

Effects of self-consistently-calculated thermodynamic properties in thermo-chemical multiphase mantle convection in a 3D spherical shell

TAKASHI NAKAGAWA¹, PAUL J. TACKLEY²,
FREDERIC DESCHAMPS³ AND JAMES A.D. CONNOLLY⁴

¹Department of Earth and Planetary Sciences, Kyushu University, Fukuoka, Japan (takashi@geo.kyushu-u.ac.jp)

²Institute of Geophysics, ETH Zürich, Switzerland (ptackley@ethz.ch)

³Institute of Geophysics, ETH Zürich, Switzerland (frederic.deschamps@erdw.ethz.ch)

⁴Institute of Mineralogy and Petrology, ETH Zürich, Switzerland (connolly@erdw.ethz.ch)

High pressure and temperature experiments and calculations of the properties of mantle minerals show that many different mineral phases exist as a function of pressure, temperature and composition (e.g. Irifune and Ringwood, 1987), and that these have a first-order influence on properties such as density and elastic moduli (hence seismic velocity). Numerical models of thermo-chemical mantle convection have typically used a simple approximation to treat these complex variations in material properties, such as the extended Boussinesq approximation. Some numerical models have attempted to implement multiple, composition-dependent phases into thermo-chemical mantle convection (e.g. Tackley and Xie, 2003; Nakagawa and Tackley, 2005) and to calculate seismic anomalies from mantle convection simulations based on polynomial fitting for temperature, composition and mineral phase (Nakagawa and Tackley, 2006). However, their linearised treatments are still approximations and may not adequately represent properties including effect of composition on phase transitions. In order to get closer to a realistic mineralogy, we here calculate composition-dependent mineral assemblages and their physical properties using the code PERPLEX, which minimizes free energy for a given combination of oxides as a function of temperature and pressure, and use this in a numerical model of thermo-chemical mantle convection in a three-dimensional spherical shell, to calculate three-dimensionally-varying physical properties. In this presentation we compare the results obtained with this new, self-consistently-calculated treatment, with results using the old, approximate treatment, focusing particularly on thermo-chemical-phase structures and seismic anomalies in the CMB region and the transition zone.

References

- Irifune, T., and Ringwood, A. E., (1987), *Earth. Planet. Sci. Lett.*, **86**, 365-376.
Nakagawa T., and Tackley, P.J., (2006), *Geophys. Res. Lett.*, **33**, L12S11, doi:10.1029/2006GL025719.
Nakagawa, T., and Tackley, P.J., (2005), *Proc. 3rd MIT conference*.
Tackley, P.J., and Xie, S., (2003), *Proc. 2nd MIT conference*.

Development of chelate resin column preconcentration method for precise isotope analysis of Mo in seawater

Y. NAKAGAWA¹, M. LUTFI FIRDAUS¹, K. NORISUYE¹,
Y. SOHRIN¹, K. IRISAWA² AND T. HIRATA²

¹Institute for Chemical Research, Kyoto University, Uji, Kyoto, 611-0011, Japan (ynakagawa@inter3.kuicr.kyoto-u.ac.jp)

²Tokyo Institute of Technology, 2-12-1 Oookayama, Meguro-ku, Tokyo, 152-8550, Japan

Mo is present nearly conservatively in the modern ocean (~10 ppb). However, Mo is depleted in reducing environments and hydrothermal systems and so on, and such fractionation should be reflected in the Mo isotope composition. In addition, because Mo is an essential element for organisms, biological activity may change the Mo isotope composition. Therefore, precise isotope analysis of Mo in seawater is expected to provide new valuable information, and to be a good tool in geochemical oceanography.

Only a few data have been reported on the isotopic composition of Mo in seawater. More than 50-fold concentration of Mo in seawater is required for isotopic measurement. An ion exchange resin method was used to purify Mo, but this method requires concentrated acid for elution, and may not be able to separate major elements of seawater completely. So, we have newly developed a chelate resin column preconcentration method.

8-hydroxyquinoline (8HQ) bonded covalently to a vinyl polymer resin, TSK-8HQ (Dierssen *et al.*, 2001), was used in a column to concentrate Mo. The sample solution that has been adjusted to pH 2.0 by HCl was passed through the column, and then the adsorbed Mo was eluted by the back flushing of 2 M NH₃. To obtain a high concentration factor, the eluate was evaporated to dryness, and Mo was then re-dissolved in 0.05% tetramethylammonium hydroxide. Mo isotope ratio was measured by MC-ICP-MS (Nu Plasma 500). The mass discrimination effect on Mo was internally corrected by ⁸⁸Sr/⁸⁶Sr to be 0.1194 using the exponential law. Individual sample uncertainties (2σ) of this element spike method are 0.03‰ per amu for 1 ppm Mo.

Mo in 500 mL seawater sample was collected quantitatively. The procedure blank was less than 10⁻³ times of Mo concentration in seawater. The residual ratio of major elements of seawater in the eluate was less than 10⁻⁵, and their matrix effects on isotope analysis of Mo were negligible.

^{98/95}Mo in seawater collected from 697 m depth in Suruga Bay, Japan was 2.49 ± 0.10 (2σ) relative to JMC standard. We will report the vertical profiles of Mo isotope ratio from stations in the western North Pacific Ocean at the presentation.

References

- Dierssen, H., Balzer, W., Landing, W.M., (2001), *Mar. Chem.* **73**, 173-192.