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Pleistocene sediments and basalts along the Snake River in the area between Blackfoot and Eagle Rock, southeastern Snake River Plain, southeastern Idaho

By

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This report is preliminary and has not been reviewed for conformity with U.S. Geological Survey editorial standards and stratigraphic nomenclature.

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CONTENTS

ILLUSTRATIONS

TABLES

ABSTRACT

A complex history of Pleistocene erosion, sedimentation and basaltic fissure flows is recorded along the ancestral and present Snake River drainage of the Snake River Plain in southeastern Idaho. The area studied is between Blackfoot and Eagle Rock, but special emphasis was given to an area between Blackfoot and American Falls Reservoir. Five Pleistocene sedimentary units are recognized in the Fort Hall area and consist of three units of gravel separated by two fine-grained alluvial or lacustrine units. The units record two cycles of basalt damming of, and basalt-dam breaching by the Snake River. The upper lacustrine unit is known as American Falls Lakebeds and the lower fine-grained unit expressed only in the subsurface is called unit B. In the Blackfoot-Pocatello area south of the Snake River, Pleistocene sediments lie unconformably on Pliocene basalt.

North of the Snake River near Tilden Bridge, the age relations among the numerous basalt flows that intertongue with the sediments are locally ambiguous, but general correlations are made that seem reasonable based on lithologies reported in well logs. Between Blackfoot and American Falls Reservoir, two major channels apparently were incised into Pliocene basalts by the ancestral Snake River. One channel was developed west of the present Snake River and west of Ferry Butte (Pingree channel). This channel is older than about 310,000 years, the age of basalt flow west of the Snake River at Tilden Bridge, on the west side of Ferry Butte, that apparently caused rerouting of the Snake River eastward into the Fort Hall channel on the east side of Ferry Butte. The ancestral Snake River was rerouted many times by the repeated outpouring of basaltic lavas during late Pleistocene time. Virtually all of the basalts that modified the course of the ancestral Snake River in the Blackfoot-Eagle Rock area were derived from vents that lie west of the Snake River.

Basalt-dam breaching by the Snake River led to deposition of extensive gravel deposits between Blackfoot and American Falls Reservoir that consist of two gravel units separated by American Falls Lakebeds. Locally, in the Fort Hall channel, the American Falls Lakebeds were eroded prior to the deposition of gravel of Pinedale age, and the upper (Pinedale) and middle gravels are indistinguishable.

Near Springfield, and near the northernmost shore of American Falls Reservoir, American Falls Lakebeds lie unconformably on the basalt of Crystal Springs, which is about 210,000 years old. At this locality, the basalt is only about 6-9 feet thick. The lake beds are about 3-6 feet thick, and they are unconformably overlain by gravel of Pinedale age that is generally less than 10 feet thick; this gravel is locally overlain by at least 3 feet of loess.

INTRODUCTION

This study of the Pleistocene alluvial and lacustrine deposits and basalts of the Snake River drainage between Eagle Rock and Blackfoot was undertaken to better understand low-grade placer gold occurrences that were mined around the turn of the century. The stratigraphic sequence of the sediments in the ancient courses of the river is important to locating the upstream source of the gold, as well as silver tellurides (Desborough and others, 1986) in the gravels.

The surficial geology of the area was mapped by Scott (1982), and Scott and others (1982) have revised the Quaternary stratigraphy and chronology in the area. Earlier studies of Quaternary geology in the area include those of

Stearns and others (1938), Stearns and Isotoff (1956), Trimble and Carr (1961a, 1961b, 1976), Carr and Trimble (1963), and Trimble (1976). Our study concentrated on the area between Blackfoot and American Falls Reservoir.

BLACKFOOT-FORT HALL-SPRINGFIELD AREA

The area is chiefly east of the Snake River, north of Pocatello and southwest of Blackfoot (fig. 1). No sites of subsurface data are shown on figure 1, and only a few (those used in the cross sections) are on figure 3. Most of the subsurface data is from drillers logs of waterwells and therefore may be subject to some uncertainty in both lithology and depth. The Fort Hall Bottoms lies east of the Snake River, between Ferry Butte and the America Falls Reservoir; the bottoms are generally enclosed on the east side by the 4,400-foot topographic contour. The Fort Hall upland area is an alluvial bench east of the Fort Hall Bottoms and Snake River; this area lies above the 4,400-foot contour and below the 4,500-foot contour.

In the Fort Hall uplands we sampled and examined natural and artificial exposures of gravel and sand and examined subsurface data of water-well drill-hole logs. In the Fort Hall Bottoms we dug 17 backhoe pits to depths of about 15 feet and drilled 8 shallow holes to depths of 120 feet. In addition, 85 drillers logs were used for the Fort Hall upland area between Blackfoot and Fort Hall.

Stratigraphy of the Blackfoot-Pocatello area

In the area between Pocatello and Blackfoot, Michaud Gravel covers much of the benchlands and was deposited by the Bonneville Flood that entered the area via the Portneuf River drainage (fig. 1) (Trimble and Carr, 1961a, 1961b). Scott and others (1982) show that the Bonneville Flood occurred about 14,000-15,000 years ago. Michaud Gravel, as well as extensive but thin Holocene eolian sand, obscures older deposits and makes interpretation of the Pleistocene history difficult. Trimble and Carr (1961a, 1961b) noted that the basal erosional contact of the Michaud Gravel with the underlying American Falls Lakebeds "is uniformly about 4,400 feet in altitude" in the Michaud Flats area. Table 1 contrasts the distinctive characteristics of the Snake River gravel deposits versus the Michaud Gravel, and the data suggests that except for basalt, igneous rocks are absent from Michaud Gravel, which is composed mostly of clasts of sedimentary and metasedimentary rocks.

The Fort Hall upland area, north of Fort Hall, is thinly mantled by eolian sand and Michaud sand and gravel deposits, that total less than about 15 feet in thickness. The Fort Hall Bottoms is thinly mantled by Holocene soil developed on very fine grained alluvium that averages about 8 feet thick, and that unconformably overlies alluvial Pleistocene gravel and sand.

