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Study on the Source and Occurrence of Metallogenic Materials of the Tianchong Scheelite Deposit, Yunnan Province, China

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The Tianchong scheelite deposit, located in the western border of Caledonian fold belt of southern China, is a fluorite-quartz vein type scheelite deposit (Rogert et al., 2000). It was the first discovered deposit in Wenshan-Malipo fault zone. Strata exposed in the mining area are not complicated without any igneous rocks. The main ore body is strictly controlled by the Wenshan-Malipo fracture. The surrounding rocks are marmorized limestone and dolomitic breccia of the second section of middle Cambrian Tianpeng group. In consistent with the fracture, the attitude of the main ore body is $230^{\circ} \angle 76^{\circ}$. The whole vein body stretches about 500 meters along the strike and gradually decreases in dip angle. The main type of scheelite ore is a fluorite-quartz vein with a few silicified rocks. According to the fluid inclusions study, Ore-forming fluid of Tianchong scheelite deposit is hypabyssal fluid with low temperature, low salinity and low density. Comparing geochemical characteristics with Laojunshan granite rocks, the ore-forming fluid of the deposit shows some degrees of inheritances from those rocks. Therefore, the formation of Tianchong scheelite deposit could be an external reaction of those metallogenic events related to Laojunshan granite rocks.

1 Sources of the Metallogenic Material Discussion

Studies have shown that Tungsten (W) is highly enriched in the study area. W abundance of Laojunshan granite rocks range from 9.39 to 288 ppm while that of the mining areas is 31.6-1018 ppm (Zhang Binhui et al., 2012). The background value of W in mining area is triple the average of China. Therefore, the enrichment of W in the deposit is due to the element may be extracted from the strata with hydrothermal evolution process which is associated with Laojunshan granite rocks. Existence of

fluorite in the scheelite deposit indicates that the hydrothermal fluid contains a lot of F. The F^{-} most likely comes from deep crust by Magmatic hydrothermalism. Concentration of F^{-} in the metallogenic fluid often controls the PH of the fluid as F^{-} is a strong anion. Hydrothermalism often shows acidic property when F^{-} in the fluid has high activity and shows alkalinity while the activity is low (Tan Yunjin et al., 1999). F is a good mineralizer for Tungsten deposit. W in the fluid with high concentration of F^{-} is most likely to migrate in the form of oxygen fluorine complex (Liu Yingjun et al., 1987). In general, the concentration of F is an important factor for the Tianchong scheelite deposit as it controls the migration and the precipitation of scheelite.

For this scheelite deposit, the composition of surrounding rock has a huge impact on the hydrothermal evolution process and the precipitation of metallogenic materials. Therefore, Ca, a key element of mineralization, mainly comes from leaching and extraction in the process of hydrothermal migration. The strong silicification of surrounding rock indicates that the metallogenic fluid is weakly acidic. Reaction between the fluid and the surrounding rock is the most probable mechanism for the precipitation of fluorite in the system when the PH of the fluid is in a transition stage from acidic to neutral (Constantopoulos et al., 1988). Materials released from the surrounding carbonate rocks during the process of water-rock reaction would lead the PH increase and meanwhile provides Ca^{2+} to the mineralization system. Fluorite crystallized from the fluid during the whole process (Constantopoulos et al., 1988; Peng Jiantang et al., 2002). The ability of F^{-} combining with Ca^{2+} is stronger than with WO_4^{2-} (Tan Yunjing et al., 1999). It means that Ca^{2+} has priority to react with F^{-} when F^{-} , Ca^{2+} and WO_4^{2-} coexist in the system. When the concentration of F^{-} decreased in the system, the scheelite deposited gradually.

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2 The Occurrence of Wolfram

Wolfram usually exists in the form of wolframite and scheelite in quartz vein-type hydrothermal deposit. According to previous studies (Liu Yingjun et al., 1987; Kang Yongfu et al., 1981; Tan Yunjin et al., 1999), occurrence of W can be affected by many factors in all kinds of deposits. W only formed as scheelite in Tianchong deposit. It is a result of coupling actions in metallogenic system.

First of all, the abundance of Ca^{2+} provided by the water-rock reaction in the system, is a significant premise of scheelitic mineral precipitation. Secondly, Fe and Mn concentration in the fluid is far below the level of Ca in the system. It is another important factor that controls the occurrence state of W element. According to the results from Ore Constant Element analysis, the concentration of Ca is dozens or even hundreds times of the total levels of Fe and Mn. Thus, it effectively prevents the formation of wolframite in the deposit. Thirdly, F^- is a necessary mineralizer in the system. It is also one of the important adjustment factors for fluid pH and scheelite mineralization process. The content of F^- in fluid only has a weak influence on Ca^{2+} in the system as there was no other minerals which contain F except fluorite. The scheelite mineralization process becomes effective while the pH circumstance gradually transited from acidic to alkaline with the precipitation of fluorite. As a consequence, the relatively moderate range of remaining F in fluid is a necessary condition. Finally, according to the results from the fluid inclusion homogenization temperature analysis, temperature of the metallogenic

stage from 140°C to 230°C belongs to low temperature category. The crystallization of quartz-vein type wolframite occurs in between 246 °C and 320 °C, while that of the scheelite was from 200 °C to 300 °C (Kang Yongfu et al., 1981). Scheelite can precipitate under hydrothermal conditions even in a slightly alkaline circumstances and around one hundred degrees (Liu Yingjun et al., 1987). Therefore, low ore-forming temperature is also a determinant factor that controls the occurrence state of W in Tianchong deposit.

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