Are marine clathrates tied to the abrupt atmospheric methane events recorded in ice cores?

Todd Sowers
Department of Geosciences and the Earth and Environmental Systems Institute
Penn State University, sowers@geosc.psu.edu

Atmospheric methane (CH\textsubscript{4}) levels recorded in ice cores covering the last 800,000 years vary on timescales ranging from tens of thousands of years to decades. One explanation for the millennial scale CH\textsubscript{4} oscillations that are prevalent during glacial periods involve the destabilization of clathrates located along the continental margins. The destabilization is thought to be a result of warmer thermocline waters that are nearly coincident with warming events recorded in Greenland ice.

Marine clathrates have a well-defined deuterium/hydrogen (D/H) isotopic signature that is distinct from all terrestrial CH\textsubscript{4} emissions. As such, a record of the D/H ratio of atmospheric CH\textsubscript{4} provides a powerful means of assessing whether or not clathrate destabilization events have contributed CH\textsubscript{4} to the atmosphere in the past. If an atmospheric CH\textsubscript{4} increase, observed in the ice cores, is the result of clathrate degassing, then the D/H ratio of atmospheric CH\textsubscript{4} should increase. A new high-resolution record of the D/H isotopic composition of atmospheric methane has been constructed with special emphasis on the previously documented rapid CH\textsubscript{4} increases associated with the last glacial termination. Results indicate no observable increase in the D/H ratio of atmospheric CH\textsubscript{4} during the three abrupt CH\textsubscript{4} events. I conclude from this data that, during these rapid CH\textsubscript{4} events, clathrate destabilization has not contributed to the increased atmospheric CH\textsubscript{4} concentrations.

It is important to note that high-resolution sampling (~30 years) is needed to assess clathrate destabilization events in the past. At this stage, only three such events have been measured with sufficient detail. Additional work on other events will be necessary to determine whether clathrates may have been involved. These results also have little bearing on the future stability of clathrates as global temperatures continue to
rise.