Petrogenesis and Geological Significance of Ultramafic Rocks in Singok area within the Honseong Belt, Gyeonggi Massif, South Korea

V.J. Rajesh[1)*]· S-G. Choi[1)]·J. Seo[1)]·C.W. Oh[2)]

Introduction

The Hongseong belt in the Gyeonggi Massif of the Korean Peninsula is recently described as a Permian-Triassic collision zone and is interpreted as the eastern extension of the Triassic Dabie-Sulu collision belt in China (Oh et al., 2005). Ophiolite sequences/suites (hereafter ophiolites) are considered as one among the typical features of many collisional zones and the peridotites present in collision zones are treatedas pieces of oceanic crust indicative of the locale of the suture of the collision zones while formulating the tectonic models (e.g Zhai et al., 2005). Several isolated lenticular serpentinized ultramafic bodies within the Precambrian granitic gneiss are common in the Hongseong area. The origin and the tectonic significances of these ultramafic rocks are not well constrained for the original igneous assemblages are obliterated by later several stages of deformation, metamorphism (including high-P/T metamorphism) and secondary alterations (such as serpentinization, chloritization etc.). However, retracing the primary assemblages in ultramafic rocks will help in its petrogenetic interpretations and also to check any signatures of those ultramafic rocks reported from ophiolites/suprasubduction zones (SSZ). Taking this into account, the present study focuses on the petrography and mineral chemistry of the serpentinized harzburgites cropped out in Singok area to bring out its petrogenesis and probable tectonic significances in relation to collision zone tectonics.

Geological Setting and Petrography

The Honseong area is situated in the southwestern part of the Precambrian Gyeonggi gneissic complex (henceforth Gyeonggi Massif). It comprises the Wolhyeonri Formation and the Deokjeongri granitic gneiss to the west and the Yugu granitic gneiss to the east. The predominant lithological units of the Wolhyeonri Formation are the closely allied biotite schists, metabasites and marbles, while the amphibole and biotite bearing granitic gneiss and leucogranites dominate the orthogneisses of the Deokjeongri granitic gneiss. Both the Deokjeongri and the Yugu granitic gneisses are renowned for the occurrence of many lensoid shaped ultramafic bodies (with varying degrees of serpentinization) within the major lithological units (e.g., Choi et al. 1998 Seo et al. 2005). At Singok, the ultramafic body can be traced for several hundreds of meters and is

Key words: Singok, harzburgite, Gyeonggi Massif

1) Department of Earth and Environmental Sciences, Korea University, Seoul, South Korea (rajeshvj@korea.ac.kr).

2) Department of Earth and Environmental Sciences, Chonbuk National University, Jeonju, South Korea

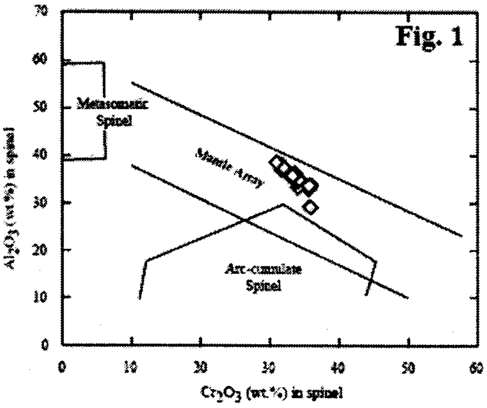
elongated in N 30-40^{0}E direction that is parallel to the general trend of the main fault in the Hongseong area. Large porphryroclasts of orthopyroxene set in a matrix of medium to fine-grained olivine, spinel, and amphibole indicative of mylonitic fabric are the dominant texture in least serpenitnized portion of the harzburgites. An equigranular-mosaic to porphyroclastic texture is predominant in harzburgite. Along with the core part of orthopyroxene (that might be equilibrated under the same conditions as the formation of spinel and olivine), we define the primary mineral assemblage in the harzburgites as olivine + orthopyroxene + Al-spinel + amphibole ± phlogopite.

