Extended Abstract Presented to:
The Great Basin Symposium on Glacial and Postglacial Drainage: Great Basin Aquatic System History, Salt Lake City, Utah, 17–20 September 1997

FROM THE NORTH AMERICAN GREAT BASIN TO THE PLANET MARS: TAKING LACUSTRINE GEOMORPHOLOGY INTO THE 21ST CENTURY

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Introduction: The entire planet Mars is presently a desert more arid than any on Earth. The planet appears to have had more water in the past, and some of this water affected the surface geology and geomorphology by carving a variety of channels. Despite the evidence for running water in the martian past, the presence of sanding bodies of water (lakes, oceans) has been a topic of considerable controversy in the past two decades. The issue is still not settled, but evidence has mounted to suggest that lakes and oceans were indeed a major factor in shaping the present geomorphology of the martian surface. Although there remains uncertainty as to whether lakes were present on Mars, major efforts to seek evidence for fossil martian organisms are focused on the search for lake sediments and tufa deposits [1]. In 2001 and 2003, the NASA Mars Surveyor Program will launch mobile rovers designed to explore the surface and collect samples for return to Earth. The first set of samples will reach Earth in 2008. The types of landing sites being considered for the ’01 and ’03 missions include areas interpreted as ancient lacustrine deposits. Knowledge and experience with the geomorphology of lacustrine features in the North American Great Basin is crucial for identifying lake features on Mars.

Martian Lakes and Oceans: Prior to spacecraft exploration of Mars, many early astronomers though that the low-albedo surfaces of Mars could be seas or lakes, others considered these to be vast tracts of vegetation [2]. The low-albedo surfaces are now known to be the result of aeolian action on the distribution of sand and dust. The *Mariner 4*, *6*, and *7* spacecraft in 1965 and 1969 stunned the world by showing a cratered, lunar-like martian surface. In 1972, *Mariner 9* showed a more Earth-like surface— indeed, there were numerous channels, some carved by massive floods, others perhaps by fluvial run-off or sapping. The *Viking* orbiters (1976–1980) provided additional images; these formed the basis of study for the past two decades. In the mid-1980s some investigators began to speak of Mars as having a more “wet” history than was discussed earlier [3, 4]. *Parker et al.* [5–7] showed similarities between landforms along the margins of the great northern plains of Mars and landforms along the margins of Great Basin Lakes Bonneville and Lahontan; this work has stimulated much additional research [*e.g.*, 8] and controversy [*e.g.*, 9]. Others began to identify smaller basins that seem to contain sediments deposited by various channels. Among the earliest convincing arguments were presented by De Hon [10], who simply noted the occurrence of places where water had ponded along the course of some of the giant martian outflow channels.

Evidence Mounts: The most commonly–cited place on Mars that may have been an ancient lake is within a 175 km-diameter crater, Gusev, located at 5°S, 184.5°W. A channel, Ma’adim Vallis, flowed into this crater; and an eroded, delta-like deposit is found at the site where the channel contacts the basin. This particular site has been repeatedly described in recent years as a place worthy of future Mars landers and sample returns, largely because it is one of the few possible lake features that most of the Mars science community can agree upon. Many more possible ancient lakebeds have been identified and summarized by Goldspiel and Squyres [11], Scott *et al*. [12], De Hon [13], Wharton *et al.* [14], and Parker and Currey [15]. Most of the proposed lakebeds are areas of low elevation where one or more channels appear to terminate at the location of a smooth, flat-lying deposit. In some cases, the smooth deposit has been eroded to form buttes and mesas. Other lake features are identified on the basis of thick, layered deposits [16]; or high-albedo deposits on crater floors, interpreted to be possible evaporates [17]. Parker [18, 19] has continued the approach of looking for Bonneville-like paleoshore features, but has moved from looking at the margins of great northern plans to the large (100s to 1000s of km) impact basins. Edgett and Parker [20] recently proposed that a vast portion of ancient cratered highlands terrain in the martian region of western Arabia was once part of a vast, northern hemisphere ocean that was bigger than previously envisioned by anyone.

Upcoming Missions: NASA's decade-long Mars Surveyor Program is focused on the theme of "water." The program's emphasis recently shifted toward the search for evidence of martian life. One of the main types of sites desired for exobiologic investigation is "sublacustrine spring deposits and evaporates/lacustrine shales" [1]. New high resolution images (1.5 m/pixel) and thermal infrared mineral spectra will be obtained by *Mars Global Surveyor* instruments during its primary mission (March 1998–January 2000)— these are both expected to contribute greatly toward the identification of lacustrine features. In addition, the *Mars Global Surveyor* laser altimeter may confirm topographic continuity of shore features identified by Parker *et al.* [6,7]. Additional orbiters with complimentary capabilities will launch in 1998 and 2001. Rovers designed to cache samples for return to Earth will land in 2002 and 2004, and at least one of these is expected to be a lacustrine site. Knowledge of North America's Great Basin lacustrine geomorphology will contribute greatly to the exploration of this new frontier in the 21st Century.

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