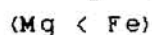
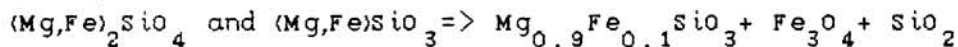
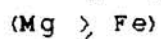
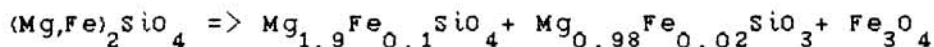


# CHEMICAL WEATHERING OF OLIVINES AND FERROMAGNESIAN PYROXENES ON THE SURFACE OF VENUS. M. Yu. Zolotov, Vernadsky Institute USSR Academy of Science, Moscow, USSR.

olivine  $(\text{Mg,Fe})_2\text{SiO}_4$  and ferromagnesian pyroxene  $(\text{Mg,Fe})\text{SiO}_3$  are known as the rockforming minerals of basalts which are expected to be widespread on the surface of Venus. The previous stability estimations of these minerals in relation to the atmospheric gases ( $\text{CO}_2, \text{CO}$  - [1];  $\text{H}_2\text{O}, \text{H}_2$  - [2]) predicted a chemical weathering of Fe-rich phases. This report presents the stability estimation of these minerals at the expected redox range on the surface [3] made by the free energy minimization method. The equilibrium mineral compositions were calculated in the system  $\text{Mg-Fe-Si-O-C-S}$  which was opened in respect to  $\text{CO}_2$ ,  $\text{SO}_2$ , and  $\text{O}_2$ . Mixing ratios for  $\text{CO}_2$  (0.965) and  $\text{SO}_2$  ( $1.5\text{E-}4$ ) were used according to instrumental data [4]. Redox conditions were used within the interval:  $-22 < \log P(\text{O}_2) < -18$ . The input data contain also free energies of formation and chemical composition for the initial minerals and possible weathering products. Thermodynamic properties of olivine and Fe-Mg-pyroxene solid solutions were estimated from [5,6].

The calculations of equilibrium mineral assemblages as a possible weathering products show the instability of Fe-rich olivines and pyroxenes on the present surface (Fig. 1, Table 1). The weathering of these minerals could result in formation of forsterite, enstatite, pyrite, magnetite, hematite and quartz. The equilibrium mineral assemblages of weathering products are found to be strongly depended on redox conditions, elevation and composition of primary minerals. For instance, at 735 K and  $\log P(\text{O}_2) = -21$  the following weathering reactions are expected:



High-magnesian olivines (Fo>95) and pyroxenes (En>90) are found to be stable at such conditions. If the  $\log P(\text{O}_2) > -20.5$  (at 735 K) the oxidation of these silicates could be resulted in hematite formation. Pyrite could be formed if  $\log P(\text{O}_2) < -21.46$  at 735 K.

Water vapor and carbon dioxide should be considered as the main oxidizers of ferromagnesian silicates. While pyrite could be formed as a result of interaction of some Fe-bearing mineral with  $\text{H}_2\text{S}$  and  $\text{S}_2$  rather than  $\text{COS}$  [7].

The similar calculations for the highlands (705 and 690K) show that if the redox conditions are governed by really existing gases rather than  $\text{O}_2$  penetrated from 35-40km (see [3]) the weathering of Fe-Mg-minerals should result in pyrite formation as well as magnesite, enstatite and quartz (see Table 1 and [7]).

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## Chemical weathering

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Table 1. Possible products of chemical weathering of some Fe-,Mg-bearing minerals at the surface of Venus

Initial mineral	Weathering products	
	Lowlands	Highlands
Fayalite $\text{Fe}_2\text{SiO}_4$ (Fa)	Py/Mt/Hem + Q	Py + Q
Olivine (Fa-Fo<50)	Py/Mt/Hem + En>86 + Q	Py + En + Q
Olivine (Fo>50)	Py/Mt/Hem + En>94 + Fo>94	Py + En + Mag
Forsterite $\text{Mg}_2\text{SiO}_4$ (Fo)	no	En+Mag
Ferrosilite $\text{FeSiO}_3$ (Fs)	Py/Mt/Hem + Q	Py + Q
Pyroxene (Fs-En)	Py/Mt/Hem + En>86 + Q	Py + En + Q
Enstatite $\text{MgSiO}_3$ (En)	no	no
Magnetite $\text{Fe}_3\text{O}_4$ (Mt)	Py/no/Hem	Py
Hematite $\text{Fe}_2\text{O}_3$ (Hem)	Py/Mt/no	Py
Pyrite $\text{FeS}_2$ (Py)	no/Mt/Hem	no
Pyrrhotite $\text{Fe}_{0.877}\text{S}$	Py/Mt/Hem	Py
Magnesium sulfate $\text{MgSO}_4$	no /Fo	Mag
Magnetite $\text{MgCO}_3$ (Mag)	no /Fo	no
Basaltic assemblage of Fe-,Mg-minerals	Py/Mt/Hem + En>86 + Fo>94 + Q	Py + En + Mag + Q

Fig.1. Phase relations of olivine and Fe-,Mg-pyroxene solid solutions and their weathering products as a function of oxygen partial pressure and and composition of initial minerals for the conditions of Venus' surface at the temperatures 735 and 735 K. The pointers on the right of the plots show  $\log P(\text{O}_2)$  value estimated from  $\text{CO}_2\text{-CO}$  equilibrium (4).

\* if a primary mineral is isolated from enstatite; / - and/or; no - without any weathering products; Q - quartz.

