wall of Pequop fault. The map only depicts geology to the west of the Long Canyon fault. Strike and dip symbols highlight geometry of units.

to be asymmetric and some define fault-bend or propagation folds associated with small-scale thrust faults. In addition, in a few places intense outcrop-scale folding may have accommodated local thickening of units. For example, the Dunderberg Shale in the hanging wall that is in proximity of the thrust contact appears to be substantially thickened (see map and cross section A–A'). Sparse outcrops of the shale in this area reveal locally intense small-scale folding and crenulation of S_1 and bedding, which may account for a greater apparent thickness. Moreover, some crenulations microscopically exhibit solution features along their limbs indicating an incipient "S_2". These types of crenulations, although sparse, also occur in the footwall in proximity of the thrust.

The sense of slip on the Independence thrust can't be precisely constrained because no exposures of the thrust surface were found. However, sense of slip is inferred to be top-to-the-southeast, broadly perpendicular to hanging wall map-scale fold hinges and the Big Springs thrust.

On the basis of cross-cutting relationships, the Independence thrust is inferred to postdate the metamorphic fabric but predate the Pequop fault. Truncation and deformation of S_1 by the Independence thrust and structures in its hanging wall indicates that the thrust postdates development of the ~ 84 Ma metamorphic fabric (Camilleri and Chamberlain, 1997). Moreover, the

Pequop fault appears to truncate gentle folds in the hanging wall of the Independence thrust, and consequently the thrust is inferred to predate the Pequop fault (see cross sections D–D' and E–E').

Sixmile Fault

The Sixmile fault is a nearly vertical northeast trending fault that cuts, and is exposed in, Cambrian and Ordovician strata in the hanging wall of the Independence thrust on the western flank of the range (see geologic map and fig. 2). In map view, the fault terminates at a north-trending high-angle fault that drops down the hanging wall of the Pequop fault. However, the Sixmile fault is inferred to be cut by the north-trending high-angle fault and to continue eastward beneath the hanging wall of the Pequop fault. Consequently, in map view, the Sixmile fault is shown dotted (i.e., concealed) through the hanging wall of the Pequop fault. Eastward continuation of the Sixmile fault beneath the Pequop fault is geometrically required to explain apparent structural discordance of units beneath the Pequop fault. Figure 6B is an inferred map depicting the Sixmile fault and stratigraphic units immediately beneath and concealed by the hanging wall of the Pequop fault. This map was constructed by projecting exposed stratigraphic units in the footwall of the Pequop fault beneath the hanging wall. The Sixmile fault is required to explain the projected discordance of units to the north and south of the fault (compare fig. 6B with the geologic map).

The sense of slip and amount of displacement along the Sixmile fault can only be gauged in a relative sense because the fault surface is not exposed and much of the fault is concealed. The amount of displacement probably increases eastward as suggested by the greater amount of stratigraphic separation across the fault towards the east. The apparent left-lateral sense of offset of contacts across the fault in map view along the exposed portion of the fault could be produced by dip slip with relative downward motion of the northern block or by strike slip or a combination thereof.

Several cross-cutting relationships suggest that the Sixmile fault postdates the metamorphic fabric and Independence thrust but predates the Pequop fault. First, the Sixmile fault is inferred to be cut by, and therefore older than, the Pequop fault. Second, the juxtaposition of metamorphosed Ordovician strata with unmetamorphosed Mississippian strata across the eastern end of the Sixmile fault suggests that the fault is post metamorphic (see cross section E–E'). Last, the Sixmile fault is inferred to postdate the Independence thrust because it appears to truncate a flexure in the hanging wall of the Independence thrust (see fig. 6B).

Timing of Emplacement of Granitic Intrusions

At least two different generations of granitic intrusions are present in the Pequop Mountains. The oldest generation predates metamorphism and is deformed by the S_1 metamorphic fabric. These intrusions are scarce and were only found in the hanging wall of the Independence thrust on the west flank of the range. Only one of the larger bodies is shown on the map. The mapped intrusion yielded a 154 Ma (Late Jurassic) U-Pb zircon age (Camilleri and Chamberlain, 1997). The youngest generation of intrusions are undeformed and cut the ~84 Ma metamorphic fabric and therefore are constrained to be Late Cretaceous or younger. These intrusives are most common in Lower Cambrian strata in the footwall of the Independence thrust.

GEOMETRY OF THE PEQUOP FAULT AND STRUCTURE IN ITS HANGING WALL

The Pequop fault forms the base of a klippe that is cut by younger, nearly vertical, small displacement faults (see map and figs. 2 and 6). Structure contours on the Pequop fault indicate that it has a gentle eastward dip (fig. 6A). The presence of breccia adjacent to the Pequop fault and the lack of ductile fault rock indicate that it is a brittle fault.

The hanging wall of the Pequop fault consists of an east-dipping sequence of Ordovician to Mississippian strata that is thrust over east-dipping Permian strata along the unnamed thrust. The unnamed thrust trends east-west, dips at a moderate angle to the north, and is cut by and therefore older than the Pequop fault (fig. 6A and cross sections D–D' and E–E'). Hanging-wall and footwall cutoffs trend northeast in the plane of the thrust suggesting a top-to-the-southeast sense of slip for the unnamed thrust.

Both relative and absolute age constraints can be placed on the Pequop fault, but the relative and absolute ages of the unnamed thrust are poorly constrained. The Pequop fault is relatively younger than the Sixmile fault but older than the 41–39 Ma volcanic rocks that depositionally overlap strata in its hanging wall and footwall. The Pequop fault must be Late Cretaceous or younger because it emplaces unmetamorphosed strata atop foliated metamorphosed rocks and therefore cuts the ~84 Ma metamorphic fabric. Thus, the age of the Pequop fault is bracketed between 84 and 41 Ma. Although the unnamed thrust is constrained to be older than the Pequop fault, its age relative to structures in the footwall of the Pequop fault are unconstrained. Camilleri and Chamberlain (1997) infer that that the Pequop fault is a top-to-the-west normal fault that cut two different Paleozoic sections that were duplicated by thrust faulting prior to slip along the Pequop fault.

