Cows and Climate; Sundry Catastrophes

When the American Geophysical Union (AGU), the umbrella organization for the earth sciences, met in Baltimore on 28–31 May, it had to spread a wide canopy indeed for the 2800 scientists who attended. AGU's 13 sections range from atmospheric chemistry to volcanology by way of seismology—the three disciplines represented here.

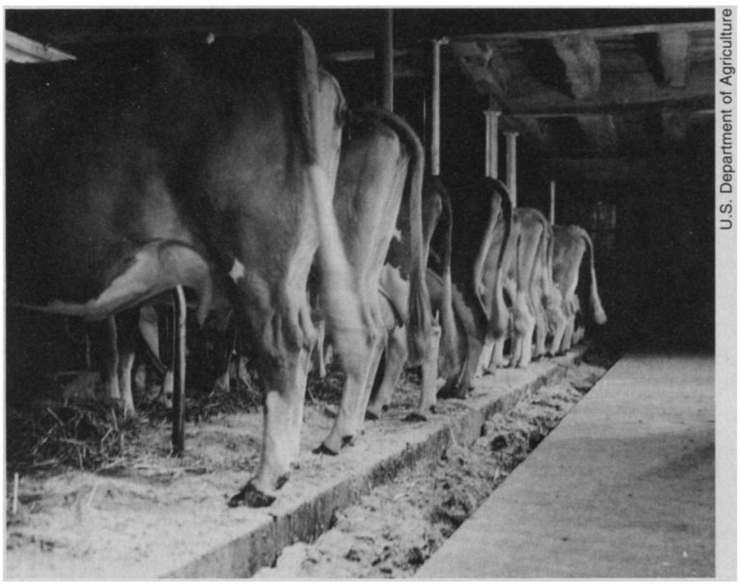
The Buildup of a Greenhouse Gas Slows

A modicum of good news on the greenhouse front: The seemingly inexorable increase in atmospheric methane—a powerful greenhouse gas that now accounts for about a quarter of the greenhouse warming caused by carbon dioxide—has slowed. Why methane's steady climb, which began about 300 years ago, should begin to level off is a mystery. But any respite is welcome, and the very fact of the slowing may encourage steps to moderate the global warming expected in the next century.

The new trend in methane actually began a while back, according to atmospheric chemists Sherwood Rowland and Donald Blake of the University of California, Irvine. Rowland, who in the 1970s brought the bad news that chlorofluorocarbons could destroy stratospheric ozone, and his group have been analyzing air samples from sites around the globe since 1978. During the first 6 years of observations, atmospheric methane—present in concentrations of about 1700 parts per billion by volume (ppbv)—was increasing at an annual rate of about 18 ppbv. By the late 1980s, though, Rowland and Blake thought they might have detected a slowing of the increase. At the American Geophysical Union meeting Rowland announced that the new trend is now clear. Since 1984 methane has been increasing at only 12 to 13 ppbv per year. Whether that rate of increase will continue or slow even further Rowland cannot say.

Nor can he explain the current slowing. The 300-year methane increase reflects growth in a variety of methane sources: the anaerobic decay of organic matter in rice fields and landfills; digestion in ruminant animals; biomass burning; and release from coal mines and natural gas distribution systems. The recent slowing of the increase, says Rowland, could be the tail end of a temporary surge in production by any one of these sources in the 1950s and 1960s. As one candidate for a surge that is now tapering off, Rowland points to a big jump in bovine flatulence as the cattle population shot up after World War II, but he sees no way to be sure. Or the explanation might lie not in a methane source but in a sink: enhanced removal of atmospheric methane through reactions instigated by smog-generated ozone in the lower atmosphere.

The sudden slowing in the rise of methane does underscore one thing, Rowland told his audience—there really is nothing inexorable about the methane increase. In fact, methane is an attractive target for greenhouse controls, in part because its relatively short lifetime in the atmosphere—about 10 years—allows the atmosphere to respond rapidly to cutbacks. A modest step, such as cutting natural-gas leakage in half, might be enough to stabilize atmospheric concentrations. "I don't see any downside to driving concentrations back to 1930s' levels," says Rowland. "We really can think about stabilizing."



U.S. Department of Agriculture

One way to warm the globe. *Fifteen percent of the methane fueling the greenhouse is livestock digestive gas.*

Did a Volcano Help Kill Off the Dinosaurs?

