PHOSPHATE-MOBILIZATION ON MARS? IMPLICATION FROM LEACH EXPERIMENTS ON SNC'S; G Dreibus, E. Jagoutz, B. Spettel and H Wänke, Max-Planck-Institut für Chemie, Saarstrasse 23, D-55122 Mainz, Germany.

Leach experiments on Shergotty, Zagami, and ALHA77005 showed that their phosphates dissolve readily with diluted acids at room temperature. Even an only slightly acidified brine-solution (MgSO₄, pH=3) dissolved more than 50 % of the REEs and U whereas K remained insoluble. These experiments indicate the possibility of alteration and mobilization of phosphates in the Martian environment with the consequence of an enrichment of U relative to K in the soil compared to igneous rocks.

A major difference between terrestrial and Martian rocks as inferred from the SNC meteorite composition is the high phosphorus content of the SNC's [1]. The high abundance of phosphorus in the SNC-meteorites is in all likelihood the consequence of high P abundance in the Martian mantle as compared to the terrestrial mantle [2].

The estimated Martian mantle P-abundance of 0.35 as derived from observed element correlation exceeds the Earth's data by a factor of 10. In the terrestrial basalts P correlates well with the incompatible light REE's element Nd and no correlation exists between P and the heavy REE's element Yb. The opposite was found in the case of SNC-meteorites. In SNCs phosphorus correlates with Yb and not with Nd (Fig. 1, Ref. [3]). Phosphates, especially whitlockite, are the major host phase of the REEs and U, halogens reside in apatite.

Leach experiments on whole rock samples of Shergotty, Zagami, and ALHA77005 showed that their phosphates dissolve readily by diluted acids. The analytical method for the leach experiments was the INAA. After irradiation the finely pulverised samples were treated with selected leaching-solution in an ultrasonic-bath for 10 minutes at room temperature. The leaching solutions were: In HCl, In HNO₃ and a slightly acidified saturated MgSO₄-solution as brine analogues. The Martian soil composition as derived from the Viking-Mission with its extremely high S- and Cl-concentrations was interpreted as weathering products of mafic igneous rocks, hence evolution of brines could be possible in the Martian environment [1].

The REEs pattern of the whole rock, the leach and the residue for Shergotty and Zagami are shown in Figs. 2 and 3. The major fraction of the REEs were leached from the whole rock within 10 minutes with In acids and even with a slightly acidified saturated MgSO₄-solution (pH = 4) about 20 % of the REEs are leachable at the first step. The strong positive Eu-anomaly in the residue indicates that maskelynite is not dissolved. In all leach-experiments with acid or brine-solution the phosphates are dissolved whereas plagioclase was not attacked. Except the negative Eu-anomaly the REE's pattern of the phosphate-leach match the pattern of the whole rock in all leach experiments of shergottites indicating phosphates as the dominant REE's source of shergottites. As the bulk REE's pattern of the SNC-meteorites have no Eu-anomaly it is obvious that they were not subjected to removal or addition of phosphates. This is also clearly indicated by the constant K/La ratio in all SNC's as illustrated in Fig. 4.
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In our leach experiments the REEs and U are considerably more leachable than K which does not reside in phosphates. The high mobility of U compared to K, could be an explanation for the discrepancy of the K/U-ratios of about 6,500 at the Martian surface as measured by Mars-5 and Phobos-2 missions [4] and of about 16,000 in Martian basalts. Most of the Martian surface is covered by a soil with a complex weathering history. Outcrops of igneous rocks as represented by the SNC-meteorites seem to be not very abundant. The gamma-spectroscopy from orbit mainly measured the brine-rich soil which could be enriched in U relative to K as compared to igneous rocks by evaporates.

In comparison to the Earth, planet Mars is water-poor but has a 2-3 fold amount of halogens and S. Therefore we should expect at least at the time close to the final disappearance of liquid water the evolution of a fluid phase saturated with sodium- and magnesium-chlorides, sulfates and carbonates. Under these conditions a high mobility of REEs and U on Mars could be expected as the leach experiments have shown. Leaching experiments at elevated temperatures are in progress. The possible bearing of the phosphate mobility to the isotope systems will be discussed at the meeting when we will have data on leach experiments at elevated temperatures.