Depositional environment and microbial activity recorded in 2.7 Ga sedimentary rocks in Wawa area, Ontario, Canada

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Geological survey was performed at 2.7Ga Michipicoten Greenstone Belt, Wawa, Ontario, Canada. The main purpose of this study is to examine as to if the sedimentary environments and types of primary microbes affect the preservation of organic matter in the Archean sedimentary rocks.

In the studied area, marine sedimentary rocks including sideritic banded iron formation, conglomerate, sandstone and shale are well-preserved. The banded iron formation is associated with pyritic black shale and brecciated chert, but not with conglomerate and sandstone. The banded iron formation is absent in the most upper stratigraphic section of the examined area where sandstones, which show the cross lamina and ripple mark, and conglomerates were the dominant lithology. Conventional petrography and electron microprobe analyses were performed on the representative samples. Concentrations of carbon and sulfur and their isotope compositions were also analyzed.

It is found that the lithology of the banded iron formation and the associated rocks change. The lowest section is composed of black shales, which contain abundant nodular and disseminated pyrite. This shale unit is overlaid by chert unit. Most parts of chert were brecciated within a single layer. This chert was often interbedded with shale then transited to siderite BIF. Clastic quartz and feldspar were dominant with minor rutile and illmenite in sandstones.

Concentrations of total organic carbon (TOC) in black shale samples were ranging from 1.1 to 6.6 wt%, and sulfide-sulfur concentrations were from 9.8 to 22.9 wt%. Such high sulfur concentrations were probably due to the syngenetic pyrite precipitation from euxinic water column. Concentrations of TOC in overlaid brecciated chert and siderite BIF were ranging from was 0 to 0.1 wt%. Pyrite and arsenopyrite, concentrating specific layer concordant with sedimentary bedding, were dominant sulfides in the chert samples. Such concentrated layers result in high sulfide-sulfur concentrations (0 to 12.4 wt%) in the examined chert samples. These sulfides were also precipitated syngenetically from the euxinic water column. Because of occurrence of siderite BIF, this euxinic water column was also saturated with HCO^{3-} (or H_2CO_3), Fe^{2+}, arsenics and H_2SiO_4. Only the local closed basin could saturate the above chemical species and local submarine hydrothermal activities were responsible for supply of inorganic species. Extracted organic matter from black shale and chert samples were most likely microbes active in the closed basin.

Concentrations of pyrite sulfur were rather low (almost zero) in conglomerates and sandstone samples and very small for organic carbon. Small organic carbon may have been the remnants of microbes in shallow and high energy sedimentary environments.

Carbon isotope compositions of black shale kerogen were -22 per mill and -18 per mill for a sandstone sample. Such difference may indicate the diversity of biota according to the depositional environment in the 2.7 Ga Wawa sedimentary basin.