

convergence), the high slopes within Ishtar lend additional support to the compressional origin of the banded terrain and further serve to distinguish Ishtar Terra from the extension-dominated equatorial highlands [Schaber, 1982].

5. Eastern Ishtar Terra is fundamentally different from Ishtar west of Maxwell Montes. Its regional slope and elevation characteristics closely resemble those of central Aphrodite Terra. This suggests that the intense deformation observed in radar images of eastern Ishtar [Basilevsky *et al.*, 1986] may also occur in the central regions of Aphrodite.

6. There is a global tectonic fabric on Venus, consisting of broad terrain belts and aligned regional slope features within the plains, trends of elongate planitia, highland margin segments, chasmata, and linear topography within the highlands. The fabric is characterized by several major great-circle-like patterns oriented at less than about 45° to the equator. This fabric differs from both the complex terrestrial mosaic of lithospheric plate boundaries and the more subtle and pervasive ancient lunar and Mercurian grids. This fundamentally different pattern suggests that the major mechanism of heat transfer and associated tectonics on Venus is neither simple conduction, as on the moon, nor a well-integrated pattern of plate recycling, as on earth. Venus may have a distinctive tectonic style related to less complex, more fundamental patterns of heat loss.

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REFERENCES

- Anderson, D. L., Tectonics and composition of Venus, *Geophys. Res. Lett.*, **7**, 101–102, 1980.
- Anderson, D. L., Plate tectonics on Venus, *Geophys. Res. Lett.*, **8**, 309–311, 1981.
- Arvidson, R. E., Effects of lateral resolution on the interpretability of geologic features sampled by the Pioneer-Venus altimeter (abstract), *Lunar Planet. Sci.*, **XII**, 31–33, 1981.
- Arvidson, R. E., and G. F. Davies, Effects of lateral resolution on the identification of volcanotectonic provinces on earth and Venus, *Geophys. Res. Lett.*, **8**, 741–744, 1981.
- Barsukov, V. L., *et al.*, The geology and geomorphology of the Venus surface as revealed by the radar images obtained by Veneras 15 and 16, *Proc. Lunar Planet. Sci. Conf. 16th*, Part 2, *J. Geophys. Res.*, **91**, D378–D398, 1986.
- Basilevsky, A. T., A. A. Pronin, L. B. Ronca, V. P. Kryuchkov, A. L. Sukhanov, and M. S. Markov, Styles of tectonic deformations on Venus: Analysis of Venera 15 and 16 data, *Proc. Lunar Planet. Sci. Conf. 16th*, Part 2, *J. Geophys. Res.*, **91**, D399–D411, 1986.
- Ben-Avraham, Z., A. Nur, D. Jones, and A. Cox, Continental accretion: From oceanic plateaus to allochthonous terranes, *Science*, **213**, 47–54, 1981.
- Brass, G. W., and C. G. A. Harrison, On the possibility of plate tectonics on Venus, *Icarus*, **49**, 86–96, 1982.
- Burke, K. C., and J. T. Wilson, Hot spots on the earth's surface, in *Continents Adrift and Continents Aground*, pp. 58–69, W. H. Freeman, San Francisco, Calif., 1976.
- Campbell, D. B., and B. A. Burns, Earth-based radar imagery of Venus, *J. Geophys. Res.*, **85**, 8271–8281, 1980.
- Campbell, D. B., J. W. Head, J. K. Harmon, and A. A. Hine, Venus: Identification of banded terrain in the mountains of Ishtar Terra, *Science*, **221**, 644–647, 1983.
- Campbell, D. B., J. W. Head, J. K. Harmon, and A. A. Hine, Venus: Volcanism and rift formation in Beta Regio, *Science*, **226**, 167–170, 1984.
- Cogley, J. G., Continental margins and the extent and number of the continents, *Rev. Geophys.*, **22**, 101–122, 1984.
- Dietz, R. S., and J. C. Holden, Reconstruction of Pangaea: Breakup and dispersion of continents, Permian to present, *J. Geophys. Res.*, **75**, 4939–4955, 1970.
- Dzurisin, D., Scarps, ridges, troughs and other lineaments of Mercury, Ph.D. dissertation, Calif. Inst. of Technol., Pasadena, 1976.
- Ehmann, W. J., and J. W. Head, Morphology and topography of Aphrodite Terra, Venus, Reports of the Planetary Geology Program, *NASA Tech. Mem.*, **TM-85127**, 77–78, 1982.
