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TEMPORAL RELATIONSHIP OF INCREASED PALAEODISCHARGES AND LATE GLACIAL DEGLACIATION PHASES ON THE CATCHMENT OF RIVER MAROS/MUREŞ, CENTRAL EUROPE

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Abstract

River Maros/Mureş has one of the largest alluvial fans in the Carpathian Basin. On the surface of the fan several very wide, braided channels can be identified, resembling increased discharges during the Late Glacial. In our study we investigated the activity period of the largest channel of them, formed under a bankfull discharge three times higher than present day values. Previous investigations dated the formation of the palaeochannel to the very end of the Pleistocene by dating a point bar series upstream of the selected site. Our aim was to obtain further data on the activity period of the channel and to investigate temporal relationships between maximum palaeodischarges, deglaciation phases on the upland catchment and climatic amelioration during the Late Pleistocene.

The age of sediment samples was determined by optically stimulated luminescence (OSL). The investigation of the luminescence properties of the quartz extracts also enabled the assessment of sediment delivery dynamics in comparison to other palaeochannels on the alluvial fan.

OSL age results suggest that the activity of the channel is roughly coincident with, but slightly older than the previously determined ages, meaning that the main channel forming period started at 13.50±0.94 ka and must have ended by 8.64±0.82 ka. This period cannot directly be related to the major phases of glacier retreat on the upland catchments, and in terms of other high discharge channels only the activity of one overlaps with a major deglaciation phase at ~17-18 ka. Based on these, high palaeodischarges can be rather related to increased Late Glacial runoff, resulted by increasing precipitation and scarce vegetation cover on the catchment. Meanwhile, the quartz luminescence sensitivity of the investigated channel refers to fast sediment delivery from upland subcatchments. Therefore, the retreat of glaciers could affect alluvial processes on the lowland by increasing sediment availability, which contributed to the development of large braided palaeochannels.

Keywords: OSL dating, River Maros/Mureş, deglaciation, luminescence sensitivity, sediment delivery

INTRODUCTION

According to Starkel (2002, 2007) and Vandenberghe (2008), in Eastern and Northern Europe the periods of the most intensive fluvial activity can be related to the beginning of interstadials, partly as a consequence of the accelerated retreat of ice sheets and mountain glaciers. This hypothesis however needs to be attested at different catchments at different latitudes (Antoniazza and Lane, 2021). The key to this question is to find relationships between archives located on upland catchments and on alluvial fans.

Alluvial fans are major elements of the central part of the Carpathian Basin, and as such research related to these geomorphological units has a well-established literature in Hungary (e.g. Gábris, 1995; Gábris and Nádor, 2007; Mezősi, 2011; Kiss et al., 2015). Among these sedimentary bodies the Maros/Mureş Alluvial Fan is one of the largest ones, and special in several respects: fluvial activity has been the dominant process up till the river regulation works and this is recorded by a complex set of palaeochannels; parts of the river's upland catchment were affected by glaciation during the Last Glacial Maximum and the Late Glacial. Consequently, the alluvial fan is an excellent candidate for investigating upland–lowland interactions under the changing environment of the Late Pleistocene and the Holocene.

The evolution of the Maros/Mureş Alluvial Fan, the discharge and age of its palaeochannels have been extensively studied by previous authors (Katona et al., 2012; Sipos, 2012; Sümeghy et al., 2013; Kiss et al., 2013, 2014, 2015; Sümeghy, 2014). A great number of paleodrainage directions were identified, being active from the Late Glacial to the Early Holocene (Kiss et al., 2013, 2015; Sümeghy, 2014). Based on the reconstruction of the channels, the discharge and sediment transport capacity of the river increased significantly during this period. Bankfull discharge calculations suggest that by the end of the Pleistocene, the river was several times larger than today, and its dimensions steadily decreased during the Holocene (Kiss et al., 2014).

According to Kiss et al. (2014) and Sümeghy (2014), the highest bankfull discharge palaeochannels were occupying the northern half of the alluvial fan and were active between 15.2±2.0 ka and 9.6±1.3 ka (Fig. 1B). These channels had mostly a braided pattern, and the largest of them, located near Orosháza (palaeochannel "D" on Fig. 1B) could have a bankfull discharge of ~2600 m3/s (Katona et al., 2012). During the transition from the Late Glacial to the Holocene, only slight variations can be detected in bankfull discharge values (Kiss et al., 2015; Sümeghy, 2014).

