Appendix 1: precision of lead dating

On a centennial time scale, dating of sedimentary layers was carried out based on ^{210}Pb and ^{137}Cs measurements. Concentrations of both nuclides, together with U, Th and ^{226}Ra, were determined by gamma spectrometry. The 2-cm-thick sediment layers were washed in de-ionised water and sieved. The sediment fraction <1 mm was first finely crushed after drying, and transferred into small gas-tight Polyethylene Terephtalate (PETP) tubes having an internal height and diameter of 38 and 14 mm, respectively, and then stored for more than 3 weeks to ensure equilibrium between ^{226}Ra and ^{222}Rn.

The activities of the nuclides of interest were determined using a CANBERRA Ge-well detector, by comparison with the known activities of an in-house standard. Activities of ^{210}Pb were determined by integrating the area of the 46.5 keV photo-peak. ^{226}Ra activities were determined from the average of values derived from the 186.2 keV peak of ^{226}Ra and the peaks of its progeny in secular equilibrium ^{214}Pb (295 keV and 352 keV) and ^{214}Bi (609 keV). In each sample, the ^{210}Pb (unsupported) excess activities were calculated by subtracting the ^{226}Ra (supported) activity from the total ^{210}Pb activity (Sabatier *et al*., 2008).

The basic methodology of ^{210}Pb dating was established by (Goldberg, 1963). ^{210}Pb precipitates from the atmosphere through ^{222}Rn decay and accumulates in surface soils, glaciers or lakes, lagoons, where successive layers of material are buried by later deposits. Many ^{210}Pb models were proposed, allowing calculating sedimentation rates (Appleby and Oldfield, 1992). In the simplest model, the initial ($^{210}Pb_{ex}$), [($^{210}Pb_{ex}$) =(^{210}Pb)−(^{226}Ra)] is assumed constant and thus $^{210}Pb_{ex}$ at any time is given by the decay law [($^{210}Pb_{ex}$) = ($^{210}Pb^{0}{}_{,ex}$) $\exp^{-\lambda_{210}\cdot t}$]. The CFCS model (Goldberg, 1963) supposes a constant ^{210}Pb flux and a constant sedimentation rate. In a logarithmic diagram, $^{210}Pb_{ex}$ should define a straight regression line whose slope allows calculating an average sedimentation rate. Using the average sedimentation rate W (mm.a^{-1}), the age T_m of the sediment layer can be calculated, for each depth Z_m (cm).

$$\ln\left(\left({}^{210}Pb_{ex}^{m}\right)\right)=\ln\left(\left({}^{210}Pb_{ex}^{0}\right)\right)-\left(\frac{\lambda_{210}}{W}\right)\times Z_m,\quad with:\quad T_m=\frac{W}{Z_m}$$ eqn. 1A

This simple model gives an estimation of the average sedimentation rate.

The peak of ^{137}Cs is search in the top most sediment based on the fact that the depth of the maximum ^{137}Cs activity in the sediment corresponds to the 1963 maximum atmospheric production (Robbins and Edgington, 1975).

REFERENCES

Appleby, P., Oldfield, F., 1992. Uranium Series Disequilibrium, Application to Earth, Marine and Environmental Sciences, Chapter Application of Lead-210 to Sedimentation Studies. Clarendon Press, Oxford, pp. 731–778.

Goldberg, E., 1963. Geochronology with lead-210 radioactive dating. Vienna, *International Atomic Energy Agency*, 121–131.

Robbins J.A., Edgington D.N., 1975. Determination of recent sedimentation rates in Lake Michigan using Pb-210 and Cs-137. *Geochimica et Cosmochimica Acta* **39**, 285–304.

Sabatier, P., Dezileau, L., Condomines, M., Briqueu, L., Colin, C., Bouchette, F., Le Duff, M., Blanchemanche, P., 2008. Reconstruction of paleostorm events in a coastal lagoon (Hérault, South of France). *Marine Geology* **251**, 224–232.