Colloid-particle dynamics and element transport through the low-salinity (<3‰) zone in the stable boreal Kalix River estuary, Gulf of Bothnia

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It is well known that scavenging in the estuarine mixing zone may attenuate the continent to ocean transport of several elements. Many studies suggest that such non-conservative behavior often occur at very low salinities. Significant tidal mixing - resulting in a non-steady state situation and potentially resuspension - complicates discrete sampling of this low salinity zone (LSZ; here defined as ≤3‰). The Kalix River estuary is an ideal location for studying fundamental processes in the LSZ as it exhibits extremely weak tidal pumping and has no significant tributaries and the LSZ stretches over 80 km in the spring. The Kalix River, draining a representative portion of the wide northern shields into the northernmost Gulf of Bothnia, is pristine and distinctive in having low concentrations of suspended detrital particles and high concentrations of organic material and non-detrital particles dominated by authigenic Fe and Mn.

Previous studies of element input through northernmost Baltic Sea estuaries have produced apparently conflicting results with some studies showing conservative behavior while others are suggestive of non-conservative removal processes in the LSZ. Here, we present a summary of a number of studies of particle-mediated removal process of both major elements and radio-nuclides during spring flood discharge in the Kalix River estuary. Cross-flow filtration (CFF) techniques were used to separate particles (>0.2µm) and colloids (>3k Daltons) from ultrafiltered water (<3kD), sampled from six stations stretching over 60 km distance. A broad spectrum of biogeochemical methodologies were applied to investigate how aggregation processes affected the phase distribution and mixing of Fe, Si, organic carbon and U isotopes. The result suggests that there is a strong aggregation of both iron oxyhydroxides and organic matter but no significant settling during transport through the LSZ. The scenario with aggregation without settling for detrital poor rivers, such as the Kalix and neighbouring Arctic rivers, may imply smaller trapping in the vicinity of the river mouth and instead off-shelf transport of a larger than expected fraction of river introduced material.

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