

Geologic Map of the Iceberg Canyon Quadrangle, Clark County, Nevada and Mohave County, Arizona

By

Robert J. Brady, Joan E. Fryxell, and Bryan P. Wernicke

Qa Alluvial deposits (Holocene) Gray to light-brown or light-reddish-brown, unconsolidated, poorly sorted and subround to angular gravel, pebbles, sand, and silt. Thin (~3 cm) to medium bedded. Incised into all older rock units; variable thickness up to ~10 m.

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. Clasts are locally derived, commonly from dissected older conglomerate (QTfgw, QTf, QTg, QTfm, QTcg, Tcgw, and Tcg). 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 Grand Wash (not on this quad) and Wheeler Ridge faults. Up to 15 (?) m thick.

Qc Colluvium (Holocene to Pleistocene?) Gray to light-brown, usually unconsolidated, rarely calcite cemented, poorly sorted, subangular to angular, boulder to sand. Although occurring on many slopes, this unit was only mapped where it was thick enough to conceal the underlying unit.

QTfgw Alluvial fan and pediment deposits of Grand Wash Bay (Holocene to Pleistocene?) 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; clast composition suggests derivation from QTfm, Tbgw, Trgw, Tcgw, and Tcg. Occurs as slightly to strongly dissected erosional remnants adjacent to Grand Wash Bay, as much as 5 m higher than nearby Qa. Exposed thickness ~5 m.

QTI Landslide and talus deposits (Holocene to Pliocene?) Slump blocks and unconsolidated rubbly debris composed of angular cobbles and boulders of local bedrock; blocks range up to ~50 m in length and are up to ~10 m thick.

QTf Older alluvial fan and pediment deposits (Pleistocene to Pliocene?) 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 locally derived, commonly from dissected older conglomerate (QTg, QTfm, QTcg, Tcgw, and Tcg). 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.

QTg Pediment, stream, and alluvial fan deposits of Grapevine Wash (Pleistocene to Pliocene?) Unconsolidated to poorly consolidated, moderately to subrounded, poorly sorted pebble to cobble clast-supported conglomerate and subordinate sandstone lenses and beds. Clast types indicate derivation from Tcg and exposed Paleozoic units in Wheeler Ridge, they range in diameter from a few mm to 0.75 m and include varnished basalt, granite, and Paleozoic limestone, chert, and sandstone. Medium- to coarse-grained sand matrix. Exposed as a thin veneer ≤10 m thick) in the southeast corner of the quadrangle.

QTfm Fanglomerate of Million Hills (Pleistocene to Pliocene?) Weakly to moderately indurated, medium to thick beds of poorly sorted, moderately rounded to subangular clast-supported conglomerate containing a coarse-grained sand matrix cemented by calcite; clast types include abundant Proterozoic gneiss and granite, as well as Paleozoic limestone, chert, and sandstone. Crops out as a deeply incised alluvial fan surface throughout the Million Hills, between Grand Wash Bay and Azure Ridge; laps onto Tbgw, indicating a Pliocene or younger age. Exposed thickness as much as ~40 m.

QTC Chemehuevi Formation (Pleistocene to Pliocene) The Chemehuevi Formation (Longwell, 1936) is a light-tan or buff, poorly consolidated to unconsolidated, moderately to well-sorted, rounded to subrounded

medium- to coarse-grained quartz arenite and siltstone with common medium-scale cross-bedding. Within the Meadview North Quadrangle to the south, QTc grades laterally into QTcg (Wallace and others, 2005). Exposed thickness ~25 m.

QTcg Colorado River gravels (Pleistocene to Pliocene) Unconsolidated to weakly consolidated, moderately to well-sorted, clast-supported conglomerate. Clasts are composed of well rounded to rounded pebbles and cobbles (1.5-20 cm in length) of resistant Paleozoic limestone, chert, fine-grained sandstone/quartzite (each ~30%), and ~10% Proterozoic granite, gneiss and pegmatitic quartz. Matrix consists of fine to coarse sand. Clasts are commonly coated with rock varnish. Crops out only as erosional remnants (mostly < 2 m thick) exposed on tops of small hills near Lake Mead.