Previous research has shown that climate change played a major role in affecting water and sediment yields, and thus determining fluvial aggradation and erosion processes (Vandenberghe, 2008; Gábris, 2013). For example, the climatic fluctuations of the Pleistocene and parallel variations of runoff and vegetation cover resulted a cyclic change in the activity of Eastern European sub-basins, which could lead to the formation of sediment pulses (e.g. Starkel et al., 2007, Antoniazza and Lane, 2021). Furthermore, changing runoff and sediment conditions could also affect the number of sediment cycles observed along rivers. Similar processes were hypothesised for River Maros/Mureş (Sipos, 2012), draining the waters of several mountain ranges of the Eastren and Southern Carpathians, which were heavily glaciated during the Pleistocene (Urdea, 2004). The repeated retreat of glaciers could alter both the water and sediment discharge of the river (Sipos, 2012).

Recent surface exposure dating (SED) results in the northern and southern valleys of the Retezat Mts. (Southern Carpathians), being the highest mountain range on River Maros/Mureş catchment, suggest that the maximum extent of glaciers and the onset of deglaciation occurred at ~20-21 ka, the same as in the rest of Europe. Deglaciation in the area was uneven, and several separate stages can be identified on the basis of the age of moraines at different altitudes (Ruszkiczay-Rüdiger et al., 2016, 2017, 2021). However, due to rapid glacier retreat, these phases partially overlap (Ruszkiczay-Rüdiger et al., 2021). Based on the measurements of Ruszkiczay-Rüdiger et al. (2016), the youngest moraines in the northern valleys of the Retezat Mts. are related to a minor glacial advance at ~14.5 ka during the GI-1 interstadial (Bølling/Allerød). There is no direct evidence for later glaciation cycles in the area, i.e the last moraines in the area have been stable for nearly 13.5 ka (Ruszkiczay-Rüdiger et al., 2016).

Based on the above, the major aim of the present study was to investigate the possible temporal linkages between Late Glacial deglaciation processes on the upland catchment and lowland fluvial processes related to River Maros/Mureş, with special emphasis on the largest palaeochannel identifiable on the alluvial fan of the river. Besides, by using a novel approach we attempted to assess the dynamics of sediment delivery from upland sediment sources.

STUDY AREA AND SAMPLING

River Maros/Mureş is the fourth largest river of the Carpathian Basin, and it is the largest tributary of the Tisza River (Fig. 1A). The area of its catchment is ~30,000 km^2, it drains the waters of the Transylvanian Basin, and it is bordered by the Apuseni Mountains and the Eastern and Southern Carpathians. The highest range on the catchment, affected greatly by Pleistocene glaciation is the Retezat Mts., with a maximum height of 2509 m (Fig. 1A). The northern, western and major southern exposure valleys of the mountain range are all drained to River Strei, a tributary of the Maros/Mureş. The actual mean discharge of the river at its lowland section is 160 m^3/s, while its bankfull discharge can reach 850 m^3/s (Fiala et al., 2007).

Samples for OSL dating were collected from sediments related to the largest palaeochannel generation (palaeochannel "D"), located north of the axis of the alluvial fan, along the Kétegyháza – Orosháza – Hódmezővásárhely line. This channel was also investigated by Kiss et al. (2014) and Sümeghy (2014) at Orosháza (Fig. 1B). Based on their data, the channel was active between 12.4±2.1 and 9.6±1.3 ka (Sümeghy, 2014). The channel is characterised by a change from a braided to a meandering channel pattern near Orosháza and a braided pattern again on its lower reaches. The width of the channel can reach up to 1000 m, its average bankfull depth was estimated to be 2.8 m on the basis of topographical and shallow geophysical surveys (Katona et al., 2012). The bankfull discharge of the palaeochannel was estimated to be ~2600 m^3/s (Katona et al., 2012; Sümeghy, 2014).

Sediment samples were collected 30 km downstream of the Orosháza site (Kiss et al., 2014) near the former confluence with the palaeo-Tisza River (Fig. 1B). A total of four samples were collected from two sampling sites in a recently opened sand quarry, located in the area of the former village of Csomorkány, north-east of the town of Hódmezővásárhely (Fig. 1B).

The first sampling point (CSOM1) represents the point bar on the left bank of the former palaeochannel, while at the second sampling point (CSOM2) an aeolian sand sheet with parabolic dune forms was sampled (Fig. 1C). Based on the topography and the dominant wind direction (N-NW), the aeolian sediments investigated were blown out from the abandoned channel, and can indicate the minimum age of fluvial activity.

At the first CSOM1 profile, coarse grain cross-bedded deposits were observed, interbedded with thin silty layers, referring to a cyclic deposition during channel development (Fig. 2). The first sample (OSZ1468) was collected at 81.5 m asl., from a cross-bedded, coarse-grained fluvial deposit, while the second sample (OSZ1467) was taken from a sand layer between two silty deposits (Fig. 2). The third sample (OSZ1466) was collected at 82.5 m asl., from, above the topmost silt layer.

