A Study of the Dětaň Locality (Oligocene, Doupovské hory Mts. Volcanic Complex, Czech Republic): Collection of Field Data and Starting Points for Interpretation

Radek MIKULÁŠ[1], Oldřich FEJFAR[2], Jaromír ULRYCH[1], Anna ŽIGOVÁ[1], Eva KADLECOVÁ[1] and Vladimír CAJZ[1]

[1] *Institute of Geology, Academy of Sciences CR, Rozvojová 135, 165 02 Praha 6, Czech Republic*
[2] *Charles University, Faculty of Science, Albertov 6, 128 43 Praha 2, Czech Republic*

ABSTRACT. During the Early Oligocene, a limiting factor for subaerial vegetation at southern margin of the Doupovské hory Mts. was a repeated fall of basaltic tuffs. Because no tuff level provided a record of pedogenesis, intervals between the eruptions must have been very short (tens of years at maximum). Subsequently, the locality was lying on a flood plain of a watercourse bringing volcanic material; at that time, the ecosystems were at least twice destructed by pyroclastic flows, which left violet, sharply bounded strata. The age of the basaltic lava flow overlying the tuffs and tuffites was determined by K/Ar method (bulk sample) at 32.6±1.7 Ma. According to relative paleontological dating, the locality belongs to mammalian Zone MP 21. These data point to the conclusion that all the volcaniclastic series appeared in a relatively short time in the Early Oligocene.

KEY WORDS: Volcaniclastic rocks, Oligocene, Doupovské hory Mts., zoopaleontology, ichnology, pedology, geochemistry.

Introduction

The locality of Dětaň represents one of the exceptional geological sites of the volcanic complex of the Doupovské hory Mts. The present exposure from the 1970s to 1980s yielded rich paleontological material, partly reviewed by Fejfar (1987). A brief description of the locality, with general paleontological and paleoenvironmental characteristics, were published by Fejfar and Kvaček (1993). The locality lies in an extensive pit after exploitation of kaolin and basaltic tuffs south of the village of Dětaň. The body of kaolin is covered by a 45–50 m thick succession of weakly cemented to non-lithified basaltic tuffs and tuffites. The exposure is currently subjected to slumping and overgrowth by vegetation, which causes a gradual destruction of the locality.

A complex interdisciplinary study of the locality was commenced in 1999, with the objective to cover various geochemical aspects, sedimentology, ichnology and pedology, and to combine the new results with modern studies in endogenous and exogenous regional geology of volcanic bodies (cf. Hradecký 1997). Even during the fieldwork from 1999, the outcrop lost a lot of its informative value and the observable stratigraphy is less complete. As we expect that the locality will be also an exceptional and valuable source of information in both regional and more general view in the future, we decided to publish the primary documentation as completely as possible, including descriptions of each bed and colour photos documenting the state in 2000–2001. The aim of the present contribution is, therefore, to provide a collection of field data and starting points for interpretation.

Geological setting

The locality is situated on the southern margin of the Doupovské hory Mts. (Mikuláš et al. 2002). The area of Doupovské hory Mts. represents a complicated volcanic complex of Cenozoic age situated in the Ohře Rift graben, i.e., a SW–NE-trending volcano-tectonic zone. The volcanic rocks overlie mostly the Upper Carboniferous continental sandstones and arkoses and the Upper Cretaceous marine rocks in the southern and eastern part of the complex, where the study locality is situated. The volcanics are mostly basaltic, with non-olivine types (i.e., tephrites and foidites) prevailing over olivine ones. The ratio between solid rocks and volcaniclastics is about 1:4. These rocks were most probably produced from the main crater vent, situated near the former small town of Doupov. Now it is marked by small intrusions of syenitic rocks. Also several parasitic vents are presumed to exist during the activity of the volcano. The preserved thickness of the volcanic and pyroclastic rocks in the area is max. 500 m. Some pyroclastic accumulations are developed *in situ* as ash beds and pyroclastic flows, a certain part (over 50 %) was redeposited by volcanic mudflows (lahars) and by fluvial processes (fluvial and lacustrine environments). A large part of the volcaniclastic rocks was influenced by secondary carbonization. The whole volcanic complex was subjected to intensive post-Miocene erosion.

