

DESCRIPTION OF MAP UNITS

[Consist of gravel, sand, silt, and clay deposited in Lake Bonneville (Bonneville lake cycle), Great Salt Lake, and other smaller lakes. These deposits are divided into four groups: (1) deposits that post-date the Bonneville lake cycle; (2) deposits associated with the Provo shoreline and the regressive phase of the Bonneville lake cycle; (3) deposits associated with the Bonneville shoreline and the transgressive phase of the Bonneville lake cycle; and (4) undivided sediments of the Bonneville lake cycle deposited at altitudes below the Provo shoreline that cannot be assigned to either phase of the Bonneville lake cycle. Sediments deposited near the mountain front are mostly gravel and sand; silt and clay were deposited in quieter, deeper water on the valley (lake) bottom, in sheltered bays between headlands, and less commonly in lagoons behind barrier bars]

LACUSTRINE DEPOSITS

Deposits Post-Dating the Bonneville Lake Cycle Marsh and lacustrine deposits (Holocene to uppermost Pleistocene)—Silt, clay, and minor sand deposited in shallow lakes and marshes after the regressive phase. Commonly organic rich; locally may contain peat deposits. Occur in areas of standing water or where the water table is or has recently been at the ground surface. Include sediment in mud flats or playas exposed by fluctuations of Great Salt Lake. Commonly grade into and may contain small deposits of unit lbpm. Subject to lacustrine flooding and high water table. Thickness < 5 m

laly Lacustrine, marsh, and alluvial deposits (Holocene to uppermost Pleistocene)—Undivided clay, silt, sand, peat, and very minor pebble gravel. Deposited after the regressive phase of the Bonneville lake cycle in shallow lakes and marshes, in deltas along the lower reaches of the Jordan River, and on distal parts of alluvial fans. Unit probably contains small deposits of unit clsp in urbanized areas. Thickness 1 to >3 m

Regressive-Phase Deposits of Bonneville Lake Cycle Deltaic deposits related to regressive phase (uppermost Pleistocene)—Clast-supported pebble and cobble gravel, in a matrix of sand and minor silt; locally includes thin beds of silt and sandy silt. Moderately to well sorted within beds; clasts subround to round. Deposited as thin to thick, parallel and crossbedded foreset beds having original dips of 5° – 30° locally deposited as topset beds. More commonly capped with topset beds of poorly sorted, silty to sandy, pebble and cobble alluvial gravel (alp). Forms large delta complexes graded to Provo shoreline at the mouths of Big and Little

Cottonwood Canyons. Thickness 1–25 m lpg Lacustrine sand and gravel related to regressive phase (uppermost Pleistocene)—Clast-supported pebble and cobble gravel, in a matrix of sand and pebbly sand; locally interbedded with beds and lenses of silt and sandy silt. Good sorting within beds; clasts subround to round. Deposited in parallel and crossbedded, thin to thick beds dipping from horizontal to as much as 15°. Deposited in beaches, bars, and spits, as well as small deltas that no longer retain distinctive morphology. Mapped at Provo shoreline (1,463-1,469 m (4,800-4,820 ft) in map area) and below. Contact with unit lbpg is mapped where lpg deposits can no longer be correlated with other regressive-phase deposits or shorelines Thickness 1-25 m

Lacustrine clay and silt related to regressive phase (uppermost Pleistocene)—Clay, silt, and minor fine sand deposited in quiet-water areas along the Provo shoreline. Thickness > 1 m Transgressive-Phase Deposits of Bonneville Lake Cycle lbg Lacustrine sand and gravel related to transgressive phase

(upper Pleistocene)—Clast-supported pebble, cobble, and rarely boulder gravel, in a matrix of sand and pebbly sand; locally includes interbedded silt and clay ranging from thin beds and lenses to lagoonal deposits as much as 10 m thick. Good sorting within beds; clasts subround to round. Deposited in parallel and crossbedded, thin to thick beds, dipping from horizontal to as much as 15°. Base is bouldery in some places. Deposited in beaches, bars, spits, and small deltas and lagoons. Mapped between the Provo and Bonneville shorelines (1,463-1,585 m; 4,800-5,200 ft). Commonly covered by deposits of hillslope colluvium (chs), but typically forms wave-built bench at the Bonneville shoreline and at several less well developed beach berms between the

Provo and Bonneville shorelines. Thickness 1-25 m Lacustrine clay and silt related to transgressive phase (upper Pleistocene)—Clay, silt, and minor fine sand; locally contains medium to coarse sand and pebble gravel. Good sorting within beds; deposited in very thin to thick, parallel and crossbedded, horizontal to gently dipping beds; bedding locally disrupted by soft-sediment deformation or liquefaction. Deposited in quiet-water environments, in sheltered bays between headlands, in lagoons behind barrier bars, or on lake floor in deeper water. Usually overlie coarse-grained transgressive shoreline deposits, implying deposition in increasingly deeper, quieter water. Thickness 1-25 m

Undivided Deposits of Bonneville Lake Cycle acustrine sand and gravel, undivided (upper Pleistocene)— Sand and clast-supported pebble gravel in a matrix of sand and silt, mapped downslope from Provo shoreline, where deposits cannot be directly correlated with regressive-phase deposits or shorelines. Usually consists of a thin, discontinuous veneer of regressive-phase deposits overlying transgressive-phase deposits. Numerous shorelines developed on these deposits have not been identified as either

transgressive or regressive. Thickness > 1 m Lacustrine sand, undivided (upper Pleistocene)—Sand and minor silt and pebble gravel, mapped downslope from Provo shoreline where deposits cannot be directly correlated with regressive-phase deposits or shorelines. Several shorelines developed on these deposits have not been identified as either transgressive or regressive. Thickness 1–5 m Lacustrine clay and silt, undivided (upper Pleistocene)—Clay, silt, and minor fine sand and pebble gravel; bedding locally disrupted by soft-sediment deformation or liquefaction. Deposited in deep and (or) quiet water in lower part of basin

Usually grades laterally into other deposits of the Bonneville lake cycle. Unit probably contains small deposits of unit clsp in urbanized areas. Thickness 1 to >10 m ALLUVIAL DEPOSITS

[Consist of variable amounts of gravel, sand, silt, and minor clay, deposited by perennial and intermittent streams. Map units are separated into four deposits of stream alluvium and seven alluvial-fan deposits. Stream deposits are mapped on flood plains and as thin terrace deposits along perennial streams; gravel in these deposits is generally more rounded and better sorted than that in alluvial-fan deposits. Stream deposits are differentiated by their stratigraphic and geomorphic positions relative to glacial deposits of the Bells Canyon advance and to levels of the Bonneville lake cycle and modern stream level. Alluvial-fan deposits occur on the piedmont at the mouths of most canyons along the mountain front. Fan deposits are differentiated according to the following criteria: (1) their relation to lacustrine deposits and shorelines of known age; (2) their relation to modern stream level; and (3) differences in soil development. The Holocene fan deposits (af1, af2) are differentiated by soil properties as outlined by

all Stream alluvium 1 (upper Holocene)—Sand, silt, and minor clay and gravel along Jordan River and lower reaches of its tributaries; deposits along upper reaches of tributaries consist of pebble and cobble gravel, and minor sand and silt Poorly to moderately sorted; parallel bedding and crossbedding. Forms modern flood plain and terraces less than 5 m above modern stream level. Subject to flooding and

Stream alluvium 2 (middle Holocene to uppermost Pleistocene)—Sand, silt, clay, and local gravel along Jordan River and lower reaches of its tributaries; deposits along upper reaches of tributaries consist of pebble and cobble gravel, and minor sand and silt. Poorly to moderately sorted; parallel bedding and crossbedding. Deposited by streams graded to recessional stands of Lake Bonneville and to lakes of early Holocene age; forms terraces more than 5 m above modern stream level, usually inset into deposits of the Bonneville lake cycle. Exposed thickness 1-5 m

high water table. Exposed thickness 1–3 m

aly Younger stream alluvium, undivided (Holocene to uppermost Pleistocene)—Sand, silt, and minor clay and gravel deposited by streams that post-date the regressive phase of the Bonneville lake cycle. Forms terraces along Jordan River from Taylorsville north to Salt Lake City International Airport. Thickness > 1 m alp Stream alluvium related to regressive phase (uppermost Pleistocene)—Clast-supported pebble and cobble gravel,

locally bouldery, in a matrix of sand and silt; poorly sorted, clasts subangular to round; parallel bedding and crossbedding; locally massive. Deposited by streams graded to the Provo shoreline and other shorelines of the regressive phase of the Bonneville lake cycle. Also deposited as topset beds on deltaic deposits (Ipd) related to the Provo shoreline; fluvial scarps are preserved on the surfaces of some deposits. In glaciated drainages, deposits of unit alp grade upstream into deposits of unit gbco. Thickness 1-10 m Fan Alluvium

af1 Fan alluvium 1 (upper Holocene)—Clast-supported pebble and cobble gravel, locally bouldery, in a matrix of sand and silty sand; poorly sorted; clasts subangular to round. Thin to thick, parallel bedding and crossbedding; locally massive. Deposited by intermittent streams, debris flows, and debris floods (hyperconcentrated floods) graded to modern stream level. May contain small deposits of units cd1 and af2. Many deposits of unit af 1 too small to be shown at the map scale are included in unit af2. No shorelines present on surfaces. Typical soil profiles range from A-Cn to A-Bw-Cox-Cn. Thickness 1 to >10 m

af2 Fan alluvium 2 (middle Holocene to uppermost Pleistocene)— Clast-supported pebble and cobble gravel, locally bouldery, in a matrix of sand and silty sand; poorly sorted; clasts subangular to round. Thin to thick, parallel bedding and crossbedding; locally massive. Deposited by perennial and intermittent streams, debris flows, and debris floods (hyperconcentrated floods) graded approximately to modern stream level. May contain small deposits of units af1 and cd1, especially near fan heads and along active stream channels. No shorelines present on surfaces. Typical soil

profiles range from A-Bw-Cox-Cn to A-Bt(weak)-Cox-Cn. Thickness 1 to >10 m afy Younger fan alluvium, undivided (Holocene to uppermost Pleistocene)-Post-dates the regressive phase of the Bonneville lake cycle. Mapped in areas where deposits of units af 1 and af 2 are too small to map separately, or in areas where ages of fan deposits post-dating the Bonneville lake cycle have not been differentiated. Exposed thickness > 2 m Fan alluvium related to transgressive phase (upper Pleistocene)—Clast-supported pebble and cobble gravel, locally bouldery, in a matrix of sand and silty sand; poorly sorted; clasts subangular to round. Thin to thick, parallel bedding and crossbedding; locally massive. Deposited by streams graded to shorelines of the transgressive phase of the

