Geologic Map of the Mann Creek SE Quadrangle, Washington County, Idaho

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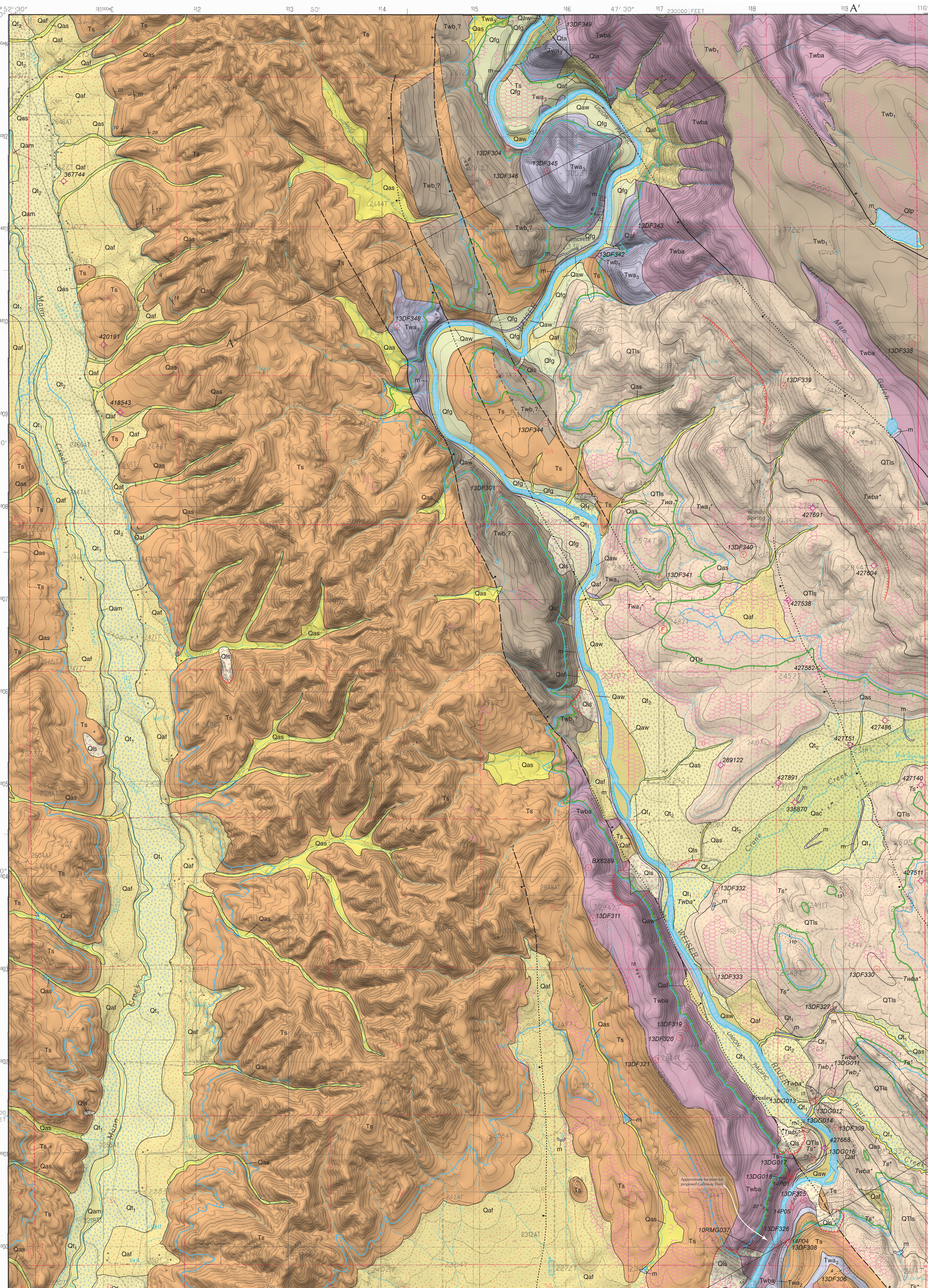
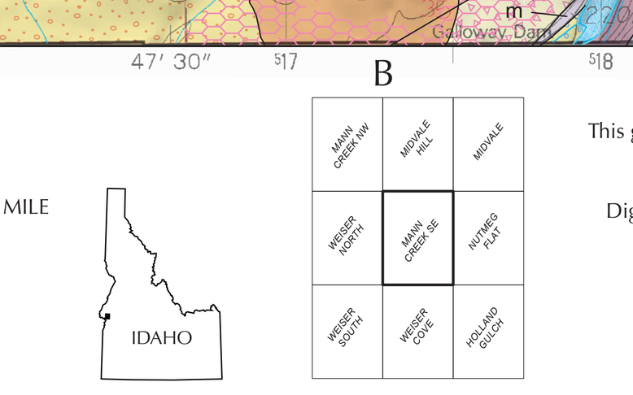
2014



Base Map Credit
Base digitally scanned from 24,000-scale USGS film separates, 1987.
Shaded elevation from 10 m DEM.
Topography by photogrammetric methods from aerial photographs taken 1981. Field checked 1984.
Map edited 1987.
Projection: Idaho coordinate system, west zone (Transverse Mercator). 1927 North American Datum.
10,000-foot grid ticks based on Idaho coordinate system, west zone.
1000-meter Universal Transverse Mercator grid ticks, zone 11.
Declination from NOAA National Geophysical Data Center.