At the second sampling point (CSOM2), one sample was collected (OSZ1469) at a depth of 70 cm compared to the ground surface level (~85.2 m asl), from a medium to coarse-grained, homogeneous, unstratified sand deposit. Based on its stratigraphic features the deposit was interpreted as an aeolian sand sheet; its material was presumably blown out of the already abandoned channel (Fig. 2).

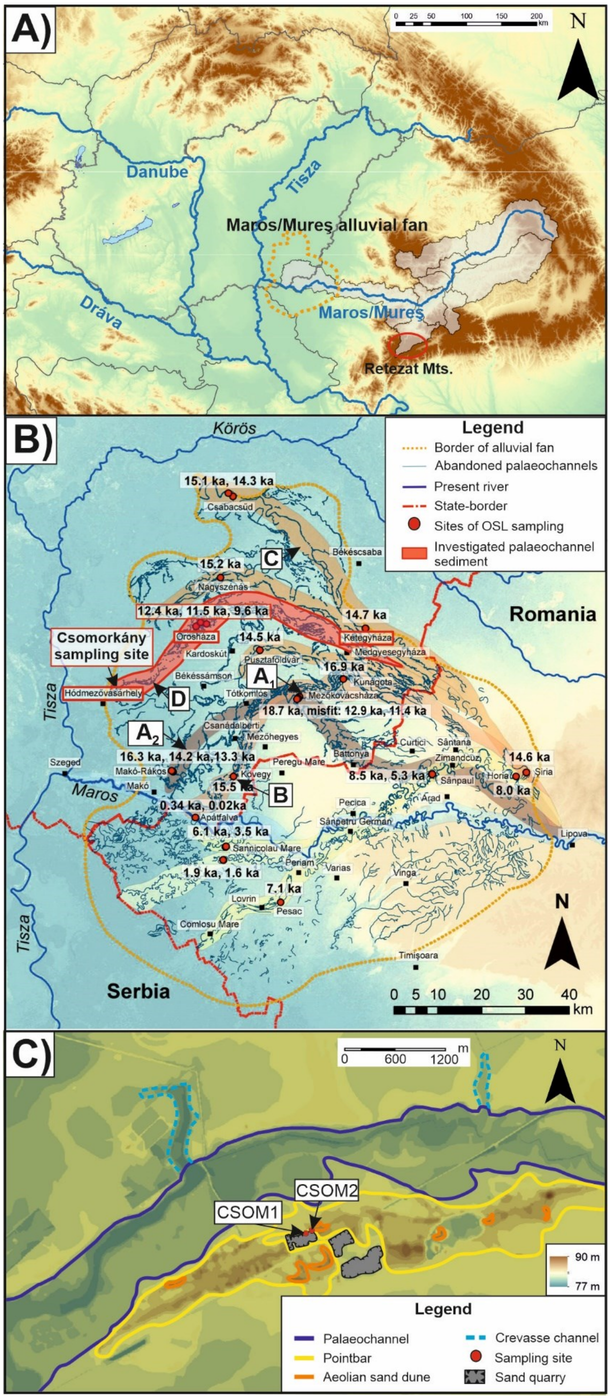

Fig. 1 A) Location of the Maros/Mureş Alluvial Fan and the Retezat Mts. in the Carpathian Basin;
B) Position of palaeochannels on the alluvial fan (after Sipos, 2012), those being active during the Late Glacial are marked by capital letters (following the system of Kiss et al., 2015), and the location of the Csomorkány sampling site;
C) DEM and most important geomorphological features of the Csomorkány sampling site.

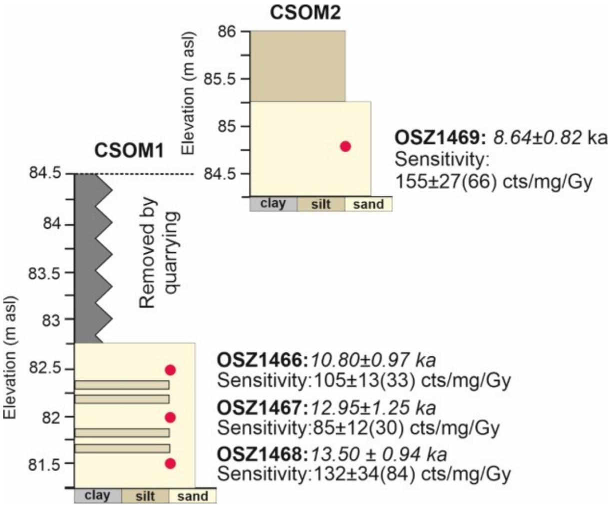

Fig. 2 The vertical position of sampling profiles and sampling points with the obtained OSL ages and quartz sensitivity values.

