

## MINERALOGICKÁ CHARAKTERISTIKA ŽILNÉ KŘEMENNÉ MINERALIZACE S MOLYBDENITEM Z LOMU POHLED, HAVLÍČKOBRODSKÝ RUDNÍ REVÍR (ČESKÁ REPUBLIKA)

MINERALOGY OF MOLYBDENITE-BEARING QUARTZ VEIN FROM POHLED QUARRY,  
HAVLÍČKŮV BROD ORE DISTRICT (CZECH REPUBLIC)

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### Abstract

Dolníček, Z., Ulmanová, J., Malý, K., † Havlíček, J., Krejčí Kotlánová, M., Koutňák, R., 2023: Mineralogická charakteristika žilné křemenné mineralizace s molybdenitem z lomu Pohled, havlíčkobrodský rudní revír (Česká republika). – Acta Musei Moraviae, Scientiae geologicae, 108, 2, 145–170 (with English summary).

*Mineralogy of molybdenite-bearing quartz vein from Pohled quarry, Havlíčkův Brod Ore District (Czech Republic)*

A mineralogical study of a poorly mineralized quartz vein with macroscopic molybdenite, cutting biotite paragneisses in the Pohled quarry (Moldanubicum), revealed a very rich mineral assemblage involving 24 species. In addition to quartz (belonging probably to several populations) and molybdenite, we proved the presence of pyrrhotite, pyrite, marcasite, chalcopyrite, cobaltite, arsenopyrite, galena, gustavite, native bismuth, josiéite-A, Te-rich zipserite, anatase, brookite, uraninite, coffinite, *hydroxylsynchysite-(Ce)*, baryte, muscovite, chamosite, clinocllore, fluorapatite, K-feldspar, and calcite. Apart from calcite, which fills youngest veinlets cutting the quartz vein, all remaining minerals form small disseminations in a quartz gangue; in some cases, these minerals probably represent components of older quartz-rich veinlets. The textural development and chemical compositions of minerals indicate that temperature decreased significantly during evolution of the vein – from 350–370 °C in early stage to up to 160 °C in the late stage. The Eh and pH of the fluid also experienced significant changes during evolution of the vein. The presence of hardly remobilizable elements in the given mineralization, including W, Sn, Zr, Nb, Th, Ti, Sc, Y, and REEs, suggests that specific complexing ligands (likely fluoride and/or sulphate anions) were present in the fluids. Broad similarities are found when texture and compositions of a number of silicate and sulphide minerals are compared with those from other types of mineralization in the quarry Pohled. This implies for co-genetic nature of various types of hydrothermal mineralizations and continuous evolution of the hydrothermal system, with variable local representation of individual mineralizing stages. The differences in chemical compositions of some minerals can be at least in some cases explained by topomineral influence of host rocks (the local source of Co and Ni in small bodies of amphibolites and serpentinites, source of W and Mo in granitoids).

*Key words:* Havlíčkův Brod Ore District, Pohled quarry, ore veins, molybdenite, hydrothermal alteration

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## ZEOLITY Z LOMU BERNARTICE U ZRUČE NAD SÁZAVOU (ČESKÁ REPUBLIKA)

ZEOLITES FROM THE BERNARTICE QUARRY NEAR ZRUČ NAD SÁZAVOU (CZECH REPUBLIC)

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### Abstract

Sejkora, J., Pauliš, P., Dolníček, Z., Plášil, J., Škoda, R., 2023: Zeolity z lomu Bernartice u Zruče nad Sázavou (Česká republika). – Acta Musei Moraviae, Scientiae geologicae, 108, 2, 171-193 (with English summary).

