Post-depositional alterations of tephra layers as indicators for palaeoenvironmental conditions

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Introduction and study area

Tephra layers are widely used as isochronous marker horizons in Quaternary sciences. In this study, we concentrate on the depositional milieu as well as post-depositional alterations of a thick (ca. 0.8 m) tephra layer, originating from the dacitic Ciomadul (Csomád) volcanic dome complex (CVDC). This tephra layer is intercalated in the polygenetic sediment section Bodoc, approx. 20 km south of the volcano. The section is located on a alluvial fan in the Olt valley in southeastern Transylvania, Romania, and consists of sediments of fluvial, alluvial, aeolian and colluvial origin.

The tephra is sitting on a clayey floodplain sediment, containing vegetation imprints. The ash shows striking reworking features such as redoximorphous overprinted layers as well as remnants of periglacial dynamics.

Here, we present a multi-proxy study, using geochemical and grain size analyses, supported by field oberservations in order to reconstruct the palaeoenvironment using the tephra layer. The first results are presented together with challenges in chronology.

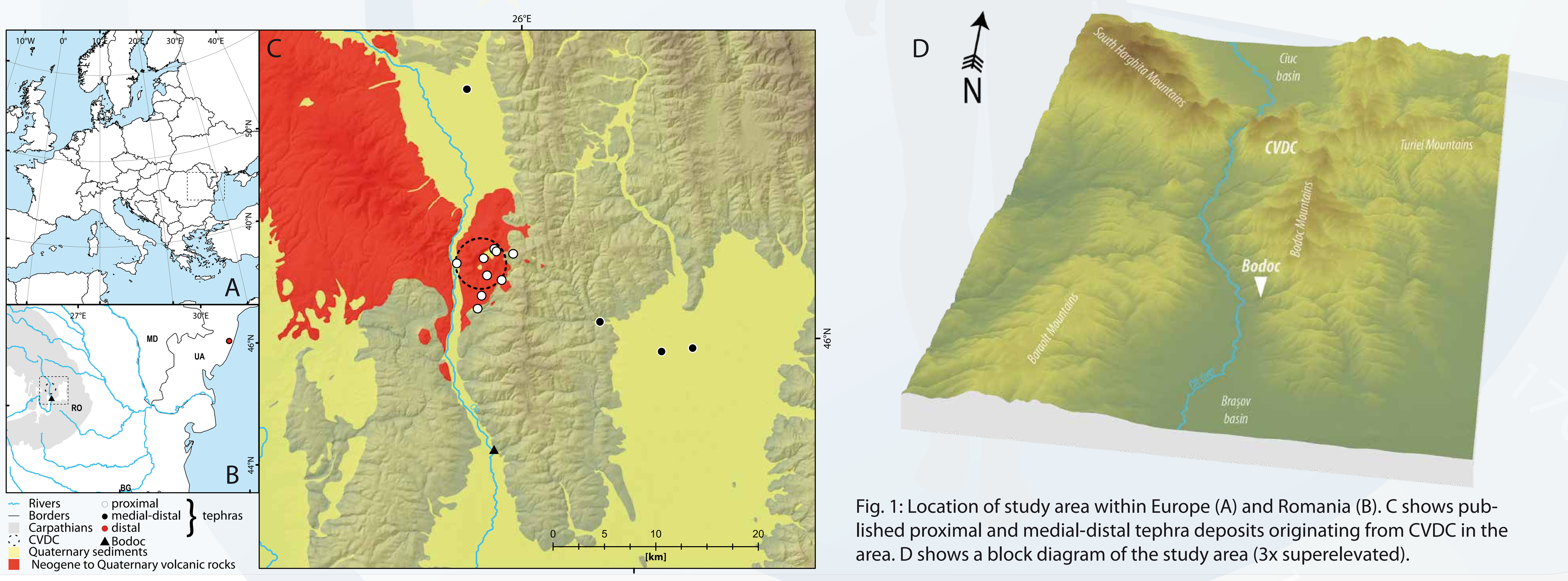


Fig. 1: Location of study area within Europe (A) and Romania (B). C shows published proximal and medial-distal tephra deposits originating from CVDC in the area. D shows a block diagram of the study area (3x superelevated).

