Geological Features of Iron Formations and Associate Rock in Bulunkuole Group, West Kunlun, Xinjiang, China

Chaoyang Huang\textsuperscript{1,a}, He Wang\textsuperscript{2,b}, Guangli Ren\textsuperscript{3,c} and Wenying Wu\textsuperscript{1,d}

\textsuperscript{1}Chongqing Institution of Engineering, 402260, Chongqing, China; \textsuperscript{2}Guangzhou Institute of geochemistry; Chinese Academy of Sciences, 510640, Guangzhou, China \textsuperscript{3}Xi’an Center of China Geological Survey, 710054, Xi’an China.

\textsuperscript{a}:345245972@qq.com, \textsuperscript{b}:wanghe@gig.ac.cn, \textsuperscript{c}:155219321@qq.com, \textsuperscript{d}:569111860@qq.com

Abstract. West Kunlun is located at northwest part of the Tibetan plateau, and it’s divided into North Kunlun terrane, South Kunlun terrane and Tianshuihai terrane. Bulunkuole Group is located in Tianshuihai terrane, and Taaxi, Yelike, Laobing, Zankan, Mokaer and Jiertiekegou iron deposit was found in this terrane. Those iron deposits are set to the important iron ore mineralization belt of Xinjiang and even China. By investigation the geological features, ore distributions, and mineralization characters; and analyze the electron microprobe of magnetite and pyrite, stable isotope of pyrite, magnetite and anhydrite to discussion the tectonic setting and its genesis analysis iron ore deposit in Blunkuole Group, and establish the metallogenic model in this area. By contrastive analyzing of Taaxi, Yelike Zankan-Mokar iron ore deposits in Bulunkuole Group, it was found that all the iron ore deposit share the similar sedimentary environment. Those deposits have 3 ~ 4 ore bodies, each get a meter to dozens of meters in width, extend to thousands of meters. The wall rocks are biotite quartz schist and plagioclase amphibole schist, and the two rocks interbed usually. It should be distinguish in the stratigraphic correlation of Bulunkuole Group for the influenced by the magma intrusion, such as granite and felsite porphyry.

1. Introduction

Precambrian is one of the most important period for iron deposition, and it’s proved about 65.6% iron ore resource of the total in China\cite{1}. In China, Banded Iron Formations(BIFs) are mainly distributed in the North China Craton \cite{2}, and the distribution of iron-formation in the west kunlun has been reported widely since\cite{3}. The Taxkorgan is one of the most important iron-ore mining districts in the west Kunlun Orogenic belt, in the province of Xinjiang, China \cite{4} (Fig. 1).

Since the discovery of the iron deposit in 2005, the reconnaissance studies and mineralization studies have been done gradually. Based on the analyzed of the prospecting exploration data of the deposit geology, ore bodies and ore-structure characteristics, it is concluded that the Taxkorgan magnetite iron deposit belongs to sedimentary-metamorphic type, or the Algoma-type BIF \cite{5}. By tested the metamorphic zircon age of the ore deposit (532±3.9Ma) in biotite-quartz-schist of Bulunkuole Group, and the combination of a anhydrite-gypsum-iron formation, Changhai think it’s a new type of iron deposit named Pamir-type \cite{6}.

The depositional time frame of the Taxkorgan BIF in Bulunkuole Fomation, is not as precisely
known. It is wildly believed that the Blunkuole Group is a part of early Paleozoic component by comparing with the metamorphic grade and isotopic data in southwest Pamir region as well as the magnetite-quartz combination in it. By test the detrital zircon from the Taxkorgan region and got the ages of 540-220Ma, suggested that the deposition time of this region should be later than the Neoproterozoic [7]. Ji got the in situ zircon U-Pb LAICPMS date on rhyolite zircons yielded an age of 2481±14Ma and interpreted the as the eruption age of the Bulunkuole Group volcanic rocks [8]. Yan C.H. obtained a metamorphic age early Paleozoic period age from zircon in the biotite-quartz schist in Laobing iron mine.

The purpose of this study is to describe the geology characters of these mines in Taxkorgan, and study on the mineralogy and geochemistry elements of the iron ores of the Bulunkuole Group and in aims at discussing the origin of the Taxkorgan iron formations in the West Kunlun.

2. Geological settings

The West Kunlun orogenic belt is located in the northwest part of the Qinghai-Tibet Plateau, southwest of Tarim Basin, Western China (Fig. 1). The two main structural faults, Kangxiwa Fault and Karakunun Fault are divided the west Kunlun into the North Kunlun, South Kunlun, and Karakunun domains, and the Paleoproterozoic Bulunkuole Group is between the two faults. And the two regional faults not only control the tectonic framework of this region, but also to monitor the development of secondary faults, magmatism, volcanism and sedimentary formations.

