Using 3D Computational Modeling to Represent Deep Structures and Facilitate Ore Prediction: An Example from Tongling Orefield, China

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Because surface exploration data are never enough to reveal the deep structures even in extensively explored orefields, computational 3D modeling has become an indispensable technique to model deep structures to further facilitate predictive ore exploration. The Tongguangshan orefield is abundant in Au-Cu skarn ores and have been mined for over 1000 years. There is some evidence that the orefield contains considerable potential ore resources at the depth, but the challenge to discover and recover such potential ore resources is great because of poor understanding of deep geological structures. In this study, we demonstrate how the 3D computational modeling is used to represent deep structures and facilitate ore prediction in the Tongguangshan orefield.

We carried out a magnetotelluric (MT) survey on a 200 ×100 m grid, mainly to detect the extent at depth of the ore-controlling intrusions and ore-favorable strata. The apparent resistivity of different frequencies are inversed into resistivity at different depths. Information available for 3D structural modeling includes two groups: (1) the known data about the position of geological interfaces revealed by drilling holes and tunnels; (2) possible position data of geological interfaces deduced from the MT resistivity data. Based on comprehensive analysis of the geological setting and the ore-controlling structures, we selected the concept model of thrust fault-propagation fold and fault-bend fold to use in interpreting MT resistivity data and inferring the position of geological interfaces.

We simulated the major geological interfaces within the orefield to a depth of -2000 m by applying the modeling method of knowledge-driven integration of multi-sourced data under multi-scaled constraints. Reconstruction of the 3D geological interfaces through integrating multi-sourced data is carried out on the virtual platform of coupled Micromine and GOCAD. The algorithms of Delaunay TIN and DSI are applied for representation and optimization of 3D surfaces. The final modeling results have the following important results and implications for deep ore prediction. The Tongguangshan- and Tianerbaodan- intrusions, with very complex spatial variation in 3D geometric shape, are generally dipped toward to west and diminish sharply at deeper levels. There would be no economic potential ore resources at depth in the east contact zone of Tongguangshan intrusion where the major orebodies of the Tongguangshan deposit are located because the contact zone become steeper and comes in direct contact with sandstone of the upper Devonian at greater depths. The principal structure deep in the orefield is the NE-trending bend thrust fault. The mid to upper Carboniferous in the eastern southern limb of the Tongguangshan anticline as the favorable ore-hosting strata would change its steeply upturned attitude to normal attitude with the gentle tipping to eastern south at a depth of -1200 to -1500 m, where its lowest part is overlapped by the bend thrust fault; this is possibly the favorable target to explore for deep ores.