SCALE 1:24,000

Contour interval 40 feet



Field work conducted 2013.
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Digital cartography by Jane S. Freed and Loudon R. Stanford at the Idaho Geological Survey's Digital Mapping Lab.
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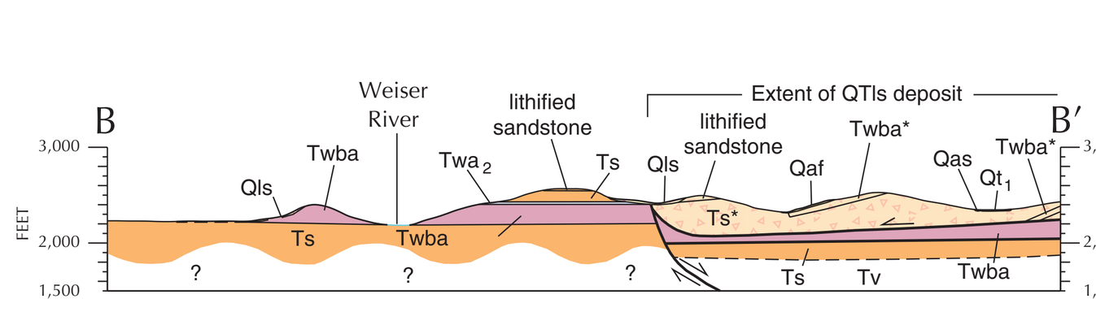
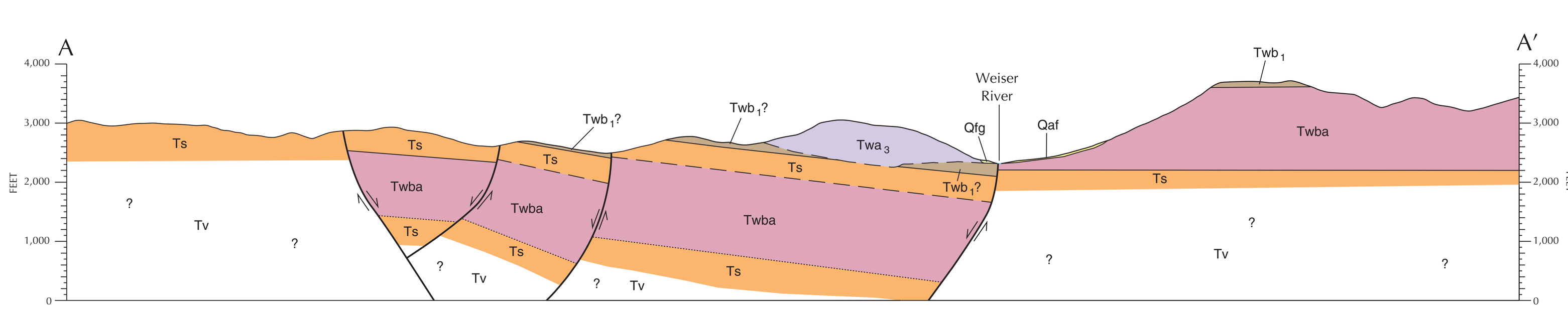
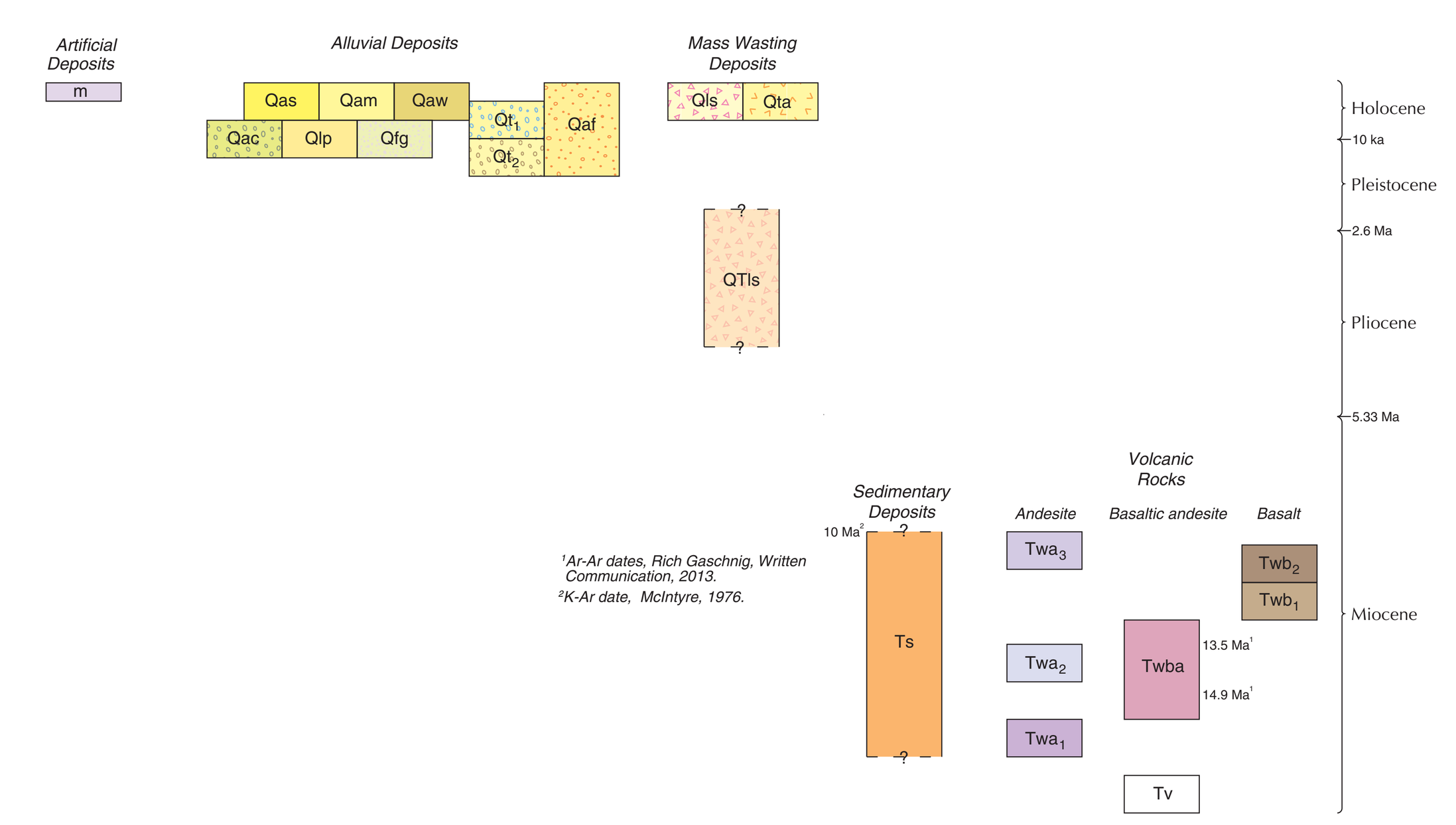
PDF (Acrobat Reader) map may be viewed online at www.idahogeology.org.





CORRELATION OF MAP UNITS



INTRODUCTION

The geologic map of the Mann Creek SE quadrangle depicts rock units exposed at the surface or underlying thin surficial cover of soil and colluvium. Thicker surficial deposits are also depicted where they mask or modify the underlying rock units or form significant units. The map is the result of field work conducted in 2013 by the authors and compilation from previous work, including that of McIntyre (1976), Fitzgerald (1981, 1982), Othberg (1982), and Lund (2004).

The bedrock that composes the Mann Creek SE quadrangle consists of a suite of compositionally diverse Miocene flows of the Weiser volcanics interbedded and underlain by Tertiary sedimentary deposits. Compositions of the Weiser volcanics range from rhyolite (exposed in neighboring Nutmeg Flat quadrangle, Garwood and others, 2014), andesite, basaltic andesite to basalt. Undated massive landslides (*QTls*) occupy much of the eastern portion of the Weiser River valley. Landslides are abundant in this map and primarily occur where the volcanic rocks are associated with, or interbedded with, poorly indurated Tertiary sediments, and may be driven by seismic activity or colder, wetter climate conditions. Large-scale normal faults trending north-northwest bound the Weiser River valley in a series of grabens and half-grabens. The proposed Galloway Dam site on the Weiser River within the project area is presently under study by Idaho Department of Water Resources and the U.S. Army Corps of Engineers. The dam site, designed to impound 760,000 acre feet of water at an elevation of 752 m (2470 ft) (BCAL, 2013), is underlain by Weiser volcanics.

