Ore-controlling characteristics of Devonian stratum in the Dachang Sn ore-field, Guangxi (south China)

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Abstract

The Dachang ore-field, which locates in Nandan county of Guangxi province, China, is an important tin-polymetallic mining industry and the typical research base for cassiterite-sulfide deposit in this world. In this mineralization zone, almost all of the deposits are hosted by Devonian stratum, which evolves every group of Devonian. It is undeniable that Devonian stratum is one of the key factor for the formation of Sn polymetallic deposit. The diversity and disparity of Devonian stratum tend to cause the different deformation in the same tectonic stress field and form the favorable space, which is rather important for the migration and filling of the ore fluid. The alternate phenomenon, specially between the limestone and mudstone or shale, make Devonian stratum an excellent reservoir and cover in itself. According to the hydrothermal diagram of Al\textsubscript{2}O\textsubscript{3}-SiO\textsubscript{2}, the sedimentary environment of Devonian stratum is rather complicate, which show that it experienced several times of sea-level changes and turbulence during the formation of Devonian stratum.

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Keywords: Devonian; sedimentary environment; ore-controlling characteristics; Dachang; China

1. Introduction

Tin is one of the elements by found and used for people earliest. It is undeniable that China is the largest tin producing country in this world at present. But, because of the limited reserve, tin has been

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considered one of the four strategic resources. In China, the tin ore deposits are dominated by large-scale and medium-scale, specially the Yunnan Gejiu and Guangxi Dachang, which are the world-class Sn polymetallic ore district. The domestic Sn ore deposits are characterized by the native (being 80%), sand tin ore deposit minor (about 16%). The Dachang tin ore deposit, which is one of the largest Sn ore deposits in the world [1], locates in Nandan county of Guangxi Zhang Autonomous Region, south China (Fig. 1). It is an excellent natural laboratory for the research of tin-polymetallic ore deposit.

Fig. 1. Simplified geological map of the Dachang Sn-polymetallic ore deposit, Guangxi, China: 1- Triassic; 2- Carboniferous – Permian; 3- Devonian; 4- Anticline axis; 5- Normal fault; 6- Thrust fault; 7- Faults; 8- Granite porphyry

2. Geological setting

The Danchi mineralization belt is situated in the south margin of the Yangtze Platform [2]. The belt formed as a NW–SE trough, surrounded by shallow–water carbonate platform from two sides. The trough has an area of 3000 km² (100 km long and 30 km wide) and includes many ore deposits, of which the tin–polymetallic sulfide deposits in the Dachang ore field are the most important.

The Dachang ore field is situated at the joining part between the Guangxi platform and the Jiangnan uplift in northwest Guangxi [3]. A partially restricted sea basin was formed in this area during late Paleozoic as a result of depression along the NW-striking basement fault, with the fast depressing sector developed into the middle-late devonian Nandan-type basin in Guangxi [4]. Major strata are composed of C- and S-rich black shales and argilloealeareous or silty sediments with a total thickness of over 1700m.

The Dachang tin-polymetallic deposit is located in the Danchi devonian rift basin that flanks the southwest border of the Jiangnan Massif. The orebodies lie within a 4000 m thick succession of Devonian to Permian sedimentary rocks. Many deposits occur in Devonian strata in the Dachang ore field. For example, the Dafulou, Huile and Kengma deposits are located in the Lower Devonian, and the Lamo and Chashan deposits are found in the Upper Devonian. The giant Longtoushan and Tongkeng-Changpo
deposits occur in Middle-Upper Devonian beds. There are three major types of orebodies: (a) stratabound, bedded and massive ores; (b) vein-type ores; and (c) stockwork-type ores. The host rocks of the deposit are Devonian carbonates, siliceous rocks, and shales.

3. Lithology and mineralization

In the Dachang ore district, all of the deposits are hosted by Devonian stratum, which evolves every group of Devonian [5]. In the west mineralization belt, the cassiterite-sulfide deposits are located in the middle and upper Devonian, such as shale, marl, reef limestone, lentils limestone, band-like limestone and chert. In the middle mineralization belt, the skarn zinc-copper deposits are located in the middle and upper Devonian, such as marl, lentils limestone and band-like limestone, yet the quartz vein type W-Sb deposits are located in the marl, shale, chert, lentils limestone and band-like limestone of middle and upper Devonian. In the east mineralization belt, the cassiterite-sulfide deposits are located in the shale and marl of the middle and lower Devonian.

(1) The diverse type and disparity lithology of Devonian stratum lead to the different mechanical properties and cause the different deformation in the same tectonic stress field, which make the rock broken and form the favourable fracture zone and the stripping surface for the migration and filling of the ore fluid.

(2) By the field observation, it exist the alternate phenomenon among limestone and mudstone, shale, clay shale, etc, which make Devonian stratum an excellent reservoir and cover (Fig. 2). The limestone is easy to be broken and supply the favourable space for the mineralization, yet the low porosity rocks can play the role of the cover, such as mudstone, shale, clay shale, etc. All of these facilitate the mineralization of the Dachang tin polymetallic deposit.

Fig. 2. Interbedded of limestone and mudstone in Liujiang group

4. Ore-controlling characteristics

In the Dachang ore-field, the stratum consist of Devonian, Carboniferous and Permian, in which the Devonian stratum is the main ore-hosting rock including of carbonaceous shale, mudstone, limestone reef, lentils limestone, band-like limestone and chert [6]. Around of the concealed Longxianggai rock, it exists three mineralization belts. In the west belt, there are Changpo and Longtoushan deposit, which is characterized by the mineral assemblage of Cassiterite-sulfide-sulfur salts. In the middle mineralization belt, the main deposits consist of Lame deposit, Chashan deposit, which belongs to the skarn zinc-copper
sulphide deposits. In the east mineralization belt, the main deposits consist of Dafulou deposit and Kengma deposit, which is characterized by the cassiterite-pyrrhotite assemblage.

