Base from U.S. Geological Survey,

Pocatello, 1954, 1962; Driggs,

Twin Falls, 1955, 1962; Ashton,

Dubois, Hailey, Idaho Falls,

1955, 1967; Challis, 1957,

bg GRAVEL DEPOSITS OF THE BONNEVILLE FLOOD (UPPER PLEISTOCENE) --This map portrays the distribution of surficial materials that cover most of the landscape of the eastern Snake River Plain and adjoining areas in a large part of southeastern Idaho and a very small area in western Wyoming (fig. 1). Almost 350,000 people or 40 percent of Idaho's population (estimated 1979 population from Rand McNally (1979)) live in the area, which constitutes about 30 percent of Idaho's The great majority of this population resides in the major irrigated agricultural areas along the Snake River between American Falls and Ashton and between Bliss and Lake Walcott, which contain the important and growing commercial centers of Rexburg, Idaho Falls, Blackfoot, Pocatello, Burley-Rupert, Twin Falls, and Jerome. These areas encompass almost two-thirds of Idaho's irrigated croplands, and, along with water, are the region's most important resource. Major products include potatoes, sugar beets, alfalfa, small grains, and other Along the margins of the Plain and in adjacent basins, smaller areas of irrigated farming and population are present, such as Teton Basin, Mud Lake area, Big and Little Lost River Valleys, Big and Little

This map provides information of interest to geologists, engineers, planners, soil scientists, governments, and citizens concerned with resources and land use. For instance, geologists seeking information on sand and gravel resources or location of young surface faults, engineers interested in foundation materials or in landslides, and soil scientists wanting information on the parent materials of the important agricultural and range soils all should find this map useful.

Wood River Valleys, and Raft River Valley. In several of these basins

and in nearby upland areas, dry farming of grains is important. Some of

these lands are now being converted to irrigated croplands. Grazing is

the dominant economic use of grasslands on the Plain and in adjacent

basins and uplands. At present, industry assumes a minor role in the

region's economy, although food processing and nuclear research at the

Idaho National Engineering Laboratory(INEL) locally are important.

The surficial deposits shown on this map are differentiated on the basis of their origin, character, and age. Mapping was accomplished by field investigations during the summers of 1975-77, by interpretation of aerial photographs and topographic maps, and by compilation and ation of the published and unpublished mapping of other 2). As the map area is very large, and mapping progressed rapidly, most of the contacts between units were locally defined on the ground and then extended through interpretation of maps and aerial photographs. This is especially true of gradational boundaries such as

those between many loess units.

HOW THIS MAP WAS MADE

ACKNOWLEDGEMENTS J. E. Frederick assisted with field mapping during 1975-76 and 1 am grateful for her motivation and contributions. Consultation in the field or office with K. L. Pierce, G. M. Richmond, M. A. Fosberg, S. M. Colman, M. H. Hait, Jr., M. A. Kuntz, D. E. Trimble, Betty Skipp, S. S. Oriel, I. J. Witkind, H. R. Covington, G. Embree, D. L. Schmidt, and H. J. Prostka contributed greatly to my understanding of the problems of Snake River Plain geology. G. B. Dalrymple (USGS) provided two K-Ar age determindations. H. E. Malde, V. S. Williams, and Betty Skipp provided constructive reviews of the map and manuscript. EXPLANATION

Alluvial deposits of mainstreams, tributaries, and fans are

differentiated on the basis of their geomorphic setting, sedimentary features, and age. Mainstream alluvium is the best sorted and rounded material and forms planar and terraced fills. A thin mantle of finegrained sediment of eolian and (or) alluvial origin is generally present. In areas with mixed sediment sources, mainstream alluvium consists mostly of resistant lithologies such as quartzite, and is commonly the most desirable material for aggregate and other uses. Along tributaries, gravelly alluvium is not as well sorted and rounded as it is along mainstreams where it is usually overlain by several meters of fine-grained alluvium, and, due to a limited source area, contains mostly local lithologies. At this map scale, alluvium of tributaries includes narrow planar fills and valley-side deposits of colluvium and fan alluvium. Alluvium of fans and fan remnants varies greatly in sorting and rounding, but is generally less well sorted and ounded than mainstream deposits and consists of local lithologies. A thin mantle of fine-grained sediment of eolian origin is common on fan deposits. Geomorphic position, weathering and degree of soil development, and stratigraphic relation to deposits of known age are generally used as indicators of age.

Mainstream alluvium Deposits of mainstreams are generally better sorted, rounded, and

alluvium are predominantly of quartzite and other resistant

bedded than other types of alluvial deposits. The clasts of mainstream

lithologies. This is due to selective destruction during transport of clasts of less-resistant rock types such as welded tuff, basalt, limestone and dolomite, sandstone, intrusive igneous rocks, and metamorphic rocks. For example, although most of the fans flanking the Big Lost River Valley are composed of limestone and dolomite gravel with subordinate quartzite, clasts in mainstream alluvium near Arco are predominantly quartzite and hard, siliceous rocks of the Mississippian Copper Basin Formation exposed in the headwaters of the drainage. Similarly, alluvium of Henrys Fork at Ashton largely is composed of basalt and welded tuff. A short distance downstream quartzite-rich gravels of the Falls and Teton Rivers are found in the alluvium and the ratio of basalt and welded tuff clasts to quartzite clasts decreases progressively downstream. Well-log data show that along the Snake River and Henrys Fork, mainstream gravel of late Pleistocene age interfingers with basalt flows. Although minor changes of stream courses have occurred in response to this volcanic activity, the courses of the Henrys Fork and the Snake River during middle(?) to late Pleistocene time have always occupied the southeastern margin of the Plain. A single deposit of mainstream alluvium (mm) of Henrys Fork(?) lying approximately 10 km east-northeast of Hamer has been isolated from Henrys Fork by the eruption of lavas from Little Grassy Butte, which are underlain by gravels of the Snake River and Henrys Fork. Prior to this eruption, drainage from basins north of the Plain apparently flowed into the Hearys Fork-Snake River through the low-gradient Mud Lake basin and possibly across the now-buried, low-relief basalt divides that stabilized the level of glacial-age lakes in the Mud Lake basin (see acustrine and mixed alluvial and lacustrine deposits section in this The major fill of mainstream alluvium of Pinedale age (mm) along the Henrys Fork and the Snake River was deposited, and later incised in response to climatic and geomorphic factors to form terrace deposits (mc) and flood-plain deposits (mf). During times when large glaciers occupied the Yellowstone and Teton areas, streams conveyed greater discharges and sediment loads than at present and aggraded their courses. During interglacial times, as at present, discharge and sediment loads were smaller and streams incised their fills. Volcanic eruptions on the Plain have intermittently dammed some reaches of streams, causing aggradation upstream; when the streams breached these lava dams the fills upstream were incised. An example of this occurrence is the Bonneville Flood removing the lava dam below American Falls. A huge fan formed by the Snake River where it enters the Plain north of Idaho Falls also exerts a base-level control on upstream areas. The width of a modern flood plain is related to the discharge an gradient of the mainstream. Streams with smaller discharges generally have narrower flood plains. The gradient, which in part determines the width of the flood plain, varies with distance from bedrock knickpoints where streams maintain steep gradients over basalt bedrock, as at Idaho Falls and St. Anthony. Reaches immediately downstream from knickpoints have steeper gradients and straighter courses, are more deeply incised, and have narrower flood plains than reaches farther downstream and immediately above knickpoints where streams have laterally eroded fills resulting in sinuous channels and wide flood plains. Along the Snake River and Henrys Fork upstream from Pocatello, almost no alluvial deposits older than the last glacial/pluvial cycle are exposed; small remnants of older deposits of the Teton River south of St. Anthony are the only exception. In general, the area above Pocatello is aggrading because extensive young volcanism on the eastern Plain exerts local base-level controls by damming and reducing gradient along the Snake River and its tributaries. Filling and incision caused by climatic changes apparently are only second-order effects on this overall aggradational regime. Downstream from Pocatello, where there is less extensive young volcanic activity, long reaches of the Snake River occupy deep canyons that expose older alluvial and lacustrine deposits. The Bonneville Flood greatly affected this reach by removing several major knickpoints and enlarging canyons (Malde, 1968). Between Ashton and Rexburg evidence of catastrophic flooding is found along the Henrys Fork. An abandoned spillover channel is present between the Falls and Teton Rivers and bouldery flood deposits are exposed between Ashton and St. Anthony. In addition, of older deposits of the Teton River south of St. Anthony are the only exception. In general, the area above Pocatello is aggrading because extensive young volcanism on the eastern Plain exerts local base-level controls by damming and reducing gradient along the Snake River and its cributaries. Filling and incision caused by climatic changes apparently are only second-order effects on this overall aggradational regime. 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The older flooding was probably caused by catastrophic draining of water impounded in the Island Park area by pre-Pinedale glaciers that blocked we outlets of Henrys Fork and Warm River. The source of floodwaters of Pinedale age is uncertain, however, the obsidian-rich composition of the flood deposits suggests a source in the Yellowstone area.

