UNITED STATES DEPARTMENT OF THE INTERIOR

GEOLOGICAL SURVEY

LAKE BONNEVILLE:
SELECTED FEATURES OF RELEVANCE TO NEOTECTONIC ANALYSIS

By

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Open-File Report
82-1070

INTRODUCTION

Lake Bonneville, the largest late Pleistocene lake of nonglacial origin in the western hemisphere, fluctuated greatly in size during the last major lacustral interval, which occurred between about 25,000 and somewhat less than 10,000 years ago. At high stages, Lake Bonneville inundated much of northwestern Utah, and parts of southeastern Idaho and northeastern Nevada.

In over a century of intermittent research, a large body of information--including much that is fragmentary or that has the appearance of being inconsistent with other information--has been compiled regarding Lake Bonneville. Shoreline delineation and hypsometry are among the many aspects of the lake that have been pursued over the years. In this report, the configurations of major shorelines are documented more thoroughly than in any previous work.

PURPOSE AND SCOPE

The primary purpose of this report is to provide information of fundamental importance to neotectonic analysis of the Lake Bonneville region. It is also anticipated that this data set is likely to find applications in other areas of Quaternary studies, including stratigraphy, surficial geology, paleohydrology, and paleoclimatology, as well as in tectonophysics.

The scope of this report is threefold. (1) Several major shorelines of known approximate age, differentiated as to erosional or depositional origin, and several shoreline-controlling thresholds are delineated at a scale of 1:500,000 on plate 1. (2) Altitudes and supporting data pertaining to 345 shoreline and threshold localities denoted on plate 1 are listed in table 1 (see p. 2-19). (3) Other selected elements of Quaternary geology that are related directly to Lake Bonneville or that may be related to the deformation of its basin are depicted on plate 1 and described briefly below.

SOURCES OF INFORMATION

Many quadrangle-scale mapping products have portrayed relatively short segments of Lake Bonneville shorelines, but delineation of shoreline continuity on a regional basis has been undertaken less frequently. The highest shoreline was first mapped in its entirety by Gilbert (1890, map folded in back of cover, scale 1:800,000) and subsequently has been depicted at regional scales by Jones (1940, series of maps at 1:2,000,000), Hubbs and Miller (1948, map ff. p. 166, Nevada portion at 1:2,500,000), Crittenden (1963, fig. 1, 1:2,500,000), Ridd (1963, Utah portion at 1:660,000), Feth (1964, pl. 4, 1:2,500,000), Snyder et al. (1964, 1:1,000,000), Fisher (1974, 1:750,000), and Mifflin and Wheat (1979, pl. 1, Nevada portion at 1:1,000,000). Two or more major shorelines were delineated by Gilbert (1890, pl. XIII, 1:3,700,000), Jones (1940), and Fisher (1974).

Shoreline altitude data have been reported by Webster (1890, 33 points on Bonneville, 12 on Provo, and two on Stansbury shoreline), Crittenden (1963, table 1, 90 points on Bonneville shoreline), Doelling (1964, p. 308 and fig. 39, two points on Bonneville and two on Provo shoreline), R. C. Bucknam (unpublished data, 1975, 21 points on Bonneville shoreline), DeGraff (1976,

TABLE 1A.—Bonneville shoreline altitudes

Circle no.	W. long. (deg.)	N. lat. (deg.)	Altitude ± error (m)	Method†	7.5-min. quad.**Locality name**Geomorphic setting
1	112.06	42.38	1552 ± 2	3	Downey East, Idaho (1968)**Zenda Threshold**dissected coalescing alluvial fans
2	112.01	42.34	1552 ± 1	3	Oxford, Idaho (1968)**Peak 5558 SE Cove**SW-facing beach ridge
3	111.88	42.24	1556 ± 2	1	Banida, Idaho (1969)**Poverty Flats E Headland**W-facing beach ridge
4	111.81	42.21	1555 ± 2	2	Riverdale, Idaho (1969)**Oneida Narrows SW Bench**upper limit of Bear River delta
5	111.79	42.10	1558 ± 3	1	Franklin, Idaho (1969)**Johnson Reservoir SE Cove**N-facing beach ridge
6	111.80	41.88	1568 ± 1	3	Richmond, Utah-Idaho (1964)**Richmond S Cove**NW-facing beach ridge
7	111.80	41.69	1571 ± 3	2	Logan, Utah (1961)**Providence Canyon S Bench**W-facing beach ridge on delta
8	111.88	41.58	1577 ± 3	2	Mount Pisgah, Utah (1955)**Baxter Pothole**N-facing beach ridge
9	111.95	41.49	1580 ± 3	2	Mantua, Utah (1955)**Mantua Cemetery Bench**NW-facing shore terrace on alluvial fan
10	112.01	41.35	1582 ± 2	2	Plain City, Utah (1955)**Pole Patch Tombolo**SW-trending tombolo
11	111.76	41.13	1577 ± 1	3	Snow Basin, Utah (1955)**Cottonwood Creek S Bench**upper limit of Weber River delta
12	111.85	40.86	1584 ± 1	2	Fort Douglas, Utah (1963)**Mueller Park Spit**NE-trending spit
13	111.87	40.80	1586 ± 3	3	Fort Douglas, Utah (1963)**City Creek Canyon Spit**N-trending spit
14	111.90	40.46	1573 ± 2	2	Jordan Narrows, Utah (1951)**Point of the Mountain V-bar**SW-trending cuspate barrier
15	111.78	40.46	1574 ± 2	2	Lehi, Utah (1951)**Alpine NW Spit**E-trending spit
16	111.60	40.07	1564 ± 3	1	Spanish Fork Peak, Utah (1949)**Snell Canyon V-bar**N-trending cuspate barrier
17	111.65	40.03	1553 ± 1	2	Spanish Fork, Utah (1948)**Salem SE Bench**NW-facing beach ridge
18	111.81	40.03	1562 ± 1	2	West Mountain, Utah (1950)**West Mountain SE Cove**NE-facing beach ridge
19	111.81	39.94	1558 ± 1	3	Santaquin, Utah (1979)**Cedar Hollow S V-bar**W-trending cuspate foreland
20	111.95	39.87	1562 ± 3	1	Slate Jack Canyon, Utah (1979)**Goosenest Canyon N Cove**NE-facing beach ridge
21	112.01	39.98	1565 ± 2	1	Eureka, Utah (1954)**Hillside SW Beach**E-facing beach ridge
22	112.09	40.06	1568 ± 2	2	Allens Ranch, Utah (1947)**Allens Ranch Beach**N-facing beach ridge
23	111.98	40.22	1571 ± 2	1	Soldiers Pass, Utah (1950)**Mercer Canyon W Beaches**NW- and SW-facing beach ridges
24	111.90	40.28	1571 ± 2	1	Saratoga Springs, Utah (1951)**Losee Canyon V-bar**NE-trending cuspate foreland

TABLE 1A.—Bonneville shoreline altitudes—Continued

Circle no.	W. long. (deg.)	N. lat. (deg.)	Altitude ± error (m)	Method†	7.5-min. quad.**Locality name**Geomorphic setting
25	112.04	40.38	1574 ± 3	2	Tickville Spring, Utah (1954)**West Canyon Wash Beach**SE-facing beach ridge
26	112.07	40.54	1580 ± 2	1	Lark, Utah (1952)**Midas Gulch Beach**SE-facing beach ridge
27	112.05	40.62	1583 ± 1	3	Lark, Utah (1952)**Highway 111 Beach**SE-facing beach ridge
28	112.14	40.69	1590 ± 3	1	Farnsworth Peak, Utah (1972)**Little Valley Wash Cove**NE-facing beach ridge
29	112.20	40.93	1599 ± 2	1	Antelope Island, Utah (1972)**Peak 5616 SE Cove**SE-facing beach ridge
30	112.35	40.47	1596 ± 1	3	Stockton, Utah (1980)**Stockton Bar**SW-trending spit
31	112.37	40.34	1591 ± 1	2	Ophir, Utah (1980)**Ophir Canyon V-bar**W-trending cuspate barrier
32	112.21	40.22	1581 ± 1	3	Fivemile Pass, Utah (1949)**Fivemile Pass SW Beach**SW-facing beach ridge
33	112.39	40.20	1588 ± 2	2	Faust, Utah (1971)**Faust N Beach**N-facing beach ridge
34	112.49	40.48	1603 ± 1	3	South Mountain, Utah (1980)**South Mountain NW Beach**NE-facing beach ridge
35	112.54	40.56	1608 ± 3	1	Timpie SE (USFS, 1975)**Baker Canyon Beach**E-facing beach ridge
36	112.51	40.89	1615 ± 2	1	Badger Island, Utah (1968)**Peak 5429 Stack**upper limit of erosional platform
37	112.68	40.60	1613 ± 3	1	Timpie SW (USFS, 1975)**Broons Canyon Cove**NW-facing beach ridge
38	112.70	40.48	1610 ± 3	1	NW 1/4 Deseret Peak, Utah, 15-min. (1955)**Big Creek Canyon S Beach**SW-facing beach ridge
39	112.65	40.20	1598 ± 2	1	Davis Knolls, Utah (1955)**Davis Knolls NE Cove**NW-facing beach ridge
40	112.67	40.11	1595 ± 1	2	Indian Peaks, Utah (1955)**Davis Mountains SE Tombolo**N-facing beach ridge
41	112.76	40.17	1600 ± 2	1	Camels Back Ridge NE, Utah (1955)**Little Davis Mountain SE Tombolo**N-trending tombolo
42	113.01	40.34	1610 ± 2	1	Wig Mtn., Utah (1955)**Rocky S Cove**S-facing beach ridge
43	113.02	40.47	1615 ± 2	2	Wig Mtn. NE, Utah (1955)**Rydalch Canyon Cove**NW-facing beach ridge
44	113.02	40.61	1617 ± 2	1	Aragonite SE, Utah (1973)**Peak 5405 Tombolo**N-facing beach ridge
45	112.89	40.80	1621 ± 2	2	Low, Utah (1973)**Low Radio Tower Stack**SE-trending spit
46	112.82	40.83	1622 ± 2	1	Delle, Utah (1973)**Peak 5924 S Cove**SE-facing beach ridge
47	112.86	40.96	1624 ± 2	2	Craner Peak, Utah (1968)**Well Pass NW Ridge**S-trending spitlet
48	112.88	41.08	1626 ± 1	3	Strong Knob 3 SW, Utah (advance)**Pass 5197 NE Headland**upper limit of erosional platform

