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MINERALOGICAL NOTES AND FLUID INCLUSION STUDIES ON QUARTZ-FELDSPAR GRANITE PEGMATITES AND QUARTZ VEINS FROM MÓRÁGY AND ERDŐSMECSKE GRANITOID, S-HUNGARY

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ABSTRACT

This paper is devoted to investigation of quartz–feldspar granite pegmatites and quartz–calcite veins from Mórágy and Erdősmecske Granitoid, South Hungary, by microprobe and fluid inclusion studies. The result is the first verification of the presence of native gold, arsenopyrite, stibnite, cassiterite and scheelite. Three types of constituents can be divided into the following groups:
"granitophile", early-formed accessory minerals: ilmenite, rutile, thorite, garnet, allanite, titanite, zircon, apatite, monazite, Y-, Ce-La-Ca phosphates, etc.
"granitophile", high temperature – hydrothermal – minerals: arsenopyrite, molybdenite, cassiterite and scheelite, which sometimes associated with other sulphides (pyrite, chalcopyrite, fahlore, sphalerite, and galena).
"epithermal" type, low temperature hydrothermal assemblage: – gold, stibnite, barite, carbonate phases including bastnäsite, Ce-La-Nd carbonates and Ca-Fe-Mn-Mg double carbonates. The gold–stibnite pair can be interpreted as a decomposition of the Sb-bearing ligand during the transportation of gold. In granite environments, the Au-Sb association is not infrequent.
The microthermometric study with limited number of fluid inclusion samples does not allow detailed interpretations. However a few remarks can be made. The Th distribution shows three maxima – 140–150 °C, 200–210 °C and 260–270 °C, suggesting a wide range of fluid temperature history both in the pegmatite and the grown-up (vein) quartz-calcite materials. The uncertainty of the genetic type of inclusions does not allow speculations regarding to the fluid evolution from high PT conditions. The registered Th data set reflects some "late" history of fluids, without any time-related considerations.
The fluid character is mainly Na-Ca-Cl type. The influence of Ca-bearing fluids can be traced also by the following facts: a) Garnet overgrowth by Ca-rich rim, b) Allanite overgrowth by Ca-rich rim, c) Decomposition–redistribution process of REE-bearing minerals like monazite, allanite, etc. to REE-bearing carbonate species like bastnäsite, or other REE-bearing carbonate during a "hydrothermal" process, d) Formation of "sterile", late carbonate-bearing veinlets.
The calculated salinity (expressed in NaCl eq.wt. %) is low: 6–0 NaCl eq.wt.%
The Th/c plot shows the trapping of fluids in a wide density range. Comparing to the similar data of Velence Mts., it exhibits the presence of significantly lower salinity fluids in Erdősmecske–Mórágy Granitoid. These data suggest an overlapping as a result of subsequent tectonic and fluid rejuvenation events.
Key words: Erdősmecske–Mórágy Granitoid, granite pegmatite, accessory minerals, fluid inclusions

INTRODUCTION

The "older type", so called "syn-collision" granitoid zone occurs as a narrow belt in S Hungary between the Danube–Tisza Interfluve Region – in the Tisza Unit – (hit by oil exploration boreholes) and the SE branch of the Mecsek Mts., as a form of discrete outcrops (Erdősmecske - Mórágy region). Granitoids of this zone have mainly of S-type character with some I-type features (Buda, 1985). The rocks exhibit typical migmatite appearance, which crystallised from a water-saturated silicate melt. They have heterogeneous composition, with slight alkaline influence. The typical, but not abundant composition of this series are the pegmatite nests, lenses and veins which are incorporated in the granitoids, or in the adjacent metamorphic rocks. The presence of primitive quartz-feldspar-(mica) pegmatite was partly mentioned by Jantsky (1979).

The aim of this paper is to show and summarise the so-called accessory minerals in the main pegmatite constituents (feldspar and quartz) as well as the fluid inclusion content of the quartz in pegmatite bodies and lenses and quartz–calcite veins in granitoids and metamorphic rocks.

GEOLOGY

The discontinuous distribution of outcrops of the granitoid rocks (called as "Mórágy Granitoid Formation" – Fülöp, 1994) covers about 200–220 km^2 area are placed at the SE-part of the Mecsek Mts. This rock formation is composed mainly of monzonite/monzogranite of metaaluminous (slightly peraluminous) character. The temperature of crystallisation estimated by K-feldspar triclinity was about 685 °C (Buda, 1985). The granitoid bodies contained mafic enclaves, as relicts of magma mixing. The PT estimation from amphibole/plagioclase pairs suggests temperature of 540–560 °C, and the pressure less than 2 kbar (Árkai and Nagy, 1994; Király, 1996). The main types of the granitic rocks are as follows: a) microcline megacryst-bearing granitoid, b) amphibole-rich enclaves, c) microgranite.

The granitoids are in contact with a metamorphic rock series, – called "Ófalu Phyllite Formation" – with a well-developed mylonitic structure. The PT condition of the postkinematic events estimated by Lelkes-Felvári et al. (2000), suggests 450 °C and 5.7–6.3 kbar. The age of shearing was determined to be about 270–303 Ma and 294–307 Ma respectively by Lelkes-Felvári et al. (2000), and later Tüske (2001). Extended, successive compressive fault rejuvenation events occurred also during late Mesosoic and Cenosoic era – Wórum (1999).

The main outcrops are situated in the Lovászhetény – Bátaszék – Mórágy – Erdősmecske zone. These places are delineated and partly covered by Middle/Upper Miocene residual sediments, Pannonian sand/sandstone series or Pleistocene loess. The studied outcrops included the Miocene residual sediments, since pegmatites occur in these as sharp rock fragments. The location of the outcrops are plotted on Fig. 1.

