Geology Geophysics and Earth Science
Volume 1, Issue 1, No. 5
Received 28 October 2022; Accepted 26 November 2022
Published online 6 December 2022

Sanderman Publishing House

Simple analysis of geological characteristics and deposit genesis of Tulukumushi copper mine in Atushi city, Xinjiang

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Abstract. The deposit is produced in the northern wing of Kalpintag anticline in Kalpin Foreland Basin, and occurs in the upper section of Paleogene Suwiyi Formation, the lithology of the ore-host layer is gray-green medium and fine calcareous sandstone, and the ore body occurs in strati-form-like and stratified form, which is consistent with that of the stratum. Total 4 copper ore bodies have been delineated, at the length of 40-530m, the thickness of 1.00-3.94m, and copper grade at 0.33-0.74%. The ore minerals are malachite, copper blue and chalcocite, the ore texture consists of granular texture, metasomatic relict texture and interstitial texture, and the ore structure consists of sparse disseminated structure, crumby structure and scattered structure. In accordance with the deposit geological characteristics, it was preliminarily judged that the type of deposit genesis belonged to continental sedimentary-layer controlling type sandstone copper deposit. The main ore-controlling factor was Palaeogene calcareous sandstone strata ore-controlling.

Keywords. Geological characteristics, strata ore-controlling, sedimentary-layer controlling type, Tulukumushi.

1. Geological background of the region

Tulukumushi copper mine is located at 96km in the direction of 85° of Atushi City. The tectonic structure position is located in Tarim-North China Plate, Tarim Micro Plate, and Kalpin Foreland Basin. The oldest strata in the region are of Cambrian shallow sea - lagoon facies fine clastic rock - carbonate formation; there are occurrence of Ordovician, Silurian, Devonian, Carboniferous, Permian and Cretaceous systems here, but lack Triassic and Jurassic systems. The Paleogene is the ore-host stratum of upper copper deposits in the region, the lithology is mainly brick-red mudstone and siltstone with gray-green color, with conglomerate layer at the bottom, which is in fault-type contact with the Cretaceous system. the Neogene is a fine clastic deposit of coastal facies. The regional structure is manifested by a series of tight folds close to the direction of east-west-northeast, and a few faults close to the direction of east-west-northeast as occurred along the core of Kalpintag anticline. A series of sandstone deposits (points) such as Tongguzi Agazi, Dashankou, Jiashi and Xike occur in the Paleogene strata on the southern flank of anticline, and North of the Kashgar Mountains, Tulukumushi and other sandstone copper mine points are also discovered successively in the north wing of the anticline, in addition, copper, lead, zinc, sulfur, gypsum and other mineral (mineralization) points are also found in Carboniferous - Paleogene of the region.

2. Geology of the mine

2.1. Ore-host strata

The mine is located in the northern wing of the Kalpintag anticline of the Tianshan Mountains in southwest Xinjiang, and the exposed strata in the mine are the Upper Devonian Keziltag Formation, the Upper Carboniferous Conklin Formation, the Upper Cretaceous Bashijiqike Formation, Oligocene Suwiyi Formation, and Miocene Jidike Formation. Consistent with ore-host strata of standstone copper mine in the region, the ore-host stratum of the mine is Paleogene Suwiyi Formation. Suwiyi Formation is distributed in the middle of the mine, spreading in the east-west direction, and belongs to an ore-bearing stratum. Suwiyi Formation stratum of the mine can be divided into three sections: the lithological association in the upper section is medium-thick layered red fine sandstone with gray-green fine sandstone and siltstone, where, the gray-green fine sandstone is an ore-bearing stratum in stratified structure and uniform bedding, the main ingredients of the fine sandstone are quartz, carbonate and a small amount of feldspar and siliceous rock, and the clasts are in sub-angular form with uniform grain size. The lithological association in the medium section is thin-stratified conglomerate; the lithological association in the lower section is medium-thick stratified red fine sandstone interspersed with siltstone, in which thin layer of anhydrite can be found.

2.2. Structure

The mine is located in northern wing of the Kalpintag anticline, and is in single oblique structure, which is very simple, at the formation dip angle of 20—40°. No big faults are discovered in the mine, but small blatter flaws develop in a relatively good way, in the direction of fault line of NE—NNE. The NW wall of the fault pushes to the SW, while the SE wall pushes to the NE, which is a sinistral rotation type. The fault surface tends to SE, and shows no obvious crush zones.

3. Geological characteristics of deposit

3.1. ore body characteristics

Copper ore body occurs in the upper section of Suwiyi Formation, and the lithology of ore-bearing stratum is gray-

green medium fine calcareous sandstone, and total four ore bodies are delineated in the mine, which are No. I-1, II-1, III-1 and IV-1 ore bodies, respectively. The ore bodies are in the strati-form-like and stratified form, which is consistent with that of the stratum.

No. I-1 copper ore body is located in the west of the mine, and is controlled by 10 exploratory trenches numbered TC30, TC31, TC42, TC43, TC44, TC45, TC46, TC47, TC48 and TC49, respectively. The intermittent exposure of the surface is 2,500m long, with the ore body in stratified form in the direction of near EW, and dips toward the north at the angle of 25°-37°. the ore body is 1.47-3.94m thick, at the average thickness of 2.43m, and its copper grade is 0.22%-0.72%, at the average grade of 0.58%.