Figure 2 shows a generalized sequence of late Quaternary sediments in the Fort Hall area as determined by the U.S. Geological Survey, drilling and examination of 85 water-well drill logs. The American Falls Lakebeds were named by Stearns and others (1938, p. 69) for sediments deposited in a lake formed by the Cedar Butte Basalt flow that dammed the Snake River southwest of Eagle Rock Formation. Carr and Trimble (1963, p. G28) and Trimble and Carr (1976) restricted the formation to the upper part of the beds named by Stearns and others, with the base of the formation as a 0.7 foot thick gravel at an altitude of about 4,320 feet. The beds below the gravel are referred to as the Raft Formation. The American Falls Lakebeds in the Michaud flats area (fig. 1) are well exposed in the bluffs that rim most of American Falls

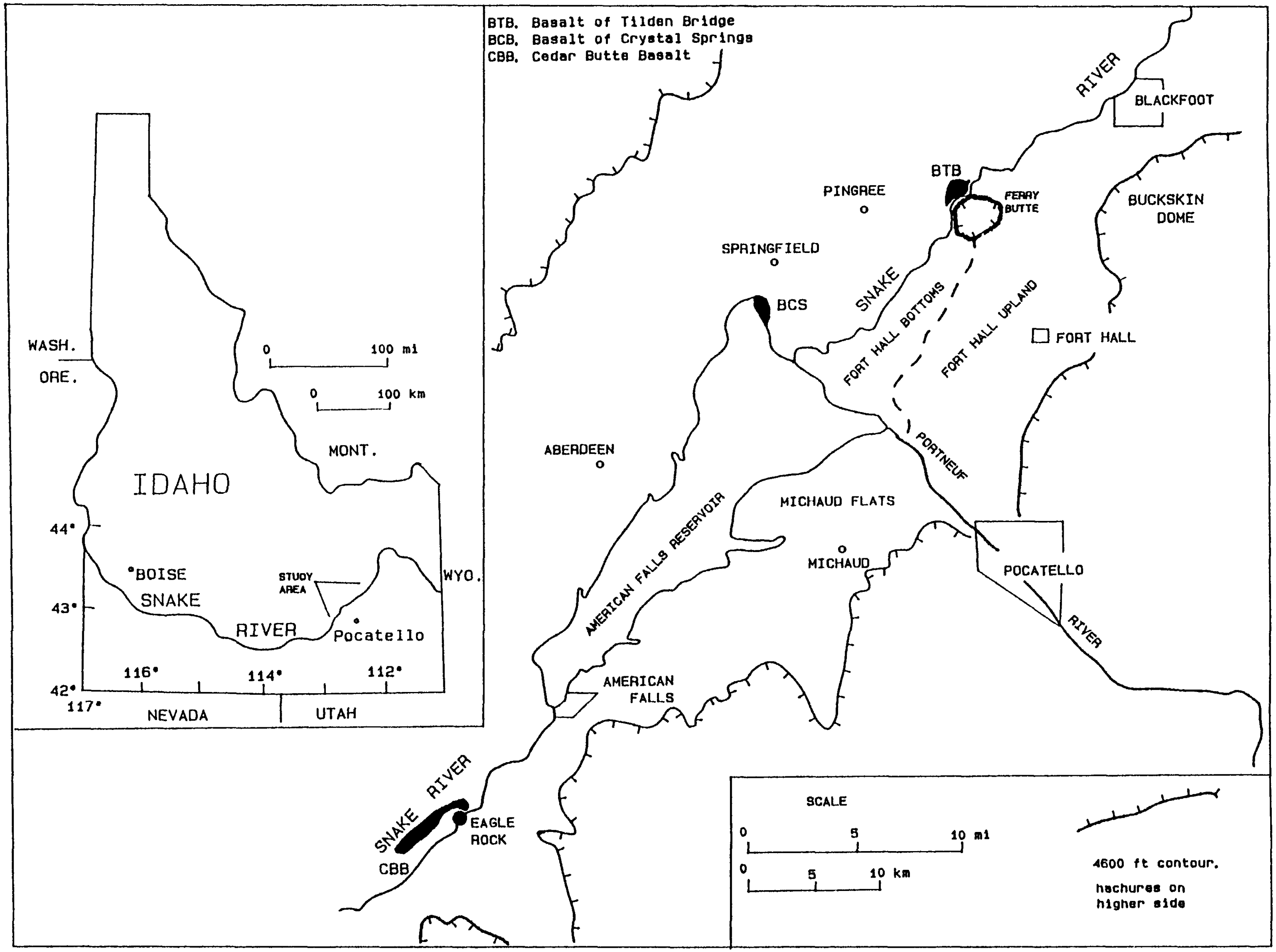

Figure 1.--Location of study area and salient geographic localities and geomorphic features in the Blackfoot-Eagle Rock area of the Snake River Plain, southeastern Idaho.

Table 1.--Characteristics of Snake River gravel deposits and Michaud Gravel in the Fort Hall and Pocatello area, Idaho

Snake River gravel deposits	Michaud Gravel deposits
SORTING AND BEDDING	
Well-sorted and distinctly bedded with large-scale and small-scale crossbedding.	Not sorted, bedding features virtually absent.
CLAST AND GRAIN CONSTITUENTS	
Conspicuous obsidian grains 0.5 to 1.0 mm, pink to maroon pebbles and cobbles of Proterozoic metaargillite and metasiltstone, grains of rhyolite glass in the size range of 0.5-2.0 mm with red, blue and milk tints, sparse cobbles of rhyolite and welded tuff, sparse Archean granite clasts, cobbles of quartzite.	Large boulders of basalt, limestone, and quartzite. Cobbles of chert limestone, dolomite, and quartzite common.
SIZE OF LARGER CLASTS	
Generally smaller than 10 cm.	Generally larger than 10 cm and many larger than 30 cm.

Reservoir and along the valley walls of the lower parts of Bannock Creek and the Portneuf River. "The upper limit of the American Falls Lakebeds is at an altitude of about 4,400 feet, and the total thickness is about 80 feet" (Trimble, 1976, p. 54). Ridenour (1969) demonstrated that the lower part of the American Falls Lakebeds (unit D, fig. 2) is alluvial rather than lacustrine, because exposures along the south side of American Falls Reservoir consist of crossbedded sand. However, because of the generalized nature of the available drill hole logs we have used, the most logical distinction to be made was between coarse (gravel-bearing) material versus fine (sand-, silt-, and clay-size) material. Unit D (fig. 2) is American Falls Lakebeds; it includes fine sand and silt associated with clay-size material, the coarser portions of which may be of fluviatile origin.

The ancestral Snake River occupied a broad, prominent channel cut on an erosion surface on Pliocene(?) basalt bedrock, based on drill-hole information for the subsurface (sections A4-E and F-F′, figs. 3, 4, and 5 (at end of report)). Prior to the Bonneville Flood (about 14,000-15,000 years ago) the Snake appears to have had two main channels, one northwest of Ferry Butte (the Pingree channel) and the other between Ferry Butte and Buckskin dome (the Fort hall channel) (see figs. 5, 6, 7 (at end of report)). These channels are newly recognized and named in this report. Ferry Butte, composed of Pliocene(?) basalt flows and cinders, at times may have been an island in a broad channel; at least once it was the eastern buttress of a basalt dam formed by the basalt of Tilden Bridge. As a result, the main flow of the Snake River was forced through the Fort Hall channel. Units A-E, the sediments of Fort Hall (fig. 2) were deposited in parts of both channels.

