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VAST ATMOSPHERIC COLD TRAPS WITHIN THE LARGE RINGED TOPOGRAPHIC FEATURES IN NE SIBERIA: IMPLICATION FOR MARS. G. A. Burba, Vernadsky Institute of Geochemistry and Analytical Chemistry, 19 Kosygin St., Moscow 119991, Russia e-mail: burba@online.ru

Introduction: The ridges within the vast mountain country of the NE Siberia have been revealed recently to comprise two giant ring structures (RS), 500 and 400 km in diameter [1] . Such evidence is a new look on the general topographic structure of the area and could be of importance for climatic consequences.The central lower areas of these structures, which are enclosed within a ring wall of mountain ridges, work as giant "cold traps" for the atmospheric air. During the winter seasons the temperature inversion in the near-surface layer of the atmosphere take place there.

Topographic description: The highest area of the North-East Siberia, Russia, consists of the mountain ridges arranged as the two adjacent RS. These RS are located between Lena River Mouth and Magadan Coast of the Sea of Okhotsk. Each of the two rings have circular pattern of mountain ranges, which encircle a plateau area in the central part of the ring. The general topographic shape of each RS is a complex of high mountain rings (altitudes 1000 to 3000 m) with a lower, but still topographically high (400-1200m) plateau inside, and lowland plains outside (50-200 m). The outer diameter of each structure is about 700 km. The rim crest diameters are about 500 km for Yana Ring Structure (YRS), NW in the couple, and 400 km for Oymyakon Ring Structure (ORS), SE one. YRS is located between 63 and 70°N, 125 and 140°E, and ORS – between 61 and 67°N, 136 and 151°E. In general YRS is somewhat lower than ORS, especially with its inner area. The structures are named after the Yana River and Oymyakon settlement, which are located within each of the them.

Air temperature data: The weather observations at Verkhoyansk on Yana River, near the center of YRS, and at Oymyakon on Indigirka River, near the center of ORS, have determined as early as in 1930s that these areas are the coldest places at the Northern hemisphere of the Earth with the minimal records of air temperature as low as – 68° C at Verkhoyansk and – 71° C at Oymyakon. Further long-term meteorological data revealed the areas of Verkhoyansk and Oymyakon as the enclosed regions with very low air temperatures in winter. Both areas have value of the mean monthly air temperature for January defined as "lower than – 48° C" [2]. And over the whole NE Asia such low values are typical ONLY to these two areas, the central parts of YRS and ORS.

Interpretation: Now, after a new look at the topographic structure of the NE Siberia, it could be explained that each of these "cold poles" is located within the lower areas at the central parts of the large ring structures (intermountain basins), which works as a giant cold traps being enclosed within a ring wall of mountain ridges. Such situation could lead to the circumstances of the temperature inversion in the near-surface layer of the atmosphere.

Implication for Mars: Couldn't the similar situation with the air temperature take place during the winter season within the craters and large basins in the polar regions of Mars?

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LIFE IN MARTIAN SNOWS – MEASUREMENTS OF UV PROTECTION UNDER NATURAL ANTARCTIC SNOWS IN THE UVC (254 nm)

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Introduction: Ultraviolet radiation down to 195 nm penetrates to the surface of the Martian north polar ice cap during the polar summer on account of the lack of an ozone column, in contrast to the Earth where only radiation above ~290 nm penetrates to the surface (except under ozone depletion, when radiation down to ~280 nm may penetrate). During the winter, spring and fall some ozone production does occur over the Martian poles, but the column abundance is about two orders of magnitude lower than terrestrial stratospheric ozone values. Although this ozone will provide some protection from UVC (200-280 nm) radiation, it is transient. The DNA-damage experienced on the surface of the Martian poles is approximately (under clear, dust-free skies at vernal equinox) three orders of magnitude higher than that experienced by terrestrial polar organisms (under an undepleted ozone column at the same orbital position).

UV in Antarctic and Martian Snows: To investigate the potential of Martian snow to act as a protection mechanism for contaminant microorganisms or organics, the penetration of 254 nm radiation (produced from a field-portable mercury vapor source) into natural snows was measured at Mars Oasis, Antarctica (72°S) during the 2001 austral summer.

