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Ore Characteristics and Fluid Inclusion of the Base Metal Vein Deposit in Moncong Bincanai Area, Gowa, South Sulawesi, Indonesia

Karakteristik Bijih dan Inklusi Fluida pada Deposit Urat Logam Dasar di Daerah Moncong Bincanai, Gowa, Sulawesi Selatan, Indonesia

Asmariyadi, R. Langkoke, A. Maulana, I. Nur, and W. Astaman

Department of Geological Engineering, Hasanuddin University,
Jln. Perintis Kemerdekaan Km. 10, Tamalanrea, Makassar 90245, Indonesia

Abstract

This paper is dealing with ore characteristics and fluid inclusion of the Moncong Bincanai, Biringbulu Subregency of Gowa Regency, South Sulawesi Province, Indonesia. The mineralization is a vein type, with the orientation of N170^{o}E /65^{o}SW, hosted in open-space filling within basalt. The mineralization consists of galena, sphalerite, chalcopyrite, and pyrite. Vein thickness ranges from 5 - 17 cm, showing a crustiform banding texture, with a sequence from outer to centre: quartz, carbonate (siderite), sulphide. The quartz displays primary growth textures such as comb, crystalline, saccharoidal, and colloform. Analytical methods applied include AAS and fluid inclusion microthermometry. Chemical composition of the vein indicates an average of Pb = 47.92%, Cu = 1.27%, Zn = 1.02%, and Fe = 9.46%, which shows a significant concentration of Pb. Fluid inclusion microthermometry results indicate a range of formation temperature of 240^o - 250^{o}C and salinity of the responsible hydrothermal fluid of 2.1 - 2.5 wt.% NaCl eq. The deposit is categorized into low-sulfidation epithermal deposits, which was formed within a range of 410 - 440 m below paleosurface.

Keywords: epithermal vein, base metal, ore mineralization, fluid inclusion

Sari

Tulisan ini membahas karakteristik bijih dan inklusi fluida pada daerah Moncong Bincanai, Kecamatan Biringbulu, Kabupaten Gowa, Provinsi Sulawesi Selatan, Indonesia. Tipe mineralisasi berupa urat dengan orientasi N170^{0}E/65^0 SW yang terdapat sebagai pengisi retakan dalam basal. Mineralisasi terdiri atas mineral galena, sfalerit, kalkopirit, dan pirit. Tebal urat antara 5 - 17 cm. Tekstur urat yaitu symmetric crustiform banding, dengan urutan dari luar ke dalam: kuarsa, karbonat (siderit), dan lapisan sulfida yang didominasi galena. Kuarsanya memperlihatkan tekstur pertumbuhan primer yaitu dari tekstur comb, kristalin, saccaharoidal, dan colloform. Metode analisis yang digunakan yaitu AAS dan mikrotermometri inklusi fluida. Berdasarkan hasil analisis pada percontoh urat, kadar rata-rata unsur Pb = 47,92%, Cu = 1,27%, Zn = 1,02%, dan Fe = 9,46%. Hal ini menunjukkan konsentrasi mineralisasi Pb yang cukup potensial. Dari hasil pengamatan inklusi fluida pada urat kuarsa didapatkan kisaran temperatur 240 - 250^{o}C serta salinitas antara 2,1 - 2,5 wt.% NaCl eq. Endapan tersebut termasuk dalam lingkungan epitermal sulfidasi rendah yang terbentuk pada kedalaman sekitar 410 - 440 m di bawah permukaan purba.

***Kata kunci**: urat epitermal, logam dasar, mineralisasi bijih, inklusi fluida*

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Corresponding Author: +6285242538606/*asmariyadi@yahoo.co.id*

INTRODUCTION

Baturappe area in Gowa, South Sulawesi Province is a known potential regency of base metal mineralization. One of the prospect areas within the regency is Moncong (Mount) Bincanai (Figure 1). A number of works related to the deposit have been reported *(e.g.* Zulkifli *et al.,* 2002; Nur *et al.,* 2009) both in regional and local scales. However, so far no detailed studies particularly focused on ore characteristic and fluid inclusion microthermometry of the base metal deposit in the area have been conducted. This kind of study is very important in order to elucidate the genesis of the mineralization. This paper discusses a recent study ofthe deposit, which is focused on the pattern and textures of the base metal vein (quartz and sulphide bands), ore grade and distribution in the vein, as well as fluid inclusion microthermometry. The objectives ofthe study are to interpret the genetical aspects responsible to the mineralization, and to estimate the depth of formation.

The paper has been presented in the Seminar of the 36th HAGI and 40th IAGIAnnual Convention and Exhibition Makasar 26 - 29 September 2011. The paper is also contained in the Proceedings JCM Makasar 2011.

