KOSI-6, ASTEROIDS AND COMETS.

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Introduction: Important problems amenable to study by laboratory simulations are the low density of some asteroids, the interpretation of spectral reflectivity and mid- to far-IR emissivity of asteroids, the relationship between comets and asteroids, and the origin and history of meteorites. Comet nuclei should have spectra resembling those of D, P and C asteroids [1]. Furthermore, the class distributiuon of near-Earth asteroids is very similar to that of the main belt and this, like dynamic arguments [2], suggests that half of the NEA could be extinct comet nuclei. Since comets formed in the outer planet regions they should evolve into asteroids with higher amounts of volatiles. A crucial laboratory simulation is the KOSI-6 experiment in which the comet analogue was composed of an unusually large amount of silicate[3,4].

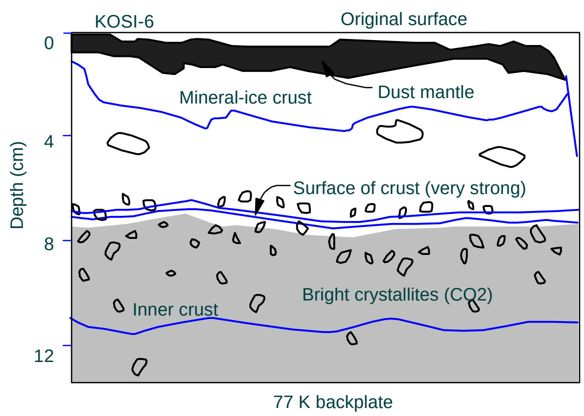

Fig. 1. Schematic representation of the structure of a vertical section through the KOSI-6 sample after insolation [3]. The sample is tilted 45°, with the right side higher, so there is a slight slumping of material.

KOSI-6: The sixth KOSI (Kometen-Simulation) analogue sample was 43 wt% dust (71 wt% olivine, 17 wt% montmorillinite, 12 wt% carbon), 17 wt% CO_2-ice 70 wt% H_2O ice produced by pouring an aqueous suspension of minerals and dry ice into liquid nitrogen. The initial porosity was 29 %, albedo was 0.12 and density was 0.59 g cm^{-3}. The insolation consisted of a 30.3 h exposure to 1.2 solar constants from 10 6.5 kW Xe lamps. The other 10 KOSI experiments had silicate-to-ice weight ratios of about 1:9 with porosities 40-60%. KOSI-6 was the least "active" of the KOSI experiments, with low CO_2, H_2O and dust production rates and little change in the surface level. Despite this, a relatively thick (2-cm) dry dust mantle was produced and a hard subsurface crust of recrystallized ice was formed at a depth of about 8 cm. In the soft mineral/ice layer between the subsurface crust and dust mantle were lumps of hardened material. Material strength measurements reflected these stratigraphic layers.

Discussion:

The low density of asteroids. The known densities of asteroids are typically 2-3 g cm^{-3} consistent with macroporosities of ~20% assuming meteorite grain densities and porosities and empty void space [5]. However, an equally likely proposal is that asteroids are typically like the KOSI-6 sample (poorly crystallized ice and silicate sublimation residues that approximate condensates) but with ~30 volume % of the asteroid, presumably in the outer crust or the regolith, resembling chondritic material.

Interpretation of spectral reflectivity data for asteroids. The difference in class distribution of asteroids and their meteorite look-alikes has led to the suggestion that a number of exogenic processes have altered their surface compositions [6]. To this list should be added endogenous processes of the sort discussed in connection with comets [7] and extended further to include mineralogical processes discussed in connection with chondrite genesis [8].

Implications for the origin and history of meteorites. Asteroids and comets are both potential meteorite parent bodies, but the subtle compositional and textural properties displayed by the meteorites are usually attributed to nebular processes. The dynamic potential of parent body surface processes are likely to be more dominant than nebular processes in determining meteorite properties.

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