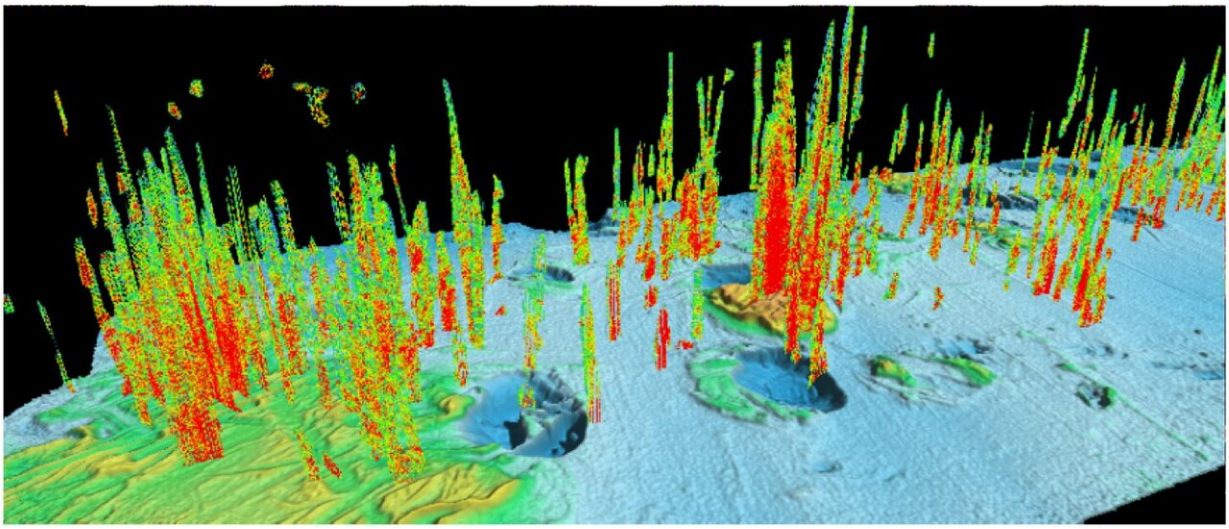
New study reveals cracks beneath giant, methane gushing craters

June 5 2020, by Maja Sojtaric



Craters found on the seafloor of the Barents Sea are up to a kilometer wide and 35 meters deep. They are still leaking methane. Credit: Malin Waage

A paper published in *Science* in 2017 described hundreds of massive, kilometer-wide craters on the ocean floor in the Barents Sea. Today, more than 600 gas flares have been identified in and around these craters, releasing the greenhouse gas steadily into the water column. Another study, published the same year in *PNAS*, mapped several methane mounds, some 500 meters wide, in the Barents Sea. The mounds were considered to be signs of impending methane expulsions that created the craters.

The most recent study in *Scientific Reports* looks into the depths far beneath these craters in the ocean floor and reveals the geological structures that have made the area prone to crater formation and subsequent methane expulsions.

"It turns out that this area has a very old fault system—essentially, cracks in bedrock that likely formed 250 million years ago," says Malin Waage, a postdoc at CAGE, Centre for Arctic Gas Hydrate, Environment and Climate, and the first author of the study. "Craters and mounds appear along different fault structures in this system. "These structures control the size, placement and shape of the craters. The methane that is leaking through the seafloor originates from these deep structures and is coming up through these cracks."

