Geologic Map of the Mammoth Cave Quadrangle, Lincoln County, Idaho

John D. Kauffman and Kurt L. Othberg

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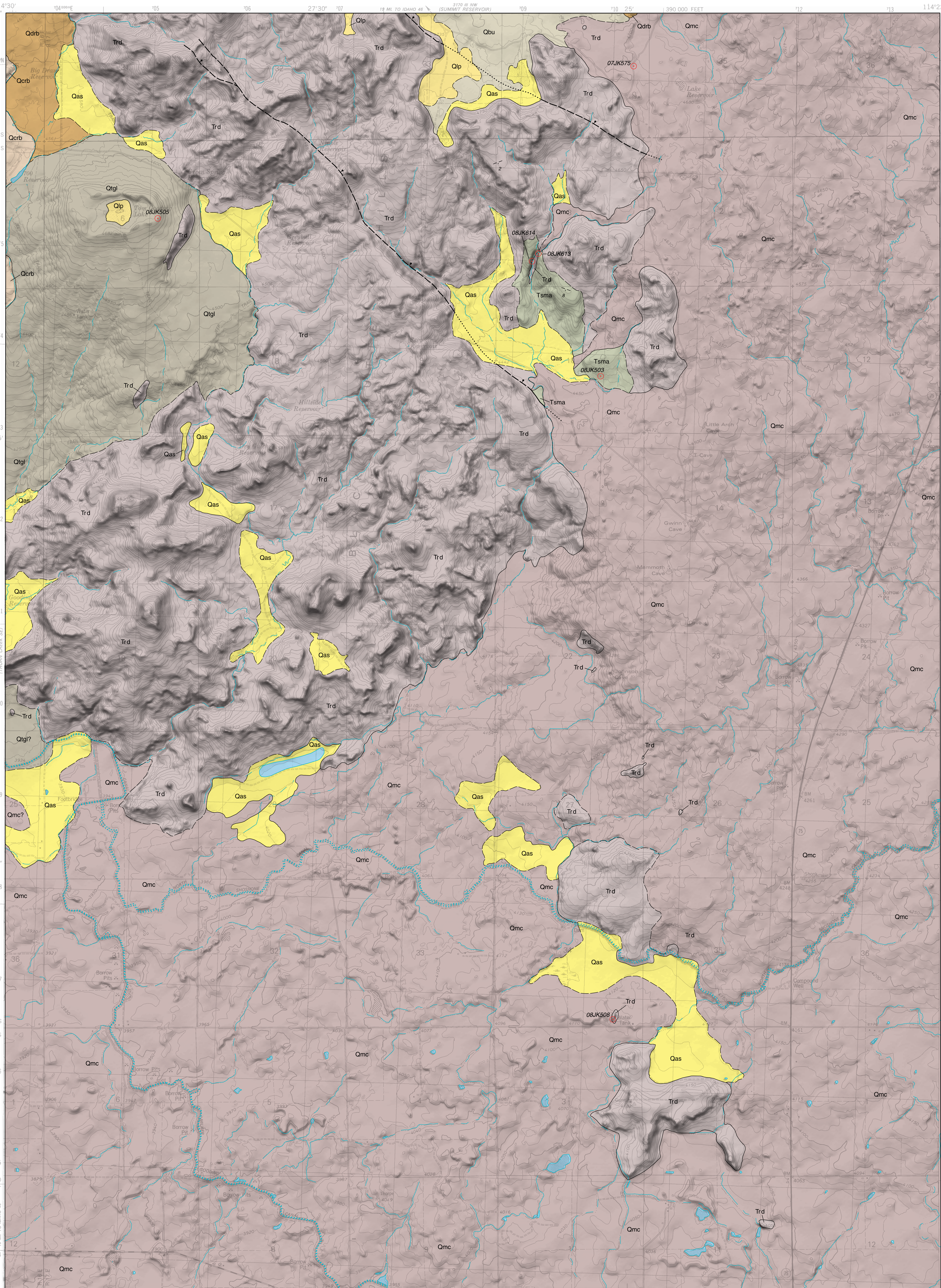
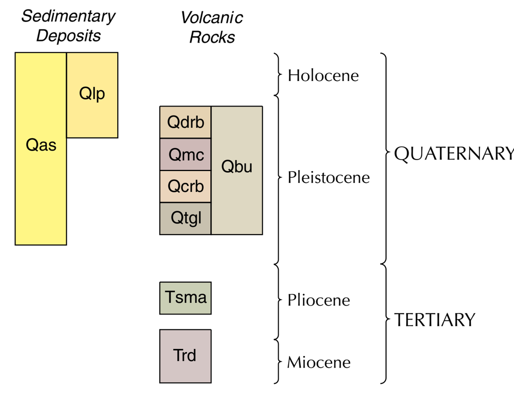