Bonneville lake cycle, and forms fans graded to these

shorelines. May be covered by thin deposits of post-

transgressive phase alluvium and colluvium. Typical soil

pebble and cobble gravel, locally bouldery, in a matrix of

Fan alluvium 4 (upper middle Pleistocene)—Clast-supported

profile, A-Bt-Cox-Cn. Thickness 1 to >10 m

sand and silty sand; poorly sorted; clasts subangular to round. Thin to thick, parallel bedding and crossbedding; locally massive. Forms small fans and fan remnants topographically above or cut by the Bonneville shoreline. Correlative deposits probably underlie much of the map area and are buried by younger deposits downslope from the Bonneville shoreline. Typical soil profile, A-Bt(moderatestrong)-Cox-Cn. Thickness 1 to >10 m Fan alluvium 5 (middle Pleistocene)—Clast-supported pebble and cobble gravel, locally bouldery, in a matrix of sand and silty sand; poorly sorted; clasts subangular to round. Thin to thick, parallel bedding and crossbedding; locally massively bedded. Forms high fan remnants on ridge tops near front of Wasatch Range. Some remnants may be deposits of old till that lack morainal morphology. Typical soil profile,

GLACIAL DEPOSITS [Consist of variable amounts of boulder, cobble, and pebble gravel, sand, and silt deposited by glaciers (till) or glacial meltwater streams (outwash). The nomenclature and dating of glacial deposits used here follows the work of McCoy (1977), Madsen and Currey (1979), and Scott (1988a). Deposits of Bells Canyon age are broadly equivalent in age to deposits of Pinedale age mapped widely in the Rocky Mountains; most deposits at the mountain front predate the initial occupation of the Bonneville shoreline by a few thousand years. Deposits of Dry Creek age have weathering

characteristics similar to those of deposits of Bull Lake age in the Rocky Mountains that

Exposed thickness >2 m

A-Bt(strong)-Cox-Cn. Thickness 1 to >10 m

Older fan alluvium, undivided (middle Pleistocene)-Pre-

dates the Bonneville lake cycle; mapped near the Salt Lake

salient, where old fan deposits have not been differentiated.

are thought to be about 150 ka (Pierce and others, 1976)] Outwash of Bells Canyon age (upper Pleistocene)—Clastsupported cobble and pebble gravel, locally bouldery, in a minor matrix of sand and silt; poorly to moderately sorted; clasts subangular to round. Thin to thick, parallel bedding and crossbedding. Deposits grade into alluvial gravel graded to Provo shoreline (alp) below Big and Little Cottonwood Canyons. Exposed thickness 1-40 m gbct Till of Bells Canyon age (upper Pleistocene)—Matrix-supported

boulder, cobble, and pebble gravel in sandy silt to silty sand matrix; very poorly sorted; clasts subangular to subround massive. Forms large moraines at mouths of Little Cottonwood and Bells Canyons and smaller moraines in cirque valleys in Wasatch Mountains. Exposed thickness 1–10 m Outwash of Dry Creek age (middle Pleistocene)-Clastsupported cobble and pebble gravel, locally bouldery, in minor matrix of sand and silt; poorly to moderately sorted; clasts subangular to round. Thin to thick, parallel bedding and crossbedding. Exposed in large gravel pit north of mouth of Big Cottonwood Canyon and along Dry Creek downstream from Bells Canyon. Soil profile: A-Bt(moderatestrong)-Cox-Cn. Exposed thickness 1–15 m

Till of Dry Creek age (middle Pleistocene)—Matrix-supported boulder, cobble, and pebble gravel in sandy silt to silty sand matrix; very poorly sorted; clasts subangular to subround; massive. Surface of deposit contains abundant grus derived from weathering of quartz monzonite (Ti) boulders. Exposed near mouths of Little Cottonwood and Bells Canyons. Soil profile: A-Bt(moderate-strong)-Cox-Cn. Exposed thickness **EOLIAN DEPOSITS**

indblown silt) cover most early Holocene and older surficial deposits (Shroba, 1984). oess is weathered and mixed with upper parts of underlying sediments and soils, and is not mapped as separate unit es Eolian sand (Holocene and upper Pleistocene)—Fine to

[Consist of eolian sand deposits. However, thin (<1 m), discontinuous deposits of loess

coarse sand and minor silty sand; moderately to well sorted. Thin to medium bedding; usually crossbedded, locally massive. Forms sheets of sand and low parabolic and longitudinal dunes; deposit derived from reworked sandy deposits of the Bonneville lake cycle. Thickness 1–3 m COLLUVIAL DEPOSITS

[Consist of poorly sorted to unsorted, gravity-generated deposits, generally derived from sources directly up slope. Debris-flow deposits (cd1, cd2) differentiated by degree of soil development, surface morphology, and relations to present stream level and alluvial deposits of similar age

Debris-flow deposits 1 (upper Holocene)—Clast-supported pebble, cobble, and boulder gravel in a matrix of sand, silt, and clay; boulders are as much as several meters in diameter and are angular to subround. Very poorly sorted; bedding massive. Deposited by rapidly moving flows of rock debris, sand, mud, and water. Forms fan-shaped to lobate deposits at mouths of several canyons south of Big Cottonwood Canyon. Typical soil profiles range from A-Cn to A-Bw-Cox-Cn. Thickness 1 to >5 m

Debris-flow deposits 2 (middle Holocene to uppermost Pleistocene)—Clast-supported pebble, cobble, and boulder gravel in a matrix of sand, silt, and clay; boulders are as much as several meters in diameter and are angular to subround. Very poorly sorted; massive to crude parallel bedding. Some deposits are hummocky. Deposited by rapidly moving flows of rock debris, sand, mud, and water. Forms fan-shaped to lobate deposits at mouths of several canyons south of Bells Canyon. Typical soils range from A-Bw-Cox-Cn to A-Bt(weak)-Cox-Cn. Thickness 1 to >5 m Hillslope colluvium (Holocene to upper Pleistocene)—Pebble,

cobble, and boulder gravel, usually clast supported, in a matrix of sand and silt; clasts usually angular to subangular, but unit contains some recycled lacustrine gravel of the Bonneville lake cycle. Very poorly sorted; massive to crude parallel bedding. Forms small fans, cones, and debris aprons at the mouths of small canyons and at the bases of bedrock slopes. Deposited by mass-wasting processes, sheetwash, and small debris flows. Thickness 1 to >10 m Lateral-spread deposits (Holocene to upper Pleistocene)-Sand, silt, clay, and minor pebble gravel of the Bonneville lake cycle and younger lacustrine, marsh, and alluvial

deposits redeposited by lateral spreading as a result of liquefaction, probably during major earthquakes. Bedding usually contorted or the deposit is unstratified. Two large deposits at north end of map area were first recognized on aerial photographs by Van Horn (1982). The northern spread appears to truncate the southern spread; the dashdot contact between the two is based on changes in vegetation and preservation of hummocky topography. Both deposits incompletely truncate the Gilbert shoreline and a topographically lower undesignated shoreline, indicating both lateral spreads formed less than 10.5 ka. Urbanization probably has destroyed surface evidence of additional deposits in areas mapped as units lbpm and laly. Thickness > 1 m

Landslide deposits (Holocene to middle Pleistocene)—Grain size and texture reflects character of deposits in source area; usually unsorted, unstratified. Deposited as slides and slump-earthflows on relatively steep slopes in mountains. Thickness 1 to >10 m

Colluvium and alluvium, undivided (Holocene to middle Pleistocene)—Gravel, sand, silt, and clay; grain size and texture reflect character of deposits directly upslope. Generally poorly sorted, with parallel bedding and crossbedding; commonly massive. Deposited by intermittent streams and mass-wasting processes; forms small fans and debris aprons at base of slopes in unconsolidated deposits. Also mapped in some grabens along Wasatch fault zone. Thickness 1 to >10 m

FILL DEPOSITS Manmade fill (historic)—Most consist of locally derived surficial deposits of variable grain size; used as engineered fills for highways, railways, and buildings; also includes assorted materials in landfills and tailing piles and ponds. Thickness

BEDROCK Tertiary sedimentary and volcanic rocks (Neogene)—Consists of undivided sedimentary, volcanic, and volcaniclastic rocks in the Salt Lake salient and Traverse Mountains Tertiary sedimentary and volcanic rocks (Paleogene)— Consists of undivided sedimentary, volcanic, and volcaniclastic rocks in the Salt Lake salient and Traverse Mountains Tertiary intrusive igneous rocks (Oligocene)—Consists primarily of quartz monzonite of the Little Cottonwood stock of Oligocene age (Crittenden and others, 1973); some

minor diorite is present near the mouth of Bells Canyon (Crittenden, 1965a) Mesozoic sedimentary rocks (Cretaceous to Triassic)-Consists of shale, siltstone, sandstone, and limestone Paleozoic sedimentary rocks (Permian to Cambrian)— Consists of shale, siltstone, sandstone, conglomerate, limestone, and dolomite Precambrian metamorphic rocks (Proterozoic and Archean)—

Consists of low- to high-grade metamorphic rocks - Contact—Dashed where approximately located; dash-dot lines are contacts between geomorphic features in a map unit • Pormal fault—Bar and solid ball on downdropped side along Wasatch and other active fault zones: bar and hollow ball along other faults in bedrock. Dashed where approximately located, dotted where concealed, and queried where origin is uncertain. Height of fault scarp and amount of geomorphic surface offset (in parentheses) shown in meters. Trench locations shown with cross bar: DC-1-4, Dry Creek trenches; LC1-4, Little Cottonwood trenches

Thrust fault—Sawteeth on overriding plate or block (mapped in bedrock only); dashed where approximately located, dotted where concealed Major shorelines related to levels of the Bonneville lake cycle—Coincide with geologic contacts in some places Bonneville shoreline

--b-- Other shorelines of the transgressive phase --P-- Provo shoreline

——p—— Other shorelines of the regressive phase --G-- Gilbert shoreling

——x—— Undesignated shorelines of the Bonneville lake cycle Topographic crest of lacustrine bar or spit

Topographic escarpment—Escarpments along stream channels, terraces, and deltas; formed primarily by fluvial processes; coincide with geologic contacts in some places; tear drops point up slope Landslide escarpment—Major headscarps and fissures in landslides and lateral-spread deposits; coincide with geologic contacts in some places

= ⇒ = Paleostream channels—Preserved as abandoned channels Tilted geomorphic surface—Arrow points in general direction of downward tilt

This map shows the surficial deposits and the faults that offset them along the Salt Lake City segment and adjacent parts of the Weber and Provo segments of the Wasatch fault zone in north-central Utah. The map area includes the central and eastern part of the Salt Lake Valley, site of metropolitan Salt Lake City and its southern suburbs. Although a major

surface-faulting earthquake has not occurred on the Wasatch fault zone since the state was settled in 1847 (Arabasz and others, 1979), the geologic record contains abundant evidence of large earthquakes during Holocene and late Pleistocene time (Gilbert, 1890, 1928; Cluff and others, 1975; Swan and others, 1980; Schwartz and Coppersmith, 1984; Machette and others, 1987, 1989, in press). The size, age, and distribution of fault scarps produced by these prehistoric earthquakes can be used to determine the most likely sites for future earthquakes, and are therefore the principal focus of this map. Most long, active fault zones are thought to be composed of several seismically independent pieces or segments. Initial work on segmentation of the Wasatch fault zone, summarized in Schwartz and Coppersmith (1984), identified six discrete fault segments, but recent work by the U.S. Geological Survey has identified ten to twelve segments (Machette and others, 1987, 1989, in press). The concept of fault segmentation is critically important to paleoseismic analysis of active fault zones because during a major earthquake, surface faulting usually is restricted to a single segment of a fault zone. As used here and in other studies (Schwartz and Coppersmith, 1984; Bruhn and others, 1987; Machette and others, 1987, 1989, in press), the Salt Lake City segment consists of the Warm Springs fault, the East Bench fault, and that part of the main Wasatch fault zone from Mount Olympus south to Corner Canyon (labeled "CS" on fig. 1). Another active fault in the region, the

West Valley fault zone, appears to be seismically independent of the Wasatch

fault zone, and is discussed separately.

