

Comparative mineralogic-genetic studies of sedimentary and hydrothermal barite crystals from Hungary

Magyarországi üledékes és hidrotermás baritkristályok összehasonlító ásványtani-genetikai vizsgálata

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(4 figures and 3 tables)

Abstract

Barite crystals from the postvolcanic-hydrothermal polymetallic mineralization of Gyöngyösoroszi and from other, sediment-hosted mineralizations (Buda Mts., Gerecse Mts., Rudabánya, Mecsek Mts.) with uncertain origin have been studied. The results of comparative studies suggest that there is some correlation between the morphological characteristics and the conditions of crystallization. The variation of the Sr-content tendentially also depend on the locality and morphology of crystals. According to the fluid inclusion characteristics the crystallization of barites in sedimentary environments was also related to postvolcanic activity.

Összefoglalás

A dolgozat a gyöngyösoroszi posztvulkáni-hidrotermás polimetallikus ércesedésből és Magyarországon egyéb, üledékes környezetű (Budai-hegység, Gerecse-hegység, Rudabánya, Mecsek-hegység) származó, bizonytalan genetikájú baritkristályain végzett összehasonlító vizsgálatok eredményeit közli. Az eredmények arra utalnak, hogy a barit morfológiai bélyegei és a kristályosodás körülményei között összefüggés van. További jellegzetesség, hogy a barit Sr-tartalma szintén a lelőhelyre és morfológiai típusra vonatkozóan változik. A folyadékzárvány vizsgálatok eredményei bizonyították, hogy az üledékes környezetben előforduló kristályok képződése is magmás folyamatokhoz kapcsolható.

Key words: barite, fluid inclusions, Hungary, hydrothermal processes, sedimentary barite

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Introduction

Barite is a very common mineral in postmagmatic and sedimentary environments. Hungarian mineralogists already focused their attention on various barite occurrences during the last century, however, the main objective of those studies was only the morphological description and the paragenesis of well-developed crystals.

The various occurrences of barite in Hungary were systematically summarized by MAKLÁRI (1940), who modified BRAUN's morphogenetic system (BRAUN, 1932). The main difference between these two classification schemes is that MAKLÁRI joined BRAUN's "Antimonite" and "Silicate" groups into the "Antimonite A" (the former "Antimonite" group) and "Antimonite B" (the former "Silicate" group) on the basis of detailed paragenetic studies of barites from Hungary.

Barite has quite different crystal morphology in the various morphogenetic groups. The comparative study of this mineral might be convenient for outlining the genetic value of the outer (morphology, colour) and inner (optical and X-ray data, trace element content, solid and fluid inclusions) properties. These features also would yield more informations about the origin of barites occurring in sedimentary environments of Hungary.

Geological characteristics

Ten barite-bearing occurrences in Hungary were studied. According to their geological characteristics they can be classified as follows:

1. Barite in sedimentary environments:

a. Barite is a very common mineral occurring in fractures and cavities of the carbonate and clastic rocks of Mesozoic-Tertiary age in the Buda (Samples 1-4), and Gerecse Mts. (Sample 5, Fig. 1). The barite-bearing parageneses (Table I) are considered as precipitations from "thermal water" (SCHERF, 1928; KOCH, 1985). The hot solutions probably ascended along a tectonic zone ("Buda Line"; BÁLDI, 1983). A magmatic-volcanic origin of these hot solutions is uncertain, although Tertiary volcanic complexes (Pilis-Dunazug Mts.) are known north of the Buda Mts.

b. Barite is a typical mineral in the metasomatic iron ore deposit of Rudabánya (Sample 6, Fig. 1). There, the host rocks of mineralization are Triassic carbonates and sandstones. Barite most frequently forms massive bodies, but well-developed crystals also occur on fracture walls. These crystals precipitated from "late epithermal solutions" (HERNYÁK, 1977), and are associated with various sulphide phases (Table I). The origin of these solutions is not clear.

c. Finally, barite from cavities of pelitic bedrocks of a Jurassic coal deposit near Komló (Mecsek Mts.) also belongs to this first group (Sample 7, Fig. 1). The unusual feature of geology of this occurrence is the presence of igneous (basalt) dikes cutting the coal layers. The heat effect of the igneous activity produced "natural coke" along the contact zone between the volcanics and coal layers. The special characteristic of the paragenesis of this locality is the presence of solid hydrocarbon compounds (Table I).

