Bringing light into the darkness – Chernozem evolution in Central Germany clarified by single-grain luminescence data

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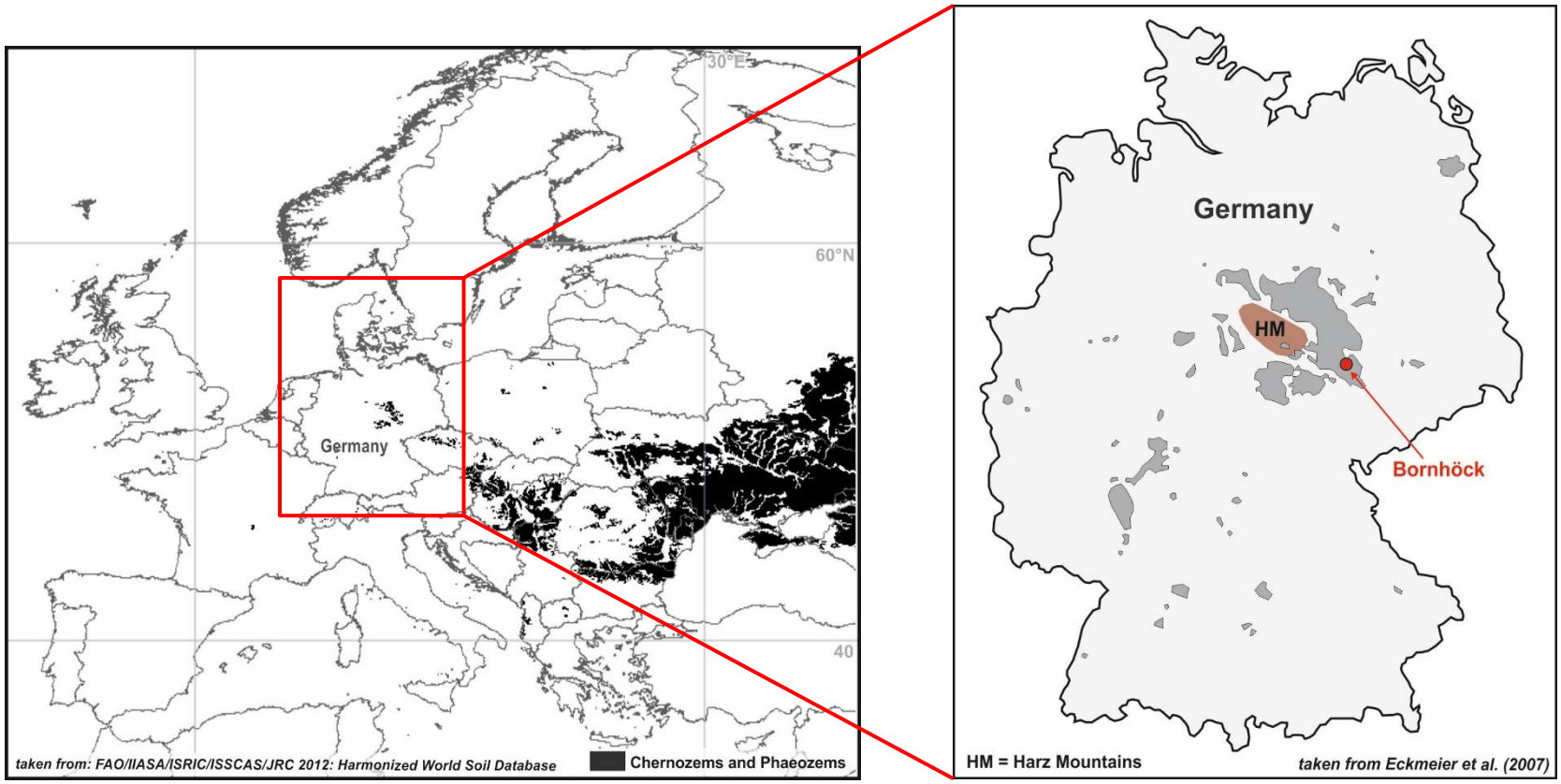
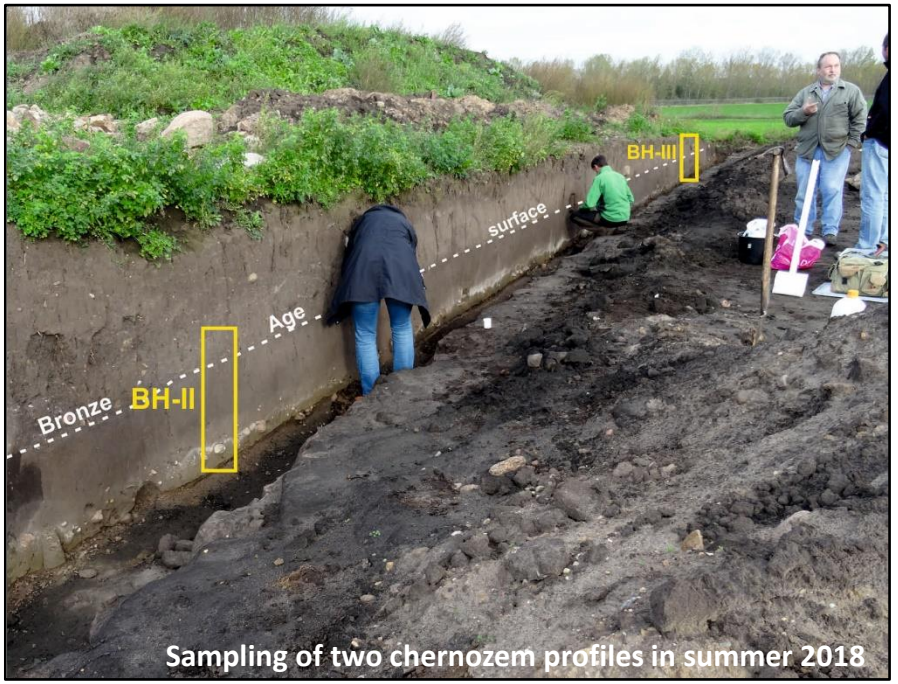
Central German chernozems