### *Zeolites from the Bernartice quarry near Zruč nad Sázavou (Czech Republic)*

An unusual zeolite mineralization was found in fissures and cavities of oligoclasite pegmatite hosted in serpentinite rocks in the active Bernartice quarry, 7 km S from Zruč nad Sázavou, central Bohemia, Czech Republic. The earliest thomsonite-Ca forms light grey acicular crystals, up to 10 mm in size, usually replaced by Mg-Al-Si-(Ca) saponite-like mineral. It is orthorhombic, space group  $Pnca$ , with unit-cell parameters refined from PXRD:  $a$  13.108(4),  $b$  13.068(3),  $c$  13.244(4) Å and  $V$  2268.6(9) Å<sup>3</sup>. Barium- and Mg-rich chabazite-Ca forms abundant white rhombohedral, cube-like crystals with vitreous lustre, up to 4 mm in size. It is trigonal, space group  $R\bar{3}m$ , with unit-cell parameters refined from PXRD:  $a$  13.8055(12),  $c$  14.967(2) Å and  $V$  2470.4(5) Å<sup>3</sup>. The rare chabazite-Mg and chabazite-K form sometimes the youngest 30–40 µm thick margin of chabazite crystals. The youngest harmotome was observed as white prismatic crystals with vitreous lustre up to 0.5 mm in size. It is monoclinic, space group  $P2_1/m$ , with unit-cell parameters refined from PXRD:  $a$  9.8581(16),  $b$  14.1494(12),  $c$  8.6854(11) Å,  $\beta$  124.622(8)° and  $V$  997.0(3) Å<sup>3</sup>. The quantitative chemical composition (by electron microprobe) for all studied zeolites are given.

**Key words:** zeolite, chabazite-Ca, chabazite-Mg, chabazite-K, harmotome, thomsonite-Ca, powder X-ray diffraction data, unit-cell parameters, chemical composition, Bernartice, Czech Republic.

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### ÚVOD

Činný lom Bernartice (5 km sz. od Dolních Kralovic, 7 km j. od Zruče nad Sázavou, GPS: 49°41'2,44"N, 15°7'11,19"E) těží horniny serpentinitového tělesa, které se nachází asi

## PSEUDOMORFÓZY KALCITU PO ARAGONITU Z HORNIN TĚŠINITOVÉ ASOCIACE V PODBESKYDÍ

CALCITE PSEUDOMORPHS AFTER ARAGONITE FROM TESCHENITE ASSOCIATION ROCKS  
IN THE BESKYDY PIEDMONT AREA

JAKUB JIRÁSEK, DALIBOR MATÝSEK, BRONISLAV NOVOSAD

### Abstract

Jirásek, J., Matýsek, D., Novosad, B., 2023: Pseudomorfózy kalcitu po aragonitu z hornin těšinitové asociace v Podbeskydích. – Acta Musei Moraviae, Scientiae geologicae, 108, 2, 195–212 (with English summary).

### *Calcite pseudomorphs after aragonite from Teschenite Association Rocks in the Beskydy Piedmont area*

The occurrence of prismatic hexagonal calcite crystals is known from the Beskydy Piedmont area since 1852. Radial aggregates of such material, enclosed in the green clay mineral, reached the diameter ca. 60 cm. We revised three historical occurrences (Janovice-Baranec: GPS between N 49° 33.284' E 017° 57.494' and N 49° 33.182' E 017° 57.722', Jičina-Grasmanka: N 49° 33.555' E 017° 58.200', and Žilina-Hýlovec: between N 49° 34.390' E 018° 02.060' and N 49° 34.327' E 018° 02.124') and described two new ones (Kunín-Čarodějka: N 49° 37.984' E 018° 00.313', Jičina-Požaha: N 49° 33.460' E 017° 58.745'). All mentioned localities show similar geological features – they are bound to effusive volcanism of the Early Cretaceous Teschenite Rock Association. Typically to strongly altered (carbonatized, silicified) amygdaloid rocks such as picrites, porphyric olivine nephelinites, and also their tuffs and tuffites, near their contact with sediments. As expected in the past without the serious evidence, the hexagonal calcite crystals are in fact pseudomorphs after aragonite. We managed to find incomplete pseudomorphs, with cores still composed of predominant aragonite. Powder-XRD analyses also revealed that some pseudomorphs contain relatively pure calcite, while others mixture of pure calcite and Mg-Fe-rich calcite. Scanning electron microscopy and microanalysis proved that during the transformation of Sr-rich aragonite (up to 5 wt.% SrO) to calcite (max. 1 wt.% SrO) the excess of strontium was fixed in newly formed grains of strontianite. They are locally abundant, but less than 10 μm in size. Pseudomorphs also contain quartz, pyrite, Mg-Ca-rich siderite, and iron oxide. Green clay mineral is related to glauconite polytype 1M, but was not studied in detail. Stable oxygen isotope ratio  $\delta^{18}\text{O}$  in the calcite pseudomorphs range between -20.53 and 26.96 ‰ SMOW, while stable carbon isotope ratio  $\delta^{13}\text{C}$  varies between -4.05 and -8.03 ‰ PDB. Intersection of these results, with respect to local geological setting, points out the hydrothermal origin of aragonite/calcite. Supporting evidence is the presence of the aragonite at nearby Petřkovická hora site, with the similar macroscopic appearance and mineral association. The easiest method to prove presence of aragonite in the described pseudomorphs is pale yellow to pale brownish-yellow luminescence under long-wave ultraviolet light, which can be probably ascribed to some of REE + Sr acting as activators.