TABLE 1A.—Bonneville shoreline altitudes—Continued

Circle no.	W. long. (deg.)	N. lat. (deg.)	Altitude ± error (m)	Method†	7.5-min. quad.**Locality name**Geomorphic setting
49	112.88	41.10	1628 ± 2	1	Strong Knob 3 SW, Utah (advance)**North Lakeside S Cove**SW-facing beach ridge
50	112.89	41.14	1623 ± 2	1	Strongs Knob, Utah (1969)**Death Ridge S Stack**S-facing berm
51	112.86	41.18	1621 ± 2	1	Lakeside, Utah (1969)**Scad Ridge Stack**upper limit of erosional trimline
52	113.02	41.04	1625 ± 2	1	Terrace Mtn 4 SE, Utah (advance)**German Valley Stack**upper limit of erosional platform
53	113.05	40.97	1623 ± 3	1	Grassy Mountains, Utah (1973)**Grass N Cove**N-facing beach ridge
54	113.04	40.90	1623 ± 3	1	Grassy Mountains, Utah (1973)**Cobble Hill SW Cove**SW-facing beach ridge
55	113.02	40.86	1623 ± 2	1	Ripple Valley, Utah (1973)**Hill 5948 Coves**W- and E-facing beach ridges
56	113.30	40.48	1615 ± 2	1	Wildcat Mtn., Utah (1954)**VABM 5306 Stack**upper limit of erosional trimline
57	112.88	39.94	1593 ± 3	1	Table Mountain, Utah (1955)**Table Mtn NE Beach**E-facing beach ridge
58	112.78	39.91	1591 ± 1	1	Coyote Springs, Utah (1955)**Sixmile Spring SW V-bar**SW-trending cuspate barrier
59	112.66	39.87	1586 ± 2	1	Erickson Wash SW, Utah (1971)**Judd Creek West Fork Cove**SW-facing beach ridge
60	112.54	39.79	1580 ± 2	2	Desert Mtn. Pass, Utah (1971)**Coyote Knoll Bay**S-facing beach ridge
61	112.33	39.72	1567 ± 3	2	NE 1/4 Lynndyl, Utah, 15-min. (1962)**Jericho Wash Beach**SW-facing beach ridge
62	112.04	39.56	1559 ± 2	1	Sage Valley, Utah (1967)**West Fork Sage Valley**S-facing beach ridge
63	111.88	39.28	1556 ± 2	1	Hells Kitchen Canyon SW, Utah (1965)**Gunnison-Fayette Canal Bluff**upper limit of W-facing erosional platform
64	112.02	39.36	1558 ± 3	2	SE 1/4 Scipio North, Utah, 15-min. (1952)**Yuba Dam SE Headland**NW-trending tombolo
65	112.09	39.49	1561 ± 3	2	NE 1/4 Scipio North, Utah, 15-min. (1952)**Leamington Pass Road E Spit**N-trending spit
66	112.24	39.48	1563 ± 4	2	NW 1/4 Scipio North, Utah, 15-min. (1952)**Leamington Pass Road SW Cove**W-facing beach ridge
67	112.37	39.27	1568 ± 1	3	SE 1/4 Oak City, Utah, 15-min. (1951)**Clay Spring Wash-Whisky Creek Beach**SW-facing beach ridge
68	112.28	39.15	1561 ± 1	3	NE 1/4 Holden, Utah, 15 min. (1962)**Church Spring Wash Beach**SW-facing beach ridge
69	112.54	39.13	1553 ± 1	2	Pavant Butte North, Utah (1971)**Pavant Butte NE Spit**SE-trending spit
70	112.32	39.01	1561 ± 2	2	Holden, Utah (1962)**Cedar Mountain SE Cove**SW-facing beach ridge

TABLE 1A.—Bonneville shoreline altitudes—Continued

Circle no.	W. long. (deg.)	N. lat. (deg.)	Altitude ± error (m)	Method†	7.5-min. quad.**Locality name**Geomorphic setting
71	112.47	38.78	1563 ± 4	1	SW 1/4 Fillmore, Utah, 15-min. (1962)**Dual Springs NW Beach**NW-facing beach ridge
72	112.66	38.77	1574 ± 2	1	SW 1/4 Tabernacle Hill, Utah, 15-min. (1962)**Lava Ridge E Cove**N-facing beach ridge
73	112.89	38.75	1565 ± 1	1	Black Rock, Utah (1973)**Black Rock NE Spit**NW-trending spit
74	112.93	38.52	1558 ± 2	1	Read, Utah (1973)**Negro Mag V-bar**NW-trending cuspate barrier
75	112.97	38.38	1556 ± 2	1	Ranch Canyon, Utah (1958)**The Pass Road V-bar**W-trending cuspate barrier
76	113.12	38.16	1555 ± 1	3	Ninemile Knoll, Utah (1953)**The Sink Cove**N-facing beach ridge
77	113.26	38.10	1555 ± 1	3	Latimer, Utah (1971)**Blue Knoll W Cove**W-facing beach ridge
78	113.29	38.18	1554 ± 1	3	Burns Knoll, Utah (1971)**WT Well Beach**SE-facing beach ridge
79	113.15	38.25	1554 ± 1	3	SW 1/4 Milford, Utah, 15-min. (1958)**Lick Canyon V-bar**NE-facing beach ridge
80	113.03	38.42	1557 ± 1	3	Milford, Utah (1958)**Milford Municipal V-bar**NE-facing beach ridge
81	113.08	38.55	1559 ± 3	1	SE 1/4 Beaver Lake Mts., Utah, 15-min. (1960)**Copper Mtn Mine Cove**NE-facing beach ridge
82	112.85	38.88	1571 ± 1	1	Borden, Utah (1973)**Bloom SW Tombolo**SE-trending tombolo
83	112.85	39.06	1576 ± 2	1	Neels, Utah (1971)**Cricket Mountains NE Cove**SE-facing beach ridge
84	113.06	38.87	1570 ± 2	1	Headlight Mtn., Utah (1972)**Petes Knoll NE Cove**SW-facing beach ridge
85	113.19	38.66	1562 ± 3	1	NW 1/4 Beaver Lake Mts., Utah, 15-min. (1960)**Iron Mine Pass NW Beach**N-facing beach ridge
86	113.33	38.57	1559 ± 3	1	SE 1/4 Frisco Peak, Utah, 15-min. (1960)**Hill 6204 NW V-bar**W-trending cuspate barrier
87	113.44	38.43	1555 ± 3	1	NW 1/4 Frisco, Utah, 15-min. (1959)**Quartz Creek Beach**NE-facing beach ridge
88	113.24	39.14	1571 ± 1	1	Long Ridge Reservoir, Utah (1972)**Miller Canyon V-bar**NE-facing beach ridge
89	113.07	39.19	1570 ± 1	1	Long Ridge, Utah (1972)**Long Ridge S Tombolo**S-trending tombolo
90	113.17	39.30	1576 ± 1	1	Whirlwind Valley SW, Utah (1972)**Coyote Knolls SE V-bar**E-trending cuspate barrier
91	113.05	39.39	1579 ± 2	1	Little Drum Pass, Utah (1972)**Dennison-Whalen Cove**SW-facing beach ridge
92	112.98	39.59	1583 ± 2	1	Drum Mts. Well, Utah (1971)**Hill 5251 SW Beach**NE-facing beach ridge
93	113.04	39.71	1588 ± 3	1	NE 1/4 Topaz Mtn., Utah, 15-min. (1953)**Antelope Ridge NE Cove**NE-facing beach ridge

TABLE 1A.—Bonneville shoreline altitudes—Continued

Circle no.	W. long. (deg.)	N. lat. (deg.)	Altitude ± error (m)	Method†	7.5-min. quad.**Locality name**Geomorphic setting
94	112.97	39.81	1592 ± 2	1	Keg Pass, Utah (1971)**Flint Spring SW Cove**N-facing beach ridge
95	113.10	39.86	1591 ± 3	1	Dugway Pass, Utah (1953)**Dugway Pass NW Bay**SE-trending spitlet
96	113.19	39.55	1583 ± 3	1	SW 1/4 Topaz Mtn., Utah, 15-min. (1953)**Dry Lake Creek Spit**SW-trending spit
97	113.39	39.58	1583 ± 2	1	Sand Pass, Utah (1967)**Sand Pass SE Cove**NE-facing beach ridge
98	113.40	39.31	1570 ± 3	1	Swasey Peak SW, Utah (1972)**Howell Peak W Cove**W-facing beach ridge
99	113.53	39.08	1564 ± 3	1	SE 1/4 Conger Mountain, Utah, 15-min. (1960)**King Cove**N-facing beach ridge
100	113.63	38.32	1567 ± 3	1	SW 1/4 Cowboy Pass, Utah, 15-min. (1959)**Camp Canyon V-bar**NE-trending cuspate barrier
101	113.63	39.57	1576 ± 3	1	SW 1/4 Granite Mountain, Utah, 15-min. (1960)**Granite Mountain SE Bay**S-facing beach ridge
102	113.48	39.67	1583 ± 1	1	Sand Pass NW, Utah (1967)**Fish Springs Range SW V-bar**W-trending cuspate barrier
103	113.47	39.82	1591 ± 1	1	Fish Springs SW, Utah (1967)**Cactus Mine SE Cove**NW-facing beach ridge
104	113.73	39.64	1579 ± 3	1	NW 1/4 Granite Mountain, Utah, 15-min. (1960)**Smelter Knolls E Beach**N-facing beach ridge
105	113.82	39.27	1564 ± 3	1	SE 1/4 Gandy, Utah, 15-min. (1960)**North Knoll Spring E V-bar**NW-trending cuspate barrier
106	113.92	39.09	1562 ± 3	1	SW 1/4 Conger Range, Utah, 15-min. (1960)**Eskdale SE V-bar**W-trending cuspate barrier
107	113.83	38.98	1560 ± 2	2	NE 1/4 Burbank Hills, Utah, 15-min. (1960)**Ceuar Beach**N-facing beach ridge
108	114.00	39.00	1557 ± 2	2	NW 1/4 Burbank Hills, Utah, 15-min. (1960)**Southern Snake Valley**NE-facing beach ridge
109	114.02	39.20	1560 ± 5	2	NE 1/4 Baker, Nev.-Utah, 15-min. (not published)**Hendrys Creek SE V-bar**E-trending cuspate barrier
110	113.50	39.47	1565 ± 1	2	NW 1/4 Gandy, Utah, 15-min. (1960)**Gandy NW V-bar**E-trending cuspate barrier
111	113.81	39.77	1582 ± 3	1	Indian Farm Creek, Utah (1972)**Granite Creek V-bar**SE-trending cuspate barrier
112	113.78	39.94	1588 ± 1	1	Goshute Canyon, Utah (1972)**Reilly Canyon V-bar**SE-trending cuspate barrier
113	113.78	40.04	1590 ± 3	1	Clifton, Utah (1973)**Canyon Sta Beach**SE-facing beach ridge
114	113.92	40.28	1592 ± 2	1	Elephant Knoll, Utah (1972)**Red Mountain NE Tombolo**SE-trending tombolo