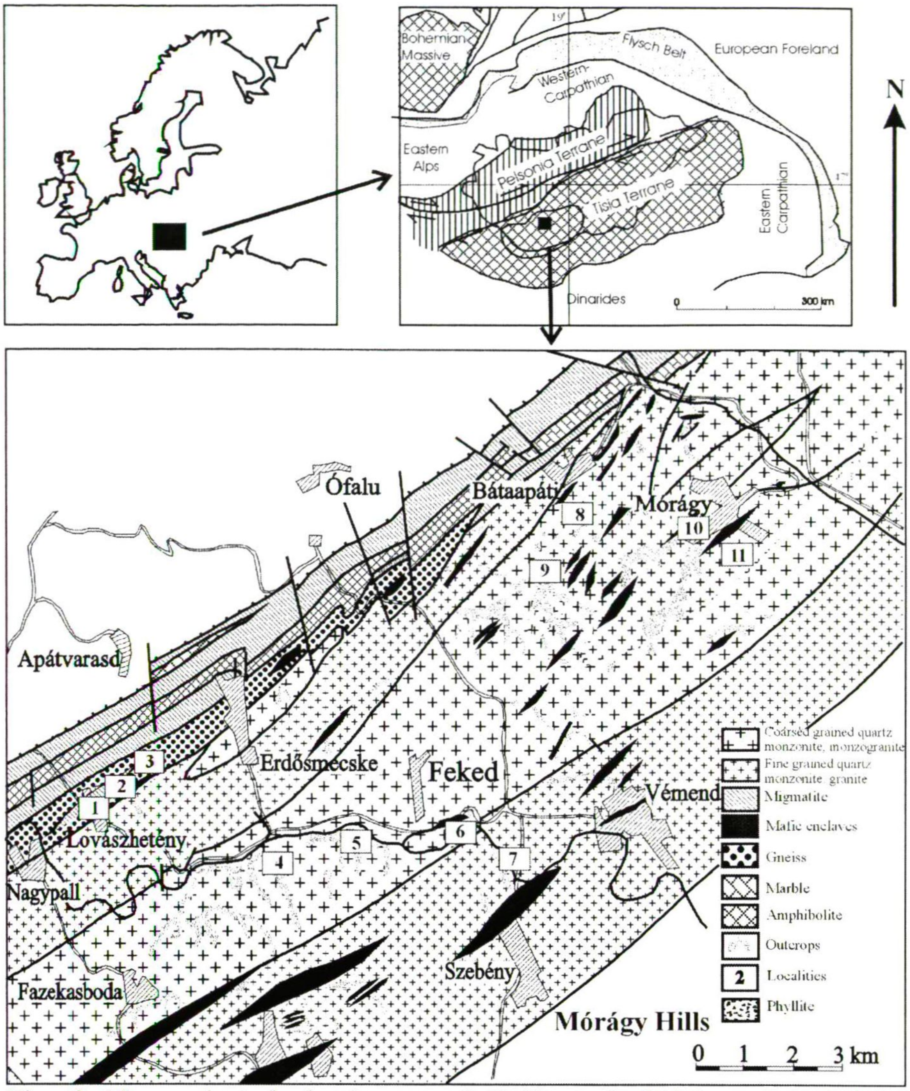

Fig. 1. The geological sketch map of Erdősmecske-Mórágy area, and its geographical position. Compiled from the data of Jantsky (1979), Fülöp (1994) and Buda et al. (1999). List of sampling points: 1-2-3 Lovászhetény, creek, along the stream, 4. Erdősmecske, abandoned quarry, 5. Feked, sand pit, 6. Feked, abandoned quarry, 7. Szebény, creek, 8. Bátaapáti, Hosszú valley, N-Part, 9. Bátaapáti, Hosszú valley, S-part,10. Mórágy, small abandoned quarry, 11. Mórágy, abandoned quarry.

Description of pegmatites

The main mineral constituents are quartz, K-feldspar, and biotite. Less frequent mineral is amphibole. In rare cases the intergranular parts of the pegmatite bodies filled by pyrite-chalcopyrite-galena paragenesis (Kiss, 1962), or molibdenite (Jantsky, 1979), Erdősmecske quarry.

A few quarries also contain segregated hydrothermal quartz veins/veinlets, with embedded euhedral quartz crystals, followed by calcite precipitations (Mórágy) – (see later as "Q–Cal veins" in the text).

The primary pegmatite sites occur as 0.2–0.5 m thick irregular veins (e.g. Erdősmecske quarry, Creek of Lovászhetény, etc.), lens-shaped bodies (e.g. Mórágy), distorted, oriented blocks in granites (e.g. Bátaapáti–Hosszú valley, Üveghuta etc.) or in form of irregular bodies of a few tenths of m^3 in volume.

The real connection of the pegmatites with the parent rock in the most cases ambiguous. Only in some places (Erdősmecske, Mórágy) can be seen sharp transition between the pegmatite and the host rock. In other outcrops the contact is transitional (Feked, Szebény etc.). Visible rock alteration along these mineral enrichments is not known.

The fragments of pegmatites in the Miocene sediments form occasional sharp irregular parts of more than 10 cm diameter. The pegmatite clasts in Pannonian sand (Feked and Véménd villages) are usually little rounded quartz pebbles, with less than 10 cm diameter. Clasts of vein-quartz can also be found.

Macroscopic description of main constituents of pegmatites

Quartz

Occurs as irregular patches, lenses, thick veins in pegmatite. The presence of grown-up, "free" crystals from pegmatite are not known. The colour is typical white-milky, in some cases semitransparent, fractured, banded. Clast samples have a pale semitransparent "smoky" tint.

The quartz originated from Q-Cal veins (Mórágy), or clasts from sediments (Hosszú valley) have different character: the few mm long crystals are water-clear or light cloudy, often crashed, delineated by badly developed prism and rhombohedron faces.

K-feldspar

The euhedral-anhedral K-feldspar grains usually show intense or pale reddish colour. Based on the optical and X-ray measurements (Buda, 1974, 1985), they are maximum microclines.

Amphibole

Mentioned from Mórágy by Buda et al. (1999), as "large", (few cm) zoned crystals. Microprobe analysis yielded Mg-hornblende-actinolite composition.

Mica

At some places, the pegmatite bodies contain mica (biotite) flakes in pods of a few cm in diameter (Lovászhetény creek).

Accessory minerals

The presence of the following constituents was detected by naked eye (with 10x magnification) during this study:

Garnet: Rounded, ball-shaped, reddish-brown, grains of diameter of 1–3 mm, which developed at the grain boundary of feldspars. Garnet was found in the abandoned quarry and dump at Erdősmecske.

Epidote/allanite: Oval-shaped, or slightly elongated, greenish-gray grains of a length of 1–2 mm with traces of cleavage at the Lovászhetény creek.

