

Application of microbiological tools to studies of DOM

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Soil organic matter (SOM) provides the microniches for microbial growth and is composed of decomposing residues, the by-products formed by microorganisms responsible for breakdown of plant and animal remains. Humates within SOM are partially derived from microbial products, where the carbon is composed of 10-20% carbohydrates primarily of microbial origin. The dissolved organic matter (DOM) is a reservoir for nutrients and microbes and soil microbial communities play a vital role: in all processes of SOM/DOM formation and transformation. There have been a limited number of comprehensive studies on the relationship between SOM and microbial activity. During the last ten years the development of new molecular methods has offered powerful tools for culture independent studies of microbial community structure. With the progress in genomics an increasing number of these studies have also provided data on the functional potential of selected components within the microorganisms inhabiting soil. Our approach has been to exploit these molecular methods to study microbial activity *in situ* within bulk or fractionated soil and its biofilms. Amplification by the polymerase chain reaction (PCR) of phylogenetic marker genes such as small subunit of rRNA (16/18S rRNA) were targeted for the determination of microbial diversity. We have used this approach and combined it with fingerprinting methods such as denaturing gradient gel electrophoresis (DGGE) to study turnover of organic carbon in soil. In particular chitin degradation was studied by this approach and in addition functional gene probes were developed to detect both bacterial and fungal chitinases. Different approaches were made to detecting communities with potential for chitin breakdown and baiting techniques proved successful in field studies of the changes of diversity within the decomposer communities during different soil treatments. These studies focused on extracted DNA but with the use of reverse transcriptase (RT) RNA can also be targeted to monitor diversity within rRNA and mRNA extracted from soil. Due to the role in transcription and translation these molecules provide data on the active components in soil. A major advance in linking functional activity to community structure came with the development of stable isotope probing (SIP), which relies on the labelling of R/DNA with ^{13}C , resulting in the separation of heavier labelled DNA during density gradient centrifugation. Labelled R/DNA can then be analysed for functional and taxonomic markers. Both labelled nucleic acids and other biomarkers such as phospholipid fatty acids (PLFA) are being used in our studies to monitor the role of mycorrhiza fungi in the transfer of plant derived carbon into the soil microbial community.

Mechanisms and kinetics of the post-garnet transformation in natural pyrope

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Garnet, which is one of the major constituent minerals of the subducting oceanic plates, decomposes to form silicate perovskite (post-garnet transformation) at the depth of ~600-800 km. Kubo et al. (2002) found that the kinetics of the post-garnet transformation is much slower than for the post-spinel transformation, and suggested that metastable garnet possibly exist in the slab even at a temperature of 1600 K and the geological time scale. In order to discuss how much and how long the metastable garnetite survives at the top of the lower mantle quantitatively, we examined temperature dependence of the post-garnet transformation rate at wider temperature ranges of 1320-2000 K and 28-32 GPa.

In-situ X-ray diffraction experiments were carried out using sintered-diamond multi-anvil apparatus "MAX-III" installed at KEK-PF. The starting material is natural pyrope in garnet Lherzovite from Czechoslovakia, whose composition is $(\text{Mg}_{0.724}\text{Fe}_{0.184}\text{Ca}_{0.111})_3(\text{Al}_{0.872}\text{Cr}_{0.044}\text{Ti}_{0.010})_2\text{Si}_{3.064}\text{O}_{12}$. This pyrope garnet decomposes at around 25-30 GPa into magnesian-silicate perovskite, calcium-silicate perovskite, aluminous phase and stishovite. The sample was annealed at 20 GPa and 1523 K for 2 hours prior to the transformation to achieve equilibrium microstructures, resulting in equigranular polycrystalline pyrope of 12 μm in diameter.

The transformation did not occur at 1320 K in 3 hours. We could obtain kinetic data on the time dependence of the transformed fraction at 1600, 1710, and 1820 K. The transformation quickly completed at 2000 K. Microstructural observations suggest that the transformation started from the grain boundary of the parental garnet. The post-garnet assemblages did not show the lamellar growth texture as observed in the post-spinel transformation. These transformation microstructures are consistent with those of the transformation from pure pyrope to perovskite and corundum. More quantitative analysis of the obtained kinetic data based on the observed transformation mechanisms will be presented.

References

Kubo T. et al., (2002). *Nature*. **420**, 803-806.