GRAVEL AND SAND (HOLOCENE) -- Mostly sandy pebble and cobble gravel, varies from boulder gravel in openwork deposits to pebbly sand; poor to moderate sorting; clasts generally subround to round, some angular; parallel bedding and large scale crossbedding. Thickness 1-10(?) m. Forms pendant bars in canyon of Teton River and sheets of gravel at canyon mouth; surfaces commonly display asymmetrical giant-current ripples SAND AND SILT (HOLOCENE) -- Sand and silt, locally some clay and gravel; moderate to good sorting; parallel bedding and small-scale crossbedding, some graded bedding, very thin to thin beds. Thickness 0.3 to 2 m. Deposited in-tributaries

near mouth of canyon of Teton River by surging floodwaters

Deposits of flood caused by failure of Teton Dam in 1976 (see SOURCES OF

COLOGIC MAPPING, Scott, 197

mf DEPOSITS OF MODERN FLOOD PLAINS (HOLOCENE) -- Silt, sand, and clay, minor gravel; humic in poorly drained areas; poor to moderate sorting; parallel bedding, bedding often obscure, very thin to thick beds. Thickness generally 1-3 m, locally thicker in abandoned channels. Overlies sandy gravel of cut terraces (mc) or mainstream alluvium (mm). Locally includes me and mm within 1 m altitude of modern flood plains. In Teton Basin and in Raft, lower Big Wood, Big Lost, and Little Lost River valleys, in Birch Creek Valley, and in other small areas; includes large spring areas close to modern flood plains of major streams that contain thick deposits of fine grained sediments and, locally, peat. Subject to high water tables, poor drainage, and periodic flooding

DEPOSITS OF CUT TERRACES (HOLOCENE TO UPPER PLEISTOCENE) --Pebble and cobble gravel to gravelly sand; upper 1-2 m usually fine-grained sediments; poor to good sorting; clasts subround o round; parallel bedding and large-scale crossbedding, thin o thick beds. Clast lithology same as mainstream alluvium (mm). Forms terraces 2-10 m above modern flood plains. Along Big Lost River on INEL includes deposits of modern flood plains (mf) which are difficult to differentiate. Finergrained deposits of cut terraces (mcf), shown only on INEL along Big Lost River, are mostly sand with minor fine

Eolian sand and loess (silt and sandy silt) cover wide areas of the mm DEPOSITS OF MAJOR FILLS OF PINEDALE AGE ALONG MAINSTREAMS (UPPER PLEISTOCENE) -- Pebble and cobble gravel to pebbly sand; poor to moderate sorting; clasts subround to round; parallel bedding and large-scale crossbedding, thin to thick beds; upper 0.5-2 m or less generally sand, silt, and clay of eolian and/or alluvial origin; commonly gravelly where less than 1 m windblown sediment. thick. Bouldery deposits of large floods (mmf) mapped along Henrys Fork. Along Snake River, lithology of gravel clasts generally quartzite with minor limestone and basalt. Obsidian, welded tuff, and basalt clasts common minor components in gravels of Henrys Fork and in gravel along Snake River between American Falls and Burley. In basins north of Plain clasts mostly quartzite; in Big Lost River Valley siliceous rocks of Copper Basin Fm common. Forms terraces that generally lie 3-20 m above modern flood plains. Includes deposits of large fan of Snake River northeast of Idaho Falls and fans at mouths of major basins north of Plain. Total thickness of fills, which includes buried older mainstream deposits (mo) and other sediments where fills are thicker than several tens of meters, ranges from a few meters to several southwesterly east from Raft River, hundred meters along Snake River to more than 1000 m in basins north and south of the Plain; commonly about 10-30 m thick overlying basalt along Snake River and Henrys Fork. Upper parts of fills of Pinedale age based on degree of soil development and relation to outwash of Pinedale age. In somedrainages (Portneuf, Bancock, East Fork Wood River, etc.) includes terrace deposits (mc) and deposits of modern flood plains (mf), not mappable at this scale eposits of the Bonneville Flood

Pocatello, was accompanied by rapid erosion of the outlet that caused catastrophic flooding in the Marsh Creek-Portneuf River-Snake River system. Over a period of perhaps only weeks, floodwaters eroded new canyons and tracts of scabland and greatly modified existing canyons; ravel and finer-grained sediments were deposited over large areas (Malde, 1968; Trimble and Carr. 1961). The age of the flood is controversial. Radiocarbon dates from the Pocatello area suggest the flood is about 30,000 yr old (see SOURCES OF GEOLOGIC MAPPING, Trimble, 1976), whereas radiocarbon dates from Lake Bonneville deposits and interpretations of lake history place the date f the flood between 12,000 and 15,000 yr ago (Broecker and Kaufman, 1965; Morrison, 1965; Bright, 1966; Currey, 1980; Scott and others, Malde (1968) concluded, based on evaluation of weathering of flood deposits and the work of Bright (1963) in the Lake Thatcher area oncerning diversion of Bear River into the Bonneville basin, that the flood occurred about 30,000 yr ago. This age for the diversion of Bear River now seems suspect. Bright (1963) reported that the basalt in Portneuf Valley south of Pocatello, which was presumably related to the diversion of Bear River, was 30,000 14C yr old based on dating of rganic material beneath the flow. Recently, the flow was K-Ar dated by . B. Dalrymple (personal commun., 1979, USCS) as 583,000 + 104,000 yr i. Also, the presence of several buried soils, which are equally or etter developed than the soil developed on flood deposits within the loess mantle on the flow, suggests strongly that the basalt is at least several hundred thousand years old. The reported, finite radiocarbon dates probably result from small amounts of contamination by young organic matter. At present, roots of sagebrush and other shrubs extend down fractures in the basalt and enter underlying deposits. Thickness of the loess mantle on flood deposits and the extent of reworking of

flood deposits by the Snake River and its tributaries support an age of

the flood similar to the estimate based on Lake Bonneville history--

about 12,000-15,000 yr old.

Geology mapped by W. E. Scott.

1975-1977, assisted by

and compiled and

modified from sources

of Geologic Mapping

(fig. 2)

J. E. Frederick, 1975-1976.

The overflow of Lake Bonneville at Red Rock Pass, 65 km southeast

Boulder to pebble gravel, sandy gravel, pebbly sand, upper 0.5-2 m commonly a mantle of loess; poor to moderate sorting; clasts mostly subround to round, scarce angular clasts; parallel bedding and large-scale crossbedding, thin to thick beds. Thickness 0.5-30 m. Forms large fans at mouth of Portneuf River and at head of Burley-Rupert basin, and large bars along Portneuf and Snake Rivers. Includes the Michaud Gravel of Carr and Trimble (1961) (also see SOURCES OF GEOLOGIC MAPPING, Carr and Trimble, 1963; Trimble, 1976) and the Melon Gravel of Malde (1968) (also see SOURCES OF GEOLOGIC MAPPING, Malde, Powers, and Marshall, 1963; Malde and Powers, SAND AND SILT DEPOSITS OF THE BONNEVILLE FLOOD (UPPER

