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Quaternary alluvial fans in the Most Basin?

Kvartérní aluviální kužely v Mostecké pánvi?

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Abstract: The coarse grained clastics accumulated at the foot of the Krušné hory Mountains and termed "proluvial sediments" are associated regionally with an abrupt change in slope or with decrease of gradient and thus of transportation power when streams leaving the mountains enter the flat landscape in Most Basin. In this detrital belt, rimming most of the mountain front, three distinct types of accumulations i.e. aprons, fluvial fans and alluvial fans have been distinguished.

Aprons (sheet-like accumulations) occur in areas where no larger stream exist. They represent deposits of rill wash, sheet wash and sheet flow and conformably overlie a gently sloping pediment. The morphological form is therefore termed "apron-topped pediment".

The deposits of larger streams equivalent to the fluvial fan type are preserved in different altitudes much like normal river terraces. They are stratigraphically assigned to the time span Late Pliocene-Middle Pleistocene and their formation is controlled by marked climatic oscillations.

Typical alluvial fans are represented by small steep-sloped accumulations deposited close to the mountain front. The main factors controlling their deposition are low discharge and low-energy stream dynamics. This is contrary to previous interpretations that invoked neotectonic movements for their formation.

The Hořany Fan, a single alluvial fan present at the foot of a neovolcanic hill, passes laterally into the Middle Pleistocene Hořany Terrace of the Bílina River. The original palaeomagnetic dating of the fan to Pliocene (Gauss Normal Epoch) is therefore reinterpreted to Middle Pleistocene (Brunhes Normal Epoch).

The other type of deposits in this region are thick talus accumulations that occur at the foot of exhumed subvolcanic bodies. The rimming sediments together with the projecting necks produce forms resembling typical volcanic cones. The shape of such illusive "volcanoes" results in fact from combined effect of denudation and accumulation and is unrelated to volcanic origin.

The normal undisturbed development of fans and river terraces disproves the supposed neotectonic control of these features, at least since Late Pliocene. Nevertheless a slow uplift of the whole region marked by vertically, well defined river terrace systems cannot be excluded.

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The Most Basin is a relatively large tectonic depression infilled by Neogene lacustrine sand and clay with intervening brown coal seams. It is characterized by a generally smooth landscape, except for the marginal scarp, several deeper valleys of larger streams and a few marked isolated randomly scattered neovolcanic hills. The basin is limited at its NW side by the morphologically prominent tectonic front of the Krušné hory Mountains (Krušné hory fault zone) separating the crystalline complex from the Neogene basin. In contrast towards the SE the basin, also bounded tectonically but passes into the rimming Cretaceous without marked change in morphology, apart from those parts emphasized by neovolcanites. On both sides of conspicuous Krušné hory Mountains front, a relatively flat landscape occurs. At the top of the mountains an ancient Paleogene peneplain is preserved. It is irregularly dissected by shallow valleys related to the modern drainage system. The Neogene in the basin is also forming slightly undulating plains their surfaces sloping gently into the basin centre or passing gradually into the terraced valleys of larger streams, particularly into that of the Ohře River.

The Neogene brown coal is exploited in numerous opencast mines the huge exposures of which are several kilometres long and several tens of metres high. These made possible the detailed study of the overlying Quaternary.

The Quaternary sediments such as loess, talus deposits and river terraces are typically of discontinuous development, the isolated accumulations being scattered irregularly all over the basin. An exception to this are large accumulations of diverse water-laid deposits referred to in the older literature generally as "proluvial sediments".

Proluvial sediments

Proluvial sediments are the most widespread type in the Most Basin and are the main subject of this article. The accumulations are of greatly varied size, morphology, thickness and lithology and represent a complex mixture of different types of deposits. Regionally they occur at the foot of steep scarps and at parts of abrupt stream gradient decrease. It results in reduction of transport power where the streams leave the mountains and enter the flat landscape of the basin. The sediments occur in two, regionally separated areas, namely along the foot of the Krušné hory Mountains on the NW rim of the basin and also around the isolated neovolcanic hills in the basin.