Portions of Mann Creek and the Weiser River in the map area were flooded by the Bonneville Flood at circa 17.5–18.5 cal. ka (O'Connor, 1993; Miller and others, 2013). Modeling of Bonneville Flood water surface profiles along the Snake River indicate a minimum ponding level of 746 m (2447 ft) and a maximum ponding level of 760 m (2493 ft).

The western part of the Crane Creek Known Geothermal Research Area (KGRA) (Spencer and Russell, 1979) overlaps the Mann Creek SE quadrangle. Sinter, silicified *Ts* (Spencer and Russell, 1979; McIntyre, 1976) and hydrothermally altered clay and sediments in the area indicate the widespread and long-lived nature of the geothermal area. In the 1970s and 1980s numerous studies were conducted to evaluate the potential for geothermal energy development in the KGRA (Hoover and others, 1976; Mitchell and others 1980; Mitchell and others, 1984; Spencer and Russell, 1979; Young and Whitehead, 1975). Elevated surface (92°C) and subsurface temperatures (166-176°C) put the area high on the list for potential geothermal plays in Idaho but low groundwater flow rates have kept development down.

Crestesen No. A-1 (IGS, 2014 and Bond and others, 2011) was drilled by Phillips Petroleum Geothermal Operations in 1977, to a depth of 8,016 feet, just east of this quad in the southwest corner of Nutmeg Flat quadrangle. The well reached granite at 7,725 feet with the majority of material above being volcanic flows. Sediments make up the top 265 feet and a minor component between flows throughout the well.

SYMBOLS

Contact: Dashed where approximately located.

Normal fault: ball and bar on downthrown side; dashed where approximately located; dotted where concealed.

20 Strike and dip of bedding.

8 Approximate strike and dip of bedding.

12 Approximate strike and dip of basalt flows.

Estimated strike and dip of bedding; from McIntyre (1976).

Silicified *Ts*.

427486 Water well showing Well ID number.

13DG017 Paleomagnetic sample.

13DF330 Geochemical sample.

F Fossil locality.

Landslide headwall.

Line marking reservoir fill level of proposed Galloway Dam at 752 m (2470 ft) (BCAL, 2013).

Line marking slackwater fill level from Bonneville floods at 760 m (2493 ft) (O'Connor, 1993).

Patterned ground: Circular to elongate silty mounds separated by gravelly zones form a pattern of contrasting soil characteristics and vegetation that are readily mappable from aerial images. The mounds average 9-29 m (30-95 ft) in diameter and 0.3-2 m (1-6 ft) in height and they are associated with a grain size contrast that varies from silt and clay in the mounds to gravel in the intermounds. The patterned ground occurs on surfaces of gravel terraces, alluvial fans, and basalt flows with varying degrees of weathering. Malde (1964) noted that patterned ground of soil mounds and stone pavements is common in southern Idaho on gravel fans, basaltic lava flows, and rocky colluvium. His description is aptly applied to the best-developed patterned ground observed in this quadrangle: "Soil mounds in flat areas are closely packed, monotonously uniform circular heaps 50-60 feet across and 3 feet high, but on slopes they are elliptical and lie in rows along paths of soil that trend downhill. Each mound is composed of a lens-shaped cap of silt about 18 inches thick, abruptly underlain by 1-2 feet of brown clay" (Malde, 1964: p. 191). It is likely that the patterned ground formed through periglacial processes during times of colder climate in the Pleistocene. These processes are investigated and modeled by Kessler and Werner (2003), who attribute the resulting landform to freeze-thaw cycles that sort stones and soil.

DESCRIPTION OF MAP UNITS

ARTIFICIAL DEPOSITS

m **Man-made (Holocene)**—Sand, gravel, cobble, and boulder fill. Makes up the abandoned Pacific and Idaho Northern railroad grade in the Weiser River canyon, canal intake structures for the Sunnyside Canal on the Weiser River (lat 44.262°N, long 116.763°W.), dams <1.5 m (<5 ft) in the Crane Creek floodplain, and dams in Dead Man Gulch and surrounding plateau. Thickness where mapped is generally less than 2 m (6.5 ft).

ALLUVIAL DEPOSITS

Qlp **Lake and playa deposits (Holocene)**—Fine sand, silt, and clay sorted into thin laminated beds. Sediments derived from Tertiary sediments (*Ts*). Deposited during periodic floods around small manmade reservoirs.

Qas **Alluvium of tributary streams (Holocene)**—Clayey sand, silt, and fragments of shale in small channels draining landscapes underlain by Tertiary sediments (*Tsp*); in basaltic landscapes, deposits are silty sands derived from eolian sediments with lesser basaltic sand and cobbles. Thicknesses range from <1 m to 2 m (<3 ft to 6.5 ft). Many tributary streams are ephemeral. Subject to seasonal flooding during spring snowmelt and summer thunderstorms.

Qam **Alluvium of Mann Creek (Holocene)**—Clayey sand and silt, locally organic rich; contained in a narrow, incised, meandering channel. Poorly exposed in map; based upon data from below the Mann Creek dam at lat 44.392°N., long 116.894°W., deposit is about 1.2 to 4.3 m (4.5 to 14 ft) in thickness with gravel and boulders at base (USBR, 2012).

Qac **Alluvium of Crane Creek (Holocene)**—Clayey sand and cobble gravels primarily composed of well-rounded basalt with lesser silicified sandstone; forms numerous braid channels 0.6 to 1.5 m (2 to 5 ft) deep separated by several low terraces composed of clayey sandy silt. Minimum thickness is 1.8 to 3 m (6 to 10 ft); water and geothermal exploration wells (336870, 427891, 427486, and 427751) indicate that area is underlain by interbedded clay and gravel (IDWR, 2014).

Qaw **Alluvium of Weiser River (Holocene)**—Well-rounded cobbles and coarse- to medium-grained subrounded sand; cobbles dominated by dark gray to black basalt, with rare light gray to yellowish tuffs and granitic rocks. Sand consists of quartz, feldspar, and black and orange-gray lithic fragments. Micas are absent. Forms cobble point bars with braided channels 1 to 1.5 m (3 to 5 ft) deep. Islands and tops of some bars have thin deposits of arkosic sand. Thickness estimated at 2 to 3 m (6.5 to 10 ft).

