Super-reducing assemblages in mantle xenoliths: evidence for marine carbonate recycling

DETAO HE[1], YONGSHENG LIU[1]*, CHANGGUI GAO[1], STEPHEN FOLEY[2], ZHAOCHU HU[1], KEQING ZONG[1], MAX W. SCHMIDT[3] AND SHAN GAO[1]

[1]State Key Laboratory of Geological Processes and Mineral Resources, Faculty of Earth Sciences, China University of Geosciences, Wuhan, 430074, China (yshliu@hotmail.com)

[2]Geocycles Research Centre and Institute of Geosciences, University of Mainz, Becherweg 21, 55099 Mainz, Germany

[3]Institute of Geochemistry and Petrology, ETH-Zürich, CH-8092 Zürich, Switzerland

Computed phase equilibria indicate that, from 80 to 180 km depth, little devolatilization occurs for all carbonate-bearing marine sediments along low-temperature geotherms [1], and >70–80% of the subducted carbonate will bypass the volcanic arc region and get buried to larger depths [2]. There has been no direct petrologic evidence, however, of the return of subducted marine carbonate to the deep mantle.

Highly reduced phases bearing carbonatitic xenoliths were now found in the Cenozoic basalt, North China, which could have witnessed the deep mantle recycling of marine carbonate [3]. The highly reduced phases include diamond, moissanite, graphite, Fe_3Si and some native metals. The mineral assamblage implies that the carbonatitc xenoliths once had been exposed to deep mantle (>150 km). However they still remain the trace element patterns of marine carbonate. They have remarkable positive Sr anomaly, but low REE, LILE and HFSE contents. Furthermore, temperature and pressure estimated by the coexisting clinopyroxene, orthopyroxene and garnet in the carbonatitic xenoliths are 943 °C and 2.2 GPa, indicating that the carbonatitic xenoliths were eventually captured by basalts at the shallow lithospheric mantle. These characters together suggest that the carbonatitic xenoliths were primarily originated from marine carbonates which were transported to deep mantle by subduction and then emplaced into the mantle wedge (~75 km) by diapiric rise.

[1] Kerrick DM, *et al* 2001. *Nature* (**411**), 293-296. [2] Thomsen TB, *et al* 2008. *Earth Planet. Sci. Lett.* (**267**), 17-31. [3] Liu *et al* (2014) *Nature* (subm.).