CLASSIFICATION OF MARTIAN LACUSTRINE BASINS. R.A. De Hon, Department of Geosciences, Northeast Louisiana University, Monroe LA, 71209.

LACUSTRINE LANDFORMS. Terrestrial lacustrine deposits are best recognized by the sediment compositions, sedimentary features, fossil assemblages, and depositional patterns. In the absence of field inspection of sedimentary materials, diagnostic features of recognition are commonly associated with secondary landforms and juxtaposition of lacustrine plains in respect to regional drainage patterns. As a result of deposition from standing water, lacustrine sediments tend to fill existing topographic irregularities; hence, lacustrine deposits are seen as smooth, level surfaces within basins. Watercut inlets, outlets, and deltas are significant indicators of water flow through basins.

Shoreline features common to large terrestrial lakes, including wave-cut terraces and beach ridges, bars and spits are generally absent on Viking images because of their relatively small size compared to Viking resolution and because of the relatively short duration of the lakes on Mars. After initial drainage, evaporation, or infiltration of the ponded water, exposed sediments of the lake floor may exhibit superposed channels cut by later flow, dessication cracking, or modification by eolian processes. Polygonally-fractured ground in low areas of Mars may be indicative of sedimentary deposits (1), and the material may have been deposited as slurries or, more likely, in a standing body of water.

CLASSIFICATION OF LAKE BASINS. At this stage of understanding the nature of martian lakes, it seems appropriate to attempt a classification of the paleolake basins. Terrestrial lake classification schemes range from a simple classification based on the origin of the basin in the broadest sense such as the constructive, destructive, and obstructive categories of Davis (2) to the 76 types based on agents, processes, bed rock characteristics, and locations of Hutchinson (3). Detailed breakdown into the 76 types requires recognition of more detail than is presently practical for some martian basins.

BASINS ON MARS. Because of uncertainty in recognition of some of the processes on Mars, this first classification of martian basins is limited to categorizing basins by location in respect to the presumed water source. Those martian plains that are unquestionably lacustrine are identified by their proximity to drainage courses. Many lacustrine plains occupy topographic basins along outflow channels (4). Other plains are of less certain origin because water sources are uncertain. They are assumed to be lacustrine because the floors of the basins are covered by smooth plains similar to those of the more certain classification. Basins of lacustrine deposition may be craters or irregular topographic depressions of various origins.

A proximal classification is based on the location of the basin in respect to the associated valley system. Four major types of basins are recognized. They are--

Type 1	-- Valley-head basin	-- At head of valley
Type 2	-- Intravalley basin	-- Along drainage course
Type 3	-- Valley-terminal basin	-- At terminus of valley
Type 4	-- Isolated basin	-- Not associated with drainage or valley

Examples of terrestrial lake basins and comparable martian basins are listed in the following sections.

Valley-head basin.--Some terrestrial streams originate as a fully developed channel from a ponded source. Surface depressions are often collection basins which feed runoff through one or more valleys. Terrestrial examples of valley-head basins include: glacial ice-dammed lakes, cirque basins and tarns, and pocket valleys in karsted terrains.

Martian valley-head basins are of several different varieties. Basins located at the head of a valley or outflow channel cannot be unequivocally assumed to be associated with standing bodies of water. They may have formed by subsidence caused by the removal of groundwater. Alternately, such basins may have collected water at the surface before releasing it to overland flow. Martian examples of valley-head basins include: chasmata (canyons) with well-developed outflow channels, flat-floored depressions at the heads of outflow channels, and chaos-floored craters with outlet channels.

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The problems of initiating rapid discharge from subsurface ice were recognized by Carr (5). He proposed a mechanism involving groundwater with sufficient pore pressure in the aquifer to overcome overburden pressures and discharge to the surface rapidly. Such a mechanism requires extremely large permeabilities such as those associated with lava tubes in terrestrial basalts. This problem is alleviated if water is discharged into a surface basin which subsequently releases the water to overland flow. Ample terrestrial precedents exist for lakes fed by water from the subsurface.

Intravalley basins.--Water moving downslope as a consequent flow ponds in local irregularities in the surface. If there is sufficient flow, overflow carves an exit valley which completely or partially drains the lake. Examples of terrestrial intravalley basins include: oxbow lakes, low-water stage thalwegs and plunge pools, and lakes along streams that have been obstructed by, landslides, volcanic flows, or moraines.

Martian examples of intravalley lakes are common along the outflow channels. These are among the surest lacustrine sites on the planet. Examples of intravalley lakes on Mars include: breached craters along valleys, abandoned channels, and other depressions along channels.

The highest confidence level includes modified craters and basins located along outflow channels that exhibit breached rims on the upstream side, flat featureless floors, and an outlet breach on the downstream side of the basin. Such basins received sufficient influx of water to fill and crest the downstream barrier. Once water spilled over the rim, one or more outlet gorges were rapidly cut to release water for continued flow. In contrast, craters traversed by alcoved valleys carved by headward erosion (6) need not have held standing water.

Valley-terminal basins.--Basins at the terminal portion of a drainage system are those that impounded the flow without further outflow. Such basins vary in dimensions from barely sufficient to hold the total input to those in which the influx was minor compared to the total basin capacity. These basins may have more than one input source, and the sources may be active at different times. Ponding may have covered the entire basin floor with water or only a portion of the floor at any particular time. Terrestrial examples of valley-terminal basins include: landlocked seas, sag ponds, playas, and ponds on glacially-deranged topography.

Martian valley-terminal basins have breached inlets, inlet deltas or fans, and featureless floors, but they have no apparent outlet. As their terrestrial counterparts, these basins range from simple depressions fed by a single valley to large basins fed by multiple valley or outflow systems. Impounded water was lost by infiltration or evaporation. Martian examples of valley-terminus basins include: the norther polar ocean, irregular basins, and craters.

Isolated basins.--Terrestrial lake basins without surface inlets or outlets contain water because they intersect the water table and are maintained by effluent discharge from the subsurface or because their floors are impermeable and they catch and hold rainfall. Water is lost by infiltration or evaporation. Examples of isolated terrestrial basins include: Karst lakes, thermokarst lakes, kettles, volcanic crater lakes including maare, and meteor craters.

Many featureless plains of indeterminate origin are found on Mars. These plains materials are often interpreted as either volcanic or sedimentary in origin (7, 8, 9). Without an examination of the materials of these basins, an interpretation of the basin-filling material as lake sediment is uncertain, but some basins may be suspected as sites of ponding based on their level, featureless surfaces and their lack of criteria for other types of plains-forming material (volcanic or aeloian). High-resolution images by future missions should allow recognition of shoreline features. Martian examples of isolated basins include: steep-sided, irregular depressions; shallow, ill-defined, topographic lows; and flat-floored craters.

REFERENCES: (1) Lucchitta et al. (1986) J. Geophys. Res. 91, E166-E174. (2) Davis (1882) Proc. Boston Soc. Nat. Hist. 21, 315-381. (3) Hutchinson (1975) A Treatise on Limnology; Pt.1, J. Wiley and Son, N.Y., 540p. (4) De Hon (1988) LPSC XIX, 261-262. (5) Carr (1979) J. Geophys. Res. 84, 2995-3007. (6) Laity and Malin (1985) Bull. Geol. Soc. Amer. 96, 203-217. (7) Scott and Carr (1976) US Geol. Surv. Misc. Inves. Map I-1083. (8) Scott and Tanaka (1986) US Geol. Surv. Misc. Inves. Map I-1802A. (9) Greeley and Guest (1987) US Geol. Surv. Misc. Inves. Map I-1802B.