2. Barite in postvolcanic hydrothermal ore deposit:

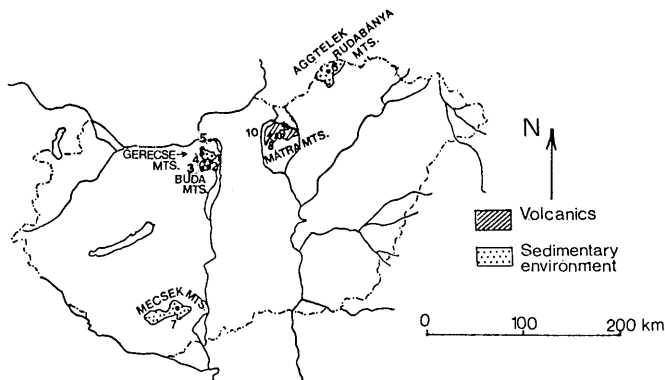


Fig. 1. Localities of studied barite crystals. Buda Mts 1-4, Gerecse Mts. 5, Rudabánya Mts. 6, Mecsek Mts. 7, SW-Mátra Mts. 8-10. 1. Budapest, Róka Hill; 2. Budapest, Martinovics Hill; 3. Budapest, Ferenc Hill cave; 4. Budapest, Mátvás Hill; 5. Csolnok; 6. Rudabánya; 7. Komló; 8. Gyöngyösoroszi, Dögkút; 9. Gyöngyösoroszi, Vöröskő; 10. Gyöngyösoroszi, Asztagkő.

1. ábra: A vizsgált baritkristályok lelőhelyei

Barite is also a characteristic mineral in the paragenesis of the epithermal polymetallic ore deposit of Gyöngyösoroszi, SW Mátra Mts. (Samples 8-10, Fig. 1). The host rocks of the ore veins are Neogene andesites. The infillings of veins were deposited in several stages, and barite precipitated in the late phases of the extended hydrothermal activity. It occurs more frequently in the apical-marginal zones of the ore deposit and it is associated mostly with silica minerals (Table I).

Methods

The forms of well-developed crystals were determined by one-circle, Fuess-type reflexion goniometer.

The measurements of the optical angle were carried out on an universal optical stage using oriented thin sections.

Cell parameters were calculated from X-ray powder diffraction patterns (Siemens D-500 equipment, Cu-tube, 0.5 cm/min goniometer and 1 cm/min paper speed) by using a local version of the Appelman-Evans calculation (APPELMAN and EVANS, 1973).

The Sr contents were determined by AAS analysis (Dept. of Petrology and Geochemistry, Eötvös L. University, analyst: L. HOFFMAN).

The fluid inclusion studies were carried out on a gold plated Chaixmeca microthermometry apparatus (POTY et al., 1976) on double-polished 0.5 mm thick sections of barite crystals.

Results

Mineralogical and chemical data

The morphology of the euhedral barite crystals shows some differences in the studied occurrences (Fig. 2). Most of the studied samples belong to the "Antimonite A" and "B" groups, whereas barite from Komló has morphology characteristic to the "Carbonate A" group in the morphogenetic system of barite. It is interesting that the samples from the sedimentary environments show morphological differences according to the different geological units (e.g. "Antimonite A" group: Sample 6 from Rudabánya; "Antimonite B" group: Sample 1-4 from Buda Mts., and Sample 5 from Gerecse Mts.; "Carbonate A" group: Sample 7 from Komló).

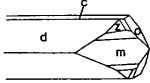
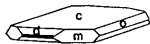
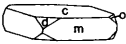
Crystal type	Main forms	Morphogenetic groups
	d (102) m (110) c (001) o (011)	Carbonate A Sample: 7
	c (001) m (110) d (102) o (011)	Antimonite A Samples: 6, 9
	c (001) m (110) d (102) o (011)	Antimonite B Samples: 1, 2, 3, 4, 5

Fig. 2. Morphological characteristics of the studied crystals in the morphogenetic system of barite (MAKLÁRY, 1940) (for sample numbers see Fig. 1).

2. ábra: A vizsgált baritkristályok morfológiai jellemzői a MAKLÁRY (1940) által kidolgozott morfogenetikai rendszerben

Based on the colour of crystals, the samples can be divided in two groups. The yellowish brown, generally zoned crystals occur in the Buda and Gerecse Mts. (Samples 1-5). The translucent white or water-clear crystals are characteristic to the other localities: Rudabánya (Sample 6), Komló (Sample 7), Gyöngyösorszi (Samples 8-10).