Qt_1 **Lower terrace alluvium (Holocene)**—Along Weiser River, brown silty sand and clayey sand; indistinctly to medium bedded; about 1.8 to 3 m (6 to 10 ft) in thickness. Capped with 1 m (3 ft) dark gray soil horizon. Along Mann Creek, consists of brown clayey sand and silt poorly exposed in irrigation ditches. Thickness estimated at 2 to 4 m (6.5 to 13 ft).

Qt_2 **Higher terrace alluvium of Weiser River and Mann Creek (Late Pleistocene)**—Along Weiser River, consists of cobbles and sand capped with eolian sediments and sandy colluvium about 6 m (20 ft) above floodplain. May represent, in part, distal outwash of event that produced flood gravels (unit *Qfg*). Along Mann Creek, consists of poorly exposed gravel and sand capped with eolian sediments and sandy colluvium. Best exposed at confluence of Mann Creek with Weiser River valley (lat 44.24464°N., long 116.86149°W.) where it is 7.6 m (25 ft) thick and consists of well-rounded imbricated cobbles with thick, planar bedding. Cobbles consist of basalt and granite, and are clast-supported with light brown medium- to coarse-grained arkosic sand matrix. Locally interbedded with orange-brown, coarse- to medium-grained arkosic sand. The sand beds are cross-bedded and form lenticular, discontinuous beds as much as 0.6 m by 4 m (2 ft by 13 ft) in height and length. The deposit is capped by about 1 m (3 ft) of light brown sandy silt. Clasts in the upper portion of exposure are partially coated with silica-carbonate. Terrace surface is as much as 9 to 15 m (30 to 50 ft) above lower terrace and alluvium of Weiser River.

Qaf **Alluvial fans (Holocene-Late Pleistocene)**—Crudely bedded, poorly sorted, brown to red, subangular to angular gravel in a matrix of granules of sand, silt, and clay. Fans vary compositionally and appear as volcanic colluvium on steep canyon slopes. Form where small streams exit uplands. Deposits of individual fans have coalesced into semi-continuous fan aprons. Apparent thickness from topography and water wells (e.g. wells 418543, 420191, 367744) is 6 to 12 m (20 to 40 ft) with poor prospects for encountering sufficient water for domestic use (IDWR, 2014).

Qfg **Flood gravels of Weiser River (Late Pleistocene)**—Boulders and cobbles forming streamlined point and pendant bars composed almost entirely of basalt. Boulders are subangular 0.5 to >1.5 m (1.6 to >5 ft) in length; cobbles are sub-rounded to rounded. Surface of deposits are littered with boulders and partially covered by thin (<15 cm; 6 in) brown soil. Thickness is as much as 25 m (82 ft). Best exposures are near lat 44.372°N., long 116.809°W. where streamlined bars block confluence of Thousand Springs Creek with Weiser River (Fig. 1). Boulder gravel deposits are traceable upstream to large landslide scarp (Midvale Hill quadrangle at lat 44.402°N., long 116.783°W. (SE¼, SE¼, sec. 34, T. 13 N., R. 4 W.) near the maximum extent of ponded Bonneville Flood waters. Below this, unit Qt_2 occupies similar landscape position but lacks large boulders. The gravels may have formed when a landslide dam on the Weiser River failed.

MASS WASTING DEPOSITS

Qta **Talus (Holocene)**—Blocks of basalt at base of cliffs in Weiser River canyon.

Qls **Landslides (Holocene-Late Pleistocene)**—In the Weiser River canyon, rotational and translational slides involving competent basalt over less competent, weakly consolidated sediments. Main body of slide typically consists of basalt blocks or intact sections in diamict matrix with hummocky surface. Elsewhere, consists of small flows and spreads of weakly consolidated Tertiary sediments.

QTls **Older Landslides (Quaternary – Tertiary)**—Two rotational slides composed of mega-blocks of intact sections of volcanic flows (*Twa$_1$*, *Twba*, *Twb$_1$*, *Twb$_2$*), sandstones and sediments of *Ts*, steeply dipping, with variant strikes and dips. The landslides are classified as 'older' due to the lack of geomorphic evidence seen in younger landslides. Two slides occupy much of the eastern Weiser River valley, both slides are approximately 3.5 km (2.2 mi) long; the southern landslide covers 24.2 km^2 (9.3 mi^2) and the northern landslide covers 16.8 km^2 (6.49 mi^2). Slides are likely caused by the overburdening of poorly indurated sediment with multiple volcanic flows. The original head scarp of the southern landslide is in the southwest corner of Nutmeg Flat quadrangle (Garwood and others, 2014), while the head-scarp of the northern unit likely originated in both the Mann Creek SE and the Nutmeg Flat quadrangles

SEDIMENTARY DEPOSITS

Ts **Tertiary Sediments (Tertiary)**—*(Ts* on map indicates unit is within landslide and not in place.)* Undifferentiated Idaho Group and Payette Formation, clayey silt, fine- to coarse-sand rich sediment. Poorly sorted to well sorted, subangular sand composed of quartz, potassium feldspar, plagioclase feldspar, and in places to a minor degree biotite, muscovite, tuffaceous material and volcanic ash, occasional laminar beds and thin (<5 cm) organic beds, and frequent sets of climbing ripples and cross-cutting beds. Strike and dip of bedding varies in the area; the general trend is flat with dips less than 15° to the west- southwest. An active sand quarry found at lat 44.3717°N., long 116.8616°W., (S½ sec. 18, T. 12 N., R. 4 W.), has 12 m (40 ft) of exposed fluvial Tertiary sediments. At the top of the section there is a fine white chalky layer, ranging from 0.5 to 2 m (1.5 to 6.5 ft) thick that has limited lateral continuity; this layer likely is related to the diatomite deposit noted by Powers (1947) that has been mined on a small scale. The unconsolidated sediments of the Payette Formation and Idaho Group have been well described (Kirkham (1931), Malde and Powers (1962), Shah (1968), McIntryre (1976), Fitzgerald (1982) and Smiley and others (1975)) however a definitive break between the two is not obvious in the Mann Creek SE quadrangle. More analytical work on ash and fossils in the area could help differentiate the units. Leaf fossils were found at lat 44.3163°N., long 116.7821°W. (S½ sec.2, T. 11 N., R. 4 W.), in an ashy-clay layer, but no effort was made to identify the leaf or correlate the unit member since it was found within a landslide. Patterned areas on the map represent zones of outcropping silicified sandstone. The presence of hot springs at the mouth of the Crane Creek canyon and the continued interest in geothermal exploration points to geothermal processes as the likely source of the silicic lithification and mineralization of the Almaden mine (Forester and Wood, 2012). Included in the map are several apparent strike and dip measurements of sediments across the central portion of the map taken by McIntyre (1976). McIntyre (1976) suggests most if not all the *Ts* with in Mann Creek SE predates a cross-cutting basaltic andesite dike dated at 10 Ma (K-Ar).