METHODS

The geomorphology of the study area was studied on the basis of a topographic map (scale of 1:10000). Geomorphological features were mapped using ESRI ArcGIS 10.4.1 (Fig. 1C).

At both sites, OSL samples were taken from an open profile of the sand quarry using an Eijkelkamp undisturbed sampler with light tight steel cylinders. An additional ~500 g of sediment was taken from around the OSL samples to determine the environmental dose rate necessary for age calculation. As most of the surface sediments have been removed by quarrying, the original altitude of the terrain could only be estimated using topographical maps (scale: 1:10000) made well before the opening of the quarry. The exact elevation of sampling points (m asl) was measured using an RTK GPS.

Optically Stimulated Luminescence (OSL) is a method to investigate the age of the last deposition of sediments, and thus it is suitable to date fluvial activity periods, for example the formation of palaeochannels and point bars (Rittenour, 2008). Although, the method is primarily used for dating, there is a number of additional information provided by luminescence measurements that can help to refine geomorphological reconstruction. One of these is measuring the OSL response to unit radioactive dose, by which the so called luminescence sensitivity, a parameter largely dependent on the petrological background and the sedimentation history of grains (Sawakuchi et al., 2018, Bartyik et al., 2021a), of the investigated mineral extract (this time quartz) can be assessed (Gray et al., 2019).

The preparation of the collected OSL samples has followed usual laboratory techniques (Mauz et al., 2002; Sipos et al., 2016). First a 1 cm thick layer was removed from each end of the sampling cylinders. The samples were then dried to constant weight to determine *in situ* water content. The coarse-grained sand was separated using sieves of 150-200 µm and 220-300 µm. The most abundant fraction was then subjected to acid treatment, using 10% HCl to remove the carbonate content and 10%

H_2O_2 to remove the organic matter content of the sample. The quartz fraction, essential for OSL measurements, was separated using an adjustable density heavy liquid (LST-Fastfloat). The separated quartz minerals were subjected to a 40% hydrogen fluoride (HF) treatment for further purification and accurate calculation of the dose rate. The clean quartz grains were spread on a 1 cm diameter stainless steel disc using a 2 mm mask. For luminescence sensitivity measurements, grains were placed in 1 cm diameter stainless steel cups. The weight of the samples in the sample carrier was recorded using an analytical balance for the mass normalisation of results later.

Equivalent dose (D_e) and sensitivity measurements were both carried out using a RISØ TL/OSL-DA-20 luminescence reader. Irradiation was made using a calibrated $^{90}Sr/^{90}Y$ beta source. Luminescence intensities were detected through a Hoya U-340 filter placed between the sample and the photomultiplier.

The Single Aliquot Regeneration (SAR) protocol, developed by Wintle and Murray (2006), was used to determine the De of quartz samples. Prior to De measurements a combined preheat and dose recovery test was performed on two samples (OSZ1466, OSZ1469) in order to determine optimal heating parameters. Based on the dispersion, skewness and kurtosis of single aliquot results, the minimum age model (MAM) was used to calculate sample equivalent dose values (Galbraith et al., 1999; Arnold et al., 2007).

The luminescence sensitivity of samples was assessed using both OSL and TL (thermoluminescence) responses for the same dose. Measurements and evaluation followed the steps of Nian et al. (2019) and Bartyik et al. (2021a). The previously bleached samples were irradiated with a uniform dose of 24 Gy. OSL sensitivity was determined using the first 0.5 s of the continuous wave OSL (CW-OSL) luminescence decay curves. For calculating TL sensitivity, the signal obtained in the 80-120°C range (TL 110°C peak) of the growth curve was integrated. These data were then normalised by sample mass, dose and background. The error of sensitivity results is expressed both using standard error (SE) and standard deviation (SD), the later one is put in parentheses hereinafter.

Environmental dose rate (D*), which is also essential for the calculation of the OSL age, was determined by measuring the specific activity of sediment samples using a Canberra XtRa extended range gamma spectrometer equipped with a Coaxial type Germanium detector. The cosmic dose rate was calculated using the empirical formula of Prescott and Hutton (1994).