REGIONAL GEOLOGY

The studied area is situated in the southwestem part of the Geological Map of Ujungpandang, Benteng and Sinjai Quadrangles (Sukamto and Supriatna, 1982). The area is occupied by volcanic units of the Baturappe Volcanics, which is a series of extrusive and intrusive rocks, potassic alkaline in affinity, and 12,8 ± 0,64 Ma or Middle Miocene in age (Yuwono *et al.*, 1987, in Darman and Sidi, 2000). Sukamto and Supriatna (1982) grouped these volcanics into a single group ofLate Pliocene in age, based on its stratigraphic position.

The Baturappe Volcanics consist of lava and breccia, with intercalations of some tuffs and conglomerates, basaltic in composition. The lava commonly displays columnar and sheeting joints. The breccia consists mostly of coarse components, 15 - 60 em, mainly basaltic with small amounts of andesitic material, cemented by coarse tuff lapilli,

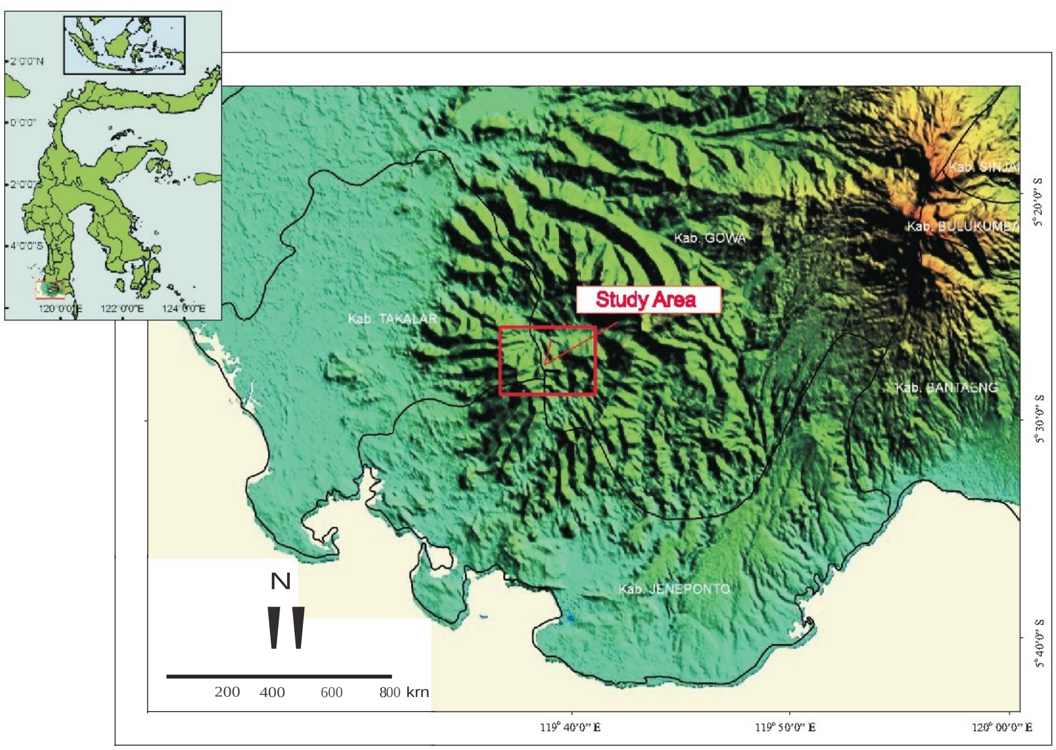

Figure 1. Studied area in Moncong Bincanai (red box in SRTM imagery), Gowa, South Sulawesi.

containing abundant pyroxene fragments. Dioritic intrusive consisting of stock and dyke at the vicinities of Baturappe is thought to be the remnant of eruptive centre (Tpbc); the rocks in its surroundings are highly altered, amygdaloidal with secondary minerals of zeolite and calcite; ore mineral at Baturappe is possibly related to the dioritic intrusives, whilst the area around Baturappe is dominated by lavas (Tpbl). This unit is at least 1,250 min thickness.

LocAL GEOLOGY

Based on surface geological studies, rocks in the studied area is composed ofbasaltic and andesitic lava member of the Baturappe Volcanics. Generally, the lavas have been affected by hydrothermal alteration of chloritization, epidotization, and propilitization. In certain places where faulting is intensified, this unit is brecciated and fractured. The fractures are filled with 0.5- 5 m dykes of diorite, andesite and basalt, as well as mineralized quartz veins (Zulkifli *et al.*, 2002).

Location and orientation of the Bincanai vein (the object of this study) are shown in Figure 2, which are plotted on the geological map of Sapaya Quadrangle (Dinas Pertambangan dan Energi Kabupaten Gowa, 2007), based on coordinate data which were determined by a high accuracy level (10 - 15 error) of Garmin Etrex GPS.

