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SURFICIAL GEOLOGIC MAP OF THE UPPER BEAR RIVER AND BEAR LAKE DRAINAGE BASINS, IDAHO, UTAH, AND WYOMING

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SCALES 1:150,000 and 1:50,000

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DESCRIPTION OF MAP UNITS

[Fractional map symbols (for example, ed/rx and ed/tpo/ldo) are used where a thin veneer of one or more younger units overlies an older unit; ages and descriptions are identical to those of the individually mapped units; seven patterns indicate the veneer as follows: ed; fao or fay; fdm; ld; lso; md; vf. Queried map symbol (for example, gpy?) indicates uncertain identification of map unit]

FLUVIAL DEPOSITS

Channel and floodplain deposits of active streams (late Holocene)—Silt, clay, sand, and gravel; variably bedded and sorted; gravel tends to increase toward base. Gravel content greater along major streams and in areas of higher gradient. Commonly combined with unit th (at+th) where mapped along smaller streams

Low terraces deposited by perennial streams (Holocene)—Mostly 1–3 m above active channel; locally within reach of large flood events. Silt, clay, sand, and gravel; variably bedded and sorted; gravel tends to increase toward base. Gravel content greater along major streams and in areas of higher gradient. Distinguished from younger unit at by height above floodplain and from older unit tpy by presence of meander scars

Channel and floodplain deposits and low terraces of small perennial streams, undivided (Holocene)

Terraces and glacial outwash along perennial streams, undivided (Pleistocene)—Predominantly gravel and sand, variably bedded and crossbedded; clasts generally rounded. Subdivided into three units:

Generally smooth surfaces with little dissection (late Pleistocene)—More than 3 m above active channel; weakly developed calcic soils. Near glaciated areas, includes outwash of Smiths Fork glaciation (equivalent to Pinedale) (Munroe, 2001)

Moderately dissected surfaces (middle Pleistocene)—Above active channel by 3–10 m; moderately developed calcic soils. Intermediate terraces, only mapped in Bear Lake basin and along Bear River immediately downstream of Uinta moraines. Includes outwash of Blacks Fork glaciation (equivalent to Bull Lake) (Munroe, 2001)

Strongly dissected surfaces (middle and early Pleistocene)—More than 10 m above active channel; very strong calcic soils. Higher terraces along perennial streams; includes outwash of pre-Blacks Fork glaciations in headwaters (Munroe, 2001). From Bear Lake south to latitude 41∞00' (north boundary of Kings Peak 1:100,000 quadrangle), includes unit tpm. Along Bear River upstream of Evanston and along Yellow Creek to west, includes at least five terraces of different ages based on relative height of surface as estimated from aerial photographs

Relict fluvial terrace deposits (early Pleistocene to Pliocene?)—Sand and gravel with minor silt and clay; variably bedded and crossbedded. Mapped along crest of Bear Lake Plateau east of lake; one gravel pit exposes about 5 m of deposits. Apparently represents ancient course of Bear River prior to opening of Bear Lake Valley; locally, gravels descend slope eastward toward present course of Bear River. Also mapped along Smiths Fork east of Cokeville; as much as 45 m thick (Rubey and others, 1980). Appears graded to same level as pediment surfaces west of Smiths Fork

ALLUVIAL DEPOSITS

Alluvium of side slopes, small fans, and small intermittent streams (Holocene and late Pleistocene)—Silt, clay, sand, and gravel as available from local sources; weakly to moderately well bedded; clasts generally not well rounded

Alluvium on flat to gently sloping valley floors away from perennial streams (Holocene and late Pleistocene)—Mostly silt, clay, and sand. Includes fills in closed depressions (sinkholes) along Bear River Range west of Bear Lake

Deposits of active alluvial fans (Holocene)—Mostly sand and gravel, some silt and clay; variably bedded to massive; interbedded debris flows and fluvial sediment. Undissected

Deposits of mostly inactive alluvial fans (Holocene and late Pleistocene)—Grain size and bedding same as those of unit fa. Fan surfaces retain depositional topography, including debrisflow levees. Commonly incised by modern drainages; along larger streams may grade into unit tpy