The range in thickness of units A through E (fig. 2) is due to several erosional and depositional factors. The lower gravel, unit A of figure 2, is as thick as 132 feet near the axis of the Fort Hall channel, but is not recognizable south of Ferry Butte and near Fort Hall along the channel margins (fig. 7). We do not know how thick the basal gravel may be in the southern part of the Fort Hall Bottoms due to lack of subsurface information. However, our shallow drill holes have penetrated as much as 20 feet of lower gravel; artesian flow from the lower gravel in that area prohibited deeper drilling.

Unit B is as much as 54 feet thick in the Fort Hall upland area, but it is usually in the range of 15 to 30 feet thick (fig. 7). This unit is absent from the northeastern part of the Fort Hall upland area where it either was not deposited, or it was removed by erosion during deposition of the middle gravel--unit C (fig. 2). In the Fort Hall Bottoms, unit B ranges from 17 feet thick on the south side of Ferry Butte to 62 feet thick in the central part of the Fort Hall Bottoms (figs. 3, 5). In logs of three water wells east of the central part of the Fort Hall Bottoms, unit B is 31-32 feet thick; the mean elevation of the base is 4,310 feet and the range is 4,304 to 4,319 feet. The elevation, thickness, and lateral persistence of the clay and sand of unit B in the Fort Hall area may indicate that, downstream in the American Falls area, this interval is not distinguishable from the lowest part of the American Falls Lakebeds because the gravel of unit C is absent or not recognized downstream (B-B′, figs. 3 and 4).

Unit C, the middle gravel interval, has a maximum thickness of 52 feet in the Fort Hall upland near well III on figure 7. Unit C is either absent between Ferry Butte and Buckskin dome or it cannot be clearly differentiated from unit A due to upstream pinch-out of unit B (C3, fig. 4). Unit C cannot be identified with reasonable certainty west of the Snake River, and thus the age of this gravel is uncertain. It is possible that this gravel is outwash from Bull Lake glaciation that occurred about 140,000 years ago (Pierce and

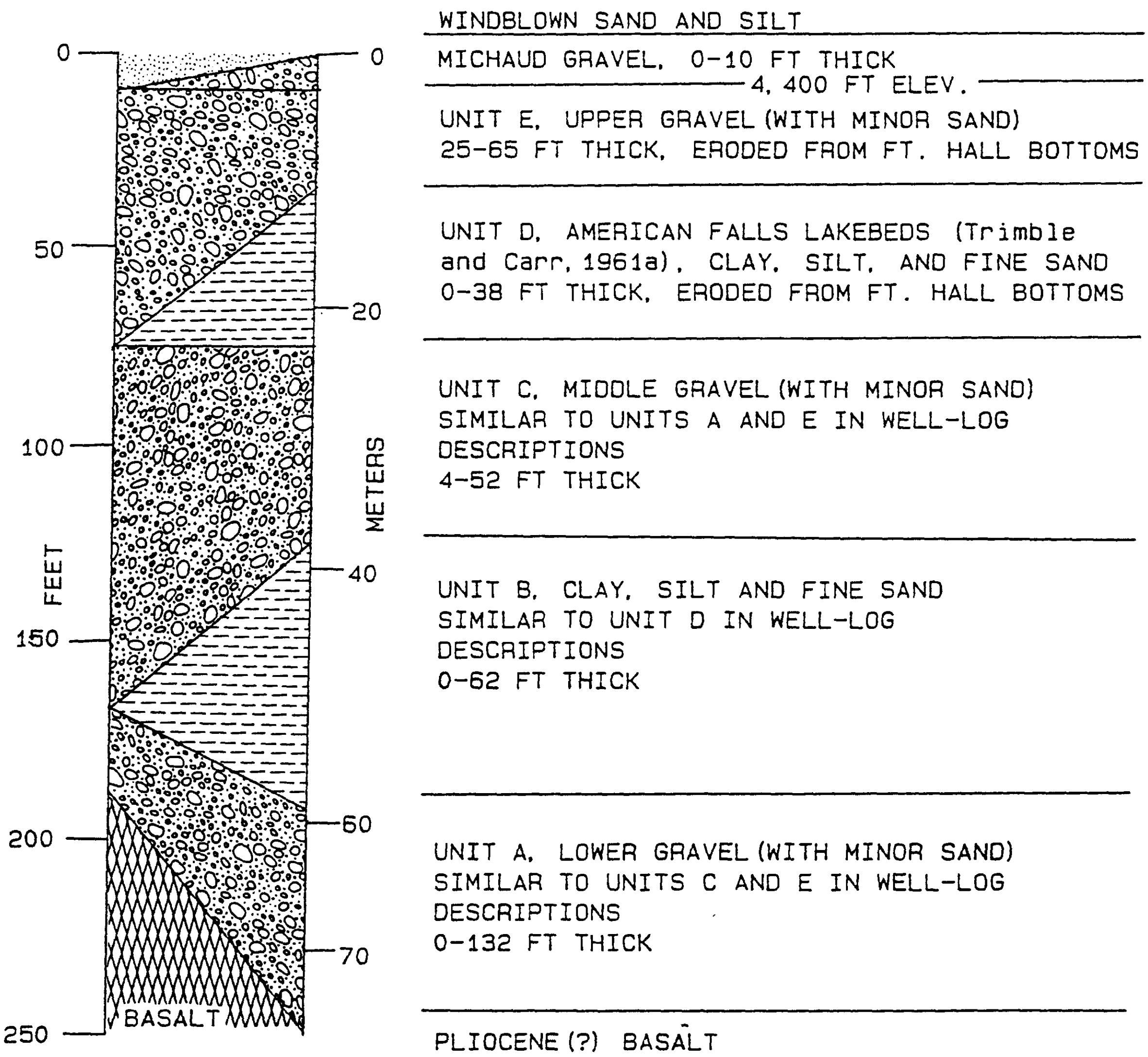

Figure 2.--Generalized stratigraphic section of unconsolidated Pleistocene sediments in the Fort Hall upland and Fort Hall Bottoms. Based on U.S. Geological Survey drilling of 2 holes in the Fort Hall upland, drilling of 8 holes in the Fort Hall Bottoms and 85 water well records for the Fort Hall upland.

others, 1976). If so, it would be younger than the basalt of Crystal Springs and basalt of Tilden Bridge.

