PALEOLAKES AND LACUSTRINE BASINS ON MARS. David H. Scott, James W. Rice, Jr., and James M. Dohm, U.S. Geological Survey, Flagstaff, Arizona 86001

The problems of how warm and wet Mars once was and when climate transitions may have occurred are not well understood. Mars may have had an early environment similar to Earth's that was conducive to the emergence of life. In addition, increasing geologic evidence indicates that water, upon which terrestrial life depends, has been present on Mars throughout its history (1-8). This evidence does not detract from the possibility that life may have originated on early Mars, but rather it suggests that life could have developed over longer periods of time in longer lasting, more clement local environments than previously envisioned. Indications of past or present life most likely would be found in areas where liquid water existed in sufficient quantities to provide for the needs of biological systems. We suggest that such environments may have been provided by paleolakes--located mostly in the northern lowlands and probably ice covered. Such lakes probably would have had diverse origins. Glacial lakes may have occupied ice-eroded hollows or formed in valleys obstructed by moraines or ice barriers. Depressions in which larger lakes accumulated probably originated by processes other than glacial action, such as crustal warping or impact. Unlike the case on Earth, the Martian record of the origin and evolution of possible life may not have been erased by extensive deformation of the surface. Thus the basins that may have contained the paleolakes are potential sites for future biological, geological, and climatological investigations.

Our initial work combining geologic information acquired earlier (1,2,8) with a study of new topographic maps of Mars (9) has identified at least 15 large basins that exceed 100,000 km^2 in area and 1000 m in depth (Fig. 1). For comparison, in Pleistocene time, Lake Bonneville in Utah had a maximum areal extent of about 50,000 km^2 (10). Elysium is the only basin on Mars where we have found direct evidence, both geologic and topographic, of former water levels and spillways or other outlets (8). Spillway elevations indicate that Elysium was probably filled to a depth of about 1500 m during a recent period in Martian history. The Chryse and Aurorae basins are known to have contained substantial volumes of water during the Hesperian Period (1,3), and eight other basins show evidence of interior drainage.

Many of the postulated paleolakes shown in Figure 1 may once have been connected by waterways, as suggested by the occurrence of small channels identified in places on Viking images and by topographic data (9). For example, if water extended above the -1000-m contour line enclosing the Elysium basin, it may have drained east and northeast into the Amazonis basin as well as westward into the Utopia, Isidis, and Cebrenia basins. In Amazonis, small channels and landforms that appear to have been modified by water flow are visible on Viking images. Crater densities are very low (1,11), indicating an Amazonian age for the floor deposits of the paleolake that may have existed here.

If water extended above the -2000-m contour enclosing the Amazonis basin, it may well have drained across a narrow saddle centered near lat 40°N., long 155° (9) into the Diacria basin (Fig. 1). Small channels near the saddle area, as well as those mapped (1) farther north, lead directly into Diacria. The Diacria basin, in turn, may have been connected with both the Chryse and Acidalia basins by a waterway extending around the north margin of the Alba Patera lava flows, which are now covered by low-lying plains of the Arcadia Formation (1,2). The Acidalia basin also probably received runoff from the profuse channels in Deuteronilus Mensae near lat 45°N., long 340° (3,4).

The waterways noted above that may have connected the Isidis, Utopia, and Cebrenia basins are suggested by topographic contours (9) and by channels observed on Viking images during our studies. The large impact basins Hellas and Argyre have inflow channels along their margins; they may have been important water reservoirs and may contain extensive areas of sedimentary deposits (1,3). Basins 12-15 (Fig. 1) show no evidence of interior drainage and are considered the least likely sites for ancient lakes.

