EARTH SCIENCE

Contacts With the West Bring Cultural Revolution

For 70 years, Soviet earth scientists were walled off from Western practitioners to a greater extent than their colleagues in almost every other discipline, aside from classified military research. The Communist authorities may have allowed a few favored biologists and physicists to collaborate with their counterparts in the West, but they certainly drew the line at teams of Western earth scientists crawling over the Soviet interior. Today, however, the raising of the Iron Curtain and the collapse of Russian government research funding is throwing Western and Russian earth scientists together as never before. "Now, we have a rather wide exchange of scientists," says glaciologist Vladimir Kotlyakov, director of the Institute of Geography in Moscow.

As the Russians jostle to win Western dollars and technology to shore up their floundering science, they are wheeling and dealing with the cards they have been dealt—their long-sought-after field sites and unique data repositories. And the Westerners are like kids in a candy shop, finally gaining access to huge tracts of land that had been denied them for so long, not to mention data from extraordinary studies conducted by former Soviet scientists.

But forging intimate contacts between the two communities is not proving simple. First, there are the inevitable logistic problems of doing business in a country that is on the brink of economic and political chaos. And decades of isolation in the rigidly hierarchical Russian system has bred a scientific culture in which archaic theories, long abandoned in the West, can still hold sway. But as Westerners gravitate toward researchers—particularly younger Russian scientists—who are ready to assimilate new ideas, that culture is at last transforming itself. "[Russian] geologists are now seeing that it's very important to update themselves; they're doing it very quickly," says geochemist Kent Condie of the New Mexico Institute of Mining and Technology.

Despite the inevitable problems, however, the forces driving East and West together are irresistible. In their enthusiasm, Western earth scientists have started the scientific equivalent of a land rush. Walter Mooney, a geophysicist at the U.S. Geological Survey (USGS) in Menlo Park, California, who wants to understand how continental crust formed and stabilized, puts it simply: "They have what I need: geography." The Soviet Union was huge, covering 15% of the world's land area, and even after that country's disintegration, the Russian Federation still stretches across 11 time zones.

Mooney, in collaboration with Russian colleagues from the Center for Regional Geophysical and Geoecological Research in Moscow, has already profited handsomely from this immense geography. Together they have surveyed much of the region's continental crust through analysis of one of the unique Russian resources—recordings of seismic waves generated by underground chemical and nuclear explosions set off since the early 1970s in a grid spanning most of the former Soviet Union. Now that details of this never-to-be-repeated experiment in deep seismic sounding are available, Westerners can clearly see that the textbook figure for the average thickness of Earth's continental crust—30 kilometers—is 10 kilometers shy of the truth because the exceptionally thick crust of the former Soviet Union had not been included. The collaboration, says Mooney, was "the bargain of the century."

VLADIMIR KIRIANOV/INST. OF VOLCANIC GEOLOGY AND GEOCHEMISTRY

Hot property. Kamchatka volcanoes lure U.S. researchers.

The mammoth chunk of real estate now open to the West seems to have something for everyone. "Almost every part of the geologic column with an important problem is represented in Russia," says paleontologist Jere Lipps, director of the Museum of Paleontology at the University of California, Berkeley. Last summer Lipps went after one of those problems—animal evolution 600 million years ago in the Vendian Period before shell and bone evolved—by co-leading a field trip to fossil deposits on the White Sea near the Arctic Circle with colleagues from the Paleontological Institute in Moscow. The finds included fossils of two previously unknown kinds of animals and a new form of animal track. Even after the Russians had first choice of the newly collected fossils, the remainder made the Berkeley collection "the second largest collection of Vendian fossils in the world," says Lipps.

In exchange for access to former Soviet field sites, data repositories, and scientific talent, Western scientists are contributing computers, data processing, visits to the West, and, perhaps most importantly, hard currency. But as Russia's economic crisis deepens, many collaborations are becoming difficult to manage.

