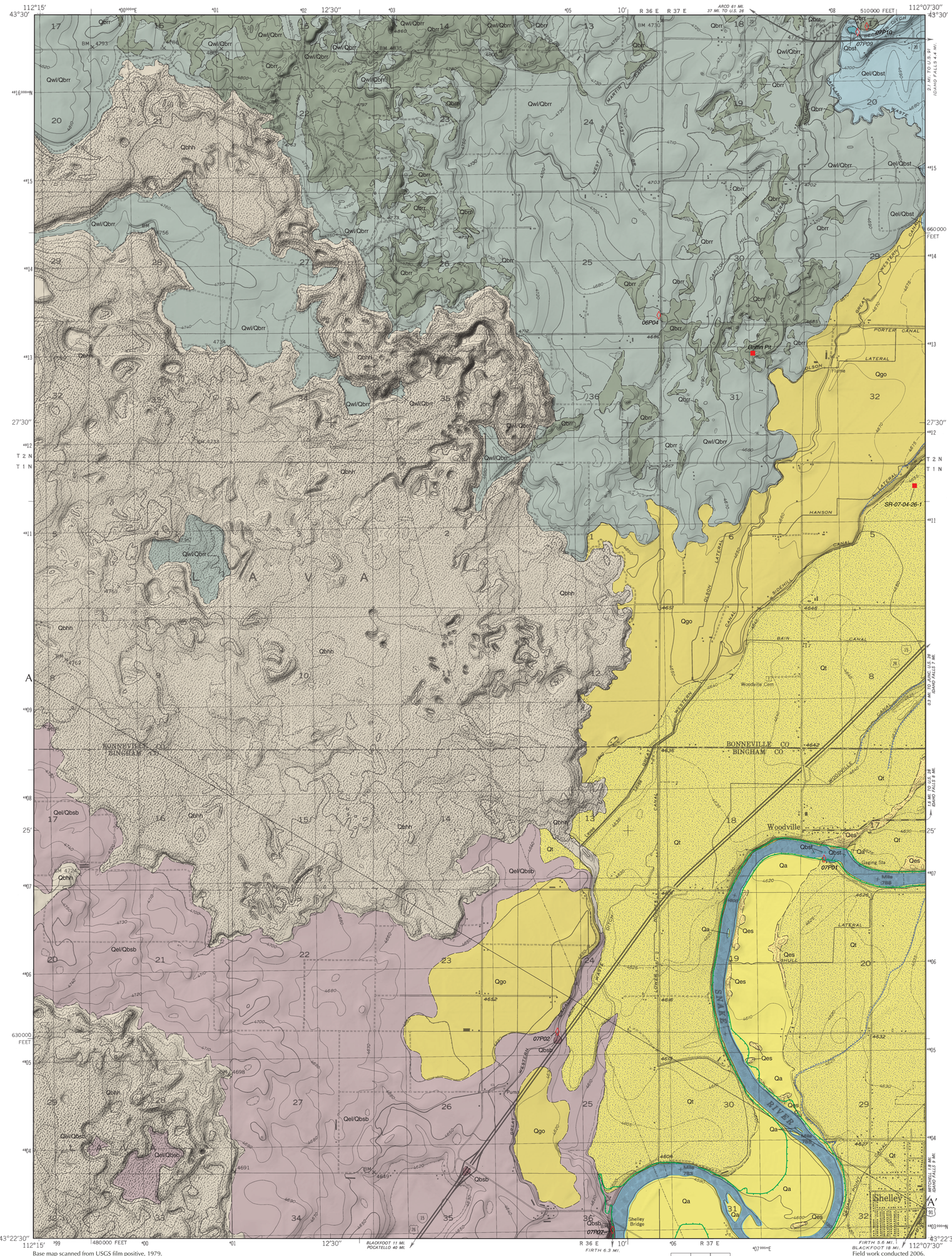
Geologic Map of the Woodville Quadrangle, Bingham and Bonneville Counties, Idaho

William M. Phillips and John A. Welhan

2011



Base map scanned from USGS film positive, 1979.

