C21B MCC: Level 2 Tuesday 0830h

The Roles of Permafrost in Climate Change: Archive, Translator, and Facilitator III Posters *(joint with A, B, H, PP, GC)*

Presiding: **F E Nelson,** University of Delaware**; O A Anisimov,** State Hydrological Institute

C21B-0810 0830h POSTER

Active Layer Thickness of Soils in the Ross Sea Region, Antarctica

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Soil temperature, air temperature, solar radiation, soil water content, and other parameters have been monitored continuously at four locations in the Ross Sea Region, Antarctica since January 1999. Although the time of record is too short to discern long-term trends, relationships between active layer thickness and various other parameters can be appraised. The active layer depth increased at all four sites during the study period. The average annual air temperature increased at three of the four sites and the annual maximum air temperature increased at all sites. One of the more interesting trends show the average annual soil water content near the surface increasing at all sites; however, these soils remain very dry; average annual soil water contents seldom exceed five percent by volume. The maximum soil water content can sometimes exceed 20 percent for short periods during snow melt and this leads to percolation into the soil. Average annual incoming solar radiation behaved similarly to air temperature. January solar radiation increased at two sites and decreased at two.

C21B-0811 0830h POSTER

Climate Change and Periglacial Landslide Activity in South-Western Yukon Territory

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Six case studies of recent landslides in southwestern Yukon Territory help predict the influence of future climate change on periglacial landslide activity in the region. The presence of permafrost and frozen ground has played an important role in each of the case studies. Permafrost degradation and thaw consolidation after recent forest fires has caused debris flows and active layer detachment slides in sub alpine and valley bottom settings. The interface between frozen and unfrozen ground has controlled the depth of movement for active layer detachment slides and debris flows in various hill slope positions. In addition, elevated pore water pressure and poor drainage due to the presence of a frozen substrate has caused debris flows in mid-slope and alpine settings. Lastly, thawing of massive segregated ice bodies has caused large thaw slumps of fine sediment in river terraces. The triggering events in each case study relate to rapid snowmelt, river migration, intense summer rainfall and permafrost degradation caused by forest fires. Climate change scenarios predict an increase in the frequency and magnitude of these incidents in south-western Yukon Territory. Therefore, a similar increase in the frequency and magnitude of periglacial landslides is expected in the region.

C21B-0812 0830h POSTER

Comparison of Methane Content in Upper Permafrost of Eastern Siberia and Alaska

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Due to significance of methane contribution to greenhouse effect its concentration in permafrost is an important issue; thawing of the frozen ground could affect the global carbon cycle to a substantial degree. Experiments show a potential chance of methane production in permafrost; however, importance of the process for forecast of methane content in frozen soils is problematical. Amount of methane trapped in permafrost is generally poorly studied; for the first time a comparison of methane content of marine and continental permafrost deposits was made. Gas samples were collected from frozen alluvial deposits from upper permafrost of Lena river valley, Eastern Siberia, and from marine deposits of Barrow, Alaska. Ice wedges and mineral soils were investigated. Maximum methane content was found in frozen soils of continental alas deposits (up to 70000 ppmv in air bubbles); however, frozen marine deposits contain large amount methane. Methane concentration up to 12000 ppmv was found in air bubbles of ice wedges of alluvial deposits in Fairbanks region, Alaska. There was no correlation found between the methane content and depth; however, thawed in past and now frozen soils contain almost no methane; therefore, methane can be easily lost due to thawing of deposits.

C21B-0813 0830h POSTER

Developing a numerical model of frost boils dynamics.

