Tracing the sources of nutrients sustaining red tide blooms in the southern and eastern coastal regions of Korea using Ra isotopes

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We measured salinity, inorganic and organic nutrients, pigment signatures, and radium isotopes (^{223}Ra and ^{224}Ra) in initial red tide outbreak region as well as a region ~200 km away from the initiation region during September 1-2 and 19-20, 2014. The red tide propagates to the remote region (the eastern coast of Korea) along the coast of the Korean peninsula. In this study, we aimed at determining the source of nutrients for sustaining red tide blooms in the remote area using short-lived Ra isotopes, ^{224}Ra (half life: 3.6 days) and ^{223}Ra (half life: 11.4 days). These Ra isotopes, which are soluble in seawater, are useful for tracing nutrient mixing since the same source for Ra and nutrients can be assumed.

Dissolved inorganic nitrogen (DIN) and dissolved inorganic phosphate (DIP) were almost depleted in both red-tide regions, with DIP being more depleted. However, the average concentrations of dissolved organic nutrients were 2-5 folds higher than those of dissolved inorganic nutrients, which are known to be favourable for the growth of red tide species in competing with diatoms. If the red tide is sustained by recycling of nutrients in a closed system, ^{224}Ra/^{223}Ra should be much lower in the remote region. However, in the remote region, salinities and ^{224}Ra/^{223}Ra activity ratios were higher, with lower Ra activities. The levels of nutrients were similar for both regions. Our results suggest that the supply of nutrients from bottom water (higher salinities, Ra ratios, and nutrients) is active in the course of red tide transport to the remote region from the initiation region.