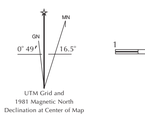
Shaded elevation from 10 m DEM.

Topography by multiplex methods from aerial photographs taken 1946 and plane-table surveys, 1948. Photorevised 1979.

Projection: Idaho coordinate system, east zone (Transverse Mercator). 1927 North American Datum.

10,000-foot grid ticks based on Idaho coordinate system, east zone.

1000-meter Universal Transverse Mercator grid ticks, zone 12.



SCALE 1:24,000

1 0.5 0 1 MILE

1000 0 1000 2000 3000 4000 5000 6000 7000 FEET

1 0.5 0 1 KILOMETER

Contour interval 10 feet
Supplement contour interval 5 feet

QUADRANGLE LOCATION

ADJOINING QUADRANGLES

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Digital cartography by Collette Gantenbein, Loudon R. Stanford, and Jane S. Freed at the Idaho Geological Survey's Digital Mapping Lab.

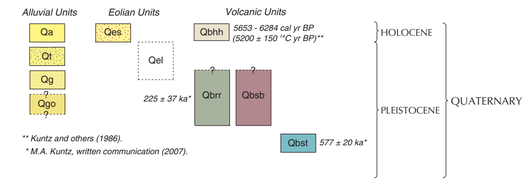
Reviewed by Dean L. Garwood, Idaho Geological Survey.

Map version 2-4-2011.

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

Field work conducted 2006.

CORRELATION OF MAP UNITS



INTRODUCTION

This map depicts bedrock and surficial geological units in the Woodville quadrangle. The map area sits on the edge of the eastern Snake River Plain, a major crustal downwarp associated with the Yellowstone Hotspot. The oldest bedrock units in the region are rhyolitic volcanic rocks of the Heise volcanic field erupted between 6.7 and 4.5 million years ago as hotspot volcanism progressed through the region. These units crop out to the east of the Woodville quadrangle in the Blackfoot Mountains. Subsequent Pliocene-Pleistocene basaltic volcanism and subsidence created the lava plains characteristic of the eastern Snake River Plain. The Snake River drainage also developed during this time in response to both regional subsidence and voluminous eruptions of basaltic lavas. Eruptions in and west of the map area caused the Snake River to occupy a position between the flows and the foothills of the Blackfoot Mountains. Volcanism continued as recently as 5700-6300 cal yr BP when flows of Hells Half Acre were erupted. At least several times during the middle and late Pleistocene, alpine glaciation in the headwaters of the Snake River generated huge volumes of outwash. During these periods, the Snake River was a braided stream with a much greater discharge than the present-day river. This caused a broad outwash plain to be built. Waning discharge near the end of the last (Pinedale) glaciation led to the cutting of a series of channels into the outwash plain, forming fill-cut terraces. These terraces occupy a position between the loess-covered basalt flows of the western map area and the thickest gravel deposits of the outwash plain to the east. The present-day Snake River, now a meandering stream, flows along this course. The outwash plain was an excellent source of eolian sediments during glacial periods. Deposits of fine sand, silt, and clay (loess) were deposited by strong winds during the Pinedale glaciation between ~24-15 ka. Loess thickness varies with the age of underlying units; it is absent on Holocene lava flows of Hells Half Acre and as much as 20 m thick on the oldest flow, basalt of Shattuck Butte.

SOURCES OF INFORMATION

The map is based upon compilation of existing geologic mapping (Scott, 1982; Rember and Bennett, 1979; Karlo, 1977; Shadid, 1971), field work conducted in 2006, and analysis of air photos, digital elevation models, soil maps (Salzmann and Harwood, 1973; Miles, 1981), paleomagnetic measurements of basalt, and drilling logs of water well records (Idaho Department of Water Resources, 2010). Radiocarbon ages were calibrated using CALIB, version 5.0 (Stuiver and Reimer, 1993).