INTRODUCTION

Numerous published geologic and soils maps exist for most of the map area, but the recent map by Scott and Shroba (1985) was the primary source used to compile this map (see Sources of Geologic Data diagram). Their map units were modified for consistency with the units of Personius (1990) to insure continuity with the other maps in this series (see Map Area diagram). Other sources used to compile the surficial geology of this map in areas not covered by Scott and Shroba (1985) include Miller (1980, 1982) and Van Horn (1982). The trace of the West Valley fault zone and a discussion of these structures were taken from Keaton and others (1987) and J.R. Keaton (written commun., 1987, 1988, 1989). Other map data were compiled from ished work along the East Bench fault near the Forest Dale Golf Course (Machette and others, 1987, in press), from geologic mapping on the north side of the Salt Lake salient (Nelson and Personius, 1990, in press) and in the Traverse Mountains (Machette, 1989, in press), and from preliminary geologic data for the South Fork Dry Creek area (Lund and Schwartz, 1987) Schwartz and Lund, 1988). The geology in the Wasatch Range was compiled and generalized from maps by Crittenden (1965a,b), Van Horn (1981), Davis (1983a,b), Bryant (1984), and Van Horn and Crittenden (1987). The senior author mapped parts of the Salt Lake salient and the area near the mouth of Little Cottonwood Canyon on 1:6,000- and 1:12,000scale low-sun-angle aerial photographs taken for the Utah Geological and Mineral Survey in 1970; these photographs were particularly helpful in identifying fault scarps in surficial deposits. In addition, some areas along the Jordan River in the southwestern part of the map area and on the Salt Lake salient were mapped on aerial photographs taken for the U.S. Soil Conservation Service in 1952–1953 at scales of 1:10,000 and 1:62,500. Much of the scarp-measurement data shown on the geologic map was derived from measurements made in the field with an Abney level and stadia rod; most are from Scott and Shroba (1985). A few measurements along the Warm Springs fault and the Weber segment were determined from profiles measured on aerial photographs with a computer-assisted stereoplotter

and Machette (1982). The following discussion begins with a brief description of the Quaternary deposits in the map area, continues with a description of the distribution, age, and amount of displacement of late Quaternary faulting, and concludes with a description of segmentation of the Wasatch fault zone in the Salt Lake City area. Together, this information can be used to describe the paleoseismic history of the Salt Lake City segment and to help identify key sites for further detailed studies.

(A.R. Nelson, written commun., 1988). Terminology used to describe fault-

scarp parameters follows that established by Bucknam and Anderson (1979)

QUATERNARY DEPOSITS AND DEPOSITIONAL HISTORY This discussion of late Quaternary depositional history of the Wasatch Front is summarized from McCoy (1977, 1987), Madsen and Currey (1979), Currey (1980), Currey and others (1983, 1984), Scott and others (1983), Currey and Oviatt (1985), Scott and Shroba (1985), and Scott (1988a,b). Most surficial deposits along the north-central part of the Wasatch fault zone were deposited during the Holocene (<10 ka, or thousands of years ago) and the last cycle of Lake Bonneville (known as the Bonneville lake cycle) between 30 and 10 ka. Lake Bonneville began rising from a low level about 30 ka and rose slowly, with several fluctuations and pauses, to the Bonneville shoreline (1,573-1,585 m (5,160-5,200 ft) above sea level in the map area)about 16 ka. After 1,000–2,000 years at or near this level, the lake dropped about 110 m (360 ft) to an altitude of about 1,465 m (4,800 ft) as a consequence of catastrophic downcutting of its outlet in southeastern Idaho. The resulting Bonneville Flood deposited debris northward into southern Idaho (Gilbert, 1890; Malde, 1968; Jarrett and Malde, 1987). In the map area, this rapid decline in lake level was accompanied and followed by rapid erosion of lacustrine transgressive-phase sand and gravel (Ibg) and other glacial-outwash and alluvial-fan deposits; much of this debris was redeposited as deltas (Ipd, alp) at the Provo shoreline near the mouths of major canyons. Between 14 and 13 ka, the lake level again dropped quickly, this time in response to changing climatic conditions, further downcutting of its outlet, and isostatic rebound of shoreline areas. Lake Bonneville reached a level near that of modern Great Salt Lake (1,280 m; 4,200 ft) about 11 ka and rose briefly to the Gilbert shoreline (1,295 m; 4,250 ft) 10–10.5 ka. Since then, the lake level has remained within 10 m of the level of present Great Salt Lake. Glaciers in Little Cottonwood and Bells Canyons advanced beyond the Wasatch Range and into the eastern Salt Lake Valley 26–18 ka, while Lake Bonneville stood at a low to intermediate level during the transgressive phase that eventually reached the Bonneville shoreline. Till (gbct) deposited by these glaciers forms large end moraines that extend nearly 1 km into the valley. Meltwater from these glaciers and from glaciers in Big Cottonwood Canyon deposited gravelly outwash fans (gbco) along the range front and deltaic deposits in Lake Bonneville. Other streams, emanating from valleys in the Wasatch Range whose headwaters were at altitudes too low to support more than small glaciers, also deposited gravelly fans and deltas graded to the lake. The rising lake culminated at the Bonneville shoreline about 16 ka several thousand years after the glaciers in Little Cottonwood and Bells Canyons had retreated some distance upvalley from their end moraines. The outwash and alluvial-fan deposits along the mountain front also were inundated by the rising lake and, except for small areas near the canyon mouths that stood above the level of the lake, are covered by a veneer of lake sediment (lbg and lbm).

As the level of Lake Bonneville receded from the Provo shoreline during the regressive phase, alluvial-fan deposits (af2) and debris-flow deposits (cd2) were emplaced at canyon mouths along the mountain front. Rates of alluvial-fan deposition appear to have declined later in the Holocene, because deposits of late Holocene age (af1, cd1) are restricted to small deposits covering parts of the surfaces of much larger alluvial fans (af2). Debris flows continue to be a common phenomenon in many canyons along the Wasatch Front (Wieczorek and others, 1989). Pre-Bonneville-lake-cycle deposits are limited to small remnants of alluvial-fan (af4, af5) and glacial-drift deposits (gdco, gdct), and to a few

exposures of deposits of the Little Valley lake cycle that are too small to show at the scale of this map. Till of the Dry Creek advance (gdct) of Madsen ar Currey (1979) is exposed at the mouths of Little Cottonwood and Bells Canyons. Although undated, the till is weathered to a degree that suggests it may be about 150 ka, and thus Dry Creek moraines roughly correlate with Bull Lake-aged moraines (Pierce and others, 1976) in the Rocky Mountains (Scott and Shroba, 1985). Outwash of probably the same age is exposed in gravel pits near the mouth of Big Cottonwood Canyon and along Dry Creek downstream from Bells Canyon, below the type Dimple Dell Soil of Morrison (1965). A uranium-trend age of $250\pm90~ka$ was obtained on a deposit of unit af4 near South Fork Dry Creek (J.N. Rosholt, written commun., 1984, in Scott and Shroba, 1985); the lithologic and soil-development characteristics of this deposit suggest that it may be outwash of Dry Creek age. Thus, glacial deposits of Dry Creek age are probably at least 150 ka, and some may be

Deposits of the Little Valley lake cycle (Scott and others, 1983; McCoy, 1987; Scott, 1988b,c) are exposed in a few places in the map area, but not extensively enough to show at the scale of this map. Small exposures have been located in an abandoned gravel pit near the University of Utah, at several places along the south side of Parleys Creek near Interstate Highway 215, below outwash of Dry Creek age in a gravel pit north of the mouth of Big Cottonwood Canyon, and in gravel pits on the Salt Lake salient and Point of the Mountain in the southern part of the map area (Scott, 1981; Scott and others, 1983; Scott, 1988b,c). On the basis of stratigraphic, soil-development, and amino-acid data, the Little Valley lake cycle appears to correlate with the later part of marine oxygen-isotope stage 6, which ended about $130\,\mathrm{ka}$ (Scott and others, 1983; Scott, 1988b).

DESCRIPTIONS OF QUATERNARY FAULTS The relatively well dated sequence of Quaternary deposits in the map area greatly aids in the interpretation of Quaternary faulting along the Wasatch fault zone. The age of offset of these surficial deposits and the size of

fault scarps can be used to calculate slip rates and average recurrence

intervals at various places along the Salt Lake City segment.

