HYDROGEOLOGIC PROVINCES OF MARS: R. A. De Hon, Department of Geosciences, Northeast Louisiana University, Monroe, LA 71209.

Summary--In order to examine the occurrence of water on Mars, the surface is divided into 12 hydrogeologic provinces that are defined by closed, topographic basins of internal drainage. Provinces may be further subdivided into smaller, closed basins and nested, open basins. A low-elevation plain within each province provides a natural sedimentary trap.

Introduction--Abundant evidence of water-flow across the surface of Mars exists as outflow channels and integrated drainage networks [1-3]. In addition, water may have been present as glaciers [4,5]. If water existed on the surface, then it may be logically assumed that some of it was stored in the subsurface as ground-water and/or permafrost.

In order to treat effectively the occurrence of water on Mars, the surface is divided into 12 contiguous topographic basins of regional extent (Fig. 1). A number of factors bear on this division. For example: physiography; nature of the reservoirs; physical state of water storage; location of recharge and discharge areas; nature of discharge; age and timing of discharge; stratigraphy and structure.

Hydrogeologic Provinces--Regardless of whether water reaches the surface as precipitation or as seepage from the subsurface, once on the surface its movement is controlled by topography and gravity. Hence, physiography is a major hydrologic control and may be used as a first order criterion to define hydrogeologic provinces. Each basin is surrounded by a continuous, topographic divide and is characterized by internal drainage (a watershed or drainage basin). Each is floored by a low-elevation plain. Further, low sections of the topographic divides provides a low sill passage to at least one adjacent basin. Where channels are present within a province, they conform to existing topography and follow hypothetical flow lines toward the basin floor. Provinces incorporate both smaller, enclosed basins and nested, open basins.

A small, unnamed topographic basin at 60°N; 300°W, Utopia, Arcadia, and Acidalia provinces are primarily northern lowland regions with low relief, minimal highland catchment zones, and floor elevations below the planetary mean. Elysium Planitia is viewed as a sub-basin within the Utopia Province. Isidis, Aeolis, Chryse, and Amazonis are regions of rugged highland catchments and low elevation plains. Hellas Province includes rugged highlands surrounding a deep impact basin which includes the lowest elevation on the planet. Argyre, Icaria, and Australe Provinces are primarily south polar basins of moderate-to-low relief with interior plains that are above the planetary mean elevation.

Significance--Many of the provinces display unique occurrences of water-derived features. The highland portions of these provinces preserve ancient network drainage as well as young outflow and sapping channels. The lower elevations of the provinces typically exhibit only young plains-forming materials and young channel systems. The lowest plain within each province is formed by materials that are often assigned to volcanic or mixed origins [6,7]. Many such plains may be fluvial or lacustrine in origin [8,9].

The non-integrated nature of the existing remnants of drainage and relative isolation of one basin from the next tends to indicate that extensive precipitation in the form of rainfall was probably a major factor only in early martian geologic history. Any exchange of sediments between provinces would require filling the floor-basin to the point of topping the sill and spilling over into adjacent basins.

During more humid climatic cycles than that of the present--such as the proposed maritime
climate [10]--physiography offers some indication of ground-water movement. The location of ground-water discharge as seepage and catastrophic outflow provides some insight into ground-water conditions at the time of discharge. During the present period of extreme aridity, physiography may be only a minor guide to the position of the water table and to the movement of ground-water.

The low-elevation plain within each province is a natural trap for the ultimate deposition of detritus from the highlands [11]. These sediment-filled lowland-basins are natural locations for ground-water reservoirs. Seeps and springs could be expected to form around the edges of these basin-floor plains. Duracrust formation and cementation could significantly alter the properties of sediments by decreasing porosity and permeability.


FIGURE 1. Hydrogeologic Provinces of Mars. Short dashed lines mark divides; solid contours are drawn at 5 km intervals; dashed contours of intermediate intervals show highest and lowest elevations of closure; dot-and-dash lines are drainage networks or channels; heavy solid lines with arrow mark prominent surface troughs.