Tbgw Basalt of Grand Wash Bay (early Pliocene) Porphyritic olivine basalt; columnar jointed with spacing ranging from ~20 cm at the top to ~50 cm at the base; layering suggests at least 3 flows in the vicinity of Cormorant Cove; overlain by QTf, QTfgw, and QTfm; intercalated with Trgw. The basalt has yielded a 3.8 ± 0.11 Ma K-Ar age (Damon and others, 1978) and has been correlated to the Sandy Point basalt (Lucchitta, 1966), which yielded an $40\text{Ar}/39\text{Ar}$ age of 4.41 ± 0.03 Ma (whole rock) (Wallace and others, 2005). Total thickness ~60 m.

Trgw Red sandstone and siltstone of Grand Wash Bay (early Pliocene to middle Miocene?) Red, poorly to moderately consolidated sandstone and siltstone. Alternating beds of fine- to medium-grained sandstone, siltstone, and mudstone with subordinate lenses and minor interbeds of pebble conglomerate with coarse sand matrix; clasts mostly composed of granite or individual angular to subrounded grains of quartz, feldspar, and mafic minerals, clasts of basalt locally abundant; lenses of primary and/or secondary(?) gypsum locally common with individual laths 1-2 cm in length oriented perpendicular to bedding. This unit was previously included in the sandstone and siltstone facies of the Muddy Creek Formation (Longwell, 1936) and Muddy Creek Complex (Lucchitta, 1966), and the red sandstone unit of the rocks of the Grand Wash trough (Bohannon, 1984). Trgw is intercalated with Tbgw, suggesting an early Pliocene age for its top, the age of the base of the unit is unknown; this unit is possibly correlative in part with Tsgw. Maximum exposed thickness ~90 m.

Tcgw Conglomerate of Grand Wash Bay (early Pliocene to middle Miocene?) Medium grayish-red, poorly to moderately consolidated conglomerate and sandstone. Alternating beds of medium- to coarse-grained sandstone and pebble to cobble conglomerate with coarse sand matrix; clasts mostly composed of granite or individual angular to subrounded grains of quartz, feldspar, and mafic minerals, with lesser amounts of Paleozoic carbonate and

sandstone. Crops out underneath Trgw on the west side of Grand Wash Bay; it is unclear whether this represents the base of Trgw, or a coarse-grained bed intercalated with Trgw; this unit is possibly correlative with Tsgw and/or Tcg. Maximum exposed thickness ~20 m.

Tsgw Sandstone and siltstone of the Grand Wash Trough (late to middle Miocene) Red to gray and brown poorly to moderately consolidated sandstone and siltstone. Alternating beds of fine- to medium-grained sandstone, siltstone, and mudstone with subordinate lenses and minor interbeds of pebble conglomerate with coarse sand matrix; clasts mostly composed of granite or individual angular to subrounded grains of quartz, feldspar, and mafic minerals; root/stem traces and burrowing are common; lenses of primary and/or secondary(?) gypsum locally common with individual laths 1-2 cm in length oriented perpendicular to bedding. This unit was previously named the sandstone and siltstone facies of the Muddy Creek Formation (Longwell, 1936) and Muddy Creek Complex (Lucchitta, 1966), and was included in the red sandstone unit of the rocks of the Grand Wash trough (Bohannon, 1984). The unit ranges in age from <11 Ma to 14 Ma. Non-welded ash-fall tuffs in the Pearce Ferry area intercalated within Tsgw yielded zircon fission track ages of 10.8 ± 0.8 Ma to 11.6 ± 1.2 Ma (Ttu; Bohannon, 1984) and an $40\text{Ar}/39\text{Ar}$ age of 13.11 ± 0.08 Ma on sanidine (Ttpf; Wallace and others, 2005). Another nonwelded ash-fall tuff was found intercalated within Tsgw, near lake level, ~2 km north of Pearce Ferry and just east of the edge of the quadrangle, and was dated at 13.94 ± 0.12 Ma (plateau age, $40\text{Ar}/39\text{Ar}$; step heating experiment; isochron age: 13.69 ± 0.11 Ma). Tsgw crops out in the southeast corner of the quadrangle, east of Wheeler Ridge, where it interfingers westward with Tcg. Tsgw could be sourced from the southern Virgin Mountains to the west, the Lost Basin Range or Garnet Mountain to the south, or a paleo-Colorado or Virgin River flowing from the north and/or east. Exposed thickness is as much as ~120 m; probably was much more extensive before erosion by the modern-day Colorado River.

