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The magmatic conditions and geodynamic setting for the Carboniferous volcanic eruption type iron deposits in West Tianshan, China

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The discovery of Awulale volcanic type iron deposit is one of the most important progresses in recent exploration in Xinjiang, China. The iron deposit locates in the Awulale volcanic belt, which is in the north edge of Yili block of Chinese West Tianshan. The ore deposit is hosted by the Carboniferous volcanics, and belongs to ore-pulp eruption magnetite type deposit. This work takes the Zhibo iron deposit as example, focusing on the magmatic conditions of volcanic eruption type iron deposits and the geodynamic implications.

The geochemistry studies show that the volcanics in Zhibo mining area are tholeiitic basalt. The volcanics, both interbedding with the ore body and in the footwall of the ore body, are characteristic with high magnesium (with 10.9 wt% MgO) and iron. The Carboniferous high-Mg basalts (with 12.67 wt % or 13.01 wt % MgO) have been reported in previous works [1-2], which implies very high mantle potential temperature in their source [3]. The enrichment of LREE and depletion of HREE in the lower part of volcanics also indicate a deep mantle source within the garnet stable region. The upper part of volcanics is low in MgO and high in SiO_2 (basaltic andesite-andesite-dacite), with MORB-type geochemical features (flat or depleted LREE and enriched HREE pattern), showing shallow part of mantle source in spinel stable region. Thus we considered the mantle source of Zhibo volcanics have experienced two stages partial melting: the early stage melting in garnet stable region and the later one in spinel stage region. It also indicates a process of mantel upwelling and migrating from the deep, accompanied with decompression melting.

The development of large-scale volcanics eruption type iron deposit in Awulale suggests an enrichment of giant iron in magmatic process of the Carboniferous volcanics. According to the geochemistry of Zhibo volcanics and contemporaneous igneous rocks in adjacent areas in west Tianshan, following necessary conditions for the enrichment of giant iron have been suggested: (1) the volcanics hosting the ore body should derive from mantle, for the sufficiently feeding of iron; (2) Partial melting of mantle source in high pressure (in garnet stable region), for more iron entry the magma during the mantle melting; (3) High melting temperature, for the high melting degree and large volume of magma, the scale of iron ore body thereby could be considerable; (4) low oxygen fugacity of primary magma, preventing the FeO in the magma dispersed in the early stage by Fe-oxide crystallization; (5) low water contents in magma (dry system), avoiding the loss of FeO by crystallization of pyroxene prior to plagioclase. On the other hand, the priority of plagioclase crystallization in the dry system results in a rise of FeO contents or Fe-saturation. The nearly Fe-saturated magma would form ore deposit under high oxygen fugacity in the later stage. Within-plate rift environment related to mantle plume upwelling and decompress melting meets these requirements, and is benefits to form large scale volcanic magnetite-type iron deposits. Arc volcanics in the subduction environment, which derived from “cold melting” of a water-rich mantle wedge, could not suit for the formation of this type iron deposit. Synthesize the above geochemical features of Zhibo volcanics, we considered these large scale

Carboniferous volcanic eruption type iron deposits could relate to a mantle plume in an Within- plate environment.

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