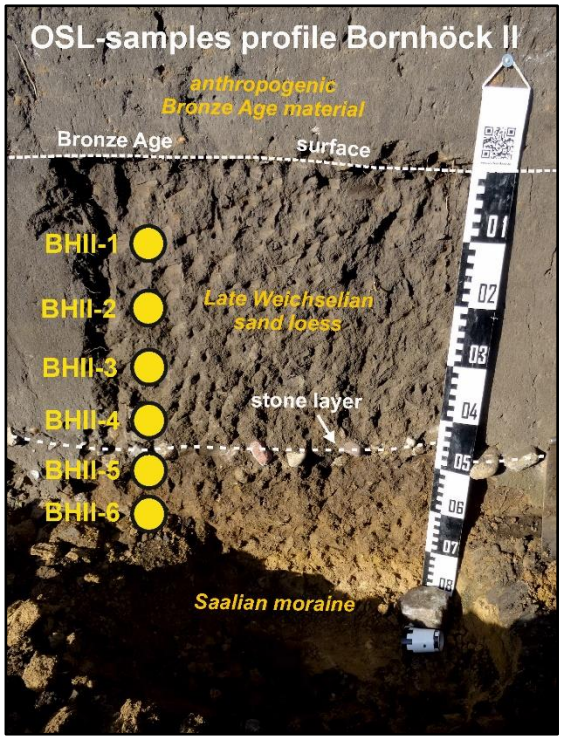
- Chernozems are among the most productive soils in the world, and often show long records of intensive human land use.
- Central Germany in the rain shadow of the Harz Mountains is the westernmost area in Europe with a continuous distribution of chernozems over larger areas.
- However, many important aspects regarding chernozem formation – e.g. its timing and the question whether natural or human factors were dominant for their formation - are still poorly understood so far (Eckmeier et al. 2007).

