Gold ore characterisation, mercury use & value chains analysis of the artisanal & small-scale gold mining sector of Wau, Morobe Province, Papua New Guinea

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ABSTRACT

Wau, in the Morobe Province of Papua New Guinea (PNG), is a rural township with a growing artisanal and small-scale gold mining (ASGM) sector working with mercury (Hg). It was once the centre of gold mining activities for European prospectors and companies between the 1930s and the late 1980s. Mercury amalgamation is used globally for gold extraction in the ASGM industry but was banned by the Minamata Convention in 2013 due to its toxicity to human beings. Miners and their families in Wau are exposed to Hg contamination during the amalgamation and retorting of the Au-Hg amalgam.

The Mineral Resources Authority (MRA) regulates the PNG mining industry using the Mining Act 1992 and the Mining Safety Act 1997. Gravity concentration and mercury amalgamation are gold recovery techniques used in the ASGM sector of Wau. Cyanidation, a common technique for processing free-milling Au and AuAg grains less than 0.2 mm in size, is largely used in the corporate mining sector but has not been used within the ASGM sector of PNG.

The purpose of this research is to halt the use of mercury in Wau through an improved understanding of its gold ore characteristics. Hence, a study into the economic value chains system, gold grade distribution and ore characterisation was conducted on nine selected ASGM sites located throughout the Namie and Kaindi prospects in Wau. Although modestly profitable, all sites excluded the fundamental practices of grade control and ore characterisation, which are vital to the mining value chain. Comminution, also an important step for liberating gold, was only practised at one mine site. The average gold grades of the nine sites ranged from 0.06 to 5.45 mg/kg Au with the primary mineralization of Kaindi containing higher gold grades than the secondary deposits of Namie. The main gold minerals observed in the scanning electron microscope (SEM) include native Au and electrum AuAg with a predominant grain size of less than 0.07 mm. Mercury amalgamation is only useful on gold crystals with a grain size of 0.07-1.5 mm. Hylander et al. (2007) discovered that mercury will not efficiently amalgamate gold particles less than 0.07 mm. In addition, mercury amalgamation is only useful on free-milling, liberated native gold but will not recover gold that is attached to or encapsulated within other minerals. This suggests that the Wau miners are losing fine-grained gold less than 0.07 mm or any gold that is insufficiently liberated as waste or tailings. This was confirmed in the tailings sample from Site 1 which had numerous fine-grained Au measuring less than 0.07 mm. Thus, cyanidation would be

the appropriate technique to process the gold mineral type (Au and AuAg) and gold grain size observed in most sites in Wau. Cyanidation after comminution are steps that must be included in the Wau ASGM value chain in order to optimize the recovery of the dominantly fine-grained Au.

DEDICATION

I dedicate this thesis to my son Ranen Matawai and the people of Wau and Aotearoa.

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