RESULTS AND DISCUSSION

Luminescence properties

The preheat and dose recovery tests on sample OSZ1466 and OSZ1467 resulted very high recuperation values, close to the 5% threshold at all temperature ranges investigated (Fig. 3). In such cases, as suggested by Murray and Wintle (2003), an additional high temperature stimulation (280°C) (Hot Bleach) was added to the SAR protocol at the end of each measurement cycle. Consequently, the error caused by high recuperation values could be significantly reduced. Based on the combined preheat and dose recovery tests, a 200°C preheat temperature was chosen for subsequent measurements, as samples passed other SAR criteria (Wintle and Murray, 2006) also at this temperature (Fig. 3).

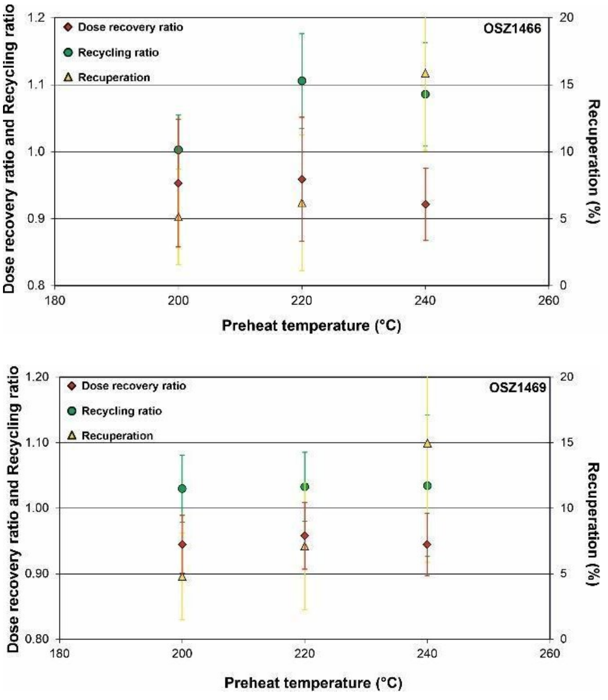

Fig. 3 Preheat and dose recovery test results for samples OSZ1466 and OSZ1469.

During sensitivity measurements, each sample produced an adequate amount of luminescence signal. The lowest sample in the CSOM1 section, OSZ1468, had a sensitivity of 132±34(84) cts/mg/Gy, while the two samples above (OSZ1467, OSZ1466) had slightly lower values: 85±12(30) cts/mg/Gy and 105±13(33) cts/mg/Gy (Table 1). Sample OSZ1469 with an aeolian origin had the highest CW-OSL sensitivity, being 155±27(66) cts/mg/Gy.

In terms of the TL 110°C peak sensitivity values, no significant differences could be identified at the CSOM1 profile (Table 1). OSZ1466 yielded 1517±148(419) cts/mg/Gy, OSZ1467 1447±106(300) cts/mg/Gy and the lowest sample OSZ1468 1530±211(597) cts/mg/Gy. However, the OSZ1469 sample from CSOM2 had a TL sensitivity of 2160±290(821) cts/mg/Gy, which is significantly higher than in the case of the previous samples (Table 1).

After plotting the two sensitivity parameters against each other it became possible to compare quartz sensitivities to previous data obtained from other sediments related either to the Maros/Mureş, Tisza or Danube Rivers (Fig. 4) investigated by Bartyik et al. (2021a). The detailed comparison of the CW-OSL and TL 110°C peak sensitivities of the Csomorkány quartz with the results of the Carpathian Basin fluvial samples (Bartyik et al., 2021a), reflects that the CSOM1 section samples represent a transitional sensitivity level (Fig. 4).

Table 1 Dose rate, equivalent dose and sensitivity data of the investigated samples.

Lab ID	OSZ1466	OSZ1467	OSZ1468	OSZ1469
Altitude of the sample [m asl]	82.5	82	81.5	84.8
Water content [%]	10±2	10±2	10±2	10±2
U [ppm]	1.35±0.02	1.47±0.02	1.21±0.02	1.51±0.02
Th [ppm]	4.81±0.11	5.11±0.12	4.33±0.11	5.27±0.12
K [ppm]	1.34±0.04	1.26±0.04	1.14±0.03	1.21±0.04
D* [Gy/ka]	1.85±0.04	1.65±0.04	1.60±0.04	1.84±0.04
D_e [Gy]	19.97±1.73	21.38±1.94	21.66±1.44	15.93±1.46
Age [ka]	10.80±0.97	12.95±1.25	13.50±0.94	8.64±0.82
CW-OSL sensitivity mean±SE(SD) [cts/mg/Gy]	105±13(33)	85±12(29)	132±34(84)	155±27(66)
TL 110°C peak sensitivity mean±SE(SD) [cts/mg/Gy]	1517±148(419)	1447±106(300)	1530±211(597)	2156±290(821)

