



Contents lists available at ScienceDirect

Quaternary Geochronology

journal homepage: www.elsevier.com/locate/quageo

Research paper

Luminescence dating of Weichselian interstadial sediments from the German Baltic Sea coast

Michael Kenzler^{a, b, *}, Sumiko Tsukamoto^b, Stefan Meng^a, Christine Thiel^b,
Manfred Frechen^b, Heiko Hüneke^a^a University of Greifswald, Institute of Geography and Geology, F.-L. Jahn Str. 17a, 17487 Greifswald, Germany^b Leibniz Institute for Applied Geophysics (LIAG), Geochronology and Isotope Hydrology, Stilleweg 2, 30655 Hannover, Germany

ARTICLE INFO

Article history:

Received 4 November 2014

Received in revised form

11 May 2015

Accepted 13 May 2015

Available online xxx

Keywords:

Southwestern Baltic Sea

Weichselian

Fluvial

Optically stimulated luminescence (OSL)

MIS 3

Interstadial

ABSTRACT

A cliff outcrop called Kluckow, in the Baltic Sea area, with a (glacio-) fluvial to (glacio-) lacustrine succession, provides a unique opportunity to resolve uncertainties in the timing and extent of several poorly constrained Weichselian ice advances. Based on a detailed lithofacies analysis, we selected four sampling horizons for luminescence dating to determine a depositional chronology. We measured both coarse-grain quartz and potassium-rich feldspar for age determination using optically stimulated luminescence (OSL) and post-IR infrared stimulated luminescence (pIRIR). Furthermore we addressed potential problems such as incomplete bleaching and quartz saturation effects. The resulting luminescence-chronology, supported by one radiocarbon age, illustrates a depositional time interval of the investigated sequence between ~62 and ~22 ka. Within this sequence a mussel-bearing fluvial sand indicate interstadial climate conditions at approximately 46 ka. The upper part of the section is composed of a 4 m thick glaciolacustrine silty clay and an overlying glaciofluvial sand; the latter yielded an OSL age of ~22 ka. Shortly after these sequences formed, the subsequent ice advance (indicated by the overlying till sheet) reached the study area. Based on our new chronology and lithofacies analysis, we conclude that the Scandinavian Ice Sheet did not reach the study area between ~62 and ~22 ka.

© 2015 Elsevier B.V. All rights reserved.

1. Introduction

The southwestern Baltic Sea and its vicinity are key areas for understanding the complex interactions between climate conditions and the advance and retreat of the Scandinavian Ice Sheet (SIS) during the Weichselian Glaciation (115–11.7 ka) (Houmark-Nielsen, 2010). Due to the large climate variability, especially during Marine Isotope Stage 3 (MIS 3, 60–27 ka), various stadial and interstadial phases have been defined in this area (Wolff et al., 2010). The stratigraphy during this time has been well described in Denmark and southern Sweden (e.g., Larsen et al., 2009; Anjar et al., 2012). However, sedimentary records of Early and Middle Weichselian age (MIS 5d – MIS 3, 115–27 ka) are rare in northeastern Germany and chronological data are also sparse (Ludwig, 2006). Most of the dated deposits in this region are ice marginal sediments connected to the Late Weichselian (MIS 2, 27–11.7 ka) (Lüthgens and Böse, 2011).

Rügen Island, located at the southwestern border of the Baltic Sea basin (Fig. 1), has several cliff outcrops with deposits correlated to Saalian and Weichselian periods (Panzig, 1995), but aside from a few thermoluminescence (TL) and radiocarbon ages from Weichselian deposits (Krbetschek, 1995; Steinich, 1992), no numerical chronologies are available for these sediments. Hence the age of most of the different till sheets and intercalated deposits is still under debate (Müller, 2004), resulting in uncertainty in the timing of the events they reflect. Chronological constraint of these sediments will allow for new understanding of the Weichselian sedimentary history in northeastern Germany. Further, a comparison with data from Denmark, Sweden and Poland will be made possible; this is an important framework for the reconstruction of former climate and event history.

