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A LOWER CRETACEOUS SUBMARINE FAN SEQUENCE IN THE GERECESE MTS., HUNGARY

by

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Abstract

The Barremian coarse clastics of Köszörűkőbánya quarry (Lábatlan, Gerecse Mts.) are deposits of a proximal submarine fan, displaying channel-filling conglomerates transported by fluidized grain flow, proximal turbidites and contourite sandstones. This formation is the top of an upward shoaling Lower Cretaceous sequence, containing Berriasian to Hauterivian distal turbidites, and Barremian sandy flysch. Contrasting results of palaeocurrent measurements urge more detailed studies.

Introduction

The clastic Lower Cretaceous (Berriasian to Barremian) formations in the Gerecse Mts. (Fig. 1) considerably differ from other — mostly carbonate — complexes of the Bakony unit of similar age (KÁZMÉR, 1986). While most of the southwestern Bakony unit is characterized by thin, condensed limestone beds (FÜLÖP, 1964), the northeastern region bears a more than 300 m thick shale-sandstone sequence with conglomerate and breccia intercalations. Stratigraphy and lithology are shown Fig. 2.

Contrasting opinions on the origin and depositional environment of these formations are in circulation. Following general studies of several geologists made through a century FÜLÖP (1958) published the first and only detailed description on the Lower Cretaceous formations in the Gerecse Mts. (with full references to previous works). His main points were the followings:

- the Gerecse Lower Cretaceous formations were deposited in a shallow marine embayment with alternating marl and sand sedimentation,
- the Köszörűkőbánya conglomerates are the nearshore regressive deposits of the Neocomian sedimentary cycle,
- the Köszörűkőbánya quarry exposes the ancient shore-line, with reworked frame-building organisms (Urgonian limestone) embedded in the conglomerate,
- the regressing sea eroded older sandstone beds,
- the quartzite and chert pebbles suffered long fluvial transport before sedimentation in the marine environment,

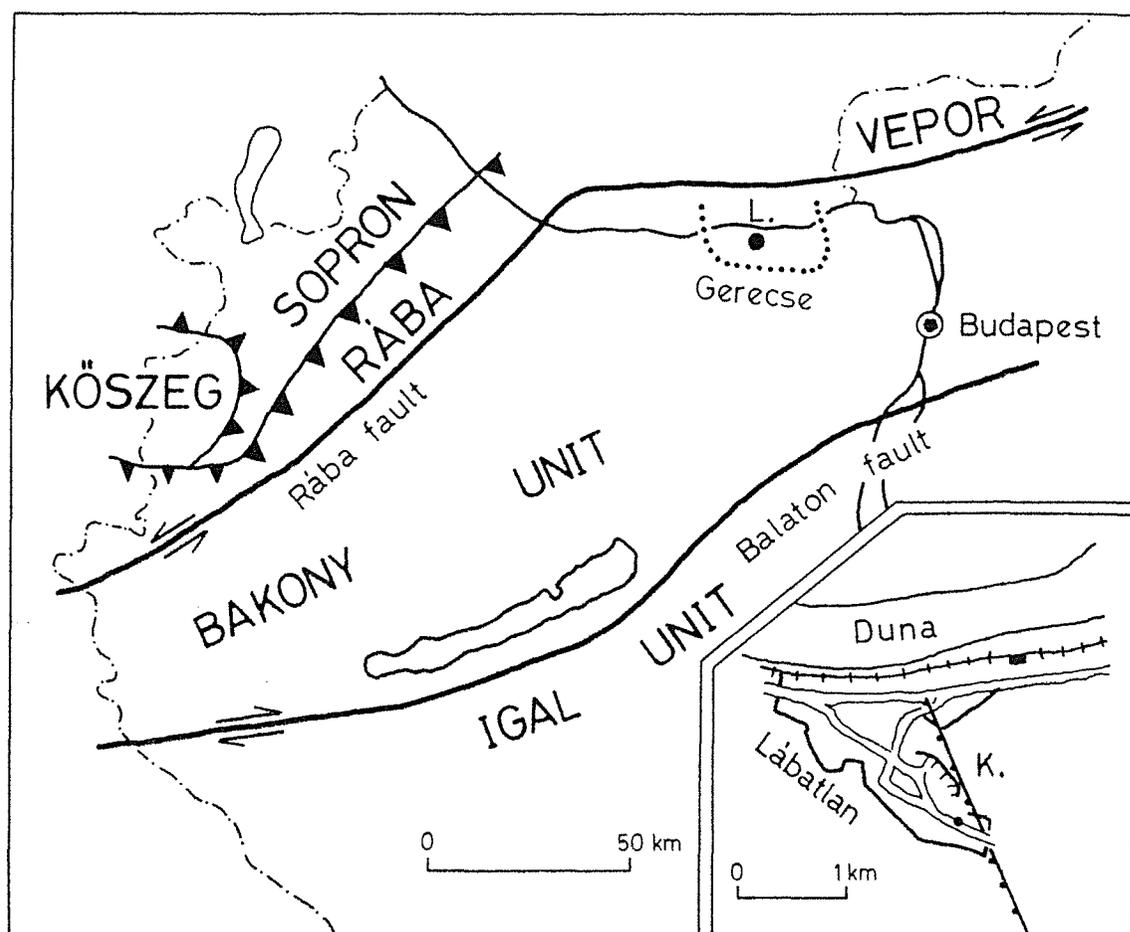
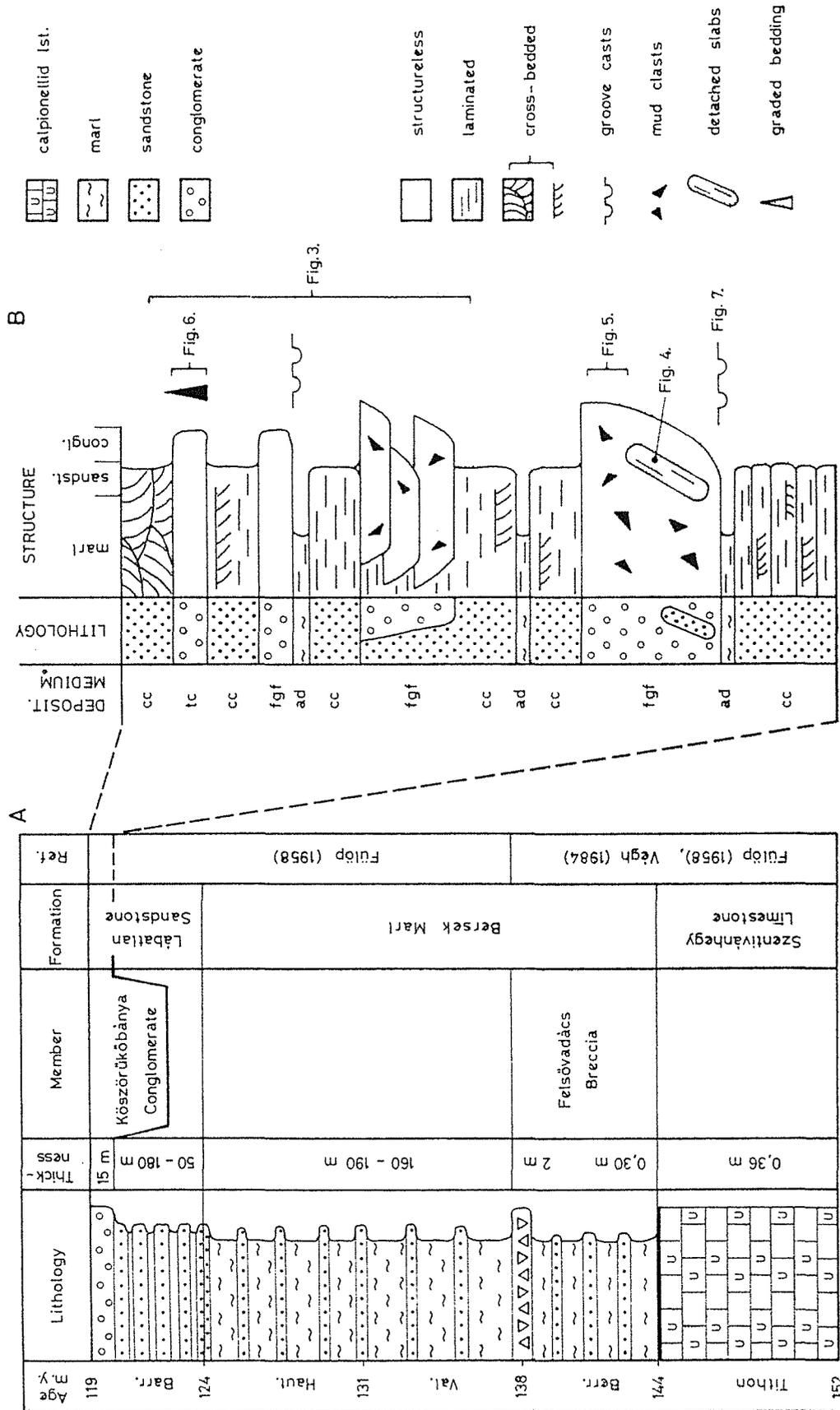


