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

Introduction. Water-bourne sediments in streams are deposited, upon eventual cessation of flow, either as deltas or as alluvial fans or plains. Deltas and alluvial fans share a common characteristic; both may be described as depositional plains at the mouth of a river or stream. A delta is formed where a stream or river deposits its sedimentary load into a standing body of water such as an ocean or lake. An alluvial fan is produced where a stream loses capacity by a greatly decreased gradient. A delta has subaerial and subaqueous components, but an alluvial fan is entirely subaerial In terrestrial conditions, deltas and alluvial fans are reasonably distinct landforms. The juxtaposition of concomitant features composition and internal structure are sufficiently explicit as to avoid any confusion regarding their proper identification.

On Mars, the recognition of deltas and their distinction from alluvial fans is made difficult by low resolution imaging. Further, although it may be demonstrated that standing bodies of water existed on the surface of Mars, many on these bodies may have existed for extremely short periods of time (a few days to months [1]); hence, distinctive shoreline features were not developed. Thus, in an attempt to derive a martian classification of deltas, the inclusion of wholly subaerial deposits may be unavoidable.

A simple, broad, morphologic classification of martian deltas, based primarily on planimetric shape, includes (1) digitate deltas, (2) fan-shaped deltas, and (3) re-entrant deltas A fourth, somewhat problematical class includes featureless plains at the end of many valley systems.

Digitate deltas. Digitate deltas are characterized by parallel, longitudinal bars projecting from the valley mouth onto the basin floor. Terrestrial digitate deltas such as that of the modern Mississippi River, are composed of multiple, branching, distributary channels. Longitudinal bars of digitate levees are formed by accretion of suspended load as it spreads laterally under plane-jet flow [2]. Possible martian digitate deltas consisting of a single, leveed channel are found in Terra Sirenum [3] and Elysium Planitia [4] at breaches in basin walls An alternate interpretation as lateral moraines is considered unlikely.

Fan-shaped deltas. As a broad classification, this includes classical deltaic forms ranging from the Gilbert-type, lacustrine delta and marine Nile delta to wave- and current-modified forms of lobate and arcuate deltas. Gilbert-type deltas are built by axial-jet flow and complete mixing very close to the mouth [5]. Martian examples include (1) a small delta on the interior wall of a crater at lat. 8.7° S long. 159.4° in Terra Sirenum and (2) a low relief, dissected fan at the mouth of Maja canyon on the western edge of Chryse Planum [6]. In the absence of reliable indicators of deposition

into standing water, similar deposits may be fan-deltas or alluvial fans.

Re-entrant deltas. Re-entrant or estuarine deltas, such as those of the Susquehanna and Seine Rivers, consist of fluvial sediments filling embayments in the coast line. The planimetric shape of estuarine deltas is controlled by the enclosing topography. Martian examples of re-entrant deltas include plains in re-entrants at the mouths of valleys dissecting the highland-northern plains boundary scarp.

Featureless plains. Many valleys on Mars merge with featureless plains. Some valleys are partially buried by prograding basin sediments. It is uncertain whether deposition is subaerial or subaqueous. The formation of featureless plains at the mouths of valleys, on Earth and Mars, appears to be associated with a continuous low gradient with no distinct break in slope between valley floor and depositional surface.

Discussion. The morphology of a delta is a function of the interdependence of competing environmental influences, including sediment load of the stream, tectonic stability of the coast density contrast between inflow and standing water, and currents, waves, and tides in the basin. The morphologies of martian deltas reflect conditions prevalent on the surface at the time of formation and subsequent modification. Although a range of deltaic forms is present, they are simple variants, suggesting a restricted range of environmental factors. Most martian deltas are high-constructive deltas [7] in which fluvial action dominates; most are small by terrestrial standards; and most indicate short-lived inflow into basins of standing water without significant wave or current action.

High-destructive deltas, in which current and wave energy in the basin are dominant factors [7], are not obvious on Mars. Such forms require current or wave action which is unlikely in small, short-lived catchments. Presumably, if an ocean did exist in the northern plains [8, 9], deltaic sedimentation along the highland-northern plains boundary may have been masked by later burial, by subsequent thermokarst or glacial modification, or by complete destruction by interbasinal currents.

References:

[1] De Hon R.A. and E.A. Pani (1992) Earth, Moon, and Planets 56, 95-122.
[2] Morgan J.P. (1970) Journ. Geol. Edu. 18, 107-117.
[3] De Hon R.A (1989) 4th International Conf. on Mars, 90-91.
[4] Mouginis-Mark P J. (1985) Icarus 64, 265-284.
[5] Ritter D.F. (1978) Process Geomorphology, 603 p
[6] Rice J.W. et al. (1988) Lunar Planet. Sci. Conf. XIX, 976-977.
[7] Scott A.J. and W.L. Fisher (1969) Delta Systems in the Exploration of Oil and Gas, Univ. of Texas, Bur. Econ. Geol., Austin, 10-39.
[8] Parker T.J. et al. (1987) NASA Tech. Mem. 89971, 319-324.
[9] Baker V R. et al. (1990) Lunar Planet Sci. Conf. XXI, 40-41.