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The origin of life near deep-sea hydrothermal systems during the Cambrian explosion: data from the Kyzyl Tashtyg sulphide deposit (Central Asia)

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On Earth the solar radiation and the hydrothermal circulation both affect life evolution. Recent extensive studies of the World Ocean have shown that the biodiversity of Earth is linked with hydrothermal activity on the oceanic floor. These deep-sea ecosystems use chemical energy, not solar radiation. In the last quarter of the XX century, a new type of hydrothermal systems, so-called black smokers, was discovered in mid-oceanic ridges. As black smokers form sulfide ores and are surrounded by abundant bio-oases or symbioses, identification of their analogues in ancient orogenic belts is necessary for studying life origin and evolution. Of special importance are problems of life associated with deep-sea hydrothermal systems acted at the Precambrian-Cambrian boundary - the time of Cambrian explosion (Maruyama et al., 2013). During that explosion life significantly evolved and diversified due to dramatic changes of Earth's environment. Consequently, the early Cambrian - late Precambrian Kyzyl Tashtyg sulphide deposit of East Tuva in the Central Asian Orogenic Belt is of special interest. This deposit was formed on the bottom of ancient back-arc deep-sea basin as a result of black smoker hydrothermal activity and is hosted by volcanogenic-sedimentary rocks altered by the high temperature solutions.

The altered Kyzyl Tashtyg basalts have an amygdules (filled by albite, epidote and carbonates), contain brown-green microfossils, often attached to their walls. The microfossils are thin tubes 5 to 25 microns in diameter and 500 microns long. This tubes are empty and have straight, curved or branching shape. Chemically, the tube material is close to epidote. In consideration of microscopic dimensions, simple morphology and similarity with modern tubular microorganisms, the studied tube-shaped microfossils can be related to cyanobacteria. Almost the same fossils, associated with oceanic basalt complexes, were described earlier (Furnes et al., 2007; Mcloughlin et al., 2007). Our studies of fluid inclusions in minerals of amygdules showed that basalts, which contain microfossils, were altered by hydrothermal solutions heated up to 120-180 C and compositionally close to the sea water.

The Kyzyl Tashtyg sedimentary complexes include hydrothermal quartz-hematite constructions. Ferriferous-siliceous rocks from these structures contain different types of ancient biota: monocyatea, cyanobacteria, cribricyatea and sponge spicules.

Thus, our study of early Cambrian - late Precambrian volcanogenic-sedimentary rocks determine different types of ancient biota, which natural occurrence was connected with deep-sea hydrothermal ore-forming black smoker systems of the Kyzyl Tashtyg sulphide deposit. Some part of these hydrothermal solutions were suppliers of energy and nutritive elements for microfossils in closed spaces of amygdules in altered basalts, where cyanobacteria evolved without light and depend on chemosynthesis only. Presence of fossils in the ferriferous-siliceous rocks, formed on the bottom of the ancient deep-sea basin, was connected with biota growth during formation of quartz-hematite constructions as a result of hydrothermal system activity.