Grain Growth in Salty Ice and Applications for Icy Moon Interiors

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Large-scale geophysical processes within the ice shells of icy moons depend heavily on microstructural characteristics, especially the size and growth of individual ice grains. The ice shells of moons such as Europa are in direct contact with salty subsurface oceans, but little data exists on how saltwater may affect grain growth at these warm and melt-present conditions. In order to study these effects, we created pure ice samples that we flooded with saltwater at two different salinities, then allowed grains to grow in temperatures of -5° Celsius and -13° Celsius, both above the H2O-NaCl eutectic point, for periods of 3.16, 7, 31, 100, and 310 hours. We then analyzed the microstructure through visual imaging and calculated effective mean grain size as a function of time, which we then compared to the growth of pure ice over the same time periods. We found that both salinity and temperature affect grain growth parameters in temperate, salty ice shell environments. This suggests that the grain-size-dependent viscosity and convective state of an ice shell may be controlled by local temperature and salinity, which may have significant implications for ice shell evolution.