The key aspect of our research is a comparative dating approach for glaciofluvial, fluvial and lacustrine deposits, including a comparison of quartz and feldspar luminescence dating results, in order to evaluate the bleaching conditions (e.g. Lüthgens et al., 2010). This study represents the first application of optically stimulated luminescence (OSL) dating to sediments from Rügen Island, and one of few applications to northeast German Middle Weichselian deposits (Lüthgens et al., 2011). Based on these dates and detailed

* Corresponding author. University of Greifswald, Institute of Geography and Geology, F.-L. Jahn Str. 17a, 17487 Greifswald, Germany.

E-mail address: kenzlerm@uni-greifswald.de (M. Kenzler).

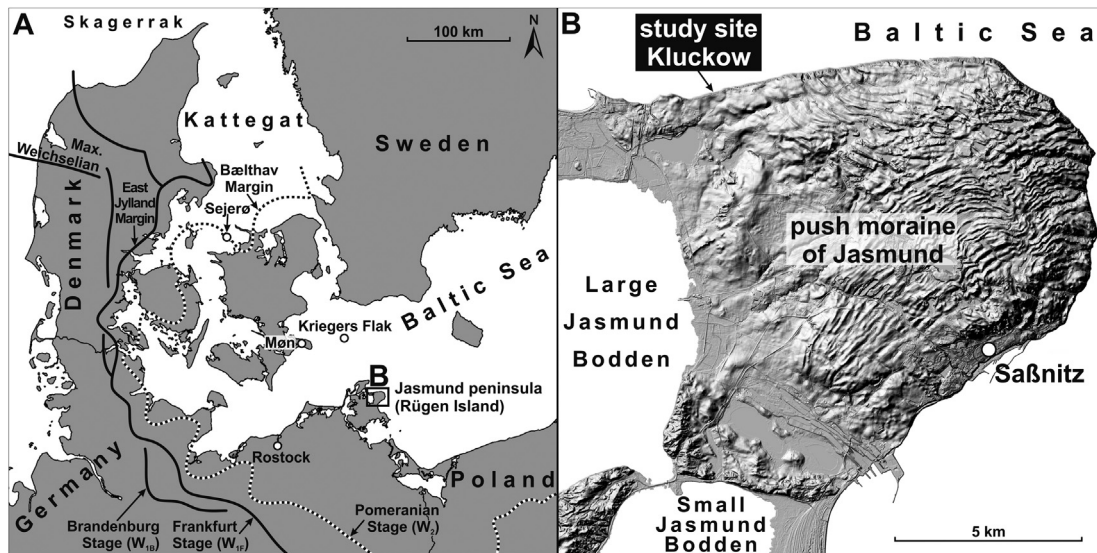


Fig. 1. (A) Map of the southwestern Baltic Sea area with ice marginal positions of the Weichselian glaciation (based on Houmark-Nielsen, 2010; Houmark-Nielsen et al., 2012); (B) Digital elevation model (DEM) of the Jasmund push-moraine complex with the location of the sample site, Kluckow (based on @GeoBasis-DE/M-V 2015, processed by J. Hartleib).

stratigraphy, we critically reassess the chronostratigraphical position of these sediments on Rügen Island and place them in the context of the Weichselian glacial history of the SIS to improve our understanding of the response of the SIS to the global climate.

2. Study area

2.1. Previous studies and chronostratigraphic framework

The dynamics of the SIS in the southwestern Baltic Sea area during the Early and Middle Weichselian glaciation are still discussed controversially. Stephan (2014) and Müller (2004), for example, indicated Early to Middle Weichselian ice advances in north and northeastern Germany, but these have not been fully confirmed. However, Houmark-Nielsen (2010) correlated these ice advances with the Ristinge advance (50 ± 4 ka) in Denmark. Furthermore, Houmark-Nielsen (2010) described the Klintholm ice advance on Møn (Denmark) (32 ± 4 ka), but this ice advance has not been found in Germany to date. There are also indications of pre-Last Glacial Maximum (LGM) ice advances in Poland at ~ 36 to 32 ka (Marks, 2012). A correlation of these ice advances is very difficult; one reason is the lack of suitable age data in the German region. Several locations with interstadial sediments of Early and Middle Weichselian age are reported in Denmark and Sweden, e.g., at Pilgrimstad (44 ± 8 ka, Alexanderson et al., 2010) and Sejero (~ 41.5 cal ka BP, Bennike et al., 2007), but little evidence of these interstadials exists in northeastern Germany (Steinich, 1992).

