Earth Sciences

Scars from an ancient collision

The Alps, Appalachians, and Himalayas all evolved out of earth-wrenching crashes between two or more of the slow but relentlessly moving tectonic plates that cover the planet's surface. Similar continental smashups have occurred for at least 2 billion years, but much of the evidence from earlier collisions has been wiped out or covered by subsequent events, making the ancient history of the world a dim realm for geologists.

Now, a project in the Bay of Bothnia – between Finland and Sweden – has provided some of the clearest information yet about an ancient crash relatively early in the Proterozoic era, which lasted from 2.5 billion to 570 million years ago. To probe the geology beneath the bay, researchers used a technique called seismic reflection profiling, which sends sound waves down into the earth and measures the waves reflected back from structures in the interior. The British, Danish, Finnish, German and Swedish scientists who collaborated on this project report on their work in the Nov. 1 NATURE.

Seismic profiles of the rock structure beneath the bay show a sharp break in the Moho – the boundary between the Earth's crust and the mantle. On the southwestern side of the break, the Moho dips downward into the mantle, suggesting this region represents an ancient "suture zone" where one plate slid beneath another as the two collided. The rocks in this area date to between 1.9 billion to 1.8 billion years ago.

Crust from the Proterozoic era is much thicker than crust from more recent periods. But the features seen beneath the Bay of Bothnia closely resemble structures in younger collision zones, indicating that the style of plate collisions has not changed much in 1.9 billion years.

A little oxygen is better than none

If the thin air atop a mountain peak makes you gasp for breath, consider how hard it would have been to breathe during the Archean era, the first 2 billion years of Earth's history. Scientists have long believed that the atmosphere back then held virtually no oxygen. But new calculations paint a considerably different picture of that distant period, suggesting that Archean air held a low but significant amount of oxygen.

Geologist Kenneth M. Towe of the Smithsonian Institution in Washington, D.C., estimates that oxygen made up 0.2 to 0.4 percent of the air at that time. While this concentration pales in comparison with the current level of nearly 21 percent, it is a trillion times greater than what many scientists thought was present in the Archean atmosphere. Towe discusses his work in the Nov. 1 NATURE.

Oxygen in the modern world comes from photosynthetic organisms, which produce the gas by breaking down water molecules. Such organisms existed during the Archean, but scientists believed that the oxygen produced by photosynthesis never had a chance to build up in the atmosphere. The prevailing theory holds that iron in the oceans absorbed the oxygen, keeping atmospheric levels of the gas at essentially zero. But Towe calculates that the iron in Archean rocks could not have absorbed all the oxygen produced by the photosynthetic organisms.

Noting that atmospheric oxygen concentrations did not rise to extremely high levels during the Archean, Towe reasons that some factor other than iron must have helped keep the levels down. He proposes aerobic respiration as that factor. In the modern world, organisms use the oxygen-absorbing aerobic process to metabolize food and gain energy. While most scientists believe aerobic organisms did not evolve until oxygen levels increased dramatically at least a billion years later, Towe suggests they emerged during the Archean, surviving on the small amounts of oxygen available at the time.

Environment

Janet Raloff reports from Arlington, Va., at the annual meeting of the Society of Environmental Toxicology and Chemistry

Ins and outs of pesticide residues

On field-grown crops, pesticide residues tend to diminish rapidly through decomposition by sunlight or rinsing by rain. Regulators usually take this into account when approving instructions for pesticide application. But safety margins based on outdoor use may not protect greenhouse workers, asserts J.J. van Hemmen of the Netherlands Organization for Applied Scientific Research in Rijswijk.

He observes that Dutch flower workers seldom wear gloves in the hot, sweaty greenhouse environment. Moreover, van Hemmen's team found that pesticide residues on greenhouse-grown carnations and roses showed "no decay" over time. One experiment indicated that greenhouse workers who cut, sort or bundle carnations sprayed with chlorothalonil may expose their unprotected hands and forearms to five times the recommended 10-milligram daily limit of this fungicide.

These findings, which surprised many scientists at the conference, highlight the pitfalls of extrapolating data from one occupational setting (outdoor fields) to another (the greenhouse), says Richard A. Fenske of Rutgers University in New Brunswick, N.J., who studies pesticide exposures.

Reassessing costs of keeping baby dry

Because human feces may contain many disease-causing organisms, environmental engineers worry about the long-term safety of burying disposable diapers in landfills. To investigate the threat, researchers have now exhumed a total of more than 200 diapers from landfills in New York, Florida and Arizona. They tested fecal samples from each soiled diaper for a host of common childhood intestinal pathogens, including rotoviruses, hepatitis A virus and the protozoans *Giardia* and *Cryptosporidium*. After an average of two to 10 years of burial, none of the diapers showed evidence of viable pathogens, reports Charles P. Gerba of the University of Arizona in Tucson.

A report released last month offers environmentally conscious parents further license to consider the convenience of disposables. Consultants with Franklin Associates in Prairie Village, Kan., compared all costs associated with disposable diapers against those for cloth diapers. Their environmental audit considered not only the costs of diaper production, packaging and disposal or washing, but also those of products used with cloth diapers, such as pins and plastic pants.

Per year of diapering, the team found that disposables require about half as much energy as cloth diapers (the equivalent of about 53 gallons of gasoline), use one-quarter as much water (2,570 gallons), produce half as much air pollution (16 pounds of combustion products) and generate about one-seventh as much water pollution (3 pounds). Solid waste was the one category where disposables did not come out ahead: They send four times as much garbage to landfills.

The overall comparison lumped commercially laundered cloth diapers with those washed at home. Yet even these differ on several environmental measures, the team found. Home washing consumes 19 percent less water but requires 79 percent more energy and contributes twice as much air pollution, according to their calculations.

Makers of disposable diapers remain concerned about public perceptions of their product as an environmental nuisance, with disposable diapers now constituting 1.5 to 2 percent of all paper products in U.S. landfills. Procter & Gamble Co. announced this fall that it is developing fully "compostable" diapers and will commit $20 million to advancing municipal composting worldwide. The Franklin Associates audit indicates that if other makers follow suit, the new compostables will beat out cloth diapers on all environmental counts – provided the throwaways end up in municipal compost systems rather than in landfills.