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The potential of thermoluminescence from basalt for relative and numerical dating of volcanic eruptions

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Chronometric dating of Holocene basalts or basalt-like volcanic rocks is often challenging by means of the Ar/Ar technique due to insufficient concentrations of radiogenic Ar. The luminescence signal of basalt is believed to be dominated by its feldspar components; the athermal luminescence signal loss over time (anomalous fading) of these components results in age underestimation. However, there appears to be a relationship between the thermoluminescence (TL) signal of bulk basalt samples and their age, which could be exploited for chronometry. May (1977) established a functional relationship between test-dose and dose-rate normalised TL and age for Hawaiian alkali basalt, whereas Sears et al. (2017) used the TL dose sensitivity of basalt from the Eastern Snake River Plain (Idaho, USA) for this purpose. In both cases, the TL emitted is attributed to plagioclase. Such an approach of relative dating of basalt would be valuable for exploring the temporal dynamics of (geologically recent) volcanism on Earth, but also on other planets (e.g., Mars). Furthermore, if independent time markers are available, a calibration curve for one specific volcanic field with homogeneous lava composition could be developed, onto which basalt from eruptions of unknown age can be projected.
The aim of this contribution is to test the potential of this approach by investigating the TL of basalt and basalt-like samples from mid-ocean ridge and intraplate volcanic settings, for which an independent age estimate is available. The age of the various types of studied basalt covers not only the Holocene period but extends back to $\sim$180 Ma. Although integrated signals of regenerated TL (following a fixed laboratory β-dose) show considerable scatter between aliquots and samples, there exists a dependence between signal strength and basalt age for both mid-ocean ridge and intraplate basaltic lava flows. Furthermore, it will be explored how TL signals can be normalised to reduce scatter in the age-TL relationship and if undated eruptions can be assigned a relative or numerical age estimate.

References

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