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Mineral assemblage of the Červený vrch locality

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Abstract. Mineral assemblage was studied in shales and siltstones and the accompanying siliceous concretions of the Šárka Formation within the geological and palaeontological investigations of the temporary excavations made by the Skanska Company on the Červený vrch Hill in Prague-Vokovice, Czech Republic. Mineral identification was performed with the use of DRON-2.1 powder X-ray diffractometer (Institute of Geology, Mineralogy and Mineral Resources, Faculty of Science, Charles University in Prague). Mineral composition was specified by the CamScan S4 (Cambridge) scanning electron microscope equipped with Link ISIS 300 (Oxford) energy dispersion system (Laboratory of Geological Institutes, Faculty of Science, Charles University).

Key words: mineral assemblages, Ordovician, Barrandian

Previous studies

Previous studies of mineralogical character of the Červený vrch Hill and its broader vicinity (Šárka, Vokovice, Jenerálka, Džbán) were summarized by Kratochvíl (1957–1966) and Tuček (1970). Mineralogical conditions on the Červený vrch Hill were treated by Kraus (1867), Woldřich (1914a, b), Tuček (1949), Röhlich et al. (1957), Horný et al. (1963), Láznička (1964) and others, especially in connection with the deposit of Ordovician sedimentary iron ores at the base of the Šárka Formation. Occurrences of barite, chalcopyrite, pyrite, sphalerite and ankerite were reported by Ulrich (1935). Chalcocite and its secondary mineral, malachite, were described from fractures in iron ores by Kratochvíl (1913) and Tuček (1949). On spoil tips of an abandoned iron mine, Láznička (1964) encountered hematite, siderite, calcite, quartz, pyrite, ankerite, dubious cinnabar and red iron-rich quartz with goethite and hematite in cavities. According to the same author, barite and sulphides were also found in the Vokovice brickyard, eliminated by a landfill as early as in 1964. Feldspar phenocrysts in a porphyritic dyke rock, up to 3 cm large and locally kaolinized, were reported from the Červený vrch Hill by Krejčí (1853). Later studies (after 1970) generally represent compilations of the above mentioned sources of information.

Results

Aragonite is present on bedding planes of shales and in septaria of siliceous concretions. It forms white, radiating or irregularly arranged aggregates up to 5 mm large, composed of acicular crystals (Figs. 1, 2), covering surfaces up to tens of cm^2 in area. The amounts of admixtures lie below the detection limit of the method used (energy dispersion analysis, EDA).

Ankerite was found on fractures in shales. It has the character of radially fibrous yellow-brown aggregates up to 3 mm in diameter, usually strongly corroded and partly limonitized. It was not studied by means of electron microanalysis.

Barite forms clear platy crystals up to 10 mm large on fractures in shales. The amount of admixture lies below the detection limit of the EDA.

Calcite was found together with aragonite on a bedding plane in shale. It has the form of rhombohedral crystals up to 0.5 mm large (Fig. 3). EDA also revealed isomorphous admixture of 13–16 mol. % $MgCO_3$ (see Tab. 1), other admixtures lie below the detection limit of the method.

Limonite is present (1) in the form of black-brown to black reniform coatings in septaria of siliceous concretions, where it was formed by the decomposition of siderite, (2) is frequent in the form of powder coatings and minute porous aggregates of rusty brown colour on bedding planes and fractures in shales and in septaria of siliceous concretions. Results of ED analyses of three samples of rusty brown limonite from a bedding plane of shale are given in Tab. 2.

Manganese oxide is relatively rare, forming porous coatings and films on bedding planes of shales together with calcite and aragonite. Results of ED analyses of three samples are given in Tab. 2.

Gypsum is frequent on walls of septaria of siliceous concretions, having the form of clear crystalline coatings of nacreous lustre (Fig. 4) covering the area of up to X cm^2. It was not subjected to EDA.

Siderite forms frequent light brown to dark brown fine-grained coatings on walls of septaria of siliceous concretions. The coatings are composed of lens-like crystals (Fig. 5) up to 0.2 mm large, often with prominent drusy surface (Fig. 6). It is locally partly limonitized. EDA revealed an isomorphous admixture of 12–15 mol. % $MgCO_3$, 3–4 mol. % $MnCO_3$ and 1–1.5 mol. % $CaCO_3$ (see Tab. 1).