METHODS

Sampling of rocks and veins was conducted systematically using channel sampling method on four different points at the Bincanai base metal vein, with an interval of 25m (Figure 3). Analytical methods applied include:

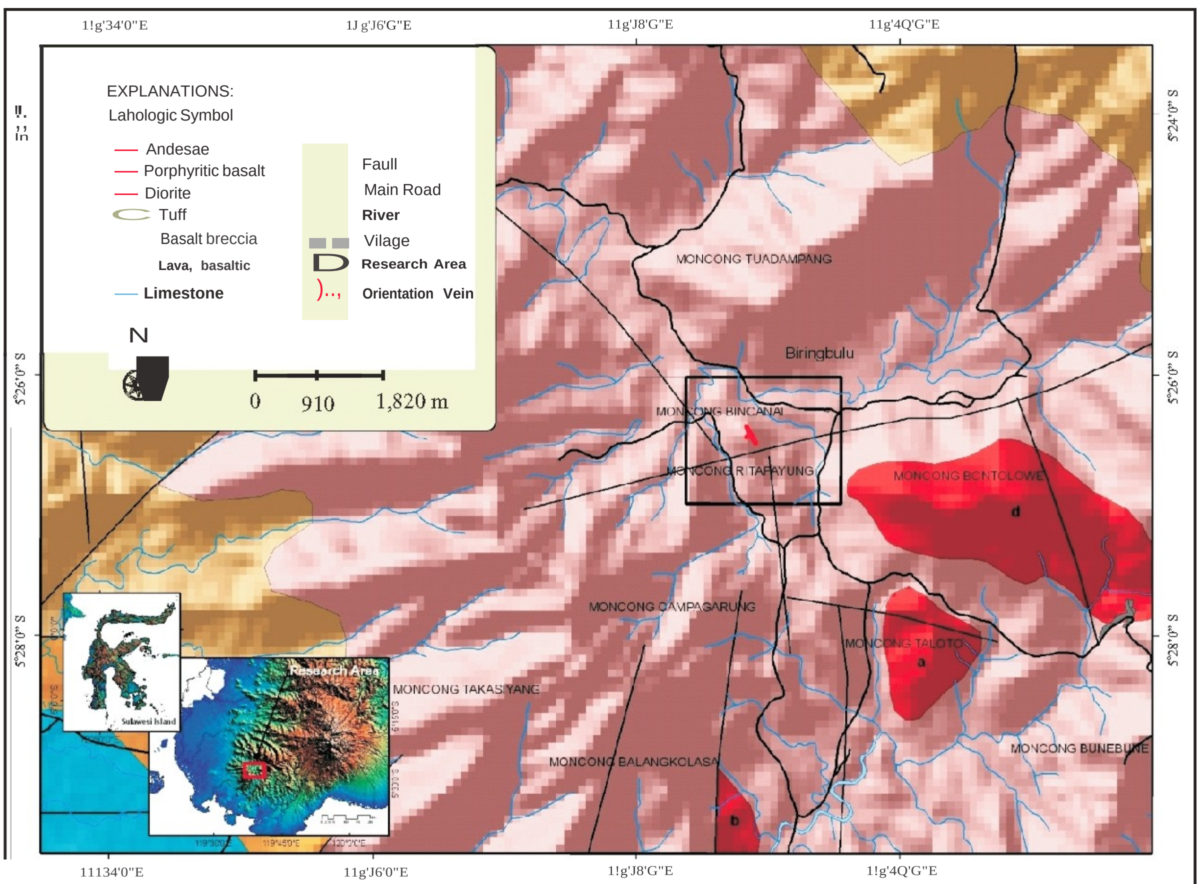

Figure 2. Geological map of the studied area, Sapaya Quadrangle, 1 : 50.000 in scale (Dinas Pertarnbangan dan Energi Kabupaten Gowa, 2007).