labeled crb are

combined with

unit crr

PLEISTOCENE) - Sand and silt, minor clay and gravel, includes mantle of 0.5-2 m of loess; poor to good sorting; parallel bedding and large- and small-scale crossbedding, minor graded bedding, very thin to medium beds. Deposits lie immediately downstream from gravel deposits (bg) in American Falls and Burley-Rupert basins. Deposits too small to be mapped lie at mouths of many Snake River tributaries DEPOSITS IN SCABLANDS FORMED BY BONNEVILLE FLOOD (UPPER PLEISTOCENE) -- Flood-scoured basalt bedrock discontinuously mantled with heterogeneous mixture of boulders and sand and

gravel and a discontinuous, thin (0.5-2 m) blanket of loess

basalt flows and deposited sediments in depressions. Scabland

terrain generally typified by rugged topography with relief of

and eolian sand. More than 25 percent of area is basalt

bedrock. Passage of flood locally to extensively scoured

several meters to tens of meters, much exposed rock, and

isolated sediment-covered areas. Also includes major

cataracts along Snake River OLDER DEPOSITS OF MAINSTREAMS (MIDDLE PLEISTOCENE TO PLIOCENE) -of Pebble and cobble gravel to pebbly sand, may include mantle of as much as 5 m of loess; poor to moderate sorting; clasts subround to round; parallel bedding and large-scale crossbedding, thin to thick beds. Forms terraces as high as 6 m above mainstream alluvium of major fills (mm). Flood deposits (mof) of this age occur along Camas Creek near Idmon. along Henrys Fork, and at mouth of Falls River. Bull Lake age is most probable. Deposits along Camas Creek display a train of asymmetrical, giant current ripples, presumably formed by flood originating in Island Park area. Includes upper Pleistocene Crowsnest Gravel, (see SOURCES OF GEOLOGIC PPING, Malde and Powers, 1972) and sediments of Hog Hollow, (G. M. Richmond, unpublished data, 1980), east of St. Anthony,

that underlie the 2 million-yr-old Huckleberry Ridge Tuff

Alluvium of tributaries

(Christiansen and Blank, 1972)

ALLUVIUM OF TRIBUTARY STREAMS (HOLOCENE TO UPPER PLEISTOCENE) --Silty sand to clayey silt, minor angular to round gravel. locally humic; nonbedded to parallel bedded. Thickness 1-4(+) m. Overlies pebble and cobble gravel to gravelly sand, minor lenses of sandy silt; clasts subround to round; parallel bedding and large- and small-scale crossbedding. Maximum exposed thickness of fine-grained deposits and underlying gravel about 8 m. Maximum total thickness of fills in tributaries including older deposits probably several tens of meters. Includes fan alluvium and colluvium (fc) along valley margins. In many valleys, unit forms terraced fills; elsewhere forms valley fills only slightly entrenched by streams. Lower lying areas subject to periodic flooding, high water tables, and poor drainage. Local areas along valley margins subject to flash flooding from side streams

Alluvial-Fan Deposits

Broad aprons of alluvial-fan deposits are striking features of basins flanking the Snake River Plain. Typically these basin landscapes are composed of several elements: remnants of older fan surfaces that are dissected by gullies and small canyons and locally have well developed, calcic soil profiles; extensive surfaces of relatively undissected alluvium that have relatively weakly to moderately developed soils; small areas along channels and near fan heads that appear active or recently active; and numerous, small (less than a few square kilometers in area), more steeply sloping fans at mouths of small drainage basins. In addition, the axis of the basins contain mainstreams and their associated alluvium. The areal importance of these elements varies from basin to basin. Near Pocatello, many of the basins contain broad, dissected surfaces of fan alluvium of intermediate age (f2) (often thickly loess covered) and only small, if any, surfaces of fan alluvium of Pinedale age (fl). Due to falling, local base levels along the Snake River, and perhaps due also to uplift of the basins, the streams on piedmonts flanking the basins occupy canyons as deep as 120 m in the older deposits; younger alluvial activity has been restricted to these canyons. Other basins, such as the Raft Valley and basins north of the ain, contain remnants of older surfaces and broad areas of fan alluvium of Pinedale age (fl). Regional patterns can be discerned, as in an east-northeast-trending belt of extensively preserved older alluvial surfaces (units f2 and f3) from Mackay in the Big Lost River Valley to Lone Pine in the Birch Creek Valley. Apparently this pattern resulted from uplift of a zone generally transverse to the trend of the basins and ranges and parallel to the northern margin of the Plain. Much of the alluvial-fan landscape in these basins is relict. The large fans are not being built today and have not been active for

Loess on Snake River Plain perhaps the last 10,000 yr. The youngest extensive fan deposits (f1), VERY THIN, VERY DISCONTINUOUS LOESS OVERLYING BASALT (UPPER which are of Pinedale age, have weakly to moderately developed soil profiles that are similar to soils developed in deposits of the Pinedale Glaciation, and presumably are of equivalent age. The sedimentary features of these fan sediments suggest deposition in a high-energy braided system characterized by fluctuating water and sediment discharges, and rapid aggradation -- an environment similar to proximal segments of outwash fans (Funk, 1976). This includes deposits from glaciated as well as nonglaciated drainage basins. Today, steamflow and sediment deposition on the fans are greatly restricted in space and ime. Narrow channels and small areas near fan heads receive minor streamflow only during short intervals of snowmelt or intense local rainstorms -- major, sustained discharge capable of producing the types of THIN LOESS OVERLYING BASALT (UPPER AND MIDDLE PLEISTOCENE) -deposits forming the extensive fans does not occur. This suggests that fan building occurred during pluvial (glacial) periods of increased runoff accompanied by increased sediment transport. Interpluvial (interglacial) periods, like today, were times of low sediment and water discharge, of local fan incision especially at fan heads, of soil formation, and of general fan-surface stability. However, some streams in relatively wet areas do produce large and sustained discharges sufficient to maintain active fans, although smaller than fans of Pinedale age (f1), or wide flood plains. These are limited to drainages

AND MIDDLE PLEISTOCENE) -- Pebble to boulder gravel with matrix of silty sand to clayey silt; in areas of loess or finegrained, poorly consolidated bedrock, gravel may be matrix supported; poorly sorted; clasts mostly angular to subround; nonbedded to crudely bedded. Distal portions of larger fans better sorted and grade to fan surfaces of Pinedale and intermediate age (fl and f2). Forms fans at mouths of Segments of fans range in age from Holocene to middle Pleistocene based on degree of soil development, but cannot be differentiated at this scale. Includes thin gravel of small pediments in mountainous areas. Subject to flash flooding, debris flows and mudflows FINE-GRAINED ALLUVIAL-FAN DEPOSITS (HOLOCENE AND UPPER

in northern Camas Prairie and scattered basins draining high peaks in

than the larger fans, although perhaps not as active as they were during

nges north of the Plain. The smaller drainage basins and their

pluvials. Local intense rainstorms and rapid snowmelt do occasionally

FAN DEPOSITS OF ALLUVIUM AND COLLUVIUM (HOLOCENE AND UPPER

associated fans of alluvium and colluvium (fc) are more active today

produce significant runoff and, in some basins, debris flows and

PLEISTOCENE) -- Silty sand to clayey silt, minor gravel; poor t moderate sorting; gravel clasts angular to subround; parallel bedding and crossbedding, commonly indistinct, thin to thick beds. Forms fans and coalescing fans along southeastern margin of Snake River Plain and in Raft River Valley. Sediment largely derived from stripping of loess from upland areas. Locally subject to flooding. Includes deposits of reddish-brown, silty clay; thickness as much as 3 m; mantles mainstream alluvium (mm) in area south and southeast of Idaho Falls. These sediments derived in part from erosion of red beds of Mesozoic age in north end of Blackfoot Mountains FAN ALLUVIUM (HOLOCENE) -- Pebble to cobble gravel,

some pebbly sand; locally fine grained and humic; poor to moderate sorting; clasts subangular to round; parallel bedding and large-scale crossbedding. Forms fans and surfaces of active deposition inset within older fan deposits (fl and 2). Mapped primarily in Camas Prairie. In most other areas confined to narrow channels and small areas at fan heads, not differentiated at this scale. Subject to flooding, high water tables, and poor drainage FAN ALLUVIUM OF PINEDALE AGE (UPPER PLEISTOCENE) -- Pebble to

cobble gravel, locally bouldery near fan heads, contains

variable amounts of sand to silty sand matrix, some lenses of

sand and silty sand, most common on distal portions of fans;

