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Isotopic chemical weathering behaviour of Pb derived from a high-Alpine Holocene lake-sediment record

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Several studies assessing the chemical weathering systematics of Pb isotopes provided evidence for the incongruent release of Pb from source rocks during early stages of chemical weathering, resulting in runoff compositions more radiogenic (higher) than the bulk source-rock composition [e.g. 1]. Deep NW Atlantic seawater Pb isotope records covering the last glacial-interglacial transition further support these findings. Clear excursions towards highly radiogenic Pb isotopic input in the deep NW Atlantic seen during the early Holocene, hence after the large-scale retreat of the Laurentide Ice Sheet in North America, are interpreted to be controlled by preferential release of radiogenic Pb from U- and Th-rich mineral phases during early stages of chemical weathering that are less resistant to chemical dissolution than other rock-forming mineral phases [2-4]. To date, however, no terrestrial Pb isotope record exists that could corroborate the evidence from deep marine sites for efficient late deglacial weathering and washout of radiogenic Pb. We present a high-resolution adsorbed Pb isotope record from a sediment core retrieved from Alpine Lake Grimsel (1908 m.a.s.l.) in Switzerland, consisting of 117 Pb compositions over the past 10 kyr. This high-Alpine study area is ideally located for incipient and prolonged chemical weathering studies. The method used to extract the adsorbed lake Pb isotope signal is identical to previous marine approaches targeting the authigenic Fe-Mn oxyhydroxides fraction within the lake sediments [5, 6]. The Pb isotope compositions are further accompanied by various elemental ratios derived from the same samples that equally trace climatic boundary conditions in the Grimsel Lake area. The Pb isotopic composition recorded in Lake Grimsel is remarkably constant throughout the majority of the Holocene until ∼2.5 ka BP, despite variable sediment composition and –age, and isotopically relatively close to the signature of the granitic source rock. In contrast, adsorbed Th and U concentrations (given in concentrations of ng/g of sediment) are indeed significantly elevated during the earliest part of the record, while other adsorbed metals such as Al and Ti display highest adsorbed concentrations during the mid-Holocene. Elements such as Nd display fairly constant normalised concentrations throughout the record. Hence, while our Pb isotopic record appears remarkably insensitive towards climatic perturbations seen during the Holocene, the various elemental records display a striking sensititivity towards the overall climate evolution of the Holocene. Finally, the rise and fall of the Roman Empire as well as the onset of the industrial revolution are clearly resolvable in our Pb isotopic records.

References

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