Fig. 1. Location of Lower Cretaceous clastic sediments in the Gerecse Mts. of Hungary (dotted line). Tectonic units after KÁZMÉR (1986). L = Lábatlan. Inset: location of Kőszörűkőbánya quarry (K) at Lábatlan.

- well-sorted sandstone layers between the conglomerate beds are the products of the winnowing effect of wave action.

FÜLÖP in his treatise on the Bakony Lower Cretaceous (1964) figured this region as a bay surrounded by land to the W, S and E. Papers of the next decade (SZENTES, 1968; FÜLÖP, 1968, 1969, 1976; HORVÁTH, 1978) repeated the statements in FÜLÖP's (1958) volume. A probably new interpretation showed up in a palaeontransport map series of the Carpathian region based mostly on flysch sediments (ŠLAČKA, 1976), indicating west to east transport direction for the Bersek Marl. Other tentative remarks appeared in the paper of CSÁSZÁR and HAAS (1979), stating that the Lábatlan Sandstone displays many features typical of flysch sediments (graded bedding, flute casts, trace fossils, etc). The Barremian chert breccia and conglomerate was again considered as the final member of the Early Cretaceous sedimentary cycle. This thesis was supported by the occurrence of "biogenic limestone lenses"; this autochthonous interpretation is a retrograde step compared to FÜLÖP's results (1958). In a synoptic lithostratigraphic



Age	Lithology	Thickness	Member	Formation	Ref.
119	calpionellid lst.	15 m	Közorükőbánya Conglomerate	Lábatlan Sandstone	Fülöp (1958)
Barr.	marl	50 - 180 m			
124	sandstone				
Haut.	conglomerate	160 - 190 m		Bersék Marl	Fülöp (1958), Végh (1984)
131	structureless				
Val.	laminated			Szentivánszky Limestone	
138	cross-bedded	2 m	Felsővadás Breccia		
Berr.	groove casts	0,30 m			
144	mud clasts				
Tithon	detached slabs	0,36 m			
152	graded bedding				

hic chart. (CSÁSZÁR and HAAS, 1983) the Bersek Marl is drawn in the colours of pelagic sediments, the Lábatlan Sandstone is flysch, but its upper part (Köszörűkőbánya Conglomerate ?) is marked as "Shallow marine detrital formation".

CSÁSZÁR and HAAS (1984) repeat the interpretations of their (1979) paper with a slight modification: the biogenic limestone boulders in the Köszörűkőbánya Conglomerate are referred to as olistolites.

CSÁSZÁR (1984a) extends the appearance of the flysch characters to the Bersek Marl, stresses the exclusiveness of nektonic and planktonic elements in the fauna and considers the Lábatlan Sandstone as a bathyal deposit. CSÁSZÁR (1984b) more or less repeats the description on Köszörűkőbánya quarry of FÜLÖP (1958) and reprints his Fig. 32 in part. Császár correlates the Köszörűkőbánya profile with a gravel bed at the top of the Lábatlan Sandstone, but does not put it down if he accepts its bathyal origin. In the present paper I try to give some evidences in support of the bathyal origin of the Köszörűkőbánya Conglomerate. These results are preliminary and may change in several details during further investigations.

Sedimentology

The composite lithological column of the Köszörűkőbánya quarry at Lábatlan village (Fig. 2) summarizes the most conspicuous sedimentary features observed in the field.