The angle of the optical axes ($2V$) of barite is about 37.5° in the "ideal" case (DANA, 1932). The average values for the studied samples are usually higher ($2V = 37.6-40.6^\circ$) than this value (Table II). The largest values have been found in the samples from sedimentary environments.

The samples from the Buda Mts. are characterized by the highest Sr-contents (2893-4314 ppm). It is remarkable that the samples from other sedimentary

environments (Komló and Rudabánya) have much lower Sr-contents (7 and 526 ppm) than the crystals from postvolcanic ore occurrences (718–1430 ppm), (Table II).

The cell parameters of the studied crystals vary within the following intervals (Table II):

$$\begin{aligned} a_0 &= 7.141\text{--}7.154 \text{ \AA} \\ b_0 &= 8.846\text{--}8.905 \text{ \AA} \\ c_0 &= 5.448\text{--}5.461 \text{ \AA} \end{aligned}$$

Table 1.: Mineral paragenesis of the studied barite occurrences.

1. táblázat: A vizsgált baritkristályok lelőhelyeinek ásványparagenezisei

Sample no.	Locality	Minerals
1.	Budapest, Róka Hill	calcite, metacinnabarite, cinnabarite, marcasite, (limonite)
2.	Budapest, Martinovics Hill	calcite, fluorite, quartz, pyrite, goethite, gypsum
3.	Budapest, Ferenc Hill cave	calcite
4.	Budapest, Mátyás Hill	calcite, pyrite, gypsum
5.	Csolnok /*/	calcite
6.	Rudabánya	quartz, calcite, pyrite, sphalerite, chalcopyrite, bornite, tetrahedrite, galenite, jamesonite, bournonite, pyrrargyrite
7.	Komló	quartz, calcite, dolomite, pyrite, asphalt, kerogene, wax
8.	Gyöngyösoroszi, Döggút /*/	quartz, chalcedony
9.	Gyöngyösoroszi, Vöröskő	quartz, chalcedony, hematite
10.	Gyöngyösoroszi, Asztagkő	quartz, chalcedony, pyrite (limonite) clay minerals

/*/ these samples are not contained suitable fluid inclusions for microthermometric study

Fluid inclusion data

The studied barite crystals contain the following inclusion types:

Monophase inclusions:

(i) Liquid inclusions were observed along cleavage planes and are thus of secondary origin (ROEDDER, 1984). They are characterized by plate-like, angular shape. This type of inclusion is characteristic for barite from sedimentary environments, but it was also observed subordinately in barite from postvolcanic ore deposit.

(ii) Solid inclusions. The outer zones of the barite crystals from the Buda Mts. contain calcite inclusions, showing high birefringence. Not frequently, hematite plates were also observed. Samples from the postvolcanic ore occurrences contain quartz inclusions besides calcite.

Two-phase inclusions:

(i) Gas-rich inclusions. The liquid phase was observed as a thin film on the wall of this type of inclusion. These inclusions most abundantly occur in samples from postvolcanic environments. They were also observed in two samples from the Buda Mts. (Samples 1 and 3) and in the sample from Komló. Their shape is rounded to elongated. They occur as single inclusions or are accompanied by liquid-rich two phase inclusions.

In the sample from Komló the gas-rich inclusions show intensive fluorescence (brownish, reddish orange) under UV-illumination. This suggests the presence of hydrocarbon gas in these microvacuoles.

Table 2.: Results of the mineralogical studies.
2. táblázat: Az ásványtani vizsgálatok eredményei

