

ON A MODE OF Fe^{3+} , OH^- OCCURRENCE IN OLIVINE (MÖSSBAUER, IR, EELS
COMBINED WITH TEM)

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Traces of Fe^{3+} or OH^- detected by spectroscopic methods in olivine samples can either be incorporated in the olivine lattice (intrinsic mode) or form their own phases included in the olivine host (extrinsic mode). We used the combination of TEM, Mössbauer spectroscopy, IR, EELS and *ab initio* methods to elucidate the intrinsic and extrinsic mode of Fe^{3+} and OH^- occurrence in olivine samples from mantle xenoliths in kimberlites.

We found that *intrinsic* H^+ is incorporated in the olivine structure via formation of M1 vacancies. *Intrinsic* H^+ can occur in olivine as (i) OH^- -bearing point defects homogeneously distributed in the olivine matrix (isolated point defects) and (ii) OH^- -bearing point defects arranged into planar defects parallel to either (100) or (001) and (101). *Extrinsic* OH^- occurs as nano-inclusions of OH^- -bearing phases such as hydrous olivine, 10Å-Phase, serpentine and talc precipitated at planar defects and dislocations. The planar defects are distributed in the olivine matrix either randomly or regularly; in the latter case they produce the *2a*, *3a*, *3c* and *3d*₁₀₁ superperiodicity with respect to the olivine structure by formation of hydrous olivine structures. *Ab initio* methods were used to predict the H^+ location and hydrogen bonds parameters for the *2a*-hydrous olivine structure.

From IR and TEM data we conclude that protonation of olivine occurred during crystallization in the mantle and is not a result of a later metasomatic hydration.

The *intrinsic* Fe^{3+} ions are incorporated in the olivine structure via formation of M1 vacancies which form planar defects parallel to (001) of olivine under low-temperature oxidation. Periodic arrangement of such kind of planar defects results in the laihunite (or, the same, ferriolivine) formation. Low-temperature oxidation of olivine which contains OH^- -bearing nano-inclusions results in transformation of precursor hydrous olivine phases to a mixture of nanometer-sized FeOOH , $\text{Fe}(\text{OH})_3$ and SiO_2 due to interaction between Fe^{3+} and OH^- defects (*extrinsic* Fe^{3+} and OH^-).