GIS AND ITS APPLICATION TO PLANETARY RESEARCH. T. M. Hare, J. M. Dohm, and K. L. Tanaka, U.S. Geological Survey, Flagstaff, AZ, 86001; thare@flagmail.wr.usgs.gov.

Geographic Information Systems (GIS) are an organized collection of computer hardware, software, geographic data, and personal design to efficiently capture, store, update, manipulate, analyze, and display all forms of geographic and geologic information [1]. GIS has revolutionized how investigators view and analyze geographic and geologic data of the Earth to solve complex problems; examples include (a) comparing time series of maps and cross sections that document geologic events to help better explain their evolution [2], (b) characterizing ground-water movement through aquifers to assess their potential for ground-water contamination [3], and (c) predicting spatial patterns of soil attributes [4].

Geologic databases are now being transferred into GIS packages for Mars research. For example: (1) a global database of martian channels was prepared and examined to determine their gross spatial, age, density, topographic, and geologic relations [5,6], (2) rock-outcrop contacts and structure of a 1:500,000-scale map of Mars were converted for analysis of the enigmatic Medusae Fossae Formation [7], and (3) image, topographic, and geologic data bases were used to study mass-wasting features in Valles Marineris [8]. Additionally, we have completed comprehensive geologic mapping of the Thaumasia region of Mars [9-13] and transferred the regions' highly detailed rock outcrop, paleotectonic, and paleoerosional information into a multilayered GIS database to help unravel its complex geologic history (Fig. 1). Thus far, we have determined the precise area of rock outcrops, which increases speed and flexibility of crater-density statistics [9], and measured the total number and length of structural features (tectonic and erosional) and determined their density for major stages of geologic activity [10,11,13].

A strength of GIS is the capability to separate out layers of diverse information at any appropriate scale (e.g., rock-unit, relative-age, structural, topographic, location, and remote-sensing data) to compile, examine, and compare their temporal and spatial relations quantitatively. In addition to determining the density of tectonic structures and channels per stage for the Thaumasia region [10,11,13], we intend to apply GIS to determine location and duration of local and regional stress centers and factors controlling the formation of various sets of tectonic structures and channels. We have begun to examine, for example, how groups of channel systems compare and relate in time and space with other types of structures and the materials they dissect as well as slope, relative-age, degree of channel branching, and morphological characteristics, which leads to more robust conclusions on their origin (e.g., such as whether material strength, rainfall, structural control, proximity to a possible hydrothermal system, etc., or some combination of these factors, resulted in channel formation) [13]. This process can be likened to isolating individual pieces of a convoluted jigsaw puzzle and putting them together first as pairs, then as groups, to better visualize the total picture.

Planetary researchers have only begun to apply rudimentary GIS techniques. Because of its (1) flexibility in data management, (2) time and cost efficient production of large databases (including planetary maps), (3) ability to create multilayered databases for comparison studies, and (4) capacity to readily update and add information obtained from future missions and studies, GIS will become an increasingly valuable tool in planetary studies.

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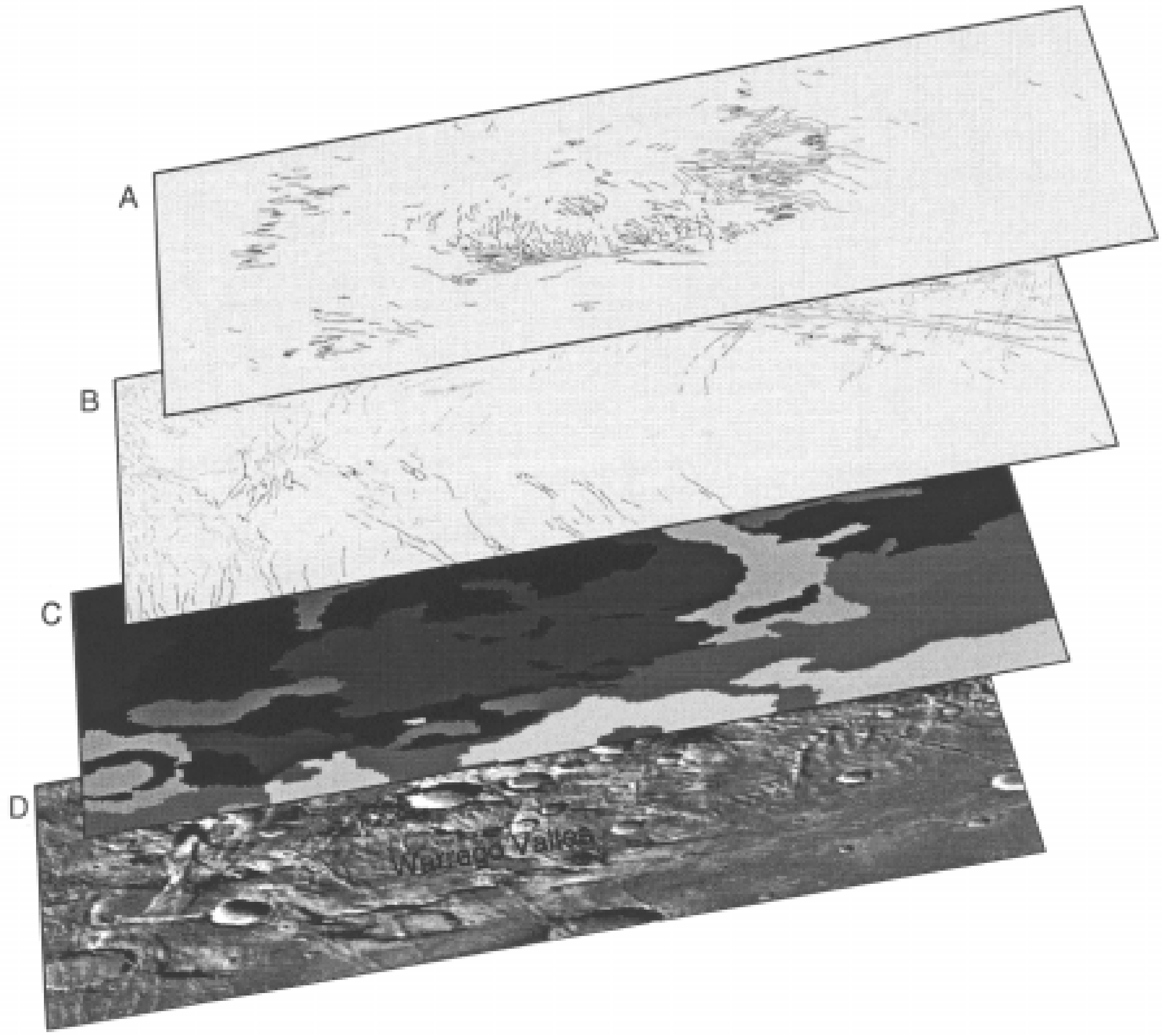

Fig. 1. Multilayered GIS database of the Warrego Valles region of Mars along the southern margin of the Thaumasia Plateau. Layers include channels and furrows (A), faults (B), geologic units (C), and a Viking photomosaic (D).