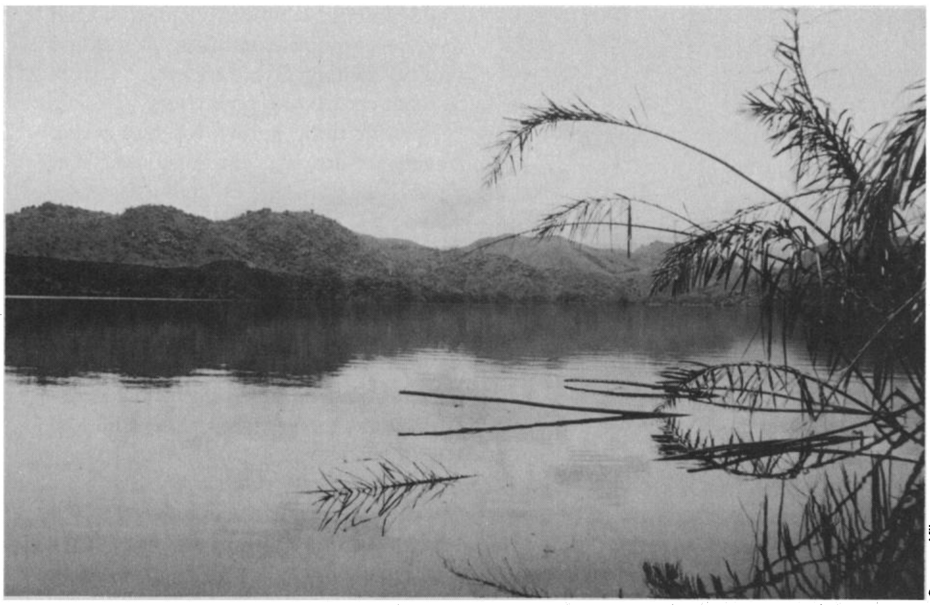
Nyos, the Killer Lake, May Be Coming Back

Subtle changes in the Cameroon lake that wiped out hundreds suggest that the lake could be preparing for another onslaught



Lake Nyos before the killing. *The carbon dioxide that had accumulated deep within the lake, shown here in 1985, would burst forth a year later to form a lethal cloud.*

George Kling

AFTER REPEATEDLY PROBING the West African lake that "exploded" and killed 1700 people in 1986, a group of U.S. scientists has now uncovered new evidence that Lake Nyos could kill again. It is rebuilding, albeit extremely slowly, toward the same lethal conditions that led to the lacustrine massacre.

The apparent cause of it all is as innocuous as a glass of Perrier. Warm, mineral-laden spring water is feeding the lake and presumably recharging it with carbon dioxide, conclude limnologist George Kling of the Marine Biological Laboratory in Woods Hole and two geochemists from the U.S. Geological Survey—Michele Tuttle of the Golden, Colorado, office and William Evans in Menlo Park, California. It was carbon dioxide that burst from the lake depths one night, spewed over the lake shore, and snuffed out so many lives. The survivors have been relocated and the death zone is officially off limits. Still, researchers are eager to solve the Nyos mystery.

Within months of the tragedy, Kling and his colleagues had inferred that there must be an unseen spring, but they could not prove it. They based their inference on the chemical and isotopic compositions of Nyos immediately after the gas outburst and the presence nearby of carbon dioxide–laden springs (*Science*, 30 January 1987, p. 528).

Kling, Tuttle, and Evans still cannot point to a specific spring feeding carbon dioxide to Nyos, but they believe their inference is far stronger now that they have seen changes deep within the lake. They detected the changes after sampling Lake Nyos in September 1986, the month after the disaster, and again in January, March, and May 1987.

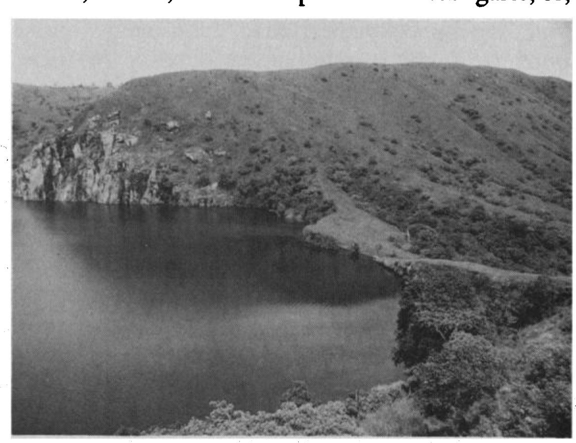
The most revealing samples came from the deep waters of the lake. They do not mix with surface waters because Nyos is permanently stratified. Its deep, carbon dioxide—laden waters being heavier than plain water, they stay where they are. During the 9-month sampling interval, the temperature of the deepest water, between a depth of about 185 meters and the bottom at 208 meters, increased steadily until the heat content was up by almost 1%. In the same time, the concentrations of a half dozen ions in the bottom layer increased substantially.