Mineral Chemistry

The core compositions of olivine, spinel and phlogopite that do not show any evidences of alterations, replacement or recrystallization are analyzed to ensure that the compositions correspond to those of the primary (igneous) stage. The Mg# (=100*Mg/Mg+Fe) of olivine varies between 91 and 92. The Mg# (=100*Mg/Mg+Fe) and the Cr# (=100*Cr/Cr+Al) of the spinel grains range from 59-66 and 38-42respectively. The orthopyroxene has a composition of En_{89-90}.

Discussion and Conclusions

Many studies on ultramafic rocks particularly have proved that Cr-rich spinel can be employed as a potential petrogenetic indicator since they can survive the later several stages of metamorphism. In addition, the Mg# of olivine and Cr# of spinel are distinguished symbols of the degree of partial melting experienced by the rock (e.g. Dick and Bullen, 1984; Arai, 1994).



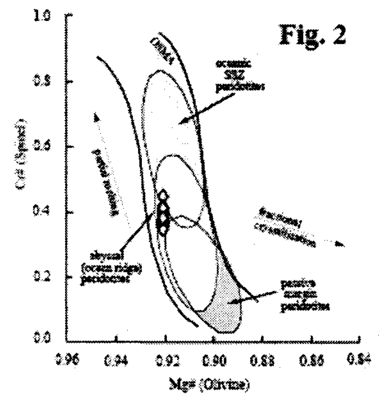


Fig. 1. Al_2O_3 versus Cr_2O_3 (wt. %) diagram (compiled by Franz and Wirth, 2000) for the spinels in harzburgite and Fig. 2. Characterization of harzburgites in the olivine-spinel mantle array (OSMA: olivine [Mg#] versus spinel [Cr#]) diagram of Arai (1994) modified by Pearce et al. (2000).

In the Al_2O_3 versus Cr_2O_3 diagram (Fig. 1) compiled by Franz and Wirth (2000), the spinel compositions plot within the mantle array suggesting that the harzburgites were part of mantle sections. Kamentsky et al. (2001) proposed that TiO_2 and Al_2O_3contents in spinel could be used to discriminate the environment of formation and geodynamic settings of various mantle-derived rocks. They explained this mainly due to the dependence of spinel Al_2O_3 and TiO_2 concentrations on the parental melt compositions. In the spinel Al_2O_3(wt. %) versus TiO_2(wt.%) diagram the spinels fall in an overlap area between the fields of suprasubduction zone peridotites and mid ocean ridge peridotites. In the Fe^{3+}-Cr-Al (a.p.f.u) diagram all the spinel compositions fall within the fields of residual peridotite/ophiolite/ocean floor. The olivine spinel mantle array (OSMA) diagram devised by Arai (1994) is extensively employed to characterize the mantle-derived spinel bearing ultramafic rocks especially the mantle restites. Pearce et al. (2000) modified this diagram by incorporating the fields of the oceanic supra-subduction zone peridotites and the passive continental margins. In this diagram (Fig. 2) the data plot in an overlap region between the abyssal peridotite and supra-subduction zone fields.

Many ophiolite sequences contain a range of igneous compositions and a variety of chemical and crustal components from MORB- or identical lavas, island arc tholeiites to boninites (e.g. Colemen, 1984). Although we could not trace a well-developed ophiolite sequence in the Gyeonggi Massif, we can argue here based on various discrimination that the Singok harzburgite has characteristics same as those of supra-subduction zone or MORB-type ophiolites. The harzburgite displays a flat REE pattern on a chondrite normalized diagram (Sun and McDonough, 1989). The calculated Al_2O_3contents and FeO/MgO ratios of the parental melts are within the range of MORB type magma than a boninitic source typical of supra-subduction zones.We are interpreting here that the Singok harzburgite has many features akin to the MORB-type ophiolites usually occurring together with the SSZ ophiolites in orogenic belts. The zircons from the metabasites in Hongseong area yielded inherited core ages of 887 $\pm$ 14, which Guo et al. (2004) considered as the protolith formation ages. We do not have any age data of the harzburgites at this moment, but we assume that they were also formed at around the same time of the protolith formation of the metabasites. The northern margin of the South China craton has been known well to develop passive margins during Neoproterozoic to Late Paleozoic before the continental collision between the North China and South China cratons. This development of passive margin along the northern side of the South China craton has been known to be related to the continental dispersion from the Rodinia supercontinent during the Neoproterozoic. This proposed tectonic scenario may be well consistent with the occurrence of ultramafic rocks with MORB type features in the Gyeonggi massif.

