# Plate 1-Generalized Geologic Map of the Lost Basin Range

## Mapping and Compilation by Zack Swaney After Blacet (1975), Wallace (1999), and Blythe (2005)

### Explanation of Map Units

Modified from Blythe (2005)

#### Quaternary sedimentary deposits

Poorly sorted, poorly stratified alluvial fan deposits of sheet-flood and debris-flow origins. Clasts chiefly derived from Proterozoic rocks. Subunits gradational and boundaries not necessarily time-correlative.

**Qal** **Alluvium (Holocene)** Sandy gravel in terraces and alluvial fans. Poorly sorted. Clasts angular to subangular. Surface characteristically exhibits bar-and-swale forms. Subject to sheet floods. Thickness up to ~10 m. (Plate 1: undifferentiated Quaternary deposits)

**Qf** **Alluvial fan and pediment deposits (Holocene to Late Pleistocene?)** Gray to brown poorly consolidated, poorly sorted subangular to angular pebble to cobble, clast-supported conglomerate with subordinate lenses and thin beds of matrix-supported pebble and cobble conglomerate and coarse-grained sandstone. Lithologically similar to QTf where clasts are locally derived from dissected older conglomerate (Qf and Tc), Tlgb, and Paleozoic limestone. Bedding ranges up to 1.5 m thick. On steeper slopes, uppermost beds are overlain by minor colluvium. Probably post-extensional because the deposits cover exposures of the Wheeler Ridge fault. Up to ~15? m thick.

**QTf** **Older alluvial fan and pediment deposits (Pleistocene to Holocene?)** Gray to brown, poorly sorted, poorly to moderately consolidated, subangular to angular pebble to cobble clast-supported conglomerate with medium- to coarse-grained sand matrix and subordinate lenses and beds of coarse-grained sandstone; beds generally up to 2 m thick; lithologically similar to Qf with clasts of local derivation and occurs as slightly to strongly dissected erosional remnants as much as 3 m higher than nearby Qf and Qa. Some upper surfaces contain clasts with rock varnish and thin caliche crusts suggesting relatively long exposure. Up to ~15? m thick.

**Qtl** **Landslide and tallus deposits (Holocene to Pliocene?)** Slump blocks and unconsolidated rubbly debris composed of angular cobbles and boulders of Tlgb and the sandstone of Gregg basin; blocks range up to ~250 m in length and are up to ~50 m thick.

#### Miocene and Pliocene Rocks

**Tcs** **Ancestral Colorado River Sedments** Unconsolidated silt, sand, and well-rounded gravel in scattered, high-level remnants of the ancestral Colorado River (Blacet, 1975).

**Tlgw** **Limestone of Grand Wash Trough (Late Miocene to Early Pliocene?)** White to pinkish-tan, vuggy, thin to massive bedded, pelleted packstone, wackestone, and calcareous mudstone commonly with thin, wavy lenticular laminations. Pelmicrite dominates and commonly contains oncolites ranging up to 6 mm in diameter with nuclei ranging from micrite intraclasts, algal filaments, and rip-up clasts of algal laminations. The age of this unit is bracketed by geochronology of tuffs to between 11.6 +/- 1.2 Ma (Bohannon, 1984), and 4.41 +/- 0.03 Ma. Exposed thickness of this unit is ~300 m in Grapevine Wash.

**Tlgb** **Limestone of Gregg basin (Middle Miocene to Early Pliocene)** White to pinkish-tan pelleted packstone, wackestone, and calcareous mudstone; pelmicrite dominates. Records >300 m of throw on the Wheeler Ridge fault. Exposed thickness up to 170 m.

**Tc** **Conglomerate of Gregg basin and Grand Wash trough (Middle Miocene to Early Pliocene)** Brown, pinkish, and light gray poorly sorted, moderately to poorly consolidated alluvial fan and braided plain facies of Gregg basin and the Grand Wash trough. Subordinate lenses of unstratified breccia (Tbp, Tbx, and Tbpx) are intercalated within the conglomerate on the western margin of the Grand Wash trough. Angular to subangular clasts of the conglomerate range in size from pebbles to large boulders (>5 m). Bedding thickness ranges up to ~2 m; weakly to moderately cemented by calcite. Clasts dominantly locally derived from the west, with a large constituent of Gold Butte clasts. In the southern Grand Wash trough the clasts are strictly derived from the Lost Basin Range. Total thickness is unknown but exposed thickness is as much as 250 m.

