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Residence time of suspended particles in the Garonne River (SW France): indications derived from Th-234, Be-7 and Pb-210

Sabine Schmidt and Hanna-Kaïsa Saari
CNRS - Université de Bordeaux, UMR5805, Talence, France (s.schmidt@epoc.u-bordeaux1.fr)

Particulates that enter the ocean from rivers are the products of integrated basin-wide processes (soil erosion, sediment transport and deposition in watersheds). The fate of sediments in river is therefore challenging and generally analysed using hydrodynamics models. An alternative method relies on the use of fallout radioactive tracers to identify sediment source regions and/or to estimate suspended sediment age or the fraction of the suspended sediment recently eroded from the landscape.
This work presents the application of naturally occurring radionuclides: Pb-210 (T1/2 = 22.3 years) and Be-7 (T1/2 = 53 days), both delivered by atmospheric fallout, and Th-234 (T1/2 = 24.1 days), to investigate residence times of particles in the lower Garonne River (South-West France). Th-234, produced continuously by decay of U-238, is widely used in marine sciences for studying particle dynamic on time-scales of days to weeks, but a major limitation to extend its application from the ocean to river is the activity (level, variability) of its parent, U-238, in contrast with the high and rather constant levels of oceanic uranium. The Garonne River has a watershed of 55 000 km2 with a mean discharge of 650 m3 s-1 (range: 12500 m3 s-1). It flows westward about 647 km from the Spanish Pyrenees, ending into the Gironde, its common estuary with the Dordogne River. To investigate suspended particle dynamic of the lower Garonne River, monthly samplings were performed from January 2006 to December 2007 at selected sites along this river system, including a site in its estuarine section. Dissolved and particulate activities of radionuclides were determined using a low-background, well-shaped gamma spectrometer. Additional data (river discharge, rain rate, suspended particulate concentrations) were also collected to better interpret radionuclide data. Whereas dissolved fractions are always negligible, particulate Th-234, Be-7 and Pb-210 activities present marked spatio-temporal variations. Temporal changes in Th-234/Pb-210 and 7Be/210Pb activity ratios (ARs) are complex, depending on river discharge and suspended matter load. To derive sediment ages from the present dataset, two distinct models have been used: 1/ based on radionuclide budget (Dominik et al, 1987, Earth Planet. Sci. Lett. 84 165–180), and 2/ using Be-7/Pb-210 ARs (Matisoff et al, 2005, Earth Surf. Process. Landforms 30 1191–1201). These age estimates will be detailed in order to discuss particulate transport processes in the Garonne river during contrasted hydrological periods (flood and low waters).