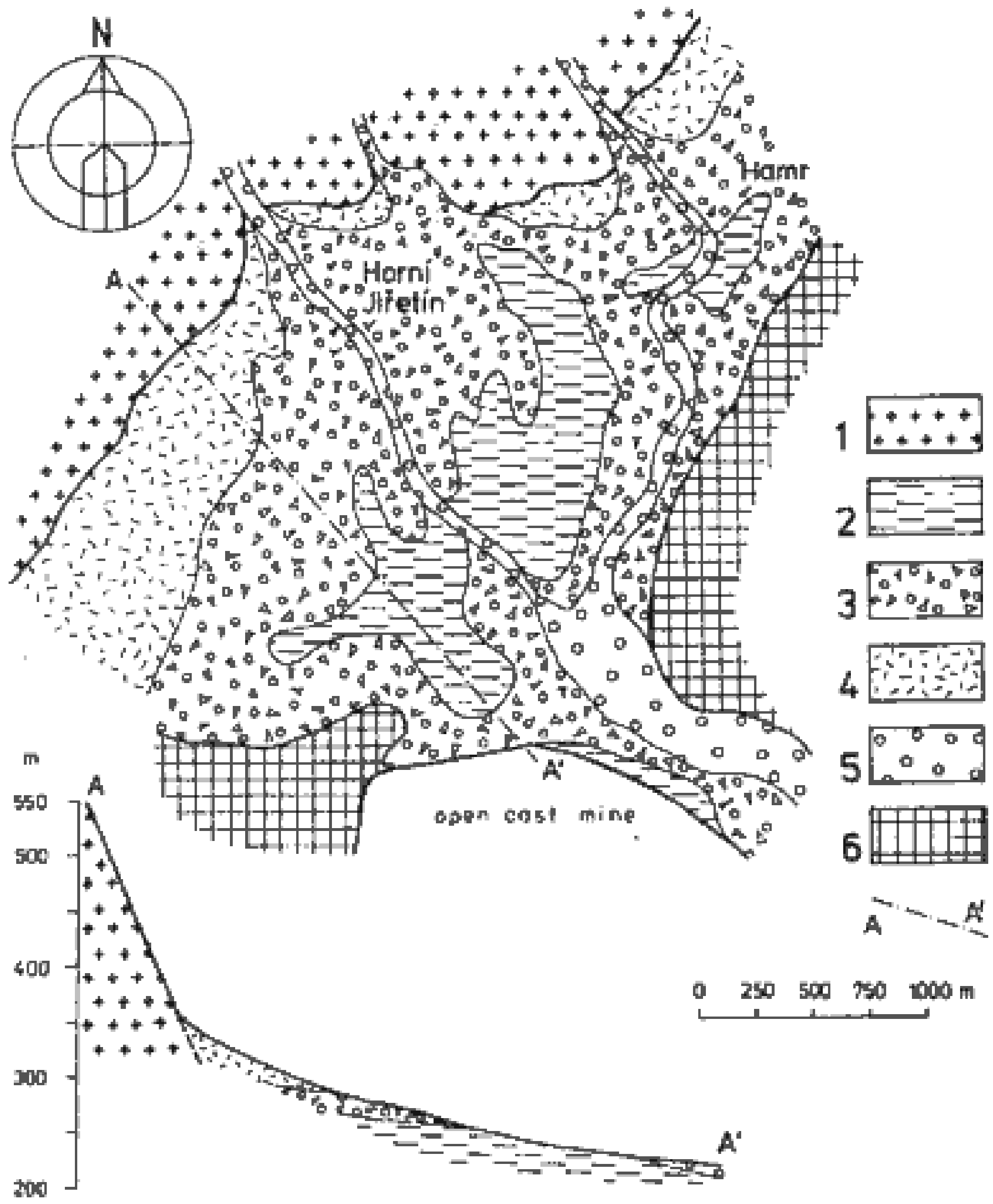
The proluvial sediments at the foot of the Krušné hory Mountains are associated with this morphologically conspicuous, very steep and, in places, even vertical mountain front towering some 300 to 500 m above the surface of the basin. The fault bounded piedmont slope in this area is overlain by detritus and detrital outwash which forms a broad flanking blanket along several tens of kilometres long scarp. This blanket obscures the tectonic contact between the Krušné hory crystalline complex and the Neogene sediments. The origin of this detrital accumulation is usually explained in the previous literature as representing coalescence of a series of alluvial fans. The more or less continuous belt is on average 1 to 3 km wide but, in places, particularly along the larger streams, the lobes may extend as far as 10 km into the basin. The detrital accumulation forms aprons (sheets), lobate tongues and fan-like bodies. Sedimentologically they fall into two different depositional types, i.e. aprons and "alluvial fans".

Aprons (sheet-like accumulations)

Aprons or sheet-like accumulations form the dominant portion of the detrital deposits at the foot of the mountain front. These deposits occur in those areas that lack larger streams i.e. lines of concentrated drainage. The sediments are lithologically relatively uniform. In general, they are composed of sandy gravel which is usually poorly sorted and includes a high percentage of sand and silt matrix. Well sorted lenses and interlayers are subordinate. The clasts are subangular to subrounded and are compositionally immature containing the whole wide range of rock types that occur in the source area. The gravel sized material on average is 5 to 15 cm but larger cobbles and boulders up to 30–50 cm are not exceptional. The sediment is usually unstratified, only rarely some poorly developed planar stratification parallel to the surface is observed. Normally imbrication is also lacking. The lithology and sedimentology therefore is of debris flow type. The main processes were probably rill wash, sheet wash and sheet flow (Králík, Tyráček et al. 1989).

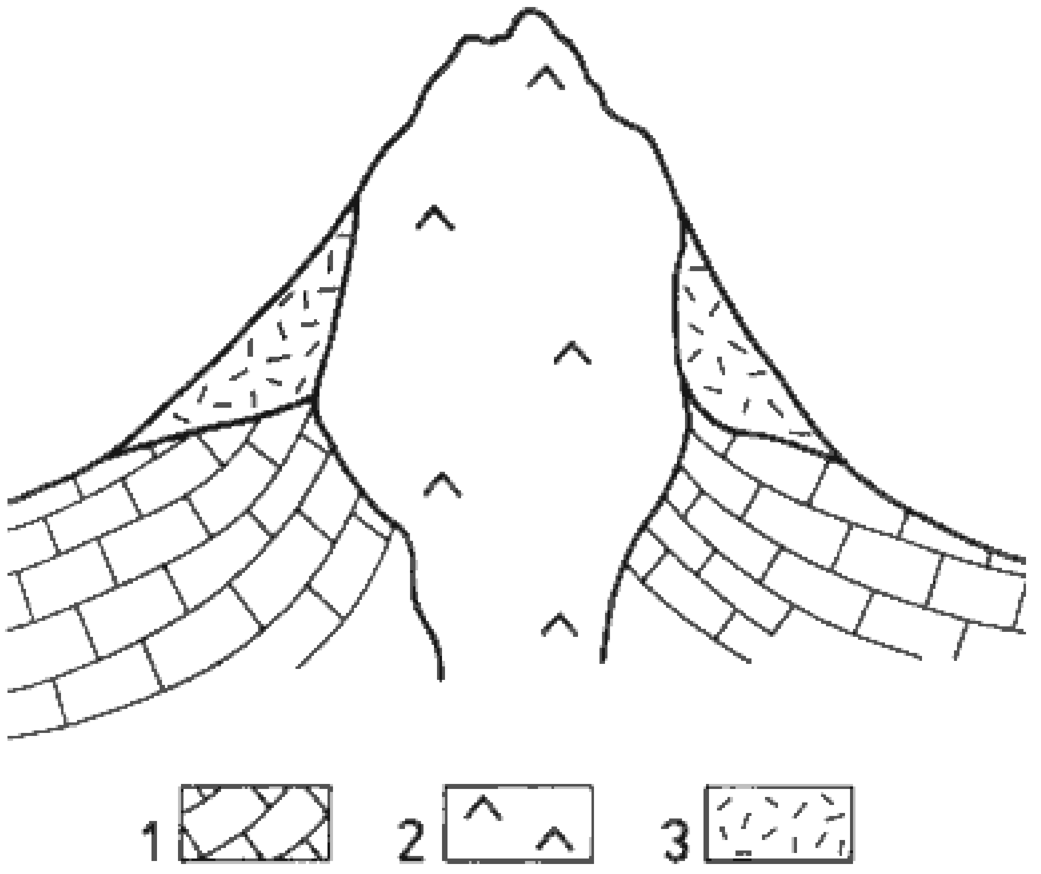
The bedrock forms gently sloping plains little dissected and smooth of surface molded by erosion within the horizontally bedded Neogene. This rock-cut surface is taken for pediment. The thickness of overlying deposits is variable along the mountain front (5 to 15 m) but holds perpendicularly to it (Růžičková et al. 1987). It demonstrates that these forms represent a normal pediment capped by clastic sediments. This composite pediment-sheetwash combination can be termed "apron-topped pediment", analogous to the term fan-topped pediment (Blackwelder 1931).

