Exploring the application of IRSL rock surface exposure dating of archaeological stone structures in Val di Sole, Italy

CRC 806 - Our Way to Europe

Cologne Luminescence Laboratory

University of Cologne

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Introduction

Here we present **preliminary chronological data** from **infrared stimulated (IRSL) rock surface exposure dating of dry stone structures** in the Italian Alps. Direct dating of dry stone structures is challenging. Radiocarbon dating is usually not applicable to directly date such structures since no mortar was used between the rocks during construction. Thus, usually dating is restricted to archaeological layers associated with such structures. IRSL rock surface dating can potentially be used to **constrain exposure periods** recorded in surfaces of rocks which were collected from the **structure walls.** To examine this we have collected rocks from a dry stone wall in the Italian Alps.

Theoretical background

Exposure to daylight resets (bleaches) the IRSL signal in feldspar minerals in rocks. Sohbati et al. (2011) presented a model:

$$L(x) = L_0 e^{-t_e \overline{\sigma \varphi_0} e^{-\mu x}}$$

where luminescence intensity L at depth x is dependent on the saturated luminescence intensity (L_0), the exposure time (t_e), the photoionisation cross section (σ), the light-flux at the rock surface (φ_0), and the light attenuation of the lithology (μ). Thus, the IRSL intensity should be decreasing with depth as the exposure time increases.

Using this rationale, Sohbati et al. (2012) demonstrated that exposure ages for rock surfaces with unknown t_e can be calculated by constraining $\sigma\varphi_0$ in rock surfaces from the study site, for which the t_e is known. In this study, we use surfaces which were exposed during fieldwork, and collected one year later.

Study site

The **study site is located at ~2300 m elevation** in Val di Sole, Trentino, in the Italian Alps. This upland area has been used for **pastoralism** since the **Early Bronze Age**. Dry stone structures were constructed in the pastures, including **large enclosure complexes**, which were used to house livestock. The **dates of construction** for these structures are **generally not known**. Excavations from one large enclosure – **MZ005S** – indicate use during the **Renaissance** (Carrer & Angelucci, 2013). The samples presented in this poster were collected from another enclosure – **MZ001S** (Fig. 1) – for which a recovered potsherd indicates that the enclosure was in use during the **mid-19th century** (Dell'Amore, 2014/2015).

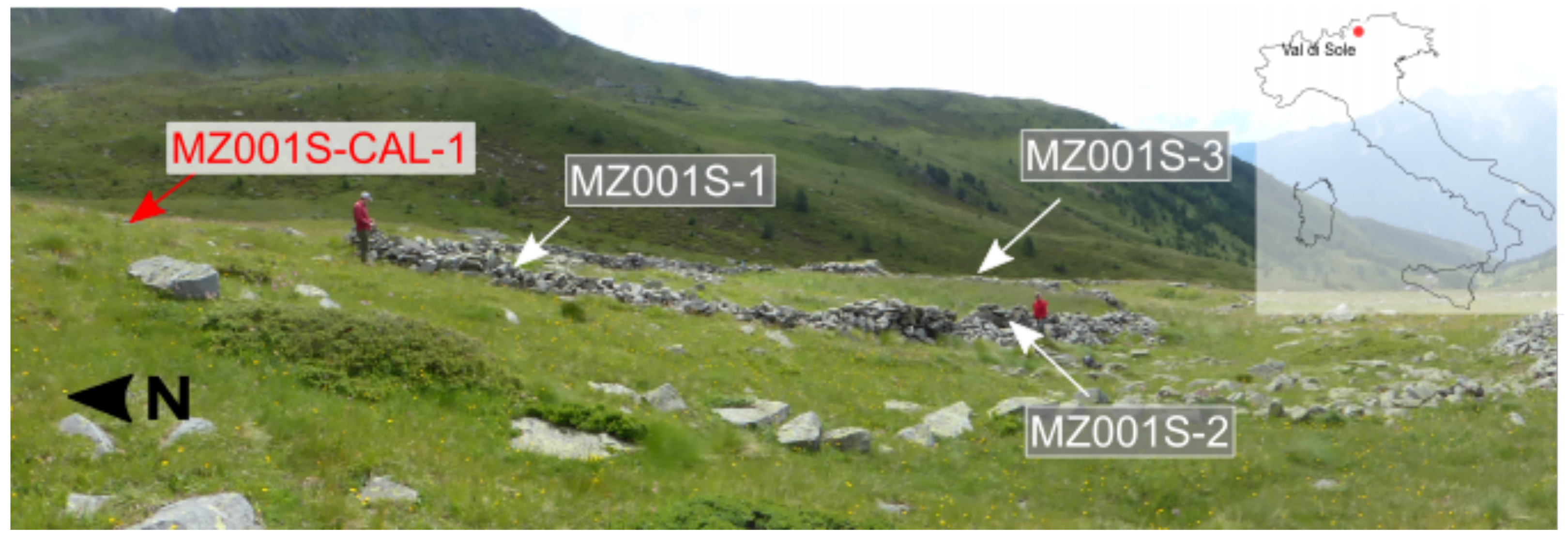

Fig. 1: Enclosure complex MZ001S. Samples MZ005S-CAL, MZ051S-CAL were collected from an adjacent valley. Photo: Diego Angelucci, 2018.

