BONNEVILLE BASIN ANALOGUES FOR LARGE LAKE PROCESSES & CHRONOLOGIES OF GEOMORPHIC DEVELOPMENT ON MARS.

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Introduction: Pleistocene Lake Bonneville was a large (~50,000 sq km) terrestrial closed lake system in Utah, USA that developed during the Last Glacial Maximum (~20 ka BP), and persisted at highstand until a catastrophic outburst flood event ~17.4 ka cal BP and warming climate significantly lowered its volume [1]. Lake Bonneville and its modern relict Great Salt Lake (fig. 1) is one of the most extensive, well preserved, and best dated lake systems on Earth and can serve as an analogue for deducing the style of development and age of similar features imaged on Mars [2]. Lake Bonneville exhibits prominent shorelines, spits, bay mouth barriers, deltas, gullies, outburst channels, and playa lake features, including patterned grounds and downwind aeolian systems, all of which are features inferred from imagery of Mars landforms.

Discussion: We have begun to inventory geomorphic analogues for Lake Bonneville and Mars, with focus on potential standing-water features (e.g., figs. 2 and 3). Lake Bonneville is a better comparison than Earth's tidal oceans, given Mars' small moons and great distance from the sun [3]. The Bonneville Basin preserves a number of morphologies that record surface water dynamics, and easy field access permits detailed study that can build upon the existing interpretations available for Bonneville at a variety of temporal and spatial scales:

-- The size of Lake Bonneville is a close approximation to a number of the proposed water bodies believed to have existed in the craters of Mars [4].

-- The extensional tectonic setting of Bonneville Basin produced a steep sided water body that closely approximates morphologies of Martian craters [5-6].

-- The diversity of landforms (some showing cross-cutting relationships) preserved at Lake Bonneville include gullies, channels, deltas, fans, shorelines [7] similar to what has been observed on Mars (e.g., HiRISE images).

-- Rapid climatic change from lacustrine to arid conditions in this part of Utah during the Pleistocene – Holocene transition [8] enables comparisons to Mars.

The sentimentology, geochronology, and geomorphology of Lake Bonneville is well established, and the analysis of shoreline features has yielded specific parameters, including paleowater depths, fetch, duration of wave activity, etc [9-10]. Landforms associated with Bonneville include erosional and aggradational sedimentary features that developed over different timescales, ranging from gradual (e.g., wave-cut shoreline terraces, lobate fan deltas developed over 1000s of years) to the sudden or catastrophic (e.g., outburst channels, boulder-strewn plains developed over 10-100s of years).

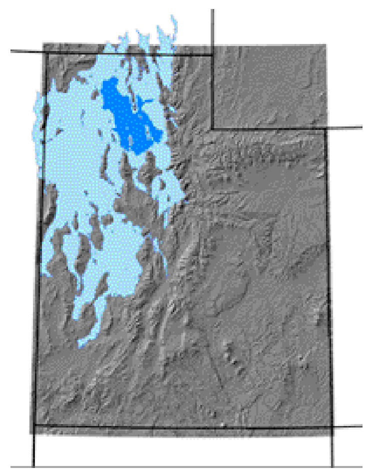


Figure 1. Location of study area, with Lake Bonneville (in the light blue) at highstand, and the modern lowstand relict Great Salt Lake (in dark blue) in Utah, USA.

Summary: What we know about the evaporite-clastic-carbonate sedimentary facies and microbial contexts of Lake Bonneville and the water-limited Great Salt Lake in 4-D (i.e., 3-D architectures and over timescales ranging from the millennial to decadal) will contribute to an emergent understanding of basin development on Mars [11-12], sulfate and clay mineralization [13-14], iron-oxide concretion processes [15-16] and biotic evolution within Mars's extreme environment [17]. Our inventory of geomorphic landforms and new Lake Bonneville analogues has strong potential to inform discussions and debates regarding water cycling, surface weathering, climate change and large water body dynamics on the planet Mars [18-25].

Figure 2.
Bonneville shoreline geomorphology at the Stockton Bar, UT study area, in a 1985 vertical aerial photo (inset A) courtesy of the Utah Geological Survey, and mapped by GK Gilbert in 1890 (inset B). Photo and Map are portrayed at similar scales. In each, the lower-case letters mark: a = erosional shoreline notch at Bonneville shoreline; b, c, and d = depositional shoreline gravel spits at the Bonneville shoreline. The crest of spit c is about 9 m higher that spit b, and the crest of d is about 6 m higher than that of c [26].