DESCRIPTIONS OF MAP UNIT

ALLUVIAL UNITS

Qa **Alluvium of Snake River (Holocene)**—Well-rounded, pebble and cobble gravel, sand, and minor silt and clay of the Snake River floodplain. Thickness generally less than < 3 m (<10 ft). . Clast lithologies are same as unit *Qg*. Consists of gravel-rich point-bar deposits of the main channel and low terraces composed of finer-grain overbank deposits overlain by sandy loam soils of the Wardboro, Hayeston, and Heiseton soil associations (Salzmann and Harwood, 1973).

Qt **Snake River terraces (late Pleistocene)**—One or more terrace tread surfaces along the Snake River separated by 1.5-6 m (5-20 ft) scarps from the floodplain (*Qa*) and outwash plain (*Qg*) units. The terraces are largely erosional surfaces cut into underlying outwash alluvium rather than depositional features. Exposures in gravel pits suggest that terrace alluvium, when present, consists of thin (<1.5 m) planar-bedded gravel truncating underlying outwash. Terrace deposits cannot be separated reliably from unit *Qg* in most exposures or in well logs because of similar clast lithology, texture, and sedimentary structures. Terrace surfaces are generally covered by 0.5-1.5 m (1.3-5 ft) of loess-derived soils of Bannock and Bock associations with a Bk horizon developed at 30-70 cm (1.0-2.3 ft; Salzmann and Harwood, 1973; Miles, 1981). The terraces are inferred to have formed near the end of Pinedale glaciation between ~14–13 ka because of diminishing discharge of the Snake River. The OSL age of 23.33 ka (Table 1; sample SR-07-04-26-1) is interpreted to be from eroded unit *Qg* rather than dating formation of the *Qt* surface.

Qg **Alluvium of Snake River outwash (late Pleistocene)**—Well-rounded, clast-supported gravel, thickly planar- to cross-bedded, separated locally by thin, cross-bedded sand beds. Gravel is dominantly pebble- to cobble-sized, clast-supported, locally normally-graded and imbricated. Gravel framework is filled by subrounded fine- to medium sand. Gravel clasts are dominated by very hard, pink, purple, and gray quartzite with lesser sandstone, granitic rocks, rhyolite, porphyritic mafic igneous rocks, basalt, and limestone. Grains in sand beds are composed of subangular black obsidian, quartzite, quartz and feldspar phenocrysts, muscovite, and fragments of basalt and rhyolite. Sand beds are locally black because of high obsidian content. Covered by 0.5 to >1.5 m (1.6-5 ft) of loess-derived soils of the Bannock and Bock soil associations with a Bk horizon developed at 30-70 cm (1.0-2.3 ft; Salzmann and Harwood, 1973). Based on water well logs, unit is 6-15 m (20-49 ft) thick in the Woodville quadrangle. The unit is part of the huge braided-stream outwash plain deposited during the Pinedale glaciation by meltwaters from the Snake River headwaters (Scott, 1982). OSL ages ranging from ~25-13 ka (Phillips and others, 2009 are consistent with cosmogenic surface exposure ages of moraines in the Yellowstone headwaters (Licciardi and Pierce, 2008) An OSL age of 23.33 (Table 1, sample SR-07-04-26-1) from the Lopez gravel pit (NE 1/4 sec. 5, T. 1 N., R. 37 E.) is interpreted to date eroded unit *Qg*. Unit is important source of sand and gravel. *Shown on cross section only.*

