JOURNAL OF ENVIRONMENTAL GEOGRAPHY
Journal of Environmental Geography 7 (3–4), 39–47.
DOI: 10.2478/jengeo-2014-0005
ISSN: 2060-467X

ENVIRONMENTAL CHANGES IN HISTORICAL TIMES NEAR APOSTAG ON THE DANUBE-TISZA INTERFLUVE, HUNGARY (A COMPLEX RESEARCH BASED ON ARCHAEOLOGICAL EXCAVATION AND GEOMORPHOLOGICAL INVESTIGATIONS)

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Research article, received 26 February 2014, accepted 31 March 2014

Abstract

The sensitive, partly fixed dune areas are good indicators of alteration, since they react rapidly to changing environmental conditions. Due to the climate changes, especially the increased aridity during the Holocene, many blown sand areas became active. Later, humanity had increasing impact of on its environment, thus sand movements occurred due to anthropogenic activities. Aeolian activities were identified not only in the historical times but also a few decades ago, when the moving sand caused significant problems on surfaces becoming bare. The present work will provide good evidence on sand movement in historical times caused by human impact on the environment with the help of OSL dating and archaeological research in the vicinity of the town of Apostag, which is located on the largest blown-sand area of Hungary on the Danube-Tisza Interfluve. The aims of the research were to identify the ethnical groups and their possible activities; to map the geomorphology of the study area; to determine the periods of aeolian activity; to assign the possible types of human activities in connection with climatic changes enabling aeolian activity.

Keywords: environmental changes, optically stimulated luminescence, archaeology, geomorphology, blown sand movement

INTRODUCTION

The sensitive, partly fixed dune areas are good indicators of alteration, since they react rapidly to changing environmental conditions. It can be confirmed by the result of an Australian survey where sand sheet was detected in a fixed dune area covered by forests due to sand movement in the early Holocene. The palinological investigations did not confirm aridification in the area; the precipitation increased continuously after the Pleistocene and reached the maximum 4000 years ago (Shulmeister, 1992; Shulmeister and Lees, 1992). However, the presence of the dry period is confirmed by many proofs; the change was probably so rapid and the dry period lasted so shortly that its influence could not be detected in the pollen spectrum (Nott et al., 1999). Therefore, the investigation of sand movement has an important role in the assessment of environmental impacts, since small changes can modify the sensitive balance and can indicate mobilisation.

Due to the climate changes, especially the increased aridity during the Holocene, many blown sand areas became active e.g. in the United States (Forman et al., 1992, 1995; Olson et al., 1997; Rawling et al., 2003; Stokes and Swinehart, 1997; Wilkins and Currey, 1999). On the European coastal areas climate change due to the Little Ice Age indicated sand movements (Borja et al., 1999; Clarke et al., 2002, Wilson and Braley, 1997; Wintle et al., 1998). Forest fires also resulted in bare surfaces where wind erosion could become dominant (Filion, 1984; Filion et al., 1991; Kayhkö et al., 1999). Later, humanity had increasing impact of on its environment, thus sand movements occurred due to anthropogenic activities (Wilkins and Currey, 1999; Wilson and Braley, 1997; Wintle et al., 1998). Thus, the investigation of Holocene sand movements has an important role in the assessment of global warming, climate change and the human impact on the environment.

Sand movements were identified not only in the historical times but also a few decades ago, when the moving sand caused significant problems on surfaces becoming bare. In Ireland the improper land use in the 1930-40s caused the degradation of cultivated areas, and the huge amount of sand blocked roads (Wilson and Braley, 1997). Increased aeolian activities were identified in Canada in the 1920-30s (Lemmen et al., 1998), furthermore during the 1980s as well (David and Wolfe, 1997). Huge damages were also reported in the USA in the beginning of 1930s due to wind erosion (Orlove, 2005). Sand movements caused significant damages in the lack of vegetation on the surface also in Hungary (Mezősi and Szatmári, 1998; Szatmári, 2004). According to Borsy (1972) 5-40 cm thick sand layers was transported during a few days south-east from Kiskunhalas in April 1967. Significant damages due to deflation on sandy surfaces were recorded from Nyírség region between 10 and 12 February 1984 (Lóki, 1985).

Climate change, growing population, the development of agricultural techniques and the changes in land use caused human induced environmental changes, which became increasingly significant in history. Good examples can be found in Hungary on the Danube-Tisza Interfluve where both the change in climatic conditions and the anthropogenic disturbance caused aeolian activity during historical times. Therefore, the geomorphology of the area transformed and the Pleistocene forms were reshaped by Holocene sand-movements.