HIGH-ANGLE FAULTS

The Pequop Mountains contain at least three generations of vertical or high-angle normal faults (fig. 7). The relative ages of these faults can be assessed by cross-cutting relationships with the Pequop fault and the Eocene volcanic rocks. The oldest generation is manifest by one fault, the northeast-trending Sixmile fault, which is cut by and therefore predates the Pequop fault. The middle generation consists of at least two small-displacement west-northwest and east-northeast trending faults that transect the hanging wall of the Pequop fault along its northern margin. These faults appear to be depositionally overlapped by the 41–39 Ma volcanic rocks. Other similarly oriented faults that transect the Tripon Pass Limestone and Guilmette Formation in the footwall of the Pequop fault to the north may be of the same age (see geologic map and fig. 7). The youngest generation consists of at least one fault, the Long Canyon fault (Thorman, 1970), which cuts the volcanic rocks and trends north to north-northeast. Other linear-to-arcuate but broadly north-trending high-angle faults whose relative ages are unconstrained may belong to this generation as well. For example, just south of Interstate 80, two north-trending faults cut an east-northeast-trending fault that is inferred to be a middle generation fault (fig. 7).

RANGE-BOUNDING NORMAL FAULTS

The west flank of the Pequop Mountains, is bounded by two normal faults. The oldest is a down-to-the-west listric normal fault. This fault cuts metamorphosed Paleozoic strata in the range and contains metamorphosed Cambrian and Ordovician strata depositionally overlapped by clastic and volcaniclastic strata of the Miocene (?) Humboldt Formation in its hanging wall. The Humboldt Formation is both cut by and overlaps the fault, suggesting that it was deposited in response to slip along the fault. Moreover, the presence of abundant coarse-grained sediment (gravel- to map-scale clasts) composed of metamorphic rocks derived from the footwall of the fault further suggests that the Humboldt Formation was deposited as a consequence of relief generated by slip along the fault. The youngest fault along the west flank of the Pequop Mountains is an inferred high-angle fault that cuts the northwestern margin of exposures of the Humboldt Formation. This fault is not exposed but is inferred on the basis of aerial photographs that revealed a conspicuous Quaternary (?) scarp. This fault is likely part of the modern range-bounding fault system.

SUMMARY: CHRONOLOGY OF STRUCTURAL EVENTS

In the northern Pequop Mountains, at least six phases of deformation can be distinguished by cross-cutting relationships. These are the phases in chronologic order:

1) Regional metamorphism concomitant with the production of S and S-L tectonites and attenuation of stratigraphic units. Metamorphism is bracketed between 154–84 Ma (Camilleri and Chamberlain, 1997).

2) Transection of the metamorphosed Paleozoic section by the Independence thrust accompanied by hanging-wall shortening that was accommodated by thrusting along the Big Springs thrust and folding.

3) Transection of the hanging wall (and probably the footwall at depth) of the Independence thrust by the Sixmile fault.

4) Emplacement of the unmetamorphosed Paleozoic sequence atop the regionally metamorphosed section along the Pequop fault. The unnamed thrust in the hanging wall of the Pequop fault predates the Pequop fault, but its age relative to events 1, 2, and 3 above is unconstrained.

5) Transection of strata in the hanging wall and footwall of the Pequop fault by a set of small-displacement west-northwest and east-southeast trending high-angle faults followed by deposition of the 41–39 Ma volcanic rocks across strata in the hanging wall and footwall of the Pequop fault.

6) Formation of north-trending high-angle faults including the Long Canyon fault and the range-bounding listric normal fault. The relative ages between the high-angle faults within the range and the listric range-bounding fault are unknown.

