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

Lloyd Hulbert

The Konza Prairie

A vast stretch of grassland extending as far as the eye can see, the prairie looks much as it did in presettlement times.

prairie had never been plowed because it was too steep and rocky. In the spring of 1970, he and his colleague, ecologist Richard Marzolf, went to Washington in search of funds. At about that time, the Nature Conservancy in Arlington, Virginia, had been given money by Katharine Ordway, an heiress to the 3M Corporation fortune, for the preservation of prairies. Ordway, who came from Minnesota, had a great fondness for prairies, and requested that the prairies she supported be given Indian names.

Using Ordway's funds, Kansas State bought a 1000-acre piece of prairie from Alf Landon and named it Konza, one of 100 different spellings of the tribe that lived there, another spelling being Kansas. A few years later, Hulbert learned that the owners of a much larger adjacent piece of prairie might be willing to sell and the Nature Conservancy, in 1977, ended up paying $3.62 million for this land. They then bought an additional 480 acres, once again with Ordway's funds, resulting in the large tract of Konza Prairie that exists today. In 1983, the National Science Foundation awarded the Kansas State scientists a long-term research grant, a new type of funding developed to support continuous projects for many years or even decades.

One of the principle research projects at the Konza Prairie is a study of how fire maintained this ecological system in presettlement times. If a prairie is not burned periodically, trees encroach and it gradually becomes a woodland. It is fire that makes a prairie a prairie, and with the dense buildup of dead grasses on the prairie, fires are easy to start and hard to control.

The ecologists believe that fires used to be started by lightning and by the Indians, who would purposely set fires to draw buffalo to the site where they could be hunted. Within a few days after a prairie fire, tender shoots of new grass push up through the charred ground and the buffalo would come to graze.

But no one, Hulbert says, knows what was the natural period between fires in the presettlement days. The Kansas State group is experimenting with different periods on areas of land defined by watersheds. The time between the fires they set range from once a year to once every 10 years and already they are able to see that the time between burns enormously affects the diversity of plant and animal life. They are finding that a 4- to 6-year burn period seems to result in maximum productivity, with more grass, higher flower stalks, and even a greater variety of insects. In the areas that they burn every year, the grass grows less tall and the dominant grass species become even more dominant. The areas burned every 10 years are being encroached on by trees, starting with trees at the edges of streams and fanning outward. Hulbert estimates that it may take 30 years of burning every year to get rid of most of these trees.

According to Marzolf, it makes some intuitive sense that a 4- to 6-year burn period might be ideal. "If you look at the accumulation of dead grasses that might serve as fuel [for fires], they accumulate for 3 to 5 years and then they start to decompose as fast as they accumulate," he says. "We think the presettlement interval between fires was 3 to 5 years." Many cattle farmers nearby are burning their fields every year or so—raising the possibility that they may be burning too often.

The Kansas State researchers are carefully studying weather patterns and the effects of unusual years on the prairie's plant and animal life and they are planning next year to reintroduce the original grazers—bison, elk, and pronghorn antelope—to the land. It is the long-term aspects of this research that most excite Woodmansee. "There are lots of concepts that deal with short-term phenomena," he points out. But those concepts may be misleading. "It may well be that what happens in normal years is next to useless and that the abnormal years are the important ones." Periods of drought or unusually wet or cold years may reset the system, bringing in plant and animal life that otherwise would not exist there. But the only way to test this hypothesis, which many ecologists feel is correct, is to study a system like the Konza Prairie in great detail and for many years.

Woodmansee is confident that new principles will come out of this long-term research. "Within a decade we're going to see some major changes in the way we think of ecosystems," he says. Jenkins agrees and adds that the work should also help the Nature Conservancy to manage the small plots of prairie, some of which are only a quarter acre, that it is trying to preserve. "Many of these plots still have essentially the same composition as the large prairie. But their management is very tricky. You can't make a mistake," he says.

According to Jenkins, the Konza Prairie is one of the nation's most precious research sites. "As far as we [at the Nature Conservancy] can see, the Konza is *the* premier prairie research institution in the country. And it should get better and better." Besides, he adds, "I love the place."—GINA KOLATA