# JUKE BOX TRENCH: A VALUABLE ARCHIVE OF LATE PLEISTOCENE AND HOLOCENE STRATIGRAPHY IN THE BONNEVILLE BASIN, UTAH

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*by Charles G. Oviatt [1], Jeffrey S. Pigati [2], David B. Madsen [3], David E. Rhode [4], and Jordon Bright [5]*

[1]*Emeritus, Department of Geology, Kansas State University, Manhattan, KS 66506, joviatt@ksu.edu*
[2]*U.S. Geological Survey, Denver Federal Center, Box 25046, MS-980, Denver, CO 80225*
[3]*Research School of Arid Environment and Climate Change, Lanzhou University, Lanzhou, Gansu 73000, China*
[4]*Desert Research Institute, 2215 Raggio Parkway, Reno, NV 89512*
[5]*7351 E. Speedway Blvd 30C, Tucson, AZ 85710*

***Cover photo:*** *View from Juke Box trench toward the northwest. The entrance to Juke Box Cave is visible in the background on the east-facing slope of the Leppy Hills near the high end of the steep arcing trail on the colluvial slope below the rocky outcrops (visible in the upper middle of the photo). Photo credit: D.E. Rhode, 2013.*

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# JUKE BOX TRENCH: A VALUABLE ARCHIVE OF LATE PLEISTOCENE AND HOLOCENE STRATIGRAPHY IN THE BONNEVILLE BASIN, UTAH

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## ABSTRACT

A backhoe trench in deposits of Pleistocene Lake Bonneville and Holocene wetlands below the mouth of Juke Box Cave, near Wendover, Utah, provides an excellent view of the late Pleistocene and Holocene geologic history of the area. The following stratigraphic units are exposed (ascending): pre-Bonneville gravel (fluvial or lacustrine) and oolitic sand (ages greater than 30,000 yr B.P.); Lake Bonneville marl (30,000 to ~13,000 yr B.P.); an unconformity stratigraphically above the Bonneville marl marked by lacustrine gravel of probable Gilbert-episode age (~11,500 yr B.P.); and poorly sorted sand and carbonate mud deposited in post-Bonneville spring-fed wetlands. The wetland deposits include layers of poorly sorted sand, peat composed of bulrush remains and other organic-rich muds, and the Mazama volcanic ash (~7600 yr B.P.). Four calibrated $^{14}C$ ages suggest the wetland deposits span nearly the entire Holocene, from about 10,700 to at least 1200 yr B.P. The spring and wetland are now dry.

Key words: Lake Bonneville; Holocene spring and wetland deposits; Gilbert episode; Mazama ash in Utah

## INTRODUCTION

In this report, we describe the stratigraphy exposed in an open trench at the western edge of the mud and salt flats of the Great Salt Lake Desert (GSLD) near Wendover, Utah (USA). The trench was first excavated by a bulldozer, possibly during the development of a spring during and after World War II. In 1986, D.B. Madsen and others used a backhoe to enlarge and extend the trench in order to examine the Holocene wetland sediments; this work was undertaken from an archaeological perspective because the spring and its associated wetlands were used by prehistoric inhabitants of nearby Juke Box and Danger Caves (Jennings, 1957) on the southeastern-facing slopes of the adjacent Leppy Hills (figure 1A). In 2009, the trench was enlarged again by J.S. Pigati and C.G. Oviatt to freshen the exposures and study the stratigraphy of the Bonneville and post-Bonneville sediments. The trench was re-examined in 2013 by D.E. Rhode, who cleaned the walls of the trench and collected new samples for examination of the composition of the gravel and for radiocarbon analysis. Murchison (1989) discussed the trench as it existed in 1986, but we have found that his description was incomplete and incorrect. In this report our goal is to provide an accurate, but generalized, description that can be used as the basis for other more detailed and interpretive studies or as a guide for visitors to the site.

The exposure of Lake Bonneville sediments in the trench is excellent and provides a nearly complete view of the stratigraphy of Lake Bonneville, almost as complete as the sedimentary record preserved in Great Salt Lake at a slightly lower elevation, where the entire history of Lake Bonneville is recorded (for example, see Thompson and others, 2016). Lake Bonneville was the largest late Pleistocene lake in the Great Basin of North America. At its highest level it was over 300 meters (m) deep in the center of the basin near modern Great Salt Lake and covered more than 50,000 km$^2$ of what is now western Utah and the adjoining states of Nevada and Idaho. Detailed scientific investigations of the lake began with G.K. Gilbert (1890), and it is a well-studied example of a geologically recent and large lake that formed in response to global climate change in what is now a dry desert. We refer the reader to publications by Madsen and others (2001), Oviatt (2014), Munroe and others (2015), and Oviatt and Shroder (2016), in addition to numerous other papers cited therein, for additional background on Lake Bonneville and the post-Bonneville Gilbert episode. Holocene sediments exposed in Juke Box trench have not been studied in detail. A good analysis of the Holocene pollen record for the western Great Salt Lake Desert is given by Louderback and Rhode (2009).

Juke Box trench lies about 400 m southeast of the entrance to Juke Box Cave and about 900 m north of Danger Cave, about 3 km northeast of Wendover, Utah, and 8 km west of the Bonneville Salt Flats (figure 1A). Its elevation is 1297 m, and is located 40.7549° N, 114.0102° W, roughly 3 km into Utah from the Nevada state line. For comparison, the modern average elevation of Great Salt Lake is 1280 m. The trench is located in a Utah State Park Heritage Area, and in 1961 nearby Danger Cave was designated a National Historic Landmark.

Juke Box trench is oriented northwest to southeast (figure 1B) below the lower limit of modern alluvial-fan gravel, where the ground surface slopes less than 3° toward the southeast at the western edge of the mudflats. The trench is 40 m in length, 7 m in width, and oriented roughly perpendicular to the trend of

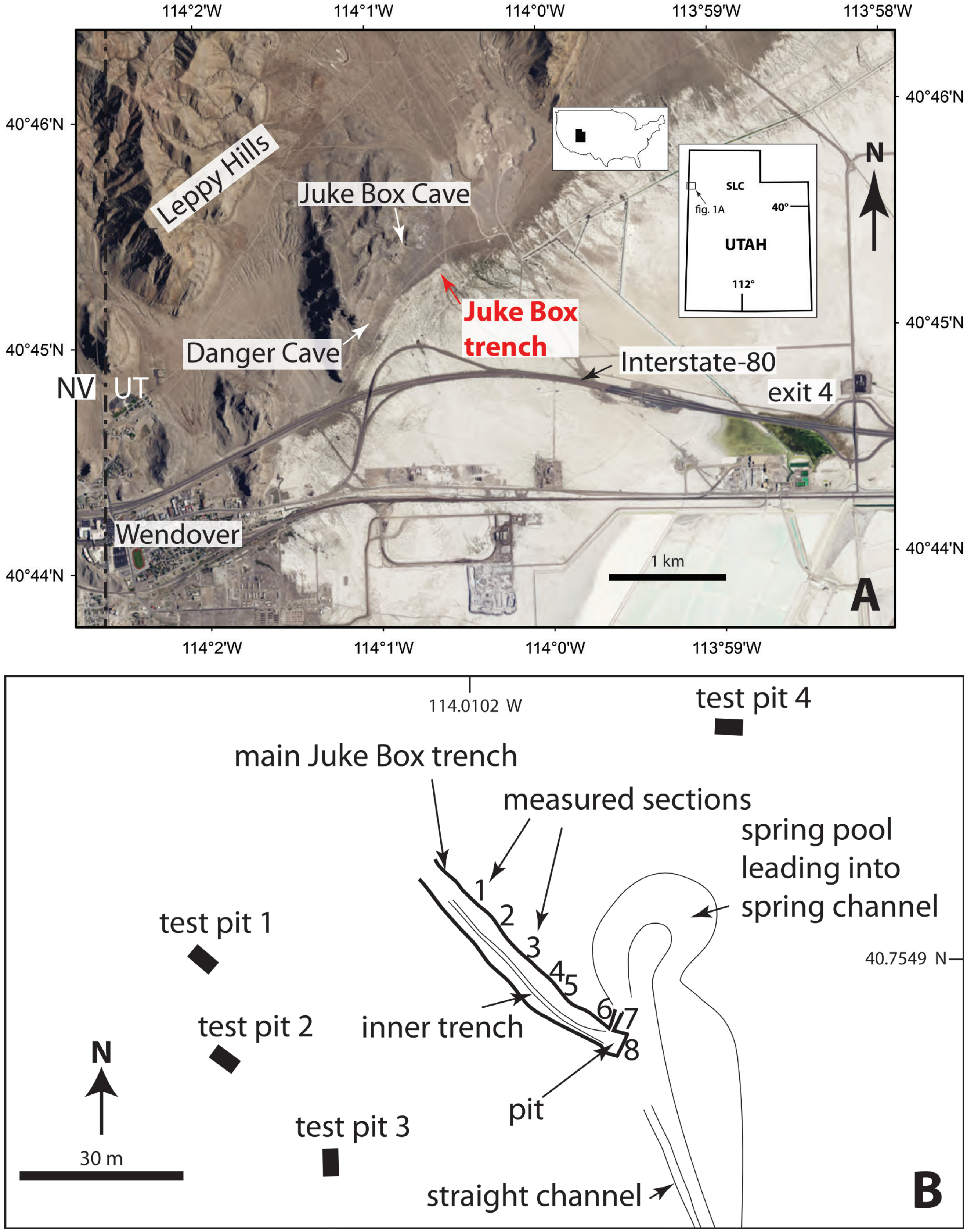


*Figure 1. Image and map showing location of the Juke Box trench. A) Satellite image (Landsat image courtesy of the USGS Earth Resources Observation and Science [EROS] Center) showing Juke Box trench location in the state of Utah and relative to Interstate Highway 80 and the town of Wendover, Utah; SLC = Salt Lake City. B) Large-scale map of the Juke Box trench and surrounding area. Approximate locations of numbered measured sections along the walls of the trench are shown (see figures 2–6 for stratigraphic details). The locations of test pits (table 5) dug by the track-hoe in 2009 are shown.*

the nearby mountain front and the margin of the mudflats. The trench has a broad step about 1.5 m wide and about 2 m below the ground surface above a narrow inner trench, which itself is ~1.5 m wide and ~1 m deep. A square pit, roughly 4 m across and 3 m deep, adjoins the trench at the southeast end. The pit has a narrow ~1.5 m wide trench extending from it to the north into a dry spring pool about 10 m across. The spring pool curves around to the southeast into a channel that contained flowing water when the spring was running. We measured a series of stratigraphic sections along the southwest-facing wall of the main trench above the step (sections 1–5); the three eastern-most measured sections (6, 7, 8) are in the pit and on the walls of the short north-trending trench (figures 1B, 2–6).

Finally, we note that the name "Juke Box" is not listed in the Geographic Names Information System (https://geonames.usgs.gov). As an informal geographic name, however, various spellings have been used for the spring associated with Danger and Juke Box Caves. The spelling for the cave on the 1971 U.S. Geological Survey Leppy Peak 7.5-minute quadrangle is "Jukebox." In the original report of cave excavations (Jennings, 1957) the name is given as "Juke Box." In this report we employ the spelling "Juke Box" for the cave, trench, and spring.

The ground surface near the middle of Juke Box trench has an elevation of 1297 m, and the upper elevational limit of the gravel, which we think was deposited during the Gilbert episode (see elsewhere in the text), is about 1296 m (Oviatt, 2014). This is within the estimated range of elevations of the upper limit of the Gilbert-episode lake (1295–1297 m; Oviatt, 2014). Local variations in elevation of the Gilbert-episode lake should be expected because of variations in incoming wave direction, fetch, shorezone gradient, and other factors; a precise and unique elevation for the upper limit of the Gilbert-episode lake, which would apply everywhere in the basin, cannot be given.

# METHODS

## Field Descriptions

At each measured section in the open trench, we described stratigraphy and sedimentology of the deposits at both the outcrop scale (e.g., bedding, unit thickness, stratigraphic relations) and hand-sample scale (e.g., grain size, sorting, color, fossil content). Field textures were determined using procedures described in the U.S. Department of Agriculture's Soil Survey Manual (1951), and sediment colors were determined using the Munsell Soil Color Chart. All described sections were documented with photos, and their positions were recorded with a hand-held GPS unit relative to the 1984 World Geodetic System (WGS84) reference datum. A horizontal string held in place by nails was used as a reference line for measuring thicknesses of stratigraphic units and as the datum for the measured sections in figure 5. The locations of measured sections are given in table 1.

## Physical and Microfaunal Properties

The percentages of total inorganic carbon (TIC) and acid-insoluble sand-sized particles (>62.5 µm) were measured using a Chittick apparatus (Machette, 1986) in the sedimentology laboratory at the Department of Geology, Kansas State University. Ostracode samples prepared by Jordon Bright (formerly Northern Arizona University, now University of Arizona; samples from sections 1, 5, and 6) were treated by soaking and gently agitating the sediment in a weak solution of bicarbonate-sodium hexametaphosphate for up to a week. Samples were then washed with hot water over a 150 µm sieve, and individual ostracode valves were handpicked, sonicated gently, rinsed with deionized water, and dried under laminar flow. Ostracode identifications by Jordon Bright are given in table 2. Ostracode samples prepared by C.G. Oviatt (samples taken at 2-cm intervals in section 1) were immersed in boiling water to which sodium bicarbonate was added, then allowed to cool; after cooling, sodium hexametaphosphate was added to the solution, followed by freezing, thawing, washing through a 180-µm sieve, and drying, following the procedure of Forester (1988). Adult ostracode valves were identified under low-power magnification using a binocular microscope. The occurrence of different species in the samples is plotted in figure 6. Sediment samples from gravel and sand units were sieved using 0.5 and 2.0 mm sieves, and fish bones and plant remains were then hand-picked from the >0.5 mm and >2.0 mm fractions under low-power magnification using a binocular stereo-zoom dissecting microscope.

## Radiocarbon Dating

Radiocarbon ($^{14}C$) dating of a variety of materials was used to determine ages of the post-Bonneville wetland deposits. The two organic samples collected in 2009 (WW-7863 and WW-7864) were treated using the standard acid-base-acid procedure prior to combustion ("WW" indicates the U.S. Geological Survey Radiocarbon Laboratory, Reston, Virginia, USA). The resulting $CO_2$ gas was measured manometrically and split into two aliquots. One aliquot was converted to graphite using an iron catalyst and the standard hydrogen reduction process and submitted for AMS $^{14}C$ analysis. The second aliquot was submitted for $\delta^{13}C$ analysis in order to correct the measured $^{14}C$ activity of the dated material for isotopic fractionation. $^{14}C$ samples collected prior to 2009 were prepared and dated by Beta Analytic, Inc., Miami, FL. The $^{14}C$ sample collected in 2013, which consisted of seeds of *Ruppia* sp. cf. *cirrhosa* (spiral ditchgrass), was also prepared and measured by Beta Analytic. Five of the $^{14}C$ ages were calibrated using the CALIB 7.1 program and the IntCal13 dataset (Stuiver and Reimer, 1993; Reimer and others, 2013), and the resulting ages are presented in table 3 in calibrated years B.P. (Before Present; 0 yr = A.D. 1950). Uncertainties are given at the 95% (2σ) confidence level. For some of the samples we are uncertain of the exact collection localities and stratigraphic contexts, and for those ages plus the two

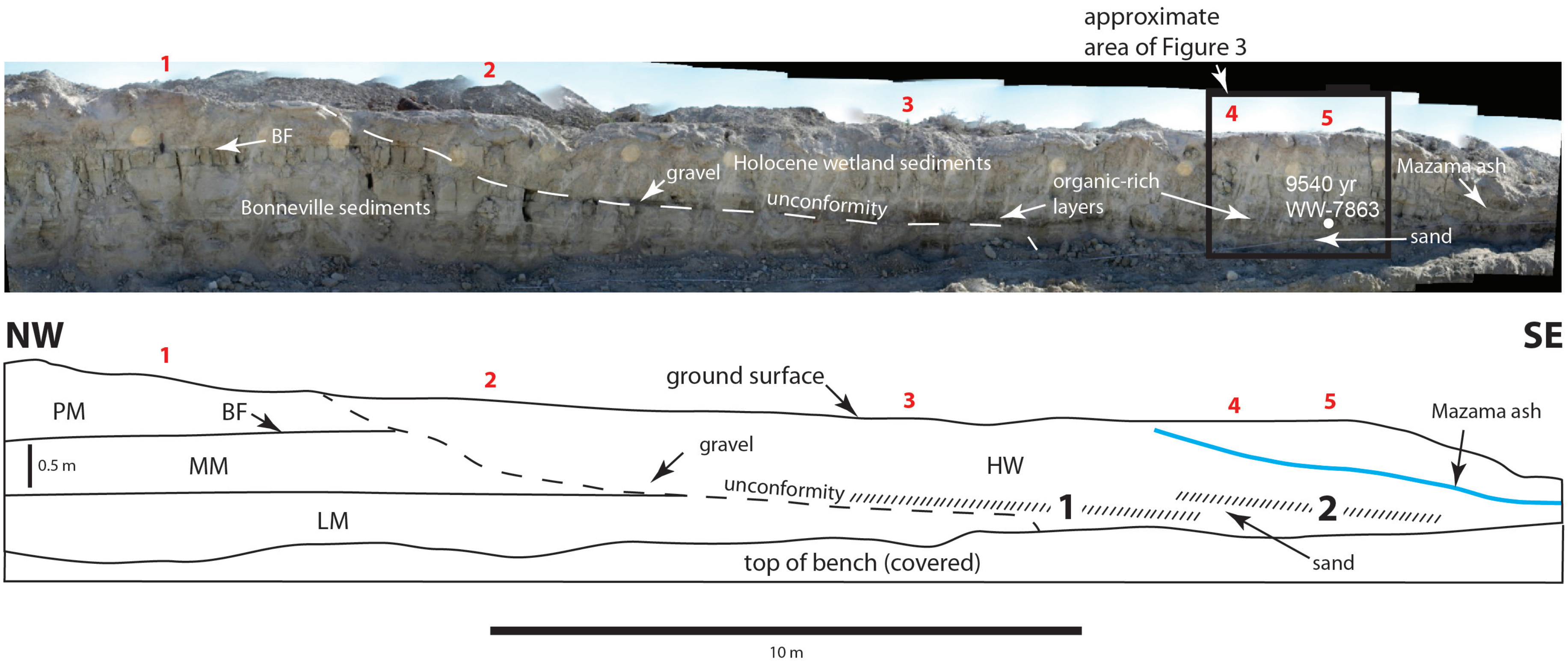


***Figure 2.*** *Photo composite (upper image) and generalized cross section (lower image) of the southwest-facing trench wall. The location of a $^{14}C$ sample collected in 2009 is shown with a solid dot. HW = Holocene wetland deposits; PM = Provo and post-Provo marl; BF = Bonneville flood; MM = massive marl; LM = laminated marl. Red numbers show the locations of five of the measured sections. Cross-hatched lines represent organic-rich layers in the Holocene wetland sediments ("organic 1" and "organic 2" in figure 4E). The gravel is interpreted to be of Gilbert-episode age.*