The earliest blown sand movements on the Danube-Tisza Interfluve took place in the Inter Pleniglacial of the Pleistocene (Sümegi and Lóki, 1990; Sümegi, 2005) and subsequently there was aeolian activity during the Middle Pleniglacial of the Pleistocene after 25 200 ± 300 year ago (Krolopp et al., 1995; Sümegi, 2005). According to earlier researches on the Danube-Tisza Interfluve the most significant aeolian activity occurred during the Upper Pleniglacial (Borsy, 1977ab, 1987, 1989, 1991; Sümegi et al., 1992; Sümegi and Lóki, 1990; Sümegi, 2005). Later, the two cold and dry periods, the Older Dryas and Younger Dryas in the Pleistocene were convenient for aeolian rework (Borsy et al., 1991; Hertelendi et al., 1993) which is supported by radiometric, optical and thermo-luminescenece measurements too (Gábris et al., 2000, 2002; Gábris, 2003; Újházy, 2002; Újházy et al., 2003).

Sand dunes, formed under cold and dry climate in the Pleistocene, were gradually fixed as the climate changed to warm and humid during the Holocene. However, researchers draw attention to the possibility of sand movement in the Holocene too. The warmest and driest Holocene phase (Boreal Phase) was the most adequate for dune formation (Járainé, 1966, 1969; Borsy, 1977ab, 1987, 1991; Gábris, 2003; Kádár, 1956; Marosi, 1967; Újházy et al., 2003), though, certain investigations claim that the second half of the Atlantic Phase could also be dry enough for the remobilisation of sand (Járainé, 1966, 1969; Borsy and Borsy, 1955; Borsy, 1977ab; Gábris, 2003; Újházy et al., 2003). Nevertheless, the latest, usually local signs of aeolian activity can be related to various types of human impact. Former investigations consider that sand movement could occur during the Turkish occupation (16th - 17th century AD) and subsequently in the 18th -19th century AD due to deforestation (Borsy, 1977ab, 1987, 1991; Marosi, 1967).

Based on archaeological investigations and OSL measurements on the Danube-Tisza Interfluve aeolian activity occured in the Bronze Age (Gábris, 2003; Újházy et al., 2003; Nyári and Kiss, 2005a, b; Kiss et al., 2006; Nyári et al., 2006, 2007a and b; Sipos et al., 2006), then the surface became stable for a long period, until the 3rd-4th centuries AD. As later the climate turned dry (Rácz, 2006; Persaits et al., 2008) and the anthropogenic disturbance became more significant conditions became suitable for aeolian activity, which is proved by several researchers (Lóki and Schweitzer, 2001; Kiss et al., 2006; Nyári et al., 2006, 2007a, b; Sipos et al., 2006). Sand movement was also characteristic in the Migration Period, especially during the 6th-8th century AD, which was the realm of the Avars (Nyári and Kiss, 2005a,b; Kiss et al., 2006; Nyári et al., 2006, 2007a, b; Sipos et al., 2006) Subsequent aeolian activity occurred also in the Árpád Age (11th-13th c. AD, Lóki and Schweitzer, 2001; Gábris, 2003; Újházy et al., 2003; Nyári et al., 2006) and when the Cumanians inhabited the territory (13th c. AD, Sümegi, 2001; Kiss et al., 2006; Nyári et al., 2006, 2007a, b; Sipos et al., 2006). The latest aeolian activity occurred in the 15th century AD (Nyári et al., 2007a).

The present work will provide good evidence on sand movement in historical times caused by human impact on the environment with the help of OSL dating and archaeological research in the vicinity of the town of Apostag, which is located on the largest blown-sand area of Hungary on the Danube-Tisza Interfluve. The aims of the research were to identify the ethnical groups and their possible activities; to map the geomorphology of the study area; to determine the periods of aeolian activity; to assign the possible types of human activities in connection with climatic changes enabling aeolian activity.

STUDY AREA

The study area is located on the west part of the Danube-Tisza alluvial fan, south from Apostag *(Fig. 1.).* The archaeological sites are situated on the south part of the study area *(Fig. 8.).*

METHODS

Archaeological investigations

The archaeological investigations enabled to determine the historical characteristic of the study area and to assign the activity of the seated people who inhabited the area.

