Pre-industrial rise in methane gas had natural and anthropogenic causes

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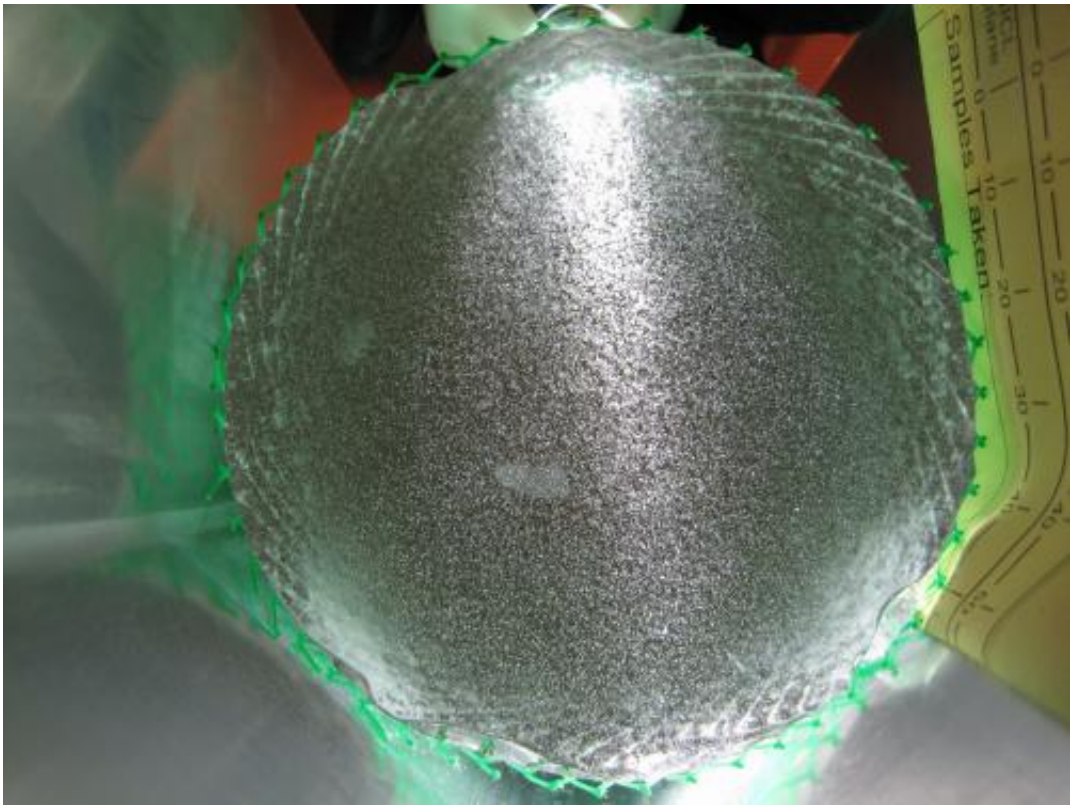

Air bubbles trapped in an ice core from the West Antarctic Ice Sheet Divide ice core. Air samples were used to reconstruct the methane interpolar difference (IPD) over the late Holocene to constrain early anthropogenic emissions of methane. Credit: Logan Mitchell

(Phys.org) —For years scientists have intensely argued over whether increases of potent methane gas concentrations in the atmosphere – from

about 5,000 years ago to the start of the industrial revolution – were triggered by natural causes or human activities.

A new study, which will be published Friday in the journal *Science*, suggests the increase in methane likely was caused by both.

Lead author Logan Mitchell, who coordinated the research as a doctoral student at Oregon State University, said the "early anthropogenic hypothesis," which spawned hundreds of scientific papers as well as books, cannot fully explain on its own the rising levels of atmospheric methane during the past 5,000 years, a time period known as the mid- to late-Holocene. That theory suggests that human activities such as rice agriculture were responsible for the increasing methane concentrations.

Opponents of that theory argue that human activities during that time did not produce significant amounts of methane and thus natural emissions were the dominant cause for the rise in atmospheric CH_4.

"We think that both played a role," said Mitchell, who is now a post-doctoral researcher at the University of Utah. "The increase in methane emissions during the late Holocene came primarily from the tropics, with some contribution from the extratropical Northern Hemisphere.

"Neither modeled natural emissions alone, nor hypothesized anthropogenic emissions alone, are able to account for the full increase in methane concentrations," Mitchell added. "Combined, however, they could account for the full increase."

Scientists determine methane levels by examining ice cores from polar regions. Gas bubbles containing ancient air trapped within the ice can be analyzed and correlated with chronological data to determine methane levels on a multidecadal scale. Mitchell and his colleagues examined ice cores from the West Antarctic Ice Sheet Divide and the Greenland Ice

Sheet Project and found differences between the two.

Ice cores from Greenland had higher methane levels than those from Antarctica because there are greater methane emissions in the Northern Hemisphere. The difference in methane levels between the hemispheres, called the Inter-Polar Difference, did not change appreciably over time.

"If the methane increase was solely natural or solely anthropogenic, it likely would have tilted the Inter-Polar Difference out of its pattern of relative stability over time," Mitchell said.

Since coming out of the ice age some 10,000 years ago summer solar insolation in the Northern Hemisphere has been decreasing as a result of the Earth's changing orbit, according to Edward Brook, a paleoclimatologist in Oregon State's College of Earth, Ocean, and Atmospheric Sciences and Mitchell's major professor. This decrease affects the strength of Asian summer monsoons, which produce vast wetlands and emit methane into the atmosphere.

Yet some 5,000 years ago, atmospheric methane began rising and had increased about 17 percent by the time the industrial revolution began around 1750.

"Theoretically, methane levels should have decreased with the loss of solar insolation in the Northern Hemisphere, or at least remained stable instead of increasing," said Brook, a co-author on the Science article. "They had been roughly on a parallel track for some 800,000 years."

Mitchell used previous models that hypothesized reasons for the methane increase – both natural and anthropogenic – and compared them to the newly garnered ice core data. None of them alone proved sufficient for explaining the greenhouse gas increase. When he developed his own model combining characteristics of both the natural

and anthropogenic hypotheses, it agreed closely with the ice core data.

Other researchers have outlined some of the processes that may have contributed to changes in methane emissions. More than 90 percent of the population lived in the Northern Hemisphere, especially in the lower latitudes, and the development of rice agriculture and cattle domestication likely had an influence on methane emissions. On the natural side, changes in the Earth's orbit could have been responsible for increasing methane emissions from tropical wetlands.

"All of these things likely have played a role," Mitchell said, "but none was sufficient to do it alone."

More information: "Constraints on the Late Holocene Anthropogenic Contribution to the Atmospheric Methane Budget," by L. Mitchell et al. *Science*, 2013.

Provided by Oregon State University