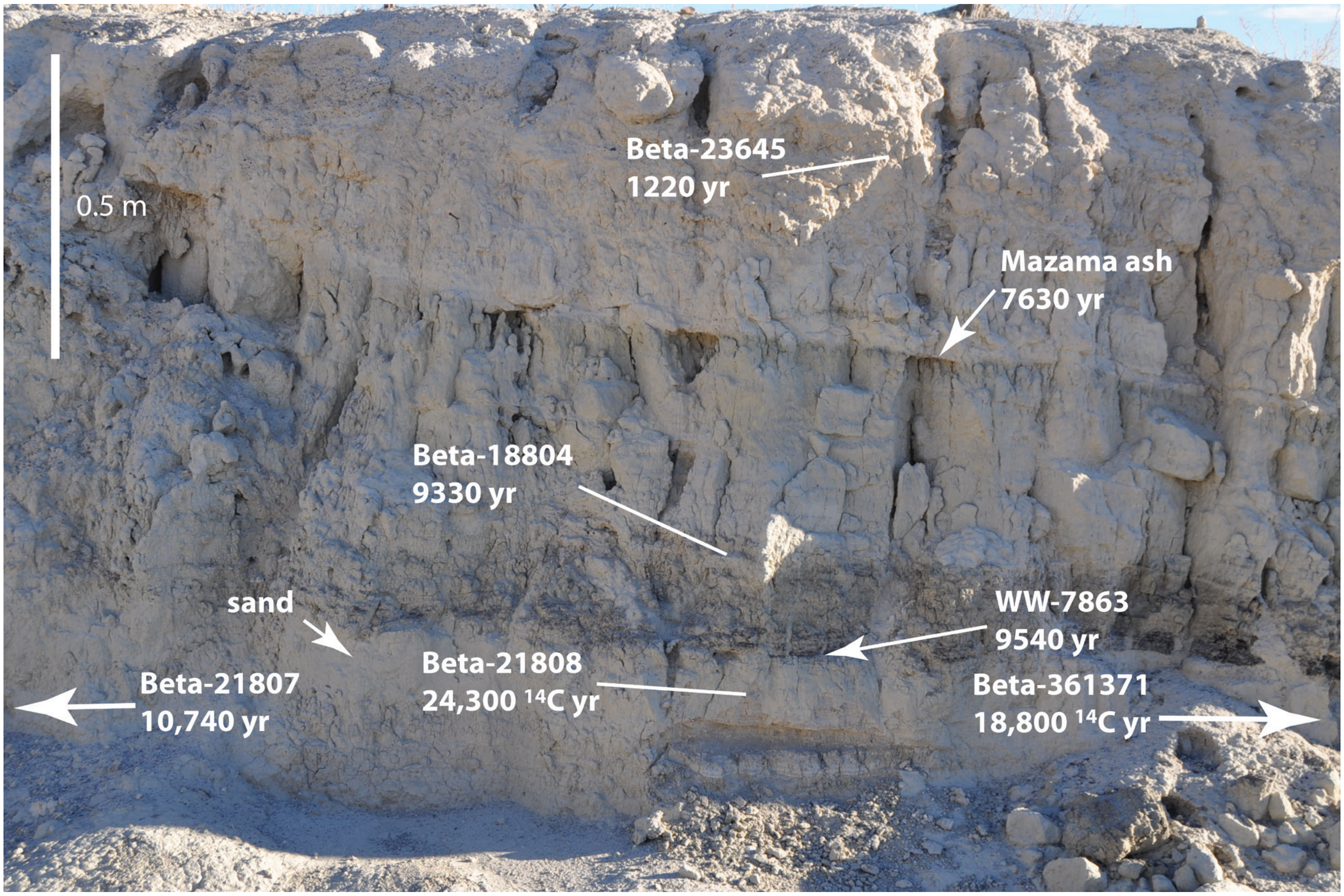


***Figure 3.*** *Photo enlargement of part of the Juke Box trench wall in the vicinity of section 5 showing approximate stratigraphic levels of $^{14}C$ samples; the horizontal positions of samples collected in 1986 and 1988 are not precisely known. Locations of sample WW-7863 and the Mazama ash, which are known precisely, are marked with arrows. The 1220-yr B.P. sample was not collected in this part of the trench, but it is shown in its approximately correct stratigraphic position. The samples for ages Beta-21807 and Beta-361371 were collected near this section at slightly different locations, west and east, respectively, of this photograph. Refer to table 3 and the text for more information about the $^{14}C$ ages. Calibrated median ages are given. "Sand" is the poorly sorted sand of early Holocene age.*

***Table 1.*** *Locations of measured sections, as determined using a hand-held global-positioning system (GPS) unit.*

| Section | Latitude (°N) (WGS84) | Longitude (°W) (WGS84) |
|---|---|---|
| 1 | 40.754979 | 114.010209 |
| 2 | 40.754941 | 114.010151 |
| 3 | 40.754895 | 114.010094 |
| 4 | 40.754848 | 114.010049 |
| 5 | 40.754830 | 114.010026 |
| 6 | 40.754773 | 114.009922 |
| 7 | no GPS data available; section 7 is located near section 6 | |
| 8 | 40.754736 | 114.009888 |

very old ages listed in table 3, we present the results in $^{14}C$ years (as they were originally reported) but not in calibrated years; this is partly to avoid the potential perpetuation of erroneous ages. Throughout the text and figures in this report, ages are reported in calibrated years B.P. except where noted.

# DESCRIPTIONS OF STRATIGRAPHY

## Stratigraphic Section 1

The following description of the strata exposed in the trench walls is generalized. The trench provides an excellent window into the late Pleistocene and Holocene geologic history of this area, and this generalized description should be refined by future efforts that will involve detailed logging and analyses of the sediments exposed in the trench walls.

A small exposure of coarse limestone or dolomite gravel (not shown in figure 5) derived from the Paleozoic carbonate bed-

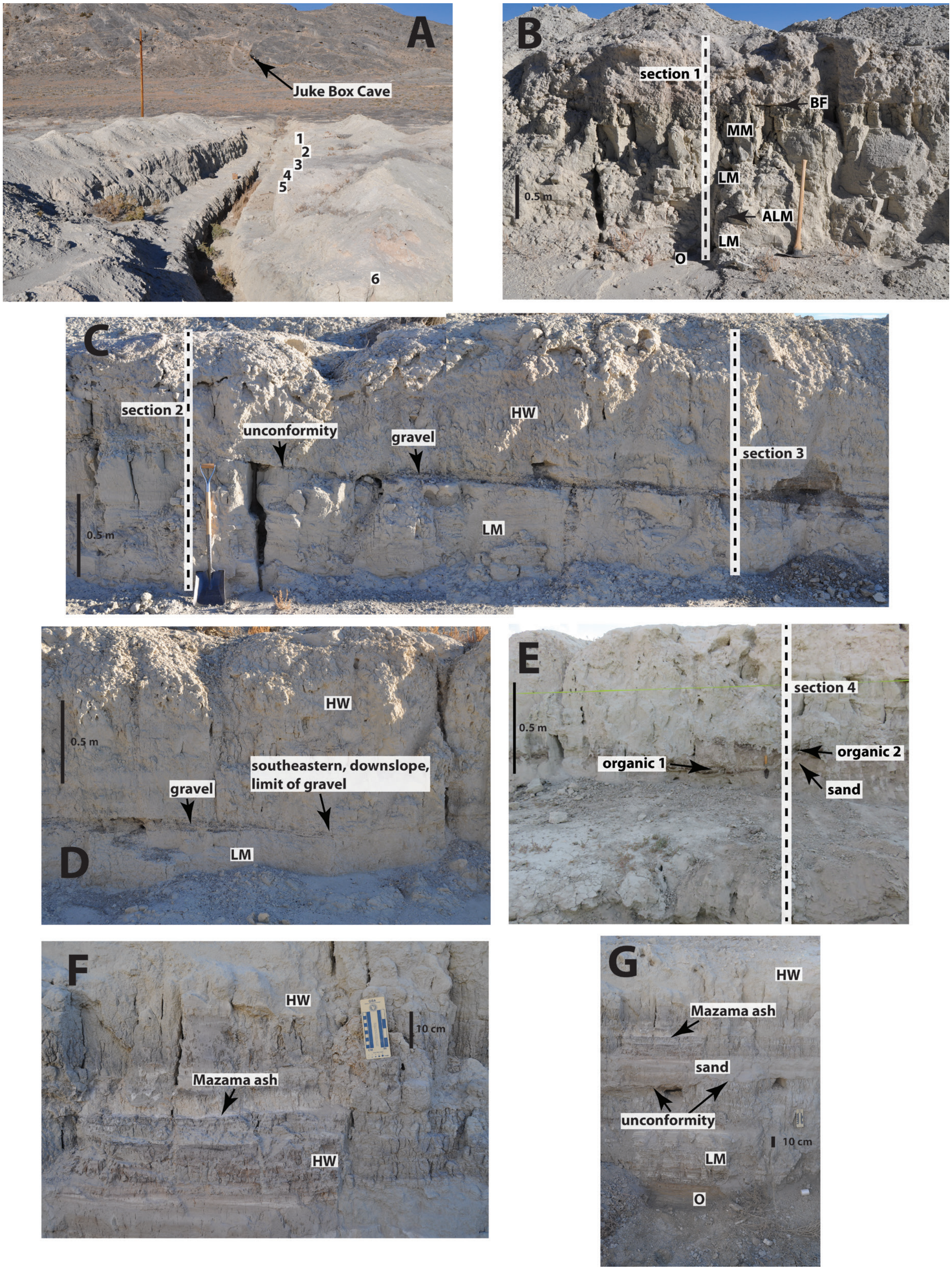


***Figure 4.*** *Photos of the Juke Box trench walls taken in 2013. A) View of Juke Box trench looking northwest toward the entrance of Juke Box Cave on the flank of the Leppy Hills. The approximate positions of the numbered measured sections along the southwest-facing trench wall are shown. Utility pole for scale. B) Section 1, trench wall. O = oolitic sand; LM = laminated marl; ALM = algal-laminated marl; MM = massive marl; BF = Bonneville flood (these abbreviations apply to all the photos in this figure). C) Section 2 and section 3, trench wall showing the unconformity at the base of the gravel. D) Trench wall showing the southeastern extent of the gravel. E) Section 4, trench wall. Organic 1 is the organic-rich bed that overlies the gravel toward the northwest and dated at 10,740 yr (table 3); organic 2 is the organic-rich bed dated at 9540 and 9300 yr (table 3). F) Section 8, enlargement of the wall showing the Mazama ash and overlying carbonate-rich mud in the Holocene wetland deposits. G) Section 8, east wall of the "pit" at the southeast end of the Juke Box trench.*

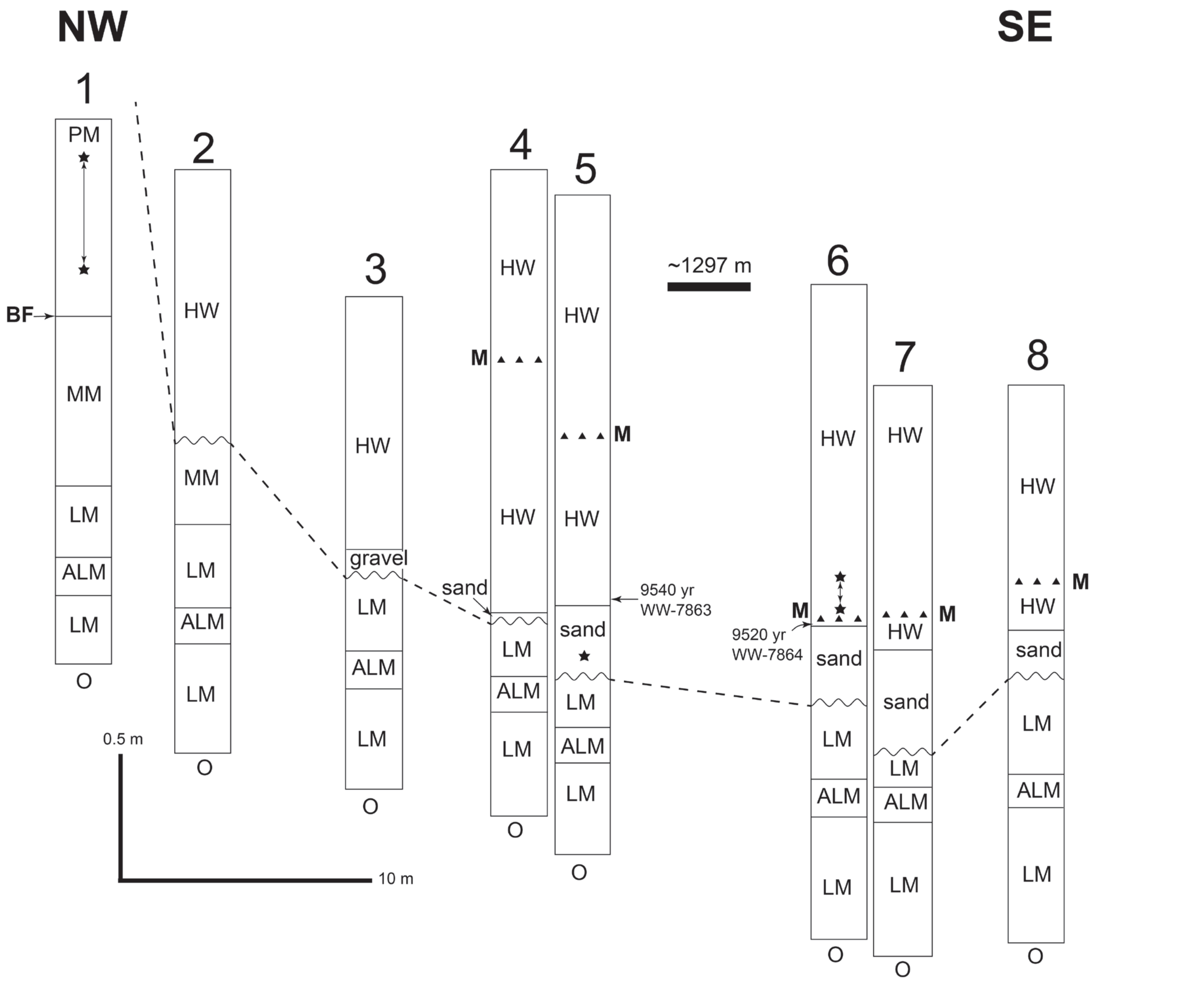


***Figure 5.*** *Diagram showing measured stratigraphic sections along the southwest-facing trench wall. Stars mark the locations of ostracode samples examined by Jordon Bright (table 2). ALM = algal-laminated mud (Bonneville marl); BF = Bonneville flood (Bonneville marl); LM = laminated marl (Bonneville marl); M = Mazama ash (Holocene); MM = massive marl (Bonneville marl); O = pre-Bonneville oolitic sand; PM = Provo and post-Provo marl (Bonneville marl); HW = Holocene wetland sediments, including carbonate mud with black organic-rich layers. The gravel lens ends toward the southeast between sections 3 and 4 (see figure 4D). Note that the "sand" above the unconformity in sections 4–8 is the poorly sorted sand, which is muddy in some places. The locations of the two* $^{14}C$ *samples collected in 2009 are shown in sections 5 and 6. Note that the lower parts of sections 1 through 5 are exposed in the inner trench below the step. The locations of the measured sections are shown in figures 1B, 2, and 4, and are listed in table 1. Mazama ash was collected in sections 5 and 6 (samples JC5-3 and JC6-4, table 4). The dashed line shows how the unconformity can be traced between sections; the wavy line represents the unconformity in individual sections. Thicker bar shows approximate elevation of 1297 m relative to the sections.*

rock in the nearby Leppy Hills protrudes from below the marl at the base of the trench at its northwest end. The gravel is well cemented and could have been deposited as fan alluvium, or could be part of a pre-Bonneville lacustrine barrier—the exposure in the trench floor is too small to determine the depositional environment of the gravel. Overlying the cemented gravel is about half a meter of oolitic sand, which in places is cemented into flat plates. We have observed oolitic sand at this stratigraphic position (beneath the Bonneville marl) at many places in the GSLD, including in Pilot Valley north of the trench, northeast of Juke Box Cave along the Leppy Hills, on the east side of the GSLD near Knolls, and south of Wendover near Blue Lake. In Juke Box trench, the oolitic sand is overlain by a complete section of marl deposited in Lake Bonneville (section 1; figure 6).

