USING HIGH-RESOLUTION PORTABLE OSL (POSL) PROFILING TO CHARACTERIZE HOLOCENE BEACH RIDGES AT LAKE SCHWERINER SEE (LSS), NE-GERMANY

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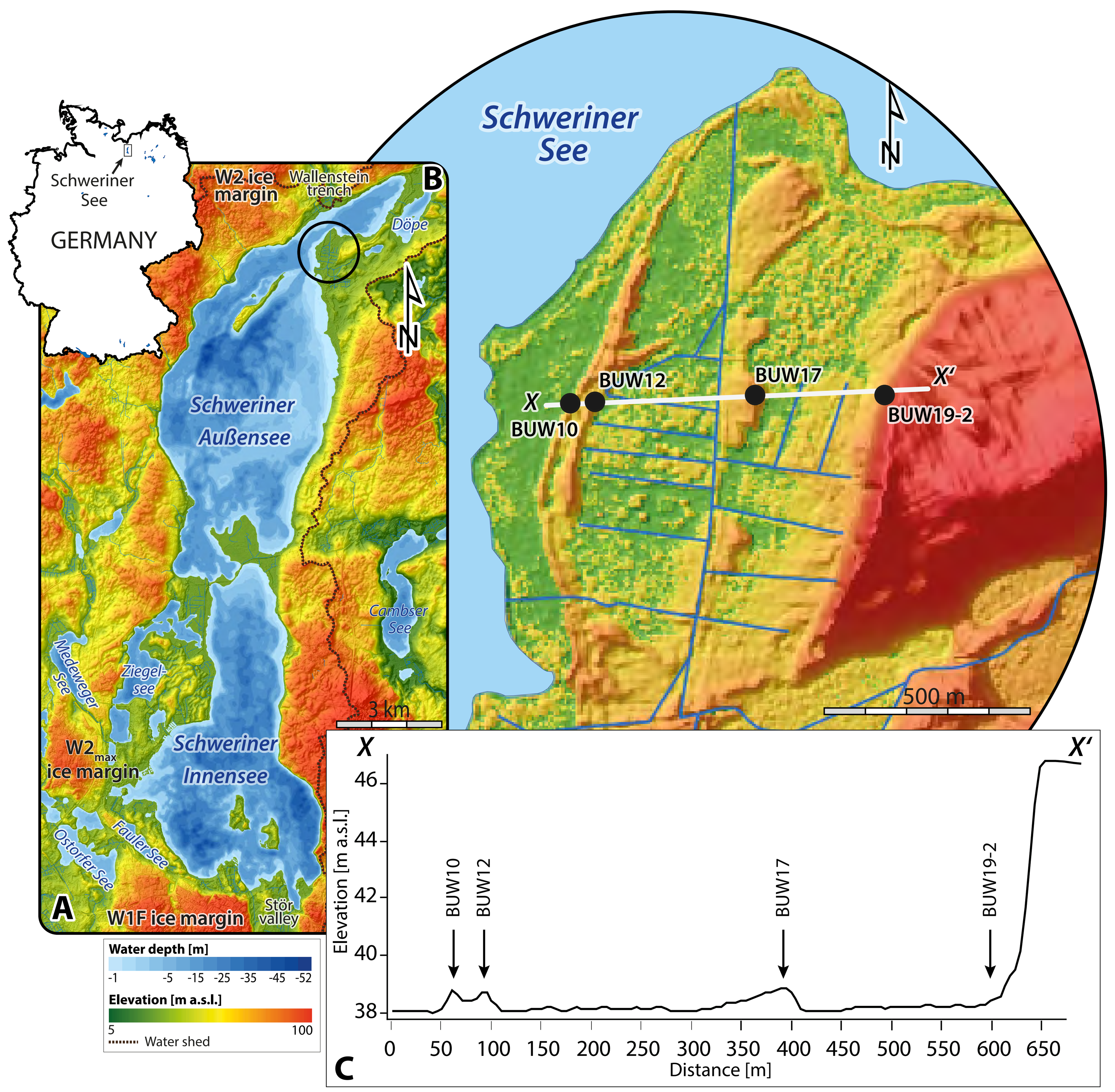
INTRODUCTION AND MOTIVATION