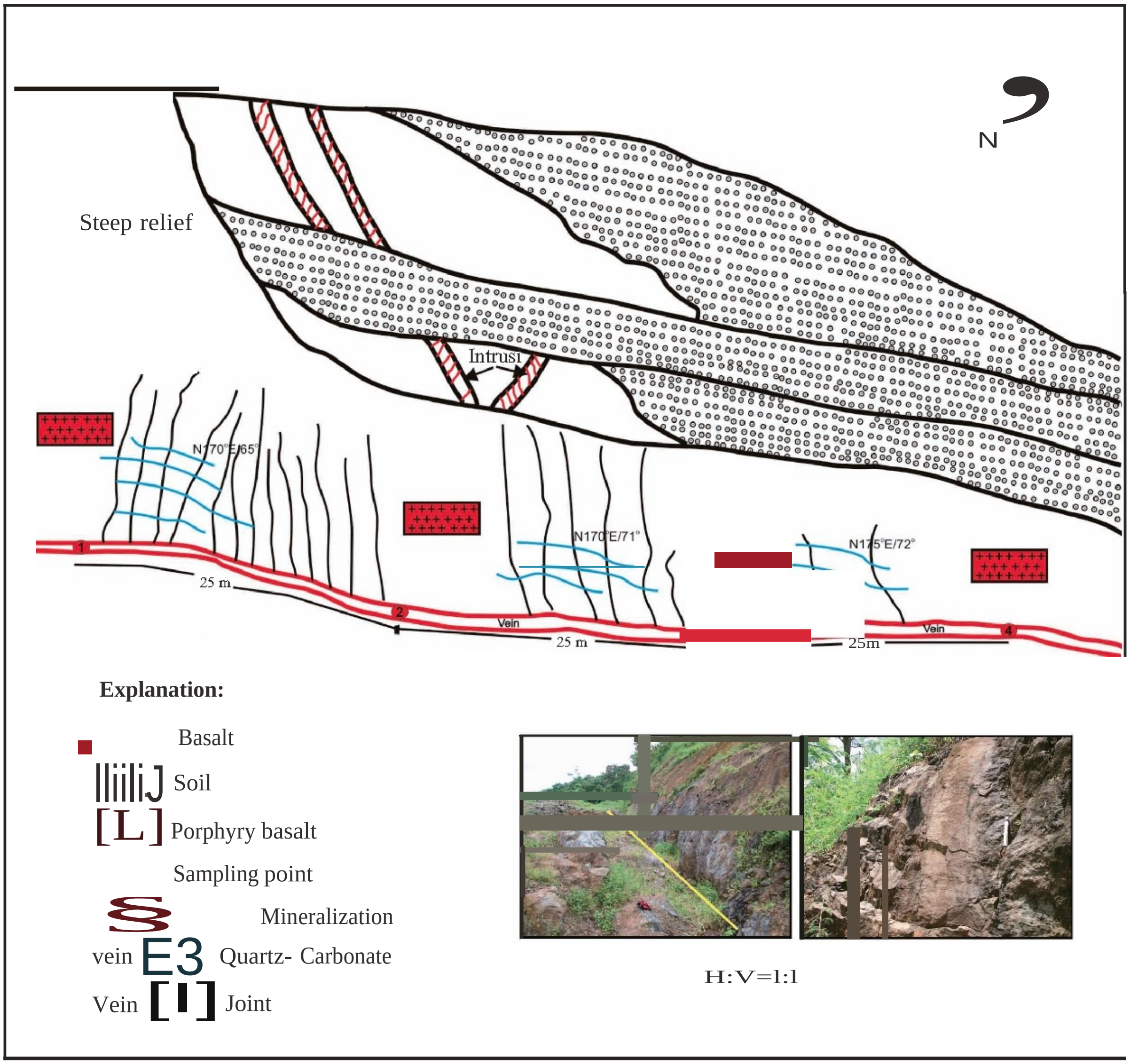

Figure 3. Sketch of the Bincanai vein distribution and sampling points. Inset pictures are outcrops of the vein (left) and dyke (right).

AAS (Atomic Absorption Spectrometry) conducted on the sulphide band samples of the vein, to determine the ore grade and distribution. Elements determined include Cu, Pb, Zn, and Cr. The analysis was conducted at the tek:tvfiRA laboratory, Bandung.

Fluid inclusion microthermometry; which was conducted on the quartz band samples of the vein, to estimate the formation temperature of the vein. The analysis was conducted at the Mineral Physic Laboratory, Pusat Penelitian Geoteknologi, LIPI, Bandung.

REsuLTS AND DiscussiON

Vein Characteristics

In the field it was recognized that the Bincanai vein lies within Nl70°E/65°SW orientation, 5 - 17 em thick, and hosted in basalt. This vein is distributed around 150 m long on the east slope of Moncong Bincanai (Figure 3). The mineralization occurs as an open space (fracture) filling which consists of galena, sphalerite, and chalcopyrite, with pyrite as a gangue.

The vein texture is a symmetric crustiform banding, with a succession from outer to inner: quartz, carbonate (siderite), and sulphide. The sulphide band is dominated by galena (Figure 4a). Based on THE observation on the vein samples, some indications of primary growth textures in the quartz of the vein are recognized, such as comb in samples ST 1 and ST 4 (Figure 4b); colloform in sample ST 3; as well as fine-grained crystalline (saccharoidal) in sample ST 2 and ST 3 to coarse-grained crystalline (Figure 4c and 4d).

The dominant sulphide in the sulphide band of the vein is galena, gray to black in color, coarse-grained crystalline (0.2 - 1.5 em); the thickness of the sulphide band is up to 10 em (Figure 5).

Based on textural model and zoning by Morrison *et al.* (1990), the base metal vein in the study area is categorized into crystalline superzone which is characterized by crystalline texture of the quartz. The quartz vein in the studied area is associated with carbonate and sulphide (siderite and sulphide). Thus the vein is subsequently categorized into a crystalline quartz+ carbonate+ sulphide- crustiform zone.