TABLE 1A.—Bonneville shoreline altitudes—Continued

Circle no.	W. long. (deg.)	N. lat. (deg.)	Altitude ± error (m)	Method†	7.5-min. quad.**Locality name**Geomorphic setting
115	113.97	40.21	1590 ± 3	1	Ochre Mountain, Utah (1973)**Bar Creek Tombolo**N-facing beach ridge
116	114.13	40.32	1583 ± 1	1	White Horse Pass, Nev. (1972)**Ferber Wash N Cove**NE-facing beach ridge
117	114.13	40.48	1588 ± 1	1	Ferguson Mtn., Nev. (1972)**Ferguson Mtn NE Cove**NE-facing beach ridge
118	114.20	40.76	1585 ± 1	1	Pilot, Nev. (1971)**Playa Res V-bar**E-trending cuspate barrier
119	114.10	40.77	1589 ± 3	1	Leppy Peak, Nev.-Utah (1971)**Leppy Peak SW V-bar**SW-trending cuspate barrier
120	113.84	40.93	1600 ± 3	1	Graham Peak, Utah (1971)**Campbell Peak SW Cove**SW-facing beach ridge
121	113.77	41.10	1600 ± 2	1	Crater Island, Utah (1970)**Crater Island N Stacks**upper limit of erosional trimline
122	113.39	41.06	1615 ± 3	1	Terrace Mtn 3 SW, Utah (advance)**Peak 6048 W Cove**NW-facing beach ridge
123	113.40	41.13	1615 ± 3	1	Terrace Mtn 3 NW, Utah (advance)**Peak 5902 S Cove**S-facing beach ridge
124	114.26	40.93	1580 ± 3	1	Silver Zone Pass, Nev. (1971)**Clifside NE V-bar**E-trending cuspate barrier
125	114.20	41.08	1580 ± 2	1	Pilot Peak SW, Nev. (1967)**Castle Park Well SW V-bar**E-trending cuspate barrier
126	114.26	41.20	1575 ± 2	2	Loray, Nev. (1967)**Loray Wash W Cove**NE-facing beach ridge
127	114.24	41.28	1574 ± 2	1	Montello, Nev. (1967)**Hoppie Creek V-bar**SE-trending cuspate barrier
128	114.20	41.38	1574 ± 2	1	Twelvemile Ranch, Nev. (1967)**Gamble Ranch NW Spit**N-trending spit
129	114.12	41.20	1580 ± 2	1	Patterson Pass, Nev.-Utah (1967)**Pilot Range W Beach**W-facing beach ridge
130	114.15	40.99	1584 ± 2	1	Leppy Peak NW, Nev. (1971)**Cummings Ranch NE V-bar**W-trending cuspate barrier
131	114.01	41.02	1591 ± 3	1	Pilot Peak, Nev.-Utah (1967)**Pilot Peak E Beach**SE-facing beach ridge
132	113.96	41.19	1590 ± 2	1	Crater Island NW, Utah (1967)**Birch Canyon V-bar**SE-trending cuspate barrier
133	114.01	41.33	1582 ± 2	1	Tecoma, Nev.-Utah (1967)**Rhyolite Butte SE Cove**NE-facing beach ridge
134	114.01	41.45	1579 ± 1	1	Jackson Spring, Nev.-Utah (1967)**Jackson NE Cove**SE-facing beach ridge
135	113.89	41.59	1577 ± 2	1	Toms Cabin Spring, Utah (1971)**The Buttes NE V-bar**W-trending cuspate barrier
136	113.79	41.48	1589 ± 1	1	Lucin NE, Utah (1967)**Grouse Creek Mountains S Cove**S-facing beach ridge
137	113.48	41.46	1600 ± 2	1	Terrace Mtn 2 NW, Utah (advance)**Terrace Mountain Stack**upper limit of erosional trimline
138	113.62	41.61	1585 ± 2	1	Prohibition Spring, Utah (1971)**Rosebud Field Station SW Beach**SE-facing beach ridge

TABLE 1A.—Bonneville shoreline altitudes—Continued

Circle no.	W. long. (deg.)	N. lat. (deg.)	Altitude ± error (m)	Method†	7.5-min. quad.**Locality name**Geomorphic setting
139	113.53	41.68	1585 ± 1	1	Warm Hills, Utah (1971)**Muddy Creek NE Cove**SW-facing beach ridge
140	113.43	41.63	1591 ± 2	1	Runswick Wash, Utah (1971)**Airplane Hill E Cove**S-facing beach ridge
141	113.34	41.61	1598 ± 2	1	Matlin, Utah (1971)**Matlin Basin NE Bayhead Beach**S-facing beach ridge
142	113.16	41.51	1605 ± 1	2	Hogup Bar, Utah (1969)**Storage Bin Beach**NW-facing beach ridge
143	113.19	41.39	1613 ± 1	1	Terrace Mtn 1 NW, Utah (advance)**Hogup Mountains S Cove**S-facing beach ridge
144	113.08	41.45	1610 ± 1	2	Dolphin Island West, Utah (1969)**The Fingerpoint V-bar**NE-facing beach ridge
145	113.14	41.59	1600 ± 2	1	Hogup Bar, Utah (1969)**Radio Facility SE Island**S-trending spit
146	113.24	41.69	1592 ± 2	1	Peplin Flats, Utah (1969)**Baker Mountain SE Cove**S-facing beach ridge
147	113.47	41.74	1581 ± 2	1	Runswick Wash, Utah (1971)**Dove Creek Cove**E-facing beach ridge
148	113.29	41.78	1587 ± 3	1	SE 1/4 Park Valley, Utah-Idaho, 15-min. (1959)**Chicken Ridge S Beach**SE-facing beach ridge
149	113.18	41.86	1586 ± 3	1	SW 1/4 Kelton Pass, Utah-Idaho, 15-min. (1959)**Black Butte W Cove**SE-facing beach ridge
150	113.15	41.96	1577 ± 3	1	NW 1/4 Kelton Pass, Utah-Idaho, 15-min. (1959)**Cedar Creek Tombolo**SE-facing beach ridge
151	112.99	42.09	1572 ± 1	1	Black Pine, Idaho (1973)**Black Pine NW V-bar**NE-trending arcuate barrier
152	112.96	42.16	1565 ± 3	1	Juniper, Idaho (1973)**Juniper N Spit**W-trending spit
153	112.77	41.99	1580 ± 1	1	Monument Peak NE, Utah-Idaho (1968)**Stone Hills S Tombolo**SE-trending tombolo
154	112.77	42.08	1574 ± 2	1	The Cove, Idaho (1973)**Sublett Range SE Tombolo**SE-trending tombolo
155	112.70	42.15	1571 ± 2	1	Holbrook, Idaho (1973)**Holbrook SW Cove**S- and E-facing beach ridges
156	112.61	42.23	1564 ± 3	2	Sheep Creek Spring, Idaho (1973)**Sheep Creek V-bar**NE-trending cuspate barrier
157	112.61	42.08	1572 ± 3	1	Co-op Spring, Idaho-Utah (1973)**North Hansel Mountains NW Beach**NW-facing beach ridge
158	112.62	41.98	1577 ± 2	1	Rattlesnake Pass, Utah (1968)**Hill 5290 W Cove**NW-facing beach ridge
159	112.70	41.84	1587 ± 2	1	Salt Wells, Utah (1968)**Hansel Mountains S Cove**SW-facing beach ridge
160	112.81	41.77	1595 ± 1	1	Monument Peak, Utah (1968)**Monument Peak SW Tombolo**SW-trending tombolo
161	112.58	41.81	1588 ± 2	2	Bulls Pass, Utah (1968)**Bulls Pass N Cove**N-facing beach ridge

TABLE 1A.—Bonneville shoreline altitudes—Continued

Circle no.	W. long. (deg.)	N. lat. (deg.)	Altitude ± error (m)	Method†	7.5-min. quad.**Locality name**Geomorphic setting
162	112.59	41.69	1600 ± 2	2	Sunset Pass, Utah (1968)**Sunset Pass Beach**NW-facing beach ridge
163	112.60	41.60	1605 ± 2	1	Golden Spike Monument, Utah (1967)**Kings Pass NE Cove**S-facing beach ridge
164	112.47	41.26	1614 ± 2	2	Pokes Point, Utah (1968)**Lead Mountain W Cove**SW-facing beach ridge
165	112.41	41.31	1610 ± 2	1	Pokes Point, Utah (1968)**Promontory NE Beach**NE-facing beach ridge
166	112.47	41.45	1606 ± 2	1	East Promontory, Utah (1967)**Peak 6549 NE Cove**SE-facing beach ridge
167	112.51	41.76	1590 ± 2	1	Bulls Pass, Utah (1968)**Howell SW V-bar**NE-trending cuspate barrier
168	112.44	41.95	1576 ± 1	2	Ridgedale Pass, Utah (1968)**Ridgedale Pass S Cove**S-facing beach ridge
169	112.35	41.67	1593 ± 2	1	Thatcher Mountain, Utah (1972)**Thatcher Mountain SW Cove**SE-facing beach ridge
170	112.25	41.60	1591 ± 2	1	Public Shooting Grounds, Utah (1972)**Little Mountain W Cove**W-facing beach ridge
171	112.27	41.79	1582 ± 3	1	Blind Springs, Utah (1968)**Blind Springs NE Headland**S-facing beach ridge
172	112.21	41.76	1582 ± 2	1	Riverside, Utah (1964)**West Hills SE Cove**SE-facing beach ridge
173	112.35	42.27	1559 ± 3	2	Elkhorn Peak, Idaho (1968)**Monson Canyon Spit**NW-trending spit
174	112.21	42.24	1559 ± 3	1	Malad City East, Idaho (1968)**Hill 5144 NE Beach**N-facing beach ridge
175	112.20	42.07	1568 ± 3	1	Henderson Creek, Idaho-Utah (1968)**Henderson Creek NW Headland**upper limit of SW-facing erosional platform
176	112.16	41.92	1572 ± 2	1	Portage, Utah-Idaho (1964)**Little Canyon NW Spit**NW-trending spit
177	112.05	41.85	1575 ± 2	2	Cutler Dam, Utah (1964)**Long Divide Cove**S-facing beach ridge
178	112.06	41.92	1570 ± 2	1	Clarkston, Utah-Idaho (1964)**Clarkston W Spit**N-trending spit
179	112.01	42.06	1567 ± 3	1	Weston Canyon, Idaho (1968)**Weston Creek NE Cove**SW-facing beach ridge
180	111.96	42.18	1557 ± 2	2	Banida, Idaho (1969)**Little Mountain NW Tombolo**W-trending tombolo
181	112.02	42.18	1561 ± 3	2	Clifton, Idaho (1968)**Clifton Cemetery Spit**NW-trending spit

†Methods: 1, aerial photo and map interpretation; 2, interpretation augmented by field reconnaissance; and 3, interpretation augmented by spirit leveling