The ages of scarps formed by surface displacements along Quaternary faults in the map area have been estimated by stratigraphic techniques and fault-scarp morphology. Limits on the ages of fault scarps have been determined by the ages of stratigraphic units in which the scarps formed and by younger units that cross the scarps but are not offset. Two parameters used on the map to describe amount of vertical offset along a fault zone are faultscarp height and net vertical tectonic displacement, or surface offset. Scarp height is simply the vertical distance from the base to the crest of the scarp. As defined by Bucknam and Anderson (1979), surface offset is the net vertical offset of a geomorphic surface across a fault zone. Surface offset is typically less than scarp height because most fault scarps are formed on sloping surfaces. Where the fault zone consists of a broad zone of deformation that includes fault scarps, grabens, and surfaces that are backtilted toward the main scarp, the surface offset, or net vertical tectonic displacement, may be less than half the height of the highest scarp in the zone. The following discussion contains brief descriptions of known and suspected latest Quaternary faults in the Salt Lake Valley, including the Warm Springs fault, the East Bench fault, the active trace of the Wasatch fault zone from Mount Olympus to Corner Canyon (herein informally named the Cottonwood section), and the West Valley fault zone (fig. 1). The apparently inactive part of the Wasatch fault zone north of Mount Olympus also is briefly

WARM SPRINGS FAULT The Warm Springs fault represents the northernmost extent of late Quaternary faulting in the Salt Lake City area, forming the western flank of the Salt Lake salient. The fault is named after the thermal springs (Becks hot springs and Wasatch warm springs) along the fault. Unfortunately, much of the evidence of surface faulting along the Warm Springs fault has been destroyed by gravel quarrying and highway construction, but evidence from old photographs and observations made by G.K. Gilbert in the late 1800's (Gilbert, 1890, 1928, in Hunt, 1982) were used by Scott and Shroba (1985) and Scott (1988d) to evaluate recurrent Holocene faulting. Gilbert described fault scarps 10-14 m high on alluvial-fan deposits post-dating the Bonneville lake cycle at the mouths of two canyons southeast of Becks hot springs (Gilbert, 1890, p. 348-349, in Hunt, 1982, p. 27-29). At Jones Canyon, strath terraces upstream from the scarp and variations in size of the scarp in inset parts of the fans suggested to Gilbert that the scarp resulted from three faulting events. Gilbert measured terraces 4.5, 1.5, and 3 m above stream level in the footwall block at the fault scarp on the Jones Canyon fan and concluded that these terraces represented three surface-faulting events producing surface offset similar to the amount of vertical terrace separation. We now know that the average displacement resulting from paleo-surface

faulting events along much of the Wasatch fault zone is 1.5–2.5 m (Swan and

others, 1980; Schwartz and Coppersmith, 1984; Machette and others, 1987,

in press); thus Gilbert's estimate of three faulting events should be viewed as a

minimum number. The possibility that part of the scarp was eroded or buried

during deposition of the fan also suggests that three Holocene surfacefaulting events should be considered a minimum (Scott, 1988d). Topographic profiles measured by A.R. Nelson (written commun., 1988) across the Warm Springs fault on aerial photographs taken in 1952, before much of the gravel mining, yielded surface offsets of 13.7-15.8 m in Bonneville-lake-cycle non-conservative barrier to rupture propagation. gravels. Given these scarp measurements, perhaps as many as six to eight As discussed above, the Warm Springs fault trends northward 2 km surface-faulting events have occurred on the Warm Springs fault during latest beyond Becks hot springs, and then turns northeastward before dying out on

The north and south extents of the Warm Springs fault are uncertain. To the north, our mapping from the 1952 aerial photographs clearly shows that the fault continues northward about 2 km beyond Becks hot springs and then turns northeastward and dies out on the northern flank of the Salt Lake salient. Van Horn (1982) shows the Warm Springs fault trending directly northward from Becks hot springs along a scarp that we have interpreted as the Gilbert shoreline. To the south, urbanization has obscured evidence of surface faulting, but Scott and Shroba (1985) and Scott (1988d) concluded that there probably has been no significant late Quaternary surface faulting south of 600 North Street. The active part of the Warm Springs fault thus appears to be about 7 km long. A shallow lake and marsh, now drained, formerly lay west of Becks hot

Quaternary time.

springs (unit ly; Hot Spring Lake of Van Horn, 1982). Gilbert (in Hunt, 1982, p. 27) noted that the low area occupied by this lake is anomalous because it was not filled by deposits of the Jordan River and suggested the lake represented an area of local subsidence related to the Warm Springs fault. Recent local or regional tectonic activity probably has backtilted this area toward the Warm Springs fault, although alternatively this low area may have formed behind a levee of the Jordan River and not be related to tectonism (Scott and Shroba, 1985; Scott, 1988d). EAST BENCH FAULT

Marsell (1964, 1969) first recognized that the active part of the Wasatch fault zone diverges from the mountain front near Tolcats Canyon and trends north across much of Salt Lake City before intersecting the range front at the mouth of Dry Creek, near the University of Utah. This fault zone is known as the East Bench fault, a structure that has clearly been more active in Quaternary time than faults along the range front directly to the east (Marsell, 1964, 1969; Van Horn, 1972b; Scott and Shroba, 1985). The trace of the East Bench fault is marked by very large fault scarps; our

data show a double scarp almost 40 m high near 3900 South, and Scott and Shroba (1985, p. 8, 9) discuss scarps as much as 50 m high north of 2100 South. The height of these larger scarps along the East Bench fault suggests surface faulting along the East Bench fault during much of the middle and late Quaternary. However, Scott and Shroba (1985) suggested that perhaps only about 11 m of offset occurred during latest Pleistocene and Holocene time; this estimate yields a slip rate of about 1 mm/yr. A shallow seismicreflection profile across the East Bench fault along Interstate Highway 80 between 1300 East and 700 East suggested to Crone and Harding (1984) that there has been about 85 m of vertical offset on the East Bench fault during Quaternary time. They used this estimate of offset and an age of 600–2,000 ka to determine a long-term slip rate of 0.04–0.14 mm/yr. This slip rate is substantially less than the estimated latest Quaternary rate of about 1 mm/yr, and suggests that the latest Quaternary slip rates may not be representative of average longer term slip on the East Bench fault. This phenomenon has been recognized at several other locations along the Wasatch fault zone (Machette and others, 1987, in press). Machette and others (1987, in press) described preliminary results of two trenches dug across the East Bench fault at the Dresden Place site near 550 South Street (trench locations are shown on the map). The exposures revealed evidence of a minimum of 7 m of deformation in deposits of the

transgressive phase of the Bonneville lake cycle. This deformation appears to have occurred in two distinct phases. The first phase consisted of plastic deformation expressed as 3 m of monoclinal warping, thought to have occurred during a single faulting event while the site lay under the waters of Lake Bonneville. The altitude of the Dresden Place site (about 1,326 m; 4,350 ft) and hydrographs of Lake Bonneville (Scott and others, 1983; Currey and Oviatt, 1985) suggest that this event probably occurred 12.5–25 ka. The absence of colluvial deposits and unconformities within the plastically deformed lake sediments suggests that the deformation occurred as a single event. The second phase of deformation at the Dresden Place site consisted of a minimum of 4 m of brittle deformation expressed as planar fault ruptures that extend to the top of the in-place sediment in the trenches. The deformation associated with these structures probably post-dates 12.5 ka, and was formed by one or more surface-faulting events during latest Pleistocene and Holocene time (Machette and others, 1987, in press). The age of these events cannot be determined more precisely because manmade disturbance of the upper part of the trenches has removed any colluvial deposits that may have been present. The extensive urbanization present in the eastern part of Salt Lake Valley has prevented further trenching studies on the East Bench fault, and will make future investigations of this important

COTTONWOOD SECTION OF THE WASATCH FAULT ZONE Latest Quaternary faulting on the main trace of the Wasatch fault zone in the Salt Lake City area lies in a relatively narrow zone along the base of the Wasatch Range from near Mount Olympus south to Corner Canyon. For ease of discussion this part of the fault zone is herein informally named the Cottonwood section of the Salt Lake City segment of the Wasatch fault zone. The northernmost extent of the Cottonwood section is marked by a single small (1–2 m high) scarp that extends about 3 km from its intersection with the East Bench fault near the mouth of Tolcats Canyon (the "bifurcation zone" on fig. 1) to near Casto Spring (Scott and Shroba, 1985); from the bifurcation zone southward, scarps along the Cottonwood section show about 10-15 m of surface offset. These changes in scarp size suggest that most late Quaternary faulting was restricted to the East Bench fault and that part of the Cottonwood section south of the bifurcation zone. Only small, scattered faults that mostly pre-date the end of the Bonneville lake cycle have been mapped along the Wasatch Range north of the termination of the Cottonwood section (Scott and Shroba, 1985). Fault scarps are consistently large and complex along the central part of

structure very difficult.

the Cottonwood section (figs. 2, 3). The fault zone may be as wide as 500 m, and backtilting and graben formation associated with faulting have created scarps as high as $30 ext{-}40$ m, although surface offset post-dating the Bonneville lake cycle is probably no more than about 15 m along this part of the Salt Lake City segment (Scott and Shroba, 1985). South of Little Willow Creek, scarps along the fault zone decrease in surface offset from 10-14 m near Little Willow Creek to about 6 m near

Corner Canyon (Scott and Shroba, 1985). The height of late Quaternary

fault scarps appears to decrease rapidly near Corner Canyon, where the

Wasatch fault zone turns sharply to the east and divides the Traverse Mountains from the Wasatch Range The Cottonwood section has been the site of two extensive trenching investigations. In 1979, geologists with Woodward-Clyde Consultants conducted a comprehensive investigation of Quaternary faulting near the mouth of Little Cottonwood Canyon (trenches LC-1-4; see fig. 2). Data from this investigation is included in Swan and others (1981); summaries of the conclusions of this study are included in Swan and others (1980), Schwartz and Coppersmith (1984), Machette and others (1987, in press), and Schwartz and Lund (1988). The fault zone is extremely complex in the trench area, but studies indicate a slip rate of 0.76 (+0.6, -0.2) mm/yr over the past 19,000±2,000 yrs, average displacement per event of 2 m, and an average recurrence interval of 2,400-3,000 yrs. In addition, the trenches exposed evidence of two surface-faulting events within the main graben in the past 8,000-9,000 yrs. The older of the two events occurred just prior to 8-9 ka, but the age of the most recent event could not be determined. Because of the width of the fault zone near Little Cottonwood Canyon, not all fault splays in the area could be trenched; Schwartz and Lund (1988) concluded that because of this complexity, the youngest event affecting the Cottonwood section may well have been missed at the Little Cottonwood trench site. The other major trench investigation on the Cottonwood section was conducted by the Utah Geological and Mineral Survey and U.S. Geological Survey in 1985 near the mouth of South Fork Dry Creek (fig. 3), about 1.5 km south of Bells Canyon (not to be confused with the other Dry Creek in the map area north of the University of Utah). Four trenches (trenches DC-1-4; see fig. 3) were excavated across three strands in a 300-m-wide fault zone consisting of at least six fault scarps formed in late Quaternary surficial deposits. Preliminary results of this investigation include evidence for two large surface-faulting events with offsets of $4\!-\!5$ m each in the past 5.5 ka, and a slip rate greater than 1 mm/yr. The age of the most recent event is still uncertain, but preliminary radiocarbon ages on soil organic matter suggest that the last event occurred about 1.1-1.8 ka. In addition, diffusion modeling of a single-event fault scarp (trench DC-3) suggests an age of about 900 yr (Lund and Schwartz, 1987; Machette and others, 1987, 1989, in press; Schwartz and Lund, 1988). Schwartz and Lund (1988) concluded from analysis of the Little Cottonwood and South Fork Dry Creek trench sites that the Cottonwood section has been the site of at least three Holocene surfacefaulting events; these occurred just prior to 8–9 ka, shortly after 5.5–6 ka, and the most recent about 1.1–1.8 ka. These data yield an average recurrence interval of 3,000-4,000 yrs between major earthquakes on this part of the

