



Geochemistry of Au-bearing pyrite from the Sepon Mineral District, Laos DPR, Southeast Asia: Implications for ore genesis

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ABSTRACT

The Sepon gold-copper district occurs along the Truong Son Foldbelt in a 10 km × 40 km east-trending corridor in southern Laos. This study has investigated the nature of gold in pyrite and ore-forming fluid characteristics using Laser Ablation Inductively Coupled Plasma Mass Spectrometry (LA-ICP-MS) and Proton Induced X-ray Emission (PIXE) techniques. Gold is present as invisible gold (Au^{+1}) and as nanoparticles of gold (Au^0) in both sedimentary-rock hosted gold and skarn Cu-Au deposits. Gold is present in an early syngenetic pyrite generation (pyrite 2B) with concentrations to 0.5 ppm. Post-sedimentation processes included formation of quartz veins which host pyrite 3B with concentrations to 1.8 ppm Au. The highest concentrations of gold were found in the rims of hydrothermal vein-hosted pyrite 4A and in skarn related pyrite, suggesting gold concentration at a later stage during the ore-forming processes and not during sedimentation.

As rhyodacite-porphyry is proximal to calcareous shale and dolomite that host ores, it is plausible that the emplacement of rhyodacite-porphyry introduced significant amount of hydrothermal fluids that circulated through fractures and favoured high grade (to 293 ppm Au) in pyrite 4A and pyrite SKN2. Gold is preferentially concentrated in As-rich zones and in areas that underwent brittle deformation, as evidenced by fracture-fill coarse-grained pyrite 4A, indicating a structural control to ore formation. The predominance of Se, Bi and Te in pyrite SKN1 and the elevated concentrations of Bi, Cu, Se, Sn and Mo in pyrite SKN2 raise the possibility of derivation from a magmatic source. The presence of primary hematite associated with the skarn suggests prevailing oxidising fluid conditions during Au mineralisation in pyrite SKN2. There is a striking chemical similarity between pyrite 4A core and py-SKN1 and rimmed zones of pyrite 4A and pyrite SKN2, which indicates possibility of two types of hydrothermal fluids. The As-rich fluids with elevated concentrations of Au, Se, Sb, Tl, and Cu recorded in pyrite 4A rims and pyrite SKN2. The As-poor fluids with elevated concentrations of Ni and Pb yielded in pyrite 4A cores and pyrite SKN1. The chemistry of pyrite has also shown that both ore-forming fluids are undersaturated in Au similar to Au-bearing pyrite in the Carlin-type deposits, Nevada, USA.

1. Introduction

The Sepon Mineral District (SMD) is located north of the town of Sepon and 130 km east of the provincial centre of Savannakhet in Savannakhet Province, in southern Laos (Fig. 1). Known gold and copper deposits and prospects occur in an east trending corridor, approximately 40 km long by 10 km wide. At least three broad mineralisation styles are recognised: sedimentary-rock hosted gold deposits; Cu-Au skarn, and quartz stockwork porphyry Cu-Mo (Manini et al., 2001; Cromie, 2004a,b, Olberg et al., 2006; Cannell and Smith, 2008; Cromie 2010, Cannell et al., 2015). The Australasian Joint Ore Reserves Committee (JORC Code) compliant gold resources of 4.5 Moz Au have

been reported (Cannell et al., 2015). Extensive exploration and near mine resource development programs in the SMD by Oxiana Limited (2000–2005) significantly upgraded the indicated and inferred resources to 82.7 Mt @ 1.8 g/t Au for 4.75 million ounces of gold (at 0.5 g/t Au cut-off) in 8 separate but adjacent SHGD, as well as a gold resource of 18 Mt @ 0.76 g/t occurring in an ironstone horizon over the Khanong copper deposit.

Previous studies have concluded that the gold mineralisation in the sedimentary-rock hosted gold deposits is predominantly disseminated at the micro-scale, and is closely associated with pyrite. These deposits share similarities with Carlin-type gold deposits in Nevada, USA (Manini et al., 2001; Cromie, 2010; Bouttathep, 2013; Cannell et al.,

