

Rising mountains dried out Central Asia, scientists say

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Stanford researchers visited the Nemegt Basin in Mongolia's Gobi Desert in search of clues to Central Asia's extreme aridity. Credit: Hari Mix

(Phys.org) —A record of ancient rainfall teased from long-buried sediments in Mongolia is challenging the popular idea that the arid conditions prevalent in Central Asia today were caused by the ancient uplift of the Himalayas and the Tibetan Plateau.

Instead, Stanford scientists say the formation of two lesser mountain ranges, the Hangay and the Altai, may have been the dominant drivers of climate in the region, leading to the expansion of Asia's largest desert, the Gobi. The findings will be presented on Thursday, Dec. 12, at the annual meeting of the American Geophysical Union (AGU) in San Francisco.

"These results have major implications for understanding the dominant factors behind modern-day Central Asia's extremely arid climate and the role of mountain ranges in altering regional climate," said Page Chamberlain, a professor of environmental Earth system science at Stanford.

Scientists previously thought that the formation of the Himalayan mountain range and the Tibetan plateau around 45 million years ago shaped Asia's driest environments.

"The traditional explanation has been that the uplift of the Himalayas blocked air from the Indian Ocean from reaching central Asia," said Jeremy Caves, a [doctoral student](#) in Chamberlain's terrestrial paleoclimate research group who was involved in the study.

This process was thought to have created a distinct rain shadow that led to wetter climates in India and Nepal and drier climates in Central Asia. Similarly, the elevation of the Tibetan Plateau was thought to have triggered an atmospheric process called subsidence, in which a mass of air heated by a high elevation slowly sinks into Central Asia.

"The falling air suppresses convective systems such as thunderstorms, and the result is you get really dry environments," Caves said.

This long-accepted model of how Central Asia's arid environments were created mostly ignores, however, the existence of the Altai and Hangay,

two northern mountain ranges.

Searching for answers

To investigate the effects of the smaller ranges on the [regional climate](#), Caves and his colleagues from Stanford and Rocky Mountain College in Montana traveled to Mongolia in 2011 and 2012 and collected samples of ancient soil, as well as stream and lake sediments from remote sites in the central, southwestern and western parts of the country.

The team carefully chose its sites by scouring the scientific literature for studies of the region conducted by pioneering researchers in past decades.

"A lot of the papers were by Polish and Russian scientists who went there to look for dinosaur fossils," said Hari Mix, a doctoral student at Stanford who also participated in the research. "Indeed, at many of the sites we visited, there were dinosaur fossils just lying around."

The earlier researchers recorded the ages and locations of the rocks they excavated as part of their own investigations; Caves and his team used those age estimates to select the most promising sites for their own study.

At each site, the team bagged sediment samples that were later analyzed to determine their [carbon isotope](#) content. The relative level of carbon isotopes present in a soil sample is related to the productivity of plants growing in the soil, which is itself dependent on the annual rainfall. Thus, by measuring carbon isotope amounts from different [sediment samples](#) of different ages, the team was able to reconstruct past precipitation levels.

An ancient wet period

The new data suggest that rainfall in central and southwestern Mongolia had decreased by 50 to 90 percent in the last several tens of million of years.

"Right now, precipitation in Mongolia is about 5 inches annually," Caves said. "To explain our data, rainfall had to decrease from 10 inches a year or more to its current value over the last 10 to 30 million years."

That means that much of Mongolia and Central Asia were still relatively wet even after the formation of the Himalayas and the Tibetan Plateau 45 million years ago. The data show that it wasn't until about 30 million years ago, when the Hangay Mountains first formed, that rainfall started to decrease. The region began drying out even faster about 5 million to 10 million years ago, when the Altai Mountains began to rise.

The scientists hypothesize that once they formed, the Hangay and Altai ranges created rain shadows of their own that blocked moisture from entering Central Asia.

"As a result, the northern and western sides of these ranges are wet, while the southern and eastern sides are dry," Caves said.

The team is not discounting the effect of the Himalayas and the Tibetan Plateau entirely, because portions of the Gobi Desert likely already existed before the Hangay or Altai began forming.

"What these smaller mountains did was expand the Gobi north and west into Mongolia," Caves said.

The uplift of the Hangay and Altai may have had other, more far-reaching implications as well, Caves said. For example, westerly winds

in Asia slam up against the Altai today, creating strong cyclonic winds in the process. Under the right conditions, the cyclones pick up large amounts of dust as they snake across the Gobi Desert. That dust can be lofted across the Pacific Ocean and even reach California, where it serves as microscopic seeds for developing raindrops.

The origins of these cyclonic winds, as well as substantial dust storms in China today, may correlate with uplift of the Altai, Caves said. His team plans to return to Mongolia and Kazakhstan next summer to collect more samples and to use climate models to test whether the Altai are responsible for the start of the large dust storms.

"If the Altai are a key part of regulating Central Asia's climate, we can go and look for evidence of it in the past," Caves said.

More information: fallmeeting.agu.org/2013/

Provided by Stanford University

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