all the technical advances that had been mastered in the early mission. The project continues with the tradition of international collaboration—often with the same collaborators who worked on VEGA. It even follows up on VEGA's pioneering small-body research: the tiny satellite Phobos, like the icy nucleus of Halley's comet and indeed, most of the other comets and asteroids in the solar system, is thought to consist of primitive, relatively undisturbed material dating back to the origin of solar system.

It is true that Phobos is the first of a new generation of spacecraft—in essence, a modernized Venera that has been optimized for the environment of Mars. But even that fact expresses continuity: in the 1960s the Soviets flew mission after mission to the moon; in the 1970s they turned their attention just as resolutely to Venus; and now, for the late 1980s and 1990s, they are preparing a series of missions for Mars.

"We make analogy with agriculture, extensive versus intensive," Sagdeev explained to *Science*. "[Our program] is probably more intensive." There are many arguments for making it so, he says: "Cost efficiency—since after you build spacecraft, is much better suited to perform same type of mission. Redundancy—eventually every experiment would work. Also, it provides a kind of logic—even without knowing the details, what can be the next step, each mission is providing additional questions for the next mission. And also, to avoid unnecessary duplication of America's program, which during the last decade was wide-ranging reconnaissance of the solar system."

Of course, as Sagdeev's colleague Galeev points out, the intensive approach does have its drawbacks. Boredom, for example: "Maybe I'm not a specialist," he told *Science*, "but I couldn't see a big difference between [the results of] the different landers. . . . Is growing opinion we should stop for awhile our Venus research. Maybe is time to do something else."

Moreover, as Sagdeev himself admits, the Soviet approach is as much a matter of inertia as of logic. Soviet factories, even spacecraft factories, tend to be very production oriented. The managers like to keep stamping out items one after the other. Moreover, the Soviet system, even in science, is highly segmented, which means that the scientists have had no direct say in how the spacecraft are designed. "We had spacecraft designed for Venus," says Galeev. "So it was very difficult to get spacecraft for other planets . . . We can influence design of spacecraft only by discussion."

Be that as it may, the Soviet program is now committed to Mars through the turn of the century. And indeed, Mars is an eminently reasonable choice: not only is it the most Earth-like of the planets, offering a host of unanswered questions about its climate and geologic history, but it has popular appeal—a not inconsiderable factor even in the Soviet Union. A manned expedition to Venus, with its 750 K surface temperatures, is inconceivable. But a manned mission to Mars is quite conceivable. "This is why many people in our country are interested in Mars research," says Galeev. "[The public] can understand why we should send people there—to prove that we can have life outside our planet."

Granted that the Soviet Union is unlikely to send cosmonauts to Mars anytime soon—although the Salyut and Mir space stations have certainly given them a great deal of experience in long-duration spaceflight—the scientists at IKI and the Vernadsky Institute have nonetheless mapped out a series of increasingly more ambitious pathfinding missions for the interim. The detailed sequence is still in flux. But the first, obviously, will be Phobos in 1988. Next will come Mars 1992, which may well involve an exploration of the surface with an instrument package wafted from point to point by a French-built balloon. Subsequent missions will carry penetrators, rodlike devices that will be dropped from high altitude to probe the subsurface rocks; rovers that will wander across the martian boulder fields; and perhaps even "moles," devices that will burrow down into the planet-wide layer of permafrost.

And finally, of course, as a last step before the first (hypothetical) manned expedition, there will come the Mars Sample Return—the mission that Sagdeev thinks is such a natural candidate for Soviet-American collaboration. ■ M. MITCHELL WALDROP

High-Temperature Superconductor Hints

During the past several weeks, several groups have reported tantalizing "drops" in the resistivity of their samples when cooled to about 240 K. The sudden decreases were taken as indicating the possible presence of superconductivity at this high temperature. Now, two sets of researchers are claiming to have seen the resistivity disappear altogether (that is, to below the sensitivity of their instruments) in the same temperature range. Although still short of proof of superconductivity, the new evidence adds to the expectation that a new high-temperature ceramic oxide superconductor will be identified soon. Additional evidence comes from a third group, which says it has magnetic data supporting high-temperature superconductivity.

Ideally, to verify superconductivity, researchers want to observe a vanishing resistivity and a substantial Meissner effect (magnetic flux expulsion from the interior of a specimen) that are reproducible in several samples whose properties do not change with thermal cycling between high and low temperatures.

Ching-Wu (Paul) Chu, who heads a group at the University of Houston that is collaborating with researchers at the Lockheed Palo Alto Research Laboratory and the National Magnet Laboratory, told the National Science Board late last month that the group had seen the disappearance of the resistivity in just one sample of a ceramic oxide of undisclosed composition at 225 K. Moreover, the behavior survived thermal cycling for a period of 2 weeks before the material lost its putative superconductivity. Thermal cycling is necessary for a Meissner effect measurement, and the researchers were able to detect a small effect of less than 1%, suggestive of a small volume fraction of high-temperature superconductor in the sample.

Investigators at the University of California at Berkeley have also observed a vanishing resistivity at about 230 K, once again in a ceramic oxide of undisclosed composition but one that is not dramatically different from that of the rare earth–barium–copper–oxygen compounds that become superconducting between 90 and 100 K. According to Berkeley's Alex Zettl, the sample remains resistanceless on warming until 292 K (or 66°F, a warm spring day). But, after further heating followed by cooling, the resistivity no longer vanishes. By way of explanation, Zettl says it is possible that thermal cycling disrupts tiny filaments of superconductor embedded in a mostly nonsuperconducting sample.

Finally, at Energy Conversion Devices, a Troy, Michigan, company, scientists have magnetic evidence for superconductivity up to 280 K in samples containing fluorine in place of some of the oxygen. The resistivity vanishes (becomes too small to measure) at 155 K, but anomalies in the temperature dependence of the magnetization occur at the higher temperature. According to Stephen Hudgens, the samples consist of at least four ceramic phases. The speculation is that the so-far unidentified superconducting phase is present in too small a volume fraction to give a measurable Meissner effect. ■ ARTHUR L. ROBINSON