Nothing but a warm, mineral-laden subsurface spring seems capable of causing the observed changes, the group concluded. A spring rising through volcanic rock, the sort that must lie beneath the volcanic crater forming the lake, would deliver just the sort of ions seen to increase. Springs draining into surface waters have a quite different composition, and the stratification would prevent their water from mixing downward anyway, so the observed change in composition implies a spring feeding the bottom water. The temperature increase is also consistent with a deep spring because one of modest temperature and flow could have caused the warming.

"Our assumption," says Kling, "is that one of these carbon dioxide–rich springs that litter the countryside in Cameroon is near or below Nyos." The only gap in the chain of evidence is the group's failure to detect an increase in dissolved carbon dioxide itself. Its concentration varied too much from place to place in the lake to say it had increased above the level due to the 0.4 cubic kilometer of dissolved gas left after the disaster. However, the increasing heat and minerals require a spring and the springs of the area are commonly charged with carbon dioxide, so Tuttle concludes that "it's certainly the logical way to get a lot of carbon dioxide in there."

How long before Lake Nyos is charged back up to the lethal level that killed 1700 people? The rate of increase of carbon dioxide cannot be determined yet, but unless it increased dramatically it would be decades before Nyos is recharged.

Carbon dioxide may be recharging only slowly, but the U.S. group cautions that some immediate hazard remains. There is still the matter of the lingering 0.4 kilometer of carbon dioxide dissolved in the lake. It was left behind when something—a rock slide, a minor eruption of volcanic gases, or,



George Kling

Another gas burst? *One end of Nyos (on right) is inherently weak. Its failure would cause another gas burst.*

as Kling prefers, a strong breeze—disturbed a precarious equilibrium in Nyos that kept carbon dioxide bottled up under the pressure in deep waters. Once the lake was disturbed on that night in 1986, some of the stratification broke down and about two-thirds of the lake's store of gas burst forth in a runaway process like popping the top on a bottle of warm soda. That left only one-third of the lake's original store of carbon dioxide, so an exact repeat is no longer possible.

Another, probably smaller outburst is possible now, but it would take a stronger kick to the system to again raise gas-laden water to the surface. Kling and his colleagues find that Nyos is now too stable and its carbon dioxide too depleted for anything short of a volcanic eruption or large rock slide to trigger another outburst. The group sees no evidence of any sort of eruption in 1986. Large rock slides are rare but not unheard of.

Unfortunately, another potential disturbance is built into the volcanic crater that forms the lake. Nyos drains over a natural dam formed only a few hundred years ago from weak volcanic rock. If the dam failed, a distinct possibility according to the group, not only would the resulting flood be devastating for tens of kilometers downstream, but the sudden lowering of the lake would trigger another massive gas release.

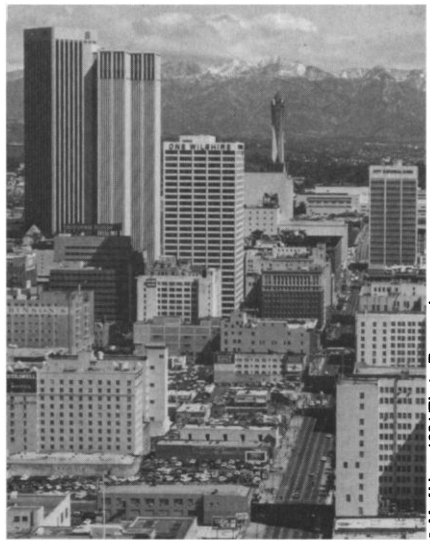
One solution to the lingering threats from Nyos would be to lower the lake slowly by pumping out the gas-laden deep water. Ironically, the lake could pump itself down using the same energy source that drove the gas burst. Once pumping starts water moving up a pipe from the bottom, the gas released by the decreasing pressure would continue to drive the flow.