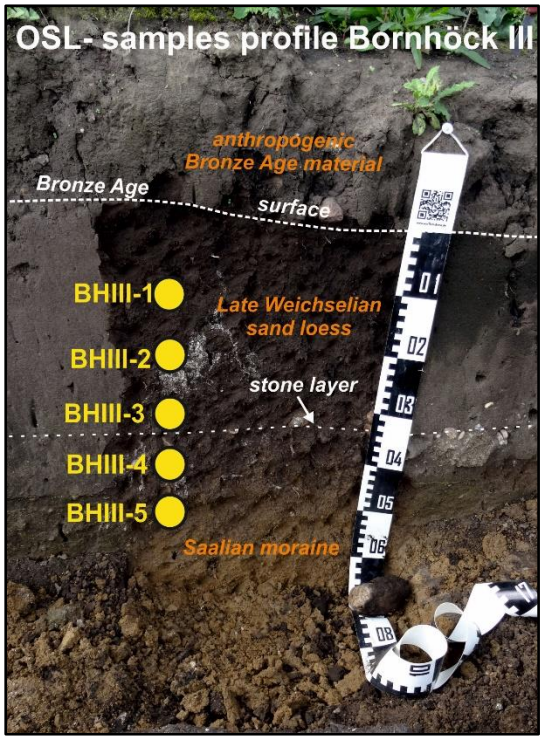
In Central Germany a chernozem was fossilized by the Early Bronze Age burial mound Bornhöck ca. 3.8 ka ago



- The burial mound Bornhöck was constructed with a diameter of 65 m and a height > 10 m by the Early Bronze Age Unětice-culture ca. 3.8 ka ago and was destroyed ca. 100 years ago.
- The Bornhöck fossilized a chernozem for almost 4.000 years from subsequent soil forming processes, and therefore offers the unique possibility to investigate the properties of these soils in Central Germany 3.8 ka ago.
- During the last years, the Bornhöck was excavated by the State Office for Heritage Management and Archeology Saxony-Anhalt. In this context, two chernozem profiles were investigated during summer 2018 (BH-II and BH-III)

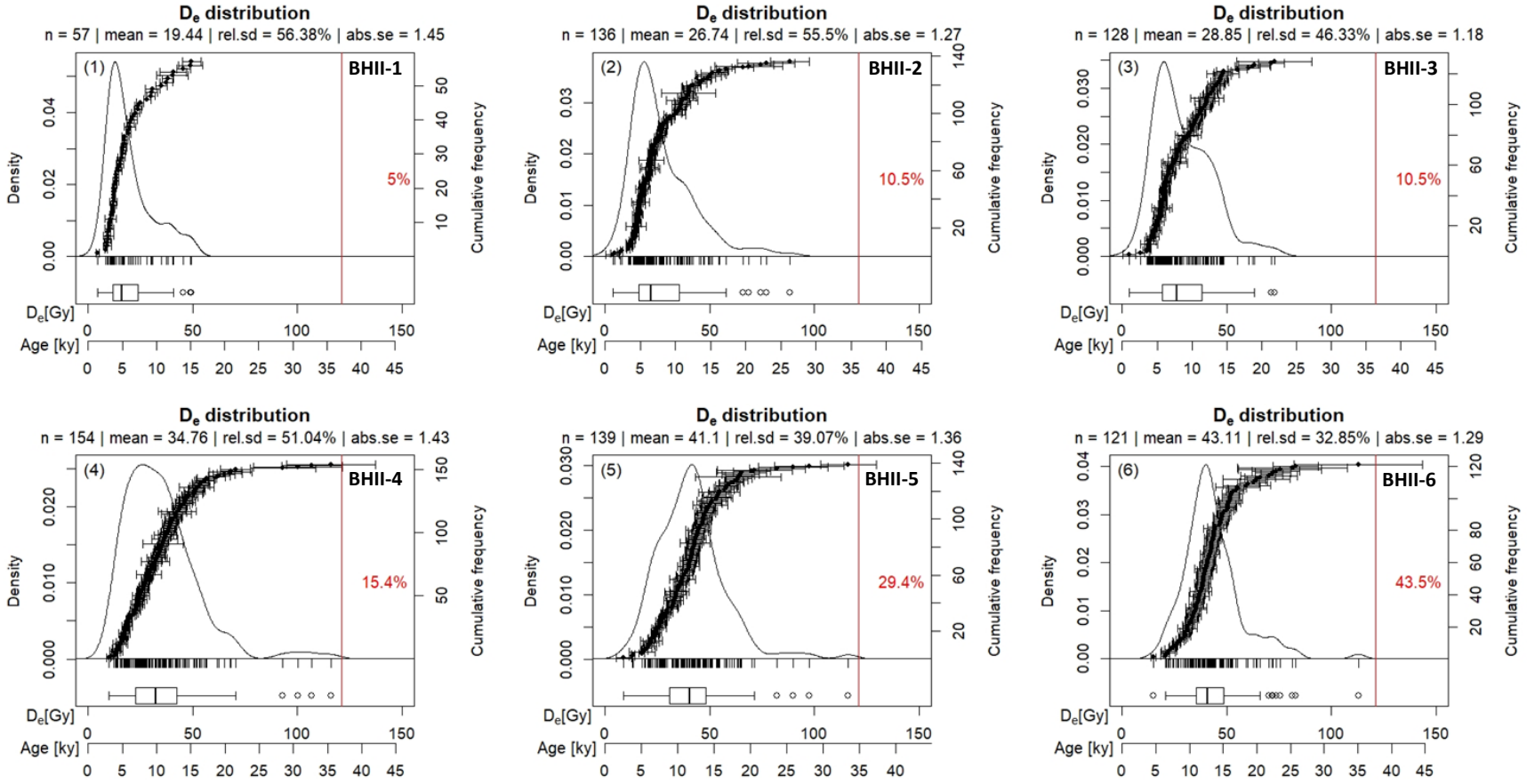
Single grain feldspar luminescence dating of two Chernozem profiles





