

Advances in optical dating of young fluvial deposits

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Abstract

Optically stimulated luminescence (OSL or optical) dating can be used to determine the time of deposition of sediments. Application of the method for young fluvial deposits is difficult due to incomplete zeroing of the luminescence clock, resulting in overestimation of the burial age. Here we present new optical dating methods and ages obtained on two sites in embanked floodplains of the River Waal. Results are in correct stratigraphical order and agree favourably with available age constraints.

Introduction

Fluvial deposits provide an archive of the behaviour of rivers in the past. This natural archive can be exploited to improve our understanding of fluvial systems and thereby aid the development of safe and sustainable river management strategies. Reliable dating methods are essential to read the geological archive. Available dating methods are, however, largely restricted to fine-grained deposits.

Aim

In this study we explore the applicability of Optically Stimulated Luminescence (OSL or optical) dating for determining the time of deposition of fluvial sediments in embanked floodplains. We present the first results of our investigations, obtained using optimised single-aliquot optical dating methods. We investigated both overbank and channel facies formed during the past decades to centuries.

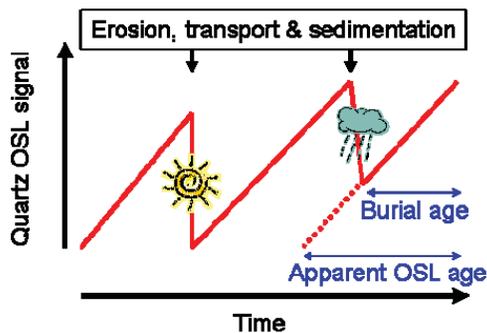


Fig. 1. The resetting of the OSL signal.

Methods

Optical dating determines the last exposure to light of sand-sized grains of quartz. If light exposure prior to deposition and burial is limited, the OSL signal may not be completely

reset, resulting in overestimation of the burial age, especially for young samples (Fig. 1). To avoid OSL age overestimation we developed optical dating methods that are particularly suited for young fluvial deposits, most important advances are shown in Figs. 2 – 4.

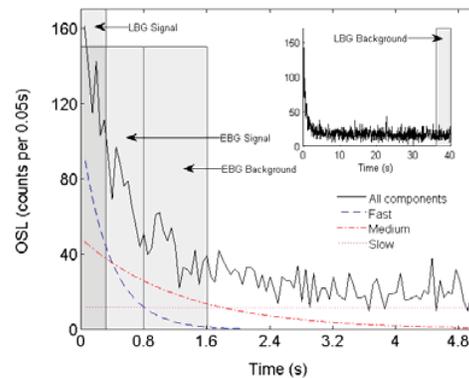


Fig. 2. The quartz OSL signal is composed of different components. The fast component is most suitable for dating and is selected through early background (EBG) methods.

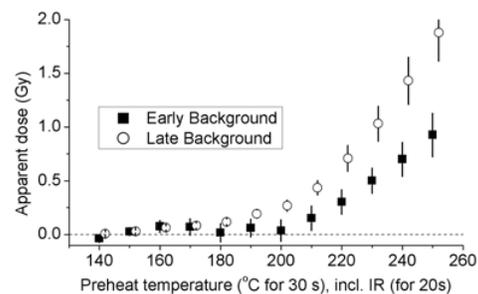


Fig. 3. Heating the samples prior to OSL measurement is needed to compare the natural OSL signal to that induced by laboratory irradiation. However, stringent preheating should be avoided as it may induce charge transfer from less light-sensitive traps (rising trend shown above). To avoid age overestimation due to charge transfer we selected a preheat of 200° C for these young samples.

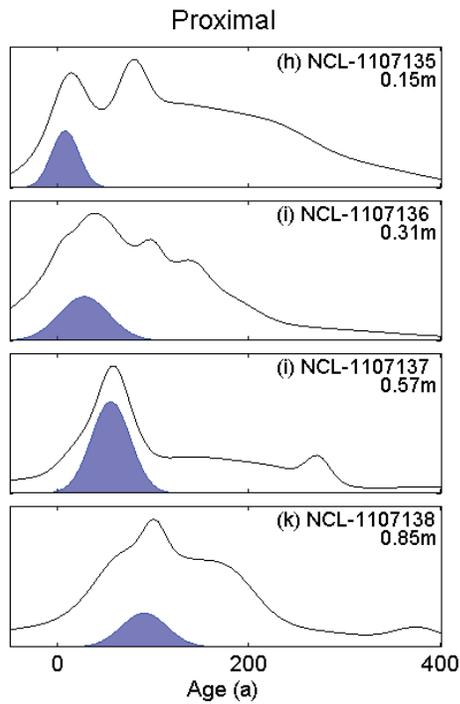


Fig. 4. OSL measurements are made on many small sub samples. The tail of the distribution toward older ages is caused by incomplete resetting of the OSL signal in some grains. Hence, youngest results will reflect the burial age. We distilled the burial age by fitting a Gaussian to the youngest part of the age distribution. The age distributions for four samples from a core on the Waal river bank at Neerijnen are shown.

Results

The optical dating results obtained are in correct stratigraphical order and agree with independent age constraints. The data can be used to determine sedimentation rates in the Neerijnen (Fig. 5) and Winssen (Fig. 6) floodplains. Our results demonstrate the applicability of optical dating for dating fluvial deposits on decadal to century timescales.

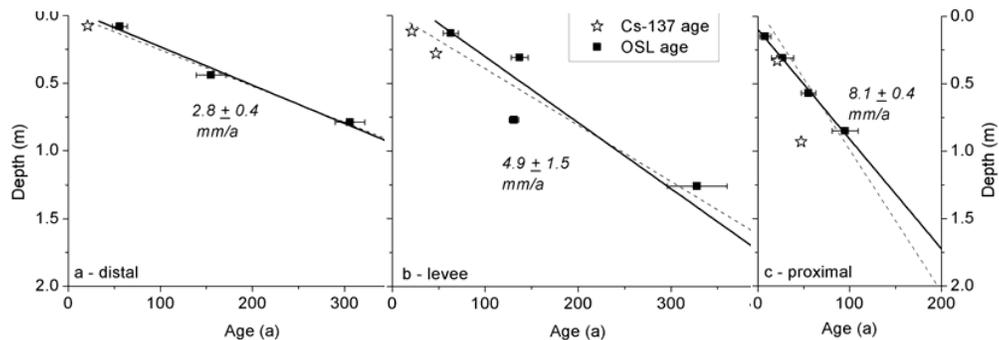


Fig. 5. Optical dating results and derived sedimentation rates for embanked floodplain overbank deposits of the Waal near Neerijnen (see also Hobo et al., this issue; Wallinga et al., submitted).

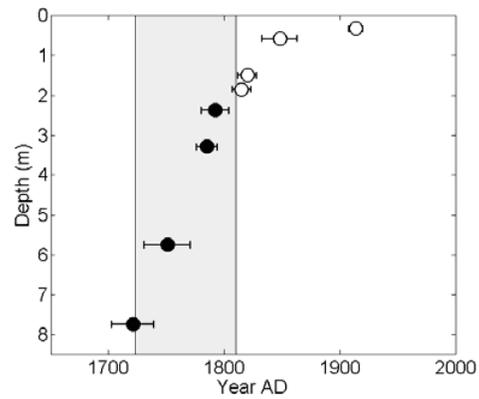


Fig. 6. Optical dating results for 8 samples from embanked floodplain sediments of the Waal near Winssen (Bakker et al., 2007; Cunningham et al., submitted). Results indicate rapid sedimentation of channel sediments, followed by slower aggradation of overbank deposits.

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