Marl

Thin (10–20 cm) marl layers separate some conglomerate and sand beds. In some places these contain gypsum (FÜLÖP, 1958) formed from pyrite in the weathering crust. Marl clasts of irregular shape (referred to as mud clasts in Fig. 2B) are embedded in the conglomerate (Fig. 5).

Sandstone

Parallel laminated and cross-stratified sandstone beds form the majority of rocks exposed in the quarry. Beds are frequently truncated by channel-filling conglomerate lenses. Cross-bedding is visible on weathered joint

Fig. 2. Stratigraphy and lithology of the Lower Cretaceous formations in Gerecse Mts. Fig. 2A: Upward shoaling flysch sequence. Tithonian calpionellid limestone (covered by hardground) overlain by condensed Berriasian marl beds. Lowermost Valanginian limestone olistostrome is covered by thick marly flysch. Sandy flysch deposited in Barremian time, topped by proximal fan conglomerates.

Fig. 2B: Composite lithological column of Köszörűkőbánya quarry at Lábatlan (not to scale). Profile of a proximal fan sequence. Channel-filling conglomerate bodies with marl clasts and sandstone slabs are embedded in sandstone deposited possibly by contour currents. Most conglomerates show no internal structures except the topmost one with graded bedding. Total thickness about 15 m. Geochronology after PALMER (1983). Abbreviations: cc = contour current or truncated turbidity current; tc = turbidity current; fgf = fluidized grain flow; ad = autochthonous deposition.

surfaces of the sandstone; the determination of the true dip of foresets was not carried out due to their poor preservation; more patient studies may improve this situation. These beds might represent truncated Bouma (1962) sequences: T_b or T_d for parallel laminated beds and T_c for cross-bedded layers; however, these also might be contourites (BOUMA, 1973). Further studies are needed to resolve this question. The sandstones contain the foraminifer *Orbitolina birmanica*, indicating Barremian age for this sequence (FÜLÖP, 1958).

Conglomerate

Thick, lense or wedge-shaped conglomerate bodies made mostly of chert pebbles are the most striking features of the Kőszörűkőbánya quarry. These were deposited in distributary channels, sometimes cross-cutting each other (Fig. 3). These lag deposits does not bear any internal structure. Large sandstone slabs of 0.5 – 1.5 m in diameter are embedded in the conglomerate: these are fragments from the undercut wall of a submarine canyon (Fig. 4). Normally lying, vertically oriented and overturned slabs occur; overturning was determined from the shape of cross-bedding within the slabs.

Several channel-infilling conglomerate bodies contain angular mud clasts (Fig. 5), probably reworked from non-lithified banks of the channel.

A conglomerate bed with sharp, parallel lower and upper boundaries shows graded bedding (Fig. 6), indicating deposition from a turbidity current. Its composition is somewhat different from that of the channel fills, containing more limestone than chert clasts and pebbles. The largest boulder is about 15 cm in diameter (not figured in the picture).

Olistoliths

CSÁSZÁR (1984b) mentioned the presence of olistoliths in Kőszörűkőbánya quarry: he affixed this term to the bioclastic limestone boulders in the channel-filling conglomerate. I think, that all pebbles and other clasts (rounded or not rounded) must be ranged within this group.

Direction of transport

An average S to N (or N to S) direction of transport (with SW to NE and SE to NW components) was determined from sole marks, orientation of slabs and dip of slide(?) surface (Fig. 8). Dip azimuths of foresets in cross-bedded sandstones were not measured. The graded conglomerate bed did not yield sole mark data.

Groove casts or channel casts

The lowermost, lense-shaped conlomerate body bears 15 – 20 cm wide, 5 cm deep straight casts of former grooves on its underside (Fig. 7). The grooves were made on the surface of a marl bed (now removed by erosion) and were contemporaneously filled with coarse clastics.

