ELYSIUM BASIN, MARS: IMPLICATIONS OF A DEEP, INTERMITTENT LAKE SYSTEM; Mary G. Chapman, David H. Scott, and Kenneth L. Tanaka, U.S. Geological Survey, Flagstaff, AZ 86001.

The Elysium basin, one of the largest depositional basins on Mars, is the only one exhibiting direct geologic and topographic evidence of former water levels. Data have been presented previously that suggest the past existence of large standing bodies of water on Mars (Haberle, 1986; Carr et al., 1987; Goldspiel and Squyres, 1989). That the Elysium basin may have been the locus of an ephemeral sea or large lake has important climatic and biological implications. Ice-covered lakes could have held liquid water at 0 °C that may have significantly extended the period when biological habitats could persist (McKay et al., 1985; Wharton et al., 1987; McKay and Nedell, 1988). Gas-concentration mechanisms operating in these lakes could have enhanced atmospheric gases and provided a source of biologically important gases (pricipally CO_2 and N_2) as the Martian atmosphere thinned (McKay and Stoker, 1989).

Our study of the Elysium basin has two objectives, to determine (1) the maximum extent of the basin and (2) the former volume of water in the basin and the sources of this water. To fulfill the first objective and part of the second, we have compiled a preliminary map of the basin on nine 1:2,000,000-scale quadrangles to determine its maximum shoreline on the basis of geologic indicators. To fulfill the second objective, we are examining and mapping source channels in the circumbasin materials. Our final products will be a geologic map and a physiographic-topographic map, both showing the entire basin at 1:5,000,000 scale. The second map, compiled on a new topographic base (U.S. Geological Survey, in press and work in progress in the Memnonia and Amazonis subquadrangles) shows former shorelines, basin extent, and drainage channels.

Our study indicates that the highest shoreline of the basin lay between 1,000 and 500 m below the Martian datum. Etched lava flows having parallel terraces occur at lat 2° S., long 197° (Viking Orbiter image 725A21) near an elevation of -1,000 m. Eroded possible shoreline material is found near lat 1° N., long 184° at an approximate elevation of -500 m. Two spillways are observed that lead into northern Amazonis Planitia at about lat 24° N., long 176° (Viking Orbiter image 545A22); these spillways lie above an elevation of -1,000 m. (A southern spillway lies at about lat 10° N., long 175°.) Because the deepest part of the basin lies below an elevation of -2,000 m, water depth may have been as great as 1,500 m.

Was the Elysium basin an intermittent or a persistent lake system? Three different ages of inflow from channel systems into the area suggest that a lake recurred in the basin. Initially, before the formation of the basin and the Elysium volcanic rise, many small, dendritic channels of probable Noachian age drained from the highlands into a broad lowland plain. During the Hesperian, after the basin had become well defined, large outflow channels such as Ma'adim and Al-qahira Valles funneled highland waters into the basin (Scott et al., 1978; Greeley and Guest, 1987). Finally, lake filling in Amazonian time is indicated by several lines of evidence. (1) Amazonian-Hesperian volcanic flows of Apollinaris Patera blocked the mouth of Ma'adim Vallis, and later sapping fluids cut around Apollinaris and flowed out into the basin. (2) Channels within the Amazonian Medusae Fossae

Formation drained toward the basin. (3) Fluids flowed into the basin from the north, cutting streamlined features into Amazonian volcanic flows of the Elysium rise at lat 9° N., long 204° (Viking Orbiter image 883A30).

Simple life forms may have evolved on Mars during a more hospitable climate in the ancient past. If such life had developed the capability to remain dormant for extremely long periods until conditions for metabolism were favorable, biologic activity may have been reawakened (McKay and Stoker, 1989). Our evidence for episodic lake filling in the Elysium basin throughout much of Martian history provides a mechanism for possible periodic biologic activity, perhaps even close to the present.

References

Carr,M.H., Wu, S.S.C., Jordan, Raymond, and Schafer, F.J., 1987, Volumes of channels, canyons and chaos in the circum-Chryse region of Mars (abs.): 18th Lunar & Planet. Sci. Conf., p. 155-156.
Haberle, R.M., 1986, The climate of Mars: Sci. Amer., v. 254, p. 54-73.
Goldspiel, J.M., and Squyres, S.W., 1989, Ancient lakes on Mars? (abs.): NASA Conf. Publ. 10027, p. 26.
Greeley, Ronald, and Guest, J.E., 1987, Geologic map of the eastern equatorial region of Mars: U.S.G.S. Misc. Inv. Ser. Map I-1802-B, scale 1:15,000,000.
McKay, C.P., Clow, G.D., Wharton, R.A., Jr., and Squyres, S.W., 1985, Thickness of ice on perennially frozen lakes: Nature, v. 313, p. 561-562.
McKay, C.P., and Nedell, S.S., 1988, Are there carbonate deposits in Valles Marineris, Mars?: Icarus, v. 73, p. 142-148.
McKay, C.P., and Stoker, C.R., 1989, The early environment and its evolution on Mars: Implications for life: Rev. of Geophys., v. 27, no. 2, p. 189-214.
Scott, D.H., Morris, E.C., and West, M.N., 1978, Geologic map of the Aeolis quadrangle of Mars: U.S.G.S. Misc. Inv. Ser. Map I-1111, 1:5,000,000 scale.
Wharton, R.A., Jr., McKay, C.P., Mancinelli, R.L., and Simmons, G.M.,Jr., 1987, Perennial N_2 supersaturation in an Antarctic lake: Nature, v. 325, p. 343-345.
U.S. Geological Survey, in press, Topographic maps of the Aeolis NE and NW and the Elysium NE, SE, and SW quadrangles of Mars: U.S.G.S. Misc. Inv. Ser. Maps I-2118, I-2121, I-2126, I-2127, and I-2128, respectively. 1:2,000,000 scale.