Methodology

Cores were extracted and sliced during red light conditions (Fig. 2).

The IRSL intensity was measured in a Risø TL/OSL readers at 50 °C for 300 s, following a 100 s long preheat at 180 °C. The IRSL intensity of each slice was sensitivity corrected by measuring the IRSL intensity following a beta test dose of ~17.4 Gy.

The global $\sigma\varphi_0$ from the calibration surfaces, and the subsequent t_e from enclosure surfaces were fitted with *R version 3.6.1*.

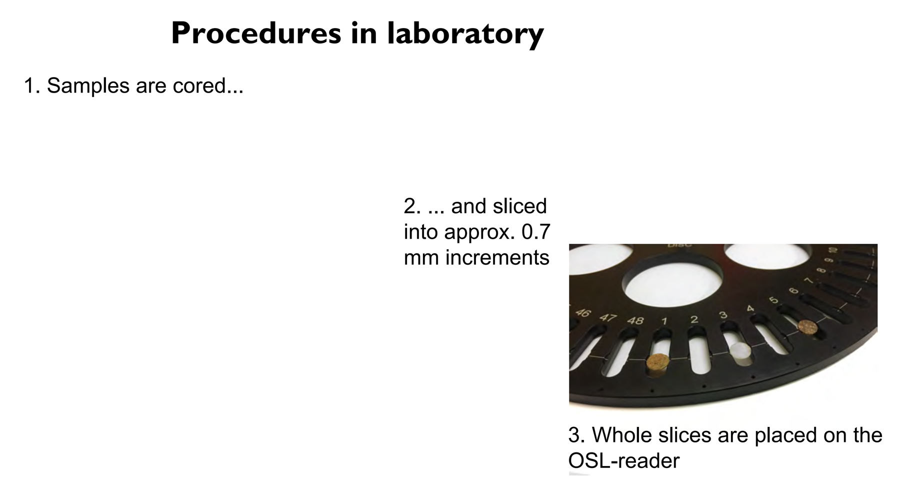

Fig. 2: The workflow for preparing slices for measure-ments.

IRSL-depth profiles and preliminary ages

All calibration surfaces have been bleached (<1 % residual signal) in the outer 0.5 mm (Fig. 3). **MZ001S-CAL-1** reaches saturation at **2 mm** depth, and **MZ005S-CAL** and **MZ051S-CAL** reach saturation at 4-5 mm depth.

The IRSL signal in the surfaces of the rocks from enclosure MZ001S (Fig. 4) is bleached to ~ **3.5 mm** and **7 mm** of depth in **MZ001S-1** and **MZ001S-3**, respectively. At **no depth** in **MZ001S-2** has the IRSL signal not been reset below 1 % residual signal.

The fitted preliminary ages are **8 ± 5**, **0.1 ± 0.1**, and **100 ± 49** years of exposure for **MZ001S-1**, **MZ001S-2**, and **MZ001S-3**, respectively.