The locality of Dětaň provides, in contrast to other Occurrences on the southern margin of the Doupovské hory Mts. (e.g., Dvérce), a geological record mainly in subaerial context.

Stratigraphy

The lowermost exposed interval, i.e., kaolinized arkoses and sandstones, was subjected to former exploitation. The overlying interval reaches max. 50 m in thickness. At the top of the kaolinized arkoses, irregular lenses and lentiles of white quartzose sandstones to quartzites (up to 80 cm thick) are developed; they are followed by a 1–2 m thick, non-lithified to weakly consolidated, non-laminated bed composed of sand mixed with basaltic ash. The remaining 30–40 metres of the section are represented by tuff and tuffite beds usually several tens of centimetres thick. More than 90 individual beds were distinguished. The beds typically differ in colour (grey, brownish, reddish and violet hues), grain size (compact matrix and several centimetres long smectite aggregates; beds composed of grains of equal size, e.g., 1–2 mm, and other varieties), lateral stability (lentiles, quickly nipping beds, stable beds), presence of lamination, and in paleontological content. The lower 15–20 metres of the volcaniclastic sequence

are composed of non-laminated tuff beds gradually passing to one another. Some beds contain frequent angular lava shreds or, less frequently, lapilli. The tuff beds are overlain by laminated, locally cross-bedded tuffites; two stable, parallel-laminated, violet, sharply bounded beds are also present. A few tuff beds are also present in the upper part of the sequence. The volcaniclastic sequence was covered by a basalt lava flow, which is observed in debris only at the locality; large outcrops of the lava have been preserved ca. 300 m to the W (the Vrbička Quarry).

Data on the age of the rock exposed at Dětaň are as follows: 1.The age of biotite/smectite crystals from the tuffs was determined at 37.5 Ma by K/Ar dating method; however, because of the alterations of biotite, this indication may not be exact. 2. The age of the basaltic lava flow overlying the tuffs and tuffites was determined at 32.6 ± 1.7 Ma by K/Ar method (bulk sample). 3. According to relative paleontological dating, the locality belongs to mammalian Zone MP 21. These data point to the conclusion that all the volcaniclastic series appeared in a relatively short time during the Early Oligocene.

The lowermost tuff beds, which provided mammal fossil record, are poorly exposed at present. We may only guess, considering the superposition and lateral changes of strata, that the 2–3 m of fossiliferous tuffs (cf. Fejfar 1987) lie immediately below the oldest documented bed of the uninterrupted section of the southwestern side of the quarry (Pl. I) as described in Table 1. The basal tuff beds, as exposed in small outcrops in the northeastern wall of the quarry, are typically greyish-brown, coarse-grained tuffs rich in smectite. Fragments of bones and teeth are rather rare and spread all over the rock volume. A kettle-like depression as described in "Paleontology" provided an exceptionally rich fossil record (Pl. II, Fig. 1, 4).

Paleontology

1. Zoopaleontology. Skeletal remains of vertebrates (predominantly mammalian) are highly fragmented and widely scattered through the basal ash beds (2–3 m thick bed). The whitish bones

