YAN Changhai, CAO Xinzhi, LI Shanpo, CHEN Junkui, ZHANG Shaobo and ZHANG Zheng, 2013. "Pamir-type" Iron Deposits: A New Deposit Type. *Acta Geologica Sinica* (English Edition), 87(supp.): 173-176.

"Pamir-type" Iron Deposits：A New Deposit Type

YAN Changhai[1,3,4], CAO Xinzhi[2], LI Shanpo[1], CHEN Junkui[1,3], ZHANG Shaobo[1] and ZHANG Zheng[1]

1 Henan Institute of Geological Survey/Henan Key Laboratory of Geological Process of Metal Mineralization and Resources Utilization , Zhengzhou 450007,Henan,China;
2 Graduate school(a), Faculty of Resources(b), China University of Geosciences,Wuhan 430074, Hubei, China；
3 China University of Geosciences, Beijing 100083, China;
4 Henan Provincial Bureau of Geo-exploration and Mineral Development, Zhengzhou 450001, Henan, China.

1 The Proposal of "Pamir-type" Iron Deposits

A series of relatively large-size magnetite deposits have been discovered in Taxkorgan area of western Kunlun, Xinjiang, e.g., Laobing iron deposit, Qiaopukalimo (Zankan) iron deposit, Yelike iron deposit and Jiertiekegou iron deposit(Figure 1).Because this area is located in the alpine region, the degree of geological work is very low here, previous researches (Liu,G., et al.,2005; Chen,J., et al.,2011) always classify iron deposits in this area into the category of Precambrian sedimentary metamorphic iron deposits (BIF). The authors made comprehensive and systematic analysis of the tectonic background, litho-geochemical characteristics of iron-bearing series, geological and geochemical characteristics of typical deposits, ore genesis and metallogenic regularity. The results show that these deposits have similar metallogenic features， and mainly formed in early Paleozoic, hosted in biotite quartz (gypsum) schist and plagioclase amphibole schist. The iron minerals are syngenetic combinations of sedimentary magnetite, pyrite and anhydrite, which constitute a special anhydrite-magnetite formation. Because these deposits have unique geological features and metallogenic epoch and the research area is located in the Pamirs, the authors name them "Pamir-type" iron deposits as a new type of iron deposit in the world (Yan, C, et al., 2012).

2 Geological and Theoretical Basis for the Proposal of "Pamir-type" Iron Deposits

"Pamir-type" iron deposits is proposed by the authors through a comprehensive study of the metallogenic features of the iron deposits in Taxkorgan area and a comparison between these deposits and the existing typical iron deposits in the world(Yan,C, et al.,2012). The authors made a systematic research on iron deposits in Taxkorgan area of Xinjiang, especially the typical deposits such as Laobing iron deposit, Qiaopukalimo iron deposit, Jiertiekegou iron deposit, and Ta'axi iron deposit. Through the research, the authors have gained the following important understandings:① These deposits have obvious sedimentary mineralizations, mainly come from volcanic-sedimentary rock series and controlled by stratigraphic horizon and lithologic characteristics. The wall-rocks are mainly biotite quartz (gypsum) schist and metamorphic fine sandstone (siltstone), plagioclase amphibole schist comes second. The ore bodies occur in bedded and stratoid forms, and are in conformable contact with the wall-rocks, changing gradually with local synchronous folding. Meanwhile, magnetite (pyrite) mineralization is common in upper and lower sides of wall rocks. ②The ore types are complicated, the types and scales of mineralization is clearly zoned in space. The under part of iron-bearing rock formation is mainly magnetite mineralization, while the upper part is mainly pyrite mineralization. In addition, gypsum-magnetite formation, quartz-magnetite formation, pyrite-magnetite formation and other iron-bearing formations frequently occur in associations in space, the principal part is anhydrite- magnetite formation. ③ The mineral association of anhydrite- magnetite formation is gypsum + anhydrite + magnetite + pyrite, which is a unique iron-bearing formation in sedimentary iron deposits. ④The genetic type of ore deposit is marine volcanic-sedimentary magnetite deposits, and the principal part of iron minerals is

* Corresponding author. E-mail: ddyych@126.com

mainly primary sedimentary magnetite with a small quantity of hematite and pyrite. The deposit was little transformed by metamorphism after its formation. ⑤ The metallogenic epoch of the deposit is around early Paleozoic.⑥Mineralizing materials of this type iron deposit come from volcanic materials, which formed by the mixture of seawater and hydrothermal fluids through chemical deposition with a great deal of terrigenous materials involved.

