

金瓜石黃金瀑布酸性礦山排水沉澱物之礦物學研究

A Mineralogical Study of Acid Mine Drainage Precipitates from Golden Falls, Chinkuashih

陳君榮¹ 江威德²

Chun-Jung Chen¹, Wei-Teh Jiang²

摘 要

金瓜石金銅礦床及廢礦石經化學風化作用，長年排放酸性礦山排水，在黃金瀑布河床表層形成黃褐色氫氧化鐵沉澱物，該沉澱物之 X 光繞射、紅外線光譜、電子顯微鏡和熱重 / 熱差分析顯示其主要礦物組成為 schwertmannite (四方硫酸纖鐵礦)，生成纖維狀奈米晶束，放射狀排列聚集形成直徑大多為數微米之準圓球狀集合體，集合體表面具刺蝟狀形貌，比表面積達 76 m²/g。感應耦合電漿分析顯示此 schwertmannite 之平均化學式為 Fe₁₆O₁₆(OH)₁₁(SO₄)_{2.5}·16H₂O，並含有 2,794 ppm 砷、439 ppm 鋁、115 ppm 銅及 23 ppm 鉻。Schwertmannite 沉澱及其對砷和金屬之吸附作用有助於延緩或降低黃金瀑布酸性礦山排水對環境污染之影響。

關鍵詞：酸性礦山排水、四方硫酸纖鐵礦、砷、金瓜石。

Abstract

Ochreous iron-oxyhydroxide precipitates occur at the bedrock surface of Golden Falls as a result of the long-term discharge of acid mine drainage (AMD) produced by chemical weathering of the Chinkuashih gold-copper deposits and tailings. X-ray diffraction, SEM, TEM, FTIR, ICP, and TG-DTA data indicated that the ochre precipitates were dominated by schwertmannite with an average chemical formula of Fe₁₆O₁₆(OH)₁₁(SO₄)_{2.5}·16H₂O. The schwertmannite occurred as nanometric fibrous crystallites that had a radiating arrangement forming spheroidal aggregates with hedgehog-like surface microstructures and a specific surface area of 76 m²/g. The ICP analysis further suggested that the schwertmannite contained 2,794 ppm As, 439 ppm Al, 115 ppm Cu, and 23 ppm Cr on average. The result implies that the environmental impacts of the Golden Falls AMD may have been deferred and/or reduced by the precipitation of schwertmannite and the sorption of As and metals thereon.

Key words: acid mine drainage, schwertmannite, arsenic, Chinkuashih.

一、前 言

在礦業活動發展的過程中，往往會製造出大量無法再提煉或利用之廢礦堆，其中硫化金屬礦床廢礦堆常含有許多黃鐵礦或白鐵礦等硫化鐵礦物，當其暴露於大氣或水體中易於氧化，經由

102 年 1 月 22 日收件 102 年 3 月 27 日受理

國立成功大學地球科學系¹博士生²教授 (¹ Ph.D. Student, ² Professor, Department of Earth Sciences, National Cheng Kung University)。