	Thickness, colour, grain size, primary structures	Paleontological content
1.	26 cm; greyish-brown, homogeneous, medium- to coarse-grained tuffs; large clasts of smectite	–
2.	12 cm; light brown, coarse-grained tuffs	–
3.	21 cm; reddish-brown, fine- to medium-grained tuffs	Infrequent, thin vertical root traces
4.	21 cm; light to medium grey, fine-grained tuffs	Three finds of *Celliforma* isp., 12, 17, and 18 cm below the top
5.	22 cm; reddish-brown, fine-grained tuffs	–
6.	13 cm; light-grey, very fine-grained tuffs with numerous large smectite aggregates	–
7.	10 cm; brown, fine-grained tuffs.	Root traces passing from the overlying bed
8.	55 cm; light to dark reddish-brown fine-grained tuffs; 8a – light bed, ca. 15 cm; 8b – darker bed, ca. 25 cm; 8c – light bed, ca. 15 cm	Common long, subvertical root traces passing all through Bed 8. 8a – one find of *Celliforma* isp.; 8b – several groups of *Celliforma* isp.; one *?Palmiraichnus* isp.
9.	17 cm; brownish-red, fine-grained tuffs	Common minute root traces
10.	20 cm; dark grey, coarse-grained tuffs with numerous smectite aggregates	–
11.	45 cm reddish-grey, fine-grained tuffs having a light lamina in the middle	2 small *Celliforma* isp. ca. 10 cm above the base
12.	20 cm; 12a – 6 cm light-grey, fine-grained tuffs; 12b – 14 cm light-brown fine-grained tuffs	–
13.	42 cm; generally umber to grey tuffites with large angular, sometimes argillaceous clasts (= lapilli, lava shreds) and clay laminae	–
14.	18 cm; dark, reddish brown, fine-grained tuffs	2 finds of *Celliforma* isp.
15.	12 cm; light brown, medium- to coarse-grained tuffs	One*?Palmiraichnus* isp., one *Celliforma* isp. orientated "bottom-up" (angle of axis 35°)
16.	10 cm; dark reddish-brown, fine-grained tuffs	–
17.	18 cm; light-brown, fine-grained tuffs	–
18.	18 cm, brownish-red, medium- to coarse-grained tuffs	Two *?Palmiraichnus* isp. at top
19.	18 cm; light-brown, fine-grained tuffs	One large *Celliforma* isp.
20.	11 cm; brownish-red, fine-grained tuffs	–
21.	31 cm; light fine-grained tuffs. 21a – 11 cm light brown; 21b – 20 cm grey	One *Celliforma* isp. at top
22.	17–25 cm; reddish-brown tuffs; 21a – 13 cm; medium-grained (clasts up to 2 mm); 21b – 5–12 cm; fine-grained matrix and phenocrysts up to 5 mm in size.	Common thin root traces
23.	10 cm; grey graded-bedded tuffs	–
24.	15 cm; light-grey, medium-grained tuffs	–
25.–26.	40 cm; reddish-brown, fine- to medium-grained tuffs with rare large clasts	Sole *Celliforma* isp. 11 cm above the base; vertical and subhorizontal root traces
27.	60 cm; mostly light brown medium-grained tuffs with laterally discontinuous laminae and colour features (e.g., 27a – 20 cm light grey; 27b – 8 cm reddish-brown; 27c – 16 cm light grey; 27d – 16 cm pink)	27d: 4 finds of *Celliforma* isp.; common minute rootlets; 27a–c: no paleontological finds
28.	50 cm; reddish-brown, medium-grained tuffs	Sole *Celliforma* isp.; frequent rootlets
29.	43 cm; light grey, coarse-grained tuffs	–
30.	25 cm; greyish-brown, medium-grained tuffs	–
31.	17 cm; greyish-brown to reddish-brown, medium-grained tuffs	Subvertical tube 15–30 mm in diameter (?rodent burrow), root trace inside (Pl. II, fig. 6 herein)
32.	11 cm; dark grey coarse- to medium-grained tuffs.	Large *Celliforma* isp. at base; rootlets
33.	80 cm; greyish-brown tuffs to tuffites; graded bedding (numerous large clasts in basal part), uneven weathering (lower part is more resistant)	–
34.	10 cm; laterally unstable dark grey tuff bed	–
35.	12 cm; light grey, medium-grained tuffs	–

Tab. 1. Complete stratigraphic column of the Oligocene volcaniclastic section exposed in the southwestern wall of the quarry. Numbers of beds correspond to those given in the photographs on Plate I. Numbering of beds from bottom to top.

	Thickness, colour, grain size, primary structures	Paleontological content
36.	50 cm; reddish tuffs; middle part less resistant to weathering	–
37.	55 cm; grey to greyish brown coarse- to medium-grained tuffs	One *?Palmiraichnus* isp. 4 cm above base
38.	10 cm; dark grey coarse- to medium-grained tuffs	–
39.	35 cm; light grey coarse- to medium-grained tuffs	–
40.	15 cm; grey, medium-grained tuffs; sharp lower and upper boundary	–
41.	0–10 cm; laterally unstable reddish tuff bed	–
42.	55 cm; brown-grey coarse- to medium-grained tuffs	–
43.	38 cm; brown-grey, prone to weathering, in places indistinctly laminated medium-grained tuffites(?)	One small *Celliforma* isp.; fragments of leaves of dicotyledon plants
44.–46.	58 cm; grey to violet tuffs (?tuffites)	Fragments of mineralized wood; large root system (several decimetres in diameter)

Note to Beds 47–51:
The following succession applies for the southern part of the quarry. In the central to northwestern part, the interval includes 11 distinctive beds of a total thickness of 180 cm of tuffites with large root systems and wood fragments.