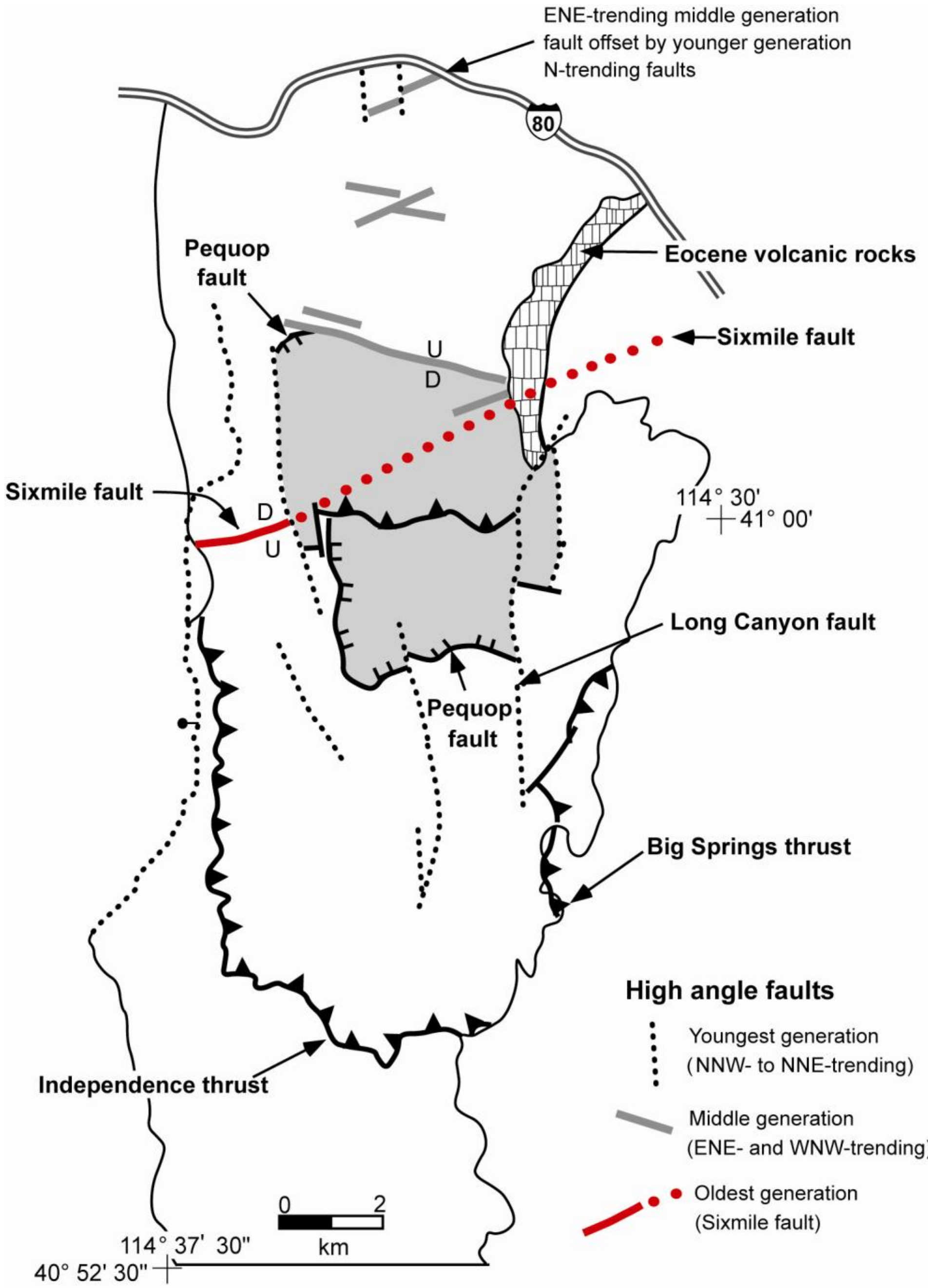

Figure 7. Simplified map depicting three generations of high-angle faults in the Pequop Mountains. The Sixmile fault is shown as dotted where it is concealed by the hanging wall of the Pequop fault and the Eocene volcanic rocks.

DESCRIPTION OF MAP UNITS

Preface

All thicknesses reported for Paleozoic strata represent structural thickness rather than stratigraphic thickness. Much of the Paleozoic section is ductiley attenuated and metamorphosed and/or deformed by map- to outcrop-scale folds and thrusts related to the post-metamorphic Independence thrust. All of this deformation in metamorphosed and non-metamorphosed strata has resulted in laterally variable thicknesses of units. Thicknesses are given only for formations whose bottoms and tops are exposed and whose thicknesses can be geometrically calculated from the map. These thicknesses are estimates. In addition, several metamorphosed units were mapped as combined units (e.g., Oplkc, Opba etc.). This was done because, in places, metamorphism and deformation made some adjacent formations indistinguishable.

Qa Alluvium (Quaternary) Unconsolidated gravel, sand, and silt deposited in intermittent streams and on alluvial fans.

Qla Lacustrine deposits and alluvium, undivided (Quaternary) Pluvial lacustrine deposits of gravel, sand, and silt and alluvial deposits of gravel, sand, and silt deposited in intermittent streams and on alluvial fans.

Qu Alluvium and sedimentary rocks, undivided (Quaternary) Unconsolidated gravel, sand, and silt deposited in intermittent streams and on alluvial fans, and sparse light-gray to tan conglomerate, breccia, sandstone, and siltstone.

Th Humboldt Formation (Miocene) Tan siltstone, conglomerate, and sparse white vitric tuff. Conglomerate contains abundant clasts of metamorphic rocks derived predominantly from the hanging wall of the Independence thrust. This unit also contains large mappable clasts of Cambrian and Ordovician metamorphic rocks.

Tv Volcanic rocks (Eocene) Light-green to reddish-brown volcanic and sedimentary rocks. Brooks et al. (1995) report the presence of 1,200 meters of hornblende rhyolite, dacite, rhyolite ash-flow tuff, andesite ash-flow breccia, and sparse conglomerate in this unit. These volcanic rocks have been dated by $^{40}Ar/^{39}Ar$ methods at 41 to 39 Ma (Brooks et al., 1995).

Pp Pequop Formation of Steele (1960) (Permian) Light-gray limestone and silty limestone. Thickness of this unit ranges from approximately 80 to 400 feet.

Ppf Pequop Formation of Steele (1960) and Ferguson Mountain Formation, undivided (Permian) Tan to light-gray silty limestone and fusilinid-bearing limestone with sparse dolomite in the hanging wall of the Pequop fault.

Pe Ely Limestone (Pennsylvanian) Light-gray limestone with sparse chert; conglomerate with chert and limestone clasts at the base. Thickness of this unit is as much as 167 feet.

PPfe Ferguson Mountain Formation (Permian) and Ely Limestone (Pennsylvanian), undivided Light-gray limestone with sparse chert and silty limestone.

Mdpc Diamond Peak Formation and Chainman Shale, undivided (Mississippian) Gray to tan to black shale, sandstone, siltstone, chert-pebble conglomerate, and sparse limestone. Thickness of this unit is at least 3,600 feet.

Md Dale Canyon Formation (Mississippian) Gray to tan to black shale, sandstone, siltstone, chert-pebble conglomerate, and sparse limestone.