In some places the overlying sediments die out (Fig. 1) and the bare pediment with the Neogene outcropping at the surface can be seen. This form is probably controlled by younger denudation reducing the covering deposits.



1. Proluvial deposits at the foot of the Krušné hory Mountains (adapted from Mlčoch, Líbalová 1983: Geological map 1:25 000 sheet Litvínov). 1 – crystalline complex; 2 – Miocene sediments; 3 – proluvial deposits undifferentiated; 4 – talus; 5 – modern valleys; 6 – waste dumps; A–A' – cross section

It is exceptional to find typical proluvial sediments at the foot of neovolcanic hills, where the Quaternary is represented mostly by talus deposits. Their thickness does not usually exceed 10 m and is controlled by the character of the piedmont angle. In some cases, particularly around the well- exhumed subvolcanic bodies (diatremes, feeding channels), the talus accumulations are considerably thicker and typically have steep slopes. The resulting morphological feature is an apparently typical effusive volcanic cone that is in fact built up by Pleistocene talus deposits rimming the exhumed central Tertiary volcanic neck. In other words such "cones" are a combination of relatively young denudation and accumulation forms Quaternary in age, unrelated to effusive volcanic activity (Fig. 2).



2. Idealized cross section of an illusive "volcanic cone"
1 - Cretaceous; 2 - exhumed subvolcanic body; 3 - talus deposits

Only along larger valleys draining the neovolcanic hills do the sediments form lobate tongues more typical of the alluvial fan depositional type where the piedmont angle permits.

Fan-like accumulations

Along the base of the Krušné hory Mountains front many fan-like bodies of clastic deposits are developed besides the aprons. The superficial morphology of these deposits is exactly similar to that of alluvial fans of various sizes and slope gradients. They differ, however, in their inner structure and three dimensional form and therefore two main forms i.e. alluvial fans and fluvial fans were distinguished.

In general the accumulations are composed predominantly of sandy gravel, and variable amounts of silt-rich matrix. A higher silt content appears either in the uppermost part of the accumulations or in the well-defined lenses and interlayers of limited extent. The mean silt content in the near surface parts is about 20 %, in the interlayers it is up to 10 % (Růžičková et al. 1987, Marek 1980) and in other parts less than 10-8 %. The clasts are more rounded than expected in alluvial fans, nevertheless the subangular to subrounded particles predominate. Some angular clasts also appear in larger quantities, mostly in the proximal zones. The frequency of less worn gravel decreases with the distance from the mountain front. The occurrence of more rounded clasts in the wider surroundings of Kundratice and the Dřínov water reservoir is controlled more by the physical properties of the local granitoids (Marek 1980) than by the length of the transport. The size of the gravel clasts ranges from 5 to 15 cm; larger pebbles and cobbles (20–40 cm) are frequent and boulders of over 1 m in diameter are also present. The clasts in the better sorted lenses show some imbrication and cross bedding and have a typical clast supported structure. Some lobate interlayers lacking finer grained fraction resemble sieve deposits. The more poorly sorted sediments have no imbrication, no stratification and in many places are matrix-supported.

Alluvial fans

Along the foot of the Krušné hory Mountains front the whole suite of small fans exists. Individual accumulations are developed at the mouths of smaller and particularly of intermittent streams and dry valleys at the rim of the Most Basin. The fans are usually short (size in hundred metres), steep-sloped and relatively thick (up to 20 m in the apex part - Fencl, Záruba 1956) and are deposited close to the mountain front.

These fans are usually composed of poorly sorted immature sandy gravel with subangular to subrounded clasts. The loamy matrix content is relatively high, nevertheless the clast supported structures prevail. They are considered as typical simple alluvial fans, each one corresponding to one depositional cycle.

Fluvial fans

Along larger streams like Chomutovka or Bílina relics of several fan-like bodies are preserved. Their areas of deposition reach relatively far from the mountain front (in size of kilometres) and their slopes and base gradients are gentle and resemble those of graded streams. The gravel accumulations lie in different altitudes much like normal river terraces. Nevertheless the original fan-shaped morphology is still discernible.

In contrast with the above described alluvial fans the sandy gravel composing these relics is in general better sorted and perspicuously stratified and has majority of rounded and subordinate subrounded clasts. The clasts show imbrication in places. The original admixture of clayey matrix is practically negligible and the sediment has a clast supported structure. The size of clasts ranges to 10 cm and no visible decreases of both average and maximum clast size was observed. Typical stream sediments prevail in the studied gravel bodies whereas the flash flood and debris flow types are rather exceptional.

The thickness of older fans (except for the denuded head zones) ranges from 4 to 6 m and is practically constant parallel to the original direction of the flows. The gravel in the head zone of the Chomutovka fan has 13 m in thickness (Váně 1957) which decreases downfan to some 3-5 m. In comparison to typical alluvial fans in older formations (Blissenbach 1954, Reineck, Singh 1980, Scholle, Spearing 1982) these deposits are very thin and the fans are anusually flat and gentle sloped.

The lithology and sedimentology of the fans in Chomutovka and Bílina drainage areas testify a transitional facies between typical alluvial fans and fluvial terraces. Indeed the lithology and shape are more typical of fluvial fans (sensu Czajka 1958) rather than of alluvial fans.

In both above mentioned valleys of Chomutovka and Bílina the fluvial fans, developed in several levels, form sets analogous to river terrace systems.

The Chomutovka system

In the Chomutovka valley, the relics of four fluvial fans and five development phases have been recognized (Fig. 3).

1st phase. The sediments of the first phase represent the highest (oldest) level, termed the Vtelno Fan. They cap the high elevations on both banks of the recent valley at altitudes of 357-350 m a.s.l. and slope due E to 320-310 m at Velemyšleves where they pass into the Vtelno Terrace of the Ohře River. The impoverished gravel is composed exclusively of quartz and other resistant mainly silicified rocks derived from the crystalline complex. The relics of outer parts of the fan do not exceed 5 m in thickness. The probably thicker "head", part has been totally destroyed by younger denudation.

