



## Spectral characteristics of propylitic alteration minerals as a vectoring tool for porphyry copper deposits



Luke C. Neal<sup>a</sup>, Jamie J. Wilkinson<sup>a,b,c,\*</sup>, Philippa J. Mason<sup>a,b</sup>, Zhaoshan Chang<sup>c,d</sup>

<sup>a</sup> Department of Earth Science and Engineering, Imperial College London, Exhibition Road, London SW7 2AZ, United Kingdom

<sup>b</sup> LODÉ, Department of Earth Sciences, Natural History Museum, London SW7 5BD, United Kingdom

<sup>c</sup> ARC Centre of Excellence in Ore Deposits (CODES), School of Geological Sciences, University of Tasmania, Hobart, Tasmania 7001, Australia

<sup>d</sup> Economic Geology Research Centre (EGRU) and Academic Group of Geosciences, College of Science and Engineering, James Cook University, Townsville, Queensland 4011, Australia

### A B S T R A C T

Short-wave infrared (SWIR) reflectance spectroscopy is a quick and effective method of detecting and characterising hydrothermal alteration associated with ore deposits, and can identify not only mineral species but also changes in the major element composition of minerals. Porphyry deposits represent large accumulations of valuable metal in the Earth's crust and have extensive alteration signatures making them an attractive target for exploration, particularly by remote sensing which can cover large areas quickly. Reflectance spectroscopy has been widely applied in sericitic (phyllitic), argillic and advanced argillic alteration domains because it is particularly effective in discriminating bright clay minerals. However, the propylitic domain has remained relatively unexplored because propylitic rocks are typically dark and produce relatively poorly-defined spectra.

This study utilised an ASD TerraSpec 4 handheld spectrometer to collect SWIR spectra from rocks surrounding the Batu Hijau Cu-Au porphyry deposit in Indonesia, where previous work has identified systematic spatial variations in the chemistry of chlorite, a common propylitic alteration mineral. Spectra were collected from 90 samples and processed using *The Spectral Geologist* (TSG) software as well as the *Halo* mineral identifier to characterise mineralogy and extract the positions and depths of spectral absorption features, which were then correlated with major element geochemistry. Two diagnostic chlorite absorption features located at around 2250 nm and 2340 nm correlate with the Mg# ( $\text{Mg}/[\text{Mg} + \text{Fe}]$ ) of chlorite, both in terms of wavelength position and depth. As the Mg# increases, the wavelengths of both features increase from 2249 nm to 2254 nm and from 2332 nm to 2343 nm respectively, and absorption depths also increase significantly. In the spatial dimension, these feature variations act as reasonably strong vectors to the orebody, showing systematic increases over a transect away from the porphyry centre, peaking at distances of around 1.6 km, which matches the spatial trend displayed by Mg#, as well as various trace element indicators in chlorite. The hull slope in spectra between 1400 nm and 1900 nm is also shown to increase with Mg#, and the position of an absorption feature at 1400 nm increases with the Al:Si ratio, a parameter that also tends to increase with proximity to porphyry deposits.

Feature depth variations in particular appear to represent a new finding in chlorite reflectance spectroscopy; however, the causes are not entirely clear and require further investigation. Nonetheless, the systematic behaviour provides a potentially useful new tool for exploration in propylitic alteration zones.

### 1. Introduction

Porphyry deposits represent some of the largest accumulations of metal in the Earth's crust and are the primary source of the world's Cu and Mo, and an important source of Au and other metals (Sillitoe, 2010). Deposits are formed as a result of hydrothermal fluids that exsolve from intrusive magmatic bodies, precipitating metals into the surrounding rocks. The outward movement of these hydrothermal

fluids creates distinct alteration zones recognised by the occurrence of specific mineral assemblages (Sillitoe, 2010; Cooke et al., 2014a). The propylitic alteration zone represents the most distal signature of mineralisation, detectable kilometres away from the main orebody (Cooke et al., 2014a) and, as such, is an important target for exploration. Alteration zoning is not only expressed in mineralogy, but in whole-rock and mineral geochemical trends which can act as vectors towards orebodies (e.g. Emmons, 1927; John, 1978; Norman et al., 1991; Cooke

\* Corresponding author at: Department of Earth Science and Engineering, Imperial College London, Exhibition Road, London SW7 2AZ, United Kingdom.  
E-mail address: [j.wilkinson@nhm.ac.uk](mailto:j.wilkinson@nhm.ac.uk) (J.J. Wilkinson).