Tcg Conglomerate (late to middle Miocene) Previously called Gregg's breccia by Lee (1908), the conglomerate and breccia units of the Muddy Creek Formation (Longwell, 1936), and conglomerate-breccia facies of the Muddy Creek Complex (Lucchitta, 1966). Brown, pinkish, and light gray poorly sorted, moderately to poorly consolidated conglomerate. The matrix of the conglomerate and interbedded lenses of sandstone consist of coarse- to medium-grained, poorly to moderately sorted, subangular grains of quartz, feldspars, and micas. Angular to subangular clasts in the conglomerate range in size from pebbles to large boulders (>5 m). Bedding thickness ranges up to ~2 m; includes both matrix and clast-supported beds; weakly to moderately cemented by calcite. Grades laterally into and interfingers with overlying sandstone/siltstone facies (Tsgw). Clasts derived from the

~1.45 Ga Gold Butte Granite and pebble imbrication indicate provenance from the Gold Butte block in the southern Virgin Mountains 6-15 km to the west (Lucchitta, 1966). The clasts derived from the Gold Butte Granite consist of a rapakivi-type granite and are coarsely porphyritic, euhedral to subhedral perthite biotite granite with a medium- to coarse-grained groundmass of potash feldspar, quartz, plagioclase, and biotite. The perthite is mantled by oligoclase and albite and clumps of biotite aggregates. Within the quadrangle, Tcg crops out along the west flank of Gregg Basin, in the valley west of Wheeler Ridge, and in the southeastern corner of the quadrangle as a deeply incised alluvial fan, which was apparently sourced from the South Virgin Mountains to the west, and built eastward through a paleo-canyon that cuts through Wheeler Ridge. Maximum exposed thickness is ~250 m.

Ttu Tephras, undifferentiated (middle Miocene) Two horizons of white to blue-gray very fine- to fine-grained nonwelded ash-fall tuff, intercalated within Tsgw a few meters stratigraphically above Ttpf in the Pearce Ferry area. Thicknesses of these tuffs range from ~30 to 50 cm. The lower of the two tuffs has yielded zircon fission track ages of 11.6 ± 1.2 Ma and 11.1 ± 1.3 Ma, and the higher tuff yielded a zircon fission track age of 10.8 ± 0.8 Ma (Bohannon, 1984).

Ttpf Tephra in Pearce Ferry area (middle Miocene) White fine to medium-grained nonwelded biotite tuff with laminations consisting of 1 to 10 mm of brown mud. Contains ~5% phenocrysts of which ~40% are quartz, ~30% plagioclase, ~20% sanidine, and ~10% greenish-brown biotite. Groundmass consists of volcanic glass shards (~100-250 μ m in length) preferentially oriented parallel to bedding). This tuff is intercalated with Tsgw near or at the shore of Lake Mead in the Pearce Ferry area. Thickness is ~0.5 to 2 m.

