Shining a light on the past: luminescence dating in geology and archaeology

Andrew Murray[1]

With contributions from: Jan-Pieter Buylaert[1,2], Reza Sohbati[1], Kristina Thomsen[2] and Mayank Jain[2].

1. Nordic Laboratory for Luminescence Dating, Department of Geoscience, University of Aarhus, Denmark
2. Center for Nuclear Technologies, Technical University of Denmark.

The Earth's surface is an archive of the history of our species and of our environment. The waxing and waning of ice ages leave behind both water-lain and windblown sediments recording the occurrence and extent of global cold periods. Changes in rainfall, temperature, flora and fauna are recorded in both marine and freshwater sediments. Artefacts such as ceramics, fireplaces, tools, worked bones and megaliths, are preserved in sedimentary successions and record the presence and activities of modern humans and other hominids. Finally, extreme events of very real importance to modern society such as river flooding, storm floods, tsunamis and earthquakes all leave a record in the sedimentary archive. But to read and interpret this archive, we must have a means of knowing when the various records were preserved, and so when the events actually happened.

Trapped charge dating is an important and widely-applicable chronological tool used to date these records. The technique is not new, but recent developments have led to an explosion in applications, so that today it is one of the three most widely used methods in the geo- and archaeo-chronology of the last 500,000 years. This talk will outline the principles of trapped charge dating, particularly using the ubiquitous natural minerals quartz and feldspar. The history of the technique's most widely used form, luminescence dating, is reviewed, from its 1960s origins in the thermoluminescence (TL) dating of pottery, through the major discoveries and developments from the 1980s using TL in marine core dating, and later the observation of two optically stimulated luminescence (OSL) signals in natural minerals, and finally to the cascade of new instrumentation and techniques of the last two decades.

The advantages and limitations of OSL dating, especially in terms of precision and accuracy, are outlined, before illustrating the importance of the technique to studies of human evolution and migration, and to our understanding of past climate change. Other applications to the reconstruction

of past radiation doses from nuclear accidents, or from the mishandling of radioactive sources are also mentioned. Finally, exciting new developments in rock surface dating are summarised.

It is concluded that OSL dating in its various forms is the most widely applicable dating tool available to earth scientists and archaeologists. It has grown from being relatively minor and unimportant to become one of the three pillars supporting modern archeo- and geo-chronology, and despite nearly 60 years of development, new signals, new techniques and new applications are constantly appearing. It continues to be a very exciting field in which to work.