Mj Joana Limestone (Mississippian) Light-gray-blue cherty limestone and limestone or fine-grained calcite marble. Thickness of this unit ranges from approximately 100 to 200 feet.

Mtp Tripon Pass Limestone (Mississippian) Basal, bedded, black to gray-brown chert and overlying tan, laminated limestone and sparse conglomerate. Limestone contains sparse small-scale synsedimentary folds. Thickness of this unit is as much as 1,200 feet.

MDgj Guilmette Formation (Devonian) and Joana Limestone (Mississippian), undivided Cliff-forming light-gray limestone with minor light-gray to tan argillaceous limestone. The uppermost part of this unit contains beds with abundant pelmetazoan fragments. C.H. Thorman (personal communication, 1992) reports that conodonts from these pelmetazoan-bearing beds indicate a Mississippian age, and N. J. Silberling (personal communication, 1999) indicates that these beds are correlative with, and represent an erosional remnant of, the Joana Limestone. Thickness of this unit is as much as 2,100 feet.

Dg Guilmette Formation (Mississippian and Devonian) Cliff-forming light-gray limestone with minor light-gray to tan argillaceous limestone. The uppermost part of the Guilmette Formation in the footwall of the Independence thrust contains limestone conglomerate and argillaceous limestone; this distinctive lithology appears to be absent from the Guilmette Formation in the hanging wall of the Independence thrust and in the hanging wall of the Pequop fault. Thickness of this unit in the footwall of the Independence thrust is at least 1,600 feet and in the hanging wall of the Pequop fault it is as much as 1,915 feet.

DOu Simonson Dolomite, Lone Mountain Dolomite (Devonian and Silurian), Roberts Mountains Formation (Silurian), Laketown Dolomite (Silurian), and Fish Haven Dolomite (Ordovician), undivided.

Ds Simonson Dolomite (Devonian) Laminated light-gray to black dolostone with minor amounts of gray-green laminated limestone. Red-brown-weathering, cross-bedded dolomitic sandstone is present at the base of the Simonson Dolomite in the hanging wall of the Independence thrust. The Simonson Dolomite in the footwall of the Independence thrust and in the hanging wall of the Pequop fault does not contain sandstone. The contact between the Simonson Dolomite and the overlying Guilmette Formation is gradational and is placed at the base of cliff-forming limestone assigned to the Guilmette Formation. Thickness of this unit in the footwall of the Independence thrust is as much as 1,230 feet and in the hanging wall of the Pequop fault it is as much as 610 feet.

DSlm Lone Mountain Dolomite (Devonian and Silurian) Light-gray to white, coarsely crystalline, massive dolostone. The contact between the Lone Mountain Dolomite and the overlying Simonson Dolomite is gradational. Thickness of this unit in the footwall of the Independence thrust is as much as 375 feet and in the hanging wall of the Pequop fault it is at least 840 feet.

Srm Roberts Mountains Formation (Silurian) The Roberts Mountains Formation in the footwall and hanging wall of the Independence thrust is composed of thin-bedded (platy) to thick-bedded, dark-grayish-purple, calcareous dolostone and dolomite with sparse chert nodules and lenses. In the hanging wall of the Pequop fault, the bulk of the Roberts Mountains Formation consists of platy light-grayish-purple limestone but the basal part is composed of dark-gray dolostone, chert, and dark-grayish-purple calcareous dolomite and dolostone. Thickness of this unit in the footwall of the Independence thrust is as much as 480 feet and in the hanging wall of the Pequop fault it is as much as 490 feet.

SOlf Laketown Dolomite (Silurian), and Fish Haven Dolomite (Ordovician), undivided Unit consists of dark-gray cherty dolostone at the base (= Fish Haven Dolomite; Thorman, 1970) and overlying layers of alternating light-gray to dark-gray dolostone (= Laketown Dolomite; Thorman, 1970). The contact between the Laketown Dolomite and Roberts Mountains Formation is gradational. Thickness of this unit in the footwall of the Independence thrust is as much as 820 feet.

Oe Eureka Quartzite (Ordovician) Fine-grained white quartzite with sparse gray streaks. The contact between the Eureka Quartzite and the Fish Haven Dolomite is sharp. Thickness of this unit in the footwall of the Independence thrust is as much as 215 feet, and in the hanging wall of the Pequop fault it is as much as 320 feet.

Divisions of the Pogonip Group

Opl Lehman Formation (Ordovician) In the hanging wall and footwall of the Independence thrust, the Lehman Formation is composed of light gray-green calcite marble or limestone with brown-weathering silty layers. In addition, the Lehman Formation in the hanging wall of the Independence thrust on the east side of the Pequop Mountains also contains dolomite beds near the top of the unit. The Lehman Formation in the hanging wall of the Pequop fault consists of unmetamorphosed, fossiliferous gray-green limestone and silty limestone. The contact between the Lehman Formation and the Kanosh Shale is poorly exposed, but the contact between the Lehman Formation and the Eureka Quartzite is sharp. Thickness of this unit in the footwall of the Independence thrust is as much as 500 feet, and in the hanging wall of the Independence thrust it is at least 680 feet. The thickness of this formation in the hanging wall of the Pequop fault is as much as 500 feet.

Oplkc Lehman Formation, Kanosh Shale, and unit C, undivided (Ordovician)

Opkc Kanosh Shale and unit C, undivided (Ordovician)

Opk Kanosh Shale (Ordovician) The Kanosh Shale in the footwall and hanging wall of the Independence thrust consists of phyllite or argillite with subordinate light-gray limestone, argillaceous limestone or fine-grained marble and argillaceous limestone. The Kanosh Shale in the hanging wall of the Pequop fault consists of unmetamorphosed fissile shale that weathers into small chips. Thickness of this unit in the hanging wall of the Independence thrust is as much as 160 feet, and in the hanging wall of the Pequop fault it is as much as 135 feet.

