

**Sunday, May 4<sup>th</sup>, 2003**

**BLUSZCZ “Physics of luminescence phenomena”**

The foundations of various luminescence phenomena are presented with emphasis on radioluminescence (RL), thermoluminescence (TL) and optically stimulated luminescence (OSL). Simple models explaining some aspects of luminescence phenomena related to luminescence dating are then discussed. Other, non-dating, applications of luminescence are outlined. An experiment with UV-photoluminescence will conclude the lecture.

**MURRAY “The dating of sedimentary events using optically stimulated luminescence”**

The principles of luminescence dating are first outlined, and the main assumptions discussed. These include constancy of dose rate, and complete resetting of the signal at the time of deposition; the reliability or otherwise of these assumptions is illustrated using case studies involving a variety of types of sediment from around the world. The age limits of the technique are explored, and the evidence for accuracy and reliability presented.

**Monday, May 5<sup>th</sup>, 2003**

**BRAUER “Varve chronology – an old concept in modern palaeoenvironmental research”**

About one hundred years ago, counting annually laminated (varved) sediments from proglacial lakes for the first time provided absolute dating of past environmental changes. Today, varved sediments have been described in a wide variety of environmental settings and are used as both, chronological tool and climate proxy data. This presentation will give an overview on (1) modern microstratigraphical methods of varve analyses, (2) different varve facies and micro-facies types, and (3) the potential and pit falls of varve chronologies.

**Tuesday, May 6<sup>th</sup>, 2003**

**Hajdas “Extension of the calibration curve – Variability of the <sup>14</sup>C time scale between 12 and 40 ka BP”**

1. variable <sup>14</sup>C atmosph. content –production rates, geomag, carbon cycle
2. need of calibration beyond the present dendrocurve
3. overview of data --Mono Lake & Laschamp
4. Perspective

<sup>14</sup>C time scale of the last 40 ka presents history of fluctuations of the atmospheric <sup>14</sup>C content. I will discuss the background of such variability, which encompasses changes in production rate of cosmogenic isotopes and carbon cycle. Extension of the presently accepted calibration curve beyond the 12 ka BP is complicated due to lack of continuous dendro chronology. Records such as varves, corals, stalagmites dated using varve counting and U/Th method will be discussed. <sup>14</sup>C chronologies of climate proxies and correlation between records beyond Holocene will be looked at in details.

### **HARKNESS “Experience from 35 years of Applied Radiocarbon Dating: most good but some bad”**

Abstract (not exceeding 500 characters): During the 50 or so years since the inception of the C-14 dating method the applications of natural C-14 measurement have grown almost exponentially.

In that time radiocarbon chronologists have had to recognise a special responsibility for building bridges of communication across the environmental science community. However, as in human adolescence, many of the essential lessons leading towards the maturity of applied C-14 science were not learned without pain. Some specific examples will be discussed to highlight:

- i) The benefits from close collaboration between the providers and the users of natural C-14 measurements.
- ii) The experiences from 50 years of applied C-14 research are equally important for the more recent and/or emerging methods of dating past events.

### **HALAS “Physical foundations of K/Ar method”**

The K/Ar method consists of two independent analyses – potassium and argon – in a mineral. The date is calculated from the determined K and Ar concentrations. These concentrations may be determined with accuracy better than 1% by means of isotope dilution techniques which are used in Lublin MS Laboratory. Examples of dating of the oldest materials (meteorites) and young geological formations will be presented.

**Thursday, May 8<sup>th</sup>, 2003**

**HAJDAS “Beyond the Younger Dryas--14C dating in paleoclimate studies”**

1. changes of 14C during the YD--fast and slow clock, problems in absolute dating
2. high resolution 14C chronologies of proxies
3. Problems addressed: YD and Late Glacial, Heinrich Events.
4. Correlation between records around the globe

**PAZDUR “Conventional techniques of <sup>14</sup>C dating ”**

In radiocarbon dating methods <sup>14</sup>C concentration is measured in sample containing carbon. Beta radioactivity of that isotope is proportional to <sup>14</sup>C concentration in the sample. Conventional dating techniques use gas proportional counters and liquid scintillation spectrometers for detection of beta radiation. Precision and range of the radiocarbon dating are limited by low <sup>14</sup>C concentration in different radiocarbon reservoirs. Other limitations of radiocarbon dating method using conventional techniques has its source in the very low value of <sup>14</sup>C decay constant and low maximum energy of beta particles. The precision of radiocarbon dating results is described by error given together with dating results