**Key words:** calcite, aragonite, glauconite, pseudomorph, Teschenite Association Rock, Czech Republic

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## ORTOSERPIERIT Z CÍNOVCE V KRUŠNÝCH HORÁCH (ČESKÁ REPUBLIKA)

ORTHOSERPIERITE FROM CÍNOVEC, KRUŠNÉ HORY MOUNTAINS (CZECH REPUBLIC)

JIRÍ SEJKORA, PETR PAULIŠ, ONDŘEJ POUR, ZDENĚK DVOŘÁK,  
ZDENĚK DOLNÍČEK

### Abstract

Sejkora, J., Pauliš, P., Pour, O., Dvořák, Z., Dolníček, Z., 2023: Ortoserpierit z Cínovce v Krušných horách (Česká republika). – Acta Musei Moraviae, Scientiae geologicae, 108, 2, 213-224 (with English summary).

### *Orthoserpierite from Cínovec, Krušné hory mountains (Czech Republic)*

A rare mineral orthoserpierite,  $\text{Ca}(\text{Cu,Zn})_4(\text{SO}_4)_2(\text{OH})_6 \cdot 3\text{H}_2\text{O}$ , was found in rock material from the third level of an abandoned Cínovec mine 1 of the Cínovec Sn-W deposit, Krušné hory Mountains, northern Bohemia. This is the third occurrence of this mineral in the Czech Republic. Light blue coatings of orthoserpierite occur cover the area, up to  $5 \times 7$  mm in size, and are formed by flattened acicular crystals, up to 0.3 mm in length, in association with linarite, brochantite and anglesite. Orthoserpierite is orthorhombic, space group  $Pca2_1$ , with the unit-cell parameters refined from X-ray powder diffraction data:  $a$  22.080(6),  $b$  6.196(4),  $c$  20.345(6) Å and  $V$  2783.6(1.2) Å<sup>3</sup>. Chemical analyses of orthoserpierite correspond to the empirical formula  $(\text{Ca}_{1.02}\text{Pb}_{0.02})_{\Sigma 1.04}(\text{Cu}_{3.65}\text{Zn}_{0.30})_{\Sigma 3.95}(\text{SO}_4)_{1.96}(\text{PO}_4)_{0.03}(\text{OH})_6 \cdot 3\text{H}_2\text{O}$ , calculated based on the sum of cations = 5 *apfu*. Its origin is connected with simultaneous weathering of primary tennantite, sphalerite, and galena in the conditions of supergene zone *in-situ*.

*Key words:* orthoserpierite, unit-cell parameters, chemical composition, Raman spectroscopy, Cínovec, Czech Republic

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## ÚVOD

Cín-wolframové ložisko Cínovec (německy Zinnwald) se nachází ve vrcholové části východních Krušných hor a je rozděleno státní hranicí mezi Německem a Českou republikou na dvě části, nichž větší jižní část leží na českém území (PAULIŠ *et al.* 2022).

Těžba cínu je v oblasti Cínovce písemně datována od konce 14. století. Původní dolování bylo soustředěno kolem předního Cínovce, svým významem však nedosahovalo úrovně blízké Krupky. Podrobnější údaje o zdejších dolování pocházejí až z 16. století. V roce 1547

## CHARAKTERISTIKA CHEMICKÉHO ZLOŽENIA TURMALÍNOV Z FYLITOV V OKOLÍ ŠTÍTNIKA (SLOVENSKÁ REPUBLIKA)

CHARACTERISTICS OF THE CHEMICAL COMPOSITION OF TOURMALINES FROM PHYLLITES  
NEAR ŠTÍTNIK (SLOVAK REPUBLIC)

PETER RUŽIČKA

### Abstract

Ružička, P., 2023: Charakteristika chemického zloženia turmalínov z fylitov v okolí Štítnika (Slovenská republika). - Acta Musei Moraviae, Scientiae geologicae, 108, 2, 225-242 (with English summary).