VOLCANIC ROCKS

Twa_3 **Weiser andesite 3 (Miocene?)**—Medium- to dark-gray, fine-grained andesite, occasional small (<1 mm) grains of plagioclase. Lies uncomfortably on *Twb$_1$* and *Twba*. Two lithological zones are present, the western unit appears to form as flow while the larger north central unit appears more as dome or knob-like. Fitzgerald (1979) describes a vent, just north of the map, as 350 meters long and partially dissected by the Weiser River, comprised of an outer zone of loosely welded scoria with bombs and an inner zone of greatly welded core of splatter. Compared to the rest of the Weiser volcanics this unit is significantly smaller in volume. Chemically differentiated from *Twa$_1$* and *Twa$_2$* by moderate TiO_2 values (1.5 wt. %).

Twb_2 **Weiser basalt 2 (Miocene)**—*(Twb$_2$* on map indicates unit is within landslide and not in place.)* Medium- to dark-gray, fine- to medium-grained basalt with scarce rusty weathered olivine/iddingsite grains 1-2 mm in diameter, hornblende? phenocrysts up to 3mm long, and fibrous plagioclase phenocrysts generally <2 mm long. Normal magnetic polarity as determined in the field (fluxgate magnetometer) and formal paleomagnetic analysis. Mapped as the Star Butte member by Fitzgerald (1982). Consists of up to four flows ranging from about 1.5 to 9 m (5 to 30 ft) in thickness (Fitzgerald, 1982). Forms the capping flow in the Nutmeg Flat quadrangle to the east (Garwood and others, 2014). Outcrops typically are small knobs or patches of rounded or vesicular, blocky boulders. Source areas uncertain, but probably erupted to the northeast, along northwest-trending structures. Composition characterized by moderate to high TiO_2 (1.7-2.6 wt. %) and low SiO_2 (48.2-49.9 wt. %) (Table 1); differences in composition may reflect separate flows.

Twb_1 **Weiser basalt 1 (Miocene)**—*(Twb$_1$* on map indicates unit is within landslide and not in place.)* Purplish-brown to dark-gray, coarse-textured basalt with very abundant plagioclase phenocrysts as interlocking crystals as large as 8 mm, or as glomerocrysts, commonly with clinopyroxene; groundmass is fine grained. Voids are common among the interlocking crystals. Reverse magnetic polarity as determined in the field (fluxgate magnetometer) and formal paleomagnetic analysis. Mapped as the Sugarloaf member by Fitzgerald (1982). Consists of up to nine flows ranging from about 9 to 18 m (30 to 60 ft) in thickness (Fitzgerald, 1982) and has abundant ash, other pyroclastic material, and sediment associated with top and bottom contacts. Vent is unknown; topography and geochemistry suggest that Star Butte, located along the northern boundary of the Nutmeg Flat quadrangle to the east, may be a possible source (Garwood and others, 2014). Composition characterized by moderate TiO_2 (1.2-1.6 wt. %) and moderate SiO_2 (49.6-51.6 wt. %) (Table 1); differences in composition may reflect separate flows. *Twb$_1$?* (found along the Weiser River) denotes a series of basalt flows similar in total alkali vs SiO_2 and TiO_2 concentration to *Twb$_1$*, but is stratigraphically complex and contains anomalously low Cr/Sr ratios and may represent a separate unit.

Twa_2 **Weiser andesite 2 (Miocene)**—Light-gray to dark-gray with mottled yellow texture. Comprised of two flows approximately 2 to 5 m (6 to 15 ft) in thickness; significant *Ts* is found between the two flows. Chemically differentiated from *Twa$_1$* and *Twa$_3$* by low TiO_2 (0.6 wt. %). Ashy and tuffaceous sediments (*Ts*) may form interbeds between individual flows and beneath unit. Reverse magnetic polarity as determined by formal paleomagnetic analysis.

Twba **Weiser basaltic andesite (Miocene)**—*(Twba* on map indicates unit is within landslide and not in place.)* Purplish-gray to greenish-gray, medium- to coarse-textured basalt with occasional plagioclase phenocrysts as large as 1 cm, commonly with clinopyroxene and hornblende?; groundmass is a fibrous mix of plagioclase and clinopyroxene. Voids and vesicles are common, sometimes filled with secondary minerals. *Twba* includes some interbedded silicified and unsilicified (*Ts*) Tertiary sediments. Reverse magnetic polarity as determined in the field (fluxgate magnetometer) and formal paleomagnetic analysis. Mapped as the Cambridge member by Fitzgerald (1982). Consists of up to fourteen flows ranging from about 9 to 12 m (30 to 45 ft) thick (Fitzgerald, 1982) and has abundant ash, other pyroclastic material, and sediment interbedded with this unit. Source area is unknown. Composition characterized by low TiO_2 (0.8-1.4 wt. percent) and high SiO_2 (52.6-57.0 wt. %) (Table 1); differences in composition may reflect separate flows. Unit correlates to Tac and Tab in Forester and Wood (2012). Forester and Wood (2012) have two $^{40}Ar/^{39}Ar$ dates from *Twba* within Nutmeg Flat; they are not included in this map due to large error bars, but a minimum age of 12 Ma is suggested from their work.

Twa_1 **Weiser andesite 1 (Miocene)**—*(Twa$_1$* on map indicates unit is within landslide and not in place.)* Mottled reddish-gray to dark-gray. Chemically classified as trachy-andesite. Unit not found outside of *QTls* boundary. Tertiary sediments (*Ts*), ashy and tuffaceous sediments may form interbeds between individual flows and beneath unit.

Tv **Unknown volcanics**—Unknown volcanic material reported in geothermal well log (Chrestesen No. A-1) at depths 98 to 2,237 m (322 to 7,460 ft) (IGS, 2014) below surface, and in water wells 427668, 427511, 427140, 427604, 427691, 427751, 427486, 427891, 427582, and 427538 (IDWR, 2014). Only shown in cross section.