2nd phase. During the second phase the stream was diverted north-eastwards and a smaller accumulation (Otvice Fan) was deposited that links to the Vrskmaň Terrace of Bílina. This accumulation is composed of two sediment types. The dominant portion is represented by coarse gravel 10-15 cm in diameter with cobbles 30-50 cm sporadically present. The sediment has a clast supported structure, shows no imbrication and is interpreted as a high energy torrent type of deposit. The second type is well-sorted with well-rounded clasts and occurs in units of limited extent. It contains lenses of cross-bedded sand and interlayers of redeposited Neogene clays (Marek 1980) that testify more quiet water sedimentation.

The gravel fraction is petrologically richer than in that of previous fan, although it is still of poorer rock assemblage. Clasts of less resistant rocks are strongly weathered in situ.

3rd phase. The third phase is represented by the formation of two separate fans. One was deposited by the Hutná Brook and is composed of poorly sorted, relatively fine grained gravel. The second accumulation (Pohlody Fan) was deposited by the Chomutovka and is represented by coarse-grained gravel with a mean clast size of 10 cm. In this fan larger pebbles and cobbles are frequent. It also has a clay-rich and silt matrix, the clasts show no imbrication and the deposit has a matrix-supported structure. Together these features indicate that the fan is a debris flow type of deposit. Well sorted sand and sandy gravel lenses are exceptional. Downstreams the fan passes into the Pohlody Terrace of the Bílina.

4th phase. The deposits of the fourth phase are preserved in a typical fan form that accumulated between the Hačka and Chomutovka streams. It extends from the mountain front as far as to the confluence of both streams. This Chomutov Fan is generally composed of coarse gravel (0.5 to 25 cm in diameter) with dominant orthogneisses and scarce neovolcanites (Růžičková 1985). Quartz is present in the finer fraction. Some well-rounded gravels also occur and indicate apparent derivation from some older cycle. The remaining clasts are subrounded to subangular.

In the proximal part of the fan, two superimposed accumulations occur. They are separated from each other by a fossil soil developed either at the surface of the older gravel or at a loess interlayer (Růžičková 1985). The lower accumulation is composed of rusty brown coarse gravel with a high content of loam-sand in the matrix. The sediment shows neither stratification nor imbrication. The clasts range in size from 2 to 15 cm. They are composed solely of rocks of local part of the Krušné hory crystalline complex. The overlying upper accumulation is just 1.0-1.5 m thick and is a finer grained (3-10 cm) sandy gravel and sand. A sand interlayer interbedded between two gravel bodies is diagonally bedded parallel to the recent Chomutovka. The upper gravel shows only horizontal bedding. Orthogneisses still dominate in clast assemblage, nevertheless the paragneisses occur in higher quantities than in the underlying unit; quartz is sporadic.

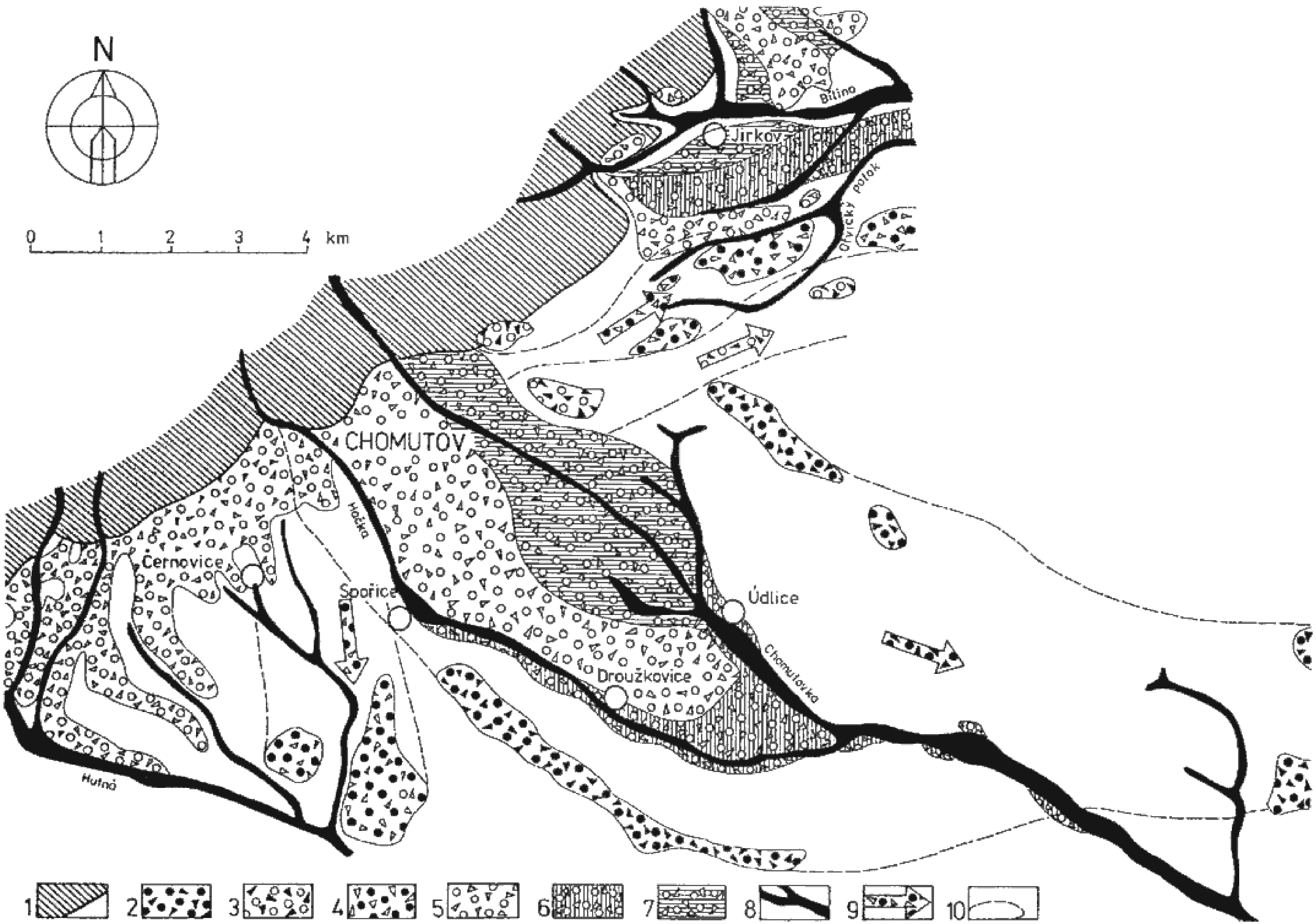
5th phase. During the fifth phase the Chomutov Fan was terraced. Three levels can be distinguished morphologically, i.e. the original surface and two terraces cut into it (Fig. 3). The existence of younger sediments corresponding to younger phases has not been proven.