What killed the dinosaurs? The debate of the past decade presented a stark choice between the impact of a huge meteorite or catastrophic volcanism—the eruption of the 2 million cubic kilometers of lava that formed the Deccan Traps of India. The impact has won out as the best explanation for the thin layer of debris deposited around the world at the time of the mass extinctions about 65 million years ago. But now new evidence shows that the peak of the Deccan outburst came near the moment of the meteorite impact. That rough coincidence hints that the volcanic eruptions, among the most intense in geologic history, may have played a role in the extinctions after all.

Announced in back-to-back talks at the American Geophysical Union meeting, the evidence hinges on precise new dates for the impact and the Deccan eruptions. Michael McWilliams of Stanford University, Ajoy Baksi of Louisiana State University, and Halfdan Baadsgaard of the University of Alberta reported that they dated minerals deposited just above the debris layer at three sites in Alberta, Saskatchewan, and Montana. Using an improved version of argon-40/argon-39 dating—in which the clock is the radioactive decay of potassium-40—they found an overall mean age for the three sites of 64.68±0.12 million years, according to McWilliams. That precision is ten times greater than that of previous impact dates.

In the next talk, Robert Duncan of Oregon State University and Malcolm Pringle of the U.S. Geological Survey in Menlo Park reported that the bulk of the Deccan lavas have a mean argon-40/argon-39 age of 65.2±0.2 million years, just 0.5 million years older than the impact debris. And even that gap need not be real: Given the uncertainties in the dates, the difference is not statistically significant. What's more, Duncan and Pringle's number is a mean age for lavas thought to have erupted over roughly 0.5 million years, so the eruptions could easily have overlapped with the impact.

Did the Deccan eruptions contribute to the extinctions? Given the temporal proximity of impact, eruptions, and extinctions, Pringle is inclined to make some connection, but many researchers are hesitant to do so. For one thing, the coincidence of eruptions and extinctions is still a loose one. The impact and some of the extinctions occurred at the same geologic instant, as recorded in the same few millimeters of rock. Signs of the Deccan eruptions are spread over several meters of the geologic record near the extinctions, making the link far less impressive.

Then there is the matter of the mechanism by which volcanic eruptions could wreak destruction on the world of 65 million years ago. The impact has an abundance of them—cold and darkness from a global dust shroud, acid from the meteor's burning of the atmosphere, and global fires, to name a few—but volcanic eruptions look relatively feeble. Ken Caldeira and Michael Rampino of New York University simulated the greenhouse warming from the Deccan's carbon dioxide emissions and found a negligible effect. Volcanic debris blocking sunlight in the stratosphere or acids released into the sea might do the trick, but there have been few signs of such changes in the geologic record.

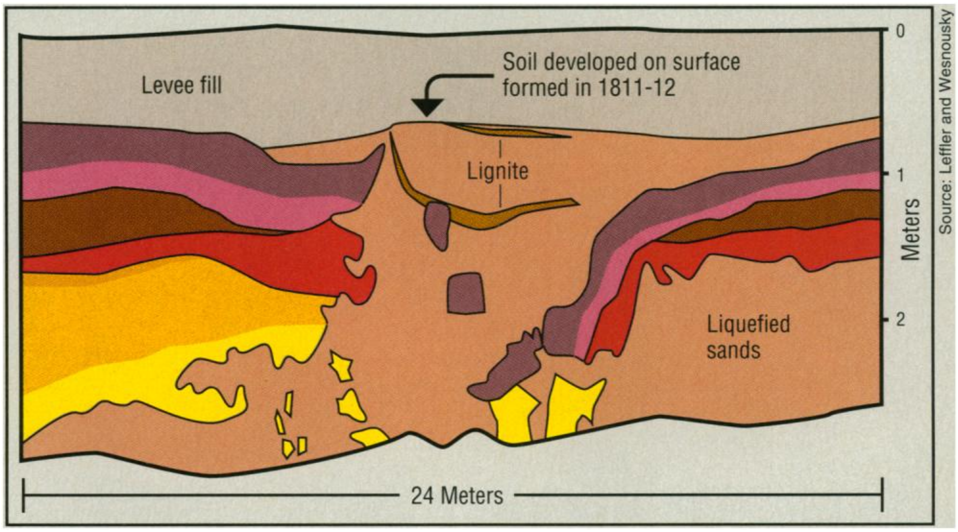
Some researchers are suggesting the possibility of more modest roles for the eruptions. The stress of several hundred thousand years of volcanism, they say, may have had the effect of weakening whole ecosystems, making the impact all the more devastating when it came. Or the eruptions might have directly triggered some of the extinctions that took place around 65 million years ago but have not yet been linked to the impact.

