

Thesis abstracts

Thesis title: Application des méthodes de datation par luminescence optiquement stimulée à l'environnement océanique de l'Atlantique Nord

Translated title: Application of optically stimulated luminescence dating methods to the North Atlantic oceanic environment.

Author: Anasse Jennane
Grade: Ph.D.
Date: December 2001
Supervisor: Michel Lamothe
University: Université du Québec à Montréal,
 Département des Sciences de la Terre et de l'Atmosphère

In this study, the optically stimulated luminescence dating method was applied to Pleistocene sediments from three cores from the northern sector of the North Atlantic. The drill site Troll 91/8903 lies in the middle of the Norwegian Channel in the north-eastern region of the North Sea. The second core, SAB-85, is from Sable Island along the outer edge of the continental shelf of the coast of Nova Scotia. The third core (TWC/PC 84-030-001) comes from the abyssal plain of the southern sector of the Labrador Sea. The location of these three sediment cores provides a valuable record of Quaternary climatic fluctuations and ice sheet volumes in the circum-Atlantic zone. The analyzed samples represent marine and glacio-marine units, and their chronostratigraphic positions have been determined using lithologic, biostratigraphic and aminostratigraphic criteria, and a limited number of radiocarbon dates.

In order to date these samples, potassium feldspar was used as the natural dosimeter and the sediments were dated using the Infrared Stimulated Luminescence (IRSL). Analyses were performed on polymineralic fine grains (4-11 μm), and K-feldspar coarse grains (125-250 μm) and the IRSL ages were calculated using multiple and single aliquots. The latter included both the single grain and the single aliquot regeneration (SAR) methods. In order to measure the equivalent dose (D_e), we applied the additive dose, regeneration, and Australian slide methods, the latter of which combines the first two.

The apparent IRSL ages obtained from the polymineralic 4-11 μm fraction from core Troll 8903 are generally in agreement with the assumed sediment ages based on the regional chronostratigraphy. Together, the good reproducibility of the results, and the observation of a plateau of equivalent dose values plotted as a function of stimulation time would have indicated that the IRSL signal of the samples was reset to zero at the time of sediment deposition. Nevertheless, this type of plateau is also observed for partially bleached diamictic sediments. Analysis of the coarse,

monomineralic K-feldspar fraction revealed indeed a heterogeneous collection of well to partially bleached grains, this being based on the variability of the parameter R_I ($L_{N+\gamma}/L_N$). The R_I values measured after a delay of several days demonstrated that the IRSL signal was unstable and affected by fading. This phenomenon incurs an underestimation of IRSL ages. The *fadia* method, which uses the relationship between $R_I(t_1)$ and $R_I(t_2)$, allowed for an estimation of fading, which varied between 7 and 30 %. For some of the fine-grained samples (4-11 μm), it appears that the agreement between apparent IRSL ages and assumed ages is therefore the result of the combined yet opposing effects of partial bleaching and fading.

The IRSL ages obtained for the samples from core SAB-85 (Nova Scotia) indicate that the major glaciation period that affected the Eastern Canada continental platform predates the Early Wisconsinan and probably prevailed until Late Illinoian (isotopic stage 6), or even earlier. Evidence of this major glaciation includes, among other facts, the incision from sub-glacial channels that became filled with the sediment sequence sampled by drill hole SAB-85.

A modified version of the single aliquot regeneration method revealed that both reproducibility and precision of the results were excellent. This technique was tested on fine-grained polymineralic and coarse-grained K-feldspar samples from all three cores. In contrast to the coarser grains aliquots, the estimated equivalent doses for the fine-grained fraction displayed considerable homogeneity between aliquots, suggesting that the sediment was reset to zero. These samples, however, are affected by fading on the order of 2.5 to 5 % per decade. IRSL ages corrected for fading are therefore greater than the presumed ages. Some of this overestimation is the result of thermal transfer within the natural aliquot upon the first preheating.

(Translated and edited from original French version)

Thesis title : Application des méthodes de datation par luminescence optique à l'évolution des environnements désertiques - Sahara occidental (Maroc) et Iles Canaries orientales (Espagne)

Translated title : Application of optically stimulated luminescence dating techniques to desert environment evolution - Western Sahara (Morocco) and Eastern Canary Islands (Spain)

Author : Nawal Bouab

Grade : Ph.D.

Date : December 2001

Supervisor : Michel Lamothe

University : Université du Québec à Montréal,
Département des Sciences de la Terre et de l'Atmosphère

This paleoenvironmental study establishes a geochronological framework for the alternating arid and humid phases in Western Sahara and Eastern Canary Islands. This work is one component of a multidisciplinary study on global changes (Earth Processes in Global Change, EPGC) included within the scope of the CLIP project (Climate of the Past), sponsored by UNESCO (United Nations Educational, Scientific and Cultural Organization) and IUGS (International Union of Geological Sciences).

Optically stimulated luminescence (OSL) dating methods were applied to feldspar (IRSL) and, when possible, to quartz (GSL) from sediments that represent successive humid phases in three sections: Tah in Western Sahara, Rosa Negra and Mala on the islands of Fuerteventura and Lanzarote. Various methods inherent to the OSL technique (additive dose, regeneration, Australian slide, SAR, SAAD) were applied to multiple aliquots, single aliquots or single grains. A fading correction was applied to the feldspar ages. In the absence of independent chronological control, this comparative approach was considered necessary in order to validate the resultant ages.

In the Tah section (Western Sahara), different OSL methods gave comparable quartz and feldspar ages for every samples for which the OSL of quartz was far from saturation. It was found that the Tah section spans a period of 110 thousand years marked by humid phases at 107 ± 11 ka, 50 ± 5 , 31 ± 3 and 13 ± 1 ka. The latter was dated using ^{14}C . The first event is thought to be a more pronounced humid phase.

In the Eastern Canary Islands, the application of OSL methods was restricted by mineralogical constraints caused by elevated carbonate contents and low concentrations of quartz and feldspar. In addition, the dated feldspar minerals show apparent sensitivity changes, probably due to their volcanic

origin. Only the SAR method provided reliable results due to its advantage of properly correcting the luminescence sensitivity changes from single aliquots. Quartz was not dated since this mineral was absent from the topmost units and those grains present in the oldest units were saturated. Once the fading correction had been applied, the Rosa Negra section at Fuerteventura revealed the existence of humid phases at 253 ± 27 , 190 ± 50 and 147 ± 25 ka. On Lanzarote, the basal samples from the Mala section could not be dated due to low IRSL emission and low reproducibility. Nevertheless, two humid phases in the upper horizons were dated at 191 ± 55 and 130 ± 11 ka. These ages correlate with those from the Rosa Negra section, suggesting that the *lacunae* observed at Rosa Negra carry regional significance.

A composite sequence was obtained by combining the Tah section with the apparently contemporaneous Rosa Negra and Mala sections. The newly compiled sequence reflects the dry to humid transitions that affected the Sahara during the past 250 000 years. These seems to coincide with interglacial or interstadial boundaries defined by stable isotope ($\delta^{18}\text{O}$) variations recorded in marine cores from the Canarian Basin, the latter being synchronised with the SPECMAP curve. In addition, the humid phases correspond to those recorded in travertine or high lake levels scattered throughout the rest of the Sahara and Sahel. With the exception of the horizon that should represent the 80 ka humid period (e.g. 5a isotopic stage) which was probably eroded by eolian deflation, these sections represent a unique land sequence covering several climatic cycles, found in an arid environment within the Saharian intertropical zone.

(Translated and edited from original French version)