Sample	Sr ppm	2V (°)	Calculated cell parameters (Å)		
			a ₀	b ₀	c ₀
1. Budapest, Róka Hill	3104	37.6 ± 0.9	7.1534 ± 0.0017	8.8811 ± 0.0023	5.4528 ± 0.0012
2. Budapest, Martinovics Hill	4314	39.6 ± 1.5	7.1415 ± 0.0023	8.8578 ± 0.0033	5.4485 ± 0.0023
3. Budapest, Ferenc Hill cave	2839	39.9 ± 0.7	7.1482 ± 0.0021	8.8789 ± 0.0031	5.4478 ± 0.0015
4. Budapest, Mátyás Hill	3316	38.9 ± 1.2	7.1479 ± 0.0014	8.8742 ± 0.0023	5.4525 ± 0.0008
5. Csolnok	4124	40.6 ± 1.5	7.1414 ± 0.0019	8.8464 ± 0.0040	5.4484 ± 0.0016
6. Rudabánya	526	40.1 ± 1.3	7.1527 ± 0.003	8.8780 ± 0.0018	5.4503 ± 0.0012
7. Komló	7	37.8 ± 1.5	7.1788 ± 0.0027	8.9050 ± 0.0027	5.4607 ± 0.0012
8. Gyöngyösoroszi, Dégkút	718	39.8 ± 0.9	7.1517 ± 0.0013	8.8756 ± 0.0016	5.4535 ± 0.0010
9. Gyöngyösoroszi, Vöröskő	1238	39.9 ± 1.0	7.1450 ± 0.0008	8.8703 ± 0.0011	5.4513 ± 0.0006
10. Gyöngyösoroszi, Asztagkő	1430	38.9 ± 1.1	7.1480 ± 0.0006	8.8692 ± 0.0010	5.4525 ± 0.0005

(ii) Liquid-rich inclusions. These microobjects contain 95–80 vol % liquid phase and its saturated vapour phase ("bubble") at room temperature. They are of primary and, occasionally (mainly in the crystals from postvolcanic environments), pseudosecondary in origin (ROEDDER, 1984).

The common occurrence of the primary liquid-gas, and gas inclusions was observed at some locality in Buda Mts. (Samples 1 and 3), and in the studied polymetallic mineralization (Sample 9 and 10). This inclusion association refers to the boiling of fluids during the mineral deposition processes (ROEDDER, 1984).

During the heating runs the liquid-rich two phase inclusions homogenized between 82 °C and 265 °C. The first melting point values (the eutectic/cotectic temperatures of the frozen inclusions) are distributed between -48.4 °C and -1 °C. It is interesting that the low first melting data (below -21 °C) were found only in the samples from Buda Mts. and Gyöngyösoroszi/Asztagkő. The total concentration values calculated from the melting point depression (POTTER et al., 1978) are extremely low in most cases. The exception is the sample (No. 10) from Gyöngyösoroszi, in which very concentrated solutions were also recorded in the two-phase inclusions.

During the cryoscopic measurements the deposition of CO₂-hydrate (CO₂·5 ½ H₂O) was also observed. The most frequent occurrence of CO₂-hydrate is characteristic to the samples from sedimentary environments. The appearance of CO₂-hydrate refers to the very small concentration of CO₂ in the mineralizing fluids, probably below 1 mol % (COLLINS, 1979; HEDENQUIST & HENLEY, 1985).

The liquid-rich two phase inclusions of barite from Komló (Sample 7) show greenish-greyish yellow fluorescence under ultraviolet illumination. This suggests that

the liquid phase should be organic material (e.g. liquid hydrocarbon). These inclusions homogenized between +35°C and +70°C.

One sample from Gyöngyösoroszi (Sample 10) subordinately also contains liquid hydrocarbon-bearing inclusions. The starting of the dissolution of the oil droplets in the saline solutions was observed above +60 °C.

The results of the microthermometry studies of liquid-rich inclusions are summarized on Table 3.

Table 3.: Results of the fluid inclusion studies. **Th**: homogenization temperature; **Tm1** first melting point of ice; **C**: concentration; **CO₂h**: CO₂-hydrate; **n**: number of measurements; **min.** minimum value; **max.** maximum value; **s.d.** standard deviation; **rel. abundance of CO₂-hydrate**, **-n** not observed, **+** rare; **++** frequent; **+++** very frequent

3. táblázat: A zárányvizsgálatok eredményei. **Th** homogenizációs hőmérséklet; **Tm1**: a jégfázis első olvadáspontja; **C**: koncentráció; **CO₂h**: CO₂-hidrát; **n**: mérések száma; **min.** minimum érték; **max.** maximum érték; **s.d.** szórás; **+** ritka; **++** gyakori; **+++** nagyon gyakori.