Basalt is exposed along the west side of the Snake River extending discontinuously from opposite the northwest side of Ferry Butte to the northwest side of American Falls Reservoir and may represent more than one flow. Exposures of a basalt flow are no more than 10 feet thick along the Snake River, although the base is not exposed. Basalts locally exposed northwest of the Snake River and south of Springfield (figs. 1 and 3) may be at least in part correlative with the Big Hole Basalt complex of flows mapped by Carr and Trimble (1963) along the west side of American Falls Reservoir. Scott and others (1982) reported that the American Falls Lakebeds--unit D, of the present study--overlie the basalt along the west side of the Snake River south of Springfield. We have also observed similar relations in two gravel quarries along the west side of the Snake River as well as in exposures along American Falls Reservoir south of Springfield.

Unit D, American Falls Lakebeds (fig. 2), ranges from 0 to 38 feet thick in the subsurface of the Fort Hall upland area; this unit is 100 ft thick southwest of the Fort Hall area (C, fig. 4). These beds are absent from the Fort Hall Bottoms probably due largely to late Pleistocene or Holocene erosion. Between Ferry Butte and Buckskin dome, the lakebeds of unit D are mostly less than 10 feet thick, although some erosion of unit D prior to or during the deposition of unit E may have occurred. Subsurface data show that unit D is as much as 15 feet thick 6 miles northeast of Blackfoot at elevations of about 4,450 feet, with an overlying upper gravel, unit E, that is about 20 feet thick (B′, fig. 4).

Unit E, the upper gravel of the Fort Hall upland area, is as much as 65 feet thick. It was eroded from the Fort Hall Bottoms. It cannot be differentiated from unit C where unit D is absent. Scott (1982) mapped this gravel as Pinedale in the area between Blackfoot and Fort Hall.

Stratigraphic relations of Pliocene and Quaternary basalts and Quaternary sediments between Blackfoot and Eagle Rock

For the Fort Hall area, the oldest basalts upon which gravels of the Snake River lie are of Pliocene age; Kellogg and Marvin (1988) obtained radiometric K-Ar ages for basalts exposed on the western margin of Buckskin dome (fig. 1) that are 2-3 Ma (million years old). These basalts have been tectonically deformed and have dips that deviate as much as 20 degrees from horizontal. An erosional surface of moderate relief was developed on the Pliocene basalts prior to deposition of mainstream Snake River gravel and lacustrine deposits in the Fort Hall area according to subsurface data (C-C′, fig. 4) and F-F′, fig. 5).

Stratigraphic relations determined from surface and subsurface studies in the region are shown for water well logs (fig. 3) from which eight cross sections have been prepared (figs. 4, 5, 7). Correlations among the Pleistocene sediments of Fort Hall and with Pleistocene basalts (figs. 2, 4, 6, and 7) are also shown in relation to adjacent areas, such as those west and northwest of the Snake River and American Falls Reservoir. The location of the Big Hole Basalt of Carr and Trimble (1963) on our cross sections is based on their mapping in the American Falls quadrangle. In the western part of the area, Big Hole Basalt overlies fine-grained sediments (fig. 5, cross sections A2-D and A4-E). The basalt of Crystal Spring (210,000 years old, table 2) south of Springfield (fig. 1) is also shown in cross section F-F′ (BCS at F2, fig. 5) to be younger than unit B, but older than part of American Falls

Lakebeds; these relations are similar to those in exposures of the basalt of Crystal Spring, American Falls Lakebeds, and upper gravel in ascending order along the shoreline of American Falls Reservoir south of Springfield (figs. 8A, 8B). The upper gravel at this locality is of Pinedale age, according to Scott (1982). About 3 miles southeast of this locality, Scott and others (1982, fig. 7) show identical relations of basalt overlain by 9 feet of fine-grained alluvium and deposits of American Falls Lakebeds. A hole we drilled 1 mile south of their locality penetrated 40 feet of gravel (unit C) underlain by 26 feet of brown clay (unit B).

Cross section legs B7–B′ and C2–C′ (fig. 4) respectively, lie along two major axes of Pleistocene river channels that developed on both sides of Ferry Butte (figs. 6 and 7). The channel west of Ferry Butte is called the Pingree channel; the channel east of Ferry Butte is called the Fort Hall channel. Prior to the eruption of the basalt at Tilden Bridge (310,000±50,000 years ago, table 2), a major Pleistocene river channel flowed on the west side of Ferry Butte. Ferry Butte is thickly mantled by loess, but the log for a well on the south flank shows 200 feet of basalt flows and cinders (fig. 7). We think Ferry Butte is a remnant of Pliocene basalt because its petrographic characteristics are similar to those of the basalt of Buckskin Basin, 5 miles to the east (Kellogg and Marvin, 1988). The basalt at Tilden Bridge may have blocked the Pingree channel, causing the main course of the river to flow in the Fort Hall channel (fig. 6 and 7).

Age relations are based upon both K-Ar radiometric data (table 2) and relative stratigraphic positions (figs. 2, 4, and 5).

Table 2.--Whole-rock K-Ar ages of olivine basalt flows between Blackfoot and American Falls, Snake River Plain, Idaho (analyst: Richard F. Marvin)

Locality	Sample No. and name	Lat. (N) Long. (W)	K_2O wt.%	$*^{40}Ar$ 10^{10}moles/gm	$*^{40}Ar$%	Age (Ma)±2
1. 50 m west Tilden Bridge, west of Snake River	RK85-1692A basalt of Tilden Bridge	43°07′45″ 112°30′45″	0.69	0.003068	4	0.31±0.05
2. 2-bluff just west of parking area, near Crystal Spring	SP85-1693A basalt of Crystal Spring	43°02′45″ 112°41′00″	0.78	0.002345	2	0.21±0.06

* Radiogenic argon
Constants used: $\lambda e + \lambda e = 0.581 \times 10^{-10} yr^{-1}$; $\lambda\beta = 4.962 \times 10^{-10} yr^{-1}$; atomic abundance of 40K/K total = 1.167×10^{-4}

Table 3 gives our interpretation of the relative ages of basalts and the mainly non-eolian sediments along the Snake River drainage areas between

Figure 8a.--Basalt of Crystal Springs (foreground) overlain unconformably by American Falls Lakebeds (unit D, at level of man) and upper gravel (unit E, above man's head) along the north shore of American Falls Reservoir (NE, SW, sec. 26, T.4S., R.32E.).