Titanite: Tabular, isometric, brownish-yellow grains in dimension of 1–2 mm in the debris of pegmatite bodies Hosszú valley region at Bátaapáti.

Sulphides: Pyrite-sphalerite-galena massive, limonitized assemblages of a few cm dimensions filled the cracks in feldspar and quartz, molybdenite flakes of a diameter of 1–2 cm, embedded in massive feldspar and/or quartz. (Kiss, 1962; Jantsky, 1979). These are very rare constituents, detected only in the abandoned quarry at Erdősmecske.

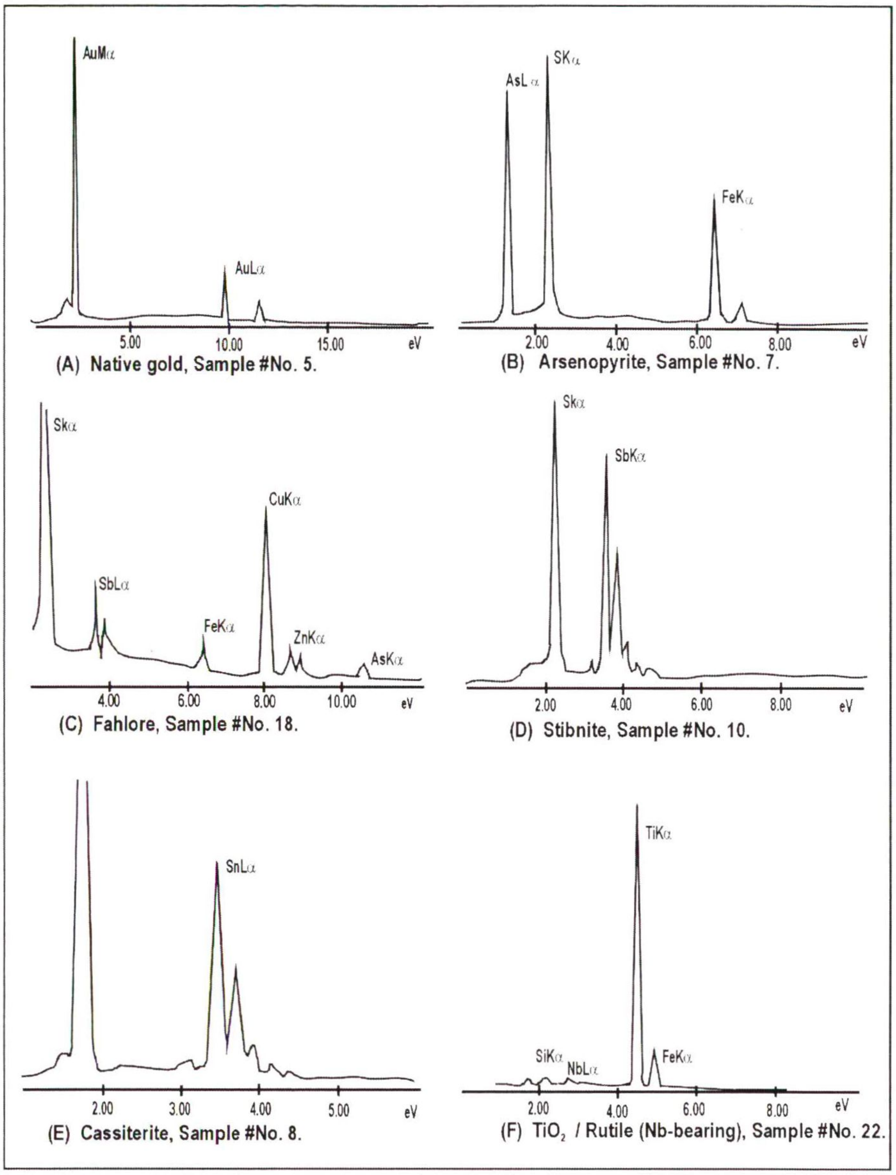

Fig. 2. Spectra of various components (part one)

ANALYTICAL METHODS

From the collected samples (about 40 items from over 10 localities) wafers of 0.2–0.5 mm thickness had been made for routine petrographic descriptions. These were double polished, and selected for microprobe analysis, and finally for fluid inclusion studies. Table 1. contains the list of samples suitable for these studies (23 samples).

MICROPROBE MEASUREMENTS

Microprobe analysis have been done on the selected preparates by AMRAY 1830i scanning electron microscope equipped with EDAX PV 9800 EDS detector at the Department of Petrology and Geochemistry at Eötvös University, Budapest.

FLUID INCLUSION STUDIES (MICROTHERMOMETRY)

Routine microthermometric measurements have been performed on the selected preparates using Chaixmeca heating-freezing stage at the Dept. of Mineralogy, Eötvös Loránd Univ., Budapest (Poty et al., 1976), and on a few samples – the smaller objects – control measuring had taken place on Linkam TH-600 Stage (Shepherd, 1981) at the Dept. of Applied Mineralogy and Geochemistry, Technical University Munich / TUM, Garching, Germany.

RESULTS

Microprobe analysis

According to the investigation of the polished sections by microprobe, the presence of the following minerals had been detected as independent, disseminated solid phases or grain boundary objects, summarised in Table 1.

Gold (native)

Anhedral elongated 8–10 μm single grain in recrystallized quartz nest along euhedral quartz grains in granite. Associated with pyrite and stibnite. Typical occurrence is at Lovászhetény creek (Sample No.5) Spectrum: Fig. 2A, Photo: Fig. 3A.

Arsenopyrite

Anhedral-euhedral crystals with rhomb-shapes, or slightly isometric corroded blebs in the fissures of recrystallized quartz. Their average size is usually 10–15 μm. These grains did not contain Co, Sb or Au

Table 1. Comparison chart of accessory minerals in pegmatitic and hydrothermal quartz from the Mórágy Granitoid, S-Hungary, detected by microprobe.