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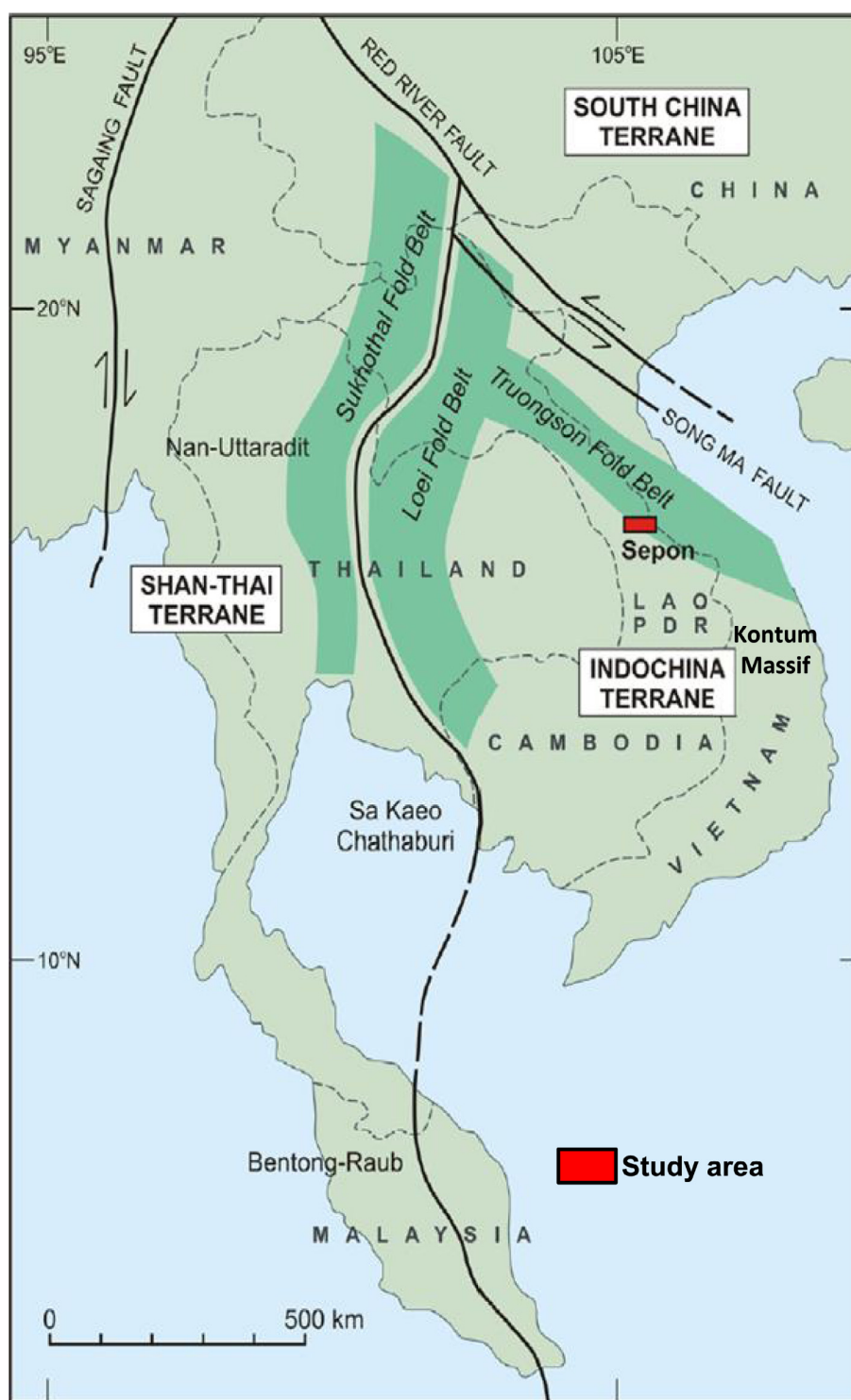


Fig. 1. Map showing the study area, the tectonic setting of mainland SE Asia and the present location of continental terranes (adapted from Metcalfe, 1999). The South China, Indochina and Shan-Thai terranes are separated respectively by the sinistral Red River Fault, the Nan-Uttaradit, Sa Kaeo-Chathaburi and Bentong-Raub ophiotic zones in Malaysia, and the dextral Sagaing Fault in Myanmar. The Sepon Mineral District is shown as a red boxed area that is located along the Truong son Fold Belt on the NE margins of the Indochina Terrane.

2015; Fig. 1).

In this paper, we document the texture and trace element composition of pyrite using both Laser ablation inductively coupled plasma mass spectrometry (LA-ICP-MS) and Proton Induced X-ray Emission (PIXE) techniques and discuss implications for ore genesis.

2. Regional geological setting

The tectonic setting of mainland Southeast Asia including the Indochina Terrane has been described by Metcalfe (1999), Lepvrier et al. (1997,), and Sone and Metcalfe (2008). Fold belts composed of Palaeozoic sedimentary and volcanic rocks surround the Precambrian Indochina Terrane, and host a range of hydrothermal deposits,

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