will lose a portion of its herbicide market. "I do not believe it's the role of the USDA to mandate the monitoring of [resistance] ... it is the developer of the product that has the interest in assuring that resistance does not build up," says John Payne, acting director of the Biotechnology, Biologics, and Environmental Protection Division of APHIS.

As ecologists and regulators debate these issues, the stakes surrounding transgenic crops are rising. Developing nations—where crops may have more native relatives—are beginning to test and adopt the new varieties. For example, a potato genetically engineered for virus resistance has been in field trials in Mexico since 1992. If this year's large-scale trials go well, the potato could come up for deregulation in mid-1997, according to Ariel Alvarez-Morales, principal investigator on the potato project at CINVESTAV, a federally funded Mexican research organization in Iracuato, Guanajuato.

The introduction of transgenic crops to regions where many crops originated raises another concern. One of the centers of diversity for the potato is central Mexico, for example, and many wild potatoes still grow there. Traditional breeders and transgenic crop critics worry that transgenic varieties could introduce a potentially dominant genotype into the wild. Such a takeover would reduce the genetic pool available to breeders who currently tap these diverse populations to develop new crop strains. "It's all hypothetical ... but everybody agrees that the release of [a transgenic crop] in its center of origin is not a good idea," admits R. James Cook, a research pathologist with the USDA Agricultural Research Service at Washington State University in Pullman.

But Cook notes that existing rules for selling seed crops would prevent such a takeover, by guarding against hybridization. Most widely grown crops go through a rigorous certification process, in which fields are monitored for signs of hybridization. Cook and others insist that it is important for developing nations to get the benefit of these new technologies, and say that careful seed certification in these countries can prevent the shadowy dangers of gene flow. "Unfortunately, the benefit side of these equations gets far too little press," says Judith Chambers, senior biotechnology adviser at the U.S. Agency for International Development. "We're talking about many nations with limited arable land and burgeoning populations, and they are going to need some infusion of technology in order to meet their food needs."

Whether or not transgenic crops spawn superweeds, they are likely to generate continued debate, as the opinions of officials like Chambers sometimes clash with those of research ecologists. In Jørgensen's view, "If you want to deregulate transgenic crops, you have to take a chance."

–James Kling

James Kling is a science writer in Bellingham, WA.

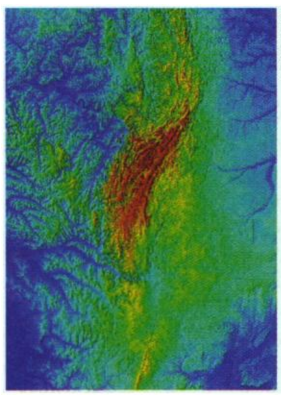
PLATE TECTONICS

Urals Yield Secret of a Lasting Bond

Like modern marriages, geologic unions have a disconcerting tendency to fail. Two great tectonic plates collide, driving up a mountain belt like the Appalachians, only to rift apart again, forming an ocean-filled breach. The Atlantic in fact marks the latest failed marriage between the continents flanking it. Now an international team of researchers from Russia, Germany, the United States, and Spain has drawn a portrait of a geologic union that has stood the test of time, revealing the deep underpinnings that, for 250 million years, have preserved the bond between Europe and Asia marked by the Ural Mountains of central Russia.

Beginning on page 220, researchers recount the findings of URSEIS '95, a multipronged effort to image the rock beneath the Urals to a depth of a couple of hundred kilometers by probing it with artificial seismic waves. "It was a tremendous success," says deep-crustal specialist Walter Mooney of the U.S. Geological Survey in Menlo Park, California, who followed the project closely. "It's as close as they're going to get to a [geologic] cross section." And it shows a sharp contrast to most collisional mountain ranges, where the plate thickened by the collision eventually sheds its deepest layers into the mantle, weakening the continental bond. Under the Urals, the thickened plate is intact. "We see now that the [crustal] root really has survived," says Rolf Meissner, professor emeritus at Kiel University. The question now is why.

The URSEIS '95 researchers aren't the first to glimpse that puzzle. A variety of studies by Soviet researchers, including ones that used seismic waves generated by underground nuclear explosions spread across the country to probe the crust, convinced them that the Urals had retained a crustal root, but Western scientists were less certain. "We didn't have direct access to these data," says James Knapp of Cornell University, a member of the U.S. URSEIS '95 team. In addition, the concept of a mountain belt with a thick crust was "very foreign to our experience in the West," where seismic studies beneath older mountains tend to show that the crust has thinned back to normal thickness.


URSEIS '95

Strong union. Urals (seen in a color-coded topographic map) have held together for 250 million years.

So URSEIS '95 took a new look by generating seismic waves—this time with truck-mounted "thumpers" and conventional explosives, not nukes—and exploiting them in two imaging techniques. One, called seismic refraction, maps out structure based on variations in the speed of the waves; the other, called seismic reflection profiling, creates an image from seismic waves reflected by subtle boundaries within the rock.

Based on the picture that emerged, says Knapp, "we can definitely say that we have a preserved example of a collision that is 250 [million] to 300 million years old." The crust thickens from about 40 kilometers on either side of the Urals to more than 55 kilometers beneath them. And the gently sloping faults created by the compression that raised the Urals are still there. At the same time, the suture shows none of the signs of weakening so familiar under other mountain ranges, such as churning of the deep crust and crustal melting.

Why the Urals and the plate suture they represent have held together so long is not so obvious from the seismic data, but the URSEIS '95 group thinks the answer may lie in the suture's modest thickness. Today, as India plows into Asia, it not only squeezes up the Himalayas but also dives beneath the Asian plate, doubling its thickness to 75 kilometers and raising the broad Tibetan plateau. Such thickening can pile up more cold, dense rock than can float on the underlying mantle. Eventually, the extra plate thickness will fall away, allowing plate-weakening magma to intrude—a process that will thin and weaken the suture and allow it to rupture as soon as the plates change direction and start to pull apart.

The URSEIS researchers suggest that Asia and Europe never had a chance to go that far. The Uralian suture is a hodgepodge of different rock types, indicating that when Europe and Asia converged, bits and pieces of new crust—like the volcanic island arcs now common in the southwest Pacific—became caught between them. These crustal fragments may have acted as spacers, keeping the plates far enough apart that their union did not deepen to the point of instability. Make your own parallels with marriages that last.

–Richard A. Kerr