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Experimental study of ice lens formation and application for planetary surface environment

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Ice lenses are formed by the migration and freezing of water in partially frozen state during soil freezing. Nucleation and growth of ice lenses cause the upwards displacement of ground surface and formation of periglacial landforms. Beyond the terrestrial environment, similar processes are believed to occur in planetary environment. For example, periglacial landforms or high-purity ice are observed at the Phoenix landing site on Mars. Formation of ice lenses is complicated phenomena including heat and mass transport. Several theoretical models address its physical processes in terrestrial environment, however, many questions still remain for the formation of ice lenses. Especially, experimental constraints are not enough. We performed systematic cooling experiment using granular materials to observe the behavior of ice lenses. Our experimental results demonstrate the relationships between the behavior of ice lenses and particle size, temperature conditions and force balance. We also compared our experimental results to numerical model of ice lens formation that focuses on the force balance of thermomolecular force and hydrodynamic force. As a results of comparison, qualitative consistency is obtained, however, important quantitative differences existed. We developed initial numerical model using kinetic effect around particle surface and obtained good agreement.

Application experiments that simulate planetary surface environments are also performed (e.g., low pressure environment, carbonated water etc.) and we observed different behaviors as compared with basic experiments.

In this presentation, we report the comparison between the experimental results and theoretical model and application experiment under simulated planetary environment.

Keywords: ice lens