Research progress in metallogenic rules of antimony ores in western Guizhou province

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Abstract. The research progress in metallogenic rules of antimony ores is analyzed based on previous materials. It is found that basic properties of antimony ores in southwestern Guizhou Province have been clearly explored, whereas their provenances and metallogenic epoch are still controversial. Content such as ore-forming processes and properties of ore-forming fluids remain to be further studied.

Keywords: Antimony ores, metallogenic rules, research progress, western Guizhou province.

1. Introduction
Western Guizhou Province is an important area of Guizhou Province where antimony ores are distributed and has large-scale antimony deposits. Many experts and scholars have investigated antimony ores of Guizhou Province (Yuan, 1997; Wang, 2002; Wang, 2011; Xing, 2013; Wang, 2016; Yu, 2017), achieving considerable outcomes. Based on previous data, studies about metallogenic rules of antimony ores in western Guizhou Province are summarized, in order not only to provide basic data for exploring gold ores, but also have certain significance for guiding further research and development of antimony ores in western Guizhou Province.

2. Geological Backgrounds of Metallogenesis
Sichuan and Yunnan are the most potential provinces for prospecting super-large Pb-Zn ores and gold deposits in China (To et al., 2000). In the west of Guizhou Province, the metallogenic province of
lead-zinc ores is on the southwestern margin of Yangtze paraplatform and in the east of Xizang Yunnan axis as a upper Yangtze metallogenic sub province in the metallogenic province of Yangtze par platform, which is an integral part of polymetallogenic ore clusters in Sichuan, Yunnan and Guizhou provinces (Jin, 2006). Listed from the old to new, exposed strata include Simian Denying Formation, Cambrian system, Silurian, Devonian system, carbonic system, Permian system, Triassic system, Jurassic system, tertiary system and quaternary system, among which Permian Emeishan basalts are extensively distributed across the whole area.

3. Types of Mineral Deposits and Ore-bearing Strata
Antimony ores in Guizhou Province are classified into five types, namely marine volcanic hydrothermal sedimentary antimony ores, clastic antimony ores, low-grade metamorphic antimony ores, carbonate antimony ores and epigamic accumulative antimony ores (Non-ferrous metals geological exploration bureau of Guizhou, 2009). In Western Guizhou Province, antimony ores are mostly distributed in Qing long County and marine volcanic-hydrothermal sedimentary (Wang, 2009; Yu, 2017). “Dashing Stratum” is the ore-bearing stratum, where highly silicified rocks are in the lower part and highly silicified brecciated clay rocks in which antimony ores are mostly produced on the stratum; basaltic breccia is in the middle, in the lower part of which highly silicified brecciated clay rocks are where most antimony ores are generated; clay rocks are in the upper part, where the altered upper basalts are major areas for yielding antimony ores (Xing, 2013).

4. Provenance Analysis
Plenty of scholars think that the formation of antimony ores is related to Emeishan Basalt, the eruption of which leads to the formation of the “Dashing Stratum”, Dashing Stratum and Emeishan Basalt separately or jointly make provenances available to the formation of antimony ores (Liao, 1990; Chen, 1994; Nia and Kang, 2014). Peng (2003) thinks that there are external sources for both ore-forming fluids of antimony ores and metallogenesis, which don’t originate from host rocks. Wang (2017) considers that hydrocarbon gases from fossil oil reservoirs get involved in metallogenesis to produce stibnite ores. Wang (2011) deems that some minerals are from late hydrothermal fluids. This paper suggests that antimony ores form similarly like gold ores. In addition to Emeishan Basalt and “Dashing Stratum”, there are also other provenances for the formation of antimony ores. These provenances are hard to identify due to multi-stage hydrothermal alteration.

5. Metallogenic Epoch
Some scholars consider that antimony ores formed in the Yanshanian period (Chen, 1984; Liao, 1990; Wang et al., 2002). By measuring Qinglong antimony ores with Sm-ND, Wang Zapping discovered that the metallogenic age of Qing long antimony ores was 141Ma, which was measured to be 104Ma and 125Ma respectively by Zhu Layman. After analyzing fluid inclusions, Hu (2011) judged that antimony ores came into being from the late stage of the middle Triassic period to the late Triassic period. Measured with isotopes of fluorite Sm-ND by (Peng, 2003), the metallogenic age was identified to be about 148Ma. Wang (2012) suggested that the metallogenic epoch was generally the same when measured by calcite and fluorite Sm-ND. All their research results suggested that metallogenic epoch was the late Jurassic and early cretaceous period. Antimony ores form through extremely complicated processes. A rather long process must be experienced from primary sedimentation of ore-forming materials to final lifting, and antimony ores are products of this process. It is unscientific to define the metallogenic epoch of antimony ores within a relatively short period, because long process of formation is a common characteristic among many types of deposits. The metallogenic epoch of sedimentary deposits shall be calculated from the depositional period until the metallogenesis through burial and alteration.

Above all, the metallogenic period would extend from the early triassic period to the early cretaceous period, which is more reasonable. In other words, both the processes of weathered
transported deposit and lifting for alteration are taken into account, on the grounds that the former process can be hardly detected.