Geomorphological mapping

The relief and geomorphological map of the investigated area was compiled on the basis of field measurements and 1:10,000 scale topographic maps. Forms typical on stabilised blown-sand areas were allocated — blowout depressions, blowout ridges, hummocks, and the brink lines of dunes — and also former flows could be determined.

OSL measurements

Four samples were collected from two profiles. Extraction and sample preparation procedures followed the steps introduced by Aitken (1998) and Mauz (2002) and aimed at the separation of quartz grains of suitable (90-150 µm) size. Measurements were made on an automated RISOE TL/OSL-DA-15 type luminescence reader. Throughout the measurements the SAR technique, described in detail by Murray and Wintle (2000), was followed.

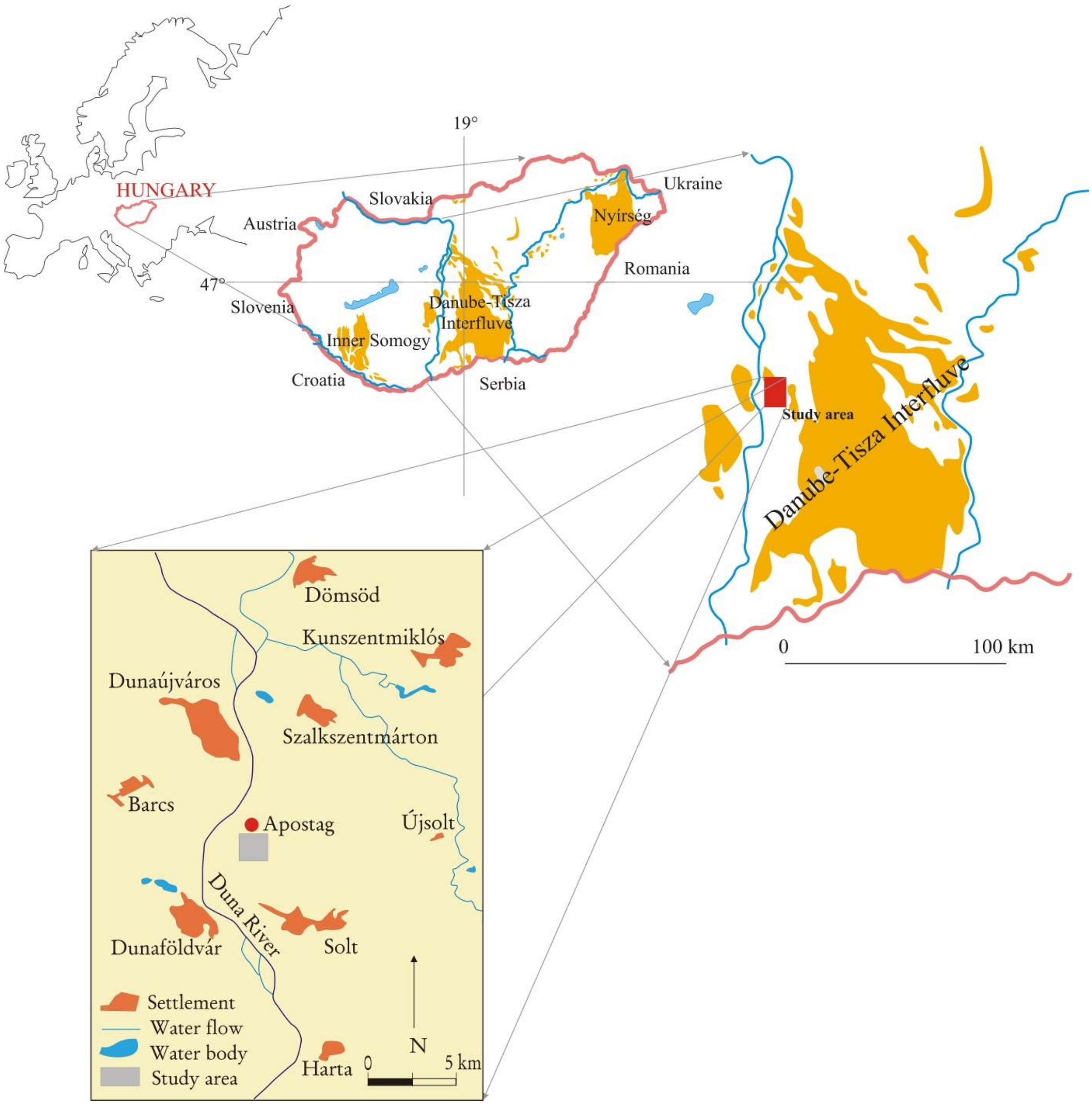

Fig. 1 Location of the study area

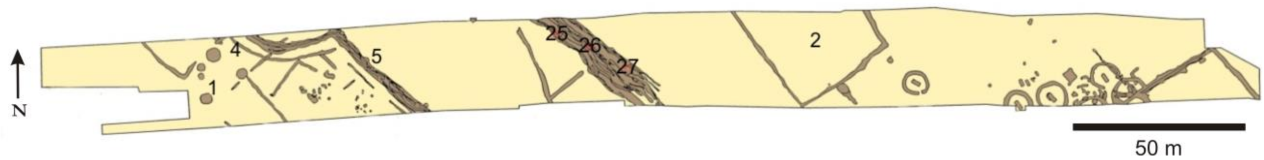

Fig. 2 The archaeological site and the excavated features
1: Pit, 2: Stock yard, 3-5, 25-27: Ditches

RESULTS

Archaeological research

During rescue excavation on the area about 300x25 meters 34 chases, 38 holes, 15 pile holes, 3 pits, nine graves from the sarmatian era as well as a modern pit were explored. The objects of the settlement were sometimes dug on each other, and often they formed small groups and were situated quite rarely. The excavated area was arranged into well segregated parts. On the western part next to an expansive ditch system, on stock-raising referring hurdle ditches and pits showed up, in the middle another large ditch system, and on the eastern part scarce marks of settlement and a few graves of the cemetery were founded (*Fig. 2*). On the western edge of the rescue excavated area, close to the animal keeping hurdles three middle-sized pits were excavated, which included no rateable appendices; only in one of the pits a skeleton of a dog was found (*Fig. 3*). In addition on the middle of the area a stock-yard was found (*Fig. 2*).

Fig. 3 Skeleton of a dog

