



Strontium isotopes – A tracer for river suspended iron aggregates



Katharina Wortberg^a, Sarah Conrad^{a,*}, Per S. Andersson^b, Johan Ingri^a

^a Division of Geosciences and Environmental Engineering, Department of Civil, Environmental and Natural Resources Engineering, Luleå Technical University, 971 87, Luleå, Sweden

^b Department of Geosciences, Swedish Museum of Natural History, Box 50007, 104 05, Stockholm, Sweden

ARTICLE INFO

Article history:

Received 15 August 2016

Received in revised form

26 January 2017

Accepted 16 February 2017

Available online 20 February 2017

Keywords:

Strontium isotopes

⁸⁷Sr/⁸⁶Sr

Iron-organic carbon aggregates

River suspended matter

Riparian zone

Ultrafiltration

Spring flood

ABSTRACT

The Kalix River shows distinct temporal variations in the Sr-isotope ratio in filtered water (0.726–0.732). During base flow in winter the ⁸⁷Sr/⁸⁶Sr ratio is on average 0.730. When discharge increases and peaks during spring flood the ⁸⁷Sr/⁸⁶Sr ratio shows the most radiogenic (0.732) values. The temporal variations in the ⁸⁷Sr/⁸⁶Sr ratio in the Kalix River can be explained by mixing of water from the woodlands and the mountain areas.

During high water discharge in May the ⁸⁷Sr/⁸⁶Sr ratios are more radiogenic in the suspended phase (1 kDa - 70 μm) compared to the truly dissolved phase (<1 kDa). The difference in ⁸⁷Sr/⁸⁶Sr ratio between the two phases (Δ ⁸⁷Sr/⁸⁶Sr) is linearly correlated with the suspended iron concentration. During spring flood Sr and Fe derived from an additional source, reach the river. Deep groundwater has a more radiogenic ⁸⁷Sr/⁸⁶Sr isotope ratio than the Kalix River during spring flood and thus, represents a possible source for the suspended Fe and the associated Sr. Strontium can be coprecipitated with and adsorbed to different types of Fe aggregates. We propose that the Sr-isotope ratio in the suspended phase reflects the isotopic composition of the water at the interface between anoxic groundwater and oxic stream water in the riparian zone, where the Fe aggregates are formed. These particles dominate the suspended phase in the river and the mixing with mountain waters, poor in Fe, produces the difference in the isotopic signature.

The different signatures in suspended and truly dissolved fraction indicate that these aggregates are relatively stable during stream-river transport. As such the ⁸⁷Sr/⁸⁶Sr can be used to trace the origin of the non-detrital suspended phase.

© 2017 The Authors. Published by Elsevier Ltd. This is an open access article under the CC BY-NC-ND license (<http://creativecommons.org/licenses/by-nc-nd/4.0/>).

1. Introduction

Iron-organic carbon (Fe-OC) aggregates in the colloidal particle continuum (1–1000 nm) are an important carrier phase for metal transport in aquatic systems in the boreal landscape (Hamon et al., 2005). These aggregates are formed at organic rich redox interfaces, where anoxic water with high dissolved Fe(II) concentrations mixes with oxic surface water (Riedel et al., 2013) and Fe(III) precipitates with organic carbon (OC). Two end-components of Fe-OC rich aggregates have been suggested: (1) Fe-OH representing Fe-oxyhydroxides with an adsorbed organic carbon coating, and (2) Fe-OC, Fe with co-precipitated organic carbon (Raiswell and

Canfield, 2012). It has been shown that a fraction of dissolved Sr can be coprecipitated with Fe-oxyhydroxides (Andersson et al., 1994). Aggregates being formed in from bacterial OC have shown to be especially prone to adsorb Sr (Small et al., 1999; Ferris et al., 2000). Ferris et al. (2000) found Strontium to be retained by bacterial iron oxides from a subterranean environment in Sweden.

It is of interest to know when and where the different aggregates are formed, as they develop different scavenging properties. Depending on the type of Fe-OC rich aggregates, these may transport different elements due to (1) the surface properties of different types of aggregates and (2) the availability of scavenged elements at different sites of formation of aggregates in the river system.

In this study we discuss the role of deep groundwater as a source for dissolved Fe(II) during high water discharge, and the possibility to trace the origin of suspended Fe-rich aggregates in boreal rivers using Sr-isotopes.

* Corresponding author.

E-mail addresses: katharina.wortberg@yahoo.de (K. Wortberg), sarah.conrad@ltu.se (S. Conrad), per.andersson@nrm.se (P.S. Andersson), johan.ingri@ltu.se (J. Ingri).

