Shed Light To Magma Genesis & Seismicity

Water-transfer from the subducted slab to the overlying mantle wedge leads to magma genesis & seicmicity

magma

The processes that give rise to arc magmas at convergent plate margins have long been a subject of scientific research and debate. H_2O-transfer from the subducted slab to the overlying mantle wedge has been largely recognized as one of the major processes driving rheological modifications of the upper mantle, affecting its petrological variability and promoting magma genesis. There is increasing evidence from the geological record that H_2O flux pathways through the slab-mantle interface is not a simple gravity driven transfer of H_2O from mafic rocks of the oceanic crust to ultramafic mantle wedge compositions.

The challenge:	HAPY phase can be identified in a high pressure multiphase synthetized sample
Solution:	3D diffraction tomography & precession electron diffraction

The best way to investigate what is under our feet is to simulate the earth interior conditions in our laboratory. This can be done in a special press where chemical mixtures, having rock compositions, can be brought to high pressure (10-100 GPa) and high temperature (from room temperature to 2500 K) conditions. In a pilot study planned to explore the stability of chlorite, a phase of unknown chemical composition was encountered and powder diffraction pattern in a run charge synthetized at 720 °C 5.4 Gpa on a bulk composition representing a clinochlore: an anhydrous Al-bearing pyroxene. The stability of such previously unknown hydrous silicate beyond the chlorite pressure breakdown significantly promotes the H_2O transport in the subduction channel to depths exceeding 150Km.

The structure was solved using the 3D electron diffraction tomography method. A crystal of 3.5 µm of the unknown phase was selected on the basis of its chemical composition determined by EDS and characteristic interplanar distances observed in conventional electron diffraction. The structural model delivered after processing of 3D tomography / PED data by direct methods routine (Sir2008) in space group C2/c had a final residual (R) of 31%. The combination of EPMA mineral chemistry data, structural model resolved by 3D electron diffraction tomography method and refinement from XPRD data point to the mineral formula $Mg_{2.1}Al_{0.9}(OH)_2Al_{0.9}Si_{1.1}O_6$. Phase HAPY can account for H_2O-transport in high-pressure slab to- mantle interfaces, but the range of bulk compositions where this is possible largely depends on the degree of H_2O saturation, and on the effect of Fe and Ca in altering phase relationships.

The structure solution obtained with electron diffraction indicates that HAPY contains water as OH groups, therefore it can bring water to lower depth than chlorite. This information is of crucial importance for geologists, since the depth at which water is released is the key factor for magma formation in the mantle and earthquake activation. 3D diffraction tomography and precession can give a fundamental contribution to understanding how and where the magma of volcanos forms!

Crystal Structure

$Mg_{2.1}Al_{0.9}(OH)_2Al_{0.9}Si_{1.1}O_6$

Monoclinic C2/c
a=9.88 Å
b=11.63 Å
c=5.08 Å
β=111.07°

Experimental data

tilt range: ±60° step: 1°
No ind. reflections: 498
No ind. atoms: 8
R = 31%

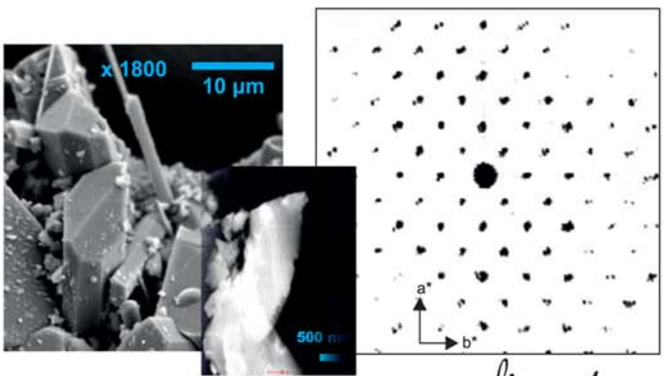

figure 1

Euhebdral Prismatic Crystals (SEM Image)
Crystal for Data Collection (STEM Image)
Corresponding 3D Reflections Reconstruction

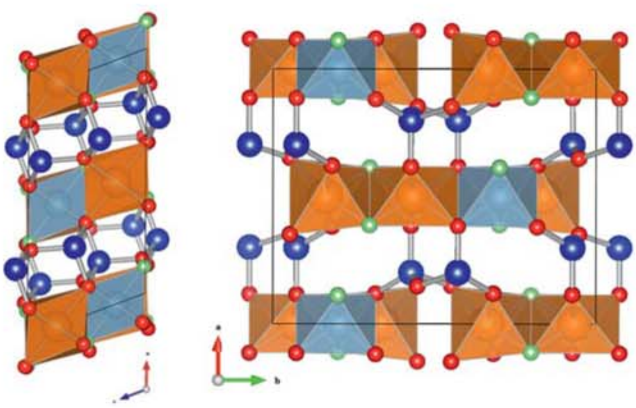

figure 2

Model of the New HAPY Phase

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