6. Geochemical Characteristics
Zhu (2010) reported in his research that the content of SiO2 was generally high on the “Dashing Stratum”, where the content of other components changed significantly, and some rocks exhibited features of hydrothermal sedimentation. After performing isotope analysis of carbon, hydrogen, oxygen and sulfur, Yuan(1997)judged that sulfuring antimony ores came from marine sulfate and rainfall was the major source of ore-forming fluids(Ye, 1996).The ratio of Sir isotopes in fluorite of antimony ores is much higher than that in fluorite of ore-bearing strata and Emeishan Basalt (Peng, 2003) After studying H, O, S and Pub isotopes, Pan(2017)concluded that rainfall and host rocks were sources of ore-forming fluids and sulphur in antimony ores respectively. After his investigation of fluorite, Sir Isotopes and organic geochemistry of the deposits, Wang (2002) suggested that like sea water, negative Ce anomalies also existed in ore-forming fluids, which were basin fluids; from the early to the late metallogesis, the reduction conditions were transformed into oxidization conditions and medium rare earth was enriched, thus evolving into light rare earth.

7. Discussions
Although antimony ores have been studied relatively comprehensively, many issues are still controversial due to complicated and long metallogenic processes of these ores. Lots of scholars consider that Emeishan Basalt and Dashing Stratum are dominant provenances. Nevertheless, some scholars think that they are not major provenances, or there are still other provenances. This paper suggests that Emeishan Basalt and “Dashing Stratum” are leading provenances of antimony ores. However, in long processes of metallogenesis and alteration, other ingredients will be some inevitable provenances for the formation of antimony ores. Nonetheless, the contributions of these materials would not surpass those of Emeishan Basalt and Dashing Stratum. At present, the metallogenic epoch of antimony ores still can’t be determined exactly. Lots of scholars think that these ores formed in the Yanshanian period. This paper reports that for ores with relatively long metallogenic period, it is unrealistic and unscientific to define certain short period as metallogenic epoch. Similar to bauxites of northern Guizhou Province, antimony ores should have formed across certain epoch. After comprehensive considerations, this epoch might extend from the early Triassic period to the early cretaceous period. To be sure, these deposits might be enriched and altered to certain extent. In spite of this, antimony ores have generally taken shape. According to geochemical studies, the formation of antimony ores is closely associated with basin fluids. Currently, related research remains to be further deepened, and it is necessary to identify the roles of ore-forming fluids with more evidences.

8. Conclusion
Fairly comprehensive and thorough studies have been performed regarding antimony ores. However, some issues are still controversial because complex metallogenesis of these ores. After a comprehensive analysis, we reach following conclusions: 1) mineralogy and deposit features of antimony ores have been clearly understood; 2) Provenances of antimony ores are still controversial. In this paper, Emeishan Basalt and “Dashing Stratum” are expected to be major provenances of the ores, followed by other provenances; 3) The metallogenic epoch of antimony ores is quite controversial, which coincides with the fact that antimony ores don’t form over a short period, whereas the metallogenesis always existed from the early Triassic period to the early cretaceous period; 4) Content such as the formation process of antimony ore ores and properties of ore-forming fluids have to be further explored systematically.

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References

[1] 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.

[2] 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.

[3] 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.

[4] 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.

[5] 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.

[6] Yu chong. Study on characteristics of fluid inclusions and its significance of Qinglong Dachang antimony deposit in Guizhou province. Kunming University of science and technology, 2017.

[7] Tu Guangzhi. Super large deposits, Science press, 2000, 350-390.

[8] Jin Zhongguo. Research on the ore-controlling factors, metallogenic regularity and prediction of lead-zinc ore district in Northwest, Guizhuo, Central south university, 2006, 79-111.

[9] Gao Zhengmin. The formation and exploration of major gold in Yunnan and Guizhou province, Geology Press, 2002:78-96.

[10] Non-ferrous metals geological exploration bureau of Guizhou. Mineral resources of Non-ferrous metals and ferrous metals in Guizhou. Metallurgical industry press, 2009.

[11] Nie Aiguo, Kang geng. Research on the Metallogenic difference of Emeishan basalt in Guizhou. Guizhou technology press, 2014, 86-87.

[12] 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.

[13] 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.

[14] 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.

[15] 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.

[16] Wang Denghong, Qin Yan, Wang Chenghui et al. Mineralizaition pedigree for epithermal Hg, Sb, Au deposits in Guizhou province-taking the Dachang Sb deposit, the Zimudang Au deposit and the Luanyangtang Hg deposit for examples. Geotectonica et metallogenia, 2012, 36(3):330-336.

[17] Zhu Junbin. Studies on lithofacies and geology-geochemistry in Qinglong antimony deposit, Guizhou province. China University of Geosciences, 2010.

[18] Ye Zaojun. Fluid Inclusion and isotope of Dachang antimony in Guizhou. Geology and geochemistry, 1996, 5: 18-20.

[19] 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, 2017, 36 (4):123-132.