Optical dating of geological and archaeological rock surfaces potential and limitations of a new dating tool for the earth and archaeological sciences

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Luminescence dating is a well-established chronological technique normally applied to fine-grained (< 300 µm) sediments of clastic origin to estimate the time since sediment burial. Further development of this technique suggests that it can also be used to determine the exposure history of solid rock surfaces (e.g. Sohbati et al., 2012), which is based on the following principle: below a certain ambient temperature (i.e. closure temperature) latent luminescence begins to accumulate within the crystal lattice as a function of time due to the naturally occurring ionizing radiation inside rocks. Once the rock is exposed to daylight, e.g. due to erosion or transportation, this latent luminescence begins to gradually reset. The resetting (or bleaching) will eventually leave the topmost millimetres (typically < 30 mm) of a rock surface completely bleached. The rate of bleaching reduces systematically with depth (due to lower daylight intensity) to negligible values at depths where the luminescence signal is effectively unbleached and in field saturation. Given sufficient time, the profile reaches a secular equilibrium, where the rate of trapping due to ionising radiation becomes equal to the rate of detrapping due to daylight exposure at all depths. For a rock which is not in secular equilibrium, measuring and calibrating the depth-dependent luminescence signal below the exposed surface (via generating luminescence-depth profiles) allows – in principle – the exposure age of a geological or archaeological rock surface to be constrained (i.e. rock surface exposure dating; Sohbati et al., 2012, Sohbati et al., 2015; Meyer et al., 2018; Gliganic et al., 2018). As such rock surface exposure dating provides similar but complimentary information to surface exposure dating using cosmogenic radionuclides.

In this presentation the application potential of rock surface exposure dating will be discussed and methodological limitations evaluated. Dating studies applying rock surface exposure dating to archaeological sites, including a lithic quarry site from the Tibetan Plateau, and to crystalline head scarps in order to constrain the timing of alpine mass wasting processes will be presented.

References:

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