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A MODEL OF FLUVIAL ACCUMULATION LOCATED AFTER A GORGE

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ABSTRACT

The suggested model of fluvial accumulation is just one of the possible. The model is based on an examined area of the Topolnitza River in the periphery of the Thracian Lowland, directly after the gorge of the river in Sredna Gora Mountain.
In this area the fluvial deposits and the floodplain terrace of the Topolnitza River are mainly interpreted as a result of large scale erosion, transport and accumulation during the catastrophically flooding events. During each of them the water element has widely overflowed its banks, destroyed a great number of anthropogenic structures, transported a large quantity of material at the time of hollowing wide channel incision to the badrocks and simultaneously backfilled it. The flooding events are followed by relatively quite periods of several centuries each, with frequent, small-scale and larger, but not catastrophic floods. They caused transport and reworking of the fluvial sediments only from the uppermost levels of the section.
According to the authors this model of fluvial accumulation is valid for analogical areas of other streams comparable to the Topolnitza River flowing in a humid zone.
This is a model of humid fluvial accumulation in the valley-like areas in the periphery of flatland morphostructures directly after gorges, close to mountains.

INTRODUCTION

The object of the reason work is the valley bottom of the Topolnitza River in the periphery of the Thracian Lowland, directly after the gorge of the river in the Sredna Gora Mountain. The subject is the fluvial sediments of the valley bottom and mainly the ceramic fragments founded in these sediments and the aim – a commentary of a model of humid fluvial accumulation in the periphery areas of flatland morphostructures (flatlands, lowlands, cockpits) right after grogs in enclosed mountains.

The Topolnitza River originates in the central parts of the Sredna Gora Mountain. Its length is of 155 km. 130 of them is in the mountain and only the last 25 km are in the Thracian Lowland. The catchments area is about of 1800 km^2. These features define the Topolnitza River as a mainly mountainous one with small catchments area (according to the classification scheme of Solomontcev et al. 1976, p. 129). The climate of the region is a humid one. The river has an unstable snow-rain regime. The river leaves the mountain at Kalugerovo village (Fig. 1, 2) and flows into the Thracian Lowland where it runs into the Maritsa River.

The Topolnitza River mainly is deeply incised in gorge valley in its upland part. The valley bottom is in width of dozens of meters to a few hundred and more meters in the enlargements. It is entirely covered with fluvial sediments.

After the gorge in the area by the foot of the mountain follows the valley transition from a mountainous to a lowland type. The valley still has well outlined slopes here. Its bottom is enlarging fast. In it, in a 9 km. area exploration shafts on 4 profile lines for exploration of a gold-bearing placer were excavated (Fig. 2). In some of the fluvial sediments were established ceramic fragments of bricks, root tiles and pottery. They are not a subject of study in the fund reports (Ivanov et al., 1989) about the completed geo-exploration works. A report about them is published for the first time by Bakalova et al. (2003) where their archaeological aspect is commented in details. The launching model of fluvial accumulation is studied in the present publication

MATERIAL AND METHODS

The lithological description of the fluvial deposits, the definition of their grain size and the roundness of their gravel fragments as well as the collecting and the documentation (numbering and location) of the connected in them ceramic fragments were done during the excavation of the shafts for the explorations of the gold-bearing placer (Иванов и др., 1989). Generally the ceramic fragments are 98 and are from 1 to 7 in any single sample (on an average of 1-2). They are established in 49 samples of 33 shafts.

The ceramic fragments which age can be determined are dated by the archaeologists (Bakalova et al. 2003).

The grain size and the roundness of the ceramic fragments are examined by the authors of the present publication. It is done a classification of the age to the fluvial sediments using the locality of the dated fragments and the demarcating erosion incisions are established as well.

The grain-size distributing of the ceramic fragments is realized through the Udden-Wenworth scale (in Friedman et al., 1992, Fig. 1 and in Pettijohn, 1981, Fig. 3-6) and is used the width of the fragments. The description of the hard coursed lithological varieties is based on the proposed from Folk et al. (1970) scheme.

