



## The problem of the lower boundary of the Pleistocene in Eastern Lithuania



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### ABSTRACT

A sequence of lacustrine and alluvial sediments represented by stratified sand, silt and, rarely, clay over 20 m-thick is widespread in the Anykščiai and Vilnius districts in Eastern and South-eastern Lithuania, respectively. These sediments are exposed only in Eastern Lithuania, in the Šventoji River valley and its tributaries. Here they overlie Devonian bedrock and are overlain by the Pleistocene glacial deposits. The results of different geological investigations (palaeobotanical, mineralogical, geochemical, etc.) indicate that these sediments probably formed in the basins and rivers that date from the Neogene to the Early Pleistocene. Stratigraphical subdivision and correlation of sediments from the transition zone between the Neogene and Quaternary are problematic for several reasons. This article presents new results of palaeomagnetic investigations of these sediments from five outcrops, accompanied by lithological studies. The sediments were laid down during a relatively long and variable period of palaeomagnetic reversals comparable to the Matuyama and Gauss polarity chrons. The boundary between the Brunhes and Matuyama polarity chrons has been traced in the upper part of the sections. The stratigraphical subdivision and correlation of the entire sequence, as well as the identification of the Neogene/Quaternary boundary in these sediments, remain undetermined.

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### 1. Introduction

The Neogene and Early Pleistocene strata, represented by lacustrine and alluvial sediments, are widely distributed in the environs of Anykščiai, Eastern Lithuania (Fig. 1). The outcrops of these sediments, along the Šventoji River, were first investigated in 1926 by Dalinkevičius (1928). He supported the conclusion of Karpinsky (1887) of a Tertiary landbridge connecting the Baltic Sea (Sambia Peninsula) and Volhynia (Ukraine). For this reason these sediments were therefore attributed to the Tertiary. Such a position was based on the discoveries of A. Giedraitis (Giedroyc) who found similar sediments near the Šventoji River, to the south-west of Anykščiai, and identified them as Paleogene (Giedroyc, 1895). This approach was also supported by observations German geologists

carried out in 1915 concerning the occurrence of coal layers similar to those in the Sambia peninsula (Kaveckis, 1928). Thus, on the geological map of this era a large area of Lithuania was indicated as being of Tertiary age (Dalinkevičius, 1928). Following the new discoveries of Devonian fauna in 1931, these wide so-called 'Tertiary' areas were reduced to small patches and termed 'Neogene-preglacial sediments' (Dalinkevičius, 1933, 1944).

Starting in the 1960s, a large number of investigations were carried out in this region in an attempt to solve stratigraphical and palaeogeographical problems of the sediments under consideration. Following the palynological investigations, performed by Baltakytė-Vienožinskienė (1956), the Eastern Lithuanian sediments were attributed to the Pliocene to Early Pleistocene, and termed the Vilnius preglacial. These sediments were renamed the Daumantai layers by Gudelis (1961, 1973). Subsequently a series of pollen analyses and lithological investigations in the Šventoji River valley outcrops and surrounding boreholes were performed starting during the 1970s (Vienožinskienė, 1960; Kondratienė, 1965, 1971a,

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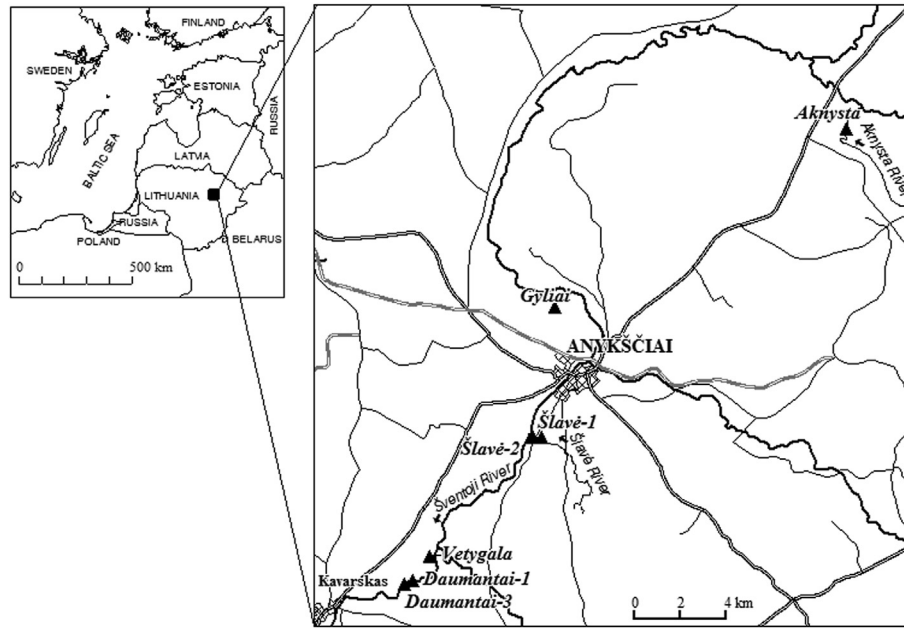


Fig. 1. Study area in Eastern Lithuania and location of investigated outcrops.

