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Origin of siderite mineralization in western Guizhou, SW China: Constrains from REEs, C, O, Sr and S isotopes

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ABSTRACT

Numerous siderite deposits in western Guizhou of SW China are mainly hosted in the Middle Devonian dolostones. The larger Caiyuanzi (CYZ) and Xiongxiongjia (XXJ) deposits have an ore reserve in excess of 300 Mt with an average ore grade of ~35% total iron. There are banded and massive siderite ores and sulfide–siderite ores. The major ore mineral is magnesian siderite and gangue minerals are ankerite, dolomite, kaolinite, quartz and carbon. There are also metallic minerals including pyrite, chalcopyrite, and minor galena, tetrahedrite and enargite.

Rare earth elements (REEs) and carbon, oxygen, and strontium isotope data indicate a marine origin of the host dolostones and a hydrothermal metasomatic origin of the siderite mineralization. The variations of REEs and carbon and oxygen isotopic compositions of siderite from the CYZ and XXJ deposits reflect the variable mineralization processes and different fluid/rock ratios. The LREE depletion of siderite from the CYZ deposit could be due to crystallographic control, whereas the LREE depletion along with MREE enrichment and positive Eu anomalies of siderite from the XXJ deposit was possibly controlled by both crystallography and fluid composition. Siderite and calcite have $\delta^{13}C_{PDB}$ and $\delta^{18}O_{SMOW}$ values ranging from −8 to −4.01‰ and from 13.42 to 20.07‰, respectively. The variations in C and O isotopic compositions of siderite and calcite may reflect metasomatic replacement of marine carbonates by hydrothermal fluids at different fluid/rock ratios. Dolostones have $(^{87}Sr/^{86}Sr)_{initial}$ values of 0.70844–0.70920, whereas siderite and calcite have values ranging from 0.71396 to 0.71708. Negative correlations of initial Sr isotope ratios versus carbon and oxygen isotopes of the host dolostones, siderite and calcite indicated that carbonate minerals were metasomatic products of marine carbonates by hydrothermal fluids leaching from the Proterozoic basement rocks. Iron was possibly derived from the basement leaching rather than from the continental weathering. The $\delta^{34}S_{CDT}$ values (−19.9 to 13.6‰) of sulfides associated with siderite indicated that the sulfur was probably derived from the marine sulfates through either bacterial sulfate reduction or organic mediated thermochemical reduction.

1. Introduction

Numerous Fe deposits are distributed in western Guizhou of China, which include the Caiyuanzi, Tiekuangshan, Xiongxiongjia, Guanyinshan and Guanziyao deposits from north to south (Fig. 1). The ore reserves of these deposits account for 72% total ore reserve of Fe deposits in Guizhou province (Li et al., 1996). The Fe orebodies occur as stratabound, stratoid, vein, and lenticular bodies and are mainly hosted in the Devonian carbonates and locally in the Lower Carboniferous carbonates. The ore genesis of these Fe deposits has been a matter of debate. These deposits were considered to be typical sedimentary deposits, hydrothermal or hydrothermal-reworked sedimentary deposits (Liao et al., 1984 and references therein). Continental weathering was considered to be the principal source of the iron.

In this study, we describe the geology of the larger Caiyuanzi and Xiongxiongjia deposits in West Guizhou with emphasis on the siderite mineralization. We obtain REE concentrations, carbon, oxygen and strontium isotopes of the host dolostones, siderite and calcite, and sulfur isotopes of sulfides. The new dataset is used to constrain the origin of the two deposits. An integrated model for siderite mineralization in western Guizhou is also proposed.

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2. Geological setting

2.1. Regional geology

West Guizhou is situated at the western part of the Yangtze Block. The Yangtze Block is separated from the North China Craton by the Triassic Qinling–Dabie–Sulu orogenic belt to the north and bounded by the Tibetan Plateau to the northwest (Fig. 1a). To the southeast, the Yangtze Block is separated from the Cathaysia Block by a Neoproterozoic suture zone most likely formed at ~830 Ma (e.g. Zhao et al., 2011; Zhou et al., 2009). The Yangtze Block consists of a late Archean basement overlain by a Neoproterozoic to Cenozoic cover. The crystalline basement is represented by ~2.9 to 3.3 Ga tonalitic–trondhjemitic–granodioritic (TTG) rocks in the northern part of the Yangtze Block (e.g. Gao et al., 2011; Qiu et al., 2000). Paleo- to Mesoproterozoic strata exposed mainly in the western Yangtze Block are represented by the ~1.7 Ga Dongchuan and ~1.0 Ga Huili Groups (e.g. Sun et al., 2009; Zhao, 2010), which are considered to represent the folded basement (e.g. Yan et al., 2003). The cover sequences consist mainly of Paleozoic and Lower Mesozoic strata of shallow marine origin (Yan et al., 2003; Zhou et al., 2002).

