Appalachian Mountains, carbon dioxide caused long-ago global cooling

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The rise of the Appalachian Mountains may have caused a major ice age approximately 450 million years ago, an Ohio State University study has found.

The weathering of the mountains pulled carbon dioxide (CO_2) from the atmosphere, causing the opposite of a greenhouse effect -- an "icehouse" effect.

Scientists have suspected that our current ice age, which began 40 million years ago, was caused by the rise of the Himalayas. This new study links a much earlier major ice age --one that occurred during the Ordovician period -- to the uplift of the early Appalachians .

It also reinforces the notion that CO_2 levels in the atmosphere are a major driver of Earth's climate.

Seth Young, a doctoral student in earth sciences at Ohio State, reported the new study October 25 at the Geological Society of America meeting in Philadelphia.

Because we are currently living in an ice age -- or, more precisely, in a slightly warmer interglacial period within an ice age -- CO_2 levels worldwide would ordinarily be low; but scientists believe that humans have raised CO_2 levels by burning fossil fuels.

Matthew Saltzman, professor of geological sciences and Young's

advisor, looks for evidence of ancient climate change to help scientists gain perspective on the climate change of today. He believes the geologic record can help solve current debates.

One such debate is whether atmospheric carbon dioxide truly drives Earth's climate. The planet has shifted between greenhouse conditions and icehouse conditions throughout its history, and research from Saltzman's team strongly suggests that carbon dioxide levels are a key cause.

"In this study, we're seeing remarkable evidence that suggests atmospheric CO_2 levels were in fact dropping at the same time that the planet was getting colder. So this significantly reinforces the idea that CO_2 is a major driver of climate," Saltzman said.

This study builds on work the same team published in 2005, when they used quartz sandstone deposits in Nevada and two sites in Europe to determine when the Ordovician ice age began -- approximately 450 million years ago.

They've now analyzed the same set of rock samples in a different way, comparing the ratio of two isotopes of the element strontium, strontium-87 and strontium-86.

They found that, immediately prior to the time that the Ordovician ice age began, the strontium ratio dropped dramatically. The likely cause: a vast amount of volcanic rock was being eroded away, and the resulting sediment was being deposited in the world oceans.

"We observed a major shift in the geochemical record, which tells us something must have changed in the oceans," Young said.

The timing of the strontium ratio decline matches the rise of the

Appalachian Mountains . The crustal plate underneath what is now the Atlantic Ocean pushed against the eastern side of North America, lifting ancient volcanic rock up from the seafloor and onto the continent.

This kind of silicate rock weathers quickly, Young explained. It reacts with CO_2 and water, and the rock disintegrates. Carbon from the CO_2 is trapped in the resulting sediment.

The chemical reaction that weathered away part of the Appalachians would have consumed large amounts of CO_2 from the atmosphere –- right around the time that the Ordovician ice age began.

The Ordovician period started out warm, with high sea levels worldwide. It ended cold, with low sea levels as glaciers covered the poles and portions of the continents. According to the Ohio State study, most of the Appalachian weathering took place over 7 or 8 million years -- a very short time, by geological standards -- as the climate moved from one extreme to the next.

The crossover between greenhouse and icehouse conditions set the stage for mass extinctions around the planet at the end of the Ordovician.

"We are seeing a mechanism that changed a greenhouse state to an icehouse state, and it's linked to the weathering of these unique volcanic rocks," Young said.

This kind of rock is often called "island arc" rock, because it forms curved chains of volcanic islands such as Indonesia and Japan.

"Those rocks are around today, where you have ocean crust being subducted under a crustal plate," Young explained. "What's unusual about the Ordovician period is that those island arcs were being uplifted onto a continent. The ones in the Pacific Ocean now are mostly

underwater, so they're not weathering away like the Appalachian rock did."

The rise and subsequent weathering of the Himalayas may have caused our current ice age, the one that began 40 million years ago.

"In the Himalayas, the process would have been the same -- silicate rocks are exposed to the atmosphere, weathering sucks CO_2 out of the atmosphere and chills the planet," Saltzman said.

"This may be the only effective way to bring CO_2 levels down to a threshold that's cool enough for ice to start building up."

Source: Ohio State University