*Characteristics of the chemical composition of tourmalines from phyllites near Štítnik (Slovak Republic)*

The zonal metamorphic tourmalines with detrital cores were identified in the phyllites near Štítnik (Bôrka Nappe, Western Carpathians). The younger metamorphic tourmalines of dravite composition ( $Drv_2$ ) have preserved older detrital cores of schorl or dravite composition ( $Drv_1$ ). Dravite cores ( $Drv_1$ ) have slightly reduced  $Si^{4+}$  (up to 5.95 *apfu*) compared to schorl cores (6.00 *apfu*). Dravite cores have increased  $Al^{3+}$  values (up to 6.54 *apfu*) compared to schorl cores (up to 5.85 *apfu*). Schorl cores have higher  $Fe^{2+}$  (up to 1.91 *apfu*),  $Ti^{4+}$  (up to 0.19 *apfu*) and  $Na^+$  (up to 0.88 *apfu*), compared to dravite cores (up to 1.08 *apfu*  $Fe^{2+}$ ; up to 0.09 *apfu*  $Ti^{4+}$ ; up to 0.61 *apfu*  $Na^+$ ).  $Mg^{2+}$  values are higher in dravite cores (up to 1.80 *apfu*) compared to schorl cores (up to 1.66 *apfu*). Vacancy values in schorl cores range from 0.03-0.19 *apfu* in contrast to dravite cores (0.28-0.31 *apfu*), the values of  $OH^-$  in the *W* position in schorl cores are in the range of 0.89-0.95 *apfu*, in contrast to dravite cores (0.59-0.63 *apfu*). Dravite rims ( $Drv_2$ ) show slight differences in  $Al^{3+}$  contents (5.86-6.17 *apfu*), with lower  $Al^{3+}$  values than dravite cores ( $Drv_1$ ) and higher  $Al^{3+}$  values than schorl cores.  $Mg^{2+}$  values in dravite rims (up to 1.78 *apfu*) are comparable to dravite cores.  $Fe^{2+}$  contents in dravite rims (up to 1.44 *apfu*) are lower compared to schorl cores and higher compared to dravite cores.  $Na^+$  values in dravite rims (up to 0.92 *apfu*) are higher compared to dravite cores. Vacancy values in dravite rims (up to 0.18 *apfu*) are lower compared to dravite cores.  $OH^-$  values at the *W* position in dravite rims (up to 1.00 *apfu*) are higher compared to dravite cores. The chemical zoning of tourmalines documents its polystadial development, which reflects the conditions of regional metamorphism within the studied area of Bôrka Nappe. The identified mineral association of the studied phyllites consists of muscovite, Mg-chlorite, albite, quartz and calcite. From the point chemical analyses of Mg-chlorites in the phyllites near Štítnik, the temperatures in the interval 309-331 °C ± 4 °C were calculated, which confirms metamorphism in the greenschist facies conditions.

*Key words:* zonal tourmalines, chemical composition, mineral association, phyllites, Western Carpathians, Slovak Republic

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### ÚVOD

Korelačné závislosti medzi variabilným chemickým zložením minerálov turmalínovej superskupiny a typom zdrojovej (materskej) horniny sú významným genetickým indikátorom pre interpretáciu geologických procesov. Štandardne používané diskriminačné diagra-

## RADIOAKTIVITA A CHEMISMUS GRANITOIDŮ VE VÝCHODNÍ ČÁSTI LUGIKA (ČESKÁ REPUBLIKA)

RADIOACTIVITY AND CHEMISTRY OF GRANITOIDS IN THE EASTERN PART OF THE LUGICUM  
(CZECH REPUBLIC)

JIRÍ ZIMÁK

### Abstract

Zimák, J., 2023: Radioaktivita a chemismus granitoidů ve východní části lugika (Česká republika). – Acta Musei Moraviae, Scientiae geologicae, 108, 2, 243–268 (with English summary).

*Radioactivity and chemistry of granitoids in the eastern part of the Lugicum (Czech Republic)*