Deposits of inactive alluvial fans (late and middle Pleistocene)—Grain size and bedding same as those of unit fa. Commonly smooth surfaces incised by modern drainages. Along larger streams may grade into, or be combined with, unit tpm. Includes some areas of pediment deposits (unit pd)

Deposits of inactive alluvial fans (middle and early Pleistocene)—Grain size and bedding same as those of unit fa. Commonly irregularly shaped surfaces, deeply incised by modern drainages. Along larger streams may grade into, or be combined with, unit tpo. Includes some areas of pediment deposits (unit pd)

Pediment deposits (Pleistocene)—Commonly a thin veneer of gravel and finer sediment, weakly bedded, overlying surface eroded on bedrock (bedrock features may still be discernible on aerial photographs). Locally subdivided into two units:

Pediment deposits, little dissected (late Pleistocene)

Pediment deposits, moderately dissected (late? and middle Pleistocene)

FLUVIAL AND ALLUVIAL DEPOSITS

Dissected alluvial-fan and terrace deposits, undifferentiated (middle and early Pleistocene)

GLACIAL DEPOSITS

Till deposited by young cirque glaciers (Holocene)—Bouldery gravel and sand; unsorted, unbedded. Moraine surfaces extremely irregular in shape and undissected. May include rock glacier deposits

Older till, undifferentiated (Pleistocene)—Bouldery gravel, sand, and minor silt and clay; mostly unsorted and unbedded, except where waterlaid ice-contact deposits are included. Subdivided into three units:

Till of the Smiths Fork glaciation (late Pleistocene)—Moraine surfaces irregular in shape, commonly with undrained depressions; equivalent to Pinedale till (Munroe, 2001; Bryant, 1992)

Till of the Blacks Fork glaciation (middle Pleistocene)—Moraine surfaces smooth and dissected; equivalent to Bull Lake till (Munroe, 2001; Bryant, 1992)

Till of pre-Blacks Fork glaciations (middle and early? Pleistocene)—Morainal geomorphic forms generally not preserved (Munroe, 2001; Bryant, 1992)

MASS-WASTING DEPOSITS

Artificial fill (historic)—Mapped along highways, around mines, and lining canals

Colluvial deposits (Holocene and Pleistocene)—Commonly mixtures of boulder to clay-size sediment, weakly sorted and bedded, that

accumulated in hollows and along gentle hillslopes around Bear Lake (present but not separately mapped along upper Bear River)
Talus deposits (Holocene and late Pleistocene)—Angular to subangular blocks, with variable amounts of clay, silt, and sand in interstices; occurs on steep, poorly vegetated slopes. Along crest of Bear River Range west of lake, may include small rock glaciers
Landslide deposits (Holocene and Pleistocene)—Chaotic mixtures of gravel, sand, silt, and clay; unbedded, unsorted. Locally divided into two units:
Younger landslide deposits (Holocene and late Pleistocene)—Relatively undissected, with undrained depressions and obvious hummocky surfaces
Older landslide deposits (late and middle Pleistocene)—Dissected, with smoother surfaces than unit lsy
LAKE DEPOSITS
Lacustrine deposits of Bear Lake, undifferentiated (Holocene and Pleistocene)—Gravel, sand, silt, clay, and marl; very well bedded and sorted. Gravel and sand form wave-sorted beach and nearshore barriers and ridges; silt, clay, and marl deposited in deeper water underlie flat plains. Where better drained and unburied, surfaces of the deeper water facies of unit ld are marked by small undrained depressions (not shown on map) on topographic maps and aerial photographs—for example, between Ovid and St. Charles on the west side of Bear Lake Valley, and around Montpelier. Thus, where poorly exposed and (or) covered by marsh deposits, presence of such depressions is used as the primary mapping criterion for unit ld—for example, between Meadowville and Laketown south of Bear Lake. Locally divided into three units:
Young, undissected lacustrine deposits (Holocene and late Pleistocene)—Where well exposed or dated, divided into two units:
Deposits of Garden City and Lifton phases (late and middle Holocene)—Age <9 ka (Laabs, 2001; Laabs and Kaufman, 2003)
Deposits of Willis Ranch, Cisco, and Raspberrry Square phases (early Holocene and late Pleistocene)—Age 16–9 ka (Laabs, 2001; Laabs and Kaufman, 2003; Reheis and others, 2005). Little-dissected lacustrine deposits. Locally subdivided into:
Beach sand and gravel of Willis Ranch, Cisco, and Raspberry Square phases (early Holocene and late Pleistocene)
Intermediate lacustrine deposits (late Pleistocene)—Includes deposits of Jensen Spring phase (~40 ka; Laabs, 2001; Laabs and Kaufman, 2003; Reheis and others, 2005). Dissected and moderately uplifted on east side of Bear Lake
Older lacustrine deposits (middle and early Pleistocene)—Includes deposits of Bear Hollow phases (1,000–100 ka; Laabs, 2001; Laabs and Kaufman, 2003; Reheis and others, 2005).