A regular series of sedimentary sub-facies within the Bonneville marl has been recognized in sediment cores and outcrops throughout the lower-elevation parts of the Great Salt Lake basin (Oviatt and others, 1994; Oviatt, 2018). These sub-facies include, from the base upward, laminated marl (LM) deposited between approximately 30,000 and 24,000 yr B.P., massive marl (MM) deposited between approximately 24,000 and 18,000 yr B.P., the Bonneville flood bed (BF) deposited approximately 18,000 yr B.P., and marl deposited during the Provo overflowing phase and the post-

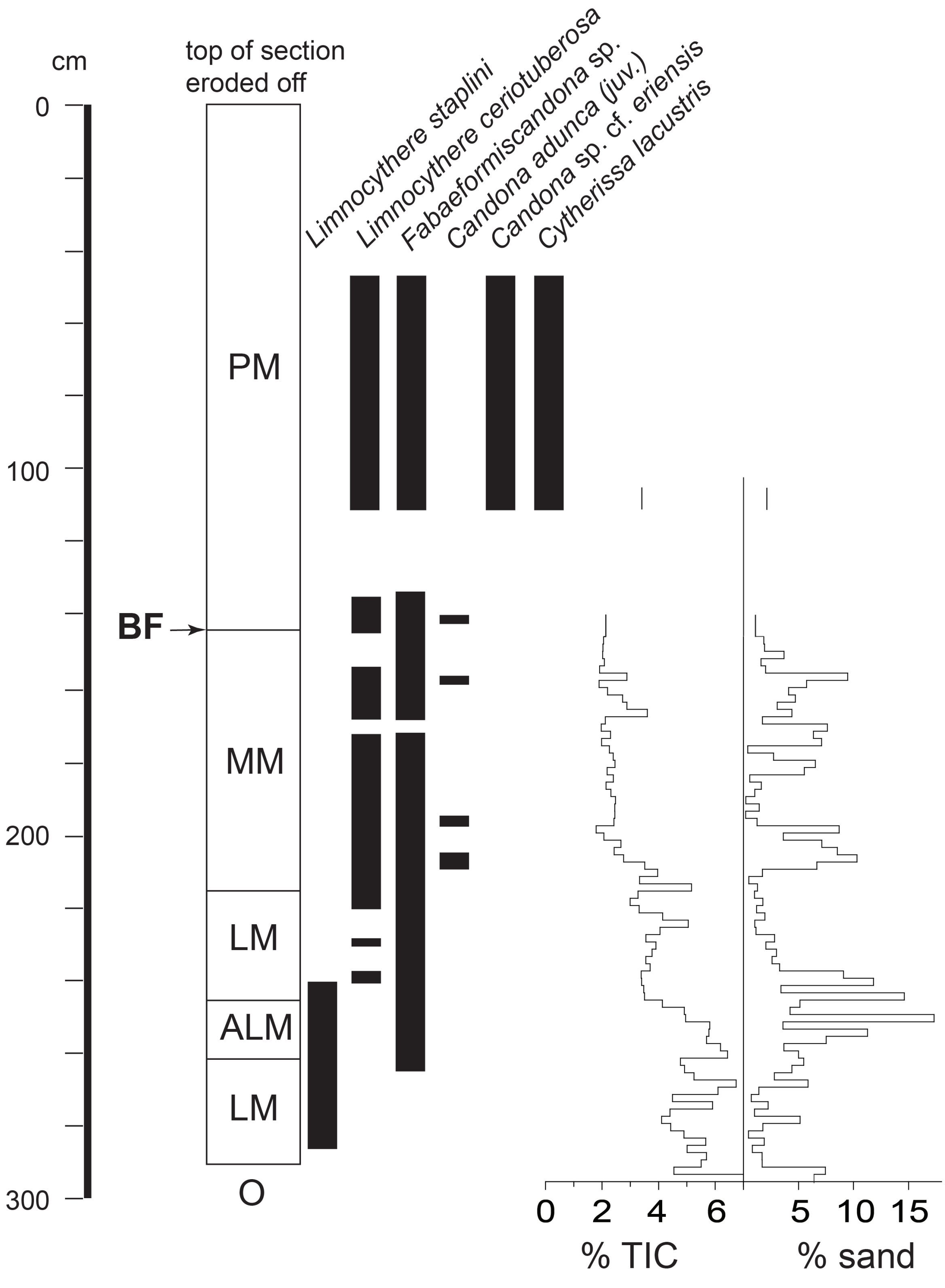


*Figure 6. Diagram showing measured stratigraphic section 1, Bonneville marl. Percentages of total inorganic carbon (TIC) and acid-insoluble sand are shown for samples taken at 2-cm contiguous intervals, except for one sample, which was 5 cm thick, above the Bonneville flood marker bed (BF). See the caption for figure 5 for definitions of the marl sub-facies. Ostracode identifications by C.G. Oviatt for the 2-cm samples below the BF, and by Jordon Bright (table 2) for samples above the BF.*

***Table 2.*** *Ostracode samples examined by Jordon Bright.*

| section | sample number | ostracodes present | environmental interpretation |
|---|---|---|---|
| 1 | 200–210 | *Limnocythere ceriotuberosa*; *Cytherissa lacustris* (mostly as juveniles); *Candona* sp. [probably *Fabaeformiscandona*, (with juv. valves); dirty, infilled valves common | regressive-phase Bonneville |
| 1 | 195–200 | *Limnocythere ceriotuberosa*; *Cytherissa lacustris* (mostly as juv.); *Candona* sp. [probably *Fabaeformiscandona*], (with juv. valves); dirty, infilled valves common | regressive-phase Bonneville |
| 1 | 190–195 | *Limnocythere ceriotuberosa*; *Cytherissa lacustris*; dirty, infilled valves common | regressive-phase Bonneville |
| 1 | 185–190 | *Limnocythere ceriotuberosa*; *Cytherissa lacustris* (mostly as juv.); fragments of *Candona* sp. [probably *Fabaeformiscandona*]; dirty, infilled valves common | regressive-phase Bonneville |
| 1 | 180–185 | *Limnocythere ceriotuberosa*; *Cytherissa lacustris* (mostly as juv.); fragments of *Candona* sp. [probably *Fabaeformiscandona*]; dirty, infilled valves common | regressive-phase Bonneville |
| 1 | 175–180 | *Cytherissa lacustris*; *Limnocythere ceriotuberosa*; fragments of *Candona* sp. [probably *Fabaeformiscandona*]; dirty, infilled valves common | regressive-phase Bonneville |
| 1 | 170–175 | *Limnocythere ceriotuberosa*; *Cytherissa lacustris* (mostly as juv.); fragments of *Candona* sp. [probably *Fabaeformiscandona*]; dirty, infilled valves common | regressive-phase Bonneville |
| 1 | 165–170 | *Limnocythere ceriotuberosa*; fragments of caudatid-type *Candona* [probably *Fabaeformiscandona*] | regressive-phase Bonneville |
| 1 | 160–165 | *Limnocythere ceriotuberosa*; fragments of caudatid-type *Candona* [probably *Fabaeformiscandona*] | regressive-phase Bonneville |
| 1 | 155–160 | abundant *Candona* sp. cf. *eriensis* (similar to *Candona* sp. 1 at Bear Lake); less abundant *Candona* sp. 2 (similar to *Candona* sp. 3 at Bear Lake); rare *Cytherissa lacustris*; juveniles of *Limnocythere ceriotuberosa*; juveniles of *Cytherissa lacustris* | regressive-phase Bonneville |
| 5 | gastropod-bearing sand | abundant *Cyprideis beaconensis*; abundant *Heterocypris fretensis*; few *Limnocythere ceriotuberosa*; rare juvenile *Candona*; snails | springs, wetlands |
| 6 | 80–85 | 2 *Candona compressa* valves; ~dozen juvenile *C. compressa* | springs, wetlands |
| 6 | 75–80 | one *Candona* juvenile [probably *Fabaeformiscandona*] | springs, wetlands |
| 6 | 70–75 | no ostracodes; two clam fragments | springs, wetlands |

Provo regressive phase between approximately 18,000 and 13,000 yr B.P. (PM).

In Juke Box trench, LM consists of ostracode-rich marl that is clearly laminated or finely bedded. In some intervals within LM, gray calcitic mud is interlaminated with white aragonitic mud. LM contains an algal-laminated marl (ALM) interval, which is brown where it has been desiccated and oxidized. Tiny algal filaments are visible in the ALM under a hand lens. Ostracodes are exclusively *Limnocythere staplini* in the lower 40 cm of LM; *L. staplini* is replaced by *L. ceriotuberosa* in the upper part of the unit, and *Fabaeformiscandona* sp. appears in the middle of LM. The overlying MM contains clean sand beds that we interpret as possible turbidites. Dominant ostracodes in the MM are *L. ceriotuberosa* and *Fabaeformiscandona* sp. A few specimens of juvenile valves of *Candona adunca* are found in some samples of MM and PM, and it is likely that adult valves of *C. adunca* were also present at the time the marl was deposited but are no longer preserved (the relatively large valves of *C. adunca* are thin and fragile, and the marl exposed in Juke Box trench is desiccated and compacted). The MM was deposited during the middle-to-late transgressive phase of the lake, including the time of development of the Bonneville shoreline at the end of the transgressive phase. An abrupt, flat contact at the top of the MM is interpreted as the base of the BF bed, which is overlain by PM. The ostracodes *Cytherissa lacustris* and *Candona* sp. cf. *eriensis* (table 2) are found in the PM, both of which are indicator species for the regressive phase of Lake Bonneville (Oviatt, 2017).

Data for TIC and acid-insoluble sand are shown in figure 6. TIC and % sand were analyzed in one sample above the BF.

***Table 3.*** *$^{14}$C ages and calibrated ages from Juke Box trench.*

| lab # | material dated | $d^{13}C_{vpdb}$ (‰) | $^{14}$C age | $^{14}$C uncertainty | calibrated age range at 2σ | section; depth in section (cm) | stratigraphic unit | latitude °N, longitude °W (WGS84) | calibrated median age | reference |
|---|---|---|---|---|---|---|---|---|---|---|
| Beta-23645 | hearth charcoal ~20 cm below the surface of the uppermost *Scirpus* sp. peat layer | – | 1310 | 230 | 700–1700 | – | upper HW | – | 1200 | 1986 field notes and analytical results; Murchison, 1989 |
| Beta-18804 | *Scirpus* sp. peat | -26.4 | 8360 | 140 | 9000–9600 | – | HW | – | 9300 | 1986 field notes and analytical results; Murchison, 1989 |
| WW-7864 | humic acids | -18.8 | 8520 | 30 | 9483–9540 | 6; 132–135 | HW | 40.75477, 114.00992 | 9520 | this study |
| WW-7863 | humic acids | -25.7 | 8570 | 30 | 9498–9554 | 5; 153–162 | HW | 40.75483, 114.01003 | 9540 | this study |
| Beta-21807 | humates | – | 9450 | 150 | 10298–11174 | – | basal HW, directly above gravel | – | 10740 | 1986 field notes and analytical results; Murchison, 1989 |
| Beta-361371 | *Ruppia* sp. seeds | -13.7 | 18,799 | 90 | – | near section 5; ~165–185 | HW, directly above organic bed dated by Beta-18804 and WW-7864 | 40.75483, 114.01003 | – | 2013 field notes and analytical results |
| Beta-21808 | *Tryonia* sp. shells | -0.3 | 24,300 | 270 | – | – | sand of Holocene age | – | – | D.R. Currey, University of Utah, 1988 |

Calibrated ages (in years before present, A.D. 1950) were calculated using CALIB 7.1, IntCal13 dataset (Stuiver and Reimer, 1993; Reimer and others, 2013). In all cases the probability of the calibrated age falls within the reported range as calculated by CALIB. Calibrated age ranges are based on uncertainties at the 2σ (95%) confidence level. $^{14}$C uncertainties are given at 1σ (68%). Median calibrated ages are rounded to the nearest decade for WW-7863 and WW-7864, and to the nearest century for Beta-23645, Beta-18804, and Beta-21807. The precise locations of samples Beta-23645, Beta-18804, Beta-21807, and Beta-21808 (in gray boxes), are poorly known partly because they were collected from the walls of the 1980s trench, which no longer exists. $^{14}$C ages for Beta-361371 and Beta-21808 are greater than expected; see text for discussion. HW = Holocene wetland deposits.

TIC generally decreases from the base of the Bonneville marl upward to the BF, and increases slightly in the one sample above the BF. Sand percentage is generally higher at the base of the section than near the top of the LM; the sand spikes in the MM may represent density flows (turbidites) that were generated on the nearby steep mountain front as the lake became very deep (up to 290 m at this site). It is possible that the sand content of the marl at Juke Box trench is greater than the data in figure 6 show because sand-sized fragments of limestone or dolomite derived from Paleozoic carbonate bedrock units in the nearby mountains might have been dissolved in the acid treatment of the samples and not recorded as siliciclastic sand.

## Stratigraphic Sections 2 Through 8

Most of the sediments exposed in sections 2 through 8 consist of Holocene-aged wetland (marsh) deposits. An unconformity cuts out the upper part of the Bonneville stratigraphic sequence between sections 1 and 3 then extends farther to the southeast (figures 2–5). The unconformity is directly overlain by gravel in section 3. The gravel is well sorted and weakly cross-bedded, with cross-beds dipping at a low angle toward the southeast (basinward). The gravel contains fish bones identified by J.M. Broughton (University of Utah, 2017) as some species of Salmoninae (most likely cutthroat trout [*Oncorhynchus clarki*], or bull trout [*Salvelinus confluentus*]), and whitefish (*Prosopium* sp.). We currently do not have enough information to determine whether the fish were living in the lake that deposited the gravel or were winnowed from the Bonneville marl at the site as waves in the Gilbert-episode lake eroded and dispersed the fines.

The sand bed consists of poorly sorted fine sand, which in places contains mud beds. It lies stratigraphically above the unconformity and above the organic bed dated at 10,700 yr (table 3; figures 2 and 4E). The sand bed contains aquatic gastropods of the genus *Tryonia* near sections 4 and 5 (figure 5), and ostracodes that live in springs and wetlands (table 2). A possible interpretation of the sand is that it was deposited in a pool fed by groundwater discharging into Juke Box spring.

The relatively steep unconformable surface between sections 1 and 3, where it cuts out marl deposited in Lake Bonneville, may be the shoreline angle at the base of the wave-cut bluff of the Gilbert-episode lake. However, from the evidence in the trench alone, it is not possible to know how much higher the lake that produced the unconformity might have reached. The suggestion that the steep segment of the unconformity is the shoreline angle of the Gilbert-episode lake is partly based on the inferred elevation of the upper limit of that lake.

Stratigraphically above the lacustrine gravel is calcareous mud that contains vertical root traces and is finely bedded to massive. These sediments contain beds of black, organic-rich mud and peat composed of leaves and stems of wetland plants (including bulrush [*Scirpus* sp. sensu lato). A thin layer of white volcanic ash, identified as the Mazama ash (table 4; appendix), varies in thickness from 0 to 3 cm, and averages about 2 cm. Abundant irregularly shaped nodules of calcium carbonate, mostly less than ~3 cm in diameter, are eroding out of the upper third of the wetland muds and the upper part of the Bonneville marl. The nodules were probably precipitated in interstitial spaces in the sediments as groundwater evaporated from the fine-grained deposits; the nodules are now being eroded out of the mud at the ground surface.

Calibrated $^{14}C$ ages of organic materials in samples from the wetland muds range in age from 10,700 to 1200 yr B.P. (table 3). Four $^{14}C$ ages were obtained in the 1980s, two in 2009, and one in 2013. One of the samples collected at section 6 (figure 5) (WW-7864;), from a 3-cm thick interval directly below the Mazama ash yielded an age of 9510 yr B.P. The age of the Mazama ash (7630 yr B.P.) is well known, having been dated numerous times using the $^{14}C$ ages of materials associated with it at many localities in western North America, and by ice-layer counting in the Greenland ice sheet (Zdanowicz and others, 1999). It is not clear why the calibrated age reported here is much older than the ash; possibilities are that there are significant hard-water effects in the spring/wetland system that caused the calibrated $^{14}C$ age to be too old, or that there is an unconformity between the radiocarbon age and the volcanic ash in section 6. Regardless of these chronologic details, which can probably be resolved with future work, the wetland deposits at Juke Box trench are clearly of Holocene age.

One of the $^{14}C$ samples from the 1980s (Beta-21807; ~10,740 yr B.P.; table 3) was collected from organic-rich sediments directly above the gravel. This age is consistent with the inferred age of the gravel (~11,500 yr B.P.; Oviatt, 2014).

The $^{14}C$ age of *Tryonia* sp. shells collected from sand near and just southeast of section 5 is greater than would be expected based on the stratigraphic context and $^{14}C$ ages below and above the sand (figure 3; table 3; younger than 10,740 yr, and older than 9540 yr). The reported $^{14}C$ age of the snail shells is about 24,300 $^{14}C$ yr B.P. (table 3). The *Tryonia* sp. snails are aquatic organisms and obtain their carbon primarily from the water, not from the atmosphere. Therefore, it is possible that some or all of the carbon in the dated sample was derived from old groundwater (i.e., the “hard-water effect”) that had discharged in the spring and wetland. A similar explanation might apply to the $^{14}C$ age of the *Ruppia* sp. seeds collected from the same sand unit (table 3)—*Ruppia* utilizes inorganic carbon in bicarbonate dissolved in the water, not carbon in $CO_2$ from the atmosphere. The $^{14}C$ age of the *Ruppia* sp. seeds is about 18,800 $^{14}C$ yr B.P., but the “true” age must be roughly 9000 $^{14}C$ yr B.P. (10,000 cal yr B.P.). Emergent plants receive their carbon for photosynthesis from $CO_2$ in the atmosphere, not from bicarbonate dissolved in the water—$^{14}C$ ages of that organic material (as in the humic compounds or peat of other samples from Juke Box trench; table 3) would have ages di-

***Table 4.*** *Chemical compositions of volcanic glass shards[1] in tephra samples from Juke Box trench, as determined by electron microprobe analysis compared with an average composition of 100 previously analyzed samples of the Mazama ash, erupted from Mount Mazama, Crater Lake, Oregon, approximately 7600 yr ago. Data from Elmira Wan (U.S. Geological Survey). Sample JC5-3 is from section 5, and JC6-4 is from section 6 (figure 5). See the supplementary information in the appendix for more detailed analytical results and comparisons with other Mazama-ash analyses.*

| sample | $SiO_2$ | $Al_2O_3$ | $Fe_2O_3$ | MgO | MnO | CaO | TiO2 | $Na_2O$ | K2O | total |
|---|---|---|---|---|---|---|---|---|---|---|
| average of 100 Mazama ash samples | 72.79 | 14.65 | 2.12[2] | 0.46 | 0.05 | 1.61 | 0.42 | 5.19 | 2.71 | – |
| Juke Box trench JC5-3 | 72.53 | 14.86 | 2.14 | 0.47 | 0.06 | 1.65 | 0.41 | 5.13 | 2.76 | 96.03 |
| Juke Box trench JC6-4 | 72.74 | 14.81 | 2.11 | 0.46 | 0.05 | 1.60 | 0.42 | 5.09 | 2.72 | 96.14 |

[1] Oxide concentrations in the average are in weight-percent oxide, recalculated to 100 percent. For the two samples from Juke Box trench, original oxide totals before recalculation are given to indicate approximate degree of hydration of volcanic glass. About 20 individual points were analyzed for each sample. Electron microprobe chemical analyses performed by USGS Tephrochronology Project, Menlo Park, California.

[2] Iron reported as FeO for the standard.

rectly comparable to samples from localities around the world that had received their carbon from the atmosphere.

Oviatt and others (2015) have hypothesized that after Lake Bonneville regressed to its lowest levels, groundwater leaked out of upland aquifers, where it had been stored for thousands of years, onto the basin floor, and that the rate of groundwater discharge would have been greater during the latest Pleistocene and early Holocene than later in the Holocene because the difference between the groundwater hydraulic heads in the recharge areas and discharge areas was greater at that time than it was later in the Holocene. Wetland deposits formed during the 1500-yr period between the end of Lake Bonneville (~13,000 yr B.P.) and the culmination of the Gilbert episode (~11,500 yr B.P.) have not been found near Juke Box trench, although it is likely they were present but eroded away by waves in the Gilbert-episode lake. The Juke Box wetland was more extensive during most of Holocene time than in historic time, given the distribution of wetland deposits exposed in the trench compared to the relatively meager spring-flow organic mats from historical time. At Blue Lake spring, about 30 km south of Juke Box trench, the shells of living snails have an apparent age of 21,000 to 22,600 yr B.P. (based on two $^{14}C$ ages of modern snail shells: 18,730 ± 130 $^{14}C$ yr B.P. *Melanoides* sp., AA83867; and 17,500 ± 120 $^{14}C$ yr B.P., Planorbidae, AA83868; Jay Quade, University of Arizona 2009), and modern groundwater discharging at the spring has a Lake Bonneville age (Lerback and others, 2017). Thus, old groundwater is currently being discharged at Blue Lake Spring on the western margin of the GSLD, and old groundwater likely was discharged at Juke Box spring during the early Holocene.