The Bílina system

A well developed system of fan-like accumulations has also been found in the Bílina valley. Here sickle-shaped SW-NE trending accumulations are well preserved thanks to constant shift of the stream towards north. The Bílina system includes only the Middle Pleistocene deposits because the Lower Pleistocene units originated from the Chomutovka and are described above.

The highest level, i.e. Otvice Fan, was deposited mostly by Chomutovka, but the easternmost occurrence on the right bank of the Otvice Brook was deposited by both streams.

The next younger accumulation, the Jirkov Fan on the right bank of Bílina, can be linked to the phase 4 of the Chomutovka. It forms a well-shaped, fan-like body com-



3. Chomutovka and Bílina fluvial fans

1 - Krušné hory Mountains front; 2 - Vtelno Fan - Pliocene; 3 - Otvice Fan - older phase of Lower Pleistocene; 4 - Hutná and Pohlody Fans - younger phase of Lower Pleistocene; 5 - Chomutov and Jirkov Fans - Middle Pleistocene (early Elsterian); 6 - terraced fans - higher level; 7 - terraced fans - lower level; 8 - modern valleys; 9 - direction of the flow; 10 - supposed original boundaries of the fans

posed of rusty brown coarse petromictic gravel (up to 25 cm in diameter). The sediment is rather compact and has a subordinate silt-rich matrix. The total thickness of this unit is about 6–8 m.

Two lower terraces corresponding to the 5th phase of Chomutovka are composed of coarse gravel with clasts ranging between 10 and 20 cm, although clasts up to 50 cm are not exceptional. The terraces are not cut into the fan body but are represented by new gravel bodies deposited upon contemporarily formed rock terrace platforms. The thickness is each about 5 m.

Fans at the foot of isolated hills

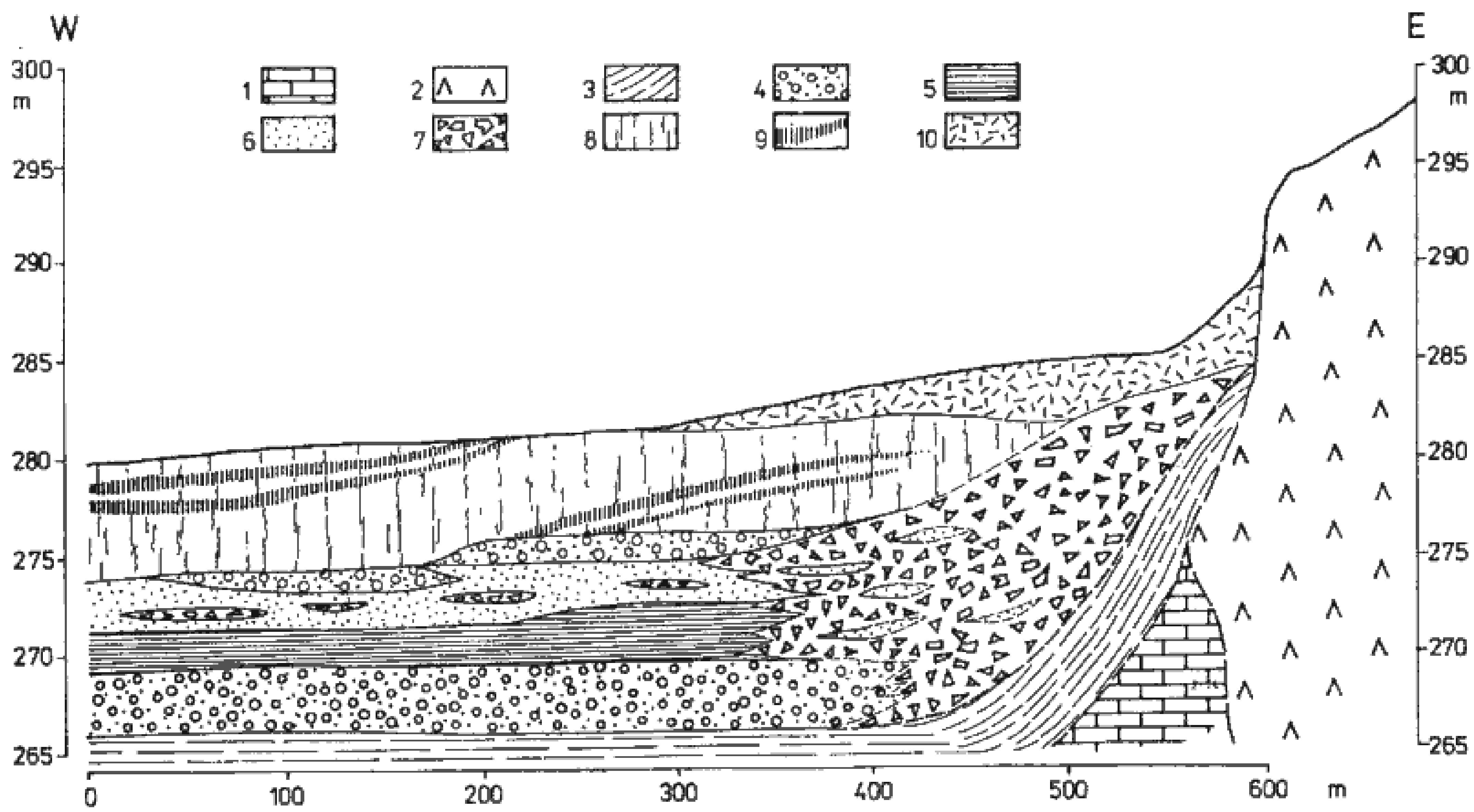
The fans of this type resulting from limited source areas and considerably shorter streams are of restricted dimensions. For their development they require sufficient piedmont angles, which are scarce and they are therefore rather exceptional.