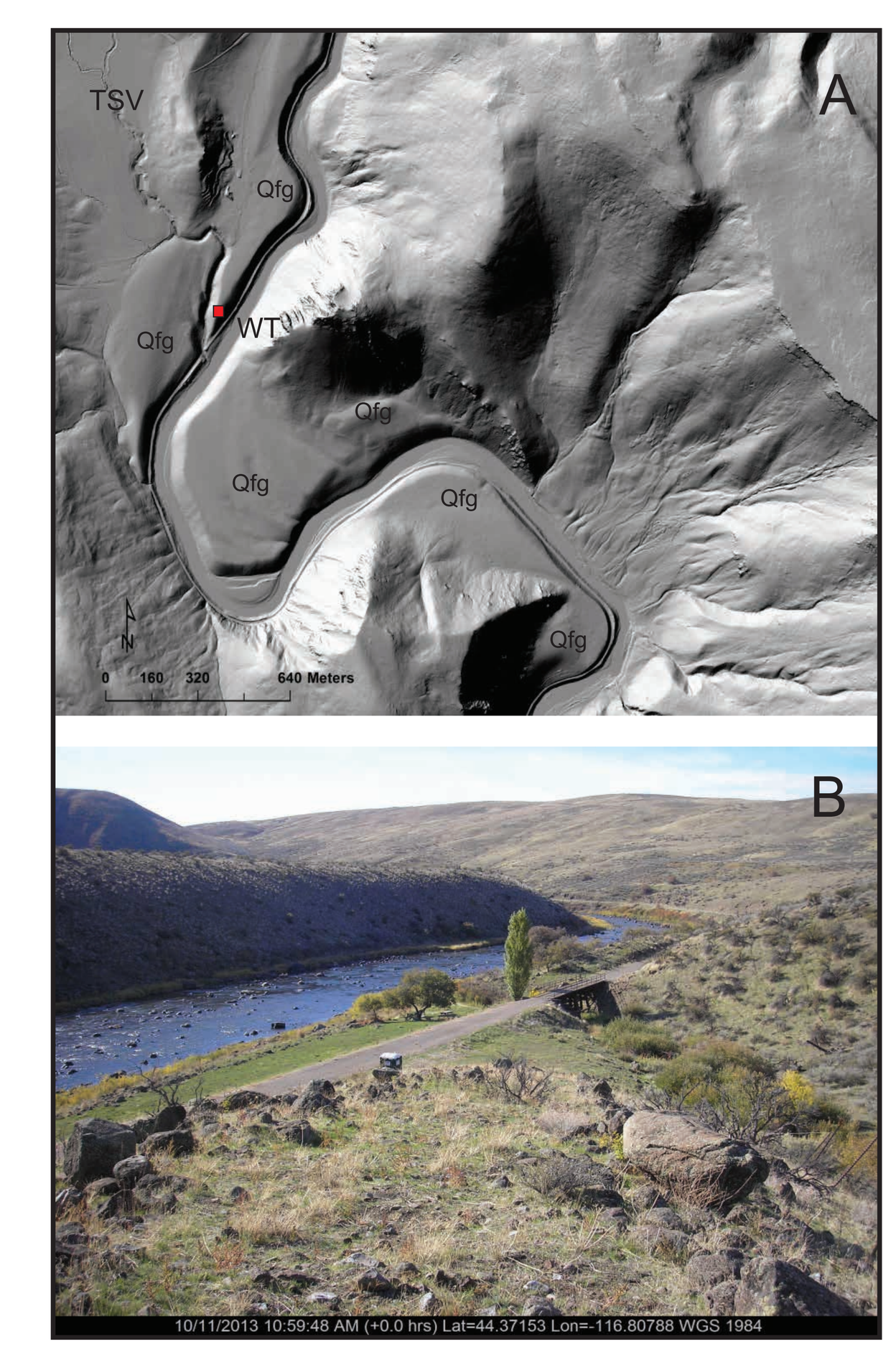


Figure 1. A: LiDAR image showing flood gravel deposits (unit *Qfg*) in the canyon of the Weiser River. River flows from north to south. Red rectangle marks photo (B) position next to Weiser Trail (WT). Thickness of *Qfg* is about 25 m (82 ft) here. Note blocking of Thousand Springs Valley (TSV) by streamlined flood gravel deposits. B: Photo looking south of *Qfg* point bar. Note large basalt boulders on bar surface in foreground.

Table 2. Paleomagnetic data for the Mann Creek SE quadrangle.

Sample number	Unit name	Latitude	Longitude	n	D	I	α_{95}	R	κ	Polarity	Treatment
14P01	Twba	44.2617	-116.7692	7/8	177	-23	4.7	6.96	165	R	PCA
14P04*	Twa_2	44.2554	-116.7694	3/8	216	-50	14.2	2.97	77	R	PCA
14P05*	Twba	44.2590	-116.7688	4/8	181	-41	2.6	3.99	1267	R	PCA

n = number of cores used / number of cores measured.
D = site mean declination of characteristic remanent magnetization (ChRm).
I = site mean inclination of ChRM.
α_{95} = confidence limit for the mean direction at the 95% level.
κ = precision parameter.
Polarity: N = normal; R = reverse.
Treatment: method used to isolate ChRM; PCA = principal component analysis.
Analyses performed in the IGS paleomagnetism laboratory, Moscow, Idaho.
*Analyses performed in the USGS paleomagnetism laboratory, Meno Park, California.