Sections of icy snow-pack of approximate dimensions 10 x 10 cm were placed between the cosine-corrected collector of a calibrated Ocean Optics S-2000 spectrometer and the radiation source. A control measurment was taken before each snow-pack measurement and the ratio of the value under the snow-pack to the control was calculated as the attenuation coefficient. The thickness of each snow-pack sample was measured.

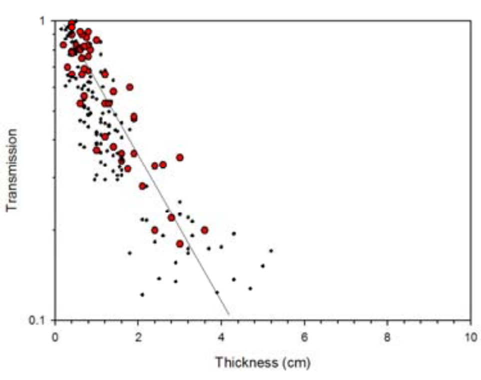

Figure 1. Attenuation of 254 nm radiation (large circles) through snow-pack of different thicknesses. Small dots show attenuation of solar radiation at 310 nm.

The measurements at 254 nm were used as an approximation of the UV-attenuating properties of Martian snows across the whole UVC range. The attenuation of the snow was linearly interpolated between 254 and 310 nm and then linearly extended to 200 nm to make a crude attenuation throughout the Martian UVC range.

For measurements of natural solar radiation between 310 and 400 nm, values were acquired at 1 nm intervals and the collector was held in a clamp directly pointing towards the sun for the control and snow-pack measurement. The penetration of solar radiation from 310 to 400 nm was used for transmission values for the UV ranage common to Earth and Mars [1].

Convolved with a simple Mars radiative transfer model, the data suggests that under ~6 cm of Martian snow, DNA-damage would be reduced by an order of magnitude [2]. Under approximately 30 cm of snow, DNA damage would be no worse than that experienced at the surface of the Earth. Although we do not know the exact characteristics of Martian snows, these first-order data suggest that burial in even modest coverings of Martian snows could allow for the long-term survival (and if water if present, even growth) of contaminant microorgannisms at the Martian polar caps even under the extreme UV fluxes of clear Martian skies. These coverings of snow will also allow for enhanced preservation of organics against UV-degradation.

Intriguingly, at the depth at which DNA damage is reduced to similar levels as those found on the surface of present-day Earth, light levels in the photosynthetically active region (400 to 700 nm) are still two orders of magnitude higher than the minimum required for photosynthesis, showing that within snow-pack on planets lacking an ozone shield, including Mars, UV damage can be mitigated, but light levels are still high enough for organisms that have a requirement for exposure to light for their energy needs. Photosynthetic life is not expected at the Martian poles, but the data reveal the apparently favourable radiation environment for life within the polar caps.

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A Radar System for High-Resolution Mapping of Near-Surface Internal Layers in the Polar Ice sheets

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Accumulation rate is an important variable in determining the mass balance of polar ice sheets. It is currently determined by analyzing ice cores and identifying layers in snow pits, which limits spatial extent over which accumulation rate may be determined. Near-surface internal layers caused by density and conductivity changes can be mapped with a high-resolution radar for estimating accumulation rate. We designed and developed two radars for mapping near-surface internal layers. We developed an airborne radar to operate over the frequency range 600-900 MHz. with a range resolution of about 50 cm to a depth of about 100m. We developed a surface-based system that operates over the frequency range from 500 to 2000 MHz to map layers with 10-cm resolution to a depth of about 100 m. During the 2002 and 2003 field seasons, we collected a large volume of data with the airborne system over the ice sheet in Greenland. We also collected data with the surface-based system at North Greenland Ice Core (NGRIP) drill site in conjunction with detailed in-situ observations from several snow pits and a 15-m firn core. Results from these experiments show that we can map near-surface layers to a depth of atleast 150 m in the dry-snow zone, 120 m in the percolation zone, and 20 m in the melt zone.

In this paper we will discuss the scientific requirements for mapping near-surface internal layers, design considerations and system performance, and present results from airborne and surface-based field experiments. We will also discuss the design of a system for mapping polar-layered deposits in Martian ice caps.

ACCURACY OF MARS' POLAR AXIS DETERMINATION BY EARTH-BASED RSDI.