Sample/Locality	Th (°C)				Tm1 (°C)				C (NaCl equiv. wt%)			Boiling	CO ₂ h	
	n	min.	max.	mean ± s.d.	n	min.	max.	mean ± s.d.	n	min.	max.			mean ± s.d.
1. Budapest, Róka-hill	22	118.2	264.8	193.2 ± 38	6	-35.1	-22.5	-29.6 ± 3.8	7	1.21	1.89	1.53 ± 0.25	yes	+++
2. Budapest, Martinvics-hill	23	82.0	248.2	186.5 ± 36	7	-32.5	-29.5	-30.6 ± 1.2	7	0.87	1.89	1.21 ± 0.33	no	++
3. Budapest, Ferenc-hill cave	15	87.2	234.8	191.6 ± 36.1	5	-24.5	-21.5	-23.2 ± 1.3	5	0.87	1.04	0.96 ± 0.09	yes	+++
4. Budapest, Mátyás-hill	22	100.8	230.2	172.1 ± 32.2	5	-35.9	-25.5	-30.8 ± 3.5	8	0.87	1.72	1.33 ± 0.28	no	++
6. Rudabánya	24	116.9	243.3	180.7 ± 28.3	8	-9.4	-1.0	-3.1 ± 2.9	8	0.70	1.55	0.96 ± 0.27	no	+++
7. Komló (*)	10	35.2	69.9	57.2 ± 9.9										
9. Gyöngyösoroszi, Vöröskő	22	126.2	263.5	178.8 ± 35.8	8	-4.5	-3.7	-4.1 ± 0.3	8	1.55	1.72	1.58 ± 0.07	yes	++
10. Gyöngyösoroszi, Asztalgő	17	108.5	182.9	142.5 ± 21	6	-48.4	-16.1	-35.9 ± 8.5	6	1.89	18.00	8.02 ± 5.38	yes	+

(*) homogenization temperatures of liquid hydrocarbon + gas inclusions

(iii) "Wax"-gas inclusions. In the samples from Komló, these two-phase microobjects usually do not show fluorescence under UV-illumination. During heating, the visually "liquid" phase started to melt above +50 °C, suggesting that these inclusions contain solid natural wax at room temperature. The total homogenization was not observed due to the decrepitation of this type of inclusion above 110 °C.

The sample from Csolnok (Gerecse Mts., Sample 5), and other from Gyöngyösoroszi (Döggút, Sample 8) do not contain two-phase inclusions, therefore these samples were excluded from the heating-freezing studies.

Discussion

The high Sr content (up to 60 mol% SrSO₄) increases the 2V value, but decreases the values of refractive indices and cell parameters of barite. These peculiarities were observed on artificial (Ba,Sr)SO₄ crystals (HANOR, 1968; BURKHARD, 1973, 1978). These well-defined relationships were not found in the studied natural barite crystals, though the samples from Buda Mts. with relatively high Sr content display a trend characterized by lower cell parameter values than the crystals with lower Sr-content from other localities (Table II). The colour of the studied crystals also shows some

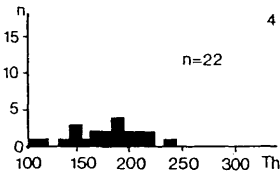
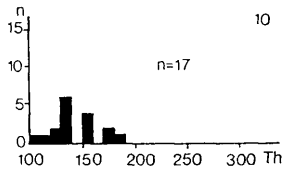
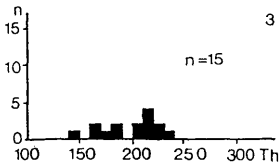
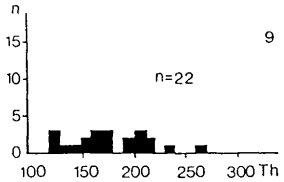
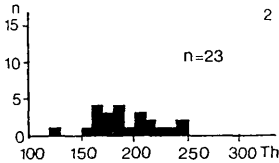
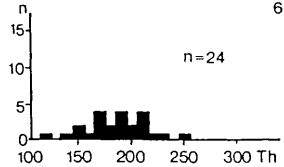
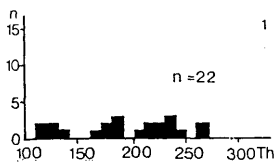


Fig. 3. Distribution of the homogenization temperatures of liquid-gas inclusions (1, 2, 3 etc. sample numbers, see Fig. 1).

