

Parajamesonite revisited: background of the discreditation of an enigmatic mineral species

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ABSTRACT

Original parajamesonite samples of Zsivny & Náray-Szabó (1947) and other authentic museum specimens containing the same material were studied by ore microscopy, electron probe microanalysis (EPMA) and X-ray powder diffraction (XRPD). The “parajamesonite crystals” proved to be pseudomorphs built of polycrystalline aggregates of euhedral jamesonite, sometimes intergrown with argentic tetrahedrite (freibergite) and/or ramdohrite. Other asso-

ciated minerals are “plumosite”, i.e. fibrous jamesonite (rarely with boulangerite), iron-rich sphalerite, siderite, pyrrhotite, semseyite, a fizélyite-related mineral, and galena. All XRPD patterns correspond to jamesonite, without any similarity to the original pattern of parajamesonite. All these data prove that parajamesonite is actually jamesonite, permitting to discredit definitively parajamesonite as a mineral species.

Introduction

Parajamesonite is listed in mineralogy handbooks as a poorly characterised dimorph of jamesonite. Its history began during the First World War period, and wars and politics subsequently had an unfavourable influence on the mineral’s research history. An ore mineral, previously unknown from that locality, was found in the Salán vein at Herzsa mine near Kisbánya, Hungary between 1915–1920 (present name of the locality is Sălán vein at Herja mine near Chiuzbaia, 7 km ENE from Baia Mare, Romania). The area, together with most of the Hungarian mining districts, was detached from Hungary in 1920, but in the late 1920–30s some specimens of the mineral in question reached the Hungarian Natural History Museum (HNHM, Budapest), through local mining officers Sándor Fizély and Gyula Ádámcsik.

The first reference to the later parajamesonite was given by Zsivny (1939). The investigations were obviously delayed by the Second World War and closed only in 1946; the new species was published by Zsivny & Náray-Szabó (1947). The chemical composition of parajamesonite (Table 1a) was the same as for jamesonite, but its X-ray diffraction pattern was

distinctly different (hence the name, alluding to the dimorphism); observed lines [$d(\text{Å})$, (int.)]: 4.67 (3); 4.21 (8–9); 3.78 (5); 3.29 (1); 3.01 (1); 2.734 (1); 2.649 (1); 2.488 (1); 2.232 (1); 2.021 (1); 1.921 (1); 1.841 (1) (d values were calculated from $\sin^2\Theta_{\text{corr}}$ values given by Zsivny & Náray-Szabó 1947). Some of the accompanying phases remained unidentified because of the war damage to the laboratories. Moreover, the symmetry of parajamesonite remained unknown, and ore microscopic studies were not performed.

Zsivny and Náray-Szabó were unable to publish a more detailed description of the species, because Náray-Szabó was imprisoned in 1947 during the communist take-over and was released only in 1953, the year when Zsivny died. Zsivny’s notes were destroyed by the fire at the HNHM caused by Soviet artillery bombardment in 1956 and the same was supposed to have happened to the original samples (cf. Náray-Szabó 1962).

Koch et al. (1960) investigated several jamesonite specimens from Herja. Some of them were similar in habit, and two of them were even considered as parajamesonite, but their X-ray diffraction patterns proved to be identical to that of jamesonite. Since nobody was able to find parajamesonite at

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Tab. 1. Chemical composition of “parajamesonite”

sample	(a)	(b)	(c)	(d)	(e)	(f)	(g)
<i>n</i>	P58	P58	P58	P58	P61	P61	1
		8 (esd)	6 (esd)	1	1	1	1
Ag	...	0.05 (07)	0.03 (03)	0.00	0.01	0.00	0.07
Bi	...	0.06 (07)	0.10 (11)	0.03	...	...	...
Pb	39.81	38.83 (28)	38.63 (31)	38.69	40.12	39.05	40.44
Cu	...	0.08 (09)	0.04 (03)	0.06	...	...	...
Sb	34.74	35.91 (26)	36.15 (25)	35.88	36.54	37.25	36.32
Zn	...	<	<	0.07	...	...	...
Fe	2.98	2.46 (05)	2.43 (07)	2.38	2.33	2.42	2.32
Mn	...	0.13 (05)	0.18 (06)	0.16	0.23	0.06	0.16
Cd	...	0.04 (05)	<	0.05	...	...	...
S	21.96	21.51 (12)	21.53 (10)	21.78	20.48	20.57	21.01
sum	99.62	99.07	99.09	99.10	99.71	99.35	100.32

(a) Parajamesonite, Zombory in Zsivny & Naray-Szabo (1947), sum includes 0.13% insoluble residue. (b–g) Euhedral (jamesonite) crystals within the “parajamesonite crystals”, this study. EPMA results, average of *n* point analyses; (b–d) Cameca SX50 operating conditions: 20 kV, 25 nA; standards: pure metals for Ag, Bi, Cd, Cu, Te, Zn; FeS for Fe, PbS for Pb, PbSe for Se; Te and Se were below detection limit; (e–g) selected analyses made on a JCXA-733 operated at 20 kV, 40 nA, beam defocused to 5 μm; standards: pure metals for Ag, Sb and Mn, PbS for Pb, FeS₂ for Fe and S; conventional ZAF correction was applied.