Opcb Unit C and unit B, undivided Present in the hanging wall of the Pequop fault.

Opc Unit C (Ordovician) Light-gray to light-gray-green, fine-grained, calcite marble or limestone and micaceous calcite marble or argillaceous limestone with an approximately 50-foot-thick grayish-yellow-weathering quartzite or calcareous quartzite at the base. In various places, unit C is texturally unmetamorphosed due to the partitioning of strain. Unit C is present in the hanging wall and footwall of the Independence thrust.

Opb Unit B (Ordovician) Light-gray to light-gray-green micaceous calcite marble or silty limestone, calcite marble or limestone and minor phyllite or argillite. In various places, unit B is texturally unmetamorphosed (unfoliated) due to the partitioning of strain. Unit B is present in the hanging wall and footwall of the Independence thrust. Thickness of this unit in the footwall of the Independence thrust is as much as 800 feet, and in the hanging wall of the Independence thrust it ranges from approximately 240 to 900 feet.

Opba Unit B and unit A, undivided (Ordovician)

Opa Unit A (Ordovician) Light-grayish-green to light-gray, white or cream-colored, micaceous calcite marble with sparse chert or light-grayish-green limestone with sparse chert. In various places, unit A is texturally unmetamorphosed due to the partitioning of strain. Where unmetamorphosed, a distinctive feature of unit A is the presence of flat-pebble limestone conglomerate. Unit A is present in the hanging wall and footwall of the Independence thrust. Thickness of this unit in the footwall of the Independence thrust is as much as 800 feet.

OCu Calcite marble, dolomite marble, and quartzite, undivided (Ordovician and Cambrian)

OCnp Notch Peak Formation (Early Ordovician and Late Cambrian) The Notch Peak Formation consists of limestone and dolostone with bedding-parallel chert lenses. However, dolostone does not appear to be entirely a primary lithology because in many places limestone beds can be traced laterally into dolostone. The Notch Peak Formation in the footwall of the Independence thrust is predominantly light gray and in outcrop its appearance ranges from texturally unmetamorphosed to a very fine-grained marble. In the hanging wall of the Independence thrust, the color of the Notch Peak Formation varies laterally from light-gray-green to black, and parts have zebra-striping (alternating layers of wavy white coarse-grained dolomite and finer-grained dark dolomite). Much of the Notch Peak Formation in the hanging wall of the Independence thrust is texturally unmetamorphosed; however, on the extreme northwestern flank of the Pequop Mountains, it is recrystallized to a medium-grained dolomite marble. Thickness of this unit in the footwall of the Independence thrust ranges from approximately 1,150 feet to as much as 1,960 feet, and in the hanging wall of the Independence thrust it ranges from at least 400 feet to 1,300 feet.

Cd Dunderberg Shale (Late Cambrian) Phyllite or schist and light-gray, micaceous calcite marble or limestone. Thickness of this unit in the hanging wall of the Independence thrust ranges from approximately 335 feet to as much as 1,200 feet.

Com Oasis Formation (Late Cambrian), Shafter Formation (Late and Middle Cambrian), Decoy Limestone (Late and Middle Cambrian), and Morgan Pass Formation (Middle Cambrian), undivided Light-gray-green to light-gray-blue calcite marble, micaceous calcite marble, and minor phyllite. Thickness of this unit ranges from approximately 800 feet to as much as 1,675 feet.

Cdm Dunderberg Shale (Late Cambrian), Oasis Formation (Late Cambrian) Shafter Formation (Late and Middle Cambrian), Decoy Limestone (Late and Middle Cambrian), and Morgan Pass Formation (Middle Cambrian), undivided Schist or phyllite with minor light-gray-green to light-gray-blue calcite marble and micaceous calcite marble in uppermost part of unit (= Dunderberg Shale) with underlying light-gray-green to light-gray-blue calcite marble, micaceous calcite marble, and minor phyllite and tan dolomite marble (= Oasis, Shafter, Decoy, and Morgan Pass Formations). Thickness of this unit is as much as 1,600 feet.

Ccl Clifside Limestone (Middle Cambrian) The Clifside Limestone is composed of light-grayish-blue limestone or fine-grained calcite marble with scarce phyllitic layers. However, parts of the Clifside Limestone in the hanging wall of the Independence thrust are variably dolomitized. Where the Clifside Limestone is deformed, it is a foliated fine-grained marble with a platy aspect. Where undeformed, the Clifside Limestone consists of thick-bedded limestone with oolites. The contact between the Toano Limestone and the Clifside Limestone is gradational and is placed at a color change in the rocks from light-grayish-blue of the Clifside Limestone to the grayish-green of the Toano Limestone. Thickness of this unit ranges from approximately 250 feet in the footwall of the Independence thrust to at least 2,600 feet in the hanging wall of the thrust.

Ct Toano Limestone (Middle Cambrian) The Toano Limestone consists of grayish-green, hornblende- or tremolite-bearing calcite marble and grayish-green calcite marble with 1-mm- to 1-cm-thick orange-weathering phlogopite-bearing layers. The contact between the Killian Springs Formation and Toano Limestone is gradational and is placed at a color change in the rocks from black or dark gray of the Killian Springs Formation to gray-green of the Toano Limestone. Thickness of this unit is at least 320 feet.

Cks Killian Springs Formation (Middle and Early Cambrian) The Killian Springs Formation consists of graphitic, gray to black, tremolite-bearing marble, dark micaceous quartzite, and biotite-muscovite schist. The contact of the Killian Springs Formation with the underlying Prospect Mountain Quartzite is gradational and is placed at the lowermost marble or schist within the Killian Springs Formation. Thickness of this unit is at least 560 feet.