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The research was initiated as a part of biocomplexity project, which investigates cryoturbation in continuous permafrost regions in the Arctic. The project explores influence of climate (mean annual and summer temperatures, and snow cover depth and density), vegetation layer composition and physical properties, soil textures and moisture content on evolution of frost boils. The work deals with analysis of temperature regimes and moisture distribution and dynamics during seasonal cycles of freezing and thawing. The research focuses on the development of a computational approach to the study of frost boils as a self-organized system. The model is calibrated using temperature and moisture content data collected from a field experiment at two study sites. A thermo-mechanical model of the frost boil phenomena based on principles of macroscopic thermodynamics and continuum mechanics will be presented. The model includes the energy and mass conservation equations, continuity equation, the Clausius-Claiperon equation, and an empirical formula which relates unfrozen water content to temperature. The complete system is reduced to a computationally convenient set of coupled equations for temperature, pore water pressure and porosity in a two-dimensional domain. A finite element method and an implicit scheme in time were utilized to construct a non-linear system of equations, which was solved iteratively. The model describes dynamics of frost boils and helps to explain geometric form and size of distinctly visible patterned ground north of the Alaska's Brook Range.

C21B-0814 0830h POSTER

Effects of Permafrost on the Rate of Spruce Migration During Climate Warming

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Although white spruce has advanced into tundra ecosystems throughout Alaska since the late 1800s, presumably in response to a regional increase in temperature, there is high variance in the magnitude of change in treeline position among arctic treeline sites. We investigated the role of permafrost as a modulator of vegetation response to climate by estimating the migration rate of spruce advancing into lowland sites with very poorly drained soils and upland sites with more well-drained soils. Migration rates were estimated from published reconstructions of spruce population dynamics at 2 lowland and 4 upland sites on the Seward Peninsula, Alaska. Migration rate was calculated by dividing the distance between two locations along an advancing front by the difference in stand age at the two locations. We estimated the hypothetical effect of variation in migration rate on the areal extent of land cover change over a 100 year period by multiplying the length of the forest-tundra boundary on the Seward Peninsula by the estimated migration rates. Migration rates in upland sites (129 m/yr) were greater than those in lowland sites (0.2 m/yr). Differences in estimated spruce migration rates had a large effect on the land area that could hypothetically be affected by spruce expansion. Migration rates equivalent to those found in upland sites would result in spruce colonizing 33% of the treeless area of the Seward Peninsula over a 100 year period, while rates equivalent to those found in lowland sites would result in 0.05% of the treeless area being colonized by spruce. Three hypotheses may explain the variation in migration rates in the two types of sites. First, differences in migration rate may reflect different climatic histories. The upland and lowland sites are separated by <10 km, however, so it is unlikely that the rate of warming differed significantly between them. Second, the density of spruce behind the advancing front may limit seed availability and thus reduce migration rate. Spruce density behind the advancing front at lowland sites was an order of magnitude greater than in upland sites, however, so source population density is not a likely explanation for the slow migration rate from lowland sites. Finally, migration into lowland tussock tundra may be limited by the availability of suitable microsites. Two lines of evidence support this hypothesis. First, lowland sites have extremely high subsurface soil moisture, which may inhibit spruce colonization. Second, prior research has shown that spruce preferentially colonize lowland tundra in thermokarst-affected sites with improved drainage. Our results thus suggest that permafrost, by impeding soil drainage, reduces the rate of the transition from tundra to forest vegetation, and therefore acts to dampen the response rate of forest vegetation to climate.

C21B-0815 0830h POSTER

The Evaluation of Permafrost Dynamics within the Circumpolar Region in 21st Century.

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Permafrost is one of the main factors controlling ecosystems health and stability in circumpolar region. With the possibility of climate change in the nearest future permafrost dynamics should be evaluated to estimate the possible effect of those changes on infrastructures, and carbon and hydrological cycles. Existing models for the evaluation of permafrost dynamics over large regions can only be used as rough approximations due to poor spatial resolution. That is why in our studies we used a physically based spatially distributed analytical thermal model (the GIPL model), developed at the Geophysical Institute Permafrost Lab specifically for regional scale investigations of the ground temperature regime and active layer thickness dynamics. In addition to, climate forcing from the high resolution Regional Climate Model (HIRHAM4) was used as upper boundary condition. Two scenarios of climate change (A2 and B2) have been applied. The GIPL model was further improved by incorporating fires effects. This includes major changes in ecosystems after the fire (forest with moss cover transforms into steppe-like ecosystems). There is still the possibly that the forest will recover over the period of 40 - 60 years if the fire severity was low. Due to the lack of the forest fire statistics for the entire circumpolar region, the effect of forest fires was only applied to the Alaskan and East-Siberian transects. The results of the modeling include circumpolar maps of the active layer thickness and mean annual ground temperatures for several temporal intervals within the 21st century. Depending on the climate change scenario, the projective increase in mean annual ground temperatures will range from 2 to 6°C, in active layer thickness is up to 1 m, and will be most pronounced in southern parts of the domain. During the current century, permafrost degradation will start

