STOP 13: Inland dune field near Daugavpils, East-Latvian Lowland

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The landforms of aeolian origin located in the eastern and northern parts of Daugavpils town, as well as to the north and to the west of the town, represent one of the largest inland dune fields in Latvia. This dune field is located at the south-eastern edge of the East-Latvian Lowland, covering at least 260 km^2 of the southern part of the Jersika Plain.

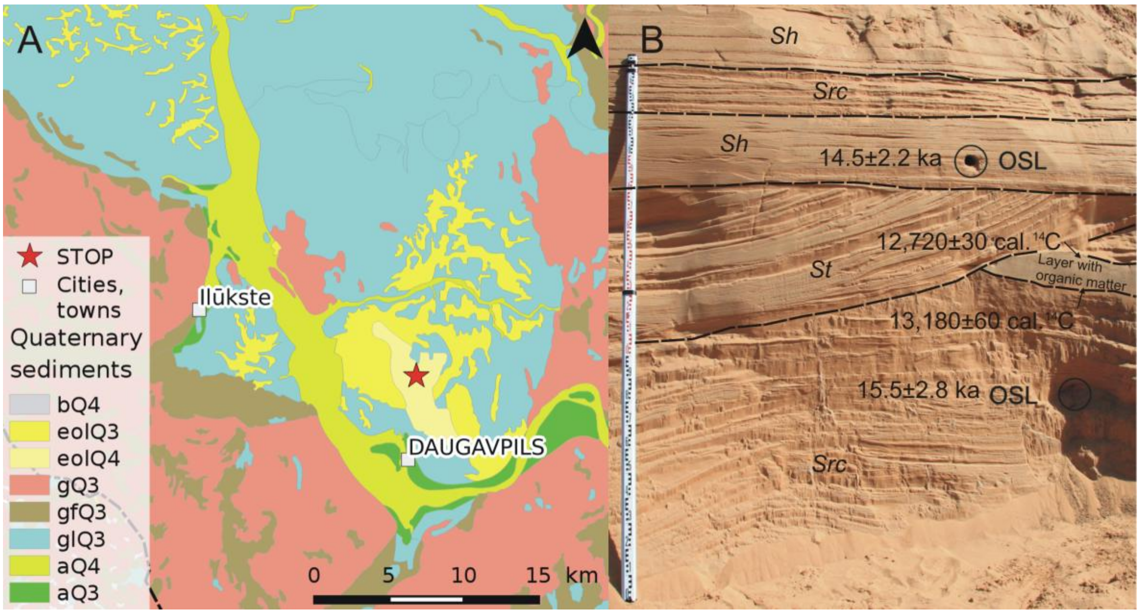

Fig. 13.1. A – Location of the investigated site and its surroundings on the Quaternary sediment map (Juškevičs and Skrebels 2003): bQ4 – peat, eolQ3 – older aeolian sand, eolQ4 – younger aeolian sand, gQ3 – glaciogenic sediments, gfQ3 – glaciofluvial sand and gravel, glQ3 – glaciolacustrine sand and silt, aQ4 – younger alluvial sediments, aQ3 – older alluvial sediments; B – Sedimentary succession, luminescence and radiocarbon age at the investigated site. Lithofacies symbols are distinguished by Miall's code (Miall 1978, 1977).

According to Eberhards (1972), the inland dunes have developed on the surface of the River Daugava paleodelta, which reflects an event of glaciofluvial sedimentation in the Nīcgale ice dammed lake (Fig. 13.1A) during the Younger Dryas. After the drainage of the glacial lake, the abundance of unconsolidated sediments, lack of vegetation cover and climatic conditions favoured the transportation of sand and fine sandy material by wind and the formation of aeolian landforms.

Despite the evidence of past aeolian activity in this area, under modern climatic conditions the dune field has been almost entirely stabilized by canopy vegetation, mainly represented by Scots pine forest, which prevents mobilization of the sand by aeolian processes. Although information about this area as an inland dune field was presented in the literature more than 30 years ago (Straume 1979, 1984), the morphology and spatial distribution of aeolian landforms located in this part of Latvia, their internal structure and chronology of formation still remain poorly documented.

Analysis of topographic maps at scale 1:10,000 with a contour interval 2 m and remote sensing data have made it possible to identify within the dune field more than 340 dunes of different morphology; many of them have an asymmetric profile and parabolic shape in planar view. The results also indicate that many of the dunes form groups which are randomly scattered across the dune field.

The altitude of the dunes varies from 90 to 138 m a.s.l. The highest dunes are *Alu kalns* ('Burrow Hill'), *Spaidu kalns* ('Coercion Hill') and Plikais kalns ('Bare Hill'), which reach altitude of 139.5, 125 and 124.7 m a.s.l., respectively. Notable is that the altitudes of the dunes generally decrease from south-east to north-west, i.e. from the proximal to distal direction of the paleodelta of the River Daugava.

The internal structure and geological composition of the dune field can be observed in the ca. 20 ha *Kāpas* sand-pit, which is located 0.8 km SW of the *Gijantari* railway stop. Due to sand excavation, 5 to 14 m high outcrops of Quaternary sediments have been formed; here the uppermost layers of glaciolacustrine sediments and covering aeolian sediments are available for detailed study.

