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Origin of the Coronas in the Mafic Granulite Xenoliths from Hannuoba, Northern Sino-Korean Craton

Shaohai Chen (shaohaic@hotmail.com), **Xinhua Zhou** (zhouxh@public3.bta.net.cn), **Guohui Zhang**, **Jiliang Li** & **Lihui Chen**

Inst.Geol.& Geophy.,CAS, P.O. Box 9825, Beijing, 100029, P.r. China

Besides the abundant ultramafic xenoliths, many mafic granulite xenoliths have also been entrained to the surface by Cenozoic Hannuoba alkali basalts. The granulite xenoliths are consisted of clinopyroxene, orthopyroxene and plagioclase. Biotite exists in two of them. No primary olivine or alkali feldspar exists in the xenoliths. Coronas have developed in some granulite xenoliths around the biotite, clinopyroxene and orthopyroxene grains in various degree. All the coronas around pyroxene grains contain alkali feldspar, olivine and secondary pyroxene. The coronas around biotite grains are also alkali feldspar- and olivine-bearing except for secondary pyroxene. The coronas are in granular structure with subhedral olivine, anhedral pyroxene and interstitial alkali feldspar. Alkali feldspar is in glass as revealed by X-Ray diffraction analysis over the coronas. Generally, Cr, Mn and Mg contents in clinopyroxene increase and Al, Na, Ca and Ti contents decrease from the primary core to the rim and the secondary one in the coronas. While in orthopyroxene, Ti, Cr, Ca, Mn and Mg contents increase and Al and Fe contents decrease from the primary core to the rim and the secondary one in the coronas. The Mg number (=Mg/Mg+Fe, atomic) of the olivines in the coronas varies from 0.68 to 0.76. Though homogeneous in a corona, the composition of alkali feldspar is dramatically variable among different coronas.

The decomposition of the primary pyroxene grains can provide most of the necessary materials for the formation of the coronas except for sodium and potassium. The plagioclase grains from the different layers of a layered xenolith shows no compositional difference. The plagioclase-rich layer of the xenolith is corona-bearing while the pyroxene-rich layer is corona-free. Therefore, plagioclase is not the alkali source for the coronas. The higher alkali and light rare earth element contents in the corona-bearing xenoliths than those corona-free ones implies that exotic fluids have played important roles to the formation of the coronas. As pyroxene instead of amphibole appears in the coronas, the fluids are probably dry and carbon dioxide-rich ones. A pressure-temperature track of decompression and heating is also inferred from the corona-bearing xenoliths.

A supposition for the formation of the coronas is suggested here. Heating, which probably originated from deep mantle, causes the partial melting of the lower crust with the assistance of alkali- and light rare earth element-rich fluids. Basaltic magmas bring these xenoliths to a shallower level of the crust where olivine becomes stable and crystallizes in the partial melts. Though the composition of the residual melts is close to alkali feldspar, no alkali feldspar crystallizes because of improper conditions. Then the xenoliths are brought out to the surface and rapidly cooled by the eruption of the basaltic magmas. The corona-bearing granulite xenoliths are not only suggesting a possible way of crustal melting but also meaningful for the recycling of crustal materials to mantle.