## Test Pits

After the main trench was enlarged in 2009, we asked the track-hoe driver to dig four pits near the trench (figure 1B) to look for the lacustrine gravel deposited during the culmination of the Gilbert-episode lake. We did not encounter the gravel or Holocene wetland deposits in any of the test pits (table 5).

***Table 5.*** *Generalized test-pit stratigraphy. Refer to figure 1B for locations of test pits.*

| pit number | depth (cm) | stratigraphic unit |
|---|---|---|
| 1 | 0–40 | alluvial-fan gravel |
| 1 | 40–140 | Bonneville marl |
| 1 | >140 | cemented fan gravel |
| 2 | 0–170 | Bonneville marl |
| 3 | 0–200 | Bonneville marl |
| 4 | 0–200 | Bonneville marl |

## Historical Changes

Apparently the spring at the Juke Box trench site was actively flowing in historic time; it may have been developed as a water source for the city of Wendover and/or for the nearby military base during and after World War II. The spring channel, which was dug during historic time, and which leads toward the southeast away from the trench, contains clumps of dried bulrush-root mat. Piping (erosion) is well developed in the Lake Bonneville marl and wetland deposits in the area around the trench and at least 6 km to the northeast along the base of the Leppy Hills and Silver Island Mountains. Piping is caused by water flowing into cracks in silty sediment (Parker, 1964). The cracks, which form in response to sediment drying, widen through time as more water runs through them, and an extensive underground network of open passageways develops, with sink holes at the surface that admit more water when it rains.

The cracks observed around the trench would not have formed in the silty Bonneville and wetland deposits unless the sediments had dried out. The water table was near the ground surface in the vicinity of the spring while the spring and wetland were active during the Holocene and early 20th century, but the water table is now lower than the lowest part of the trench (2.5 to 3 m below the ground surface), thus indicating that the water table has dropped since the middle of the 20th century.

## SUMMARY OF GEOLOGIC HISTORY

The sequence of paleohydrologic events that can be deduced from the deposits at Juke Box trench (table 6; figure 7) is consistent with the late Pleistocene and Holocene history of the basin as documented by many researchers (see multiple references in Oviatt, 2014, 2015; Oviatt and Shroder, 2016). The following summary is derived from deposits exposed in the trench and events deciphered elsewhere in the basin.

In ascending order, coarse gravel was deposited in an alluvial fan or a lacustrine barrier at the site of the trench, followed by the deposition of oolitic sand in a shallow saline lake in the GSLD. Both of these depositional events are undated but occurred prior to the initial transgression of Lake Bonneville. At about 30,000 yr B.P. Lake Bonneville began to rise in the basin. During the time when the level of Lake Bonneville was higher than the elevation of Juke Box trench, offshore marls were deposited, from just after 30,000 yr B.P. until just prior to 13,000 yr B.P. when the lake had regressed to elevations similar to those of modern Great Salt Lake. During a period of about 1500 yr, from about 13,000 to 11,500 yr B.P., the lake remained at elevations lower than Juke Box trench. No deposits from this period have been identified in the trench, although it is likely that the spring was active at this time and that wetland deposits of this age were present in the trench area. The culmination of the Gilbert episode, during which Great Salt Lake rose about 15 m higher than its modern average elevation, occurred at about 11,500 yr B.P. At the trench site, part of the Bonneville marl, and any wetland deposits that had been laid down after the final regression of Lake Bonneville and prior to the Gilbert episode, were eroded by the Gilbert-episode lake; the gravel exposed in the trench was probably deposited at the margin of the lake at this time. During most or all of the Holocene, poorly sorted sand, and carbonate- and organic-rich muds, were deposited in wetlands around the spring. Groundwater continued to discharge in the spring and wetland into the 20th century before drying up altogether.

## CONCLUSIONS

Exposures of late Quaternary sediments in the Juke Box trench are available for casual observation or detailed study. Extensive sampling and/or additional excavations should be approved by the Utah Division of State History in Salt Lake City, but casual observations at the trench do not require a permit. The stratigraphic units exposed in the Juke Box trench, and the geomorphology and archaeology of the surrounding area, will provide future scientists opportunities for research into the late Pleistocene and Holocene history of this part of the GSLD.

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***Table 6.*** *Summary of geologic history derived from Juke Box trench.*

| stratigraphic unit | interpretation | age span (calibrated age; yr B.P.) | basis of age determination |
|---|---|---|---|
| carbonate mud; sand, peats, black mats (HW) | Holocene wetland deposition | 10,500–historical time | $^{14}C$ ages; Mazama ash; historical spring activity |
| Mazama ash (M) | well-dated volcanic eruption | 7630 | numerous published sources (including Zdanowicz and others, 1999) |
| poorly sorted sand | deposition in a spring pool | between 10,740 and 9540 | bracketing between $^{14}C$ ages |
| gravel | nearshore deposition at the culmination of the Gilbert episode | ~11,500 | stratigraphic context (Oviatt, 2014) |
| Bonneville marl (LM, ALM, MM, PM) | Bonneville lake cycle; shallow to deep, to shallow, lake | 30,000 to ~13,000 | correlations with well dated Lake Bonneville deposits (e.g., Oviatt, 2017) |
| oolitic sand (O) | offshore deposition in a shallow saline lake | >30,000 | stratigraphic context |
| carbonate-cemented coarse gravel | alluvial fan or barrier beach | >30,000 | stratigraphic context |

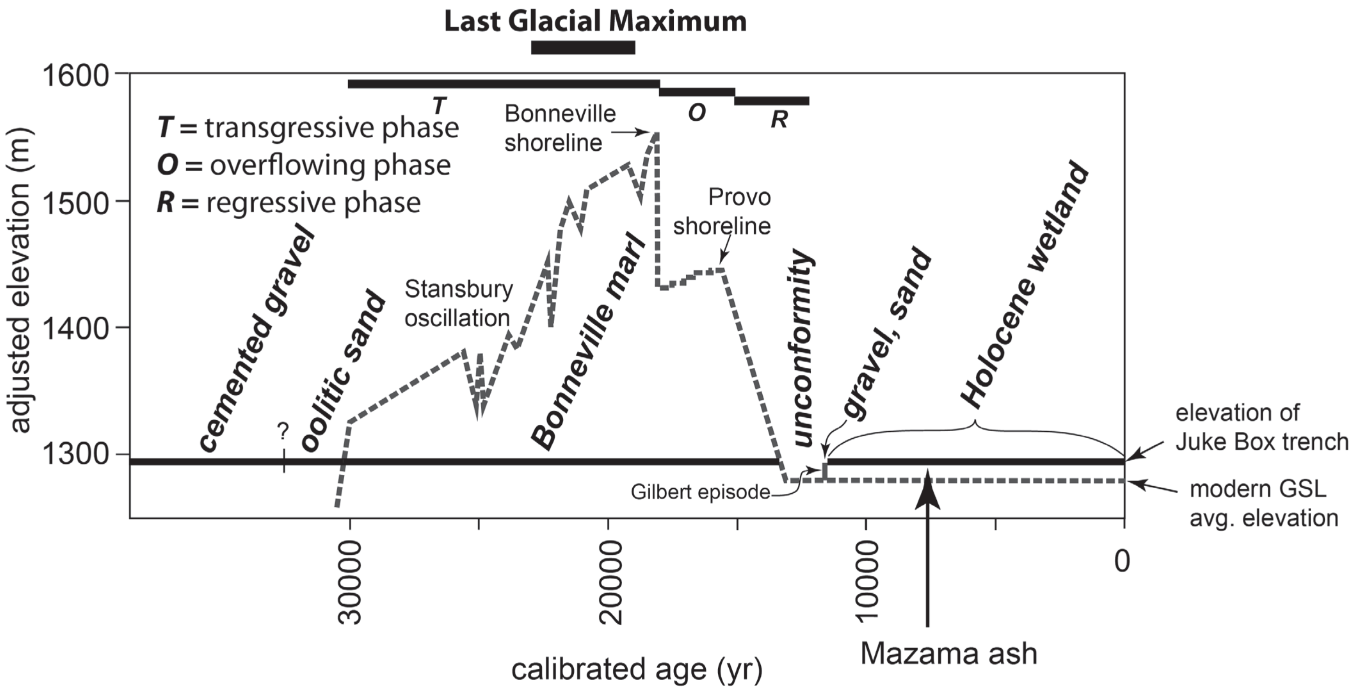


***Figure 7.*** *Summary diagram showing the relative ages of lithologic units exposed in the Juke Box trench compared to the approximate lake-level changes during the Bonneville lake cycle (dashed line). Elevations are adjusted for the effects of differential isostatic rebound in the basin (Oviatt, 2015), which does not affect elevations below about 1300 m, as at Juke Box trench.*

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# APPENDIX

Electron Microprobe (EM) analyses of tephra samples JC5-3 and JC6-4 (= USGS Tephrochronology Project laboratory sample numbers: MOJ09-JC5-3, and MOJ09-JC6-4, respectively) from Juke Box trench, Utah. Tables of volcanic glass compositions, similarity coefficients (Sim. Co.), and geochemical correlatives (at ≥0.98, Sim. Co., without manganese (Mn), and with or without alkalis sodium (Na) and potassium (K)) derived from use of six to eight major and minor elements out of a total of nine EMA elements. Given values are weight percent oxide, normalized to 100 percent. For increased statistical accuracy of correlations, oxides with <0.10 weight percent (in this case MnO) were excluded in comparisons. Also provided are recalculated data tables that exclude sodium and potassium (which are relatively mobile elements) to yield chemical fingerprints using more stable and definitive elements, and to test for reproducibility of correlations.

Electron Microprobe (EM) Analyses by Elmira Wan, U.S. Geological Survey, Menlo Park, CA, 08/03/2017. Identification as Mazama ash.

## JC5-3

Listing of 35 closest matches for COMP. NO. 5850 for 8 elements: Na, Mg, Al, Si, K , Ca, Ti, Fe  Date of Update: 08/03/17

| | C.No | Sample Number | Date | SiO2 | Al2O3 | Fe2O3 | MgO | MnO | CaO | TiO2 | Na2O | K2O | Total,R | Sim. Co. | Comment: |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | 5850 | MOJ09-JC5-3 T580-3 | 4/29/10 | 72.53 | 14.86 | 2.14 | 0.47 | 0.06 | 1.65 | 0.41 | 5.13 | 2.76 | 100.01 | 1.0000 | JUKEBOX TRENCH, UT |
| 2 | 5841 | JSM 09-01d-1 T579-8 | 4/29/10 | 72.65 | 14.89 | 2.14 | 0.47 | 0.06 | 1.64 | 0.41 | 5.03 | 2.71 | 100.00 | 0.9941 | |
| 3 | 958 | DR-72 | | 72.61 | 14.74 | 2.15 | 0.47 | 0.04 | 1.65 | 0.41 | 5.22 | 2.71 | 100.00 | 0.9939 | |
| 4 | 972 | DR-87 | | 72.60 | 14.74 | 2.13 | 0.47 | 0.06 | 1.65 | 0.42 | 5.21 | 2.71 | 99.99 | 0.9911 | |
| 5 | 960 | DR-74 | | 72.85 | 14.65 | 2.11 | 0.46 | 0.04 | 1.65 | 0.41 | 5.12 | 2.71 | 100.00 | 0.9908 | |
| 6 | 3698 | PLB 130 #2 T341-2 | 11/96 | 73.13 | 14.41 | 2.08 | 0.47 | 0.05 | 1.62 | 0.41 | 5.04 | 2.80 | 100.01 | 0.9854 | |
| 7 | 5851 | MOJ09-JC6-4 T580-4 | 4/29/10 | 72.74 | 14.81 | 2.11 | 0.46 | 0.05 | 1.60 | 0.42 | 5.09 | 2.72 | 100.00 | 0.9853 | JUKEBOX TRENCH, UT |
| 8 | 4606 | SG17-A1 T438-10 | 5-5-00 | 73.01 | 14.57 | 2.10 | 0.46 | 0.04 | 1.65 | 0.42 | 5.02 | 2.73 | 100.00 | 0.9847 | |
| 9 | 1178 | DUMP CREEK-1 t89-8 | 2/28/85 | 72.99 | 14.49 | 2.10 | 0.47 | 0.05 | 1.63 | 0.43 | 5.11 | 2.73 | 100.00 | 0.9846 | |
| 10 | 965 | DR-80 | | 72.62 | 14.66 | 2.14 | 0.48 | 0.07 | 1.66 | 0.43 | 5.22 | 2.71 | 99.99 | 0.9846 | |
| 11 | 976 | DR-93 | | 72.83 | 14.45 | 2.17 | 0.48 | 0.05 | 1.69 | 0.41 | 5.22 | 2.71 | 100.01 | 0.9843 | |
| 12 | 3512 | MAZAMA AVR 100 COR | | 72.79 | 14.65 | 2.12 | 0.46 | 0.05 | 1.61 | 0.42 | 5.19 | 2.71 | 100.00 | 0.9842 | Average 100 Mazama samples |
| 13 | 1219 | CRL-8 T88-11 | 5/2/85 | 72.98 | 14.29 | 2.11 | 0.47 | 0.05 | 1.64 | 0.40 | 5.25 | 2.80 | 99.99 | 0.9842 | |
| 14 | 969 | DR-84 | | 72.85 | 14.75 | 2.15 | 0.47 | 0.06 | 1.66 | 0.43 | 4.92 | 2.71 | 100.00 | 0.9840 | |
| 15 | 5847 | JEO 6/23/07-1(10) T579-5 | 3/10/10 | 72.47 | 15.00 | 2.16 | 0.46 | 0.06 | 1.64 | 0.43 | 5.00 | 2.79 | 100.01 | 0.9838 | |
| 16 | 196 | LD-38, T3,4 | | 72.72 | 14.78 | 2.11 | 0.46 | 0.08 | 1.61 | 0.43 | 5.05 | 2.76 | 100.00 | 0.9838 | |
| 17 | 1179 | LRR-KP1 74-75 t89-9 | 2/28/85 | 72.95 | 14.67 | 2.12 | 0.46 | 0.05 | 1.61 | 0.40 | 5.03 | 2.72 | 100.01 | 0.9835 | |
| 18 | 1005 | RC-33 | | 72.82 | 14.46 | 2.15 | 0.46 | 0.05 | 1.61 | 0.41 | 5.32 | 2.71 | 99.99 | 0.9831 | |
| 19 | 5856 | JEO 6-23-07-1(10)combo | | 72.72 | 15.01 | 2.14 | 0.47 | 0.06 | 1.65 | 0.43 | 4.80 | 2.72 | 100.00 | 0.9828 | |
| 20 | 5448 | WE072605-1230 T535-8 | 2/1/06 | 72.85 | 14.68 | 2.11 | 0.45 | 0.05 | 1.59 | 0.42 | 5.09 | 2.76 | 100.00 | 0.9824 | |
| 21 | 5004 | SP-2-24-PW-308 T493-4 | 3-18-03 | 73.15 | 14.68 | 2.14 | 0.48 | 0.05 | 1.62 | 0.41 | 4.72 | 2.75 | 100.00 | 0.9821 | |
| 22 | 4605 | SG11-A1 T438-9 | 5-5-00 | 73.03 | 14.59 | 2.10 | 0.45 | 0.04 | 1.62 | 0.41 | 5.04 | 2.70 | 99.98 | 0.9820 | |
| 23 | 5559 | KP06P49(364-366cm) T546-5 | 3/7/2007 | 72.87 | 14.62 | 2.14 | 0.45 | 0.05 | 1.60 | 0.40 | 5.17 | 2.70 | 100.00 | 0.9816 | |
| 24 | 709 | LD-47* | | 72.40 | 14.74 | 2.18 | 0.47 | 0.05 | 1.61 | 0.42 | 5.42 | 2.71 | 100.00 | 0.9815 | |
| 25 | 4413 | IL-JG-1 T405-7 | 4-1-99 | 72.08 | 14.92 | 2.19 | 0.46 | 0.07 | 1.65 | 0.42 | 5.36 | 2.84 | 99.99 | 0.9813 | |
| 26 | 5726 | FL-D9-A1 T572-8 | 3/18/09 | 72.12 | 14.85 | 2.14 | 0.47 | 0.07 | 1.65 | 0.42 | 5.60 | 2.66 | 99.98 | 0.9812 | |
| 27 | 784 | GS-29 | | 72.37 | 14.94 | 2.14 | 0.46 | 0.05 | 1.67 | 0.45 | 5.11 | 2.81 | 100.00 | 0.9811 | |
| 28 | 4600 | ARN99-11 T438-3 | 5-5-00 | 72.80 | 14.77 | 2.03 | 0.46 | 0.04 | 1.61 | 0.42 | 5.15 | 2.71 | 99.99 | 0.9809 | |
| 29 | 1216 | CRL-3 T88-8 | 5/2/85 | 72.76 | 14.38 | 2.16 | 0.48 | 0.05 | 1.64 | 0.40 | 5.30 | 2.83 | 100.00 | 0.9809 | |
| 30 | 792 | GS-37 | | 72.79 | 14.66 | 2.12 | 0.46 | 0.05 | 1.67 | 0.42 | 5.22 | 2.61 | 100.00 | 0.9806 | |
| 31 | 4737 | LP-WA 98C-6 (0-50CM) T458-4 | 02/14/01 | 73.09 | 14.40 | 2.12 | 0.45 | 0.05 | 1.61 | 0.42 | 5.08 | 2.78 | 100.00 | 0.9806 | |
| 32 | 2344 | FLV-71-FC  T195-5 | 7/21/89 | 73.10 | 14.41 | 2.11 | 0.48 | 0.07 | 1.68 | 0.42 | 5.05 | 2.69 | 100.01 | 0.9806 | |
| 33 | 705 | LD-38 | | 72.74 | 14.75 | 2.11 | 0.46 | 0.08 | 1.61 | 0.43 | 5.02 | 2.81 | 100.01 | 0.9806 | |

| C.No | Sample Number | Date | SiO2 | Al2O3 | Fe2O3 | MgO | MnO | CaO | TiO2 | Na2O | K2O | Total,R | Sim. Co. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 34 2434 | YOUNG 126-7 | 08/10/90 | 72.97 | 14.68 | 2.10 | 0.45 | 0.05 | 1.61 | 0.40 | 4.98 | 2.76 | 100.00 | 0.9803 |
| 35 2431 | YOUNG 124-9 | 08/10/90 | 72.78 | 14.74 | 2.08 | 0.45 | 0.05 | 1.62 | 0.42 | 5.05 | 2.81 | 100.00 | 0.9803 |

