Results of an Interdisciplinary Research Project on Soil Aggregate Formation in CZO's

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Soil physical properties such as aggregate stability and porosity are crucial for the soil's agricultural productivy, carbon sequestration capacity and water holding capacity. The formation of soil aggregates is the result of complex interactions between biological, chemical and physical soil processes. Therefore, multi-disciplinary research on Critical Zone Observatories (CZO's) is needed to unravel the key-factors controlling aggregate formation [1].

We will discuss the role of soil chemical and biological processes in the formation of soil aggregates. These data are the result of the joined efforts from soil chemists and biologist collaborating within the SoilTrEC project [2]. We show that organic-mineral interactions and solution chemistry are important for formation of primary soil aggregates. Especially Fe-(hydr)oxides play a crucial role because of their strong interactions with organic substances in the soil [3]. Macro-aggregates are formed when both organic matter, clay minerals and Fe-(hydr)oxides are present in sufficient amounts. These soil macro-aggregates act as habitats for micro-organisms which may in turn alter the organic substances within the soil aggregates. The microbial communitities within the macro-aggregates are affected by the land use. Furthermore, land use shows pronounced effects on the structure of the pores within the soil macro-aggregates.

Overall, we want to highlight the importance of multi-disciplinary research in understanding the complex interactions between chemical and biological processes within the critical zone.

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Reconstructing subducted sediment fluxes using ancient arc lavas

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Previous studies have shown that there exists a relationship between the fluxes of trace elements contained in subducting sediments at active subduction zones, and the trace element composition of the associated arc lavas, after correction for melting and fractionation effects [1]. This relationship apparently holds despite the wide range in thermal structure of present-day subduction zones resulting from variations in subduction rate, slab dip and the age of the subducting plate and could be used, together with trace element analyses of ancient arc lavas, to estimate past sediment fluxes at former subduction zones.

This method might be used to test the hypothesis that high atmospheric CO_2 concentrations in the late Mesozoic-early Cenozoic was maintained by subduction and decarbonation of large volumes of carbonate-rich sediment deposited in the former Tethys Ocean [2-4]. If this were the case, then ancient arc lavas from the margins of Tethys would be expected to have relatively high Sr and Ba, and low Th normalised concentrations. The approximate mass of carbonate subducted could be estimated from the Sr concentration of Tethyan carbonate.

The volume and average composition of deep-sea sediment available for subduction at ancient subduction zones has likely varied over time-scales that are long compared to the average age of the oceanic crust (~60 Ma) [5]. Biogenic sediments, which are important hosts of some trace elements, would not have been available for subduction before 500 Ma. The mid-Mesozoic proliferation of planktic calcifiers resulted in a larger carbonate component in deep-sea sediments available for subduction. If carbonate makes up 7-15% of average subducting sediment and has Sr contents an order of magnitude higher than the detrital fraction, then sedimentary Sr fluxes into subduction zones may have been ~50% lower than present before 500 Ma (i.e. for much of Earth's history).

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