Stratigraphy

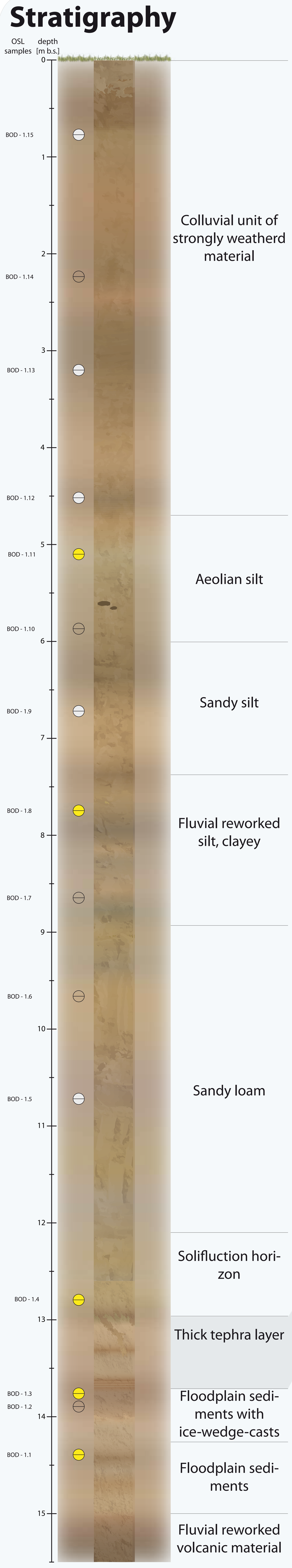


Fig. 9: Profile sketch with lithological obeservations from the field, as well as OSL samples (yellow: measured, grey: in measurement)

Depositional milieu

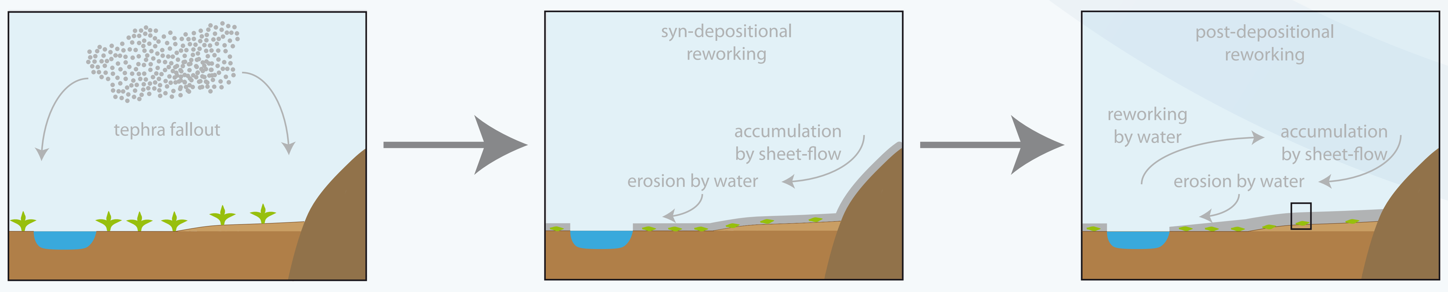


Fig. 2: Schematic sketch of the depositional setting of the tephra in a simplified cross section looking from the south.

Fig. 3: Photos of the vegetation imprints (A) and the laminated tephra (B).