TABLE 1B.—Provo shoreline altitudes

Square no.	W. long. (deg.)	N. lat. (deg.)	Altitude ± error (m)	Method†	7.5-min. quad.**Locality name**Geomorphic setting
1	112.05	42.35	1444 ± 2	3	Oxford, Idaho (1968)**Red Rock Pass Threshold**paleochannel buried by Holocene alluvial fans
2	111.99	42.29	1441 ± 1	3	Swan Lake, Idaho (1969)**Swan Lake Paleochannel**paleochannel bed-load deposits buried by Holocene fill
3	111.94	42.14	1447 ± 1	2	Banida, Idaho (1969)**Little Mountain SE Beaches**E-facing beach ridges
4	111.78	42.06	1449 ± 3	1	Franklin, Idaho (1969)**Cub River S Bench**SW-facing beach ridge
5	111.77	42.03	1450 ± 3	1	Franklin, Idaho (1969)**Maple Creek Cove**W-facing beach ridge
6	111.80	41.94	1455 ± 3	2	Richmond, Utah-Idaho (1964)**Richmond NE Beach**SW-facing beach ridge
7	111.81	41.69	1460 ± 3	2	Logan, Utah (1961)**Millville NE Beach**SW-facing beach ridge
8	111.91	41.60	1466 ± 2	2	Mount Pisgah, Utah (1955)**Mount Sterling E Bayhead Beach**N-facing beach ridge
9	111.95	41.11	1466 ± 1	2	Kaysville, Utah (1955)**Hill Field Road Shoreline**upper limit of Weber River deltaic platform
10	111.85	40.55	1459 ± 1	2	Draper, Utah (1963)**Draper NE Spit**SW-trending spit
11	111.92	40.45	1464 ± 2	2	Jordan Narrows, Utah (1951)**Point of the Mountain SW Spit**SW-trending spit
12	111.71	40.34	1444 ± 1	2	Orem, Utah (1948)**Pleasant Grove SE Beach**NW-facing beach ridge
13	111.70	40.03	1446 ± 2	2	Spanish Fork, Utah (1948)**Rocky Ridge E Cove**N-facing beach ridge
14	111.81	40.13	1454 ± 2	1	Lincoln Point, Utah (1950)**Lincoln Point S Cove**SE-facing beach ridge
15	111.97	39.89	1448 ± 2	1	Goshen, Utah (1979)**Goshen Valley SW Bayhead Beach**NE-facing beach ridge
16	111.99	40.14	1457 ± 2	1	Soldiers Pass, Utah (1950)**Cat Hill NE Cove**NE-facing beach ridge
17	111.95	40.36	1460 ± 1	2	Saratoga Springs, Utah (1951)**Tickville Gulch**SE-facing beach ridge
18	112.00	40.55	1467 ± 1	3	Midvale, Utah (1963)**South Jordan W V-bar**E-trending cuspate barrier
19	112.02	40.64	1471 ± 1	3	Magna, Utah (1952)**Kearns SW V-bar**E-trending cuspate barrier
20	112.21	41.02	1486 ± 2	2	Antelope Island North, Utah (1972)**Camera Flats NW Stack**upper limit of erosional platform
21	112.37	40.49	1481 ± 2	3	Stockton, Utah (1980)**Tooele Valley Bayhead Beach**NW-facing beach ridge
22	112.51	40.83	1497 ± 2	1	Corral Canyon, Utah (1968)**Castle Rock SW Cove**SW-facing beach ridge

TABLE 1B.—Provo shoreline altitudes—Continued

Square no.	W. long. (deg.)	N. lat. (deg.)	Altitude ± error (m)	Method†	7.5-min. quad.**Locality name**Geomorphic setting
23	112.71	40.38	1483 ± 3	1	NW 1/4 Deseret Peak, Utah, 15-min. (1955)**Indian Reservation V-bar**SW-trending cuspate foreland
24	112.71	40.22	1480 ± 1	2	Davis Knolls, Utah (1955)**Easy Area E Beach**NW-facing beach ridge
25	112.90	40.47	1495 ± 2	1	Tabbys Peak, Utah (1955)**Black Knoll N Cove**NE-facing beach ridge
26	112.90	40.60	1494 ± 3	1	Quincy Spring, Utah (1973)**Peak 5420 SW Cove**SE-facing beach ridge
27	112.87	40.78	1500 ± 2	1	Delle, Utah (1973)**Peak 6173 NE Cove**NE-facing beach ridge
28	112.81	40.83	1500 ± 2	1	Delle, Utah (1973)**Peak 5924 SE Cove**S-facing beach ridge
29	112.89	41.08	1503 ± 2	2	Strong Knob 3 SW, Utah (advance)**Pass 5197 NW Shoreline**upper limit of SW-facing depositional platform
30	112.90	41.14	1501 ± 2	1	Strongs Knob, Utah (1969)**Sedal Pass NW Beach**SW-facing beach ridge
31	112.87	41.17	1500 ± 2	1	Lakeside, Utah (1969)**Scad Ridge W V-bar**SW-facing beach ridge
32	113.13	40.92	1500 ± 1	1	Finger Ridge, Utah (1973)**Finger Ridge NE Stack**upper limit of erosional platform
33	113.02	40.79	1501 ± 2	1	Ripple Valley, Utah (1973)**Grassy Mountains SE Cove**NE-facing beach ridge
34	113.04	40.66	1497 ± 2	1	Aragonite, Utah (1973)**Hickman NE Cove**NE-facing beach ridge
35	113.30	40.48	1495 ± 2	1	Wildcat Mtn., Utah (1954)**Wildcat Mountain NW Coves**NW-facing beach ridges
36	112.76	40.10	1479 ± 1	2	Simpson Springs, Utah (1955)**Government Creek SW Beach**NW-facing beach ridge
37	112.70	39.79	1467 ± 1	2	Erickson Wash SW, Utah (1971)**Erickson Wash V-bar**W-trending cuspate barrier
38	112.49	39.68	1462 ± 2	2	NW 1/4 Lynndyl, Utah, 15-min. (1962)**Road Junction 4784 NE Shoreline**SW-facing berm
39	112.38	39.40	1457 ± 2	1	NW 1/4 Oak City, Utah, 15-min. (1951)**Oak City NW Beach**SW-facing beach ridge
40	112.54	39.10	1450 ± 1	2	Pavant Butte South, Utah (1971)**Pavant Butte S Beaches**SW- and E-facing beach ridges
41	112.38	39.06	1455 ± 1	1	The Sink, Utah (1962)**Bald Mountain SE Cove**SW-facing beach ridge
42	112.44	38.88	1457 ± 1	2	Meadow, Utah (1960)**Meadow SW Beach**NW-facing beach ridge
43	112.80	38.95	1459 ± 2	2	Borden, Utah (1973)**Borden S Beaches**NE-facing beach ridges
44	112.87	39.09	1464 ± 2	1	Neels, Utah (1971)**Headquarters Reservoir SW Cove**NE-facing beach ridge
45	112.74	39.23	1467 ± 1	1	Sunstone Knoll, Utah (1971)**Great Stone Face E Beach**E-facing beach ridge

TABLE 1B.—Provo shoreline altitudes—Continued

Square no.	W. long. (deg.)	N. lat. (deg.)	Altitude ± error (m)	Method†	7.5-min. quad.**Locality name**Geomorphic setting
46	113.04	38.98	1460 ± 2	1	Sevier Lake NE, Utah (1972)**Fillmore Wash NW V-bar**NW-trending cuspate barrier
47	113.09	38.85	1458 ± 2	1	Headlight Mtn., Utah (1972)**Dorthy Draw W V-bar**NW-trending cuspate barrier
48	113.28	38.67	1458 ± 3	1	NE 1/4 Frisco Peak, Utah, 15-min. (1960)**Lakeview Reservoir 2 V-bar**W-trending cuspate barrier
49	113.38	38.53	1452 ± 2	1	SW 1/4 Frisco Peak, Utah, 15-min. (1960)**Wah Wah Valley S Bayhead Beach**NE-facing beach ridge
50	113.25	39.05	1459 ± 3	2	SE 1/4 Notch Peak, Utah, 15-min. (1960)**Skull Rock Pass NE Beach**E-facing beach ridge
51	113.13	39.16	1461 ± 1	1	Long Ridge Reservoir, Utah (1972)**Long Ridge SW Bay**S-facing beach ridge
52	113.03	39.20	1462 ± 1	1	Long Ridge, Utah (1972)**Long Ridge E V-bar**E-trending cuspate barrier
53	112.87	39.43	1465 ± 1	2	Smelter Knolls East, Utah (1971)**Smelter Knolls W Tombolo**E-trending tombolo
54	112.90	39.63	1470 ± 1	1	Picture Rock Hills, Utah (1971)**Crater Bench W Tombolo**SE-facing beach ridge
55	112.89	39.93	1477 ± 3	1	Table Mountain, Utah (1955)**Table Mtn S Coves**SW- and NE-facing beach ridges
56	113.03	39.84	1475 ± 2	1	Dugway Pass, Utah (1953)**Dugway Valley SW Bayhead Beach**NE-facing beach ridge
57	113.14	39.88	1476 ± 3	2	Dugway Range NW, Utah (1953)**Dugway Pass NW Beach**NW-facing beach ridge
58	113.26	39.61	1471 ± 2	2	Sand Pass SE, Utah (1967)**Fish Springs Flat SE Bayhead Beach**N-facing beach ridge
59	113.47	39.15	1460 ± 3	1	NW 1/4 Notch Peak, Utah, 15-min. (1960)**Notch Peak W V-bar**SW-trending cuspate barrier
60	113.38	39.02	1458 ± 2	2	SW 1/4 Notch Peak, Utah, 15-min. (1960)**Tule Valley SE Bayhead Beach**NW-facing beach ridge
61	113.55	39.28	1466 ± 3	1	SE 1/4 Cowboy Pass, Utah, 15-min. (1959)**Chalk Knolls W Tombolo**E-trending tombolo
62	113.62	39.43	1460 ± 3	2	NE 1/4 Cowboy Pass, Utah, 15-min. (1959)**Coyote Knolls SW V-bar**SE-facing beach ridge
63	113.52	39.55	1470 ± 3	2	SE 1/4 Granite Mountain, Utah, 15-min. (1960)**Middle Range SE Tombolo**E-trending tombolo
64	113.49	39.64	1470 ± 3	2	Sand Pass NW, Utah (1967)**Roadside Reservoir NW Bay**SE-facing beach ridge
65	113.54	39.74	1475 ± 2	1	NE 1/4 Granite Mountain, Utah, 15-min. (1960)**Fish Wash S Cove**NE-facing beach ridge