Volcanologist and remote-sensing specialist David Pieri of the Jet Propulsion Laboratory in Pasadena, California, for instance, first worked with the Institute of Volcanology in Petropavlovsk-Kamchatskiy, in the Russian far east, in 1988, when he helped begin a collaboration to bring a U.S. National Aeronautics and Space Administration jet with state-of-the-art remote sensors to the Kamchatka Peninsula. The objective was to monitor the area's abundant volcanoes, thrown up where the Pacific plate dives into the mantle—as happens beneath the U.S. Aleutian Islands to the east. Since then, internal politics has split the Institute of Volcanology into two, but—more worryingly for Western collaborators—its scientists are being diverted away from pure science and into more profitable pursuits. "We're dealing less and less with full-time professionals," says Pieri, "and more with people with side businesses or [practicing volcanology] on an amateur basis."

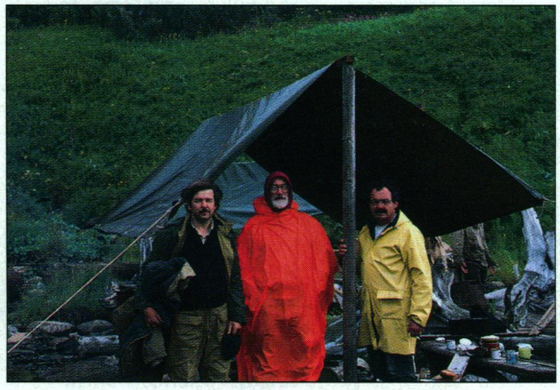
Indeed, to stave off as much downsizing as possible, "the Russians are working every angle," says Berkeley's Lipps. Moscow's Paleontological Institute, for instance, has sent an exhibit, "The Great Russian Dinosaurs," on a world tour. The institute, like many others, has also gone into the field trip business, charging Westerners enough for services and support to clear a modest profit. And the Shirshov Institute for Oceanology in Moscow, meanwhile, has already leased its vessels to a number of commercial organizations (see box).

Furthermore, as times get even tighter, Russian earth scientists are guarding their data more closely as they seek to strike deals with Western labs that will maximize their financial returns. "Institutes regard their data as their means of economic survival," says Cornell University geophysicist James Knapp, who in collaboration with Russian geophysicists is studying the Ural Mountains to better understand Appalachian-style mountain building. The trend extends right to the top of the Russian scientific system. In the early 1990s, for instance, the

Geological Committee of Russia (formerly the Soviet Ministry of Geology) began passing out to the West deep seismic sounding data sets in return for nothing more than computer reprocessing of the data. Now it is holding on to the bulk of them and considering how it might get a higher return on its investment.

PALEONTOLOGICAL INSTITUTE

Northern exposure. Jere Lipps *(below, right)* with M.A. Fedonkin *(left)* and James Valentine collected 600-million-year-old fossils like this medusoid *(left)* in the Russian Arctic.



JERE LIPPS

Indeed, some Western earth scientists are finding it difficult to determine who among their Russian colleagues they should deal with in this new commercial environment. "Everybody has something to sell, but you don't [always] know what's worth buying," says geophysicist Mark Zoback of Stanford University, who is interested in obtaining data from Russia's scientific drill holes, which include the deepest hole in the world, located on the Kola Peninsula in the Russian Arctic. Gone, he says, are the days when data produced by Western instruments lowered down the holes were sufficient reward for access to the field sites. Meanwhile, says Richard Grieve of the Geological Survey of Canada in Ottawa, Western geologists are finding that hundreds of kilometers of drill core recovered from meteorite impact craters—a resource unequaled anywhere else in the world—are out of reach while the groups of Russians who drilled, analyzed, and are storing the cores haggle over who owns them.

Disputes over the value and ownership of data are not the only obstacles to effective collaboration. Western researchers have also found that the distinct culture of Russian earth science can pose problems. For example, although all agree there is considerable talent to be found among Russian earth scientists, that talent has been enmeshed in a rigid intellectual hierarchy that began to crumble only in the late 1980s with the reforms of *perestroika*.

