Computational modeling of intrusion contact's control on orebodies in the Anqing orefield, China

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Abstract: The skarn ore depsots, as an important deposit type, are controlled by the contact zones of felsic intrusions. In this paper, the 3D geometric shape modeling is used to reveal the localization pattern of orebodies along the intrusion contact, and geodynamic modeling is used to probe the controlling mechanism of contact zone on orebodies in the Anqing orefield, China. The modeling results show that the orebodies are located in the dilation zones close to the intrusion contact, as a result of the coupled mechano-thermo-hydrological dynamics during the syn-stretching cooling process of the intrusion. The ore-controlling dilation zones are closely associated with the shape of the intrusion contact surface. The computational modeling is a promising tool for understanding mineralization processes and for facilitating predictive discovery of blind orebodies at depth.

Key words: geometric modeling, geodynamic modeling, intrusion contact, skarn, Anqing orefield

1 Geological setting

The Anqing orefield, located in the centre of the Yangtze River Metallogenic Belt in the eastern China, consists of a series of ore deposits originally associated with the Yueshan diorite intrusion. The wall rocks around the intrusion include Paleozoic through Mesozoic sedimentary rocks (Fig. 1). The mid-Carboniferous to mid-Tertiary rocks are littoral to neritic carbonate interbedded with bathyal facies beds, alternating with marine-continental clastics, which are the most favorable wall rocks for hosting Cu- and Fe-Cu-skarn deposits in the region. The Anqing Fe-Cu deposit, with more than 90% reserve discovered in the orefield, is located along the eastern branch of

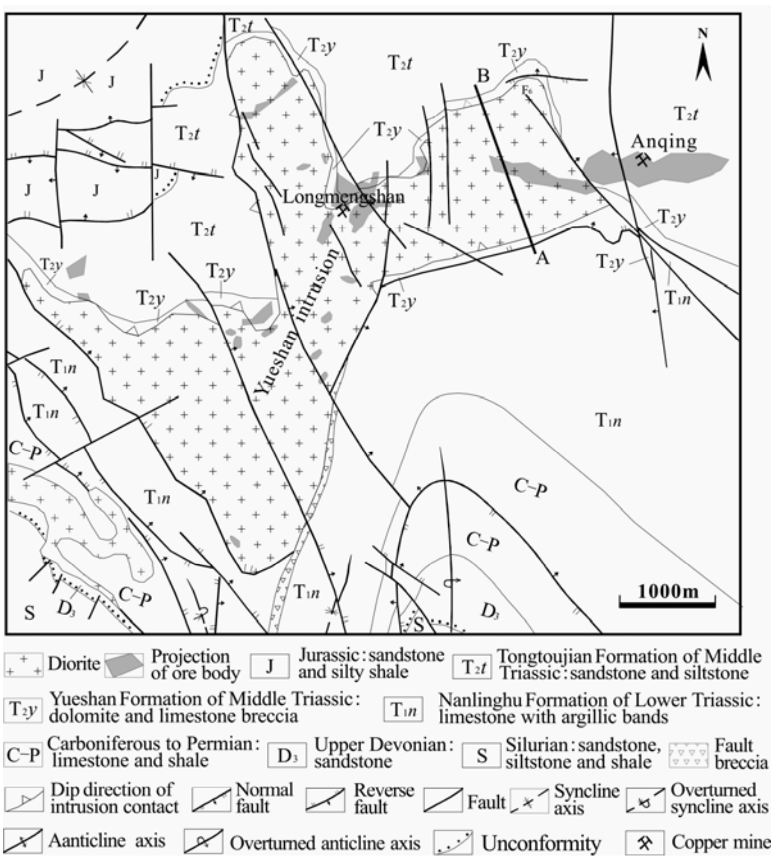

Fig.1 Geological map of the A4rnqing orefield

the Yueshan intrusion (Fig.1). The Yueshan intrusion, as the key factor of the mineral system, is composed mainly of diorite and minor of quartz diorite. The remarkable feature of the intrusion is its complex shape. The occurrences of the ore veinlets in diorite and skarn, as well as the sharp zigzag boundary of the orebody indicate that the Cu and Fe-Cu ores were deposited after solidification of diorites and skarn formation, and located in some tensional structural spaces distributed unevenly along the contact zone between the felsic intrusion and sedimentary carbonates (Liu et al., 2008)

