N89-15014

VOLATILIZATION-DEVOLATILIZATION REACTIONS

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Experiments that explore chemical and physical aspects of volatilization reactions that require the microgravity and low pressure in or near the projected Space Station are proposed.

Chemical Aspects:

We envisage a program of experiments utilizing near zero pressure conditions available with molecular shield technology (see Duba, Electrical Conductivity. . .,this report) attached to the Space Station to study:

a) reaction rates of mineral devolatilization. Two mineral groups, the amphiboles and micas (and all the sheet silicates in general) are primary carriers of H_2O and F in rock-forming processes. The important reaction type: hydrous solid = anhydrous solids + vapor, studied over a range of temperatures from 1300°C to as close to space-ambient temperature as reaction rates can be measured will provide fundamental limiting data on the energetics of the crystalline state. The amphiboles and micas can be synthesized in their pure OH- and F-forms so that comparative data of great value could be derived from experimental studies in the Space Station. The time frame for the experiments will be a few days to 60 days. Gravity control is not essential, but pressures less than 10^{-10} Pa are required.

b) the equilibrium vapor pressure of volatile-bearing mineral species. Completing equilibrium studies at very low pressures would allow fixation of the reaction boundaries - expressed, for example, in conventional f_{H2O}-1/T diagrams - in parts of the diagrams not accessible on Earth. These experiments would utilize pressures from station-ambient preferably to $< 10^{-10}$ Pa.

Physical Aspects:

We suggest a program focused on the precipitation, growth, and recrystallization of various cosmically important minerals, particularly ices of H_2O and CO_2, and mixtures of these, to study:

a) textural patterns and their evolution with sequential modification of boundary conditions. Meteorites, and especially asteroidal material subsequently to be obtained, can provide information on their formation histories as well as that of the solar system through detailed textural studies. These studies will have to be calibrated against synthetically produced textures from the Station experiments.

These experiments would need both controlled gravity ($\sim 10^{-5}$g) and access to pressure ranges from station-ambient (~1 bar) to space ambient (molecular shield to obtain $<10^{-10}$ Pa) over time-scales of 1 day to 60 days. Slowly rotating furnaces would probably prevent crystal settling conditions for such long periods.

b) scattering, absorption, and reflectivity of radar and other wavelength radiation. Ices and particulate silicates are important constituents of dispersed planetary matter. The proposed measurements are to provide baseline data for all our remote sensing studies of these materials, particularly fragile aggregates of such material which could not be synthesized or maintained under 1 g. Initial experimental requirements are the same as under the sections above. Subsequent to synthesis radiation sources and detectors on or near for comparable analysis the station will be required in some cases before returning samples to earth.

Technical Requirement Summaries:

Volume:	2 m^3 for the first three experiments
Mass:	Estimated 10-30 kg for assembly
Temperature:	Space-ambient to 1300^{o}C
Pressure:	Space-ambient (<10^{-10} Pa) to station ambient
g-level:	10^{-4} to 10^{-5} g for certain experiments. Rotation of the sample may be required to offset effects of density aggregation on longer (month +) experiments.
Duration:	Experiments will last from about 1 day (possibly even hours at T > 1000^{o}C) to 60 days.
Instrumentation:	Power controllers, continuous temperature and pressure measurements down to the

space-ambient, gas analysis (mass spectrometry), gas pressure controllers and flow rate regulators.

Crew Interaction: Conditions during experiments can be controlled automatically, but sample changing and periodic human monitoring required. Some physical measurements will have to be performed by crew.