poor to moderate sorting; clasts subangular to round; parallel

medium to thick beds. Forms fans and coalescing fans at range

bedding and large-scale crossbedding, locally crudely bedded

fronts. Soil developed in unit fl commonly characterized by cambic B or oxidized C horizon, thickness 20-50 cm, in gravelly loam to loamy gravel; overlying a Cca horizon, thickness 30 to 80 cm, in gravel. Cca has stage I, thin (1 mm or less), discontinuous calcium carbonate coats on bottoms of stones, to stage II morphology, thin (1 mm), continuous coats on entire stone. Degree of soil development and relation to moraines and outwash of Pinedale age suggest that unit fl is also of Pinedale age. In Raft River Valley, includes younger and intermediate fan alluvium (see SOURCES OF GEOLOGIC MAPPING, Williams and others, 1974; Pierce and others, unpublished mapping, 1980). Local areas near mountain fronts and along and near active channels subject to flash flooding, flooding from rapid snowmelt, and debris-flow and mudflow activity. Unit disrupted by fault scarps generally lower than 3 m along west-facing range fronts in northern parts of Lost River and Lemhi Ranges and Beaverhead Mountains FAN ALLUVIUM OF INTERMEDIATE AGE (MIDDLE TO LOWER? PLEISTOCENE)--Pebble to cobble gravel, locally bouldery near fan heads. contains variable amounts of sand to silty sand matrix, some lenses of sand and silty sand; poor to moderate sorting; clasts subangular to round; parallel bedding and large-scale crossbedding, locally crudely bedded, medium to thick beds. Includes some fan deposits of alluvium and colluvium (fc) and narrow channels of fan alluvium of Pinedale age (f1). Forms terraces, small fan remnants, and some extensive fan surfaces, along range fronts. Differentiated from unit fl by topographically higher position, better developed soil having 2-10-mm-thick caliche coats on clasts, and usually a strongly cemented, stage III calcic horizon 15-50 cm thick. In basins south of Snake River, unit f2 commonly includes mantle of loess as thick as several meters, which may contain one or more buried soil profiles. Unit ek/f2 mapped where gravel totally obscured by loess more than several meters thick (see THICK LOESS, ek). Includes pediment gravel (see SOURCES OF GEOLOGIC MAPPING, Trimble, 1976; Trimble and Carr, 1976) and older fan alluvium (see SOURCES OF GEOLOGIC MAPPING, Williams and others, 1974; Pierce and others, unpublished mapping, 1980). Locally subject to flash flooding, debris flows, and mudflows near mountain fronts. Unit extensively faulted (fault scarps as high as 12 m) along western fronts of Lost River and

OLD FAN ALLUVIUM (LOWER PLEISTOCENE TO PLIOCENE) -- Pebble to cobble gravel, with scattered boulders, variable amounts of sand to silty sand matrix, local lenses of sand and silty sand; poor to moderate sorting; clasts subangular to round; parallel bedding and large-scale crossbedding. Locally to pervasively cemented with calcium carbonate deposited from ground water (Funk, 1976). Pedogenic calcretes as thick as 1 m locally preserved, however, original surface is greatly eroded. Includes Tuana Gravel (>1.4 m.y. old) (see SOURCES OF GEOLOGIC MAPPING, Malde and Powers, 1972)

mhi Ranges and Beaverhead Mountains (Malde, 1971) and east

of Henrys Lake (Myers and Hamilton, 1964; K. L. Pierce,

written commun. 1980)

portrayed at this scale.

Snake River Plain and its southern and southeastern margins. Many of the units of alluvial and glacial origin are mantled by eolian sediment, although the underlying unit is generally shown on this map unless the eolian sediment is very thick. The high agricultural productivity of soils on the Plain is due, in large part, to a mantle or admixture of Dunes and sheets of colian sand are locally abundant near Snake River and Mud Lake. The sand was deflated from alluvial surfaces or abandoned lake floors and transported in major downwind (east to northeast) directions. The deposits of eolian sand between Pocatello and Idaho Falls, between Rupert and American Falls, and east of Hagerman ere derived from deposits of the Bonneville Flood. Eolian sand near . Anthony was derived from the fan of the Snake River north of Idaho alls and the fill of Henrys Fork downstream from St. Anthony. Sand that was deflated from the bed of the former Lake Terreton and from alluvial surfaces of the Big Lost and Little Lost Rivers and Birch Creek ies on, and downwind from, the Mud Lake area. Wind directions deduced from sand deposits generally parallel the trend of the Plain--in a westerly direction west of Raft River, becoming south-southwesterly then A single loess blanket buries basalt flows and geomorphic surfaces f late Pleistocene age, whereas on older surfaces the loess mantle is generally composed of several loess units of different ages separated by buried soils and/or erosional surfaces and their attendant deposits of alluvium and colluvium. As older loess units are always covered by an upper loess unit that was deposited during Wisconsin time, it is not possible, on the surface, to differentiate and map loess units by age. On this map, loess units are defined by variations in thickness and continuity. In the loess cover on the basalts of the Plain, four units are recognized that range from thin and discontinuous to thick and continuous. Loess cover on upland areas, generally southeast and east of the Snake River and Henrys Fork, is divided into thin and thick units. Drifting of loess in these upland areas of moderate relief has resulted locally in great variation of loess thickness that cannot be

Pluvial is used here to denote times when there was more water on the landscape than at present--stream discharges were greater, and lakes in closed basins had higher levels. Annual precipitation may have been more than, less than, or equal to present precipitation; however, lower mean annual temperatures than at present caused an increase in effective precipitation.

areas of thin loess on slopes, slope processes (solifluction, sheet wash) active during and since primary deposition have reworked the loess and nearby deposits and redeposited the material as "slope loess" Pecsi, 1965) -- a mixture of clay, silt, sand, and minor gravel of alluvial and/or colluvial origin. These reworked deposits are included in the various loess units. Three factors influence the thickness of loess that is present on a given surface: 1) Age of the surface. As loess has accumulated during several successive cycles, old surfaces tend to have thicker mantles than young surfaces. However, the following two factors complicate this 2) Distance and direction from source areas of loess. The distribution of loess suggests that during glaciations the extensive, active alluvial surfaces of major streams were the main sources of loess. Therefore, rolling areas nearby and downwind from source areas are mantled more thickly than distant areas or areas upwind from sources. There also tends to be a thinning of loess as altitude increases (McDole, 1969).

The thicker loess deposits contain mostly primary or true loess--

silt and sand that was deposited by wind. Locally, and especially in

3) Post-depositional stripping of loess by slope and eolian processes. Local areas on the Rexburg bench, on benches close to the Plain east of iaho Falls, and in the area at the mouth of the Raft River Valley (see SOURCES OF GEOLOGIC MAPPING, Pierce and others, unpublished mapping, 1980) have a thin loess cover that overlies bedrock or a complex, calcium carbonate-silica hardpan even though they are close to and downwind from major source areas. Apparently, active slope processes and deflation tended to erode much of the loess deposited in these areas uring a given cycle. In places, the eroded loess forms fine-grained Boundaries between loess areas are generally gradational and contacts are approximately located, except where young, thin-mantled basalt flows border much older and thicker-mantled flows and boundaries are sharply defined. Dashed contacts represent very poorly defined boundaries. In addition to field mapping and aerial photographic reconnaissance (generally using high-altitude, false-color-infrared aerial photographs), data was obtained from county maps of loess deposits that were compiled from various sources (see SOURCES OF

esa DEPOSITS OF ACTIVE DUNE AREAS (HOLOCENE) -- Very fine to medium sand, minor coarse sand; good sorting; small-scale and largescale crossbedding, bedding often indistinct, thin to thick 35 km. Forms longitudinal dunes and transverse dunes with interdune areas of thin- to thick-sheet sand. Includes some basalt bedrock in interdune areas. Areas of actively blowing and drifting sand and migrating dunes

GEOLOGIC MAPPING, Fosberg, unpublished mapping, 1978) and published at

Eolian sand

reduced scale by Lewis and others (1975).

