

## Partial melting experiments of CO<sub>2</sub>-H<sub>2</sub>O-bearing peridotite: Genesis of carbonatite as an inorganic source of phosphorus

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Phosphorus is one of the biologically essential elements. Because phosphorus is nonvolatile and insoluble to water on the Earth's surface, all phosphorus available for the biosphere should have been supplied from the solid Earth. Thus the supply of phosphorus from the solid Earth has been one of the essential mechanisms that have had a great influence on the birth and evolution of life. On the modern Earth, weathering and erosion of continental rocks are the main process of phosphorus supply to the biosphere. However, it is not certain how much and what kind of continental rocks existed on the early Earth, and therefore it's difficult to know the main process of phosphorus supply then.

On the other hand, there are several types of rock that contain much more abundant phosphorus than ordinary continental rocks. One of the phosphorus-rich rocks is carbonatite, which consists mainly of carbonate minerals and contains up to > 10 wt.% of P<sub>2</sub>O<sub>5</sub>. Although the abundance of carbonatite is very small, it can be a main source of phosphorus on the Earth's surface because it is easy to be weathered due to vulnerability of carbonate minerals to weathering. Previous experimental studies have demonstrated that carbonatite melt can be generated from peridotite at pressures higher than 2 GPa under CO<sub>2</sub>-H<sub>2</sub>O saturation, but it's not clear whether such mantle-derived carbonatite melt could have phosphorus concentration as high as in natural carbonatites. In this study, we determined phosphorus concentration in mantle-derived carbonatite melt by high-pressure melting experiments on CO<sub>2</sub>-H<sub>2</sub>O-bearing primitive peridotite, and examined probable processes that lead to very high concentration of phosphorus in carbonatite melt like observed in natural carbonatites.

We conducted melting experiments on KLB-1 peridotite composition with 10 wt.% oxalic acid, using a piston-cylinder apparatus at 2.5 GPa and 1100-1250°C. The experimental charges were analyzed with an EPMA and a SEM-EDS. We obtained carbonate melt with < 4 wt.% SiO<sub>2</sub> at 1150°C, and silicate melt with ~32 wt.% SiO<sub>2</sub> at 1200°C. The carbonate melt of 1150°C contained 0.15 wt.% P<sub>2</sub>O<sub>5</sub>. A mass balance calculation demonstrated that the degree of melting was ~ 10 wt.% and that the bulk partition coefficient of P<sub>2</sub>O<sub>5</sub> was 0.11 at 1150°C. These results indicate that carbonatite melt, if it's generated at much lower degrees of melting, could have ~0.3 wt.% P<sub>2</sub>O<sub>5</sub>, which is much lower than the values observed in natural carbonatites. Thus, some process other than partial melting of CO<sub>2</sub>-H<sub>2</sub>O-bearing peridotite is necessary to explain the very high phosphorus concentrations in natural carbonatites. One of the possible processes is melting of phosphorus-rich peridotite metasomatized by mantle-derived carbonatite melt. This process could have occurred in subduction zone environments in the early Earth. The details of such a process will be discussed in the presentation.

Keywords: high pressure experiment, carbonatite, phosphorus