The degree of roundness of the fragments is defined on the scale proposed by Greensmith (1981, Fig 5.4) with the specialty, that the fragments with very angular and angular degree of roundness are united in one group. In this way the degrees of roundness which are used are *angular*, *subangular*, *subrounded*, *rounded* and *well rounded*. If there are two degrees of roundness visible in a fragment, following fracturing during the transport and subsequent smoothing is considered the older one i. e. the smoother one.

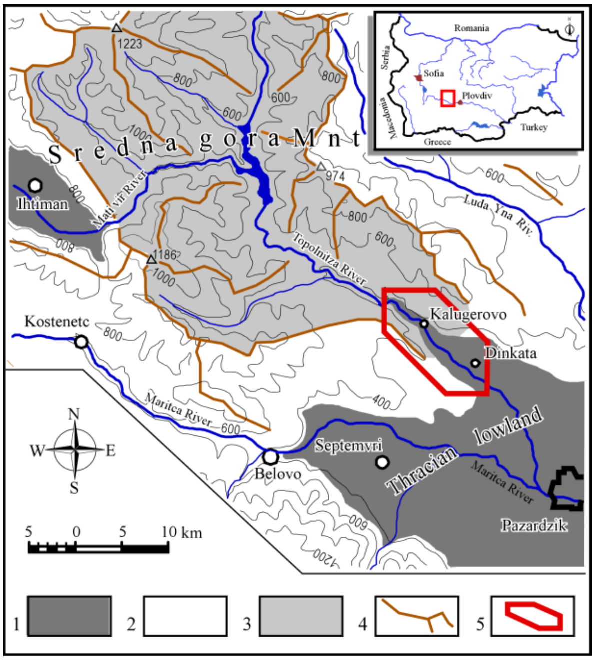

Figure 1. Geological-morphohydrographical schematic map of the studied part of the Topolnitza River valley. Geological data (1-2): 1 – undivided Quaternary sediments; 2 – undivided pre-Quaternary sedimentary, magmatic and metamorphic rocks. Morpho-hydrographical data (3-4): 3 – part of the catchment's area of Topolnitza River; 4 – ridges; 5 – studied area.

For studying the grain-size and roundness of the ceramic fragments initially they were separated in groups according to their presence in fluvial sediments of a defined age. After the subgroups are formed in every group and the fragments are divided into such of undated and such of dated, and the second ones are placed according to the respective ages. Histograms for the ceramic fragments of each groups and subgroups are designed on the base of grain-size and degree of roundness.

STATE OF PROBLEM OF THE MODELS OF THE RIVER ACTIVITY

It is generally known that the destructive, transport and accumulative force of the rivers are in a close connection in between. Widely discussed in a different expense in the specialized geological, geomorphologic and hydro-geologic literature are the models of their mechanisms of going off and mutuality. We will pay attention only on some aspects of them which are connected to the present investigation.

The destructive and the accumulative activity of the streams is takes place mainly on high waters (Zukov et al., 1970, p. 227).The question with the moving bottom sediments is vexed. Widely practiced in the hydro-geological is the attitude that that width is small and it is limited within the sweep of the moving alluvial dunes (banks) and to some decimeters beyond them (Solomontcev et al., 1976, p. 227). Geologists and geo-morphologists have another attitude, especially those of them who study fluvial placers. According to Bilibin (1955, p. 105) for example, with the overflowing of the waters become to wash away and to be involved in moving the deeper layers of the bottom sediments, due to the width of the moving layer marked of him as an active layer increases continuously. The supreme quantity of the active layer depends on the high water. The highest high waters can involves such layers of the fluvial sediments, which in course of a long period have not felt any moving.

AGE SUBDIVISION OF THE FLUVIAL SEDIMENTS FROM THE TOPOLNITZA RIVER VALLEY IN THE STUDIED AREA

The subdivision of the fluvial sediments from the Topolnitza River valley in the studied area by age has been done mainly on geomorphologic and geological data and refined according to the archaeological evidence.