Beach ridges are promising geoarchives to study shifts in lake shore e.g., as evidence for variations in lake level or littoral sediment budget. Furthermore, detecting subaerial paleo-shorelines, their elevation, inner structure and age helps to quantify lake-level variations. If the bottom and the top are dated, the duration of elevated lake levels can be derived. In this study we investigated beach ridges and littoral sediment stratigraphies at Lake Schweriner See (LSS), NE-Germany, to reconstruct phases of lake-level highstands. We applied a combined approach of sedimentological methods and continuous wave Portable OSL (POSL) measurements to

1) characterize beach ridge development using optically stimulated luminescence,
2) investigate if it is possible to differentiate between depositional phases inside beach ridges (even if lithology and sedimentology showed no explicit evidence of multiphase development) and
3) examine if depositional phases detected by luminescence can be also found in parameters obtained from a classic multi-proxy sedimentological investigation and pedologic features.

RESEARCH AREA

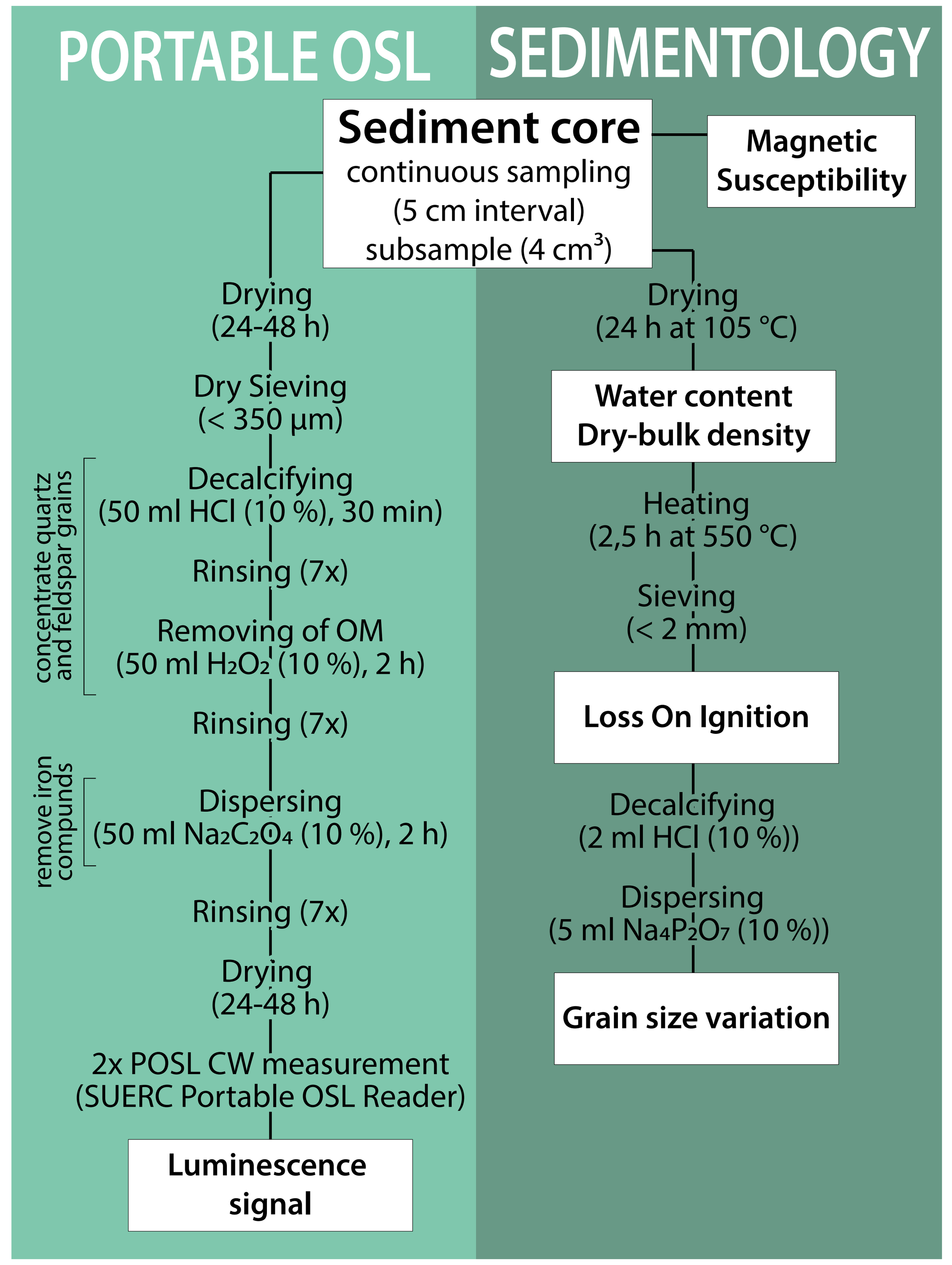
LSS formed after the LGM in the Western Mecklenburg Lake District (Westliche Mecklenburgische Seenplatte). Since the Weichselian Late glacial its lake level had distinct fluctuations, which have not been determined in age and extend yet (Lorenz et al. 2017). The shore is mostly surrounded by cliffs and only few siltation areas developed (Fig. 1), where paleoshore landforms such as beach ridges are preserved. We investigated the northeastern lakeshore of LSS, where a succession of beach ridges is developed. These landforms have a distance of up to 700 m away from the recent shoreline and are elevated up to 1.5 m above today's mean lake level (~37.8 m a.s.l.). In the flat area between the beach ridges fen soils accumulated.



