

## Modeling weathering rates in the critical zone with stable isotopes

LEMARCHAND, D.<sup>1\*</sup> AND DI CHIARA, ROUPERT R.<sup>1</sup>

<sup>1</sup>LHyGeS-EOST, University of Strasbourg, Strasbourg, France, lemarcha@unistra.fr (\* presenting author)

Accurate knowledge of the chemical budget, rates and parameters that control soil-forming reactions is a crucial issue because they determine the long-term evolution of soils and landscape but also determine the rate at which soil nutrients can be renewed. This latter knowledge helps making short-term decisions on sustainable agricultural and forestry practices. Classically, hydrological models and pore waters chemistry are used to determine the instantaneous budget of the exchange of matter between soils particles, solutions and sometimes vegetation. However, the complexity and non-linearity of the soil/water/plant interactions often leads to underconstrained systems that makes a full characterization of the reactions in progress on the basis of chemical composition alone quite difficult.

In the present study, we developed a general model of stable isotopes fractionation intended to determine reaction rates in soil layers. It is based on mass and isotopic budgets and treats the bulk soil evolution as a simple gain-and-loss problem in which soil-forming reactions consist of mineral dissolution (loss) and secondary mineral precipitation (gain). Although the model can be theoretically applied to any stable isotopes, we specifically focused on B isotopes because 1) all cogenetic silicate minerals have similar  $\delta^{11}\text{B}$ , thus limiting uncertainty on the actual mineralogy of the dissolving phases; 2) B isotopes undergo large isotopic fractionation during precipitation of secondary products and 3)  $\delta^{11}\text{B}$  in the vegetation pool is very different from the soil mineral one that greatly helps the recognition and quantification of B exchange between soil and vegetation.

We developed a population-based stochastic search technique based on a modified Particle Swarm Optimization approach (PSO). This has the advantage of providing sets of analytical solutions without requiring the precise knowledge of model parameters such as the isotopic fractionation factors, the relative mass of parent material lost, or even the chemistry of the pore waters. We applied the model to B isotopes in different soil profiles developed on a granite bedrock (Strengbach watershed, Vosges, France). Models outputs provide dissolution and precipitation rates that are consistent with the overall bulk soil chemistry and mineralogy [1]. The model also interestingly indicates that the bound-water chemistry is more consistent with the bulk soil profile than the water collected by the zero-tension lysimeter plate.

[1] Lemarchand, D., et al. (2012) *Geochim Cosmochim Acta* **98**, 78–93 (2012).