RANGE FRONT FAULTING NORTH OF MOUNT OLYMPUS The geomorphology of the northeastern part of the Salt Lake Valley suggests that late Quaternary faulting on the Wasatch fault zone has shifted from the base of the range front to the East Bench fault. This is evident from the more subdued geomorphology of the range front north of the bifurcation zone near Mount Olympus (Marsell, 1964, 1969; Hamblin and Best, 1980; Scott and Shroba, 1985), the presence of bedrock at shallow depths beneath the surficial cover on the piedmont east of the East Bench fault (Marsell, 1964, 1969), and the lack of significant movement on the range front faults ollowing the Bonneville lake cycle (Van Horn, 1972b; Scott and Shroba, 1985). One fault that may have some latest Quaternary movement is the Virginia Street fault (City Cemetery fault of Van Horn and Crittenden, 1987) about 2 km northwest of the University of Utah. Evidence of recent movement on this fault has been destroyed by gravel mining, but Scott and Shroba (1985) concluded that if this structure had been recently active, the amount of displacement is small. Scott and Shroba (1985) also concluded that no movement post-dating the Bonneville lake cycle had occurred on several other faults along this section of the Salt Lake City segment. These faults included the University Hospital fault (Everitt, 1979), on the University of Utah campus, and a short fault just south of the mouth of Parleys Canyon (Van Horn, 1972a.b). The time when faulting shifted from along the range front to the East Bench fault is unknown, but because Scott and Shroba (1985) found no evidence of significant faulting along the range front younger than the

WEST VALLEY FAULT ZONE

is about 15 ka.

transgressive phase of the Bonneville lake cycle, the minimum age of this shift

Although not a part of the Wasatch fault zone, the proximity of the West Valley fault zone to much of the Salt Lake City metropolitan area and a recent paleoseismic investigation (Keaton and others, 1987) have heightened awareness of this active fault zone. The two main traces of the West Valley fault zone, the Taylorsville and Granger faults, were first recognized by Marsell and Threet (1960) and later named by Marine and Price (1964), who used the term "Jordan Valley fault zone" for these structures. Van Horn (1979, 1982) attributed these features to alluvial erosion and did not show them on his surficial geologic maps of the region. In a more recent study, Keaton and others (1987) renamed the zone the "West Valley fault zone" after nearby West Valley City, but retained the names "Granger and Taylorsville faults" for the two main fault traces. The locations of trenches excavated by Keaton and others (1987) are labelled on the geologic map. Although urbanization has destroyed much of the surface evidence of the West Valley fault zone, Keaton and others (1987) used surface, borehole, and trench data, and studied pre-urbanization aerial photographs and topographic maps to delineate the fault zone and determine some of its faulting history. They recognized two distinct fault patterns. South of about 2100 South Street, the fault zone consists of two subparallel, east-facing scarps that mark the traces of the Taylorsville and Granger faults. North of about 2100 South Street, the fault zone consists of numerous small scarps in a zone as much as 7 km wide. In total, the West Valley fault zone is as much as 7 km wide and 16 km long. The Granger fault extends 1.5 km west and 3.5 km north of the map area margin (see fig. 1) On the northern part of the West Valley fault zone, Keaton and others

1987) found evidence for a minimum of four surface-faulting events that post-date lacustrine deposits associated with the Gilbert shoreline (10–10.5 ka). At least two of these events formed scarps on the Taylorsville fault. Scarps along the Granger fault pre-date the Gilbert shoreline, but show evidence of at least two post-Gilbert shoreline surface-faulting events. Taken together, the entire West Valley fault zone has a post-Provo shoreline (<13.5 ka) slip rate of 0.5–0.6 mm/yr, and an average recurrence interval of 1,800–2,200 yr, based on six or seven surface-faulting events. Unfortunately, Keaton and others (1987) did not find evidence of the age of the most recent event. We concur with them and with Keaton (written commun., 1989) that the West Valley fault zone probably is seismically independent of the Wasatch fault zone, but that sympathetic movement on the fault zone from earthquakes along the Wasatch fault zone is a distinct possibility.

SEGMENTATION

The trace of the Salt Lake City segment is clearly the most complex of any segment of the Wasatch fault zone (Schwartz and Coppersmith, 1984; Machette and others, 1987, 1989, in press). From north to south, the segment consists of three active branches, the Warm Springs fault, the East Bench fault, and the Cottonwood section of the Wasatch fault zone (fig. 1). We will describe some of the significant features along the Salt Lake City segment, including its northern and southern boundaries and the bifurcation zone at the intersection of the East Bench fault and the Cottonwood section. Bruhn and others (1987) described all three of these areas as "nonconservative barriers" to fault-rupture propagation. Non-conservative barriers are regions along a fault where the orientation of the slip vector changes between adjacent parts of a fault; these regions commonly mark the location of the initiation and termination of fault ruptures (King and Yielding, 1984; King and Nabelek, 1985). As such, these features may have controlled the geometry of surface ruptures in the past and may do so in the future. NORTHERN SEGMENT BOUNDARY

The Salt Lake salient marks the boundary between the northern end of the Salt Lake City segment and the southern end of the Weber segment (fig. 1; Machette and others, 1987, in press), previously known as the Ogden segment (Schwartz and Coppersmith, 1984). The structural significance of the salient was first recognized by Gilbert (1890, 1928), who was intrigued by the "bedrock spurs" found in several places along the Wasatch fault zone. In almost all cases these spurs are areas of reduced structural relief that are now recognized as probable boundaries between fault segments (Schwartz and Coppersmith, 1984; Machette and others, 1987, 1989, in press; Wheeler

and Krystinik, 1988). The active part of the Warm Springs fault is probably too short (about 7 km) for it to be a seismically independent structure, so we think it is related seismogenically to the rest of the Salt Lake City segment. Bruhn and others (1987, p. 345) have described the Salt Lake salient as a

the north side of the Salt Lake salient. Several short, north-trending fault scarps are preserved in the 2-km-wide gap between the northern end of the Warm Springs fault and the southern end of the Weber segment. The southernmost end of the Weber segment is marked by a single scarp that trends southwest across the drainage of North Canyon and then trends south, offsetting the Bonneville shoreline before dying out in bedrock. The amount of surface offset along this scarp decreases from 11.6 m in Bonneville-lakecycle gravels (Ibg) to 3.7 m in alluvial-fan deposits post-dating the Bonneville lake cycle (af2); these changes in surface offset clearly indicate recurrent latest Pleistocene and Holocene faulting. The numerous fault scarps on the northwest flank of the salient appear to form a network of subsidiary faults that may have diffused the energy of earthquake ruptures propagating into the salient from the Salt Lake City and (or) Weber segments. Another indicator of structural complexity at the northern segment boundary may be the location of Becks and Wasatch thermal springs. These springs may be localized by increased permeability associated with faulting and fracturing in the subsurface near the Salt Lake salient (Murphy and Gwynn, 1979a). Although it may be coincidental, thermal springs along the Salt Lake City segment are found only near the segment boundaries (Mundorff, 1970; Klauk, 1984). Hot springs on the Brigham City segment of the Wasatch fault zone (Personius, 1990) are similarly localized at the

segment boundaries. The eastern flank of the Salt Lake salient is also bounded by a normal fault, the Rudys Flat fault of Van Horn and Crittenden (1987), that places Tertiary sedimentary and volcanic rock against Precambrian metamorphic rock. Although this fault appears to connect the southern end of the Weber segment with the northern end of the East Bench fault, we have observed no evidence of Quaternary movement on this structure. Therefore, latest Quaternary fault activity on the northern end of the Salt Lake City segment appears to be restricted to the Warm Springs fault on the northwest side of the Salt Lake salient. SOUTHERN SEGMENT BOUNDARY

The Traverse Mountains salient marks the boundary between the southern end of the Salt Lake City segment and the northern end of the Provo segment (fig. 1; Schwartz and Coppersmith, 1984; Machette and others, 1987, 1989, in press). Scott and Shroba (1985) ended their mapping of latest Quaternary faulting on the Cottonwood section of the Salt Lake City segment near the mouth of Corner Canyon, but Machette and others (1987, in press) discussed evidence that extends Quaternary faulting across the Traverse Mountains salient along the Fort Canyon fault of Bruhn and others (1987). However, the rate of Quaternary movement on the Fort Canyon fault appears to be much lower than on the adjoining segments. The reduced rate of Quaternary slip is consistent with the lower structural relief apparent across this part of the Wasatch fault zone.

Gravity data suggest that the steep northwest flank of the Traverse Mountains is bounded by northeast-trending normal faults (Cook and Berg, 1961; Zoback, 1983), but Scott and Shroba (1985) and photogeologic reconnaissance by the senior author found no evidence of latest Quaternary displacement on these structures. Bruhn and others (1987, p. 345) described the Traverse Mountains as a non-conservative barrier, consisting of three large normal faults that intersect in a "triple junction" at the sharp bend in the Wasatch fault zone near the mouth of Corner Canyon. The northeasttrending faults on the northwest flank of the salient form a presently inactive arm of this triple junction. Crystal (hot) Springs may be localized by increased permeability in the subsurface associated with these faults (Mundorff, 1970; Murphy and Gwynn, 1979b; Klauk, 1984). Analysis of structural data by Bruhn and others (1987) suggested that

future ruptures on the Salt Lake City segment may begin at the Traverse Mountains salient and propagate northward along the Cottonwood section and the rest of the Salt Lake City segment. The distribution and size of fault scarps on the Cottonwood section near the bifurcation zone (see discussion below) support this suggestion.

BIFURCATION ZONE

Bruhn and others (1987) delineated a third non-conservative barrier in the Salt Lake City area, at the bifurcation zone between the Cottonwood section of the Salt Lake City segment and the East Bench fault. However, this barrier does not appear to be as resistant to ruptures as the two segment boundaries previously discussed. The distribution of late Quaternary faulting suggests that most late Quaternary ruptures probably propagated from the southern segment boundary and the Cottonwood section northward into the East Bench fault, with only rare or very small displacements occurring on the Cottonwood section north of its intersection with the East Bench fault. Scarps north of the bifurcation zone are only 1–2 m high, whereas scarps in deposits of similar age on the Cottonwood section to the south and on the East Bench fault to the east are at least 10-15 m high. The small scarps north of the bifurcation zone may represent extension of minor fault displacements into this otherwise inactive part of the Wasatch fault zone. This pattern may be similar to the pattern of surface rupture that accompanied the 1983 Borah Peak, Idaho, earthquake, during which a small amount of displacement "jumped" across the segment boundary at the north end of the rupture (Crone and others, 1987). Unfortunately, this idea cannot be tested at present because trench data from the East Bench fault is not detailed enough to correlate individual surface ruptures from the Cottonwood section across the bifurcation zone.