DEPOSITS OF LARGELY STABILIZED DUNES (HOLOCENE AND UPPER PLEISTOCENE) -- Very fine to coarse sand, minor fine gravel; good sorting; small- and large-scale crossbedding, bedding often indistinct, thin to thick beds. Thickness ranges from 0.5 to 7 m, locally thicker. Generally forms longitudinal dunes with interdune areas of thin sand sheets; locally forms transverse dunes. In Mud Lake area, eolian sand overlying units mm, mcf, and 1 indicated by symbols ess/mm, etc. Largely stabilized by grass and shrubs. Includes small areas of active dunes (esa) not differentiated at this scale. Local areas of blowing and drifting sand; susceptible to deflation where ground cover disturbed stn DEPOSITS OF THIN SAND SHEETS (HOLOCENE AND UPPER PLEISTOCENE) --

Fine to coarse sand, locally some gravel derived from underlying unit, numerous small outcrops of bedrock; moderate to good sorting; indistinct small- and large-scale crossbedding. Thickness 0.5-3 m commonly less than 1.5 m. Forms thin, discontinuous sheets of sand with some longitudinal dunes and a few low transverse dunes formed by blowouts. Largely stabilized by grass and shrubs. Local areas of blowing and drifting sand; susceptible to deflation where ground cover disturbed

estk DEPOSITS OF THICK SAND SHEETS (HOLOCENE AND UPPER PLEISTOCENE) --

Fine to coarse sand, locally some gravel derived from underlying unit, few small outcrops of bedrock; moderate to good sorting; indistinct small- and large-scale crossbedding. Thickness 1-8 m, commonly 1-3 m. Forms nearly continuous sheets of sand with minor longitudinal dunes and small transverse dunes formed by blowouts. Largely stabilized by grass and shrubs. Local areas of blowing and drifting sand; susceptible to deflation where ground cover disturbed eso OBSIDIAN-RICH EOLIAN SAND (HOLOCENE AND UPPER PLEISTOCENE) --Coarse sand, minor to abundant fine and medium sand and fine gravel, few to 20 percent or more of obsidian; occurs northwest of Henrys Fork between Menan Buttes and Fall River. Sediment deflated from Egin Bench and possibly also deposited above level of Egin Bench by catastrophic flooding along Henrys Fork (see section on mainstream deposits) then largely reworked by wind. Moderate to good sorting; indistinct bedding, minor parallel and large- and small-scale crossbedding. Thickness 0.5-3 m. Includes few to numerous areas of bedrock. Largely stabilized by grass and shrubs. Local areas of blowing and drifting sand; susceptible to deflation where ground cover disturbed

PLEISTOCENE) -- Silt and sandy silt, abundant angular basalt gravel, many large areas of bedrock exposed in 75-95 percent of surface; poor to good sorting; nonbedded, crudely bedded where loess reworked by slope processes. Maximum loess thickness about I m, commonly less than 0.5 m. Generally occurs on lava flows of latest Pleistocene age that lie far from loess sources; features on lava flows (tumuli, levees, lava tubes, etc.) clearly displayed. Very stony land, unfit for cultivation. Locally unstable surfaces over caves in

Silt and sandy silt, common and locally abundant angular to subround basalt gravel, bedrock outcrops about 30-75 percent of surface; poor to good sorting; nonbedded, crudely bedded where loess reworked by slope processes. Maximum thickness about 3 m, commonly 0.5-2 m. Generally occurs on basalt of late Pleistocene age and on older basalts that lie far from loess sources. Includes common colluvium of basalt and loess. Many lava-flow features not obscured by loess cover. Small, discontinuous areas are cultivatable, but most of area generally unfit for cultivation MODERATELY THICK LOESS OVERLYING BASALT (UPPER TO LOWER? PLEISTOCENE) -- Silt and sandy silt, common to sparse angular to

subround basalt gravel, bedrock outcrops about 1-30 percent of

surface; moderate to good sorting; nonbedded, crudely bedded

where loess reworked by slope processes. Maximum loess thickness about 7 m, commonly 1-4 m. Generally occurs on basalts of late and middle Pleistocene age close to loess sources and on older basalts farther from loess sources. Lava-flow features in basalts mostly obscured by loess mantle. Generally cultivatable except for small, local areas of outcropping basalt and thin loess e4 THICK LOESS OVERLYING BASALT (UPPER TO LOWER? PLEISTOCENE) ---It and sandy silt, sparse angular to subround basalt gravel bedrock outcrops constitute less than 1 percent of unit: moderate to good sorting; nonbedded, crudely bedded where loess reworked by slope processes. Maximum loess thickness

about 30 m, commonly 3-10 m. Generally occurs on old basalts

near loess sources. Commonly forms thick drifts downwind from

hills. No lava-flow features discernible through thick loess

cover. Cultivatable nearly everywhere Loess on uplands adjacent to Snake River Plain en THIN LOESS (UPPER AND MIDDLE PLEISTOCENE) -- Silt and sandy silt, common clayey silt, abundant to sparse admixed angular to subround gravel; moderate to good sorting; nonbedded, crudely bedded where loess reworked by slope processes. Includes few to numerous small areas of bedrock, colluvium, and alluvium. Maximum loess thickness probably about 10 m commonly 1-2 m thick. Generally occurs far from and high above loess sources on rolling uplands in ranges south and

east of Plain

silt, locally clayey silt, sparse admixed angular to subround gravel near bedrock outcrops; good sorting; nonbedded, crudely bedded where loess reworked by slope processes. Includes few, small areas of bedrock and colluvium. Maximum loess thickness 60 m or more, commonly 7-15 m. Commonly forms elongated drifts of loess, oriented in direction of wind downwind from ridges and hills. Occurs on rolling uplands on south and east margins of Plain. Deep exposures and auger holes reveal complex sequence of loess, buried soils (McDole, 1969), and locally, tephra. Symbol ek/f2, ek/got, etc., indicates underlying unit, where known. Includes upper Pleistocene Sunbeam Formation (see SOURCES OF GEOLOGIC MAPPING, Carr and Trimble, 1963; Trimble, 1976; Trimble and Carr, 1976)

k THICK LOESS (UPPER TO LOWER PLEISTOCENE) -- Silt and sandy

LACUSTRINE AND MIXED LACUSTRINE AND ALLUVIAL DEPOSITS Volcanic eruptions and tectonism have periodically dammed the Snake River or its tributaries and formed basins that contained lakes and(or) had impeded drainage. West of Twin Falls, Malde (1965) described the deposits and geologic history of middle Pleistocene and older lacustrine and associated alluvial units that are now deeply incised. East of Twin alls, several basins that are only shallowly incised contain similar, but younger, deposits. Much of the fill in these basins is fine-grained alluvium with only minor lake beds, which reflects deposition in low-gradient basins rather than in basins containing large lakes. Extensive volcanism along the axis of the Plain dammed and obstructed drainage from areas north of the Plain. Basins formed that during glacial/pluvial periods received more runoff than now and contained large shallow lakes in contrast to the present small playas. Numerous drill holes and wells along the north margin of the Plain penetrate sequences of fine-grained deposits, many of which are of luvial and lacustrine origin. Along the axis of the Plain thick interbeds of fine-grained sediments in drill holes are rare. Other lake deposits mapped here were deposited in small depressions on or between lava flows, in Lake Bonneville, or in various glacier- or moraine-dammed basins.