Ore grade of the vein determined by AAS is shown in Table 1. From four samples analyzed, the vein indicates to contain an average of: Pb = 47.93%, Cu = 1.27%, Zn = 1.03%, and Fe= 9.46%. From the composition, it is shown that the vein has a significant concentration ofPb. The high Fe content of the vein is probably controlled by the abundance of pyrite as gangue mineral. Another possibility is the occurence of iron oxide in the wall rocks

Fluid Inclusion Microthermometry

The fluid inclusions in quartz of the vein are mostly liquid-rich two-phase (L + V) inclusions

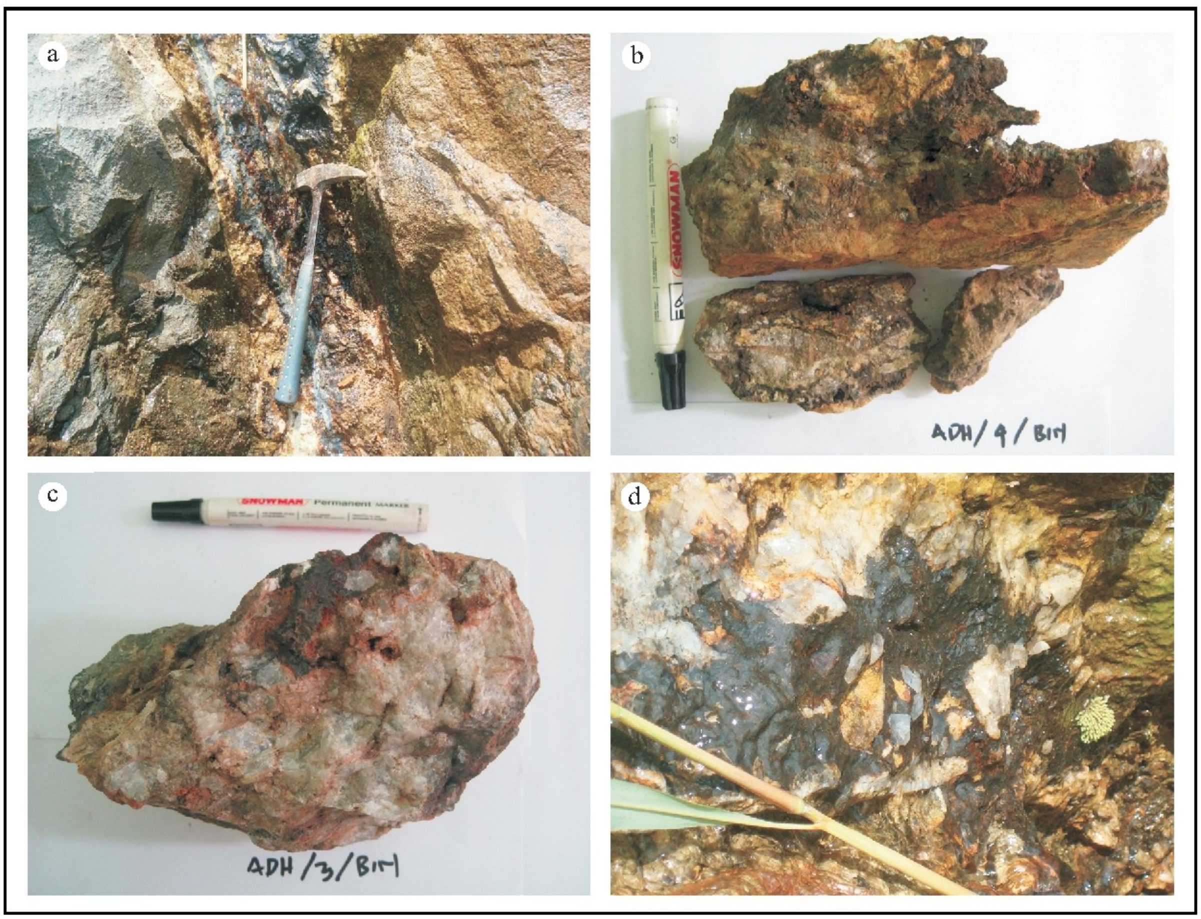

Figure 4. (a) Outcrop of the mineralized vein shows a symmetrical crustiform banding texture, (b) Quartz vein showing comb texture, (c) Quartz showing saccharoidal texture, (d) Coarse crystalline quartz texture.

