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A Study on Bi-Sb Minerals in the Damajianshan Tungsten Polymetallic Deposit and Its Geological Significance, Yunnan Province, China

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1 Geological Features of Ore Deposit

Damajianshan tungsten (-copper-arsenic-molybdenum-bismuth) polymetallic deposit is located in the south of the Sanjiang Tethyan metallogenic domain in Yunnan province. The tectonic location of this tungsten polymetallic deposit belongs to the southmost part of Jiangda-Weixi-Lvchun arc-volcanic belt's obduction phase formed in the end of late Paleozoic to early Mesozoic according to the division of structure-lithofacies in Sanjiang region. The emergence strata are of Silurian, Devonian, Permian, Trias, Jurassic and Cretaceous in the deposit. The stratum in the study area is composed of lower Silurian low-grade regional metamorphic which original rock belongs to the shallow-bay facies muddy clastic rock. The upside stratum is phyllitic slate which contains metamorphic siltstone and the lower part is mainly of fine-siltstone. Fold is not well developed but fault, joint and fracture are relative growth in the study area. There are 11 faults which are also accompany a large of secondary faults and with the direction of north-northwest. They provide favourable metallogenic and ore-containing space for the movement and deposition of ore-forming fluid. The main orebody I is controlled by the F₁ fault. The magmatism in Damajianshan tungsten polymetallic is characterized by the frequent magmatic activity, multi-stages, long period and output from Variscan to Himalayan period. The most of long axis direction of rock body are northwest and consistent with the main structure lines. Most of ore bodies are dominated essentially by the main faults in the deposit. The movements of magma in this deposit are mainly marked intrusion of Indosinian quartz porphyry and a spot of lamprophyre. The intrusion of Indosinian quartz porphyry are closely connected to the formation of the

magmatic hydrothermal tungsten-bismuth deposit.

2 Mineral Assemblage

There are great varieties of ore minerals and their compositions are quite complex in Damajianshan tungsten polymetallic deposit. The main ore minerals are arsenopyrite, pyrite, chalcopyrite, scheelite, wolframite, galena, sphalerite, molybdenite, pyrrhotite, bornonite, cassiterite, bismuth minerals (including native bismuth, bismuthinite, coscalite, izoklakeite, ikonolite and an undefined mineral (Pb₃Sb₂S₇)) (Table 1) and gangue minerals are quartz, dolomite, manganocalcite, sericite, chlorite and others. The mineral formation sequence is carried out in four stages according to the mineral assemblage and intercalating relationship. The stages from the early to late are in order of silicate, quartz-sulfide, sulfide-oxide and carbonate. The bismuth-antimony minerals are mainly formed in the middle and late stage of sulfide.

3 Conclusion

Bismuth-antimony activation is related to moderate-high temperature hydrothermal activities within the perspective of geochemical properties. They often enrich in the post-magmatic hydrothermal. The emergence of one of the bismuth-antimony sulfosalt minerals is restricted by $f(\text{S}_2)$, $f(\text{O}_2)$, PH and the concentration of Pb²⁺, Bi³⁺, Sb³⁺ and so on in the ore forming process. The bismuth-antimony sulfosalt have so many mineral species and output ikonolite, izoklakeite, undetermined mineral (Pb₃Sb₂S₇) which are rare at home and abroad in this deposit (Harris et al., 1986; Wagner et al., 2001; Zakrzewski et al., 1986). They may have a close relation with special geologic structure background,

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Table 1 EPMA and specturm analysis of three rare minerals (%).

Mineral	Formula		Number of analysis	S	Fe	As	Cu	Pb	Zn	Sb	Cr	Bi	Mo
Ikunolite	$\text{Bi}_4\text{S}_{3.03}$	Min	5	9.11	-	-	-	-	-	-	-	86.86	-
		Max		10.65	-	-	-	-	-	-	-	89.52	-
		Mean		10.19	-	-	-	-	-	-	-	87.86	-
Izoklakeite	$\text{Pb}_{20.4}(\text{Cu},\text{Fe})_{2.25}(\text{Sb},\text{Bi})_{20.58}\text{S}_{60.16}$	Min	11	17.12	0.01	-	0.27	35.15	-	7.63	-	14.61	-
		Max		21.26	0.06	-	1.80	47.71	-	18.68	-	31.58	-
		Mean		19.25	0.22	-	1.18	42.17	-	12.71	-	21.23	-
Pb-Bi-Sb-S undefined mineral	$\text{Pb}_3\text{Sb}_2\text{S}_{7.13}$	Min	8	19.50	-	-	-	53.02	-	18.86	-	2.16	-
		Max		19.85	-	-	-	55.01	-	21.65	-	4.63	-
		Mean		19.68	-	-	-	53.63	-	20.91	-	3.15	-

(“-” neglection or lower than detection limits)

magma and mineralization events. Based on the investigation of Paragenetic mineral assemblages, fluid inclusion, and thermodynamics, we conclude preliminarily that physicochemical environment is Volatility and uncertainty during metallogenic evolutionary process in the Damajianshan tungsten polymetallic deposit. $\log f_{\text{S}_2}$ and $\log f_{\text{O}_2}$ have the fluctuation changes showing an negatively correlative with the fluid evolution process, excepting the changing of temperature and ion concentration (Ohmoto et al., 1972; Simon et al., 1996).

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