MELTING AND FREEZING OF ICE IN RELATION TO IRON OXIDATION OF METEORITES

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Introduction: The highest concentration of meteorites discovered on Earth is found in the Antarctic ice sheet [1, 2, 3]. The interior of the ice sheet is considered an accumulation zone, where snow falling over time is compressed into ice flowing outward under its own weight. At the periphery of the ice sheet is a broad, distinct ablation zone, where loss mechanisms dominate. Ice is lost within the ablation zone through a variety processes including calving of icebergs, melting, sublimation and physical abrasion [4].

Although melting does not appear to be an important process at high-altitude meteorite sites [4], in some coastal areas of Antarctica, summer temperatures are high enough for ice surfaces to melt [5]. “Black body” of meteorites allows them to absorb significant amounts of solar radiation. It can promote production of liquid water [6], which subsequently freezes again.

We provide direct temperature measurements of the ice formed under natural winter conditions over the pond in the Czech Republic to demonstrate how gas concentration in water influences its freezing. The gas content in water is limited by the gas solubility. The solubility in water increases with both the increase of gas pressure and the decrease of temperature [7]. As water freezes to ice, dissolved gases, too large to fit into the lattice of ice, are rejected and redistributed at the ice-water interface, where the gas content in the water is a maximum at the interface [7, 8].

Results: Data show decrease in ice growth rates [$\mu m\ s^{-1}$], while cooling rates [$°C\ s^{-1}$] remain constant or increase. The growth rates decreased towards greater depths, while cooling rates did not. We identified this phenomenon to be consistent with the water composition change. At the water/interface water is enriched with gas and the amount of gas content in this layer controls the heat flow across this layer (the convective transport of heat is thought to be hindered with increasing gas content). As the ice thickens, it increases the concentration of the gases near the ice-water interface. Therefore the ice progression actively increases the concentration of gases in the immediate vicinity of the ice-water interface.

Discussion: Meteorites hidden in Antarctica´s ice are better preserved than specimens elsewhere as the ice protects them from rusting, weathering, and corrosion [3]. But they often are seen to have pendants of ice or snow adhering to their surfaces, which may melt or sublimate directly on them. Thaw cycles during a typical Antarctic summer provide liquid water, which interacts with the specimen [4]. As water freezes, ice-water interface in the vicinity of meteorite becomes saturated with gas (e.g. oxygen) and may cause its oxidation. This is monitored by measuring meteorite magnetism.

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