Large-scale iron-bearing formations in the world mainly distribute in Precambrian strata, and their mineral-hosting rock series all underwent metamorphism to varying degrees, the ore type is mainly banded ferrosilicon ore（Samuel S.Goldich，1973；Klein C，2005）. The sedimentary and sedimentary metamorphic iron deposits in our country are mainly Precambrian sedimentary metamorphic banded iron deposits and Devonian sedimentary iron deposits. For examples, Archean “Anshan-type” iron deposit, Proterozoic “Dalizi-type” and “Xuanlong-type” iron deposit, Devonian “Ningxiang-type” iron deposit and so on. Moreover, strata of the Cambrian and Ordovician system in southwest China, strata of the middle Ordovician in Shanxi, strata of the lower Carboniferous in Xinjiang and Guizhou, strata of the Carboniferous-Permian in Hubei and strata of the Triassic in Sichuan all contain siderite and hematite deposits of different sizes (Song, S., et al., 1994; Cheng, Y., et al., 1978; Yang, Z., 1980; Zhao, Y., 1958; Shen, B., et al., 2010). Up to now, people have not found large-scaled sedimentary iron deposits formed before early Paleozoic and mainly hosted in biotite quartz schist, whose iron minerals are mainly syngenetic combinations of sedimentary magnetite, pyrite and anhydrite.

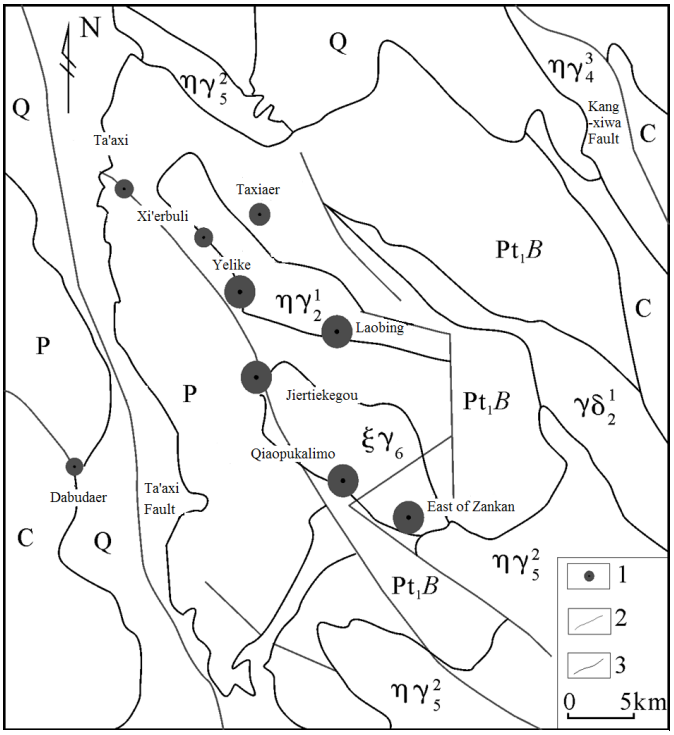

Figure 1. The Geologic Map of Distribution of the Iron Deposits in Taxkorgan Area

Q-Quaternary；C-Carboniferous；P-Permian；Pt_1B- Bulunkuole Group of Paleoproterozoic；$\zeta\gamma_6$Orthoclase Granites of Himalayan；$\eta\gamma_5^2$-Adamellite of early Yanshanian；$\eta\gamma_4^3$-Adamellite of late Variscan；$\gamma\delta_2^1$-Granodiorite of Paleoproterozoic；$\eta\delta_2^1$-Adamellite of Paleoproterozoic；1-iron deposit；2-fault；3-geological boundary

From the above-mentioned geological characteristics, metallogenic epoch and genesis, the features of iron deposits in Taxkorgan area differentiate clearly from the typical sedimentary deposits and sedimentary metamorphic deposits in the world (Table 1). They are a very special type of iron deposits. Combined with the unique geographical position of the research area (located in the Pamirs), the authors name them “Pamir-type” iron deposits.

3 The Geological Importance of Putting Forward “Pamir-type” Iron Deposits

Various types of iron deposits are hosted in the widely distributed volcanic-sedimentary formations on epigeosphere, such as magmatic type, magmatic hydrothermal type, magmatic metamorphic type and so on. Bringing the concept of “Pamir-type” iron deposits into the research field of sedimentary iron deposits not only enriches the types of sedimentary iron deposits, but also has significance for deepening the metallogenic theory of iron deposits and applying them to mineral exploration.