Qgo **Older alluvium of Snake River (late to middle Pleistocene?)**—Poorly exposed gravel, sand, and minor clay overlain by loess; known largely from water well logs. In Bonneville County, overlain by basalt of Rifle Range (*Qbrr*) as shown by pattern of flow lobes and well logs (e.g. sec. 6, T. 1 N. R. 37 E.). In Bingham County, overlain by basalt of Shelley Bridge (*Qbsb*) as indicated by well logs and "islands" of *Qgo* surrounded by *Qbsb* (e.g. sec. 23, T. 1 N., R. 36 E.). Generally separated from unit Qt by a 2-6 m (7-20 ft) loess-draped scarp. Thickness estimated from well logs is 3–13 m (10-43 ft); overlain by 1-4 m (10-13 ft) loess. Age and correlation uncertain. Older than about 25 ka based on OSL ages of units *Qg* and *Qel*. Regional stratigraphy (e.g. Pierce, 2003; Forman and others, 1993) suggests correlation with either the Bull Lake glaciation (~140-160 ka) or an early Wisconsinian glaciation (~65-80 ka). However, *Qbrr* has a preliminary $^{40}Ar/^{39}Ar$ age of ~225 ka, so the unit could be much older. Also, well logs west of Woodville show multiple sand and gravel beds interbedded with basalts, suggesting a complex history of river-lava flow interactions in this area.

EOLIAN UNITS

Qes **Dune sand (Holocene)**—Medium- to fine-grained sand and lesser silt forming low hummocky dunes draped over south- and west-facing terrace scarps along the Snake River; deposits probably derived from the Holocene Snake River floodplain. Thickness is < 2 m (<7 ft). The Wolverine soil is developed on this unit (Salzmann and Harwood, 1973).

Qel **Loess (late Pleistocene)**—Massive, light gray to pale brown, silt, clay, and very fine sand. Calcareous except in leached near-surface soil horizons. Maximum thickness generally correlates with age of underlying unit. Where the unit is underlain by basalt of Rifle Range (*Qbrr*) and Shelley Butte (*Qbsb*), maximum thickness is about 6 m (20 ft). Loess is 1-4 m (3-13 ft) thick over *Qgo* and 1.5 m (5 ft) or less over *Qg* and *Qt*. No loess is present on basalt of Hells Half Acre. Soils developed on this unit when it overlies basalts include the Pancheri and Polatis soil associations (Miles, 1981; Salzmann and Harwood, 1973). At least three buried paleosoils consisting of carbonate-silica (Bk) and clay (Bt) horizons have been documented in loess elsewhere in the eastern Snake River Plain (Pierce and others, 1982). The buried soils separate multiple periods of loess accumulation correlated with regional glaciations, i.e. Pinedale (ca. 25-14 ka), early Wisconsinian (ca. 65-70 ka) and Bull Lake (ca. 160-130 ka). In the Griffin test pit (NE 1/4, sec. 31, T. 2 N., R. 36 E.; Table 1), 4.1 m (13.3 ft) of loess overlies basalt of Rifle Range. OSL ages of the loess range from 20.5-24.3 ka and have a linear depth-age relationship that indicates a deposition rate of 0.56 m/ka (1.83 ft/ka) and cessation of deposition at 17.2 ka (Phillips and others, 2009). Assuming an average bulk density of 1.45 x 106 g/m2 (90.5 lb/ft^3; Bettis and others, 2003), the loess mass accumulation rate is 812 g/m^2/yr (0.166 lb/ft^2/yr).

VOLCANIC UNITS

Qbhh **Basalt of Hells Half Acre (Holocene)**—Black to light gray, vesicular, olivine- and plagioclase-phyric basalt with groundmass of olivine, plagioclase, augite, and glass. Erupted from a single vent about 24 km northwest of the map area (Karlo, 1977). Dated by radiocarbon on bulk organic matter beneath the flow at 5653-6284 cal yr BP (5200 ± 150 ^{14}C yr BP; Kuntz et al., 1986, p. 166). Consists of several overlapping inflated pahoehoe flow units. Thickness ranges from 9-18 m (30-59 ft) to <1.5 m (<5 ft) at flow edges. Flow fronts are steep and extremely rough with pressure ridges, plateaus, collapse pits, pahoehoe lobes, and aa-like rubble. Away from fronts, relief is low and surface almost flat. Unit is unweathered, with minimal soil development and loess cover.