The best known accumulation of this type occurs at the foot of a phonolite hill Ryzel close to Most town. It has been studied here because it has practically all been exposed by the opencast mine working. The accumulation which we name here the Hořany Fan is composed of poorly sorted to unsorted, unstratified sandy gravel with an abundant loam-rich matrix (Fig. 4). The angular to subangular coarser clasts are composed solely of phonolite; in the finer fractions more rounded quartz, orthogneisses, paragneisses and granitoids appear (Růžičková et al. 1987) these lithologies apparently derived from older deposits. Small lenses and layers of well sorted and well rounded gravel, sometimes cross bedded are typical for the middle part of the fan and are of fluvial origin. The size and number of these lenses increases downfan and the fan sediments pass laterally into the fluvial deposits of the Hořany terrace. A matrix supported structure predominates in the unsorted deposits, while a clast supported matrix is typical of the better sorted strata. The sedimentology and lithology of the former type correspond to those of debris flow and torrent type deposits, whereas the stratified and well sorted lenses are clearly sediments originating from the stream flow.

This accumulation is interpreted as a normal simple alluvial fan passing laterally, over a few hundred metres, into the Bílina River terrace (Middle Pleistocene Holešice Terrace – Tyráček 1988). The required piedmont angle originated by coincidence by lateral erosion of the Bílina River. This therefore explains the exceptional occurrence of this type of fan. In most other cases, the gradient of the hill slope passes imperceptibly into the surrounding plain.

Discussion

The sedimentological criteria for the recognition of fossil alluvial fans are relatively well established (Reineck, Singh 1980, Scholle, Spearing 1982, Kukal 1986). Equally the morphological characteristics for the recent forms



4. Hořany Fan – longitudinal section

1. – Cretaceous; 2 – Phonolite – Ryzel hill; 3 – Neogene; 4 – fluvial sandy gravel – Hořany Terrace; 5 – laminated overbank silt and clay – Hořany Terrace; 6 – fluvial sand – Hořany Terrace; 7 – ill sorted debris flow deposits (Hořany Fan); 8 – loess; 9 – fossil soils; 10 – talus deposits

(Blissenbach 1954, Bull 1968, Fairbridge 1968) are also well known.

Small fans deposited close to the Krušné hory Mountains front and the Hořany Fan meet most of the alluvial fans characteristics. They are therefore interpreted as simple alluvial fans which were formed during a single Pleistocene climatic cycle. The same holds good for the aprons. However, where weak erosion has occured, the existence of superimposed bodies from different cycles cannot be excluded. In this case they should be separated from each other by phases of non-deposition. The presence of fossil soils and weathering zones within these sequences, mentioned by some authors (Růžičková 1985, Růžičková et al. 1987) can be explained in this way. On the other hand the frequent areas of non-deposition, due to shifting of the channels, are typical of the alluvial fans.

Larger accumulations and sets of fan-like bodies in humid climate are not easy to interpret. Climatic control of the fan formation is beyond all questions. The fans are usually interpreted as representing accumulations of arid or semiarid regions with typical flash floods. Similar conditions occurred in Central Europe during the glacial periods or more precisely during the transition from glacial to interglacial periods. At these times the abundant precipitation and lack of vegetation protection, allowing supply of material, was accentuated by surplus water from melting permafrost. Surviving permafrost in deeper zones, in addition to it, also restricted or prevented infiltration and controlled thus larger discharge. In addition the huge supply of mechanically desintegrated material loosened by degrading permafrost was delivered downslopes into the valleys by solifluction.

Many of these accumulations are, however, of minor thickness. In order to explain this, the other controlling factor, i.e. time, must be taken into consideration. Because of frequent and relatively short climatic oscillations during the Pleistocene, there was insufficient time for the formation of more typical thick fans, where deposition was short lived during the course of each cycle. During interglacials with temperate and humid climate when dense vegetation and hardwood forests protected the land, no matter whether there was sufficient precipitation or not, the flash floods, debris and torrent flows and supply of loose material were so restricted that fans could not form. The same holds good for (pleni)glacials when the precipitation was mostly in form of snow, and the regolith was fixed by permafrost. This implies that fan deposition could only potentially occur during short time intervals of transition from interglacial to glacial and glacial to interglacial of each climatic cycle. The most important periods seem to be cataglacial phases (glacial-interglacial transition) when a strong supply of huge masses of debris loosened during permafrost degradation were accompanied by synergic activity of solifluction and melt waters. The depositional phase was allways truncated by subsequent erosional period during which not only most of the older fan was removed but also a new platform (rock terrace) for the younger fan was cut. This interpretation implies that the deposit of each older accumulation preserved at different elevation is a relic of a simple fan capping its own pediment, each belonging to one climatic cycle.

The inner texture of the Chomutov Fan is more complex. It is built up of at least two separate accumulations separated by an intervening soil or zone of weathering. This clearly demonstrates that a break in deposition occurred between accumulation of the two bodies. This phase of non-deposition can be interpreted as a normal phenomenon typical of alluvial fan formation. Such break represent those areas not receiving deposits for a period and are apparently quite frequent. Indeed such features are used as one of the criteria for identification of alluvial fans (Scholle, Spearing 1982). On the other hand they have also been used as an analogy of so-called double terrace, sensu Šibrava (1964), when the lower accumulation corresponds to the cataglacial phase of one glacial and the upper one to the anaglacial phase of the next glacial; both separated by an interglacial event. The explanation of the character of the breaks remains obscure.

The loess interlayers found at several localities within the proluvial sediments prove the glacial character of the fan-type of deposits even without paleontological support.

The fans of both described sets differ slightly. Contrary to the Chomutovka where the stream sediments of fluvial fans prevail, for the Bílina valley debris flow sediments resembling more the alluvial fans are typical.

The regular, undisturbed development of the fan systems along Chomutovka and Bílina, analogous to the simplified terrace systems of the upland rivers, suggests a tectonic stability along the Krušné hory fault and non existence of differential movements during the whole period of their formation i.e. since the Late Pliocene. On the other hand, slow uplift of the whole region of the Most Basin may be indicated by the pronounced Ohře River terrace system with well defined vertical intervals.