Dissected and strongly uplifted on east side of Bear Lake and south of Montpelier

MARSH AND SPRING DEPOSITS

Marsh deposits (Holocene and late Pleistocene)—Silt, clay, and marl, locally organic rich; moderately sorted and bedded to massive; deposited in poorly drained areas or in shallow standing water. Mapped north and south of Bear Lake, where unit may include lacustrine deposits, and at a seasonally dry pond in northeastern Ogden quadrangle. Also mapped within areas of unit gpy (young glacial till) in the glaciated Uinta Mountains, where sediments may be laminated and more sandy

Spring deposit (Holocene and Pleistocene)—Carbonate-rich silt and sand, moderately sorted; locally includes layered and cemented travertine. Mapped in only one isolated spot east of Bear Lake; also occurs west of Bear River north of map area

EOLIAN DEPOSITS

Eolian deposits (Holocene and Pleistocene)—Sand and silt, well sorted, variably bedded to massive. Dunes and sand ramps as much as 50 m high (Dover, 1995) lie east of Bear River against faulted front of Crawford Mountains (Dover, 1995); in sand ramps, sand beds commonly interfinger upslope with gravelly colluvium. Loess as much as 30 m thick (Rubey and others, 1980) locally blankets low hills east of Bear River south of Cokeville. As much as several meters of loess also overlie older lake deposits of Bear Lake (units ldm and ldo), locally much thicker where banked against a topographic obstruction. Not mapped where <1 m thick on younger lake deposits

MIXED DEPOSITS

Alluvium and colluvium, undifferentiated (Holocene and late Pleistocene)—Typically mapped where alluvium of unit afs abuts steeper slopes that shed colluvium or talus

Alluvium and marsh deposits, undifferentiated (Holocene)—Typically mapped around distal parts of streams entering marsh north of Bear Lake as distributary channels, and where abandoned channels are occupied by freshwater marshes

Diamicton (Pleistocene)—May include landslide, glacial, and colluvial deposits. Mapped only along east flank of Bear River Range west of lake, in areas where poor exposure prevented identification of deposits

Fan-delta deposits (Holocene to middle Pleistocene)—Gravel, sand, and silt; moderately sorted and bedded. Deposited where perennial streams with steep gradients delivered coarse sediment into lake, for example at mouth of Bear River and along east side of Bear Lake. Commonly reworked by wave action. Locally divided into four units:

Youngest fan-delta deposits (late and middle Holocene)—Associated with youngest shorelines of Bear Lake (<9 ka, Garden

City and Lifton phases; Laabs, 2001); locally incised due to uplift along East Bear Lake fault zone
Young fan-delta deposits (early Holocene and late Pleistocene)—Associated with Willis Ranch, Cisco, and Raspberry Square phases of Bear Lake (16–9 ka; Laabs, 2001; Reheis and others, 2005); little dissected. Subdivided into two units (fdy1 and fdy2) in one location south of Bear River along footwall block of East Bear Lake fault zone, where uplift has accentuated differences in surface altitudes of deposits:
Young fan-delta deposits (early Holocene?)—Forms surface about 3 m above base of fault scarp south of Bear River
Young fan-delta deposits (late Pleistocene?)—Forms surface about 6 m above base of fault scarp south of Bear River
Intermediate fan-delta deposits (late Pleistocene)—Associated with Jensen Spring phase of Bear Lake (about 40 ka; Laabs, 2001; Reheis and others, 2005); moderately dissected and uplifted
Older fan-delta deposits (middle to early? Pleistocene)—Associated with Bear Hollow phases of Bear Lake (about 1,000–100 ka; Laabs, 2001; Reheis and others, 2005); dissected and strongly uplifted on east side of Bear Lake and south of Montpelier
BEDROCK
Bedrock, undifferentiated (Tertiary through Precambrian)

