
Equilibrium thermodynamic calculations show that the interaction between atmospheric gases and Venus' surface rocks could result in anhydrite formation and oxidation of Fe*-bearing minerals with subsequent production of magnetite (1,2). In this report we consider the possibility of incorporation of atmospheric CO₂ and chlorine in scapolites. The majority of natural scapolites belong to two solid solution series: marialite (Na₄Al₃Si₇O₂₄Cl or Na or Me₀) - mizzonite (NaCa₃Al₅Si₇O₂₄CO₃ or Mz or Me₇/₈) and mizzonite - meionite (Ca₄Al₆Si₆O₂₄CO₃ or Me or Me₁₀₀). Terrestrial assemblages of these minerals were listed by Shaw (3) and belong to regionally metamorphosed rocks (marbles, calcareous gneisses, granulites and greenschists), skarns, metamorphosed salt deposits, etc. Perhaps, scapolites could be suggested as volatile bearing rockforming minerals in the Earth's and Venus' crusts (4).

We need reliable experimental measurements of thermodynamic properties to estimate the stability of scapolites on Venus surface. The measurements of heat capacity of 6 natural scapolite samples over the temperature range from 8 to 1000K and enthalpies of the dissolution in the melt 2PbO·B₂O₃ at 973K were carried out (5). Standard entropies, enthalpies and free energies of formation of end-members and some intermediate (Me II, Me, Me, Me₆1₈, Me₆1₀₀, Me₁₀₀) members of Ma-Mz-Me series were calculated basing on these experimental data. The following atmospheric composition is used to estimate the stability of scapolites on Venus surface: CO₂, 96.4%; SO₂, 130 ppm; H₂O, 20 ppm; H₂O, 160 ppm; S₂, 13 ppm; HCl, 0.4 ppm; H₂, 0.6 ppm.

We considered the reactions of interaction between scapolites and SO₂, as the most chemically active atmospheric gas. The reaction may proceed differently for Na-Mz and Mz-Me solid solution series:

Me₁-74 + SO₂ + H₂O = NaAl₂Si₆O₁₆; CaSO₄; Na₂SiO₃; Al₂SiO₅; CO₂; HCl; S₂
Me₁₀₀ + SO₂ = CaSO₄; Na₂SiO₃; Al₂SiO₅; CO₂; S₂

Using the thermodynamic data for scapolites and for other necessary substances equilibrium partial pressures of CO₂ (Fig.1) and SO₂ (Fig.2) of these reactions are calculated taking into account the atmospheric composition. It follows from Fig.1,2 that the conditions on Venus surface correspond to the region of stability of anhydrite, albite, andalysite and quartz. CO₂ pressure is not high enough for the formation of scapolites, while partial pressure of SO₂ is sufficient for decomposition of scapolites on Venus surface. If SO₂ content were lower by an order of magnitude we could expect the presence of mizzonite in soil, as the most stable of all scapolites. The field of stability of scapolites broadens with the increase of temperature (Fig.2,3), but even in the deepest chasmata the temperature doesn't reach the value corresponding to mizzonite formation.

It's worth noting that the increase of CO₂, HCl and S₂ content and decrease of SO₂ and H₂O concentration lead to broadening of
scapolite stability region. The variations of $S_2$ and $H_2O$ content, stated above don't significantly effect on the estimated scapolite stability (Fig.3).

Thus, our data demonstrate that scapolites of marialite-melilitite series aren't stable on present Venus surface. The incorporation of $CO_2$ may probably proceed only with production of carbonates ($MgCO_3$ on highlands and $MnCO_3$). Incorporation of chlorine may occur in terms of the formation of chlorides. If fresh scapolite-bearing rocks are found on the surface, the scapolites are probably decomposed with the formation of anhydrite as a final product.

Unfortunately storage of the reliable reliable thermodynamic information on the sulfate scapolites doesn't allow us to evaluate the possibility of incorporation of sulfur in scapolites.


Figure 1. Equilibrium $CO_2$ partial pressures ($SO_2$ for Figure 2) in the reactions of decompositions of scapolites under the Venus' surface conditions. $T$ 735 K, $P_{tot}$ 90 bar.

Figure 3. Equilibrium condition in the reaction of mazzonite decomposition.