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Petrology, geochemistry and tectonic significance of serpentinized ultramafic rocks from the South Arm of Sulawesi, Indonesia

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ABSTRACT

Serpentinized ultramafic rocks occur in two separate basement complexes in the South Arm of Sulawesi, the Bantimala and Barru Blocks. We present petrographic, mineral chemical and geochemical data for these rocks, and interpret them in terms of petrogenesis and tectonic setting. The rocks of both blocks show strong serpentinization of original anhydrous silicates. The Bantimala ultramafics consist mainly of peridotite (harzburgite and dunite) and clinopyroxenite, with lenses of podiform chromitite. Metamorphism is evidenced by the occurrence of amphibolite-facies tremolite schist. In contrast, the Barru ultramafics consist of harzburgite peridotite and podiform chromitite, which also show an amphibolite-facies overprint that in this case may be related to intrusion by a large dacite/granodiorite body. Whole-rock trace element analyses and spinel compositions show that the Barru harzburgite is depleted relative to primitive mantle, and has had some melt extracted. In contrast, the Bantimala dunite, harzburgite and clinopyroxenite are cumulates. Both are derived from a supra-subduction zone environment, and were obducted during the closure of small back-arc basins. If there has been no rotation of the blocks, then the Bantimala ultramafics were emplaced from an ENE direction, while the Barru ultramafics were emplaced from the WNW. The ultramafic suites from these two blocks are juxtaposed with metamorphic assemblages, which were later intruded by younger volcanics, particularly in the Barru Block.

1. Introduction

Sulawesi Island is located in the central part of the Indonesian archipelago, which consists of four tectonic provinces (Kadarusman et al., 2004; Maulana, 2009): (1) the West and North Sulawesi Pluto-Volcanic Arc in the south and north arms of the island, (2) the Central Sulawesi Metamorphic Belt, extending from the centre of the island to the southeastern arm, (3) the East Sulawesi Ophiolite Belt in the eastern arm, and (4) the Banggai-Sula and Tukang Besi continental fragments (Fig. 1). Each tectonic province has occurrences of pre-Tertiary rocks containing metamorphic and mafic-ultramafic suites. The mafic-ultramafic sequences have been variously interpreted as members of ophiolites from different tectonic settings (Sukamto, 1982; Smith and Silver, 1991; Monnier et al., 1995; Bergman et al., 1996; Kadarusman and Parkinson, 2000; Kadarusman et al., 2004). Petrology and geochemistry of the ultramafic suites from the Central Sulawesi Metamorphic Belt and the East Sulawesi Ophiolite Belt as well as the Banggai-Sula and Tukang Besi have been studied in detail((Smith and Silver, 1991; Kadarusman and Parkinson, 2000; Kadarusman et al., 2002, 2004). However, unlike those three provinces, no studies have been conducted so far on the ultramafic suites of the Western Sulawesi Volcanic Arc, particularly from the south arm of Sulawesi, except those of van Leeuwen (1981) and Sukamto (1982), which only reported the general geology of the ultramafic sequences. Recently, Maulana (2009) investigated the south arm ultramafic suites and considered them part of the South Sulawesi Basement Complexes. As the occurrences of ultramafic suites may provide important information on the tectonic evolution of this region, detailed study is needed to shed the light on their tectonic significances.

In this paper, mineral chemistry and whole-rock geochemical data (major and trace elements) from the ultramafic suites of two separate blocks, Bantimala and Barru, are reported for the first time. These data are used to identify the origin of the suites by comparing