Listing of 35 closest matches for COMP. NO. 5850 for 6 elements: Mg, Al, Si, Ca, Ti, Fe  Date of Update: 08/03/17

| C.No | Sample Number | Date | SiO2 | Al2O3 | Fe2O3 | MgO | MnO | CaO | TiO2 | Na2O | K2O | Total,R | Sim. Co. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 5850 | MOJ09-JC5-3 T580-3 | 4/29/10 | 72.53 | 14.86 | 2.14 | 0.47 | 0.06 | 1.65 | 0.41 | 5.13 | 2.76 | 100.01 | 1.0000 |
| 2 5841 | JSM 09-01d-1 T579-8 | 4/29/10 | 72.65 | 14.89 | 2.14 | 0.47 | 0.06 | 1.64 | 0.41 | 5.03 | 2.71 | 100.00 | 0.9984 |
| 3 958 | DR-72 | | 72.61 | 14.74 | 2.15 | 0.47 | 0.04 | 1.65 | 0.41 | 5.22 | 2.71 | 100.00 | 0.9977 |
| 4 5726 | FL-D9-A1 T572-8 | 3/18/09 | 72.12 | 14.85 | 2.14 | 0.47 | 0.07 | 1.65 | 0.42 | 5.60 | 2.66 | 99.98 | 0.9950 |
| 5 972 | DR-87 | | 72.60 | 14.74 | 2.13 | 0.47 | 0.06 | 1.65 | 0.42 | 5.21 | 2.71 | 99.99 | 0.9937 |
| 6 960 | DR-74 | | 72.85 | 14.65 | 2.11 | 0.46 | 0.04 | 1.65 | 0.41 | 5.12 | 2.71 | 100.00 | 0.9910 |
| 7 5712 | FavreLake(composite) | 3/18/09 | 72.29 | 14.83 | 2.10 | 0.47 | 0.06 | 1.64 | 0.42 | 5.56 | 2.62 | 99.99 | 0.9910 |
| 8 5856 | JEO 6-23-07-1(10)combo | | 72.72 | 15.01 | 2.14 | 0.47 | 0.06 | 1.65 | 0.43 | 4.80 | 2.72 | 100.00 | 0.9901 |
| 9 5004 | SP-2-24-PW-308 T493-4 | 3-18-03 | 73.15 | 14.68 | 2.14 | 0.48 | 0.05 | 1.62 | 0.41 | 4.72 | 2.75 | 100.00 | 0.9901 |
| 10 5738 | FL-D9-A1 T572-8 | 6/4/09 | 72.89 | 15.15 | 2.18 | 0.47 | 0.05 | 1.68 | 0.41 | 4.44 | 2.72 | 99.99 | 0.9900 |
| 11 969 | DR-84 | | 72.85 | 14.75 | 2.15 | 0.47 | 0.06 | 1.66 | 0.43 | 4.92 | 2.71 | 100.00 | 0.9885 |
| 12 5739 | FL-D9-A2 T572-9 | 6/4/09 | 73.05 | 15.09 | 2.11 | 0.47 | 0.05 | 1.67 | 0.42 | 4.40 | 2.74 | 100.00 | 0.9880 |
| 13 5736 | FL-C10-A1 T572-6 | 6/4/09 | 73.02 | 15.07 | 2.18 | 0.46 | 0.05 | 1.67 | 0.41 | 4.43 | 2.72 | 100.01 | 0.9880 |
| 14 3945 | SQC-3 T359-6 | 3/97 | 72.83 | 14.84 | 2.19 | 0.48 | 0.06 | 1.69 | 0.41 | 4.71 | 2.80 | 100.01 | 0.9879 |
| 15 709 | LD-47* | | 72.40 | 14.74 | 2.18 | 0.47 | 0.05 | 1.61 | 0.42 | 5.42 | 2.71 | 100.00 | 0.9873 |
| 16 4413 | IL-JG-1 T405-7 | 4-1-99 | 72.08 | 14.92 | 2.19 | 0.46 | 0.07 | 1.65 | 0.42 | 5.36 | 2.84 | 99.99 | 0.9870 |
| 17 1005 | RC-33 | | 72.82 | 14.46 | 2.15 | 0.46 | 0.05 | 1.61 | 0.41 | 5.32 | 2.71 | 99.99 | 0.9865 |
| 18 792 | GS-37 | | 72.79 | 14.66 | 2.12 | 0.46 | 0.05 | 1.67 | 0.42 | 5.22 | 2.61 | 100.00 | 0.9861 |
| 19 3698 | PLB 130 #2 T341-2 | 11/96 | 73.13 | 14.41 | 2.08 | 0.47 | 0.05 | 1.62 | 0.41 | 5.04 | 2.80 | 100.01 | 0.9859 |
| 20 2898 | FLV-1.5 T267-4 | 10/27/92 | 72.10 | 14.96 | 2.09 | 0.47 | 0.05 | 1.65 | 0.39 | 5.55 | 2.72 | 99.98 | 0.9859 |
| 21 5727 | FL-D9-A2 T572-9 | 3/18/09 | 72.41 | 14.76 | 2.07 | 0.49 | 0.06 | 1.66 | 0.41 | 5.57 | 2.57 | 100.00 | 0.9853 |
| 22 965 | DR-80 | | 72.62 | 14.66 | 2.14 | 0.48 | 0.07 | 1.66 | 0.43 | 5.22 | 2.71 | 99.99 | 0.9853 |
| 23 1219 | CRL-8 T88-11 | 5/2/85 | 72.98 | 14.29 | 2.11 | 0.47 | 0.05 | 1.64 | 0.40 | 5.25 | 2.80 | 99.99 | 0.9852 |
| 24 4606 | SG17-A1 T438-10 | 5-5-00 | 73.01 | 14.57 | 2.10 | 0.46 | 0.04 | 1.65 | 0.42 | 5.02 | 2.73 | 100.00 | 0.9850 |
| 25 976 | DR-93 | | 72.83 | 14.45 | 2.17 | 0.48 | 0.05 | 1.69 | 0.41 | 5.22 | 2.71 | 100.01 | 0.9850 |
| 26 798 | GS-44 | | 72.54 | 14.85 | 2.15 | 0.46 | 0.04 | 1.72 | 0.42 | 5.22 | 2.61 | 100.01 | 0.9848 |
| 27 5724 | FL-C10-A1 T572-6 | 3/18/09 | 72.23 | 14.84 | 2.14 | 0.46 | 0.05 | 1.62 | 0.43 | 5.57 | 2.65 | 99.99 | 0.9848 |
| 28 5827 | JEO 6/23/07-1(10) T577-3(Pop2) | 10/7/09 | 73.15 | 15.04 | 2.11 | 0.47 | 0.06 | 1.67 | 0.43 | 4.47 | 2.60 | 100.00 | 0.9845 |
| 29 5847 | JEO 6/23/07-1(10) T579-5 | 3/10/10 | 72.47 | 15.00 | 2.16 | 0.46 | 0.06 | 1.64 | 0.43 | 5.00 | 2.79 | 100.01 | 0.9845 |
| 30 5725 | FL-C10-A2 T572-7 | 3/18/09 | 72.36 | 14.89 | 2.07 | 0.46 | 0.06 | 1.63 | 0.42 | 5.50 | 2.62 | 100.01 | 0.9843 |
| 31 5851 | MOJ09-JC6-4 T580-4 | 4/29/10 | 72.74 | 14.81 | 2.11 | 0.46 | 0.05 | 1.60 | 0.42 | 5.09 | 2.72 | 100.00 | 0.9841 |
| 32 1216 | CRL-3 T88-8 | 5/2/85 | 72.76 | 14.38 | 2.16 | 0.48 | 0.05 | 1.64 | 0.40 | 5.30 | 2.83 | 100.00 | 0.9840 |
| 33 3512 | MAZAMA AVR 100 COR | | 72.79 | 14.65 | 2.12 | 0.46 | 0.05 | 1.61 | 0.42 | 5.19 | 2.71 | 100.00 | 0.9839 |
| 34 1179 | LRR-KP1 74-75 t89-9 | 2/28/85 | 72.95 | 14.67 | 2.12 | 0.46 | 0.05 | 1.61 | 0.40 | 5.03 | 2.72 | 100.01 | 0.9837 |
| 35 3704 | VWB 180 #2 T341-5 | 11/96 | 72.94 | 14.70 | 2.10 | 0.46 | 0.04 | 1.58 | 0.41 | 4.94 | 2.83 | 100.00 | 0.9835 |

Listing of 35 closest matches for COMP. NO. 5853 for 8 elements: Na, Mg, Al, Si, K, Ca, Ti, Fe  Date of Update: 5/11/10

| C.No | Sample Number | Date | SiO2 | Al2O3 | Fe2O3 | MgO | MnO | CaO | TiO2 | Na2O | K2O | Total,R | Sim. Co. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 5853 | MOJ09-JC5-3 T580-3 | 4/29/10 | 72.53 | 14.86 | 2.14 | 0.47 | 0.06 | 1.65 | 0.41 | 5.13 | 2.76 | 100.01 | 1.0000 |
| 2 5844 | JSM 09-01d-1 T579-8 | 4/29/10 | 72.65 | 14.89 | 2.14 | 0.47 | 0.06 | 1.64 | 0.41 | 5.03 | 2.71 | 100.00 | 0.9941 |
| 3 958 | DR-72 | | 72.61 | 14.74 | 2.15 | 0.47 | 0.04 | 1.65 | 0.41 | 5.22 | 2.71 | 100.00 | 0.9939 |
| 4 972 | DR-87 | | 72.60 | 14.74 | 2.13 | 0.47 | 0.06 | 1.65 | 0.42 | 5.21 | 2.71 | 99.99 | 0.9911 |
| 5 960 | DR-74 | | 72.85 | 14.65 | 2.11 | 0.46 | 0.04 | 1.65 | 0.41 | 5.12 | 2.71 | 100.00 | 0.9908 |

| | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 6 | 3698 | PLB 130 #2 T341-2 | 11/96 | 73.13 | 14.41 | 2.08 | 0.47 | 0.05 | 1.62 | 0.41 | 5.04 | 2.80 | 100.01 | 0.9854 |
| 7 | 5854 | MOJ09-JC6-4 T580-4 | 4/29/10 | 72.74 | 14.81 | 2.11 | 0.46 | 0.05 | 1.60 | 0.42 | 5.09 | 2.72 | 100.00 | 0.9853 |
| 8 | 4606 | SG17-A1 T438-10 | 5-5-00 | 73.01 | 14.57 | 2.10 | 0.46 | 0.04 | 1.65 | 0.42 | 5.02 | 2.73 | 100.00 | 0.9847 |
| 9 | 1178 | DUMP CREEK-1 t89-8 | 2/28/85 | 72.99 | 14.49 | 2.10 | 0.47 | 0.05 | 1.63 | 0.43 | 5.11 | 2.73 | 100.00 | 0.9846 |
| 10 | 965 | DR-80 | | 72.62 | 14.66 | 2.14 | 0.48 | 0.07 | 1.66 | 0.43 | 5.22 | 2.71 | 99.99 | 0.9846 |
| 11 | 976 | DR-93 | | 72.83 | 14.45 | 2.17 | 0.48 | 0.05 | 1.69 | 0.41 | 5.22 | 2.71 | 100.01 | 0.9843 |
| 12 | 3512 | MAZAMA AVR 100 COR | | 72.79 | 14.65 | 2.12 | 0.46 | 0.05 | 1.61 | 0.42 | 5.19 | 2.71 | 100.00 | 0.9842 |
| 13 | 1219 | CRL-8 T88-11 | 5/2/85 | 72.98 | 14.29 | 2.11 | 0.47 | 0.05 | 1.64 | 0.40 | 5.25 | 2.80 | 99.99 | 0.9842 |
| 14 | 969 | DR-84 | | 72.85 | 14.75 | 2.15 | 0.47 | 0.06 | 1.66 | 0.43 | 4.92 | 2.71 | 100.00 | 0.9840 |
| 15 | 5850 | JEO 6/23/07-1(10) T579-5 | 3/10/10 | 72.47 | 15.00 | 2.16 | 0.46 | 0.06 | 1.64 | 0.43 | 5.00 | 2.79 | 100.01 | 0.9838 |
| 16 | 196 | LD-38, T3,4 | | 72.72 | 14.78 | 2.11 | 0.46 | 0.08 | 1.61 | 0.43 | 5.05 | 2.76 | 100.00 | 0.9838 |
| 17 | 1179 | LRR-KP1 74-75 t89-9 | 2/28/85 | 72.95 | 14.67 | 2.12 | 0.46 | 0.05 | 1.61 | 0.40 | 5.03 | 2.72 | 100.01 | 0.9835 |
| 18 | 1005 | RC-33 | | 72.82 | 14.46 | 2.15 | 0.46 | 0.05 | 1.61 | 0.41 | 5.32 | 2.71 | 99.99 | 0.9831 |
| 19 | 5448 | WE072605-1230 T535-8 | 2/1/06 | 72.85 | 14.68 | 2.11 | 0.45 | 0.05 | 1.59 | 0.42 | 5.09 | 2.76 | 100.00 | 0.9824 |
| 20 | 5004 | SP-2-24-PW-308 T493-4 | 3-18-03 | 73.15 | 14.68 | 2.14 | 0.48 | 0.05 | 1.62 | 0.41 | 4.72 | 2.75 | 100.00 | 0.9821 |
| 21 | 4605 | SG11-A1 T438-9 | 5-5-00 | 73.03 | 14.59 | 2.10 | 0.45 | 0.04 | 1.62 | 0.41 | 5.04 | 2.70 | 99.98 | 0.9820 |
| 22 | 5559 | KP06P49(364-366cm) T546-5 | 3/7/2007 | 72.87 | 14.62 | 2.14 | 0.45 | 0.05 | 1.60 | 0.40 | 5.17 | 2.70 | 100.00 | 0.9816 |
| 23 | 709 | LD-47* | | 72.40 | 14.74 | 2.18 | 0.47 | 0.05 | 1.61 | 0.42 | 5.42 | 2.71 | 100.00 | 0.9815 |
| 24 | 4413 | IL-JG-1 T405-7 | 4-1-99 | 72.08 | 14.92 | 2.19 | 0.46 | 0.07 | 1.65 | 0.42 | 5.36 | 2.84 | 99.99 | 0.9813 |
| 25 | 5726 | FL-D9-A1 T572-8 | 3/18/09 | 72.12 | 14.85 | 2.14 | 0.47 | 0.07 | 1.65 | 0.42 | 5.60 | 2.66 | 99.98 | 0.9812 |
| 26 | 784 | GS-29 | | 72.37 | 14.94 | 2.14 | 0.46 | 0.05 | 1.67 | 0.45 | 5.11 | 2.81 | 100.00 | 0.9811 |
| 27 | 4600 | ARN99-11 T438-3 | 5-5-00 | 72.80 | 14.77 | 2.03 | 0.46 | 0.04 | 1.61 | 0.42 | 5.15 | 2.71 | 99.99 | 0.9809 |
| 28 | 1216 | CRL-3 T88-8 | 5/2/85 | 72.76 | 14.38 | 2.16 | 0.48 | 0.05 | 1.64 | 0.40 | 5.30 | 2.83 | 100.00 | 0.9809 |
| 29 | 792 | GS-37 | | 72.79 | 14.66 | 2.12 | 0.46 | 0.05 | 1.67 | 0.42 | 5.22 | 2.61 | 100.00 | 0.9806 |
| 30 | 4737 | LP-WA 98C-6 (0-50CM) T458-4 | 02/14/01 | 73.09 | 14.40 | 2.12 | 0.45 | 0.05 | 1.61 | 0.42 | 5.08 | 2.78 | 100.00 | 0.9806 |
| 31 | 2344 | FLV-71-FC T195-5 | 7/21/89 | 73.10 | 14.41 | 2.11 | 0.48 | 0.07 | 1.68 | 0.42 | 5.05 | 2.69 | 100.01 | 0.9806 |
| 32 | 705 | LD-38 | | 72.74 | 14.75 | 2.11 | 0.46 | 0.08 | 1.61 | 0.43 | 5.02 | 2.81 | 100.01 | 0.9806 |
| 33 | 2434 | YOUNG 126-7 T200-1 | 08/10/90 | 72.97 | 14.68 | 2.10 | 0.45 | 0.05 | 1.61 | 0.40 | 4.98 | 2.76 | 100.00 | 0.9803 |
| 34 | 2431 | YOUNG 124-9 T199-6 | 08/10/90 | 72.78 | 14.74 | 2.08 | 0.45 | 0.05 | 1.62 | 0.42 | 5.05 | 2.81 | 100.00 | 0.9803 |
| 35 | 3704 | VWB 180 #2 T341-5 | 11/96 | 72.94 | 14.70 | 2.10 | 0.46 | 0.04 | 1.58 | 0.41 | 4.94 | 2.83 | 100.00 | 0.9799 |

