Luminescence Dating of Sediments

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Thermoluminescence (TL) dating was first proposed 50 years ago as a method for dating the time elapsed since the last heating of artifacts such as pottery and heated flint stone. In the 1980s, optically stimulated luminescence (OSL) and infrared optically stimulated luminescence (IRSL) were proposed as methods for dating the deposition age of sedimentary grains. Luminescence dating methods date the deposition age of common minerals like quartz and feldspar. Quartz and feldspar grains behave like dosimeters in the sediment. The natural radioactivity accumulate as equivalent dose (De) in the mineral grains and can be determined by comparing the luminescence signal from the natural sample with that of artificially induced dose by a radioactive source. The natural radioactivity of the sediment is measured separately in the field or in the laboratory, for example by gamma spectrometry. An important dating assumption is a sufficient long exposure to daylight prior to the deposition of quartz and feldspar grains.

Single-aliquot regenerative (SAR) protocols have been established successfully for measuring the equivalent dose (De) of the minerals with much greater precision than those using multiple aliquot protocols. All measurements for the SAR protocol are done on one aliquot. Each aliquot gives rise to a De value and these many De values are then combined in the final age determination. The SAR protocol includes a suite of internal checks on the behaviour of the luminescence signals. Sensitivity changes occurring within the measurements sequence are monitored and corrected. Thus, evidence is given for the reliability of the applied method increasing the confidence of the final OSL age and so gives us information on the suitability of the method for the application to each sample studied..

OSL dating is able to provide better chronologies for the past 350 years than radiocarbon dating, the latter one having large uncertainties when the ^{14}C ages are calibrated owing to fluctuations in the cosmic radiation and subsequently in the ^{14}C production. OSL ages covering the past decades and centuries have been obtained for coastal sand dunes, being in excellent agreement with the time ranges expected from local historical records.

The fast component of the OSL signal from quartz is suitable for dating sediments up to about 100 ka (ka = 1,000 years). OSL ages beyond 100 ka are currently studied using OSL signals with a higher saturation limit. However, these signals are much less sensitive to light and so are restricted to aeolian deposits. Several new luminescence dating approaches, such as isothermal thermoluminescence (ITL), thermally-transferred OSL (TT-OSL) or IRSL at elevated temperatures, are under investigation to extend the age range from about 100 ka to about 1 Ma (Ma = 1,000,000 years) but need further experimental testing.

Luminescence dating methods provide a reliable, precise and accurate dating method for sediments from aeolian, fluvial, coastal, periglacial and glacial environments, making a major contribution to Quaternary sciences.

Further Reading

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