- The chernozem is mainly developed in a Late Weichselian sand loess layer, but also overprints the upper part of the underlying Saalian moraine. Both units are separated from each other by a stone layer.
- Six luminescence samples were taken from profile BH-II below the center, and five samples from profile BH-III located below the northern margin of the Bornhöck.
- **Novel feldspar single-grain luminescence analyses should give answers to the following research questions:**
  - When did the formation of Central German chernozems start and stop?
  - Is an influence of prehistoric ploughing visible in the soil profiles?
  - What were the soil reworking rates in Central German chernozems?

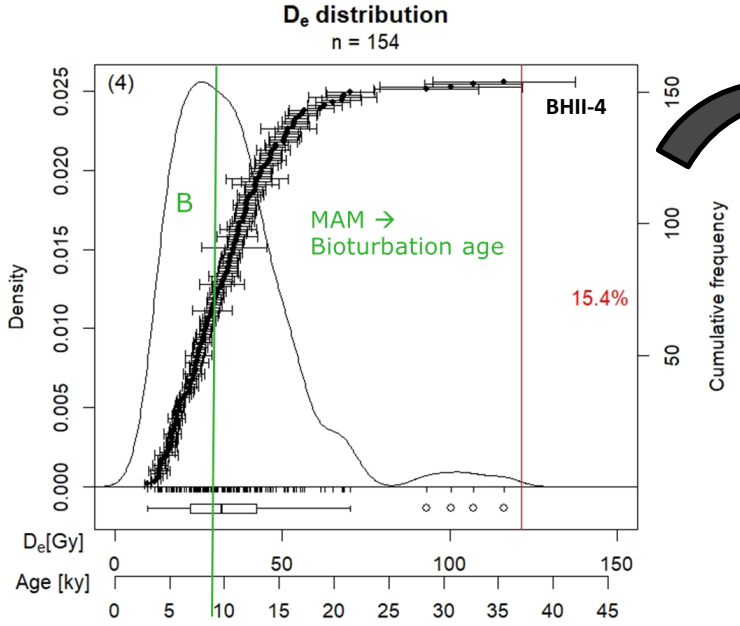
Resulting feldspar single-grain D_e distributions of six samples from profile BH-II[1]



- Broad and complex single-grain D_e distributions → associated to complex depositional/reworking history of samples
- Number of very old grains (% in red) increases with depth → deposition of Saalian moraine presumably during MIS6
- Samples show young population → presumably associated to soil mixing (bioturbation) → proxy for Chernozem formation

