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Geology and geochemistry of Makeng Fe-Mo Deposit, Fujian

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The Makeng Fe-Mo deposit in the polymetallic belt of southwestern Fujian Province is the largest iron deposit in South China. It is a large magnetite deposit hosted in the interlayer fractures of Huanglong Formation（C_2h）carbonates and Lindi Formation（C_1l）clastic rocks at the exo-contact zone of the Juzhou-Dayang granite. Skarn has genetic relationship with ore fromation. Zonation can be found almost anywhere, and occurs on scales from kilometers to micrometers. The formation of Makeng iron deposit can be calssified into skarn stage, retrograde stage, and quartz sulfide and carbonate stage, among which the retrograde stage was the main mineralization stage.

Juzhou-Dayang granites are exposed surround the Makeng iron deposit, and have genetic relationship with ore formation. According to its geochemical compostion such as high silicon and alkali, low calcium and magnesium, and high differentiation index, the Juzhu-Dayang granite can be identified as weak peraluminous-metaluminous granite; The rocks have high and remarkably varying REE, and their distribution patterns show LREE enrichment with gentle right oblique deviation, and a "V" model characterized by significant negative Eu anomaly; The trace elements compositions are strongly enriched in Rb, U, Th and La and considerably depleted in Ba, Sr, P and Ti; Petrogeochemical and isotopic characteristics indicate that the Juzhu-Dayang granite is crust-derived, and has experienced high differentiated evolution. Lithospheric thinning related to paleo-Pacific plate (subduction) is a likely responsible geodynamic background for their formation. The magma sources of the Dayang-Juzhou granite were mainly derived from Proterozoic crustal materials, but also involved some proportion of EMII components.

Skarn mineral assemblages consist of pyroxene, garnet and bustamite, and retrograde minerals comprise chlorite, epidote, amphibole, quartz. Electron microprobe analyses show that the pyroxenes are mainly diopside and hedenbergite, with minor johannsenite, whereas associated pyroxenoids are bustamite and rhodonite. The garnet is dominated by andradite, with minor grossular. The amphibole in the Makeng iron deposit belongs to calcic amphiboles. The mineralogical characteristics of skarn indicate that they mainly formed under oxidizd conditions.

Garnet, pyroxene, pyrite and magnetite have similar chondrite-normalized REE distribution patterns with light REE(LREE) enrichment, moderate Eu positive anomaly and absent Ce anomaly, indicating that they were formed under the oxidation environment, and there was genetic relation between ore formation and skarns. The REE geochemistry of marble and alterated rocks varied regularly, and that alteration is featured by metasomatism and magmatic hydrothermal solution, and its ore-forming materials might come from surrounding strata and diabase partly.

Fluid inclusion studies show that the inclusion types of Makeng deposit are complex, mainly with vapor- and liquid-rich, daughter mineral-bearing and CO_2-rich fluid inclusions, among which the liquid-rich type is predominant. Gas composition of fluid inclusions mostly includes CO_2, H_2O, N_2 and O_2, with minor CH_4, C_2H_4, C_2H_6 and a small amount of C_2H_2. Cations of liquid composition are dominant with Na^+, K^+, Mg^{2+}, followed by Ca^{2+} and a small amount of Li^+. Anions are mainly consist of SO_4^{2-}, F^-, Cl^-, with minor Br^- and NO_3^-. Homogenization temperatures of three group fluid inclusions from early to late stage are 460～600℃, 260～540℃, 160～400℃, respectively. Salinities are (6～24 wt.%, 32～44 wt.%), (4～16%, 36～44%), (0～4%), respectively.

H, O, C and S isotopic geochemistry shows that the ore-forming fluids of the skarn stage were mainly derived from magmatic water, whereas the fluids of the quartz-sulfide stage mixed with the meteric water with variable proportions. Carbon and sulfur in the fluids were mainly derived from mantle or a deep-seated place, but other factors, such as country rocks, contributed as well. Phase

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separation of magmatic water, fluid mixing with meteoric water, and buck boiling may be the main causes of mineralization.

Zircon LA-ICP-MS U-Pb dating indicates that the Dayang granite, the Juzhou granite and diabase in the Makeng deposit were formed at (127±1Ma and 128±1Ma), (125M±1a, 126±1Ma, 129±1Ma, 130±1Ma and 130±1Ma) and (303±2Ma and 64±1Ma), respectively; The SHRIMP ziron U-Pb age of Dayang granite is 133±1Ma; Re-Os isotopic dating of the molybdenites symbiosis with magnetites obtained model ages of 133.0±0.8Ma. The main mineralization stage was of the Early Cretaceous, which was consistent with the emplacing age of the host rock Juzhou-Dayang granitic intrusion. These features indicated that they were results of the same magma-structure-fluid activity. The mineralogenetic epoch of Makeng Fe-Mo deposit may be related to the lithospheric extension event of the back arc of the southeastern margin of Eurasian continent caused by the Pacific plate subduction.