No. II-1 copper ore body is located in the west of the mine, and is controlled by TC29 exploratory trench. The ore body surface is exposed 40m long, and the ore body is in lentoid form, at the occurrence of 0°∠26°. the ore body is 1.48m thick, at the grade of 0.35%.

No. III-1 copper ore body is located in the middle of the mine, and the surface of the ore body is exposed 320m long, which is controlled by TC24 and TC25 exploratory trenches, where, the depth is controlled by four boreholes i.e., ZK22001, ZK22801, ZK22802 and ZK22803. The ore body is in the direction of NEE 280°, dips toward NE at the angle of 23°-30°, and is 1.97-2.97m thick, with copper grade of 0.30%-0.36%, at the average grade of 0.33%.

No. IV-1 copper ore body is located in the east of the mine, and the surface of the ore body is exposed 530m long, which is controlled by TC34 and TC35 exploratory trenches. The depth is controlled by ZK24801 borehole, and the ore body occurs at 355°∠26°, is 1.0m-3.88m thick, at the average thickness of 2.27m, with copper grade of 0.21%-1.07%, at the average grade of 0.74%, and the ore body is in lentoid form.

3.2. Composition and structure construction of the ore

Main metallic minerals of ore are malachite, copper blue, chalcocite and pyrite. The malachite is distributed between arenes in spotted structure (1-10mm) and crumby structure, or is distributed surrounding chalcocite and copper blue. The copper blue is in sheet structure or other irregular structures, with fine particles, and is embedded in sand debris cement or malachite, and it is always closely related with chalcocite and malachite. Chalcocite is unevenly distributed in xenomorphic granular, spotted, crumby, and disseminated structure, with uneven crumb sizes. Pyrite in the ore is distributed in xenomorphic small granular and interstitial structure, and some show residual structure after being replaced by goethite, at the grain size of 0.05—0.2mm, in sporadic and uneven distribution. Gangue minerals mainly consist of quartz, potassium feldspar, plagioclase, calcite, sericite and so on.

The structure of ore consists of granular structure, metasomatic relict structure, interstitial structure and so on. Granular structure is the most common structure of ores, and malachite is in xenomorphic granular structure. Metasomatic relict texture is manifested by that the copper blue and malachite is in residual structure along the edge metasomatic chalcocite. Chalcocite, copper blue and argillaceous silicate, calcium, etc. constitute cement of feldspar, quartz and other debris in sandstone, which is manifested by interstitial structure. The ore structure consists of sparse disseminated structure, crumby structure and scattered structure.

4. Deposit genesis and ore-controlling factors

4.1. Deposit genesis

Tulukumushi copper mine is distributed in Cenozoic basin with marginal area of Tarim ancient landmass where the water is not deep, where, the basin is relatively stable and is subject to long-term sedimentation of terrigenous debris, thus forming thick purple mudstone layer and evaporite (gypsum layer) under the hot arid climate and oxidation condition, besides, due to action of colloid and clay adsorption, etc., preliminary gathering of copper element has been formed. In diagenetic period, local reducing environment was formed due to the action of organic matter and anaerobic bacteria, the inter-layer water and interstitial water made continuous extraction of copper from the underlying or laterally attached source beds and then made enrichment and mineralization in sandstone with good permeability. Therefore, the type of deposit genesis belongs to Paleogene continental sedimentary-layer controlling type sandstone copper deposit sedimentary-layer controlling type.

4.2. Ore-controlling factors

ore body distribution is basically consistent with spreading direction of Paleogene calcareous sandstone. Calcareous sandstone plays an important role in migration, precipitation and enrichment of mineral liquids due to its good porosity and permeability. It is proved upon observation that fine grained sandstone has the best ore capacity. In addition, roof-floor rock of calcareous sandstone is mud-stone, which is of good baffling function, and plays a great role in enrichment of mineral liquid.

The gypsum layer at the bottom of the mine is stable and spreads extensively, and it has indicated the climatic factors equipped for formation of ore body. Due to the existence of a large number of gypsum layers, the water flowing through the rock strata can be transformed into high salinity mineralized water, which is more conducive to leaching minerals in the rock strata, besides, migration of mineral liquid is under the control of evaporation action, which results in vertically upward dynamic gradient, thus enabling the ore-bearing solution to flow upward vertically, and make enrichment and mineralization in zones of stability.

5. Conclusion

(1) The deposit is produced in Kalpin Foreland Basin, and occurs in the upper section of Paleogene Suwiyi Formation, the lithology of the ore-host layer is gray-green medium and fine calcareous sandstone, and the ore body occurs in strati-form-like and stratified form, which is consistent with that of the stratum. Total 4 copper ore bodies have been delineated, at the length of 40-530m, the thickness of 1.00-3.94m, and copper grade at 0.33-0.74%. The ore minerals are malachite, copper blue and chalcocite, the ore texture consists of granular texture, metasomatic relict texture and interstitial texture, and the ore structure consists of sparse disseminated structure, crumby structure and scattered structure.

(2) In accordance with the deposit geological characteristics, it is preliminarily judged that the type of deposit genesis belonged to continental sedimentary-layer controlling type sandstone copper deposit. The main ore-controlling factor was Palaeogene calcareous sandstone strata ore-controlling.

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