Post-depositional alterations

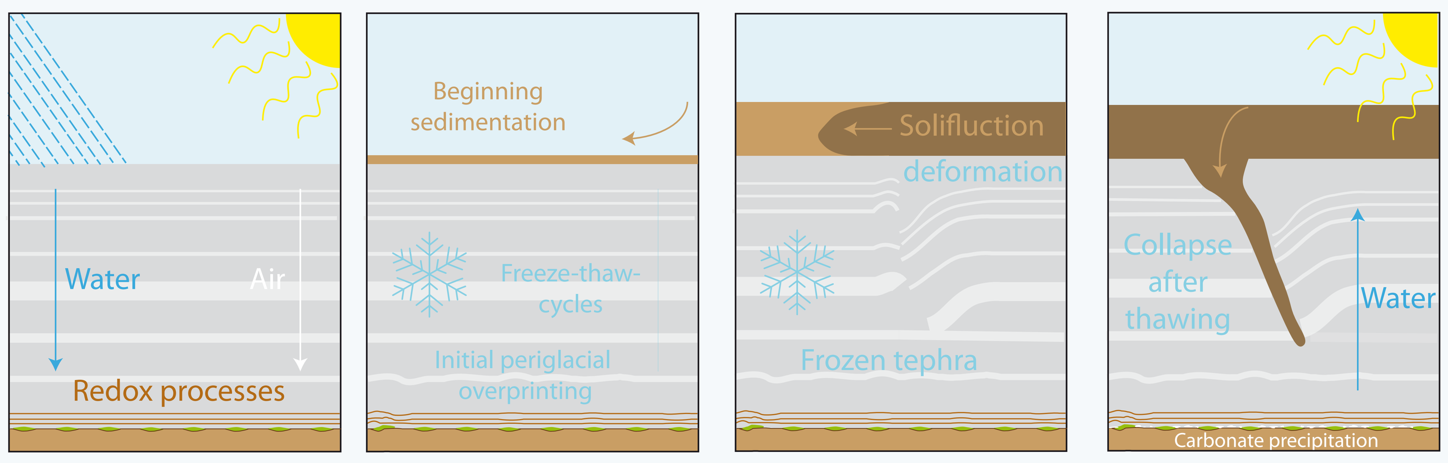


Fig. 4: Schematic sketch of the post-depostional alterations of the tephra layer.

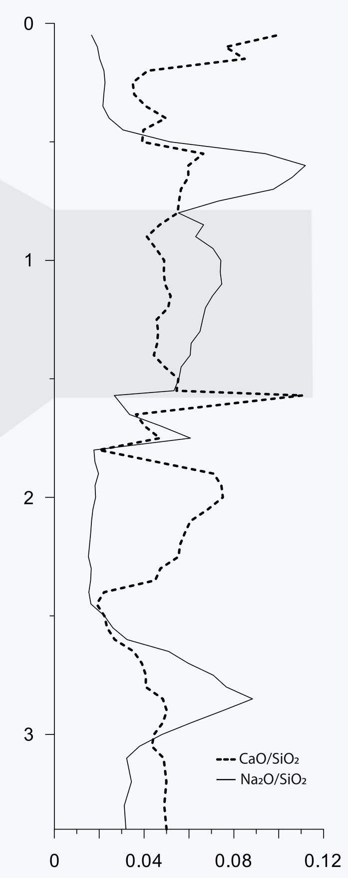
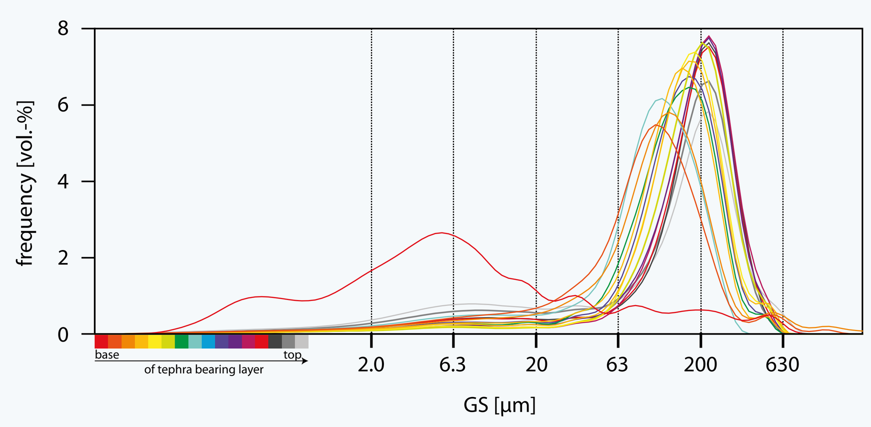


