3-D Electromagnetic characterization of the Tuoniuhe epithermal gold deposit in the Duobaoshan area, northeast China

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Epithermal gold deposits are important precious-metal ore deposits that form in subaerial hydrothermal systems. Such hydrothermal systems commonly develop in association with calc-alkaline to alkaline magmatism, in volcanic arcs at convergent plate margins, as well as in intra-arc, back-arc, and post-collisional rift settings. Magmatic intrusions, volcanic arcs and associated hydrothermal systems that occur along the circum-Pacific region host many important word-class epithermal gold deposits. Located in the northern Great Xing'an Range, the Duobaoshan area has the largest Cu-Mo-Au deposits in northeast (NE) China (Figure 1). Previous geological and geochemical studies focused on Cu-Mo deposits in the Duobaoshan area, with less research on the epithermal gold deposits associated with hydrothermal activity. The lack of geophysical studies limits our understanding of the deep structure of the mineral system and tectonic setting. Despite the close association of magmatic activity with gold deposits, there is still considerable debate about their signature and the extent to which these magmas contributed to the formation of the deposits. Gold mineralization is commonly accompanied by vein quartz or disseminated sulfides which cause significant contrasts in electrical properties between the mineralization and the surrounding rocks, making mineralized areas amenable to electromagnetic detection. Ground geophysical techniques play an important role in defining drill targets through detecting buried conductive alteration systems and resistive gold-bearing silicified zones and shallow quartz vein systems. Using natural electromagnetic signals, audiomagnetotelluric (AMT) exploration is a cost-effective method of mapping the resistivity structure of epithermal gold deposits. Integrated with aeromagnetic and gravity surveys, we used the AMT method to characterize the Tuoniuhe epithermal gold deposit in the Duobaoshan area from regional to deposit scale. To map the resistivity structure on a regional scale, array data at 292 stations covering the ore deposit and the surrounding area were collected along 12 intersecting profiles. An additional profile was collected across the ore body to study the structure of the Tuoniuhe gold deposit. The 2-D and 3-D resistivity models (Figure 2) reveal a highly conductive zone associated with a Cretaceous magma chamber, which supplied heat and fluids for the Tuoniuhe epithermal gold deposit. These magmatic fluids were transported upwards through fractures and/or regional faults and mixed with meteoric water, as illustrated by a circulation system with moderate resistivity from the subsurface to the Cretaceous magma chamber at the depth range ~600-800 m. The alteration zone is dominated by quartz-sericite-chlorite-pyrite minerals. In contrast to the resistive andesite wall rock, the alteration zone shows relative low resistivity, perhaps owing to pyrite. The resistivity structure provides compelling evidence for the close relationship of gold formation and the Early Cretaceous volcanism in NE China, which could be related to the subduction of the Paleo-Pacific plate.

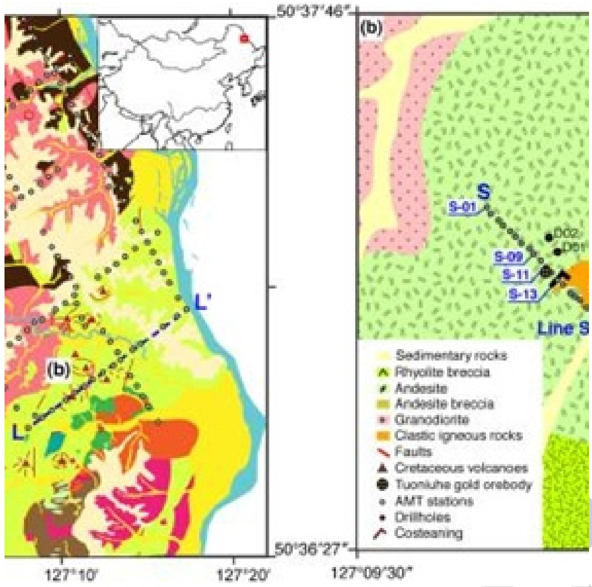

Figure 1. Geological map of the study area with locations of AMT stations.

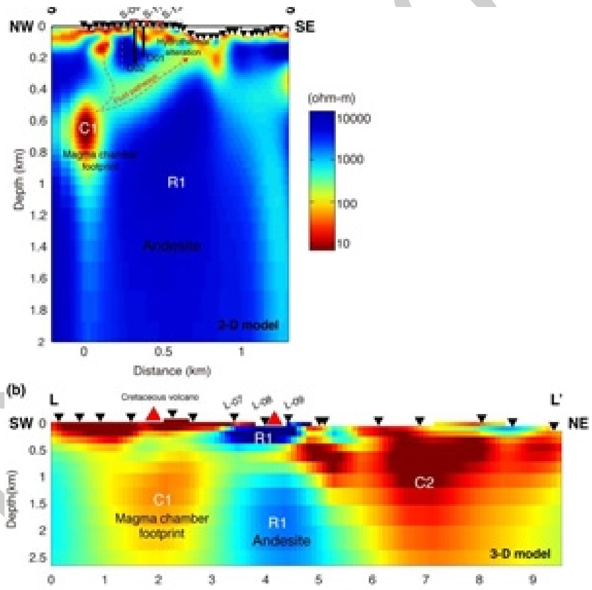

Figure 2. Resistivity models for the Tuoniuhe epithermal gold deposit and adjacent area.