2. Materials and methods

2.1. Study area

The Kalix River originates on the slopes of the Kebnekaise Mountain (2106 m) and flows through the Northern Swedish lowlands into the Bothnian Bay (Fig. 1). The total drainage area

covers 23 102 km² and is characterized by woodland (55%) with coniferous spruce and pine as well as birch trees. Another 16% are covered by wetlands (SMHI). The average discharge (based on daily measurements from 1937 to 2013) is 289 m³/s and it increases by factor of ten from base flow (~100 m³/s) to peak discharge during spring flood (>1000 m³/s) (SMHI). The catchment is ice-covered for up to six months every year. The precipitation is 400–700 mm/yr in

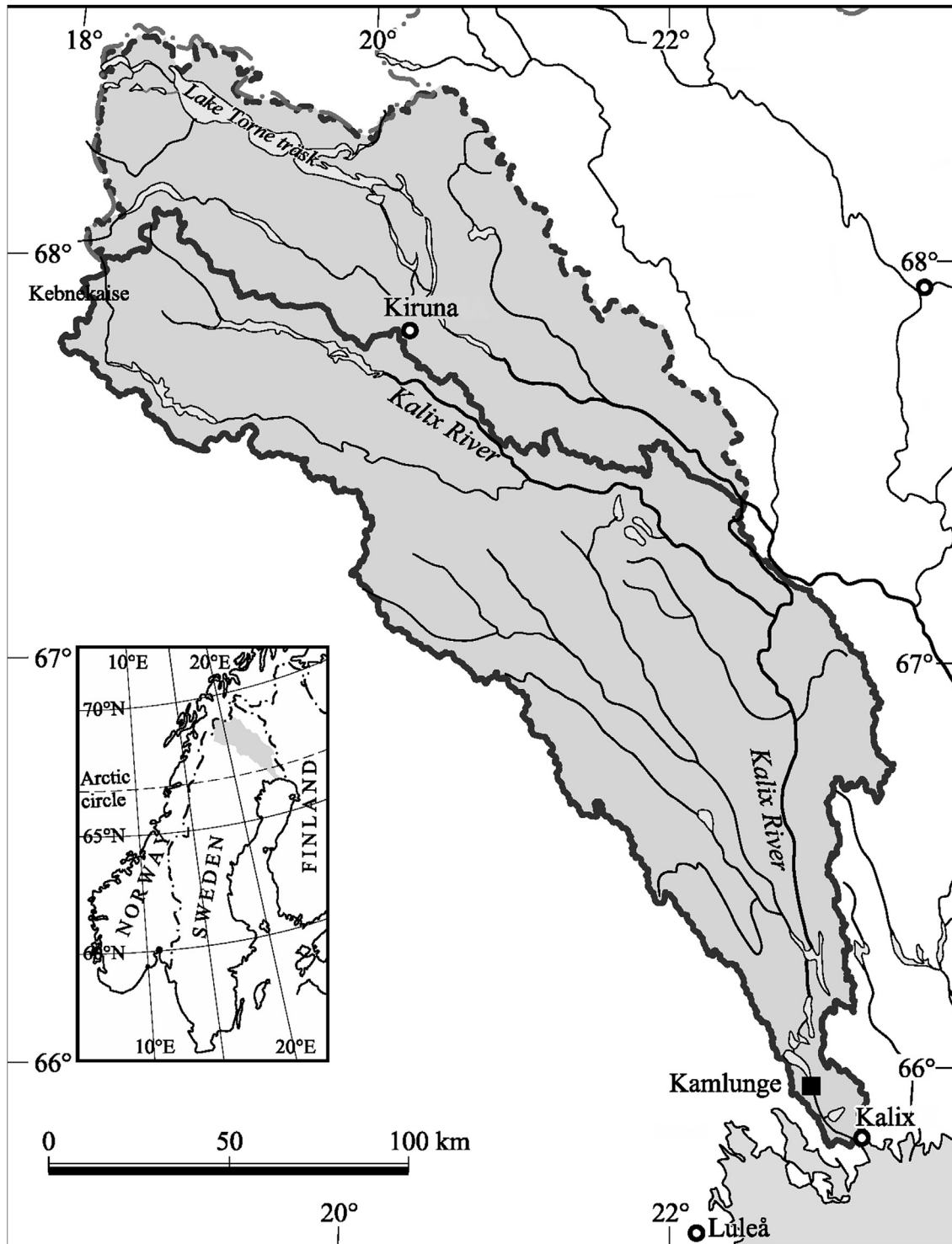


Fig. 1. Kalix River drainage area in Northern Sweden. The sampling location Kamlunge, sampled in 1991/1992 and 2014, lies approximately 36 km inland from the river mouth in Kalix. Samples taken at this location represent a mixture of all different tributaries of the river.

Download English Version:

<https://daneshyari.com/en/article/5752572>

Download Persian Version:

<https://daneshyari.com/article/5752572>

[Daneshyari.com](https://daneshyari.com)