It is also clear that the CSOM1 samples have considerably lower CW-OSL values compared to the mean of all other Maros/Mureş sediments (175±10(67) cts/mg/Gy) from other palaeochannels on the alluvial fan (Bartyik et al., 2021a; Fig. 4). This average value is only approached by the aeolian sample in the CSOM2 profile (OSZ1469). The same trend can be identified concerning the TL 110°C peak sensitivity. In this case the average value of CSOM1 samples, being 1476±86(437) cts/mg/Gy is also significantly lower than the average TL sensitivity of other samples from the alluvial fan, being 2193±146(506) cts/mg/Gy. From among the samples studied by Bartyik et al. (2021a) one represented the same palaeochannel, but was collected at the Orosháza site investigated by Sümeghy (2014). This sample plots very close to CSOM1 samples and just like these it can clearly be differentiated from other Maros/Mureş Alluvial Fan samples (Fig. 4). Consequently, the low sensitivity of samples is not site specific, but can be characteristic for the entire palaeochannel.

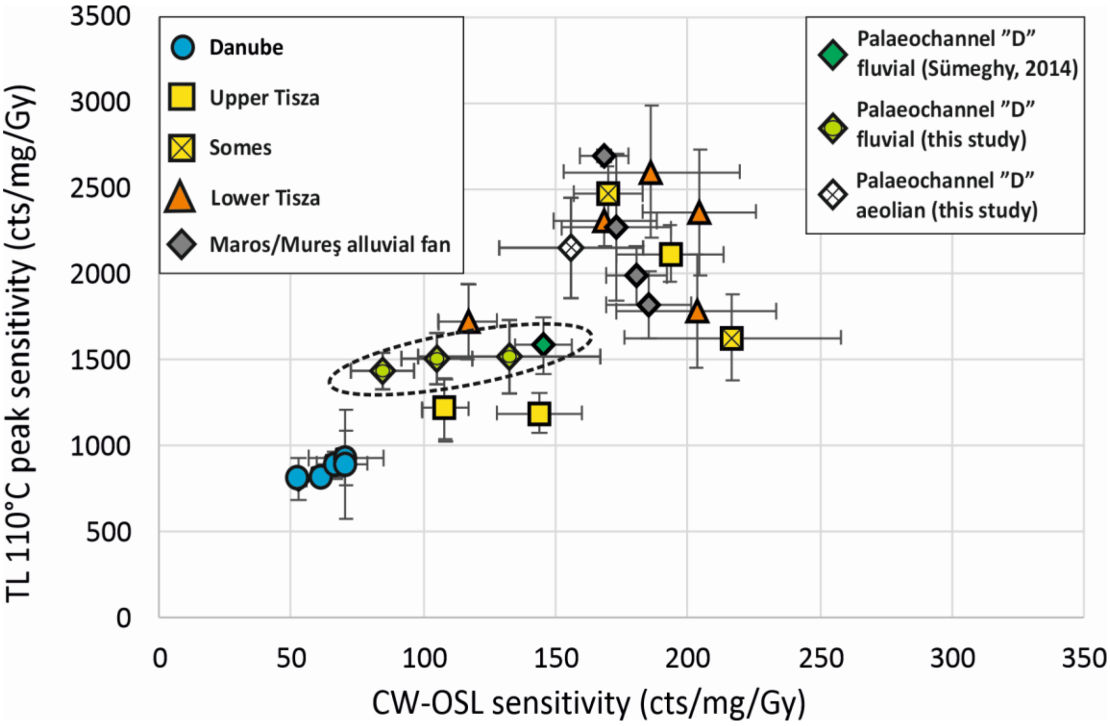

Fig. 4 CW-OSL and TL 110°C peak sensitivity results compared to the sensitivity results of Bartyik et al. (2021a). Values measured for the fluvial samples at the Csomorkány site and at the upstream Orosháza site are circled with a dashed line.

Low sensitivity values experienced in case of palaeochannel “D” can be explained by two factors. Firstly by the increased contribution of catchments rich in low sensitivity quartz to the sediment mixture of the palaeochannel. For example, it was demonstrated by Bartyik et al. (2021b) that the quartz sensitivity in a major tributary of the Maros/Mureş (River Strei), collecting the sediments of the Northern and Southern slopes of the Retezat Mts., is lower than the sensitivity of quartz from other catchments. Consequently, after the deglaciation this catchment could provide a considerable input to the main river. Secondly, as the number of sedimentary cycles can increase significantly the sensitivity of quartz grains (see e.g. Preusser et al., 2006; Fitzsimmons, 2011), the fast transfer of sediments from the upper catchments to the alluvial fan can also explain the low sensitivity of fluvial sediments related to palaeochannel “D”. Taking into consideration that the redeposited aeolian sample at the investigated site (OSZ1469) has higher sensitivity than fluvial ones, it seems probable that the second factor, i.e. limited sediment recycling due to fast sediment transfer can be the main reason behind low sensitivity values of palaeochannel “D”.

