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Microstructural development of coarse granular peridotite derived from Kaapvaal cratonic lithosphere, South Africa

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Kimberlite was generated in deep upper mantle (70-250km) beneath craton and subsequently ascended to surface rapidly. Peridotite xenoliths, which were entrained by kimberlite, record composition and texture formed in upper mantle beneath the craton. Peridotite xenoliths from Kimberley pipe, Southern Africa, are divided into two groups: granular type and foliated type. The granular type peridotite has difficulty in identifying any foliation, whereas the foliated type shows distinct foliations. The granular type peridotite has a few studies in terms of microstructural development, presumably because of very coarse grain. In this study, five large samples have been selected among thirty-five samples and several thin sections for three orthogonal planes in each sample have been made after lineation and foliation were identified visually. We performed microstructural analyses and measured major mineral compositions and water contents in minerals in order to reveal microstructural and petrological characteristics of peridotite xenoliths in kimberlite and to interpret cratonic lithosphere. All five samples are garnet harzburgites. They were divided into two groups: Group1 includes two samples containing no clinopyroxene and Group2 includes three samples containing minor amounts of clinopyroxene. The crystallization of clinopyroxene appears to be associated with metasomatism. Rounded garnets were observed in Group1 peridotites, whereas elongated garnets occur in Group2 peridotites. Olivine and orthopyroxene Mg# in Group2 are lower than those in Group1 peridotite. Olivine and orthopyroxene have different compositions between Group1 and Group2 peridotites. Equilibrium temperature and pressure are similar (1000 degree C, 40kbar) among all five samples regardless of the group. With respect to CPO analyses, Group1 olivine fabrics were characterized by a point maximum of [010] and girdle distribution of [100] and [001]. Orthopyroxene fabrics were characterized by a point maximum of [001] and girdle distribution of [100] and [001]. Group2 olivine and orthopyroxene fabrics did not show any dominant concentration. Water contents in garnet are different between two types. Rounded garnet in Group1 had relatively low water contents (10ppm), whereas elongate garnet in Group2 presents high water contents (50ppm). Although both Group1 and Group2 peridotites have similar equilibrated P-T conditions, they showed different mineral compositions of olivine and orthopyroxene. It appears that Group2 peridotite has been affected by metasomatism process. The change of mineral compositions from Group1 to Group2 is attributed to melt infiltration, possibly resulting in different fabrics of olivine and orthopyroxene. With respect to garnet shapes, rounded garnet in Group1 might be facilitated to strain and be transformed elongate garnet in Group2 by water added with melt during metasomatic event. It is generally considered that granular type peridotite represents the steady state mantle process in the cratonic lithosphere. However, this study suggested that granular type peridotites show a variation, resulting from melt infiltration in the cratonic mantle.

Keywords: Kaapvaal craton, Kimberlite xenolith, olivine fabrics, metasomatism, seismic anisotropy