Assessing groundwater dynamics in the multi-layer aquifer of the Lake Chad Basin using ^{36}Cl and ^{14}C data

C. BOUCHEZ[1], P. DESCHAMPS[1], J. GONCALVES[1], B. HAMELIN[1], J. L. SEIDEL[2], J. C. DOUMNANG[3] AND F. SYLVESTRE[1]

[1]CEREGE, AMU–CNRS–IRD–College de France, Aix en Provence, France (bouchez@cerege.fr)
[2]HSM, UM II–CNRS–IRD, Montpellier, France
[3]LGGT, Université de N'Djaména, Tchad

Located in Central Africa, at the fringe between Sahel and Sahara, the Lake Chad Basin (LCB) is an endorheic basin of $2{,}5.10^6$ km^2. This sedimentary basin contains a multilayer aquifer system. The Quaternary unconfined aquifer represents the main water resource in this region: it covers 500 000 km^2 and is characterized by the occurrence of poorly understood piezometric depressions and flow paths. Two underlying confined aquifers (early Pliocene and Continental Terminal) are artesian but have undergone significant piezometric decline due to extensive abstraction since the 1960's.

To identify the origin of the recharge and flow dynamics in this multilayer aquifer, more than one hundred surface and groundwater samples have been collected. Together with major and stable isotope analyses, measurements of ^{36}Cl have been carried out at CEREGE, on the French 5MV AMS National Facility ASTER. Moreover, ^{14}C activities have been analyzed for 17 samples on the French AMS ARTEMIS.

The geochemical and isotopic signatures of the Quaternary aquifer show very large variations. In the southern part of the LCB and near the Chari/Logone Rivers and the Lake Chad, groundwaters are of Ca-Mg-HCO_3 type with high $^{36}Cl/Cl$ ratio (>1000 at/at). This $^{36}Cl/Cl$ signature is similar to the one of surface waters indicating that these groundwaters are recent and very likely imprinted by the 1950s' bomb pulse. Elsewhere, waters are more concentrated and evolve to Na-SO_4-Cl type. Their $^{36}Cl/Cl$ ratio is lower and less variable (around 200.10^{-15} at/at). The ^{14}C contents for these latter groundwaters are above 50 pmc, suggesting recent or Holocene recharge. A flow pattern and a groundwater recharge scheme for the Quaternary aquifer is proposed based on these geochemical data.

In contrast, the confined aquifers have a more homogeneous geochemical and isotopic signature. ^{14}C contents are all below 0.5 pmc and mainly below the detection level, the $^{36}Cl/Cl$ ratios are under 100.10^{-15} at/at and stable isotopes show more depleted waters. This consistently indicates a major episode of recharge of the confined aquifers during a humid period older than 50ky.