Cutting-edge, 3-D seismic technology

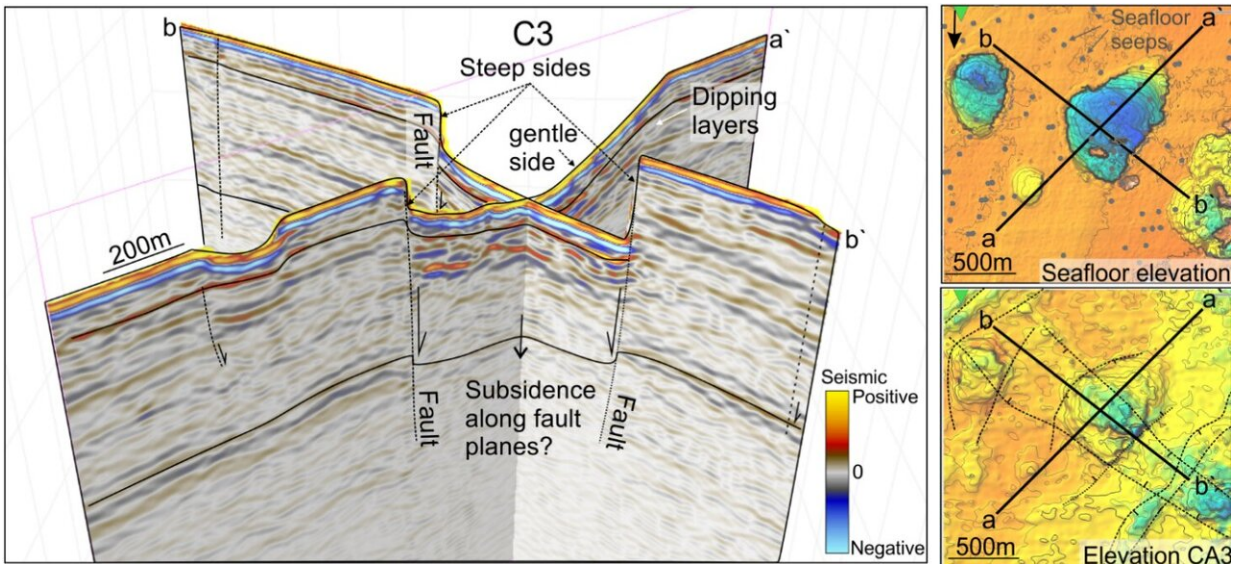
The deep origin of craters and mounds was discovered using cutting edge 3-D seismic technology that can penetrate deep into the ocean floor and help scientists visualize the structures in the hard bedrock underneath.

"Our previous studies in the area hypothesized that climate warming and the retreat of the ice sheet some 20,000 years ago caused the gas hydrates beneath the ice to melt, leading to abrupt methane release and creating craters," said Waage.

Gas hydrates are a solid form of methane that is stable in the cold temperatures and high pressure that an enormous ice sheet provides. As the ocean warmed up, and the pressure of the ice sheet lifted, the methane ice in the seafloor melted, and thus the craters formed.

"This study, however, adds several layers to that picture, as we now see that there has been a structural weakness beneath these giant craters for

much longer than the last 20,000 years. Deep below the seafloor, the expansion of gas and release of water built up a muddy slurry that eventually erupted through the fractures and caused seafloor collapses and craters in the hard bedrock. Think of it as a building: The roof of a building can cave in if the ground structure is weak. We believe that this is what happened in the crater area after the last glaciation," says Waage.



Cracks in bedrock that formed 250 million years ago. Craters and mounds appear along different fault structures in this system. These structures control the size, placement, and shape of the craters. The methane that is leaking through the seafloor originates from these deep structures and is coming up through these cracks. Credit: Malin Waage

The Barents Sea is poorly understood

The exploration of petroleum resources in the Barents Sea is a hot topic in Norway and beyond, as the area is a part of a vulnerable Arctic ecosystem. But the area's geological system is poorly understood.

"Our 3-D survey covered approximately 20 percent of the entire crater area. We believe that it is important to understand if similar fault systems exist in the larger context of the Barents Sea, because they potentially could pose a threat to marine operations."

Some of the questions that scientists pursue: Will these weak structures lead to unpredictable and explosive methane release? Can such release and related geohazards be triggered by drilling? And can the gas reach the atmosphere in the case of abrupt blow-outs, adding to the greenhouse gas budget?

"There is still very much that we don't know about this system. But we are currently collecting and analyzing new data in the Barents Sea, which is dominated by similar crater structures. This can help us map in greater detail the fault systems and associated weakness," says Waage.

More information: Malin Waage et al, Geological controls of giant crater development on the Arctic seafloor, *Scientific Reports* (2020). DOI: 10.1038/s41598-020-65018-9

Provided by CAGE - Center for Arctic Gas Hydrate, Climate and Environment