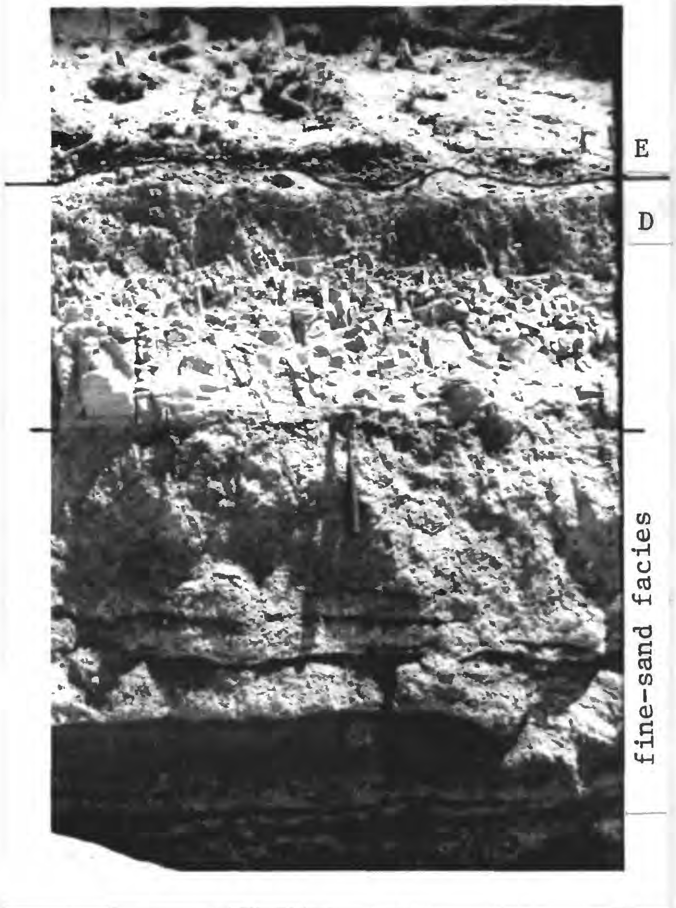

Figure 8b.--American Falls Lakebeds (unit D) unconformably overlain by upper gravel (unit E). Fine-grained lacustrine facies between gravel and hammer is underlain by fine-sand facies that lies on basalt of Crystal Springs (not shown). Locality of figure 8a.

Blackfoot and Eagle Rock (fig. 1). For the K-Ar radiometric data we have used those incorporated in reports of Armstrong and others (1975), Scott and others (1982), Williams and others (1982), Kellogg and Marvin (1988), and two new ages (table 2). Based on the uncertainty of K-Ar dating of the basalt of Crystal springs and Cedar Butte Basalt, the minimum hiatus between the basalt of Crystal Springs and American Falls Lakebeds is about 100,000 years.

It is clear that on the west side of the ancestral American Falls Lake, Pleistocene basalt flows entered the area from the northwest long before the lake was established. North of Blackfoot, section B–B′ (fig. 4) shows lakebeds at an elevation of about 4,450 feet. Subsurface data in the Fort Hall upland area indicate fine-grained sediments at elevations as high as about 4,420 feet; however, at all of these localities an upper erosional surface on the lakebeds is indicated by the presence of overlying gravel of the Snake River. West of American Falls, Idaho (fig. 1), Trimble and Carr (1976) mapped American Falls Lakebeds as high as 4,400 feet. In the American Falls quadrangle, Carr and Trimble (1963) mapped American Falls Lakebeds as high as 4,390 feet near the Union Pacific Railroad west of American Falls (fig. 1).

The Raft Formation of early or middle Pleistocene age was mapped by Carr and Trimble in the American Falls quadrangle (1963, G21-G22) and described as "light-colored beds of massive silt, and of clay, stratified silt, and sand, widely distributed between American Falls and the mouth of the Raft River." The Raft Formation is also described in the Raft River Basin by Williams and others (1982, p. 491-504) and "consists of fine-grained lacustrine and fluvial deposits, principally clay, silt, and sand, that were deposited on the Salt Lake Formation." K-Ar whole rock ages of basalt in the Raft Formation of the Raft River Basin range from 709,000±210,000 to 446,000±220,000 years (Williams and others, 1982, p. 497, table 2). Originally the Raft Formation was named "Raft lakebeds" by Stearns and others (1938, p. 48), but this was changed to "Raft Formation" by Carr and Trimble (1963, p. G22) because Trimble and Carr (1961) thought much of the unit was fluviatile, rather than of lacustrine origin. Carr and Trimble (1963, p. G22) state that "A large part of the formation, however, probably did accumulate in a lake." The Raft Formation was not mentioned in the recent report of Scott and others (1982) that includes our area of study. We suspect that the Raft Formation is probably age-equivalent to beds older than unit D (fig. 2). Although Carr and Trimble (1963) measured a Raft Formation section southwest of their study area, we cannot readily identify this unit, either in surface exposures or from water-well drilling logs. Therefore, although the Raft Formation is likely to be equivalent to units encountered in water well records, it is not designated as a unit of our stratigraphic studies east of the American Falls Reservoir dam.

Table 3.--Age relations and areal distribution of Pliocene and Quaternary basalts and sediments in the Blackfoot-Fort Hall-Eagle Rock area. Eolian deposits are excluded.

HOLOCENE	DISTRIBUTION AND COMMENTS
Hells Half Acre Basalt, 5,200±150 years (Kuntz and others, 1986)	North and northeast of Blackfoot
PLEISTOCENE	
Michaud gravel, Bonneville Flood Deposits, 14,000-15,000 years old (Scott and others, 1982)	Ferry Butte to Eagle Rock; but mostly south of the Snake River and south of American Falls Reservoir
Unit E, upper gravel of Fort Hall, Pinedale age (Scott, 1982)	Fort Hall, Blackfoot, Pingree and Springfield areas
Unit D, upper American Falls Lake Beds of Trimble and Carr (1961a, b) and Carr and Trimble (1963) and Scott and others (1982)	Blackfoot to Eagle Rock area
Cedar Butte Basalt, 72,000±14,000 years old (Scott and others, 1982)	Small areal extent near Eagle Rock and Cedar Butte
Unit C, middle gravel of Fort Hall	Fort Hall upland and Fort Hall Bottoms
Big Hole Basalt (Carr and Trimble, 1963)	Aberdeen to near Eagle Rock northwest of Snake River and American Falls Reservoir
Basalts northwest of the Snake River and north of American Falls Reservoir Basalt south of Springfield near Crystal Spring, 210,000±60,000 years old Basalt on the west side of Tilden Bridge West of Ferry Butte, 310,000±50,000 years old	Chiefly in the area of Springfield and west of Ferry Butte; may be flows of the Big Hole Basalt
Unit B, clay, silt and fine sand in subsurface of Fort Hall area	Fort Hall upland and bottoms and Springfield area
Unit A, lower gravel in subsurface of Fort Hall area	Fort Hall Bottoms and part of Fort Hall upland; chiefly lies on erosional surface of Pliocene basalts in Fort Hall area
PLIOCENE	
Basalts in the Buckskin Dome area and probably at Ferry Butte-2.2-2.5 million years old (Kellogg and Marvin, 1988)	Minimal thickness of about 155 feet in the area of the northeast part of Buckskin dome; underlain there by gravel and sand (well data). On the south side of Buckskin dome it is 200 feet thick; underlain by gravel and sand (well data)

