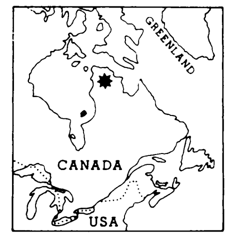
Christmas Quake Presents Geologic Gift

An earthquake that rocked a remote section of northern Canada on Dec. 25, 1989, has broken new ground in the realm of geology. At a meeting in Baltimore this week, scientists described the event as the first known instance of a quake fault rupturing the land surface in the eastern half of North America.

The shock, centered in the middle of the lake-strewn Ungava peninsula (see star on map) between Hudson Bay and Ungava Bay, registered a magnitude 6 on the Richter scale. Because it occurred during winter, when snow and darkness blanket the region, geologists could not inspect the epicentral area until last summer. After several days of searching, a team from the Geological Survey of Canada in Ottawa found the unusual surface fault.

Despite its location in the uninhabited interior of the peninsula, the Ungava fault is capturing considerable attention from earth scientists. "It is something unique and will provide very valuable insights into the process of earthquakes in stable continental regions," says Robert J. Wetmiller, who led the Canadian team.

Some of the largest earthquakes in North American history have originated in the "stable" heart of the continent. Unlike temblors in active tectonic areas, such as California or the Himalayas, seismic shocks in continental interiors rarely break the surface – a trait that has hampered efforts to define quake risk for these regions. The Ungava rupture represents one of only 10 exceptions to that rule and is the sole example in North America east of the Rockies, says geologist Thomas F. Bullard of Geomatrix Consultants in San Francisco. Bullard and Arch C. Johnston of Memphis (Tenn.) State University accompanied the Canadian team and discussed the quake this week at a regional conference of the Geological Society of America.



Wetmiller

Johnston, a specialist in midplate earthquakes, contacted the Canadian researchers soon after the Ungava tremor to suggest looking for a visible rupture. He suspected surface faulting because the shock was large and shallow – two traits shared by the other ground-breaking quakes in midcontinents.

The investigators located the fault after spotting unusual turquoise water in two of the thousands of slate-blue lakes near the shock's epicenter. The earthquake had lifted the shorelines of these lakes, causing sediments to alter the water's color. The surface fault measured 8 kilometers long, running in a northeast direction. The southeast side of the fault had slipped up over the northwest side during the quake.

The fault direction raises difficult questions for experts in plate tectonics, says Randall Richardson of the University of Arizona in Tucson. Scientists have assumed that tectonic forces squeeze the Ungava peninsula in a northeast-southwest direction and that this stress arises primarily from seafloor spreading in the Atlantic. But the recently discovered fault challenges the idea of northeast-southwest stress, because such forces are oriented in the wrong direction to trigger the observed rupture. The quake, says Richardson, "is making us reevaluate what we think is going on there."

Researchers have virtually no information about subsurface stress in northeastern Canada, and the quake raises the possibility that they have miscalculated the direction of forces throughout the region. Alternatively, the Ungava site may represent a unique place where local features have redirected the stress, Richardson says.

In the past, scientists haven't had to consider seriously the chance of earthquakes breaking the ground surface east of the Rockies. "Seismic-hazard analysts must now allow for the possibility," says Gilbert A. Bollinger of Virginia Polytechnic Institute & State University in Blacksburg. He notes that such faulting could seriously damage a nuclear power plant or pierce a hazardous-waste site, allowing dangerous chemicals to enter underground water systems.

– R. Monastersky

Plant chloroplasts evolved more than once

A disingenuous alga, aptly named *Cryptomonas,* picked up the ability to harvest solar energy by gobbling one of its photosynthesizing distant cousins, researchers report in the March 14 NATURE.

The finding supports the idea that early complex cells gained new components with specialized functions by kidnapping one another – not just by engulfing simpler cells. It also calls into question the family tree outlining the heredity of several hard-to-classify algae.

Scientists have long suspected that cellular organelles, such as energy-generating mitochondria and sugar-producing chloroplasts, were once independent organisms. A century ago, microscopists pointed out that organelles of complex cells look much like simpler free-living microbes. In the early 1960s, researchers showed that mitochondria and chloroplasts, which lie outside the cell nucleus, contain their own genetic material.

To explain these findings, scientists devised the serial endosymbiosis theory, which essentially holds that primitive microbes evolved into more complex ones by swallowing other microbes and putting them to work as organelles. But most researchers believed that each type of organism swallowed only organisms less advanced than itself and that a single organelle takeover sufficed over the evolutionary long run.

Now, a team led by Susan E. Douglas of the Canadian Institute of Marine Biosciences in Halifax, Nova Scotia, has demonstrated that *Cryptomonas* – already advanced enough to have a nucleus – must have gained its chloroplast by gobbling another cell with a nucleus. Within *Cryptomonas,* the researchers identified bits of genetic synthesizers, or ribosomes, that closely resemble the ribosomes of red algae, an equally advanced organism. They found the ribosome fragments in a nucleus-like structure known as the nucleomorph.

Douglas surmises that the nucleomorph, which exists independently of the nucleus, is a vestige of a red alga coopted by *Cryptomonas* in the distant past. "This is the first definitive proof," she says, that cells with nuclei conquered other cells with nuclei.

"This is the type of evidence people will believe," comments algae researcher Sally Gibbs of McGill University in Montreal. Gibbs says the work confirms on a molecular level her own observations of the similarity between *Cryptomonas'* nucleomorph and red algae. "But this will get it out in the public and in the textbooks," she adds.

In a commentary accompanying the research report, David Penny and Charles J. O'Kelly of Massey University in Palmerston North, New Zealand, suggest the new finding will overturn the conventional notion that all chloroplasts are descendants of one evolutionary cell-swallowing event. "These bits of molecular evidence support predictions . . . that chloroplasts have arisen many times," they write.

Penny and O'Kelly add that Douglas' report will force biologists to reevaluate the relationships among various algae, fungi and green plants. "The simplistic first stage of the search for the single universal evolutionary tree is coming to an end," they assert.

– C. Ezzell