Bruhn and others (1987) noted several structural features that may be influencing the behavior of the Salt Lake City segment near the bifurcation zone. These features include a west-trending Mesozoic thrust fault system that intersects the Wasatch fault zone west of Neffs Canyon, and a westtrending gravity gradient (Zoback, 1983, fig. 4) that extends across the Salt Lake Valley at about the same latitude. J.R. Keaton (written commun., 1989) has noted that the southern end of the West Valley fault zone also terminates at this latitude, suggesting that a major west-trending structure may be controlling both the geometry of the West Valley fault zone and the bifurcation zone of the Salt Lake City segment. SEGMENTATION SUMMARY

Paleoseismic analysis of fault scarps and limited trench data suggest that the active parts of the Salt Lake City segment consist of the Warm Springs fault, the East Bench fault, and the Cottonwood section of the Wasatch fault zone. Bedrock salients at the Salt Lake salient and Traverse Mountains probably are non-conservative barriers that form the northern and southern boundaries, respectively, of the Salt Lake City segment. The bifurcation zone that marks the intersection between the East Bench fault and the Cottonwood section may be a less resistant non-conservative barrier that directs ruptures from the Cottonwood section into the East Bench fault. Unfortunately, correlation of surface-faulting events along the length of the Salt Lake City segment is impossible at the present time because data on the timing of individual events is available only for the Cottonwood section. Additional paleoseismic data will be especially difficult to obtain along the heavily urbanized Warm Springs and East Bench faults.

CONCLUSION

Mapping of Quaternary deposits and measurement of fault scarps in deposits of various ages have helped us identify some of the paleoseismic characteristics of the Salt Lake City segment and parts of the adjacent segments of the Wasatch fault zone. The Salt Lake City segment has clearly been active during Holocene time: fault scarps in Holocene alluvial deposits attest to several surface-faulting events during the past 10,000 yrs. Trench studies at several sites on the Salt Lake City segment have documented Holocene surface faulting having average recurrence intervals of 3,000-4,000 yrs and slip rates of at least 0.75-1 mm/yr. The age of the most recent surface-faulting event has not been well constrained, but preliminary ages from the South Fork Dry Creek trench studies suggest that the youngest event on the Cottonwood section of the Salt Lake City segment occurred

The Salt Lake City segment exhibits the most complex pattern of surface faulting of any segment of the Wasatch fault zone. The branched nature of the segment complicates paleoseismic studies in the Salt Lake City area because insufficient trench data are available to correlate individual faulting events on the various fault strands. However, fault scarp and trench data indicate that all three active branches of the Salt Lake City segment have experienced recurrent Holocene faulting and that these structures probably are seismically independent of the Weber segment to the north and the Provo segment to the south. The Salt Lake salient and the Traverse Mountains form the northern and southern boundaries, respectively, of the Salt Lake City segment and exhibit most of the geologic features characteristic of such boundaries, including reduced structural relief, sharp fault bends, thermal springs, and changes in rate and timing of Quaternary slip. The nearby West Valley fault zone has also undergone recurrent faulting in latest Pleistocene and Holocene time, but this structure probably is seismically independent of the Wasatch fault zone. Therefore, the West

REFERENCES CITED Arabasz, W.J., Smith, R.B., and Richins, W.D., 1979, Earthquake studies along the Wasatch front, Utah-Network monitoring, seismicity, and seismic hazards, in Arabasz, W.J., Smith, R.B., and Richins, W.D., eds., Earthquake studies in Utah 1850–1978: Salt Lake City, Special Publication of University of Utah Seismograph Station, Salt Lake City, p. 253–285. Birkeland, P.W., 1984, Soils and geomorphology: New York, Oxford

Valley fault zone constitutes an additional potential source of seismic hazard

to the Salt Lake City area.

University Press, 372 p. Bruhn, R.L., Gibler, P.R., and Parry, W.T., 1987, Rupture characteristics of normal faults-An example from the Wasatch fault zone, Utah, in Coward, M.P., Dewey, J.F., and Hancock, P.L., eds., Continental extensional tectonics: Geological Society [of London] Special Publication No. 28, p. 337–353. Bryant, Bruce, 1984, Reconnaissance geologic map of the Precambrian

Farmington Canyon complex and surrounding rocks in the Wasatch Mountains between Ogden and Bountiful, Utah: U.S. Geological Survey Miscellaneous Investigations Series Map I–1447, scale 1:50,000. Bucknam, R.C., and Anderson, R.E., 1979, Estimation of fault-scarp ages from a scarp-height-slope-angle relationship: Geology, v. 7, p. 11–14. Cluff, L.S., Hintze, L.F., Brogan, G.E., and Glass, C.E., 1975, Recent activity of the Wasatch fault, northwestern Utah: Tectonophysics, v. 29, p. 161–168. Cook, K.L., and Berg, J.W., Jr., 1961, Regional gravity survey along the central and southern Wasatch front, Utah: U.S. Geological Survey Professional Paper 316–E, p. 75–89. Crittenden, M.D., Jr., 1965a, Geology of the Draper quadrangle, Utah: U.S. Geological Survey Geological Quadrangle Map GQ-377, scale 1:24,000.

Utah: U.S. Geological Survey Geological Quadrangle Map GQ-380, scale 1:24,000 Crittenden, M.D., Jr., Stuckless, J.S., Kister, R.W., and Stern, T.W., 1973, Radiometric dating of intrusive rocks in the Cottonwood area, Utah: U.S. Geological Survey Journal of Research, v. 1, no. 2, p. 173–178. Crone, A.J., and Harding, S.T., 1984, Near-surface faulting associated with Holocene fault scarps, Wasatch fault zone, Utah—A preliminary report, in Hayes, W.W., and Gori, P.L., eds., Proceedings of Conference XXVI—A workshop on evaluation of regional and urban earthquake hazards and

_1965b, Geology of the Sugar House quadrangle, Salt Lake County,

risk in Utah: U.S. Geological Survey Open-File Report 84-763, p. 241-268. Crone, A.J., Machette, M.N., Bonilla, M.G., Lienkaemper, J.J., Pierce, K.L., Scott, W.E., and Bucknam, R.C., 1987, Surface faulting accompanying the Borah Peak earthquake and segmentation of the Lost River fault, central Idaho: Seismological Society of America Bulletin, v. 77, no. 3, p. 739-770. Currey, D.R., 1980, Coastal geomorphology of Great Salt Lake and vicinity,

in Gwynn, J.W., ed., Great Salt Lake—A scientific, historical, and

p. 69-82.

economic overview: Utah Geological and Mineral Survey Bulletin 116,

Currey, D.R., Atwood, Genevieve, and Mabey, D.R., 1984, Major levels of Great Salt Lake and Lake Bonneville, May 1984: Utah Geological and Mineral Survey Map 73, scale 1:750,000. Currey, D.R., and Oviatt, C.G., 1985, Durations, average rates, and probable causes of Lake Bonneville expansions, still-stands, and contractions during the last deep-lake cycle, 32,000-10,000 years ago, in Kay, P.A., and Diaz, H.F., eds., Problems and prospects for predicting Great Salt Lake levels—Proceedings of a NOAA Conference held March 26–28, 1985: Salt Lake City, Center for Public Affairs and Administration, University of Utah, p. 9–24.

Currey, D.R., Oviatt, C.G., and Plyler, G.B., 1983, Lake Bonneville stratigraphy, geomorphology, and isostatic deformation in west-central Utah, in Gurgel, K.D., ed., Geologic excursions in neotectonics and engineering geology in Utah: Utah Geological and Mineral Survey Special Studies 62, p. 63–82. Davis, F.D., 1983a, Geologic map of the central Wasatch Front, Utah: Utah Geological and Mineral Survey Map 54-A, scale 1:100,000. _1983b, Geologic map of the southern Wasatch Front, Utah: Utah Geological and Mineral Survey Map 55-A, scale 1:100,000. Everitt, B.L., 1979, Geology of some foundation excavations in northeastern

Salt Lake City: Utah Geological and Mineral Survey Report of

Gilbert, G.K., 1890, Lake Bonneville: U.S. Geological Survey Monograph 1, ___1928, Studies of basin-range structure: U.S. Geological Survey Professional Paper 153, 92 p. Hamblin, W.K., and Best, M.G., 1980, Patterns and rates of recurrent movement along the Wasatch-Hurricane-Sevier fault zone, Utah, during Cenozoic time, in Andriese, P.D., compiler, Proceedings of Conference X—Earthquake hazards along the Wasatch and Sierra-Nevada frontal fault zones: U.S. Geological Survey Open-File Report 80-801, p. 601–633.

Hunt, C.B., ed., 1982, Pleistocene Lake Bonneville, ancestral Great Salt

Lake, as described in the notebooks of G.K. Gilbert, 1875-1880:

Investigation No. 149, 24 p.

Brigham Young University Geology Studies, v. 29, part 1, p. 1–225. Jarrett, R.D., and Malde, H.E., 1987, Paleodischarge of the late Pleistocene Bonneville Flood, Snake River, Idaho, computed from new evidence: Geological Society of America Bulletin, v. 99, p. 127–134. Keaton, J.R., Currey, D.R., and Olig, S.J., 1987, Paleoseismicity and earthquake hazards evaluation of the West Valley fault zone. Salt Lake City urban area, Utah: Unpublished technical report to U.S. Geological Survey, Denver, under Contract No. 14-08-0001-22048, March 6. 1987, 55 p. and appendix, 33 p.

King, Geoffrey, and Nabelek, John, 1985, Role of fault bends in the initiation and termination of fault rupture: Science, v. 228, p. 984–987. King, Geoffrey, and Yielding, Graham, 1984, The evolution of a thrust fault system—Processes of rupture propagation and termination in the 1980 El Asnam (Algeria) earthquake: Geophysical Journal of the Royal

Astronomical Society, v. 77, p. 915–933. Klauk, R.H., 1984, Low-temperature geothermal assessment of the Jordan Valley, Salt Lake County, Utah: Utah Geological and Mineral Survey Report of Investigation No. 185, 160 p. Lund, W.R., and Schwartz, D.P., 1987, Fault behavior and earthquake recurrence at the Dry Creek site, Salt Lake segment, Wasatch fault zone,

Utah: Geological Society of America Abstracts with Programs, v. 19, no. 5, p. 317 Machette, M.N., 1982, Quaternary and Pliocene faults in the La Jencia and southern part of the Albuquerque-Belen basins, New Mexico—Evidence of fault history from fault-scarp morphology and Quaternary history, in Grambling, J.A., and Wells, S.G., eds., Albuquerque Country 2: New Mexico Geological Society Guidebook, 33rd Field Conference, p. 161-169. _____1989, Preliminary surficial geologic map of the Wasatch fault zone, eastern part of Utah Valley, Utah County and parts of Salt Lake and Juab Counties, Utah: U.S. Geological Survey Miscellaneous Field Studies

Map MF-2109, scale 1:50,000.