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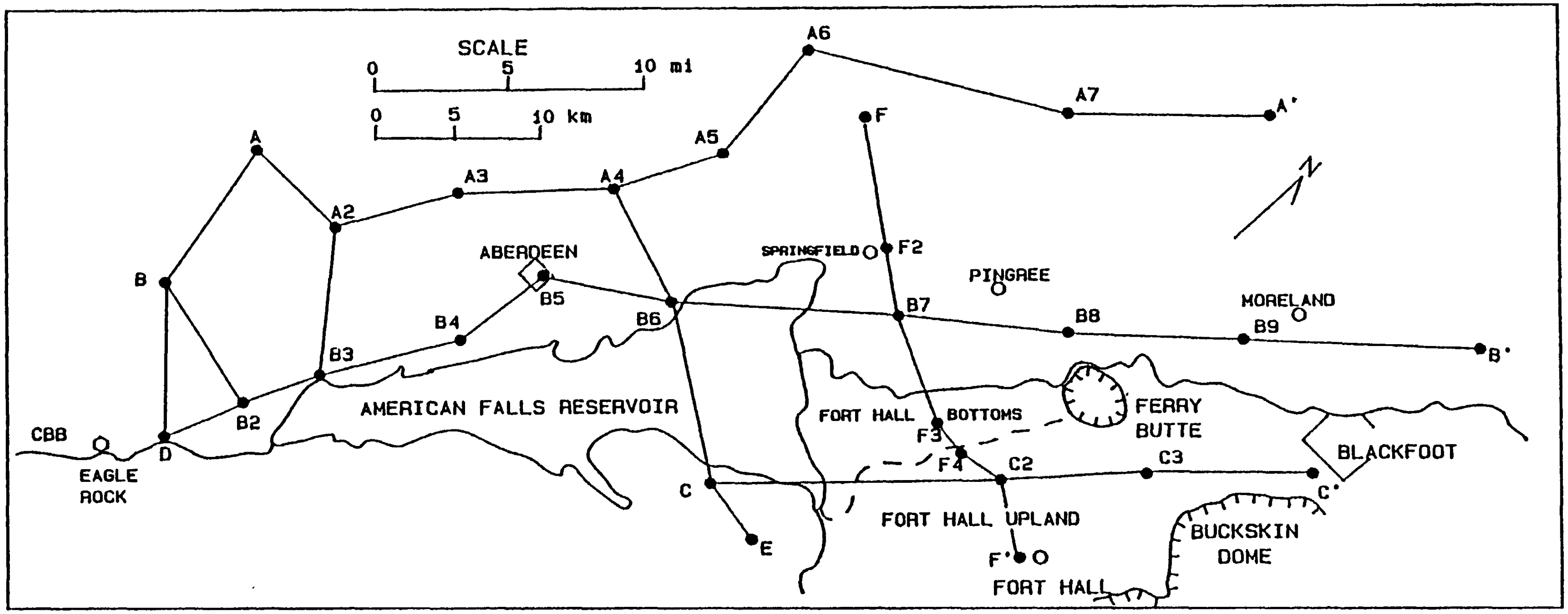

Figure 3.--Locations of subsurface data points for cross sections along the Snake River between Eagle Rock and Blackfoot. CBB near Eagle Rock is the location of the Cedar Butte Basalt.