2 3D geometric modeling of intrusion and orebodies

By using of data from the drillholes, direct current resistivity sounding and magnetotelluric surveying, the geometric shapes of the intrusion and orebodies are modeled (Fig2 &3). The 3D geometric models show that, the orebodies are mainly located in some specific places of the south contact zone of the eastern branch of the Yueshan intrusion. Shapes of mineralized contact segments show regularly variation. From east to west, the "step-shaped" contact zone, where the contact zone of the intrusion with the carbonate hanging wall alternates from a steep- to a gentle-dip (Fig.3b), becomes a "tongue-shaped" contact zone, in which the marble is surrounded by diorite (Fig.3c). The Cu and Fe-Cu ores only occur in the steep segments of the "step-shaped" contact zone and the tips of the "tongue-shaped" contact zone (Figs. 3b and 3c).

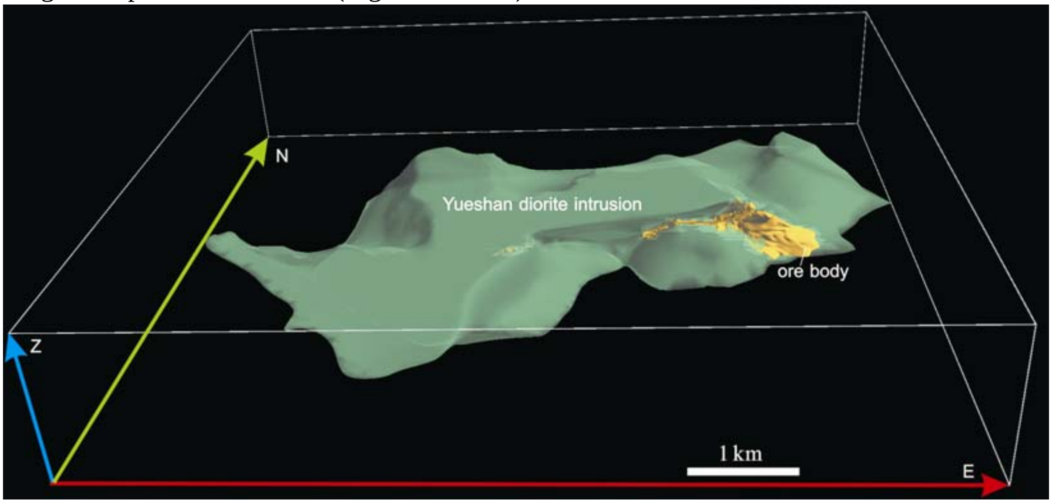

Fig.2 3-D shape modeling of the Yueshan intrusion and orebodies, by using of data from drillholes and geophysical surveying

3 Geodynamic modeling and localization mechanism of oreboies

Based on the synthesis of the surface plane and typical cross sections of the Anqing Cu-Fe deposit and 3D model of the Yueshan intrusion and related orebodies (Figs. 1, 2 and 3), the geological and geophysical constraints to the deep architecture, and the geodynamic evolution of the Anqing deposit and the regional crust (Dong and Qui, 1995; Liu et al., 2008) , two 2D models were constructed for simulating the coupled mechano-thermo-hydrological (MTH) geodynamic processes during the syn-stretching cooling process of the Yueshan intrusion. Model A is for the "tongue-shaped" contact zone. Model B is for the "step-shaped" contact zone. The geodynamic modeling was computed by using of the FLAC code (Itasca Consulting Group, 2002).

The computational results of two models show that, all significant dilation zones, where fluids were focused from different sources and the existing orebodies were located, are distributed in some specific places of the south contact of the eastern branch of the intrusion (Figs. 4 and 5), demonstrating that the dilation zones are related to the shape of the intrusion contact and control the locations of orebodies, as a result of the coupled MTH dynamics during the syn-stretching cooling of the intrusion.

This recognition can provide useful guidance in selecting exploration targets. The deep exploration should target the dilation zones close to the intrusion contact at depth . A new orebody has been discovered by drills targeting at the deep dilation zone. It demonstrates that the computational modeling is a promising tool for understanding the metallogenic processes and for facilitating deep exploration of hidden orebodies related to intrusions.

