LUOMUS

LUONNONTIETEELLINEN KESKUSMUSEO
NATURHISTORISKA CENTRALMUSEET
FINNISH MUSEUM OF NATURAL HISTORY

AJOITUS
DATERING
CHRONOLOGY

QUANTIFYING THE PAST, PRESENT AND FUTURE AT THE LABORATORY OF CHRONOLOGY

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INTRODUCTION

Laboratory of Chronology at LUOMUS proceeds towards open access policy, professional data management and standardization. Data produced and collected are publicly available at http://www.oasisnorth.org/ (δIANA for dietary stable isotopic ratios, ^{14}CARHU for ^{14}C data). From 3/2016 onwards professional Laboratory Information Management System (LIMS) supports management, data handling and quality control. Furthermore, we pioneer ISO17025 accreditation during 2016 as one of the first isotopic laboratories worldwide.

STABLE ISOTOPE STUDIES

The laboratory houses two mass spectrometers for stable isotope measurements. We routinely measure a variety of materials for δD, δ^{13}C, δ^{15}N and δ^{18}O.

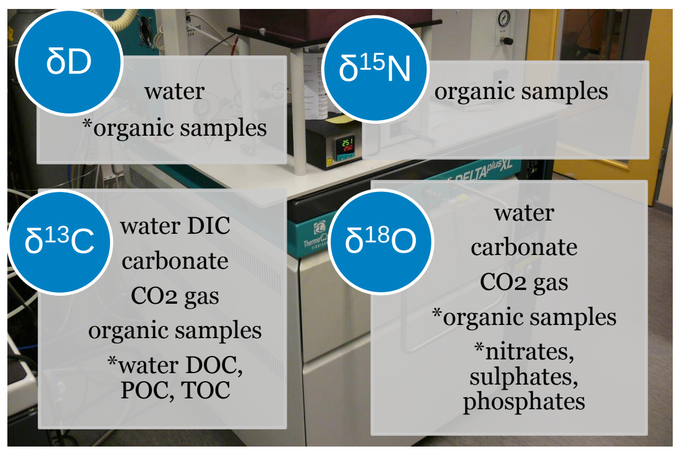

Figure 1. Materials commonly analysed at the laboratory. *= not routinely measured, capabilities exist.

Much of the stable isotope research deals with past and present climate and ecology. SA-funded CARATE and QUANOMAL projects (with LUKE) use isotopic proxies on 7500-year long annual tree-ring archive to study climate history and environmental anomalies.

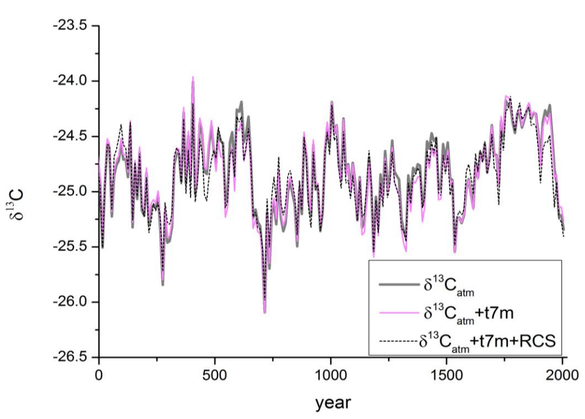

Figure 2. Tree-ring δ^{13}C chronology – a proxy for climate – for 1-2000 AD/CE from Finnish Lapland. 21000 measurements were performed through CARATE project in 2011-2015.

Bone stable isotopes tell of climate and environment via diet. For instance, we have our focus on mammoth bones and Iron Age individuals from Levänluhta and Luistari.

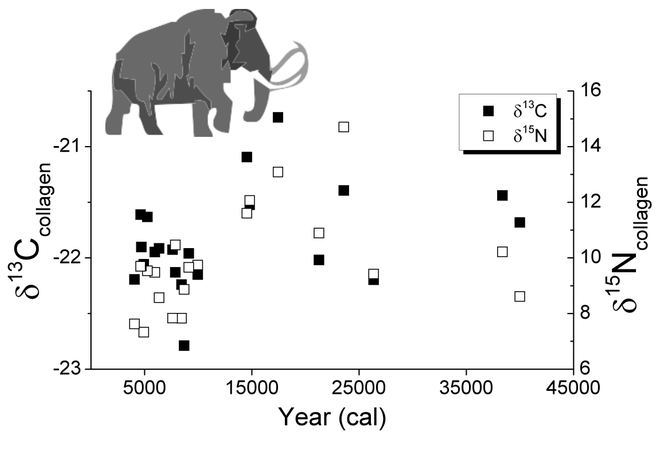

Figure 3. Mammoth collagen δ^{13}C and δ^{15}N values from Wrangel island, Siberia. Note elevated levels during the LGM.