DEPOSITS OF PLAYAS (HOLOCENE AND UPPER PLEISTOCENE) -- Silty sand to clayey silt, minor gravel and scattered basalt boulders near margins; poor to good sorting; indistinct parallel bedding and minor, small-scale crossbedding, thin laminae to thick beds. Sediments largely derived from erosion of loess from surrounding basalt uplands. Thickness 1->10 m; generally less than 2 m. Form flat to gently sloping fills in periodically flooded shallow depressions on basalt flows. between basalt flows, and between basalt flows and alluvial fans. Generally less than 5 km2 in extent. Mapped in modern "sink" areas (playas) of Birch Creek and Big and Little Lost Rivers. Deposits generally more fluvial near margins and more lacustrine near centers. Poorly drained and subject to periodic flooding, especially during periods of heavy rains and times of rapid snowmelt LAKE-FLOOR DEPOSITS (UPPER PLEISTOCENE) -- Silty clay to sandy silt; moderate to good sorting; parallel bedding and minor

small-scale crossbedding, thin laminae to medium beds. Forms low-relief plains, formerly lake bottoms. Lake Terreton, previously a shallow lake, covered a wide area near present Mud Lake; probably overflowed to Snake River-Henrys Fork system prior to eruption of Little Grassy Butte, west of Rexburg; filled due to increase in runoff from drainages north of the Plain, probably coincident with Pinedale Glaciation. Market Lake, north of Idaho Falls, was dammed by deposits from Snake River. Deposits of Lake Bonneville occur southeast of Raft, River Valley. Includes deposits of ice- and morainedammed lakes in Yellowstone Park area (see SOURCES OF GEOLOGIC MAPPING, Richmond, 1973a, 1973b). Locally includes mantle of eolian sand. Locally subject to flooding, high water tables, poor drainage and saline soils

local pebble gravel and pebbly sand; moderate to good sorting; clasts subround to round; parallel bedding to small- and large-scale crossbedding. Thickness generally less than 5 m. Includes deposits of beaches, bars, and deltas at margins of former lakes. Includes small areas of active (esa) and stabilized (ess) dune sand

Deposits of American Falls Lake Pleistocene American Falls Lake was dammed by basalt flows from Cedar Butte (Janies Nipples on Yale 15-minute quadrangle, see SOURCES OF GEOLOGIC MAPPING, Stearns and others, 1938; Carr and Trimble, 1963), a vent lying 16 km west-southwest of American Falls. Prior to this eruption, and prior to somewhat older eruptions in this area, the Snake River maintained a course farther north than at present. The evidence or this southward shift includes the paucity of Snake River deposits in he canyon walls below American Falls where volcanic rocks of Pliocene and Quaternary age are exposed, and the presence of abundant quartzite pebbles in cinders from an older vent, now being quarried, 1.5 km northnortheast of Janies Nipples. Recent K-Ar dating of the Cedar Butte Basalt has yielded an age of 72,000 + 14,000 yr (G. B. Dalrymple, personal commun., 1979), indicating that the deposits of the American alls lake began to accumulate in early Wisconsin time. Ridenhour (1969) recognized that only the upper part of the American Falls Lake Beds as mapped by Carr and Trimble (see SOURCES OF GEOLOGIC MAPPING, 1963) were of lacustrine origin. The lower part consists of crossbedded fluvial sand and flood-plain deposits of sand, silt, and clay that were deposited in the basin prior to damming. The lava dam was completely breached during the Bonneville Flood, which eroded some of the lakefloor deposits and deposited gravel and sand over much of the basin (Michaud Gravel and some of the Aberdeen and Sterling terrace deposits of Carr and Trimble (see SOURCES OF GEOLOGIC MAPPING, 1963; Trimble,

sand; moderate to good sorting; parallel bedding, thin laminae to thick beds. Contains conspicuous, laterally continuous bed of blocky, grayish-white weathering, diatomaceous clay generally 2-3 m thick. Maximum exposed thickness about 5 m; generally less than a few meters thick overlying basalt flows near Pingree. Forms part of steep bluffs around American Falls Reservoir and Fort Hall Bottoms, and along Snake River between American Falls and Neeley. Includes poorly exposed shoreline deposits (1baf) of sand, silty sand, silt, and fine gravel; moderate to good sorting; gravel clasts subround to round; parallel bedding and small- scale crossbedding, thin to thick beds. Maximum exposed thickness about 8 m near Springfield. Includes upper part of American Falls Lake Beds, Grandview terrace deposits, and some of Sterling and Aberdeen terrace deposits (see SOURCES OF GEOLOGIC MAPPING, Carr and Trimble, 1963; Trimble, 1976). Includes widespread mantle of loess and reworked loess (0.5-2 m thick) and a thin (0.1-1 m, thicker near Portneuf River), discontinuous layer of sand and gravel deposited by the Bonneville Flood. Also includes crossbedded, fluvial sand and flood-plain deposits of silt, sand, and clay exposed below lake beds in bluffs around American Falls Reservoir. This alluvium deposited in a lowgradient basin with impeded drainage that existed prior tocomplete damming by the Cedar Butte Basalt (Ridenhour. 1969). Near Portneuf River, gravel below lake beds contains a rich vertebrate fauna including Bison latifrons (Hopkins and others, 1969). Peat from 4 m below the probable top of American Falls Lake Beds near Portneuf River was radiocarbon dated at greater than 42,000 yr B.P. (W-929) (see SOURCES OF GEOLOGIC MAPPING, Trimble, 1976). Subject to slumping along steep bluffs that results in rapid cliff retreat around

American Falls Reservoir

laf DEPOSITS OF THE AMERICAN FALLS LAKE (UPPER PLEISTOCENE) -- Clay,

paf diatomaceous clay, silt, sandy silt, and very fine to fine

1bu OLDER LACUSTRINE AND ALLUVIAL SEDIMENTS NEAR BURLEY (MIDDLE PLEISTOCENE) -- Sand, silty sand, silt, minor clay. minor gravel; moderate to good sorting; parallel bedding and minor small- and large-scale crossbedding, thin to thick beds. Poorly exposed in low hills near Paul and along Snake River east of Burley. Includes fine-grained alluvium and lacustrine sediments deposited in lava-dammed, Burley-Rupert basin. Maximum exposed thickness about 13 m, east of Burley. May be as thick as 45 m in well near Burley. Includes Burley Lake Beds (SEE SOURCES OF GEOLOGIC MAPPING, Stearns and others, 1938)

r RAFT FORMATION (MIDDLE AND LOWER? PLEISTOCENE) -- Silt, sand,

and clay, minor gravel, locally abundant calcareous concretions, includes several thin beds of silicic tephra; moderate to good sorting; parallel bedding and small- and large-scale crossbedding; beds and laminations range from very thin laminae in some silt and clay to very thick beds in massive silt. Dips gently to northwest. Exposed thickness as great as 45 m; total thickness may be as much as 360 m Crosthwaite, 1974). Exposed in bluffs along Snake River from American Falls to Raft River and in tributaries to Snake River near Lake Walcott (see SOURCES OF GEOLOGIC MAPPING, Stearns and others, 1938; Carr and Trimble, 1963; Trimble and Carr. 1976). Includes fine-grained alluvium, lacustrine deposits, and possibly loess. A thin ash collected by K. L. Pierce (USCS) from the Raft Formation along Lanes Gulch, southeast of Lake Walcott, correlates with ash in the type section of Merced Formation of western San Francisco peninsula (Maidu ash of Sarna-Wojcicki; Izett, personal commun., 1980). Source of the ash is probably in southern Cascade Range of California, its age is imprecisely known--about 1 m.y. old or younger (Sarna-Wojcicki, 1976). Upper part of Raft Formation of previous workers near Lake Walcott mapped here as thick loess ek), contains several buried soils and tephra layers. Probable late Pleistocene age (see SOURCES OF GEOLOGIC MAPPING, Carr and Trimble, 1963) unlikely considering tephra

1br SEDIMENTS OF THE BRUNEAU FORMATION (MIDDLE AND LOWER PLEISTOCENE) -- Lacustrine fine silt, clay, and diatomite, alluvial sand and silt; moderate to good sorting; parallel bedding and minor small- and large-scale crossbedding, very thin laminae to thick beds. Maximum thickness about 50 m where mapped. Includes fill of lake sediments and related alluvium and colluvium deposited in former canyon of Snake River that was dammed by lava flows between Bruneau and Murphy, west of map area (see SOURCES OF GEOLOGIC MAPPING. Malde and Powers, 1972). Average K-Ar ages of associated basalt flows about 1.4 m.y. old (Evernden and others, 1964;

and loess evidence

Armstrong and others, 1975)

GLENNS FERRY FORMATION (PLIOCENE) -- Silt, sand, and clay, minor gravel, includes beds of carbonaceous shale and layers of basaltic and silicic tephra, also includes interbedded basalt flows (mapped as rubbly colluvium (crr) where exposed at surface); moderate to good sorting; parallel bedding and smallscale and minor large-scale crossbedding, beds range from very thin laminae in lacustrine sediments to very thick beds of massive silt. Maximum exposed thickness about 200 m where mapped. Sediments deposited in lacustrine, flood-plain, and fluviatile environments in subsiding basin (Malde, 1972; see SOURCES OF GEOLOGIC MAPPING, Malde and Powers, 1972). Includes important and diverse fauna of Blancan age (Neville and others, 1979, see references). Evernden and others (1964) obtained K-Ar ages of about 3.5 m.y. on basalts in the Glenns Ferry. Probably of Pliocene age where mapped; some farther west may be early