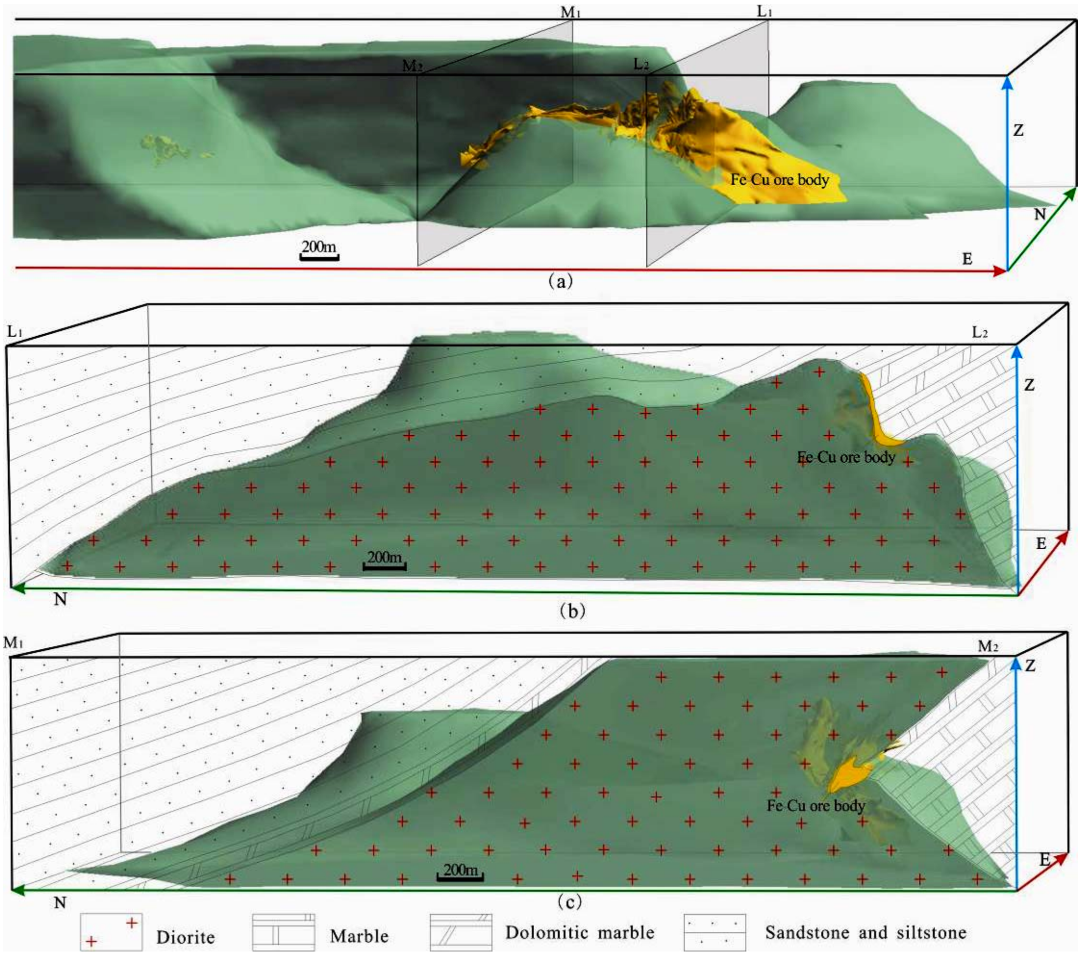

Fig.3 3D relationship of orebodies with shape of intrusion contact surface. (a) Entire view of eastern branch of intrusion and orebodies. (b) Cross section along L1-L2 and view toward east, showing typical “step-shaped” contact zone and orebody; (c) Cross section along M1-M2 and view toward east, showing typical “tongue-shaped” contact zone and orebody.

4 Conclusion

The geometric modeling reveals that the orebodies are only located some specific places of the intrusion contact zone, tips of the “tongue-shaped” contact zone and steeper segments of the “step-shaped” contact zone. The results of the computational modeling of the syn-stretching cooling processes of the ore-related intrusion demonstrate that these specific places are dilation zones where the fluids from different sources are focused to, favoring for metal minerals deposition and accumulation. The modeling results are also useful guidance in selecting exploration targets, the deeper dilation zones close to the intrusion contact. A new orebody has been discovered at depth as the modeling prediction. The computational modeling is a promising tool for understanding the metallogenic processes and for facilitating predictive discovery of hidden orebodies at depth.