Qel/Qbrr/Qbrr **Basalt of Rifle Range (late Pleistocene? to middle Pleistocene)**—Light gray, vesicular, porphyritic basalt with phenocrysts of olivine and plagioclase (Karlo, 1977). Shown as *Qel/Qbrr* where covered with loess. Erupted from vent located in the southern half of the Shattuck Butte 7.5' quadrangle about 11 km north of the map area. Outcrops along pressure ridges extending above loess cover are common in the northern part of the map area and increase toward the vent. Water well records show unit overlies gravels near the *Qgo-Qel/Qbrr* contact. Unit is well-exposed along Beckman Ditch (S/2 S. 17, T. 2 N., R. 37 E.; Table 2, sample 07P10) were it overlies loess and *Qbst*. Unit appears to end near the Bonneville-Bingham county line. Similar paleomagnetic data (Table 2) and relationships with Snake River gravels suggest that *Qbsb* and *Qbrr* may be the same unit. Overlap of Snake River gravels and patchy loess cover suggest late Pleistocene age. However, a preliminary $^{40}Ar/^{39}Ar$ plateau age of 225 ± 37 ka was obtained from the *Qbrr* vent area (43.51231°, -112.19727°) in the Shattuck Butte quadrangle (M. A. Kuntz, written communication, 2007; A. Calvert, oral communication, 2007). If unit *Qgo* is correlative with Bull Lake or younger glaciations, then this age is incorrect.

Qel/Qbsb/Qbsb **Basalt of Shelley Bridge (middle to late Pleistocene?)**—Light gray, dense, olivine phyric basalt. Where covered by loess, shown as *Qel/Qbsb*. About 3 m (10 ft) of a single flow is exposed at Shelley Bridge (SE/4 S. 36, T. 1 N., R. 36 E.). Prominent scarp 3-6 m (10-20 ft) high formed by flow edge of this unit can be traced for several km both north and south of Shelley Bridge. A rare outcrop (Table 2, sample 07P02) is exposed along the scarp. In the area adjacent to Interstate 15 (S. 23, 26, 35, and 36, T. 1 N., R. 36 E.), water wells document 3-15 m thick *Qbsb* overlying Snake River gravel and surrounding kipukas of loess-draped *Qgo*. Unit continues south into the Firth quadrangle. Similar paleomagnetic data (Table 2) and relationships with Snake River gravels suggest that *Qbsb* and *Qbrr* may be the same unit. However, loess-draped unit cannot be traced north further than the Bingham-Bonneville county line because of cover by *Qbhh*. Unit has not been dated. Overlap of Snake River gravels and patchy loess cover in the Firth quadrangle suggest a late Pleistocene age while possible correlation with *Qbrr* suggests age is ~225 ka.

Qel/Qbst/Qbst **Basalt of Shattuck Butte (middle Pleistocene)**—Basalt of Shattuck Butte (middle Pleistocene) – medium gray, olivine- and plagioclase-phyric basalt lava flows. Where covered by loess, shown as *Qel/Qbst*. Textures vary from glomercrystic with olivine and plagioclase up to 5 mm, to equigranular and fine-grained. Many vesicles filled with soft, white, non-carbonate mineraloid; carbonate and silica coatings also common. Erupted from Shattuck Butte, about 11 km north of map area. Generally poorly exposed because of thick loess cover. Best exposed along south side of the Snake River at Woodville (SE/4 S. 18, T. 1 N., R. 37 E.; Table 2, sample 07P01) and along Beckman Ditch (S/2 S. 17, T. 2 N., R. 37 E.; Table 2, sample 07P09) where unit is overlain by loess capped with unit *Qbrr*. Thickness ranges from 30 to 45 m (98-148 ft). Unit has a distinctive excursional paleomagentic declination (Table 2). Dated at Shattuck Butte at 577 ± 20 ka by $^{40}Ar/^{39}Ar$ (M. Kuntz, written communication, November, 2004). Paleomagnetic properties suggest correlation with the Emperor-Big Lost reversal excursion event, dated at 565 ± 14 ka (Champion and others, 1988) and 549 ± 6 ka (Lanphere, 2000).