Table 1. Major oxide and trace element chemistry of samples collected in the Mann Creek SE 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	U
13DF301	44.32879	-116.80848	Weiser basalt 1?	Twb_1?	50.10	1.432	17.31	9.47	0.168	6.77	11.21	2.75	0.41	0.389	136	253	34	282	266	3	420	82	23	6.8	17	64	81	2	11	28	0	15	0
13DF304	44.36198	-116.80731	Weiser basalt 1?	Twb_1?	49.88	1.488	17.43	10.17	0.145	6.10	10.60	3.05	0.62	0.515	84	94	36	276	420	5	503	112	30	10.3	18	102	94	3	18	37	1	23	1
13DF306	44.25267	-116.76141	Weiser andesite 2	Twa_2	60.36	0.660	16.67	5.93	0.118	3.96	6.78	3.12	2.20	0.195	63	60	18	155	1026	48	427	100	18	6.0	17	75	60	9	18	31	4	11	0
13DF308	44.25542	-116.76938	Weiser andesite 2	Twa_2	59.92	0.674	16.89	6.01	0.131	4.14	6.94	3.12	1.97	0.198	63	62	20	155	1125	40	440	101	18	6.5	17	79	63	8	15	37	3	18	2
13DF309	44.26664	-116.76288	Weiser basaltic andesite	Twba	55.86	1.057	17.41	7.81	0.156	4.41	7.83	3.78	1.22	0.469	77	56	21	178	753	16	588	173	27	10.8	19	50	96	8	25	52	2	26	1
13DF311	44.28706	-116.79575	Weiser basaltic andesite	Twba	56.18	1.135	18.00	7.46	0.123	3.54	7.52	3.96	1.57	0.497	72	39	22	195	761	20	587	175	28	11.0	18	78	101	6	25	52	2	29	0
13DF319	44.27633	-116.78317	Weiser basaltic andesite	Twba	56.26	1.031	17.21	7.63	0.148	4.20	7.69	3.65	1.64	0.531	68	113	21	185	915	21	754	180	26	12.3	18	50	98	7	26	57	2	30	0
13DF320	44.27541	-116.78402	Weiser basaltic andesite	Twba	55.58	1.116	17.88	7.77	0.128	4.01	8.10	3.54	1.37	0.503	70	43	22	186	1001	21	605	169	31	10.4	18	53	97	5	25	51	2	25	1
13DF321	44.27321	-116.78730	Weiser basaltic andesite	Twba	55.32	1.096	17.69	8.21	0.140	4.19	7.80	3.80	1.28	0.478	73	44	21	180	764	11	589	170	29	11.0	19	58	91	7	28	49	2	29	2
13DF325	44.25958	-116.76724	Weiser basaltic andesite	Twba	54.96	1.283	16.90	8.26	0.187	4.62	8.79	3.24	1.31	0.460	73	84	28	243	832	25	521	137	27	9.4	18	39	94	6	21	41	2	24	1
13DF326	44.25500	-116.77113	Weiser basaltic andesite	Twba	55.11	1.263	16.92	7.93	0.186	4.67	8.86	3.31	1.32	0.449	73	80	27	241	742	24	508	134	26	9.9	18	86	91	6	22	46	2	27	2
13DF327	44.27815	-116.76322	Weiser basaltic andesite	Twba	56.28	1.032	17.18	7.52	0.141	4.35	7.74	3.62	1.62	0.525	64	111	22	183	868	23	765	180	25	11.6	19	55	98	6	28	55	2	27	1
13DF330	44.28205	-116.75729	Weiser basaltic andesite	Twba	53.66	1.355	19.36	9.16	0.078	2.48	8.15	3.64	1.53	0.584	162	360	27	224	773	12	1172	131	25	11.7	20	111	94	5	24	47	2	27	1
13DF332	44.28999	-116.77902	Weiser basaltic andesite	Twba	55.18	1.097	17.55	8.34	0.151	4.48	7.77	3.73	1.22	0.481	72	38	21	187	732	25	580	171	28	10.7	19	56	94	7	25	50	2	27	0
13DF333	44.28093	-116.77943	Weiser basaltic andesite	Twba	55.15	1.108	17.61	8.25	0.148	4.38	7.83	3.79	1.25	0.482	71	36	21	179	818	10	590	172	28	9.9	20	66	93	7	27	48	2	26	2
13DF338	44.34289	-116.75246	Weiser basalt 1	Twb_1	50.02	1.275	17.01	9.73	0.148	7.37	10.68	2.72	0.73	0.330	149	454	31	266	526	9	680	79	24	8.5	17	73	85	2	16	26	1	18	3
13DF339	44.33887	-116.76986	Weiser basaltic andesite	Twba	56.26	1.022	17.27	7.70	0.176	4.18	7.88	3.70	1.31	0.515	66	105	22	188	811	21	621	175	26	11.2	19	81	98	8	29	53	2	27	2
13DF340	44.32244	-116.77533	Weiser andesite 1	Twa_1	58.58	1.261	17.18	8.62	0.095	1.52	5.96	4.31	2.02	0.457	13	2	18	154	1169	20	558	176	32	9.9	19	46	95	9	29	57	3	29	2
13DF341	44.32022	-116.78684	Weiser andesite 1	Twa_1	58.38	1.238	16.88	7.86	0.215	2.81	6.01	4.06	2.09	0.470	13	3	19	189	1122	36	552	176	30	10.7	20	46	98	9	25	51	2	26	3
13DF342	44.35148	-116.79530	Weiser basalt 1?	Twb_1?	50.64	1.324	17.46	9.72	0.173	5.99	10.39	2.89	0.96	0.434	99	203	31	267	326	11	464	110	27	8.5	18	96	91	4	11	32	1	18	1
13DF343	44.35380	-116.79008	Weiser andesite 3	Twa_3	61.21	1.157	16.61	7.02	0.098	2.05	5.18	3.94	2.41	0.335	16	6	17	191	1144	50	421	152	25	8.8	17	47	74	10	21	45	4	21	2
13DF344	44.33520	-116.80211	Weiser basalt 1?	Twb_1?	50.46	1.368	18.22	10.25	0.152	5.06	10.21	3.12	0.65	0.513	107	191	32	247	483	5	597	127	29	11.2	19	77	93	4	20	44	1	26	0
13DF345	44.35978	-116.80194	Weiser andesite 3	Twa_3	60.76	1.144	16.49	6.82	0.127	2.38	5.58	3.50	2.88	0.324	16	6	16	191	1153	50	423	150	26	8.8	18	47	78	9	17	41	3	19	3
13DF346	44.35863	-116.80979	Weiser basalt 1?	Twb_1?	50.82	1.245	17.57	10.13	0.158	5.68	10.16	2.96	0.81	0.467	108	189	30	226	418	8	583	119	26	11.1	18	78	90	3	16	37	1	22	1
13DF348	44.34476	-116.82233	Weiser andesite 3	Twa_3	60.47	1.153	16.63	7.06	0.125	2.50	5.75	3.50	2.48	0.332	18	5	15	183	1166	49	432	152	26	9.1	18	45	77	9	24	43	3	19	3
13DF349	44.37419	-116.79964	Weiser andesite 3	Twa_3	61.04	1.156	16.60	7.01	0.086	2.16	5.32	3.90	2.41	0.321	17	5	16	182	1157	49	422	150	26	8.8	18	43	78	9	22	40	4	22	1
13DG011	44.26998	-116.76346	Weiser basalt 2	Twb_2	49.24	2.047	16.56	10.63	0.164	6.87	10.23	2.85	0.83	0.569	143	270	32	305	443	10	549	117	27	14.4	17	59	100	3	19	42	2	24	0
13DG012	44.26930	-116.76543	Weiser basalt 1?	Twb_1?	50.80	1.641	17.08	10.01	0.168	5.98	9.36	3.38	0.96	0.612	114	96	28	242	544	9	582	144	28	12.9	19	41	106	2	23	55	2	28	1
13DG013	44.26915	-116.76587	Weiser basaltic andesite	Twba	55.42	1.064	17.62	8.01	0.144	4.49	7.76	3.78	1.24	0.471	77	58	21	169	779	8	587	175	28	11.0	19	64	94	6	26	49	2	26	0
13DG014	44.26666	-116.76686	Weiser basalt 2	Twb_2	49.03	2.078	16.23	11.41	0.183	6.32	10.36	2.89	0.88	0.606	125	233	32	306	464	11	603	124	29	15.1	18	63	101	3	19	42	1	24	0
13DG016	44.26346	-116.76604	Weiser basaltic andesite	Twba	53.23	1.386	18.45	9.53	0.122	4.46	7.88	3.45	0.95	0.534	70	88	26	238	697	11	551	141	25	10.0	18	77	116	5	19	47	2	25	2
13DG017	44.26216	-116.76883	Weiser basaltic andesite	Twba	54.78	1.264	17.01	8.33	0.195	4.45	9.04	3.18	1.31	0.449	79	84	27	240	723	26	510	134	26	9.2	18	83	88	5	17	45	2	23	0
13DG018	44.26175	-116.76910	Weiser basaltic andesite	Twba	56.91	0.790	17.41	7.28	0.153	4.03	7.40	3.83	1.71	0.496	82	114	19	149	879	22	701	143	21	10.0	18	73	85	8	25	53	3	26	0
BX6289[1]	44.29197	-116.79636	Weiser basaltic andesite	Twba	55.51	1.065	17.90	7.65	0.160	4.44	8.10	3.38	1.40	0.390																			
10RMG037[2]	44.25503	-116.77410	Weiser basaltic andesite	Twba	56.52	0.790	17.19	6.96	0.161	4.61	7.59	3.82	1.55	0.499	83	132	19	152	887	17	710	142	20	10	19	74	87	7	29	48	1	25	1

