Evidence of bomb-^{36}Cl in 3 lake aquifer systems in Lake Chad basin

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Lake Chad basin is one of the semi-arid zones where the population is presently most rapidly increasing: 47 million people are living there and their way of life is closely related to surface and groundwater dynamics. The strong population growth, combined with climate change uncertainties, makes water resources highly vulnerable. The development of sustainable management of surface and groundwater is thus becoming crucial, and surface-groundwater interactions and aquifer recharge assessments are required. We focus here on the use of ^{36}Cl as a tracer of these processes. ^{36}Cl is a cosmonuclide continuously produced in very small amount in the atmosphere by spallation reactions induced by cosmic-rays. Superimposed on this natural production, large amounts of ^{36}Cl were released into the atmosphere by nuclear tests during the 50's. This transient pulse of bomb-^{36}Cl has been successfully applied to estimate recharge rates in the unsaturated zone at several locations at mid-latitudes in the northern Hemisphere, but no studies took place so far in tropical areas.

Here, we use ^{36}Cl to study three lacustrine systems and their related aquifers, used as small scale analogs of the Lake Chad itself, each under distinct climatic realms: from North to South, OUNIANGA (Saharan), FITRI (Sahelian), and IRO (Sudano-Sahelian). Lake waters and related groundwaters were analysed for their ^{36}Cl content. At IRO and FITRI, the ^{36}Cl/Cl ratio range from 194 to 2290 at/at(.10^{-15}), showing a large ^{36}Cl enrichment compared to the natural baseline in almost all samples, which demonstrates the bomb-^{36}Cl footprint on the hydrological cycle in these areas, and indicates a significant modern groundwater recharge. By contrast, in the OUNIANGA lake system, fed by the Nubian Sandstone aquifer, ^{36}Cl/Cl ratios are lower and more constant, ranging from 172 to 267 at/at(.10^{-15}), which we interpret as typical of the natural fallout in this remote area. This is in good agreement with ^{14}C analyses, which indicate a Holocene recharge. From these results, we can estimate basin-scale chlorine and residence times and put new constraints on the water budget itself.