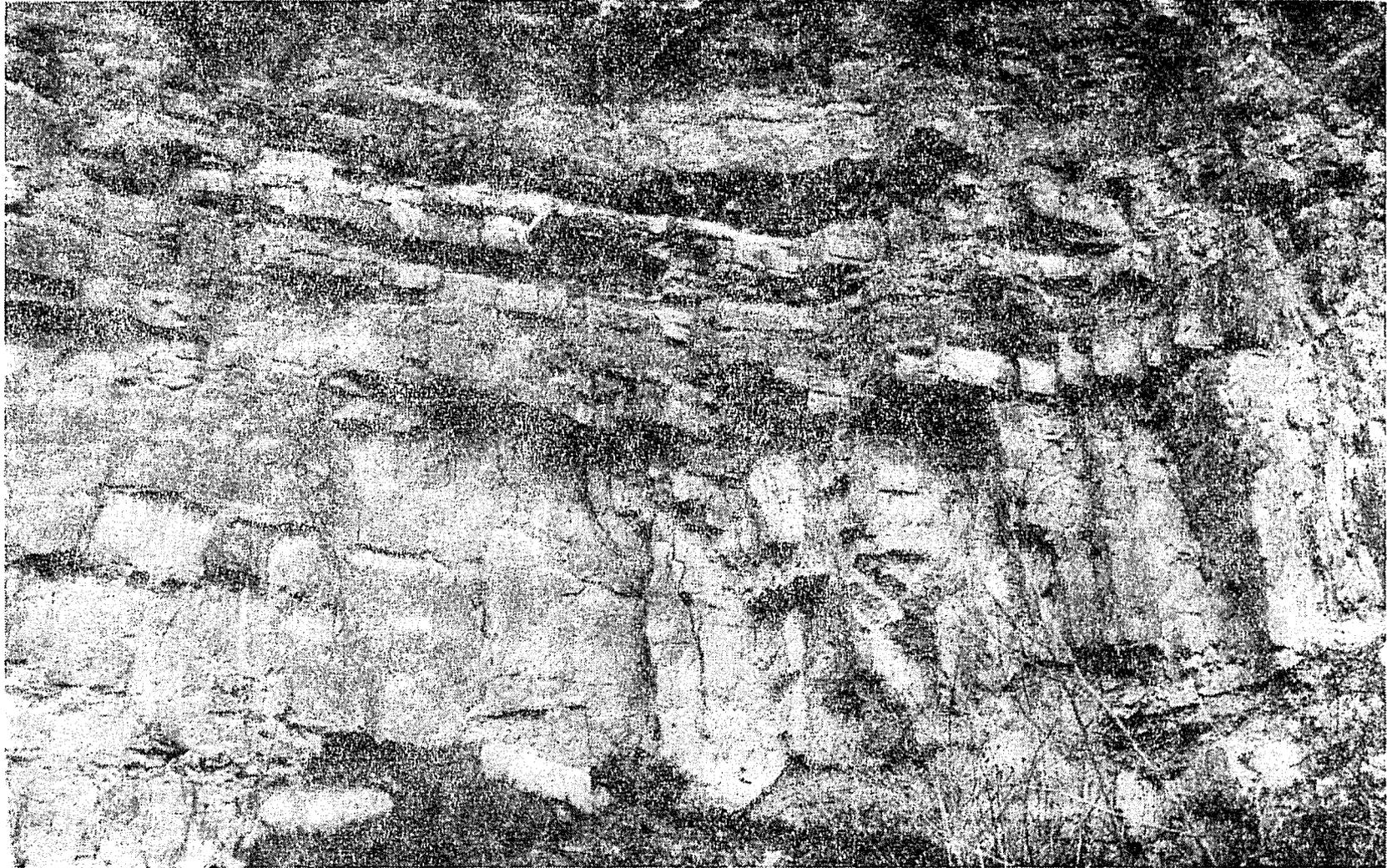
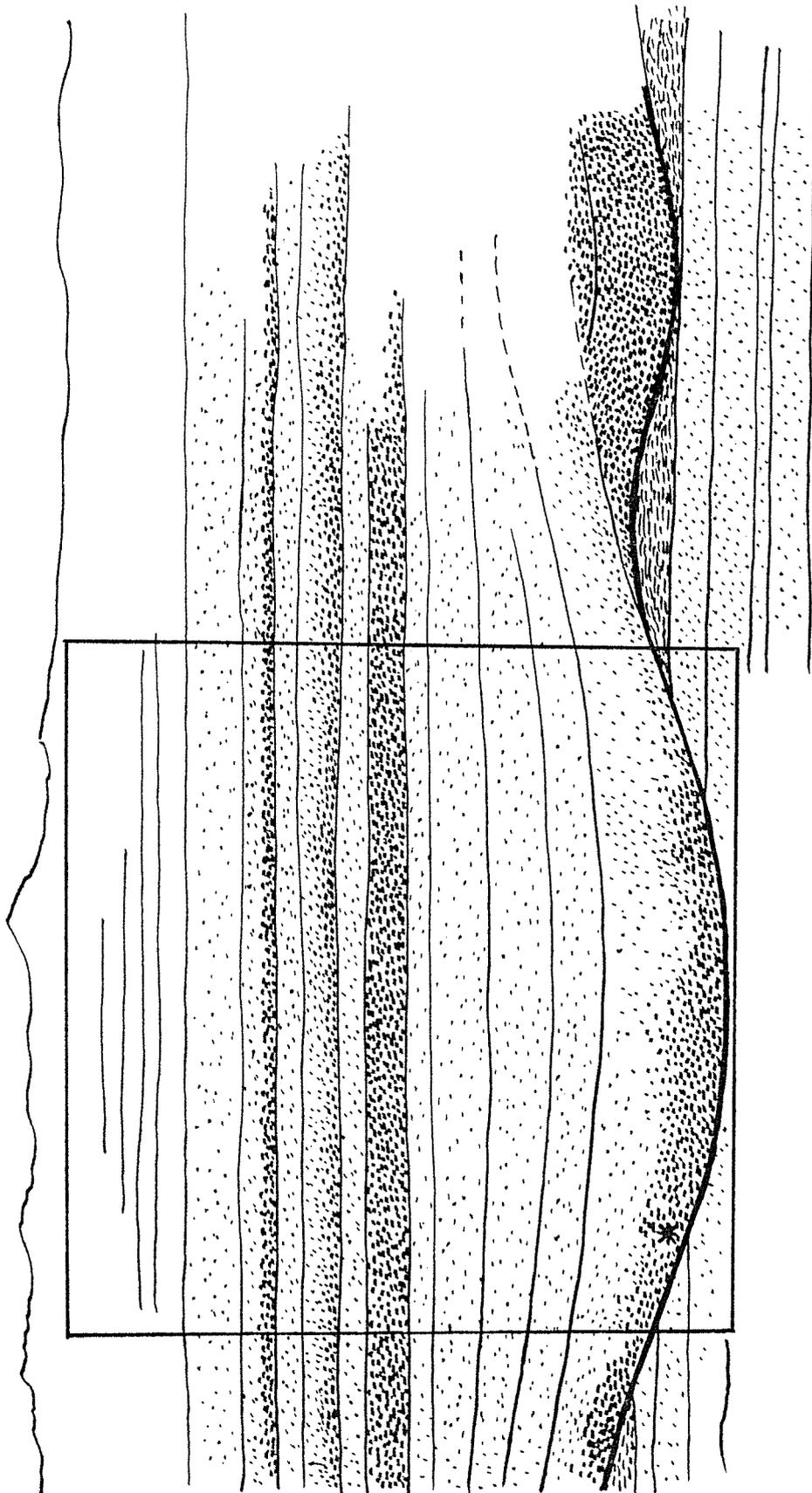


Fig. 3. Channel-filling conglomerate cut into underlying marl and sandstone. Graded beds on the top. (Photographed by I. FÖZY, drawn Gy. b TARI.) Asterisk on the drawing marks the location of the large sandstone slab figured on Fig. 4.