3. ábra: A folyadék-gáz zárványok homogenizációs hőmérsékleteinek eloszlási diagramjai (1, 2, 3 stb. minták lelőhelyeit ld. az 1. ábrán)

relation to the Sr content. The coloured (yellow) crystals from Buda Mts. have at least two times higher Sr content than the white or water-clear barites from other areas.

The bi- or polymodal character of the distributions of homogenization temperatures probably reflect the effect of the pseudosecondary-secondary inclusions (Fig. 3). It is possible to distinguish at least two temperature maxima (160–180 °C and higher than 200 °C), and to identify a lower-temperature inclusion generation (Th values are below 150 °C) in barite crystals from the Buda Mts. Presumably the higher temperatures reflect the growth conditions of the inner part of the zonal barite. The inclusions with lower homogenization temperatures probably were captured in the core part of the crystals as pseudosecondary liquid-gas inclusions during the growth of the outer zones. The homogenization temperatures are distributed between 160 °C and 210 °C in Rudabánya. The homogenization temperature data (120–220 °C) of the fluid inclusions of barite from the postvolcanic ore occurrence are distributed in similar temperature interval.

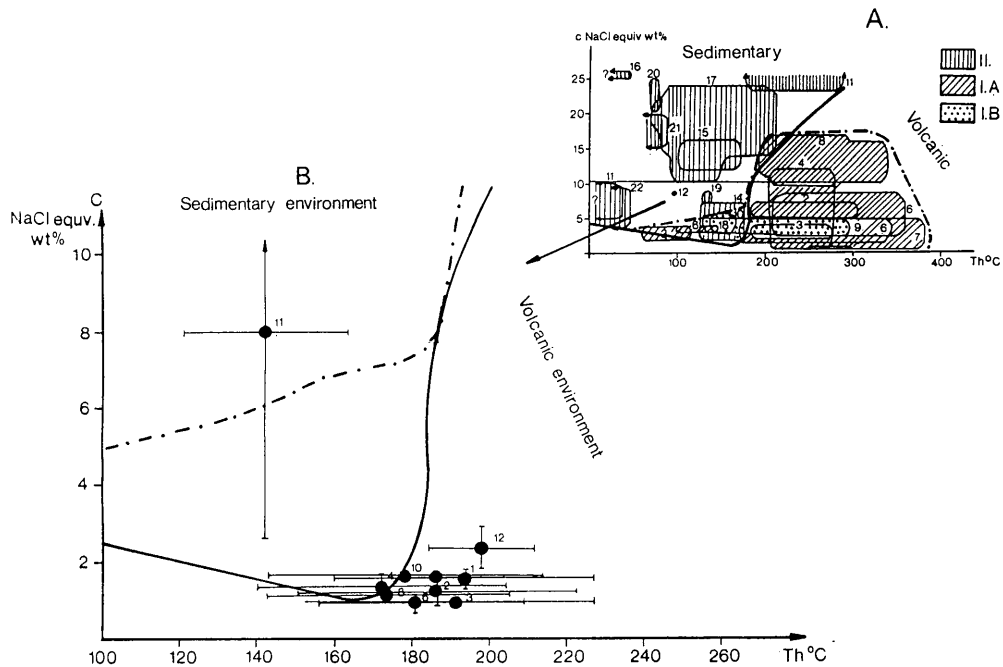
Where the boiling of mineralizing fluids was proved by fluid inclusion petrography (Table III), the distribution diagrams of the homogenization temperatures outline the real temperature of the crystal growth (ROEDDER, 1984). Where boiling was not detected (Table III) the growth temperature of the crystals was presumably not much higher than 200 °C because the so-called "pressure correction" (the difference between the homogenization temperature and the true temperature of mineral-forming solution, depending on the pressure) has important values (a few ten degree Celsius) only in high-pressure ($P > 500$ bars) systems (POTTER, 1977). There is no petrological evidence of such a high pressure environment in the sedimentary rocks.

The homogenization temperatures of the liquid-hydrocarbon-gas inclusions in barite from Komló suggest that the minimum temperature of crystallization was between 50–60 °C. However, the presence of wax-gas inclusions in which the total homogenization was not achieved before the decrepitation about 110 °C would refer to much higher crystallization temperature. It is not possible to estimate the growth temperature of the crystals from Komló, because the exact quality of the hydrocarbons is not known. The relatively high temperature data suggest that the migration of hydrocarbons was related to the effect of Cretaceous volcanic activity on the coal layers.