<: below detection limit; ...: not analysed; esd: estimated standard deviation.

Note that EPMA As values of analyses (b–d) were unreliable and are omitted from the table because of peak overlap that also caused a slight (~0.3 rel% ≈ 0.1 wt%) underestimate of Sb. Samples were checked by laser microspectrographic analyses and no As was detected in accordance with the results of Cook & Damian (1997).

Herja or anywhere in the world since its description, doubts were raised concerning the validity of the species (see e.g. Nickel & Nichols 1991). According to Cook & Damian (1997), even if a dimorph of jamesonite does exist at Herja, this is exceptionally rare and restricted to a small part of the vein system. Koch et al. (1960) noted that the possible identity of parajamesonite with jamesonite “can only be decided by further investigations of parajamesonite specimens from the original locality”. Rediscovery of original specimens in the HNHM made the solution of the parajamesonite enigma possible. Preliminary data of the reinvestigation of parajamesonite were briefly reported by Papp (2004), and taken as a basis by the IMA CNMNC to discredit this species (together with other doubtful species; voting proposal 06-C, cf. Burke 2006). Detailed data are presented here as a background of the decision on the discreditation of parajamesonite.

Methods

Investigations were carried out at the Department of Mineralogy, The Natural History Museum, London (NHM), UK, and in Budapest, Hungary, at the Departments of Mineralogy and Petrology and Geochemistry, Eotvos Lorand University (ELTE), the National Institute for Criminology and Criminalistics (OKKI), the Hungarian Academy of Sciences, the Insti-

tute for Geochemical Research (MTA GKKI) and the Chemical Research Centre (MTA KK).

Polished sections were examined by Zeiss optical microscopes equipped with a microphotometer (NHM and ELTE) and a HITACHI S-2500 SEM (NHM); the same SEM + LINK AN10000 configuration was used for a preliminary microprobe study. Quantitative analyses were made on a CAMECA SX50 (NHM) and on a JEOL JCXA-733 (MTA GKKI) microprobe, by WDS. Debye–Scherrer patterns were registered in a Ø 114.6 mm chamber (OKKI), and in a Ø 57.3 mm chamber (NHM), X-ray powder patterns were recorded on a PHILIPS PW3710/PW1050 (MTA KK) and a SIEMENS D500 powder diffractometer (ELTE). Laser microspectrographic analyses were made on a Zeiss LMA-10 + PGS-2 grating spectrograph (ELTE).

Materials

Three parajamesonite specimens were rediscovered in the HNHM, one of them (sample # P58) is undoubtedly the original material of Zsivny, the others (P59, P61) were acquired before 1938 and therefore they may also have been used for the original description. P58: HNHM # .58.3139; small fragments in glass vials (P58X), partly in a paper box labelled “Kisbanya, from Fizely, 1927”; a hand specimen (P58); two separate labels “From Gyula adamcsik, Kisbanya, between 1915–20, Salan vein” and “Parajamesonite (my own specimen, I’ve got it for study)”. All inscriptions (translated here) are written in Zsivny’s hand. P59: HNHM # .59.90 (old # w 853) hand specimen; purchased from Mrs. Mikola in 1937. P61: HNHM # .61.3340 (old # v 913) hand specimen; presented by Gyula Kupas (Baia Mare) in 1933.

Specimen description

The macroscopic features of the three specimens are the same and correspond to the description given by Zsivny & Naray-Szabo (1947).

Coarse-grained (up to 2 cm), massive black sphalerite (preserved only on one side of the largest specimen, P59) is covered by a coarse-grained (up to 1 cm) galena layer with a few chalcopyrite patches between the grains (preserved on P59, P61). Then a boxwork of partly altered lamellar pyrrhotite follows. Pyrrhotite is partly replaced by pyrite or marcasite in the polished sections. The voids of the boxwork are filled with coarse black sphalerite and galena, sometimes with tetrahedrite or “plumosite” (fibrous jamesonite). Galena is rimmed from outside by semseyite and the latter by ramdohrite (containing abundant euhedral jamesonite inclusions) in the polished sections. Lenticular siderite crystals, sometimes in globular aggregates, isometric sphalerite, tabular semseyite, acicular jamesonite crystals and “plumosite” aggregates are found in the cavities. Siderite may reach 1 mm in diameter but the largest dimension of the other minerals is usually less than 0.5 mm. Open surfaces of pyrrhotite and most of the cavity-fill-

