

Case History

Innovative seismic imaging of volcanogenic massive sulfide deposits, Neves-Corvo, Portugal — Part 1: In-mine array

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ABSTRACT

To evaluate and upscale the feasibility of using exploration tunnels in an operating mine for active-source seismic imaging, a seismic experiment was conducted at the Neves-Corvo mine, in southern Portugal. Four seismic profiles were deployed in exploration drifts approximately 650 m beneath the ground surface, above the world-class Lombador volcanogenic massive sulfide deposit. In addition to the tunnel profiles, two perpendicular surface seismic profiles were deployed above the exploration tunnels. The survey was possible due to a newly developed prototype global positioning system (GPS) time transmitter enabling accurate GPS synchronization of cabled and nodal seismic recorders, below and on the surface. Another innovative acquisition aspect was a 1.65 t broadband, linear synchronous motor (LSM) driven — electric seismic vibrator (e-vib) used as the seismic source along two of the exploration tunnels. We have evaluated the challenges and innovations

necessary for active-source tunnel seismic acquisition, characterized by high levels of vibrational noise from the mining activities. In addition, we evaluated the LSM vibrator's signal and overall seismic-data quality in this hard rock mining environment. Our processing results from the tunnel data and 3D reflection imaging of the Lombador deposit below the exploration tunnels were checked for consistency through constant-velocity 3D ray-tracing traveltimes forward modeling. For imaging purposes, 3D Kirchhoff prestack depth and poststack time-migration algorithms were used, with both successfully imaging the targeted deposit. The results obtained show that active-source seismic imaging using subsurface mining infrastructure of operational mines is possible. However, it requires innovative exploration strategies, a broadband seismic source, an accurate GPS-time system capable of transmitting GPS-time hundreds of meters below the surface, and careful processing. The results obtained open up possibilities for similar studies in different mining or tunneling projects.

INTRODUCTION

Geophysical methods have successfully been used for mineral exploration and prospecting on mining camps and regional scales,

in green and/or brownfield areas, for more than half a century (Reid et al., 1979; Reed, 1993; Eaton et al., 2003; Dentith and Mudge, 2014; Malehmir et al., 2014, 2020; Buske et al., 2015; Halder, 2018; Essa and Munsch, 2019). Although the combination of field

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