CORRELATION OF MAP UNITS



INTRODUCTION

The geologic map of the Mammoth Cave quadrangle identifies rock units exposed at the surface or underlying thin surficial cover of soil and colluvium. Thicker surficial deposits are also shown where they mask or modify the underlying rock or form significant units. The map is the result of field work conducted in 2007 and 2008 by the authors. Previous studies in the area include both regional and local mapping. Malde and others (1963) conducted reconnaissance mapping of part of the Snake River Plain and adjacent areas, and established a regional stratigraphy. Schmidt (1961) mapped a large area north of the quadrangle in the Bellevue area. Kauffman and Othberg (2007, 2008b) mapped adjoining quadrangles to the north and northeast; Othberg and Kauffman (2007) mapped the adjoining quadrangle to the east; Kauffman and others (2005) mapped the adjoining quadrangle to the south; and Cooke and others (2006) mapped the adjoining quadrangle to the southeast. Soils information is from Johnson (2002). Major oxide and trace element analyses of samples in the quadrangle were done at Washington State University's GeoAnalytical Laboratory in Pullman, Washington; analytical results are listed in Table 1.

The quadrangle is underlain by the late Miocene to Pliocene rhyolite and dacite of Eastern Mt. Bennett Hills, Pliocene andesite of Square Mountain, and Quaternary basalts erupted from several shield volcanoes within the quadrangle or in adjacent quadrangles. The andesite and basalts flowed onto a dissected topography of the rhyolitic rocks, filling the lowlands and flowing around the highlands. Several northwest-trending faults that offset the rhyolitic rocks do not disrupt the Quaternary basalts. Minor Quaternary alluvial deposits, many too small or thin to show at the map scale, fill closed basins, low areas at the edges of basalt flows, and poorly drained nearly flat surfaces.

DESCRIPTION OF MAP UNITS

SEDIMENTARY DEPOSITS

Qas **Alluvial deposits (Holocene and Pleistocene)**—Stratified silt, sand, and fine gravel deposited by intermittent streams and sheetwash into flat areas and small basins. Mostly silt in the south part of the quadrangle where loess has been redeposited onto nearly flat basalt surfaces. Thickness 2 to 10 feet.

Qlp **Playa deposits (Holocene and Pleistocene)**—Thin-bedded to massive clay and silt. Includes layers of coarse sand and small pebbles eroded from rhyolite and dacite unit (*Trd*). Forms flat to gently sloping fills in shallow closed depressions, commonly along edges of basalt flows.

VOLCANIC ROCKS

The relative ages of some Quaternary basalt units are uncertain because they are either not in direct contact or their contacts are obscured and subdued by soils. We present the units in the order we believe best approximates their relative ages, from youngest to oldest, based on geomorphological characteristics.

Qdrb **Basalt of Darrah Reservoir (Pleistocene)**—Fine to medium grained basalt with phenocrysts of plagioclase 2-4 mm long, olivine grains about 1 mm in diameter, and glomerocrysts of plagioclase and olivine 5-10 mm in diameter. Remanent magnetic polarity is normal, as determined in the field. Originates from a vent near Darrah Reservoir in the Summit Reservoir quadrangle to the north. Occurs only in northwest corner of the map. Smoother surfaces have clayey, stony soils generally less than 2 feet thick.

Qmc **Basalt of Mammoth Cave (Pleistocene)**—Flows examined are coarse grained with abundant plagioclase laths 5-7 mm long and common to abundant olivine grains and clots. Remanent magnetic polarity is normal, as determined in the field. Source is unnamed butte with survey elevation 4,975 located in the southeast corner of the Summit Reservoir quadrangle to the north. Flows of this basalt host the former tourist attraction of Mammoth Cave as well as several other lava-formed caves. In the northeast part of the quadrangle, surface of flows have common pressure ridges; stream drainage is lacking or poorly developed. Between pressure ridges loess is 2 to 6 feet thick and includes a well-developed soil caliche (duripan). In the southwest part, loess covers more of the surface and much of the land is farmed.

Qcrb **Basalt of Crater Reservoir (Pleistocene)**—Medium- to coarse-grained basalt with abundant phenocrysts of placioclase and olivine. Normal remanent magnetic polarity, as determined in the field. Source is the butte containing Crater Reservoir in the Summit Reservoir quadrangle to the north. Occupies only a small area along the northwest edge of the map.