SYMBOLS

Contact: Line showing the approximate boundary between one map unit and another. The location accuracy of an approximate contact is more than 24 m (80 feet) on the ground.

Terrace scarp, ticks on lower side.

OSL — OSL sample location (see Table 1).

07P01 — Paleomagnetic sample location (see Table 2).

Extent of the 1976 Teton Dam flood (Matthai and Ray, 1976); tic on side of flooding.

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Table 1. Optically stimulated luminescence (OSL) ages.

				Dose Information								OSL Age Information				
Sample number	Latitude	Longitude	Unit name	Depth (m)	Grain Size (μm)	H_2O (%)	U (ppm)	Th (ppm)	K_2O (%)	Rb_2O (ppm)	Cosmic (Gy/ka)	USU Number	Number of Aliquots	Equiavlent Dose (Gy)	Dose Rate (Gy/ka)	OSL Age (ka)
SR 11-12-13*	43.46544	-112.14921	Qel	1.9	63-150	3.3	2.6	11.0	2.06	92.2	0.19	USU-096	26	65.99 ± 9.84	3.2 ± 0.15	20.51 ± 1.24
SR 11-11-12*	43.46544	-112.14921	Qel	2.7	63-150	3.6	2.7	9.9	2.11	85.3	0.17	USU-095	20	72.84 ± 15.39	3.28 ± 0.16	22.21 ± 1.59
SR 11-12-15*	43.46544	-112.14921	Qel	4.03	63-150	4.1	2.7	10.5	1.95	77.2	0.14	USU-098	24	73.54 ± 19.02	3.02 ± 0.15	24.34 ± 1.87
SR-07-04-26-1	43.45190	-112.12653	Qg	3.9	150-212	1.8	2.8	11.3	2.61	109.9	0.14	USU-134	27	84.85 ± 17.27	3.64 ± 0.15	23.33 ± 1.45

Note: uncertainties are 1σ and include random and systematic errors. Age produced by Tammy Rittenour at the Utah State University Luminescence Laboratory.
*Samples from Griffin test pit.

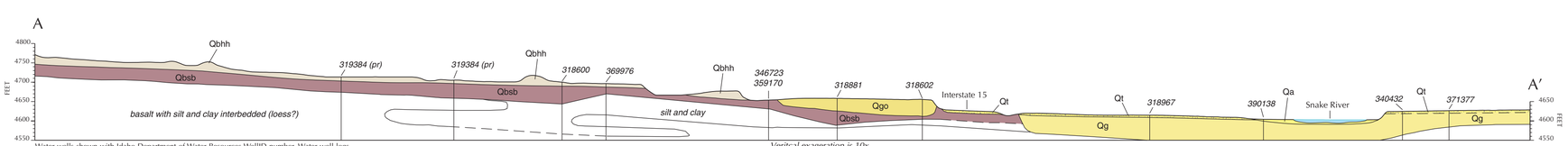

Table 2. Paleomagnetic data for the Woodville quadrangle.

Sample number	Unit name	Latitude	Longitude	n	D	I	α_{95}	k	Polarity	Demag Level (mT)
06P03*	Qbsb	43.33619	-112.20747	8	348	49	4.8	136	N	15
06P04	Qbrr	43.46933	-112.16239	7	348	55	2.4	634	N	20
07P02	Qbsb	43.39614	-112.17662	8	347	49	2.3	584	N	40
07P10	Qbrr	43.49883	-112.1332	8	358	52	2.3	588	N	30
07P07	Qbsb	43.37588	-112.16892	5	351	43	3.7	227	N	30
07P01	Qbst	43.41381	-112.13926	8	112	67	4.8	133	E	400
07P09	Qbst	43.49826	-112.13451	7	92	69	1.9	981	E	40

*Sample from Firth 7.5' quadrangle

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