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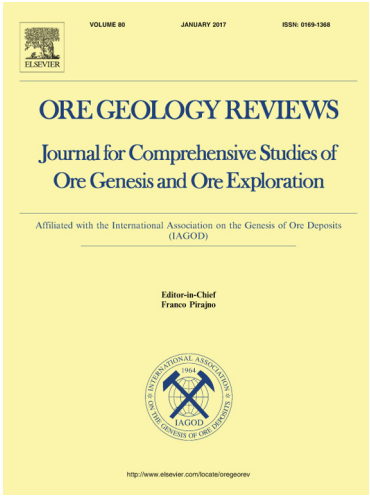

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Shuai Chen, Xuebo Yin, Xiaoyuan Wang, Xin Huang, Yao Ma, Kun Guo, Zhigang Zeng

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The geochemistry and formation of ferromanganese oxides on the eastern flank of the Gagua Ridge

Shuai Chen [a,b]*, Xuebo Yin [a], Xiaoyuan Wang [a,b], Xin Huang [c], Yao Ma [a], Kun Guo [a], Zhigang Zeng [a,b]

[a] Key Laboratory of Marine Geology and Environment, Institute of Oceanology, Chinese Academy of Sciences, Qingdao 266071, China

[b] Laboratory for Marine Mineral Resources, Qingdao National Laboratory for Marine Science and Technology, Qingdao 266061, China

[c] Guangdong Province Key Laboratory for Coastal Ocean Variation and Disaster Prediction Technologies, Guangdong Ocean University, Zhanjiang 524088, China

Abstract

Ferromanganese oxides on the eastern flank of the Gagua Ridge were collected from a water depth of 4071 m by TV-grab in 2016 and analyzed for their mineralogical and chemical compositions. These oxide fragments were broken from a large poly-core crust and can be divided into three parts: a dense inner nodule, a radial middle crust and a loose outer crust. The close proximity of the nodule and crust is similar to that observed in the amalgamated deposits from the Shatsky Rise, NW Pacific. All samples are mainly composed of Fe-rich vernadite, amorphous FeOOH and associated quartz, plagioclase, pyroxene and Mg-titanomagnetite. The mineralogy, Mn/Fe ratios, rare earth element patterns, and slow growth rates (with a mean value of 6.2 mm/Myr) of the samples reflect their predominantly hydrogenetic origin. Co, Ni, Cu, REY and other critical metals are most enriched in the Mn-rich inner nodule samples, which also have the highest Fe contents. In contrast, the Si and Al contents in the samples of the middle and outer crusts are very high, up to 19 wt.% and 6.29 wt.%, respectively. Correlation analysis indicates that Li, Sc, Cr, Rb, and Cs tend to concentrate in detrital silica-aluminosilicate phases. The Gagua Ridge samples generally have lower metal contents than the hydrogenetic crusts and nodules from other open ocean regions, which can be attributed to their dilution by detritus and the poor development of a mid-water oxygen minimum zone. However, the incorporation of detritus has little effect on the generation of Fe-Mn oxides in the Gagua Ridge. Based on their mineralogy, textures and chemical variations, the accretion of the hydrogenetic Fe-Mn oxides was initiated in the late Miocene, and the