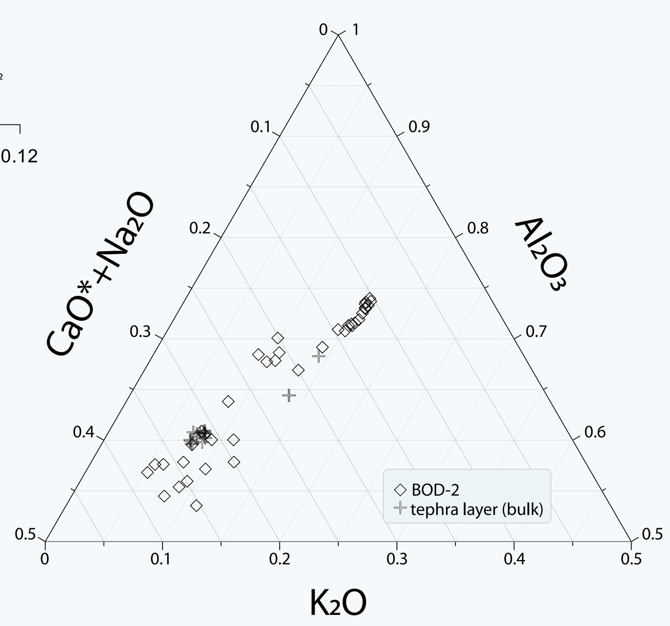
Fig. 5: Photo of the altered tephra layer in sub-profile BOD2. Cryoturbate features as well as collapses are marked with white lines, vegetation imprints with green lines. Note the ice-wedge-casts below the tephra.

Fig. 6: Depth plot for the CaO and Na₂O for sub-profile BOD2. Note that CaO is enhanced at the lower contact of the tephra, whereas Na₂O was precipitated at the top due to evaporation.

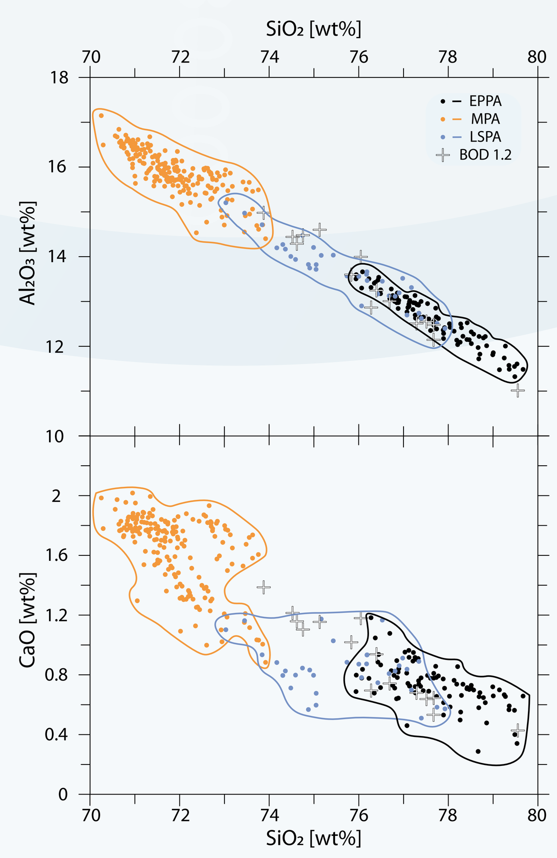
Fig. 7: Grain size distributions for bulk sediment samples taken from the tephra layer. Note the clay layer at the base, as well as the lamination of several sand sized fractions.

Fig. 8: A-CN-K ternary plot according to [2]. Not that the two outliers of the bulk tephra samples belong to the samples taken in the clay layer at the base.





Chronological challenges



Tephrostratigraphy

Geochemical fingerprinting of tephra glass shards for CVDC eruptions. Although the eruptive history can be divided in three phases (EPPA: Early Phreatomagmatic + Plinian Activiy, MPA: Middle Plinian Activity, LSPA: Late St. Ana Phreatomagmatic Activity), their geochemical fingerprints overlap. So the investigated tephra can not be clearly connected with one of these phases.

Fig. 10: Bi-variate plots for glass compositonal data for Ca, Al and Si. The colours represent the different eruption phases distinguished by [1], where the crosses show glass chemistry data for the investigated tephra layer (BOD 1.2).

