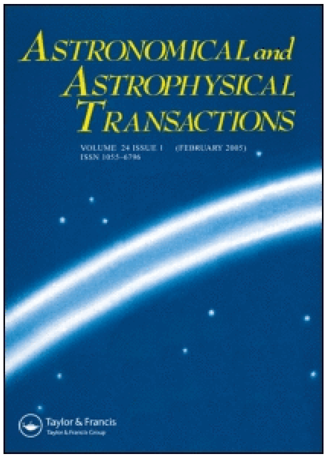

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BOOK REVIEW

VENUS GEOLOGY, GEOCHEMISTRY, AND GEOPHYSICS

edited by V. L. Barsukov, Senior Editor, A. T. Basilevsky, V. P. Volkov and V. N. Zharkov
The University of Arizona Press/Tucson & London, 1992, 421 pp.

The astronomic studies of the last centuries have illuminated a number of basic characteristics of Venus. The similarity, in many respects, of Venus with the Earth has aroused public interest in this planet. Recent studies, mostly based on the spacecraft technique, have deepened our knowledge of this planet. When we look at the Earth as one of the planets, we begin to realize that rigid constraints exist, for example, on still poorly known early stages of the geologic history of our home planet. This approach leads to a replacement of poorly based assumptions on early stages of the geological history of the Earth with a system of reliable facts based on the histories of other planets. In this logic chain of comparative-planetological analysis Venus is one of the key links because in the Solar System only Venus provides a possibility of comparing our Earth with a planet of approximately the same mass and size.

It is now time to summarize the available pre-Magellan mission data on Venus geology, geochemistry, and geophysics. The book is written by 23 authors from Russia. They give a description of the data available and try to interpret them in the context of planetological problems. The photogeological observations are mostly based on Venera 15/16 radar imagery with the resolution of 1–2 km. Geochemical measurements are presented by the data on gamma-ray spectrometry and X-ray fluorescence spectrometry at 7 points of the Venus surface where Venera 8, 9, 10, 13, 14 and Vega 1, 2 landers worked. Geophysical observations are presented by LOS gravity measurements made by the Pioneer Venus orbiter. Their spatial resolution is not better than several hundred kilometers. Moreover, there are no data over a significant part of the area of the Venera 15/16 survey. This is why in particular, a great diversity in opinion exists among Venus scholars.

Part I – Geology includes analyses of a number of problems (A. T. Basilevsky *et al.*): volcanism, hot-spot structures, the Lakshmi phenomenon, tesserae, ridge belts on plains, impact craters, evidence on the crustal dichotomy, global tectonic style, and resurfacing. The description of the geology of Venus is mostly based on the results of the 8-cm wavelength radar survey made by Venera 15 and 16 spacecrafts in

1983–84, although other data, including those obtained by the Pioneer Venus orbiter and the Venera/Vega landers, have also been taken into account. Landforms and terrains formed by endogenetic (volcanic and tectonic) resurfacing occupy not less than 99.5% of the area surveyed. Exogenetic resurfacing of Venus is negligible and the main factor that effectively generate and destroy the observed landforms are endogenetic basaltic volcanism and tectonics. An average rate of the resurfacing is less than a few centimeters per million years.

Part II – Geochemistry is focused on problems of the petrological interpretation of Venera and Vega rock composition measurements and exogenic processes in terms of chemical weathering. It includes the following topics (V. L. Barsikov *et al.*): venusian igneous rocks, chemical processes on the planetary surface, and volatiles in atmosphere and crust. It is currently possible to assume the existence of three complexes of magmatic rocks formed on the surface of Venus. Very weakly differentiated melanocratic alkaline gabbro rocks or their effusive equivalents (Venera 13), with syenitic trend (Venera 8) and low-potassium tholeiitic basalts, most probably in the form of volcanic tuffs (Venera 14), can be found on the venusian plains. Adjacent to the large young shield volcano (Beta Regio) can be found basic rocks, possibly lavas, also similar in composition to tholeiitic basalts, but with a probable lime-alkaline trend, which makes them akin to terrestrial island-arc basalts. It is evident that all three complexes of Venus, although unlike those on the Earth, were most likely formed at different geological periods and are made up of basic magmatic rocks. Since basaltic volcanism is believed to result from the mantle partial melting, the similarity of the bulk chemical composition of venusian and terrestrial basalts suggests that the material making up the upper mantle of Venus is compositionally akin to the terrestrial mantle material. It may be claimed that the relative similarity of venusian rocks to their probable petrological terrestrial equivalents in terms of potassium, uranium, and thorium concentrations may indicate that the concentrations of these elements in the Venus approximate those in the Earth's interior.

The understanding of chemical processes on the venusian surface depends on the knowledge of the chemical composition of the lower atmosphere, especially the redox conditions at the surface-atmosphere interface. If a global chemical equilibrium does exist in the atmosphere-surface rock system, weathering should be widely distributed on the surface of Venus. The recycling of volatiles could be related to the chemical weathering of rocks in recent volcanic or erosion areas (volatile sink) and a reverse process of volatile release as a result of chemical conversion (volatile source) at the other parts of the surface.

Part III – Geophysics gives a systematic description of the physics of the venusian interior in the following items (V. N. Zharkov *et al.*): the expansion of topography into spherical harmonics; gravity field, loading coefficients, anomalous density; rotation; statistical properties of topography and gravity field; model of the interior structure (Earth-like models); a physical model of Venus; the stress state of the venusian crust and variations of its thickness (implications for tectonics and geodynamics); convection (a simplified version); models of the thermal evolution of Venus. The accumulation of geophysical data on Venus and its analysis reveals not only a similarity between Venus and the Earth, but also an important difference. There gradually emerges the fact that each planet is unique.

In fact, both planets have different atmospheres, different histories of rotation, and, consequently, different histories of tidal evolution. A displacement of the center of the geometrical figure of a planet with respect to its center of mass may be interpreted as an indication of a considerable regional variation in the thickness of the crust. On Venus, the distance between both centers is much less than the corresponding differences for the Earth, the Moon, and Mars. Consequently, the variation of thickness of the venusian crust is less than that of the other planets of the Earth type. This same fact may be an indication that the outer layer of Venus is closer to spherical symmetry than that of the Earth. It is interesting to estimate the dynamic flattening of an effectively equilibrated planet for different epochs. The result suggests that Venus rotated more rapidly in the past. The lack at the venusian surface of the visible traces of retardation of rotation suggests that tidal braking has occurred several billion years ago.

The Earth has a substantial magnetic field; Venus lacks such a field. The most probable reasons for the lack of the intrinsic magnetic field of Venus are that the venusian core does not solidify, convection is absent, and the hydromagnetic dynamo does not work. The thermal regime of the crust is characterized by the following processes of heat and mass transfer: conductive heat transport, circulation of melts in the crust, exchange of basalt between the upper mantle and the crust, formation of the mantle plumes, convection in the lower part of the crust, involving the crust into the mantle convection. Tectonic development is also different for Venus and the Earth. This is revealed in the structure and thickness of their outer layers, ultimately resulting in the fact that the seismicity of Venus is much less than that of the Earth. The authors believe the tectonic regime of Venus differs from the plate-tectonic regime.

The book has two Appendices. Appendix A is the Atlas of Venus surface images obtained by Venera 15 and Venera 16 orbiters (A. I. Sidorenko *et al.*). Appendix B is the Names of topographic features on Venus (G. A. Burba).

Some controversy and disagreement exists in various parts of the book. But collaborating authors "do not consider the situation a defect, but rather a motive to go further together".

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