EAG-GS 2014 Outreach Program to Africa

Lecture Abstract:
Quaternary geochronology: the geochemical toolbox for Archaeology, Palaeontology and Paleoclimatology

Pierre Deschamps, CEREGE, UMR AMU-CNRS-IRD-Collège de France, France. deschamps@cerege.fr

No major breakthrough in our knowledge of the 4,567 Ma Earth's geological History could have been achieved without the support of radiometric dating. This statement holds also obviously true for the Quaternary, the period that encompasses both the Pleistocene and the Holocene epochs, i.e. the last 2.6 million years. Because they are, by virtue of the near-surface preservation, the most accessible, spatially comprehensive and highest-temporal- resolution records of Earth's history, Quaternary archives provide fundamental data to reconstruct climate and ecological changes, human evolution, cultural development of past societies and more. The Quaternary is characterised by large climatic fluctuations paced by Earth's orbit variations and the waxing and waning of the Northern Hemisphere ice sheets. This recent period of Earth's history is also a key period of hominid evolution, from the earliest species of the Homo genus to the anatomically modern human.

Accurate, and if possible absolute, time constraints are crucial for documenting changes in their correct temporal sequence, of climates, landscapes, flora and fauna - including the evolution and ecological impact of humans. This will further our understanding of connections, causes and consequences of these geological and biological processes during this time period at a variety of temporal and spatial scales.

In the past decades considerable progress has been made to meet the growing demand on increasingly more accurate and precise ages. These efforts involve methods ranging from traditional geologic analysis (i.e. stratigraphy and correlation) to dating methods based on radioactive decay. Since the first major breakthrough in Quaternary Geochronology that was the development by Libby of the Radiocarbon method in the 50's, revolutionary advances have been made in isotopic dating techniques. These were mainly due to improving analytical techniques and/or specific applications of geochemical tools usually used in the more traditional fields of geochemistry and geochronology (i.e., U-Th, U-Th-Pb, $^{40}Ar/^{39}Ar$ systematics) to the Quaternary period. Particularly impressive results were achieved by U-Th chronology on carbonates. U-Th dating of corals indeed allowed to calibrate the radiocarbon method and to accurately reconstruct past sea-level variations, while U-Th dating of speleothems has allowed to picture with an unprecedented precision the timing of the abrupt climatic events that punctuated the Pleistocene. Meanwhile, cosmogenic nuclide burial and exposure dating techniques have also revolutionised studies of landscape evolution, glacial history and provided new tools in the field of Palaeontology where others techniques were found to be irrelevant.

Some Quaternary dating methods are well established, while others are in the early stages of development. This course will first present the "geochemical toolbox" for Quaternary Chronology by introducing the basic principles of well-established techniques, with a particular focus on radioisotope chronometers (e.g. U-Th, ^{14}C, ^{10}Be…).

Their application will then be illustrated with case studies in the fields of archaeology, palaeontology and paleoclimatology from the African Continent.