In the examined area various ditches could be observed. Firstly there were extensive hurdle ditches connected to the animal keeping part of the settlement; furthermore, large sections of ditch systems could be observed, which were probably used for some kind of defence of the settlement. The most western parts of one of the ditch systems were the ditches nr. 5. and 4. The narrow, shallow ditch nr.4 followed the line of the ditch nr. 5. (*Fig. 2*). The 2 m wide, variable deep, arranged bottomed 5. ditch cut the excavated area in northwest- southeast direction across. Its cutting was extremely interesting: in almost its whole length in both sides of the ditch there was a sinking: it was 20-30 cm wide and came down with the same depth under the bottom level of the ditch, which is supposed to be the basic ditch of the pile lines on both sides of the ditch (Fig.4). The other great, with the previous parallel ditch system formed by the ditches 25-26-27, turned up about 40-45 m from the ditches 4-5 (*Fig. 2*). The depth of the three parallel and approaching ditches were remarkably distinct.

Fig. 4 Ditch Nr. 5

The middle and the eastern (26-27.) ditches had arranged bottoms, but according to the pruned surface they were shallow, however the ditch nr. 25 ended about 80 cm from the pruned level. Its width was about 200 cm; its lateral wall was upright, partly splay, and its bottom was mainly straight. The speciality of this ditch system is that with the sudden "jumping up" of the ditch bottom it became really shallow on a 15 m long stage. While there is no mark on a subsequent infilling of the ditch, we recognise the shallow part as the part of the original ditch. The explanation can be that there might be some kind of entrance or passage through the ditch (*Fig. 5*). According to the air photo made on the area the ditch system can be followed on few hundred meters. In the long run we can assume only generally, that it might be a part of a significant fortification-ditch defence system (*Fig. 6*).

Fig. 5 Ditch Nr. 25

The air photos show not only the great fortification system but also a wide cemetery (*Fig. 6*). On the eastern end of the excavated area nine graves were rescue excavated, with and without round-ditch (*Fig. 2.*). The NW-SE sited graves were dominantly close to each other. It is remarkable that graves without round-ditches were immediately next to those with round-ditch, close to each other, in a row. Usually young deceased were buried in those graves, while in the round-ditched graves rather adults (*Fig. 7 a, b*). Most of these were robbed.