_____in press, Surficial geologic map of the Wasatch fault zone, eastern part of Utah Valley, Utah County and parts of Salt Lake and Juab Counties, Utah: U.S. Geological Survey Miscellaneous Investigations Series Map I–2095, scale 1:50,000. Machette, M.N., Personius, S.F., and Nelson, A.R., 1987, Quaternary geology along the Wasatch fault zone—Segmentation, recent investigations, and preliminary conclusions, in Gori, P.L., and Hayes, W.W., eds., Assessment of regional earthquake hazards and risk along the Wasatch Front, Utah: U.S. Geological Survey Open-File Report 87–585, v. 1, p. A1–A72. ____in press, Paleoseismology of the Wasatch fault zone—A summary of

recent investigations, conclusions, and interpretations, in Gori, P.L., and

Hayes, W.W., eds., Assessing regional earthquake hazards and risk along the Wasatch Front, Utah: U.S. Geological Survey Professional Paper Machette, M.N., Personius, S.F., Nelson, A.R., Schwartz, D.P., and Lund, W.R., 1989, Segmentation models and Holocene movement history of the Wasatch fault zone, Utah, in Schwartz, D.P., and Sibson, R.H., eds., Proceedings of Conference XLV—Fault segmentation and controls on rupture initiation and termination: U.S. Geological Survey Open-File Report 89-315, p. 229-242.

Madsen, D.B., and Currey, D.R., 1979, Late Quaternary glacial and vegetation changes, Little Cottonwood Canyon area, Wasatch Mountains, Utah: Quaternary Research, v. 12, p. 254–270. Malde, H.E., 1968, The catastrophic late Pleistocene Bonneville Flood in the Snake River Plain: U.S. Geological Survey Professional Paper 596,

Marine, I.W., and Price, Don, 1964, Geology and groundwater resources of the Jordan Valley, Utah: Utah Geological and Mineral Survey Water Resources Bulletin No. 7, 63 p. Marsell, R.E., 1964, The Wasatch fault zone in Salt Lake County, Utah, in Marsell, R.E., ed., The Wasatch fault zone in north central Utah: Utah Geological Society Guidebook to the Geology of Utah, no. 18, p. 31–50. __1969, The Wasatch fault zone in north central Utah, in Jensen, M.L., ed., Guidebook of northern Utah: Utah Geological and Mineralogical

Survey Bulletin 82, p. 125–139. Marsell, R.E., and Threet, R.L., 1960, Geologic map of Salt Lake County, Utah, supplement to Geology of Salt Lake County: Utah Geological and Mineralogical Survey Bulletin 69, scale 1:63,360. McCoy, W.D., 1977, A reinterpretation of certain aspects of the late

Quaternary glacial history of Little Cottonwood Canyon, Wasatch Mountains, Utah: Salt Lake City, University of Utah, M.A. thesis, 84 p. _____1987, Quaternary aminostratigraphy of the Bonneville Basin, western United States: Geological Society of America Bulletin, v. 98, no. 1. p. 99–112. Miller, R.D., 1980, Surficial geologic map along part of the Wasatch Front, Salt Lake Valley, Utah: U.S. Geological Survey Miscellaneous Field

Studies Map MF-1198, scale 1:100,000.

No. 139, 86 p.

___1982, Surficial geologic map along part of the Wasatch Front, Great Salt Lake and Utah Valleys, Utah: U.S. Geological Survey Miscellaneous Field Studies Map MF-1477, scale 1:100,000. Morrison, R.B., 1965, Lake Bonneville—Quaternary stratigraphy of the eastern Jordan valley, south of Salt Lake City, Utah: U.S. Geological Survey Professional Paper 477, 80 p. Mundorff, J.C., 1970, Major thermal springs of Utah: Utah Geological and Mineral Survey Water Resources Bulletin 13, 60 p. Murphy, P.J., and Gwynn, J.W., 1979a, Geothermal investigations of the Warm Springs fault geothermal system, Salt Lake County, Utah: Utah Geological and Mineral Survey Report of Investigation No. 140, 29 p. _1979b, Geothermal investigations at Crystal Hot Springs, Salt Lake

County, Utah: Utah Geological and Mineral Survey Report of Investigation

Nelson, A.R., and Personius, S.F., 1990, Preliminary surficial geologic map of the Weber segment, Wasatch fault zone, Weber and Davis Counties, Utah: U.S. Geological Survey Miscellaneous Field Studies Map MF-2132, scale 1:50,000. ___in press, Surficial geologic map of the Weber segment, Wasatch fault zone, Weber and Davis Counties, Utah: U.S. Geological Survey Miscellaneous Investigations Series Map I–2199, scale 1:50,000. Personius, S.F., 1990, Surficial geologic map of the Brigham City segment and adjacent parts of the Weber and Collinston segments. Wasatch fault zone, Box Elder and Weber Counties, Utah: U.S. Geological Survey Miscellaneous Investigations Series Map I–1979, scale 1:50,000. Pierce, K.L., Obradovich, J.D., and Friedman, Irving, 1976, Obsidianhydration dating and correlation of Bull Lake and Pinedale Glaciations near West Yellowstone, Montana: Geological Society of America Bulletin, v. 87, p. 703-710. ____in press, Surficial geologic map of the Brigham City segment and adjacent parts of the Weber and Collinston segments, Wasatch fault zone, Box Elder and Weber Counties, Utah: U.S. Geological Survey

Miscellaneous Investigations Series Map I–1979, scale 1:50,000. Pierce, K.L., Obradovich, J.D., and Friedman, Irving, 1976, Obsidianhydration dating and correlation of Bull Lake and Pinedale Glaciation near West Yellowstone, Montana: Geological Society of America Bulletin, v. 87, p. 703-710. Schwartz, D.P., and Coppersmith, K.J., 1984, Fault behavior and characteristic earthquakes-Examples from the Wasatch and San Andreas fault zones: Journal of Geophysical Research, v. 89, p. 5681–5698. Schwartz, D.P., and Lund, W.R., 1988, Paleoseismicity and earthquake recurrence at Little Cottonwood Canyon, Wasatch fault zone, Utah, in Machette, M.N., ed., In the footsteps of G.K. Gilbert—Lake Bonneville and neotectonics of the eastern Basin and Range province: Geological

Society of America Annual Meeting, Field Trip Guidebook, Utah Geological and Mineral Survey Miscellaneous Publication 88–1, p. 82–85. Scott, W.E., 1981, Field-trip guide to the Quaternary stratigraphy and faulting north of the mouth of Big Cottonwood Canyon, Salt Lake County, Utah: U.S. Geological Survey Open-File Report 81-773, 12 p. __1988a, Temporal relations of lacustrine and glacial events at Little Cottonwood and Bells Canyons, Utah, in Machette, M.N., ed., In the footsteps of G.K. Gilbert-Lake Bonneville and neotectonics of the eastern Basin and Range province: Geological Society of America Annual Meeting, Field Trip Guidebook, Utah Geological and Mineral Survey Miscellaneous Publication 88–1, p. 78–81. ____1988b, Deposits of the last two deep-lake cycles at Point of the Mountain, Utah, in Machette, M.N., ed., In the footsteps of G.K. Gilbert— Lake Bonneville and neotectonics of the eastern Basin and Range province: Geological Society of America Annual Meeting, Field Trip Guidebook, Utah Geological and Mineral Survey Miscellaneous Publication 88-1, p. 86-88. ___1988c, Transgressive and high-shore deposits of the Bonneville

footsteps of G.K. Gilbert-Lake Bonneville and neotectonics of the eastern Basin and Range province: Geological Society of America Annual Meeting, Field Trip Guidebook, Utah Geological and Mineral Survey Miscellaneous Publication 88–1, p. 38–42. ___1988d, G.K. Gilbert's observations of post-Bonneville movement along the Warm Springs fault, Salt Lake County, Utah, in Machette, M.N., ed., In the footsteps of G.K. Gilbert-Lake Bonneville and neotectonics of the eastern Basin and Range province: Geological Society of America Annual Meeting, Field Trip Guidebook, Utah Geological and Mineral Survey Miscellaneous Publication 88–1, p. 44–46.

Scott, W.E., McCoy, W.D., Shroba, R.R., and Rubin, Meyer, 1983,

Reinterpretation of the exposed record of the last two cycles of Lake

lake cycle near North Salt Lake, Utah, in Machette, M.N., ed., In the

Bonneville, western United States: Quaternary Research, v. 20, p. 261–285. Scott, W.E., and Shroba, R.R., 1985, Surficial geologic map of an area along the Wasatch fault zone in the Salt Lake valley, Utah: U.S. Geological Survey Open-File Report 85–448, scale 1:24,000. Shroba, R.R., 1982, Soil B-horizon properties as age indicators for late Quaternary deposits along the Wasatch front, north-central Utah: Geological Society of America Abstracts with Programs, v. 14, no. 4, p. 233. $_1984$, Soil properties and loess mantles as age indicators for Holocene deposits in alpine and semiarid regions of Colorado and Utah: Geological Society of America Abstracts with Programs, v. 16, no. 4, p. 255. Swan, F.H., III, Schwartz, D.P., and Cluff, L.S., 1980, Recurrence of

moderate to large magnitude earthquakes produced by surface faulting on the Wasatch fault zone, Utah: Bulletin of the Seismological Society of America, v. 70, p. 1431–1462. Swan, F.H., III, Hanson, K.L., Schwartz, D.P., and Knuepfer, P.L., 1981, Study of earthquake recurrence intervals on the Wasatch fault at the Little Cottonwood site, Utah: U.S. Geological Survey Open-File Report 81-450, 30 p. Van Horn, Richard, 1972a, Surficial geologic map of the Sugar House quadrangle, Salt Lake County, Utah: U.S. Geological Survey Miscellaneous Investigations Series Map I–766–A, scale 1:24,000.

