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Case History

Innovative seismic imaging of volcanogenic massive sulfide deposits, Neves-Corvo, Portugal — Part 2: Surface array

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ABSTRACT

Seismic methods are an affordable and effective way of studying the subsurface for mineral exploration. With the goal of testing new technologies for mineral exploration in highly challenging mining areas, in early 2019, an innovative seismic survey was conducted at the Neves-Corvo mine, south Portugal. We have focused on the data and results from the surface array data, whereas other work deals with the underground seismic data. The surface seismic survey consisted of two perpendicular 2D profiles positioned above the known world-class tier-1 Lombador deposit. Simultaneously, a survey inside the active underground mine took place, being unique because it included the testing of a prototype system that enabled accurate GPS-time (microsecond accuracy) synchronization inside the mine tunnels, approximately 650 m below the surface profiles. Due to the active mining operations, the surface data are noisy. To handle this, a carefully tailored processing algorithm was developed and applied to enhance reflections in the data, interpreted to originate from lithologic contacts and the Lombador deposit. The results and interpretations from 2D processing were validated taking advantage of the known deposit geometry using 3D exploding reflector modeling and pseudo-3D cross-dip analysis. These analyses suggest that there is an out-of-plane signature of the Lombador deposit on the surface data. Additionally, source points activated in the exploration tunnels and simultaneously recorded on the surface profiles allowed for the creation of a 2D velocity model that was used for migration and time-to-depth conversion, providing a reliable 2D seismic section of the subsurface under the surface profiles. We determine that limited surface coverage 2D surveys and a velocity model derived from the tunnel-to-surface seismic recordings allow for imaging of key subsurface geologic structures and delineating mineral deposits of economic interest.

INTRODUCTION

In the past decade, seismic reflection methods have increasingly been used for mineral exploration applications in hardrock environments. This success may be because of the high-density contrasts of most metallic deposits relative to their host rocks (Salisbury et al., 2000; Dehghannejad et al., 2012; Malehmir et al., 2012, 2013; Yavuz et al., 2015) helping to guide mineral exploration decisions at various mining sites (Tryggvason et al., 2006; Urosevic et al., 2012; Manzi et al., 2015; Place and Malehmir, 2016). Most early works that examined the use of seismic reflection methods for direct targeting of volcanogenic massive sulfide (VMS) deposits come from Canada (Verpaelst et al., 1995; Milkereit et al., 1996; Adam et al., 1997; Malehmir and Bellefleur, 2009; Bellefleur et al., 2018),

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