TABLE 1B.—Provo shoreline altitudes—Continued

Square no.	W. long. (deg.)	N. lat. (deg.)	Altitude ± error (m)	Method†	7.5-min. quad.**Locality name**Geomorphic setting
66	113.80	39.68	1462 ± 2	2	NE 1/4 Trout Creek, Utah, 15-min. (1961)**Trout Creek SE V-bar**NW-trending cuspate barrier
67	113.74	39.78	1464 ± 1	1	Mud Lake Reservoir, Utah (1972)**Red Cedar Creek V-bar**SE-trending cuspate barrier
68	113.74	40.00	1474 ± 1	1	Callao, Utah (1972)**Redden Springs NW V-bar**E-trending cuspate barrier
69	113.76	40.17	1475 ± 3	1	Gold Hill, Utah (1973)**Gold Hill E Headland**E-trending cuspate foreland
70	113.87	40.25	1477 ± 1	1	Elephant Knoll SE, Utah (1972)**Wilson Hill W Beach**NE-facing beach ridge
71	114.06	40.33	1477 ± 2	2	Utah Peak, Nev.-Utah (1972)**Ferber Wash Beach**NE-facing beach ridge
72	114.11	40.49	1476 ± 2	1	Ferguson Flat, Nev.-Utah (1972)**Hill 4875 NW Beach**NE-facing beach ridge
73	114.13	40.77	1474 ± 2	2	Pilot, Nev. (1971)**Western Pacific Tombolo**NE-trending double tombolo
74	114.01	40.80	1480 ± 3	2	Leppy Peak, Nev.-Utah (1971)**Leppy Pass Tombolo**NE-trending double tombolo
75	113.64	40.91	1487 ± 3	1	Floating Island, Utah (1973)**Floating Island Subsummit Platform**upper limit of erosional and depositional platform
76	114.23	40.89	1465 ± 2	1	Leppy Peak NW, Nev. (1971)**Cliffside Well SE V-bar**E-trending cuspate barrier
77	114.18	41.01	1469 ± 2	1	Pilot Peak SW, Nev. (1967)**Pilot Mtn Ranch SW V-bar**W-trending cuspate barrier
78	113.99	41.01	1479 ± 2	1	Crater Island SW, Utah (1967)**Pilot Peak E V-bar**SE-trending cuspate barrier
79	113.94	41.18	1476 ± 1	1	Crater Island NW, Utah (1967)**Birch Canyon SE V-bar**SE-trending cuspate foreland
80	113.98	41.34	1471 ± 2	2	Lucin, Utah (1967)**Gartney Mountain SW Tombolo**NE-trending double tombolo
81	113.96	41.44	1469 ± 1	2	Lucin NW, Utah (1967)**Grouse Creek Delta**SE-facing beach ridge on cuspate delta
82	113.81	41.45	1472 ± 1	1	Lucin NE, Utah (1967)**Grouse Creek Mountains S Cove**SE-facing beach ridge
83	113.63	41.49	1477 ± 3	1	Lucin 1 NW, Utah (advance)**Section 24 Tombolo**NE-trending tombolo
84	113.48	41.48	1483 ± 2	1	Terrace Mtn 2 NW, Utah (advance)**Terrace Mountain NE Spit**NE-trending spit
85	113.49	41.57	1477 ± 1	1	Red Dome, Utah (1971)**Red Dome NW Bay**SW-facing beach ridge
86	113.33	41.58	1482 ± 2	1	Matlin, Utah (1971)**Matlin Basin Beach**S-facing beach ridge
87	113.27	41.67	1477 ± 2	1	Russian Knoll, Utah (1971)**Baker Mtn SW V-bar**SW-trending cuspate foreland
88	113.17	41.59	1483 ± 1	2	Hogup Bar, Utah (1969)**Radio Facility SW Cove**SW-facing beach ridge
89	113.25	41.39	1490 ± 3	1	Terrace Mtn 1 NW, Utah (advance)**Hogup Mountains SW Cove**SW-facing beach ridge

TABLE 1B.—Provo shoreline altitudes—Continued

Square no.	W. long. (deg.)	N. lat. (deg.)	Altitude ± error (m)	Method†	7.5-min. quad.**Locality name**Geomorphic setting
90	113.07	41.44	1490 ± 2	2	Dolphin Island West, Utah (1969)**The Fingerpoint V-bar**SE-trending cuspate foreland
91	113.19	41.69	1477 ± 2	1	Peplin Flats, Utah (1969)**Peplin Mtn NW Beach**NE-facing beach ridge
92	113.16	41.83	1469 ± 3	2	SW 1/4 Kelton Pass, Utah-Idaho, 15-min. (1959)**Black Butte S Tombolo**E-trending tombolo
93	113.01	41.85	1472 ± 3	1	SE 1/4 Kelton Pass, Utah-Idaho, 15-min. (1959)**Wildcat Hills E Cove**SE-facing beach ridge
94	112.92	42.08	1461 ± 1	2	Black Pine, Idaho (1973)**Black Pine E Bayhead Beach**S-facing beach ridge
95	112.76	41.98	1468 ± 1	1	Monument Peak NE, Utah-Idaho (1968)**Shale SE Cove**SW-facing beach ridge
96	112.67	42.14	1459 ± 1	1	Holbrook, Idaho (1973)**Holbrook SW Beach**SE-facing beach ridge
97	112.84	41.73	1479 ± 1	1	Monument Point, Utah (1968)**Monument Point N V-bar**SW-trending cuspate barrier
98	112.72	41.82	1472 ± 1	1	Salt Wells, Utah (1968)**Hansel Mountains S Cove**S-facing beach ridge
99	112.60	41.78	1475 ± 1	1	Bulls Pass, Utah (1968)**Bulls Pass SW Cove**SW-facing beach ridge
100	112.66	41.65	1487 ± 1	2	Lake Ridge, Utah (1968)**Lake Ridge SE Cove**SW-facing beach ridge
101	112.58	41.59	1487 ± 1	2	Golden Spike Monument, Utah (1967)**Promontory Hollow Bayhead Beach**SW-facing beach ridge
102	112.46	41.28	1495 ± 2	2	Pokes Point, Utah (1968)**Little Valley Gravel Pit**remnant of SW-facing beach ridge
103	112.51	41.63	1483 ± 2	2	Sunset Pass, Utah (1968)**Golden Spike NE Cove**SE-facing beach ridge
104	112.45	41.82	1469 ± 2	2	Howell, Utah (1968)**Blue Ridge V-bar**remnant of SW-trending cuspate barrier
105	112.23	41.61	1473 ± 2	1	Bear River City, Utah (1955)**Hill 5109 NW Cove**N-facing beach ridge and SE-trending spit
106	112.30	41.74	1472 ± 2	1	Thatcher Mountain, Utah (1972)**Bothwell NW V-bar**SE-trending cuspate foreland
107	112.20	41.82	1464 ± 2	1	Riverside, Utah (1964)**Fielding W Cove**E-facing beach ridge
108	112.27	41.98	1459 ± 3	1	Limekiln Knoll, Utah (1968)**Portage Canyon Beach**NE-facing beach ridge
109	112.38	42.14	1452 ± 3	2	Ireland Springs, Idaho (1968)**Big Hollow Cove**E-facing beach ridge
110	111.98	41.92	1460 ± 1	2	Trenton, Utah-Idaho (1964)**Pullum Hollow Beach**E-facing beach ridge

TABLE 1B.—Provo shoreline altitudes—Continued

Square no.	W. long. (deg.)	N. lat. (deg.)	Altitude ± error (m)	Method†	7.5-min. quad.**Locality name**Geomorphic setting
111	111.99	42.05	1455 ± 1	1	Weston, Idaho (1969)**Weston NW Cove**SE-facing beach ridge
112	111.99	42.09	1454 ± 1	1	Weston, Idaho (1969)**Dayton S Beach**E-facing beach ridge

†Methods: 1, aerial photo and map interpretation; 2, interpretation augmented by field reconnaissance; and 3, interpretation augmented by spirit leveling

TABLE 1C.—Gilbert shoreline altitudes

Triangle no.	W. long. (deg.)	N. lat. (deg.)	Altitude ± error (m)	Method†	7.5-min. quad.**Locality name**Geomorphic setting
1	112.20	41.60	1297 ± 1	1	Bear River City, Utah (1972)**Little Mountain E Shore**upper limit of dissected deltaic plain
2	112.10	41.14	1294 ± 1	2	Roy, Utah (1955)**Hooper Canal Beach**NW-facing beach ridge
3	112.04	41.06	1294 ± 1	3	Clearfield, Utah (1972)**Bluff Road Shore**SW-facing erosional shoreline
4	111.93	40.99	1293 ± 1	2	Farmington, Utah (1952)**Haight Creek Bluff**SW-facing erosional shoreline
5	112.06	40.71	1296 ± 1	3	Magna, Utah (1952)**Magna Spit**E-trending spit
6	112.17	40.96	1300 ± 2	1	Antelope Island, Utah (1972)**Sea Gull Point V-bar**NE-trending cuspate barrier
7	112.24	41.03	1305 ± 1	3	Antelope Island North, Utah (1972)**White Rock Bay**SW-facing beach ridge
8	112.35	40.63	1299 ± 1	2	Mills Junction, Utah (1972)**Mills Junction Spit**SW-trending spit
9	112.52	40.78	1305 ± 2	2	Corral Canyon, Utah (1968)**Tabbys Canyon V-bar**SW-trending cuspate foreland
10	112.56	41.01	1309 ± 1	1	Carrington, Island, Utah (1968)**Carrington Island SE Spit**SE-trending spit
11	112.74	40.80	1308 ± 1	3	Poverty Point, Utah (1968)**Poverty Point V-bar**SE-trending cuspate barrier
12	112.85	41.07	1311 ± 2	1	Deardens Knoll, Utah (1968)**Hill 4718 N Cove**NE-facing beach ridge
13	112.85	41.20	1311 ± 1	1	Lakeside, Utah (1969)**Little Valley Bayhead Beach**NE-facing beach ridge
14	112.98	41.09	1310 ± 2	1	Strong Knob 3 SW, Utah (advance)**Homestead Knoll SW Bay**N-facing beach ridge
15	113.11	41.02	1311 ± 2	1	Terrace Mtn 4 SE, Utah (advance)**Grassy Mountains NW V-bar**NW-trending cuspate foreland
16	113.18	40.85	1306 ± 1	1	Grayback Hills, Utah (1973)**Hill 4654 SW Coves**NW- and SW-facing beach ridges
17	113.13	40.72	1308 ± 1	2	Aragonite NW, Utah (1973)**Grayback Hill SE Spit**SE-trending spit
18	113.28	40.66	1306 ± 1	1	Knolls, Utah (1973)**Knolls SE Cove**NE-facing beach ridge
19	113.19	40.58	1306 ± 1	1	Aragonite SW, Utah (1973)**Hill 4426 SE Spits**three SE-trending spits
20	113.23	40.24	1306 ± 1	1	Dugway Proving Ground NW, Utah (1954)**Old River Bed Delta**upper limit of digitate distributaries
21	113.34	40.18	1305 ± 1	1	Granite Peak, Utah (1954)**Granite Peak NW Beach**NW-facing beach ridge
22	113.83	40.35	1300 ± 1	1	Elephant Knoll SE, Utah (1972)**Deep Creek N Beach**NE-facing beach ridge
23	114.03	40.48	1299 ± 1	1	Ferguson Flat, Nev.-Utah (1972)**Lead Mine Hills NE Headland**NE-facing berm