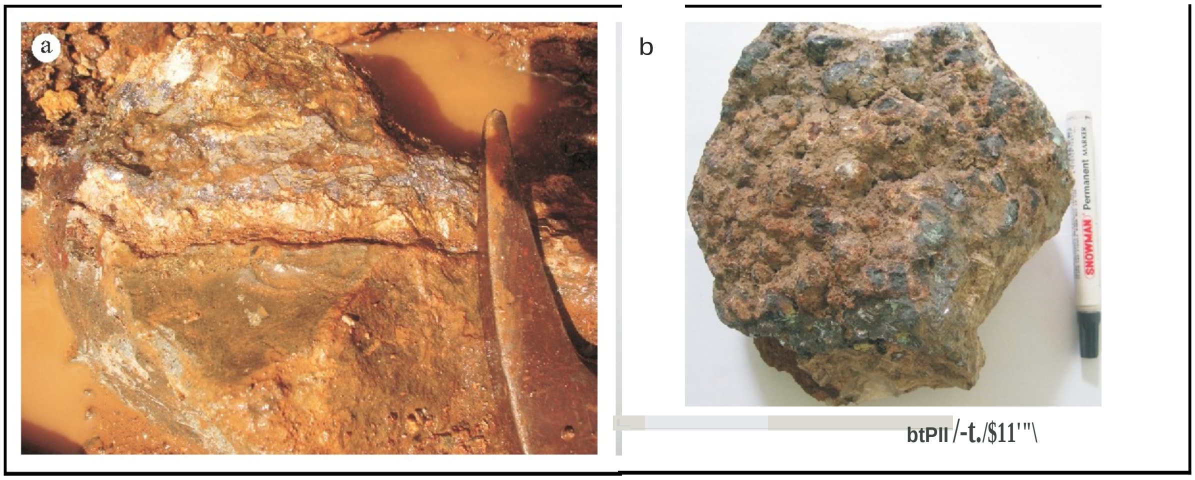

Figure 5. (a) Coarse-grained galena crystals which is up to 1.5 em in size (yellow circle) (b) The sulphide (base metal) band of the Bincanai vein (±10 em; black strip).

Table 1. Chemical Composition of the Bincanai Vein Determined by AAS

No. **Station**	**Pb(%)**	Cu(%)	Fe(%)	**Zn(%)**
ADH/Bin/01	40.2	1.30	10.41	2.93
ADH/Bin/02	64.2	0.52	3.99	0.52
ADH/Bin/03	36.7	0.50	14.55	0.15
ADH/Bin/04	50.6	2.77	8.89	0.50
	Average	47.9	1.27	9.46
	1.03			

(Figure 6). Determination of formation temperature of the vein in the studied area is based on fluid inclusion microthermometry. The homogenization temperatures (Th) which have previously been defined from the microthermometry (the range of This 208 - 267°C) were then drawn in a histogram (Figure 7). The peak of the histogram is considered as the formation temperature of the vein (240 -

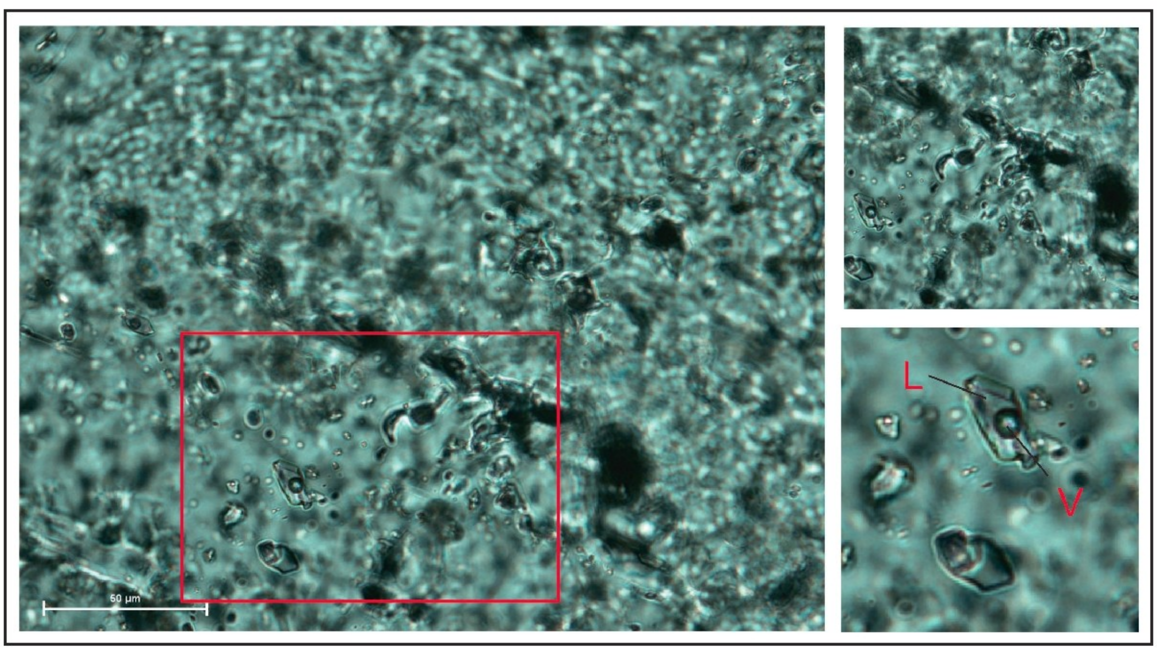

Figure 6. Photomicrograph of two-phase liquid-rich primary fluid inclusions trapped in quartz from Moncong Bincanai vein. L =liquid; V =vapor.