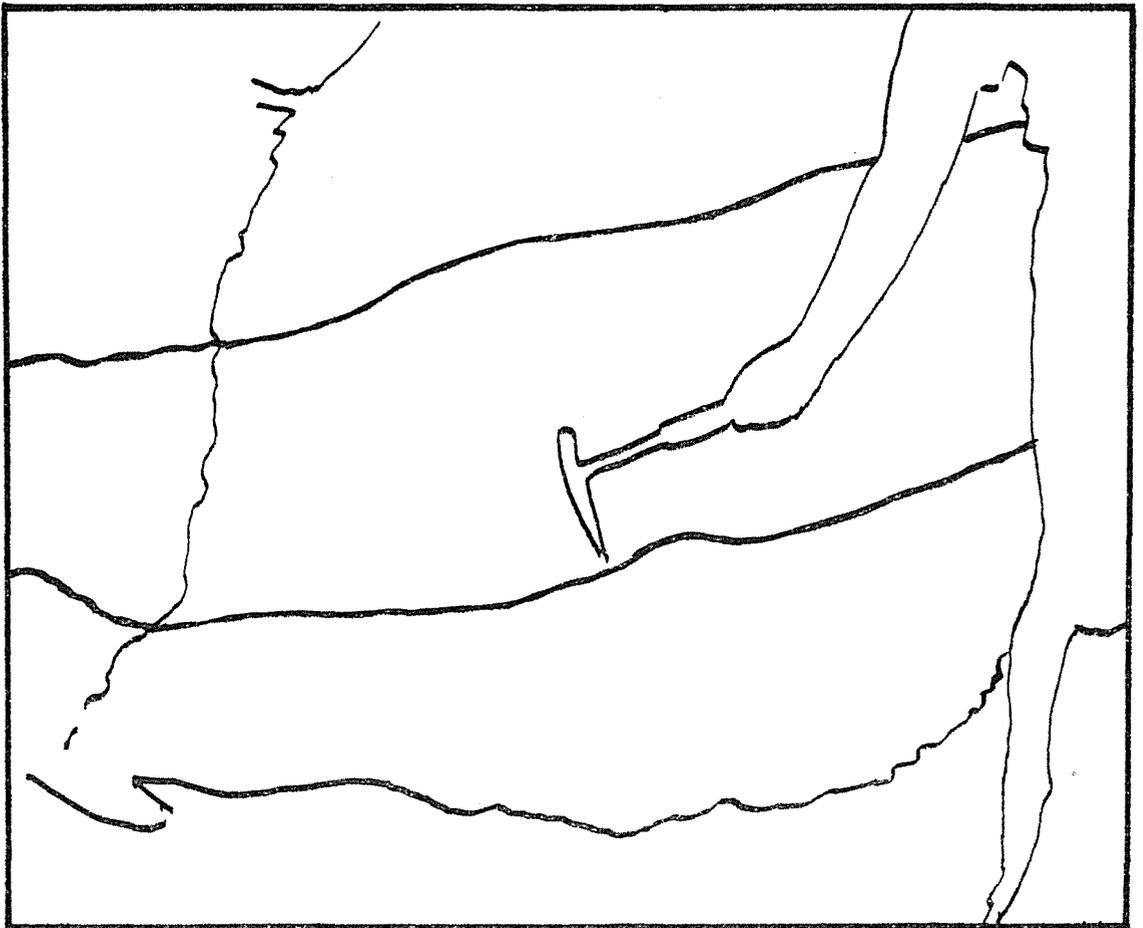
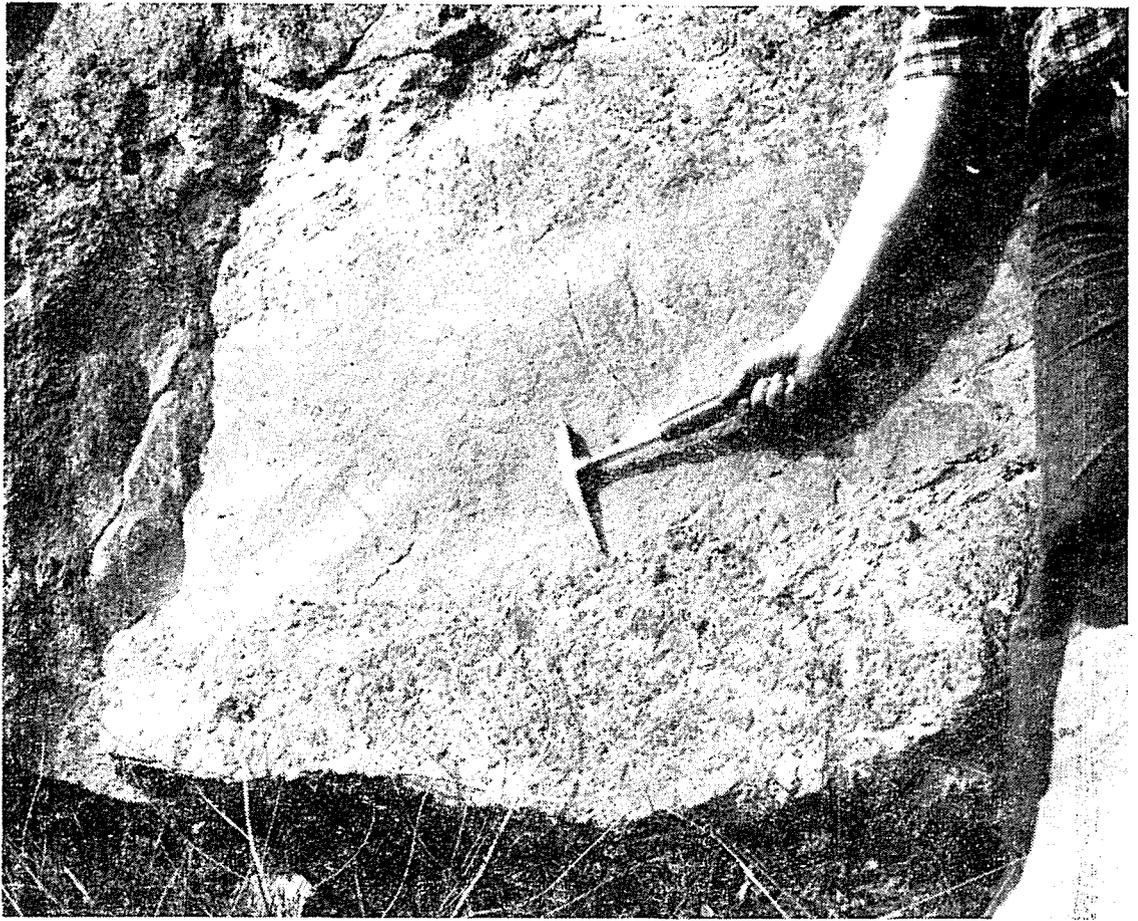




Fig. 5. Holes show the places of angular mud clasts embedded in channel-filling conglomerate (photo by I. FÓZNY).

Fig. 4. Sandstone slab detached from an undercut submarine canyon wall, embedded in channel-filling conglomerate (location is marked by an asterisk on Fig. 3B).
(Photographed by I. FÓZNY, drawn by G. TARI.)