Bulunkuole Group is one of the oldest sections of Paleoproterozoic terrane in west Kunlun Orogen, with low-grade greenstone successions and comprises BIF, mafic-felsic volcanic rocks, ultramafic rocks, chert, shale and minor carbonates. The majority of the iron ore bodies in the Taxkorgan are hosted in biotite-quartz schist and plagioclase-hornblende schist of the Bulunkuole Group (Figure 1).

Based on their mineralogical composition, the Bulunkuole Group successions can be subdivided into four lithostratigraphic units, namely, BIF, metavolcanic rocks, garnet-rich biotite quartz schist, and marble successions.

The west part of the Bulunkuole Group is BIF-bearing section is biotite-quartz schist and plagioclase-hornblende schist. In this succession, three important iron deposits are founded including Taaxi, Yelike-Laobing, Zankan-Mokar. The metavolcanic succession is in the middle of the Bulunkuole Group, with plagioclase-hornblende schist and biotite-quartz schist. In this succession, it is regarded volcanic eruption features as dark rock with light-colored rock rhythm recurring.

The garnet-rich biotite-quartz schist is located in the middle-east of the Bulunkuole Group. This succession comprises Garnet-biotite-quartz schist with minor sillimanite-garnet-plagioclase-biotite-quartz schist, and the garnet and sillimanite content of up to 20-30%.

In the east part of Bulunkuole Group is marble succession consist of marble, tremolite marble with biotite-quartz schist layers in it. Silurian sedimentary successions unconformably overlie the Paleoproterozoic Bulunkuole Group successions, which consists of predominantly clastic sediments with minor metapyroclastic rocks interbedded with minor lava sheets.
3. Local geology and petrography

The Taaxi, Yelike-Laobing, and Zankan-Mokar iron ore deposits are located in the southeast of the Taxkorgan, West Xinjiang, China, trending northwest-southeast, about 120 kilometers long.

3.1. Taaxi iron deposit point

The Taaxi iron ore point is located in the western edge of Bulunkuole Group, trending northeast in the eastern part of the mine and turn west-east trending in west part of this iron deposit. The iron deposit is composed mainly of three parallel ore bodies, are about 2200m long and 0.5–6m wide, with TFe2O3 40%wt in average, trending of 270, and an angle of 50-75.

The Taaxi iron deposit is hosted in metamorphic rocks of Paleoproterozoic Bulunkuole Group consists of iron formations, plagioclase-hornblende schist, biotite-quartz schist and marble. From the geological cross-section map in the Taaxi iron deposit, three ore bodies are interrelated in plagioclase-hornblende schist, biotite-quartz schist, and interbedded marble in the northern part, strike NW at the east part of the mine and become strike EW at west. Marble was just found at the northern part of this district, with only 2-3m in width, laminated in biotite-quartz schist. The cross-section can be divided into three groups based on the rock assemblage characters. The southern part of the cross-section comprises plagioclase-hornblende schist interlayer minor biotite-quartz schist, and some of the rock units were covered by quaternary sediments.
Figure 2. Columnar sections of the iron formations in the West Kunlun orogenic belt.

3.2. The Yelike-Laobing Iron Ore Deposit
The Yelike-Laobing iron ore deposit is one of the most important ore districts in Taxkorgan area. The ore deposit is about 5000 m in strike length and composed of 3 to 5 parallel ore bodies, which can be divided into two mines by the different mining company: Yelike and Laobing. The two iron ore deposits are of the same geological characters. The 3-5 parallel ore bodies are interlayered with plagioclase-hornblende gneiss and biotite-quartz schist, strike EW at the east part of the mine and turn NW at west (Fig. 2). Almost all massive ores have a high Fe grade of about 45wt. %.

In the east part of this mine (Laobing), some ore bodies are deformed slightly, and one Syncline was found at the east, trend NWW. While in the western part of the mine (Yelike), most of the ore bodies are interlayered with plagioclase–hornblende schist and biotite-quartz schist. In the iron ore, the major minerals are magnetite, quartz, biotite and plagioclase. Under the microscope, iron ore consist of magnetite and quartz, and they exhibit a weak linear fabric, and have a granular texture with sharp boundaries in some mineralization wall rock. The banded iron content of magnetite is between 20% and 40%, whereas that of quartz is between 50% and 70%.