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Introduction: Radar Speckle Displacement Interferometry (RSDI) is a new Earth-based radar technique to measure instantaneous spin components of inner planets with unprecedented accuracy [1-4]. To avoid mixing with known techniques (VLBI, RORI) note that RSDI is based on the effect of far coherence (speckle displacement) [3-5]. The only right comments on RSDI known to the author until now were given in [6].

RSDI instruments: The hart of RSDI as applied to Radar astronomy needs (Radio astronomy needs are not discussed in this work) is a radar transmitter. At present the only in the world fully steerable and powerful enough radar is the 70m ~450 KW Goldstone transmitting facility in South California, USA. Radar echoes scattered from planetary surfaces can be received by a radio interferometer consisting of two (or more) radio telescopes all over the world, e.g. two-element interferometers are 70m Goldstone – 100m Green Bank, West Virginia (transAmerica ~ 3000 km baseline), 100m Green Bank – 70m Madrid, Spain or 100m Green Bank – 100m Effelsberg, Germany (transAtlantic ~ 6000-7000 km baselines), 100m Goldstone – 70m Kashima, Japan (transPacific ~ 7000 km baseline) and so on.

Limiting accuracy: The limiting RSDI accuracy in instantaneous polar axis orientation of Mars can be written as [7]

$$\sigma = l / qb \sim 1 \text{ arcsec} \qquad (1)$$

where b ~ 3000 km is the baselength (Goldstone – Green Bank), l ~ 3 km is the correlation radius of scattered radar field (size of a speckle), $q = Q^{0.5}$, Q – power signal-to-additive noise ratio (snr) at the correlator output. Eq. (1) presents one-look (measuring time about 1 min) accuracy in instantaneous obliquity or precession angle that can not be overcome by Earth-based monochromatic radar.

Experiments: First RSDI experiment was proposed about Venus in 1992 [7]. Another RSDI experiment on Mercury was analysed in very details in 1999 [8]. Only in May-June 2002 after extensive discussions with S. J. Peale (nobody in Russia except the author believed in success) the first reliable RSDI experiment was carried out on Mercury with the Goldstone – Green Bank radar interferometer by Margot et al. [9]. The May-June 2002 experiments clearly confirmed the theoretical analysis [5]. Now we all know that the technique really works. Also we may hope that a few arcsec final accuracy can be achieved. Most probably RSDI experiments on Mars are upcoming as well. Accuracy on Mars during a single conjunction with Earth can be better than 1 arcsec. Also any variations in Mars'polar axis orientation (nutations) can be measured by the technique. If a new more powerful and more dedicated radar transmitter can be designed and constructed in near future to cover advanced radar astronomy needs in XXI century then after regular observations RSDI accuracy on Mars can be of an order of tens mas (milliarcseconds). We hope future RSDI experiments may help substantially to accelerate extensive theoretical work on creating adequate detailed models of spin dynamics of Mars, Mercury, Venus including all related problems (interiors, dynamics of atmospheres and other).

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PLANETARY PROTECTION FOR POLAR MARS MISSIONS. J. D. Rummel, Office of Space Science, Code S, NASA Headquarters, Washington, DC 20546 USA, <jrummel@hq.nasa.gov>.

Introduction: The picture of Mars that is emerging from the Mars Global Surveyor and Odyssey results (1,2) contrasts markedly from that portrayed shortly after the Viking missions ended (cf., 3). Particularly intriguing is the abundance of water ice seen both in the polar caps themselves, and in lower latitudes outside of the polar regions. Along with the new data comes a heightened consideration of the potential for biological contamination that may be carried by future missions, and its possible effects. Particularly challenging are scenarios where missions carrying perennial heat sources of high capacity and longevity (e.g., Radioisotope Thermoelectric Generators) could, by non-nominal landings or other mission operations be introduced to close contact with water ice on Mars—-potentially forming Earthlike environments that could accommodate the growth of contaminant organisms.

Standards and Consequences: The likelihood of impinging on those environments and situations, and the potential mitigations available to mission planners, are of critical importance to the future success of Mars polar science and exploration. Recently, the ICSU Committee on Space Research (COSPAR) has published an international consensus planetary protection policy (4) that provides a standard to address the prevention of biological contamination in sensitive areas on Mars. As Mars exploration proceeds, new data will drive future planetary protection concerns, and a framework for assessing required contamination control measures will need to be developed to be responsive to the evolving understanding of the planet.

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