CZpm Prospect Mountain Quartzite (Early Cambrian and Late Proterozoic) Dark-gray quartzite with minor garnet-bearing micaceous layers.

Zmc McCoy Creek Group (Proterozoic) Unit shown in cross section only.

Igneous Rocks

Kg Granitic pods (Cretaceous?) Undeformed, hydrothermally altered granitic pods in the footwall of the Independence thrust.

Jg Granitic dike (Jurassic) Foliated granitic dike in the hanging wall of the Independence thrust. The dike yields a U-Pb (zircon) age of ~154 Ma (Camilleri and Chamberlain, 1997).

ACKNOWLEDGMENTS

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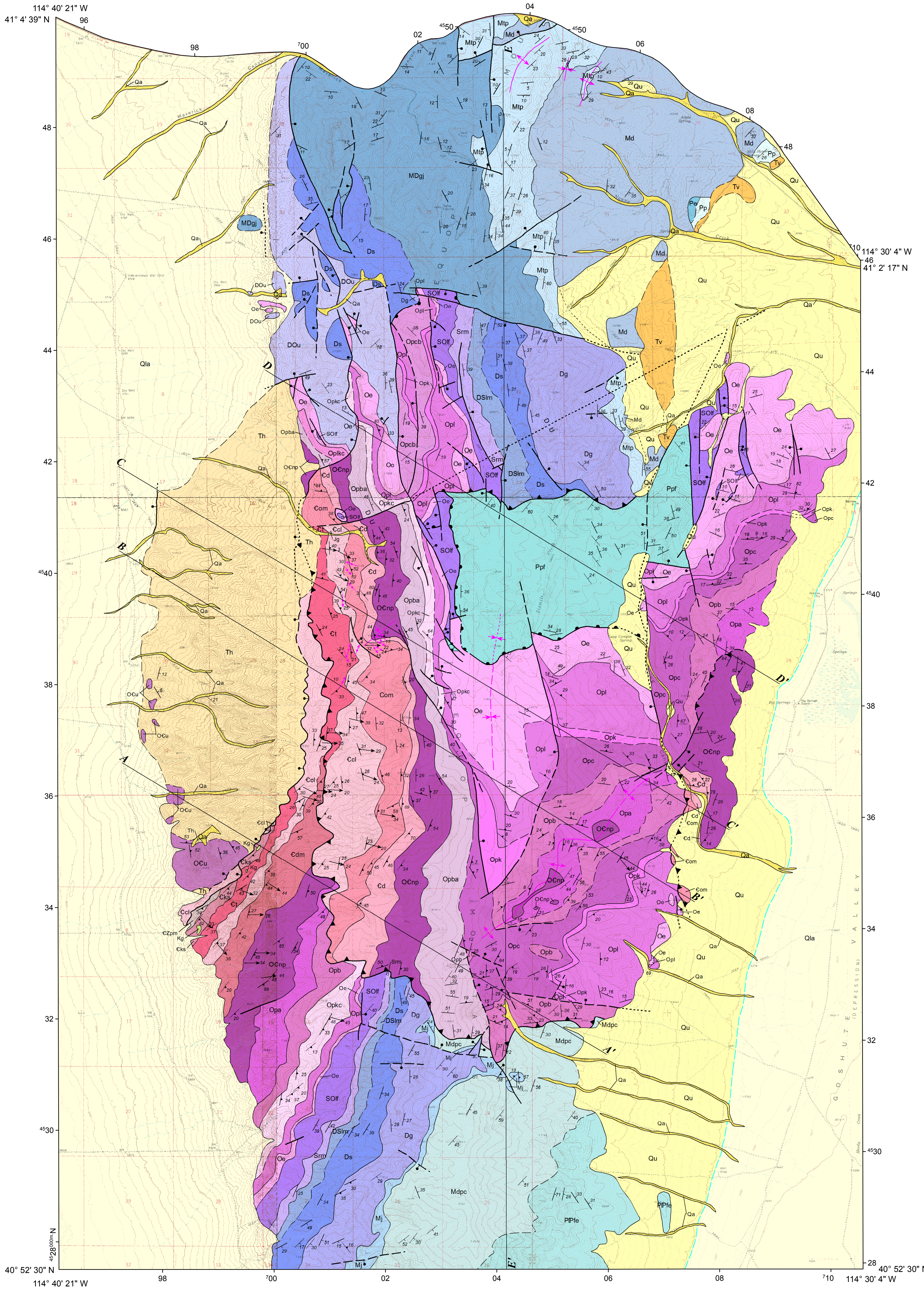


