Soviet space science looks at 'sister planet' Venus

by Carl J. Osgood

Venus Geology, Geochemistry, and Geophysics: Research Results from the U.S.S.R.
Edited by V.L. Batsukov, A.T. Basilevsky, V.P. Volkov, and V.N. Zharkov
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One of the brightest objects in the night sky, Venus has always held a fascination for man since he first began to observe the heavens. This has been no less true in the age of planetary exploration when Venus has been the target of more unmanned space probes than any other body in our Solar System with the possible exception of Earth's Moon. This latest book, a compilation based primarily on radar data from the Soviet Venera 15 and 16 orbiters and geochemistry data from the half-dozen Soviet Venera landers, is a comprehensive survey of what was known and theorized about Earth's nearest neighbor prior to the August 1990 arrival at Venus of NASA's Magellan radar mapper.

Venus Geology, Geochemistry, and Geophysics is the first major publication in English of a comprehensive survey of the findings of Soviet Venus research, and as such, it is an important contribution to an understanding of the capabilities of Soviet space science. The reader is given an extensive, detailed description and analysis of Venus based on this Russian data. We have elaborate descriptions of Venusian surface features, such as volcanoes, highland plains, craters, and rifts. In addition, conjecture is provided as to how these surface features may have been formed, with liberal comparisons to similar features on Earth. These descriptions are accompanied by hundreds of charts, graphs, and pictures of surface images.

This book is written for the scientist studying Venus in particular, and planetary geologic processes in general. However, it is also useful to the layman who has some general background in geology and geophysics if he or she avoids getting too bogged down in the mathematics (which is confined primarily to the section on geophysics). The problem for the layman, however, is the fact that there has been a very limited amount of information available on the evolution of scientific knowledge of Venus, outside of a very useful table of missions to Venus that appears in the book's introduction. The problem of this lack of information becomes particularly critical when considering the history of Soviet exploration of Venus: The Soviet work in this area prior to the Venera 15 and 16 missions almost certainly laid the basis for how these scientists approached analyzing this more recent data.

Similar forces at work on Earth

The various papers that make up this volume implicitly force the reader, as he or she reads through the descriptions of geological and chemical processes on Venus, to think about how those same processes occur on Earth. One well-known form of volcanic activity that is seen on Earth is the pyroclastic eruption, an explosion of hot gases and dust. (Last year's eruption of Mount Pinatubo in the Philippines was a pyroclastic type.) The rocks that are produced by this type of eruption are porous and of a low density, sometimes so low that they float in water. For this type of eruption to occur on Venus, however, the lava would have to have a much higher concentration of dissolved volatile gases in order to overcome the very high surface pressure—90 times that of Earth. However, porous, low-density rocks that are characteristic of pyroclastic-type eruptions appear in photographs taken by the Venera 13 and 14 landers.

The geochemistry that results from these conditions produces a certain kind of chemical weathering on the surface. Besides volcanic activity and meteor impacts, chemical weathering is the only other major force acting to change the surface of the planet. The lack of a biosphere and hydrosphere mean that there's nothing chemically acting on the surface, except the composition of the atmosphere and the rocks, catalyzed by the surface temperature and pressure. This reviewer constantly found himself thinking about how

different these chemical processes are on Earth, because of the presence of water and life.

