Studying Venus using a GIS Database
Maribeth Price and John Suppe
Dept. of Geological and Geophysical Sciences, Princeton University, Princeton, NJ 08544

Abstract: A Geographic Information System (GIS) can significantly enhance geological studies on Venus because it facilitates concurrent analysis of many sources of data, as demonstrated by our work on topographic and deformation characteristics of tesserae. We are creating a database of structures referenced to real-world coordinates to encourage the archival of Venusian studies in digital format and to foster quantitative analysis of many combinations of data. Contributions to this database from all aspects of Venusian science are welcome.

Introduction: The extended Magellan Mission has provided a wealth of high-quality data, the study of which will advance the understanding of planetary geologic and tectonic processes for many years. Making best use of this resource requires the ability analyze many combinations of data, including observed tectonic features and their characteristics, topography, gravity, and emissivity. One way to accomplish this, called georeferencing, is to register all data and observations to real-world coordinate axes. Once data are registered, it becomes possible to easily convert them into different map projections, plot them at virtually any scale or resolution, and combine them with other registered data for display and analysis. A computer system which performs such operations is called a geographic information system, or GIS. We have been using a GIS for our studies of structural geology and tectonics on Venus, enabling us to analyze and interpret our findings with greater speed, accuracy, and flexibility than traditional methods. It is our aim to establish a georeferenced database of geologic and tectonic features for use by all scientists working on Venus.

Discussion: The implementation of a GIS database is rapidly becoming the standard way of georeferencing observations and data to solve many geological and engineering problems on Earth, and we are creating one for Venus. Features currently being mapped and entered in the database include fold belts, rifts, wrinkle ridges, and tesserae. We have automated the process of reading the SAR images into our GIS format, so features are mapped directly on displayed MIDRs for greatest accuracy. If greater resolution is required, we digitize maps made on mylar overlays on MIDR photoproducts. Attributes pertaining to structures, such as latitude and longitude, orientations, areas, lengths, widths, spacings, extension or shortening, relief, and tectonic setting, are included where appropriate. We are also converting altimetric, radiometric, and gravity imagery into GIS format for quantitative analysis of these properties with respect to the mapped features. Working with combined data sets in an integrated spatial analysis environment is much more powerful and productive than looking at each data set individually. We have begun to incorporate additional data, such as coronae [1] and volcanic features [2], provided by other research groups, and plan to establish and periodically update a data library accessible over the Internet computer network, utilizing a standard format easily transported to other GIS platforms. We strongly encourage other groups to use and contribute to this database.

Several examples of our current work will serve to demonstrate the facility of GIS as a tool for analyzing combinations of data--in this case SAR, altimetry, and geologic interpretation. This work was done using the GIS ARCl/INFO [3]. First, we calculated the normalized area of tesserae terrain present within 10-degree latitude bins. With GIS the process was quick and simple. The tessera outlines were mapped digitally on twice compressed SAR MIDRs, compiled and projected into a common equal-area projection, and then geometrically intersected with latitude lines. The tessera area and total area of C2-SAR coverage were then summed for each bin (figure 2 in Price & Suppe, this issue).

In the second example we determined if a linear relationship between relief at tessera margins and the basal elevation exists, as has been demonstrated for fold belt relief [5]. We digitized 258 profile lines across tessera margins and split them into base and crest sections where they intersected the tessera outlines. Then a 20 km resolution global altimetry image was used to calculate the mean elevation along the base and crest sections of the profile (figure 1). The method was improved by masking pixels with high topographic slope from the image, in order that values from the steep margins are not included in the calculations.

Third, we created a global image of altimetry inside tesserae which emphasizes global and local topographic patterns (figure 2). When displayed behind a map of deformation trends (in progress), it will facilitate the recognition of significant patterns which may provide clues about the formation of tesserae.
Conclusions: We are using GIS to analyze fold belts, rifts, wrinkle ridges, and tesserae, and vouch for its utility for structural and tectonic studies. We are creating an Internet-accessible database to foster GIS analysis of Venus, and we encourage contributions from all aspects of Venus science. For further information contact maribeth@wanda.princeton.edu.


Figure 1. Altimetry of Aphrodite Terra (low elevation dark, high white) with high slopes masked in black. The thin lines are mapped tesserae outlines; the thick line segments are topographic profile lines; and the rectangular black patches are data gaps. The masked image was used to calculate mean elevations for the profiles inside and outside the tesserae.

Figure 2. Map of Aphrodite Terra showing the dominant deformation trends of tesserae displayed over altimetry with non-tesserae masked in black. Trends were digitized on C1 (once compressed) digital M1DRs and compiled into a common projection for display. Lines are shown in both white and black for clarity only, no classification is implied.