Significance of metastable sulfide minerals in sedimentary rocks of the 2.77 Ga Mt. Roe Basalt in Western Australia

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Metastable sulfide minerals crystallized under low-temperature condition in organic carbon-rich sedimentary rocks were discovered from drilled core samples in the Mt. Roe Basalt. The Mt. Roe Basalt is considered to be a 2.77 Ga flood basalt, widely occurring in the northern Pilbara area of Western Australia. Less metamorphosed sedimentary rocks are interbedded in the basaltic flows. Both detrital and authigenic sulfides occur in the continuous sedimentary layer.

To identify the sulfide minerals, chemical composition and crystal structure analyses were carried out by using an X-ray analysis microscope, an electron probe microanalyzer (EPMA) and a high-resolution transmission electron microscope (TEM) with analytical electron microscopy.

The detrital grain consists of quartz, metal-rich pyrrhotite with composition between FeS and Fe7S8, and minor pentlandite. Authigenic sulfide minerals occur as complex mineral assemblages: metal-poor pyrrhotite (Fe7S8), smythite (Fe9S11), pyrite, pentlandite, chalcopyrite, and sphalerite. Notable feature of authigenic sulfides is the development of crystal defects in Fe-sulfides (composition between Fe7S8 and FeS2), and their abnormally high nickel concentrations (˜3 wt.%). These sulfides were crystallized under low-temperature condition (less than100 degree C). Textures and chemical compositions of the sulfide assemblages suggest that they precipitated meta-stably in the sediment by 2.77 Ga diagenesis or 2.2Ga low grade metamorphism. It is difficult to constrain which was the case. In either case, this is the first report for the Precambrian metastable sulfide minerals.