47.	7 cm; grey tuffs (?tuffites)	–
48.	10 cm; brownish-red tuffs (?tuffites)	–
49.	15 cm; grey tuffs (?tuffites)	–
50.	15 cm; orange, limonite-rich tuffs (?tuffites)	–
51.	8 cm; grey tuffs (?tuffites)	
52.	8–18 cm; reddish, in places umber or orange, limonite-rich, fine-grained tuffite bordered with subhorizontal limonite crusts (precipitates)	Floral remains (?rhizomes)
53.–54.	38 cm; compact, laminated, brown to violet tuffites; a – 5 cm, brown to violet, matrix dominates over larger clasts; b – 4 cm; larger clasts dominate over matrix; c – 10 cm; matrix dominates; d – 8 cm, large clasts dominate; e – compact matrix-dominated brown to violet tuffites	–
55.	45 cm; reddish-grey laminated tuffite; graded bedding; one distinct red lamina 5 mm thick; generally pelitic matrix with argillized clasts up to 10 mm large	Isolated mineralized root trace 2.5 mm in diameter
56.	33 cm; full reddish-grey, fine-grained, laminated tuff to tuffite; sharp base; interpreted as a pyroclastic flow	Numerous root traces including larger root systems
57.	33 cm; reddish-grey, laminated tuffite; ca. 10 recognizable laminae include coarse grains (up to 10 mm)	Mineralized wood 120 cm long and 16 cm in diameter; rootlets
58.	33 cm; grey, compact, coarse-grained tuffs (clasts up to 7 mm large)	–
59.	14 cm; light grey, fine-grained tuff to tuffite	Thin black root traces
60.	4 cm; light grey to pink tuff to tuffite bed bordered by thin (~3 mm) limonite slabs	–
61.	18 cm; laterally unstable lens of grey tuff	–
62.	13 cm; full red, fine-grained, laminated tuff to tuffite; sharp base; interpreted as a pyroclastic flow	Isolated root traces up to 15 mm in diameter
63.	25 cm; brown, compact, medium-grained tuff to tuffite	–
64.	10–45 cm; variegated, reddish, brown to umber bed of chiefly fine-grained, laminated tuffite	–
65.–68.	70 cm; variegated bed of chiefly medium-grained, laminated tuffite	Wood fragments
69.	25 cm; grey, brown to umber, fine-grained tuff (tuffite)	Thin root traces
70.	55 cm; greyish-brown laminated tuffite; alteration of coarse-grained and pelitic laminae	Wood fragments
71.	20 cm; brown laminated tuffite; alteration of coarse-grained and pelitic laminae	–
72.	45 cm; greyish-brown laminated tuffite; alteration of coarse-grained and pelitic laminae	Wood fragments
73.	0–15 cm, umber, fine-grained, inexpressively laminated tuffite	–
74.	25 cm; light greyish-brown tuffite with pelitic matrix and occasional large clasts	–
75.	10–15 cm; umber, limonite-rich, weathered, coarse-grained tuffite	–
76.–77.	30 cm; variegated, chiefly grey and brown tuffites with large (up to 10 mm) pyroxene crystals	–
78.	10 cm; grey to violet, coarse-grained, rapidly weathering tuffs (tuffites)	–
79.	45 cm; grey to brown-grey, coarse-grained, non-laminated tuffs	–
80.	13 cm; grey, fine-grained (~silty) tuffs	Dense population of subvertical rhizomes
81.–82.	70 cm; grey to brown-grey, coarse-grained, imperfectly laminated tuffs	–
83.	12–20 cm; violet-brown, medium-grained tuff (tuffite)	Common vertical to subvertical root traces
84.	Ca. 30 cm; grey, coarse-grained, non-laminated tuffs; poorly exposed	–
85.	Ca. 130 cm; greyish-brown, coarse-grained, non-laminated tuffs; weathered and poorly exposed	–
86.	30 cm; black matrix bearing angular, usually 8–15 mm in size, umber and green argillized clasts	–
87.	120 cm; greyish-brown, coarse-grained tuffs to tuffites; gradual transition between Beds 86 and 87	–

