Venusian Geology Coming into Focus

New radar images of the surface of Venus from Soviet spacecraft reveal a relatively active planet that may resemble the early Earth

The closer geologists can look at a planet, the more interesting a story they will have to tell, and Venus is no exception. The best views yet of the surface of Venus were made available late last month by Soviet researchers monitoring their Venera 15 and 16 spacecraft now orbiting the planet. The Venera radars are piercing the enshrouding clouds and returning images of volcanoes, craters, mountains, and other, more enigmatic features. The existence of most of these had already been inferred from less detailed views; planetary geologists are particularly excited, though, because they can now tell far more about how these features formed. Preliminary indications are that although the Venusian crust may often be shaped into familiar features, the overall geological scheme is unlike Earth's.

"The Soviet effort is a great step forward," says Harold Masursky of the U.S. Geological Survey in Flagstaff, who recently visited Soviet researchers. "We can see a geologically fascinating place. It looks just wonderfully complicated. It may be the most complex geology of any planet except Earth." This new complexity, much of which makes reassuringly good sense, is made visible through the higher Venera resolution. The American Pioneer Venus orbiter had a radar resolution of only 25 kilometers. The resolution of Earth-based radar images has improved to 2 kilometers at best, but coverage is limited to middle and lower latitudes on the side of Venus that faces Earth at closest approach. Venera resolution is about 1.3 kilometers. Coverage will include one-quarter to one-third of the globe, centered on the north pole.

Venera images have confirmed that Venus is not simply an immobile ball of rock pierced by a few volcanoes. Under Venera's higher resolution, areas on the Ishtar Terra highlands that in Earth-based radar images were crossed by narrow, parallel bands of high radar reflectivity definitely look like crust folded and faulted into mountains by horizontal compression, according to James Head of Brown University, who also had a close look at some of the images when the Soviet researchers visited Brown in March. Masursky agrees that it appears as if Ishtar Terra may have been squeezed into mountains, as happens on Earth when continents collide.

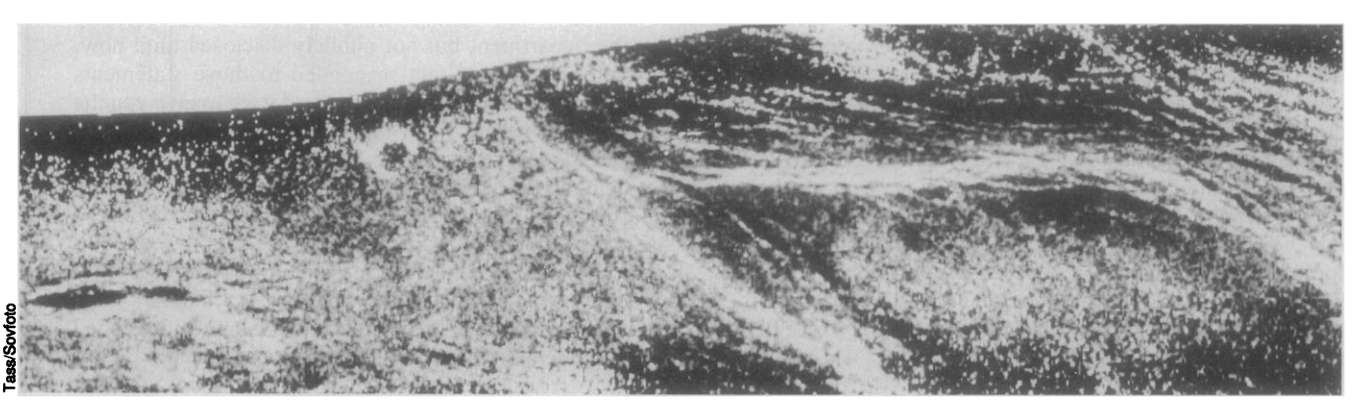
The new Soviet images have also revealed crust that has been broken up by extension, as had been deduced from Earth-based observations of other sites. At the eastern end of Ishtar Terra, a chaotic or parquet terrain, as Soviet researchers call it, appears to have been pulled apart in such a way that equidimensional blocks of crust sank below their neighbors.

Finer details recently provided by the 2-kilometer resolution of the National Astronomy and Ionosphere Center's radar at Arecibo, Puerto Rico, support the role of extension in the creation of Devana Chasma, a trough in the Beta Regio region. Donald Campbell and his colleagues at Arecibo and Head note signs of faulting within the trough and lava flows on and around two adjacent mountains. That suggests to them that extension opened a rift in the crust in this region and promoted the injection of molten rock at the resulting weak spots. The rift valleys of East Africa and the Red Sea, where new ocean basins are opening, thus bear some resemblance to Beta Regio.

The increased resolution of Venera clearly revealed other volcanoes. A depression called Colette on a plain on Ishtar Terra—a possible volcanic center in Pioneer Venus data—is now an obvious collapse crater whose lava flows merge into and form the plain, according to Head. Newly discovered volcanic features on the lowlands take the form of flows, cones, and mesas, suggesting to Head that lava compositions may vary greatly, as they do on Earth.

One family of features that Venera imaging has sharpened without identifying includes concentric, circular rings in the rolling uplands that range up to several hundred kilometers and even 1000 kilometers in size. Masursky reports that Soviet researchers are split as to whether they are scars of ancient impact craters or some kind of center of crustal deformation and movement. He notes their superficial resemblance at least to terrestrial mantle gneiss domes, thought by some to be traces of volcanic hot spots of Earth's first several billion years.