TABLE 1C.—Gilbert shoreline altitudes—Continued

Triangle no.	W. long. (deg.)	N. lat. (deg.)	Altitude ± error (m)	Method†	7.5-min. quad.**Locality name**Geomorphic setting
24	114.06	40.63	1300 ± 2	1	Wendover, Nev.-Utah (1972)**Salt SE Tombolo**E-trending tombolo
25	113.95	40.79	1297 ± 2	2	Tetzlaff Peak, Utah (1971)**Volcano Peak SE Cove**SE-facing beach ridge
26	113.65	40.94	1300 ± 1	2	Floating Island, Utah (1973)**Cobb Peak SE V-bar**SE-trending cuspate barrier
27	113.62	40.91	1302 ± 1	1	Floating Island NE, Utah (1973)**Floating Island E V-bar**SE-trending cuspate barrier
28	113.34	40.99	1306 ± 1	1	Knolls 2 NE, Utah (1973)**Newfoundland Mountains SE V-bar**SE-trending cuspate barrier
29	113.42	41.10	1304 ± 1	1	Terrace Mtn 3 SW, Utah (advance)**Newfoundland Mountains W V-bar**W-trending cuspate foreland
30	113.74	41.06	1302 ± 1	1	Lucin 4 SW, Utah (advance)**Crater Island SE Tombolo**SE-trending double tombolo
31	113.84	41.15	1299 ± 1	1	Lemay Island, Utah (1967)**Lemay Island SE Spit**NE-trending spit
32	113.71	41.28	1302 ± 1	1	Lucin 1 SW, Utah (advance)**Little Pigeon Mountains NE Beach**E-facing beach ridge
33	113.41	41.46	1299 ± 1	1	Terrace Mtn 2 NW, Utah (advance)**Terrace Mountain SE Spit**NE-trending spit
34	113.27	41.37	1303 ± 1	2	Terrace Mtn 2 SE, Utah (advance)**Crescent Spring Cove**SW-facing beach ridge
35	113.31	41.27	1304 ± 1	1	Terrace Mtn 2 SE, Utah (advance)**Newfoundland Mountains NE V-bar**E-trending cuspate barrier
36	113.13	41.28	1306 ± 1	2	Terrace Mtn 1 SW, Utah (advance)**Hogup NW Beach**SW-facing beach ridge
37	113.08	41.21	1309 ± 1	1	Hogup Ridge South, Utah (1969)**Hogup Ridge S V-bar**SE-trending cuspate barrier
38	113.04	41.40	1304 ± 1	2	Dolphin Island West, Utah (1969)**The Fingerpoint W Bay**S-facing beach ridge
39	113.15	41.67	1300 ± 1	2	Peplin Flats, Utah (1969)**Peplin Flats NE Beach**NE-facing beach ridge
40	113.12	41.79	1304 ± 2	2	SE 1/4 Kelton Pass, Utah-Idaho, 15-min. (1959)**Bar F Ranch Beach**SE-facing beach ridge
41	112.88	41.74	1299 ± 1	2	Locomotive Springs, Utah (1969)**Locomotive Springs NE Spit**NW-trending spit
42	112.69	41.71	1300 ± 1	2	Lake Ridge, Utah (1968)**Lake Ridge N Beach**NW-facing beach ridge
43	112.73	41.62	1306 ± 1	2	Rozel, Utah (1968)**Black Mountain NE Cove**N-facing beach ridge

TABLE 1C.—Gilbert shoreline altitudes—Continued

Triangle no.	W. long. (deg.)	N. lat. (deg.)	Altitude ± error (m)	Method†	7.5-min. quad.**Locality name**Geomorphic setting
44	112.64	41.51	1306 ± 1	2	Rozel, Utah (1968)**Rozel Flat Beach**S-facing beach ridge
45	112.40	41.23	1305 ± 2	2	Promontory Point, Utah (1968)**Promontory Point NE V-bar**E-trending cuspate foreland
46	112.38	41.28	1305 ± 2	2	Pokes Point, Utah (1968)**Pokes Point V-bar**E-trending cuspate barrier
47	112.48	41.61	1301 ± 2	1	Thatcher Mtn. SW, Utah (1966)**Blue Creek Ponds SW Beach**SE-facing beach ridge
48	112.29	41.63	1296 ± 1	1	Thatcher Mountain, Utah (1972)**Penrose S Cove**SE-facing berms

†Methods: 1, aerial photo and map interpretation; 2, interpretation augmented by field reconnaissance; and 3, interpretation augmented by spirit leveling

TABLE 1D.—Gunnison shoreline altitudes

Inverted triangle no.	W. long. (deg.)	N. lat. (deg.)	Altitude ± error (m)	Method[†]	7.5-min. quad.**Locality name**Geomorphic setting
1	112.75	39.79	1396 ± 1	2	Erickson Wash SW, Utah (1971)**Old River Bed Threshold**paleochannel partly buried by Holocene alluvial fans
2	112.72	39.55	1391 ± 1	2	Baker Hot Springs, Utah (1971)**Old River Bed**paleochannel at surface
3	112.98	39.11	1390 ± 1	2	Red Pass, Utah (1971)**Bitterweed Lake S Spit**E-trending spit
4	113.22	38.77	1390 ± 1	1	Sevier Lake SW, Utah (1972)**Sevier Lake SW V-bar**SE-trending cuspate barrier

[†]Methods: 1, aerial photo and map interpretation; 2, interpretation augmented by field reconnaissance; and 3, interpretation augmented by spirit leveling

table 16, 18 points on Bonneville shoreline), and Passey (1981, tables 1 and 2, 40 points on Bonneville and Provo shorelines).

In the initial stages of the present study, it was decided to use previous shoreline delineations and altitudes only for purposes of comparison in the concluding stages. The present study, therefore, comprises a data set that is completely independent of any previous efforts. Furthermore, the present study is based on a standardized set of procedures that have been applied consistently to the entire Lake Bonneville region by a single investigator. These procedures have been carried out in eight steps.

(1) Preliminary field reconnaissance trips to many parts of the Lake Bonneville region were conducted for the purposes of observing geomorphic and stratigraphic characteristics of major shorelines. On the basis of that reconnaissance, and of previous work with the geology of Lake Bonneville (e.g., Currey, 1980a), it was decided to map all of four major shorelines and part of a fifth, and to refrain from mapping another.

(2) Erosional and depositional segments of specified shorelines were differentiated and mapped in grease pencil on aerial photographs viewed stereoscopically. In some areas, the same shorelines were mapped on prints of more than one generation of photography. Approximately 2,500 frames obtained from EROS Data Center provided almost complete coverage of the Lake Bonneville region at 1:76,000. Over 2,000 photographs on loan from the Utah Geological and Mineral Survey provided essential, larger-scale coverage of certain areas. Another 1,000 frames from collections at the University of Utah provided helpful supplementary coverage.

(3) Interactively with stereo-viewing and photomapping, erosional and depositional segments of specified shorelines were mapped in colored pencil on the largest available topographic maps, i.e., at scales of 1:24,000 and 1:62,500. Of the 537 7½-minute quadrangles on which Lake Bonneville shorelines occur, more than 400 are now covered by published or advance topographic maps at the larger scale.

(4) Also on an ongoing basis, the large-scale mapping was recompiled in ink on parts of 14 2-degree sheets having a scale of 1:250,000.

(5) Cartographic assistants using a Kargl projector redrafted the 1:250,000 mapping on a 1:500,000 Cronaflex base map of the three-state region.

(6) From the annotated photographs of step (2) and the manuscript maps of steps (3) and (4), hundreds of potential sites were considered for selection as shoreline altitude localities. Selection was based mainly on three criteria. (a) The morphostratigraphic identity of a mapped shoreline at a selected locality should be unmistakable; experience to date strongly suggests that high-resolution morphostratigraphic signatures are best developed where shorelines are depositional. (b) Localities with spot elevations ascribed to identifiable features such as bench marks, section corners, and road intersections on or near a mapped shoreline were prime candidates. (c) It was desirable to optimize the spatial distribution of shoreline altitude localities over the region.

(7) More than 200 potential shoreline altitude localities were inspected

in the field, including 133 of the 345 that are denoted on plate 1 and listed in table 1 (codes 2 and 3 in column five). Rough-and-ready hand level surveys were conducted at the majority of localities inspected. At 27 localities, shorelines were tied to first-, second-, or third-order vertical control by closed hand level traverses, or by surveys using a telescopic alidade or transit. For the shoreline altitude localities finally selected, appropriate symbols were added to plate 1 and essential information was entered in table 1.

(8) Work is continuing on two aspects of the foregoing procedures. (a) The network of shoreline altitude control is being refined and extended with a Lietz B-1C precision automatic level. (b) Detailed studies of Lake Bonneville stratigraphy are being conducted at many exposed sections within the basin.

RELIABILITY OF INFORMATION

In mapping a specified shoreline over long distances (e.g., the highest shoreline of Lake Bonneville has a total length of well over 3,000 km), the main potential error is homotaxial. Meticulous attention to diagnostic morphostratigraphic traits is believed to have ensured a high degree of reliability. Shoreline identification and delineation was aided by the fact that complete breaks in shoreline continuity seldom exceed a small fraction of a photographic frame. If errors in shoreline identification and mapping do occur in this report, they are probably restricted to portions of the Gilbert Shoreline (table 1C), where morphostratigraphic details are still under review.

In determining the altitudes of specified shorelines at specific localities, potential errors are of three main kinds.

(1) Shorelines may be identified erroneously, as discussed above.

(2) Altitudes of shorelines may be measured or estimated erroneously. Where previously surveyed altitudes are available or where altitudes have been surveyed carefully in this study the altitudes listed in table 1 (column 4) are considered to have a precision (as an informal estimate of plus or minus one sigma) of ± 1 m. At many sites where surveyed altitudes are not yet available, the interrelationships of landmarks and plotted contour lines provide a basis for less precise estimates of local altitudes. Closed contours, looping contours, drainage patterns relative to contours, cultural features (in many cases, roads and grain bins on beach ridge crests) relative to contours, and similar relationships can under favorable circumstances be used to generate altitude estimates, the precision of which is essentially a function of contour interval. Where circumstances are unusually conducive to making altitude estimates directly from topographic maps, the following correspondence between contour intervals of maps and precision of altitude estimates has been assumed (and entered as the ± error in table 1, column 4): 5 and 10 feet, ± 1 m; 20 feet, ± 2 m; 40 feet, ± 3 m; and 80 feet, ± 4 m. Altitude estimates were avoided where circumstances were not conducive to these levels of resolution.