**Wednesday, May 7<sup>th</sup>, 2003**

**PATERNE “AMS Radiocarbon dating”**

The need of numerous old and accurate <sup>14</sup>C ages increased recently in order to understand the rapid, abrupt and frequent climatic changes, as observed during the last glacial period. This would help to analyse the relationships between the marine climatic fluctuations during the Oxygen Isotope stage 3 and the Dansgaard/Oeschger events as recognised in ice records, as well as the low to high latitudes connections.

Whatever the <sup>14</sup>C techniques (Accelerator Mass Spectrometry AMS or radioactive decay countings), the acquisition of a <sup>14</sup>C age requires two measurements since based on <sup>14</sup>C activities ratio: one concerns the modern standard reference, and the second the sample of unknown age. Nevertheless, as contamination by modern carbon may occur in natural environments, and along with the procedures of <sup>14</sup>C datings, a third measurement of such a contamination is required. Although some blank standards (AIEA C1 marble) are currently runned in order to check the contamination during the chemical procedures and the AMS measurements, this is not sufficient as previously described from the <sup>14</sup>C analyses of different species of old planktonic foraminifera (Schleicher et al., 1998; Nadeau et al., 2001). Such a variability does not concern uniquely carbonates, but also the different types of organic matter (charcoals or woods). Moreover the smallest the samples, the largest the contamination. Therefore, acquisition of the AMS <sup>14</sup>C age of a sample is based on measurements of blank values of the same species. During the lecture, the need of acquisition of old <sup>14</sup>C ages will be investigated in the context of global climatic changes. The technique of AMS measurements will be shown as well as the different chemical procedures as developed on carbonates, organic matter and bones. Finally, the different blank values will be presented.

## **FONTUGNE “Applications of $^{14}\text{C}$ dating in studies of environment”**

Radiocarbon is produced in the upper atmosphere by cosmic rays and its concentration can be considered as constant on a decennial time scale. However, in specific areas like volcanoes or nuclear plants, where dead or  $^{14}\text{C}$  enriched carbon dioxide, respectively, are injected, in the environment,  $^{14}\text{C}$  concentrations presents large variations that can be used as a tracer of natural processes and allow identification of sources and phase transfer of radio-element in the vicinity of nuclear plants.

In active volcanic complexes, magma derived carbon dioxide emission occurs mainly as diffuse and invisible emanations from the soils. This dead  $^{14}\text{C}$  carbon dioxide is assimilated through photosynthesis by vegetation. A mapping of radiocarbon concentrations provide the opportunity to quantify the importance of this degassing and allow to furnish information on volcanic risks prediction by reconstructing the historical activity of the volcanoes.

Around nuclear plants,  $^{14}\text{C}$  is considered as a waste, the distribution of which in the environment need to be known due to its possible impact on the wealth of the people. Furthermore, this  $^{14}\text{C}$  excess injected in river, estuary, sea water and atmosphere constitutes a tracer of carbon dioxide exchanges between these different boxes permitting to quantify natural carbon fluxes.

## **RÓŻAŃSKI “Dating methods in hydrogeology”**

The lecture will present the concept of "dating" in hydrology and the methods currently in use to derive age information for various water bodies. Focus will be on tracer methods based on isotope indicators. Methodological framework for "dating" concept in hydrology be first laid down. The following methods will be presented and illustrated by examples:

- (i) dating methods for young waters ( $^3\text{H}$ ,  $^3\text{H}/^3\text{He}$ ,  $^{85}\text{Kr}$ , CFCs,  $\text{SF}_6$ )
- (ii)  $^{39}\text{Ar}$  method
- (iii) radiocarbon method
- (iv) other methods ( $^{18}\text{O}$  and  $^2\text{H}$ ,  $^4\text{He}$ ,  $^{36}\text{Cl}$ ,  $^{81}\text{Kr}$ , noble gases)

Possibilities of deriving age information in the framework of flow and transport models of groundwater systems and existing links to tracer "ages" will be briefly outlined.