in the southern parts of the circumpolar region and will progress northward. The results of this modeling can be used by scientific communities for the forecast of ecosystems response and infrastructure stability in the 21st century on global and regional scales.

C21B-0816 0830h POSTER

Frozen Ground Data Center at NSIDC: New Data and Improved Access

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Permafrost and seasonally frozen ground regions occupy about 24% and 60%, respectively, of the exposed land surface in the Northern Hemisphere. Frozen ground data and information are critical for understanding fundamental cold regions processes, detecting environmental change, assessing climate impacts, validating models, and for engineering applications. However, much of the information collected over past decades, and currently being collected, remains widely dispersed and unavailable to the science, engineering, and modeling communities. To meet the requirements of these users for data and information management, the International Permafrost Association (IPA) developed the Global Geocryological Data (GGD) system, an internationally distributed system linking investigators and data centers around the world. The World Data Center (WDC) for Glaciology at Boulder and the National Snow and Ice Data Center (NSIDC), in collaboration with the International Arctic Research Center (IARC), have established the Frozen Ground Data Center (FGDC) as a central node of the GGD. The FGDC identifies, archives, documents, and distributes data related to permafrost and seasonally frozen ground. The FGDC currently holds over 100 data sets and information products and contains detailed metadata records describing over 100 additional data sets available at other GGD nodes around the world. The data center has improved access to these data through an online search and order system and availability in the Global Change Master Directory. The FGDC's holdings include summary data, metadata, and maps describing the Circumpolar Active Layer Monitoring (CALM) program sites, and comprehensive metadata describing the IPA's Global Terrestrial Network for Permafrost (GTN-P) boreholes. The FGDC also holds site metadata and photos from the Arctic Coastal Dynamics (ACD) program, as well as products of the Permafrost and Climate in Europe (PACE) program, and the IPA's Southern Hemisphere Working Group (SHWG) and Cryosol Working Group. The FGDC holds maps of permafrost, soil temperature, ground ice, soil classification, vegetation, and landscape in their original formats (for example, ESRI Shapefiles or binary) and as browse images. It also houses a comprehensive permafrost bibliography containing 14,000 citations for materials dating from 1783 to the present, as well as specialized bibliographies. The FGDC recently released Version 2.0 of its Circumpolar Active-Layer Permafrost System (CAPS) CD-ROM set, a compendium of GGD data and metadata currently available in the FGDC and around the world. It serves as a snapshot of frozen ground and related data holdings available as of spring 2003 and enables access to these data for users lacking ready Internet access or high-speed connections. The FGDC welcomes data and information submissions for all participating countries, institutions, and individual investigators. Visit the FGDC web site (http://nsidc.org/fgdc/) for additional information on data availability and submissions.

URL: http://nsidc.org/fgdc/

C21B-0817 0830h POSTER

Holocene Landscape Change on the Arctic Coastal Plain of Alaska: Paleoecological Evidence From Deep Organic Deposits of Erosional Landscape Remnants

