Filling gaps, dating clastic lake fills in the Rhine delta (The Netherlands)

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Clastic lake fills are sediment units within fluvio-deltaic successions. They essentially are fluvial deposits that filled gaps – lakes – on the floodplain. Recently, clastic lake fills have been recognized (Weerts et al. 2002) and described (Bos submitted) in the Holocene Rhine-Meuse delta. They essentially comprise organic lacustrine deposits at the bottom, overlain by clastic succession that shows a general coarsening upwards trend from clayey facies to sandy mouth bar facies. It is important to have time control on the formation of these sediments as it contributes to the understanding of floodplain aggradation and overbank sedimentation. However, clastic lake fills – other than the modern examples in the Cumberland Marshes, Canada (e.g., Smith and Pérez-Arlucea 1994) – have not been dated so far. Dating of clastic lake fills by application of 14C-dating is inappropriate, both concerning the onset and end of sedimentation. Because their lower boundary often is erosive, dating of the peat underneath clastic lake fill deposits would overestimate the age. The end of sedimentation can only be determined when the abandoned channels or relative low points on the clastic lake fill surface can be identified. However, when clastic lake fills are buried, the morphology becomes obscured, which subsequently hampers site selection. A promising alternative is OSL-analyses as it directly determines the time since burial.

Fig. 1. Study area. Indicated is the boundary of the Aetsveldse clastic lake fill – blue line – as well as the location of the OSL-samples. The background colours represent surface elevation (AHN, from Rijkswaterstaat-AGI).
We studied the Aetsveldse clastic lake fill (Fig. 1), which is located in between Abcoude and Weesp and is part of the Angstel-Vecht system in the downstream zone of the Rhine-Meuse delta. In this area time control is excellent due to the presence of a paleogeographic reconstruction (Bos et al. submitted). Moreover, due to its position near the top of the Holocene sequence, the deposits still have a morphological expression, which provided good site-selection opportunities. We collected 6 OSL samples (Fig. 1, Tab. 1). Two samples (NCL-3206026 and -27) were taken from similar settings, being distributary channel deposits underneath well-dated abandoned-channel deposits. Four samples (NCL-3206022 to 25) were collected from one core and covered the complete clastic lake fill sequence at that location. OSL-dating of samples from heterogeneous sediments is not straightforward as the dose rate highly depends on the clay and water content in the vicinity of the sample. Therefore, in addition to normal procedures, we paid special attention to the identification of sand and clay laminae thicknesses as well as on the appropriate application in the measurements. For instance, gamma dose rates for samples that were part of heterogeneous deposits (i.e. including sandy and clayey beds) were estimated using measurements not only on the sample itself but also on the deposits directly underlying and overlying the sample.

The results indicate that all samples were well bleached before burial. Results for the four samples in a vertical sequence (core 25G1057; samples NCL-3206022 to 25) are in correct stratigraphical order (within uncertainties). OSL ages for the upper two samples are identical (both ~ 2.8 ka) (Tab. 1), which agrees with anticipated rapid deposition of a coarse facies in a mouth bar. The OSL age obtained on associated deposits of distributary channel Gd1 (core 25G1054; sample NCL-3206026) is identical to those obtained on the mouth-bar deposits (2.84 ± 0.14 ka).

The deposits in the Aetsveldse clastic lake fill have been supplied by the Angstel-Vecht system for which the onset of clastic sedimentation has been radiocarbon dated at 2970±100 (cal yr BP; 2σ) (Bos et al. submitted). The 2σ-range of the oldest OSL-age (NCL-3206022, Tab. 1) only just overlaps with the oldest possible beginning of fluvial sedimentation. As the OSL-sample was completely reset prior to burial, we attribute the overestimation of the age to incorrect estimations of the dose rate, probably due to erroneous water content assumptions or beta and gamma dose origin (Wallinga and Bos, submitted).
We conclude that OSL can be a powerful tool for age determination of clastic lake fill sedimentation. Especially sandy samples returned ages that are in good agreement with age constraints provided by 14C-analyses. The approach proposed in our study for dating OSL samples from heterogeneous sediments may also be applicable on tidal channel sediments because of large similarities as far as the lithological composition is concerned.

References