Tab. 1. Complete stratigraphic column of the Oligocene volcaniclastic section exposed in the southwestern wall of the quarry. Numbers of beds correspond to those given in the photographs on Plate I. Numbering of beds from bottom to top, *continued*.

are often covered with fine traces of gnawing by small carnivores. Doubled traces of rodent incisors are not present. Fejfar (1987) ascertained the following taxa. Marsupialia: *Amphiperatherium* sp. Insectivora: cf. *Paratalpa* sp.; cf. *Neurogymnurus* sp.; *Quercysorex* sp. Rodentia: *Suevosciurus ehingensis* Dehm; *Palaeosciurus* sp.; *Plesispermophilus* cf. *atavus* Schmidt-Kittler & Vianey-Liaud; *Gliravus* sp.; *Bransatoglis* cf. *micio* (Misonne); *Eomys* cf. *zitteli* Schlosser; cf. *Parasminthus* sp.; *Paracricetodon* cf. *dehmi* Hrubesch; *Eucricetodon* cf. *murinus* (Schlosser); *Pseudocricetodon montalbanensis* Thaler. Artiodactyla: *Gelocus laubei* Schlosser; *Bachitherium* cf. *curtum* Filhol; *Lophiomeryx mouchelini* Brunet & Sudre; *Paroxacron* sp.; *Propalaeochoerus*

cf. *paronae* Piaz; *Entelodon antiquum* Repelin; *Antracotherium* cf. *monsvialense* Zigno; *Elomeryx crispus* Gervais. Perissodactyla: [redacted] Carnivora: *Cephalogale* sp.; *Pseudocyonopsis* cf. *antiquus* Ginsburg. Deltatheridia: *Hyaenodon* sp. Other vertebrates include *Geochelone* (giant turtle), a small crocodile and small forms of reptiles.

This assemblage excludes the age before the Grande Coupure and proves the mammalian Paleogene Zones MP21 or MP22. A more precise dating to the older zone MP21 is given by the index form *Entelodon antiquum* Repelin and by the general evolutionary level of some rodent species as well.

Fill of a kettle-shaped depression (most probably a stump cast) in one of the tuff beds was excavated in May 2000 in the eastern wall of the quarry approximately 20 m below the top of the section by Dr. Madelaine Böhme (München). It provided a new unique fauna: rodents *Bransatoglis* sp., *Bransatoglis* cf. *micio* (Misonne), *Paracricetodon* cf. *dehmi* Hrubesch, and *Eucricetodon* cf. *murinus* (Schlosser), and insectivores (gen. et sp. indet.). Remains of lower vertebrates are diverse but very fragmented; they contain amphibians: Salamandridae indet., Pelobatidae indet., Discoglossidae indet.; reptiles: Lacertidae sp. 1, Lacertidae sp. 2, Anguidae indet. (M. Böhme, unpublished data). Gastropods are represented by *Patula (Anguispira) ?frici* Klika, *Patula densestriata* Klika *Strobilus elasmodonta* Reuss, *Acme (Acicula)* sp. and other yet undetermined gastropod genera and species.

2. Paleobotany. Discernible floral remains are rare (mineralized wood; pine needles; molds of hicory nuts /*Carya*/). The assemblage (as compiled also from palynological data from the near localities) documents the influx of Arcto-Tertiary elements and the extinction of some Eocene thermophilous elements.

3. Ichnology. The tuff beds contain more or less frequent insect trace fossils (ichogenera *Celliforma* div. isp., *Coprinisphaera* isp., and *Palmiraichnus* isp.), infrequent subaquatic invertebrate traces (*Taenidium* isp.) and rare burrows of small mammals. Root traces vary in density and diversity. The insect traces indicate purely subaerial environment of the respective beds.