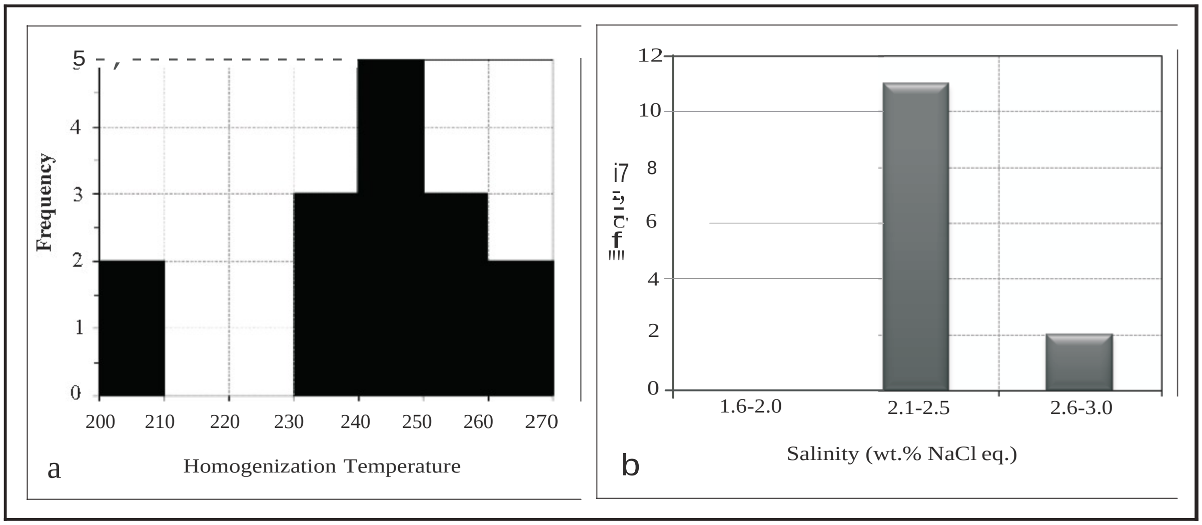

Figure 7. Histograms of fluid inclusion microthermometric results on quartz from sample ST 2: (a) Homogenization temperature, (b) Salinity.

250°C; Figure 7a), with an assumption that all of the fluid inclusions were trapped during the quartz crystal growth (Shepherd *et al.*, 1985). Salinity of the hydrothermal fluid that responsible for the mineralization was determined by converting the melting temperatures (Tm) using the equation of Bodnar (1993). The result indicates a range of salinity of 2.1 - 2.5 wt.% NaCl eq. (Figure 7b).

From the fluid inclusion study, it is indicated that the hydrothermal fluid was a fluid-rich and low salinity. This lead to an interpretation that the vein was formed in a relatively shallow level where there was a mixing between the hydrothermal fluid and groundwater. By assuming that the hydrothermal fluid was diluted, the formation temperature and the salinity which have been determined from fluid inclusion microthermometry can then be used to infer the formation depth ofthevein by applying the boiling point curve ofHaas, 1971 *(e.g.* Shepherd *et al.* , 1985). It is estimated the minimum formation depth of the vein is about 410 - 440 m below the paleo-water table (Figure 8).

CoNSEPTUAL MoDEL AND MINERALIZATION TYPE OF THE BINCANAI VEIN

Based on the physical characteristics of the vein and the fluid inclusion microthermometric results, a conceptual model of the Bincanai vein can be proposed using the genetic model of epithermal deposit of Morrison *et al.* (1990).

The physical characteristics considered include the typical texture of the vein such as the symmetric crustiform banded texture, the crystalline textures of the quartz (fine-grained or saccharoidal to coarse-grained crystalline), the comb and coHoform textures, and the metal association of galena, sphalerite, chalcopyrite, and pyrite. Those textures indicate open space filling in a hydrothermal trap filling system.

Based on the fluid inclusion microthermometric results, the vein is estimated to be formed at a temperature range from 240°C to 250°C, within a depth range about 410 - 440 m below the paleo-water table. When plotted on the epithermal model of Buchanan (1981; in Morrison *et al.*, 1990), this mineralization was formed below the boiling zone (Figure 9).

By considering the classification of hydrothermal deposit on the basis of its mineralogy and formation temperature and depth of Lindgren (1933; in Evans, 1993), combined with the results of studies and the discoveries of epithermal deposits around the Circum-Pacific by Hedenquist *et al.* (2000), it can be interpreted that the deposit in the studied area is a low sulphidation epithermal deposit type.