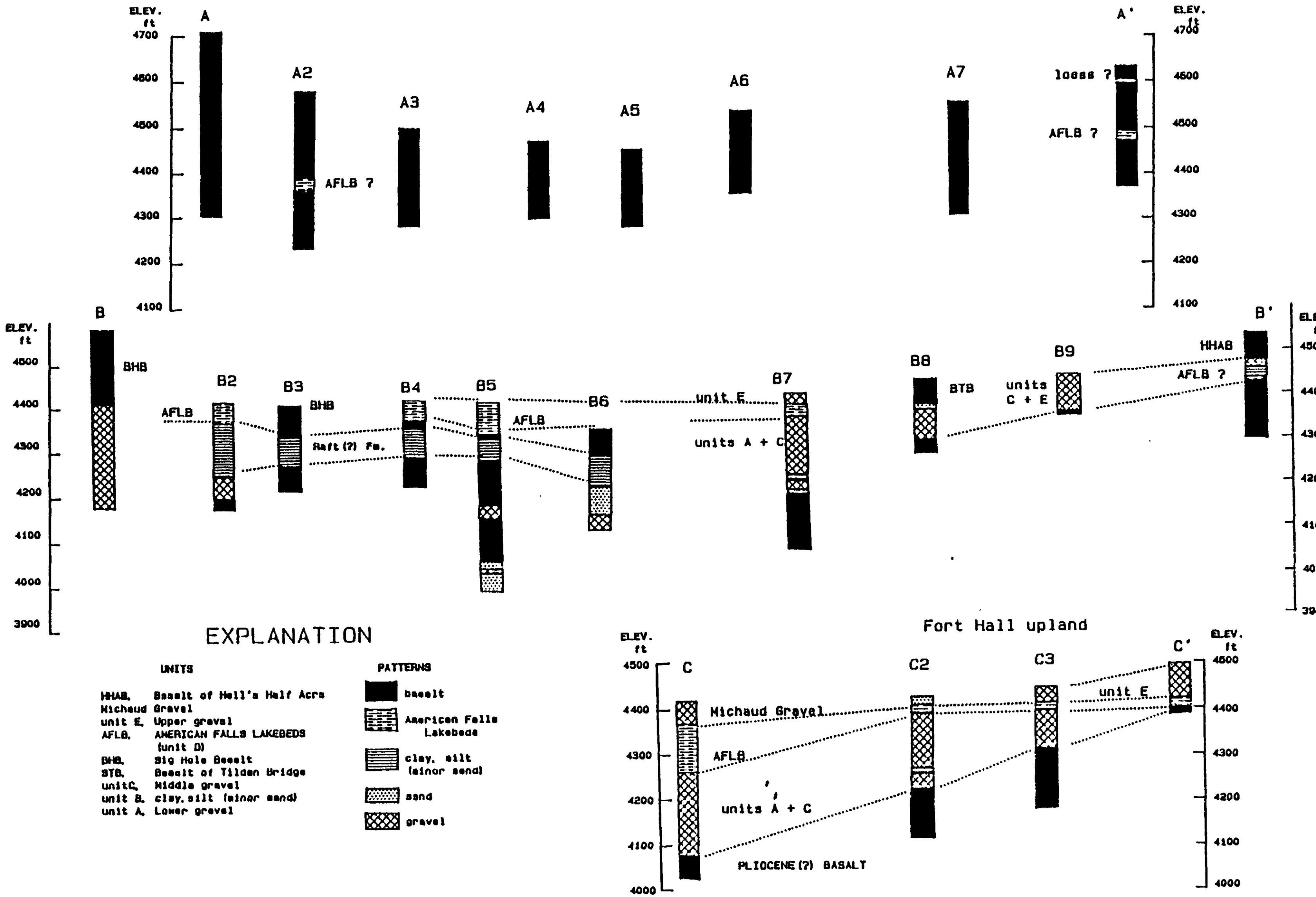

Figure 4.--Cross section A-A', B-B' and C-C' are parallel or subparallel to the axis of the ancestral Snake River and ancestral American Falls lake between Eagle Rock and Blackfoot. The location of each cross section is shown on figure 3. Section locations may be somewhat out of precise scale.

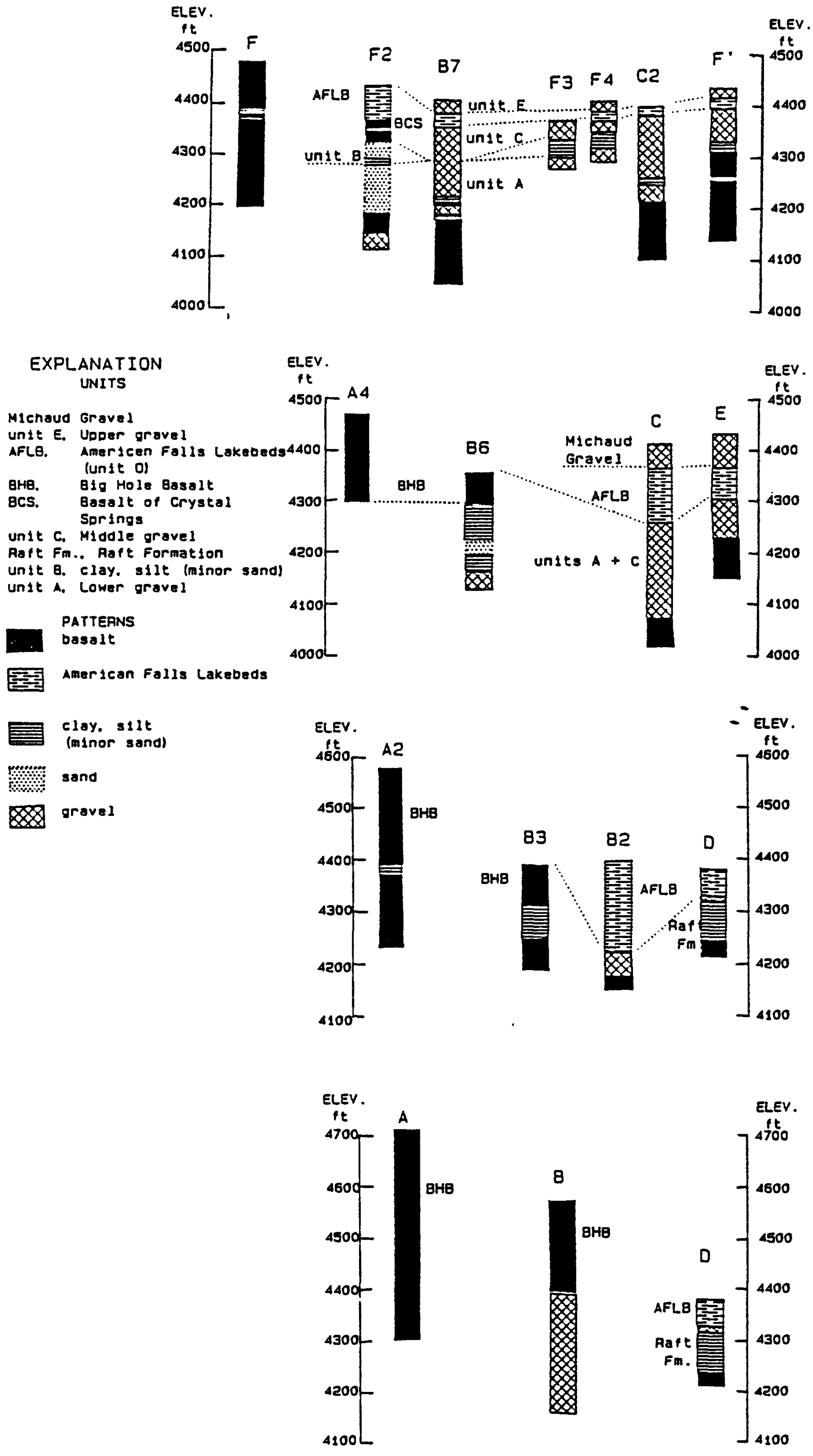

Figure 5.--Cross sections F-F', A4-E, A2-D and A-D that are approximately perpendicular to the axis of the ancestral Snake River and the ancestral American Falls lake. The location of each cross section is shown on figure 3. Section locations may be somewhat out of precise scale.

