Analysis on Characteristics of Provenance of Antimony in Western Guizhou, China

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Abstract. It has concluded that the provenance of antimony ore in western Guizhou are as follows together with the previous researches: 1) the mineralization of antimony in western Guizhou is a long, complex process with different sources in various stages. 2) the main sources of antimony may differ in areas. Metallogenic material is provided for the formation of antimony by the “Dachang Layer” and “hydrothermal process”, the area overlapped by both is beneficial for forming antimony with high grade. 3) there may be some other factors providing the metallogenic material or participate in the formation of antimony, such as “oil-gas reservoir”, however, further researches are still needed.

Keywords: Antimony ore, Provenance, Western Guizhou.

1. Introduction
There is a small amount of antimony metal used, but antimony alloy and antimony compound are widely used. Western Guizhou is home to abundant mineral resources with rich quantity of resource, such as gold, coal, antimony, manganese, iron and phosphorus. Also there are large potential rare metals, rare earth metals, scattered metals as well as shale gas. As one kind of significant mineral resources in western Guizhou, it mainly concentrated in Qinglong county, accounting for 32.59% of antimony ore resources in Guizhou, while only a small number is in some other counties (Mineral resources in Guizhou province, 2014). There are a lot of results after experts’ researches, mainly including the regularity of ore formation (Yuan, 1997; Wang, 2002; Wang, 2011; Xiong, 2011; Wang, 2016). The paper analyzes the origin of metallogenetic material of antimony ore in western Guizhou in accordance with the previous researches providing new materials for further exploration and development as the provenance of antimony ore is complicated all the way.

2. Geological Introduction
The antimony resource is mainly distributed in southwest Guizhou, where the stratum outlet is devonian system -triassic system. The stratums of different systems generally are disconformable contact and the quaternary system owns angular unconformity with its underlying stratums (Regional Geology of Guizhou Province, 1987). Devonian system includes Lijiawan formation, Guanziyao formation, Huohong formation of limestone and dolomite. The carboniferous system is composed of Baizuo formation, Huanglong formation and thinner Jiusi and Shangsi formations. Permian system mainly
contains middle and lower power system, and carbonatite is the major mass in Qixia and Maokou formation within middle system. There are obvious discontinuities between upper and underlying Maokou formation with rough ancient erosion surface. The middle Permian system is overlain by Longtan, Changxing formation and Emeishan basalts, namely the upper Permian system. Both Longtan and Changxing formations are composed of fine clastic rocks, and Longtan formation belongs to the coal-bearing measures. The bottom is Emeishan basalts and discontinuous lenticular body, known as “Dachang Layer”. Triassic system mainly develops the open platform facies of shallow sea with its lower system of Yelang, Yongning formations, middle system of Guanling formation and upper system of Luolou and Ziyun formations. The Guanling formation mainly contains carbonatite. Quaternary system in flat slopes, low-lying areas and on the both sides of rivers, is primarily composed of alluvial deposit with its lithology of gravel, gravelly clay and clay.

3. Distribution of Antimony Ore
Distributed in Qinglong county, Dushan county, Rongjiang county and Zhenning county, the main antimony mineral resources in these four counties accounts for more than 90% of the total amount in Guizhou province. The antimony in southwest Guizhou is mainly distributed in Qinglong county, where the ore occurs in the “Dachang Layer” with layered and layer-like. The age and formation of “Dachang Layer” is still controversial, while its lithology is volcanic.

4. Research on the Provenance of Antimony Ore
There are large amount of Emeishan basalts in west Guizhou, where the formation of many minerals is related to the eruption of Emeishan basalts. It is a common deposit zonation that lead, zinc and copper are formed in northwest of Guizhou, while gold, arsenic, antimony and mercury in southwest as the influence of Emeishan basalts (Nie and Kang, 2014). A slew of scholars believe that “Dachang layer” formed by the eruption of Emeishan basalt is the source rock of antimony ore, whose formation is highly effected by these basalts (Liao, 1990; Chen, 1994). Some other scholars admit that there is little relationship between the formation of antimony and Emeishan basalts and it is effected by other factors, such as the mineralization of paleo-oil reservoir (Wang, 2017), the mineralization of late hydrotherm (Wang, 2011), metallogenic materials provided by the underlying old strata and basement (Peng, 2003). It is believed that the metallogenic fluid of antimony is a combination of basin fluid in the early stage with lower temperature, some atmospheric precipitation and deep fluid in the late stage with higher temperature and the source of metallogenic fluid is complicated with its metallogenic materials coming from basement and upper mantle (Pan, 2017). In general, it still has a further move on the provenance of mineralization, which has not reached a consensus.

5. Discussion
Recent researches show that increasing scholars believe the complexity of antimony mineralization, the non-oneness of provenance as well as the unanticipated, greater influence of some factors, such as hydrotherm. There are three stages during the formation of antimony ore by studying on antimony deposit in Qinglong county, including syngenetic sedimentary mineralization stage, hydrothermal reforming mineralization stage and epigenetic transformation stage, and stibnite is formed in the early and middle stage of hydrothermal reformation stage (Zhu, 2010). The differences between east and west antimony deposits in the ancient uplift of southwest Guizhou are dominated by various ore-forming fluids, west of which is mainly fluorite and stibnite, east quartz and stibnite, showing that the ore-forming fluid of west part comes from plane of unconformity and the east part is from deep fold basement (Hu, 2011). There is a close relationship between the formation of antimony and ancient fossil reservoir, whose sulfur ion may be the source of sulfur ion in antimony deposit (Wang, 2017).