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The dominant landscape process on the Arctic Coastal Plain of northern Alaska is the formation and drainage of thaw lakes, a process which apparently began during the early Holocene more than 10,000 years ago. The continual formation and drainage of thaw lakes accounts for approximately 75% of the modern surface expression of the Barrow Peninsula. The processes associated with the thaw lake cycle usually obliterate lacustrine or peat sediments which could otherwise be used for paleoecological reconstruction. Long-term landscape and vegetation changes are therefore imperfectly understood, despite years of intensive study. We have identified several possible erosional remnants of a former peneplain surface that predate the formation of the thaw lakes. These remnants are characterized by higher elevations, a deep organic layer with very high ice content in the upper permafrost, and a plant community somewhat atypical of the region. A sediment core was extracted from one of these sites, sectioned, and sampled for pollen, soil organic carbon, and 14C dating. The lowest level of the organic sediments represents the earliest phase of plant growth, dating to about 9.3 ka calendar years. Palynological analysis and high carbon accumulation rates during this period indicate wet and possibly warmer conditions. This is interpreted as the local response to ameliorating climate during the Holocene thermal maximum (HTM) the interval of warmth associated with peak Holocene temperature. Coupled with results from other sites in northern Alaska, a pattern is emerging of the early Holocene characterized by mesic shrub tundra (including sedge, birch, willow, and heath vegetation) associated with high carbon accumulation rates; these rates slow after 8 ka, and slow even more after 4.5 ka, with a net carbon loss after 3 ka.

C21B-0818 0830h POSTER

Imaging depth-of-thaw beneath arctic streams using ground-penetrating radar

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We are investigating the responses of arctic tundra stream geomorphology, hyporheic zone hydrology, and biogeochemical cycling to climate change. In particular, we expect that hyporheic exchange dynamics in tundra streams are controlled by 1) channel features (pools, riffles, etc.), and 2) depth-of-thaw beneath the stream channel. A key objective of this effort is monitoring sub-stream thaw through the thaw season using ground-penetrating radar (GPR). In general, GPR is a well established tool for imaging active layer thickness. However, sub-stream imaging presents a unique set of challenges. This is primarily related to strong frequency dependence and high levels of attenuation as the radar signal propagates through water. To test the effectiveness of GPR imaging of sub-stream permafrost we conducted a field investigation near the end of the thaw season when we expected the depth of thaw to be near its maximum. We investigated three sites located within the Kuparuk River and Toolik Lake basins, north of the Brooks Range, Alaska. The sites were characterized by low energy water flow, organic material lining the streambeds, and water depths ranging from 20 cm to 2 m. Water saturated peat with some pooled water was present along the stream banks. We acquired data using a pulsed radar system with high-power transmitter and 200 MHz antennas. We placed the radar antennas in the bottom of a small rubber boat, then pulled the boat across the bank and through the stream while triggering the radar at a constant rate. We verified depth to permafrost by pressing a metal probe through the active layer to the point of refusal. Although there is significant shift toward the low end of the frequency spectrum due to frequency dependent signal attenuation, we achieved excellent results at all three sites with a clear continuous image of the permafrost boundary both peripheral to, and beneath the stream. Depth migration was applied to the profiles to provide an accurate image of both the streambed and top-of-permafrost geometry. We found thaw bulb thickness to increase with stream depth, with a maximum thaw depth of 1.5 m measured beneath the 2 m deep stream. It should be noted that the maximum thaw depth occurred beneath the site with not only the greatest water depth but also the lowest flow rate. Our results demonstrate that GPR is an excellent tool for measuring sub-stream thaw depth.