**Tcp** **Paleozoic clast conglomerate (Middle Miocene to Early Pliocene)** White to pinkish-brown, poorly sorted clast- and matrix-supported, pebble to cobble and boulder conglomerate; contains a sandy micritic matrix; interfingers with 15.29 Ma and 15.34 Ma tuff (Tts and Ttgb, respectively). Clast lithology consists mainly of locally-derived Paleozoic strata. Exposed thickness ranges up to 120 m.

**Tbp** **Tbpx** **Tbx** **Breccia of Gregg Basin and the Grand Wash trough (Middle to Late Miocene)** Reddish brown and gray, moderately to well indurated clast-supported breccia intercalated within Tc; commonly containing <10% silt and mud matrix; clasts range in size from boulders >3m to mm-scale angular mineral fragments of the same rock type; calcite cement; clast lithologies include granite and gneiss (Tbx), Paleozoic limestones and dolostones (Tbp), or a combination of both Paleozoic and Proterozoic rock types (Tbpx); crackle brecciation common but subordinate lenses of jigsaw brecciation also found. These breccias probably originated as large rock-avalanche deposits derived from Gold Butte and the Lost Basin Range to the west and the nearby walls of a large east-trending paleocanyon cut into Paleozoic strata. Thickness ranges from ~2-80 m.

**Tmb** **Megabreccia of Wagon Trail Wash (Middle Miocene)** Massive commonly brecciated amalgamation of black to green gneiss and white to pink leucogneiss exposed in coherent wash banks and along weathered slopes along the northeastern portion of Wagon Trail wash and western flank of Grapevine Mesa. Clasts within the breccia are angular and range from pebble to boulder size; matrix consists of angular, coarse-grained to pebbly sandstone. Composition of the megabreccia is generally homogenous throughout, suggesting it was deposited from single uplifted terrane. Composition of the blocks and clasts indicate the unit was probably sourced from the Lost Basin Range (Xgn). Local exposures are up to 70 m thick.

**Ttgb** **Tts** **Tuffs and volcaniclastic sediments of Gregg Basin and the Grand Wash trough (Middle Miocene)** Tan to white tuffaceous sandstone interbedded with brown volcaniclastic sandstone and tuffaceous matrix-supported conglomerate. Moderately well bedded, moderately well-consolidated. An $^{40}Ar/^{39}Ar$ age of 15.34 +/- 0.05 Ma was obtained from this unit (Ttgb) (Faulds et al., 2004). This unit (Ttgb) directly overlies basement rock (Ydg) and has a maximum exposed thickness of ~4 m; however this unit is inferred to extend up to 10 m in the subsurface. Ttgb is equivalent to Tts in age and stratigraphic position. Tts is a light gray non-welded tuff and medium gray to white fine- to coarse-grained, thinly bedded, weakly indurated volcaniclastic sandstone. An $^{40}Ar/^{39}Ar$ age of 15.29+/-0.07 Ma (Blythe, 2005) was obtained from this unit. Tts underlies Tc and Tmb and is interbedded with Tcp. Exposed thickness is ~2-10 m, but may be thicker in the subsurface. An $^{40}Ar/^{39}Ar$ age of 15.35+/-0.07 (this study) was obtained from a tuffaceous sandstone in the same stratigraphic position as Tts and Ttgb, thereby confirming its equivalency with the tuffs exposed in Wagon Trail wash.

#### Mesozoic Rocks

**Kp** **Pegmatite (Late Cretaceous?)** Medium- to coarse-grained unfoliated granite and pegmatite mainly consisting of potassium feldspar, quartz, muscovite, hornblende, and biotite. Granite dominates in the southwest part of the quadrangle, but these bodies typically grade into pegmatite. Age is uncertain; clearly cuts Ydg, but no bodies were found cutting Paleozoic strata; may be related to peraluminous Late Cretaceous, two-mica granites in the region (e.g., Blacet, 1975).

**Kqv** **Quartz vein (Late Cretaceous?)** Coarse-grained quartz vein probably related to Kp. Several small veins were not mapped.

#### Paleozoic Rocks

**Pz** **Undifferentiated Paleozoic sedimentary rocks (Plate 1)**

**$\mathbb{P}_{C2}$** **Lower Member of the Callville Formation (Pennsylvanian)** Thick-bedded, slope-forming, very light gray limestone. Abundant orange to reddish brown chert stringers occur near the top of the unit. Total thickness ~150 m.