Comparative planetology

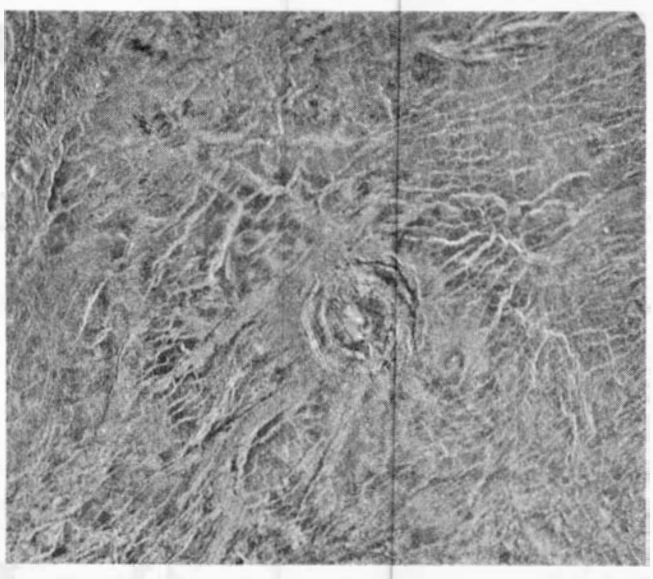
Within the science of comparative planetology, scientists can take two approaches in comparing two planets: One is to look for features and processes that are similar; the other is to look for differences. Venus and Earth are very similar in diameter and density, hence they are referred to as "sister planets." More striking differences, however, are revealed by another similarity that is less obvious. The mass of carbon dioxide contained in the atmosphere-crust system of Venus is estimated to be very close to that of Earth. If this is true, the overwhelming percentage of CO_2 on Venus, must be contained in the atmosphere. On Earth, the bulk of the mass of CO_2 is contained in the form of carbonate rocks. On Venus, there is no evidence of massive formations of carbonate rocks. Perhaps, they didn't form for thermodynamic reasons.

The theories and conclusions about Venus are developed from data from radar imaging that has a resolution of only about 1 kilometer and only covers about 30% of the surface. Without doubt, some of these theories have been overturned by the higher resolution and more complete mapping of the planet by the Magellan spacecraft. This would be especially true regarding the tectonic processes that mold the surface, but it extends to the process of cratering, as well. It was believed from the Soviet data that ejecta from crater impacts would travel a considerable distance from the impact point because the fireball from the passage of the meteor through the dense atmosphere would generate a low-density region which would allow the ejecta to travel a large distance. However, the higher resolution Magellan images showed that the ejecta does not travel very far from the impact point, and actually forms a flower petal-like pattern around the crater.

'Temporis filia veritas'

The editors themselves realize that the Venera 15/16 missions were only one step in a long process of exploration and analysis of the Solar System, which they state in their introduction:

"Our knowledge of comparative planetology is being accumulated unevenly, from one planetary mission to another. During each mission and just afterward there is an information spike, followed by a diminishing train of analyses and interpretations. This book is one coach in the train following the spike related to the Venera 15/16 mission. This mission provided geologically understandable radar images of a major portion of the Venus surface. With the background of data from previous missions, Venera 15/16 made it possible to compare Earth with all the terrestrial bodies—not only with the Moon and Mercury, which are small, and Mars, which is intermediate, but also with Venus,



The double-ring crater Klenova is the largest impact crater mapped by Venera 15/16.

which is large. Eight years have passed since the mission time. Many geological observations have been made using Venera 15/16 imagery. And although this mission did not give any additional data on on the geochemistry and geophysics of Venus, it stimulated progress in these areas because new understanding of the geology of the planet demanded a new analysis of geochemical and geophysical data obtained by the previous missions.

"Now the Venera 15/16 spike is at the trailing end and we are now looking forward hopefully to a new spike—the Magellan mission. It is now time to summarize the available data on Venus geology, geochemistry, and geophysics. . . . We would like to present this book as our pre-Magellan testament, bearing in mind the Latin epigraph above which means 'Truth is a daughter of Time.' " This spirit pervades the whole book, as the various authors refer to the hope that the data from the Magellan mission will fill in the numerous gaps left by the earlier missions, just as the Venera 15 and 16 missions made available data that had not been returned by missions that preceded these Russian probes.

In the conclusion, editors Barsukov and Basilevsky admit that while Magellan will provide vast amounts of new data on Venus, it will be of little direct use in answering the questions of Venus's geochemistry and near surface atmospherics. Therefore, "now is the time to think about new, post-Magellan missions to Venus. . . Analysis of the Magellan data should be done from the point of view of the support of the post-Magellan missions." This call for further exploration of Venus is one the West would do well to heed, before the capabilities of Soviet science are lost to the crisis of survival inside the CIS, and U.S. space science is lost because of the irrationality of the budgetary *realpolitik*.