Two petrographically different types of granitoid bodies crop out in the eastern part of the Lugicum in the territory of the Czech Republic. The first type is represented by small granite or granodiorite massifs (namely Olešnice-Kudowa Massif, Nový Hrádek Stock, Litice Massif and Javorník Massif) and less important granite or granodiorite bodies in the surroundings of the town of Rychnov nad Kněžnou. These rocks contain 2.6 ppm U and 10.8 ppm Th on average, the calculated value of mass activity of  $^{226}\text{Ra}$  equivalent ( $a_m$ ) is  $160 \text{ Bq}\cdot\text{kg}^{-1}$  (379 samples analyzed). The second type is represented by plutonic rocks of a so-called tonalite suite (“tonalites”). Modal composition of these rocks corresponds mainly to granodiorite, quartz diorite and quartz monzodiorite. These rocks outcrop along with metamorphites of the Zábřeh Group in the foothills of the Orlické hory Mountains and in the Staré Město Belt. On average, they contain 2.6 ppm U and 10.2 ppm Th,  $a_m = 148 \text{ Bq}\cdot\text{kg}^{-1}$  (378 samples analyzed). Natural radioactivity of granitoids in the eastern part of the Lugicum can be evaluated as low, more or less consistent with the average radioactivity of the continental-type crust. Natural radioactivity of the studied granitoids does not pose any health risk.

*Key words:* Lugicum, granitoids, bulk chemistry, trace elements, uranium, thorium, natural radioactivity.

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### ÚVOD

Naše populace je vystavena ionizujícímu záření, jehož podstatná část má terestrický původ. Primárně souvisí s přítomností přirozených primordiálních radionuklidů v horninovém prostředí. Zcela zásadní roli mají čtyři radionuklidy:  $^{40}\text{K}$ ,  $^{232}\text{Th}$ ,  $^{235}\text{U}$  a  $^{238}\text{U}$ . Thorium a oba uvedené izotopy uranu stojí na počátku rozpadových řad, jejichž členy jsou radioaktivní dceřiné produkty (posledním členem pak některý ze stabilních izotopů olova). Součástí rozpadové řady  $^{238}\text{U}$  je  $^{222}\text{Rn}$ , tedy radioaktivní izotop radonu, jenž při vysokých koncentracích může představovat zdravotní riziko. Jak uvádí BENCKO *et al.* (2011), radon vdechovaný z ovzduší nám způsobuje radiační zátěž 1,2 mSv/rok, litosférická radiace jen 0,5 mSv/rok (jde o ionizující záření vycházející z hornin a také z půdy). Uvedené hodnoty rámcově odpovídají obtížně stanovitelnému průměru, na konkrétních lokalitách mohou být výrazně odlišné. Území na granitoidních tělesech jsou často riziková z hlediska výskytu radonu. Vysoké koncentrace radonu například v ovzduší některých budov mohou souviset se

## STŘÍBRNOHORSKÉ SLEPENICE V MOLDANUBIKU (SPODNÍ PERM, ČESKÁ REPUBLIKA) - PŘEHLED VÝZKUMŮ

THE STŘÍBRNÉ HORY CONGLOMERATES IN THE MOLDANUBICUM  
(EARLY PERMIAN, CZECH REPUBLIC) - OVERVIEW

JAN JURÁČEK

### Abstract

Juráček, J., 2023: Stříbrnohorské slepenice v moldanubiku (spodní perm, Česká republika) - přehled výzkumů. - Acta Musei Moraviae, Scientiae geologicae, 108, 2, 269-281 (with English summary).

*The Stříbrné Hory conglomerates in the Moldanubicum (Early Permian, Czech Republic) - overview*

The aim of the paper is to give an overview of the research focused on the conglomerates from the Moldanubicum in the area of the Stříbrné Hory village (Czech Republic). The conglomerates were discovered in 1938 in former small quarry and in 1950s they were also found in the Peklo medieval mine close to the Stříbrné Hory village. These rocks contain unsorted pebbles mostly of Moldanubian paragneisses, migmatites, granites, microgranites, lamprophyres and quartz from the surroundings rock units. The original greywacke matrix consisting of aleuropelitic material and dacite ash was hydrothermally altered - chloritization and baueritization of biotite or sericitization of feldspar. Originally alluvial fan was formed in parallel with volcanism from a remote source at the rim of the Jihlava Graben in the Early Permian. The postorogenic hydrothermal alteration of the Stříbrné Hory conglomerates was associated with a transtension event ~270 Ma. The paper was written on request and in memory of † Stanislav Houzar and † Jaroslav Havlíček.

*Key words:* conglomerate, alluvial fan, hydrothermal alteration, postorogenic tectonics, Moldanubicum, Early Permian, Jihlava Graben

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### ÚVOD

Cílem příspěvku je podat souhrn výzkumů o slepenicích v okolí Stříbrných Hor v. od Havlíčkova Brodu na Českomoravské vrchovině. Přehodnocení dosavadních poznatků v kontextu s novějšími informacemi v interdisciplinárním pojetí a formulování modelu jejich vzniku a vývoje může ozřejmit jejich význam v rámci geologické stavby Českého masivu i být impulzem k dalším výzkumům.