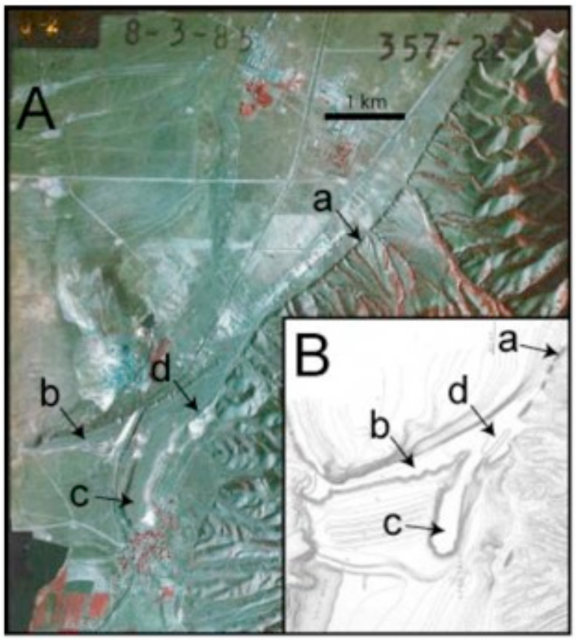
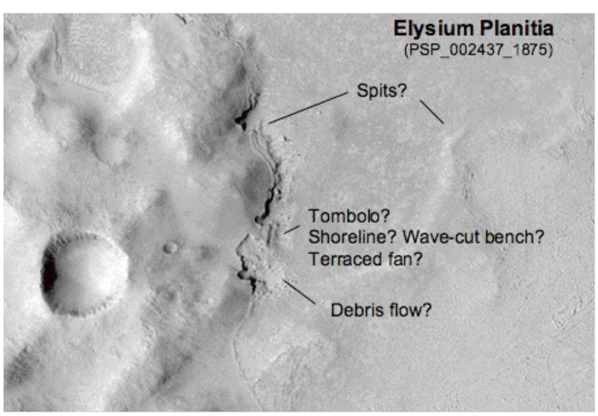


Figure 3.
HiRISE image [27] annotated with potential shoreline features analogous to those in fig 2. Credit: NASA/JPL/Univ Arizona



References: [1] Godsey, H.S., Currey, D.R., and Chan, M.A., (2005). *Quat. Res., 63*, 212-223. [2] Parker, T. J., D. S. Gorsline, R. S. Saunders, D. C. Pieri, and D. M. Schneeberger, (1993) *JGR, 98*, 11,061-11,078. [3] Parker, T.J., Grant, J.A., Franklin, B.J., and Rice, J.W. (2001). *LPS* XXXII, 2051. [4] Cabrol, N. A., and Grin, E. A. (1999) *Icarus, 142*, 160-172. [5] Cabrol, N. A., and Grin, E. A. (2002). *Global Planetary Change, 35*, 199-219. [6] Cabrol, N. A., and Grin, E. A. (2004) in: Harland, D. (ed), *Water and Life on Mars*, Springler-Verlag, 181-205. [7] Parker, T.J., and Currey, D.R. (2001) *Geomorph. 37*, 303-328. [8] Oviatt, C.G. (1997). *Geology 25*, 155-158. [9] Scott, D. H., Dohm, J. M. and Rice, J. W. Jr. (1995). USGS Map I-2561, Scale: 1: 30,000,000. [10] Currey, D.R., Atwood, G., and Mabey, D.R., (1984). Utah Geological and Mineralogical Survey Map 73. [11] McLennan et al. (2005). *EPSL, 240*, 95–121. [12] Grotzinger et al. (2005). *EPSL,* 240, 11-72. [13] Squyres et al. (2004). *Science, 306*, 1698-1703. [14] Bibring et al. (2007). *Science, 317,* 1206-1210. [15] Chan et al. (2004). *Nature 429*, 731-734. [16] Chan et al. (2005). *GSA Today 15,8*, 4-10. [17] Mahaney et al. (2004). *Icarus, 171*, 39-53. [18] Carr, M.H. (2000). *AOG, 41*, 20-26. [19] Jakosky, B.M. and Phillips, R.J. (2001). *Nature, 412,* 237-244. [20] Baker, V.R. (2007). *Nature, 446,* 150-151. [21] Baker, et al. (1991). *Nature, 352*, 589-594. [22] Parker, T.J. and Clifford, C.M. (2001). *Icarus, 154*, 40–79. [23] Malin, M.C. and Edgett, K.S. (1999). *GRL 26*, 3049-3052. [24] Moore et al., (1995). *JGR, 100*, 5433 - 5448. [25] Mustard et al. (2001). *Nature, 412*, 411-413. [26] Gilbert, G.K. (1890). *USGS Monograph 1*. [27] image source: http://hirise.lpl.arizona.edu.