There are several main Weichselian ice marginal positions (IMP) in Germany which have been connected to MIS 2 ($27\text{--}11.7$ ka) (Fig. 1). The oldest confirmed Weichselian IMP in Germany is the Brandenburg IMP, which represents the maximum extent of the Weichselian ice sheet. OSL dating of quartz from glaciofluvial sediments for the Brandenburg IMP yielded ages between 34 ± 3 ka and 28 ± 4 ka (Lüthgens et al., 2010), whereas the surface exposure dating (^{10}Be) of boulders gave ages between 21.9 and 18.2 ka (Heine et al., 2009). Lüthgens and Böse (2011) have interpreted these results as the maximum (OSL) and minimum (^{10}Be) age of the Brandenburg IMP. According to Houmark-Nielsen et al. (2012), the age of the maximum Weichselian ice extent in Denmark, represented by the East Jylland IMP (Fig. 1), ranges between 22 and 20 ka. In Poland, Marks (2012) assumed an age of 24 to 19 ka for the same IMP.

2.2. Geographical and geological settings

The cliff outcrop Kluckow (Lat: $54^\circ 34.53$ N, Lon: $13^\circ 31.24$ E) is located at the Jasmund peninsula (Rügen Island, Germany) (Fig. 1). The Jasmund area is formed by a push-moraine complex up to 161 m high characterised by Lower Maastrichtian bedrock (~ 69.5 Ma) and overlying Pleistocene sediments (Panzig, 1995). The 70 m long and 21 m high Kluckow cliff section is composed of an 8 m thick (glacio-) fluvial to (glacio-) lacustrine succession intercalated between two tills which are correlated to Saalian and Weichselian in age (Panzig, 1995) (Fig. 2). The first detailed sedimentological and palaeontological description of the site was provided by Steinich (1992), who divided the section into several lithostratigraphical units. Based on two TL ages by Krbetschek (1995), the accumulation of these deposits occurred during MIS 3, between 41 ± 5 ka and 27 ± 3 ka (cf. Fig. 2).

We conducted detailed lithofacies analysis focussing on the sedimentary structures and textural characteristics of individual depositional units and their palaeoenvironmental interpretations (Fig. 2). The sediments were analysed and termed according to the facies codes and classification scheme of Benn and Evans (2010). The overall result of our facies analysis agrees well with the descriptions and interpretations of Steinich (1992), but includes some minor modifications: We divide the investigated sequence into five lithostratigraphic units (A to E) with corresponding depositional environments (Fig. 2).

We interpret unit A as a fluvial or a glaciofluvial deposit. A sample LUM 2829 was taken from a position more than 30 cm away from the underlying till surface to avoid radiation influence from the till (Fig. 2). Unit B is a mainly lacustrine sediment that was subsequently deformed by cryoturbation in a periglacial environment. The ice-wedge casts above this unit indicate a period of periglacial conditions. Unit C represents a mainly fluvial environment during an interstadial climate. The top of this unit reflects a cooling of the climate, evidenced by the presence of ice-wedge casts, and signifies a possible periglacial land surface with a temporary halt in sedimentation. Two samples (LUM 2830 and LUM 2831) were collected from unit C (Fig. 2). During sampling, we avoided any possible contamination of the sample with material from the ice-wedge casts. Within unit C, we found undeformed *Anodonta* sp. (bivalvular preservation with intact organic

Download English Version:

<https://daneshyari.com/en/article/6442554>

Download Persian Version:

<https://daneshyari.com/article/6442554>

[Daneshyari.com](https://daneshyari.com)