Geologists Make Better Estimates of Rock Ages, Study Global Climate Change

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Ohio State University geologists have found that important rocks from Niagara Gorge -- rock formations that are used to judge the ages of rocks and fossils around North America -- formed five times faster than previously thought.

The finding means that scientists will have to re-examine studies of sedimentary rock deposited across North America during the Silurian period, from 416 to 443 million years ago.

Ultimately, the geologists hope to perform similar studies of rock from other time periods, to better pinpoint periods of global climate change in Earth's history. Just as tree rings, coral reefs, and ice cores contain chemical records of Earth's history, sedimentary rocks such as limestone vary in composition according to the climate in which they formed.

Bradley Cramer, a doctoral student in earth sciences at Ohio State, reported the study October 22 at the Geological Society of America meeting in Philadelphia.

Cramer and his advisor, Matthew Saltzman, professor of earth sciences, and their colleagues used a relatively new technique called high-resolution carbon isotope stratigraphy to determine the age of rocks in Niagara Gorge in New York.

Rocks that were originally estimated to have formed as sediments built up over 10 million years' time actually formed in only 2 million years,

they found. That means that instead of forming between 428 and 418 million years ago, the rocks actually formed between 428 and 426 million years ago.

What do a few million years matter, when they happened so long ago? Saltzman and his team need to make precise time measurements as they search for evidence of ancient climate change.

"We have this great geological record of climate changes in the past," Cramer said. "The problem is, the rate of change that we're worried about in the modern day is on a very short time scale. And when we look into the deep past, our ability to know where we are in time isn't that precise. If we can get our time constraints down more precisely, we can begin to ask the same sort of questions of the past that we're asking of the modern era."

Ancient sedimentary rocks contain chemicals such as carbon that are indicators of atmospheric conditions at the time the rocks formed. During times of apparent rapid climate change at other locations around the globe, the rock composition shows a change as well, and pinpointing exactly when things happened can be difficult.

That's why the Ohio State geologists decided to re-examine the rock formations of Niagara Gorge, which had originally been studied in the 1800s.

"That very set of rocks contains a global extinction event -- one of the largest in Earth's history," Saltzman said, "and it hadn't been examined with the most modern techniques available."

Scientists believe this extinction event, the Ireviken event, happened approximately 428 million years ago, and may have been caused by climate change. Some 80 percent of conodont species -- wormlike sea

creatures -- and 50 percent of trilobite species went extinct during that time.

The event was recorded in the rock composition of Niagara Gorge, and carbon isotope stratigraphy is the ideal technique to study it.

Cramer explained how the technique works. Scientists measure the ratio between two isotopes of carbon, carbon-13 and carbon-12, in a rock sample. Normally, the ratio is zero or one, but in certain times throughout history, such as during and after a great extinction, the ratio markedly increases. Scientists call the increase an "excursion" from the normal value of zero or one.

"What is so useful about these excursions is that they are time markers," Cramer said. "If you find an excursion in Ohio, and then the same one in Sweden, you know that the intervals containing the excursion are coincident in time. Essentially, we match the markers from one place to another. This is a chemical way of telling time."

The Niagara Gorge rocks contained a marker from the Ireviken extinction. That marker had been well documented in rocks in sites around the United States, Canada, and Sweden. In all those locations, the rocks that contain the marker formed at the same time in Earth's history.

The Niagara Gorge rocks were among the first North American rocks to be dated by geologists in the 1800s, and the gorge has been a treasure trove for scientists ever since. From the top of the escarpment, down to the floor of the gorge where the Niagara River cascades, scientists have thought that the gorge represented as much as 10 million years of history.

Cramer's analysis revealed that most of the formations originated during the Ireviken event, which lasted for only 1 million years or so.

Given this new information, the geologists decided that the formations of Niagara Gorge only represent 2 million years of history.

Rock formations there are used as a frame of reference to judge the ages of rocks throughout North America. So these new results mean that many scientists will have to revise their work. Estimates of when certain animals went extinct may change.

"Unfortunately, this means that a lot of people are going to have to re-examine work that they thought was done," Cramer said.

Next, he wants to look further back in time, to the period before the Silurian: the Ordovician, which began 488 million years ago. Geologists disagree on where exactly the boundary between the Ordovician and the Silurian should be placed, and carbon isotope stratigraphy is an ideal tool to help solve the problem.

Ohio State coauthors on the presentation included Mark Kleffner, an associate professor, Stig Bergström, a professor emeritus, and Seth Young, a doctoral student, all of earth sciences.

Source: Ohio State University