Ancient TL

www.ancienttl.org · ISSN: 2693-0935

Ancient TL, 2004. *Thesis Abstracts.* Ancient TL 22(1): 13-15.
https://doi.org/10.26034/la.atl.2004.373

Thesis Abstracts

Author: Kristina Jørkov Thomsen
Thesis Title: Optically stimulated luminescence techniques in retrospective dosimetry using single grains of quartz extracted from unheated materials
Grade: PhD
Date: February 2004
Supervisor: Lars Bøtter-Jensen and Stig Steenstrup
Address: Risø National Laboratory & University of Copenhagen, Denmark

This work investigates the possibility of applying optically stimulated luminescence (OSL) in retrospective dose determinations using unheated materials. It focuses on identifying materials suitable for use in assessment of doses absorbed as a consequence of radiation accidents (i.e. accident dosimetry). Special attention has been paid to quartz extracted from unheated building materials such as concrete and mortar. The single-aliquot regeneration-dose (SAR) protocol has been used to determine absorbed doses in small aliquots as well as single grains of quartz. It is shown that OSL measurements of single grains of quartz extracted from poorly-bleached building materials can provide useful information on radiation accident doses, even when the luminescence sensitivity is low. Sources of variance in well-bleached single grain dose distributions have been investigated in detail and it is concluded that the observed variability in the data is consistent with the sum (in quadrature) of a component, which depends on the number of photons detected from each grain, and a fixed component independent of light level. Dose depth profiles through laboratory irradiated concrete bricks have successfully been measured and minimum detection limits of less than 100 mGy are derived. Measurements of thermal transfer in single grains of poorly-bleached quartz show that thermal transfer is variable on a grain-to-grain basis and that it can be a source of variance in single-grain dose distributions. Furthermore, the potential of using common household and workplace chemicals, such as table salt, washing powder and water softener, in retrospective dosimetry has been investigated. It is concluded that such materials should be considered as retrospective dosimeters in the event of a radiation accident.

Thesis is available online at http://www.risoe.dk/rispubl/NUK/ris-phd-1.htm

Author: Jeong-Heon Choi
Thesis Title: Luminescence ages of Quaternary marine sediments on the Eastern coast of Korea and their geomorphic implications
Grade: PhD
Date: August 2004
Supervisor: Ho-Wan Chang
Address: Seoul National University

Several sets of marine terrace are exposed along the southeastern coast of the Korean peninsula. The formation ages of these terraces have attracted considerable attention because they provide essential information on local crustal stability. Over the last few years, considerable effort has been put into the determination of these ages using optically stimulated luminescence (OSL) dating of the marine sediments from which the terraces were built. However, previous efforts to establish a chronology using OSL methods have produced controversial results, particularly because of stratigraphic inconsistency and poor reproducibility. In this work, the application of OSL dating based on the single-aliquot regenerative-dose (SAR) protocol for quartz is investigated. The dependence of equivalent dose on the preheat and cut-heat temperatures (thermal treatment of the regeneration and test-doses, respectively) are examined. Linearly modulated luminescence signals from chemically cleaned quartz samples are used to identify the presence of a thermally unstable component with a large optical cross-section (component A′), which in part affects the ability to correct for sensitivity changes during measurements, and thus the reliability of the equivalent dose estimates. In some samples, a higher heat treatment after the test-dose is shown to improve the ability to measure a dose given in the laboratory before any heat treatment (dose recovery test). This higher temperature treatment effectively removes component A′, and hence improves sensitivity correction. Despite of the removal of component A′,

the samples from one site (Oryu Terrace) still exhibit various undesirable OSL characteristics, which result in stratigraphically inconsistent OSL ages. To resolve this stratigraphic inconsistency, these characteristics are investigated, and luminescence component separation used.

Results thus obtained from 2nd terraces, which is located at the elevation of 7~18m (a.m.s.l), are reproducible at each sampling location, and give ages grouping broadly into 50~70 ka (Oryu ~ Kwanseong Terraces, Nasa ~ Bihag Terraces) and 110~120 ka (Weseong Terrace), but laterally discontinuous on a scale of tens of km. The OSL results for the younger group are supported by radiocarbon ages from overlying terrestrial deposits. The OSL age of one site from 3rd terrace (Suryeom Terrace; ~43m a.m.s.l) has recently been dated to about ~100 ka. From these observations, it is suspected that the Weseong Terrace (110~120 ka; ~ 17m) belongs to 3rd Terrace (rather than 2nd Terrace), and that differential crustal uplift or vertical dislocation between Oryu-Kwanseong block and Weseong-Bihag block has led to its misidentification as 2nd Terrace. This argument is examined using OSL ages of aeolian sand dunes locate in the Pohang area.