C21B-0819 0830h POSTER

Low runoff response to permafrost dynamic within the Lena River watershed

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River runoff formation, particularly during low flow season, is one of the most sensitive processes to permafrost thawing and degradation. Historical data on river discharge, precipitation, air temperature and modeling results on active layer thickness and soil temperature are processed to study the response of river stream flow on changes in ground conditions. Analysis of the permafrost dynamics along the Lena River watershed for the past century shows that under the impact of air temperature variability significant changes occurred in the mean annual ground temperatures (±3-4 C) and active layer thickness (±1 m). It was found that air temperature rise produced additional thawing of active layer of 0.5-2.0 m everywhere within the transect. The permafrost dynamic is highly pronounced at the southern mountain region of the Lena basin. Analysis of the river discharge time series in that region (Chulman River) over the period 1936-1990 suggests the alternation in the water regime of autumn and winter natural runoff. Along with runoff alternation precipitation sum over the warm period (June-September) in that region is characterized by tendency to increase during 1964 - 1984. Air temperature in October is always below zero and ground surface freezes preventing penetration of any precipitation water. The river discharge in October tends to decrease since the beginning of 1960s whereas winter runoff is raised over this period. Increase of active layer thickness and spread of taliks suggest the subsurface capacity increase, which tends to accumulate more water within, thus, decreasing the autumn (October) and increasing the winter (November - April) discharge. It should be noted, that this pattern is not widespread along the Lena River watershed. It persists locally at the southern part of the basin.

C21B-0820 0830h POSTER

On the Use of Ground Temperature Data Obtained At Meteorological Stations For Assessment of Permafrost Status

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The ground temperature (GT) (to a depth of 320 cm) measured by extraction thermometers at meteorological stations were used to assess the status of permafrost in Russia for 1969 to 1990, which is generally a period of global warming. In all, data for 75 stations located in the zone of discontinuous permafrost and for 44 in the zone of continuous permafrost (perennially frozen ground is observed from the depth of 160-320 cm at of the 33 stations) were analyzed. Linear trends of time series of annual and seasonal GT and surface air temperature (SAT) were used to asses the s ground response to the recent warming. Generally, GT in most of the permafrost zone increases in the cold season, and is explained by the predominant rise of SAT. In summer, however, SAT shows little increase, and the GT

does not change in the upper 60 cm layer), but warming is observed below 80 cm. The latter is also attributable to the increase of winter SAT and GT. There are small linear trends of GT in perennially frozen layers and these are insignificant at most of the stations where permafrost exists. Thus, there is no significant warming of perennially frozen ground over most of the permafrost zone of Russia. These results are in accordance with observed energy exchanges in permafrost regions and with the estimates of current permafrost status that have been made using other approaches. Nevertheless, this work shows that some methods used to assess tendencies in times series of meteorological data over large territories are not suitable for those of GT. First, spatial interpolation of GT linear trends to a regular grid was impossible because of the strong variability and irregularity in the distribution of these trends. Second, the use of linear trends is not justified in all cases. For a number of stations, linear trends, even if high and significant, may be false. This can arise due to a low value at the start of the time series and higher ones at the end. Hence, trend estimates made on the basis of such records are misleading. In addition, in some cases, the GT time series for the period 1960s - 1990 include both positive and negative temperature trends, that are lacking in the corresponding SAT time series. The use of linear trends is also inappropriate in these cases. This situation arises due to the effect of fluctuations in the timing, duration, and thickness of snow cover and ground water content on GT. Thus, in comparison with SAT, the analysis of GT data requires their more detailed information at each station. In turn, this will provide fuller understanding of processes occurring in the permafrost zone of Russia.

C21B-0821 0830h POSTER

Spatial and Temporal Variation of Soil Temperatures in the Kuparuk River Basin, Alaska

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A series of environmental studies have been carried out in the northern foothills of the Brooks Range and the Arctic Coastal Plain in the Kuparuk River Basin, Alaska to develop a better understanding of the physical and climatic dynamics of an arctic ecosystem. As part of these studies, soil temperature measurements were made continuously at eight locations along a transect from near the Beaufort Sea coast across the coastal plain to the Brooks Range foothills. Soil temperatures measurements were made in the active layer and permafrost to depths exceeding 10 meters. Data collection began at three of these sites in 1986 with other sites being added until 1994. These data sets are of sufficient length to begin showing long-term trends in arctic soil temperature. All locations show a trend to warming soils over the period, especially in the deeper permafrost soils. Soil temperatures at all sites indicate warming of the permafrost and an increase in the active layer thickness. Summertime soil temperatures within the active layer do not indicate warmer soils. This paper summarizes trends observed in soil temperature spanning the last 17 years in the Alaskan Arctic.

