

Shallow Three-Dimensional Structure from Two-Dimensional Crooked Line Seismic Reflection Data over the Sturgeon Lake Volcanic Complex

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Abstract

In principle, partial three-dimensional structural information can be obtained from two-dimensional crooked line seismic reflection data by processing the traces as swath three-dimensional data, but this potential has rarely, if ever, been fully exploited. Here, we apply procedures newly designed for this purpose to mining exploration data from a high-resolution, two-dimensional crooked line survey over a part of the Sturgeon Lake Archean greenstone belt in northwest Ontario, Canada. We then examine the results in the light of geologic data based on about 20 years of mining activity in the immediate area. The area appears highly reflective, even when using standard two-dimensional data-processing methods. But because geologic dips in the section are typically steep and the majority of viewable contact surfaces do not lie directly below the processing and acquisition lines, special data-processing procedures have been essential.

Despite appreciable background noise in the constructed images owing to the limitations of the crooked line data set, a large variety of reflection events are quite clearly positioned in three dimensions. The acquisition and processing lines run northeast-southwest, and most of the observed reflection events strike approximately east-west and dip northward. In the upper 1.5 km, they correlate well with expected layering of the mafic-felsic volcanic rocks, and in the vicinity of the Cu-Zn volcanogenic massive sulfide deposit at Lyon Lake, they agree well with information from drilling. The three-dimensional processing has successfully imaged an ore-controlling thrust fault at the Lyon Lake deposit, contacts within the volcanic pile (including the top of the Beidelman Bay subvolcanic intrusive complex), and fold structures in the volcanic stratigraphy. The results suggest that simple three-dimensional seismic surveys of limited offset and azimuth range may be sufficient for imaging structures in this type of geologic environment.

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