

MINERAL COMPOSITION OF MARTIAN REGOLITH: THERMODYNAMIC ASSESSMENT. M.Yu.Zolotov 1), Yu.I.Sidorov 1), V.P.Volkov 1), M.V.Borisov 2), I.L.Khodakovsky 1). 1) Vernadsky Institute of Geochemistry and Analytical Chemistry, USSR Academy of Sciences, Moscow, 2) Moscow State University, USSR.

The mineral composition of Martian regolith is not established even in outline despite the Viking in situ measurements. The numerical modelling of mineral assemblages is an especially important clue in solving this problem. Baird et al. [1] calculated the smectite regolithic model using the statistics. The thermodynamic approach was applied for the estimates of the stability of rocks and weathering products under recent Martian conditions [2].

The thermodynamic assessment of regolithic minerals equilibrated with recent and hypothetical ancient atmosphere is carried out. The calculations were made using the free Gibbs energy minimization of multisystems at 240K and different water vapor pressures. The multisystem was considered open with respect to volatile compounds of C, O, H, N, Cl, S, F. And the contents of the compounds were taken from the earth-based and Viking measurements (for SO<sub>2</sub>, HCl, HF - upper limits). The possible mineral composition of Martian regolith was calculated in the multisystem regolith-atmosphere open with respect to CO<sub>2</sub>, O<sub>2</sub>, H<sub>2</sub>O, the starting value for regolith being taken from [3]. Besides, two models were calculated with basaltic and komatiitic primary compositions (TABLE 1.).

The calculations carried out in the system open with respect to SO<sub>2</sub>, HCl, HF lead to the following conclusion: about 10-20% of S, Cl, F could be bound in minerals which is a higher order of magnitude than in real regolith.

The calculations of selected weathering of olivine and augite in equilibrium with atmosphere indicate the possible existence of Na-montmorillonite, talc, hematite, rutile, carbonates. Basic plagioclases could be transformed into albite and dawsonite. The oxidation of magnetite and pyrite leads to the formation of hematite.

A number of minerals, e.g. gypsum, goethite, mirabilite, etc. are stable only under the water vapor pressure of about three orders of magnitude higher than the recent value. These minerals could be preserved as the relics of mineral-forming processes in the ancient humid Martian climate. Comparing the modelling mineral assemblages with initial data on regolith we may assume that there is no chemical equilibrium between Martian atmosphere and surface rocks with respect to SO<sub>2</sub>, HCl, HF and probably CO<sub>2</sub>. The coincidence of the calculational results of the equilibrium composition of water in soil with the results of direct measurements of water contents may prove to the existence of such equilibrium. Therefore, further hydration is unlikely to take place [4].

The calculated equilibrium composition of Martian regolith most probably does not conform to the real soil which may have metastable phases.

## MINERAL COMPOSITION OF REGOLITH

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TABLE 1. CALCULATED MINERAL ASSEMBLAGES EQUILIBRIUM WITH MARTIAN ATMOSPHERE (O<sub>2</sub>, CO<sub>2</sub>, H<sub>2</sub>O). I - Martian regolith, 2,3 - weathering products of basalt and komatiite. Contents of minerals - in volume%, chemical elements and water - in weight%.

Mineral	I	2	3
Quartz	20,8	8,7	-
Microcline	-	7,8	0,8
Acmite	-	9,3	0,8
Na-montmorillonite	23,9	45,9	11,1
Talc	27,9	0,3	51,9
Hematite	10,5	3,4	4,9
Rutile	0,6	0,8	0,1
Pyrolusite	0,2	0,2	0,1
Anhydrite	13,4	-	-
Kieserite	0,2	-	-
Dolomite	-	22,7	13,8
Magnesite	-	-	15,3
Halyte	0,3	-	-
Sylvine	0,5	-	-
Bischofite	1,1	-	-
Apatite	0,4	0,8	1,1
C	-	3,1	4,0
Cl	0,5	0,005	0,005
S	3,25	0,04	0,02
H <sub>2</sub> O	2,52	1,62	1,60

REFERENCES [1] Baird A.K. et al. (1976), Science 194, 1288-1293; [2] Gooding J.L., (1978), Icarus 33, 483-511; [3] Clark B.C. et al. (1976), Science 194, 1283-1288; [4] Anderson D.M., Tice A.R. (1979), J.Mol.Evol. 14, 33-38.