"The big problem I have," says climatologist Thomas Karl of the National Climatic Data Center in Asheville, North Carolina, "is that you get this reverence for a few prominent people. If one of them says something, it's got to be true. If someone says something [in the West], there are eight people trying to prove it's wrong." As Condie of the New Mexico Institute of Mining and Technology notes, however, criticism of any kind was not welcome under the Soviet regime. "You didn't dare disagree with the head of your institute," he says. "If you did, you would not be funded." Indeed, one Russian climatologist who emigrated to the United States several years ago says that, compared to an institute head, "all other people are slaves."

These rigid constraints on intellectual life also help explain the continued promulgation of ideas that elsewhere are long dead and buried. Among them is granitization, the conversion of rock to granite by the percolation of fluids. It was a popular idea in some parts of the West in the 1940s and '50s, says Condie, until modern laboratory experiments and geochemical analysis showed that melting of rock, not alteration by fluids, had to be involved. "The problem is the Russians never let go [of the idea] because a few top Russian scientists advocated it," he says.

Global tectonics was another field in which many Soviet scientists held on to outdated theories. Plate tectonics, the ruling paradigm in the West since 1970, was dismissed by Vladimir Beloussov, head of the Department of Geology of the Soviet Academy of Sciences, right up until his death in 1990. Instead of plates moving horizontally, Beloussov theorized that continental crust was sinking and becoming ocean crust. And because he said it was so, plate tectonics got short shrift in the Soviet Union.

One American geologist working in a southern former Soviet republic says that today, "the majority don't truly believe in plate tectonics or truly understand all the [theory's] tenets." And even in Russia, "there's still a small minority of workers...who are willing to entertain these [non–plate-tectonic] ideas," says Cornell's Knapp. Acquiring data presents no problem, but whenever interpretation arises, as in co-authoring a paper, conflicts can ensue.

The extreme specialization of most Russian earth scientists can also be a detriment to close interaction with Western scientists. "[M]ost of my Russian colleagues are superbly well trained in a narrow specialty and are limited in thinking in interdisciplinary ways," says Precambrian paleontologist Andrew Knoll of Harvard University. "It just wasn't in their training." Whereas a Westerner might combine paleontology, sedimentology, geochemistry, and comparative biology to decipher events in the Precambrian, he says, in Russia four specialists would be needed.

The good news, however, is the emergence of a sizable segment of the Russian earth science community—including in particular the younger researchers—that is eager to embrace new ideas. William Patton of the USGS, for instance, has been pleasantly surprised by his latest collaboration with Russian geologists. He was one of the few Western earth scientists to gain access to Russian field sites before the recent political changes, and has worked on Siberian geology off and on since 1975, encountering the familiar resistance to plate tectonic theory right through to the early 1990s.

In Patton's current collaboration with researchers from a number of Russian geological institutes, which began in 1988, he initially focused on the data and tried to avoid philosophical discussions. But this precaution turned out to be unnecessary. "The Russian group is younger," he says. "They seem to fully accept the plate tectonic theory. That goes along with the new freedoms they're having in their institutes. There seems to be a relaxing of the heavy hand." Moreover, the advantage of interdisciplinary work, says Harvard's Knoll, is now being assimilated. And as these westernizing Russians inevitably publish in Western journals, the science they have to offer is becoming apparent after years of being buried in the Russian literature, says Lipps. Indeed, Russian earth scientists hope this trend will overcome the prejudice that many feel they have been subjected to in the past. "Sometimes, Western scientists know about Russian results, but they don't give reference [to them]," complains Kotlyakov of Moscow's Institute of Geography.

As success in forging links with Western researchers will be crucial in determining which groups will survive and which will die, there is little the old hierarchy can do to hold back the new generation—particularly now that the advent of electronic mail connections is allowing forward-looking Russian earth scientists to communicate on a daily basis with their Western colleagues. The great imponderable, however, is whether Russia's economic problems will become so overbearing that even the vibrant younger generation will be unable to survive. Now everyone is waiting and watching. Says Cornell's Knapp: "We're all going to be worse off if they don't succeed in this grand experiment."

–Richard A. Kerr