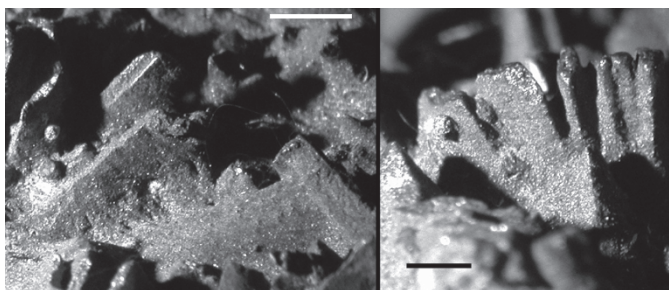


Fig. 1. Irregular (left) and crest-like aggregates (right) of lath-like “parajamesonite crystals”. The small spherical bodies are siderite (bars 1 mm). P59.

ing crystals are covered with a thin, cracked, rusty-red, amorphous layer; this alteration product obviously derived from decomposing pyrrhotite. A sample from the cavity-filling “plumosite” aggregates, which show a peculiar pinkish tint, proved to be a mixture of jamesonite and boulangerite by XRPD.

The upper part of the pyrrhotite boxwork (partly filled by sphalerite, galena and tetrahedrite) is either covered first with irregular aggregates of microscopic elongated jamesonite crystals or directly with “plumosite” reaching 1 cm thickness. Pyrrhotite (partly replaced by marcasite or pyrite) and sphalerite below the “plumosite” mass is always covered with a thin greenish to brownish yellow coating (which gave a jarosite-like pattern by XRPD). “Plumosite” is a friable, felt-like, dull grey aggregate of densely interwoven microscopic needles of jamesonite. Samples (one from each specimen) from this “plumosite” mass contained no trace of boulangerite detectable by XRPD. “Parajamesonite laths” (see below for details) project from this mass. Small (~ 0.5 mm) nodules of sphalerite, always covered with a greenish to brownish yellow coating, are also abundant in “plumosite”. Sphalerite nodules are grouped into strings or irregular aggregates on and between “parajamesonite laths” or they are coalesced into a concave layer covering a large area of the specimen (P61). Imperfectly developed (and also coated) tetrahedrite crystals (up to 2 mm) and small, thin prismatic arsenopyrite crystals are scattered in the “plumosite” mass. Microscopic grains of cubanite were found as inclusions in the argentian tetrahedrite crystals within the “plumosite” mass, and a few grains close to AgFe_2S_3 (argentopyrite and sternbergite composition) were observed in the coating of an argentian tetrahedrite crystal. Rarely globular aggregates of siderite, coloured grey by “plumosite” inclusions, are also found on “parajamesonite laths” (P59; Fig. 1).

Identification of these minerals is partly based on X-ray and ore microscopic investigations. Zsivny & Náray-Szabó (1947) observed but did not identify “plumosite” with jamesonite (“Em. B”) and the sphalerite nodules (“dunkel bräunlichgrün erscheinende Knöllchen”), whereas arsenopyrite, jamesonite (crystals in boxwork cavities), semseyite, siderite and the unidentified coatings were not mentioned in their paper.

The apparent succession shown by the samples is in contradiction with the overall sequence of deposition established for the Herja deposit (Petrulian 1934; Borcoş et al. 1975; Damian 2003). At Herja the (simplified) succession started with an initial deposition of pyrite, continued with the main base metal sulphide phase, in its first part with pyrrhotite and sphalerite, in the second part with sphalerite and galena (+ tetrahedrite), and it was terminated by the stibnite + sulfo salt phase (Damian 2003). A check of museum specimens (collected before 1945) of euhedral pyrrhotite rosettes, characteristic of this deposit, however, showed that pyrrhotite rosettes are crystallised on a base of coarse-grained sphalerite and/or galena in most of these specimens (and they may be covered by smaller euhedral sphalerite crystals). It is impossible to establish a reliable sequence of deposition using museum specimens, nevertheless they seem to confirm the deposition of some crystalline pyrrhotite after the galena-sphalerite phase as well (at least in the upper, now inaccessible parts of the veins). It is to be noted that in recently found specimens “parajamesonite-like crystals” are deposited on a sphalerite and/or galena matrix without pyrrhotite.

Morphology and physical properties of “parajamesonite crystals”

The flattened prisms, which were described as “parajamesonite crystals” usually do not exceed 3–5 mm in length and 1–2 mm in width, their cross-section is pointed elliptical (lenticular), thickness to width ratio is about 1:4–1:5. Sharp edges or plane faces could not be found, and terminations are broken or rounded. It was not possible to observe the longitudinal striation mentioned by Zsivny, as the mineral is always covered by “plumosite”. In addition to irregular intergrowths, subparallel intergrowths resulting in an irregular star-shaped cross-section can sometimes be found. No cleavage was observed. Careful inspection of the broken terminations reveals small angular cavities and gives slight hints to a polycrystalline structure. Colour is light grey, sometimes with a slight yellowish tint. Specific gravity: 5.482 (average of two measurements, Zombory in Zsivny & Náray-Szabó 1947).

