Briefing:

What Makes a Volcanic Lake a Killer?

In the absence of any hard evidence from the scene, speculation has ranged widely about the cause of August's gas burst disaster at Lake Nyos in the equatorial West African nation of Cameroon, but interest has centered on a similar catastrophe in Cameroon in 1984. That event, which killed 37 persons along the shore of Lake Monoun, was studied by a group led by Haraldur Sigurdsson of the University of Rhode Island. The group's best explanation begins with a typical deep, tropical lake, perennially warmed at the top to form a lid shutting in deeper, denser waters. As in other such lakes, decomposition of organic matter in Lake Monoun had presumably consumed all the oxygen in its deep waters and produced methane and carbon dioxide.

But when Sigurdsson and his colleagues analyzed the lake's water after the 1984 gas burst, they found that most of the gas effervescing from samples of deep water was carbon dioxide. Isotopic analysis indicated that 90% of the carbon dioxide was volcanic, the group concluded, not the product of organic decomposition. That raised the possibility that a volcanic eruption through the lake and the attendant noxious gases had killed the victims. But there were no detectable sulfur compounds in the water and there was little of the chlorine and fluorine that should have accompanied an eruption. So the group assumed that the carbon dioxide had slowly vented into the bottom of the lake, which is a 96-meter-deep volcanic crater formed several hundred years ago.

All that would have been needed to produce a catastrophe, given a deep store of gas, was a trigger to suddenly release the dense, asphyxiating carbon dioxide. The trigger need not have been all that strong. A relatively minor disturbance might set off a runaway gas release the way the popping of a cork on a warm bottle of champagne creates a burst of foam. The first gas produced from dissolved carbon dioxide by such a disturbance would lower the density of the overlying water and thus remove some of the pressure holding the remaining gas in solution. More gas would exsolve and so on. Sigurdsson and his colleagues prefer as a trigger the churning of deep waters by an earthquake-induced landslide that immediately preceded the 1984 gas burst.

How much of this explanation applies to August's gas burst at Lake Nyos, another volcanic lake, is impossible to tell from early reports. The nature and source of the gas are unknown. It could have come from a volcanic eruption, slow seepage, or organic decomposition. No particular trigger is obvious. The possibilities include an earthquake, a landslide, a strong wind shift, or a slight cooling of the water surface combined with a seasonal wind shift. The coincidence of both events in the month of August hints at the latter. Still unexplained, even after a year of laboratory work following the Lake Monoun phenomenon, is the nature of the gas or gases that burned the skin of victims. ■

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ADDITIONAL READING

H. Sigurdsson, J. D. Devine, F. M. Tchoua, T. S. Presser, M. K. W. Pringle, W. C. Evans, "Origin of the lethal gas burst from Lake Monoun, Cameroon," *J. Volcanol. Geotherm. Res.*, in press.

Charleston Quakes Are Larger or Widespread

Geologists tramping the backwoods drainage ditches of coastal South Carolina have found evidence of predecessors of the large 1886 Charleston earthquake that were either distinctly larger than this single historical example or located some distance from it. In either case, designers of nuclear power plants and other critical facilities may have to take account of the increased hazard implied by the new findings.

Stephen Obermeier and his colleagues at the U.S. Geological Survey (USGS) in Reston, Virginia, reported at the Third U.S. National Conference on Earthquake Engineering* last month on their latest studies of sand blows, little sand volcanoes triggered by the strong shaking of an earthquake, that they found far beyond the area affected by the 1886 event. John Cox of Geraghty and Miller in Tampa, then at the University of South Carolina, had already excavated a known 1886 sand blow formed by the magnitude 6.6 to 7.1 earthquake of 1886, which was centered 25 kilometers west of Charleston. Robert Weems, Obermeier, and the rest of the USGS group have found sand blows at one site near Charleston formed by at least three earlier quakes. The most recent struck about 1100 years ago. Such moderate to large earthquakes seem to strike the Charleston area at least every 1800 years on average.

But has it been the same fault breaking time after time, or are there other faults along the East Coast capable of generating large earthquakes? To find out, Obermeier headed up the coast looking for more sand blows. Those in the Charleston area erupted from ancient beach sand a few meters below the surface. Along the low-lying, swampy coast, that sand is saturated by ground water. Given a magnitude 5.5 or stronger earthquake, the shaking can liquefy the sand, much the way patting the wet sand at the water's edge softens it. Once liquefied, the sand can erupt through the overlying soil. Obermeier assumed that because the same ancient beach sand underlies the length of the South Carolina coast under similar conditions, the existence of a sand blow at another site would indicate similarly strong shaking there.

Since the mounded sand of a sand-blow crater is geologically ephemeral, Obermeier's search depended on natural or man-made exposures of the subsurface. As it happens, the timber industry is in the habit of digging drainage ditches through the wet pinelands of the coastal southeast to increase growth rates. Obermeier simply went to newly dug ditches, before undergrowth obscured their sides, and looked for signs of sand-blow craters. Unweathered sand at the top of a crater would make it an 1886 feature; a well-developed soil layer would require it to be an older, pre-1886 crater.

Within 40 kilometers of the center of the area affected by the 1886 earthquake, the USGS group found both 1886 and pre-1886 sand blows. But farther north along the coast, as far as 150 kilometers away, only pre-1886 sand blows appeared. Either an earthquake on a fault some distance from Charleston shook this part of the coast, which would lie beyond the reach of typical Charleston earthquakes, or at least one earlier event on the fault near Charleston was much stronger than the 1886 shock and thus affected a much larger area.

The problem for engineers is that someone must tell them how much shaking a particular structure should be able to withstand, but that depends on both the size of the earthquake and its distance from the structure. In light of the recent sand-blow discoveries, engineers clearly cannot simply assume that the same-sized earthquake recurs at the same site near Charleston.

The next step must be carbon-14 dating of more sand blows. If exact dating is possible, it will show whether large earthquakes in the southeast can be confined to the Charleston area or they must be assumed to roam farther afield. How far afield remains unclear. A recent claim of sand-blowlike features at a site in Connecticut, which if true would suggest a widespread hazard indeed, has met considerable resistance from some specialists in paleoseismology. ■

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*Third U.S. National Conference on Earthquake Engineering, 24–27 August, Charleston, South Carolina, sponsored by the Earthquake Engineering Research Institute.