(3) The mean position of a formative water plane, the perimeter of which theoretically constitutes an isochronous shoreline, may not be re-

flected unequivocally in the geomorphology of a shore zone. In their geomorphic development, shorelines clearly can be superelevated, coincident, or subelevated with respect to mean water levels (e.g., Rose, 1981, table 5.6). In the present study most of the shoreline altitudes have been determined at the crests of depositional shoreline forms. On spits, as well as on barriers and berms that are weakly or moderately developed, crests are likely to have been approximately tangent to formative water planes. However, the crests of barriers and berms that are strongly developed are likely to have formed in superelevated positions. In selecting shoreline altitude localities and in estimating shoreline altitudes, a consistent effort has been made to detect and avoid crestal positions that are likely to be of unusually superelevated origin. In coastal geomorphic terms, drift-aligned beaches were selected in preference to swash-aligned beaches (Davies, 1980). No geomorphic correction factors have been invoked to somehow adjust altitudes to "true" values, but if such adjustments were feasible it is probable that they would seldom exceed the ± error estimates associated with the crestal altitudes themselves. In this study, all altitudes are in meters and are referred to the National Geodetic Vertical Datum (NGVD) of 1929.

FEATURES OF RELEVANCE TO NEOTECTONIC ANALYSIS

Each identifiable and dateable shoreline of Lake Bonneville can be viewed as coplanar (lying or occurring in the same plane with reference to a plane projection of the NGVD) at the time of its formation. Any subsequent departure of a shoreline from coplanarity is clearly relevant to analysis of post-shoreline crustal deformation. Several identifiable and dateable shorelines of Lake Bonneville, some formed at the perimeters of water planes stabilized by threshold-controlled exterior flow, are delineated on the accompanying map. The extent to which each shoreline now departs from coplanarity is documented by spatial coordinates (longitude, latitude, and altitude) and supporting data that are listed in table 1 and keyed to numbered localities on plate 1. Certain other features of Quaternary geology that are related to the lake or to the deformation of its basin are also mapped and discussed.

Shorelines, Controlling Thresholds, and Altitudes

Because of their morphostratigraphic importance, depositional shorelines are emphasized symbolically on plate 1. With few exceptions, altitude localities on plate 1 occur on depositional shorelines. All of those localities, including controlling thresholds, are keyed by geometric symbols and numbers to table 1. Nine categories of information that pertain directly or indirectly to shoreline altitudes appear in table 1: locality numbers keyed to plate 1, three orthogonal spatial coordinates, error terms that convey estimated altitude reliabilities, numerical codes that denote data gathering methods, topographic map references, nominal locality designations, and basic geomorphic descriptions of localities. Tables 1A, 1B, 1C, and 1D pertain to the Bonneville, Provo, Gilbert, and Gunnison shorelines, respectively.

Bonneville Shoreline and Zenda Threshold.-- The shoreline "which holds the highest position on the slopes" and "marks the greatest expanse of the ancient lake, and forms the boundary of the area of lacustrine phenomena" was

termed the "Bonneville shore-line" by Gilbert (1890, p. 93-94). Furthermore, Gilbert (1890, p. 111-122) recognized that at depositional localities the Bonneville Shoreline comprises several, morphostratigraphically distinct components. For purposes of consistency in neotectonic analysis, the altitudinally highest component is taken as the definitive Bonneville Shoreline. All of the morphostratigraphic components of the Bonneville Shoreline complex formed while the lake was under threshold control at a broad saddle of piedmont alluvium overlying Tertiary nonmarine beds on the Bonneville-Snake River drainage divide, between the Bannock and Portneuf ranges, in southeastern Idaho. The floor of the saddle was situated about 3.3 km north of Red Rock Pass, near the present hamlet of Zenda, and has been termed the Zenda Threshold (Currey, 1980c). The reconstructed altitude of the Zenda Threshold (circle no. 1 on plate 1), and the altitude of the nearest clearly expressed remnant of the Bonneville Shoreline (circle no. 2), is 1552 m. Nowhere else in the basin is the Bonneville Shoreline known to be at quite so low an altitude. The highest observed segment of the Bonneville Shoreline that appears not to have been superelevated at the time of formation occurs in the Lakeside Mountains (circle no. 48), near the west shore of Great Salt Lake, at an altitude of 1626 m. A consensus among current workers is that the maximum level of Lake Bonneville was reached about 16,000 years ago.

Provo Shoreline and Red Rock Pass Threshold.-- In defining the "Provo shore-line," Gilbert (1890, p. 126) observed, "The shore mark so far surpasses in strength all others of the series that this character serves for its identification; and it has been recognized in all parts of the basin without the necessity either of tracing its meander or of measuring its altitude." The Provo Shoreline comprises several, morphostratigraphically distinct components, and the altitudinally highest is taken as the definitive shoreline for the purposes of neotectonic analysis. With the occurrence of the Bonneville Flood (Malde, 1968), the Zenda Threshold was intrenched catastrophically and the Bonneville-Snake River drainage divide retreated headwardly (southeastward) about 3 km, thereby establishing a drastically altered new threshold at Red Rock Pass. All of the morphostratigraphic components of the Provo Shoreline complex formed under water-plane control imposed by the Red Rock Pass Threshold, which initially was 108 m lower than the earlier threshold at Zenda. The downstream corridor scoured by the Bonneville Flood and the slightly inset channel through which continuing overflow was discharged non-catastrophically during Provo Shoreline time are depicted on plate 1. As reconstructed beneath Holocene alluvial fans, the altitude of the Red Rock Pass Threshold (square no. 1) was initially 1444 m; a few meters of additional downcutting occurred subsequently, as evidenced from the depth of paleochannel burial at Swan Lake (square no. 2; Bright, 1966, pl. 1) and from details of Provo Shoreline morphostratigraphy. At no locality in the basin is the altitudinally highest component of the Provo Shoreline known to be lower than 1444 m. The highest observed segment of Provo Shoreline occurs in the Lakeside Mountains (square no. 29), in the immediate vicinity of the highest Bonneville Shoreline, at an altitude of 1503 m. A consensus among current workers is that the Bonneville Flood occurred about 14,000 years ago and that the Provo Shoreline complex was occupied by the lake between about 14,000 and 13,000 years ago.

Stansbury Shoreline (not mapped).-- A shore "seen to divide about equally the interspace between the Provo shore and the shore of Great Salt Lake" and

probably ranking next to the Provo "in abundance of tufaceous deposit" was termed the "Stansbury shore-line" and apparently regarded as post-Provo in age by Gilbert (1890, p. 134 and fig. 34). A disconcerting tendency toward locally subdued geomorphic expression was encountered in a recent effort to map the Stansbury Shoreline over an area of 98 7½-minute quadrangles (Currey, 1980a, p. 75-76). Subsequent work (D. R. Currey, C. G. Oviatt, and G. B. Plyler, unpublished data, 1982) has shown that the Stansbury Shoreline predates the White Marl Member of the Bonneville Formation. Because stratigraphic uncertainties concerning the Stansbury Shoreline have been resolved only recently, this traditionally recognized Lake Bonneville shoreline was omitted from detailed consideration in the present study.

Gunnison Shoreline and Old River Bed Threshold.-- A shallow lake and contiguous marsh that covered much of what is now the Sevier Desert late in the last major lacustral interval have been termed Lake Gunnison and Gunnison Marsh by C. G. Oviatt (Currey and James, 1982). The Gunnison lake-marsh system was fed by the Sevier and Beaver rivers, and closure was provided on the north by the Old River Bed Threshold (inverted triangle no. 1), which is now somewhat obscured by overlying Holocene alluvial fans but seems to have a slightly rebounded altitude of 1396 m. The Gunnison Shoreline and Gunnison Marsh (inverted triangle nos. 2, 3, and 4) have essentially constant--presumably undeflected by isostatic rebound--altitudes of 1390 to 1391 m over a north-south distance of approximately 100 km. One date (Currey, 1980b, p. 112) from sediments (inverted triangle no. 3) of the Gunnison lake-marsh system indicates threshold control of standing water about 10,300 years ago.

Gilbert Shoreline.-- Spits tied to the north end of the Oquirrh Mountains (triangle nos. 5 and 8) are among the original reference localities for a shoreline roughly 15 m above the average historic level of Great Salt Lake that Eardley et al. (1957, p. 1161) named the "Gilbert beach." As mapped in the present study, altitudes on the Gilbert Shoreline range from a minimum of 1293 m near the Wasatch Front (triangle no. 4) to 1311 m near the Lakeside Mountains (triangle nos. 12, 13, and 15). Never subject to threshold control, the Gilbert Shoreline lake did receive overflow from the Gunnison lake-marsh system via the Old River Bed (Gilbert, 1890, pl. XXXI), which joined the Gilbert Shoreline at the head of a conspicuous digitate delta (triangle no. 20). Two dates (Currey, 1980b, p. 112; Currey and James, 1982) from a Gilbert Shoreline lagoon (triangle no. 5) indicate lacustrine sedimentation about 10,300 years ago. Lake Gunnison-Gilbert Shoreline time marks the last hydrologically integrated stage of Lake Bonneville.

Late Prehistoric Shoreline and Desert Threshold.-- Great Salt Lake rose at least once to what Eardley et al. (1957, figs. 1 and 2) termed the Great Salt Lake Desert Threshold--actually a pair of thresholds (black diamonds on plate 1) north and southeast of the Newfoundland Mountains--in late prehistoric time, probably between A.D. 1605 and 1840 (Currey and James, 1982). On reaching the level of the Desert Threshold (1285 m), the lake spilled southwestward to inundate the Bonneville Salt Flats and adjacent parts of the Great Salt Lake Desert (stippled hydrologic sink on plate 1). At the edge of the threshold-controlled lake (shown in part as beaded line), a berm, typically of oolitic sand, was deposited at about 1286 m; Sevier Culture archaeological sites below that altitude were covered with a veneer of lacustrine sediments. The average altitude of the Great Salt Lake surface in historic time has been

1280 m and the lowest known altitude on the bed of the lake is 1269.4 m.

Other Features of Relevance

In the course of this study there developed a growing suspicion that loading at depocenters, particularly at the conspicuous deltaic depocenters associated with the Provo Shoreline, may have produced local negative anomalies in the isostatic deflection field of Lake Bonneville. Although the unrelieved loads imposed by Lake Bonneville depocenters have yet to be quantified, and deflection anomalies related to depocenters have yet to be demonstrated convincingly, the hypothesis is introduced on plate 1 by way of symbols denoting the general locations of potentially significant deltaic depocenters.

Hydro-isostatic deflection of the Bonneville Basin by water bodies other than Lake Bonneville may have been significant, although certainly not great. Two nearby pluvial lakes, now dry much of the time, are shown on plate 1. Lake Utaho (LU), to the north, was long thought to have been an arm of Lake Bonneville; recent work has shown that it was an independent, but probably contemporaneous, water body with a maximum volume of 3.75 km^3 (Currey, 1981). Lake Wah Wah (LWW), to the southwest, was of almost identical size. The name Lake Wah Wah, which was introduced by Snyder et al. in 1964, is unfortunate from the standpoints that the lake was not in Wah Wah Valley and the name Lake Pine probably has toponymic priority (Jones, 1940, p. 25; Hubbs and Miller, 1948, p. 156). From north to south, the easternmost Nevada tier of pluvial lakes included Lakes Waring, Antelope, Spring, and Maxey (Mifflin and Wheat, 1979); these lakes may well have been of some hydro-isostatic significance, although they have not been examined carefully in connection with this study. The glacio-isostatic effects of waxing and waning alpine glaciers in the Bonneville Basin were probably negligible.