Tbp Crackle breccia (late to middle Miocene) Reddish brown and gray, moderately to well indurated clast supported crackle breccia; lithologies are entirely composed of Paleozoic strata. Tbp is deposited disconformably on Paleozoic strata. Tbp probably originated as rock-avalanche deposits derived from the steep slopes of the southern Virgin Mountains. Maximum exposed thickness ~20 m.

Th Thumb Member of the Horse Spring Formation (middle Miocene) Brown to red cobble conglomerate and medium- to coarse-grained sandstone; beds 10 to 50 cm thick; well indurated. Clasts include Paleozoic carbonates and sandstones, and Proterozoic gneiss and granite. This unit crops out along the wash that cuts through the ridge east of Iceberg Canyon. It's base is disconformable with the underlying Pakoon Limestone (Pc2); bedding dips fan upsection, decreasing from ~58° E to ~17° E through ~100m of exposed section. Such rapid fanning of dips is

typical of the syntectonic Thumb member of the Horse Spring Formation (Bohannon, 1984; Beard, 1996).

Pk Kaibab Limestone (Permian) Thick to medium bedded, cliff-forming, medium light gray, aphanitic limestone with abundant dark brown chert stringers and nodules (fossiliferous). Basal bed is a thin (~1-2 m), red, cobble conglomerate, composed of clasts derived from Pc1 and Pc2, in a matrix of medium to coarse red sand; this bed is very recessive and rarely exposed. Total thickness ~150 m.

Pt Toroweap Formation (Permian) Thick to medium bedded, cliff-forming, light gray to pinkish gray, aphanitic limestone, includes dark brown chert stringers and nodules (fossiliferous); distinguishable from Pk primarily by difference in color and less abundant chert. Total thickness ~85 m.

Pch Coconino Sandstone and Hermit Formation (Permian) The Coconino sandstone is grayish yellow to orange, medium-grained, cross-bedded sandstone, ~10 m thick; typically forms a cliff above the Hermit Formation. The Hermit Formation is red, fine grained sandstone and mudstone; bedding generally indistinct, with several thick (~2 m) beds of red and white crossbedded, medium-grained sandstone. Total thickness ~475 m.

Pq Queantoweap Sandstone (Permian) Medium to thick bedded, moderate red and white, medium-grained, cross-bedded sandstone. Total thickness ~110 m.

Pc₂ Pakoon Limestone (Permian) and upper member of the Callville Limestone (Pennsylvanian) Thick to medium bedded, slope forming, light gray limestone and pinkish gray sandy limestone; includes a few beds of yellowish gray sandy limestone. Upper ~30 m is equivalent to the Pakoon Limestone (c.f. Billingsley, 1997). Basal bed is cross-bedded sandy limestone ~2 m thick that usually weathers to form a conspicuous dark brown horizon. Total thickness ~100 m.

Pc₁ Lower member of the Callville Limestone (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.

Mr Redwall Limestone (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 sucrosic dolostone. This formation is a very prominent cliff-former, commonly holding up ridge crests in the area. Total thickness is ~150 m.

Ds Sultan Limestone and unnamed sandstone (Middle Devonian) The Sultan Limestone is a prominent cliff-forming olive-gray dolostone, frequently including abundant silicified stromatolites or vugs, overlain by less resistant, well-bedded olive gray to light gray dolostone. Well sorted, well-rounded pale pink to white quartzarenite beds or pinkish-gray sandy dolostone beds (total thickness ≤ 2 m) are locally found below the olive gray dolostone. An outcrop of these unnamed sandstone beds farther to the north, on South Virgin Peak Ridge, yielded fish plate fossils identified as *Holonema*, *Asterolepis* and “crossopterygians” of Middle Devonian age (Elliott and Johnson, 1997). Total thickness is ~ 140 m.

Cm₅ Muav Limestone, unit 5 (Late Cambrian) Equivalent to the 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 dolostone overlain by medium gray burrow mottled dolostone and interbeds of light gray to white cryptalgal dolostone. Total thickness is ~ 300 m.

