Ilulissat Fjord mouth, West Greenland: pockmark formation in response to Holocene warming

Schumann, K.; Völker, D.; Weinrebe, W.

Introduction:

Ilulissat Icefjord in West-Greenland is the fastest and most productive iceberg calving area outside Antarctica. Changes in climate exert a first-order control on the recession of the ice front and the calving of icebergs. Glacial and geological processes related to iceberg calving and transport shape the morphology of the seafloor in the area characteristically. Revealing the morphology by high-resolution bathymetric mapping helps to understand these processes.

Since the Little Ice Age, Sermeq Kujalleq retreated continuously. The drastic retreat of the glacier front in 2002 separated a tributary ice stream from Sermeq Kujalleq. At present, the glacier front is split into two single tongues.

Bathymetric data used for the digital elevation model were acquired during the RV MERIAN cruise 05/03 in summer 2007 and in summer 2008 using the private fishing vessel SMILLA for the areas close to the ice front.

RV MERIAN disposed of an ATLAS PARASOUND parametric sediment echo sounder that was continuously operated during the cruise. The digital profile data are used for the interpretation of sedimentary processes.

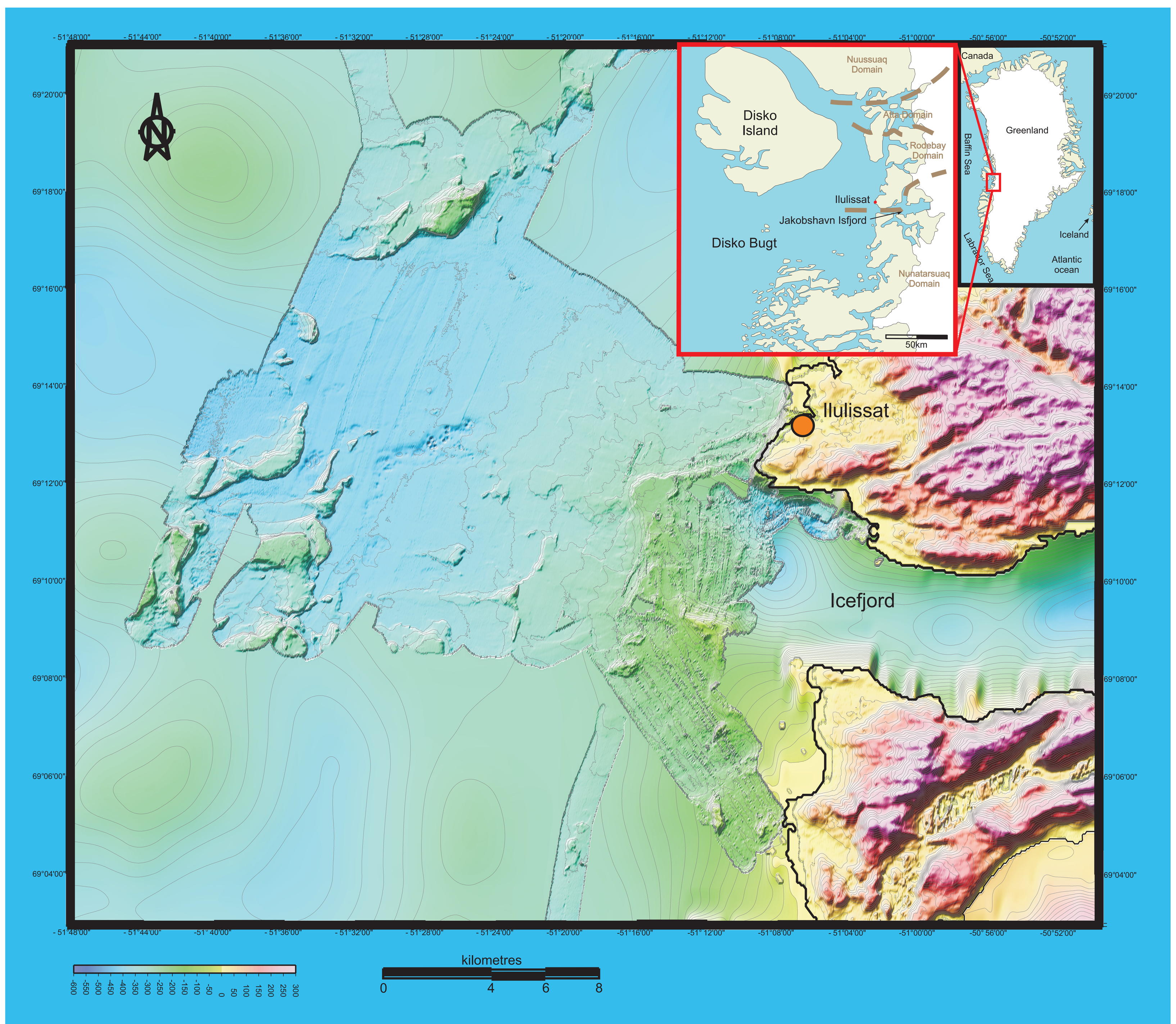

Fig. 1 Bathymetric map of the area off the mouth of Ilulissat Icefjord

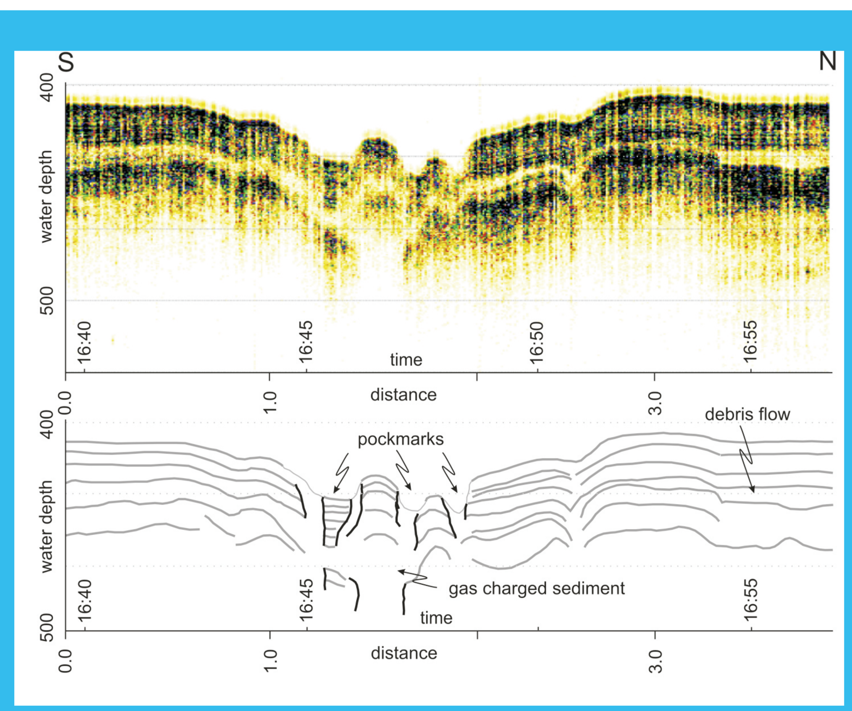

Fig. 2: Parasound profile of a composite pockmark in the central part of the mapping area. The upper sedimentary unit is clearly missing in the pockmark. An acoustical blanked area is visible in the central part beneath the composite pockmark. This might be the pathway for fluids.