No.	SAMPLE	LOCALITY	Gold (Native)	Arsenopyrite	Chalcopyrite	Fahlore	Galena	Molybdenite	Pyrite	Sphalerite	Stibnite	Cassiterite	Ti oxide (Rutile)	Th-Ti Oxide	Thorite/ Uraninite	Garnet	Allanite / Epidote	Titanite	Zircon	Barite	Schellite	Apatite	Monazite	Y Phosphate	Ce-La-Ca Phosphate	Bastnäsite	Ce-La-Nd Carbonate
1	quartzite	Lovászhetény, creek							x				x							x							
2	quartzite	Lovászhetény, creek							xx						x												
3	q-fp pegmatite with albite	Lovászhetény, creek											x							x						xx	
4	quartzite	Lovászhetény, creek													x				xx			x	x		x		
5	q nest along q-fp pegmatite	Lovászhetény, creek	x				xx												xx	xx		x	xxx				
6	quartzite	Lovászhetény, creek							xx																		
7	quartzite	Bátatapáti SW part, debris		x			x		xx	x	x		xxx							x							
8	quartzite /cataclastic	Bátatapáti SW part, debris							x	xx		x										xx					xx
9	quartzite / limonite vein	Bátatapáti SW part, debris								x	x									xx							
10	quartz vein /banded/ euhedral crystals	Bátatapáti SW part, debris							x	x	xx		x	x						x			x		x		
11	quartzite /cataclastic	Bátatapáti SW part, debris							x																		
12	quartz-calcite vein	Mórágy, abandoned quarry			x		x			x										x		xx					x
13	q-fp pegmatite	Kismórágy, abandoned quarry							x				x									x					
14	quartzite /limonite vein	Vémend / Feked abndoned quarry					x		x	x											x	x				x	
15	quartzite	Vémend / Feked abndoned quarry					x						x									x					
16	quartzite	Erdõsmecske, abandoned quarry											x						x								
17	feldspar with limonite	Erdõsmecske, abandoned quarry						xx	xx											x							
18	fp pegmatite	Erdõsmecske, abandoned quarry				xx										xx											
19	q-fp pegmatite /cataclastic with calcite	Erdõsmecske, abandoned quarry											x				xx	xx				x	x				x
20	fp with sulphide blebs	Erdõsmecske, abandoned quarry			x		x		xx	x																	
21	q-fp pegmatite	Erdõsmecske, abandoned quarry							x				x						x								
22	q-fp pegmatite	Erdõsmecske, abandoned quarry											xxx			xx			x					x			
23	quartzite with mica	Erdõsmecske, abandoned quarry											x						x								

according to microprobe analysis. Typical occurrence is around Bátaapáti (Sample No.7); Spectrum: Fig. 2B.

Chalcopyrite

5-20 μm xenomorphous flakes along the rim of fahlore, or usually occur in sulphide nests, with other sulphide species like sphalerite, pyrite etc.

Fahlore

20–100 μm xenomorphous grains, often containing galena and/or pyrite relicts. The rim of fahlore in all cases contained tiny flakes of chalcopyrite. It usually occurs in sulphide nests, along with other sulphide species. Typical timing of crystallization: pyrite-galena-sphalerite-+/–fahlore+/–chalcopyrite. According to the microprobe investigations, the homogenous part of fahlore contains Fe-Zn-As-Sb. These parts did not contain~~ed~~ Hg, Bi, Ag. Typical occurrence is the Erdősmecske quarry (Sample No.18), Spectrum: Fig. 2C, Photo: Fig. 3B.

Galena

Anhedral-euhedral crystals with (100) and (111) faces or isometric corroded blebs in the fissures of pegmatite quartz and in their recrystallized parts. In calcite veinlets it occurs as discrete grains. Average dimension is usually 2–5μm, in calcite veinlets 10–15μm. These grains did not contain Ag according to microprobe analysis. Typical occurrence is Lovászhetény and Erdősmecske quarry. (Sample No.5, 20); Photo: Fig. 3C.

Molybdenite

Euhedral, disseminated, discretely distributed, flaky 5–10μm grains in brecciated calcite veins.

Pyrite

Typical anhedral-euhedral crystals or isometric blebs in the fissures of corroded pegmatite K-feldspar or corroded/recrystallized quartz. It often occurs along these grain boundaries as single disseminated grains or group of grains or discrete crystals in calcite veinlet. It is often found associated with barite +/–pyrite +/–galena +/–sphalerite +/–stibnite. The pyrite in calcite veins contained 0.45 wt.% As.

