GEOCHEMICAL AND GEOPHYSICAL IMPLICATIONS OF THE RADIOCARBON CALIBRATION**.** Edouard Bard, Institut Universitaire de France and CEREGE, Universit d'Aix-Marseille III, CNRS UMR132-FU17, Europe de l'Arbois, BP 80, 13545 Aix-en-Provence cdx 4, France, Phone: +33 442971561, Fax: +33 442971549, e-mail: ebard@arbois.cerege.fr

A precise and accurate chronological framework is crucial to study the dynamics of a variety of phenomena which occurred during the last 40,000 yr. The radiocarbon dating method is widely applied since the fifties but it is recognized that ^{14}C ages are not strictly accurate. This problem justifies the construction of a calibration to calculate true calendar ages.

For example the ^{14}C calibration is needed in prehistoric archeology to study the spread and evolution of populations during the upper paleolithic period. In geophysics it is important in order to obtain recurrence rates of seisms or volcanic eruptions. The field of paleoclimatology clearly illustrates the importance of the ^{14}C calibration because rapid climatic change are studied in different types of archives spread at different latitudes and in different compartments of the ocean-atmosphere-biosphere system. Accuracy is also crucial to evaluate the phasing between climatic events and variations of Earth's orbit parameters.

Two decades of precise β-counting measurements on wood have resulted in the calibration for most of the Holocene period for which fossil trees are abundant. By contrast, suitable samples are very rare and/or small beyond the Holocene-Pleistocene boundary. Fortunately, the construction of the calibration has been fostered by the development of mass spectrometric techniques which can be applied to small samples:

^{14}C measured by accelerator mass spectrometry (AMS) on fossils from lacustrine and marine varved sediments, compared dating by AMS-^{14}C and uranium series analyzed by thermal ionization mass spectrometry (TIMS) on marine or lacustrine carbonates.

The calibration curve obtained so far is characterized by a long term trend with ^{14}C ages being significantly younger than calendar ages during most of the last 40,000 yr. Superimposed on this long trend of decreasing atmospheric $\Delta^{14}C$, are abrupt ^{14}C shifts which occurred over centuries to millennia. To a certain extent it is possible to delineate the different causes of atmospheric ^{14}C variations by considering complementary informations obtained for other cosmogenic nuclides studied at different latitudes.

It appears that the long trend shift of ^{14}C ages is due to several periods of lowered shielding effect of the geomagnetic dipole field which occurred during the last 50,000 yr. This interpretation is supported by paleomagnetic measurements performed on volcanic and sedimentary rocks.

Most of the high frequency component is linked to magnetic fluctuations of solar origin as revealed by studying the last three centuries for which direct observations of the Sun are available. A similar conclusion is derived by comparing ^{14}C events with cosmogenic isotope concentration maxima in polar ice cores (^{10}Be and ^{36}Cl).

Several, unusually large and rapid ^{14}C shifts occurred between 16,000 and 8000 yr. BP which corresponds to a period of major climatic changes. By contrast with the ^{14}C variability mentioned previously which is linked to fluctuation of production by cosmic rays, these so-called ^{14}C 'age plateaux' are probably due to abrupt variations in the rates of exchanges and/or in reservoir sizes within the global carbon cycle. This interpretation is supported by independent geochemical proxies and by numerical modeling of the carbon cycle.