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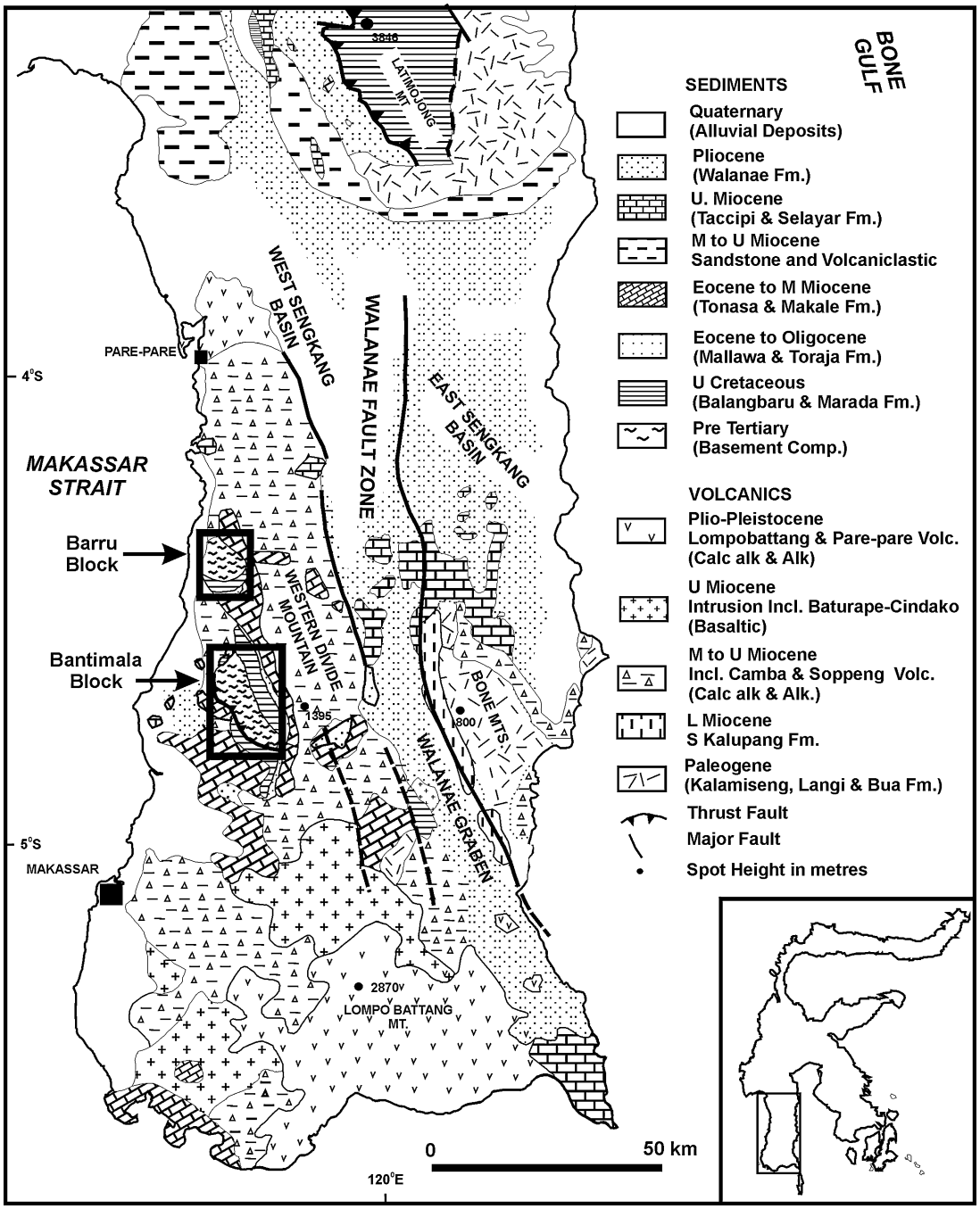

Fig. 1. Regional geological map of south Sulawesi (modified from van Leeuwen, 1981; Maulana, 2009). The Barru Block is the smaller and more northerly basement complex; the larger Bantimala Block is to the south. There is a gap of ca. 30 km between them.

them with published data for other ultramafic rocks. The conclusions drawn are used to provide insight into the petrogenesis of the rocks and their tectonic setting.

2. Regional geology

The South Sulawesi region lies in the south arm of Sulawesi, within the West-North Sulawesi Pluto-Volcanic Arc province. This region is made up of sediments and volcanic arc products overlying a pre-Tertiary basement complex. The present day tectonic system is dominated by two major NNW-SSE trending strike-slip faults, the West Walanae Fault (WWF) and East Walanae Fault (EWF) (van Leeuwen, 1981). Movement on these is mainly sinistral (Berry and Grady, 1987), but an extensional component has resulted in opening of the Plio-Pleistocene Walanae Graben between them (Fig. 1; van Leeuwen, 1981).

The geology of this region consists of five primary sequences; the pre-Tertiary basement complex, Upper Cretaceous sediments, Paleogene volcanics, Eocene to Miocene sediments, and Miocene to Recent volcanics and sediments (Sukamto, 1982; Maulana, 2009).

The pre-Tertiary basement complex, formed by metamorphic and ultramafic rock assemblages, is exposed in the Bantimala and Barru blocks (Maulana et al., 2008). The Bantimala Block is about 25 × 10 km in size, elongated in a NNW-SSE direction. The smaller Barru Block to the north, roughly circular and about 10 km in diameter, is separated from the Bantimala Block by a gap of only