Ore microscopy

Polished sections were made from a few flattened prisms and their aggregates found in glass vials (P58X), and from other similar fragments (detached from P58, P59 and P61 hand specimens) corresponding to the morphological description of parajamesonite. Our observations concerning “parajamesonite crystals” are reported here, a detailed description of the whole paragenesis will be published elsewhere.

The most remarkable result of the investigations is that “parajamesonite crystals” are in fact polycrystalline aggregates. It is to be noted that other parajamesonite-like specimens studied by Koch et al. (1960) were not monocrystals either. Most of the aggregates are built up of euhedral crystals

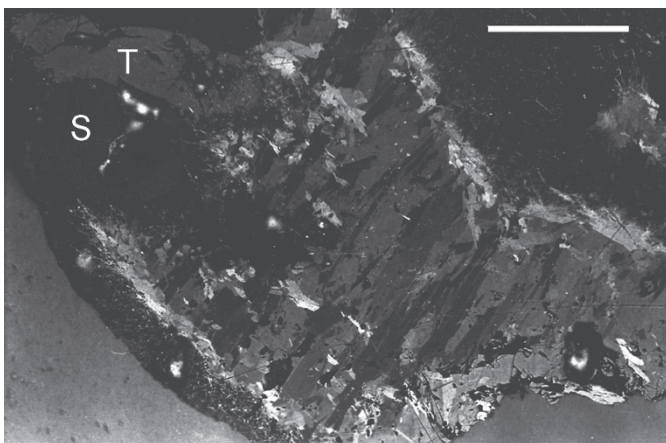


Fig. 2. Cross-section of “parajamesonite crystals”, surrounded by “plumosite” (top right and bottom left), sphalerite (S, top left) and argentic tetrahedrite (T, top left). Polished section, slightly uncrossed nicols (bar 0.25 mm). P58.

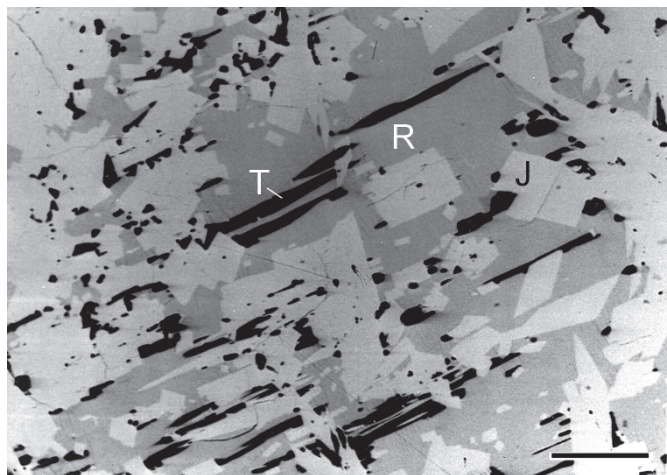


Fig. 4. Longitudinal section of a “parajamesonite crystal”. Jamesonite crystals (J, light grey) are embedded in ramdohrite (R, dark grey), which also contains argentic tetrahedrite lamellae (T, black). Polished section, SEM micrograph (bar 0.5 mm). P58X.

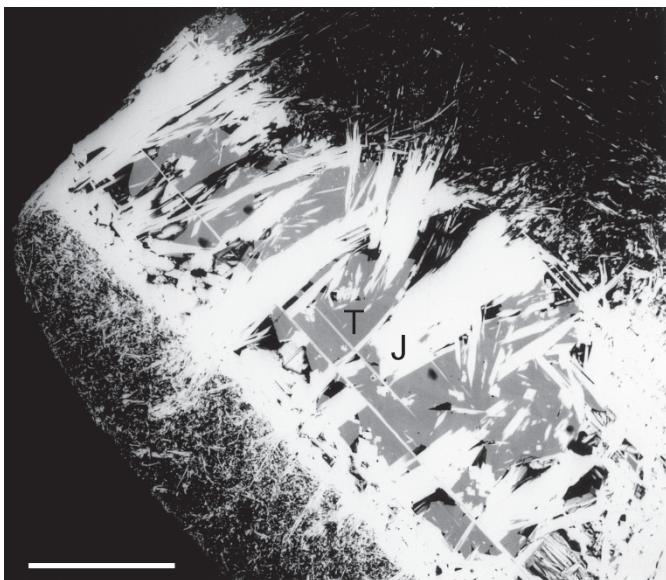


Fig. 3. Longitudinal section of a “parajamesonite crystal”, surrounded by “plumosite”. Jamesonite crystals (J, white) are embedded in argentic tetrahedrite (T, grey). A long jamesonite plate (?) running bottom right to top left is visible near the middle of the picture. Polished section, SEM micrograph (bar 0.25 mm). P58X.

