Microstructure controls longevity of exposed salt-rich ices on icy worlds

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Salt-rich water ice at the surfaces of icy worlds such as Europa, Enceladus and Ceres is of particular interest for Solar System exploration as it can record the chemistry and potential habitability of subsurface liquid water. Endogenic salts can originate by gradual freezing of fluids within outer ice layers, or through rapid emplacement of subsurface brines onto the surface *via* cryovolcanism. However, post-depositional evolution of ices exposed at the surfaces of these worlds is not understood, thus the long-term stability and detectability of salt-rich ice is rarely considered.

We investigated the sublimation dynamics of salt-rich ices under vacuum at sub-zero temperatures. Experimental ices were produced by freezing brines at contrasting rates which contained sodium salts detected at icy worlds including chlorides, carbonates and sulfates. We found that the presence of salts in general decreased the rate of ice sublimation. Furthermore, carbonate and sulfate ices formed through rapid 'flash' freezing, such as may occur during cyrovolcanism, exhibited slower ice loss rates than those formed through gradual freezing. Based on electron microscope imagery, we propose that differences in the salt-ice microstructure, which is strongly affected by freezing rate, influence the rate of sublimation by controlling the surface area of ice exposed to vacuum. Our findings demonstrate how the composition and formation history of salt-rich ices affects their post-depositional longevity at icy world surfaces, and reveal how microscale properties can influence macroscale behaviour. These findings are important for future missions that aim to detect and characterise deposits of endogenic salts at icy worlds.