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Study of micronutrients cycling in boreal forest of Central Siberia on continuous permafrost using Copper (Cu) and zinc (Zn) isotope fractionation

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Boreal forests mainly located between the latitudes 46°N and 72°N play a key role in regulating the global carbon cycle and climate of the Earth. These forests store about 140 gigatons of carbon (Gt C) in above ground biomass and 180 Gt C in soil organic matter that represents about 25% and 12% of the global amounts (Tarnocai et al., 2009). Within the context of global warming, forested permafrost regions appear to be very sensitive and are likely to be deeply modified in the near future due to the increase of soil temperature and the active layer thickness, as well as the northward shift of the vegetation. Before the quantitative modelling of the evolution of these ecosystems face to the climate change and their reciprocal influence on the whole Earth system become available, we have to constrain the main processes and parameters that control elements transfer between and within mineral and organic reservoirs in order to calculate the associated element fluxes. Indeed, the hydro- and biogeochemical functioning of these boreal environments is still poorly understood.

This study will present new results on two important metal micro-nutrient and toxicants (Cu and Zn) concentrations in soil and plants and Zn and Cu isotopes fractionation data we acquired within the pilot site of Tura (Central Siberia, Yenissey basin). This pilot site is located in the drainage area of Nizhnaya Tunguska River, the largest tributary of the Yenissey River, on continuous permafrost of 100 to 300 m thickness. This watershed is located in the field of Central Siberia basalts ages 248+/-20 millions years. The landscape morphology presents north-facing slopes and south facing slopes separated by riparian zones. These environments exhibit peculiarities in terms of hydrological regime, active soil depth, that is, seasonal thawing permafrost depth, nutrients availability, total biomass and plants community distribution (Prokushkin et al., 2007). This region is dominated by deciduous Dahurian larch (Larix gmelinii (Rupr.) Rupr.) which possess about 35% of the total forest carbon stock of Russia (Kobak et al. 1996). Larch forests, composed of L. dahurica (including the sister species L. gmelinii and L. cajanderii), have the ability to grow in continuous permafrost where winter temperature customarily drops below −40 [U+25E6]C. Larch is the main dominant species in permafrost zone of Siberia capable to grow on soils with the active layer depth as little as 10–30 cm (Abaimov et al., 2002).

Within this study we measured the concentrations of Zn, Cu and their isotopic composition in plants, soils and surficial fluids. Nutrient availability is the main factor limiting plant productivity in taiga and tundra ecosystems (Shaver and Chapin 1995) and, consequently, the understanding of these elements cycling is of high interest for the biogeochemistry of such environments.

These measurements have been performed on larch needles collected as a function of time during the growing season, on the other plant species (dwarf shrubs and mosses), on soils, and on interstitial and riverwaters during both springflood and low water level period (summer and autumn). The [U+F064]66Zn of soils varies between 0.02 and 0.13‰. The isotopic composition of larch needles changes as a function of location (north-facing slope, south-facing slope and riparian zone). The [U+F064]66Zn of needles collected in riparian zone ([U+F064]66Zn = -0.15 to -0.21‰) exhibit lighter isotopic composition than those collected in both north- and south-facing slope ([U+F064]66Zn = 0.05-0.37‰). Dwarf shrubs exhibit higher values of [U+F064]66Zn than mosses (0.23 to 0.80 and 0.03 to 0.1, respectively). We are currently acquiring new data on soil porewaters and river solutions. It is anticipated that these data will help us to trace Zn cycling in this specific ecosystem of boreal zone.