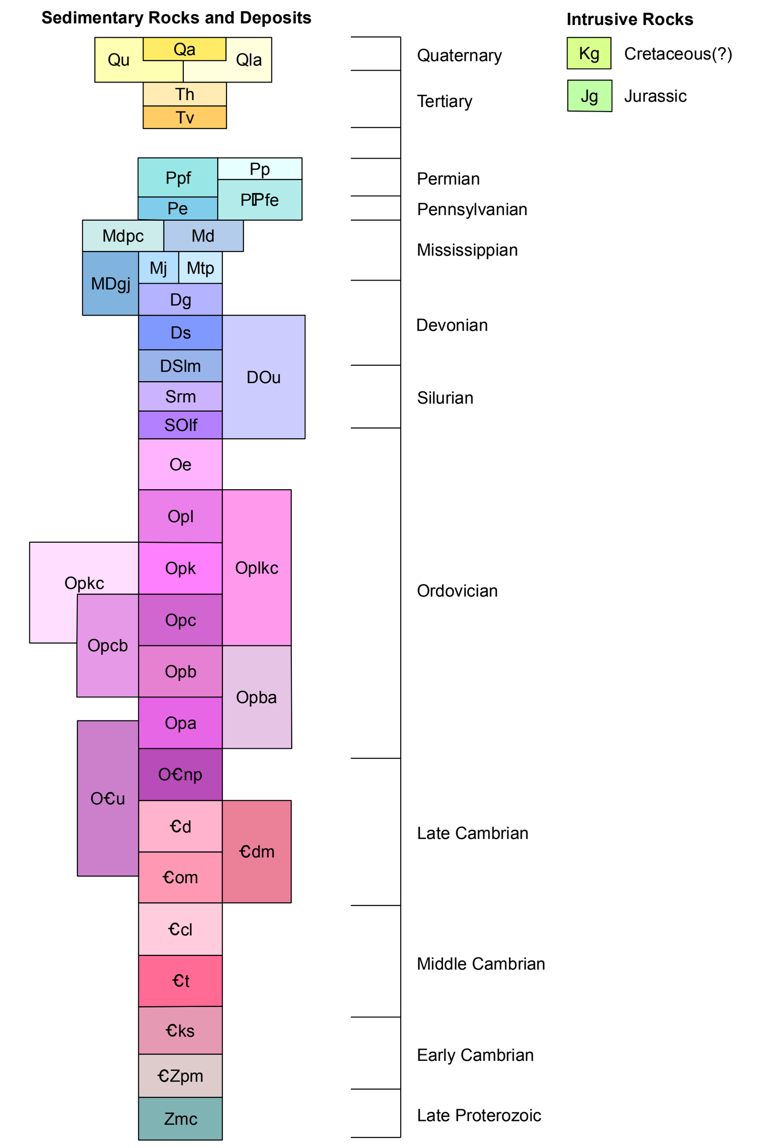
Qa	Alluvium
Qla	Lacustrine deposits and alluvium, undivided
Qu	Alluvium and sedimentary rocks, undivided
Th	Humboldt Formation
Tv	Volcanic rocks
Kg	Granitic pods (Cretaceous?)
Jg	Granitic dike (Jurassic)
Pp	Pequop Formation
Ppf	Pequop Formation and Ferguson Mountain Formation, undivided
Pe	Ely Limestone
PPfe	Ferguson Mountain Formation and Ely Limestone, undivided
Mdpc	Diamond Peak Formation and Chainman Shale, undivided
Md	Dale Canyon Formation
Mj	Joana Limestone
Mtp	Tripon Pass Limestone
MDgj	Guilmette Formation and Joana Limestone, undivided
Dg	Guilmette Formation
DOu	Simonson Dolomite, Lone Mountain Dolomite, Roberts Mountains Formation, Laketown Dolomite, and Fish Haven Dolomite, undivided
Ds	Simonson Dolomite
DSlm	Lone Mountain Dolomite
Srm	Roberts Mountains Formation
SOlf	Laketown Dolomite, and Fish Haven Dolomite, undivided
Oe	Eureka Quartzite

POGONIP GROUP

Opl	Lehman Formation
Oplkc	Lehman Formation, Kanosh Shale and Unit C, undivided
Opkc	Kanosh Shale and Unit C, undivided
Opk	Kanosh Shale
Opcb	Unit C and Unit B, undivided
Opc	Unit C
Opb	Unit B
Opba	Unit B and Unit A, undivided
Opa	Unit A

O€u	Calcite marble, dolomite marble, and quartzite, undivided
O€np	Notch Peak Formation
€d	Dunderberg Shale
€om	Oasis Formation, Shafter Formation, Decoy Limestone, Morgan Pass Formation, undivided
€dm	Dunderberg Shale, Oasis Formation, Shafter Formation, Decoy Limestone, Morgan Pass Formation, undivided
€cl	Clifside Limestone
€t	Toano Limestone
€ks	Killian Springs Formation
€Zpm	Prospect Mountain Quartzite
Zmc	McCoy Creek Group (unit shown in cross section only)

In some places unit Qa is too thin to show and is omitted from the cross section.



See accompanying text for full unit descriptions, references, and figures for this map.

Symbology (per FGDC-STD-013-2006)

Contact Solid where certain and location accurate, long-dashed where approximate, short-dashed where concealed or projected.

Normal faults Solid where certain and location accurate, long-dashed where approximate, short-dashed where concealed. Ball on downthrown side.

Vertical or near-vertical faults Solid where certain and location accurate, long-dashed where approximate, dotted where concealed; queried if identity or existence uncertain. U on upthrown block, D on downthrown block.

Thrust fault Solid where certain and location accurate, long-dashed where approximate, short-dashed where concealed. Triangles are on hanging wall.

Low-angle normal fault (the Pequop fault) Solid where certain and location accurate, long-dashed where approximate, short-dashed where concealed. Semicircles are on hanging wall.

Anticline Solid where certain, long-dashed where approximate, arrow shows direction of plunge.

Syncline Solid where certain, long-dashed where approximate, short-dashed where concealed.

Former shoreline Long-dashed where approximately located.