Geochemistry

Table 2 shows chemical analyses of distinctive beds. Generally, the chemical composition of tuffs and the lava flow is tephritic, which documents a partial differentiation of the magma. However, the results are influenced by the fact that the pyroclasts are presumably influenced by secondary carbonates. The obtained data on pH (Table 3) show a slightly acid reaction of most beds; alkaline reaction of the remaining beds corresponds with elevated content of $CaCO_3$.

Pedology

From the pedological viewpoint, many beds were suspected to represent paleosols, because of rich root structures and insect traces. However, micromorphological study of individual beds did not prove any stage of soil development.

Starting points for interpretation

There are no direct stratigraphic data for the quartzites, which are interpreted as a pre-Oligocene silcrete (its origin corresponds well with the presumed warm and humid climate). The ichnofabric of the silcrete (i.e., root and ?insect traces) documents the existence of vegetation and fauna. In the following period, contemporaneous with the mammal zone MP-21, the limiting factor of vegetation development was a repeated fall of basaltic tuff. Because no tuff level provided a record of pedogenesis, intervals between the eruptions must have been very short (tens of years at maximum) and the vegetation was poor. Subsequently, the locality appeared in a flood plain of a watercourse bringing the volcanic material; at that time, the ecosystems were at least twice destroyed by pyroclastic flows, which left violet, sharply bounded beds. A short-lived existence of swamp and lacustrine settings is also presumed. The ecosystem succession was disrupted by repeated lava flows (cf. Mikuláš et al. 2002).

Bed	1	3	13	27	32	53	56	70	79
wt. %									
SiO_2	45.28	49.94	51.34	41.18	39.14	57.69	61.99	48.53	49.25
TiO_2	3.10	3.18	4.57	3.72	4.46	3.76	2.71	4.09	4.40
Al_2O_3	13.21	13.90	14.00	12.57	13.17	14.81	14.32	14.21	10.91
Fe_2O_3	8.58	11.14	14.66	10.11	10.75	11.02	9.34	11.22	13.90
FeO	1.44	0.36	2.04	1.43	2.19	0.76	0.27	0.98	0.39
MnO	0.08	0.28	0.24	0.17	0.11	0.21	0.42	0.10	0.29
MgO	4.98	4.82	5.16	6.27	7.71	4.31	3.82	8.74	8.33
CaO	20.88	14.87	6.16	22.09	20.47	4.68	3.93	10.33	11.43
Na_2O	0.59	0.29	0.12	0.29	0.14	0.34	0.45	0.20	0.13
K_2O	1.32	0.84	0.60	1.36	0.75	1.43	1.94	0.95	0.42
P_2O_5	0.54	0.39	1.11	0.82	1.10	0.99	0.82	0.63	0.53
Total	99.99	100.00	100.00	100.00	100.00	99.99	99.99	99.99	99.99

Analyses recalculated to water-free base.

Tab. 2. Chemical analyses of distinctive beds at Dětaň.

Further specification of the geological history of the locality will arise from several studies: systematic paleontology of fossil wood, ichnology, gastropods, isotopic analyses, and repeated field study of several Oligocene localities in the region of the Doupovské hory Mts.

Acknowledgements

The paper is a part of the research program of the Institute of Geology, AS CR (No. CZK-Z3 013 912). Thanks are due to the Grant Agency of the Czech Republic for financial support (Grant No 205/00/1000). We thank Dr. Madelaine Böhme (München) for sharing her field observation with us and for her reviewer's comments. The paper also benefitted from the critical review by Dr. Thomas Poetsch (Hamburg). Stanislav Šlechta and Josef Brožek were helpful during the fieldwork.

