Characteristics of primary tin mineralization in the Central and West Bangka Island

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Abstract. Bangka Island is an important tin producer in Indonesia, mostly from the secondary tin deposits. However, the secondary tin deposit is depleting, causing further exploration shifted to the primary tin mineral. The purpose of this study is to make a mineralization model of primary tin deposit in Bangka Island. Methods that implemented in this study are petrographic analysis, mineragraphic analysis, XRD (X-Ray Diffraction), and XRF (X-Ray Fluorescence) analysis. The studied rock samples that consisted of granite, meta-sandstone, and sandstone. Some of the rocks are altered rocks with varying intensity. Petrographic and mineragraphic analysis show the presence of minerals that indicate the primary tin deposits, such as cassiterite, tourmaline, topaz, sericite, pyrite, and sphalerite. XRF analysis shows data about the value of Sn elements so that they can be classified into two classes, very high grade (> 800 ppm), and low grade (100–200 ppm). XRD analysis is necessary to do to determine the type and intensity of alterations that occur in the study area. The results of each analysis will provide supporting information regarding the primary tin mineralization process in Bangka Island.

Keywords: Primary tin deposit, mineralization, alteration, cassiterite, Bangka

1. Introduction

Bangka Island is part of the Tin Islands, located in Sundaland [1] and Bangka is part of the Southeast Asian Tin Belt [2]. Supported by the lithology condition where the stratigraphy of the Bangka island consists of: [3]

- Pemali Complex Formation (Permian), consist of metamorphic rock.
- Tanjunggenting Formation (Early–Late Triassic), consist of sandstone and mudstone.
- Granite Klabat Formation (Late Triassic), consist of granite.
- Ranggam Formation (Early–Late Pliocene), consist of sandstone and mudstone.
- Alluvial Deposits Formation (Holocene), consist of alluvial deposits.

The occurrence of granite intrusion process that penetrated two older formation layers (Pemali complex formation and Tanjunggenting formation) indicates the possibility of a metasomatism process that is related to the process of forming primary tin deposits. Minerals such as cassiterite, tourmaline,
pyrite minerals are the key minerals from primary tin deposits. An altered rock is an indication of the occurrence of a metasomatism process associated with the primary tin deposits [4].

Greisen deposit system which is influenced by granite intrusion and the process of metasomatism in sedimentary and granite rocks itself is divided into two types or two zones, namely endogreisen zone which is characterized by altered granite and exogreisen zone which is characterized by certain minerals and vein systems. [5]

The quantity of secondary tin deposits has begun to decrease, so further exploration is needed regarding primary tin deposits. The purpose of this research is to determine the characteristics of primary tin deposits in the Central and West Bangka Islands.

2. Data and method
The data used in this study are several rock samples consisting of granite, sandstone, and metamorphic both fresh and altered with varying alteration intensities.

The method used to achieve the objectives of this study is the petrographic analysis method to determine rock types and identify the presence of primary tin deposit key minerals, mineragraphic analysis to identify the presence of ore minerals and paragenesis of ore minerals, XRD analysis to determine the types of alterations formed in the study area, and XRF analysis to measure the value of Sn element concentration in the study area.

3. Results and discussion

3.1. Petrographic analysis
Based on observations using microscopes (petrographic analysis) researchers determine several types of rocks such as granite, sandstone, and metamorphic using Travis and Folk rock classification [6, 7]. Researchers found the presence of key minerals in the presence of primary tin deposits such as quartz, tourmaline, and sericite. Photographs of analysis results can be seen in figure 1. Rock samples containing tourmaline minerals are altered sandstones, this indicates that primary tin deposits in the Central and West Bangka Islands are included in the exogreisen zone.

Figure 1. Results of petrographic analysis (Qz: Quartz, Bt: Biotite, Pl: Plagioclase, Ser: Sericite, Tur: Tourmaline).
3.2. Mineragraphic analysis
The ore mineral identified from mineragraphic analysis results are pyrite, chalcopyrite, cassiterite, sphalerite, and galena (figure 2). Interactions between observed minerals from the mineral texture in all samples are quite diverse. The dominant textures formed are inclusion, coexist, liquid immiscibility, and space filling. The paragenesis of ore mineral determined from the mineral texture and mineral formation temperature can be seen in figure 3. Cassiterite is an ore mineral as a key mineral of the presence of primary tin deposits. Ore minerals such as pyrite, chalcopyrite, sphalerite, cassiterite and galena as sulfide minerals carrying base metals and valuable minerals. Ore mineralization occurs in quartz veins in sedimentary rock bodies.

3.3. XRD analysis
The results of the XRD analyses in figure 4 show that the minerals illite, quartz, topaz, tourmaline, and dickite are alteration minerals commonly found in almost all samples analyzed. Alteration zone identified from the abundance of alteration minerals is greisen alteration zone, characterized by the presence of tourmaline, topaz, and high-temperature quartz minerals. Figure 5 shows Rock samples

Figure 2. (a) Pyrite as a free grains or space filling. (b) The fluid immiscibility process occurs between the mineral pyrite and sphalerite. (c) Cassiterite and topaz coexist. (d) Chalcopyrite as free grains or filling space, and (e) Cassiterite inclusions Galena.
numbered DBU-02, DBU-13, and DBT-09 which contain the key minerals of presence primary tin deposits such as tourmaline and topaz are an altered granite, this indicates that primary tin deposits in Central and West Bangka Island are included in the endogreisen zone.

These minerals formed in environments with acidic pH to nearly neutral and indicate that the mineral-carrying fluid of ore is formed at temperatures of 210–310 °C.

**Figure 3.** Paragenesis of ore mineral

![Figure 3](image)

**Figure 4.** Graph of XRD analysis

![Figure 4](image)
Table 1. Classification of Sn concentration elements

| Sample   | Element | Percentage (%) | Concentration (Ppm) | Classification         |
|----------|---------|----------------|---------------------|------------------------|
| DBU-13   | Sn      | 33.7           | 337000              | Very high grade       |
| DBT-09   |         | 0.013          | 130                 | Low grade              |
| DBU-10   |         | 0.0061         | 61                  | -                      |
| DBU-01   | Sn      | 0.0054         | 54                  | -                      |
| DBU-14   |         | 0.1            | 1000                | Very high grade       |
| DBT-03   |         | 0.0143         | 143                 | Low grade              |
| DBU-04   |         | 0              | 0                   | -                      |

3.4. XRF Analysis

The results of measuring the concentration of tin (Sn) in the XRF analysis method and making a grade tin can be seen in table 1.

4. Conclusion

The mineralization that occurs on the Central and West Bangka islands has the character of alteration zone greisen and has a formation fluid that is relatively acidic to neutral at high temperatures (210–310 °C). Mineragraphic analysis results show the presence of ore minerals such as pyrite, chalcopyrite, sphalerite, cassiterite and galena as sulfide minerals carrying base metals and valuable minerals. Ore mineralization occurs mostly in the form of filling in quartz veins in the body of sedimentary rocks (side rocks). Data from the XRF analysis showing the value of the elemental content of tin (Sn) in several samples tested so that it can be classified into several classes, namely, Very High Grade (> 800 ppm), and Low Grade (100–200 ppm). The primary tin deposit type on the Central and West Bangka Island are included in the endogreisen zone and in the exogreisen zone.
Acknowledgments
This work is supported by Hibah Publikasi International Terindeks 9 (PIT9) with grant number NKB-0035/UN.R3.1/HKP.05.00/2019 from Universitas Indonesia.

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