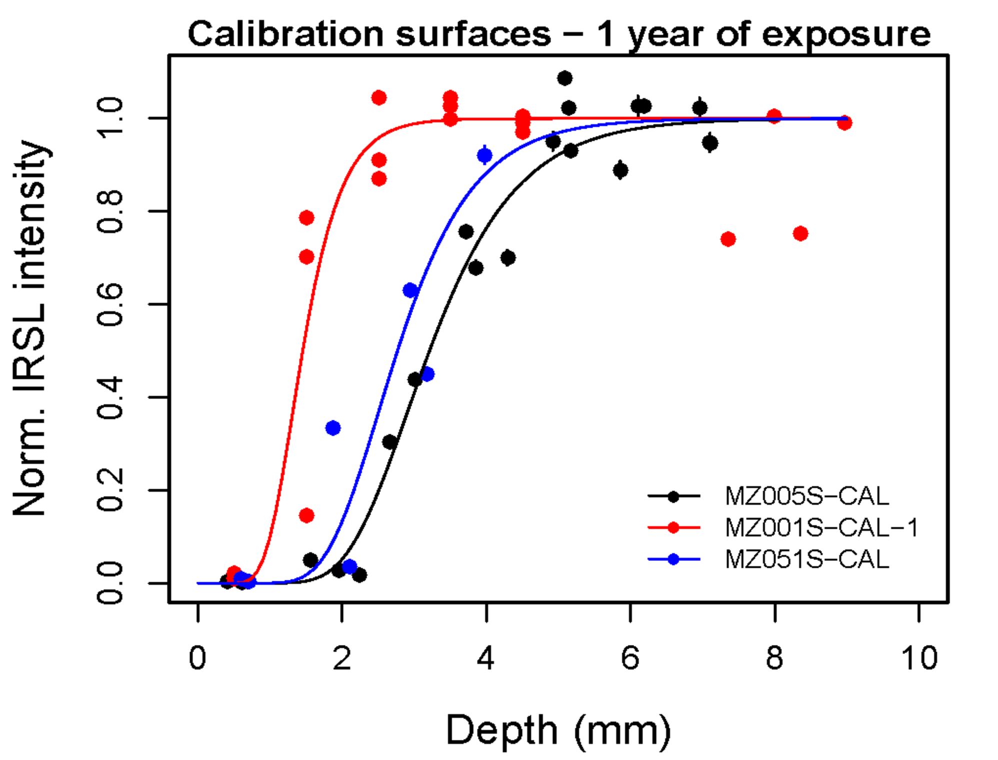

Fig. 3: Global fitting of $\sigma\varphi_0$ for the calibration surfaces. All surfaces were exposed for 1 year. μ was left unconstrained for each surface during fitting.

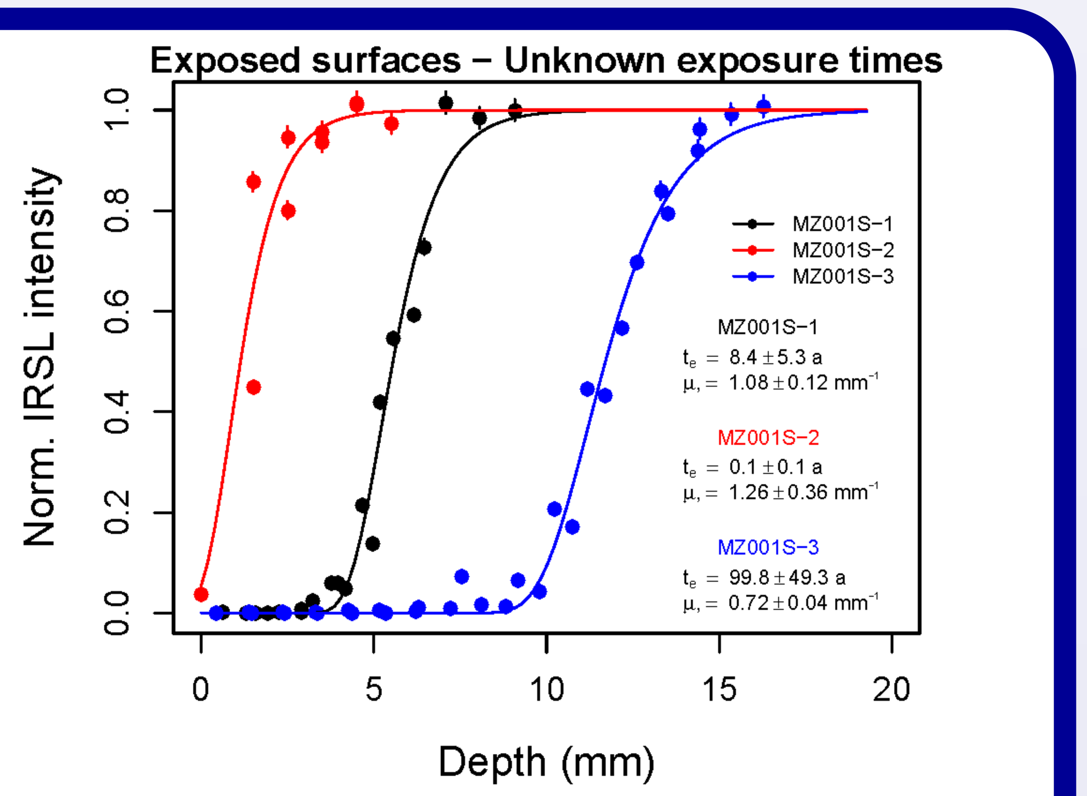

Fig. 4: Fitting of preliminary t_e for the exposed surfaces from MZ001S. The IRSL-depth profiles were fitted using the global $\sigma\varphi_0$ from the calibration surfaces. μ was left unconstrained for each surface during fitting.

Interpretation and summary

- IRSL-depth profiles in exposed rocks from dry stone structures are investigated.
- **Calibration surfaces** (1 year of exposure) indicate that the IRSL signal in the Val di Sole gneisses will **bleach with depth during exposure**.
- **Ages from 2 out of 3 surfaces** from the dry stone enclosure MZ001S severely **underestimate** the expected **minimum age** of the enclosure. It is currently unclear if this age discrepancy is due to erosion of the surfaces, which removes part of the bleached front (e.g. Sohbati et al., 2018), or due to heterogeneity in the distribution of opaque minerals, which results in small scale spatial increases in light attenuation within the rocks (e.g. Meyer et al., 2018).
- One rock – MZ001S-3 – provides a more **realistic minimum age** for enclosure MZ001S. However, the uncertainty of this date is high. Increased precision could be achieved by increasing the number of measured slices.

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