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Geological and Geochemical Characteristics of the Pingshun Akarn Iron Deposit, Southern Taihang Mountains

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1 Introduction

The Pingshun skarn iron deposits, located in southern Taihang mountains, is one of the most important and concentrated area of skarn iron deposits in North China. As the previous study degree is low, the understanding that the late diorites are the mainly mineralization mother rock is proposed (Chen et al., 2002), according to mineralization and alteration zoning and a few test data of major trace element, but lacking the evidence of S and Pb isotope. This paper is to trace metallogenic matter origin and establish metallization mode through the research on trace element, rare earth elements and Pb isotope of rocks and ores in the Pingshun skarn iron deposits.

2 The Geological Features of Ore Deposit

The Pingshun skarn iron deposits contain 126 iron orebodies, with the length varying from tens meters to hundreds meters. The morphology of orebodies is controlled by the interface and the structural shape around, with the shape of irregular tabular, lenticular, pinnate, and so on. The types of ironstones are disseminated, massive and banded, and the ironstones are dominantly composed of magnetite, pyrite, pyrrhotite and chalcopyrite. Alteration is obvious in both pluton and its country rock, and the alteration zonation can be divided into albite zone, salite albite zone, diopside anorthosite zone, magnetite zone, and marble zone from the pluton to the country rock (Zhang et al., 2009).

Test samples are iron ores and skarn rocks from Lugou and Shuigou. $\delta^{34}\text{S}$ values of 7 sulfide samples vary from 12.5‰ to 17.4‰, with the average of 15.0‰, indicating the composition of sulfur is stable. According to study (Hoefs et al., 1979; Ohmoto et al., 1979), when the oxygen fugacity is low, S exists as HS^- and S^{2-} , and $\delta^{34}\text{S}$

values of pyrite are similar to $\delta^{34}\text{S}$ values of the whole fluid, without relative loss and enrichment. When the oxygen fugacity is high, sulfate rich in ^{34}S will precipitate, resulting in $\delta^{34}\text{S}$ depletion in both residual fluid and sulfide formed late (pyrite). In a word, $\delta^{34}\text{S}$ values of sulfide are no higher than $\delta^{34}\text{S}$ values of primitive fluid. Therefore, $\delta^{34}\text{S}$ values of primitive fluid of the Pingshun skarn iron deposits should be higher ($\geq 17.4\text{‰}$), to which extent that it can neither come from organic sulfur, $\delta^{34}\text{S}$ of which is always a big negative number, nor from mantle or magma, $\delta^{34}\text{S}$ of which vary in the range of 0~2‰. So most probably primitive fluid is from sedimentary rocks containing sulfate, which always provides so much ^{34}S . Considering the fact that there is gypsum bed in the bottom of limestone in Majiagou Formation, sulfur source may be from the gypsum bed, without eliminating the function of mixture and rebalance from other sulfur sources.

As table 1 shows, lead isotopic compositions of sulfate tested change greatly. Pb isotope analyses reveal that $^{206}\text{Pb}/^{204}\text{Pb}$ ratios of ore lead are 17.365~19.032, average being 18.121, and most of them are higher than 18.000. $^{207}\text{Pb}/^{204}\text{Pb}$ and $^{208}\text{Pb}/^{204}\text{Pb}$ ratios are 15.417~15.689 and 37.433~39.762, with the average of 15.543 and 38.379 respectively. It shows the character of enrichment in uranium and lead and loss in thorium and lead. According to figure 3a, 3b, their lead isotopic values of all sulphide samples range among the three lead growth curves of mantle, orogenic belt and upper crust, near the mantle and orogenic evolution line, indicating lead sources are more complex, and comes mainly from the mantle and orogenic belt. From figure 4, we can see μ vary from 9.21 to 9.28, higher than μ value of normal lead, which ranges from 8.676~9.238. And ω varies from 34.6~39.33, higher than ω value of normal lead, which is 35.55^[6], indicating that lead source maturity is higher, enrich in uranium lead, with the character of material in orogenic belt and mantle,

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without eliminating the possibility of being from upper crust.

3 Metallogenic Model

Summary from the characters of geological features and S and Pb isotopic compositions of the Pingshun skarn iron deposits are as follows. ①Metallogenic materials are from rock mass, and earlier diorite bodies are mineralization mother rock, later gabbro massif enrich materials for magnetite-forming indirectly through magmatic mixture replacement. ②In the process of moving upward and emplacing, magma capture and extract lots of crustal material, which has been indicated significantly by S and Pb isotope of iron ore. The participation of crust material (especially for elements Cl, Na, Ca) is of importance for extraction, transportation and precipitation of iron materials. The process of the Pingshun skarn iron deposits formation is as follows:

Crust-mantle mixed magma intruded upward many times along Taihang Mountain deep faults, and located in Ordovician limestone. The interval between two pluses of magmatic activities was short. Before earlier dioritic magma consolidated, later gabbroic magma had invaded and occurred migmatitic metasomatism. At the contact place between dioritic magma and gabbroic magma, hornblende diorite formed, with Fe of gabbroic magma entering dioritic magmatic system. Meanwhile in the process of moving upward and emplacing, magma captured and extracted lots of crustal material, especially gypsum bed in the bottom of limestone in Majiagou Formation, which made the component of magma more complex. Elements Cl and Na contents of magmatic hydrothermal fluid increased greatly. With the addition of Na, magmatic rocks occurred natriumization. Lots of iron materials separated from magmatic rocks, entered in magmatic hydrothermal fluids, and formed chlorine-ferrum complex which helped the long-distance transportation of the ions. In addition, both heat and fluid carried by magma intrusion activity of multi-stages and short interval and post-magmatic hydrothermal fluid upward along deep fault in Taihang Mountain strengthened the help to the long-distance transportation of the ions, which established the foundation in forming large iron

mine and were necessary condition for the formation of great skarn iron ore deposits in China such as Hanxing type iron and Daye iron ore. During the long-distance transportation, when iron-rich magmatic hydrothermal fluids were closed to calcareous surrounding rock, hydrothermal physicochemical condition changed immediately and Fe precipitated. Because many limestones neutralized hydrochloride which formed with the precipitation of Fe, Fe could precipitated continuously. Meanwhile, altered minerals such as diopside, garnet, actinolite, epidote and calcite formed.

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