Small, steep-sloped fans, whose area of deposition remained close to the mountain front, that are conventionally explained by synsedimentary tectonic uplift of the mountains, this movement exceeding the stream downcutting (Bull 1968) are more probably controlled in the Most Basin by the size and discharge of the stream and its dynamics.

Stratigraphy

Because of lack of palaeontological evidence and datable overlying sediments, the morphostratigraphical position and the relationship with the better-dated Ohře terraces is used for stratigraphic classification.

The formation of the Ohře River terrace system is correlated with the last three palaeomagnetic epochs i.e. the end of the Gauss, the whole Matuyama and Brunhes (Tyráček 1991). The Pliocene-Pleistocene boundary is well defined (Tyráček et al. 1985, 1987) and indicates that the four highest terraces are of Pliocene age. In contrast, the Lower-Middle and Middle-Upper Pleistocene boundaries are yet not fixed with sufficient accuracy, although major classification into stratigraphical periods can be achieved. On the basis of stratigraphical interpretation of palaeomagnetic studies of porcellanites the remaining lower levels of the "high terraces group" and the higher levels of the "middle terraces group" correspond to the Matuyama Epoch, whilst the youngest levels, starting with the Chomutov Fan are assigned to the Brunhes Normal Epoch.

For dating the Bílina terraces and fans, two main morphostratigraphical levels are of importance. Firstly the highest unit (Otvice Fan and Vrskmaň Terrace) is dated to the onset of the Quaternary; the second is the valley terrace which is correlated with the Elsterian stage (Engelmann 1922, Tyráček 1988). This means that all levels distinguished in the Bílina valley fall into the time span Lower - early Middle Pleistocene.

On the basis of these index horizons, the dating of the fans is as follows:

a. The oldest Vtelno Fan, that passes laterally into the Vtelno Terrace was deposited towards the close of Pliocene, prior to the Réunion Palaeomagnetic Event (Tyráček et al. 1985).

b. The Otvice Fan can be linked to the Vrskmaň terrace of Bílina and therefore dates from the older phase of Lower Pleistocene (Tyráček 1988).

c. The Pohlody Fan of Chomutovka and the Pohlody terrace of Bílina correlate with younger phase of Lower Pleistocene.

d. The Chomutov and Jirkov Fans represent the onset of Middle Pleistocene.

e. The Hořany Fan passes laterally into the Holešice Terrace and is therefore of Elsterian age. The normal magnetic polarisation of the clay interbed found in this fan was interpreted originally as of Gauss Epoch age (i.e. older than 2.4 Ma - Růžičková et al. 1987). However, it is more likely, particularly with respect to the palaeogeographical development of the Bílina and Ohře valleys, that it should be correlated with the Brunhes Normal Epoch (i.e. post 0.75 Ma).

f. Stratigraphical meaning of two terrace levels of the Chomutov Fan and in the Bílina valley is still obscure. They may represent either short-lived erosional phases typical of alluvial fans or two separate longer phases corresponding stratigraphically to two younger stages (Saalian and Weichselian).

Summary

The accumulations of detrital, water-laid sediments in the Most Basin are classified into three main types, i.e. aprons, fluvial fans and alluvial fans. In addition to it thick talus deposits occur in the same area.

1. Majority of the detritus-covered slopes at the foot of the Krušné hory Mountains front are constructed by relatively thin and flat sheets and aprons overlying a gently sloping pediments. They form "apron-topped pediments" and are located in the sectors where no larger streams occur.

2. The fan-like accumulations along the larger streams include many sedimentological criteria associated with alluvial fans, although their three-dimensional shape differs. They form large, flat and thin bodies projecting far into the basin and correspond to the fluvial fan type. They are developed at different altitudes above the stream like river terraces and can be assigned stratigraphically into the time span Late Pliocene-Middle Pleistocene. Each of them corresponds to one cycle except for the Chomutov Fan which deposition might extend for longer period.

3. The Hořany Fan represents a rather exceptional type of fan developing at the foot of relatively small isolated hill. It is of Middle Pleistocene age. Normal palaeomagnetic polarity corresponds more likely to the Brunhes Normal Polarity Epoch than to the earlier events. The previous interpretation of a Gauss age is therefore revised here.

4. Small steep-sloped fans deposited close to the mountain front are typical alluvial fans and their deposition was controlled by the size of the stream and its dynamics at each locality.

5. The development of river terraces, fluvial and alluvial fans, as well as graded stream gradients disprove the supposed neotectonic movements of individual blocks, particularly along the Krušné hory fault, during the Quaternary Era. Slow uplift of the region as a whole is not excluded.

6. The talus accumulations around the foot of exhumed subvolcanic bodies influence strongly the recent morphology and mask true geological texture forming an illusive picture of superficial volcanoes in this region.

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References

Blackwelder, E. (1931): Desert plains. - J. Geol., 39, 133-140. Chicago.

Blissenbach, E. (1954): Geology of alluvial fans in semiarid regions. - Bull. Geol. Soc. Amer. 65, 175-189. New York.

Bull, W. B. (1968): Alluvial fan, cone. In Fairbridge, R. W. (1968): Encyclopedia of Geomorphology, 7-10. - Reinhold Book Corp. N. York.

Czajka, W. (1958): Schwemmfächerbildung und Schwemmfächerformen. - Mitt. Geogr. Gesell., 100, 18-36. Wien.

Engelmann, R. (1922): Die Enstehung des Egertales. - Abh. Geogr. Gesell., 12, 80. Wien.

Fairbridge, R. W. (1968): Encyclopedia of Geomorphology, 49-50. - Reinhold Book Corp. N. York, Amsterdam, London.

Fencl, J. - Záruba, Q. (1956): Geologické poměry okolí lázní Teplice v Čechách. - Sbor. Ústř. Úst. geol., Odd. geol., 22, 427-484. Praha.

Králík, F. - Tyráček, J. et al. (1989): Geologické problémy krušnohorského svahu v severočeské hnědouhelné pánvi. - MS Ústř. úst. geol. Praha.

Kukal, Z. (1986): Základy sedimentologie. - Academia. Praha.

Marek, J. (1980): Průzkum kvartéru v oblasti kateřinohorské klenby Krušných hor a přilehlé části severočeské pánve. - Geol. Průzk., 22, 3, 65-68. Praha.