Layered, layer-like antimony ore and other characteristics show that the main body of iron ore in west Guizhou is sedimentary formation, similar to bauxite, phosphate, coal and other mineral resources. Compared to endogenous deposits such as hydrotherm, it takes a very long time to form sedimentary minerals. The antimony ore in west Guizhou forms during early Triassic epoch to early cretaceous epoch,
which is long for mineral formation. It is difficult to ensure that the mineralization material is provided only by a single parent rock, resulting a combination of various mineralization materials. Therefore, all the analysis may be right, namely, the parent rock during the mineralization of antimony deposit may be “Dachang Layer”, ancient underlying strata, hydrothermal process as well as gas-oil reservoir. However, further researches are needed to determine which one is the dominated parent rock or method.

It is said that “Dachang Layer” should provide material source for the formation of antimony ore and the ore has obvious hydrothermal alteration according to petrology, mineralogy, geochemistry as well as characteristics of ore body, that is to say mineralization material is also provided by hydrothermal activity. The activity is a common phenomenon. The paper shows that the activity may own an effect on upgrading the antimony, not just for mineralization material, but also for metathesis, which makes the content of antimony in the early formation increase and forms a higher grade deposit. Both hydrothermal activity and gas-oil reservoir may have the same effect, but further research is a must.

It is controversial which one is more crucial in providing the mineralization material to determine the type of deposit. At present, there are following possibilities of the provenance and metallogenic process of antimony ore in southwest Guizhou: 1) “Dachang Layer” is more obvious than others. The main body of this deposit should be sedimentary one, so the function of hydrothermal process and other activities can upgrade the deposit. The local is dominated by hydrothermal activity and oil-gas reservoir, which makes the provenance and formation process present a complex situation in this area. 2) as an intermediate link, “Dachang Layer” provides some metallogenic material which cannot be called “antimony ore” until the large-scale occurrence of hydrothermal activities and antimony ore is formed finally under the combined activities. 3) “oil-gas reservoir” and other activities form antimony ore. It is concluded that it is objective in the first and second mode as there are differences in mineralization in various regions, which is similar to bauxite. It is very essential for minerals with high grade to transformation after deposition instead of direct deposition. The quality antimony resources are formed by the deposition and transformation of metallogenic materials, so the optimal metallogenic area should be the overlap of “Dachang Layer” and hydrothermal process, especially adding the other factors, such as “oil-gas reservoir”. Based on its complexity, systematic study is still needed to analyze the specific proportion of different sources.

6. Conclusion
It comes to a conclusion that the antimony ore in southwest Guizhou forms in a long, complicated process occurring various mineralization in stages. Metallogenic materials are provided by “Dachang Layer”, hydrothermal process as well as oil-gas reservoir. Different areas witness diverse formations of antimony ore, among which the overlap area of “Dachang Layer” and hydrothermal is good for forming the antimony with high grade. There is a need to further research on the mineralization and the material source dominated by specific regions because the complexity of antimony ore formation.

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References
[1] Guizhou province geology and mineral bureau. Mineral resources of Guizhou. China university of geosciences press, 2014.
[2] Yuan Wanchun, Li Yuansheng, Zhang Guoping et al.. C, H, O and S isotope geochemistry of low-temoerature Hg, Sb, Au and As deposits in the Yunnan-Guizhou-Guangxi area. Acta mineralogica sinica, 1997,17(4):422-426.
[3] Wang Guozhi, Hu Ruizhong, Su Wenchao. Geochemical constraint on ore fluid from fluorite in Qinglong antimony deposit, south-western Guizhou. Mineral deposits,2002,21:1028-1030.
[4] Wang Jinjin. The study of the coupling of metallotectonics and ore-forming fluid of Qinlong antimony deposit, Guizhou Province. Kunming university of science and technolog, 2011.
[5] Xiong canjuan, Liu Jianzhong, Liu Shuai et al.. Study on fluid inclusion of Qinglong Dachang antimony deposit. Journal of Guizhou university, 2013, 30(6):47-52.
[6] Wang Pengpeng. Geological and geochemical characteristics and determination of accumulation Epoch of the Paleo-oil reservoir in Qinglong antimony deposit, Guizhou Province, China. Kunming University of science and technology, 2016.
[7] Guizhou province geology and mineral bureau. Areal geology of Guizhou. Geology press, 1987.
[8] Nie Aiguo, Kang geng. Research on the Metallogenic difference of Emeishan basalt in Guizhou. Guizhou technology press, 2014, 86-87.
[9] Liao Shanyou and Hu tao. Ore-controlling conditions and ore-forming mechanism of the Dachang antimony deposit in Qinglong, Guizhou province. Guizhou geology, 1990, 7(3): 229-236.
[10] Chen yu, Liu Xiucheng and Zhang Qihou. A tentative discussion on the genesis of the Dachang antimony deposit, Qinglong county, Guizhou province. Mineral deposits, 1984, 3(3):1-12.
[11] Peng Jiantang, Hu Ruizhong, Jiang Guohao. Strontium isotope geochemistry of fluorites from Qinglong antimony deposit in Guizhou Province. Geological journal of China universities,2003, 9(2):244-251.
[12] Pan Jinquan, Wu Denghao. Comparison of sources for the ore-forming fluids and materials for the antimony ore deposits in south and southwest of Guizhou province, China. Geological science and technology information, 201736(4):123-132.
[13] Zhu Junbin. Studies on lithoficies and geology-geochemistry in Qinglong antimony deposit, Guizhou province. China University of Geosciences, 2010.
[14] Hu Yuzhao. Analysis on Sedimentary depression and study on the forming of antimony and gold in southwest Guizhou. Kunming University of science and technology, 2011.
[15] Wang Di. Organic geochemical characteristics and the metallogenic relationships between the Paleo-oil reservoir and Qinglong antimony deposit, Guizhou Province, China. Kunming university, 2017.