RADIOCARBON ANALYSES

Environment-human interaction is strongly on our agenda. We reconstruct Holocenic environmental and cultural event sequences (Vuoksi, 536AD Mystery Cloud) based on ^{14}C analyses and Bayesian chronological models – supported by transdisciplinary reasoning. The events may have contributed strongly in shaping our prehistorical and cultural landscapes.

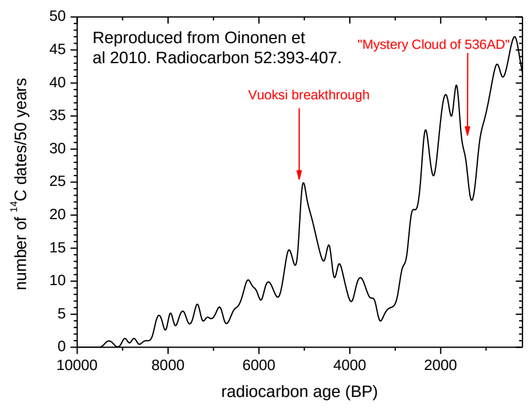

Figure 4. Sum of all eastern Fennoscandian archaeological ^{14}C dates and the appr. timing of the environmental events.

Molecular sieve -based ^{14}C methodology has been pioneered by our laboratory to sample biospheric carbon dioxide and methane – this will continue within the future carbon monitoring schemes.

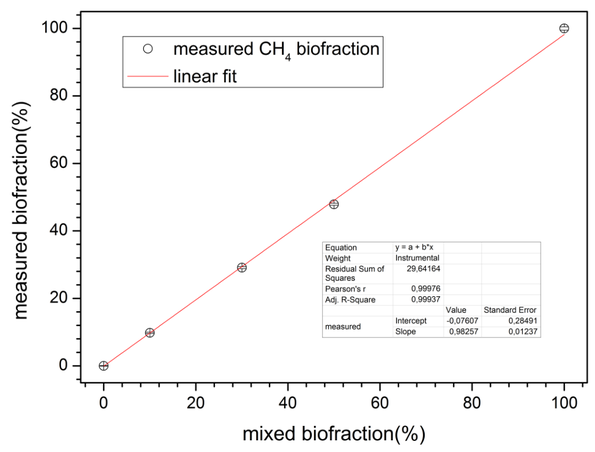

Figure 5. Measured fractions of biogenic carbon in mixed biogas/natural gas samples. The correlation is nearly perfect.

^{14}C-based biofraction measurements for gaseous (CO_2, CH_4), liquid and solid samples have been developed to support the future bio-economy and climate change mitigation. Particularly, Radiocarbon Analytics Finland (RACAF) is a common umbrella within the University of Helsinki providing AMS biofraction measurements.

LUMINESCENCE DATING

Luminescence is a phenomenon occurring in crystal materials, when electrons, trapped in special energy stages caused by defects in crystal structures, are released and emit blue light (luminescence) during the process.

When the trapped electrons are released – e.g., by heating (thermoluminescence, TL) or light (optically stimulated luminescence, OSL) – the intensity of the emitted luminescence follows linearly the amount of released electrons and the total dose of natural radiation received by the crystals.

In geology, luminescence methods are widely used to determine the age of sand deposits. Nowadays this is usually done with the OSL-method using quartz separated from sand samples.

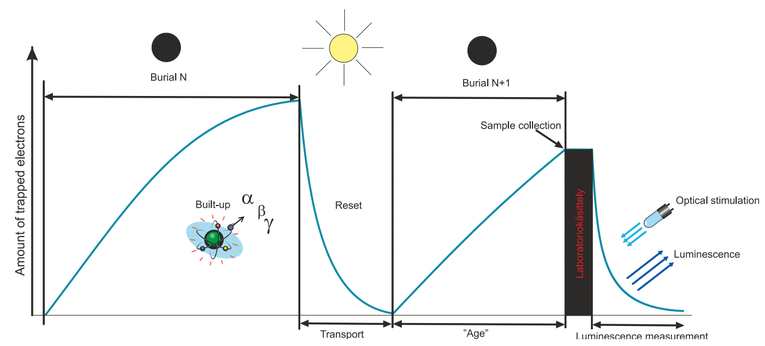

Figure 6. Building of the OSL-signal in sand grains during burial periods; bleaching by sunlight during transport.

The age range for luminescence dating is from 300 to over 100 000 years depending on the level of background radiation saturating the OSL-signal by time. The most suitable grain size of sand used in dating is 200-300 µm. To meet the demands of the sample being well bleached, the most suitable samples are from aeolian or calm water laid deposits.

Luminescence dating is also used with archaeological samples which are bleached by heating for example during the manufacturing process. Typically these are bricks, ceramics and stones from fireplaces.

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