▲**FIG. 1**: *A) Location of LSS in Germany and overview (Digital Terrain Model (5 m resolution) and Water Depth) of LSS. The lake is located in the western part of the Mecklenburg Lake District (see inset). B) Investigation area "Buerwischen" is located in the northeastern part of LSS (see circle in A). Geomorphological features were investigated using sediment cores as well as soil pits (black dots). C) The transect x-x' shows the elevation of the investigated subaerial lacustrine landforms.*

References:
Lorenz S, Adolph M-L, Schult M, Cerný A, Besler C. (2017): Der Schweriner See - ein Blick in die Landschaftsgeschichte. - In: Ruchhöft, F. (ed.): Zvarin - Schwerin: Von der Inselburg zur Residenz. Landesamt für Kultur und Denkmalpflege Mecklenburg-Vorpommern: Schwerin; 129–141.
Sanderson, D. C. W. and Murphy, S. (2010): Using simple portable OSL measurements and laboratory characterisation to help understand complex and heterogeneous sediment sequences for luminescence dating, Quaternary Geochronology, 5, 299–305.

METHODS



▲**FIG. 2**: *Methods used in our approach. The SUERC Portable OSL Reader is described in Sanderson and Murphy (2010).*

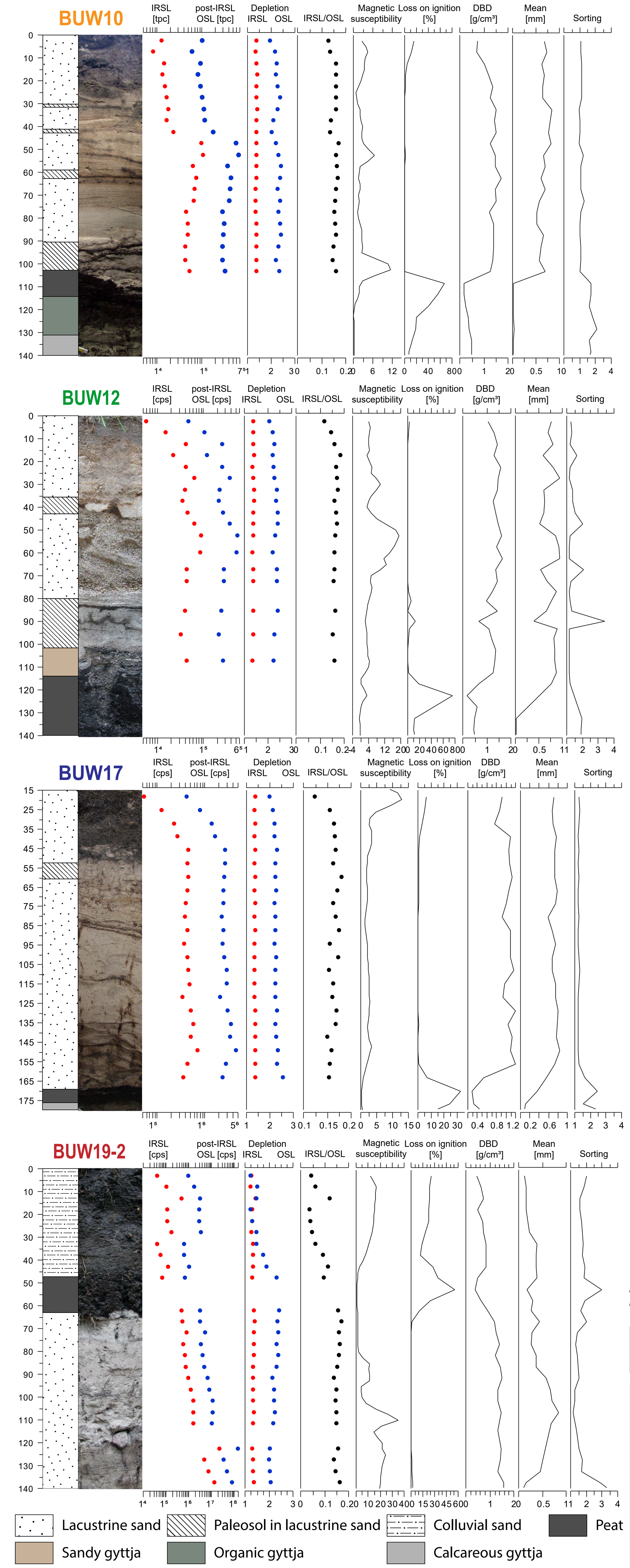
▼**TAB.1**: *Protocol used to measure total photon counts (cts) of both IRSL and post-IRSL-POSL. Both values were measured during the same run using the same sample. All measurements were performed as double determination. Final values were obtained by calculating a arithmetic mean between both runs.*

