The distribution of volatile elements in the Earth's mantle

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Background

More than 70% of Earth's surface is covered by liquid water and volatile elements (C-O-H-N-S) are concentrated in the atmosphere. These unique features provided Earth with the possibility to develop a unique environment for life to prosper at its surface. However, volatiles are also recycled from surface into the deep mantle, at subduction zones, while they are degassed into the atmosphere through volcanism, creating the 'deep Earth volatiles cycle'. In fact, scientists studying experimental and natural samples have shown that considerable amount of H, the most abundant volatile on Earth, can be stored in mantle minerals as defects [e.g., 1]. Even in low amounts (ppm wt scale), H defects greatly affect their physicochemical properties of mantle materials, for example lowering the melting temperature, governing in turn the geochemical evolution of the planet and global dynamics [2 and references therein]. While the behavior of H in the mantle has been studied in the past decades, its precise content in the deep mantle and distribution between minerals and melts still remains to be well constrained.

Aims of the project

The PhD project has the aim to improve our understanding of the behavior of volatiles in the mantle by studying natural and experimental specimens from the deep mantle. In particular, the project will (a) systematically investigate the partitioning of H between minerals and melts in a hydrous, carbonated chemical system [see e.g., 3,4] and (b) improve the current knowledge of deep mantle H_2O budget studying natural, inclusion-bearing diamonds [see e.g., 5,6,7].

Methodology

The project will use state-of-the-art facilities at the host institution or at institutes abroad (e.g., France and Germany) through the PI collaborations. Part (a) will use high-pressure and high-temperature apparatus (piston cylinder) to synthesize minerals and melts at mantle conditions. The experimental charges will be investigated by the electron microprobe, Raman and Fourier transform Infrared (FTIR) spectroscopy to determine the chemistry and volatile contents of the phases. Part (b) will use X-ray diffraction, Raman and FTIR spectroscopy to characterize a unique set of natural diamonds and study their mineral/fluid inclusions.

Student profile

The project has a laboratory-based nature therefore it is suited for a student with a strong interest in cutting-edge experimental and analytical work. Candidates should have a solid background in geology and excellent organizational and communication skills.

Funds

DOR (Novella)

References

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