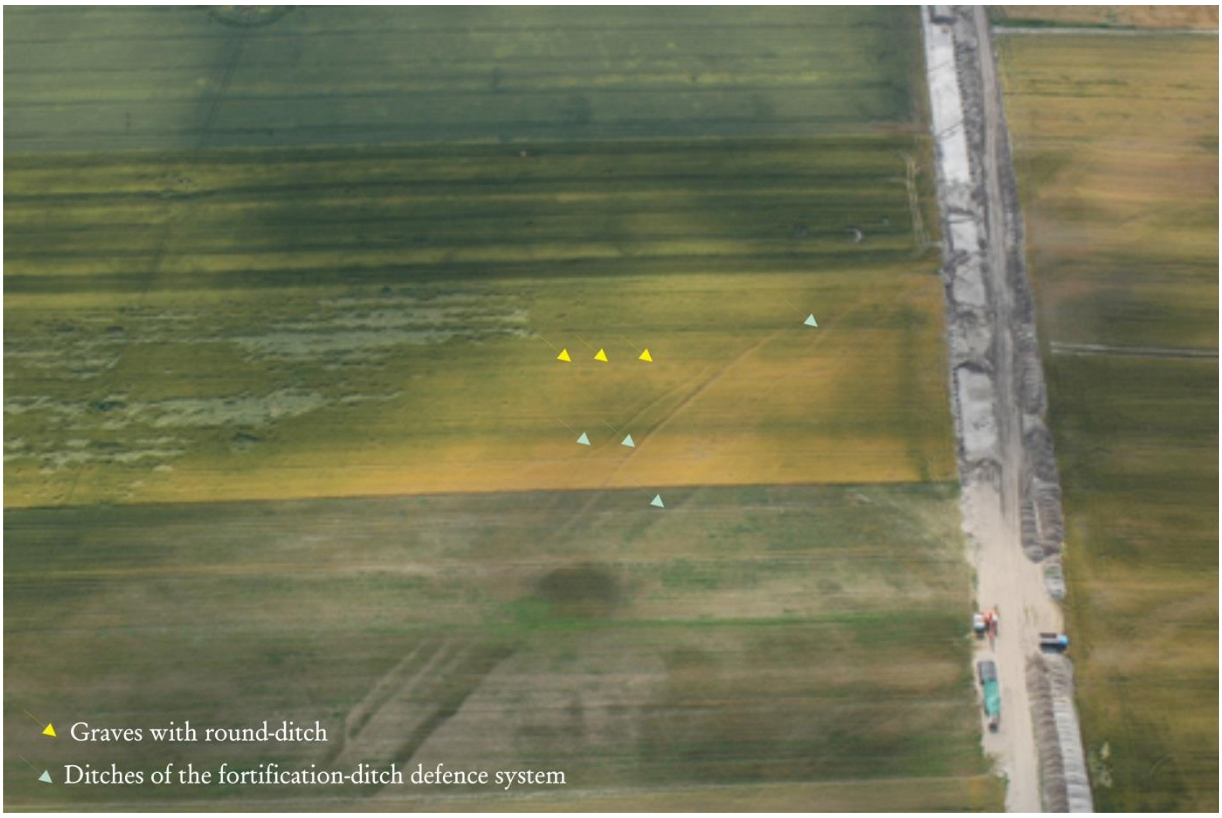

Fig.6 Air photo of the excavated area and its neighbourhood

The artefacts of untouched graves allowed of an interesting observation on costume history. In two graves a significant amount of different coloured pastry beads were found *(Fig. 7c)*. The beads were in rows, in the front part of the neck and on the wrist, so they might be the decoration of the neck and sleeve of the clothes. In the graves some brazen and silver fibulas, mostly close to the breastbone, were found and next to one skeleton there were two fibulas under each other. Other grave artefacts are: two brazen earrings, one brazen ring, one spindle knob, fragments of two small pots, fragments of an iron knife and iron sword, together with a coin from Roman age (Aurelianus: 270-275).

Geomorphological mapping

The mapped area is 4 km^2 and situated on the western part of the Danube-Tisza Interfluve 2.5 kilometers from the Danube river on the border line between a stabilized blown sand surface and a former floodplain of the Danube River (*Fig. 1*). The altitude of the area varies between 94 and 102 m asl. In the middle a sand deposit can be seen which has been blown there by the wind from the deposited sand of the Danube River. This higher sandy place is bordered by low lying, flat areas (*Fig. 8*). Based on the relief map the centre of the investigated area represents an accumulation zone,

a. b. c.