Geomorphological subdivision by age

Geo-morphologically there are a distinctive fluvial channel, floodplain and non-flooded terraces in the valley bottom of Topolnitza River (Fig. 2).

The fluvial channel is an incision in the floodplain terrace. It is well-formed in the beginning of the area and it is missing in its end. The floodplain terrace is situated on the both parts of the fluvial channel. It is distinguished with a well marked step high 2-3 m by the non-flooded terrace which is lying out in the foot of the valley slopes.

The bottom of the fluvial channel is covered by sandy-pebbly sediments.

According to the data from the exploratory shafts, the uppermost levels the floodplain terrace are represented by sands and silts. They are overbank facies. Below them follow the sandy pebbles of the channel facies. Between the sediments of both of the facieses and in the upper level of the channel facies are founded clay lenses with different degree of sandiness, dark gray and with traces of plants from the facies of the abandoned channels. All of these deposits, except of the clays, are not compacted and they are rather loose.

The sediments of the non-flooded terrace were presented of analogical lithological varieties but due to their insufficient proficiency they have clarified facial relationship. Probably between them there are facieses of the proluvial deposits. Distinctive feature of the non-flooded terraces are the reddish-brown colors and the compacting of the gravels and sands, result of secondary input of clay component.

The pointed out geomorphologic (a presence of a fluvial channel and terrace shoots) and lithological (differences colors and the compaction of the sediments) data defined as a youngest the sediments to the bottom of the fluvial channel following by the relatively older sediments of the floodplain terrace and even older – the deposits of the non-flooded terrace.

