Field Geological Characteristic of Mesozoic Paremba Sandstone, Bantimala Complex, South Sulawesi

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Abstract. We conducted preliminary survey to study field geological characteristic of Mesozoic Paremba Sandstone, Bantimala Complex, South Sulawesi in order to investigate the field occurrence and the petrographic characteristic of some samples from the sandstone unit. The samples were collected from measuring section campaign in three rivers, namely Mallapie, Ceppaga and Bontorio. The field investigation shows that The Paremba sandstone occurs as a tectonic slice within melange complex which is sandwiched by schist and melanges. The sandstones range from fine to coarse-grained sandstone forming a layer of 0.5 up to 50 cm in thickness interlayered with siltstone and shale, forming a sequence set. The sequences are intercalated with other lithologies such as limestone, mudstone, conglomerate, breccia and chert, forming a distinctive unit. In certain place, the units are intruded by basalt dike. Generally, the sandstones are grey to blackish in colour, sometimes show brown to yellowish colour if weathered. Some sandstone is calcareous as shown by strong reaction with acid and the occurrence of carbonate mineral but other samples relatively show less carbonate minerals. In all three rivers, the sandstone units have been strongly tectonized as seen by irregular fold and fault from the strike and dip of the unit layer. Petrographic analyses show that the studied sandstones consist of arkosic sandstone, siltstone and calcareous sandstone which are composed of quartz, orthoclase, plagioclase and calcite in the groundmass with opaque minerals occur as main accessory. Some samples contain muscovite, especially calcareous sample. The sandstone unit shows a typical of coarsening- and thickening upward trend with flaser, lenticular and parallel lamination sedimentary structure. It is interpreted that the sandstone were deposited in shallow marine or shelf region.

1. Introduction
Sulawesi is located in the central part of Indonesian Archipelago which has experienced numerous geological processes such as collision of microcontinent, high-pressure (HP) metamorphism, emplacement of oceanic crust segment and intensive magmatic and volcanic activity during Mesozoic to Tertiary time [1]. These processes produce a complex geological and tectonic setting of the island. The island can be simply divided into 4 provinces based on geological terrane, namely 1) South Arm; 2) North Arm; 3) Southeast Arm; and 4) East Arm. South Arm terrane of Sulawesi has been considered as part of Kalimantan hence eastern margin of Sundaland before spreading of Makassar Strait occurred in Miocene time. As a fragment of Sundaland, the arm has been an object of research by many researchers, especially the occurrence of Mesozoic basement rock in Bantimala and Barru area.

The basement rocks complex consists of various lithology including metamorphic, metasedimentary, sedimentary rocks, block of high-pressure rocks and series of ophiolite rocks forming northwest – southeast trend. There are some distinctive characteristic in this basement
complex, especially the occurrence of mélange, high-pressure metamorphic rocks and unmetamorphosed sedimentary rocks. Previous studies have reported detail discussion on metamorphic rocks [2]; [3]; [4]; [5]; [6] as well as ultramafic rocks [7]. However, report on the occurrence of unmetamorphosed sedimentary has never been conducted. The main purpose of this study is to investigate the field geological characteristic of the Jurassic Paremba Sandstone in Bantimala Complex, South Arm Sulawesi based on measuring section and petrographic observation.

Fig. 1. Geological Map of Bantimala Complex [3]

2. Tectonic Setting and Regional Geology
Paremba sandstone occurs as a tectonic slab within Bantimala Melange Complex. Stratigraphy of the Bantimala Melange Complex was discussed in detail by [5] and [3] (Fig. 1). The complex consists of tectonic slices forming a northeast-dipping trend, which included sedimentary, metamorphic, meta-sedimentary and ultramafic rocks, locally intruded by dacitic to andesitic rocks in composition. The metamorphic rocks show an increasing grade from southwest to the northeast (gresenschist to amphibolite facies). HP metamorphic rocks including glaucophane schists and eclogite found as tectonic block within metamorphic terrane. Sandstone, shale, conglomerate, radiolarian chert, siliceous shale and mélange formed a sedimentary and meta-sedimentary sequence within the complex. The peridotite showed moderately to highly serpenitization process, with local chromite lenses and basalt layers. The mélange consists of sandstone, shale, siliceous shale, chert, basalt, schist and felsic igneous rock in a sheared matrix of shale, as well as schist breccia [2]. The Bantimala Complex is sandwiched by the Balangbaru Formation in the south and north whereas bounded by Tonasa Limestone to the southwest, and by the Camba Formation to the east. The similarities of radiolarians between the
Balangbaru Formation and chert in the Bantimala Complex suggested that the Balangbaru Formation is part of Bantimala Complex. K-Ar ages of 111 Ma were reported by Obradovich in [8] and 113 – 115 ±6 Ma from muscovite in schist by [5] and [6], whereas [7] reported an age of 111± 3 Ma from microfossils in the Balangbaru Formation. The radiolarian in the chert suggested upper Albian to lower Cenomanian in age [5], i.e. from the central part of the interval 112 Ma – 93.6 Ma. Some sedimentary rocks from Bantimala Complex appear to be older than Cretaceous as suggested by [9] and [10].