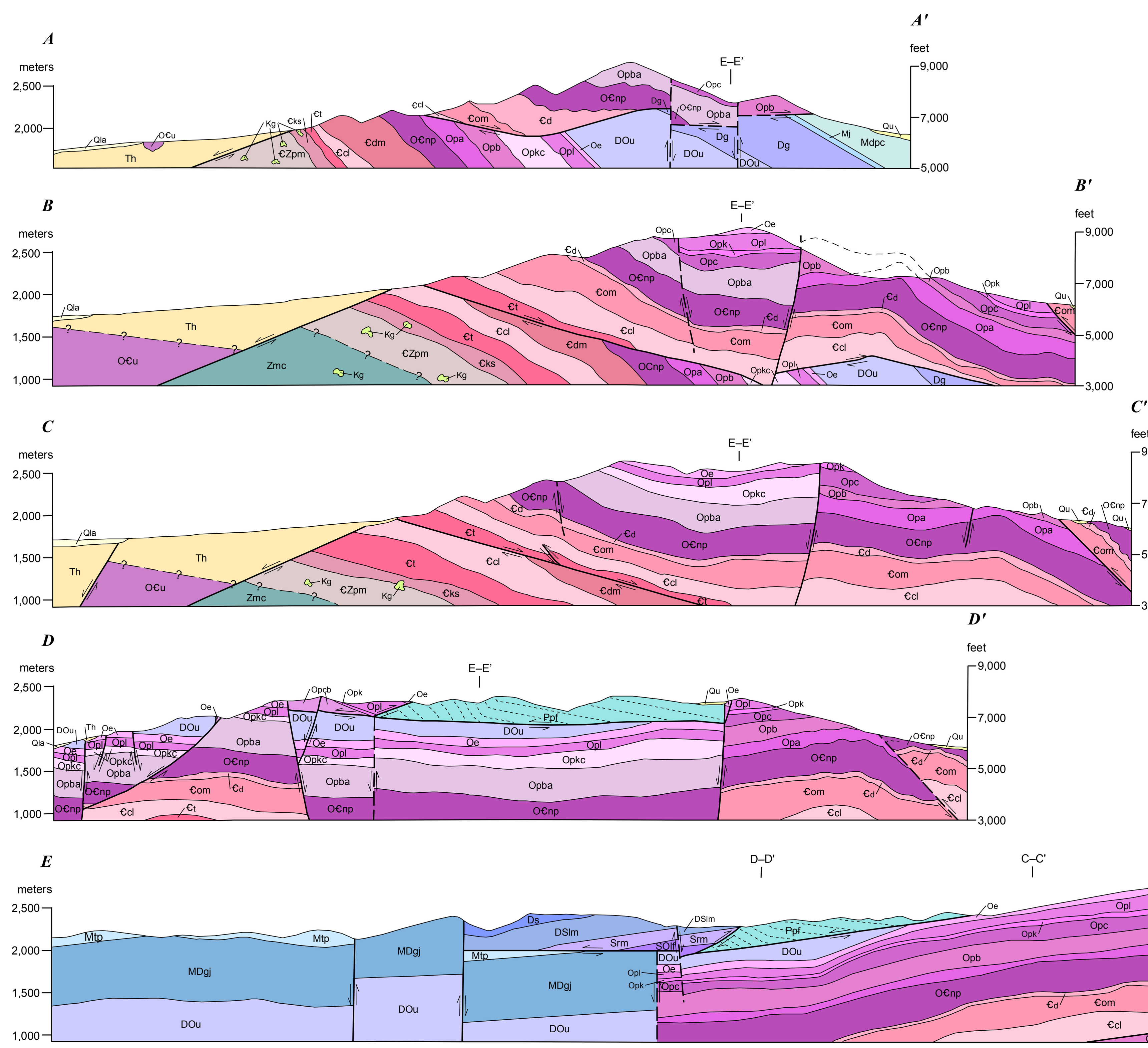
Strike and dip of bedding
41 Inclined 47 Overturned

Strike and dip of foliation (S_1)
Arrow shows trend and plunge of lineation (L_1)
47 25 Inclined

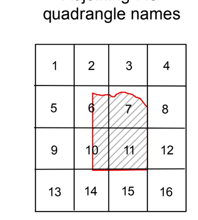
Trend and plunge of elongation lineation (L_1)
33 Inclined

Trend and plunge of hinge of outcrop-scale post-S_1 fold
Inclined

Line of cross section
A *A′*

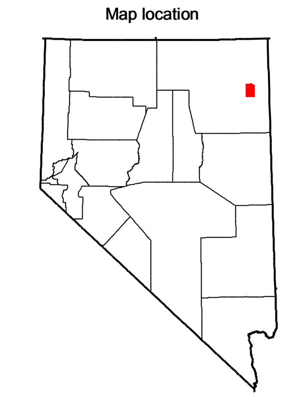


Adjoining 7.5' quadrangle names



1 Wells Peak
2 Holborn
3 Pequop
4 Valley Pass
5 Moor Summit
6 Pequop Summit SW
7 Pequop Summit
8 Cobre
9 Snow Water Lake NE
10 Independence Valley NW
11 Independence Valley NE
12 Hardy Creek
13 Ventosa
14 Independence Valley SW
15 Independence Valley SE
16 Shafter

Map location



Scale 1:48,000

0 1 2 kilometers
0 1 2 miles
0 2,000 4,000 6,000 8,000 10,000 feet

CONTOUR INTERVAL 20-40 FEET

Projection: Universal Transverse Mercator, Zone 11, North American Datum 1927 (m)

Base map: U.S. Geological Survey
Pequop Summit SW 7.5' quadrangle (1968, photoinspected 1980),
Pequop Summit 7.5' quadrangle (1968, photorevised 1982),
Independence Valley NW 7.5' quadrangle (1968, photoinspected 1980),
Independence Valley NE 7.5' quadrangle (1968)

Nevada Bureau of Mines and Geology
Mackay School of Earth Sciences and Engineering
College of Science
University of Nevada, Reno

Field work done in 1988-1992
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PEER-REVIEWED MAP
Office review by Christopher D. Henry (NBMG), Connie Nutt (USGS), and Norm Silberling (USGS)
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GEOLOGIC MAP OF THE NORTHERN PEQUOP MOUNTAINS, ELKO COUNTY, NEVADA

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