Thesis Abstracts

Author: ZhongPing Lai
Thesis Title: Luminescence dating of Chinese loess
Grade: DPhil
Date: March 2005
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The thesis has two parts: the application of quartz OSL dating to solve problems in loess research and the study of red luminescence emissions from both quartz and feldspar in order to seek the possibility of extending the luminescence dating range of Chinese loess.

In the first part of the thesis, a new approach has been proposed to locate and date the boundary between the Holocene and the Pleistocene (H/P) in Chinese loess. It assumes that the loess sedimentation rate is lower during the Holocene than during the Last Glaciation, and that the inflexional point of the sedimentation rate change is the location of the H/P boundary. The sedimentation rate can be calculated using high-resolution luminescence (quartz OSL) chronology. The age of the H/P boundary in Chinese loess was determined for the first time using this approach. The continuance of loess deposition, an assumption behind the correlation between the palaeoclimatic records in loess and that in ocean sediments or ice cores which has been challenged recently, has been examined for L1 loess by establishing high-resolution quartz OSL chronology. It has been demonstrated that loess deposition during the Last Glaciation has been continuous in the section studied. The location and age of the boundary between Marine Isotope Stage (MIS) 2 and 3 has also been defined for the first time for Chinese loess using the above-mentioned approach. The mass accumulation rates have been calculated for MIS 1, 2 and 3 for the studied loess sections. The possibility of a standardised growth curve (SGC) when using the single aliquot regenerative-dose (SAR) protocol in OSL of loess quartz has been explored. The results show that a SGC exists, and that this SGC offers an alternative approach for De determination up to about 200 Gy for loess samples from the Chinese Loess Plateau.

The second part of the thesis is the study of red emissions from both quartz and feldspar with the purpose of exploring the potential of these signals for extending the luminescence dating range for loess. The study has shown that: a) red TL of quartz and red IRSL of feldspar can be detected from Chinese loess; b) using red TL of quartz, the De determined by a modified SAR protocol is overestimated, and the red TL residual level is more than 100 Gy; c) the detection of red IRSL of feldspar from Chinese loess has been successful after a modification to the Risø Reader, and some physical characteristics of red IRSL have been observed.

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Thesis Title: Development of optically stimulated luminescence dating techniques for application to terrestrial and martian studies
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Geological processes including aeolian and fluvial activity have shaped the surface of Mars. The temporal timescale on which these events have taken place is important for understanding the geological history of Mars, including time periods in which life may have developed on the planet. However, methods do not currently exist that can be used in-situ on Mars to constrain the recent (younger than 1 million years) geological timescale. It has been suggested that optically stimulated luminescence (OSL) dating, which measures the radiation dose and dose rate minerals are exposed to over time and hence the burial time, can be developed as an in-situ tool for delineating the timing of these recent events. This study attempts to develop some of the necessary techniques for measuring the radiation dose in martian minerals by studying martian soil simulants and meteorites.

Most of the luminescent materials that will be encountered on Mars are different from those typically used for OSL dating on Earth. However, the techniques used for absorbed radiation dose determination in terrestrial OSL dating studies can be adapted to martian simulants and meteorites with a few minor but important changes. These changes have to do with the heat treatment of the samples prior to OSL readout as well as the temperature of irradiation and OSL measurement due to the ambient temperature of Mars. While many scientific challenges must still be overcome for this project, this study provides a basis for further study of martian simulants.