Acta Geologica Sinica (English Edition), 2019, 93(supp.2): 104–105

Why the Temperature Parameters of Mineralization are Similar in the Jiaodong Gold Deposits: an Inference from Geothermal Gradients

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Citation: Li et al., 2019. Why the Temperature Parameters of Mineralization are Similar in the Jiaodong Gold Deposits: an Inference from Geothermal Gradients. *Acta Geologica Sinica* (English Edition), 93(supp.2): 104–105.

Abstract: Jiaodong gold province is located at the eastern margin of the North China Craton containing >4500 t gold reserves(Feng et al., 2019). Various researches have been conducted in this area, such as petrology, mineralogy, fluid geology, geochemistry, geochronology, all of which show the similar mineralization characteristics in Jiaodong, despite there are some peculiarities. The geochronology indicates gold occurrence in Jiaodong consistently formed in a short time span with 120±5Ma. The H-O isotopic data reveal that the ore-forming fluid derived from magmatic fluid with mixture of meteoric waters at later. Sulfur isotopes of gold-related sulfide cannot mark a definite source of sulfur or metals, but indicate a same derivation, and it is same as the $\delta^{34}S_{sulfide}$ of wall rock, that might suggest an inherited association between the deposit and Mesozoic intrusion. The He-Ar isotopic research shows that the mantle-derived fluid contribute for gold mineralization (Wen et al., 2016). Ore-forming fluids belong to $NaCl\text{-}H_2O\text{-}CO_2{\pm}CH_4$ system with middle temperature and medium to low salinity.

Recent exploration shows that the gold mineralization occurs along the main ore-hosting fault to the deep and suggest potential mineralization at greater depth. Fluid inclusion study of those deep-drill ores did not show a regular variation among the vertical depth 0-2000/-4000m in Sanshandao (Hu et al., 2013; Wen et al., 2016). In addition, we carried out similar strategy in Jiaojia ore field and obtained same data as that in Sanshandao and other gold deposits in this area. Moreover, the Linglong type and Jiaojia type show the same mineralization, which researched from Linglong gold field (Wen et al., 2015). Why the characteristic of ore-forming fluids in Jiaodong is similar?

Hu et al. (2013) and Wen et al. (2016) supposed that the ore-forming fluids in Sanshandao gold deposit were similar within the fault and the gold quickly mineralized in a very short time span. Alternatively, the mutual effect between the geothermal gradients and hydrotherm might play a potential role during the mineralization. Various microthermometry data revel a decreasing temperature from early to late stage of mineralization. Convective cooling is the main controlling factor for this evolution of temperature under the small W/R ratio and a larger scale, and temperature difference is the dynamic of heat conduction. Deep fluids migrated to the shallow along the main fault, and that transfered the heat to the wall rock. The interference of intrusions to geothermal gradients can be excluded as the large time interval between the intrusion and mineralization. Giving the homogeneous heat conductivity of wall rock, so that the fault system can be regarded as “Flat wall heat transfer” model (Rosnauer, 1985). Based on this mode, we propose a possible situation in Jiaodong (Fig.1). In this case, the temperature of fluids, which derived from the deep, should be greater than or equal to the temperature of wall rock at the same depth. The hydrotherm dominated the distribution of temperature within the fault range, whereas the geothermal gradients would control the temperature as the distance increases to main fault. This dynamic “gaming” between the hydrotherm and geothermal gradients can describe as three stage during a single tectonic-thermal event (Fig.1). In the first case(Fig.1-A), named heating stage, the heat flux within fault was much larger than which of wall rock, as the preferential conductivity along the fault, the isotherm in the fault parallels to the fault plane. So that the ore-forming fluids show similar temperature and there were no lower temperature of fluid inclusions occurred in the ore-hosting fault for this case. In the latter case, named cooling stage, the hydrothermal effect was decreasing, the isotherm in the fault would intersect with main fault plane (Fig.1-B), and the lower temperature fluid inclusions could occur in the fault where the geothermal gradient was coordinate. The similar state also occurred in the shallow of system. In the last state, named post-cooling stage (Fig.1-C), the fault cool completely, so the temperature only controlled by geothermal gradients, the isotherm parallels to ground approximatively. The fluid inclusions occurred in this stage would show an increasing temperature within the vertical depth, but might be difficult to distinguish. Furthermore, the lower temperature occurred in the deeper situation where it should have been hotter, which might mean that a potential exhumation occurred during the mineralization. In this mode, the depth of gold deposits might be limited by geothermal gradients, and the mineralization occur in the restrictive depth.

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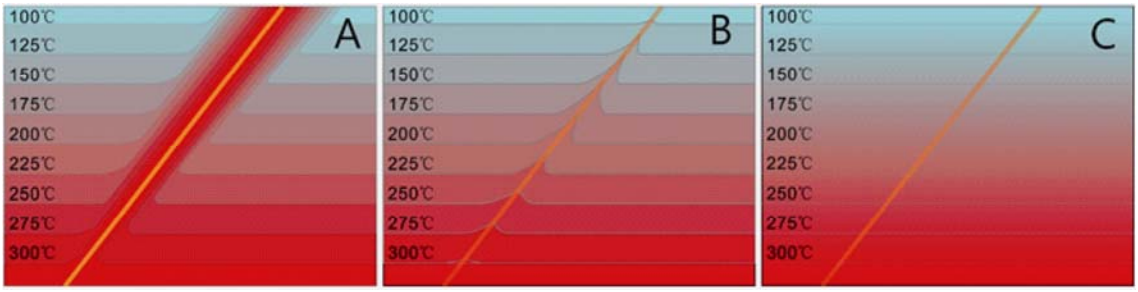

Fig. 1. Distribution and changing of isotherm during the mineralization, drawn by CorelDraw X7.

conduction-heating mode, but it give an alternative inference for Jiaodong. It can further examine or optimize via computer simulation.

Keywords: Jiaodong gold deposits, geothermal gradient, fluid inclusions

Acknowledgements: This research was sponsored financially by the National Key R&D Program of China (No. 2017YFC0601505), the National Natural Science Foundation Program of China (No. 41503037), and a grant (RRSM-KF2018-03) from KLRRSM, Ministry of Land and Resources..

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