

Study on Genesis of the Bayan Obo Fe-REE-Nb Deposit in Inner Mongolia, China

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As the largest known REE resource in the world, the Bayan Obo Fe-REE -Nb deposit is located in Inner Mongolia, northern margin of North China Craton (NCC). The REE-Nb orebodies are mainly hosted by the H8 dolomite marble of the Proterozoic Bayan Obo Group. The major ore minerals are monazite, (Ca-)REE-fluorocarbonate, aeschynite, pyrochlore (Nb, REE). The genesis and the mineralizing timing still remain debated. In this study, the mineral compositions are analyzed by EPMA and LA-ICP-MS to explore the genesis mechanism of this giant REE deposit. The H8 dolomitic marble can be identified into two groups according to its texture, i.e., coarse-grained and fine-grained dolomite marble. Wide variation of SrO content in dolomite minerals from coarse-grained dolomite marble is observed, SrO contents in the margin of the dolomite mineral reach up to 1.03 wt.%, while SrO contents in the core as low as 0.158 wt %, similar to the SrO contents of the sedimentary carbonates. We infer that the dolomite minerals from coarse-grained dolomite marble inherit SrO features of sedimentary carbonate mineral in the core, and the extremely high SrO concentrations in the margin are the results of hydrothermal fluid alteration. The MnO and FeO concentrations of dolomite minerals from the coarse-grained dolomite marble are significantly lower than those of dolomite minerals from fine-grained dolomite marble, implying that ore-forming hydrothermal solution possesses high Mn, Fe, and REE contents and metasomatic H8 dolomitic marbles. Fine-grained dolomite marbles are more intensely mineralized than the coarse-grained dolomite marble, consistent with the fact that there are more abundant magnetite and REE minerals in fine-grained dolomite marble. Two types of fluorapatite are identified, and their chemical compositions are heterogeneous in both types of fluorapatite under back-scattered electron imaging. Type I fluorapatite has few REE mineral inclusions, whereas Type II fluorapatite hosts abundant tiny REE mineral inclusions. In Type I fluorapatite, the unaltered (BSE-bright) regions contain higher Na₂O, REE, and lower CaO, P₂O₅, BaO, and SO₃ than the altered (BSE-dark) regions. For Type II fluorapatite, unaltered (BSE-bright) regions contain higher Na₂O, REE and slightly higher SO₃ than the altered (BSE-dark) regions. The BSE-dark regions in Type II fluorapatite have higher CaO, P₂O₅, SiO₂, FeO, and SrO. The SrO of the altered regions in Type II fluorapatite is dramatically higher than that of the altered regions in Type I fluorapatite. The altered regions in Type I and Type II fluorapatite show differences in the BaO, SO₃, SiO₂, and FeO contents. We conclude that the altered regions in Type I fluorapatite were formed by Na, SO₄-rich hydrothermal solution metasomatism. The altered regions in Type II fluorapatite and associated monazite inclusions indicate a dissolution-reprecipitation texture, implying later stage Sr-rich, Na-depleted hydrothermal fluid overprint. The different chemical components between the altered regions in Type I and Type II fluorapatites imply multiple stages of hydrothermal metasomatism and REE

remobilization in the geological periods. The two different styles of REE remobilization processes may be mainly controlled by the components of the metasomatic fluids.