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Freezing in Natural Porous Materials

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Neutrons provide a unique means of examining the processes of freeze-thaw in uncontrolled porous solids that are common materials in the real world, such as rock, sediment and Portland cement paste. For instance, the sensitivity of neutrons to hydrogen and their bulk penetration allows one to independently measure the ice content, via Bragg peaks, and water content, via changes in the background near the first maxima of S(Q) of D_2O, of microporous systems as a function of temperature. This allows testing of models of freeze-thaw hysteresis in systems with large freezing-point depressions. It is also possible to monitor the ejection of water during freezing from initially saturated systems. In addition neutrons have provided a method of testing the invasion hypothesis of ice through porous media in predominantly macroporous diatomite and chalk. In these rocks we see highly non-random fabrics of ice *Ih* forming inside porous rock. The orientation of the fabric is independent of the direction of bulk heat removal but is dependent on the frame of the rock. This demonstrates that ice grows coherently over length scales long enough to cause grain competition and that the inherent anisotropy of connectivity of the pore network dominates ice crystallization. This result contrasts strongly to the formation of ice through unconsolidated sediment where a much weaker fabric couples to the direction of heat flow.