Iron-rich quartz was found in Quaternary colluvia as an angular cobble 25 cm in size, probably transported from

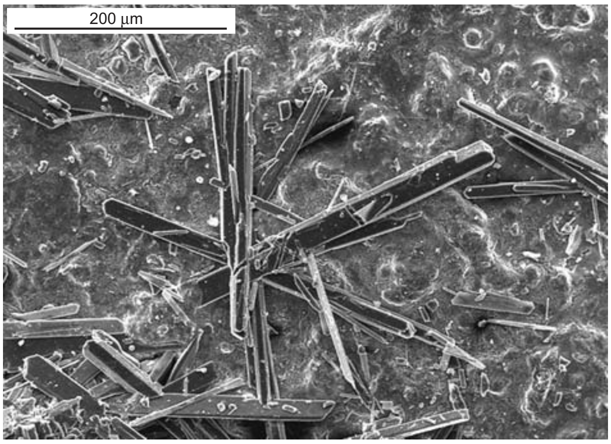

Fig. 1. Aragonite, long columnar crystals on a bedding plane in shale.

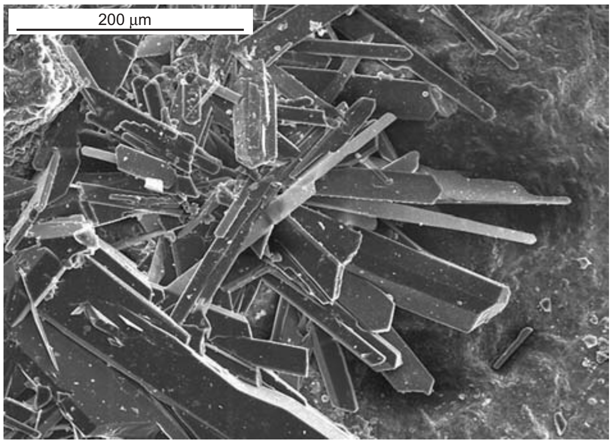

Fig. 2. Aragonite, radiating aggregate of crystals on a bedding plane in shale. SEI.

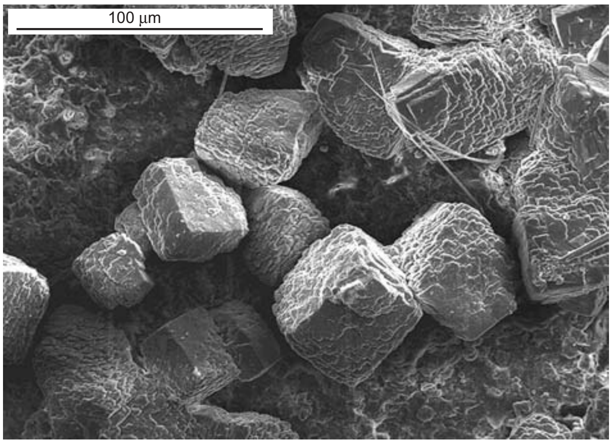

Fig. 3. Calcite, rhombohedral crystals on a bedding plane in shale. SEI.

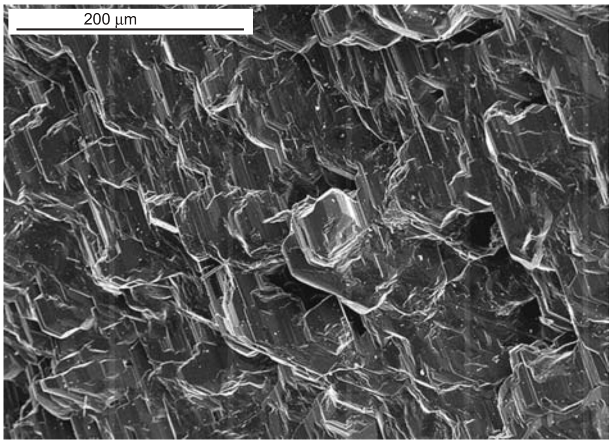

Fig. 4. Gypsum, surface of a crystalline crust on a wall of a septarium of a siliceous concretion. SEI.

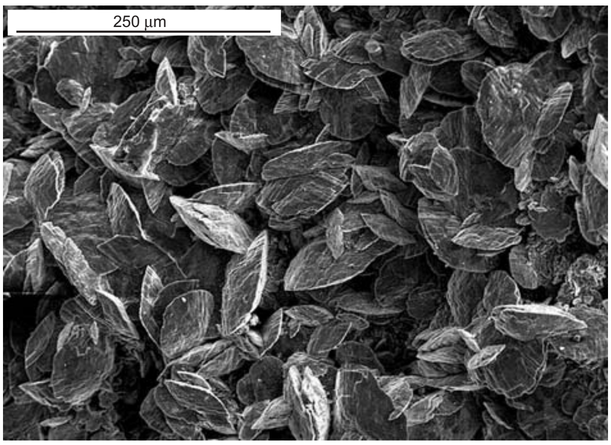

Fig. 5. Siderite, a continuous layer of lens-like rhombohedral crystals on a wall of a septarium of a siliceous concretion. SEI.

