LAMELLAR SPINEL-PYROXENE SYMPLECTITES IN LUNAR OLIVINE: EVIDENCE FOR H₂O TRACES IN LUNAR MAGMAS?

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Introduction: Individual olivine grains from the Luna-24 regolith contain Cr- and Ca-rich lamellae of 0.5-1 μm thick oriented parallel to the (100) of the host olivine. These lamellae were investigated with EMPA, SEM and TEM.

Results. The lamellae consist of diopside - chromite intergrowths. Alternating platelets of diopside and chromite ∼40 nm and ∼130 nm thick, respectively, are oriented normal to the (100) olivine/lamellae boundary, with (100)Sp//[111]Ol; (100)Cpx//[001]Ol; // [011]Sp; // [010]Cpx. The bulk mineral composition of the lamellae is close to FeCr₂O₄ + 2CaMgSi₂O₆.

Discussion. Lamellar symplectites are rare to occur. They were described in olivine from some terrestrial rocks [1, 2] and a Martian meteorite [3]. No detailed investigation of Cr,Ca-rich lamellar symplectites in lunar olivines has ever been done. The study shows that (i) the symplectitic lamellae in olivine have been formed by a solid-state reaction; (ii) subsolidus C₂⁺ → C³⁺ oxidation and 2Mg = Cr + Ca cation exchange reaction were related to the symplectite formation; (iii) chromite and diopside are probably the breakdown products of some pre-existing phase of Ca₂Mg₆Fe²⁺Si₄O₁₆ composition inferred from the bulk chemistry of the symplectites. A model of a deprotonation-oxidation process associated with a \{ Fe, 2H\} → \{ Fe, 2Cr³⁺\} point defect transformation is suggested to explain the origin of the pre-existing phase of the symplectites. The model seems to be a convincing explanation for the occurrence of lamellar spinel + pyroxene symplectites in terrestrial olivines, because the latter contain commonly n10⁻³ – n10² ppm of H₂O. Both \{ Fe, 2H\} point defects and (100)-oriented lamellar precipitates of hydrous olivine [MgFeH₂SiO₄]ₙ\{(Mg,Fe)₂SiO₄\} were found in terrestrial mantle olivine [4]. A similar mechanism has been suggested to explain the origin of oxide precipitates in olivine from a terrestrial garnet peridotite [5]. How can this model be applied to lunar rocks, because the rocks are believed to be almost free of water? Recently, some arguments suggesting an H₂O presence in the lunar mantle has come from a SIMS study of lunar volcanic glasses [6, 7].

Conclusion. The formation of the chromite-diopside symplectites in lunar olivines could be due to deprotonation-oxidation processes. If this model is correct, then the occurrence of the symplectites should be considered as additional evidence for an H₂O presence in some lunar rocks.