Fig. 7 a: robbed adult grave; b: a round ditch; c: untouched grave with artefacts

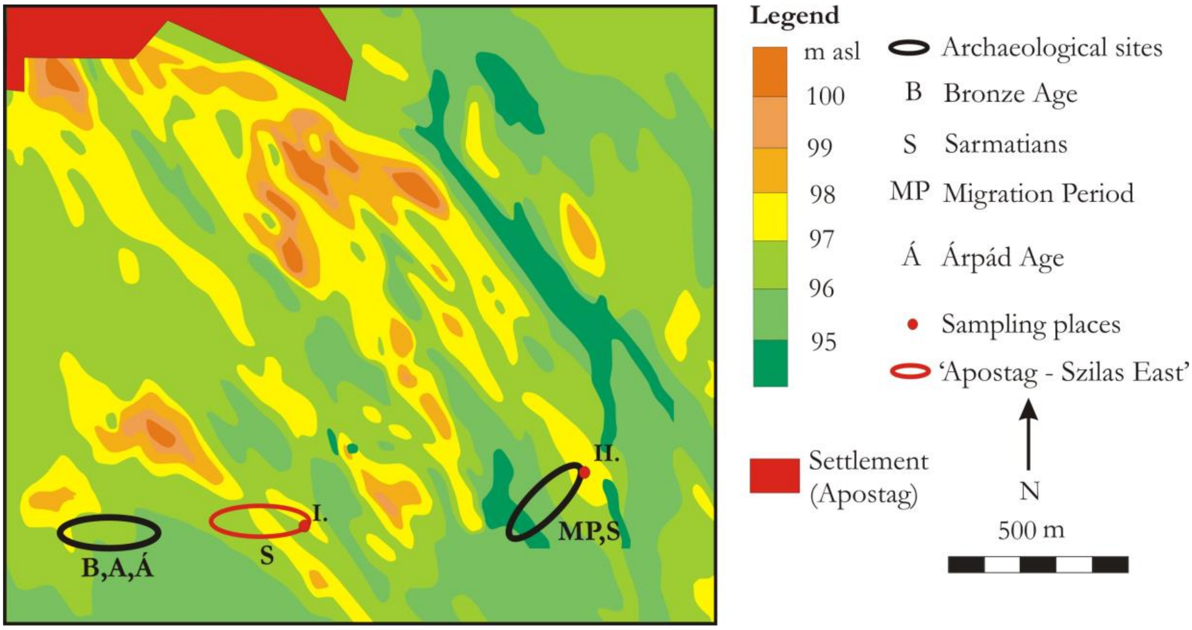

Fig. 8 The relief of the study area, the archaeological sites and the sampling places

where according to the geomorphological mapping the most typical forms are blowout depressions, blowout ridges and blowout dunes (hummocks). Around this higher sandy surface low lying, flat, former alluvial areas of the Danube River can be identified (*Fig. 9)*. The Holocene morphological evolution of the investigated area is complex. In most of the cases Pleistocene forms were reshaped and transformed, thus at certain locations the original morphology can hardly be identified. Remobilisation and reshaping was especially intensive during historical times, however it was restricted to smaller patches of land.

Depositional history

Samples were collected at two locations (*Fig. 8*). Profiles show the types of different depositions and OSL ages (*Fig. 10*). Based on the results, OSL yielded Early Holocene age for the lowermost layer (9094 ± 1096 BP), on which sequences of fluvial deposits, paleosoils and blown-sand layers were formed during the Holocene. Initially fluvial processes were characteristic on the territory.

The Danube River deposited carbonate silt on the surface. When the Danube left this area and drifted to West a thick paleosoil was formed on the