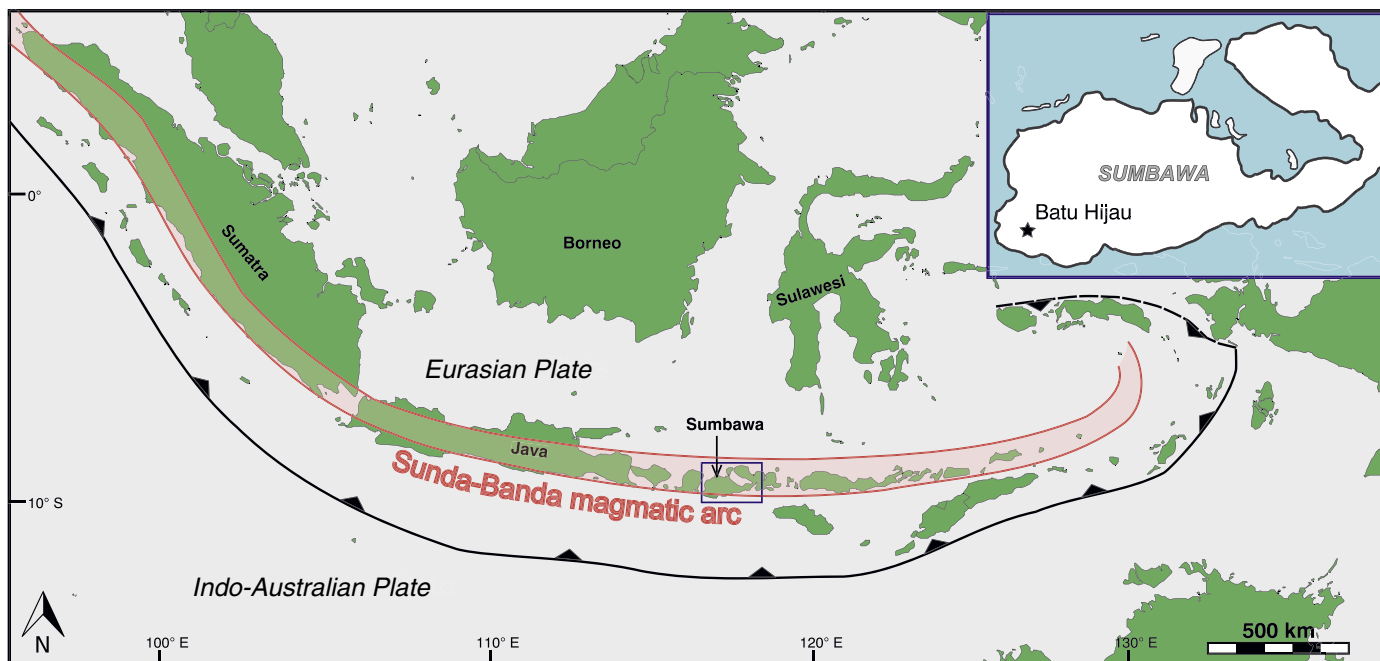


Fig. 1. Principal tectono-magmatic features of Indonesia. The major subduction zone is shown as well as the Sunda-Banda magmatic arc. Subduction of the Indo-Australian plate beneath the Eurasian plate produces the calc-alkaline magmatism that characterises the Cenozoic Sunda-Banda arc. Batu Hijau is located on the island of Sumbawa in the south-west (inset map). Modified after Garwin et al. (2005).