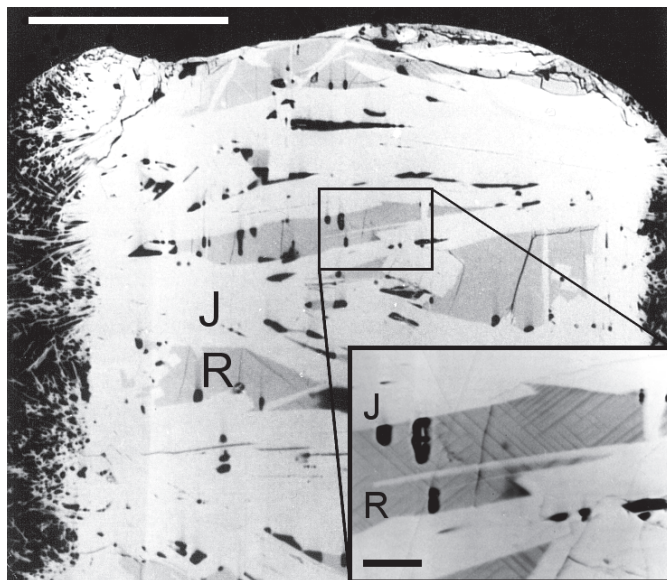


Fig. 5. Jamesonite crystals (J, light grey) embedded in ramdohrite (R, dark grey). The silver content of the thin, dark exsolution lamellae shown in the inset is approximately double the content of the ramdohrite matrix. These lamellae may correspond to andorite IV (Yves Moëlo, pers. commun.). Polished section, SEM micrograph (bar 0.1 mm, bar in the inset 0.01 mm). P58X.

of the same mineral. Individual crystals reach 0.05 mm across and 0.2 mm in length. Their cross-sections are rhomb-shaped, and may represent differently oriented sections of simple prismatic crystals. The reflectance properties of the mineral (for CIE illuminant C: $x = 0.304; 0.305, y = 0.312; 0.315, Y = 36.3; 41.7\%, \lambda_d = 482; 488, P_c = 2.7; 2.0$) are close to the values published by Criddle & Stanley (1993) for jamesonite. EPMA and

XRPD results (see below) proved that these are really jamesonite crystals and therefore the crystals may be {110} prisms.

The lath-like “parajamesonite crystals” (or rather aggregates) show a lenticular cross-section perpendicular to their elongation. The border of the larger crystals is usually composed of jamesonite prisms, which are nearly parallel with the

margin of the aggregate, whereas the middle of the laths is filled by jamesonite prisms oriented nearly perpendicular to the margin (Fig. 2). Some of the latter prisms penetrate the rim and branch away outside of the boundary of the laths forming “plumosite”-like needles. Larger aggregates frequently contain angular cavities bordered by crystal faces of jamesonite.

The lath-like aggregates may contain other mineral(s) in addition to jamesonite. In the longitudinal section of some laths from P58X sample the interior of the aggregates is filled by argentic tetrahedrite (Fig. 3) and/or ramdohrite (Figs. 4–5). Euhedral jamesonite crystals are enclosed in this ground-mass. It is to be noted that a few extremely long jamesonite needles (or lamellae) running parallel to the elongation of the laths can also be observed (Fig. 3). These needles are 0.01 mm in width but reach 1 mm in length. The ramdohrite matrix may contain tetrahedrite lamellae oriented parallel to the elongation of the laths (Fig. 4). In another case thin exsolution lamellae with high Ag content running in two directions were found in the ramdohrite matrix (Fig. 5). These lamellae may correspond to andorite IV (Yves Moëlo, pers. commun.). The outer boundary of the laths is indistinct and they are usually covered by thin needles of “plumosite” (Figs. 2–3).

Microprobe results

Except for the analytical results of jamesonite we report here only some basic data relevant to the identification of the associated minerals. Formulae (ranges) were calculated separately from the analytical data obtained in the two laboratories (NHM and MTA GKKI) because of the systematic differences. Further data of all analysed members of the mineral association and a more detailed interpretation will be published with the description of the paragenesis.

Results of the microprobe analyses of the jamesonite crystals (Table 1, b–g) are close to both the idealised formula ($\text{FePb}_4\text{Sb}_6\text{S}_{14}$) and the data published by Cook & Damian (1997) for Herja specimens. We also observed the small but consistent Mn content mentioned by Cook & Damian (1997). Calculated formulae (for $S = 14$) are in the range $\text{Fe}_{0.9}\text{Mn}_{0.1}\text{Pb}_{3.8-3.9}\text{Sb}_{6.1-6.2}\text{S}_{14}$ (NHM) and $\text{Fe}_{0.9-1.0}\text{Mn}_{0.0-0.1}\text{Pb}_{4.1-4.4}\text{Sb}_{6.4-6.7}\text{S}_{14}$ (MTA GKKI).