The strata in western Guizhou include Early Paleozoic, Devonian, Carboniferous, Permian, and Mesozoic–Cenozoic strata (Fig. 1b). The Early

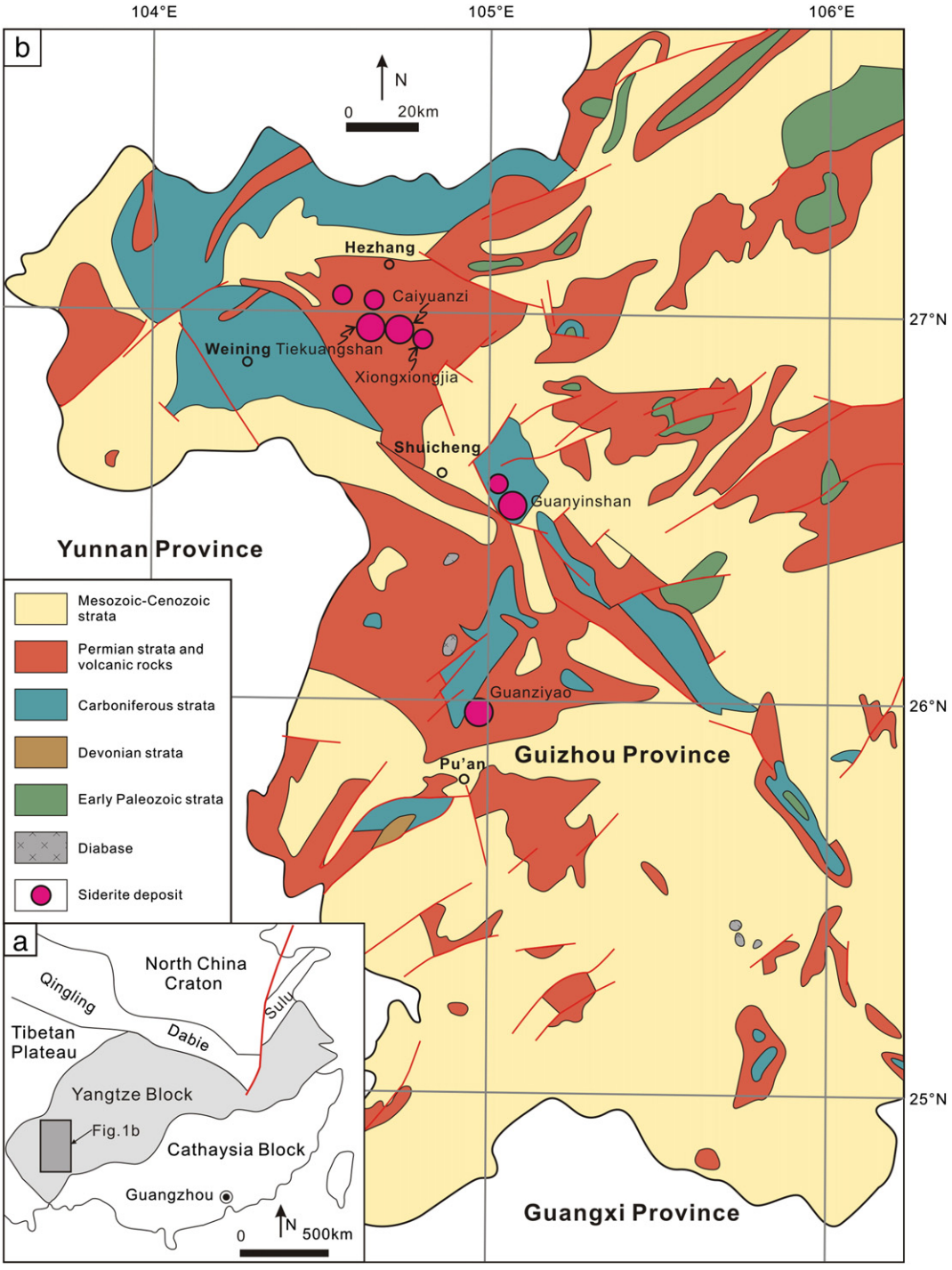

Fig. 1. (a) The location of West Guizhou in the Yangtze Block; (b) Geologic map showing the distribution of Fe deposits in the western Guizhou of SW China (modified from Liao et al., 1980). Because iron deposits are hosted in the Devonian strata that overlaid by Permian strata, these deposits are seemingly hosted in Permian strata as shown in figure (b).