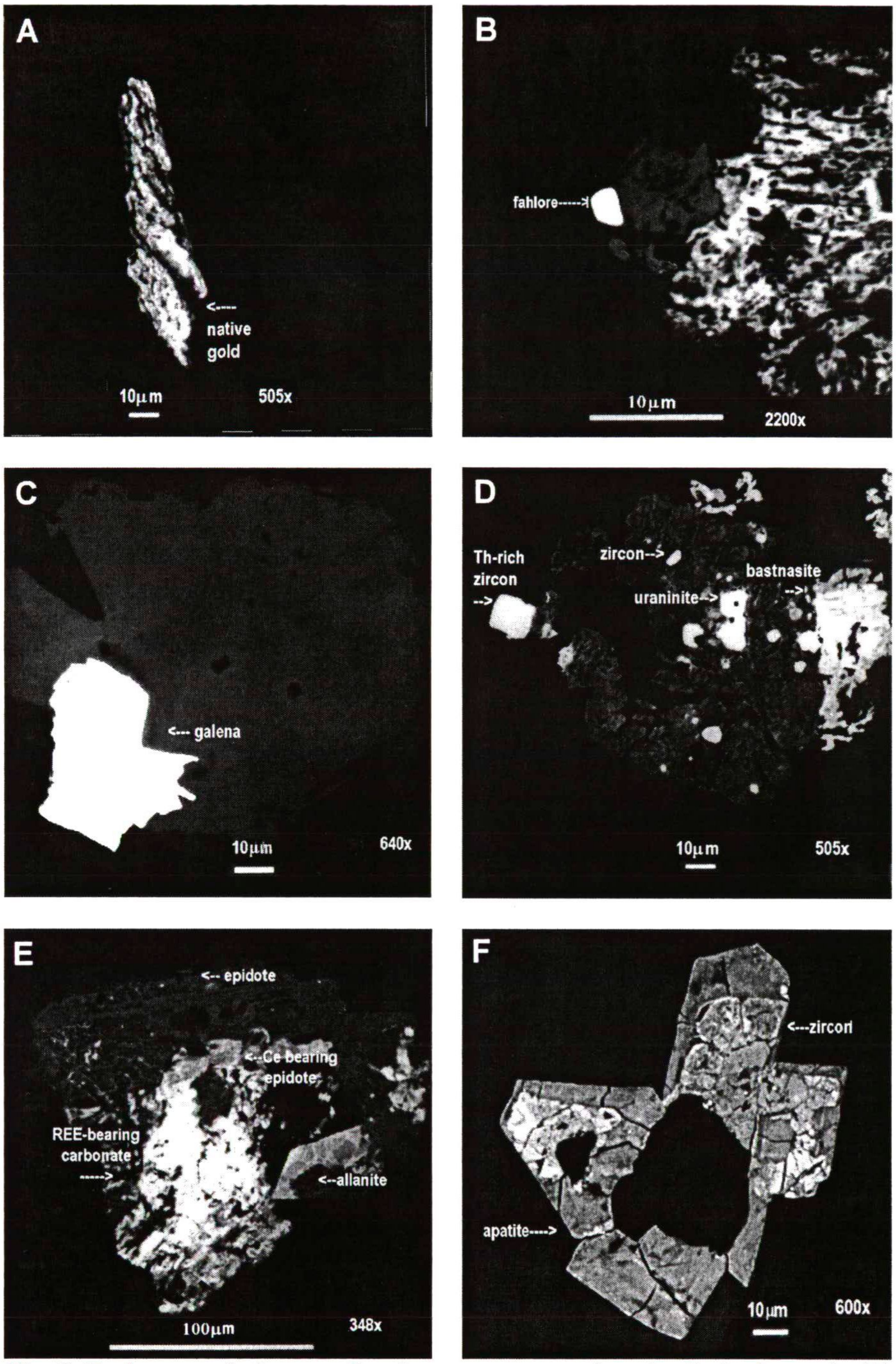

Fig. 3. Backscattered pictures of various components (see details in the text): ***(A)*** Native gold, Sample No.5, ***(B)*** Fahlore, Sample No.18, ***(C)*** Galena, Sample No.5, ***(D)*** U-Th-Zr-Ce-bearing paragenesis, Sample No.4, ***(E)*** Epidote-allanite paragenesis with late REE carbonate, Sample No.19 and ***(F)*** Apatite overgrowth on zircon, Sample No.5

Sphalerite

Anhedral-euhedral crystals, or isometric corroded blebs occurring in the fissures of pegmatite, quartz or feldspar, or in their recrystallized parts or as discrete grains in calcite veinlets, very often associated with pyrite, limonite, galena, Cu-S phase, or euhedral small quartz. Average dimension is 2–10μm. Typical occurrence is Bátaapáti (Sample No.8).

Stibnite

Euhedral elongated needles, or rhomb-shaped cross sections usually in recrystallized quartz, or in limonite-bearing veinlets. Typical dimension is 4–5μm, or larger when appears with barite. It is often associated with barite +/–pyrite +/–galena +/–sphalerite and gold. The relationship with barite seems to be close, because almost in all cases have mutual intergrowth. Typical occurrence is around Bátaapáti (Sample No.10); Spectrum: Fig. 2D.

Cassiterite

Anhedral isometric grains, of 5–10 µm size. Occurring along the border of mica and K-feldspar. Typical occurrence is Bátaapáti (Sample No.8); Spectrum: Fig. 2E.

Ti-oxide (probably rutile)

Anhedral-euhedral rhomb-shaped or elongated dipyramidal intersections usually at the grain boundaries of K-feldspar and quartz in pegmatites. Average dimension is 5-20 µm. In recrystallized or brecciated quartzite exhibits strongly corroded character, usually with "leucoxene" halo. In a few cases it also contained Nb. Typical occurrence is Bátaapáti (Sample No.22); Spectrum: Fig. 2F.

Th-Ti-oxide phase

It occurs in the limonite-bearing blebs in the small cavities of quartz, probably as a rejuvenation product forming randomly distributed xenomorphic 8–10 µm aggregates in limonite mass.

Thorite / Uraninite

They form anhedral isometric grains of 40-50µm size along the grain boundaries of mica and pegmatite quartz. Often accompanied by titanite/leucoxene-like pseudomporphs. Typical occurrence is Lovászhetény (Sample No.4), Photo: Fig. 3D. (with zircon, etc. assemblage).

Garnet (spessartine-grossular type)

Euhedral-anhedral rounded grains in the cracks, or along the cleavage surfaces in pegmatite K-feldspar crystals. The diameter is appx. 50-100 µm. Often zoned, the external part has significant Ca enrichment (see later). Typical occurrence is in the quarries at Erdősmecske in pegmatites or aplites. (Sample No.18, 22); Spectrum: Fig. 4A.

Allanite /Epidote

Anhedral-euhedral rhomb-shaped or elongated sections usually at the grain boundaries of quartz, or along the cleavage of feldspars. Average grain size is 50-150 µm. Associated with titanite, apatite and monazite. Often exhibits a Ca-rich overgrowth. Typical occurrence at Erdősmecske (Sample No.19), Spectrum: Fig. 4A and B, Photo: Fig. 3E.

