DIFFUSION OF VOLATILES IN COMETARY ANALOGS, P. Hsiung and K. Roessler,
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The goal of KOSI experiments in the Space Simulator of DLR Köln is to simulate the dynamics of cometary nuclei stimulated by solar irradiation. The analogs are prepared by spraying aqueous suspensions of fine mineral grains into liquid nitrogen (1-3). The addition of CO_2 and CH_3OH ice enabled the study of sublimation and diffusion processes with respect to real comets. The experiments KOSI-4 (May 1989, 38 h insolation at 0.65 SC) and KOSI-5 (November 1989, 12 h at 1.16 SC) were performed in a cylindrical vessel with 30 cm diameter and 13 cm depth filled with ca. 5 kg of material consisting of 70-78 weight % H_2O ice, 14-17% CO_2 ice, 7-8% minerals (7 μm grains of olivine and montmorillonite, 9:1), 0.08% carbon black, and 5% CH_3OH ice (only in KOSI-5). The samples were modified by addition of D_2O and $^{13}CO_2$ tracers to certain layers.

The concentration profiles of the volatiles after insolation were determined in cm layers during careful removal of the material with the help of gaschromatography (4,5). The data here refer to the 3rd quadrant of the KOSI sample, i.e. the left, lower part when tilted with respect to the sun.

Both samples showed an increase of mineral content decrease in H_2O and CH_3OH in the upper layers where a crust formed, cf. Figs. 1 and 4. CO_2 was totally depleted from the upper layers (such as reported earlier for KOSI-3 in ref. 4). In deeper layers an increase of CO_2 is encountered, till near the back plate the original value of CO_2 concentration is reached (Figs. 2 and 4). Figs. 3 and 6 show the percentage of total CO_2 which is lost from the upper layers to surface and interior. Fig. 4 shows for the distribution of CH_3OH a similar pattern as that for CO_2. However, CH_3OH does not disappear totally from upper layers. Also, the increase due to recondensation is only small. The steps in the CO_2 and CH_3OH profiles are congruent with discontinuities in the temperature profile. The enrichment zones contain crystallites up to 1 mm in diameter formed by recondensation on individual cold spots after inward diffusion.

Four important conclusions can be drawn from these experiments:
a) The diffusion processes of H_2O and CO_2, and to a certain extent also that of CH_3OH, seem to proceed rather independently from each other. b) The addition of CH_3OH seems to favour the heat transport through the sample, ev. via the liquid state. c) Diffusion of volatiles proceeds also into the cold interior of the KOSI sample. Different substances are enriched in layers, the depth of which depends on volatility and temperature in a kind of "thermochromatography": the more volatile, the deaper. In a real comet these reservoirs of frozen gases may give rise to sudden evaporation processes and thus to gas and dust jets. d) Dynamic enrichment and depletion of components make it difficult to extrapolate from coma gas to the quantitative composition of the nucleus.

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1) Grün, E., Kochan, H., Roessler, K., and Stöffler, D., ESA-SP-278 (1987) 501-508. 2) Kochan, H. et al., Proc. 19th Lunar Planet. Sci. Conf., LPI Houston 1989, 487-492. 3) Grün, E. et al., Proc. Comets in the Post Halley Era (1990), in press; Report MPI-H-1989-V31. 4) Roessler, K. et al., Proc. 20th Lunar Planet. Sci. Conf., LPI Houston 1990, in press 5) Hsiung, P. and Roessler, K., ESA-SP-302 (1990), in press

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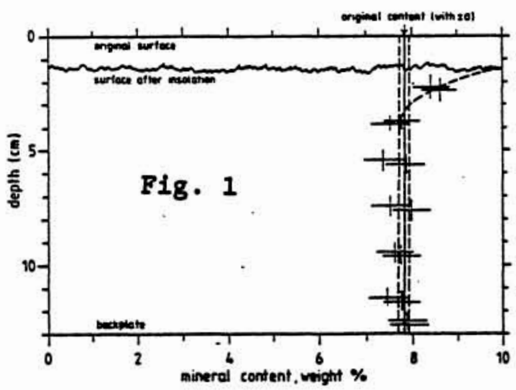

