Air clathrate hydrates of the Antarctic EPICA Dronning Maud Land ice core

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Polar ice cores are a unique climate archive as they provide the most direct record of past atmospheric gas compositions. In the deeper part of polar ice sheets, most of the ancient air molecules are stored in the crystal lattice of clathrate hydrates (air hydrates). Continuous records of air hydrate number concentration, mean size and shape (geometric properties) exist for the Vostok and Dome Fuji ice cores in Antarctica and the GRIP ice core in Greenland. It was found that the geometric properties correlate with past climatic changes, but also evolve with depth due to physicochemical processes within the ice sheet.

The EPICA Dronning Maud Land (EDML) ice core is located on an ice divide in the Atlantic sector of East Antarctica which allows for a comparison to Greenland ice cores. Furthermore, it differs from other Antarctic deep ice cores by a higher accumulation rate and higher annual mean temperatures on site. This makes it possible to analyze air hydrates with a higher temporal resolution (compared to the Dome Fuji and Vostok ice cores). These factors make the EDML ice core interesting for studying air hydrates.

We use digital image analysis on ice thick section microphotographs to create a high-resolution record of air hydrate geometric properties below the bubble-hydrate transition zone. The image acquisition was done in the field, within a few days after the sample was drilled, in order to record information of the material before relaxation. Using traditional image analysis algorithms, we can confirm the correlation between climate and air hydrate geometrical properties. In addition, we examine the air hydrate spatial distribution and evolution via depth. Digital object segmentation and object analysis offer many advantages, such as fast and efficient analysis, improved statistical data, higher spatial resolution, over the traditionally used manual methods. We are excited to contribute to the future analysis of air hydrates in polar ice cores.