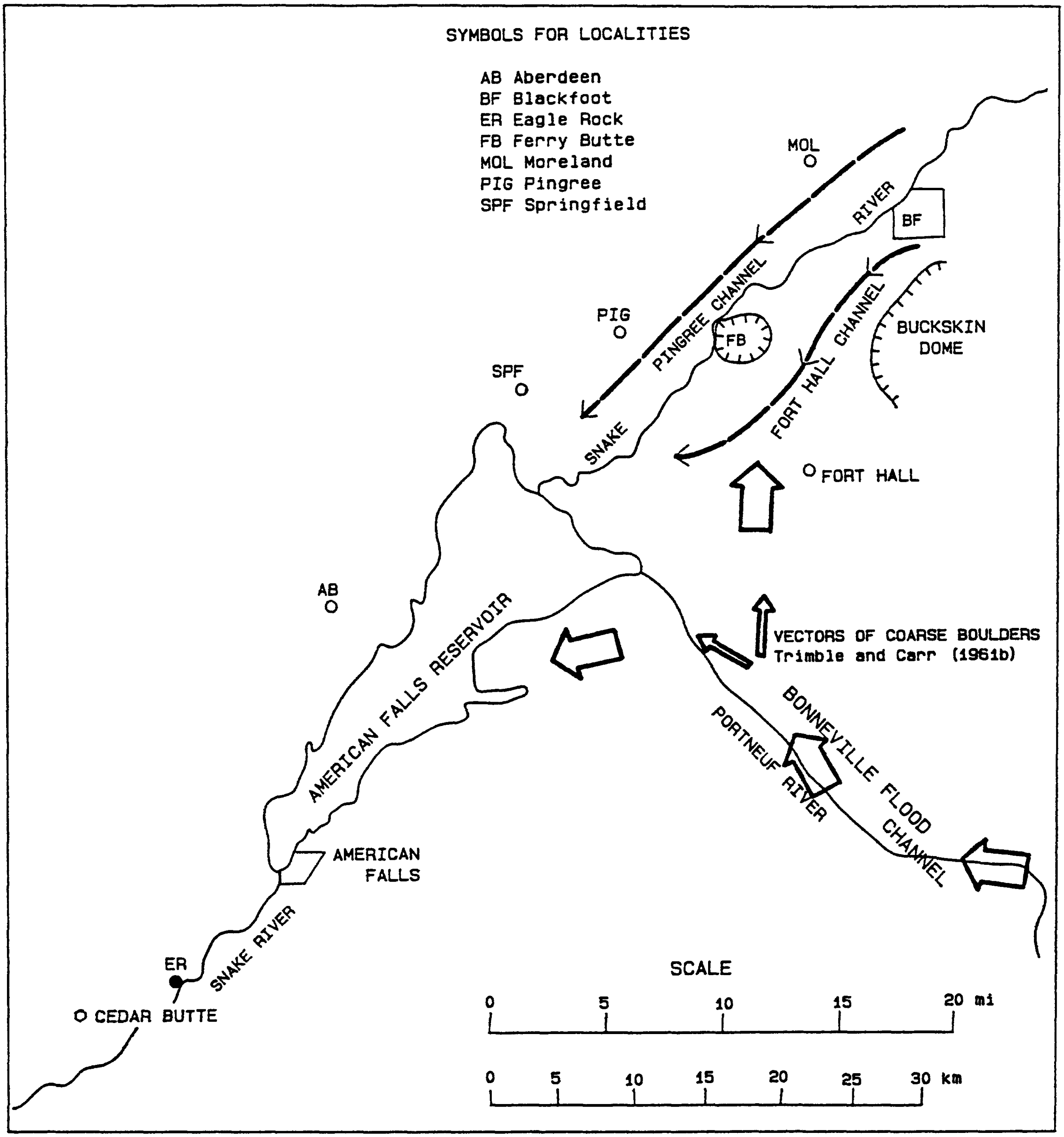

Figure 6.--Pleistocene Snake River channels and path of the Bonneville Flood in the American Falls Reservoir area.

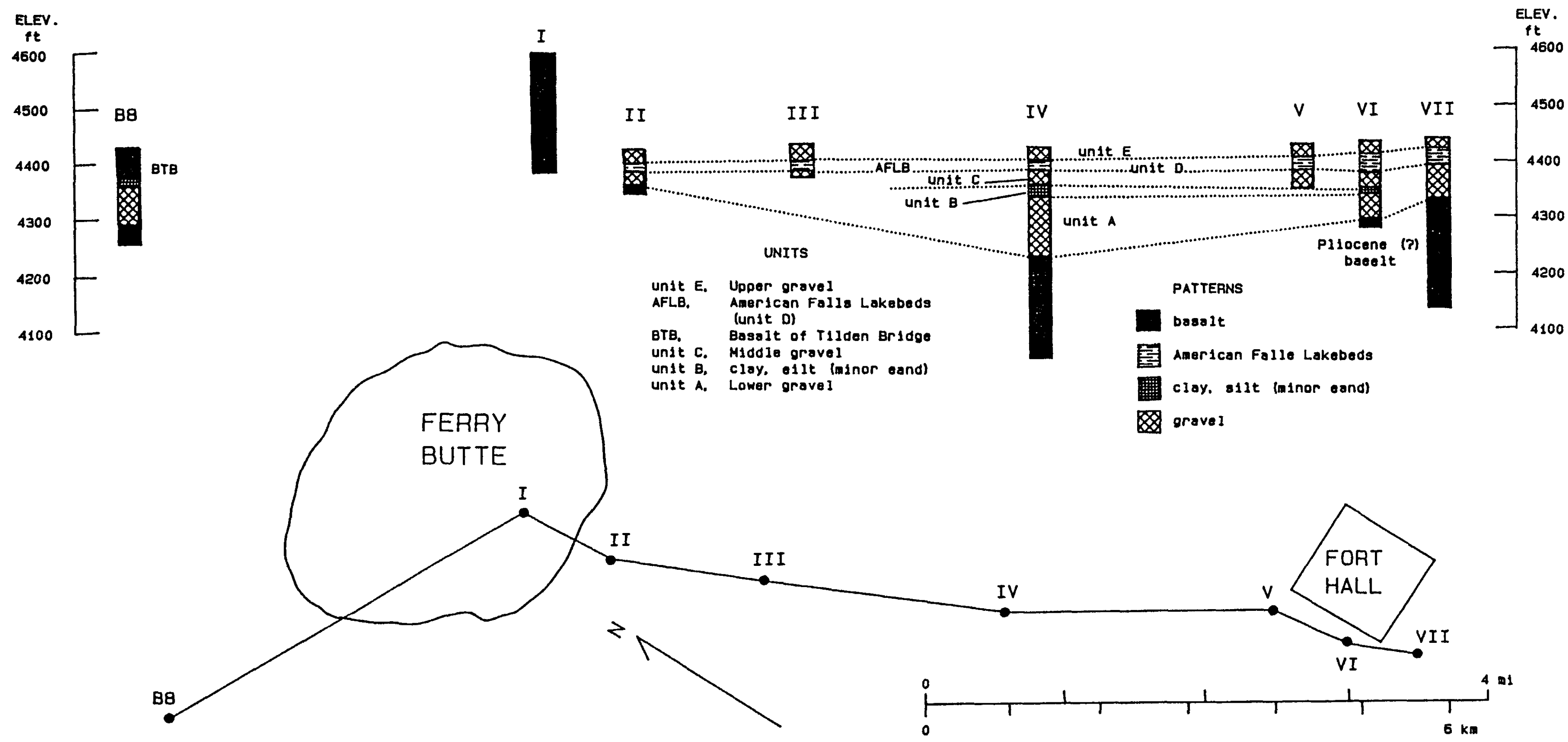

Figure 7.--Cross section from the Pingree channel (B8) through the Fort Hall channel showing Pleistocene sediments on Pliocene (?) basalt.