Author: Zenobia Jacobs
Thesis Title: Development of luminescence techniques for dating Middle Stone Age sites in South Africa
Grade: PhD
Date: May 2004
Supervisor: Ann Wintle and Geoff Duller
Address: University of Wales, Aberystwyth

Middle Stone Age (MSA) archaeological sites in South Africa can contribute to the debates on the origins of modern humans and modern human behaviour. Participation in these debates requires accurate and precise chronologies. Most of the MSA dates to beyond the range of radiocarbon dating and optically stimulated luminescence (OSL) dating is an appropriate alternative method.

This study is primarily concerned with testing and developing luminescence measurement techniques appropriate for dating complex sedimentary deposits at archaeological sites. Instrument behavioural tests are performed to test the reproducibility of the Risø single grain system and the appropriateness of the comparison between results obtained from single aliquots and single grains, when using different stimulation wavelengths. Single aliquots of quartz are measured to assess the appropriateness of the conventional and modified single aliquot regenerative-dose (SAR) measurement procedures. Single grains of quartz are measured to investigate the grain-to-grain variability in quartz OSL behaviour and how this will impact on derivation of equivalent dose (De) using the conventional or modified procedures.

Application of single grain measurements is necessary because of the likelihood of depositional and post-depositional processes which may result in the under- or overestimation of the true burial age. Single grain De distributions are discussed in terms of how instrumental, quartz behavioural and depositional and post-depositional processes can influence the shape of the distributions. Rejection criteria are proposed to eliminate both quartz grains for which the measurement procedure is inappropriate and feldspar grains.

Dose rate evaluation methods are discussed and results obtained using a number of different laboratory-based and field-based methods are compared.

OSL ages from Blombos Cave and Sibudu provided an age range between ~50 ka and 140 ka for the pre- and post-Howiesons Poort cultures. These ages are used to discuss the chronology of the MSA in South Africa and the evidence for early modern humans and modern human behaviour at Blombos Cave.

Author: Gunter Erfurt
Thesis Title: Radioluminescence spectroscopy and dosimetry on feldspars and synthetic luminophors for geochronometry applications
Grade: PhD
Date: October 2003
Supervisor: Matthias Krbetschek and Werner Stolz
Address: Technische Universitat Bergakademie Freiberg

This PhD thesis reports on new results of the characteristics of photo- and radioluminescence emissions at 865 nm (1.43 eV) and 910 nm (1.36 eV) emitted by potassium-rich feldspars (KAlSi3O8). For the physical interpretation of its behaviour, the IR luminescence in potassium-rich feldspars is compared to a well investigated IR luminescence occurring in lead-doped potassium chloride (KCl:Pb) and to a study on the IR luminescence of lead-rich KAlSi3O8 (amazonite). The emissions in both materials, potassium-rich feldspar and potassium chloride, are most likely due to electron transitions in

Pb+ from the 72P1/2 and 72S1/2 excited states to the 62S1/2 ground state of Pb+. Pb+ originates from interaction processes of Pb2+ cations, substituted for K+ cations in the tetrahedral feldspar framework or the cubic lattice of KCl, with ionising radiation (Pb2+ + β, γ, ... → Pb+). Another result of the experiments reported is the fact, that this radiatively induced conversion is reversed by thermal treatment of the minerals (Pb+ + T → Pb2+). Also, the Pb+ centres can be "optically bleached", which is also interpreted as reversed conversion Pb+ + hω → Pb2+. Implications for the theory of the infrared optically stimulated luminescence (IR-OSL) are discussed.

Following upon these results, a fully automated radioluminescence (RL) measurement instrument for dating and dosimetry was designed and built. The instrument is based on a commercial Daybreak 1100 automated TL reader system, widely used in thermoluminescence (TL) dating. It was re-designed and highly modified to adapt it to the physical and methodological needs of the IR-RF dating technique and other RL dosimetry applications. This new system holds up to 10 samples, has an integrated bleaching and irradiation unit, and measures the radio-fluorescence (RF) (excitation using 10 137Cs sources, each 5 MBq activity). All technical requirements for the measurement of optically excited luminescence were implemented in order to investigate the defect structure of luminescent materials. Because of the broad wavelength range and the high sensitivity of the photomultiplier detector used, the system is suitable for a great many luminescent materials, natural and synthetic.

Furthermore, a calibration method and the dosimetric concepts based on the Bragg-Gray cavity theory is described in detail. This calibration method uses the blue RF emission of Al2O3:C at 415 nm (3.0 eV) for the β source dose rate estimation and shows much lower calibration errors than yielded by the application of calibration procedures using natural dosimeter materials such as feldspar and quartz. Finally, examples of IR-RF dating results on Quaternary sediments together with independent age control are presented.

The conclusions of this PhD thesis have important implications for the physical precision of luminescence dating methods in principal and especially for the determination of the deposition time of Quaternary sediments using the infrared radiofluorescence (IR-RF) of potassium-rich feldspar grains.

Thesis is available online at https://fridolin.tu-freiberg.de/archiv/html/PhysikErfurtGunter946007.html