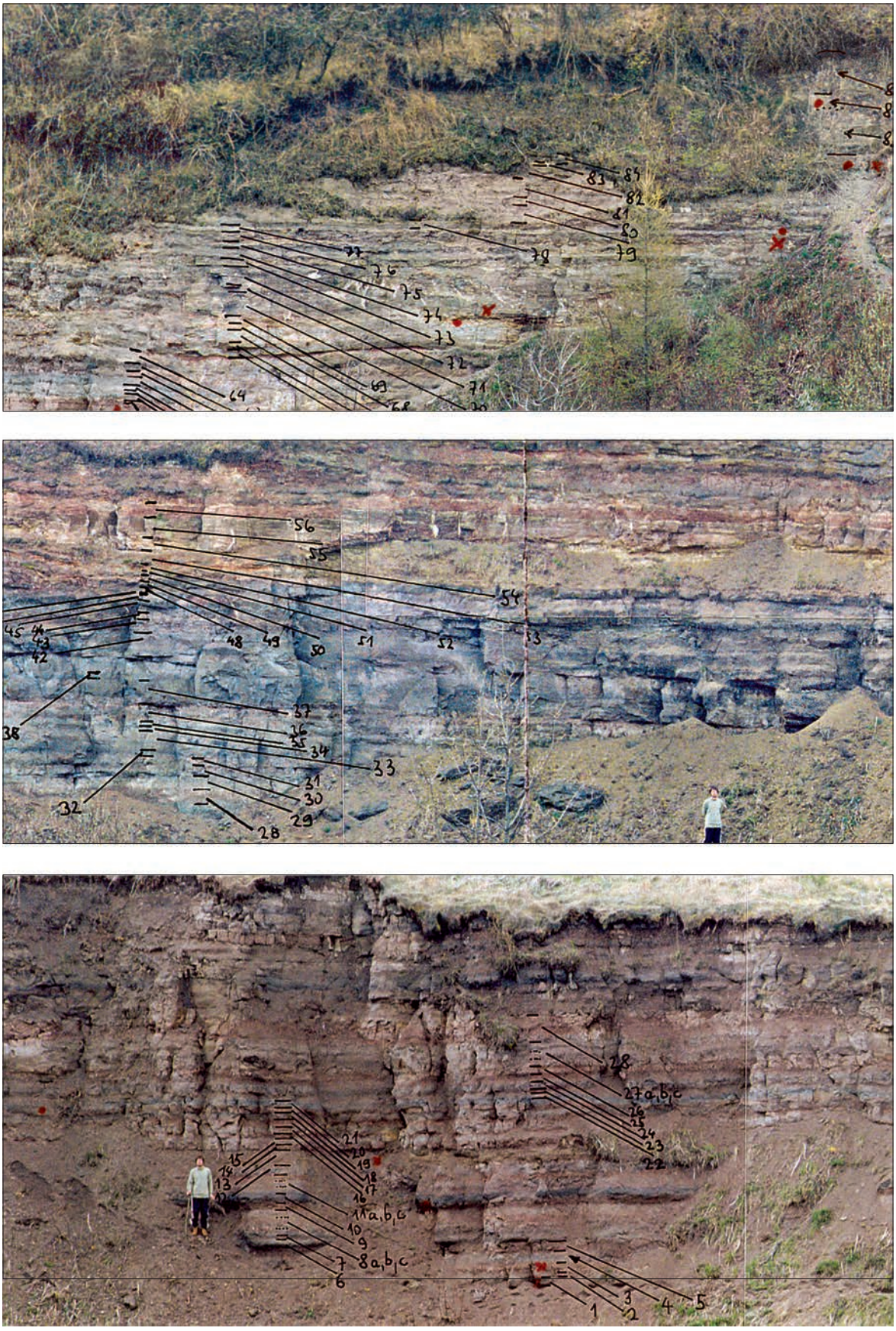


Plate I. A complete section of volcaniclastic rocks in the southwestern wall of the abandoned Dětaň Quarry. Numbers of beds correspond to those used in Table 1. Photos by J. Brožek, 2000.