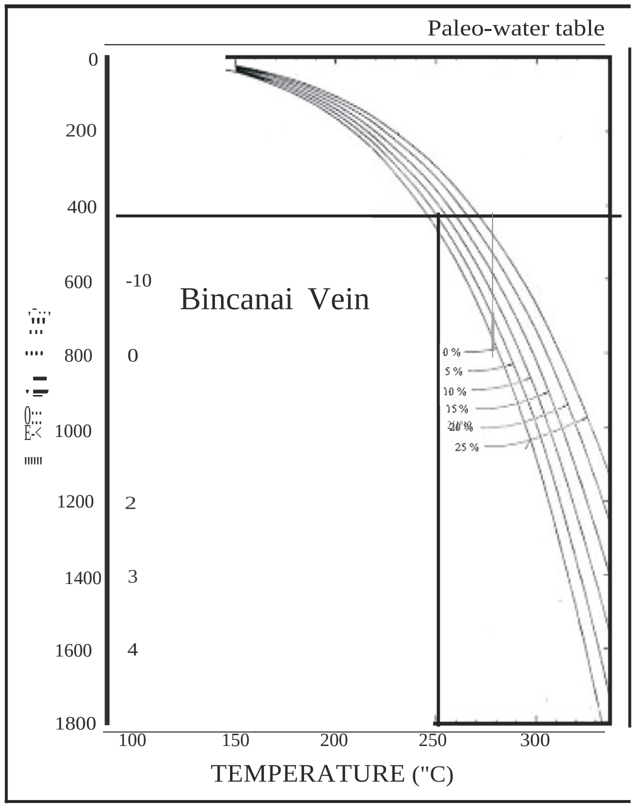

Figure 8. Estimation of the minimum formation depth of the Bincanai vein using the boiling point curve of Haas (1971).

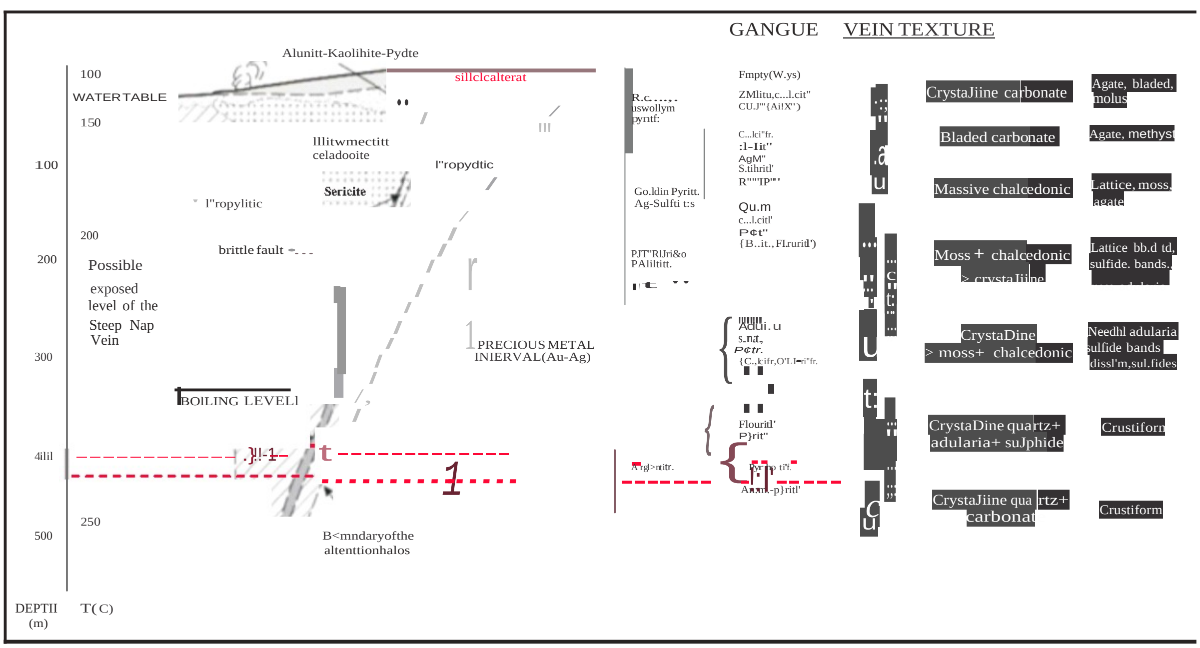

Figure 9. Conceptual model of the Bincanai base metal vein, plotted on the epithermal model (modified from Morrison *et al.*, 1990). The estimated formation depth of the deposit is within the area of the red lines.

CoNCLUSIONS

Some conclusions are defined from this study:

The mineralization in the studied area is of a vein type with the orientation of N170° E/60° SW composed of galena, sphalerite, chalcopyrite, and pyrite.

The vein texture is a symmetric crustiform banding, with a succession from outer to inner: quartz, carbonate (siderite), and sulphide band which is dominated by galena. The vein thickness ranges between 5 - 17 em.

The quartz texture of the vein is crystalline varying from saccharoidal to coarse-grained crystalline; comb and colloform textures also occur.

Based on fluid inclusion microthermometry, the formation temperature of the vein in the studied area is 240°- 250°C with an average of salinity is 2.1 - 2.5 wt.% NaCl eq.

Deposit type of the studied area is low sulphidation epithermal deposit.

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