

Development of a fully constrained structural model in a volcano caldera and its influence on open pit slope design

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Abstract

The Ladolam gold deposit, is located on Lihir Island, part of the Tabar-Lihir-Tanga-Feni island chain, New Ireland Province, Papua New Guinea. The Luise volcano hosts the deposit, presenting a 4 × 3.5 km-wide amphitheatre, elongated and breached to the northeast. A detailed structural model of the site is required in order to incorporate the influence of structure on slope stability for pit design and optimisation. Complex tectonic evolution, late diatreme intrusion, significant metasomatic overprint, ongoing hydrothermal activity and weathering of the country rock present challenges to developing a comprehensive, fully constrained structural model across the deposit. Given this geological complexity, structural model development and structural characterisation has utilised an evidence-based approach, with inputs from numerous disparate datasets ranging from high-resolution photogrammetry to field mapping data, core logs and downhole photographs. Photogrammetry data proved highly effective in delineating deposit scale structural trends, particularly in areas that are no longer accessible or that have historically been omitted from study. Geological structures and geotechnical variations have implications for slope design and operational risk management. Strain shadows of major north–south trending structures present zones of rheological weakness and preferential fluid ingress at Lihir, further highlighting the potential influence of geological structure on slope stability. Ongoing structural characterisation has important safety and economic benefits. As the structural model is further developed, it supports the identification of potentially higher-risk areas in current slope design. This, in turn, justifies more detailed analysis or monitoring controls to ensure safe and efficient mining and/or mine design adjustments to mitigate hazards. The following work is presented in this paper: 1) the methodology used to identify and delineate key structures, 2) characterisation methodologies employed, and 3) how identification and characterisation of structural systems have successfully informed decision-making at Lihir gold mine.

Keywords: structural geology, structural characterisation, caldera, stability analysis, geotechnical characterisation, slope optimisation, slope stability

1 Introduction

The Ladolam deposit is located on Lihir Island, part of the young (<4 Ma) Tabar-Lihir-Tanga-Feni island chain northeast of the New Ireland Province of Papua New Guinea (Figure 1). The deposit is among the youngest (<1 Ma) gold deposits in the world (Davies & Ballantyne 1987; Moyle et al. 1990; Carman 1994).