Biogeochemical implications of carbon isotopic compositions of sedimentary biomarkers from a meromictic lake

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We determined carbon isotopic compositions of lipid compounds in surface sediments collected from a meromictic lake, Lake Kaiike (12 m in maximum depth, area: 0.16 km^2), Japan. As reported in our companion papers (Oguri et al. and Nakajima et al.), Lake Kaiike is characterized by an existence of an O_2/H_2S boundary around water depth of 4.5 m throughout the year. The sediments were collected at four sites from both aerobic and anaerobic environments. $\delta^{13}C$ values of phytol originated from side chains of chlorophyll *a* and bacteriochlorophyll *a* ranged from –29.1 to –23.8 ‰ with being relatively depleted in ^{13}C in anaerobic sites (4.5 and 10.3 m) (Figure). The difference of $\delta^{13}C$ values between aerobic and anaerobic sites may be explained by source organisms. In aerobic site phytol could mainly be derived from cyanobacteria and diatoms, whereas in anaerobic site it is from purple sulfur bacteria Chromatiaceae forming a "bacterial plate" at the redox boundary. Farnesol covalently bonding with bacteriochlorophylls *e* is mainly produced by brown-colored green sulur bacteria Chlorobiaceae in the lake. Generally, organic matter produced by Chlorobiaceae is relatively enriched in ^{13}C due to the carbon fixation through reversed TCA cycle. However, $\delta^{13}C$ values of farnesol are -30±1 ‰ with being *depleted* in ^{13}C relative to other compounds. It may be explained by a repressed growth rate of Chlorobiaceae or utilization of remineralized inorganic carbon. $\delta^{13}C$ values of PMI produced by archaea are almost constant in these sediments, suggesting that a methane cycle is not important in spite of the anaerobic environment in the lake. We are currently underway to determine $\delta^{13}C$ of DIC and suspended particulate matter to further discuss biogeochemical cycles in the lake.
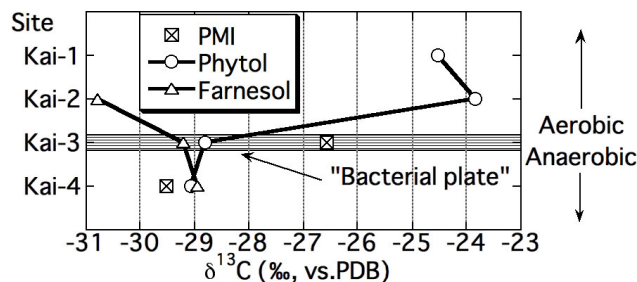

Figure. Carbon isotopic compositions of biomarkers in Lake Kai-ike

Kinetic study on trace element partitioning using *in situ* observation

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Introduction

Previous experimental studies on kinetic effects on element partitioning between minerals and melts have revealed the relationship between cooling histories and apparent partition coefficients [e.g.,1]. However, they have not been directly related to essential parameters of crystal growth, such as growth rate. For this reason, we applied *in situ* observation method [2] to kinetic study on element partitioning between forsterite and a melt.

Experiments

Forsterite crystals were grown from a melt (Fo_{20}-Di_{40}-An_{40}) doped with REE and Li in a heating stage under a transmission optical microscope. Cooling was induced by a few steps of isothermal cooling to investigate the dependence of growth rate on degree of supercooling. Growth rate was directly measured using *in situ* observation technique, and concentrations of elements of quenched run charges were determined using electron and ion microprobe analyzers. The partition coefficients (*D*) were calculated from the measured concentrations for crystals divided by those for the melt.

Results

Growth rate The crystal-melt interface moved almost linearly with time in each isothermal cooling step. The growth rate is linearly correlated with the degree of supercooling.

Trace element distribution in forsterite crystals Two types of zoning for Al and Li were recognized in the crystals; 1) sector zoning, corresponding to crystal orientations and 2) concentric zoning, corresponding to the cooling step. The outerpart, grown at the larger growth rate, is more enriched in Al and depleted in Li. The concentrations of Al and Li show a negative correlation with each other in both types of zoning.

Growth rate dependence of apparent *D* values The obtained *D* values for Al and Li are positively and negatively correlated with growth rates, respectively. This observation cannot be explained by any previous models in which one kind of substitution is simply assumed. The results require a model involving a coupling of at least two kinds of substitutions, such as AlAl-MgSi and MgMg-AlLi.

References

1. Kennedy et al. (1993) *Earth Planet. Sci. Lett.*,115,177-195.
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