Assesment on deep-sea Fe-Mn nodule in response to future ocean acidification by leaching experiments

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Most of the anthropogenic CO2 absorbed by the oceans still remains in relatively shallow waters. However, over time, this acidification effect will spread to the deep oceans. Deep-sea metallic sediments, such as Fe–Mn nodules, are currently being explored and evaluated as potential targets of deep-sea mining due to their high contents of heavy metals. Therefore we conducted leaching experiment by using artificial seawater and CO2 aeration. Geochemical reference materials JMn-1(Fe–Mn nodule) and JMS-2 (pelagic clay samples) were used for leaching experiments. Before adding both, the pH values of ASW samples were adjusted to cover the predicted pH range of natural seawater caused by ocean acidification (8.1 to 7.2) by altering the partial pressure of CO2 of ASW via CO2 or CO2-free-air aeration. The pH of each ASW sample was adjusted to a specific value (8.41, 8.08, 7.69, 7.38, 7.05, 6.92 when solid-to-liquid (S/L) ratio was set to 1/1000). The JMn-1 and JMS-2 samples were mixed with ASW in a S/L ratio of 1/100, 1/1000, and 1/10,000 at 25°C and stirred with a magnetic stirre for 24 hours. Then, the reacted solutions were analyzed by using ICP-AES and ICP-MS. Li, Mn, Cu, Zn, Rb, Cd, Cs and Ba exist mainly as free cations or positively charged complexes in seawater. As the pH of the seawater decreases, these elements are more likely to release from sediments. The principal species with negatively charged ions in seawater are V, As, Mo, Ag, Sb, W and U. As solution pH decreases, they tend to be absorbed by the sediments, resulting in a decrease of their concentrations in seawater. To assess the influence of pH changes on deep-sea Fe–Mn nodules and pelagic clays, the concentrations of these elements were compared with the chemical composition of natural seawater and there widely used international water quality criteria: EC (European Communities) 1998; WHO (World Health Organization) 2011; USEPA (United States Environmental Protection Agency) 2012. Although these concentrations did not far exceed the water quality criteria, in terms of the potential risk of heavy metal release, Mn, Cu, Zn and Cd should be taken into consideration when the influence of ocean acidification on deep-sea environment is assessed (Wang et al. Aquatic Geochemistry, 24, 307-322, 2018).