Contact—Dashed where approximately located
Faults—Only those with probable Quaternary offset shown
Fault—Relative displacement uncertain. Dashed where inferred
Normal fault—Bar and ball on downthrown side. Dashed where inferred
Fault scarp—Hachures toward downthrown side. Deposit on downthrown side may not be offset
Lakes and reservoirs
Abandoned channel—Shown only north of Bear Lake
Drainage basin boundary
Auger hole or outcrop—See Reheis and others (2005)

INTRODUCTION

This map of surficial deposits in the upper Bear River drainage basin, Idaho, Utah, and Wyoming, provides a geologic context for paleoclimate study and interpretation of sediment cores taken from Bear Lake. In addition to runoff from the small drainage basin of Bear Lake, the lake has received water and sediment from Bear River at times in the past. Surficial deposits in the upper Bear River and Bear Lake drainage basins are different in their overall compositions, although they do overlap. In the upper Bear River basin above the lake, Quaternary deposits derived from glaciation of the Uinta Mountains contain abundant detritus weathered from Precambrian quartzite, whereas unglaciated tributaries downstream mainly contribute finer sediment weathered from much younger, more friable sedimentary rocks. In contrast, carbonate rocks capped by a carapace of Tertiary sediments dominate the Bear Lake drainage basin. Because of these differences in source rocks, the composition, distribution, and relative ages of surficial deposits in the upper Bear River and Bear Lake basins were mapped to shed light on the composition, source, and timing of sediment deposition in the lake. To study this depositional history, map units were devised that emphasize both relative age and process of deposition.

METHODS OF MAPPING AND SAMPLE COLLECTION

The map was constructed in two parts that required different approaches and compilation scales. In the relatively large Bear River drainage basin upstream of Bear Lake, the map (sheet 1) was compiled from several published geologic maps supplemented by interpretation of 1:80,000-scale aerial photographs; interpretations were mostly not checked in the field. Few changes were made in areas where published mapping was sufficiently detailed and reliable. However, I altered geologic contacts in places, mainly across quadrangle boundaries where map units of previous workers did not match, where two maps of the same area showed units differently, or where I interpreted the geology differently. In addition, published unit names were revised and unit descriptions modified to achieve consistency across the entire map area. In areas where published mapping was too generalized, contacts and map units were modified as needed using aerial photographic interpretation and the author's judgment. Contacts in these areas are considered less reliable. In one area, mapping was derived entirely from interpretation of aerial photographs; these contacts may be less reliable than others.

Surficial deposits in the drainage basin of Bear Lake were mapped in detail. This map (sheet 2) was compiled on 1:24,000-scale topographic maps on a PG-2 stereoplotter by interpretation of 1:40,000-scale aerial photographs coupled with several months of outcrop investigations and hand augering. Deposit types such as river terraces of different ages and channels incised into lake plains were tentatively identified on aerial photographs. Stereoscopic viewing of the aerial photographs indicated locations where deposits were exposed in road or canal cuts. These locations were then visited in the field to check the identification. Where no exposures were available, a bucket auger was used to obtain sediment in 10- to 20-cm depth increments. Auger holes were usually terminated in loose sand or gravel beds that could not be cored by hand. Materials such as shells and organic matter, suitable for radiocarbon dating and for interpretation of hydrologic environments, were collected from both outcrop exposures and auger sediment (Reheis and others, 2005). Thus, the Bear Lake part of the map (sheet 2) contains far more detail than the Bear River part upstream of the lake (sheet 1). Consequently, the Bear Lake part can be viewed and printed at higher resolution than the overall map.

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