What Deccan advocates need in order to pin down any volcanic contribution to the extinctions is some sort of geologic record in which the effects of the impact can be clearly separated from those of any eruptions. Geochemist Roman Schmitt and his colleagues at Oregon State University think that they now have just that in nearly pure calcium carbonate sediments retrieved from the Shatsky Rise in the Pacific. Unhindered by the interfering chemical elements found in the clay layers usually studied for clues to the catastrophe, Schmitt and his colleagues believe they can pick out the impact's single spike of iridium—the traditional marker—from repeated surges in the abundance of trace elements, which the researchers link to enhanced leaching of continental rocks by volcanic acids over 2 million years. If this approach pans out, the impact-versus-volcano debate could be revived in a more constructive form—impact *and* volcano.

A Fruitless Search for Great Midwest Quakes

When free-lance seismologist Iben Browning predicted that southeastern Missouri might be struck last December by a killer earthquake, people sat up and took notice. After all, it had happened before. In the winter of 1811–1812, three great quakes, each the size of the one that struck San Francisco in 1906, ripped up the Mississippi Valley near the town of New Madrid.

Why not again? Scientists have asked themselves the same question, but instead of resorting to questionable speculation, they have been searching the geologic record for signs of even earlier big quakes to get an idea of how often they might recur. At first, the recurrence time for New Madrid quakes looked like an uncomfortably short 600 years or so, based on a preliminary perusal of the record. But now that may be changing. The latest search results, presented at the American Geophysical Union meeting, are negative: Nothing in the past 5000 to 10,000 years looks anything like that terrible winter of 1811–1812. Not that damaging earthquakes couldn't strike the Midwest any time, but an early repeat of the big ones of the last century seems increasingly unlikely.



The mark of a big one. *Subterranean sand liquefied by one of the 1811–1812 New Madrid quakes broke through soil layers developed over the past 11,000 years.*

The tentatively encouraging news about Midwest quakes comes from one of geologists' less glamorous study sites—the banks of drainage ditches. The soil layers exposed in such ditches can reveal the signature of large earthquakes, which can turn a solid, water-saturated bed of sand underlying less permeable surface layers into a pool of pressurized liquid looking for the quickest way to the surface. The sheets of sand that spurt out during the quake quickly disappear beneath fresh vegetation and a new layer of soil. But a ditch or trench can reveal the ejected sand as well as the breach in the surface layers.

Geologists Lisa Leffler of Memphis State University and Steven Wesnousky of the University of Nevada searched for such liquefaction features by following in the wake of the Army Corps of Engineers as it cleaned out drainage ditches in the southern New Madrid seismic zone, north of Memphis. The freshly exposed trench banks were 3 to 5 meters high, representing 5000 to 10,000 years of sedimentation, according to dating of everything from bits of wood to an ice-age llama's skeleton. Plenty of liquefaction features dating from 1811–12 showed up—in one place two features that formed in rapid succession cut across each other—but nothing older has turned up yet.

Leffler and Wesnousky's announcement drew immediate support from Stephen Obermeier of the U.S. Geological Survey in Reston, Virginia. An old hand at trench slogging, he told Leffler and Wesnousky after their talk that he has found nothing but 1811–12 features at the northern end of the New Madrid zone, in sediments that are at least 4000 years old and probably 11,000 years old. Farther north, in the Wabash Valley, Obermeier says he has seen signs of magnitude 6.5 quakes—but nothing bigger. Roger Saucier of the U.S. Army Engineers Waterways Experiment Station in Vicksburg recently reported in *Geology* that he too has failed to find evidence of predecessors to last century's big ones.

If these negative results hold up, Midwesterners might rest a little easier—though they would still have to worry about the lesser but damaging quakes known from the historical record and from studies like Obermeier's. And the rarity of large quakes at New Madrid doesn't mean the entire East can relax. Consider Charleston, South Carolina. A hefty magnitude 7.6 quake struck there in 1886, and trench searches have turned up six predecessors during the last 2000 to 5000 years that were at least moderate in size. It's almost enough to make Easterners hanker for the simple inevitability of the San Andreas. ■ RICHARD A. KERR