Cm₃₋₄ Muav Limestone, units 3 and 4 (Middle to Late 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 with some orange overprint on silt-rich portions. Unit 4 is slightly less resistant, dark to medium gray dolostone with interbeds of light gray to white cryptalgal dolostone. A prominent horizon of brown chert lenses occurs ~ 10 m above the base of unit 4. Total thickness is ~ 80 m.

Cm₁₋₂ Muav Limestone, units 1 and 2 (Middle Cambrian) Equivalent to the Papoose Lake Member of the Bonanza King Formation. Prominent cliff-forming light gray limestone overlain 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.

Cb Bright Angel Shale (Middle Cambrian) Shale and subordinate limestone. The basal parts consist of green and reddish brown shale containing worm burrows, oscillation 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 10 to 60 m.

Ct Tapeats Sandstone (Lower 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 Early Proterozoic metamorphic rocks. Thickness ranges from 20 to 40 m.

Pcu Undivided Proterozoic crystalline rocks (Proterozoic) Shown only in cross section.

Yg Gold Butte Granite (Mesoproterozoic) Named by Longwell (1936). Described by Volborth (1962). Coarse porphyritic perthite-quartz-biotite granite or biotite rapakivi granite, light gray, weathering to light brownish gray. This rock is distinctive because of abundant euhedral and ovoid perthite phenocrysts commonly 1-3 cm long, and 0.5-2 cm wide, with some phenocrysts as long as 5 cm (Volborth, 1962); within the map area these large feldspar phenocrysts generally compose $>50\%$ of the rock by volume, but both abundance and size of crystals decreases westward (Fryxell and others, 1992). Locally the perthite phenocrysts are rimmed with oligoclase and albite (rapakivi texture). Average modal analysis (Volborth, 1962): 45.5% perthite, 27.2% quartz, 17.6% plagioclase, 6.2% biotite, 1.2% sphene, 0.75% chlorite (altered hornblende), 1.1% fluorite, oxides, apatite, and 0.45% allanite. The Gold Butte granite has yielded U-Pb zircon and titanite ages of 1.45 Ga (work of L.T. Silver in Stewart, 1980; Reiners and others, 2000).

Xlg Leucogranite gneiss (Paleoproterozoic) Weakly to moderately foliated fine- to medium-grained gneiss, equigranular to coarsely pegmatitic, light gray to pink, except where altered to red directly under the sub-Cambrian nonconformity; composed of quartz, potassium feldspar, plagioclase, and less than 5% biotite. Includes rare garnet phenocrysts (xenocrysts?). Equivalent to the microcline granite of Volborth (1962).

Xmgf Granitic gneiss and amphibolite (Paleoproterozoic) Interleaved reddish-brown, fine- to medium-grained, weakly to moderately foliated granite and amphibolite; restricted to the southern part of the map area.

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 long; typically highly fractured and weathered reddish-brown near Cambrian nonconformity.

Xum Mafic and ultramafic rocks (Paleoproterozoic) Dark gray, strongly foliated, fine- to medium-grained amphibolite consisting of plagioclase, hornblende, pyroxene, and biotite; generally found as small concordant bodies interleaved with Xgc and Xgf. Also includes bodies of medium- to coarse-grained biotite, hydrobiotite, and vermiculite, intruded by migmatitic dikes from Xgn; this assemblage was probably metasomatized from an assemblage of hypersthene, diopside, hornblende, biotite, olivine, actinolite, and calcic plagioclase (Leighton, 1967).

Xog Orthogneiss (Paleoproterozoic) Strongly foliated gneiss containing plagioclase, quartz, hypersthene, potassium feldspar, biotite, and clinopyroxene; equivalent to the charnockite gneiss of Volborth (1962). Includes leucocratic portions in which foliation is weakly developed or absent, possibly equivalent to the migmatitic portions of Xgn (Fryxell and others, 1992).

