Ba stable isotopes in the East China Sea, Japan Sea, Gulf of Alaska, and the South Pacific

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Barium has been used as a geochemical tracer for alkalinity, productivity (barite), and riverine inputs to the ocean. Recently, to further constrain Ba oceanic cycle and to improve the utility as a geochemical tracer, Ba stable isotopes in seawaters in the Atlantic Ocean and the North Pacific, river waters, and marine sediments have been measured. These previous studies highlight that (1) riverine input is the dominant source of barium to coastal seas and Ba isotopes in the marginal sea show the binary mixing with riverine and offshore seawaters, (2) deep waters in the Atlantic Ocean are mixed with water masses of lower $\delta^{138/134}$Ba AABW (Antarctic Bottom Water) and higher $\delta^{138/134}$Ba NADW (North Atlantic Deep Water), and (3) barite dissolution in the water column and benthic sediments should be an additional important source for Ba oceanic cycle.

In this study, we measured Ba isotopic compositions ($\delta^{138/134}$Ba, relative to NIST3104a) of sea waters in the East China Sea, Kuroshio region, the Japan Sea, Gulf of Alaska, and the South Pacific. These seawater samples were obtained by multiple research cruises from 2013 to 2019. The $\delta^{138/134}$Ba showed the highest values of ~0.73‰ in the Kuroshio region (S=~34.7), and the lowest value of ~0.27‰ in the inner shelf of the ECS (S=~31). Our $\delta^{138/134}$Ba data in the ECS were significantly lower than the previously reported Ba isotopic compositions in the ECS (Cao et al., 2016), but consistent with other seawater data in the North Pacific (Geyman et al., 2019). Although our seawater samples only cover the range of salinity from 30 to 34.7 in the ECS, the $\delta^{138/134}$Ba and salinity data can be explained by the binary mixing with end-members of Kuroshio and Changjiang River waters. The surface water samples in the Japan Sea also plotted on this binary mixing line, suggesting that Changjiang River water accounts for ~5% to the Japan Sea. If [Ba] and its isotope supplied from the Changjiang River were not temporally fluctuated (i.e., repetitive adsorption-desorption of Ba to clay particles do not induce significantly temporal changes in [Ba] and its isotope), our binary mixing line can be used to estimate paleo-salinity from $\delta^{138/134}$Ba of planktonic foraminifer, bivalves, and corals.

Finally, we also found that the deep waters (>2000 m) in the North–South Pacific ranged from 0.18 to 0.32‰, indicatingrelatively lower values than the deep waters in the Atlantic (0.25–0.45‰) (Hsieh and Henderson, 2017). The distribution of $\delta^{138/134}$Ba in the Pacific deep water can be simply explained by two processes; the LCDW injection of ~0.3‰ from the south to north and an additional input of Ba with relatively lower $\delta^{138/134}$Ba, probably from sediments and sinking particulate barite.

Keywords: Barium stable isotope, seawater, barite, salinity, water mass tracer