The fahlre mineral in the samples is a practically As-free tetrahedrite with high Ag content; $\text{Ag} = 24\text{--}28$ wt%, $\text{Cu}/\text{Ag} = 1.1\text{--}1.4$ (0.85 in a single measurement). Formulae, calculated for 13 S atoms of the simplified $(\text{Cu},\text{Ag})_{10}(\text{Fe},\text{Zn})_2\text{Sb}_4\text{S}_{13}$ formula, are in the range $(\text{Cu}_{5.2-5.8}\text{Ag}_{4.1-4.7})_{9.6-10.0}(\text{Fe}_{1.8}\text{Zn}_{0.2-0.3})_{2.1}\text{Sb}_{4.2-4.5}\text{S}_{13.0}$ (NHM). These data may allow us to classify at least some of the fahlre in the samples as freibergite but with regard to the uncertainties of classification and the incomplete representativity of our analytical data we refer to all the fahlre grains collectively as argentic tetrahedrite.

There are two minerals close to the fizélyite composition, $\text{Pb}_{14}\text{Ag}_5\text{Sb}_{21}\text{S}_{48}$ (the type locality of fizélyite is the Herja deposit). One of them is always accompanied by euhedral

jamesonite (forming its “matrix” in some of the “para-jamesonite crystals” or in the exterior zone around semseyite reaction rims next to galena in the pyrrhotite boxwork). Cation compositions calculated from the microprobe data plot to the fizélyite–ramdohrite field of the Pb–Ag–Bi diagram (cf. Fig. 2 in Moëlo et al. 1989). N and x values in the $(\text{Pb},\text{Mn},\text{Fe},\text{Cd})_{N-1-2x}(\text{Ag},\text{Cu})_x\text{Sb}_{2+x}\text{S}_6$ formula calculated from the average of the analyses using equations 12 and 17 of Makovicky & Karup-Møller (1977) are $N = 4.05/4.02$ and $x = 0.69/0.67$ (NHM/MTA GKKI). Calculated formulae (for $S = 48$) are in the range $(\text{Fe}_{0.9-1.4}\text{Mn}_{0.8-1.3}\text{Cd}_{0.1-0.6})_{2.3-2.8}\text{Pb}_{10.0-12.2}\text{Ag}_{5.2-5.7}\text{Sb}_{21.3-21.8}\text{S}_{48}$ (NHM) and $(\text{Fe}_{0.7-1.9}\text{Mn}_{0.4-1.6}\text{Cd}_{0.0-0.7})_{1.9-3.1}\text{Pb}_{10.7-12.8}\text{Ag}_{4.8-6.0}\text{Sb}_{21.4-23.1}\text{S}_{48}$ (MTA GKKI). Considering the ubiquitous (Fe, Mn, Cd) content, this mineral can be classified as ramdohrite rather than fizélyite (cf. Moëlo et al. 1984, 1989).

The other fizélyite-related mineral is found rarely as minute grains in semseyite. Cation compositions plotted to the Pb–Ag–Bi diagram are shifted in the PbS direction relative to the plots of the previous mineral; $N = 4.54/4.51$, $x = 0.69/0.66$ (NHM/MTA GKKI). This mineral doesn’t contain Mn and Cd, but some Fe and Cu. Calculated formulae (for $S = 48$) are in the range $\text{Fe}_{0.0-0.1}\text{Pb}_{15.2-16.2}\text{Ag}_{4.7-4.9}\text{Cu}_{0.3}\text{Sb}_{19.7-19.9}\text{S}_{48}$ (NHM) and $\text{Fe}_{0.0-0.1}\text{Pb}_{16.8-17.6}\text{Ag}_{5.0-5.5}\text{Sb}_{20.4-21.7}\text{S}_{48}$ (MTA GKKI).

Semseyite grains are practically free from substitution, but their calculated formulae and Pb/Sb ratios, ranging $\text{Pb}_{8.6-8.8}\text{Sb}_{8.1-8.5}\text{S}_{21}$, $\text{Pb}/\text{Sb} = 1.01\text{--}1.07$ (NHM) and $\text{Pb}_{9.2-9.9}\text{Sb}_{8.4-8.6}\text{S}_{21}$, $\text{Pb}/\text{Sb} = 1.07\text{--}1.12$ (MTA GKKI), considerably differed from the ideal values ($\text{Pb}_9\text{Sb}_8\text{S}_{21}$; $\text{Pb}/\text{Sb} = 1.125$), cf. Damian & Cook (1997).

Sphalerite is iron-rich (Fe 8–10 wt%), with 0.2 wt% Cd and Mn, calculated formulae are around $\text{Zn}_{0.8}\text{Fe}_{0.2}\text{S}$. Galena contains 0.1–0.5 wt% Ag, 0.4–0.5 wt% Sb and up to 0.1 wt% Bi.

X-ray studies

For a preliminary investigation a lath-like “crystal” was selected from among the original samples found in glass vials (P58X); the loose, soft “plumosite” coating was removed with a blade. Debye–Scherrer films were made in the NHM from both the core and the coating. The patterns proved to be identical except for the presence of sphalerite lines on the film of the coating. The data bear no resemblance to those published by Zsivny & Náray-Szabó (1947) for parajamesonite (ICDD 41-1401), but corresponded to those of jamesonite (ICDD 13-461). Another part of the same grain was studied in another laboratory (OKKI), and the same result was obtained. A second “crystal” with its coating from sample P58X was investigated with an X-ray diffractometer (ELTE), and the predominant mineral was again jamesonite with some sphalerite and traces of semseyite (?). As a last attempt, randomly chosen lath-like “crystals” (one from the three hand specimens each) were X-rayed in the OKKI after the removal of the “plumosite” coating, but the three X-ray films also showed the jamesonite pattern.

