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Groundwater Al dynamics along boreal hillslopes at three integrated monitoring sites along a sulphur deposition gradient in Sweden

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To assess whether the soils in the near stream zone can significantly modify the groundwater aluminium (Al) chemistry just before it enters the stream and to what extent acid deposition influences this, a study was performed during 2000-2002 in 4 groundwater transects from 3 small, boreal catchments situated along a south-north sulphur deposition gradient at the integrated monitoring sites in Sweden. The results show that the groundwater aluminium species composition (AlT=total, Alo=organic, Ali=inorganic) and concentrations reflected the variations in groundwater pH and/or TOC (r2AlT=0.89, r2Alo=0.93, r2Ali=0.74). The highest Al concentrations were recorded in shallow groundwater, creating the prerequisites for large lateral Al-fluxes along the hillslopes during episodes of high flow when superficial flow paths are active. A downhill gradient was also seen, with increasing Alo and TOC concentrations towards the stream. Reduced Ali in absolute as well as relative terms but increased AlT concentrations in the discharge areas, indicate complex reactions favouring Alo formation and a local input of Alo from the soils. Results from the transect with the most detailed riparian sampling showed that in the last few meters before lateral flow reaches the stream, the mixing of superficial acid soil/groundwater and well-buffered groundwater that had moved along deeper flowpaths increased pH and reduced the Ali and Alt concentrations, tangibly. The Alo concentrations were affected little by this pH increase, but at the soil and stream water interface Ali formation was favoured due to the low pH and TOC concentrations in the surface water. Both the groundwater and stream water chemistry indicate that processes within the catchments were much more important than acid deposition for the Al dynamics.