* 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.
[1]From Fitzgerald, J.F., 1981.
[2]From R. Gashnig (written comm.), 2013.

REFERENCES

Boise Center Aerospace Laboratory (BCAL), 2013, Weiser river animation. Available at: www.bcal.boisetstate.edu (accessed 4 March 2014).
Bond, J.G., J.D. Kauffman, W.C. Rember, and D.J. Shiveler, 2011, Weiser Basin Evaluation: Idaho Geological Survey, Technical Report T-11-1.
Fitzgerald, J.F., 1979, An examination of two vents in the Columbia River Basalts, Weiser embayment, Idaho, Geological Society of America, Abstract with Programs, v. 11, no. 6, p.272.
Fitzgerald, J.F., 1981, Geology and basalt stratigraphy of the Weiser embayment, west-central Idaho: University of Idaho Ph.D. dissertation, 121 p.
Fitzgerald, J.F., 1982, Geology and basalt stratigraphy of the Weiser embayment, west-central Idaho, *in* Bill Bonnichsen and R.M. Breckenridge, eds., Cenozoic Geology of Idaho: Idaho Bureau of Mines and Geology Bulletin 26, p. 103-128.
Forester, C.S., and S.H. Wood, 2012, Geologic map of the Holland Gulch quadrangle, Payette and Washington counties, Idaho: Idaho Geological Survey Technical Report 12-1, scale 1:24,000.
Garwood, D.L., D.M. Feeney, and W.M. Phillips, 2014, Geologic map of the Nutmeg Flat quadrangle, Washington county, Idaho: Idaho Geological Survey Digital Web Map 168, scale 1:24,000.
Hoover, D.B., G.W. Brougham, and J.C. Clark, 1976, Station and traverse location map, audiomagnetotelluric data log, and telluric profiles of Crane Creek known Geothermal Resource Area, Idaho: U.S. Geological Survey Open- File Report: 76-409.
Idaho Department of Water Resources (IDRW, 2014, Water Well data. Available at: http://www.idwr.idaho.gov/GeographicInfo/gisdata/gis_data.htm (accessed 10 March 2014).
Idaho Geological Survey (IGS, 2014, Geothermal well data available at: http://www.idahogeology.org/webmap/, (accessed March, 2014).
Kessler, M.A., and B.T. Werner, 2003, Self-organization of sorted patterned ground: Science, v. 299, p. 380-383.
Kirkham, V.R., 1931, Revision of the Payette and Idaho Formations, Journal of Geology, v. 39, no. 3, p. 193-239.
Lund, K.L., 2004, Geologic setting of the Payette National Forest, west-central, Idaho: U.S. Geological Survey Professional Paper 1666-A, 89 p.
Malde, H.E., 1964, Patterned ground in the western Snake River plain, Idaho, and its possible cold-climate origin: Geological Society of America Bulletin, v. 75, p. 191-208.
McIntyre, D.H., 1976, Reconnaissance geologic map of the Weiser geothermal area, Washington county, Idaho: U.S. Geological Survey Miscellaneous Field Studies Map, MF-745, 1 pl.
Miller, D.M., C.G. Oviatt, and J.P. Mcgeehin, 2013, Stratigraphy and chronology of Provo shoreline deposits and lake-level implications, Late Pleistocene Lake Bonneville, eastern Great Basin, USA. Boreas, v. 42, p. 342-361.
Mitchell, J.C., L.L. Johnson, and J.E. Anderson, 1980, Geothermal investigations in Idaho—Part 9: Potential for direct heat application of geothermal resources: Idaho Department of Water Resources, Water Information Bulletin No. 30, part 9, 369 p.
Mitchell, J.C., K. Bideganeta, and J.E. Anderson, 1984, Stable isotopic evaluation of thermal water occurrences in the Weiser and Little Salmon River drainage basins and adjacent areas, west-central Idaho with attendant gravity and magnetic data on the Weiser area: Idaho Department of Water Resources, Water Information Bulletin No. 30, Part 12, 45.
Nakai, T.S., 1979, Stratigraphy of the Payette Formation, Washington county, Idaho: University of Idaho M.S. thesis, 187 p.
O'Connor, J.E., 1993, Hydrology, hydraulics, and geomorphology of the Bonneville Flood: Geological Society of America Special Paper 274, 83 p.
Othberg, K.L., 1982, Surficial geologic map of the Baker quadrangle, Idaho: Idaho Geological Survey Surficial Geologic Map 2, scale 1:250,000.
Powers, H.A., 1947, Diatomite deposits of southwestern Idaho: Idaho Bureau of Mines and Geology, Report No. 4, 28 p.
Shah, S.M.I., 1968, Stratigraphic paleobotany of the Weiser area, Idaho: University of Idaho Ph.D. dissertation, 189 p.
Smiley, C.J., S.M.I. Shah, and R.W. Jones, 1975, Later Tertiary stratigraphy and paleobotany of the Weiser area, Idaho: Idaho Bureau of Mines and Geology Information Circular No. 28, 12 p.
Spencer, S.G., and B.F. Russell, eds., 1979, Crane Creek known geothermal resource area (KGRA): An Environmental Analysis: EG&G Idaho Inc., 118 p.
U.S. Bureau of Reclamation (USBR), 2012, Mann Creek Dam – Overview. Available at: www.usbr.gov/projects/Facility.jsp?fac_Name=Mann+Creek+Dam (accessed 6 March 2014).
Young H.W. and R.L. Whitehead, 1975, Geothermal investigations in Idaho— Part 3: An evaluation of thermal water in the Weiser area, Idaho: Idaho Department of Water Resources, Water Information Bulletin No. 30, Part 3, 35p.

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