**Mm** **Monte Cristo Formation (Mississippian)** Thickly bedded yellowish gray limestone and dolostone overlain by a conspicuous horizon of interbedded gray dolostone and dark brown chert, generally fossiliferous, in turn overlain by medium bedded light gray to yellowish gray sucrose dolostone. This formation is a very prominent cliff-former, commonly holding up ridge crests in the area. Total thickness is ~150 m.

**Ds** **Sultan Formation (Middle Devonian)** Prominent cliff-forming olive gray dolostone, commonly including abundant silicified stromatolites or vugs, overlain by less resistent, well bedded olive gray to light gray dolostone. Well-sorted, well-rounded pale to pink to white quartz arenite beds or pinkish gray sandy dolostone beds are locally found below the olive gray dolostone. These may belong to the Mountain Spring Formation. Total thickness is ~140 m.

**$\mathbb{C}$m5b** **$\mathbb{C}$m5a** **$\mathbb{C}$m5** **Muav Limestone Formation, Unit 5 (Late Cambrian)** Equivalent to upper part of the Banded Mountain Member of the Bonanza King Formation, although the beds equivalent to the uppermost Banded Mountain Member have been erosionally removed by the sub-Devonian unconformity. Prominent bench of light gray, burrow mottled dolomite overlain by medium gray burrow mottled dolomite and interbeds of light gray to white cryptalgal dolomite. Total thickness is ~300 m.

**$\mathbb{C}$m3-4** **Muav Limestone Formation, Units 3&4 (Middle Cambrian)** Equivalent to the lower part of the Banded Mountain Member of the Bonanza King Formation. Unit 3 is a dark gray, cliff forming, burrow mottled, dolostone wth some orange overprint on silt-rich portions. Unit 4 is slightly less resistent, dark to medium gray dolostone with interbeds of light gray to white cryptalgal dolomite. A prominent horizon of brown chert lenses occurs ~10 m above the base of Unit 4. Total thickness is ~80 m.

**$\mathbb{C}$m1-2** **Muav Limestone Formation, Units 1&2 (Middle Cambrian)** Equivalent to the Papoose Lake Member of the Bonanza King Formation. Prominent cliff-forming light gray limestone overlian by medium gray, bedded, burrow mottled, limestone and dolostone with an orange overprint, particularly on silt-rich burrows and along some bedding planes. The top of Unit 2 is marked by a recessive orange buff, cross-bedded carbonate grainstone. Total thickness is ~200 m.

**$\mathbb{C}$b** **Bright Angel Formation (Middle Cambrian)** Shale and subordinate limestone. The basal parts consist of green and reddish brown shale containing worm burrows, oscillion ripples, and local cross-beds. The upper part consists of a light brown and dark gray oncolitic silty limestone, which is overlain by green shale with worm burrows. Approximate thickness ranges from 20-40 m.

**$\mathbb{C}$t** **Tapeats Sandstone (Early Cambrian)** Highly indurated pale brown to pale reddish brown, thin to thick bedded, locally cross-bedded fine-to coarse-grained sandstone; includes both silica and calcite cement. Unconformably overlies Paleoproterozoic gneiss and Mesoproterozoic gabbro-diabase in the southwestern part of the quadrangle. Thickness ranges from 20-40 m.

#### Proterozoic Rocks

**Ydg** **Gabbro and diabase (Mesoproterozoic)** Gray to greenish gray, medium- to coarse-grained generally unfoliated gabbro and diabase consisting of 55-60% plagioclase; lesser hornblende, augite, and hypersthene; minor magnetite and quartz; and traces of zircon. Gabbro locally has a weak foliation. Hornblende and pyroxene are locally altered to chlorite and boitite.

**Xgg** **Granitic gneiss (Paleoproterozoic)** Medium-grained granodiorite and granite gneiss. Mafic mineral content ~15%. Near Virgin Reef, in the extreme southwest portion of the map area, may include part of the gneissic border phase of granite of Burro Spring (Howard et al., 2003). East of the Lost Basin Range, unit is reddish-brown, fine- to medium-grained, weakly to moderately foliated, and consists of mainly potassium feldspar, plagioclase, quartz, hornblende, and biotite. Locally includes small bodies of Xgn.

**Xgn** **Garnet gneiss (Paleoproterozoic)** Strongly foliated, fine- to coarse-grained quartzo-feldspathic garnet-biotite-hornblende gneiss; commonly includes thin layers and small bodies of amphibolite and pegmatite gneiss; potassium feldspar grains locally range up to 1 cm; garnet is generally unaltered and not retrograded; intrafolial folds are common.

