Insights from stable isotopes into water and soil resource response to past environmental changes (D. Lemarchand, LHyGeS)

The Earth's surface is shaped by its interaction with climate, tectonics and ecosystems, and the result of this interaction dictates the distribution of soil and water resources. Thus, in order to be able to understand the evolution of these resources, and ultimately sustain them, there is a need to understand how climate, ecosystems, but also human activity, interplay to drive soil and fluvial processes. Among these interactions, one of the key controls yet to be identified and quantified is the **influence of climate on soil formation**. This requires firstly determining the relationships between climatic parameters, physical erosion rates (the process of soil removal) and chemical weathering rates, which produce soils and release nutrients to surface waters. The second control that remains to be understood is **the role of vegetation on physical and chemical erosion rates**. Indeed, plants are intimately linked to the nature of soil-forming reactions, uptake and exudates that displace chemical equilibrium or affect reaction kinetics.

The recent years have seen the emergence of new isotopic tools, which offer the possibility to study weathering and erosion processes in a less equivocal way than more classical geochemical approaches. In particular, lithium (Li) isotope fractionation is strongly controlled by weathering of silicate phases via the precipitation of secondary clays and boron (B) isotope fractionation is controlled by the coupling of mineralogical and biological processes. Thus, because of their range of sensitivity to abiotic and biotic weathering mechanisms, these tools could be combined to study not only how weathering has varied in response to past changes in climate and ecosystems, but also the impact of different vegetation covers on soil processes. The combination of these novel isotopic techniques sensitive either to silicate (chemical) weathering, plant growth and recycling as well as physical erosion offers an unprecedented opportunity to study how past climate and ecosystem changes have impacted soil and water resources.

The overall aims of this PhD thesis are to couple B and Li isotopes:

1. To quantify how chemical weathering and catchment erosion have responded to late Quaternary climate change in different Australian climatic environments (monsoon vs. winter rainfall);

2. To assess the role of biotic processes on chemical weathering and how this role may have varied during the late Quaternary;

Samples we be collected in Lake sedimentary records as well as in river paleo-channels along a South-North transect in Australia, from Tasmania to Gulfe of Caprentaria. The condition of sediment production and storage sample cover various climatic conditions and the entire last glacial-interglacial climatic cycle.

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Contact: Damien Lemarchand (lemarcha@unistra.fr, 03 68 85 04 44)