1 Introduction

The Ob-Zaysan folded zone is a fragment of a single marginal-continental structure of the Siberian continent, made up of Paleozoic sedimentary and volcanogenic rocks (mainly black shale) and characterized by a common set of magmatic complexes and mineral systems. However, there are some differences which determine the geological and metallogenic specific features of the Irtysh-Zaysan and Kolyvan-Tomsk areas of the Ob-Zaysan folded zone. In the gold fields of these areas the main gold-sulfide mineralization (orogenic gold style) is controlled by sheared zones and is formed under tectonic compression in long-developing block structures.

2 Geodynamic Position and Metallogeny of the Ob-Zaysan Folded Zone

The Altai builds the western flank of the Central Asian orogen. It includes the Ob-Zaisan and western Altai-Sayan folded areas which in the Late Paleozoic-Early Mesozoic evolved as a single large tectonic unit of the Altai collisional shear system (Vladimirov et al., 2008). The recent views of the Late Paleozoic Altai orogeny are that Kazakhstan and Siberia were converging gradually and rotating clockwise relative to each other during the closure of the Char ocean (Buslov et al., 2003). Before the collision Altai and Kazakhstan (in the Devonian-Early Carboniferous) were active continental margins. The Altai-Mongolia microcontinent with Neoproterozoic crust (Nd (2-st) = 1.5–1.0 Ga) was sliding along the edge of Siberia, and the Char oceanic plate subducted obliquely beneath Kazakhstan and Siberia along two zones (Zharma-Saur and Rudny-Altai island arcs). After the ocean closure had completed by the Middle Carboniferous, the orogen evolved in an environment of left-lateral shear (Vladimirov et al, 2008).

The Ob-Zaysan folded zone is located between Tomsk city in the north (Russia) and lake Zaysan in the south (Kazakhstan) and combines two fragments (Kolyvan-Tomsk and Irtysh-Zaysan). Both of these fragments have similar geological structure, almost the same age of the black shale and intrusive complex, similar gold-arsenic metallogenic profile, etc. However, within the Kolyvan-Tomsk zone the Upper Paleozoic volcanic rocks have been established, magmatism was not so active and fewer deep faults have been revealed.

3 Relations Between Antimony and Gold Mineralization

Antimony ores are characterized by brecciated textures and vein-like morphology of ore bodies, reflecting tectonic stretching mode. On a number of ore fields (Zherek, Mirazh, Dalny and other) Sb-mineralization is spatially removed from the main gold-sulfide ores (Kovalev et al, 2009) and have a crosscutting position to the main ore-controlling structures. In other gold deposits antimonite mineralization is combined with disseminated gold-sulfide ores and forms Sb-containing minerals with Ni, Co, Au, Pb and Fe (Alimbet, Zhanan, Legostaevskoe, Semiluzhenskoe, Kamenskoe).

Typically, the main mineral of antimony mineralization is stibnite. Mineralization commonly occurs in carbonaceous elastic-carbonate rocks, in silicified metasomatic, beresites and basic and felsic dykes. Stibnite occurs as radiating crystalline aggregates in the cavities or as massive fine-grained aggregates. Antimony mineralization in the gold-polysulfide ores is more diverse and is represented by berthierite, stibnite, native antimony, aurostibite, ullaminate, jamesonite. Other ore minerals

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contain Sb in some quantities (arsenopyrite, pyrite, and tetrahedrite nickeline). Antimony distribution in the ore is extremely uneven. Within the zone of oxidation stibnite is often replaced by antimony hydroxide - stipconite and antimony oxides-servantite and senarmontite.

In the gold-sulfide ores no direct correlation between Au and Sb is revealed. According to atomic absorption and X-ray microprobe analyzes, stibnite contains "invisible" gold few (up to tens) ppm. In the areas of overlapping of antimony and gold-sulfide mineralization (the Suzdal, Zhanan, Legostaevskoe gold deposits) occur zones of high gold content (up to 480 ppm). It can be explained by the processes of regeneration and concentration of gold during the late antimony stage.

4 Fluid Inclusion Study

Homogenization temperatures of fluid inclusions in quartz at the Suzdal gold mine in East Kazakhstan show an average of 330°C (with a range from 300 to 380°C). Late antimony mineralization has lower temperatures close to 260°C (220 - 280°C)

In quartz of the Legostaevskoe deposit (Kolyvan-Tomsk zone) the gas-liquid inclusions with CO₂ were also studied. The homogenization temperatures of fluid inclusions in samples from different ore levels of main pyrite-pyrrhotite productive mineralization is about 330°C. Inclusions from antimony mineral assemblage have the homogenization temperature in the range of 280-300°C.

5 Geochronological Study

According to Ar-Ar (sericite) data, the age of the main gold-ore stage of Suzdal deposit is 281±3.3 Ma. Younger antimony mineralization (Ar-Ar, sericite) is dated at 248.3±3.4 Ma. (Naumov et al 2011, Kovalev et al 2009). This conforms to the time of formation of trachybasalt-trachyrhyolite association in the Semeitau igneous series (248.2±0.5 Ma, Lyons et al., 2002), which occurred in the ore field of this deposit. Moreover, the Suzdal deposit hosts dikes of altered granite-porphyries dated at about 245-257 Ma (U-Pb, SHRIMP). The age of Sb-bearing gold mineralization of the Legostaevskoe gold deposit in the Kolyvan-Tomsk area was determined as 246,8±3,1 Ma (Ar-Ar, sericite).

6 Conclusions

Mineralogical study, microstructural observations, geochronological characteristics, and results of the fluid inclusions study at the gold deposits of the Ob-Zaysan zone allow us to consider antimony mineralization as a separate phase of ore-forming system, which can be separated from the early productive gold-arsenopyrite stages up to 30 Ma. The results of our Ar-Ar and U-Pb geochronological studies (Naumov et al 2011) allowed us to distinguish two main phases of gold and antimony mineralization in the Ob-Zaysan folded zone: Early Permian (282-270 Ma) and Early Triassic (250-240 Ma), which can be related to the epochs of powerful intraplate magmatism, which led to the formation of the Tarim (280 Ma) and Siberian (250 Ma) large igneous provinces. These global geological events are generally connected with the influence of Tarim and Siberian mantle plumes (Pirajno et al, 2009).

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