Up to now, researches on sedimentary or sedimentary-metamorphic iron deposits always think that the sedimentary iron deposits mainly formed in Precambrian, and the BIF iron deposit is the primary type. Besides, there are some iron deposits formed in Devonian, such as the typical “Ningxiang-type” iron deposit in south China. Although there are some iron deposits formed in other geological times, the scales of the deposits are commonly small. So far, large-scaled iron deposits formed by sedimentation before early Paleozoic have not been found, so this is undoubtedly a major discovery of the history of the study of iron deposits.

More and more prospecting achievements have been made in Taxkorgan area of Xinjiang, raising new questions for us. If the small-scaled iron deposits (siderite, hematite) in some areas in our country found in the past explorations are just special cases of iron deposits distribution in early Paleozoic strata, and

Table1. Feature Comparison between "Pamir-type" Iron Deposits and Typical Sedimentary and Sedimentary-Metamorphic Iron Deposits in the World

Main Type	(Volcanic) Sedimentary Metamorphic Iron Deposit				
Subgroup	Volcanic Sedimentary Metamorphic (Kiruna)	Terrigenous Sedimentary Metamorphic (Superior)	Volcanic-Terrigenous Sedimentary Metamorphic (Algoma)	Sedimentary Iron Deposit	"Pamir-type" Iron Deposit
Metallogenic Epoch	Proterozoic Era	Proterozoic Era (1.9Ga~2.2Ga)	Late Archean Era	Proterozoic, Devonian, Middle Carboniferous, Lower Permian	Early Paleozoic
Features of Iron-bearing Formation	mainly intermediate-acid sodium-rich volcanics with porphyritic texture (diabase, spilite, porphyrite, albitophyre or keratophyre, orthophyre contain quartz porphyry and tuff etc.), often change into various kinds of leptite	mainly quartz, sand-shale, marl, dolomite, black and red ferruginous shale and argillite formed in continental shelf	grey or dark green ferruginous flint interbedded with hematite and magnetite in thin layers or narrow strips, mainly developed in late Archean greenstone belt (made up by pillow-shaped andesite, tuff, igneous clastic rocks, rhyolite, greywacke, black carbonate shale)	mainly combination of sedimentary carbonate rock, sandstone and mudstone, marl in shallow sea	mainly littoral fine sandstone, siltstone, and argillite with little intermediate basic volcanics
Features of Mineral Deposits	Layered magnetite, hematite originate in leptite contact zone of slightly different components，there was large-scaled iron-rich deposit during the intermittent period of volcanic activity, volcanics can be found in both the overlying and underlying parts of ore bodies.	All the sedimentary iron-rich deposits (oxide, silicate and carbonate) occur in thin belts, and often became super-huge paleo-weathering crust iron-rich deposits in the later period.	Iron deposits originate in acid volcanics and covered by andesite volcanics, iron deposits and greywacke sediments form a symbiotic relationship. The ore bodies are stratoid or lenticular in form.	Iron deposits often come from sand-shale, most occur in the transitional zones between siltstone and shales or calcareous shale. The ore bodies are stratiform, stratoid or lenticular in form.	Iron deposits often originate in biotite quartz schist, mainly is disseminated mineralization. Iron-rich deposits mainly come from strata with high chiltern content. In the stratiform and stratoid ore bodies, pyrite magnetite, gypsum magnetite and quartz magnetite are in symbiotic relationships.
Main Mineral Ore Assemblage	magnetite-hematite	magnetite-hematite-specularite-siderite	magnetite-hematite-martite - specularite	hematite-siderite-perlimonite	magnetite-pyrite
Ore Deposit Genesis	volcanic sedimentary metamorphic magnetite, hematite	marine sedimentary metamorphic magnetite, hematite, siderite	marine volcanic sedimentary metamorphic magnetite, hematite	Sedimentary hematite and siderite in shallow sea	marine volcanic sedimentary magnetite
Examples of Ore Deposit	Kola Peninsula in North Sweden	Superior Lake in North America, Yuanjiacun Iron Deposit in Shanxi, Jianshan Iron Deposit, Ji'ning Iron Deposit, Huoqiu Iron Deposit in Anhui, etc.	Gongchangling Iron Deposit, Qidashan Iron Deposit in Liaoning, Iron Deposit in West Anshan, Karagas Iron Deposit in Brazil	"Dalizi-type" Iron Deposit,"Xuanlong-type"Iron Deposit, "Ningxiang-type"IronDeposit, "Shanxi-type" Iron Deposit, "Fuling-type" Iron Deposit	Laobing Iron Deposit, Qiaopukalimo Iron Deposit, Yelike Iron Deposit and Jiertiekegou Iron Deposit, etc.