References

Arai, S. (1994) Characterization of spinel peridotites by olivine-spinel compositional relationships: review and interpretation. *Chemical Geology*, 113, 191-204.

Choi, S.G., Song, S.H. and Choi, S. (1998) Genetic implications of the ultramafic rocks from the Hongseong area, western part of Chungnam. *Korean Society of*

Economic and Environmental Geology, 46.

Coleman, R.G. (1984) The diversity of ophiolites. *Geologie en Mijnbouw*, 63, 141-150.

Dick, H.J.B. and Bullen, T. (1984) Chromian spinel as a petrogenetic indicator in abyssal and alpine-type peridotites and spatially associated lavas. *Contributions to Mineralogy and Petrology*, **86**, 54-76.

Franz, L. and Wirth, R. (2000) Spinel inclusions in olivine of peridotite xenoliths from TUBAF seamount (Bismark Archipelago/Papua New Guinea): evidence for the thermal and tectonic evolution of the oceanic lithosphere. *Contributions to Mineralogy and Petrology*, **140**, 283-295.

Guo, J., Zhai, M., Oh, C.W. and Kim, S.W. (2004) 230 Ma Eclogite from Bibong, Hongseong area, Gyeonggi Massif, South Korea: HP metamorphism, zircon SHRIMP U-Pb ages, and tectonic implication. In *Abstract volume of International Association for Gondwana Res., South Korea Chapter, Miscellaneous Pbl., 2 Dec. 2004, Chonju*, 11-12.

Kamenetsky, V.S., Crawford, A.J. and Meffre, S. (2001) Factors controlling chemistry of magmatic spinel: an empirical study of associated olivine, Cr-spinel and melt inclusions from primitive rocks. *Journal of Petrology*, **42**, 655-671.

Oh, C.W., Kim, S.W., Choi, S.G., Zhai, M., Guo, J. and Sajeev, K. (2005) First Finding of Eclogite Facies Metamorphic Event in South Korea andIts Correlation with the Dabie-Sulu Collision Belt in China. *Journal of Geology*, **113**, 226-232.

Pearce, J.A., Barker, P.F., Edwards, S.J., Parkinson, I.J. and Leat, P.T. (2000) Geochemistry and tectonic significance of peridotites from the South Sandwich arc-basin system, South Atlantic. *Contributions to Mineralogy and Petrology*, **139**, 36-53.

Seo, J., Choi, S.G.., Oh, C.W., Kim, S.W. and Song, S.H. (2005) Genetic implications of two different ultramafic rocks from Hongseong area in the southwestern Gyeonggi Massif, South Korea. *Gondwana Research*, **8**, 539-552.

Sun, S.S. and McDonough, W.F. (1989) Chemical and isotopic systematics of oceanic basalts: implications for mantle composition and processes. In: Saunders, A. D. and Norry, M. J. (Eds.), Magmatism in the Ocean Basins. Geol. Soc. Spl. Publ., **42**, 313-345.

Zhai, M.J., Guo, J.H., and Liu, W. (2005) Neoarchean Paleoproterozoic continental evolution and tectonic history of North China craton: a review. Journal of Asian Earth Sciences, **24**, 547-561.