OSL quartz ages

The lowermost sample (OSZ1468) from the CSOM1 profile gave an age of 13.50±0.94 ka. A very similar result was obtained for the sample above (OSZ1467), giving an OSL age of 12.95±1.25 ka, meaning practically that the two layers can be related to the same fluvial cycle. These ages refer to channel sediment deposition during the GI-1 interstadial. The topmost sample at the CSOM1 profile is significantly younger and refers to another depositional event, in the Early Holocene at 10.80±0.97 ka. These data, by considering the uncertainty of OSL ages refer to a channel forming fluvial activity between ~14.5 and 9.8 ka ago (Table 1., Fig. 5).

The results of the samples from the CSOM1 profile are mostly in agreement with the OSL ages measured by Kiss et al. (2015) and Sümeghy (2014) on the upstream part of the same palaeochannel, determining an activity period between 12.4±2.1 and 9.6±1.3 ka. However, the present results slightly push back the start of major channel development along the investigated channel generation.

Sample OSZ1469, collected from the CSOM2 profile gave an OSL age of 8.64±0.82 ka, which is considerably younger than the fluvial records of the Csomorkány sampling site. During this period, the Maros/Mureş already shifted to the southern part of its alluvial fan (Kiss et al., 2015). The stratigraphy and the geomorphological setting suggest that aeolian activity started in the area after the avulsion, as the channel became dry. The higher luminescence sensitivity sample (OSZ1469) also refers to aeolian redeposition which can significantly increase sensitivity values as demonstrated by Fitzsimmon (2011) or Sawakuchi et al. (2011).

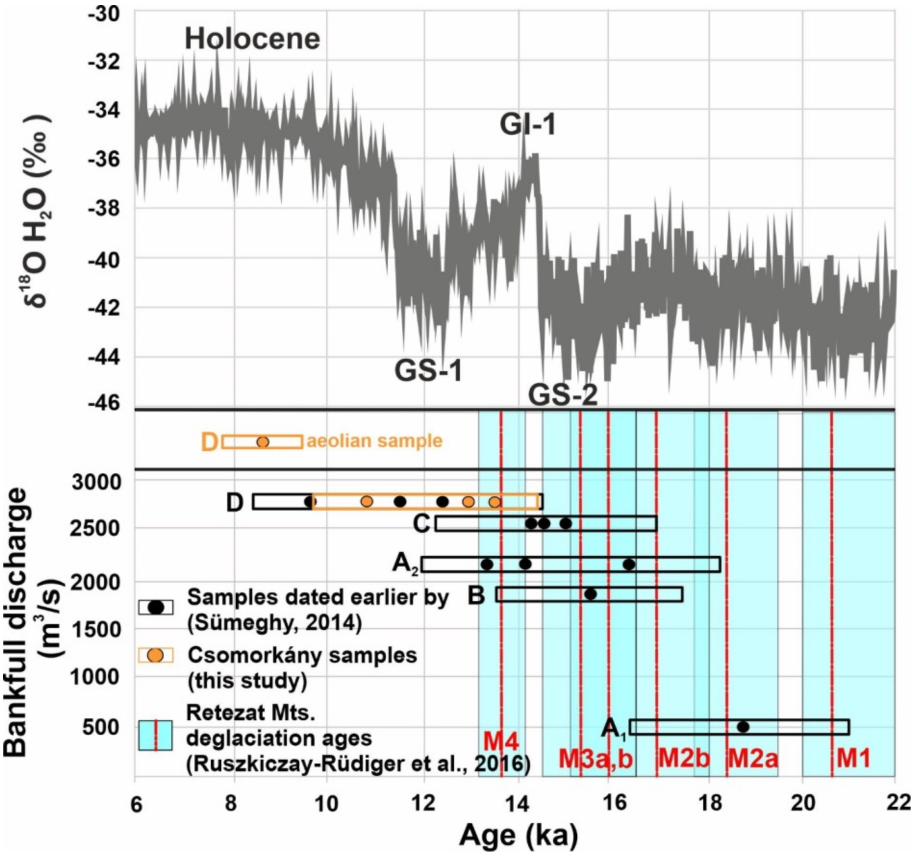

Fig. 5 Deglaciation phases in the northern valleys of the Retezat Mts. (Ruszkiczay-Rüdiger et al., 2016, 2021). B: palaeochannel activity periods on the Maros/Mureş Alluvial Fan (this study and Sümeghy, 2014) and the bankfull discharges of channels (Katona et al., 2012; Kiss et al., 2014), fitted to benthic δ^{18}O records (Lisiecki and Raymo, 2005).