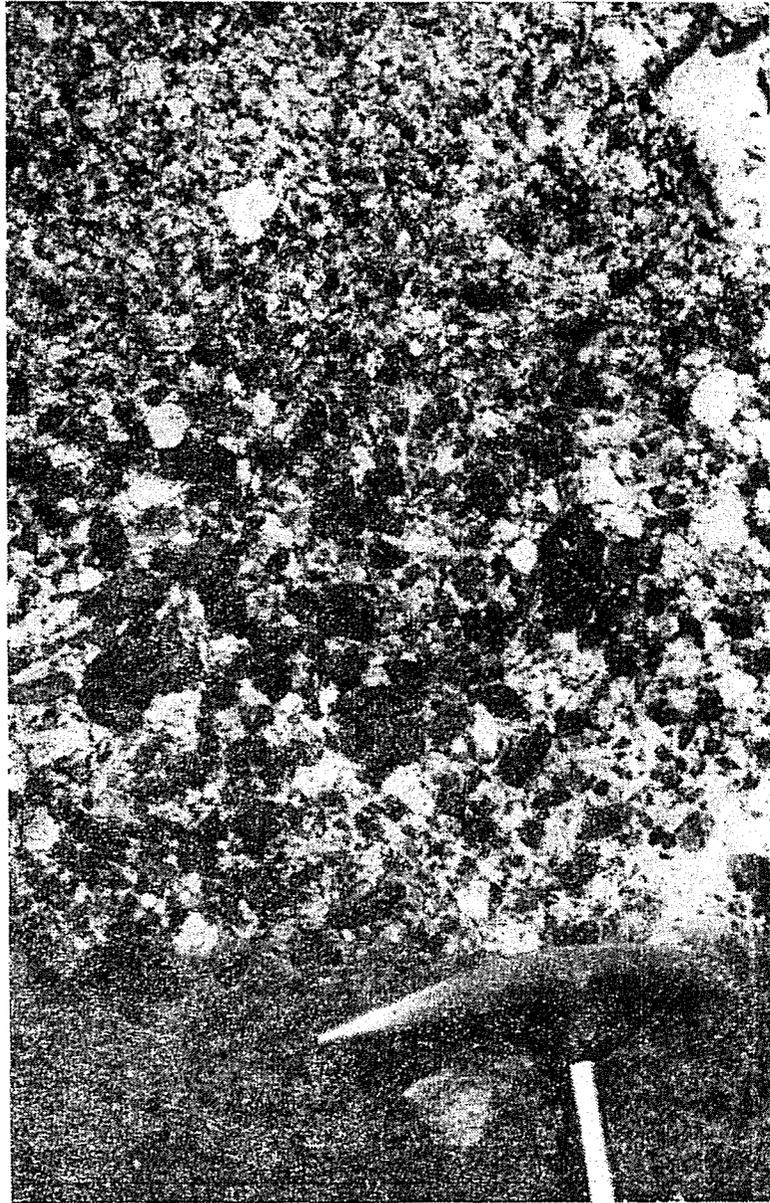


Fig. 6. Graded conglomerate bed on top of the profile (Photo by I. Főzy).

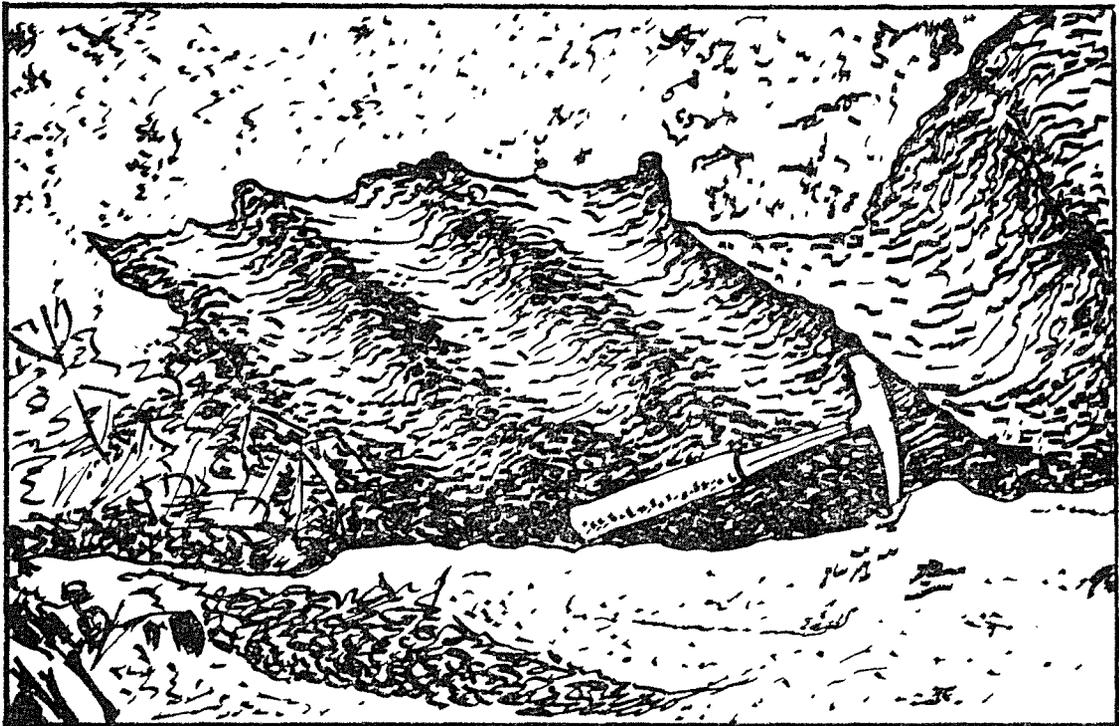
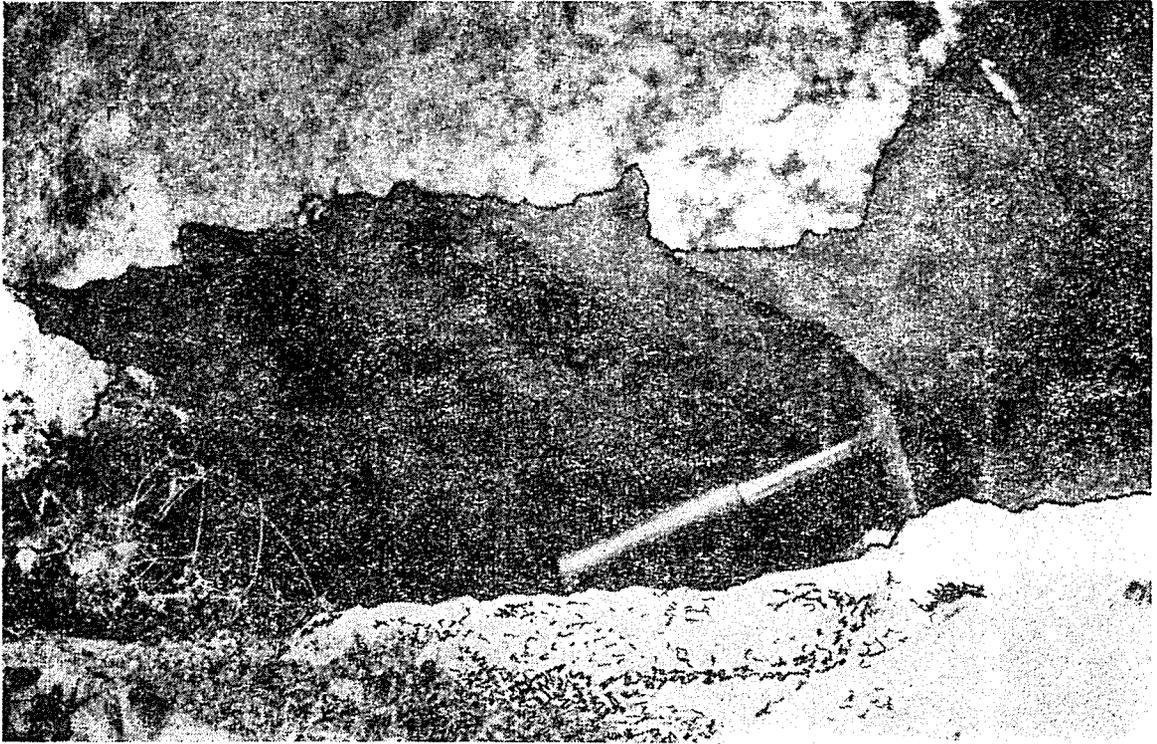