Pleistocene (Malde, 1972; Neville and others, 1979)

GLACIAL DEPOSITS During glacial times, a large ice cap covered the Yellowstone Park

area and mountain ice caps and large valley glaciers existed the Teton Range and Boulder-Pioneer Mountains. Many valley and cirque glaciers anges, the Beaverhead Mountains, and other ranges north of the Plain. outh of the Plain, cirque and valley glaciers existed in the Albion and Snake River Ranges, while scattered small glaciers formed on some of the higher peaks in other ranges. In general, equilibrium-line altitudes of glaciers were lowest in western areas (Albion Range and Soldier, Smoky, oulder, and Pioneer Mountains) and increased in altitude toward the east (Lost River and Lemhi Ranges and Beaverhead Mountains). Also, parts of ranges close to the Plain had glaciers with lower equilibriumline altitudes than areas farther from the Plain (i.e., an increase of equilibrium-line altitudes from the southeastern to the northwestern ends of the Lost River Range). This suggests that storms were directed along the Plain as they moved from west to east. Then, as today, the llowstone area was the site of high precipitation (and low equilibrium-line altitudes) because weather systems moving along the lain were lifted onto the Yellowstone Plateau (Pierce, 1979) Weathering and morphologic characteristics of the glacial deposits were used to differentiate deposits of Pinedale age from older osits. Some mapping is compiled or modified from Armstrong (see SOURCES OF GEOLOGIC MAPPING, unpublished mapping, 1979) in the Albion ange, Evenson (see SOURCES OF GEOLOGIC MAPPING, unpublished mapping, 1979) in the Pioneer Mountains, Knoll (1973) in the east-central Lemhi Range, Witkind (see SOURCES OF GEOLOGIC MAPPING, 1972) and Waldrop (see SOURCES OF GEOLOGIC MAPPING, 1975) in the Henrys Lake area, and Richmond see SOURCES OF GEOLOGIC MAPPING, 1973a, 1973b, unpublished mapping, 1979) in the southwestern Yellowstone area and in the area east and south of Ashton. Revision of Richmond's Pinedale boundary in the southwestern Yellowstone area was based on data gathered with S. M. olman (USGS), about soil development, loess thickness, and weathering rinds on basalt clasts in soils. In many of the mountain areas, deposits of till are small and discontinuous, and not distinguished at this scale. These deposits are included in various colluvial units.

pt TILL OF PINEDALE GLACIATION (UPPER PLEISTOCENE) -- Pebble to

boulder gravel in loose to compact matrix of silty sand to clayey sandy silt; nonsorted to poorly sorted; clasts subangular to subround; nonbedded to crudely bedded. Texture largely determined by characteristics of local bedrock. Thickness ranges from 1 m to more than 30 m. Forms moraines and sheet-like deposits with rolling to hummocky relief. Moraines generally sharp crested and bouldery. Till surfaces may contain numerous undrained depressions, some occupied by lakes and swamps. Includes small areas of units gpo, got, and colluvium. Displaced by faults along Cedar Creek (west of Borah Peak), along Boulder Creek (northwest of Ketchum), and along South Fork and Rock Creek (southwest of Henrys Lake) po OUTWASH OF PINEDALE GLACIATION (UPPER PLEISTOCENE) -- Pebble and cobble gravel, locally bouldery, variable amounts of sand matrix; poor to moderate sorting; clasts subangular to round; parallel bedding and large-scale crossbedding, thin to thick beds. Forms outwash fans and terraces along streams that were fed substantially by glacial meltwaters. Included in fan alluvium of Pinedale age (f1) in drainage basins less than about 20 percent glacier covered. Grades to fan alluvium of Pinedale age (f1) and mainstream alluvium (mm). Includes small areas of deposits of modern flood plains (mf), of cut terraces (mc), and of tributaries (ta). Faulted east of Henrys Lake (Myers and Hamilton, 1964; K. L. Pierce, written commun, 1980) and along Cedar Creek and Willow Creek west of Borah Peak. Some areas close to present stream channels may be subject to flooding

TILL OF PRE-PINEDALE GLACIATION(S) (MIDDLE PLEISTOCENE)--Pebble to boulder gravel in loose to compact matrix of silty sand to clayey sandy silt; nonsorted to poorly sorted; clasts angular to subround; nonbedded to crudely bedded. Thickness ranges from 1 m to more than 30 m. Forms subdued moraines with broadly rounded crests that are less bouldery than moraines of Pinedale age, and sheet-like deposits with low to rolling relief. Most of unit probably deposited during Bull Lake Glaciation, dated in nearby West Yellowstone basin at about 140,000 yr B.P. (Pierce and others, 1976). In areas east of Henrys Fork and in Teton Basin, till and soil developed in it buried by loess mantle as thick as 12 m. Near Ashton, units gotu and gotl represent inferred limits of two advances (see SOURCES OF GEOLOGIC MAPPING, Richmond, unpublished mapping, 1979). Faulted near Cedar Creek, west of

OO OUTWASH OF PRE-PINEDALE GLACIATION(S) (MIDDLE PLEISTOCENE)--Pebble and cobble gravel, locally bouldery, variable amounts of sand matrix; poor to moderate sorting; clasts subangular to round; parallel bedding and large-scale crossbedding, thin to thick beds. Forms outwash fans and terraces in drainages that were substantially glacier covered. Similar to fan alluvium of intermediate age (f2), in degree of soil development, position in drainage, and loess cover TILL, UNDIFFERENTIATED (UPPER AND MIDDLE PLEISTOCENE) -- Pebble to boulder gravel in loose to compact matrix of silty sand to clayey sandy silt; nonsorted to poorly sorted; clasts angular to subround; nonbedded to crudely bedded heet-like deposits in steep mountain valleys. Mostly Pinedale age but includes some till of pre-Pinedale age

Deposits of large landslides are distributed unevenly in the map area. Their occurrence is controlled primarily by local relief. haracter of bedrock, and climate. No large landslides have been found on the Plain owing to little local relief, although a few slides do occur along steep canyon walls. Most of the landslide deposits shown on this map are found in the ranges flanking the Plain. Bedrock units (and their distributions) that are, or were under past climates, highly susceptible to failures of various types and ontain numerous landslides include (in part from Radbruch-Hall and others, 1976): Eocene Challis Volcanics (ranges northwest of the Plain)--slumps, earthflows, and debris flows; Medicine Lodge Beds (northwest of ubois) -- slumps and earthflows; fine-grained facies of the Cretaceous to Eocene Beaverhead(?) Formation (eastern Beaverhead and western entennial Mountains) -- slumps and earthflows; intercalated volcanics and ediments of Tertiary age (Goose Creek area)--slumps. In the Albion Range and Middle Mountain area, there are numerous landslide deposits shown, most of which were mapped by Armstrong (see SOURCES OF GEOLOGIC MAPPING, unpublished mapping, 1979) as glacial deposits. Some are earthflows, but many are unlike any other landslide deposits in the map area. These hummocky to sheet-like deposits are found in and below irque-like valley heads, and on pediments at the base of slopes. The eposits appear to be thin and lack distinct morainal form. Also, they occur at altitudes lower than true glacial sediments. The origin of these deposits is in question, however nivation and solifluction probably were important. The area today receives higher snowfall than. ljacent ranges; probably due to enhanced orographic effects caused by he "protrusion" of the range into the storm tracks passing along the central Snake River Plain (K. L. Pierce, written commun., 1980). Other landslides, primarily rock avalanches and rock slides, are mapped in rrains of highly fractured, Paleozoic, sedimentary rocks. In contrast to the deposits of large landslides, extensive areas in rolling uplands and in mountain ranges flanking the Plain and the termontane basias north and south of the plain are underlain by widespread deposits of colluvium. The colluvium forms discontinuous sheets of variable thickness that mantle slopes and divides, small colluvial comes and fans at bases of slopes, and locally, masses of landslide debris. The material that comprises the colluvium was derived from the weathering of local bedrock and has generally been transported only short distances from its source by creep, solifluction, andsliding, and running water. Colluvium is generally thick on the base of slopes and on gentle slopes, and thin on steep slopes and narrow divides. Rock outcrops are nearly absent where bedrock is poorly consolidated or where colluvium is thick, whereas abundant rock outcrops are present in steep terrain, especially where the bedrock is hard. eas of mappable size where greater than about 50 percent of the surface consists of rock outcrops are mapped as rock (r). The colluvial units mapped here are differentiated on the basis of heir texture which is controlled largely by the lithology of local bedrock. Therefore, the boundaries between units are generally ithologic contacts which were modified from published and unpublished