Relationship of fluvial activity and deglaciation history

If the activity periods of palaeochannels along with their attributed discharge values determined by Kiss et al. (2015) and Katona et al., (2012) are compared to the deglaciation phases of the Retezat Mts., one can see that the lowest bankfull discharge palaeochannel "A1" coincides with the M1 (~22-20 ka) and M2 (~17-18 ka) deglaciation periods of the Late Glacial (Fig. 5). The elevation of M1 and M2 terminal moraines on the northern and southern slopes is 1080-1130 m asl. and 1220-1610 m asl (Ruszkiczay-Rüdiger et al., 2021), respectively, equalling to equilibrium line altitudes (ELA) of 1830-1900 m and 1960-1970 m (Ruszkiczay-Rüdiger et al., 2016). This means that the most intensive retreat of glaciers did not have a significant effect on the discharge of River Maros/Mureş on the alluvial fan.

The activity of channels with significantly higher discharges (palaeochannels: A2, B, C and D) can rather be related to deglaciation phases M3 and M4, occurring after minor glacier advance, leaving behind moraines at 1700-1880 m and 2050-2010 m asl, respectively, i.e. the ELA ascended to ~2040-2200 m asl. in this period (Ruszkiczay-Rüdiger et al., 2017; 2021). This also means that during these late phases the condition of glaciers affected only the top most region of the mountain range, thus melting could not significantly contribute to the high discharges experienced in terms of the palaeochannels on the alluvial fan (Fig. 5). Moreover, palaeochannel "C" with a bankfull discharge of ~2500 m^3/s was dated to GS-2 stadial, a cold period presumably resulting glacier advance anyway.

Although the activity of the now investigated palaeochannel "D" started during deglaciation phase M4, it also coincides with the GI-1 interstadial (Rasmussen et al., 2014), notable of large discharges on other Carpathian Basin rivers as a matter of precipitation increase (see e.g. Gábris, 1995, Gábris and Nádor, 2007).

At the same time, the braided pattern of palaeochannels from this period suggests a high availability of sediments on the catchment that can be partly caused by coarse grain sediments released from previously glaciated valleys on the upland catchment (Antoniazza and Lane, 2021), and the time lag between the adaptation of vegetation to climate change (Vandenberghe, 2008). Both leading to the initiation of sediment pulses towards the alluvial fan. Thus, due to the rapid warming (GI-1) and cooling (GS-1) of the climate, coarse grain sediments accumulated previously as a matter of limited runoff could be mobilised on the upper catchment. Consequently, deglaciation rather contributed to the changing sediment regime, the development of sediment pulses and the changing style of river channels on the alluvial fan.

CONCLUSIONS

The obtained ages pushed back the activity of the largest palaeochannel (palaeochannel "D") on the alluvial fan of River Maros/Mureş by approximately 1.0 ka compared to earlier studies. Still, the ages between 13.5±0.9 (this study) and 9.6±1.3 ka (Kiss et al., 2014), representing the channel forming period of the investigated palaeochannel, cannot be directly related to the major deglaciation phases of the Retezat Mts. Thus, the extremely high discharge inferred from the studied channel occurred as a matter of increased precipitation during the GI-1 interstadial and the delayed appearance of vegetation cover, both contributing to very high runoff values. Concerning other, relatively high discharge palaeochannels (A2, B, C) activity periods overlap with the final deglaciation phases of the Retezat Mts, but these final phases affected very limited areas on the upland catchment, and therefore, could not significantly contribute to increased runoff.

Though deglaciation did not affect significantly plaeodischarge values, sediment availability supposedly increased during the climatic amelioration. From upland sub-catchments a considerable amount of coarse grain sediment could be mobilised after the retreat of glaciers, and consequently shallow, braided channels could develop on the alluvial fan. Increased sediment delivery was also supported by the measured luminescence sensitivity values. Sediments associated with the fluvial activity of the investigated palaeochannel exhibit lower quartz luminescence sensitivity than any other previously investigated palaeochannels on the Maros/Mureş Alluvial Fan. Low values could be caused by 1) more active sediment supply from previously glaciated sub-catchments rich in low luminescence sensitivity quartz grains, and 2) faster delivery of grains towards the alluvial fan, whereby the grains were not subjected to several cycles of deposition which could enhance their sensitivity.

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