Fig. 7. N-S directed groove casts on the underside of the lowermost channel-filling conglomerate body, Underlying marl was removed by erosion. (Photo by I. FÖZY, drawn by G. TARI).

Dip of large sandstone slabs

Some conglomerate lenses contain large-size sandstone slabs 0.5 – 1.5 m in diameter and 0.2 – 0.5 m in thickness (Fig. 4). These slabs probably were detached from the undercut banks of a submarine canyon, overturned sometimes and after transport embedded in the coarse lag deposit of the channel. Their upcurrent dip is a reliable indicator of ancient flow direction (POTTER and PETTIJOHN, 1977). The dip direction was easily measured on weathered bedding planes of the parallel-bedded or cross-bedded sandstone slabs.

Slide surfaces

Some sandstone beds are cut by listric surfaces, being nearly perpendicular to the top and make small angle with the bottom of the respective bed. The surfaces are covered by a few millimetres thick marl layer. These are considered as traces of penecontemporaneous sliding, their dip azimuth indicating downslope direction.

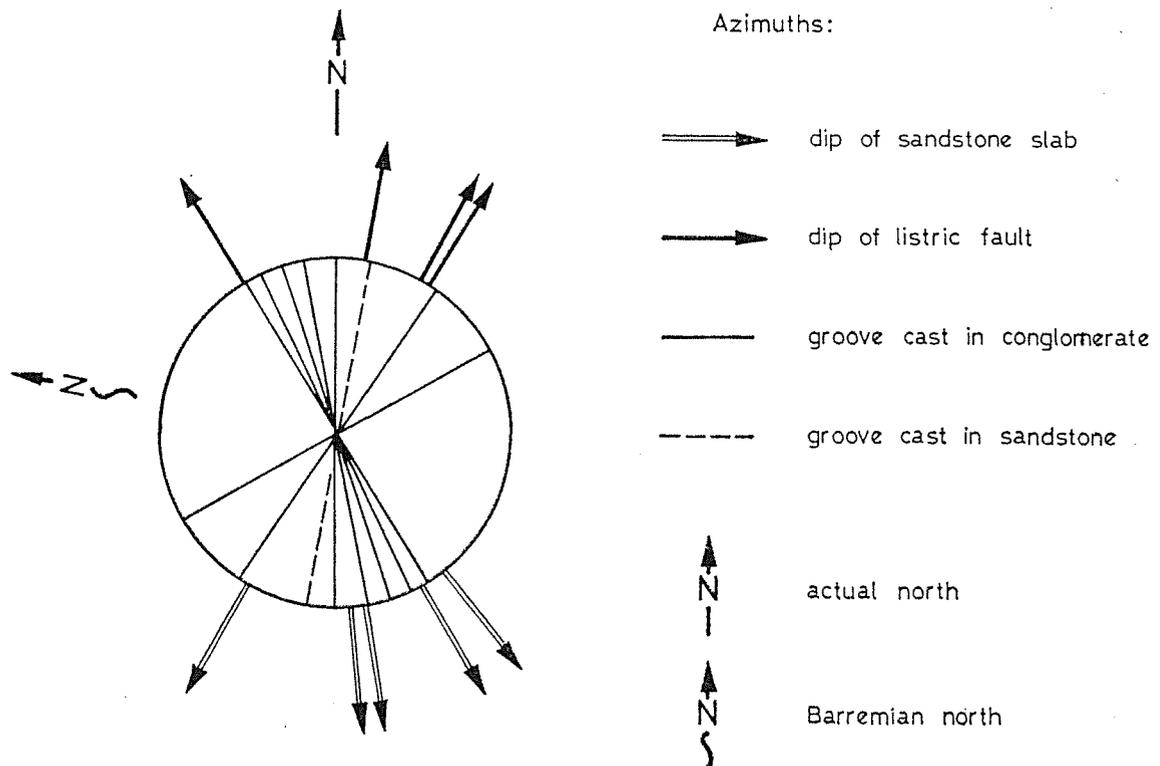


Fig. 8. Paleotransport directions at Kőszörűkőbánya quarry at Lábatlan. We measured dip directions of large (up to 1.5 m) sandstone slabs in the channel-filling conglomerate, dip directions of listric faults – probably of syndepositional slide origin – within sandstone beds, and groove casts on the underside of channel-filling conglomerate beds, and a sandstone bed. While azimuths are scattered, a definite N – S (or S – N) transport direction is shown. The apparent opposing transport directions may be due to the small number of measurements and/or uncertain interpretation of sedimentary structures. However, considering the rotation of the Transdanubian Midmountains (= Bakony unit) since Barremian time (MÁRTON and MÁRTON, 1985), there was a W to E (or E to W) transport of clastics at that time.