All of this activity seems to be reshap-



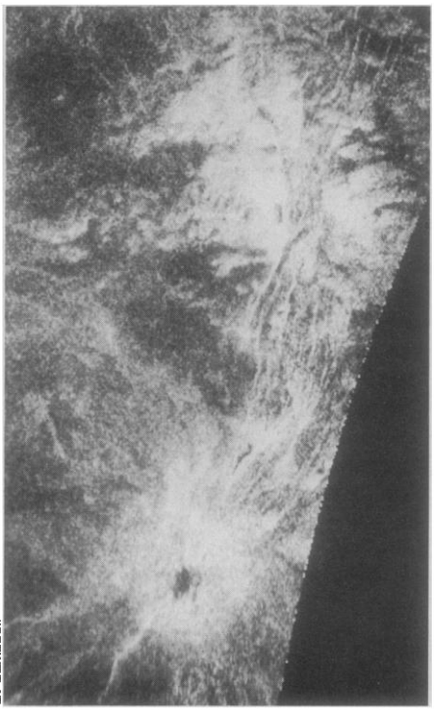
Tass/Sovfoto

A Venera radar view of Venus

This image released in November includes "intensive tectonic formations"—parallel and intersecting ridges and canyons in the northern polar area that are 1 kilometer to 8 kilometers wide, according to an accompanying news release. The resolution of Venera images that are more thoroughly processed than this one—which have been made available since March to a few American researchers—is the best available.

Beta Regio from Earth

The 2500-kilometer-long bright spot of Beta Regio appears in this Arecibo Observatory radar image to be a volcanic rift system—the band of parallel bright features are probably faults in the trough that is bounded by the volcanoes of Theia Mons to the south (bottom) and Rhea Mons (top).



D. Campbell

ing the surface of Venus at a significant rate. Now that they can distinguish between impact craters and volcanoes, Soviet researchers have compared the number of obvious impact craters against the rate that they would be expected to form. The resulting average age of the area observed so far is about 1 billion years, suggesting that the surface has been thoroughly reworked during the 4.5-billion years of the planet's history.

What drives this crustal reworking is unclear. Although many individual features are familiar from Earth, Venera and Earth-based observations have failed to detect a pervasive, Earth-like system of plate tectonics. Ishtar Terra is the only highland region or "continent" showing signs of horizontal motion. And Head, who has been a strong proponent of keeping the plate tectonics option open, points out that the latest images "do not reveal any features strikingly similar to ocean basins of Earth. There is no obvious divergent plate morphology." The alternative that Venus loses much of its heat through volcanic hot spots (*Science*, 15 January 1982, p. 278) rather than the creation of new crustal plates is becoming an increasingly attractive possibility. That may have been how Earth operated before it was cool enough to form and recycle oceanic plates.

Planetary geologists are looking toward the next improvement in radar imaging resolution in 1988 when the American Venus Radar Mapper (VRM) increases resolution from Venera's 1.5 kilometers to a range of 0.15 to 0.5 kilometer. That should allow the determination of the sequence of some events that shaped the surface as well as the identification of more features and geologic processes. Some American planetary geologists are pushing for an even higher resolution for VRM, harking back to the Venus Orbiting Imaging Radar concept. It was scrapped due to its high cost, part of which was due to its very high resolution radar. A modest enhancement of VRM's resolution, they argue, would increase the mission's cost only a few percent while greatly improving geologic understanding. Such increases in resolution have always paid off scientifically. Whether more money can be scraped up for planetary science is far less clear.—**RICHARD A. KERR**

Managing the Inland Sea

The last large tract of tallgrass prairie is in Kansas where ecologists are attempting to maintain it as it was in presettlement days

They used to call it the inland sea—the vast expanse of tallgrass prairie that once covered most of the Midwest. As the constant prairie wind blew across the grass that in the fall was higher than a man's head, the grass would undulate and would even sound a bit like the sea. But the sea has gone dry. The prairie has been replaced by farmland. Even Illinois, "the prairie state," now has a miserable couple of hundred acres of original prairie, mostly along railroad beds or at the sites of old cemeteries.

One large tract of tallgrass prairie remains, however, and is now being intensively studied by an interdisciplinary group of investigators at nearby Kansas State University, who hope to reconstruct the presettlement conditions and use the prairie as a site for long-term ecological research.

In addition to the purely theoretical reasons for wanting to know how the prairie was maintained as a stable ecological system, there are practical reasons for this research. Cattle farmers periodically burn their grazing land to help maintain it and the prairie studies should help them to determine the best period between fires. And the midwestern farmers, whose topsoil is being eroded and whose land is becoming poorer, could benefit from research on how the rich land of the prairie was maintained.

The Konza Prairie elicits nothing but praise from ecologists. "In my opinion, it is *the* superb tall grassland," says Paul Risser, a grassland researcher who is chief of the Illinois Natural History Survey. "It is certainly the best controlled, best funded tallgrass prairie in the world," says Robert Woodmansee, an ecologist from Colorado State University who is spending this year at the National Science Foundation.

When you stand in the middle of the 8616-acre Konza Prairie, all you can see are hills of brown grass with a few scraggly trees along the streams that run through the land. The thick grass impedes your steps and the unrelenting wind pushes you. The blue sky is like a bowl above your head. It is utterly peaceful, reminiscent of a time when only Indians and wild game lived on this land.

The very existence of the Konza Prairie is due to the vision and persistence of Lloyd Hulbert, an old-time classical ecologist who has spent more than 30 years at Kansas State University. As long ago as 1956, Hulbert got together with a group of eight other faculty members from five departments and put together a proposal that the university buy some of the increasingly scarce prairie land as a research area. The university administrators, Hulbert recalls, thought the proposal was a good one but they had no available funds.

Still, Hulbert did not give up. He located an ideal site nearby where the