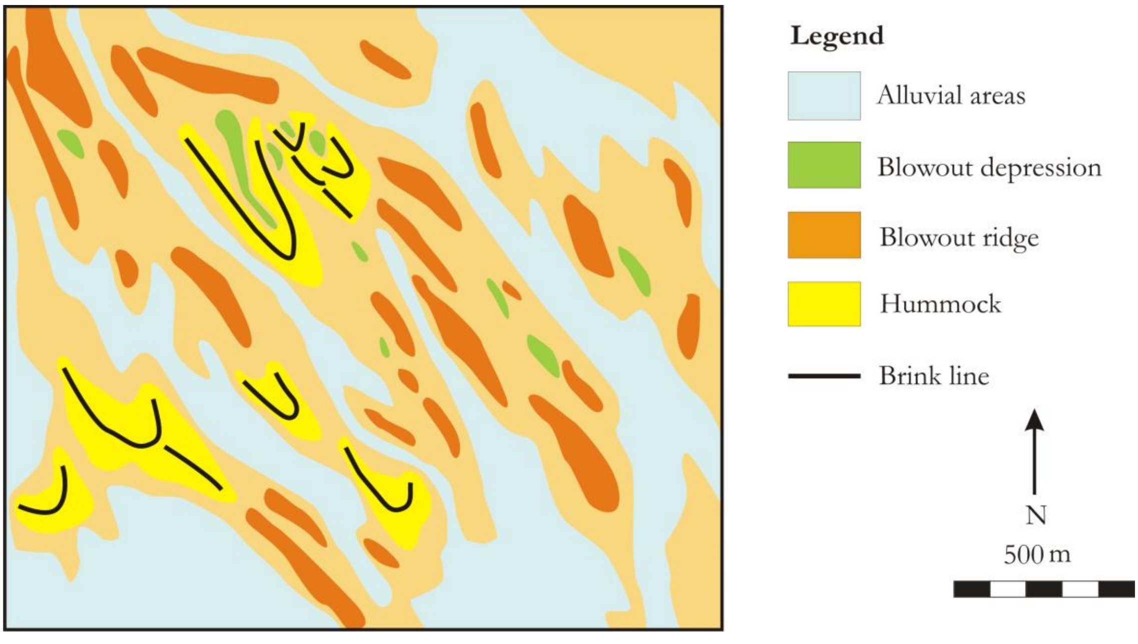

Fig. 9 The geomorphological setting of the study area

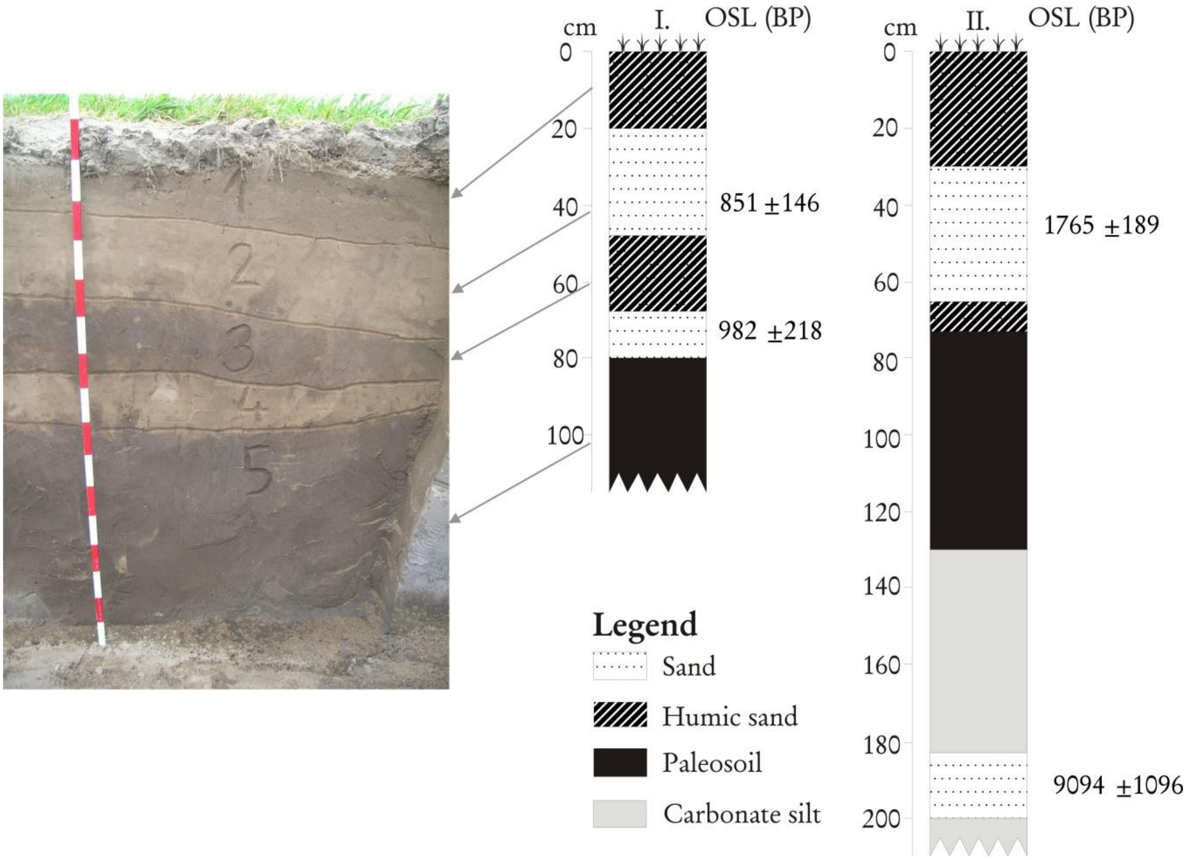

Fig. 10 Profiles of the sampling places, depositions and OSL data

surface. Paleosoil is superimposed by blown-sand layers of varying thickness in the profiles The first phase of sedimentation occurred 1765±189 y BP. Later aeolian activity restarted two times again, first 982 ± 218 y BP then 851 ± 146 y BP, according to OSL measurements

CONCLUSION

Age and sedimentological data of the profiles were compared to archaeological evidence, the spatial distribution of findings of the site (Wicker 2005), as well as archaeological relicts from the area of Apostag (KJM 1968, 1976, 1985, 2001, 2005). This enabled the reconstruction of the type, intensity and the result of human impact on the paleo-environment. All age data were plotted on a historical timescale (*Fig. 11*) According to the archaeological evidences, people settled down on the paleosoil surface. They were Sarmatians who inhabited the area between the 1st and 4th century. They were farmers and they also kept livestock on the pastures. The excavated marks of trenches and stock-yards prove that the excavated site probably functioned as a stock farm and the neighbouring mounds have been pastures or meadows. This is confirmed by the OSL measurements, as blown-sand movement was detected on the nearby higher places in the 3rd century AD (OSL: 1765 ± 189 BP). Probably the cause was ploughing or over-grazing resulting bare surfaces, which were scenes of wind erosion. Finally, a 60-70 cm sand sheet covered the paleosoils of neighbouring mound.