1

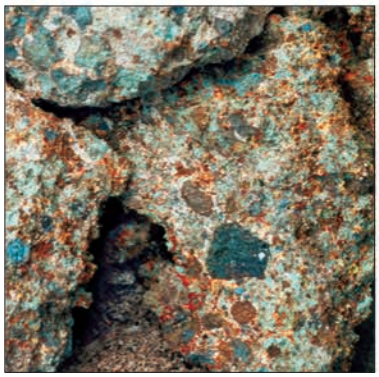
2

3

4

5

6



7

8

9

Plate II. 1, 4 – a kettle-shaped, dark-filled depression (probably a stump cast) in one of the lowermost tuff beds exposed in 2000–2002 by slumping in the northeastern wall of the Dětaň quarry. 1 – overall view; 4 – a detail of the transition between tuffs and the dark, Mn-rich fill. 2 – *Celliforma* isp.; two hymenopterous brooding chambers *in situ*, Bed 27, natural size. 3 – variegated, laminated, graded-bedded, coarse- to medium-grained tuffite; upper beds of the section (fallen block); sample 20 cm thick. 5 – grey tuffs or tuffites (Bed 51); umber, limonite-rich, fine-grained tuffite showing limonite precipitates at the base (Bed 52, marked by a yellow point); compact, laminated, brown to violet tuffites (Bed 53). Southwestern part of the quarry. 6 – greyish-brown to reddish-brown, medium-grained tuffs. Subvertical tube 15–30 mm in diameter (?rodent burrow), root trace inside (Bed 31). 7 – Bed 13: umber to grey tuffites with large, angular, sometimes argillaceous clasts (~lapilli, lava shreds). 8 – grey, fine-grained (~silty) tuffs overlain by grey to brown-grey, coarse-grained, imperfectly laminated tuffs to tuffites (Beds 80–81). 9 – Bed 56: reddish-grey, fine-grained, laminated tuff to tuffite; sharp base; interpreted as a pyroclastic flow. Numerous root traces including larger root systems are present. All photos by R. Mikuláš, 2000–2001.

No.	pH_{H2O}	pH_{KCl}	$CaCO_3$ %
1	7.78	6.81	22.0
2	7.95	6.79	10.0
3	7.95	6.76	6.4
4	7.97	6.59	0.2
5	7.98	6.86	13.0
6	8.06	6.87	21.0
7	8.09	6.91	22.0
8a	8.05	6.77	17.0
8b	8.00	6.75	5.6
9	8.07	6.78	14.0
10	8.05	6.88	16.0
11a	8.09	6.85	19.0
11b	8.07	6.76	7.0
11c	8.01	6.69	1.3
12	8.01	6.66	4.8
13	7.76	6.45	< 0.1
14	7.98	6.82	14.0
15	7.93	6.78	2.4
16	8.03	6.89	16.0
17	8.09	6.89	18.0
18	8.00	6.80	14.0
19	7.98	6.83	3.0
20	7.93	6.82	10.0
21	7.60	6.20	1.0
22	7.29	5.60	< 0.1
23	7.76	6.03	< 0.1
25	8.03	6.54	4.8
27a	7.21	5.63	0.8
27b	7.25	5.58	< 0.1
42	8.14	6.93	34.0
43	8.12	6.81	0.2
44	8.10	6.93	9.0
45	8.15	6.94	17.0
46	8.12	6.91	6.0
47	8.16	6.96	15.0
48	8.13	6.93	8.5
49	8.11	6.88	8.0
50	8.13	6.80	6.0
51	8.20	6.95	22.0
52	8.18	7.09	24.0
53	8.10	6.96	4.8
54	7.99	6.62	0.2
55	8.00	6.79	2.9
56	8.05	6.93	28.0
57	7.95	6.74	0.2
58	7.86	6.55	0.1
59	7.89	6.53	< 0.1
60	7.81	6.32	< 0.1
61	8.05	6.98	10.0

Tab. 3. The pH values and $CaCO_3$ contents in a body of subaerially exposed tuff from the lower part of the section at Dětaň.

References

FEJFAR O., 1987. A Lower Oligocene mammalian fauna from Dětan and Dvérce (NW Bohemia, Czechoslovakia). *Münchner Geowiss. Abh.*, A, 10: 253-264.

FEJFAR O. and KVAČEK Z., et al. 1993. *Paläontologische Gesellschaft, 63. Jahrestagung, 21.-26. September 1993 in Prag. Excursion Nr. 3: Tertiary basins in Northwest Bohemia.* Universita Karlova & Česká geologická společnost, 35 p. Praha.

HRADECKÝ P., 1997. Lahary v Doupovských horách. *Zpr. geol. Výzk. v Roce 1996*: 53-55.

MIKULÁŠ R., FEJFAR O., ŽIGOVÁ A., KADLECOVÁ, E. and ULRYCH J., 2002. *Stop Fri/3. Dětaň. Hibsch 2002 Symposium, Excursion Guide, Abstracts,*: 48-51. Czech Geological Survey. Praha.