Step	Process	Time (sec)
1	Dark Count	15
2	Stimulation by Infrared LED (IRSL)	30
3	Stimulation by Infrared LED (IRSL)	30
4	Dark Count	15
5	Stimulation by Blue LED (post-IRSL OSL)	30
6	Stimulation by Blue LED (post-IRSL OSL)	30
7	Dark Count	15

OUTLOOK

1) Coarse grain full SAR-OSL dating to determine the age of the beach ridges to reconstruct lake-level maxima.
2) Guided sample selection for full SAR-OSL dating based on POSL results.
3) Radiocarbon dating of all beach ridges to gain independent age control
4) Ground penetrating radar analysis of the beach ridges to confirm sedimentological units and better understand the depositional environment and processes.

RESULTS



STRATIGRAPHY: The beach ridge stratigraphies (Fig. 3; BUW10, BUW12 and BUW17) are characterized by lacustrine silty and calcareous sediment in the lower parts overlain by strongly consolidated sedge gyttja and peat. Above the gyttja-peat sequence coarse-grained sandy beach-ridge sediments are deposited. Pedologic features such as paleosoil layers within the beach ridges indicate a multiphase beach-ridge development. In contrast, core BUW19-2 has lacustrine sandy sediment in the lower part overlain by decomposed peat. On top at least two colluvial layers were deposited. Already lithologies indicate a dynamic lake-level at the silting-up plain "Buerwischen" in the past.

BUW10 and BUW12: The two youngest beach ridges are deposited in spatial proximity to each other (Fig 1B). Considering errors IRSL and post-IRSL-OSL signals of both beach ridges are comparable (Fig. 4) hinting towards a similar age of formation. However, there is a bottom up decrease in POSL in the lower part of the sequence.