The first melting point data below –21 °C infer the NaCl–CaCl₂–H₂O solution composition (ROEDDER 1984; HAYNES 1985) in the fluid inclusions of barite from Buda Mts. The chloride-type fluids were also recorded in Sample 10 from Gyöngyösoroszi (Table III). The similarity of the temperature and composition data of mineralizing fluids in Buda Mts. and in Gyöngyösoroszi occurrences suggest, that the deposition of barites in Buda Mts. was also related to postvolcanic activity.

The first melting phenomena very close to 0 °C was observed in the crystals of other localities (Table III). These unusually high values would refer to sodium (bi)carbonate/sulphate solution composition (BORISENKO, 1977; SHEPERD et al., 1985).

The appearance of the (bi)carbonate/sulphate solutions in Sample 9 from the polymetallic mineralization could be explained by the oxidizing effects in the apical zone of a boiling paleohydrothermal system, where the gases (CO₂; H₂S) exsolved from the deeper part of the boiled system were condensated by vadose meteoric water (HENLEY & ELLIS, 1983). The presence of dilute sulphate-bicarbonate fluids in the inclusions of barite from Rudabánya also was observed. This type of fluid composition was also detected in other barite deposits hosted by sedimentary rocks (e.g. Lika, Croatia;



PALINKAŠ, 1989). Considering the epithermal character of the crystallisation temperature and total salinity of parent fluids of barite at Rudabánya, the mineral deposition processes probably were related to Mesozoic volcanic activity (JUHÁSZ, 1964) known in the vicinity of deposit. Therefore the relatively high temperature, sulphate(bi)/carbonate solutions can be considered as a magmatically heated karstic or near-surface vadose fluids.

The concentration values are lower than 2 NaCl equiv. wt% in most of the samples (Table III). The higher concentration values in the barite from Asztagkő (Gyöngyösoroszi, Sample 10) probably refer to the root-zone of a boiling hydrothermal system, where the solutions were "distilled" several times. The other consequence of this assumed intensive boiling would be the lowest homogenization temperatures measured in this sample (Fig. 3.).

Fig. 4a. Discrimination diagram of the barites from sedimentary and volcanic environments, based on fluid inclusion data (Th: homogenization temperatures; C: concentration).

Ia. - barite in postvolcanic vein type or disseminated hydrothermal ore deposits

- 1- San Juan Mts., Colorado (NASH, 1975)
- 2- Bulancak, Turkey (AKINICI, 1976)
- 3- SE-Georgia (AREVADZE et al., 1978)
- 4- Lake City, Colorado (SLACK, 1980)
- 5- Beregovo, Ukraine (PLATONOVA et al., 1978)
- 6- San Vicente, Bolivia (SUGAKI et al., 1988)
- 7- Asunta, Bolivia (SUGAKI et al., 1988)
- 8- Carlin, Nevada (RADTKE et al., 1980)

Ib. Barite in postvolcanic Kuroko-type ore deposits

- 9- Kosaka, Japan (URABE & SATO, 1978)
- 10- Several deposits in Japan (TOKUNAGA & HOUMA, 1974)

II. - barite in sedimentary (non-volcanic) environment

- 11- Central Missouri (LEACH, 1979)
- 12- Mississippi (ROEDDER, 1979)
- 13- Fej-el-Haddum, Tunisia (CHARAF, 1985)
- 14- Sardinia, Italy (BONI, 1986)
- 15- Mex-Tex, New Mexico (ROEDDER et al., 1968)
- 16- Oberwolfach, Germany (GERLER & HORN, 1983)
- 17- Silvermine, Ireland (SAMSON & RUSSEL, 1987)
- 18- Nahal Hewer, Israel (GILAT et al., 1986)
- 19- Chazadir, Russia (BORISENKO et al., 1979)
- 20- Terlinghay, Russia (BORISENKO et al., 1979)
- 21- Djuerligsk, Russia (BORISENKO et al., 1979)
- 22- Missouri (LEACH, 1980)

Fig. 4b - Positions of the fluid inclusion data of barites from Hungary in the discrimination diagram (1, 2, 3, etc. sample numbers, see Fig. 1)

4a. ábra: Diszkriminációs diagram üledékes és posztvulkáni képződésű baritkristályok folyadékzárványainak jellemzői alapján (Th: homogenizációs hőmérséklet; c: koncentráció)