The sedimentary succession of the Gijantari site (Fig. 13.1B) consists of sand with trough structure – *St* (Miall, 1977 1978), where intensive wind conditions are indicated by the presence of deflation thoughts – DT (Zieliński and Issmer 2008). A significant component is sand with translatent stratification and horizontal lamination – *Src* and *Sh*, respectively, representing deposition by a gentle wind up to 6 m s^{-1} (c.f. Zieliński and Issmer 2008).

The major part of the Gijantari site consists of fairly homogeneous fine-grained sands with a mean (Mz) value of between 1.51 and 2.78 φ. Simultaneously an alternation of both coarser-grained (Mz=0.56 φ) and finer-grained (Mz=3.40 φ) laminae is visible. The alternating bedding of silty, fine and coarser sand can be attributed to the deposition and adhesion of sediments on an alternating dry and wet depositional sand sheet/dune surface and/or seasonal changes in wind velocity, as observed by Kasse (2002).

The analysis of the roundness of quartz sand grains and the character of their surface (see the description of the methodology in STOP 6) revealed the predominance of matted grains with various degrees of rounding; short-duration abrasion/transportation (EM/RM – type) quartz grains prevail (7–32%); however, a significant quantity of RM grains is also noted (6–22%). Thus, the predominance of the aeolian factor could be confirmed. However, the period of aeolian activity could be established as having lasted some hundreds of years (Mycielska-Dowgiałło 1993) due to the evidence of aeolian action at the corners and edges of the quartz grains. The latter has been proved experimentally (Costa et al. 2013); aeolian transport for short distances and during a relatively short period of time is enough to imprint significant abrasion marks. Simultaneously, the increase in perfectly rounded RM grains seems to be unusual at localities in Latvia; this has been noted in areas with a significant duration of aeolian activity, i.e. in Central Poland (Cailleux 1942; Goździk 2007). The cause of this remains unexplained, however it is considered (Mazzullo 1986) that aeolian sorting preferentially removes well-rounded quartz grains from the source. Therefore a high proportion of rounded grains can be observed in the downwind deposits, leaving behind a deflation lag with a high proportion of angular grains. Similarly, inheritance/transformation in relation to the former/parental deposits is indicated, where the entire shape of the grain is considered as crucial for further aeolian abrasion; angular grains reveal a tendency to become almost spherical (Kuenen 1960). Shiny quartz grains (EL and EM/EL) indicate a river floodplain or an estuarine shore face in a temperate climate (Marks et al. 2014). Up to 34% of these have been noted at the Gijantari site, which is rather unique for an aeolian setting. However, a similar outline has been noted within the aeolian sand-sheets in Central Poland (Kalińska 2012) and the aeolian complexes in Ukraine (Zieliński et al. 2009). Post-sedimentary frost weathering is responsible for a high content of cracked (C) quartz grains

(Woronko and Hoch 2011); up to 32% of such grains have been observed. The latter could therefore indicate seasonal frost action within the open cracks in the surface of frozen ground (Ribolini et al. 2014).

The relationship between quartz, feldspars, crystalline rocks and micaous minerals is significant for assessing the mineralogical maturity and inferring the sediment source and provenance (i.e. Kasper-Zubillaga and Zolezzi-Ruiz 2007). Dune sands are considered multi-cyclic, being derived from pre-existing recycled sediments (Howari et al. 2007). A significant occurrence of feldspars and crystalline rocks (19–29% altogether) indicates a nearby source and suggests that the major part of the sediments did not pass through several sedimentary cycles.

An intercalated layer with organic matter has been found in the middle part of the dune (Fig. 13.1B). In order to construct a timescale, two AMS ^{14}C dates obtained from *Beta Analytic INC* were calibrated at the one-δ confidence level using the *IntCal13* calibration curve (Reimer et al. 2013). The macroscopic charcoal fragments collected from the lower and upper organic layers yielded AMS radiocarbon ages of 13,180 ± 60 and 12,720 ± 30 ^{14}C BP, respectively (unpublished data). These correspond to the Allerød–Younger Dryas boundary (Steffensen et al. 2008; van Hoesel et al. 2014) or the GS–1 to GI–1a-b in the NGRIP stratigraphy (Blockley et al. 2012). These dates can be assumed to mark the lower limit of accumulation of the aeolian sediments which cover the dated organic matter. They also demonstrate good agreement with other published data from north-eastern Lithuania (Stančikaitė et al. 2009) and eastern Latvia (Heikkilä et al. 2009; Veski et al. 2012) on the development of vegetation in these areas.

Simultaneously, two luminescence ages (Fig. 13.1B) were obtained at the Finnish Museum of Natural History Dating Laboratory, Helsinki, Finland for the sandy sediment units directly below and above the organic layer. Equivalent dose *(De)* determination was carried out using the single-aliquot regenerative dose (SAR) protocol (Murray and Wintle 2000). A consistent age of 15.5 ± 2.8 and 14.5 ± 2.2 ka (unpublished data) was obtained. Within the limits of uncertainty, the luminescence ages agree with the AMS ^{14}C datings. However, with respect to the optical age results, the relatively high errors, in the range of 15–18%, must be noted. Clearly, these have to be reinvestigated.

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