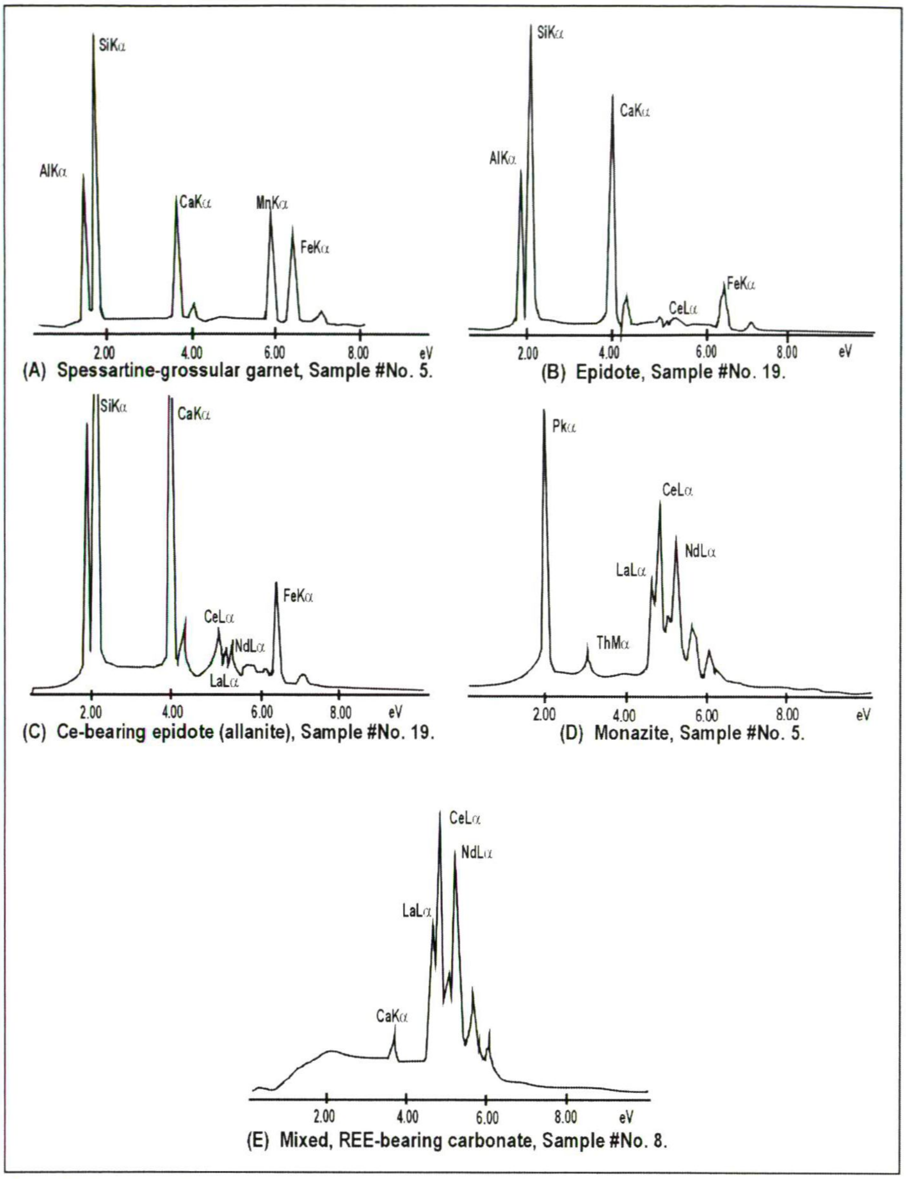

Fig. 4. Spectra of various components (part two).

Titanite

Anhedral-euhedral rhomb-shaped sections usually at along the cleavage of feldspars. Typical grain size is 50–200 µm. It is associated with allanite, apatite, and monazite.

Zircon

It usually exhibits rhomb-shaped or elongated grains. Common accessory constituent. In pegmatite, it usually occurs along the mica nests or as inclusions in feldspar. Its typical grain size is 5-25 µm and usually shows zoned character, Th-rich blebs in random distribution. Sometimes overgrowth by apatite was developed. Its typical occurrence is at Lovászhetény (Sample No.18); Photo: Fig. 3F.

Barite

It forms anhedral-euhedral rhomb-shaped or elongated sections usually at the grain borders of recrystallized quartz, or close to accessory apatite crystals in pegmatite minerals. It is also a typical satellite constituent in pyrite- +/–galena- +/–sphalerite- +/–stibnite etc. assemblage in recrystallized quartz or sometimes in calcite veinlets. Average dimension is 2–5 µm. In a few cases it contained Sr .

Scheelite

Anhedral isometric grains, of 15–20μm size, occurring along the border of mica and K-feldspar grains. It is known from one occurrence, Véménd.

Apatite

Anhedral-euhedral hexagonal-shaped or elongated needle-like sections usually at the mutual grain boundaries of K-feldspar and quartz in pegmatites, or inside the feldspar grains. Apatite is typical constituent in calcite veinlets, occurring along the fine cracks of the calcite. The characteristic dimension is usually 2–5 μm, in calcite veinlets 10–15μm. It is a widespread constituent. Photo: Fig. 3F.

Monazite

It is found in anhedral-euhedral isometric or tabular crystals of size of 120–150 μm or 10–20 μm occurring along the boundary of the host rock and the pegmatite quartz. The crystals often contain Th-rich parts in form of irregular distribution. Its typical occurrence is Lovászhetény (Sample No.5); Spectrum: Fig. 4D.

Y-phosphate phase

Along the zircon grains it exhibits euhedral-anhedral 10–15 μm grains. These minerals contain randomly distributed Th and U-rich patch. Typical occurrence is Erdősmecske.

Ce-La-Ca phosphate

It forms isometric mass or blebs around the monazite grains. Average dimension is 5 μm.

Bastnäsite

It occurs as anhedral grains of 10–50μm size along the cracks at the boundaries of mica-K-feldspar groups. In many cases it forms intergrowth with other La-Ce carbonate species, which cannot be determined precisely by microprobe. These grains often contain galena inclusions. In other places the bastnäsite and synchisite occurs along the rims of albite blebs, or at the border of dolomite/quartz veinlets. In these cases it often accompanies with apatite-Ti-oxide groups. Its typical occurrence is at Lovászhetény (Sample No.8).

Ce-La-Nd carbonate phase

Anhedral-euhedral crystals or isometric blebs in the fissures of corroded pegmatite K-feldspar. Common size is 50–60 μm. Galena is frequent in form of inclusions. Its typical occurrence is at Bátaapáti (Sample No.8); Spectrum: Fig. 4E.

Ca-Fe-Mn-Mg carbonate group

Usually lot of samples contains traces of at least one of these components in anhedral form. According to microprobe analysis, the typical timing of crystallizaton is: dolomite → Fe-Mn dolomite → calcite. It is widespread constituent.

FLUID INCLUSION STUDIES

Fluid inclusion petrography

Before starting the heating-cooling runs, the selection and classification of fluid inclusions were made at approx. 50–600x magnification range, at room temperature. The genetic classification was made by the criteria of Roedder (1984, Ch. 2.). During this study only quartz had been used.

The texture of investigated massive pegmatite quartz is irregular, equigranular type. In some cases a slight orientation can be traced. The euhedral/anhedral vein-quartz shows typical zoning character.

The distribution type of the inclusions is as follows:
Intergranular – penetrating into the grains, as "roots",
Patches – often close to the silicate minerals (like mica or amphibole),
Intragranular – "horsetail"-like pattern,
Intragranular – "crossing"-like pattern,
Intragranular – zoning pattern.

