MINERAL CHEMISTRY OF CHROMITE FROM ULTRAMAFIC ROCK IN SOUTH SULAWESI, INDONESIA

Adi Maulana*

*) Dept. of Geology Engineering, Hasanuddin University, Makassar, 90245, Indonesia

Abstract: Mineral chemistry compositions of chromite from chromitite rock in South Sulawesi Ultramafic rock were determined using Scanning Electron Microprobe (SEM) method. Chromite occurs either as podiform lens and layers ranged from 10 – 40 cm in size in ultramafic rocks from Bantimala and Barru blocks, Indonesia. Both chromitites from these two blocks showed a very different composition mineral chemistry. Those from Bantimala block has much lower Cr₂O₃ content (17.1 – 21.1 wt%) compare to those from Barru block (52.9 – 57.7). The Bantimala block chromitite have Cr/(Cr+Al) ranges from 0.95 – 0.96, Mg# ranges from 0.06 – 0.08 and Cr₂O₃ content varies from 17 to 21 wt% with extremely low value of Al₂O₃ (0.6 to 0.65 wt%). On the contrary, those from the Barru block show relatively lower value of Cr/(Cr+Al) which range from 0.75 – 0.84, Mg# from 0.59 – 0.66 and Cr₂O₃ content values ranges from 52 to 57 wt% with relatively normal value of Al₂O₃ (7 to 12.5 wt%). This result showed that these two chromitites were originated from different mechanism, which the former derived from the crystallisation of parental melt in island arc environment whereas the latter formed from crystallization of extrusive boninitic lava.

Keywords: Chromite, Ultramafic rock, South Sulawesi, Indonesia.

1. INTRODUCTION

The basement rocks complexes of south Sulawesi has ultramafic rocks series which contain chromite. The chromite constitute stratiform layer as chromitite rock or within highly depleted lherzolite and dunite. The distribution of these layers occur as disseminated crystal, in some places as thin lenses and layers. Despite the wide distribution of chromitite rocks in this area, previous reports on their occurrences are restricted to a few general geology report (Sukamto, 1982). We present for the first time chromite composition from chromitite rocks in south Sulawesi Ultramafic rocks complex, Indonesia. The purpose of this paper is mainly to describe the Cr-spinel mineral chemistry and compare the composition of Cr-spl in both chromitite rocks from Bantimala and Barru ultramafic rocks.

2. GEOLOGY BACKGROUND

The study area is part of basement complexes of south Sulawesi which consists of two separated blocks, namely Bantimala and Barru block (Maulana, 2009). It is located approximately 70 km north of Makassar (Fig.1). The geology of the study area has been investigated by many workers including Sukamto (1982), Wakita et al. (1996) and Maulana (2009) (Fig.2). The basement complex consists of high pressure metamorphic rocks including eclogite and blue schist facies rocks along metasedimentary rocks including meta sandstone and metabreccia as well as unmetamorphosed pre-Tertiary deep marine sediment (siliceous shale and radiolarian chert) and ultramafic rocks. The ultramafic rocks were found in both Bantimala and Barru block. All ultramafic rocks unit have been highly metamorphosed and have suffered high serpenitisation degree. They were chiefly serpentinized peridotite, with local chromite lenses and basalt layers. Based on K-Ar dating on muscovite from metamorphic rocks, Cretaceous age was proposed for these basement rocks assemblages (Wakita et al. 1996) as well as radiolarian age in chert (Sukamto, 1982). Paleogene volcanism in the region is represented by the Kalamiseng, Langi and Bua Volcanics. The volcanics consist of lavas and pyroclastic deposits of andesitic to
trachy-andesitic composition, with rare intercalations of limestone and shale towards the top of the sequence and show a strongly fractured, poorly bedded texture (Sukamto, 1982; van Leeuwen, 1981). Eocene to Miocene sediments can be grouped into two: Mallawa Formation and Tonasa Formation. The first are composed of arkosic sandstones, siltstones, claystone, marls and conglomerates, intercalated with layers or lenses of coal and limestone whereas the latter consists of carbonate facies rock which can be classified into four members labelled A,B,C and D from the bottom to top (Wilson and Bosence, 1996). Miocene to Recent volcanism and sedimentation in this region consists of various formations, including, in order of decreasing age, the Upper Camba Formation, Baturape–Cindako Volcanics, Soppeng Volcanics, Parepare Volcanics, Lempobattang Volcanics, and the Lempobattang Volcanics.

Structurally, Berry and Grady (1987) showed that these complexes are characterised by the occurrence of cataclasite developed in fault zones, with a strong anastomosing cleavage. They reported that most of the clasts have been strongly deformed and rotated due to intensive faulting, the schistosity strike direction being consistently to the NW, roughly parallel to the faults.