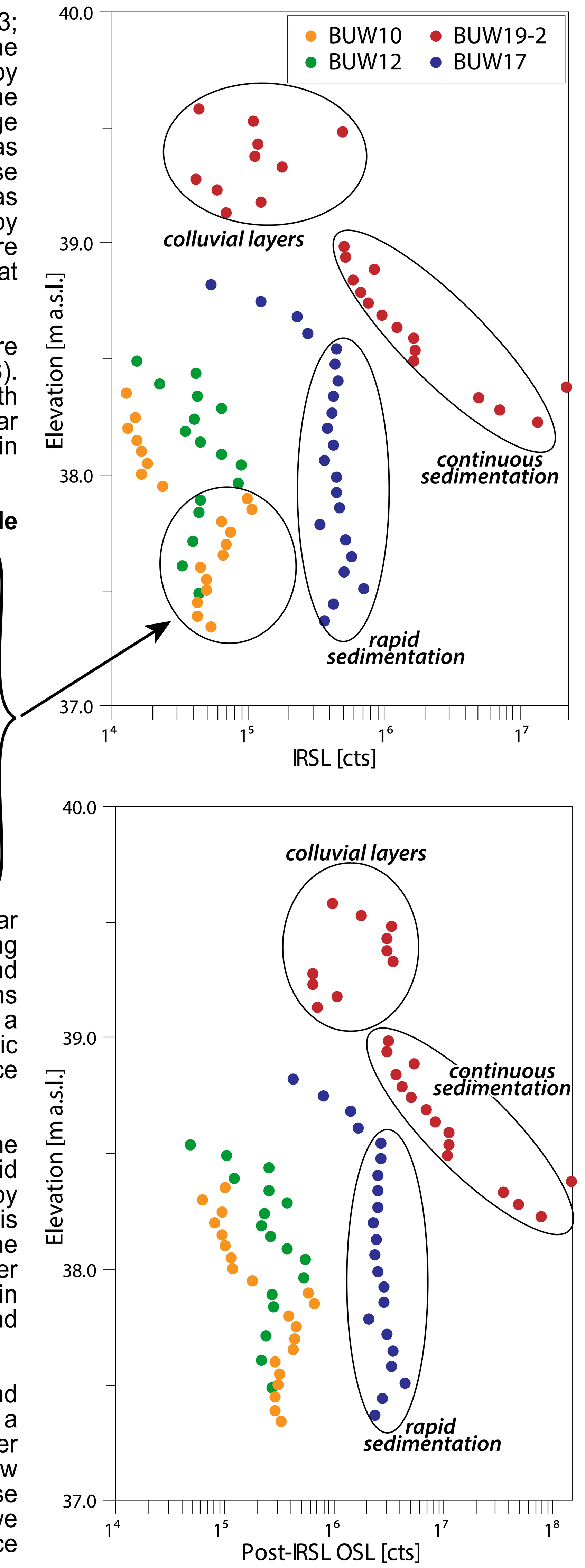
POSL signals might indicate **two different possible depositional pathways**:
1) The lower part of both beach ridges was deposited at the same time as the IRSL and post-IRSL OSL values are very similar. Afterwards beach ridges were deposited on top. Though, this does not explain the increase from bottom to top for BUW10.
2) Beach ridge BUW12 was deposited first. Afterwards some sediment was reworked during the formation of BUW10 probably with incomplete bleaching e.g., during a storm resulting in an inverted luminescence signal with depth. Those reworked sediments formed the basis for BUW10. This beach ridge has the expected increase in photon counts with depth in the upper 50 cm (Fig. 3)

Sedimentological parameters do not indicate such clear depositional changes. Both sediment cores show differing parameters with depth (e.g., noticeable peaks in sorting and mean grain size in BUW12 in contrast to only slight variations for BUW10). The different internal structure suggests also a different formation. However, some maxima of magnetic susceptibility correlate with an increase in the luminescence signal.

BUW17: The lower part shows only slight variations in the luminescence signal with depth, which might indicate a rapid deposition. The beach ridge is macroscopically structured by gravel layers. A differentiation between those layers is suggested by the IRSL/OSL ratio but also by changes in the bulk density (DBD). The other sedimentological parameter showed nearly no changes (e.g., very similar sorting and grain size). The upper 50 cm show an increase in both IRSL and post-IRSL OSL with depth.

BUW19-2: In the lacustrine sediment below the peat IRSL and post-IRSL OSL steadily increase with depth, which indicates a continuous sedimentation. Magnetic susceptibility is higher there due to a stone layer (~120 cm). The upper 50 cm show a scattered pattern, which confirms our assumption that these are colluvial layers. Pedologically and sedimentologically we assumed two colluvial layers. However, luminescence suggests even three events of colluvial activity.

◀ **FIG. 3**: *Stratigraphic diagrams of the investigated sediment cores including the portable luminescence parameter IRSL and post-IRSL OSL, depletion for both parameter and IRSL/OSL ratio. Shown sedimentological parameter are magnetic susceptibility, LOI, DBD, mean grain size and sorting.*



▲ **FIG 4**: *Comparison of IRSL and post-IRSL OSL values of the investigated beach ridges. All beach ridges show a different behavior of the luminescence values with depth.*

CONCLUSION

Portable OSL measurements in combination with sedimentological analyses provided valuable information to characterize beach ridges in lacustrine littoral setting of (Schweriner See, NE-Germany). POSL data
- **confirm hypothesis of multiphase beach ridge development (BUW10 & BUW12), when sedimentological parameter showed no such clear indications.**
- **suggest rapid sedimentation (BUW17). Considering the error there is little to no change in the luminescence signal.**
- **help to further distinguish between more colluvial layers (more than hitherto assumed (BUW19-2) by pedological and sedimentological features).**