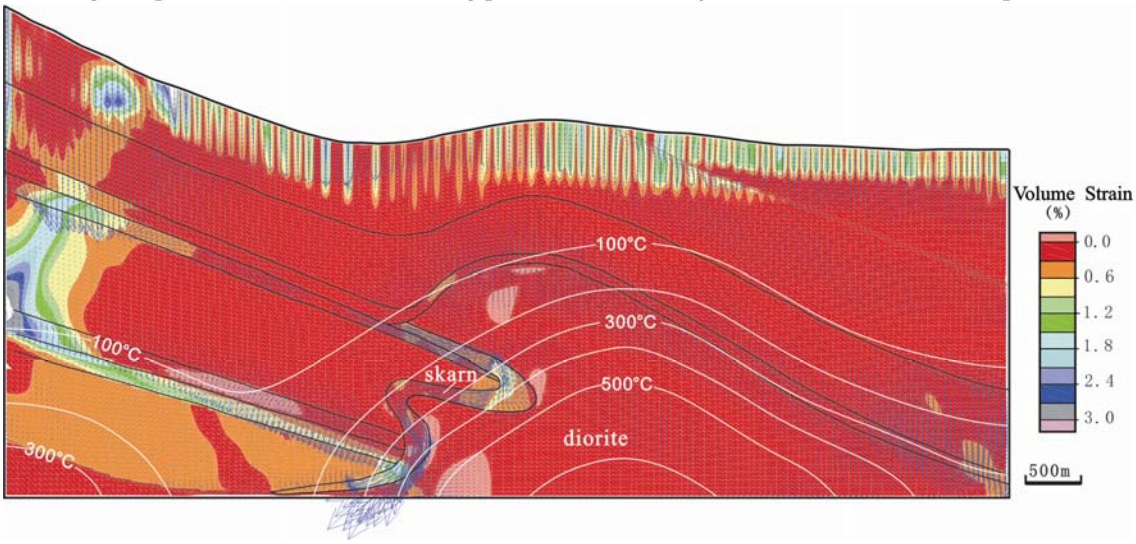

Fig.4 Deformation, temperature and fluid flow results of Model A, showing Darcy fluid flow velocities (arrows), isotherms and total volume strain contour at 9,200 years, the maximum fluid flow velocity is 3.262×10^{-6} m/s.

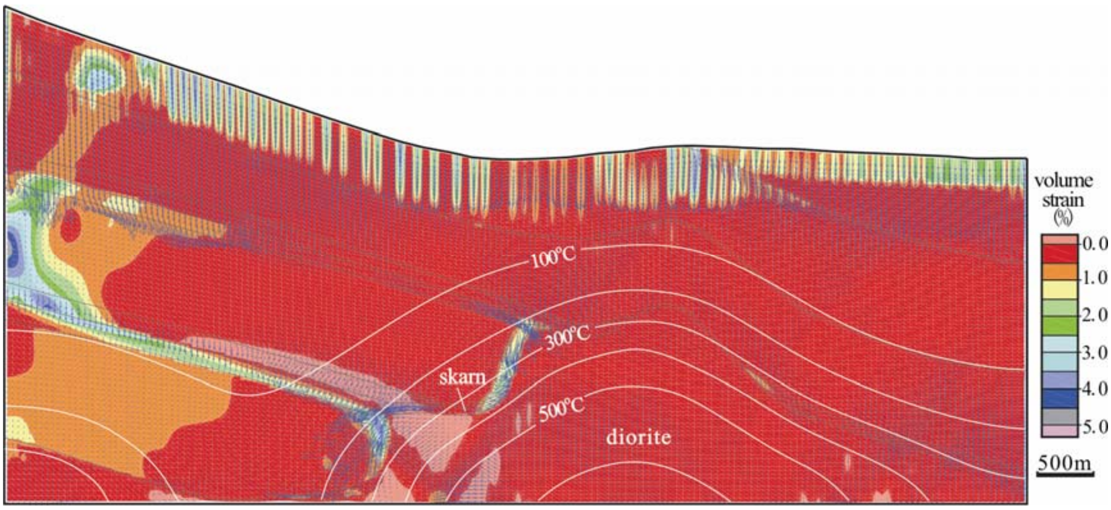

Fig. 5 Deformation, temperature and fluid flow results of Model B, showing Darcy fluid flow velocities (arrows), isotherms and total volume strain contour at 6,000 years, the maximum fluid flow velocity is 2.042×10^{-6} m/s.

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