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# Impact of seasonal redox variations in hemiboreal soils on the rare earth element chemistry in headwater streams

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Headwater streams in boreal forested regions will be heavily affected by climate change in the future, and findings from this study highlight the importance of investigating headwater streams. For understanding the effect of seasonal redox variations in hemiboreal soils on the headwater stream chemistry, a multielement approach is often used to help identify geochemical processes. Despite their abundance, headwater streams are seldom systematically monitored and sometimes not even included on topographic maps. However, the small catchment size makes headwater streams responsive to natural and anthropogenic changes. This study comprises data on trace and rare earth elements (REE) in headwater streams for over 100 hemiboreal headwater streams in southeastern Sweden. The streams were sampled up to three times during different seasons. The data show a strong effect from drought-induced seasonal redox changes in the soils on the trace element and REE signature in headwater streams on a regional scale. However, for a detailed understanding, also the sources of the headwater streams need to be considered. The water quality in headwater streams depends, among others, on the origin of the stream waters and their transport pathways before entering the streams. REE anomalies, such as the Ce anomaly, can be used to define stream end members.

The data show a clear relation between topography and the Ce anomaly, with more negative values in hilly catchments with distinct slopes, defined as an oxidised groundwater end member. The second end member is dominated by groundwater discharge from reduced, organic-rich riparian and wetland soils (reduced groundwater) having small or no Ce anomalies. Element concentrations show a wide range, depending on the end member of the stream. For example, redox elements, such as Fe, Mn, S and N, show concentrations up to 5 times higher in streams with small negative Ce anomalies (reduced groundwater) than those with large negative Ce anomalies. Moreover, these redox elements show seasonal variations due to a summer drought period and the resulting reduced conditions, while the Ce anomaly is constant throughout the year, making it an excellent tool to define source end members of headwater streams throughout seasonal variations.