METHANE AND ICE WATER RETENTION IN LARGE KBOS .

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Introduction: Recent observations have revealed that many large (>~1000 km in diameter) KBOs exhibit features of crystalline water ice in their surface spectra [1]. Some may even exhibit amorphous ice features [2]. In addition, some of these objects show distinct spectral features of volatile ices, such as Methane and Ethane [3,4]. The presence of such features of volatile ices could be explained as a consequence of atmospheric escape of these compounds [5]. The crystalline ice features on the surface suggest a thermal processing history, which would increase the rate of volatile lose. An interesting question is how to get mixed reservoirs of water and volatile ices close to the surface, so it can be either observed directly, or be subjected to a thermal escape mechanism.

Modeling Issues: We model the KBOs in question as icy, cometary-like, bodies. These are considered to be porous aggregates of ices and dust [6]. Modeling the internal evolution of such bodies takes into account various heat sources, such as insolation, crystallization, and radioactive decay (of either shirt-lived radionuclides or long-lived ones). In terms of composition, these models deal with a composition of refractory solids and a mixture of volatiles, either in solid or gaseous state. Here we restrict our simulations to using only CH_4 (and in some cases, also CO_2), as representatives of the volatile species, other than water. The equations that govern the structure and evolution are those of mass and energy conservation, coupled with a hydrostatic scheme, for a 1-D spherical body [7].

We combine in our models the thermal processing of ices, due to radioactive heating, insolation (may be negligible for surface compositions in the outer Solar System and Trans-Neptunian region) and crystallization of amorphous to crystalline ice (as a triggered source of internal energy).

Preliminary Results: We show that under certain thermochemical conditions, layers of crystalline water ice, amorphous water ice and Methane ice can co-exist, for relatively long time scales (~100 Kyr). These layers, which are a part of an overall semi-stratified internal structure, may also exist 'close enough' to the surface. By 'close enough' we mean that at a depth of 1-5 % of the object's radius, a mixed composition can survive. This depth is slightly higher than the roughness scale found for Ceres, another dwarf-planet [8]. However, we should note that KBOs probably contain more ices than MBAs, implying lower densities and corresponding higher porosities, at layers near the surface. This means that deep depression features may easily arise on surfaces of KBOs (either as primordial topography or as impact cratering), exposing water and volatile ice spectral signatures. The fraction ratios deduced from irradiative surface models, may indicate the mass fraction of ices exposed and the physical characteristics of the depression feature.

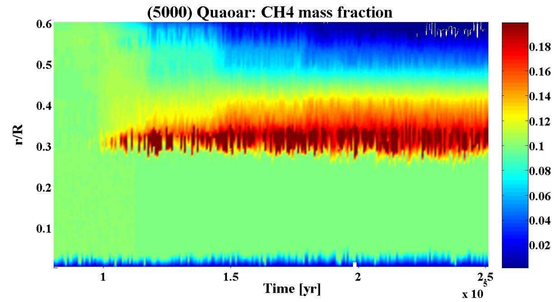

Figure 1: We show the last 150 Kyr of the simulation and a depth of ~370 km below the surface (indicated by r/R = 0). Note that at depth of 1-3% of the radius (R = 630) the fraction of ice is nearly 10% (very close to the initial fraction taken). Note also that at r/R = 0.35 there is build-up of CH_4 ice, connected with a depletion of amorphous ice.

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(More results of this research will be presented in future papers and in the following website: ***http://geophysics.tau.ac.il/personal/gal_sarid/****)*