Notes: resources from: research findings of this paper, Samuel S.Goldich，1973；Klein C，2005；Song, S. , et al.,1994; Cheng, Y., et al., 1978, Yang, Z. , 1980; Zhao, Y. , 1958; Shen, B. , et al., 2010.

cannot draw enough attention; then, the facts that the series of large-scaled magnetite found in early Paleozoic strata in Taxkorgan area and large-scaled iron-bearing (magnetite) formations distribute in the early Paleozoic strata remind us to pay sufficient attention to the early Paleozoic strata in the future mineral explorations. For a long time, people focus on the Precambrian strata in mineral explorations for iron deposits (sedimentary, sedimentary-metamorphic), which is far from enough. The possibility of finding sedimentary iron deposits in the early Paleozoic strata should also receive enough attention.

In summary, the proposal of"Pamir-type" iron deposits has the following important geological meanings: ①raising new research subjects for sedimentary iron deposit, expanding the research field of iron deposit; ② putting forward the prospecting thought that large-scaled magnetite can be found in

early Paleozoic strata, broadening the prospecting space of iron deposit (especially in the western-eastern Kunlun, Xinjiang) and breaking new ground of finding sedimentary magnetite in volcanic-sedimentary epimetamorphic strata of early Paleozoic; ③ for the iron deposit prospection in Taxkorgan area, the classical ideas of finding sedimentary metamorphic iron deposit in the old strata of Paleoproterozoic have been abandoned. In addition, the research also finds a unique anhydrite-iron formation, promoting the research of iron-bearing formation. Moreover, the proposal of"Pamir-type" iron deposit not only contributes to the economic prosperity of southern Xinjiang, safety of frontier region and national solidarity, but also provides richer iron resources for the new-built iron and steel base in national-level economic development zone of Kashgar. Meanwhile, it also offers new prospecting space for work arrangements of iron prospection in southern Xinjiang.

The discovery of "Pamir-type" iron deposit can be driven by a variety of factors such as the urgent need for iron resources of economic construction and new progresses in iron prospection. However, it is still in the beginning stage, especially is insufficient in the research of metallogenic matter origin, metallogenic mechanism and model, waiting for further study.

Key Words: "Pamir-type" iron deposit new deposit type Taxkorgan area Xinjiang

References

Liu, G., Wang, Y., Yan, C., et al. 2005. Geological Characteristics of Magnetite Ore Belt in Bulunkou-Dabudaer of Western Kunlun, Xinjiang (In Chinese). Proceedings of 2005 Symposium of China Association for Science and Technology, pp. 671-678.

Chen, J. Yan, C., Zhang, W, et al. 2011. Geological Characteristics and Prospecting Direction of the Magnetite Iron Deposits in the Taxkrongan, Xinjiang (In Chinese). Geological Survey and Research, 34(3), pp. 179-189.

Yan, C., Cao, X., Chen, C., et al. 2012. *Pamir-type Iron Deposits* (In Chinese). Beijing: Geological Publishing House.

Cheng, Y., Zhao, Y. & Lu, S.1978. Main Iron Ore Types in China (In Chinese). Geological Review, 4, pp. 253-268

Song, S., Kang, Y., Tu, G, et al. 1994. China's Deposit(In Chinese). Beijing: Geological Publishing House.

Samuel S.Goldich. 1973. Ages of Precambrian Banded Iron-Formations[J]. *Economic Geology*，68, pp. 1126-1134.

Klein C. 2005. Some Precambrian banded iron-formations (BIFs) from around the world: Their age,geologic setting, mineralogy, metamorphism, geochemistry, and origin[J]. *American Mineralogist*, 90, pp. 1473-1499.

Yang, Z. 1980. On Sedimentay-Metamorphic Iron Deposit (In Chinese). *Geology and Prospecting* ,5,pp.17-21.

Zhao, Y. 1958. Suggestions on the Genesis and Epoch of North China Shanxi-type Iron Ore and G-layer Bauxite (In Chineses). *Geological Review*, 18(4), pp. 306-309.

Shen, B., Zhai, A., Yang, C. 2010. Proterozoic Era-Important Metallogenic Period in China (In Chinese). *Geological Survey and Research*, 33(4), pp. 241-256.