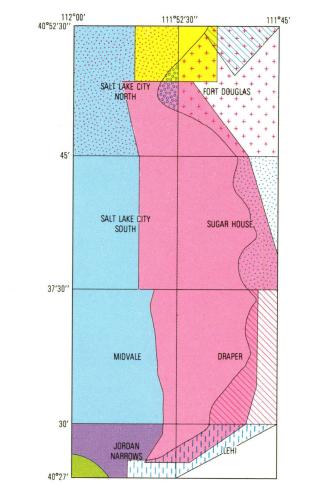
_____1972b, Map showing relative ages of faults in the Sugar House

quadrangle, Salt Lake County, Utah: U.S. Geological Survey Miscel-

laneous Investigations Series Map I-766-B, scale 1:24,000. _____1979, Surficial geologic map of the Salt Lake City South quadrangle, Salt Lake County, Utah: U.S. Geological Survey Miscellaneous Investigations Series Map I–1173, scale 1:24,000. _____1981, Geologic map of pre-Quaternary rocks of the Salt Lake City North quadrangle, Davis and Salt Lake Counties, Utah: U.S. Geological Survey Miscellaneous Investigations Series Map I–1300, scale 1:24,000. _1982, Surficial geologic map of the Salt Lake City North quadrangle, Davis and Salt Lake Counties, Utah: U.S. Geological Survey Miscellaneous Investigations Series Map I–1404, scale 1:24,000. Van Horn, Richard, and Crittenden, M.D., Jr., 1987, Map showing surficial units and bedrock geology of the Fort Douglas quadrangle and parts of the Mountain Dell and Salt Lake City North quadrangles, Davis, Salt

Lake, and Morgan Counties, Utah: U.S. Geological Survey Miscellaneous Investigations Series Map I–1762, scale 1:24,000. Wheeler, R.L., and Krystinik, K.B., 1988, Segmentation of the Wasatch fault zone, Utah—Summaries, analyses, and interpretations of geological and geophysical data: U.S. Geological Survey Bulletin 1827, 47 p. Wieczorek, G.F., Lips, E.W., and Ellen, S.D. 1989, Debris flows and hyperconcentrated floods along the Wasatch Front, Utah, 1983 and 1984: Bulletin of the Association of Engineering Geologists, v. 26, no. 2, Zoback, M.L., 1983, Structure and Cenozoic tectonism along the Wasatch

fault zone, Utah: Geological Society of America Memoir 157, p. 3–27.



SOURCES OF GEOLOGIC AND TOPOGRAPHIC DATA Index showing sources of geologic data used in compilation of this map. Some listed sources are compilations of other published reports; these other sources may not be referenced on this index] Van Horn (1982) Miller (1980)

Nelson and Personius (1990)

Van Horn and Crittenden (1987)

Scott and Shroba (1985)

Bryant (1984)

Van Horn (1981)

Crittenden (1965b) Crittenden (1965a) Miller (1982) Davis (1983b) Machette (1989)

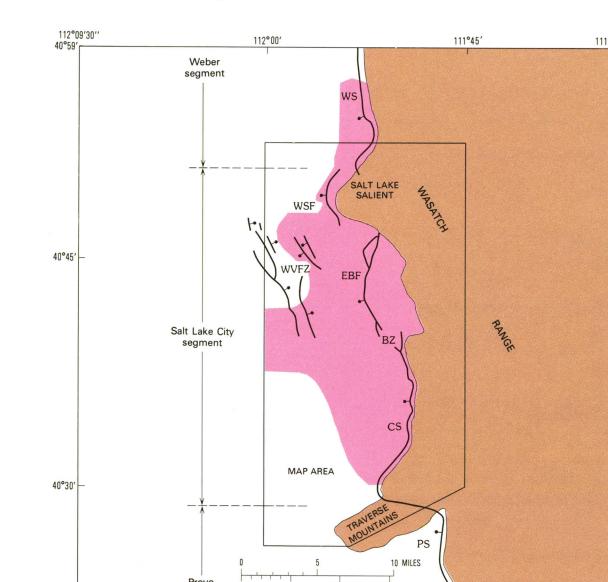
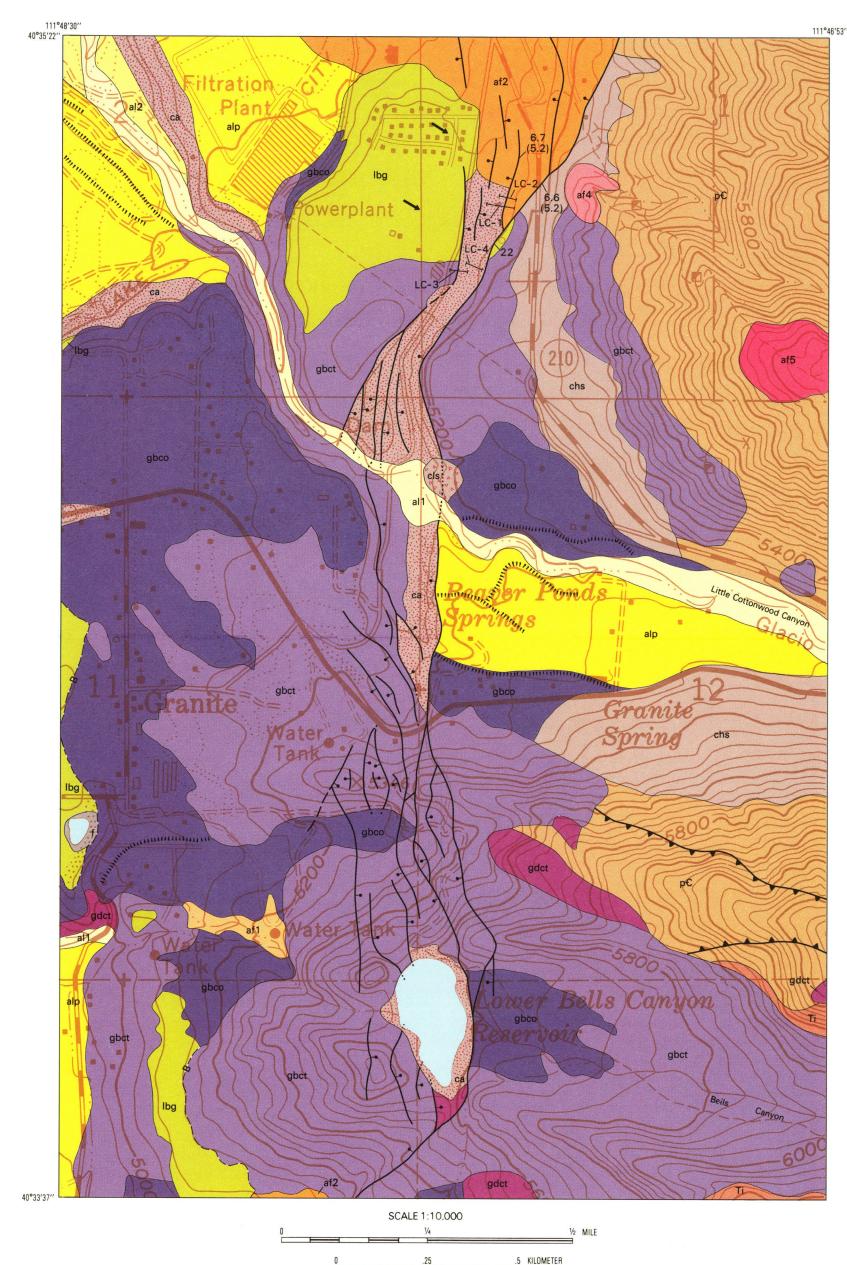
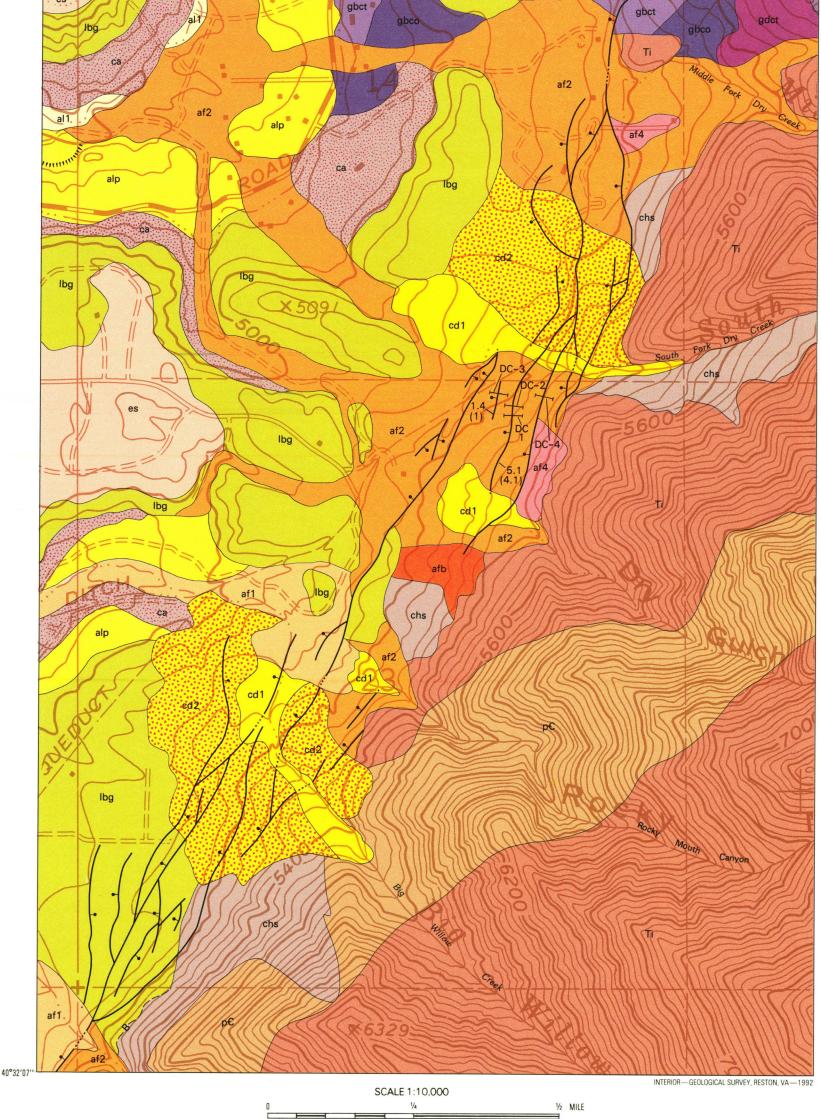


Figure 1.—Index map showing active trace (heavy line, bar and ball on downthrown side) of the Wasatch and West Valley fault zones in the Salt Lake City area. The extent of the Salt Lake City segment, and the southern part of the Weber and northern part of the Provo segments, is from Machette and others (1987, 1989, in press); this nomenclature differs from that of Schwartz and Coppersmith (1984) only in the name of the Weber (Ogden) segment. Extent of heavily urbanized area shown in pink. Abbreviations used: BZ, bifurcation zone between the East Bench fault and the Cottonwood section; CS, Cottonwood section of the Wasatch fault zone; EBF, East Bench fault; PS, Provo segment; WS, Weber segment; WSF, Warm Springs fault; WVFZ, West Valley fault zone. In this study, the West Valley fault zone is not considered part of the Salt Lake City



NATIONAL GEODETIC VERTICAL DATUM OF 1929 Figure 2. Detailed surficial geologic map of an area of complex faulting near the mouths of Little Cottonwood and Bells Canyons. Outline of figure shown on geologic map. Geologic units and symbols are explained in the Description of Map Units.



CONTOUR INTERVALS 10 AND 40 FEET NATIONAL GEODETIC VERTICAL DATUM OF 1929

Figure 3. Detailed surficial geologic map of an area of complex faulting near the mouth of South Fork Dry Creek. Outline of figure shown on geologic map. Geologic units and symbols are explained in the Description of Map Units.