

River-shelf-intermediate water system as the other pathway to connect land and open ocean - its paleoceanographic implication

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Land and Open Ocean have begun to be realized as a united system of material cycle, in which minor elements such as iron are transported from land and supports primary productivity in open ocean. So far, aerosol transport is regarded as only one effective process which links land and open ocean directly. Although total amount of material discharged by river is much larger than aerosol, riverine undissolvable elements are usually deposited on shelf and they can hardly flow out into open ocean, because high biological activities scavenge most of particle in the surface water on the shelf. However, when you look at the intermediate layer, the situation seems different. Because the biological activity in the intermediate layer is much smaller than that in the surface, particles on the shelf bottom and slope can be diffused further into off-shore area. If the water mass in the intermediate layer advects from shelf to pelagic area, the material transport through intermediate layer must be much effective, and it must become the other pathway of land-open ocean linkage. Here, I will describe a long-range material transport system through river, shelf and intermediate water in the Amur-Okhotsk area, and discuss its paleoceanographic implications.

Now, a research project (Amur-Okhotsk Project, organized by Research Institute of Humanity and Nature) is conducted to study the long-range transport of material such as iron through Amur River and Okhotsk Sea for understanding how it contributes the primary productivity of North Pacific Ocean and how it is affected by human activity on Amur River Basin. Amur River water contains about one million times higher concentration of dissolved iron than the surface water of open ocean. Although most of this huge amount of dissolved iron precipitates in the estuarine area, it can be suspended again into the benthic water on the shelf due to very active tidal mixing. Because brine water rejected during seasonal sea-ice formation creates dense benthic water there, the dense water containing large amount of suspended particles flows out into the pelagic intermediate layer (300-500m), which go through Kuril straits and eventually spread all over the North Pacific Ocean as North Pacific Intermediate Water. Because the suspended particle in the Okhotsk Sea Intermediate Water contains large amounts of riverine iron, it makes anomalous large peaks of particulate and dissolved iron in the intermediate layer, which can be recognized not only in the Okhotsk Sea but also in the Pacific Ocean such as Oyashio region. Vertical mixing of surface and intermediate waters during winter in Oyashio region seems to supply enough amounts of iron for phytoplankton growth in the surface layer (Nishioka et al., Unpublished Data).

The long range transport of iron through Amur River and Okhotsk Sea is now supported by combinations of several particular mechanisms to this area, and similar phenomenon may be seldom found in other places on the present Earth. However, when you look at this system in the viewpoint of paleoceanography, it must be realized at every place, in the past, where the intermediate water circulates actively from shelf to open ocean. It is because rivers always discharge large amounts of materials into shelf area and tidal mixing keeps acting on the shelf eternally. If some climatological factor stimulates intermediate water circulation from shelf to open ocean in some cold region, the river-shelf-intermediate water system can act as an effective linkage between land and open ocean like the present Amur-Okhotsk. As it is very well known, the circulation of intermediate water was active in global scale during the glacial periods. I will discuss the potential role of the river-shelf-intermediate water system for the environment of glacial world.