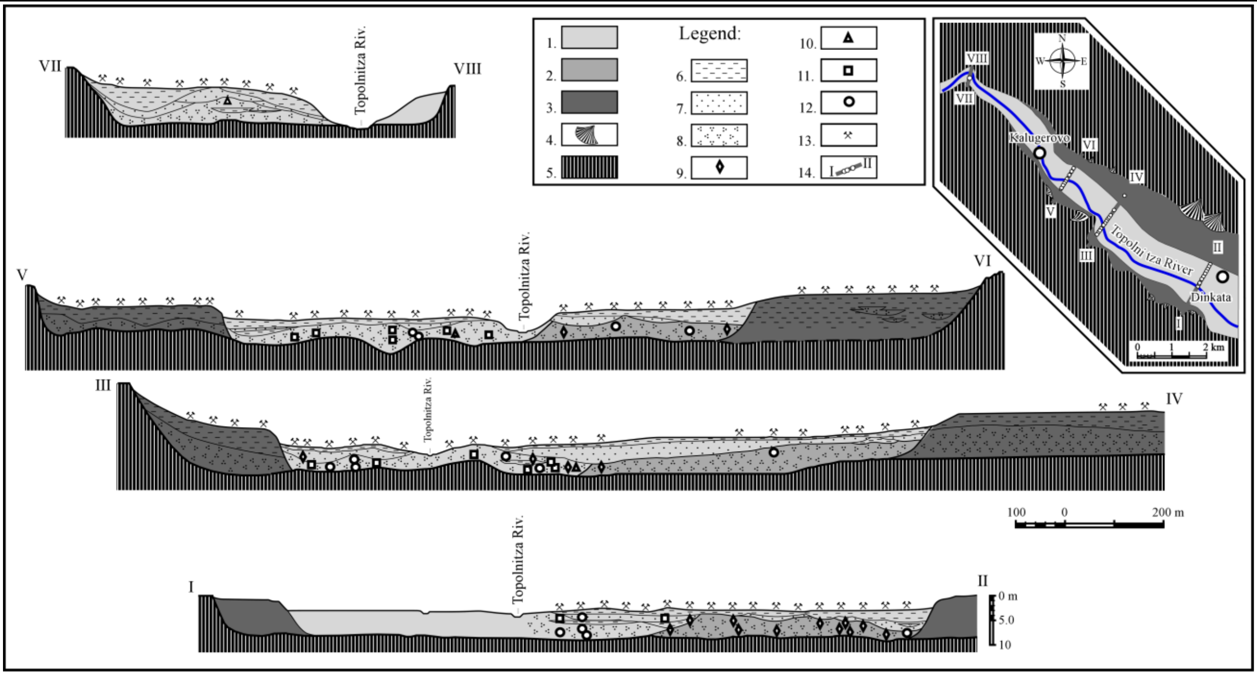

Figure 2. Geological sketch and cross-sections of the studied area of the valley of Topolnitza River with the location of the shafts and the samples with ceramic fragments (after Ivanov et al., 1989, with additions and new interpretation). Geological-morphohydrographical-archaeological data (1-12): Quaternary sediments (1-4): floodplain deposits (1-2): 1 – fluvial, not lithified, with ceramic fragments mainly from XVIII-XIX c. A. D. and single fragments from XII-XIV and IV-VI c. A. D.; 2 – fluvial, not lithified, with ceramic fragments only from IV-VI c. A. D.; 3 – non-floodplain terrace deposits: fluvial, compacted, red-brown; 4 – proluvial deposits; 5 – undivided pre-Quaternary sediments and magmatic rocks. Fluvial lithologies (6-8): 6 – clays and silts; 7 – sands; 8 – sandy gravel. Ceramic fragments (9-12): 9 – dated to IV-VI c. A. D.; 10 – dated to XII-XIV c. A. D.; 11 – dated to XVIII-XIX c. A. D.; 12 – of undetermined date; 13 - exploration shaft; 14 – profile line.

Detailization of the subdivision by age of the floodplain deposits on the base of archaeological data

The examined ceramic fragments are pieces of bricks, roof tiles and pottery. They are found only in the sediments of the floodplain mainly in the pebbles and partly in the sands (Fig. 2). The dated ceramics belong to three epochs: *first* – IV–VI c. A. D.: *second* - XI-XIV c. A. D. and *third* – XVIII-XIX c. A. D. (Bakalova et al. 2003).

On the base of the dated ceramic fragments we separate the deposits of the floodplain terrace into two laterally differentiated types: 1st – ceramic fragments only of IV-VI c. A. D.: 2nd - ceramic fragments mainly of XVIII-XIX c. A. D. but on some places of XII-XIV and IV-VI c. A. D. The age of the older deposits is on the range of IV-VI c. A. D. We conditionally accepted that the age coincides with the end of that rang and that is VIth c. A. D. (but it can be as IVth, as VIth c. A. D.). The age of the younger deposits is in the range of XVIII-XIX c. A. D. and we accepted that is XIXth c. A. D. by the same considerations.

There is no morphologic step between the two types of different aged sediments. Based on this we accept that the fine-grained sediments that cover them belong to the overbank facies of the deposits of XIX th c. A. D.

Generalized subdivision by age of the fluvial deposits

According to the above-mentioned, the examined fluvial sediments are divided in four different ages:

- *before IV c. A. D.* – these are the deposits of the non-flooded terrace. They contain no ceramic fragments. They are compacted and have secondary red-brown colors;
- *VI c. A. D.* – they fill an incision in the older sediments. These deposits contain fragments only from the 4th – 6th c. A. D. They are not compacted and only the channel facieses are preserved;
- *XIX c. A. D.* – they form the morphology of the floodplain terrace. They fill an incision. They contain ceramic fragments from XVIII-XIX c. A. D. as on some places can be found single fragments from XII-XIV and from IV-VI c. A. D. The sediments are not compacted and represent both the over-bank and the channel facieses. The second ones covered the deposits from 6th c. A. D.;
- *contemporary* – they cover the bottom of the fluvial channel. Part of the near-surface levels of the overbank facies of the floodplain terrace belongs to them.

DISTRIBUTION, GRAIN SIZE AND ROUNDNESS OF THE CERAMIC FRAGMENTS

Distribution

The distribution of the ceramic fragments in the host depositions is uneven (Fig. 2). There is a trend of increasing their number in the sediments down the river course.