C21B-0822 0830h POSTER

Warming and Thawing of Permafrost in Alaska: Recent Results and Impacts

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There has been a widespread warming of air temperatures in Alaska since 1977 and some warming of permafrost. Constant or cooling permafrost temperatures followed this in the early 1980s, probably due to thin snow covers and a short cooling trend. Permafrost temperatures along a north south transect from Prudhoe Bay to Gulkana and at other sites have generally warmed since the late 1980s, initially in response to thicker snow covers. The warming north of the Brooks Range is comparable in magnitude to the century long warming there (2 to 4°C). The trend has not been followed at Eagle and the Yukon River bridge. Warming of the discontinuous permafrost is typically $\frac{1}{2}$ to $1\frac{1}{2}{}^\circ$C. Thin discontinuous permafrost is thawing at the base at a rate of 0.04 m per year at one site. New thermokarst and thawing permafrost have been observed at several sites. Significant impacts of warming and thawing permafrost and thermokarst on the environment, ecosystems and on infrastructure will be presented.

C21B-0823 0830h POSTER

The Driving Force of Frost Boils and Hummocks Formation

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Formation of frost boils has several aspects to be explained, including the bowl shape of boils, the formation of an organic layer at the periphery of the frost boils, the elevated center of the boils, and resistance of the soil surface to vegetation colonization. Genesis of frost boils and hummocks have been widely attributed to cryoturbation-a complex of seasonally interchanging processes of frost heave and thaw settlement. Existing hypotheses, however, do not consider changes in the upper permafrost as factors of frost boil and hummock formation. Most of features listed above cannot be explained by reversible seasonal changes in the active layer. Frost boils and inter-boil areas form a well-organized and long-term functioning system closely linked to upper permafrost dynamics. Formation of this system starts with the occurrence of vegetation in inter-boil areas in shallow thermal cracks limited by the thickness of the active layer. Vegetation and its decomposition change the thermal properties of the active layer that steadily decreases with formation of aggradational ice and perennial frost heave beneath vegetated inter-boils. Due to the three-dimensional nature of the freezing front, frost heave in inter-boil areas is not perpendicular to the soil surface but is inclined in the direction of the boils, thus forming the bowl shape of boils. The organic matter formed in inter-boil areas intrudes under boils due to formation of frost cracks and thawing of ice lenses and layers at the bottom of the active layer. Penetration of organics along the active layer - permafrost boundary from an inter-boil area leads to formation of additional aggradational ice in the intermediate layer at the top of the permafrost accompanying the intruding organics. This aggradational process reinforces the bowl shape of frost-boils. Accumulation of organic matter at the lower part of the active layer leads to a decrease in active-layer thickness under the boils, which in turn leads to accumulation of aggradational ice and perennial irreversible frost heave. This increases the difference in elevation of the surface between frost boils and inter-boil areas. Vegetation colonization is then impeded by the elevation differences and formation of needle ice on the surface of the exposed mineral soil. With time, the organic layer often encircles completely the periphery of boils. The net result is carbon sequestration at the active layer-permafrost boundary. The organic matter at the bottom of the active layer is not accessible to cryoturbation. To be susceptible to seasonal frost heave, the organic matter accumulated at the bottom of the active layer has to be pushed upward in to cracks in the mineral soil, which occasionally form at the bottom of the active layer with the opening toward the bottom. Active cryoturbation of mineral and organic soil throughout the entire active layer by seasonal frost heave and thaw settlement, as is postulated in most existing explanations of frost-boil formation, have never been evident in our field observations. In the continuing evolution of frost boils, vegetation development on the boil surface and readjustment of the upper permafrost lead to the development of hummocks. The development of vegetation and accumulation of organics at the surface leads to decreasing active-layer thickness. This in turn causes increased accumulation of aggradational ice, incorporation of the previously intruded organics underneath the frost boil into the upper layer of permafrost, and increased perennial heave of the surface.

