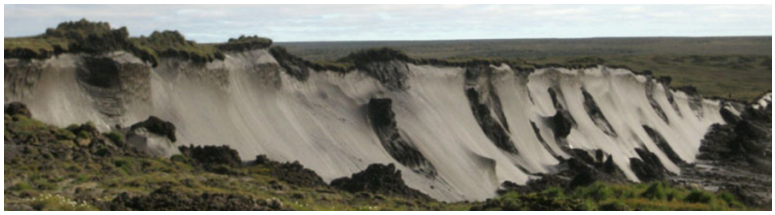
Permafrost – Heat Transport in Porous Media



© AWI | Georg Schwamborn | ce wedges (Yedoma) on the Bol'shoy Lyakhovsky, the most southern Island of the New Siberian Archipelago[1]

Motivation

Permafrost is a combination of soil, rocks and sand, held together by ice. Most of it is below freezing throughout the year. However, the top layer, called the active layer, undergoes a thawing-freezing transition during Earth's winter-summer cycle[2].The soil in this layer is a densely packed, nanoporous network composed of silica-rich grains and clays, with a large size distribution of pores that are filled or partially filled with water. When below freezing, water in pores typically smaller than 10nm will remain liquid while the water in larger pores will freeze, which is known as Gibbs-Thomson effect. Recent theory by Flekkøy and Hansen (unpublished) finds ***super-diffusive propagation*** of a melting front in a frozen, nanoporous networks[3].

Your Project

To test the theory of super-diffusive propagation in a porous medium experimentally the student will build a nano-porous network in terms of a Hele-Shaw cell, which is a thin cell with flat walls. This will be densely packed with micron-sized silica beads and varying degrees of humidity. Using fluorescent microscopy and heating provided by a focused laser we will study how heat is propagating in such a controlled environment. The experiments will be conducted in a cold room, kept at -10ºC.

Requirements

The applicant should have a very good understanding of thermodynamics and be keen on setting up the cell, including the optics and sample preparation.

Other aspects

The experimental study will be supervised by the Professor Eiser, an experimental physicist, and Alex Hansen a theoretician, Porelab (porelab.no).

Contact person

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[1] https://www.sonnenseite.com/en/science/thawing-permafrost-is-shaping-the-global-climate/
[2] J. Obu, "How Much of the Earth's Surface is Underlain by Permafrost?." J. Geophysical Research: Earth Surface, 126, e2021JF006123 (2021)
[3] E. G. Flekkøy, A. Hansen, B. Baldelli, "Hyperballistic Superdiffusion and Explosive Solutions to the Non-Linear Diffusion Equation" Frontiers in Physics 9, 640560 (2021)