Reineck, H. E. - Singh I. B. (1980): Depositional Sedimentary Environments. - Springer Verlag. New York, Heidelberg, Berlin.

Růžičková, E. (1985): Profily kvartérními sedimenty na listu mapy 1:25 000 02-333 Chomutov. - MS Ústř. úst. geol. Praha.

Růžičková, E. - Zeman, A. - Hurník, S. (1987): Vývoj jihovýchodního okraje Krušných hor a mostecké pánve v mladším kenozoiku. - Sbor. geol. Věd, Antropozoikum 18, 9-72. Praha.

Scholle, P. - Spearing, D. (1982): Sandstone depositional environment. - Memoir (Amer. Assoc. Petrol. Geol.), 27. Tulsa.

Šibrava, V. (1964): Double fluvial accumulation in the area of the Bohemian Massif and the Carpathian foredeep. - Sbor. geol. Věd, Antropozoikum, 2, 57-68. Praha.

Tyráček, J. (1988): Terasy Bíliny mezi Kyjicemi a Hořany. - Zpr. geol. Výzk. v Roce 1985, 202-204. Praha.

- (1991): Lower Pleistocene Stratigraphy. - Abstracts XIII. Internat. Congress INQUA, 361. Beijing.

Tyráček, J. - Králík, F. (1991): Proluviální sedimenty severočeské hnědouhelné pánve. - Zpr. geol. Výzk. v Roce 1989, 173-174. Praha.

Tyráček, J. - Minaříková, D. - Kočí, A. (1985): Stáří vysočanské terasy Ohře. - Věst. Ústř. Úst. geol., 60, 77-86. Praha.

- (1987): Datování hradecké terasy Ohře. - Věst. Ústř. Úst. geol., 62, 279-289. Praha.

Váně, M. (1957): O geologických poměrech Chomutovska. - Věst. Ústř. Úst. geol., 32, 192-203. Praha.

Kvartérní aluviální kužely v mostecké pánvi?

(Resumé anglického textu)

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Kvartérní sedimenty v mostecké pánvi, jako spraše, svahoviny a říční terasy, mají typicky nesouvislý a plošně omezený vývoj. Výjimkou jsou rozsáhlé akumulace klastických uloženin, označované ve starší literatuře jako proluviální sedimenty. Tento typ uloženin je regionálně vázán buď na náhlou změnu sklonu svahu při úpatí krušnohorského svahu a izolovaných neovulkanických elevací, nebo na změnu spádové křivky, kdy tok opouštějící horskou oblast vstupuje do plochého reliéfu pánve. Členíme je na tři hlavní typy, a to na plošné pokryvy, fluviální kužely a aluviální kužely.

1. Plošné pokryvy vyvinuté při úpatí krušnohorského svahu tvoří 1-3 km široký pruh vázaný na úseky bez větších toků. Jejich vznik byl dříve vysvětlován splynutím jednotlivých menších kuželů. Ve skutečnosti jde o typický pediment překrytý produkty stružkové a plošné eroze a plošných proudů.

2. Sedimenty podél Chomutovky a Bíliny vytvářejí systémy plochých fluviálních kuželů, zachovaných v různých výškách nad místními toky. Vytvářely se postupně v období pozdní pliocén až střední pleistocén a jsou obdobou říčních teras.

3. Jako typické aluviální kužely je možno označit malé formy s poměrně příkrými svahy přisedlé těsně ke krušnohorskému svahu. Jejich vývoj je ovlivněn vodností toků a jejich dynamikou, a nikoli neotektonickými pohyby, jak se uvádí v literatuře.

Hořanský kužel je výjimečná akumulace uložená na úpatí fonolitového tělesa Ryzlu u Mostu. Přechází po proudu plynule do hořanské terasy Bíliny. Proto je třeba opravit původní datování z pliocénu do středního pleistocénu.

Dalšími zajímavými sedimenty jsou svahoviny při úpatí exhumovaných subvulkanických těles (diatremy, přívodní kanály), jejich akumulace zastírají hlubší geologickou stavbu a vytvářejí klamný dojem typických efuzívních vulkanických kuželů. Ve skutečnosti jde o morfologický tvar, který je kombinací mladých, denudačně akumulačních forem.

Pravidelný vývoj teras a kuželů je dokladem tektonické stability krušnohorského zlomu po dobu nejméně posledních dvou miliónů let. Nelze tedy potvrdit názor na diferencované neotektonické pohyby jednotlivých bloků v průběhu kvartéru. Naproti tomu vzhledem k dobré výškové diferenciaci říčních teras Ohře v mostecké pánvi nelze vyloučit pomalý dlouhodobý zdvih regionu jako celku.

Vysvětlivky k obrázkům

1. Proluviální sedimenty na úpatí Krušných hor (upraveno podle Mlčocha a Líbalové 1983: Základní geologická mapa 1:25 000 list Litvínov).
   1 - krystalinikum; 2 - miocén; 3 - proluviální sedimenty nerozlišené; 4 - svahoviny; 5 - dnešní údolí; 6 - haldy (skrývka); A-A' - linie řezu.
2. Idealizovaný řez zdánlivým vulkanickým kuželem.
   1 - křída; 2 - miocén; 3 - svahoviny.
3. Kužely Chomutovky a Bíliny.
   1 - okraj Krušných hor; 2 - vtelenský kužel - pliocén; 3 - otvický kužel - starší fáze spodního pleistocénu; 4 - pohlodský kužel - mladší fáze spodního pleistocénu; 5 - chomutovský a jirkovský kužel - střední pleistocén; 6 - terasované kužely - vyšší úroveň; 7 - terasované kužely - nižší úroveň; 8 - dnešní údolí; 9 - směr toku; 10 - předpokládané původní hranice kuželů.
4. Hořanský kužel - podélný řez (zčásti převzato podle Růžičkové et al. 1987).
   1 - křída; 2 - fonolit - vrch Ryzel; 3 - neogén; 4 - fluviální písčitý štěrk - holešická terasa; 5 - laminity - povodňové sedimenty - holešická terasa; 6 - fluviální písek - holešická terasa; 7 - hořanský kužel - špatně vytříděné uloženiny; 8 - spraš; 9 - fosilní půdy; 10 - svahoviny.