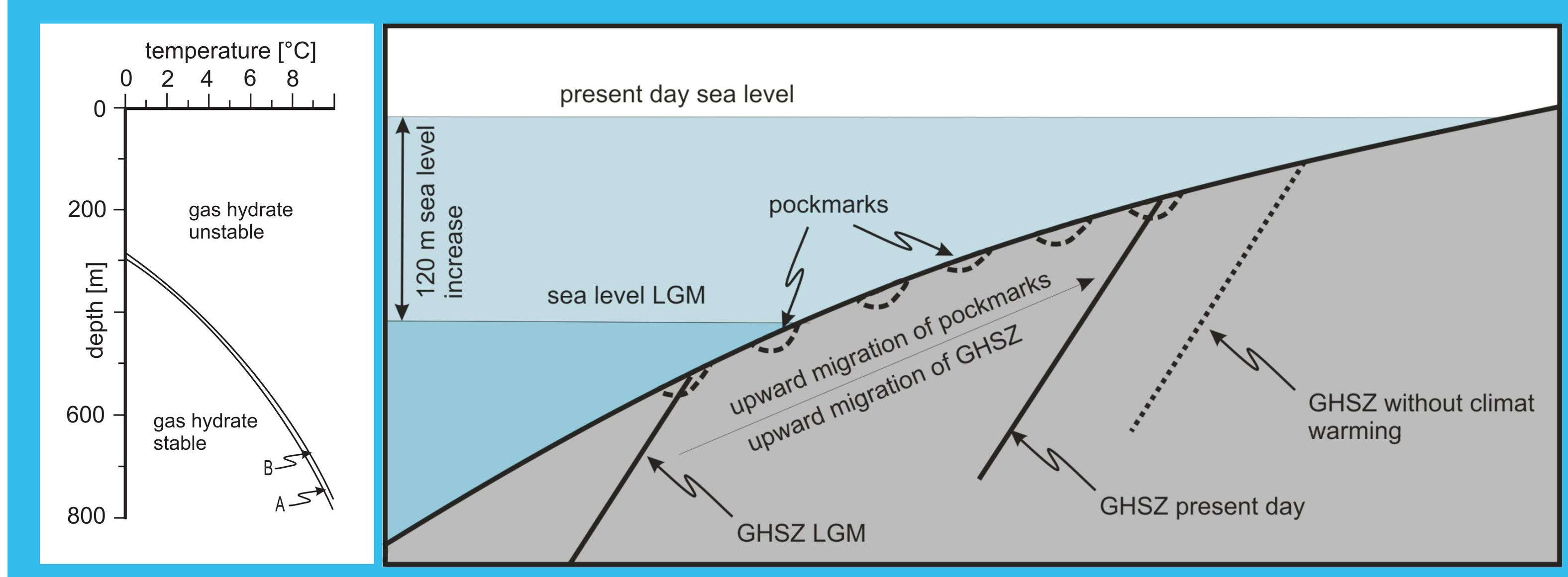

Fig. 3: Behavior of the gas hydrate stability zone (GHSZ) according to sea level rise and temperature increase. The stability of the gas hydrates is dependent on temperature and pressure, as well as on the composition of the gas (Fig. 3). Line A shows the stability curve for 100 % CH_4, line B for 97.5 % CH_4 and 2.5 % H_2S.

Bathymetric map

The most prominent morphological feature in the working area (Fig.1) consists of a group of concentric funnel-shaped depressions of 80 to 150 m in diameter and up to 30 m depth. They show up in a water depth of 400 to 450 m. The occurrence seems to be related to the position of a debris flow. In a PARASOUND cross-section (Fig. 2), the pockmarks appear symmetrical. The cross-section also shows that a thick, well-stratified sediment unit of the surrounding areas is completely or partly missing within the depressions.

In the north-western and south-western parts, some characteristic ridge-like structures with steep flanks and highs of up to 120 m can be seen.

Dissociation of gas hydrates

Gas migrating through the sediment forms gas hydrates within the gas hydrate stability zone (GHSZ). Increasing temperature and/or decreasing pressure destabilize gas hydrate, causing downward migration of the GHSZ (Fig. 3). The erosive force of migrating fluids and dissociated gas hydrate erodes unconsolidated sediments and pockmarks are formed.

Increasing temperatures would cause a downward migration of the GHSZ, while rising sea level is causing upward migration.

Contact
Kai Schumann
IFM-GEOMAR
Wischhofstr. 1-3
24148 Kiel
kaschumann@ifm-geomar.de
www.futureocean.org