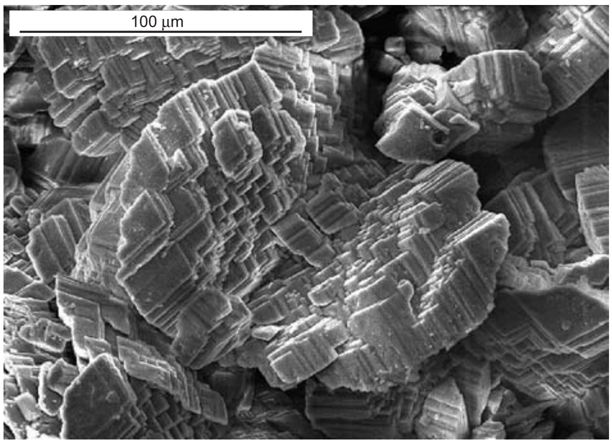

Fig. 6. Siderite, lens-like crystals with prominent drusy surface. SEI.

Tab. 1. ED analyses of calcite and siderite

	Calcite			Siderite		
wt. %	1	2	3	1	2	3
MgO	5.56	5.45	6.94	4.46	5.15	5.17
CaO	49.29	49.31	48.46	0.64	0.59	0.68
MnO	–	–	–	2.64	1.85	2.10
FeO	–	–	–	54.20	50.76	49.32
SrO	–	–	–	–	–	–
BaO	–	–	–	–	–	–
Total	54.86	54.76	55.39	61.93	58.35	57.28
	Formula (Z = 4)			Formula (Z = 4)		
Mg	0.544	0.532	0.664	0.484	0.587	0.599
Ca	3.456	3.468	3.336	0.050	0.049	0.057
Mn	–	–	–	0.163	0.120	0.139
Fe	–	–	–	3.304	3.245	3.206
Sr	–	–	–	–	–	–
Ba	–	–	–	–	–	–
Total	4.000	4.000	4.000	4.001	4.000	4.000

– ... below the detection limit of the analytical method used

Tab. 2. ED analyses of limonite and Mn-oxide

	Limonite			Mn-oxide		
wt. %	1	2	3	1	2	3
SiO_2	1.05	4.21	1.48	0.33	0.42	0.58
Al_2O_3	0.39	1.00	0.72	0.16	0.59	0.42
Fe_2O_3	66.65	63.78	65.75	1.64	2.21	1.84
MnO	–	–	0.47	53.19	51.86	52.17
MgO	–	1.33	0.67	5.72	4.11	5.69
CaO	0.40	0.39	0.49	2.94	3.23	2.79
BaO	–	–	–	–	–	–
Na_2O	–	1.41	–	–	–	–
K_2O	–	0.32	–	0.67	0.74	0.81
P_2O_5	–	–	–	–	–	–
Total	68.50	72.46	69.59	64.65	63.16	64.30

– ... below the detection limit of the analytical method used

the area of the near iron-ore deposit. It is crystalline quartz, coloured in red-brown by iron oxides, with minute cavities and younger veins of white quartz up to 2 mm thick. It was not studied in closer detail.

Phase composition of siliceous concretions was studied using X-ray diffraction analysis. Matrix of the concretions is composed of ***quartz*** and insignificant amount of ***clay phyllosilicate*** of kaolinite type (below 5 %). The matrix of the concretions also locally contains ***pyrite*** in the form of automorphic crystals bounded by {100}, up to 1 mm, exceptionally 3 mm large. Black-grey coloration of the concretions evidences the presence of organic matter. Minerals of the matrix of the concretions were not studied by means of electron microanalysis.

Succession relationships between the minerals were determined with the use of a binocular lens with max. magnification of 100. The following succession was found on the walls of septaria of siliceous concretions: siderite – limonite I – gypsum – limonite II – aragonite. The following incomplete successions were found on bedding planes and fractures in shales: Mn-oxide – calcite – aragonite; barite – aragonite – limonite; barite – ankerite – limonite. A complete succession cannot be determined on the basis of the material studied.

The mineral assemblage found at the locality indicates low-temperature (diagenetic) to supergene (weathering) conditions. Formation of siderite on the walls of septaria of siliceous concretions can be explained by reducing conditions resulting from the presence of organic matter in the matrix of the concretions. The successive minerals (limonite, gypsum) were formed by oxidation of siderite or pyrite under supergene conditions. Mineralization of bedding planes and fractures in shales is of similar character. In both cases, the last mineral in the succession is aragonite, which represents a common product of supergene processes in environments rich in sulphate anions (sulphidic weathering).

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Plate I
1 – Iron-rich quartz, polished sample. Sample size 80 x 65 mm. 2 – Siliceous concretion with siderite (light brown) and gypsum (light grey and white) on walls of septaria. Sample size 110 x 85 mm. Photo by M. Chvátal.