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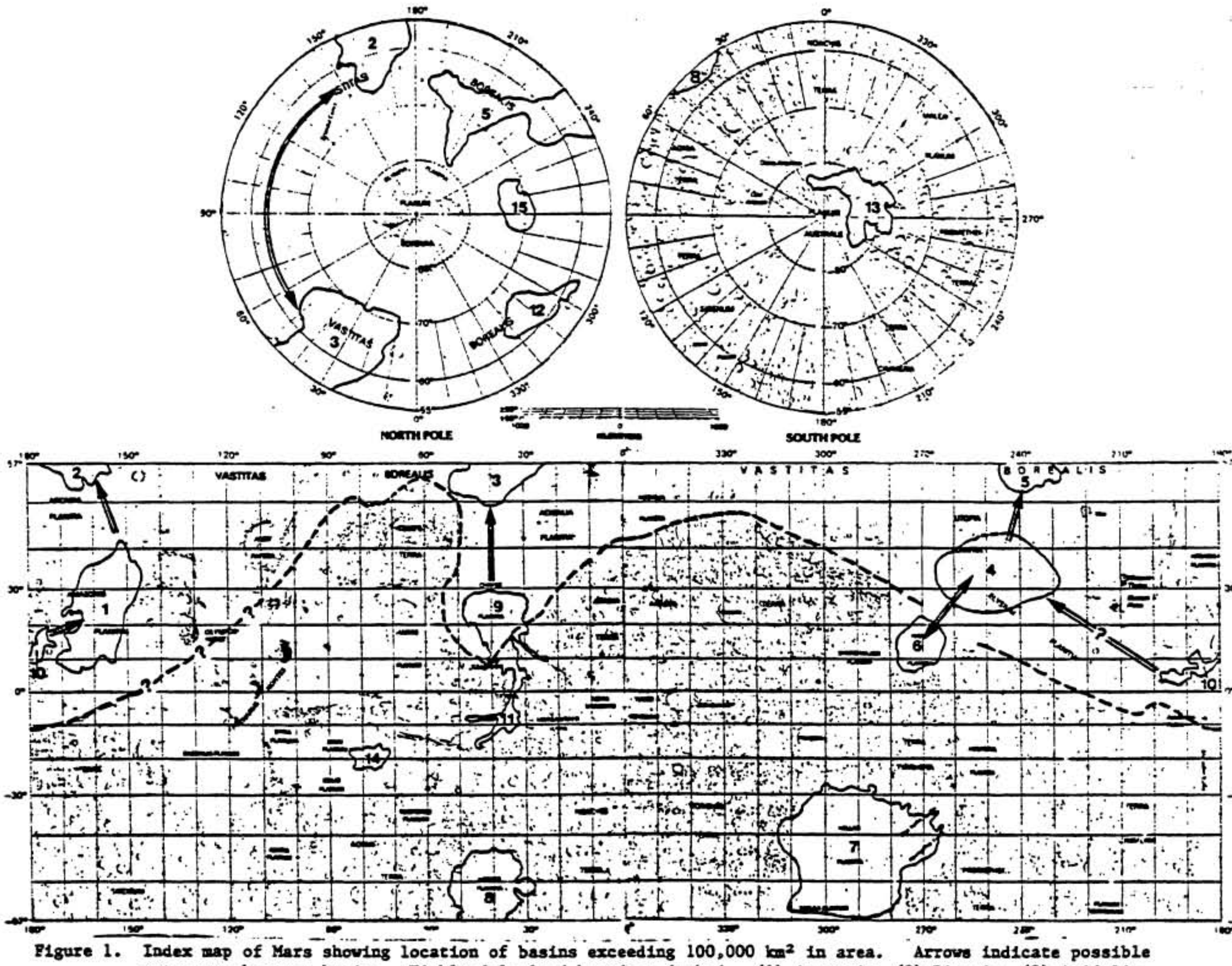

Figure 1. Index map of Mars showing location of basins exceeding 100,000 km² in area. Arrows indicate possible waterways between basins. Highland-lowland boundary dashed. (1) Amazonis, (2) Diacria, (3) Acidalia, (4) Utopia, (5) Cebrenia, (6) Isidis, (7) Hellas, (8) Argyre, (9) Chryse, (10) Elysium, (11) Aurorae, (12) Ismenius, (13) Prometheus, (14) Sinai, (15) Pyramus.