On the evidence of the archaeological investigations, later, in the Árpád Age a larger population lived on the territory of the study area and their activity meant an intensive burden on the environment. Be-

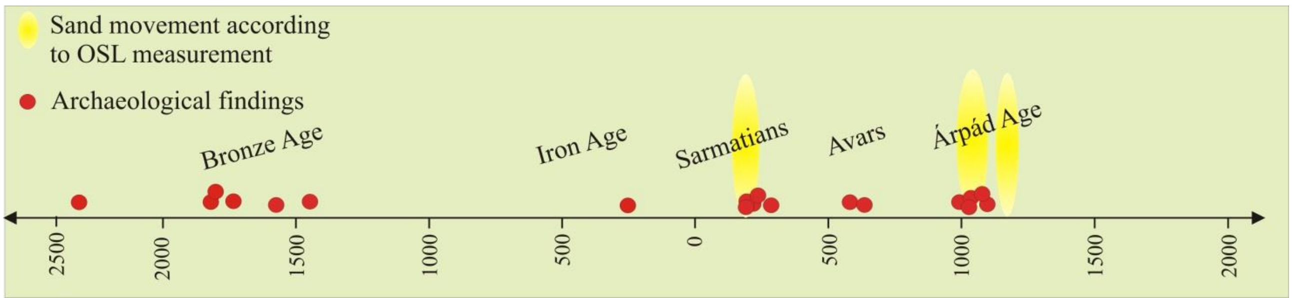

Fig. 11 OSL ages and the archaeological relicts of the area of Apostag

cause of the human impact, aeolian activity revealed again in the 11th century AD (OSL: 982 ± 218 BP) and a 20-30 cm thick sand sheet covered this time the former surface of the excavated site then a poorly developed soil was formed. Afterwards during the 12th century (OSL: 851 ± 146 BP) blown sand movement happened over again and another 60-80 cm thick sand layer covered the territory of the excavated area.

As a conclusion, there was three times spatially localized blown-sand movement on the study area. The first movement effected a sand deposition on the next mound from the archaeological site because of the activity of Sarmatians then two times blown sand movements covered the area of the site by sand sheets as a result of anthropogenic disturbance in the Árpád Age. Thus, former landscape has been changed. Today the surface is approximately 1 m higher than before and a sandy surface can be found where a thick paleosoil was situated before.

Acknowledgements

This research was supported by the European Union and the State of Hungary, co-financed by the European Social Fund in the framework of TÁMOP 4.2.4. A/2-11-1-2012-0001 'National Excellence Program'.

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