Qtgl **Basalt of Tom Gooding Lake (Pleistocene)**—Very coarse-textured basalt where examined on the east rim of the butte. Consists of an open network of interlocking plagioclase crystals 4-8 mm long and common altered or weathered olivine grains interspersed in the plagioclase. Remanent magnetic polarity is normal, as determined in the field. Forms 1-2 m diameter columns on the butte rim, but otherwise is poorly exposed because of soil cover. Source is the butte containing Tom Gooding Lake. Flows abutted *Trd* unit to the north and east, and flowed around several *Trd* ridges on the east and south flanks of the butte. Appears to be geomorphically older than Crater Resevoir and Darrah Reservoir basalts. Stream drainage is moderately well developed. Basalt surface mostly covered by thin loess locally as much as 6 feet thick and includes a well-developed soil caliche (duripan). Variations in soil characteristics and vegetation form a patterned ground visible on aerial photographs.

Qbu **Basalt flows, undivided (Pleistocene)**—Fine-grained, dark gray vesicular basalt with common 1-2 mm plagioclase laths and uncommon olivine grains 1-2 mm in diameter. Vesicles coated or filled with calcium carbonate deposits. Exposed along north edge of the quadrangle. Source not determined, but possibly early flows of basalt of Mammoth Cave, basalt of Darrah Reservoir, or basalt of Crater Reservoir.

Tsma **Andesite of Square Mountain (Pliocene?)**—Fine-grained andesitic unit with abundant plagioclase phenocrysts and common quartz and plagioclase xenocrysts. Dark gray to black glassy groundmass in upper part of unit; greenish gray groundmass in platy zones. Occurs in a small area along the road from Gwinn Cave to Tom Gooding Lake where the andesite laps against and overlies *Trd* unit. In places where phenocrysts and xenocrysts are most abundant, the unit looks very similar to *Trd*. Samples plot in the upper part of the andesite field on the total alkali-silica diagram of LeMaitre (1984). Chemical composition for several samples we collected is nearly identical to that of the Square Mountain ferrolatite reported in Honjo (1986) and Honjo and Leeman (1987), and we consider these to be equivalent units. Also equivalent to Square Mountain basalt of Schmidt (1961).

Trd **Rhyolite and dacite of eastern Mount Bennett Hills (Pliocene or late Miocene)**—Phenocryst-, xenocryst-, and locally xenolith-rich rhyolite to dacite lavas(?). Groundmass is light tan-gray in platy, interior part of flow to dark gray to black and vitrophyric at the top and possibly in zones within the interior and at the base. Small pyroxene grains are scarce to common. Many of the plagioclase xenocrysts are embayed and quartz xenocrysts are typically resorbed and rounded. Vesicular zones are probably flow tops. Spherulites ranging from several millimeters to several centimeters are common, especially in the top part of flows, and typically are more resistant to weathering than surrounding rock and form rough, knobby rock surfaces. Composes the Black Butte Hills in the northern part of the quadrangle and several isolated remnants in the southern part. Forms ridges with common outcrops and aprons composed of colluvium and sheet wash deposits with few outcrops; where thick, forms cliffs several hundred feet high. Soils are generally thin to absent. Attitude is uncertain because flow layering is typically swirling or contorted, although there appears to be a general southward dip of 2 to 8 degrees. Included in the Moonstone rhyolite by Schmidt (1961) and Leeman (1982). Equivalent to rhyolite of Magic Reservoir (Tmr unit) of Honjo (1986) and quartz latite of Magic Reservoir (Tmq unit) of Worl and others (1991). Samples plot near the dacite-rhyolite boundary of total alkali versus silica classification (LeMaitre, 1984). Honjo (1986) reports a K-Ar age of 4.2 Ma for the Tmr unit at a location in the south part of the quadrangle. Struhsacker and others (1982) report a K-Ar age of about 5.8 Ma for their "older rhyolite"at the north end of Magic Reservoir, which we believe is equivalent to the Trd unit. Kauffman and Othberg (2008b) report a low confidence $^{40}Ar/^{39}Ar$ age of about 4.22 Ma. In the south part of the Magic Reservoir West quadrangle, *Trd* is clearly overlain by the tuff of Poison Creek (Kauffman and Othberg, 2008a), for which Struhsacker and others (1982) reported K-Ar dates ranging from about 4.77 to 5.64 Ma. Therefore, we believe the 5.8 Ma age for *Trd* is the more reasonable.

ACKNOWLEDGMENTS

We appreciate the cooperation of the private landowners who allowed access to their land.

SYMBOLS

Contact: dashed where approximately located.

Fault: dashed where inferred; dotted where concealed; bar and ball on downthrown side.

10 Estimated strike and dip of volcanic flow.

08JK057 Sample location and number.