Initially, the sediments of VI c. A. D. contain single ceramic fragments (Fig. 2, profile line V-VI and III-IV). To the SE parts of the studied area their quantity increases rapidly (Fig. 2, profile line I-II).

The sediments of XIX c. A. D. are almost sterile of ceramic fragments in the NW parts of the valley (Fig. 2, profile line VII-VIII). Their quantity stay significant, but with irregular distribution in the lower part of the studied area (Fig. 2, profile line V-VI), continue to increase (Fig. 2, profile line III-IV) and it is obscure in the SE part of the area (Fig. 2, profile line I-II) due to the limited number of shafts.

Grain size

The fluvial sediments containing ceramic fragments are mainly sandy pebbles (Fig. 3). They are polymodal with poorly presented modes in the fractions *small cobbles* (-6φ/-7φ), *medium pebbles* (-3φ/-4φ) and *coarse sands* (1φ/0φ).

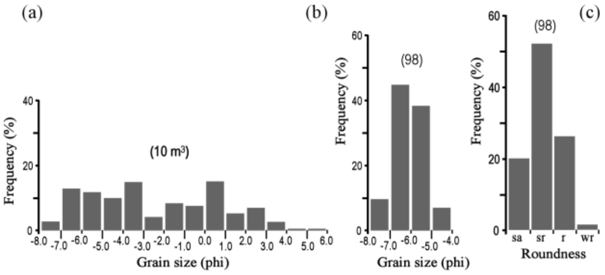

Figure 3. Diagrams of (a) grain size of the sandy gravels, (b) grain size of the ceramic fragments and (c) degree of roundness of the ceramic fragments. Abbreviations: sa – subangular; sr – subrounded; r – rounded; wr – well rounded.

The ceramic fragments have a maximal width of 154 mm and a minimal one of 29 mm. They are classified by grain size in the four coarsest fractions presented in fluvial deposits. The ceramic fragments (Fig. 3) have size of *small cobbles* to *very coarse pebbles* in roughly equal quantities. The fractions *coarse pebbles* (-4φ/-5φ) and *large cobbles* (-7φ/-8φ) are poorly represented.

The ceramic fragments in the fluvial sediments from the VI[th] c. A. D. are presented by four fractions, as the *small cobbles* (-6φ/-7φ) fraction is modal (Fig. 4). The dated fragments have a similar size distribution. The coarsest and finest fractions are missing among the undated fragments, while the two intermediate fractions *small cobbles* (-6φ/-7φ) and *very coarse pebbles* (-5φ/-6φ)) are presented in almost equal quantities.

The ceramic fragments in the fluvial sediments from the XIX[th] c. A. D. (Fig. 5) are also presented by the four fractions, but here the very coarse pebbles (-5φ/-6φ) fraction is modal. The ceramic fragments that can be dated are mostly of the *small cobbles* (-6φ/-7φ) and *very coarse pebbles* (-5φ/-6φ) fractions. The latter ones being somewhat better presented, and the *large cobbles* (-7φ/-8φ) and *coarse pebbles* (-4φ/-5φ) fractions are attested with few examples. The grain size distribution of the fragments from the XVIII-XIX c. A. D. found in these sediments is similar, with a better presented *small cobbles* (-6φ/-7φ) fraction. The redeposited older fragments from IV-VI and XII-XIV c. A. D. are generally smaller, with mainly *very coarse pebbles* (-5φ/-6φ) and without *large cobbles* (-7φ/-8φ) and *coarse pebbles* (-4φ/-5φ).

Generally, the ceramic fragments in the sediments from the XIX[th] c. A. D. are finer than the ones in the sediments from the VI[th] c. A. D. The undated fragments are finer than the datable ones. In the sediments from the IV-VI and XII-XIV c. A. D. the redeposited earlier ceramic fragments are finer than the ones from the XVIII-XIX c. A. D.

