Whole-lithosphere architecture of a mineral system and signatures of the sources and pathways of ore-forming fluids

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SUMMARY

Mineral systems can be thought of as a combination of several critical elements, including the whole-lithosphere architecture, favorable geodynamic/tectonic events, and fertility. There are open questions regarding the source of ore-forming fluids, the depth of genesis, and their transportation through the upper crust to discrete emplacement locations. In this study, we investigate an Au–Cu metal belt located at the margin of an Archean-Paleoproterozoic microcontinent in central Mongolia. We explore three-dimensional models of the electrical resistivity and shear-wave velocity throughout the lithosphere. Directly beneath the metal belt, narrow, vertical, finger-like low-resistivity features are imaged within the resistive upper-middle crust and are connected to a large low-resistivity zone in the lower crust. A broad low-resistivity zone is imaged in the lithospheric mantle, which is well aligned with a zone of low shear-wave velocity. In the upper-middle crust, the resistivity signatures give evidence for ancient pathways of fluids, below the metal belt, constrained by structure along a tectonic boundary. In the lower lithosphere, the resistivity and velocity signatures are interpreted to represent a fossil fluid source region. We propose that these signatures were caused by a combination of factors, particularly those related to refertilization and metasomatism of the lithospheric mantle by long-lived subduction at the craton margin, and discuss several possibilities.

Keywords: mineral exploration; fertilization; fluid pathways; electrical resistivity; shear-wave velocity