Stříbrnohorské slepenice byly dosud zjištěny pouze na dvou lokalitách. Poprvé byly objeveny v zaniklém malém jámovém lomu (obr. 1) na v. okraji Stříbrných Hor v roce 1938 (KOUTEK 1939, 1971). V 50. letech 20. stol. bylo nalezeno druhé těleso těchto hornin na 2. patře Pekelské štoly (obr. 1) v sv. okolí Stříbrných Hor (IMRAMOVSKÝ 1955, KOUTEK 1971). Obě lokality jsou v současnosti nedostupné - zatímco bývalý lom byl aplanován, v případě Pekelské štoly bylo 2. patro zatopeno.

## ISOLATED FISH SCALES (TELEOSTEI) FROM THE PALEOGENE AND NEOGENE SEDIMENTS OF THE CENTRAL PARATETHYS (CZECH REPUBLIC, SLOVAK REPUBLIC)

IZOLOVANÉ RYBÍ ŠUPINY (TELEOSTEI) Z PALEOGENNÍCH A NEOGENNÍCH SEDIMENTŮ  
CENTRÁLNÍ PARATETHYS (ČESKÁ REPUBLIKA, SLOVENSKÁ REPUBLIKA)

RŮŽENA GREGOROVÁ

### Abstract

Gregorová, R., 2023: Isolated fish scales (Teleostei) from the Paleogene and Neogene sediments of the Central Paratethys (Czech Republic, Slovak Republic). – *Acta Musei Moraviae, Scientiae geologicae*, 108, 2, 283-308 (with Czech summary).

*Isolated fish scales (Teleostei) from the Paleogene and Neogene sediments of the Central Paratethys (Czech Republic, Slovak Republic)*

Isolated scales and parts of the squamation were analyzed from the Paleogene and Neogene sediments of the Central Paratethys (Oligocene to Miocene, Czech Republic, Slovak Republic). The structure and morphology of the scales could be studied in detail due to their excellent preservation. This paper presents the fish scales from the families Clupeidae, Sternoptychidae, Myctophidae, Zeidae, Gadiformes fam. indet., Gadidae, Merlucciidae, Macrouridae, Trachichthyidae, Holocentridae, Gobiidae, Echeneidae, Sphyracidae, Palaeorhynchidae, Scopthalmidae, Syngnathidae, Scombridae, Euzaphlegidae, Leiognathidae, Percoidei fam. indet., Triglidae, Moronidae, Sparidae, Caproidae, Ostraciidae and Teleostei gen. indet. 1, 2, 3. This comparative analysis shows that isolated remnants have important taxonomic value and helps in the identification of incomplete fish skeletons. Four principal scale type are described in the paper: true cycloid: *Oligophus moravicus*, Gadiformes fam. indet., *Paleogadus* sp. 1, 2, ? *Paleomolva* sp., *Palimphytes* sp., *Leiognathoides* sp., *Sphyracna* sp., *Palaeorhynchus* sp., Echeneidae gen. indet.; cycloid crenate: *Maicopiella longimana*, *Alosa* sp., cycloid spinoid: *Coelorinchus* sp., *Gephyroberyx* cf. *darwinii*, Holocentridae gen. indet., Scopthalmidae gen. indet., Triglidae gen. indet., *Capros* sp.; ctenoid: *Diplodus* sp., *Gobius jarosi*, Moronidae gen. indet., Percoidei gen. indet.; specialised scales: *Argyropelecus priscus*, *Syngnathus* sp., *Gephyroberyx* cf. *darwinii*, *Zenopsis clarus*, *Oligolactoria bubiki*.

**Key words:** squamation, Teleostei scales, cycloid, spinoid, ctenoid, Paratethys, Paleogene, Neogene.

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### INTRODUCTION

Paleogene and Neogene sediments (Menilitic Formation, Hustopeče Marlstone) of the Western Carpathian Flysh zone and Miocene sediments of the Vienna basin are famous for their rich fossil fish remnants. Both whole skeletons and their isolated parts including scales are found. The very good preservation of fossil scales is due to their structure. Fish scales from modern teleost fish are high-performance materials made of cross-ply of collagen fibers (elasmidine) reinforced with hydroxyapatite (KHAYER DASTJERDI and BARTHELAT



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