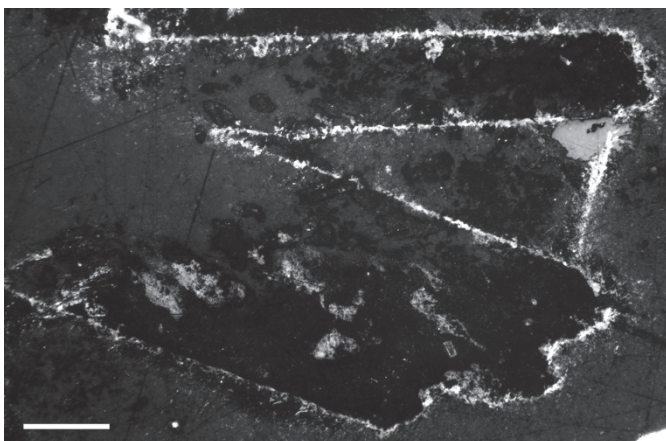


Fig. 6. Strings of minute jamesonite grains outlining the shape of an unknown precursor mineral. Dark grey and black areas correspond to synthetic resin and cavities after “plumosite” fallen out during polishing. Light grey grain (top right) is sphalerite. Polished section, slightly uncrossed nicols (bar 0.25 mm). P61.

Discussion

The “parajamesonite crystals”

The cross-section of the parajamesonite laths was described by Zsivny & Náray-Szabó (1947) as an imperfect or distorted (frequently lenticularly rounded) hexagon or rhomb. Zsivny & Náray-Szabó (1947) interpreted this shape as a combination of pinacoidal and prism faces of parajamesonite that he supposed to have an orthorhombic or lower symmetry. In fact, no crystal face is recognisable. This is not surprising if we consider the polycrystalline building of the laths. In some cases long lath-like jamesonite crystals run parallel with the length of the “parajamesonite lath” (Fig. 3.), or other lath-like or lamellar mineral grains mark the direction of elongation. In most cases, however, the “parajamesonite laths” are built up exclusively of jamesonite crystals and a growth on and around of another lath-like sulphosalt is not proved. Here and there the “plumosite” mass contain cavities, which are similar in shape to the “parajamesonite crystals”. These cavities are lined with similar jamesonite rim as the “crystals”, but they are loosely filled with long, thin jamesonite needles (Fig. 6). This observation suggests that the peculiar shape of most of the jamesonite aggregates (“parajamesonite crystals”) may be due to pseudomorphism, i.e. replacement of, or a cavity filling after a dissolved pre-existing mineral.

The validity of parajamesonite

It was impossible to resolve the contradiction between our X-ray results and those of Zsivny & Náray-Szabó (1947) directly by the re-examination of the original X-ray mount, because it is not available. We can conclude from the comment of Náray-Szabó published in 1962 that this sample was already lost at

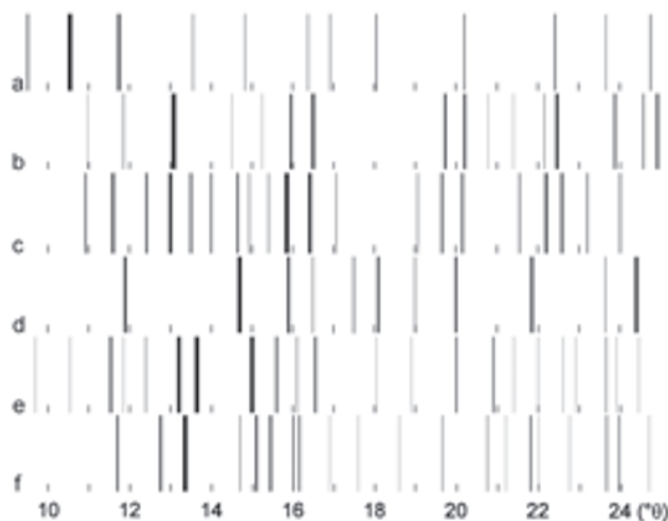


Fig. 7. A schematic representation of a part of the Debye–Scherrer diagram of (a) parajamesonite, (b) jamesonite, Cerro de Ubina (both from Zsivny & Náray-Szabó 1947), (c) parajamesonite (P58X, this study), (d) argentinian tetrahedrite (P61, this study), (e) semseyite and (f) fizélyite (both from Berry & Thompson 1962). All samples are from Herja except for (b). Line thickness is proportional to intensity. θ values are given for $\text{CuK}\alpha$.

that time, nevertheless we made inquiries about it. Professors Gábor Náray-Szabó (son of István Náray-Szabó) and Kálmán Sasvári (assistant to István Náray-Szabó in 1947) confirmed that a search after the sample is hopeless, and the original Debye–Scherrer film has also been lost. Unfortunately, the material used for the wet chemical analyses is also unidentifiable now (but see point (c) below). In this way, we had to follow an indirect approach: a reconsideration of the published X-ray data was attempted in the light of the new X-ray, ore microscope and microprobe studies.