Xgn Garnet gneiss (Paleoproterozoic) Strongly foliated gneiss and migmatite, contains garnet, biotite, cordierite, sillimanite, plagioclase, orthoclase, quartz, hercynite, and magnetite (Volborth, 1962; Thomas and others, 1988), migmatitic portions contain variably thick (1cm to > 10 m) leucosome layers of very coarse-grained quartz, feldspar, and garnet, with no internal fabric. Garnet porphyroblasts are generally unaltered, and surrounded by halos of quartz and feldspar, forming striking white on red contacts; westward from the west edge of the quadrangle, the garnet porphyroblasts become increasingly retrogressively altered to chlorite and mafic minerals (Fryxell and others, 1992). Similar gneiss crops out in the northern Virgin Mountains (Beal, 1965), at the west end of Frenchman Mountain, and to the south and west of this quadrangle (Blacet, 1975; Anderson and others, 1985; Thomas and others, 1988; Wooden and Miller, 1990; Wallace and others, 2005). K/Ar and Rb/Sr ages of 1.7 Ga were determined from pegmatites within unit Xgn (Wasserburg and Lanphere, 1965).

References Cited

- Beard, L.S., 1996, Paleogeography of the Horse Spring formation in relation to the Lake Mead fault system, Virgin Mountains, Nevada and Arizona: Geological Society of America Special Paper 303, p. 27-60.
- Blacet, P. M., 1975, Preliminary geologic map of the Garnet Mountain quadrangle, Mohave County, Arizona: U.S. Geological Survey Open-File Map 75-93, scale 1:24,000.
- Bohannon, R. G., 1984, Nonmarine sedimentary rocks of Tertiary age in the Lake Mead region, southeastern Nevada and northwestern Arizona: U.S. Geological Survey Professional Paper 1259, 72 p.
- Brady, R. J., 1998, The geology of the Gold Butte breakaway zone and the mechanical evolution of normal fault systems [Ph.D. dissertation]: California Institute of Technology, Pasadena, 188 p.
- Damon, P. E., Shafiqullah, M., and Scarborough, R. B., 1978, Revised chronology for critical stages in the evolution of the lower Colorado River: Geological Society of America Abstracts with Programs, v. 10, no. 3, p. 101-102.
- Karlstrom, K. E., and Bowring, S. A., 1991, Styles and timing of Early Proterozoic deformation in Arizona: Constraints on tectonic models, in Karlstrom, K. E., ed., Proterozoic and Ore Deposits of Arizona: Arizona Geological Society Digest, v. 19, p. 1-10.
- Longwell, C. R., 1936, Geology of the Boulder Reservoir floor, Arizona-Nevada: Geological Society of America Bulletin, v. 47, p. 1393-1476.
- Lucchitta, I., 1966, Cenozoic Geology of the upper Lake Mead area adjacent to the Grand Wash Cliffs, Arizona [Ph.D. dissertation]: Pennsylvania State University, University Park, 218 p.
- Reiners, P.W., Brady, R., Farley, K.A., Fryxell, J.E., Wernicke, B., and Lux, D., 2000, Helium and argon thermochronometry of the Gold Butte block, South Virgin Mountains, Nevada, Earth and Planetary Science Letters, v. 178, p. 315-326.
- Silver, L. T., Bickford, M. E., Van Schmus, W. R., Anderson, J. L., Anderson, T. H., and Medaris, L. G., Jr., 1977, The 1.4-1.5 b.y. transcontinental anorogenic plutonic perforation of North America: Geological Society of America Abstracts with Programs, v. 9, p. 1176-1177.
- Wasserburg, G. J., and Lanphere, M. A., 1965, Age determinations in the Precambrian of Arizona and Nevada: Geological Society of America Bulletin, v. 76, p. 735-758.
- Volborth, A., 1962, Rapakivi-type granites in the Precambrian complex of Gold Butte, Clark County, Nevada: Geological Society of America Bulletin, v. 73, p. 813-832.