Unravelling natural and human-accelerated erosion and weathering processes in the past using uranium and lithium isotopes applied on lake sediment records

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Climate change and tectonic uplift are considered to be the major control of erosional processes and landscape evolution. While tectonic uplift affects erosion on long time scales (millions of years), the recent global warming due to anthropogenic greenhouse emission might trigger a more rapid landscape evolution (years to centuries). In addition, erosional processes can be accelerated by human induced wood clearance and agricultural land-use. Therefore, it has become fundamentally important to understand and predict the response of the Earth´s surface to these changes. However, to quantify the rates and time scales of sediment formation, transport, and deposition in particular on geological time scales in which direct observations are not possible has remained challenging until today.

New, innovative analytical methods using uranium and lithium isotopes measured by means of MC-ICPMS analyses now enable a more precise assessment of past erosion and soil production rates on geological time scales. Until today, these methods have mainly been applied on fluvial and marine deposits, however, lacustrine sediment sequences probably provide even more valuable targets, as they normally showcase highly-resolved, sensitive, and continuous archives of past environmental change for a constrained catchment. The data can be linked to traditional proxies, such as pollen, stable isotope (O, C), and sedimentological information in order to obtain a comprehensive, detailed picture of past erosion, soil production, and clastic sediment deposition in response to climatic and environmental variability. Here, we will show the results obtained from the only two studies in which uranium and lithium isotope analyses have been applied on lakes (lakes Dojran and Ohrid, Macedonia) in order to demonstrate the potential of the new methods for the application on lake sediment sequences from New Zealand.