Parajamesonite was established on the finding that the chemical composition of the mineral corresponded to $\text{FePb}_4\text{Sb}_6\text{S}_{14}$ (= jamesonite) whereas its observed X-ray pattern was different from that of jamesonite. As a definite statement declaring that the *same* material was used to the wet chemical and X-ray studies is lacking from the paper of Zsivny & Náray-Szabó (1947), we cannot preclude the opposite case. This assumption offers the following theoretical alternatives (a) the X-ray mount contained another mineral(s) of the specimen, or (b) it was an entirely different material due to a (rather unlikely) fatal confusion of samples. Provided that the same material was used for the chemical and X-ray studies, we have again two alternatives, i.e. it was (c) actually jamesonite, or (d) really a new mineral, consequently, parajamesonite is a valid species. Consideration of these four options gave the following results:

(a) Sphalerite, argentinian tetrahedrite, ramdohrite and semseyite were found to occur closely intergrown with jamesonite in the polished sections. Fig. 7 is a schematic repre-

sensation of the Debye–Scherrer diagram of argentian tetrahedrite (7d), semseyite (7e) and fizélyite (7f, the pattern practically corresponds to that of ramdohrite) compared to the original parajamesonite (7a) and a reference jamesonite pattern (7b) published by Zsivny & Náray-Szabó (1947) and our parajamesonite pattern (7c). Some of the lines in (7b–f) patterns coincide with those of the parajamesonite (7a) pattern but, because of the intensity relations and especially of the lack of the three strongest lines of parajamesonite the pattern cannot be attributed to one of these minerals or to a mixture of them.

- (b) Repeated search in printed and automated ICDD databases gave no convincing evidence that either another constituent of the paragenesis or a “foreign” material may account for the pattern.
- (c) The chemically analysed sample is unidentifiable now, however, a grey powder in an unlabelled glass vial and a separate label inscribed “Zombory analysed this material. (Kisbánya) 1927” were found in the small paper box that accompanies P58 sample. As the vial was the only one containing powdered material in the box, this may be the rest of the analysed sample. The powder proved to be jamesonite according to the XRPD study. On the contrary, the X-ray diagram published for parajamesonite is very far from that of jamesonite, and we were unable to find a reliable interpretation based on a distortion of the jamesonite pattern by any kind of systematic experimental error. A gross error in the X-ray study would explain the situation, but in the lack of the original X-ray mount it cannot now be proven.
- (d) After the rejection of the preceding explanations there is a further theoretical option left, namely parajamesonite is really a distinct species, a dimorph of jamesonite. Nevertheless, the fact that neither the five different (partly original) parajamesonite samples studied now, nor the three morphologically similar samples investigated by Koch et al. (1960) show any deviation from jamesonite, raises serious doubt in this respect (especially if we consider that the grey powder mentioned in point (c) was very probably the material used for chemical analyses).

Specimens corresponding to the original morphological description of parajamesonite both in morphology and in mineral association can be encountered in the mineral market even recently. They are usually labelled as semseyite, fizélyite, or jamesonite (or boulangerite [!]) pseudomorphs after fizélyite. A cabinet-size specimen from this material from level VI of the Herja mine, purchased from a mineral dealer in 2004 (HNHM # Á.2004.76.1), was checked by XRPD and also gave the jamesonite pattern.

Conclusion

Detailed ore microscopic, EPMA and XRPD investigations of original parajamesonite samples of Zsivny & Náray-Szabó (1947) and other contemporary museum specimens (acquired

before 1938) containing the same material haven't provided any direct evidence of the existence of parajamesonite. The polycrystalline aggregates, which were originally described as crystals of parajamesonite, are really formed by a phase with $\text{FePb}_4\text{Sb}_6\text{S}_{14}$ idealised composition, sometimes intergrown with argentian tetrahedrite (freibergite) and / or ramdohrite, but the examined aggregates gave the jamesonite X-ray pattern. Therefore we assume, that the sample analysed by Zombory (in Zsivny & Náray-Szabó 1947) was in fact jamesonite. The specific gravity measured by Zombory (5.482, average of two measurements) is low, but falls within the values published for jamesonite (cf. Berry 1940). A powdered sample, presumably the rest of the analysed material, proved to be jamesonite as well, supporting this assumption. A satisfactory interpretation of the original XRPD data has yet not been found, suggesting a gross error in the X-ray study. These findings, briefly mentioned in a note in Papp (2004), conclude definitively to the discreditation of parajamesonite, in accordance with the decision of the IMA Commission on New Minerals, Nomenclature and Classification (voting proposal 06-C, cf. Burke 2006).

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