According to petrographic investigations, the following types of inclusions have been detected at room temperature:

Monophase, low density vapor inclusions (V). Small, usually less than 5 μm objects, appearing in irregular cloudy distribution. The form of inclusions are rounded, or less elongated. The genetic type of these inclusions is usually secondary. These objects are filled by low density water-vapor.

Monophase, high density liquid inclusions (L). Small, usually 10–30 μm objects, appear as irregular flat healing fractures in random distribution. The genetic type of these objects is secondary.

Two-phase inclusions (L+V). These inclusions form 5–15 μm objects, in flat, slightly elongated or isometric appearance. They contained an about 2–5 vol% gas bubble at room temperature. The genetic type of these objects is usually secondary or pseudosecondary. It is not a frequent type.

Two-phase inclusions with trapped solid particles (L+V+S). Similar to the group C., with accidentally trapped tabular/elongated birefringent crystals, which were corroded during heating runs. This sample is intergrown with calcite veinlet, thus probably the constituent is carbonate.

Solid crystals (S). Small, usually 5–10 μm objects, checked by polarization microscope. These are elongated apatite, rutile needles, slightly elongated epidote grains, rhombohedral shape of carbonates inside the host mineral (quartz) or at the boundary with other, mainly silicate species.

MICROTHERMOMETRY

For the microthermometric study, the useful fluid inclusion content was usually low for detailed, "long-run" investigations. The measurements had been made mainly on pseudosecondary-secondary fluid inclusions.

The data set was divided into two groups:
a/ massive pegmatite quartz,
b/ Q-Cal veins.

The results of heating experiments, the Th distribution (Fig. 5A) shows three maxima – 140–150 °C, 200–210 °C and 260–270 °C. This distribution suggests a wide range of fluid temperature history both in the pegmatite and Q-Cal veins. During the cooling run the freezing of the liquid phase was detected around –55 – –65 °C with a slight colouring (became brownish) of the solidified part. Upon slow increase of temperature to ambiental level, the first melting temperature (Te) was detected in a few cases between –50 – –55 °C, in both type of materials. The literature data, for this case suggest the presence of a Na-Ca-Cl type fluid (Borisenko, 1977). During further re-heating the last ice crystal/melt equilibrated temperature (T_{mice}) was registered mainly in between approx. –0.1 – –8.5 °C. In a few cases we detected the presence of a randomly distributed concentrated brine solutions by the deep T_{mice} data (–17 – –18 °C) in both pegmatite and Q-Cal veins. The calculated salinity (Potter et al., 1978) range is 0–20 NaCl eq. wt%, shown on Fig. 5B.

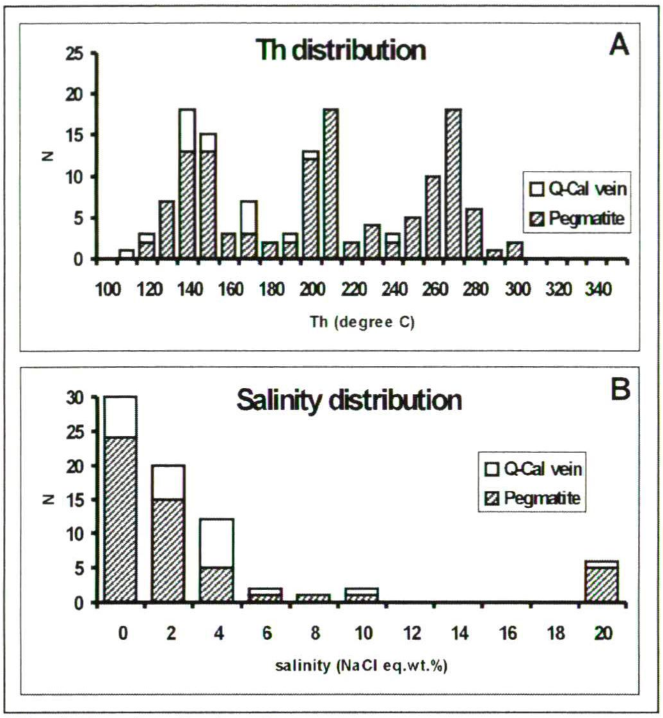

Fig. 5. Results of microthermometry.

Table 2. Comparison chart of accessoric minerals from Mórágy Granitoid, S-Hungary*.

Minerals	Occurrence of species		
	Pantó 1975	Buda & Nagy 1995	Current study
Gold (Native)			x
Arsenopyrite			x
Chalkopyrite	x		x
Fahlore			x
Galena	x	x	x
Molybdenite		x	x
Sphalerite	x		x
Stibnite			x
Pyrite	x	x	x
Cassiterite			x
Ilmenite	x		
Magnetite	x		
Rutile	x	x	x
Thorite	x	x	x
Thorianite	x		
Th-Ti Oxide			x
U-Thorite	x		
Uranite		x	
Allanite	x	x	x
Garnet			x
Titanite	x	x	x
Zircon	x	x	x
Apatite	x	x	x
Ce-La-Ca Phosphate			x
Cheralite	x		
Monazite	x	x	x
Y Phosphate			x
Bastnäsite	x		x
Zirkelite	x		
Barite	x		x
Scheelite			x
Ce-La-Nd Carbonate			x
Röntgenite		x	
Parisite		x	

* without taking into account the parent rock and abundance

DISCUSSION AND CONCLUSIONS

According to the microprobe investigations, a rich spectrum of accessory minerals had been found. These constituents can be divided into the following groups:

"granitophile", early formed accessory minerals, like ilmenite, rutile, thorite/uraninite, garnet, ortite, titanite, zircon, apatite, monazite, Y-, Ce-La-Ca phosphates etc.

"granitophile" high temperature – hydrothermal – minerals, like molybdenite, arsenopyrite, scheelite, cassiterite which are sometimes associated other sulphides (pyrite, chalcopyrite, fahlore, sphalerite, galena).

"epithermal" type, low temperature hydrothermal assemblage – gold, stibnite, barite, carbonate phases included bastnasite, Ce-La-Nd carbonates and Ca-Fe-Mn-Mg carbonates. The gold–stibnite pair can be interpreted as a decomposition of the Sb-containing ligand during the transportation of gold (Seward, 1973). In granite environments the Au-Sb association is not rare, especially in close relations, e.g. Slovakia (Chovan et al., 1995 etc.).