3.3 Zankan-Mokar iron ore deposit
The Zankan-Mokar iron ore deposit hosted total premining resources about 150 millionmetric tons (Mt), with an average grade of 41.1%, is located in the southern part of the iron ore deposit district in Taxkorgan. The Zankan-Mokar iron ore deposit consists of more than 10 ore bodies, which can be regarded as 4 parallel ore bodies from the geology map. The mineralogy and geological characters are similar to those of Taaxi and Yelike-Laobing. Biotite-quartz schist and plagioclase-hornblende schist...
are the most important wall rock in this deposit. In this iron ore deposit, the ore bodies are interlayer in the biotite-quartz schist and plagioclase-hornblende schist and ore bodies are conformable contact with their wallrocks, especially the contact zone between the two rock units.

The ore body at the southern part of the cross-section is about 40m in width, and most of the ores are banded, while some of them are massive. Biotite-quartz schist and plagioclase-hornblende schist are the most rock units, and conformable contact with the ore bodies.

4. Mineralogy and petrography

4.1. Iron formations
Most of the iron formations in Taxkorgan area are mesobands to massive structure. The petrology and mineralogy of the Bulunkuole Iron Formations are representative of most Precambrian banded iron-formations over China. Microphotographs of various iron ore samples from the West Kunlun shows there are 3 types of the iron formations, laminated magnetite quartzite, coarse laminated magnetite quartzite and fine laminated magnetite quartzite.

In sample ZK10-110, mineral abundances are quartz (40–50%), magnetite (25–30%), amphibole (10–15%), biotite (10–15%), chlorite and epidote (1–5%) and accessory plagioclase (<2.5%).

4.2. Biotite-quartz schist
Biotite-quartz schist is one of the most common rock type in this district. These schists contain quartz (50–60%), biotite (40–50%). The quartz grains are inequant and showing both strained properties, and biotite often forms continuously elongated flakes in those samples.

4.3 Plagioclase-hornblende schist
Plagioclase-hornblende schist in Bulunkuole Group show that it contains quartz (30–40%), biotite (10–20%), sericite (10–20%), muscovite (5–10%), The amphiboles are grained and some strained to , show pronounced pleochroism, and contain inclusions of allanite.

In West Kunlun area, the ore bodies are mostly occurring between the plagioclase-hornblende schist and biotite-quartz schist.

5. Summary
1. Iron ore deposits in West Kunlun have 3 to 4 ore bodies, each get one meter to dozens of meters in width, and extend to thousands of meters.
2. The plagioclase-hornblende schist and biotite-quartz schist are the most important wall rock in this area.
3. By analyzing of ore body and stratum from wild, it shows that the deposit in Bulunkuole Group has the characteristics of sedimentary deposit.

6. Acknowledgments
This study was supported by National Science & Technology Pillar Program during the Twelfth Five-year Plan Period (2015BAB05B00) and Chongqing Vaccination Institute of Engineering Commission (KJB201513).

7. References
[1] Santosh, M., 2010. Assembling North China Craton within the Columbia supercontinent: the role of double-sided subduction. Precambrian Research 178, 149-167
[2] Yuan, C., Sun, M., Zhou, M. F., Zhou, H., Xiao, W. J., Li, J. L. 2002. Tectonic evolution of the West Kunlun: Geochronologic and geochemical constraints from Kudi granitoids. International Geology Review, 44(7): 653-669.
[3] Xiao, W. J., Windley, B. F., Fang, A. M., Zhou, H., Yuan, C., Wang, Z. H., Li, J. L. 2001. Palaeozoic-Early Mesozoic Accretionary Tectonics of the Western Kunlun Range, NW China. Gondwana Research, 4(4): 826-827.

[4] Jiang, Y. H., Jia, R. Y., Liu, Z., Liao, S. Y., Zhao, P., Zhou, Q. 2013. Origin of Middle Triassic high-K calc-alkaline granitoids and their potassic microgranular enclaves from the western Kunlun orogen, northwest China: A record of the closure of Paleo-Tethys. Lithos, 156, 13-30.

[5] Feng Changrong, Wu Haicai and Chen Yong. 2011. Geological characteristics and genesis of the Zankan iron deposit in Taxkorgan, Xinjiang. Geotectonica et Metallogenia, 35(3): 407-409.

[6] Yan Changhai. 2012. Pamir Type Iron Ore. Beijing: Geological Publishing House. 1-256.

[7] Ji Wenhua, Li Rongshe, Chen Shoujian et al. 2011. The discovery of Palaeoproterozoic volcanic rocks in the Bulunkuole Group from the Tianshuihai massif in Xinjiang of Northwest China and its geological significance. Science China Earth Science, 54(1): 61-72.

[8] Zhang Lianchang, Zhai Mingguo, Wangyusheng et al. 2012. Study of the Precambrian BIF-iron deposits in North China Craton: Progresses and questions. Acta Perologica Sinica, 28(11): 3431-3445.