**Listing of 35 closest matches for COMP. NO. 5853 for 6 elements: Mg, Al, Si, Ca, Ti, Fe  Date of Update: 5/11/10**

| | C.No | Sample Number | Date | SiO2 | Al2O3 | Fe2O3 | MgO | MnO | CaO | TiO2 | Na2O | K2O | Total,R | Sim. Co. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | 5853 | MOJ09-JC5-3 T580-3 | 4/29/10 | 72.53 | 14.86 | 2.14 | 0.47 | 0.06 | 1.65 | 0.41 | 5.13 | 2.76 | 100.01 | 1.0000 |
| 2 | 5844 | JSM 09-01d-1 T579-8 | 4/29/10 | 72.65 | 14.89 | 2.14 | 0.47 | 0.06 | 1.64 | 0.41 | 5.03 | 2.71 | 100.00 | 0.9984 |
| 3 | 958 | DR-72 | | 72.61 | 14.74 | 2.15 | 0.47 | 0.04 | 1.65 | 0.41 | 5.22 | 2.71 | 100.00 | 0.9977 |
| 4 | 5726 | FL-D9-A1 T572-8 | 3/18/09 | 72.12 | 14.85 | 2.14 | 0.47 | 0.07 | 1.65 | 0.42 | 5.60 | 2.66 | 99.98 | 0.9950 |
| 5 | 972 | DR-87 | | 72.60 | 14.74 | 2.13 | 0.47 | 0.06 | 1.65 | 0.42 | 5.21 | 2.71 | 99.99 | 0.9937 |
| 6 | 960 | DR-74 | | 72.85 | 14.65 | 2.11 | 0.46 | 0.04 | 1.65 | 0.41 | 5.12 | 2.71 | 100.00 | 0.9910 |
| 7 | 5712 | FavreLake(composite) | 3/18/09 | 72.29 | 14.83 | 2.10 | 0.47 | 0.06 | 1.64 | 0.42 | 5.56 | 2.62 | 99.99 | 0.9910 |
| 8 | 5004 | SP-2-24-PW-308 T493-4 | 3-18-03 | 73.15 | 14.68 | 2.14 | 0.48 | 0.05 | 1.62 | 0.41 | 4.72 | 2.75 | 100.00 | 0.9901 |
| 9 | 5738 | FL-D9-A1 T572-8 | 6/4/09 | 72.89 | 15.15 | 2.18 | 0.47 | 0.05 | 1.68 | 0.41 | 4.44 | 2.72 | 99.99 | 0.9900 |
| 10 | 969 | DR-84 | | 72.85 | 14.75 | 2.15 | 0.47 | 0.06 | 1.66 | 0.43 | 4.92 | 2.71 | 100.00 | 0.9885 |
| 11 | 5739 | FL-D9-A2 T572-9 | 6/4/09 | 73.05 | 15.09 | 2.11 | 0.47 | 0.05 | 1.67 | 0.42 | 4.40 | 2.74 | 100.00 | 0.9880 |
| 12 | 5736 | FL-C10-A1 T572-6 | 6/4/09 | 73.02 | 15.07 | 2.18 | 0.46 | 0.05 | 1.67 | 0.41 | 4.43 | 2.72 | 100.01 | 0.9880 |
| 13 | 3945 | SQC-3 T359-6 | 3/97 | 72.83 | 14.84 | 2.19 | 0.48 | 0.06 | 1.69 | 0.41 | 4.71 | 2.80 | 100.01 | 0.9879 |
| 14 | 709 | LD-47* | | 72.40 | 14.74 | 2.18 | 0.47 | 0.05 | 1.61 | 0.42 | 5.42 | 2.71 | 100.00 | 0.9873 |
| 15 | 4413 | IL-JG-1 T405-7 | 4-1-99 | 72.08 | 14.92 | 2.19 | 0.46 | 0.07 | 1.65 | 0.42 | 5.36 | 2.84 | 99.99 | 0.9870 |
| 16 | 1005 | RC-33 | | 72.82 | 14.46 | 2.15 | 0.46 | 0.05 | 1.61 | 0.41 | 5.32 | 2.71 | 99.99 | 0.9865 |

| | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 17 | 792 | GS-37 | | 72.79 | 14.66 | 2.12 | 0.46 | 0.05 | 1.67 | 0.42 | 5.22 | 2.61 | 100.00 | 0.9861 |
| 18 | 3698 | PLB 130 #2 T341-2 | 11/96 | 73.13 | 14.41 | 2.08 | 0.47 | 0.05 | 1.62 | 0.41 | 5.04 | 2.80 | 100.01 | 0.9859 |
| 19 | 2898 | FLV-1.5 T267-4 | 10/27/92 | 72.10 | 14.96 | 2.09 | 0.47 | 0.05 | 1.65 | 0.39 | 5.55 | 2.72 | 99.98 | 0.9859 |
| 20 | 5727 | FL-D9-A2 T572-9 | 3/18/09 | 72.41 | 14.76 | 2.07 | 0.49 | 0.06 | 1.66 | 0.41 | 5.57 | 2.57 | 100.00 | 0.9853 |
| 21 | 965 | DR-80 | | 72.62 | 14.66 | 2.14 | 0.48 | 0.07 | 1.66 | 0.43 | 5.22 | 2.71 | 99.99 | 0.9853 |
| 22 | 1219 | CRL-8 T88-11 | 5/2/85 | 72.98 | 14.29 | 2.11 | 0.47 | 0.05 | 1.64 | 0.40 | 5.25 | 2.80 | 99.99 | 0.9852 |
| 23 | 4606 | SG17-A1 T438-10 | 5-5-00 | 73.01 | 14.57 | 2.10 | 0.46 | 0.04 | 1.65 | 0.42 | 5.02 | 2.73 | 100.00 | 0.9850 |
| 24 | 976 | DR-93 | | 72.83 | 14.45 | 2.17 | 0.48 | 0.05 | 1.69 | 0.41 | 5.22 | 2.71 | 100.01 | 0.9850 |
| 25 | 798 | GS-44 | | 72.54 | 14.85 | 2.15 | 0.46 | 0.04 | 1.72 | 0.42 | 5.22 | 2.61 | 100.01 | 0.9848 |
| 26 | 5724 | FL-C10-A1 T572-6 | 3/18/09 | 72.23 | 14.84 | 2.14 | 0.46 | 0.05 | 1.62 | 0.43 | 5.57 | 2.65 | 99.99 | 0.9848 |
| 27 | 5830 | JEO 6/23/07-1(10) T577-3(Pop2) | 10/7/09 | 73.15 | 15.04 | 2.11 | 0.47 | 0.06 | 1.67 | 0.43 | 4.47 | 2.60 | 100.00 | 0.9845 |
| 28 | 5850 | JEO 6/23/07-1(10) T579-5 | 3/10/10 | 72.47 | 15.00 | 2.16 | 0.46 | 0.06 | 1.64 | 0.43 | 5.00 | 2.79 | 100.01 | 0.9845 |
| 29 | 5725 | FL-C10-A2 T572-7 | 3/18/09 | 72.36 | 14.89 | 2.07 | 0.46 | 0.06 | 1.63 | 0.42 | 5.50 | 2.62 | 100.01 | 0.9843 |
| 30 | 5854 | MOJ09-JC6-4 T580-4 | 4/29/10 | 72.74 | 14.81 | 2.11 | 0.46 | 0.05 | 1.60 | 0.42 | 5.09 | 2.72 | 100.00 | 0.9841 |
| 31 | 1216 | CRL-3 T88-8 | 5/2/85 | 72.76 | 14.38 | 2.16 | 0.48 | 0.05 | 1.64 | 0.40 | 5.30 | 2.83 | 100.00 | 0.9840 |
| 32 | 3512 | MAZAMA AVR 100 COR | | 72.79 | 14.65 | 2.12 | 0.46 | 0.05 | 1.61 | 0.42 | 5.19 | 2.71 | 100.00 | 0.9839 |
| 33 | 1179 | LRR-KP1 74-75 t89-9 | 2/28/85 | 72.95 | 14.67 | 2.12 | 0.46 | 0.05 | 1.61 | 0.40 | 5.03 | 2.72 | 100.01 | 0.9837 |
| 34 | 3704 | VWB 180 #2 T341-5 | 11/96 | 72.94 | 14.70 | 2.10 | 0.46 | 0.04 | 1.58 | 0.41 | 4.94 | 2.83 | 100.00 | 0.9835 |
| 35 | 957 | DR-71 | | 72.76 | 14.75 | 2.11 | 0.47 | 0.05 | 1.60 | 0.43 | 5.22 | 2.61 | 100.00 | 0.9831 |

## JC6-4

**Listing of 35 closest matches for COMP. NO. 5851 for 8 elements: Na, Mg, Al, Si, K, Ca, Ti, Fe Date of Update: 08/03/17**

| | C.No | Sample Number | Date | SiO2 | Al2O3 | Fe2O3 | MgO | MnO | CaO | TiO2 | Na2O | K2O | Total,R | Sim. Co. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | 5851 | MOJ09-JC6-4 T580-4 | 4/29/10 | 72.74 | 14.81 | 2.11 | 0.46 | 0.05 | 1.60 | 0.42 | 5.09 | 2.72 | 100.00 | 1.0000 |
| 2 | 3512 | MAZAMA AVR 100 COR | | 72.79 | 14.65 | 2.12 | 0.46 | 0.05 | 1.61 | 0.42 | 5.19 | 2.71 | 100.00 | 0.9943 |
| 3 | 5448 | WE072605-1230 T535-8 | 2/1/06 | 72.85 | 14.68 | 2.11 | 0.45 | 0.05 | 1.59 | 0.42 | 5.09 | 2.76 | 100.00 | 0.9934 |
| 4 | 196 | LD-38, T3,4 | | 72.72 | 14.78 | 2.11 | 0.46 | 0.08 | 1.61 | 0.43 | 5.05 | 2.76 | 100.00 | 0.9932 |
| 5 | 4600 | ARN99-11 T438-3 | 5-5-00 | 72.80 | 14.77 | 2.03 | 0.46 | 0.04 | 1.61 | 0.42 | 5.15 | 2.71 | 99.99 | 0.9921 |
| 6 | 4606 | SG17-A1 T438-10 | 5-5-00 | 73.01 | 14.57 | 2.10 | 0.46 | 0.04 | 1.65 | 0.42 | 5.02 | 2.73 | 100.00 | 0.9910 |
| 7 | 960 | DR-74 | | 72.85 | 14.65 | 2.11 | 0.46 | 0.04 | 1.65 | 0.41 | 5.12 | 2.71 | 100.00 | 0.9905 |
| 8 | 705 | LD-38 | | 72.74 | 14.75 | 2.11 | 0.46 | 0.08 | 1.61 | 0.43 | 5.02 | 2.81 | 100.01 | 0.9901 |
| 9 | 872 | LM-39 | | 72.68 | 14.66 | 2.13 | 0.46 | 0.04 | 1.58 | 0.42 | 5.32 | 2.71 | 100.00 | 0.9900 |
| 10 | 1179 | LRR-KP1 74-75 t89-9 | 2/28/85 | 72.95 | 14.67 | 2.12 | 0.46 | 0.05 | 1.61 | 0.40 | 5.03 | 2.72 | 100.01 | 0.9897 |
| 11 | 5189 | SC-GL03U1-5_30CM T505-5 | 12-16-03 | 72.78 | 14.74 | 2.02 | 0.46 | 0.05 | 1.58 | 0.42 | 5.23 | 2.72 | 100.00 | 0.9891 |
| 12 | 4737 | LP-WA 98C-6 (0-50CM) T458-4 | 02/14/01 | 73.09 | 14.40 | 2.12 | 0.45 | 0.05 | 1.61 | 0.42 | 5.08 | 2.78 | 100.00 | 0.9889 |
| 13 | 871 | LM-38 | | 72.62 | 14.74 | 2.09 | 0.45 | 0.06 | 1.59 | 0.42 | 5.32 | 2.71 | 100.00 | 0.9887 |
| 14 | 2431 | YOUNG 124-9 T199-6 | 08/10/90 | 72.78 | 14.74 | 2.08 | 0.45 | 0.05 | 1.62 | 0.42 | 5.05 | 2.81 | 100.00 | 0.9883 |
| 15 | 972 | DR-87 | | 72.60 | 14.74 | 2.13 | 0.47 | 0.06 | 1.65 | 0.42 | 5.21 | 2.71 | 99.99 | 0.9882 |
| 16 | 803 | GS-50 | | 72.74 | 14.83 | 2.10 | 0.45 | 0.05 | 1.60 | 0.42 | 5.21 | 2.60 | 100.00 | 0.9881 |
| 17 | 4629 | FS-9(F34)_pop2 T441-3 | 6-29-00 | 73.03 | 14.59 | 2.15 | 0.46 | 0.06 | 1.56 | 0.42 | 4.97 | 2.75 | 99.99 | 0.9879 |
| 18 | 941 | DR-53 | | 72.75 | 14.65 | 2.16 | 0.46 | 0.05 | 1.58 | 0.43 | 5.22 | 2.71 | 100.01 | 0.9877 |
| 19 | 4605 | SG11-A1 T438-9 | 5-5-00 | 73.03 | 14.59 | 2.10 | 0.45 | 0.04 | 1.62 | 0.41 | 5.04 | 2.70 | 99.98 | 0.9877 |
| 20 | 1178 | DUMP CREEK-1 t89-8 | 2/28/85 | 72.99 | 14.49 | 2.10 | 0.47 | 0.05 | 1.63 | 0.43 | 5.11 | 2.73 | 100.00 | 0.9875 |
| 21 | 830 | GS-76 | | 72.95 | 14.65 | 2.11 | 0.46 | 0.06 | 1.60 | 0.44 | 5.12 | 2.61 | 100.00 | 0.9868 |
| 22 | 5841 | JSM 09-01d-1 T579-8 | 4/29/10 | 72.65 | 14.89 | 2.14 | 0.47 | 0.06 | 1.64 | 0.41 | 5.03 | 2.71 | 100.00 | 0.9868 |
| 23 | 2358 | TWN-L-1.84 | | 73.32 | 14.45 | 2.10 | 0.45 | 0.00 | 1.60 | 0.41 | 4.93 | 2.72 | 99.98 | 0.9858 |
| 24 | 957 | DR-71 | | 72.76 | 14.75 | 2.11 | 0.47 | 0.05 | 1.60 | 0.43 | 5.22 | 2.61 | 100.00 | 0.9857 |
| 25 | 5191 | SC-GL03U1-4_144-145CM T505-7 | 12-16-03 | 72.91 | 14.62 | 2.04 | 0.45 | 0.04 | 1.58 | 0.42 | 5.24 | 2.71 | 100.01 | 0.9856 |
| 26 | 739 | S-23 | | 72.85 | 14.75 | 2.14 | 0.45 | 0.06 | 1.59 | 0.43 | 5.12 | 2.61 | 100.00 | 0.9854 |
| 27 | 5850 | MOJ09-JC5-3 T580-3 | 4/29/10 | 72.53 | 14.86 | 2.14 | 0.47 | 0.06 | 1.65 | 0.41 | 5.13 | 2.76 | 100.01 | 0.9853 |
| 28 | 3704 | VWB 180 #2 T341-5 | 11/96 | 72.94 | 14.70 | 2.10 | 0.46 | 0.04 | 1.58 | 0.41 | 4.94 | 2.83 | 100.00 | 0.9851 |
| 29 | 1005 | RC-33 | | 72.82 | 14.46 | 2.15 | 0.46 | 0.05 | 1.61 | 0.41 | 5.32 | 2.71 | 99.99 | 0.9850 |
| 30 | 5045 | JEO-4/27/02-2(1)pop4(7s) T494- | 3-17-03 | 72.99 | 14.72 | 2.13 | 0.46 | 0.04 | 1.56 | 0.43 | 4.91 | 2.77 | 100.01 | 0.9849 |
| 31 | 5559 | KP06P49(364-366cm) T546-5 | 3/7/2007 | 72.87 | 14.62 | 2.14 | 0.45 | 0.05 | 1.60 | 0.40 | 5.17 | 2.70 | 100.00 | 0.9849 |
| 32 | 1177 | CORN CREEK-1 t89-7 | 2/28/85 | 72.99 | 14.54 | 2.08 | 0.46 | 0.06 | 1.60 | 0.39 | 5.16 | 2.72 | 100.00 | 0.9849 |
| 33 | 792 | GS-37 | | 72.79 | 14.66 | 2.12 | 0.46 | 0.05 | 1.67 | 0.42 | 5.22 | 2.61 | 100.00 | 0.9847 |
| 34 | 959 | DR-73 | | 72.66 | 14.85 | 2.06 | 0.46 | 0.04 | 1.58 | 0.42 | 5.32 | 2.61 | 100.00 | 0.9845 |
| 35 | 999 | RC-23 | | 72.62 | 14.76 | 2.16 | 0.46 | 0.06 | 1.58 | 0.42 | 5.32 | 2.61 | 99.99 | 0.9845 |

**Listing of 35 closest matches for COMP. NO. 5851 for 6 elements: Mg, Al, Si, Ca, Ti, Fe Date of Update: 08/03/17**

| | C.No | Sample Number | Date | SiO2 | Al2O3 | Fe2O3 | MgO | MnO | CaO | TiO2 | Na2O | K2O | Total,R | Sim. Co. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | 5851 | MOJ09-JC6-4 T580-4 | 4/29/10 | 72.74 | 14.81 | 2.11 | 0.46 | 0.05 | 1.60 | 0.42 | 5.09 | 2.72 | 100.00 | 1.0000 |
| 2 | 3512 | MAZAMA AVR 100 COR | | 72.79 | 14.65 | 2.12 | 0.46 | 0.05 | 1.61 | 0.42 | 5.19 | 2.71 | 100.00 | 0.9963 |
| 3 | 803 | GS-50 | | 72.74 | 14.83 | 2.10 | 0.45 | 0.05 | 1.60 | 0.42 | 5.21 | 2.60 | 100.00 | 0.9954 |
| 4 | 196 | LD-38, T3,4 | | 72.72 | 14.78 | 2.11 | 0.46 | 0.08 | 1.61 | 0.43 | 5.05 | 2.76 | 100.00 | 0.9947 |
| 5 | 872 | LM-39 | | 72.68 | 14.66 | 2.13 | 0.46 | 0.04 | 1.58 | 0.42 | 5.32 | 2.71 | 100.00 | 0.9945 |
| 6 | 705 | LD-38 | | 72.74 | 14.75 | 2.11 | 0.46 | 0.08 | 1.61 | 0.43 | 5.02 | 2.81 | 100.01 | 0.9944 |

| | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 7 | 5448 | WE072605-1230 T535-8 | 2/1/06 | 72.85 | 14.68 | 2.11 | 0.45 | 0.05 | 1.59 | 0.42 | 5.09 | 2.76 | 100.00 | 0.9936 |
| 8 | 959 | DR-73 | | 72.66 | 14.85 | 2.06 | 0.46 | 0.04 | 1.58 | 0.42 | 5.32 | 2.61 | 100.00 | 0.9933 |
| 9 | 999 | RC-23 | | 72.62 | 14.76 | 2.16 | 0.46 | 0.06 | 1.58 | 0.42 | 5.32 | 2.61 | 99.99 | 0.9932 |
| 10 | 871 | LM-38 | | 72.62 | 14.74 | 2.09 | 0.45 | 0.06 | 1.59 | 0.42 | 5.32 | 2.71 | 100.00 | 0.9927 |
| 11 | 4600 | ARN99-11 T438-3 | 5-5-00 | 72.80 | 14.77 | 2.03 | 0.46 | 0.04 | 1.61 | 0.42 | 5.15 | 2.71 | 99.99 | 0.9921 |
| 12 | 5725 | FL-C10-A2 T572-7 | 3/18/09 | 72.36 | 14.89 | 2.07 | 0.46 | 0.06 | 1.63 | 0.42 | 5.50 | 2.62 | 100.01 | 0.9920 |
| 13 | 957 | DR-71 | | 72.76 | 14.75 | 2.11 | 0.47 | 0.05 | 1.60 | 0.43 | 5.22 | 2.61 | 100.00 | 0.9919 |
| 14 | 3704 | VWB 180 #2 T341-5 | 11/96 | 72.94 | 14.70 | 2.10 | 0.46 | 0.04 | 1.58 | 0.41 | 4.94 | 2.83 | 100.00 | 0.9915 |
| 15 | 2431 | YOUNG 124-9 T199-6 | 08/10/90 | 72.78 | 14.74 | 2.08 | 0.45 | 0.05 | 1.62 | 0.42 | 5.05 | 2.81 | 100.00 | 0.9911 |
| 16 | 4606 | SG17-A1 T438-10 | 5-5-00 | 73.01 | 14.57 | 2.10 | 0.46 | 0.04 | 1.65 | 0.42 | 5.02 | 2.73 | 100.00 | 0.9908 |
| 17 | 732 | S-11 | | 73.17 | 14.65 | 2.10 | 0.45 | 0.06 | 1.62 | 0.42 | 5.02 | 2.51 | 100.00 | 0.9907 |
| 18 | 792 | GS-37 | | 72.79 | 14.66 | 2.12 | 0.46 | 0.05 | 1.67 | 0.42 | 5.22 | 2.61 | 100.00 | 0.9904 |
| 19 | 5871 | EW-022411-HL T583-2 | 3/15/11 | 72.85 | 14.96 | 2.12 | 0.46 | 0.06 | 1.63 | 0.43 | 4.84 | 2.65 | 100.00 | 0.9903 |
| 20 | 5712 | FavreLake(composite) | 3/18/09 | 72.29 | 14.83 | 2.10 | 0.47 | 0.06 | 1.64 | 0.42 | 5.56 | 2.62 | 99.99 | 0.9903 |
| 21 | 5724 | FL-C10-A1 T572-6 | 3/18/09 | 72.23 | 14.84 | 2.14 | 0.46 | 0.05 | 1.62 | 0.43 | 5.57 | 2.65 | 99.99 | 0.9902 |
| 22 | 830 | GS-76 | | 72.95 | 14.65 | 2.11 | 0.46 | 0.06 | 1.60 | 0.44 | 5.12 | 2.61 | 100.00 | 0.9901 |
| 23 | 5189 | SC-GL03U1-5_30CM T505-5 | 12-16-03 | 72.78 | 14.74 | 2.02 | 0.46 | 0.05 | 1.58 | 0.42 | 5.23 | 2.72 | 100.00 | 0.9899 |
| 24 | 4629 | FS-9(F34)_pop2 T441-3 | 6-29-00 | 73.03 | 14.59 | 2.15 | 0.46 | 0.06 | 1.56 | 0.42 | 4.97 | 2.75 | 99.99 | 0.9896 |
| 25 | 824 | GS-71 | | 73.08 | 14.76 | 2.10 | 0.46 | 0.05 | 1.59 | 0.44 | 5.02 | 2.51 | 100.01 | 0.9893 |
| 26 | 4737 | LP-WA 98C-6 (0-50CM) T458-4 | 02/14/01 | 73.09 | 14.40 | 2.12 | 0.45 | 0.05 | 1.61 | 0.42 | 5.08 | 2.78 | 100.00 | 0.9891 |
| 27 | 960 | DR-74 | | 72.85 | 14.65 | 2.11 | 0.46 | 0.04 | 1.65 | 0.41 | 5.12 | 2.71 | 100.00 | 0.9889 |
| 28 | 5045 | JEO-4/27/02-2(1)pop4(7s) T494- | 3-17-03 | 72.99 | 14.72 | 2.13 | 0.46 | 0.04 | 1.56 | 0.43 | 4.91 | 2.77 | 100.01 | 0.9888 |
| 29 | 972 | DR-87 | | 72.60 | 14.74 | 2.13 | 0.47 | 0.06 | 1.65 | 0.42 | 5.21 | 2.71 | 99.99 | 0.9887 |
| 30 | 709 | LD-47* | | 72.40 | 14.74 | 2.18 | 0.47 | 0.05 | 1.61 | 0.42 | 5.42 | 2.71 | 100.00 | 0.9885 |
| 31 | 941 | DR-53 | | 72.75 | 14.65 | 2.16 | 0.46 | 0.05 | 1.58 | 0.43 | 5.22 | 2.71 | 100.01 | 0.9884 |
| 32 | 5446 | RDK-111505-GV1 T535-1 | 2/1/06 | 73.12 | 14.76 | 2.08 | 0.46 | 0.04 | 1.60 | 0.40 | 4.83 | 2.71 | 100.00 | 0.9883 |
| 33 | 5485 | RDK-111505-GV1 T535-1 | 1/31/06 | 73.12 | 14.76 | 2.08 | 0.46 | 0.04 | 1.60 | 0.40 | 4.83 | 2.71 | 100.00 | 0.9883 |
| 34 | 739 | S-23 | | 72.85 | 14.75 | 2.14 | 0.45 | 0.06 | 1.59 | 0.43 | 5.12 | 2.61 | 100.00 | 0.9882 |
| 35 | 1179 | LRR-KP1 74-75 t89-9 | 2/28/85 | 72.95 | 14.67 | 2.12 | 0.46 | 0.05 | 1.61 | 0.40 | 5.03 | 2.72 | 100.01 | 0.9882 |

**Listing of 35 closest matches for COMP. NO. 5854 for 8 elements: Na, Mg, Al, Si, K, Ca, Ti, Fe  Date of Update: 5/11/10**

| | C.No | Sample Number | Date | SiO2 | Al2O3 | Fe2O3 | MgO | MnO | CaO | TiO2 | Na2O | K2O | Total,R | Sim. Co. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | 5854 | MOJ09-JC6-4 T580-4 | 4/29/10 | 72.74 | 14.81 | 2.11 | 0.46 | 0.05 | 1.60 | 0.42 | 5.09 | 2.72 | 100.00 | 1.0000 |
| 2 | 3512 | MAZAMA AVR 100 COR | | 72.79 | 14.65 | 2.12 | 0.46 | 0.05 | 1.61 | 0.42 | 5.19 | 2.71 | 100.00 | 0.9943 |
| 3 | 5448 | WE072605-1230 T535-8 | 2/1/06 | 72.85 | 14.68 | 2.11 | 0.45 | 0.05 | 1.59 | 0.42 | 5.09 | 2.76 | 100.00 | 0.9934 |
| 4 | 196 | LD-38, T3,4 | | 72.72 | 14.78 | 2.11 | 0.46 | 0.08 | 1.61 | 0.43 | 5.05 | 2.76 | 100.00 | 0.9932 |
| 5 | 4600 | ARN99-11 T438-3 | 5-5-00 | 72.80 | 14.77 | 2.03 | 0.46 | 0.04 | 1.61 | 0.42 | 5.15 | 2.71 | 99.99 | 0.9921 |
| 6 | 4606 | SG17-A1 T438-10 | 5-5-00 | 73.01 | 14.57 | 2.10 | 0.46 | 0.04 | 1.65 | 0.42 | 5.02 | 2.73 | 100.00 | 0.9910 |
| 7 | 960 | DR-74 | | 72.85 | 14.65 | 2.11 | 0.46 | 0.04 | 1.65 | 0.41 | 5.12 | 2.71 | 100.00 | 0.9905 |
| 8 | 705 | LD-38 | | 72.74 | 14.75 | 2.11 | 0.46 | 0.08 | 1.61 | 0.43 | 5.02 | 2.81 | 100.01 | 0.9901 |
| 9 | 872 | LM-39 | | 72.68 | 14.66 | 2.13 | 0.46 | 0.04 | 1.58 | 0.42 | 5.32 | 2.71 | 100.00 | 0.9900 |
| 10 | 1179 | LRR-KP1 74-75 t89-9 | 2/28/85 | 72.95 | 14.67 | 2.12 | 0.46 | 0.05 | 1.61 | 0.40 | 5.03 | 2.72 | 100.01 | 0.9897 |
| 11 | 5189 | SC-GL03U1-5_30CM T505-5 | 12-16-03 | 72.78 | 14.74 | 2.02 | 0.46 | 0.05 | 1.58 | 0.42 | 5.23 | 2.72 | 100.00 | 0.9891 |
| 12 | 4737 | LP-WA 98C-6 (0-50CM) T458-4 | 02/14/01 | 73.09 | 14.40 | 2.12 | 0.45 | 0.05 | 1.61 | 0.42 | 5.08 | 2.78 | 100.00 | 0.9889 |
| 13 | 871 | LM-38 | | 72.62 | 14.74 | 2.09 | 0.45 | 0.06 | 1.59 | 0.42 | 5.32 | 2.71 | 100.00 | 0.9887 |
| 14 | 2431 | YOUNG 124-9 T199-6 | 08/10/90 | 72.78 | 14.74 | 2.08 | 0.45 | 0.05 | 1.62 | 0.42 | 5.05 | 2.81 | 100.00 | 0.9883 |
| 15 | 972 | DR-87 | | 72.60 | 14.74 | 2.13 | 0.47 | 0.06 | 1.65 | 0.42 | 5.21 | 2.71 | 99.99 | 0.9882 |
| 16 | 803 | GS-50 | | 72.74 | 14.83 | 2.10 | 0.45 | 0.05 | 1.60 | 0.42 | 5.21 | 2.60 | 100.00 | 0.9881 |
| 17 | 4629 | FS-9(F34)_pop2 T441-3 | 6-29-00 | 73.03 | 14.59 | 2.15 | 0.46 | 0.06 | 1.56 | 0.42 | 4.97 | 2.75 | 99.99 | 0.9879 |

| | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 18 | 941 | DR-53 | | 72.75 | 14.65 | 2.16 | 0.46 | 0.05 | 1.58 | 0.43 | 5.22 | 2.71 | 100.01 | 0.9877 |
| 19 | 4605 | SG11-A1 T438-9 | 5-5-00 | 73.03 | 14.59 | 2.10 | 0.45 | 0.04 | 1.62 | 0.41 | 5.04 | 2.70 | 99.98 | 0.9877 |
| 20 | 1178 | DUMP CREEK-1 t89-8 | 2/28/85 | 72.99 | 14.49 | 2.10 | 0.47 | 0.05 | 1.63 | 0.43 | 5.11 | 2.73 | 100.00 | 0.9875 |
| 21 | 830 | GS-76 | | 72.95 | 14.65 | 2.11 | 0.46 | 0.06 | 1.60 | 0.44 | 5.12 | 2.61 | 100.00 | 0.9868 |
| 22 | 5844 | JSM 09-01d-1 T579-8 | 4/29/10 | 72.65 | 14.89 | 2.14 | 0.47 | 0.06 | 1.64 | 0.41 | 5.03 | 2.71 | 100.00 | 0.9868 |
| 23 | 2358 | TWN-L-1.84 | | 73.32 | 14.45 | 2.10 | 0.45 | 0.00 | 1.60 | 0.41 | 4.93 | 2.72 | 99.98 | 0.9858 |
| 24 | 957 | DR-71 | | 72.76 | 14.75 | 2.11 | 0.47 | 0.05 | 1.60 | 0.43 | 5.22 | 2.61 | 100.00 | 0.9857 |
| 25 | 5191 | SC-GL03U1-4_144-145CM T505-7 | 12-16-03 | 72.91 | 14.62 | 2.04 | 0.45 | 0.04 | 1.58 | 0.42 | 5.24 | 2.71 | 100.01 | 0.9856 |
| 26 | 739 | S-23 | | 72.85 | 14.75 | 2.14 | 0.45 | 0.06 | 1.59 | 0.43 | 5.12 | 2.61 | 100.00 | 0.9854 |
| 27 | 5853 | MOJ09-JC5-3 T580-3 | 4/29/10 | 72.53 | 14.86 | 2.14 | 0.47 | 0.06 | 1.65 | 0.41 | 5.13 | 2.76 | 100.01 | 0.9853 |
| 28 | 3704 | VWB 180 #2 T341-5 | 11/96 | 72.94 | 14.70 | 2.10 | 0.46 | 0.04 | 1.58 | 0.41 | 4.94 | 2.83 | 100.00 | 0.9851 |
| 29 | 1005 | RC-33 | | 72.82 | 14.46 | 2.15 | 0.46 | 0.05 | 1.61 | 0.41 | 5.32 | 2.71 | 99.99 | 0.9850 |
| 30 | 5045 | JEO-4/27/02-2(1)pop4(7s) T494- | 3-17-03 | 72.99 | 14.72 | 2.13 | 0.46 | 0.04 | 1.56 | 0.43 | 4.91 | 2.77 | 100.01 | 0.9849 |
| 31 | 5559 | KP06P49(364-366cm) T546-5 | 3/7/2007 | 72.87 | 14.62 | 2.14 | 0.45 | 0.05 | 1.60 | 0.40 | 5.17 | 2.70 | 100.00 | 0.9849 |
| 32 | 1177 | CORN CREEK-1 t89-7 | 2/28/85 | 72.99 | 14.54 | 2.08 | 0.46 | 0.06 | 1.60 | 0.39 | 5.16 | 2.72 | 100.00 | 0.9849 |
| 33 | 792 | GS-37 | | 72.79 | 14.66 | 2.12 | 0.46 | 0.05 | 1.67 | 0.42 | 5.22 | 2.61 | 100.00 | 0.9847 |
| 34 | 959 | DR-73 | | 72.66 | 14.85 | 2.06 | 0.46 | 0.04 | 1.58 | 0.42 | 5.32 | 2.61 | 100.00 | 0.9845 |
| 35 | 999 | RC-23 | | 72.62 | 14.76 | 2.16 | 0.46 | 0.06 | 1.58 | 0.42 | 5.32 | 2.61 | 99.99 | 0.9845 |

**Listing of 35 closest matches for COMP. NO. 5854 for 6 elements: Mg, Al, Si, Ca, Ti, Fe  Date of Update: 5/11/10**

| | C.No | Sample Number | Date | SiO2 | Al2O3 | Fe2O3 | MgO | MnO | CaO | TiO2 | Na2O | K2O | Total,R | Sim. Co |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | 5854 | MOJ09-JC6-4 T580-4 | 4/29/10 | 72.74 | 14.81 | 2.11 | 0.46 | 0.05 | 1.60 | 0.42 | 5.09 | 2.72 | 100.00 | 1.0000 |
| 2 | 3512 | MAZAMA AVR 100 COR | | 72.79 | 14.65 | 2.12 | 0.46 | 0.05 | 1.61 | 0.42 | 5.19 | 2.71 | 100.00 | 0.9963 |
| 3 | 803 | GS-50 | | 72.74 | 14.83 | 2.10 | 0.45 | 0.05 | 1.60 | 0.42 | 5.21 | 2.60 | 100.00 | 0.9954 |
| 4 | 196 | LD-38, T3,4 | | 72.72 | 14.78 | 2.11 | 0.46 | 0.08 | 1.61 | 0.43 | 5.05 | 2.76 | 100.00 | 0.9947 |
| 5 | 872 | LM-39 | | 72.68 | 14.66 | 2.13 | 0.46 | 0.04 | 1.58 | 0.42 | 5.32 | 2.71 | 100.00 | 0.9945 |
| 6 | 705 | LD-38 | | 72.74 | 14.75 | 2.11 | 0.46 | 0.08 | 1.61 | 0.43 | 5.02 | 2.81 | 100.01 | 0.9944 |
| 7 | 5448 | WE072605-1230 T535-8 | 2/1/06 | 72.85 | 14.68 | 2.11 | 0.45 | 0.05 | 1.59 | 0.42 | 5.09 | 2.76 | 100.00 | 0.9936 |
| 8 | 959 | DR-73 | | 72.66 | 14.85 | 2.06 | 0.46 | 0.04 | 1.58 | 0.42 | 5.32 | 2.61 | 100.00 | 0.9933 |
| 9 | 999 | RC-23 | | 72.62 | 14.76 | 2.16 | 0.46 | 0.06 | 1.58 | 0.42 | 5.32 | 2.61 | 99.99 | 0.9932 |
| 10 | 871 | LM-38 | | 72.62 | 14.74 | 2.09 | 0.45 | 0.06 | 1.59 | 0.42 | 5.32 | 2.71 | 100.00 | 0.9927 |
| 11 | 4600 | ARN99-11 T438-3 | 5-5-00 | 72.80 | 14.77 | 2.03 | 0.46 | 0.04 | 1.61 | 0.42 | 5.15 | 2.71 | 99.99 | 0.9921 |
| 12 | 5725 | FL-C10-A2 T572-7 | 3/18/09 | 72.36 | 14.89 | 2.07 | 0.46 | 0.06 | 1.63 | 0.42 | 5.50 | 2.62 | 100.01 | 0.9920 |
| 13 | 957 | DR-71 | | 72.76 | 14.75 | 2.11 | 0.47 | 0.05 | 1.60 | 0.43 | 5.22 | 2.61 | 100.00 | 0.9919 |
| 14 | 3704 | VWB 180 #2 T341-5 | 11/96 | 72.94 | 14.70 | 2.10 | 0.46 | 0.04 | 1.58 | 0.41 | 4.94 | 2.83 | 100.00 | 0.9915 |
| 15 | 2431 | YOUNG 124-9 | 08/10/90 | 72.78 | 14.74 | 2.08 | 0.45 | 0.05 | 1.62 | 0.42 | 5.05 | 2.81 | 100.00 | 0.9911 |
| 16 | 4606 | SG17-A1 T438-10 | 5-5-00 | 73.01 | 14.57 | 2.10 | 0.46 | 0.04 | 1.65 | 0.42 | 5.02 | 2.73 | 100.00 | 0.9908 |
| 17 | 732 | S-11 | | 73.17 | 14.65 | 2.10 | 0.45 | 0.06 | 1.62 | 0.42 | 5.02 | 2.51 | 100.00 | 0.9907 |
| 18 | 792 | GS-37 | | 72.79 | 14.66 | 2.12 | 0.46 | 0.05 | 1.67 | 0.42 | 5.22 | 2.61 | 100.00 | 0.9904 |
| 19 | 5712 | FavreLake(composite) | 3/18/09 | 72.29 | 14.83 | 2.10 | 0.47 | 0.06 | 1.64 | 0.42 | 5.56 | 2.62 | 99.99 | 0.9903 |
| 20 | 5724 | FL-C10-A1 T572-6 | 3/18/09 | 72.23 | 14.84 | 2.14 | 0.46 | 0.05 | 1.62 | 0.43 | 5.57 | 2.65 | 99.99 | 0.9902 |
| 21 | 830 | GS-76 | | 72.95 | 14.65 | 2.11 | 0.46 | 0.06 | 1.60 | 0.44 | 5.12 | 2.61 | 100.00 | 0.9901 |
| 22 | 5189 | SC-GL03U1-5_30CM T505-5 | 12-16-03 | 72.78 | 14.74 | 2.02 | 0.46 | 0.05 | 1.58 | 0.42 | 5.23 | 2.72 | 100.00 | 0.9899 |
| 23 | 4629 | FS-9(F34)_pop2 T441-3 | 6-29-00 | 73.03 | 14.59 | 2.15 | 0.46 | 0.06 | 1.56 | 0.42 | 4.97 | 2.75 | 99.99 | 0.9896 |
| 24 | 824 | GS-71 | | 73.08 | 14.76 | 2.10 | 0.46 | 0.05 | 1.59 | 0.44 | 5.02 | 2.51 | 100.01 | 0.9893 |
| 25 | 4737 | LP-WA 98C-6 (0-50CM) T458-4 | 02/14/01 | 73.09 | 14.40 | 2.12 | 0.45 | 0.05 | 1.61 | 0.42 | 5.08 | 2.78 | 100.00 | 0.9891 |
| 26 | 960 | DR-74 | | 72.85 | 14.65 | 2.11 | 0.46 | 0.04 | 1.65 | 0.41 | 5.12 | 2.71 | 100.00 | 0.9889 |
| 27 | 5045 | JEO-4/27/02-2(1)pop4(7s) T494- | 3-17-03 | 72.99 | 14.72 | 2.13 | 0.46 | 0.04 | 1.56 | 0.43 | 4.91 | 2.77 | 100.01 | 0.9888 |
| 28 | 972 | DR-87 | | 72.60 | 14.74 | 2.13 | 0.47 | 0.06 | 1.65 | 0.42 | 5.21 | 2.71 | 99.99 | 0.9887 |

| | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 29 | 709 | LD-47* | | 72.40 | 14.74 | 2.18 | 0.47 | 0.05 | 1.61 | 0.42 | 5.42 | 2.71 | 100.00 | 0.9885 |
| 30 | 941 | DR-53 | | 72.75 | 14.65 | 2.16 | 0.46 | 0.05 | 1.58 | 0.43 | 5.22 | 2.71 | 100.01 | 0.9884 |
| 31 | 5446 | RDK-111505-GV1 T535-1 | 2/1/06 | 73.12 | 14.76 | 2.08 | 0.46 | 0.04 | 1.60 | 0.40 | 4.83 | 2.71 | 100.00 | 0.9883 |
| 32 | 5485 | RDK-111505-GV1 T535-1 | 1/31/06 | 73.12 | 14.76 | 2.08 | 0.46 | 0.04 | 1.60 | 0.40 | 4.83 | 2.71 | 100.00 | 0.9883 |
| 33 | 739 | S-23 | | 72.85 | 14.75 | 2.14 | 0.45 | 0.06 | 1.59 | 0.43 | 5.12 | 2.61 | 100.00 | 0.9882 |
| 34 | 1179 | LRR-KP1 74-75 t89-9 | 2/28/85 | 72.95 | 14.67 | 2.12 | 0.46 | 0.05 | 1.61 | 0.40 | 5.03 | 2.72 | 100.01 | 0.9882 |
| 35 | 1005 | RC-33 | | 72.82 | 14.46 | 2.15 | 0.46 | 0.05 | 1.61 | 0.41 | 5.32 | 2.71 | 99.99 | 0.9878 |

**JC5-3** (= USGS Tephrochronology Project laboratory sample ID: **MOJ09-JC5-3**). Table of un-normalized individual volcanic glass shard compositions as determined by electron microprobe (Total: 20 grains, including incidental non-glass (mineral, devitrified or lithic) grains), and original oxide totals. Original oxide total indicates approximate degree of hydration of a single glass shard.

