Impact of phase separation of hydrothermal fluids on chemolithoautotrophic microorganisms in seafloor hydrothermal systems

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It is well known that seafloor hydrothermal systems host a variety of vent-endemic biological communities. The principal source of primary productivity in the vent ecosystems is chemolithoautotrophic microorganisms that obtain energy from inorganic substances, such as H_2S, CO_2, H_2, and CH_4, which are derived from hydrothermal vent fluids (e.g., Jannasch and Mottl, 1985). In other words, biological activity of the vent ecosystems is largely depends on chemistry of hydrothermal fluids.

In recent years, particular attention has been paid to H_2-enriched hydrothermal fluids supporting archaeal methanogens, because this type of hydrothermalism and microbial ecosystem is considered to be an important modern analogue to the early life on Earth (e.g., Takai et al., 2006). Hydrogen-enriched hydrothermal vent fluids have been reported from several hydrothermal vent fields along the Mid-Atlantic Ridge (e.g., Charlou et al., 2002, 2007; Melchert et al., 2008) and Central Indian Ridge (e.g., Gallant and Von Damm, 2006; Kumagai et al., 2008). These fluids have one order of magnitude higher H_2 concentartions compared to typical mid-ocean ridge hydrothermal fluids. Based on geological and petrological observations, H_2 in the hydrothermal fluids is considered to be derived from serpentinization of ultramafic rocks that have been tectonically uplifted and emplaced near the hydrothermal vent fields (Charlou et al., 2002; Douville et al., 2002; Nakamura et al., 2008).

Besides the serpentinization of ultramafic rocks, there is another possible mechanism to generate abundant H_2 in the circulating hydrothermal fluids; phase separation. The phase separation of hydrothermal fluids is known to cause selective distribution of H_2 into vapor phase (e.g., Butterfield et al., 1990), resulting in H_2-enrichment of hydrothermal fluids comparable to the ultramafic rock-hosted hydrothermal fluids. Despite the increasing interest in H_2-enriched hydrothermal fluids and related ecosystem, influence of the phase separation on chemolithoautotrophic microorganisms in seafloor hydrothermal systems is still uncertain. In the present contribution, we will discuss the chemical change of hydrothermal fluids during phase separation and its impact on chemolithoautotrophic microorganisms in seafloor hydrothermal systems.