3. ANALYTICAL METHODS

In order to obtain quantitative compositional data for the minerals, these thin sections were examined using a JEOL 6400 scanning electron microscope, equipped with an Oxford Instruments light element dispersive spectrometer (EDS) detector and Link ISIS analytical software. Operating conditions for the energy-dispersive X-ray analyses (EDXA) were 15 kV accelerating voltage, 1 nA beam current, and a range of beam diameters (higher current, focused beam for garnet; lower current, beam defocused to 5 µm for micas and plagioclase). Natural mineral standards and the ZAF matrix correction routine were used. SEM analyses and carbon coating were carried out at the Electron Microscopy Unit, RSBS, at The ANU.

The following standard were used: sanidine for Si and K, albite for Na and Al, diopside for Ca, TiO₂ and pure Ti for Ti, Fe₂O₃ for Fe, Cr₂O₃ for Cr, MgO for Mg, pure Mn for Mn, pure apatite for P, zircon for Zr and Hf, calcite for Ca, pyrite for S, chalcopyrite for Cu, pure Co for Co, pure nickel for Ni, and baryte for Ba. All samples were polished with 1 µm diamond paste and carbon-coated to approximately 20 nm thickness. In addition to spot analyses, the SEM was used to construct X-ray maps for Fe,
Mn, Mg, Ca, and either Al or Si by using a beam current of 100 nA, 50 ms dwell time, and 5–9 mm scanned area. These facilitated the identification of minerals in back scattered electron images, and the location of uncommon accessory minerals.

4. RESULT AND DISCUSSION

12 electron microprobe analyses were carried out on chromian spinel from thin section from chromitite rock from both Bantimala and Barru area. Representative analyses of chromian spinel are given in Table 1.

The chemistry of chromian spinel from Bantimala chromitite rock shows a restricted spectrum of variation with characterized by very low concentration of Al$_2$O$_3$. The Cr# [(Cr/Cr+Al) atomic ratio] ranges from 0.95 – 0.96 (corresponding to 17.1- 21.1 wt% of Cr$_2$O$_3$ and 0.65 – 0.51 wt% of Al$_2$O$_3$) and Mg# [(Mg/Mg+Fe$^{3+}$) atomic ratio] from 0.06 to 0.08. The TiO$_2$ content is relatively high, ranges from 2.7 – 2.9 wt% whereas the FeO content varies from 69.8 to 71.4 wt%. Minor amount of MnO were detected from this sample (0.2 to 0.3 wt%).

Those from Barru area has relatively higher Cr$_2$O$_3$ (52.1 to 54.4 wt%) and Al$_2$O$_3$ (11 to 12.2 wt%) which correspond to 0.75 to 0.76 of Cr#. Mg# show relatively higher values than those from Bantimala which varies from 0.62 to 0.65. TiO$_2$ content is below 0.5 wt% which ranges from 0.08 to 0.41 wt% and FeO ranges from 18.2 to 20.5 wt%. The low Al$_2$O$_3$ contents of the Bantimala chromitite are due to alteration which drives the spinel composition to magnetite through ferrit chromite.

In the Bantimala chromitite, the relation between Cr# and TiO$_2$ suggests that the chromian spinel precipitated from high Ti-island arc tholeiite whereas the chromian spinel from Barru has a composition that roughly coincide with those of MORB and boninite affinity (Fig.3). This observation indicate that the Bantimala chromitite crystallized from parental melt which derived from island arc environment whereas Barru chromitite tend to crystallized from the extrusive boninitic lava. The high Cr# chromite spinel is associated with arc-related setting (Arai & Yurimoto, 1994, 1995; Arai, 1994).

Compare with other chromian spinel from other well known chromitite rocks (Fig.4), the composition of Barru chromitite is very similar in chemistry to correspond of the Oman upper mantle chromitite whereas the Bantimala chromitite shows relatively the same field with Oman high Cr# harzburgite composition (Ismail et al. 2009).

Figure 3. Relationship between Mg/(Mg+Fe$^{3+}$) and Cr/(Cr+Al) atomic ratio of chromian spinel in chromitite from Bantimala and Barru area. Compositional range for Oman high Cr# harzburgite and Oman upper mantle chromite (Ahmed & Arai, 2002: Auge, 1987) are shown for comparison.

Figure 4. Relationship between Cr# and TiO$_2$ content of chromian spinel in chromitite rocks from Bantimala and andBarru area. Compositional range for MORB, Boninite and Island arc (Ahmed & Arai, 2002: Auge, 1987: Ismail et al, 2009) are shown for comparison.
5. CONCLUSION

Chromite occurs as podiform chromitite in Bantimala and Barru area, south Sulawesi with variation in the composition. The Bantimala and Barru chromitite rocks suggest a different chemical composition. The first is represented by extremely high Cr# (more than 0.9) which slightly low value of Mg# but high FeO content due to alteration process. The latter is characterized by relatively normal value of Cr# (0.75 in average) with high Mg# (0.62 to 0.66) and FeO which ranges from 18 to 21 wt%. The Bantimala chromitite compositions correspond to the arc-related setting environment whereas those from Barru show more boninitic affinity.

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7. REFERENCES


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