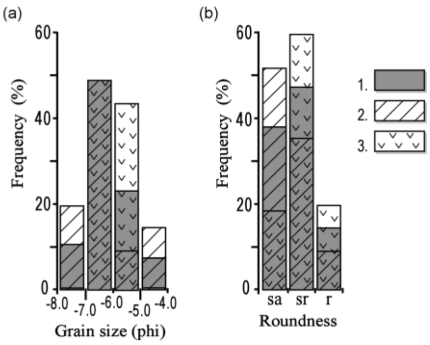

Figure 4. Diagrams of (a) grain size and (b) degree of roundness of the ceramic fragments in the fluvial sediments from the VI[th] c. A. D.: 1 – total fragments (34 pieces); 2 – dated fragments (19 pieces.); 3 – undated fragments (15 pieces). Abbreviations – as in Fig. 3.

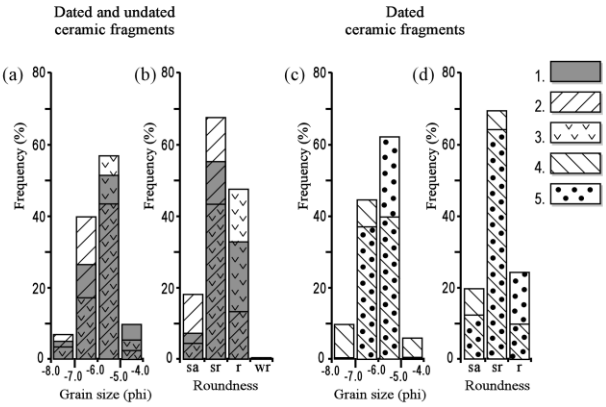

Figure 5. Diagrams of (a, c) grain size and (b,d) degree of roundness of the ceramic fragments in the fluvial sediments from the XIX[th] c. A. D.: 1 – total fragmentse (64 pieces); 2 – dated fragments (28 pieces); 3 - undated fragments (36 pieces); 4 - fragments from XVIII-XIX c. A. D (20 pieces); 5 – resedimented fragments from IV-VI and XII-XIV c. A. D (8 pieces.). Abbreviations – as in Fig. 3.

Roundness

Regardless to their petrographic composition and affiliation to sediments of one or another age, the fluvial clasts are mainly subrounded to rounded, rarely subangular to well rounded, while angular clasts are practically absent.

The roundness of the ceramic fragments is low. Subrounded fragments are the most abundant (Fig. 3). The subangular and rounded fragments are presented in equal proportions. Only one fragment is in the well-rounded class. The angular class is totally absent.

The roundness of the ceramic fragments is much varying when it is discussed differentiated according to their distribution in the fluvial sediments of various ages and to their datability.

The subrounded ceramic fragments dominate in the fluvial sediments from VI[th] c. A. D. (Fig. 4). The subangular and notably less the rounded fragments are with similar participation. The fragments that can be dated are mainly subangular, followed by subrounded and rounded. Their degree of roundness is lower than the one of the fragments that cannot be dated, which are mainly subrounded.

In the fluvial sediments from XIXth c. A. D. (Fig. 5) the general degree of roundness of the fragments is higher. Here the subrounded fragments are most numerous too, followed by the rounded class, while the subangular fragments are very few. The roundness of the datable fragments here is lower than that of the undated ones.

Generally, the ceramic fragments in the sediments from the XIXth c. A. D. are better rounded than the ones in the sediments from the VIth c. A. D. Furthermore, the undated fragments are better rounded than the datable ones in both groups.

MODEL OF AFTER GORGE FLUVIAL ACCUMULATION IN PART OF TOPOLNITZA RIVER VALLEY

It should be reminded that the Topolnitza River is in the humid zone, has a small catchment's area, does not dry out over the year, and has an unstable snow-rain regime. The studied valley segment is in the periphery of the Thracian Lowland, located after the gorge. In this area is presented the transition from a mountainous to a flatland river type.

The suggested model of accumulation is offered mainly with the ceramic fragments established in the fluvial deposits.