**Xgc** **Megacrystic granitic gneiss (Paleoproterozoic)** Pale brown to reddish brown, coarse-grained (megacrystic) weakly to moderately foliated gneiss; consists mainly of potassium feldspar, plagioclase, quartz, hornblende, and biotite; potassium feldspar grains are as much as 5 cm in length; typically highly fractured and weathered reddish-brown near Cambrian unconformity.

**Xpg** **Pegmatitic gneiss (Paleoproterozoic)** Moderately foliated pegmatitic gneiss consisting mainly of coarse-grained potassium feldspar, quartz, biotite, and accessory garnet; probably similar in age to Xgn; many small bodies within Xgn were not mapped.

#### Symbols

Strike and Dip of Bedding (Plates 1-3)
- 55 Inclined
- Vertical
- Horizontal

Foliation (Plates 1-3)
- 55 Inclined
- Vertical

Trend and Plunge of Mineral Lineation (Plate 3)
- 55

Normal Fault (Plates 1-3)
- 55 Solid where certain
- Dashed where approximately located
- Dotted where concealed
- Ball on downthrown side
- Arrow and number indicate direction and amount of dip

Area of Plate 2 (Plate 1)

Approximate Trace of Seismic Line RL-1 (Plate 1)

Apatite Fission Track Data (Plate 1)
- 15.9 Ma

Contacts (Plates 1-3)
- Certain
- Approximate
- Concealed
- Gradational

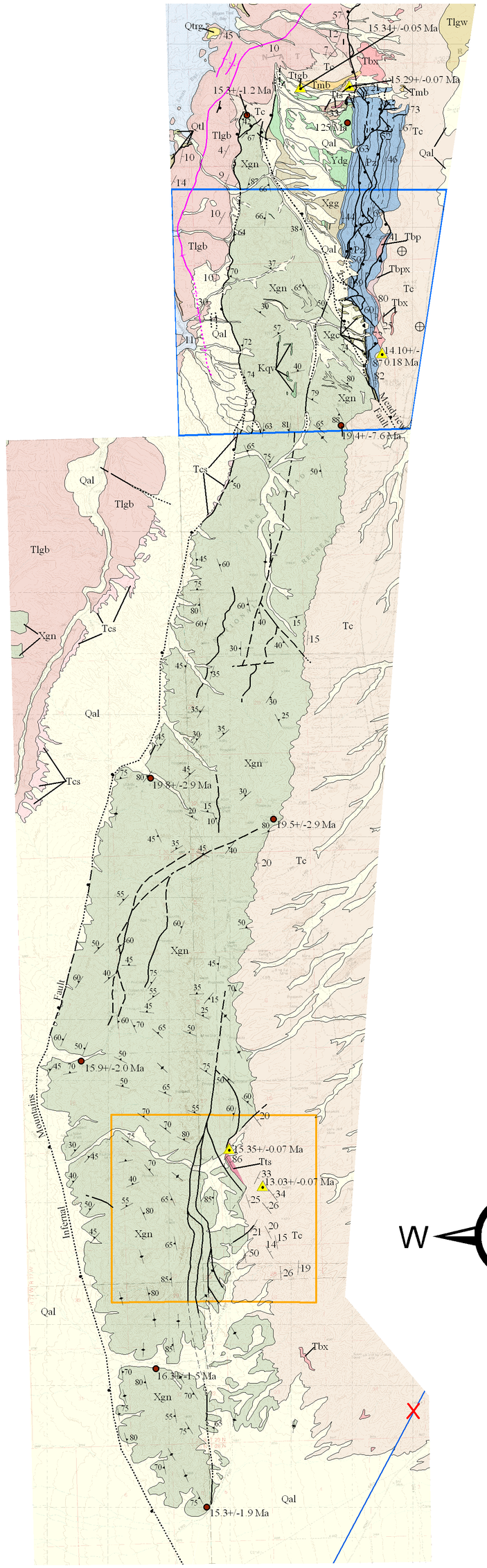
Anticline (Plates 1 and 2)

Syncline (Plates 1 and 2)

$^{40}Ar/^{39}Ar$ Geochronology (Plates 2 and 3)
- 15.35 Ma

Megabreccia Outcrops (Plate 3)

Area of Plate 3 (Plate 1)

Approximate Location of Blind Fault (Projected to the surface from Seismic Line RL-1)

Kinematic Data Locations (Plates 2 and 3)