In the west mineralization belt of the Dachang ore-field, the hosting wall-rock of cassiterite-sulfide deposits is the middle and upper Devonian [7], which consist of shale, marl, reef limestone, lentils limestone, band-like limestone and chert (Fig. 3). The main mineral elements consist of Sn, Pb, Zn, Sb, Ag, and the metallic minerals consist of cassiterite, iron sphalerite, arsenopyrite, pyrite, pyrrhotite, jamesonite [8]. For example the ore bodies of no.91, no.92, no.100 are hosted by Wuzhishan group, Liujiang group and Nabiao group respectively, and the lithology evolves of chert, siliceous shale, reef limestone. In the middle mineralization belt, the skarn deposits, whose main mineral elements are Zn, Cu, Ag and whose main metallic minerals consist of iron sphalerite, chalcopryite, pyrrhotite, pyrite, arsenopyrite, are hosted by marl, lentils limestone, band-like limestone of the middle and upper Devonian. But in this belt, the hosting stratum of quartz vein type deposits, whose main mineral elements are Sb, W and main metallic minerals evolves of stibnite, scheelite, wolframite, is the middle and upper Devonian, which evolves of marl, shale, chert, lentils limestone, band-like limestone (Fig. 3). In the east belt, the hosting stratum of cassiterite-sulfide deposits, whose main mineral elements are Sn, Zn and main metallic minerals consist of cassiterite, iron sphalerite, pyrrhotite, pyrite, arsenopyrite, is the middle and lower Devonian, which consist of shale and marl (Fig. 3).

Fig. 3. (a) and (b) Bioclastic limestone of Nabiao group; (c) and (d) Lenticular limestone of Wuzhishan group

In the Dachang ore district, there is close relationship between tin deposit and Devonian, which is always the hosting wall rock, such as in the west, middle and east mineralization belt. The Changpo
deposit evolves of several groups of Devonian, including of Nabiao group, Luofu group of the middle Devonian, Liujiang group, Wuzhishan group, Tongchejiang group of the upper Devonian. Bali-longtoushan tin-polymetallic deposit is hosted by Nabiao group reef limestone of the middle Devonian. The Heishuigou-dashujiao skarn zinc-copper deposit is hosted by the Luofu group marl and shale.

5. Mineralization characteristics

The content of major elements is listed in the table. From the table we can see that the content of silica is high for a part of sample, which maybe caused because of the silicification.

Table 1. Major element of Devonian stratum in the Dachang ore-field, Guangxi (×10^6)

<table>
<thead>
<tr>
<th>Sample</th>
<th>Stratum</th>
<th>SiO₂</th>
<th>Al₂O₃</th>
<th>Fe₂O₃</th>
<th>CaO</th>
<th>MgO</th>
<th>Na₂O</th>
<th>K₂O</th>
<th>Cr₂O₃</th>
<th>TiO₂</th>
<th>MnO</th>
<th>P₂O₅</th>
<th>SrO</th>
<th>BaO</th>
<th>LOI</th>
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<td>0.51</td>
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<td>0.01</td>
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<td>0.01</td>
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<td>0.02</td>
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<td>55.21</td>
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<td>0.02</td>
<td>0.03</td>
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<td>&lt;0.01</td>
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<td>0.01</td>
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<td>0.03</td>
<td>&lt;0.01</td>
<td>&lt;0.01</td>
<td>0.06</td>
<td>0.013</td>
<td>0.01</td>
<td>0.01</td>
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<td>&lt;0.01</td>
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<td>1.91</td>
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<td>3.24</td>
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<td>0.1</td>
<td>0.99</td>
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<td>0.04</td>
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<td>&lt;0.01</td>
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<td>0.28</td>
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<td>0.03</td>
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<td>1.88</td>
<td>0.01</td>
<td>0.6</td>
<td>0.01</td>
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<td>0.09</td>
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</tr>
</tbody>
</table>

Fig. 4. Hydrothermal diagram of Al₂O₃−SiO₂ for Devonian stratum
According to the content of Al$_2$O$_3$ and SiO$_2$ (Table 1), the value of Al$_2$O$_3$ is the abscissa, the value of SiO$_2$ is the vertical coordinate. The fifteen sample points are projected on the coordinate, which was divided into three zones, including of hydrothermal area, water area and deep-sea sediments area. All of these points are located one of these zones. With the hydrothermal diagram of Al$_2$O$_3$—SiO$_2$ for Devonian stratum (Fig. 4), it shows that the projection points scatter several zones, such as hydrothermal area, water area and deep-sea sediments area. So, it suggests that the sedimentary environment of Devonian stratum is rather complicate, which experienced several times of sea-level changes and turbulence during the sediment of Devonian stratum. It is also embody the complicate formation environment for Devonian.

6. Conclusions

There is rather close relationship between Devonian stratum and tin polymetallic deposit in the Dachang ore district. The diversity and difference of Devonian stratum is the key to cause the different deformation in the same tectonic stress field, forming the favorable fracture zone and the stripping surface for the migration and filling of the ore fluid. Between the different rock types, the alternate phenomenon makes Devonian stratum an excellent reservoir and cover, which facilitate the formation of tin polymetallic deposit. The sedimentary environment of Devonian stratum is rather complicate, mainly evolving of hydrothermal area, water area and deep-sea sediments area. In the period of sediment, it experienced several times of sea-level changes and turbulence.

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References