- Fielder, G. Lunar tectonics, *Q. J. Geol. Soc. London*, **119**, 65–69, 1963.
- Gates, W. L., and A. B. Nelson, A new (revised) tabulation of the Scripps topography on a 1° global grid, I, Terrain heights, *Rep. R-1276-1-ARPA*, 132 pp., Rand Corp., Santa Monica, Calif., 1975a.
- Gates, W. L., and A. B. Nelson, A new (revised) tabulation of the Scripps topography on a 1° global grid, II, Ocean depths, *Rep. R-1277-1-ARPA*, 132 pp., Rand Corp., Santa Monica, Calif., 1975b.
- Head, J. W., and S. C. Solomon, Tectonic evolution of the terrestrial planets, *Science*, **213**, 62–76, 1981.
- Head, J. W., S. E. Yuter, and S. C. Solomon, Topography of Venus and earth: A test for the presence of plate tectonics, *Am. Sci.*, **69**, 614–623, 1981.
- Head, J. W., A. R. Peterfreund, J. B. Garvin, and S. H. Zisk, Surface characteristics of Venus derived from Pioneer Venus altimetry, roughness, and reflectivity measurements, *J. Geophys. Res.*, **90**, 6873–6885, 1985.
- Heezen, B. C., M. Tharp, and M. Ewing, The floors of the oceans, I, The North Atlantic, *Spec. Pap. Geol. Soc. Am.*, **65**, 122 pp., 1959.
- Heirtzler, J. R., G. O. Dickson, E. M. Herron, W. C. Pitman, and X. Le Pichon, Marine magnetic anomalies, geomagnetic field reversals, and motions of the ocean floor and continents, *J. Geophys. Res.*, **73**, 2119–2136, 1968.
- Kaula, W. M., and R. J. Phillips, Quantitative tests for plate tectonics on Venus, *Geophys. Res. Lett.*, **8**, 1187–1190, 1981.
- Masson, P., and P. Thomas, Preliminary results of structural lineament pattern analysis of Mercury, Reports of the Planetary Geology Program, *NASA Tech. Mem.*, **TM-35511**, 54–55, 1977.
- Masursky, H., E. Eliason, P. G. Ford, G. E. McGill, G. H. Pettengill, G. G. Schaber, and G. Schubert, Pioneer Venus radar results: Geology from images and altimetry, *J. Geophys. Res.*, **85**, 8232–8260, 1980.
- Masursky, H., A. L. Dial, G. G. Schaber, and M. E. Strobell, Venus: A first geologic map based on radar altimetric and image data (abstract), *Lunar Planet. Sci.*, **XII**, 661–663, 1981.
- McDougall, I., Volcanic island chains and sea floor spreading, *Nature, Phys. Sci.*, **231**, 141–144, 1971.
- McGill, G. E., Venus tectonics: Another earth or another Mars?, *Geophys. Res. Lett.*, **6**, 739–741, 1979.
- McGill, G. E., S. J. Steenstrup, C. Barton, and P. G. Ford, Continental rifting and the origin of Beta Regio, Venus, *Geophys. Res. Lett.*, **8**, 737–740, 1981.
- McGill, G. E., J. L. Warner, M. C. Malin, R. E. Arvidson, and E. Eliason, Topography, surface properties and tectonic evolution, in *Venus*, edited by D. M. Hunten, L. Colin, T. M. Donahue, and V. I. Moroz, pp. 69–130, University of Arizona Press, Tucson, 1983.
- Minster, J. G., T. H. Jordan, P. Molnar, and E. Haines, Numerical modelling of instantaneous plate tectonics, *Geophys. J. R. Astron. Soc.*, **36**, 541–576, 1974.
- Moik, J. G., Digital processing of remotely sensed images, *Rep. Sp-431*, 330 pp., Natl. Aeronaut. Space Admin., Washington, D. C., 1980.
- Molnar, P., and P. Tapponnier, Active Tectonics of Tibet, *J. Geophys. Res.*, **83**, 5361–5375, 1978.
- Morgan, W. J., Convection plumes in the lower mantle, in *Plate Tectonics and Geomagnetic Reversals*, edited by A. Cox, pp. 659–661, W. H. Freeman, San Francisco, Calif., 1973.
- National Research Council, Report of the Ad Hoc Panel to investigate the geological and geophysics research needs and problems of continental margins, Office of Publ., Natl. Acad. of Sci., Washington, D. C., 1979.
- Ollier, C. C., The Great Escarpment of eastern Australia: Tectonic and geomorphic significance, *J. Geol. Soc. Aust.*, **22**, 13–23, 1982.
- Parsons, B., and J. G. Sclater, An analysis of the variation of ocean-floor bathymetry and heat flow with age, *J. Geophys. Res.*, **82**, 803–827, 1977.
- Pettengill, G. H., E. Eliason, P. G. Ford, G. B. Lorient, H. Masursky,