Canal:Trace of major irrigation canal zone that includes area of excavation and side-casted fill. Zone of disturbance ranges 50-300 feet wide.

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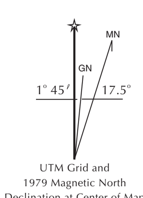
Table 1. Major oxide and trace element chemistry of samples collected in the Mammoth Cave quadrangle.

					Major elements in weight percent										Trace elements in parts per million																	
Sample number	Latitude	Longitude	Unit name	Map unit	SiO_2	TiO_2	Al_2O_3	FeO*	MnO	MgO	CaO	Na_2O	K_2O	P_2O_5	Ni	Cr	Sc	V	Ba	Rb	Sr	Zr	Y	Nb	Ga	Cu	Zn	Pb	La	Ce	Th	Nd
07JK575	43.1198	-114.416	basalt of Mammoth Cave	Qmc	47.44	2.731	15.74	13.10	0.213	7.00	10.34	2.49	0.47	0.482	69	213	33	299	420	8	324	226	35	19.2	19	43	130	6	23	51	3	30
08JK503	43.08942	-114.42042	andesite of Square Mountain	Tsma	62.57	1.482	14.35	7.67	0.124	1.84	4.53	3.23	3.85	0.357	5	15	15	113	2080	68	287	583	53	39.8	19	14	112	17	78	147	5	67
08JK505	43.10487	-114.47966	basalt of Tom Gooding Lake	Qtgl	46.61	3.304	16.30	13.69	0.203	5.80	10.33	2.72	0.43	0.596	55	170	30	313	421	4	378	249	38	19.7	20	33	138	3	31	57	1	37
08JK508	43.02639	-114.4188	rhyolite and dacite of Eastern Mt. Bennett Hills	Trd	68.37	0.836	13.78	5.49	0.104	0.58	2.51	3.41	4.60	0.317	0	3	9	25	2185	80	246	815	60	54.8	19	6	113	23	101	195	8	77
08JK613	43.10144	-114.42874	andesite of Square Mountain	Tsma	63.17	1.542	14.60	7.57	0.111	1.45	4.00	3.56	3.64	0.366	8	13	15	112	1632	67	264	580	49	39.5	21	15	116	18	73	138	7	62
08JK614	43.10056	-114.42972	rhyolite and dacite of Eastern Mt. Bennett Hills	Trd	68.74	0.918	13.64	5.47	0.099	0.54	2.14	3.55	4.62	0.272	1	6	9	36	2385	96	253	770	67	51.8	20	8	117	25	116	206	11	92

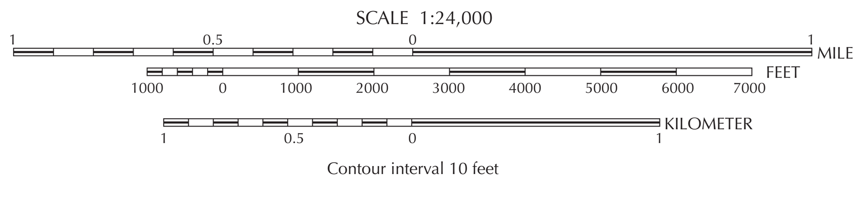
* Major elements are normalized on a volatile-free basis, with total Fe expressed as FeO.
All analyses performed at Washington State University GeoAnalytical Laboratory, Pullman, Washington.

Base map scanned from USGS film positive, 1979.
Shaded elevation from 10 m DEM, vertically exagerated 3x.
Topography by photogrammetric methods from aerial photographs taken 1971. Field checked 1973.
Photorevised 1979.
Transverse mercator projection.
10,000-foot grid ticks based on Idaho coordinate system, central zone.
1000-meter Universal Transverse Mercator grid ticks, zone 11.
1927 North American Datum.
National Geodetic vertical datum of 1929.



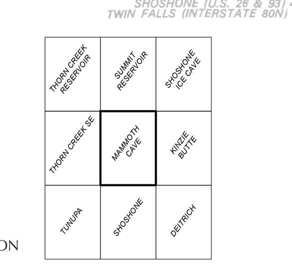
UTM Grid and
1979 Magnetic North
Declination at Center of Map

SCALE 1:24,000



Contour interval 10 feet

QUADRANGLE LOCATION



ADJOINING QUADRANGLES

Field work conducted 2007-2008.

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Digital cartography by Jane S. Freed at the Idaho Geological Survey's Digital Mapping Lab.

Note on printing: The map is reproduced at a high resolution of 600 dots per inch. The inks are resistant to run and fading but will deteriorate with long-term exposure to light.

Map version 5-1-2009.

PDF (Acrobat Reader) map may be viewed online at www.idahogeology.org.