The presence of these constituents, already had been checked by the earlier investigators (Pantó, 1975; Buda and Nagy, 1995), as a form of rock-forming accessory mineral and not as pegmatite constituent (Table 2.) . The new aspect of this study is the confirmation the presence of a low temperature "epithermal" like paragenesis native gold, arsenopyrite, fahlore, stibnite, cassiterite, garnet, scheelite, barite with carbonates. Our study has shown the presence of later REE-carbonates in pegmatite.

According to the microthermometric study, the fluid inclusion content is usually low for detailed interpretation, but allow to take a few remarks. Regarding the reliability of the samples can be divided into two groups – pegmatite and Q-Cal veins –, but the results are quite similar. The measurements in the granite pegmatite/quartz vein samples had taken place mainly on secondary inclusions, but in the Q-Cal vein samples the measurements had taken place on mainly pseudosecondary, or at rare cases primary inclusions. According to the previous statements, the Th distribution shows three maxima – 140–150 °C, 200–210 °C and 260–270 °C, suggests a wide range of registered similar fluid temperature history both in the pegmatite and the grown-up quartz materials also, as an overprinting. The uncertainty of the genetic type of inclusions cannot allow more speculations regarding to the continuity of fluid evolution from high PT conditions. Therefore the registered Th data-set should reflect some "late" history of fluids, without any time considerations – which should started in the end-stage of shearing, and finished during the youngest Alpine movements (Kovács et al., 2000).

During the investigations, the presence of inclusions with two immiscible fluids, or inclusions with NaCl/KCl daugther crystals have not been detected in these samples. The fluid character is mainly Na-Ca-Cl type.

The influence of Ca-bearing fluids can be indicated by the followings:

Garnet overgrowth by Ca-rich rim (in this study and Király and Török, 2003, in press);

Allanite overgrowth by epidote (Pantó, 1975; Buda and Nagy, 1995);

Decomposition / redistribution process of REE-bearing minerals like monazite, orthite, etc. to carbonate-bearing REE species like bastnasite, other REE bearing carbonate during a "hydrothermal" process (Buda and Nagy, 1995);

Formation of monomineralic, late carbonate-bearing veinlets.

The calculated salinity is low (6–0 NaCl eq.wt.%). The Th/c plot shows the entrapment of a wide range density (0.80–1.05 gcm^{-3}) of fluids (Fig. 6) with three slight trends upon cooling. Comparing to the similar data (Fig. 7) of the Velence Mts. (Molnár, 1996), this study exhibits a presence of significantly lower salinity fluids in Mecsek granitoids. Also, the adjacent Eocene epithermal systems (without taking into consideration of the high salinity Cu-porphyry related fluids) have higher Th interval with two peaks of salinity distribution. Our data set is in intermediate position between these two systems. These data suggest a possible overlap as a result of subsequent tectonic and fluid rejuvenation – fluctuation.

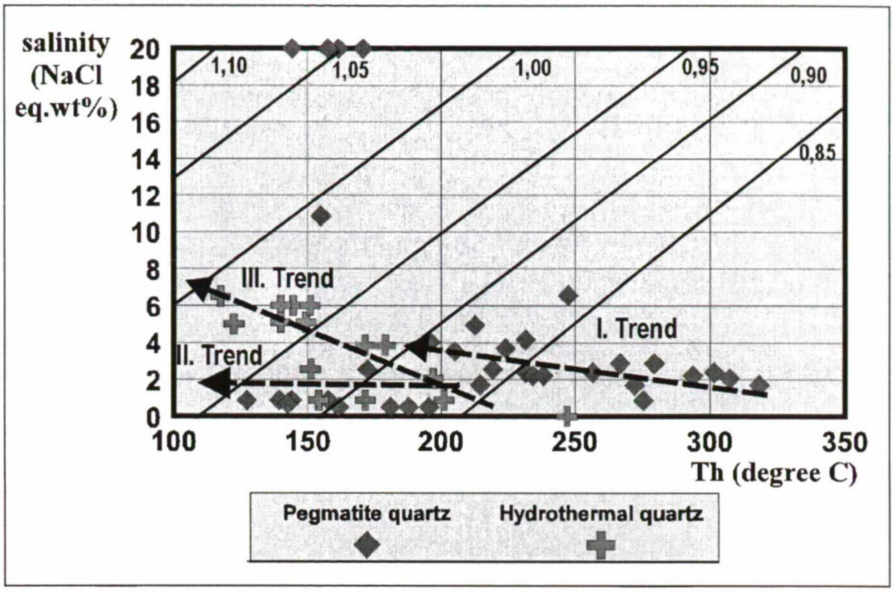

Fig. 6. Th plotted against salinity (estimated rough density included).

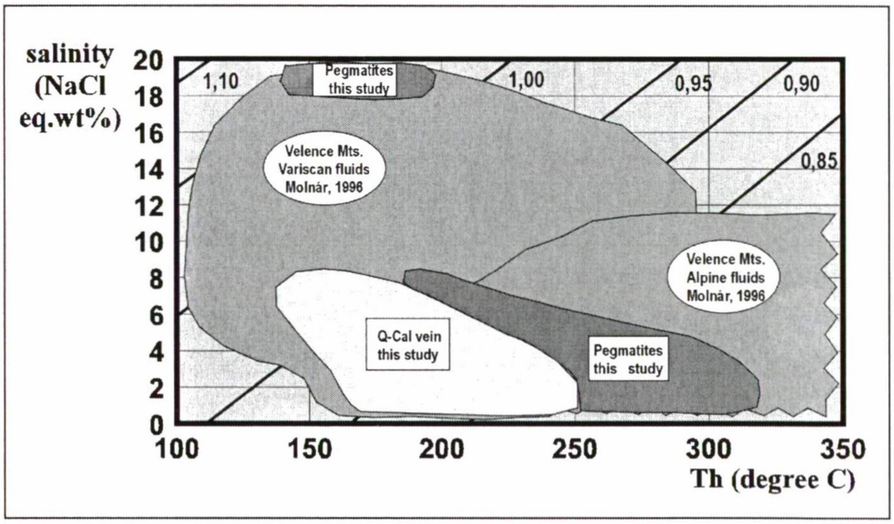

Fig. 7. Th/salinity plot comparison.

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