Researchers may be getting a handle on Nyos, but Cameroon has 39 other lakes nestled in volcanic craters, all of which were viewed with suspicion after the 1986 Nyos outburst. A gas outburst from Lake Monoun had already killed 17 people in 1984. Kling and his colleagues found the same spring-like chemistry in its bottom waters as in Nyos, implying a spring source for its carbon dioxide as well. But a survey of all other Cameroon lakes has now found nothing unusual. "We didn't find any other lakes that are going to blow up," says Kling. "The rest of the lakes are safe." And, barring the most infrequent sorts of disturbances, the two known killers should give researchers warning as the lakes gradually build their stores of gas. ■ Richard A. Kerr

ADDITIONAL READING

G. W. Kling, M. L. Tuttle, W. C. Evans, "The evolution of thermal structure and water chemistry in Lake Nyos," *J. Volcanol. Geotherm. Res.*, in press.

Flurry of Quakes in L.A.



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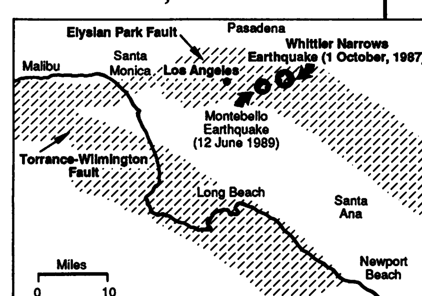
Downtown Los Angeles *sits on a fault that could fail.*

The earth is beating up on Los Angeles and nobody knows why. The shock that rocked Montebello, 12 kilometers east of downtown, on 12 June extends to six the unprecedented string of moderate earthquakes that has struck the area during the past 2 years. The surge in seismic activity could portend a powerful quake within the heavily populated basin, or it could signify nothing. Welcome to the forefront of earthquake prediction.

The one thing known for sure is that Angelenos are not just imagining that things have been shakier lately. Seismologists Lucile Jones of the U.S. Geological Survey office in Pasadena and Paul Reasenberg of the USGS in Menlo Park have found that the rate at which earthquakes have been striking within 40 kilometers of Los Angeles (off the infamous San Andreas fault) doubled 3 years ago. The chance that the increase is just a random fluctuation around a steady rate is less than 1%. It gets worse. Between August 1988 and February 1989, the end of their study period, the rate rose to 3.2 times the historical rate. And "at the level of magnitude 4.5 and greater," says Jones, "we went from one every 4 years to one every 2 months in the last 6 months." Adds Jones: "But that's too short an interval to say anything about statistical significance."

Indeed, the significance of all this is anybody's guess. "There are a couple of ways you could look at it," says Jones. "You could say that, for whatever reason, the squeeze on the Los Angeles Basin has accelerated. That would mean you've doubled the chance of a large earthquake." Statistically speaking, the chance of a damaging shock was 1.5 in 10,000 on any given day, based on past experience, while it is now 2.6 in 10,000. Of course, the flurry could end before any larger event occurred.

A more ominous alternative is that the additional earthquakes are part of a basin-wide process leading to the failure of a long section of fault and a large earthquake. One candidate for a failure would be the western section of the Elysian Park fault (*Science*, 16 December 1988, p. 1511). Both the damaging Whittier Narrows quake of 1987 and June's Montebello shock broke sections of it to the east, but to the west it has been relatively quiet. "I don't think we can rule out a magnitude 7.5 on the Elysian Park fault," says Jones, although a 6.5 might be more likely. Whatever its size, "if we had a large one next year, this surge of activity would become one of the classic precursors," says Jones. The problem is that some large earthquakes are heralded by such increases in activity, some are preceded by seismic quiescence, and some come out of nowhere with no obvious warning. Seismologists still cannot tell which is the case except in hindsight.



Jones does have one prediction. "I think we're going to have more of what we've had. There's no evidence that the rate has gone down. And almost all of the extra earthquakes are deeper than usual, especially in the case of magnitude 4.5 events. That is interesting because big earthquakes tend to be deep." Hang on, Los Angeles. ■ Richard A. Kerr

ADDITIONAL READING

L. M. Jones and P. Reasenberg, "A preliminary assessment of the recent increase in earthquake activity in the Los Angeles region," U.S. Geological Survey Open-File Report 89–162 (1989).