Discussion on the spatial distribution of the ceramic fragments

The spatial distribution of the datable ceramic fragments allows the differentiation of two erosion incisions in the floodplain completely filled with sediments (Fig. 2):

- *an older one* - the incision reaches the bedrock. The sediments include ceramic fragments of which the datable ones are only from the period IV-VI c. A. D.
- *a younger one* - the incision also reaches the bedrock. The sediments include ceramic fragments, the dated ceramic fragments are mainly from the XVIII-XIX c. A. D., but there are also some fragments from the XII-XIV and from the IV-VI c. A. D.

These two erosion incisions can be identified as the result of catastrophic floods. During every one of these the water flooded all the valley bed and destroyed the anthropogenic structures situated in it, the stream deepened and widened its channel, and almost simultaneously backfilled it. The stream is probably debris flow type i. e. with high viscosity, transporting the rock material in a floating mood. It could be nominated as a *stream of dilution* by the classification of Leeder (1986, p. 106).

The uneven distribution of the ceramic fragments in the fluvial sediments can be interpreted as an independent or combined result of: (1) "spot" sources for these fragments, of "cluster" character of their transport i. e. a near feeding up; (2). changes of the transporting capacity of the stream, influenced by the morphology to the formed channel (together with the widening of the vertical section the transporting capacity was falling down, which was driving to simultaneously precipitation of a ceramic fragments).

Two catastrophic floodings are proved and it can be suggested an intermediate one by the distribution of the dated ceramic fragments. The fluvial sediments containing ceramic fragments only of IV-VI c. A. D. indicates an older one. Such a second flooding is proved by the fluvial sediments, containing ceramic fragments of XVIII-XIX c. A. D. These sediments include fragments of XI-XIV c. A. D and even of IV-VI c. A. D.

It can be suggested that the intermediate catastrophic floods which stream load has included newly received ceramic fragments of XII-XIV c. A. D. and resedimented ones of IV-VI c. A. D. These deposits probably are entirely reworked by the catastrophic flooding in the range of XVIII-XIX c. A. D. because of the coincidence of their erosion incision.

Discussion on the grain size and the roundness of the ceramic fragments

The differences in the grain size and in the roundness of the ceramic fragments are explained reasonable with the presuming that they were stood the work of the transporting water medium to a different degree.

The periods between the catastrophic floods were at least several centuries each and are relatively quite ones. During them series of small and bigger floods caused the transport of the clastic material in the uppermost levels of the fluvial section, mainly as moving dunes (bars). That is the way that in these levels the erasing and the rounding have continued and it has began the rounding of the newly joined ones.

The dated ceramic fragments have better preserved details, they are with lower degree of roundness and they are more coarsely grained than the undated ones. This is an indication that the dated fragments have been longer in peace.

Locality of the model

The suggested model is applicable to fluvial accumulation in a valley segment incorporating the transition from a mountainous to a flatland type.

During a catastrophic flood all the valley sediments can be involved in the transport and mixed together due to the small width of the valley bottom and the high hydrodynamic energy of the stream in the gorge above the studied part of the valley of Topolnitza River.

In the inner area of the Thracian Lowland the river spreads wide during a flooding event, its destructive energy and the ability to form deep channels decrease, changing the model of accumulation.

CONCLUSIONS

The model of fluvial accumulation in the studied area of the Topolnitza River valley is based mainly on the ceramic fragments found in its fluvial sediments.

According to the duration and character of the accumulation processes, the resulting model is a catastrophic one. It covers the period between the IVth and VIth c. A. D. and it is continuing nowadays including:

- *main stages of accumulation* repeated every 5 to 8 centuries (we accept that there is entire denudation of the sediments in the result of the catastrophic flood in XII-XIV c. A. D.). Every one of them goes off with a catastrophic development simultaneous backfilling of wide and deep erosion incisions reaching the pre-quaternary bedrocks and possibly with the partial preservation of older sediments in the valley sides;
- *repeated intermediate reworking, transportation and accumulation* of the sediments only from the uppermost levels of the fluvial successions.

The model is applicable mainly for valley parts emitting into lowland located after gorges, to rivers in humid zones, with a small catchments area and unstable water regime, with rare catastrophic floods.

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