North Atlantic influence on rainfall in the Dead Sea – Sahel watersheds: Implication for abrupt Holocene climate fluctuations

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Observations of 19th and 20th century precipitation in the Dead Sea watershed region display a multidecadal, anti-phase relationship to North Atlantic (NAtl) sea surface temperature (SST) variability, such that when the NAtl is relatively cold, Jerusalem experiences higher than normal precipitation and vice versa. This association is underlined by a negative correlation to precipitation in the sub-Saharan Sahel and a positive correlation to precipitation in western North America, areas that are also affected by multidecadal NAtl SST variability. These observations are consistent with broad range of Holocene hydroclimatic fluctuations from the epochal, to the millennial and centennial time scales, as displayed by the Dead Sea and Sahelian lake levels and by direct and indirect proxy indicators of NAtl SSTs. On the epochal time scale, the gradual cooling of NAtl SSTs throughout the Holocene in response to precession-driven reduction of summer insolation is associated with previously well-studied wet-to-dry transition in the Sahel and with a general increase in Dead Sea lake levels from low stands after the Younger Dryas to higher stands in the mid- to late-Holocene. On the millennial and centennial time scales there is also evidence for an antiphase relationship between Holocene variations in the Dead Sea and Sahelian lake levels and with proxy indicators of NAtl SSTs. However, the records are punctuated by abrupt lake-level drops and extensive expansion of the desert belt at ~8.1, 3.3 and 1.4 ka cal BP, which appear to be in-phase and which occur during previously documented abrupt major cooling events in the Northern Hemisphere. The catastrophic aridity at 3.3 ka cal BP caused probably the collapse of the late Bronze cultures at the Levant, Mediterranean and Nileland. It sends an important message for the future of modern human culture.

Si isotope signatures in soils by UV femtosecond laser ablation

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Si isotope fractionation during weathering is now commonly mapped at the catchment scale. But we still lack an understanding of the processes that set isotope ratios. These take place at the mineral/pore water interface. We present the first Si isotope data of the principle Si pools in soils determined by a UV femtoseond laser ablation system coupled to a multicollector inductively coupled plasma mass spectrometer (MC-ICP-MS). This approach provides the opportunity to obtain precise and accurate data (1) on bulk sample materials as fused glass beads or pressed powder pellets, (2) at the mineral scale in thin sections and (3) for solutions after Si separation and evaporation. We investiagted two immatured Cambisol profiles developed on paragneiss and sandstone in the Black Forest (Germany), respectively, after the last-glacial maximum. Bulk soils show a largely uniform signature in both soil profiles, which is close to those of primary feldspar and quartz with δ^{30}Si value of around -0.4‰. Clay formation is associated with limited Si mobility and hence preserves the original Si isotope signature of parental minerals. Organic-rich environments can promote intense weathering, which lead to high Si mobilization during clay formation together with significant negative isotope signatures down to -1.0‰ in topsoils. Biogenic minerals, i.e. phytoliths, exhibit negative Si isotope signature of about -0.4‰, which is in the range measured for different European tree species. Their impact in bulk soil signatures is negligible but is likely important for the dissolved Si pool. These results can now be used to reconstruct weathering and Si transport processes in soils to identify the source of dissoved Si in soil and river waters, which are commenly enriched in heavy Si isotopes.