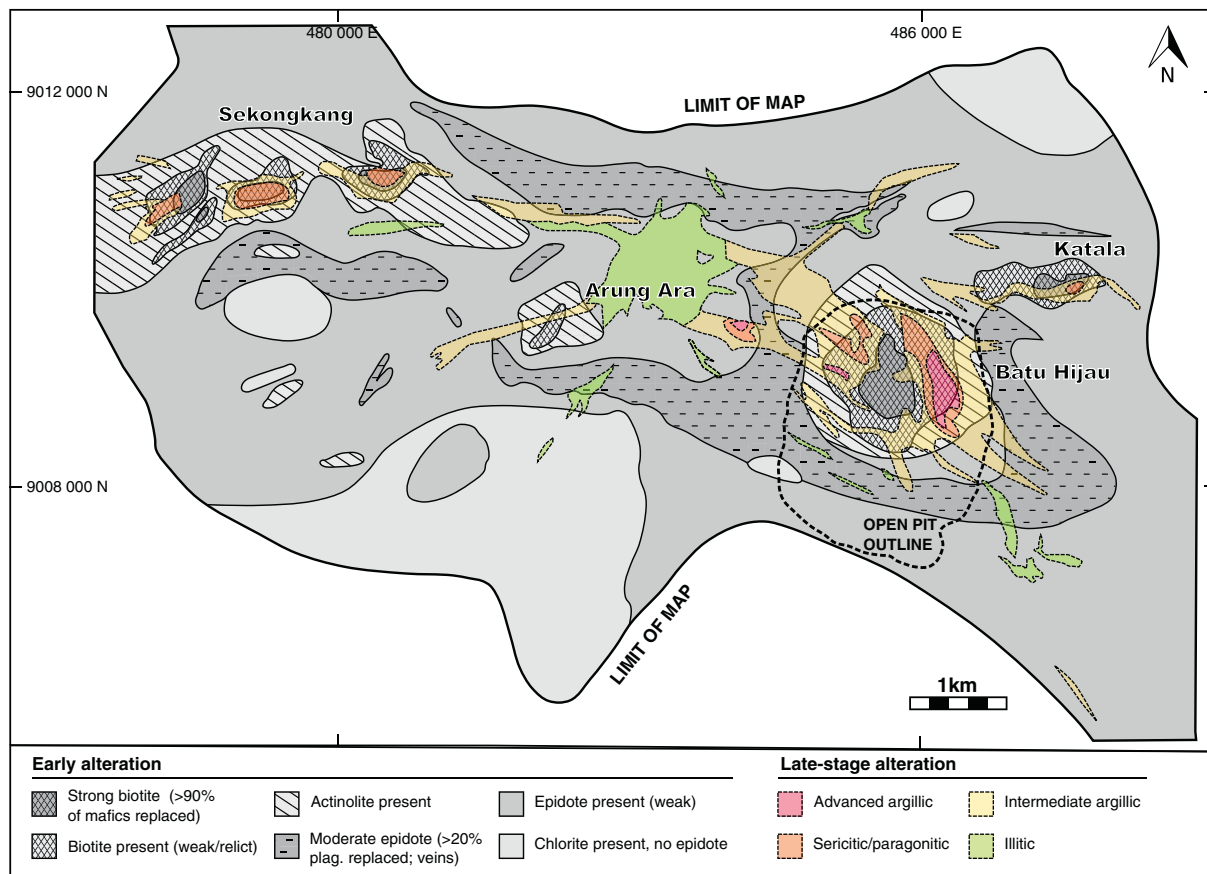


Fig. 2. Alteration map of the Batu Hijau district showing both early-stage (greyscale) and late-stage (colour) alteration. Modified after Garwin (2000). (For interpretation of the references to colour in this figure legend, the reader is referred to the web version of this article.)

Download English Version:

<https://daneshyari.com/en/article/8866192>

Download Persian Version:

<https://daneshyari.com/article/8866192>

[Daneshyari.com](https://daneshyari.com)