Ia. posztvulkáni teléres és hintett ércesedések baritkristályai

Ib. Kuroko-típusú ércesedések baritkristályai

II. üledékes környezet baritkristályai

4b. ábra: A magyarországi baritkristályok folyadékzárvány adatai a diszkriminációs diagramon (1., 2., 3. stb. minták lelőhelyeit ld. az 1. ábrán)

Knowing the homogenization temperatures and salinity data, the pressure of the boiling mineral-forming system could be calculated (HAAS, 1971). The barite crystals containing liquid-gas and gas inclusions (e.g. "boiling" fluid inclusion texture - Table III) from the Buda Mts. and from postvolcanic terrains developed at 5-40 bar pressure. It is important to note that the very minor amount of CO₂ in the hydrothermal fluids could increase the pressure of the boiling (BODNAR et al., 1985). Therefore the mentioned values should be considered as minimum values of the pressure. However the depth of mineral forming processes (calculated from the pressure data) should not exceed a few hundred metres. The observed shallow boiling conditions also strengthens the conclusions about the postvolcanic origin of the barites from Buda Mts.

Relatively large amount of fluid inclusion data of barite from various mineralization have been published recently. The characteristic homogenization temperatures and concentration values show distinct differences regarding to the barite from volcanic and sedimentary environments. The mineral-forming fluids of the sediment-hosted, barite-bearing mineralizations are characterized by relatively low temperature and high concentration values. The homogenization temperatures are higher and the concentration data are lower in the case of volcanic environment (Fig 4a).

Comparing the homogenization temperatures and salinity data of barites from Hungary (except the crystals from Komló) and from other occurrences, it is seen, that the Hungarian samples, even from the sedimentary environment, show certain similarities to the barites crystallized from solutions relating to postvolcanic activity (Fig. 4b). The exceptional position of Sample 10 (Gyöngyösoroszi, Asztalgő) in the discrimination diagram would be related to the assumed special boiling conditions.

Conclusions

On the basis of fluid inclusion data the studied barite crystals from Hungary could be divided into four groups:

1. The barites from postvolcanic ore occurrence (Gyöngyösoroszi) crystallized in boiling, chloridic-type (subordinately sulphate-(bi)carbonate type) solutions of various salinities. The fluids contain a minor amount of CO₂. The sulphate- (bi)carbonate composition refers to the apical condensation oxidation zones, whereas the high salinity fluids indicate the root zones of the boiling paleohydrothermal systems.

2. The crystals from Rudabánya developed in (bi)carbonate-sulphate type, less saline (<1.5NaCl equiv. wt%), CO₂-bearing solutions. Considering the possible minimal temperature interval of crystallization (160-210 °C) and the geological characteristics of the locality, these solution characteristics would refer to a magmatically heated karstic or near surface vadose fluid regime.

3. The deposition of barites in the Buda Mts. was characterized by chloridic type, CO₂-bearing, low salinity, and at some place boiling mineralizing solutions. These solution characteristics can be explained as a "transition"-type between the above mentioned ones.

4. The hydrocarbon-bearing inclusions in barite from Komló (Mecsek Mts.) outline a special genesis. The hydrocarbon-bearing fluid migration could be connected to the "cooking" effect of the Lower Cretaceous igneous activity on the coal layers.

The results of the comparison of fluid inclusion data of barites from Hungary and from other occurrences are in agreement with the above outlined genetic peculiarities. The parent fluids of the Hungarian barites were in connection with volcanic activities.

The genetic groups delineated by fluid inclusion studies show a certain agreement with the morphological characteristics and with the tendency of differences in Sr-content of barite crystals. The "Antimonite B" morphological group is characterized by boiled crystallization conditions in chloride (subordinately bicarbonate/sulphate)-type fluids and their Sr-content is intermediate-high. The barite crystals in the "Antimonite A" group contain predominantly (bi)carbonate/sulphate-type fluid inclusions, and are characterized by intermediate Sr-content. Finally the "Carbonate A" -type crystals contain very small amount of Sr, and hydrocarbon-bearing fluid inclusions.

The correlation between the Sr-content, optical, and cell parameters is not as well expressed in the studied natural barite crystals as it was found in the artificial barite-celestite solid solutions.

The detailed mineralogic and genetic studies of various barite crystals from Hungary show, that there is some correlation between the outer and inner properties of barite and the characteristics of the mineral-forming environment.

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