C21C MCC: Level 2 Tuesday 0830h

Planetary Permafrost II Posters *(joint with B, P)*

Presiding: **J F Mustard,** Brown University**; M Mellon,** University of Colorado

C21C-0824 0830h POSTER

Fabric Measurements of Ice Crystallized Within the Pore Networks of Chalk and Diatomite

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The phenomenon of the crystallization of ice through porous bodies is a concern in many branches of science; e.g., porous materials; biological cells and related cell damage; and permafrost on earth and other planetary bodies. Whereas in unconsolidated sediments particle-pushing and ice lens formation occur, these are not significant processes within rock, and the ice must crystallize through a pre-existing pore network. At issue is whether the pore walls act as efficient nucleation sites or whether a coherent crystallization front of ice moves through the connected porosity. In the former case each pore can be considered independent and in the latter case the state (frozen/unfrozen) is dependent on the states of its neighbors, and the ice crystallization front advances through the porosity in a manner analogous to models of invasion percolation of fluids through pores. In the latter case, one would also predict the development of strong fabric (crystallographic texture) of ice as the ice front grows through the network. We present neutron diffraction measurements of deuterated ice Ih forming *within* the pores of bulk specimens of chalk and diatomite. Preliminary neutron "powder diffraction" measurements suggested a very highly textured nature to the ice. Subsequently, we built a Peltier cooler device to form ice within the pore networks of highly porous rocks. This device was placed in a Eulerian cradle and mounted on a neutron diffractometer. The pole figures we measured strongly suggest the advance of a coherent crystallization front throughout the connected porosity.

C21C-0825 0830h POSTER

Crater-Based Evidence of Periglacial Processes in Northwest Utopia Planitia

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Pingos are ice-cored, perennial frost mounds of which there are two main types: closed or open. Along with ice wedge polygons they are benchmarks of periglacial processes in cold-climate, non-glacial landscapes. The genesis and development of both pingo types is contingent upon three limiting factors: 1. the availability of water in liquid form; 2. an impermeable and constraining boundary layer in the ground; and, 3. surface deformation driven by hydrostatic pressure (closed pingo) or hydraulic pressure (open pingo). In the case of a closed pingo, ground temperatures also must be above the freezing point of water for pingo genesis to be initiated. Ice-wedge polygons are the product of a different set of periglacial processes: thermal contraction, the infiltration of liquid water into surficial cracks, ice wedge-development and surficial temperatures supportive of freeze-thaw cycles. The existence of a Martian periglacial landscape highlighted by pingos and ice-wedge polygons would point to: 1. liquid water having been available prior to landscape genesis; and, 2. surface temperatures having been high enough to sustain water-freezing processes and repeated freeze-thaw cycles. As of yet, active periglacial landscapes on Mars have not been identified. By contrast, the existence of artefactual periglacial landscapes comprising pingos and ice wedge polygons has been hypothesised in a number of instances. However, poorly resolved Viking imagery and hypothesised periglacial landscapes not consistent with terrestrial analogues have left some key questions unanswered. On the basis of MOC2-357 we have identified a possible periglacial landscape comprising 15 pingo-like mounds arrayed in a field of small-scale, ice-wedge like polygons. The mounds, bracketed by the polygons, sit on the floor of an isolated, medium-sized, impact crater in the northwest corner of Utopia Planitia (64.8°N / 292.7°W). If the formation of the northern plains dates back to the late Hesperian or early Amazonian period, then the age of the impact crater and of the landforms residing within it must be younger still. Using the data generated by the Mars Orbiter we conducted image enhancement and photoclinometric analyses of the crater basin. Morphometric measurements of the mounds and polygons are consistent with the dimensions of terrestrial pingos and ice-wedge polygons. Equally, the location of these mounds and of the surrounding polygons on the crater floor, possibly the floor of an ancient ice covered basin or paleo-lake, is consistent with the location of closed pingos and ice-wedge polygons on the floor of drained arctic lakes. Adjacency to a region of hydrogen abundance, possibly ice-rich sediments or ground ice, has been mapped. On Mars as on Earth these sediments