OH-BEARING CRYSTALLINE MICROINCLUSIONS IN MANTLE OLIVINE: THE FIRST FINDING OF THE "10A-PHASE" (PHASE OF HIGH PRESSURE) IN NATURE

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Olivine is nominally unhydrous mineral; however FTIR data give an evidence that olivines contain some amounts of water (or hydroxyl) [1, 2]. The highest water content is found as up to 976 H/106Si in olivines from kimberlites [1, 2]. A mode of H incorporation into olivines as either intrinsic or extrinsic is discussed up to date. OH-absorption bands in IR-spectra of olivines can be referred to either OH incorporated into olivine structure (intrinsic OH) or to inclusions of hydrous minerals in olivine such as HMS - hydrous magnesian silicates (extrinsic OH). The interpretation of an IR spectrum can be unambiguous only if both IR spectroscopic measurements and TEM examination of one and the same sample are combined. A modern transmission electron microscopy (TEM) allows to obtain a local chemical and crystal structure information (including qualitative determination of hydroxyl and water [3]) from such a small square of the sample as 4 nm.

It is important to know how H is incorporated in olivine to understand the behaviour of water in the mantle, its transport and storage at great depths of the Earth. During the last years many high-pressure - high-temperature experiments were carried out to synthesize so calld DHMS - dense hydrous magnesian silicates. DHMS-phases are considered to be possible mineral phases in the upper mantle [4], however except humite-group minerals no other DHMS-phases were found in natural material till now.

FTIR and TEM examination of olivines from two mantle nodules (pipes "Udachnaya" and "Obnazennaya", Yakutiya) were carried out.

OH-absorption bands are observed in the IR spectra. TEM investigation show that olivines understudy contain OH-bearing crystalline inclusions of different morphology.

(1) "Large" inclusions (up to several hundred nm in size) are isolated and incoherent. They are composed by hydrous magnesian silicates (HMS). HMS such as talc+serpentine and talc+"10A-Phase" intergrowth were identified. "10A-Phase" $Mg_3Si_4(OH)_2nH_2O$) is known as the DHMS phase experimentally synthesized at high pressures (above 32 kb) and temperatures 300-700 C [5]. This phase, considered as a possible mineral of the mantle, was not found in nature till now. Our observations of "10A-Phase" as nanometer-scale inclusions in mantle olivines is the first finding of "10A-Phase" in nature.

(2) "Small" hydroxyle-bearing inclusions (up to several ten nm in size) are coherent; they are observed along either dislocations or planar features in the olivine grains. The inclusions are depleted in Mg compared to the olivine matrix. It was found that the inclusions have the olivine-like crystal structure with superperiodicity along certain directions. The superperiodicity is interpreted as resulted from the ordered OH-bearing point defects associated with Mg-vacancies in the olivine structure. We consuider the "small" inclusions as hydrous olivine with cation-deficient crystal structure. It should be mentioned that although the "small" inclusions have olivine-like crystall structure, they have a stoichiometry of dense hydrous magnesian silicates, namely wadsleyite $Mg_{1.75}SiH_{0.5}O_4$ [6] and Phase "D" $Mg(OH)_2SiO_2$ [7]. Therefore we can consider the "small" inclusions as intermediate metastable form of DHMS exsolution from the olivine structure.

Thus, two different modes of OH occurence in olivine are estimated, intrinsic ("small" inclusions) and extrinsic ("large" inclusions).

The origin of the "large" and "small" inclusions seems to be different. The "small" inclusions are evidently exsolved from olivine by a solid state reaction at the post-crystallization stage. The origin of "large" incusions is not clear. We supposed that the "large" inclusions represent the recrystallized fluid (or melt) inclusions. 10A-Phase is considered to be a primary crystalline phase of inclusions substituted later by talc and serpentine during the decompression and cooling process.

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