IRSL-dating

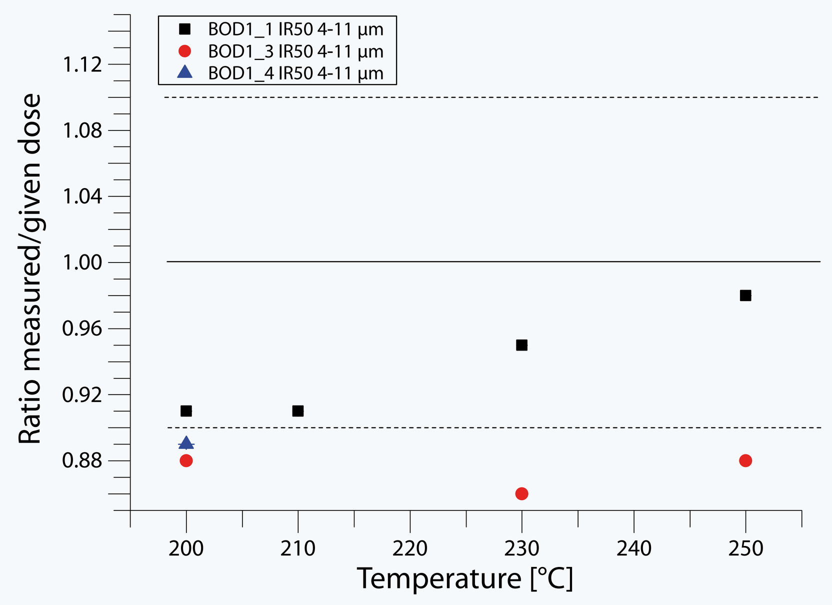


Fig. 11: Dose Revovery Tests for the OSL samples BOD 1.1, 1.3 and 1.4.

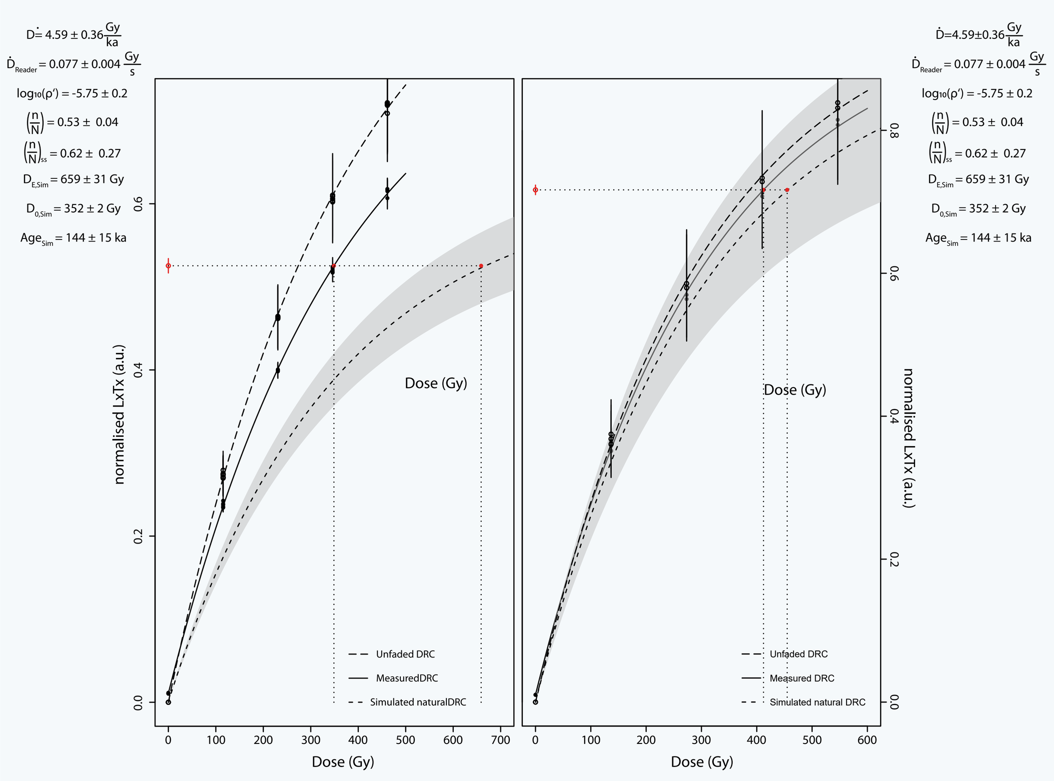


Fig. 12: Dose Response Curves (DRC) for BOD 1.1 (left) and BOD 1.4. Note that the sample is in saturation. Due to the stratigraphic position of the samples, the simulated ages do not give chronological control.

Conclusions

The thick tephra layer found in Bodoc is a good example that volcanic ashes can be used to reconstruct the palaeoenvironment. In Bodoc, we can suggest a succession of rather temperate with very harsh, periglacial conditions after the tephra fallout. Unfortunately, no age model could be established yet, but dating of the tephra itself using U/Th(Pb)-dating is planned.

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