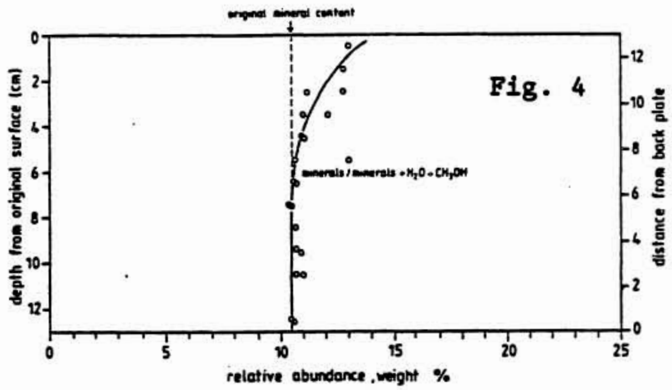

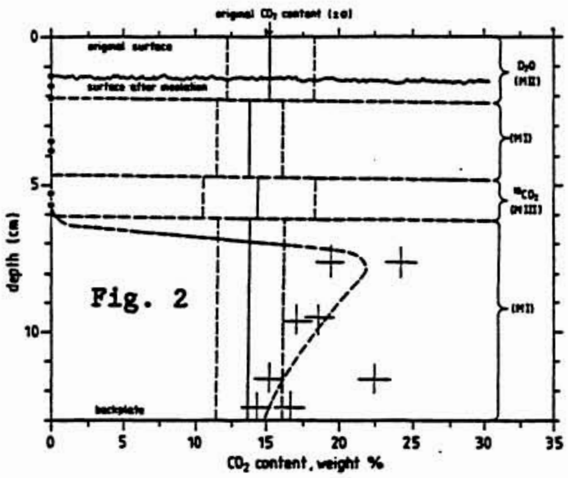

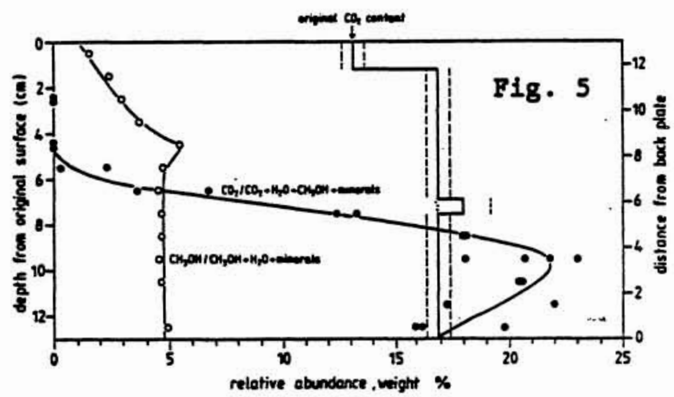

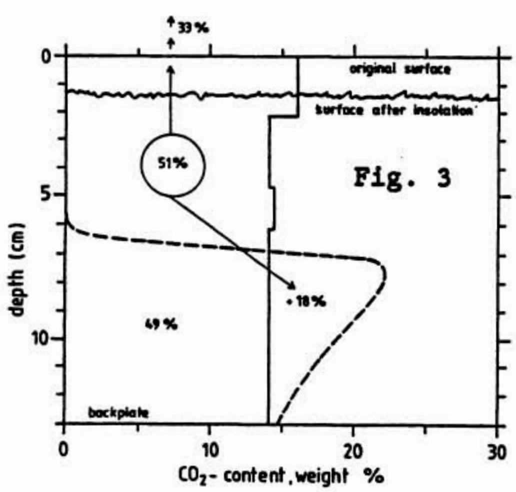

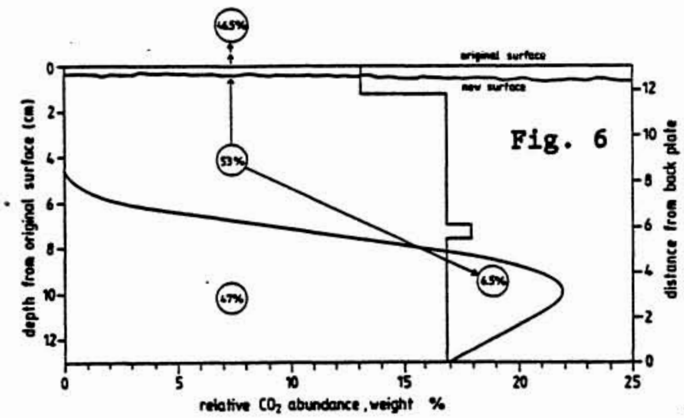

Fig. 1-3: KOSI-4 sample composition after 38 h insolation at 0.65 SC. Mineral content (1), CO_2 content (2), balance of CO_2 migration (3)

Fig. 4-6: KOSI-5 sample composition after 12 h insolation at 1.16 SC. Mineral content (4), CO_2 content (5), balance of CO_2 migration (6)