1 Introduction

The Neoarchean and Paleoproterozoic are the age of major banded iron formations (BIF) deposition (James, 1983; Trendall, 2002). At 1.85Ga, large-scale BIF disappeared from the geologic record and suddenly reappeared after a ~1 billion years hiatus (Klein and Beukes, 1993; Klein, 2005; Basta et al., 2011; Cox et al., 2013). BIF are not only an important source of iron ore for industry, but also been used to study the evolution of life, oceans, and the atmosphere in the Archean and Proterozoic era (Lascelles, 2006; Bekker et al., 2010).

Jingtieshan BIF are characterized by specularite and jasper, with higher contents of SiO₂, Fe₂O₃, and Ba, which finally led an interpretation of Jingtieshan BIF as a Sedex-type iron deposit (Xue et al., 1995, 1997; Zhou et al., 1996, 1997, 1999; Liu et al., 1998; Yang et al., 1999; Mao et al., 2003) or Superior-type BIF (Sun et al., 1998). This study presents petrologic and new geochemical data on the Jingtieshan BIF. The aim of the present discuss the genesis of Jingtieshan BIF and the deposition of such BIF.

2 Geological Setting

Northern Qilian Orogenic belt is in the middle of Qinling-Qilian-Kunlun Giant polymeric composite orogenic belt, which located at the southwestern margin of North China Craton. The outcrop strata in the region include Paleoproterozoic to Phanerozoic strata. The fault structures and intrusive rocks are well developed in the Northern Qilian Orogenic belt (Mao et al., 2003). Orebodies usually occurred in the lower zone of the Mesoproterozoic Jingtieshan Group which was metamorphosed to low greenschist facies (Yang et al., 1991; Yu, 1992; Wu and Yu, 1996). Jingtieshan iron deposit consists of two mines named as Huashugou and Heigou mine. The ores include the oxide-, carbonate- and mixed carbonate-oxide facies iron ores (James, 1954). Fault structures are well developed in the area. Diabase and quartz diorite porphyrite are the two intrusive rocks which can be recognized in the area.

3 Petrography

Oxide facies BIF: It is the main common iron ore in Jingtieshan iron deposit (which is used for major and trace elements analysis in this paper). It includes specularite and jasper, with higher contents of SiO₂, Fe₂O₃, and Ba, which finally led an interpretation of Jingtieshan BIF as a Sedex-type iron deposit (Xue et al., 1995, 1997; Zhou et al., 1996, 1997, 1999; Liu et al., 1998; Yang et al., 1999; Mao et al., 2003) or Superior-type BIF (Sun et al., 1998). This study presents petrologic and new geochemical data on the Jingtieshan BIF. The aim of the present discuss the genesis of Jingtieshan BIF and the deposition of such BIF.

4 Geochemistry

Major element reveals that Fe₂O₃ and SiO₂ are the essential components of Jingtieshan oxide facies BIF. FeO
and CO₂ are the second most abundant major elements. The average contents of TiO₂, MgO, MnO₂, CaO, Na₂O, K₂O and P₂O₅ are not more than 1.00%.

The trace element chemistry of oxide facies BIF show significant variations which has high but variable Ba, Sr, Cu, Zn, Pb, and low but variable concentrations of Ge, V, As. The contents of Co, Sc, Y, Zr, Ni, Rb, Cr and Sb usually range from 1 to 20ppm. Whereas, the concentration of Nb, Cs, Hf, Th and U generally less than 1 ppm.

The oxide facies BIF has generally low ∑REE contents. Most samples display slight HREE enrichment (PAAS normalized, McLennan, 1989), and all samples show pronounced positive Eu anomaly, which is similar to those reported for Archean and Paleoproterozoic BIF (Derry and Jacobsen, 1990; Bau and Möller, 1993; Huston and Logan, 2004), different from Neoproterozoic BIF which show weak Eu positive anomaly (Klein and Beukes, 1993; Bekker et al., 2010; Basta, 2011). Based on the combination of Ce/Ce* vs. Pr/Pr* to identify La and Ce anomalies in BIF (Bau and Dulski, 1996), the majority of the oxide facies BIF from Jingtieshan have no negative Ce anomaly and few samples have positive La anomaly.

5 Discussion

High contents of SiO₂ and Fe₂O₃ in the studied BIF signify the purity of the chemical precipitates (Klein, 2005; Bhattacharya et al., 2007). In Jingtieshan area, the SiO₂ is hosted mainly in chert/jasper and Fe₂O₃ is hosted mainly in specularite (hematite). FeO and CO₂ are the second most abundant major elements and displays a strong correlation, which may imply that FeO is hosted mainly in siderite. The CaO, MgO and MnO contents reflect the common presence of carbonates. Al₂O₃, TiO₂, Na₂O and K₂O are mainly hosted in silicates. Which indicate that the original deposits composed of Fe, Si and minor carbonate mud with little detrital material.

The pronounced Eu anomaly suggest that high-temperature hydrothermal fluids were an important source for iron (Bau and Dulski, 1996). LREE depletion and La anomaly in some BIF samples suggest that it inherited weak seawater signature (Barrett et al., 1988). The lack of negative Ce anomalies in Jingtieshan BIF, implies that redox waters in contemporaneous basin. However, the high ratios of Fe³⁺/∑Fe of Jingtieshan BIF indicating a very high degree of oxidation. This may suggest that it is not whole ocean anoxia, deep hydrothermal origin iron dissolution in anoxic deep oceans, and oxidized from Fe²⁺ to Fe³⁺ in oxidation shallow sea nearby passive continental margins rift, which led the deposition of the Jingtieshan BIF. The absent of volcanic rocks but the presence of exhalite (e.g. siliceous rock and barite rock) indicate that Jingtieshan BIF have associated to sedimentary exhalative (Sedex) deposit. Jingtieshan BIF has several characteristics which are significantly different from Algoma-, Superior- and Rapitan type, and these features that make Jingtieshan BIF unique.

6 Conclusions

Jingtieshan BIF include oxide-, carbonate- and mixed carbonate-oxide facies BIF. The original deposits composed of Fe, Si and minor carbonate mud with little detrital material. Fe and Si largely supplied by high-temperature hydrothermal solutions with weak seawater signatures. Jingtieshan BIF does not require whole ocean anoxia in Proterozoic Eon and it is an unusual BIF which is relate to Sedex deposit, does not belong to Algoma, Superior and Rapitan type.

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