[1] *D_e distributions for profile BH-III are not shown here, however, corresponding distributions are comparable to those of BH-II.*

MAM single-grain D_e population associated to bioturbation age

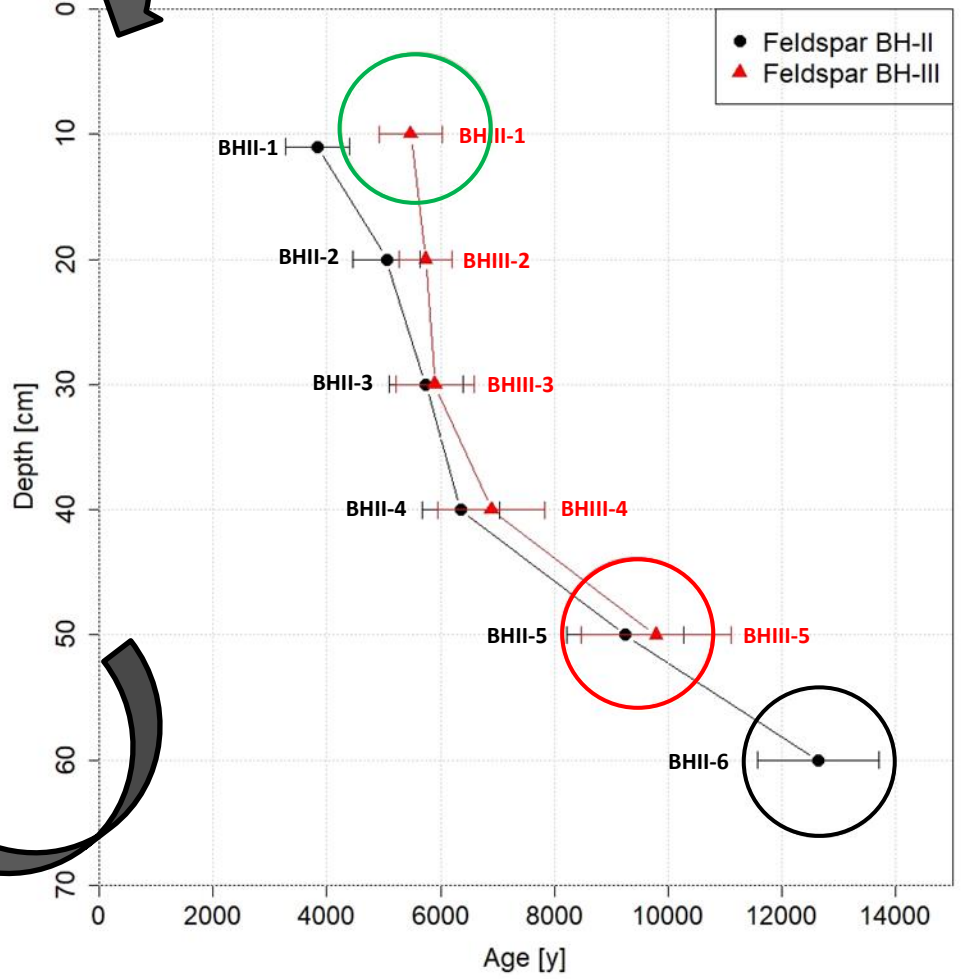


Cease of bioturbation ~ 5.0 to 5.5 ka

Latest start of bioturbation since ~ 9.0 to 10.0 ka

Early bioturbation or vertical displacement of YD grains

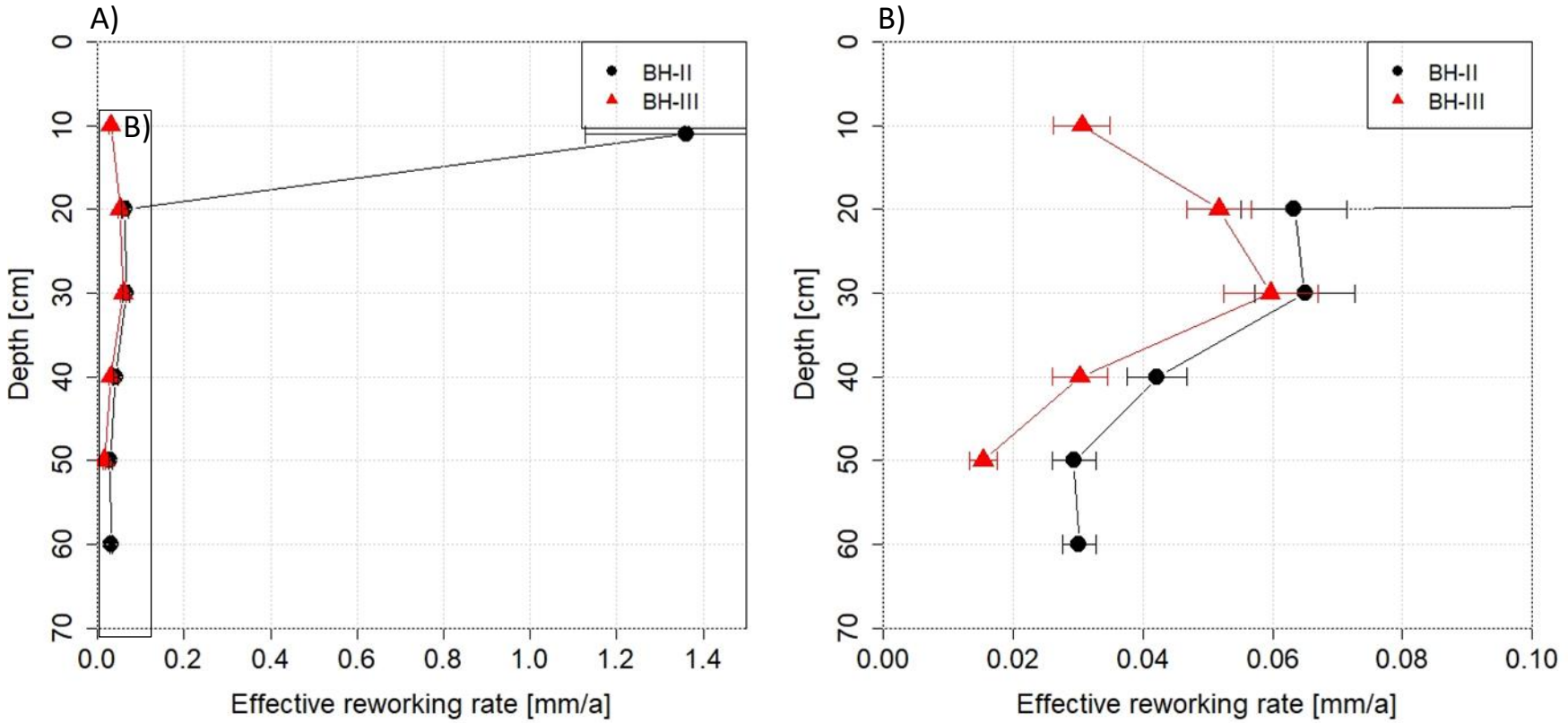
Resulting bioturbation age-depth profiles



Effective soil reworking rates according to Reimann et al. (2017; Quaternary Geochronology 42, 1-14)

→ SR_{eff} = soil depth / bioturbation age[1] * fraction non bioturbated grains

[1]*corrected for age of burial mound*



For the top sample of BH-II the soil reworking rate is an order of magnitude higher (~1.3 mm per year) most likely associated to more intensive anthropogenic ploughing of the soil. This is in line with field observations that this sample was taken from an Early Bronze age palaeo Ap horizon. The other samples show reworking rates between ~0.02 and 0.06 mm per year, which is in the normal range for natural bioturbation (e.g. Reimann et al. 2017).

Conclusions

- Feldspar single grain luminescence produces meaningful results in studying buried Central German chernozems
- Start of natural intensive bioturbation at latest since 9.0 - 10.0 ka
- Natural intensive bioturbation ceases at around 5.0 - 5.5 ka
- Profile BH-II shows signs of small-scale prehistoric ploughing (upper ~10 cm) → effective soil reworking rates one order of magnitude larger than natural reworking associated to bioturbation.