Raw (un-recalculated) sample mean composition, and single shard mean elemental oxide levels, standard deviations, ranges, minimum and maximum oxide amounts and compositions, counts, and confidence levels are also listed.

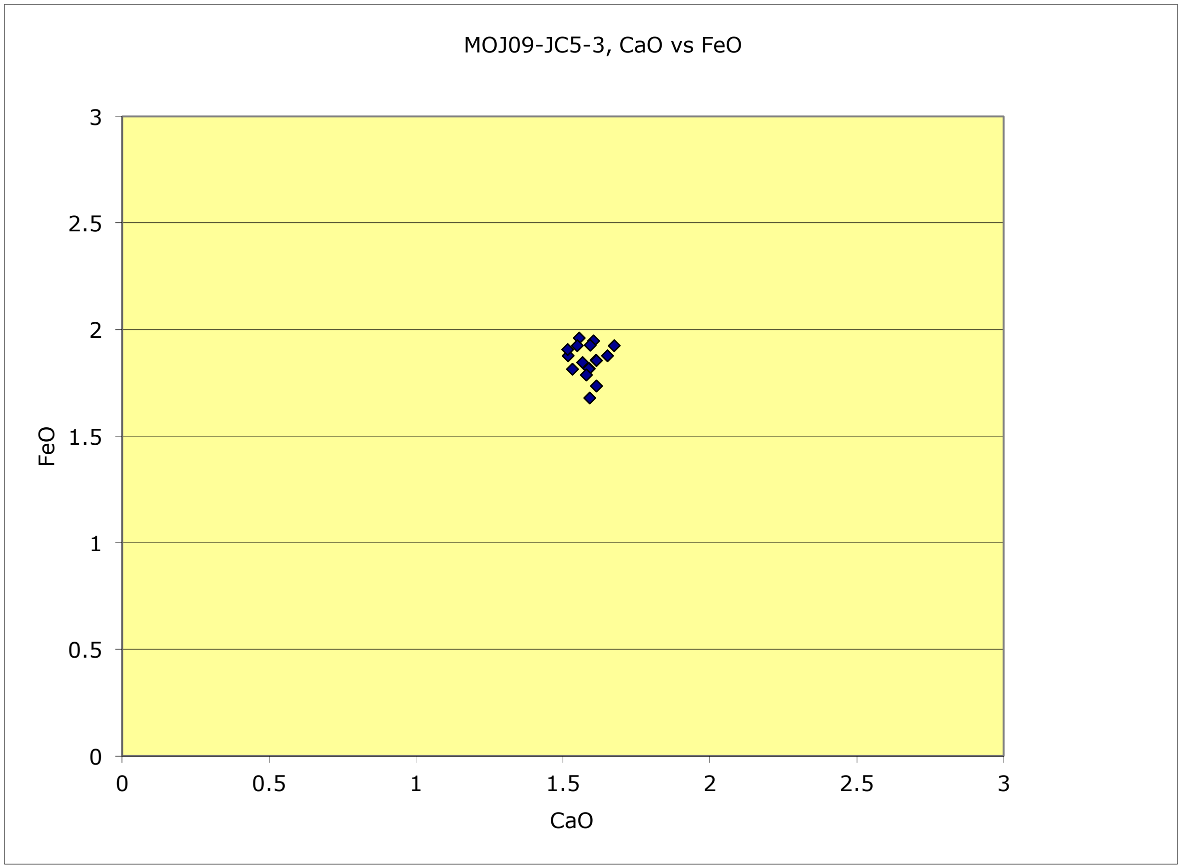
## MOJ09-JC5-3 T580-3

| No. | | Na2O | MgO | Al2O3 | SiO2 | K2O | CaO | TiO2 | MnO | FeO | Total | Sample ID, EM Mount, Hole, & Point #s |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 132 | 4.750 | 0.462 | 13.937 | 68.591 | 2.544 | 1.533 | 0.393 | 0.036 | 1.814 | 94.060 | MOJ09-JC5-3 T580-3 2 |
| | 133 | 4.782 | 0.419 | 14.323 | 70.017 | 2.711 | 1.589 | 0.368 | 0.017 | 1.818 | 96.044 | MOJ09-JC5-3 T580-3 3 |
| | 134 | 4.885 | 0.456 | 14.079 | 69.484 | 2.727 | 1.592 | 0.362 | 0.018 | 1.680 | 95.283 | MOJ09-JC5-3 T580-3 4 |
| | 136 | 5.112 | 0.468 | 14.472 | 70.607 | 2.655 | 1.652 | 0.363 | 0.063 | 1.877 | 97.269 | MOJ09-JC5-3 T580-3 6 |
| | 137 | 4.887 | 0.439 | 14.193 | 68.897 | 2.610 | 1.588 | 0.440 | 0.065 | 1.816 | 94.935 | MOJ09-JC5-3 T580-3 7 |
| | 138 | 4.713 | 0.429 | 14.111 | 68.658 | 2.684 | 1.517 | 0.407 | 0.063 | 1.877 | 94.459 | MOJ09-JC5-3 T580-3 8 |
| | 139 | 5.352 | 0.407 | 14.496 | 71.319 | 2.680 | 1.516 | 0.398 | 0.058 | 1.908 | 98.134 | MOJ09-JC5-3 T580-3 9 |
| | 140 | 5.050 | 0.473 | 14.366 | 70.007 | 2.731 | 1.612 | 0.409 | 0.056 | 1.858 | 96.562 | MOJ09-JC5-3 T580-3 10 |
| | 141 | 4.884 | 0.485 | 14.640 | 70.145 | 2.790 | 1.614 | 0.332 | 0.074 | 1.735 | 96.699 | MOJ09-JC5-3 T580-3 11 |
| | 142 | 5.010 | 0.442 | 14.401 | 70.627 | 2.678 | 1.674 | 0.401 | 0.055 | 1.924 | 97.212 | MOJ09-JC5-3 T580-3 12 |
| | 143 | 5.036 | 0.442 | 14.164 | 69.115 | 2.626 | 1.567 | 0.353 | 0.053 | 1.847 | 95.203 | MOJ09-JC5-3 T580-3 13 |
| | 144 | 4.822 | 0.433 | 14.433 | 70.345 | 2.661 | 1.605 | 0.423 | 0.077 | 1.947 | 96.746 | MOJ09-JC5-3 T580-3 14 |
| | 145 | 4.877 | 0.486 | 14.289 | 70.079 | 2.643 | 1.580 | 0.415 | 0.061 | 1.788 | 96.218 | MOJ09-JC5-3 T580-3 15 |
| | 146 | 4.964 | 0.473 | 14.672 | 70.363 | 2.630 | 1.593 | 0.384 | 0.064 | 1.927 | 97.070 | MOJ09-JC5-3 T580-3 16 |
| | 147 | 5.167 | 0.476 | 14.398 | 70.462 | 2.576 | 1.556 | 0.419 | 0.079 | 1.960 | 97.093 | MOJ09-JC5-3 T580-3 17 |
| | 149 | 4.980 | 0.478 | 14.309 | 70.130 | 2.582 | 1.614 | 0.459 | 0.053 | 1.855 | 96.460 | MOJ09-JC5-3 T580-3 19 |
| | 150 | 4.673 | 0.463 | 13.774 | 67.755 | 2.610 | 1.548 | 0.346 | 0.035 | 1.924 | 93.128 | MOJ09-JC5-3 T580-3 20 |
| Feldspars | | | | | | | | | | | | |
| | 131 | 6.226 | 0.181 | 20.002 | 61.052 | 1.366 | 4.498 | 0.207 | 0.041 | 0.969 | 94.542 | MOJ09-JC5-3 T580-3 1 |
| | 135 | 5.410 | 0.041 | 28.261 | 54.408 | 0.133 | 10.315 | 0.016 | 0.034 | 0.493 | 99.111 | MOJ09-JC5-3 T580-3 5 |
| | 148 | 7.217 | 0.025 | 25.652 | 58.980 | 0.311 | 7.033 | 0.035 | 0.034 | 0.393 | 99.680 | MOJ09-JC5-3 T580-3 18 |

| *Column1* | Na2O | MgO | Al2O3 | SiO2 | K2O | CaO | TiO2 | MnO | FeO | Total |
|---|---|---|---|---|---|---|---|---|---|---|
| Mean | 4.938 | 0.455 | 14.297 | 69.800 | 2.655 | 1.585 | 0.392 | 0.055 | 1.856 | 96.034 |
| Standard Deviation | 0.175 | 0.024 | 0.236 | 0.916 | 0.063 | 0.043 | 0.035 | 0.018 | 0.076 | 1.329 |

| | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| Range | 0.679 | 0.079 | 0.898 | 3.564 | 0.246 | 0.158 | 0.127 | 0.062 | 0.280 | 5.006 |
| Minimum | 4.673 | 0.407 | 13.774 | 67.755 | 2.544 | 1.516 | 0.332 | 0.017 | 1.680 | 93.128 |
| Maximum | 5.352 | 0.486 | 14.672 | 71.319 | 2.790 | 1.674 | 0.459 | 0.079 | 1.960 | 98.134 |
| Count | 17 | 17 | 17 | 17 | 17 | 17 | 17 | 17 | 17 | 17 |
| Confidence Level(95.0%) | 0.090 | 0.012 | 0.121 | 0.471 | 0.032 | 0.022 | 0.018 | 0.009 | 0.039 | 0.683 |

**JC5-3** (= USGS Tephrochronology Project laboratory sample ID: **MOJ09-JC5-3).** Calcium (Ca) versus iron (Fe) oxide scatter diagram graphically depicting the chemical fingerprint for JC5-3. X-Y plot uses individual glass shard calcium versus iron oxide values which were acquired by electron microprobe. Calcium and iron were used because these are relatively stable elements.



**JC6-4** (= USGS Tephrochronology Project laboratory sample ID: **MOJ09-JC6-4**): Table of un-normalized individual volcanic glass shard compositions as determined by electron microprobe (Total: 20 grains, including incidental non-glass (mineral, devitrified or lithic) grains), and original oxide totals. Original oxide total indicates approximate degree of hydration of a single glass shard.

Raw (un-recalculated) sample mean composition, and single shard mean elemental oxide levels, standard deviations, ranges, minimum and maximum oxide amounts and compositions, counts, and confidence levels are also listed.

**MOJ09-JC6-4 T580-4**

| No. | | Na2O | MgO | Al2O3 | SiO2 | K2O | CaO | TiO2 | MnO | FeO | Total | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 151 | 4.863 | 0.557 | 14.388 | 69.855 | 2.674 | 1.685 | 0.415 | 0.074 | 1.885 | 96.396 | MOJ09-JC6-4 T580-4 1 |
| | 152 | 5.105 | 0.451 | 14.381 | 70.344 | 2.582 | 1.627 | 0.413 | 0.042 | 1.761 | 96.706 | MOJ09-JC6-4 T580-4 2 |
| | 153 | 5.023 | 0.420 | 14.345 | 70.728 | 2.619 | 1.382 | 0.390 | 0.051 | 1.707 | 96.665 | MOJ09-JC6-4 T580-4 3 |
| | 154 | 4.860 | 0.423 | 13.916 | 68.382 | 2.693 | 1.562 | 0.417 | 0.054 | 1.594 | 93.901 | MOJ09-JC6-4 T580-4 4 |
| | 156 | 4.926 | 0.489 | 14.456 | 70.770 | 2.615 | 1.657 | 0.479 | 0.061 | 1.914 | 97.367 | MOJ09-JC6-4 T580-4 6 |
| | 157 | 5.100 | 0.465 | 14.370 | 70.209 | 2.521 | 1.626 | 0.382 | 0.065 | 1.919 | 96.737 | MOJ09-JC6-4 T580-4 7 |
| | 158 | 4.770 | 0.467 | 14.240 | 70.368 | 2.676 | 1.633 | 0.413 | 0.087 | 1.851 | 96.505 | MOJ09-JC6-4 T580-4 8 |
| | 159 | 4.785 | 0.407 | 13.820 | 68.192 | 2.539 | 1.470 | 0.332 | 0.044 | 1.872 | 93.461 | MOJ09-JC6-4 T580-4 9 |
| | 160 | 4.893 | 0.445 | 14.420 | 70.534 | 2.635 | 1.488 | 0.380 | 0.053 | 2.013 | 96.861 | MOJ09-JC6-4 T580-4 10 |
| | 161 | 4.861 | 0.445 | 14.310 | 69.817 | 2.671 | 1.508 | 0.427 | 0.041 | 1.847 | 95.927 | MOJ09-JC6-4 T580-4 11 |
| | 165 | 5.068 | 0.418 | 14.305 | 70.483 | 2.678 | 1.437 | 0.398 | 0.059 | 1.843 | 96.689 | MOJ09-JC6-4 T580-4 15 |
| | 166 | 4.681 | 0.413 | 14.576 | 70.104 | 2.674 | 1.510 | 0.409 | 0.041 | 1.744 | 96.152 | MOJ09-JC6-4 T580-4 16 |
| | 167 | 4.949 | 0.420 | 14.434 | 69.775 | 2.555 | 1.558 | 0.405 | 0.013 | 1.862 | 95.971 | MOJ09-JC6-4 T580-4 17 |
| | 168 | 4.644 | 0.391 | 13.860 | 70.144 | 2.668 | 1.444 | 0.422 | 0.014 | 1.652 | 95.239 | MOJ09-JC6-4 T580-4 18 |
| | 169 | 4.854 | 0.396 | 14.045 | 71.024 | 2.603 | 1.464 | 0.422 | 0.009 | 1.806 | 96.623 | MOJ09-JC6-4 T580-4 19 |
| | 170 | 5.073 | 0.447 | 14.474 | 70.486 | 2.588 | 1.606 | 0.355 | 0.046 | 1.950 | 97.025 | MOJ09-JC6-4 T580-4 20 |
| Low Totals | | | | | | | | | | | | |
| | 155 | 4.630 | 0.396 | 12.862 | 63.521 | 2.306 | 1.304 | 0.331 | 0.038 | 1.667 | 87.055 | MOJ09-JC6-4 T580-4 5 |
| | 163 | 4.172 | 0.301 | 9.955 | 38.923 | 2.284 | 1.336 | 0.373 | 0.036 | 1.429 | 58.809 | MOJ09-JC6-4 T580-4 13 |
| High Ca | | | | | | | | | | | | |
| | 162 | 5.014 | 0.365 | 15.163 | 67.640 | 2.405 | 2.219 | 0.363 | 0.055 | 1.454 | 94.678 | MOJ09-JC6-4 T580-4 12 |
| Feldspar | | | | | | | | | | | | |
| | 164 | 6.531 | 0.049 | 25.118 | 56.668 | 0.318 | 7.379 | 0.041 | 0 | 0.369 | 96.473 | MOJ09-JC6-4 T580-4 14 |

| *Column1* | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| Mean | 4.908 | 0.441 | 14.271 | 70.076 | 2.624 | 1.541 | 0.404 | 0.047 | 1.826 | 96.139 |
| Standard Deviation | 0.152 | 0.041 | 0.233 | 0.781 | 0.055 | 0.091 | 0.033 | 0.021 | 0.111 | 1.082 |
| Range | 0.536 | 0.166 | 0.756 | 2.832 | 0.172 | 0.303 | 0.147 | 0.078 | 0.419 | 3.906 |
| Minimum | 4.644 | 0.391 | 13.820 | 68.192 | 2.521 | 1.382 | 0.332 | 0.009 | 1.594 | 93.461 |
| Maximum | 5.180 | 0.557 | 14.576 | 71.024 | 2.693 | 1.685 | 0.479 | 0.087 | 2.013 | 97.367 |
| Count | 16 | 16 | 16 | 16 | 16 | 16 | 16 | 16 | 16 | 16 |
| Confidence Level(95.0%) | 0.081 | 0.022 | 0.124 | 0.416 | 0.029 | 0.048 | 0.017 | 0.011 | 0.059 | 0.577 |

**JC6-4** (= USGS Tephrochronology Project laboratory sample ID: **MOJ09-JC6-4 T580-4).** Calcium (Ca) versus iron (Fe) oxide scatter diagram graphically depicting the chemical fingerprint for JC5-3. X-Y plot uses individual glass shard calcium versus iron oxide values which were acquired by electron microprobe. Calcium and iron were used because these are relatively stable elements.