3. Methodology
The study was based on field work activity using measuring section method in three river sections namely Mallapie River, Ceppaga River and Bontorio River which are perpendicularly cross cut the Bantimala Complex major tectonic trend. We performed petrographic analyses in order to determine the field relationship and petrographic characteristic of the Paremba Sandstone. 20 samples rocks were systematically collected from various localities in three rivers section. Petrographic study was conducted by examining thin sections to determine the rock types, mineral assemblages, fabric and textural relations by using a Nikon petrographic microscope in Optical Mineralogy Laboratory, Geology Department, Hasanuddin University, Makassar.

4. Results
The Paremba sandstone occurs as tectonic slab within mélangé complex. It consists of alternating layer of thinly sandstone with siltstone and shale and sometimes with conglomerate forming a distinctive unit. The sandstone range from fine to coarse-grained sandstone intercalated with limestone, mudstone, conglomeratic sandstone, breccia, chert and shale. In certain place, the sandstone units are intruded by basalt dike. Generally, the sandstones unit are grey to blackish in colour, sometimes show brown to yellowish color if weathered. Most sandstones units are calcareous, shown by strong reaction with acid. In all three sections, the sandstone units have been strongly tectonized as seen by irregular fold and fault from the strike and dip of the unit layer.

4.1 Mallapi Section
Total measured length of Paremba Sandstone in Mallapie Section is 800 meters which is the thickest compare to other two sections. It consists of sandstone which is tectonically overlaid by schist and chert unit and ophiolitic basalt. The section is dominated by interlayering of fine- to coarse-grained sandstone; silt; shale and conglomeratic sandstone with thickness of sandstone ranges from 0.5 – 1 cm for fine-grained unit and up to 1 m thick for relatively coarser grain unit (Fig. 2. a–b). The sandstones are calcareous, showing dark grey in colour composed of quartz, mica and some rock fragments. Pararel lamination, flaser and lenticular are common sedimentary structure in sandstone layer. Cross bedding structure also found but very rare. The unit generally shows coarsening and thickening upward trend. The occurrence of thick layer chert (up to 65 m) and limestone intercalation (up to 40 m) and basalt dikes in certain part are distinctive to this section. The sedimentary environment is interpreted as shelf. In thin section, coarse-grained sandstone show moderate sortation with sub-rounded to angular quartz (Qtz) grains, orthoclase (Or) and Plagioclase (Pl), and grains of opaque (Op).
Fig. 2. Field occurrence of Paremba Sandstone. (a) fine-grained sandstone interlayering with silt and shale in Mallapie Section, (b) grey to blackish medium- to coarse-grained calcareous sandstone in Mallapie Section. (c) Coarse-grained sandstone layer in Ceppaga Section (d) Interlayering of fine- to medium-grained sandstone and silt showing parallel lamination structure in Ceppaga Section. (e) Paremba Sandstone outcrops in Bontorio Section showing a medium to fine grained texture and (f) Fine- to medium-grained sandstone showing typical of flaser and lamination sedimentary structure in Bontorio Section.

4.2 Ceppaga Section
Ceppaga Section is located in the middle region of the studied area, extending about 370 m in length. The section is tectonically sandwiched by schist and dominated by interlayering of calcareous fine- to coarse-grained sandstone and grey to blackish conglomerate. Sandstone layer range from 10 cm – 50 cm but in some layer it reach up to 1 m thick (Fig. 2. c-d). Thin layer of shale is also found associated with scaly clay, breccia and chert. The unit is interpreted to be deposited in shelf environment. The limestone is classified as wackestone. Photomicrograph of siltstone layer in Paremba Sandstone from Ceppaga Section shows a fine-grained texture consists of quartz, feldspar and calcite.

4.3 Bontorio Section
Bontorio Section is located in the most southern area with total thickness about 350 m in the main river and another 190 m in its river branch. The total thickness of Paremba Sandstone is less than 500 m occur as tectonic slices sandwiched by schist unit. Generally it is dominated by interlayering of fine- to coarse-grained sandstone with intercalation of limestone and breccia. The sandstone unit shows a typical of coarsening- and thickening upward trend. Flaser and pararel laminations are
Photomicrograph of fine-grained calcareous sandstone from Bontorio Section consists of quartz, feldspar and calcite in groundmass.

5. Conclusions

(1) Paremba sandstone found as a tectonic slab included in mélange complex. The sandstones show grey to blackish color, calcareous and are sandwiched by schist. The Paremba sandstone composed of alternating of fine to coarse-grained sandstone unit with various in thickness (range from 0.5 – 50 cm) intercalated with limestone, mudstone, conglomeratic sandstone, breccia, chert, shale and intruded by basalt dike. The sandstone has been strongly tectonized and folded.

(2) Petrographically, the studied sandstones consist of arkosic sandstone, siltstone and calcareous sandstone which are composed of quartz, orthoclase, plagioclase and calcite in the groundmass with opaque minerals occur as main accessory. Some samples contain muscovite.

(3) The sandstone unit shows a typical of coarsening- and thickening upward trend show flaser, lenticular and parallel lamination sedimentary structure. It is interpreted that the sandstone were deposited in a shallow marine area or shelf.

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