geologic maps (fig. 2). Patterned ground formed in colluvium is widely distributed on the lanks of the Plain in the western part of the map area (Malde, 1964; Fosberg, 1965). The patterns occur as nets or stripes of stones with ntervening mounds or stripes of generally silty soil with few stones. ets are common on flat to gently sloping surfaces; nets lengthening to stripes alined parallel to local slope occur as slope angle increases. Large areas of well-developed patterned ground occur in rubbly colluvium derived from basalt (crr) and thin loess over basalt (e2) on the south and north flanks of the Mount Bennett Hills, in the Timmerman Hills east of Magic Reservoir, and southwest of Twin Falls in the very southwestern corner of the map. In other parts of the map area, small patches of less strikingly developed patterned ground occur in the Albion Range, on the flanks of the Plain, and on the slopes of some shield volcanoes on he Plain. Both Malde (1964) and Fosberg (1965) felt that the patterned ground they studied formed under a more rigorous cold climate coincident with glacial times of the late Pleistocene. Most of the colluvium mapped here is either still in active Ithough at a very slow rate) transport on slopes or was deposited during late Pleistocene or Holocene time and has since been stored as aprons of debris at bases of slopes or as a part of the colluvial mantle that is now inactive due to climatic or other environmental change. How ld some of the mapped colluvium might be is open to conjecture. My feeling is that little, if any, dates from pre-Pleistocene time, and that most is younger than lower Pleistocene. Due to the small scale of this map, small areas underlain by alluvium, glacial deposits, and landslide deposits are included in the colluvial units. In many areas adjacent to loess-covered terrain, the colluvium contains reworked loess and is finer grained than colluvium from similar rock types farther from loess areas.

1 LANDSLIDE DEPOSITS (HOLOCENE TO MIDDLE PLEISTOCENE) --Pebble to boulder gravel, common silty sand to silty clay matrix, altered bedrock common in areas of Challis Volcanics. also includes largely intact slide blocks of bedrock; nonsorted to poorly sorted; clasts generally angular to subangular; nonbedded to crudely bedded. Includes deposits o avalanches, slumps, earthflows, debris flows, mudflows, and solifluction(?) lobes. Many small landslides along steep canyon walls and in mountainous terrain included in other colluvial units. Subject to major mass movements as well as small landslides

r COLLUVIUM DERIVED FROM HARD ROCKS (HOLOCENE TO LOWER PLEISTOCENE) -- Rubble of angular to subround, gravel-size clasts, dominantly cobbles and boulders with variable amounts of fine-grained matrix; nonsorted; nonbedded to crudely bedded. Thickness generally 1-3 m, but exceeds 10 m at base of slopes and in colluvial cones and fans, rock-glacier deposits, and taluses. Ranges from coarse, blocky, openwork talus at base of canyon walls, to talus and periglacial deposits in mountainous areas, to coarse, matrix-supported rubble on moderate slopes of volcanic vents and divides in thin-loess areas (en). Generally occurs in rugged terrain characteristically developed on hard bedrock. Derived from basalt, massive non-grussifying intrusive and metamorphic rocks, thicker-bedded limestone and dolomite, quartzite and hard sandstone, and conglomerate composed of these lithologies. Commonly includes numerous bedrock outcrops. Includes fine-grained colluvium (crs) where sections contai mixed lithologies with thinly bedded or poorly consolidated

COLLUVIUM DERIVED FROM SILICIC VOLCANIC AND INTRUSIVE ROCKS (HOLOCENE TO LOWER? PLEISTOCENE) -- Grus-rich, mostly sand and angular to subround fine gravel with variable amounts of coarser clasts, silty near loess areas; nonsorted; nonbedded to crudely bedded. Thickness generally 1-3 m on slopes. thickness exceeds 10 m at base of slopes. Derived from welded ash-flow tuff and rhyolite of Tertiary age, and some intrusive rocks of intermediate and silicic composition of Cretaceous and Tertiary age. Includes some rubbly colluvium (crr), especially along steep canyon walls. Also includes finegrained colluvium (crs) in areas where fine-grained sediments are intercalated with ash-flow tuffs. Locally subject to rapid erosion, especially in steeply sloping areas of thick grus where surface is disturbed

TO LOWER? PLEISTOCENE) -- Variably textured colluvium derived from sediments, tuffs, lava flows, and intrusions of Challis Volcanics, ranges from clay-rich, matrix-supported diamicton in areas of sediments, tuffs, and hydrothermally altered deposits, to rubble of angular to subangular blocks in areas of lava flows and intrusions; nonsorted; nonbedded to crudely bedded. Thickness generally 1-4 m, locally thicker in landslide areas and at base of slopes. Includes many landslide deposits, especially in areas of fine-textured colluvium, interbedded lava flows and tuffs, and hydrothermally altered rocks. Highly susceptible to slumps, earthflows, and mudflows

re COLLUVIUM DERIVED FROM EOCENE CHALLIS VOLCANICS (HOLOCENE

COLLUVIUM DERIVED FROM POORLY CONSOLIDATED OR THINLY BEDDED FINE-GRAINED ROCKS (HOLOCENE TO LOWER? PLEISTOCENE) -- Silty clay to sandy silt, locally silty sand, variable amounts of angular to round gravel; nonsorted; nonbedded to crudely bedded. Thickness generally 1-4 m, locally thicker at base of slopes and in landslide areas. Derived from shale and mudstone and poorly consolidated siltstone and sandstone of Paleozoic (minor), Mesozoic, and Tertiary age. Includes minor rubbly colluvium (crr) and grus-rich colluvium (crv) in areas of mixed lithologies. Subject to slumps, earthflows and mudtlows

ry BASALT (HOLOCENE) -- Basalt flows with no cover of surficial deposits; rocky, irregular, unstable surfaces d CINDER DEPOSITS (HOLOCENE TO MIDDLE PLEISTOCENE) -- Coarse-grained scoria; forms cinder cones and, near Craters of the Moon, blankets of cinders as thick as several meters that obscure and cover flow features of underlying lava flows of unit ry and mantle slopes to north. Cinders in shield-type vents included in unit crr LARGE AREAS OF EXPOSED BEDROCK (TERTIARY TO PRECAMBRIAN) --Greater than 50 percent of surface is exposed rock; occurs in areas of hard rocks with rugged alpine terrain, especially in

glaciated areas. Includes minor deposits of till and colluvium . GEOLOGIC MAP SYMBOLS CONTACT -- Approximately located; dashed lines very poorly defined contacts; selected buried contacts shown by dotted line FAULT--Displaces unconsolidated surficial deposits of Quaternar age; ball and bar on downthrown side. Numerous faults that displace basalts of Snake River Plain and older rocks in ranges and uplands surrounding the Plain are not shown. In part from preliminary map (Witkind, 1975) showing all known and suspected potentially active faults in Idaho. Queried where scarps possibly of alluvial rather than fault origin between Craters of the Moon and American Falls TTTT TERRACE SCARP WITHIN A SINGLE MAP UNIT--Hachures on down side of scarp. Many scarps unmappable at this scale ABANDONED CHANNELS--Includes only selected channels referred to

in map explanation; does not include numerous, recently abandoned channels on modern flood plains Upper limit of flood determined from highest evidence of erosion, deposition, and divide crossings; or by interpolation of surface of floodwaters between areas of approximately located flood limit

CIRQUE--Headwall of cirque outlined, hachures point toward center of cirque. All contained ice during Pinedale Glaciation. Queried where poorly defined REFERENCES

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SCALE 1:250 000