1971b; Klimašauskas, 1970; Klimašauskas and Prapakaitė, 1971; Vaitiekūnas and Chomutova, 1972, 1973, 1975; Vaitiekūnas, 1977a, 1977b). On the basis of the pollen evidence, the preglacial complex (Kondratienė, 1965, 1971a, 1971b; Kondratienė et al., 1993) was stratigraphically subdivided into the Late Pliocene (the Anykščiai Formation), Daumantai Preglacial Formation and the Šlavė Interglacial. The stratotype for the Daumantai Formation was proposed as the 25 m high outcrop in the Šventoji River valley, close to Daumantai village (Kondratienė, 1971b; Kondratienė and Satkūnas, 1993). There were several attempts to support various versions of the stratigraphical subdivision of the sediments, based on differing methodologies of investigations, including: palaeocarpology (Riškienė, 1968; Velichkevich, 1982), changes in mineral composition (Klimašauskas, 1970; Klimašauskas and Prapakaitė, 1971; Satkūnas, 1990, 1991) and trace chemical elements (Baltakis, 1966; Malinauskas, 1985), degree of weathering of quartz grains (Juozapavičius, 1976) and complex lithological researches (Gaigalas, 1987; Šinkūnas et al., 2001). Despite these attempts, the precise position of the Neogene/Quaternary boundary in these sequences remains problematic and uncertain in these investigated sections. This arises because of the sparse pollen content of the sediments (Kondratienė and Šeirienė, 2001; Kondratienė et al., 2001a, 2001b). Moreover, the numerical age of sediments has yet to be confirmed by geochronological data. According to the recent Lithuanian Quaternary stratigraphical scheme, (Fig. 2) these sediments are attributed to the Anykščiai Formation of the Upper Pliocene and Daumantai Formation of the Early Pleistocene, or the so-called 'Prepleistocene' (Satkūnas, 1998; Guobytė and Satkūnas, 2011), i.e. the boundary between the Neogene and Quaternary is considered to be that separating the two formations.

Stratigraphical subdivision of the sediments from the Neogene and Quaternary transition zone is difficult because only a few dating methods can be applied to this time span (Pillans and Gibbard, 2012). Taking into account the lithological composition of the sediments (they are unsuitable for the dating using isotopic methods), as well as the results of the previous researches, palaeomagnetic investigations were identified as the most suitable

method. It should be noted that some attempts to undertake palaeomagnetic measurements were tested a few decades ago (Pevzner and Gaigalas, 1976). However, the results were unsatisfactory as a consequence of the low measurement accuracy. Complex investigations of two Daumantai and Šlavė-2 outcrops, including the palaeomagnetic investigations, were undertaken a few years ago with the aim of determining the stratigraphical affinities of these sediments (Baltrušas et al., 2013, 2014). Finally, palaeomagnetic investigations of five exposures – Daumantai-1, Vetygala, Šlavė-1, Gyliai, and Aknysta – were carried out during the recent studies reported here. In the scope of the current study, some additional investigations directed towards palaeogeographical reconstruction of the sedimentary environments were also undertaken, i.e. estimates of the amount and mineralogical composition of carbonates in the problematic sediments, also the determination of distribution and quantity of chemically weathered quartz grains.

## 2. Regional setting

The sites studied in this project occur in a series of exposures that have similar lithological compositions and occur along the Šventoji River and its tributaries Šlavė and Aknysta in Eastern Lithuania (Fig. 1). The coordinates (WGS) and altitudes of the outcrops investigated (approximate position of the top of outcrop, in metres above mean sea level) are:

Daumantai-1: N 55° 26' 44", E 24° 59' 24"; 90 m m.s.l.  
 Vetygala: N 55° 27' 17", E 25° 00' 06"; 85.5 m m.s.l.  
 Šlavė-1: N 55° 30' 04", E 25° 04' 45"; 95 m m.s.l.  
 Gyliai: N 55° 33' 09", E 25° 05' 30"; 100 m m.s.l.  
 Aknysta: N 55° 37' 15", E 25° 17' 51"; 87.8 m m.s.l.

These outcrops are the only places in Lithuania where late Cenozoic (Miocene–Pliocene–Early Pleistocene) sediments are exposed. The maximum thickness of these sediments exceeds 20 m. The sediments overlie weakly cemented sandstones of the

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