Fig. 8 shows paleotransport directions in the actual tectonic position of the Gerecse Mts. However, MÁRTON E. and MÁRTON P. (1985) proved by palaeomagnetic studies that during Early Cretaceous time the long axis of the Transdanubian Midmountains (including the Gerecse) occupied a position almost perpendicular to the present-day one (their Fig. 5). The correction of our measurements with the MÁRTONS' rotation data indicates a Barremian transport from W to E or from E to W.

The approximately W to E (actual) transport direction of the Bersek Marl in the Hauterivian (ŠLA CZKA, 1976) seems to be in contrast with the above data. Since documentation of the measurements was not published, we cannot estimate their reliability. As opposite transport directions can be often observed in flysch sequences (POTTER and PETTIJOHN, 1977), a thorough investigation is badly needed.

Transport mechanisms

Products of several ways of redeposition were briefly described above. The graded conglomerate bed of Fig. 6 have been deposited by a high density turbidity current able to keep clasts up to 15 cm in motion.

Parallel and cross-laminated sandstone beds (truncated Bouma sequences?) might have been deposited by either turbidity currents or by contour currents. Further sedimentological and petrological studies (sand grain orientation, sorting, etc.) may give answer to this question.

The thick conglomerate lenses without any internal structure are lag deposits of fluidized grain flows which cut their transport channels into sand (or sandstone) beds or into older gravel-filled channels. These grain flows undercut the walls of the submarine canyon near the point of their origin or the banks of their channel and transported large, detached sandstone slabs and mud clasts far away from their original position.

Basin evolution

FÜLÖP (1958) has recognized that the Lower Cretaceous sequence in the Gerecse Mts. shows an upward increase of coarse clastic components. From short remarks of CSÁSZÁR and HAAS (1979, 1984) and CSÁSZÁR (1984a, b) we know that the marl (Bersek Formation) and sandstone (Lábatlan Formation) complex shows flysch characters and was deposited in the bathyal region. The following basin history is based on the re-interpreted excellent description of FÜLÖP (1958) and on the personal observations of the author at the Köszörűkőbánya quarry.

Approximately at the Tithonian – Berriasian boundary the sedimentation of the condensed calpionellid limestone ceased and by an abrupt change alternating marl and sandstone beds were deposited (VÍGH, 1984). This sudden change from carbonate to clastic deposition occurred in these times at various localities of the African-Apulia margin: in the middle sector of the Northern Calcareous Alps (SCHLAGER and SCHÖLLNBERGER, 1974; FAUPL and TOLLMANN, 1979) and at the Moroccan margin of the

Central Atlantic ocean (VON RAD and SARTI, 1986). The common cause was the interaction of block faulting and a global regression providing extensive subaerial regions for increased clastic supply (VON RAD and SARTI, 1986). The local block faulting in the Gerecse Mts. is indicated by an olistostrome possibly originated from a fault scarp.

The basin subsided to the zone below aragonite, but above calcite compensation depth, as shown by plenty of aptychi without much ammonites (the latter are molds only). The thin, graded sandstone beds indicate distal turbidity current activity, during the Berriasian – Hauterivian interval with occasional olistostrome deposition. During Barremian time the Lábatlan Sandstone was deposited, with more and thicker sandstone beds indicating an approaching submarine fan. The Köszörűkőbánya section topping the sequence shows proximal turbidite sedimentation, interlayered with even more proximal channel-filling fluidized grain flow deposits. The whole Lower Cretaceous clastic sequence is evidence for a bathyal basin visited by distal turbidity currents, showing upward shoaling as a result of the prograding of a submarine fan during Barremian time.

Palaeogeography

The relationships between the Gerecse Lower Cretaceous and the Rossfeld Beds of the same age in the Northern Calcareous Alps were recognized by HANTKEN more than a century ago (fide FÜLÖP, 1958). Considering the palaeogeographic model of KÁZMÉR and KOVÁCS (1985), both formations have been deposited in the Lower Cretaceous Belluno trough, east (or southeast) of the submerged Trento plateau. (Their present-day position is the result of a Palaeogene continental escape of the Bakony unit.) If – following further palaeotransport studies – the S to N transport will be proved correct, it will be in favor of the hypothesis of FAUPL and TOLLMANN (1979) on a Lower Cretaceous ridge in the middle of the East Alpine region shedding detritus towards N and S. If the N to S transport will prevail, a Dinaride origin of the detritus must be suggested.

However, new, but still insufficient palaeomagnetic data on the Mesozoic rotation history of the Northern Calcareous Alps (BECKE and MAURITSCH, 1985) may invite efforts to develop considerably renewed palaeogeographic reconstructions.

Conclusions

The Lower Cretaceous clastic formations of the Gerecse Mts. form an upward shoaling turbiditic sequence. At the Tithonian – Berriasian boundary – contemporaneously with other Tethyan and Atlantic localities – carbonate deposition ceased, due to block faulting and worldwide regression. A bathyal basin was formed with distal turbidite sedimentation. During Barremian time increasing clastic influx indicated the prograding of a submarine fan. The most proximal deposits of the fan (investigated at the Köszörűkőbánya quarry at Lábatlan, Gerecse Mts.) include channel-filling

conglomerates, transported by fluidized grain flow, proximal turbidity currents and contour currents. Preliminary investigations of directional structures provided contrasting evidences on the transport of coarse clastics. Since the investigated region was to the south of the Northern Calcareous Alps during Early Cretaceous time (KÁZMÉR and KOVÁCS, 1985) the mafic components of the Neocomian beds in the Alps and Gerecsé must have been transported either from an Intra-Alpine ridge (FAUPL and TOLLMANN, 1979) or from the Dinarids.

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