Features related to vulcanism are possibly the dominant neotectonic elements in parts of the Sevier Desert, and perhaps elsewhere in the Bonneville Basin. Because of the likelihood of their direct relevance to displaced shorelines on Pavant Butte, a Holocene normal fault west of the Butte and Holocene volcanics to the south are the only such features included on plate 1.

PRELIMINARY RESULTS OF NEOTECTONIC ANALYSIS

A brief selection of preliminary results, or comments, chosen from among many observations on the basis of possible importance and probable validity, is summarized below under shoreline headings that connote tectonostratigraphic position. Most of the results mentioned here are preliminary for at least one of the following reasons: incompleteness, need for refinement or testing, and potential for leading to extensive additional research.

Bonneville Shoreline

Contrary views of at least one previous worker (Morrison, 1965, footnote 4) notwithstanding, at no depositional locality or series of depositional localities observed in this study was evidence seen that would disprove the

hypothesis that the altitudinally highest component of the Bonneville Shoreline complex is everywhere the same isochronous morphostratigraphic unit, or invalidate the observations that led Gilbert (1890, p. 120) to conclude that "the latest was the highest of all." Several field surveys conducted between Swan Lake and Downey, Idaho, in connection with this study have shown to the satisfaction of everyone involved that Lake Bonneville was never subject to control by a threshold higher than the Zenda Threshold, which at 1552 m is only 2 m higher than the threshold altitude suggested by Crittenden (1963, table 1). The elevation of the overflow point was 13 m lower than the altitude of 5135 feet suggested by Williams (1962, p. 145). In the region of greatest post-shoreline isostatic rebound, the Bonneville Shoreline has attained a maximum altitude of 1626 m, which is 10.5 and 7 m higher than the highs reported by Crittenden (1963, table 1) and Passey (1981, table 1), respectively, and 16 m lower than the high reported by Doelling (1964, p. 308). The isostatically deflected Bonneville Shoreline surface is less peaked near the high than has been indicated by Doelling (1964, fig. 39) and Passey (1981, fig. 4).

Contrary to initial expectations (Anderson and Bucknam, 1979), and despite repeated efforts in the field and with several sets of aerial photographs in the office, our attempts to trace the Bonneville Shoreline southward into the heart of the Escalante Desert have merely reinforced the earlier conclusions of Dennis (1944) and Crittenden (1963, p. E6-E7)--viz., Lake Bonneville did not inundate the main part of the Escalante Desert. The southern extremity of Lake Bonneville was situated on the gently shelving floor of the northern Escalante Desert, and was probably not more than 5 km south of Lund, Utah. The southernmost reliable altitudes on the Bonneville Shoreline are 1554 to 1555 m, about 20 km northeast of Lund. Near the southern end of its Escalante Desert arm the bed of Lake Bonneville may have been deformed by Holocene offset on a normal fault 3 km west of Lund. As in Crittenden's (1963, p. E13-E14) study, any basin-wide north-south tilting that may have occurred in post-Bonneville time is smaller than the limits of resolution inherent in this study.

Impressive evidence of neotectonic deformation occurs on and near Pavant Butte (circle no. 69), a large, basaltic tuff cone of late Quaternary age (Condie and Barsky, 1972, p. 338). The Bonneville Shoreline has an altitude of 1553 m at the crest of a prominent spit on the southeast flank of the volcano. However, the isostatically deflected Bonneville Shoreline surface, interpolated to the position of Pavant Butte from the surrounding region, has an altitude of 1570 m, which strongly suggests that the volcano has undergone about 17 m of downward displacement in post-shoreline time. (See additional comments under Provo Shoreline, p. 27.)

Other striking indications of neotectonic deformation occur in southern Utah County, where the Bonneville Shoreline is clearly expressed on the footwall (circle no. 16) and hanging wall (circle no. 17) of the Wasatch Fault at localities only a few kilometers apart. Comparative shoreline altitudes indicate that 11 m of throw have occurred in post-shoreline time. This is comparable to net throw near the mouths of Little Cottonwood and Bells canyons (northeast of square no. 10), in Salt Lake County, where the Wasatch Fault displaces glacial moraines that have been bracketed by radiocarbon dates of 26,080 and 12,300 years B.P. (Madsen and Currey, 1979).

Provo Shoreline

Red Rock Pass Threshold controlled the Provo Shoreline, initially at an altitude of about 1444 m and subsequently a few meters lower than that, at levels several meters lower than believed by previous workers (Williams and Milligan, 1968; Passey, 1981). In the region of greatest post-shoreline isostatic rebound, the Provo Shoreline has attained a maximum altitude of 1503 m, which is 10 m higher than the high reported by Passey (1981, table 1) and 16 m lower than the high reported by Doelling (1964, p. 308).

The Provo Shoreline occurs near the base of Pavant Butte (square no. 40) at an altitude of 1450 m. The regional Provo Shoreline surface, interpolated to the position of Pavant Butte, has an altitude of 1460 m. These relationships suggest that about 10 m of downward displacement has occurred in post-Provo time. It also follows that about 7 m of displacement must have occurred during the interval between the formation of the Bonneville and Provo shorelines (see comments under Bonneville Shoreline, p. 26). Subsidence related to late Pleistocene vulcanism in the Pavant Volcanic Field would be entirely consistent with the chronology of eruptions presented by Condie and Barsky (1972, fig. 2).

Basaltic ash in lacustrine sediments that contain gastropods with an average radiocarbon age (calculated using 95% of the activity of the NBS modern standard) of 15,400 ± 300 years B.P. (L-711B, L-774F, L-774H, L-774N; Broecker and Kaufman, 1965, p. 562-563) occurs in the Sevier Desert northeast of Pavant Butte. The ash appears to date from the interval between the development of the Bonneville and Provo shorelines, and may mark an eruption related to subsidence of the Butte during that interval. The source of the ash may have been some of the "steam-tipped black plumes" of sideromelane ash that were ejected from the Butte during the series of late Pleistocene sublacustrine eruptions that constructed the tuff cone; Pavant sideromelane ash has been observed as far as 11.3 km southeast of the Butte, interbedded with Lake Bonneville deposits (Hoover, 1974, p. 16).

As with segments of the Bonneville Shoreline, the Provo Shoreline in Utah County occurs at anomalously low altitudes on portions of the Wasatch Front piedmont that are west of the Wasatch Fault. The lowest such occurrence appears to be near the north end of the Provo (Orem) Bench (square no. 12), where the Provo Shoreline occurs at an altitude of 1444 m. That is as low as at the controlling Red Rock Pass Threshold and is 12 m lower than an unfaulted regional projection of the Provo Shoreline surface.

One of the most conspicuous occurrences of post-Provo faulting in the Bonneville Basin is immediately west of Crater Bench (east of square no. 54), where a large tombolo at the Provo Shoreline is cut by multiple NNE-striking, WNW-dipping normal faults. The post-Provo faults are geometrically very similar to faults with much larger visible displacements that cut pre-Bonneville basalt flows of Crater Bench. Somewhat farther south (3 km south of square no. 53), a phreatic explosion crater draped with lacustrine sediments occurs a short distance below, and hence probably predates, the Provo Shoreline.

Gunnison and Gilbert Shorelines

The low to imperceptible gradients that now characterize former water levels of the Gunnison lake-marsh system suggest that isostatic rebound in response to the last regression from deep-lake conditions in the southwestern part of the Sevier Desert had been largely completed prior to Gunnison Shoreline time. Indications that isostatic compensation in that area had been so nearly completed by approximately 10,000 years ago further imply relatively short mantle-lithosphere response time and relatively low upper mantle viscosity.

Gunnison Marsh sediments are offset by a Holocene fault (west of square no. 40) that is downthrown, and slightly concave in plan, toward the Pavant, Ice Spring, and Tabernacle volcanic fields. Post-deep lake eruptions (Condie and Barsky, 1972, fig. 2) of the latter two fields (volcanics south of square no. 40) may have been associated with the faulting, and with the post-Provo subsidence of Pavant Butte mentioned on page 27.

The lowest observed occurrences of the Gilbert Shoreline are a few kilometers west of the Wasatch Fault, near the toe of the Wasatch Front piedmont east of Great Salt Lake. Low shoreline altitudes there may partly reflect downward displacement of tectonic blocks west of the fault. In that same area, the Gilbert Shoreline is truncated (immediately south of triangle no. 4) by the largest lateral spreading failure known in the United States (Van Horn, 1975). Onset of the failure is constrained by the age of the Gilbert Shoreline, which establishes a maximum limiting age of approximately 10,000 years. It is not altogether certain that the toe of the failure has been completely stable since the time of the late prehistoric shoreline, i.e., since about 300 years ago.

What appears to be a significant positive altitude anomaly in the northernmost arm of the Gilbert Shoreline (triangle no. 40) may be related to Holocene tectonism, and possibly to historic seismicity, in the Utah-Idaho border region.

As noted above, the highest occurrences of the Gilbert, Provo, and Bonneville shorelines are all in or at the base of the northern Lakeside Mountains. From this spatial coincidence of maximum-rebound loci, it might be inferred that little or no lateral shift of water-load centroids occurred during the unloading that followed Bonneville Shoreline time. The geophysical and tectonostratigraphic implications of the comparative geometry of the isostatically-deflected Gilbert, Provo, and Bonneville water planes are now being analyzed using the data set (table 1) developed in this study.

ACKNOWLEDGMENTS

This study was conducted pursuant to U.S. Geological Survey Contract No. 14-08-0001-18289. For valuable information and assistance, the study is indebted to the following professional colleagues: Genevieve Atwood, Ron Bruhn, Bob Bucknam, Bill Case, Gary Christenson, Max Crittenden, John Czarnomski, Fitzhugh Davis, Les Dean, Wyllis Dorman-Ligh, Ben Everitt, Hal Gill, Hank Goode, Steve Gordon, Vasyl Gvosdetsky, Wally Gwynn, Joe Harmon, Kyun

Han, Wendy Hassibe, Chas. Hunt, Marilyn Isgreen, Steve James, Brent Jones, Bruce Kaliser, Jeff Keaton, Lyle Kemper, Guy King, Toren Klinge, Heber Lessig, Bill Lund, David Madsen, Jim Madsen, LaRell Nielson, Carolyn Olsen, Jack Oviatt, Fred Pashley, Carol Petersen, Jim Petersen, Glenn Plyler, Sherm Ross, Bob Rudy, Dorothy Sack, Bob Sewell, Jack Shroder, Sandy Stewart, Dick Van Horn, Carl Wentworth, and Galen Williams.

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