THE MAGMATIC SULFIDE INCLUSIONS IN SOME INTRUSIONS FROM THE METALIFERI MOUNTAINS, ROMANIA (PRELIMINARY DATA)

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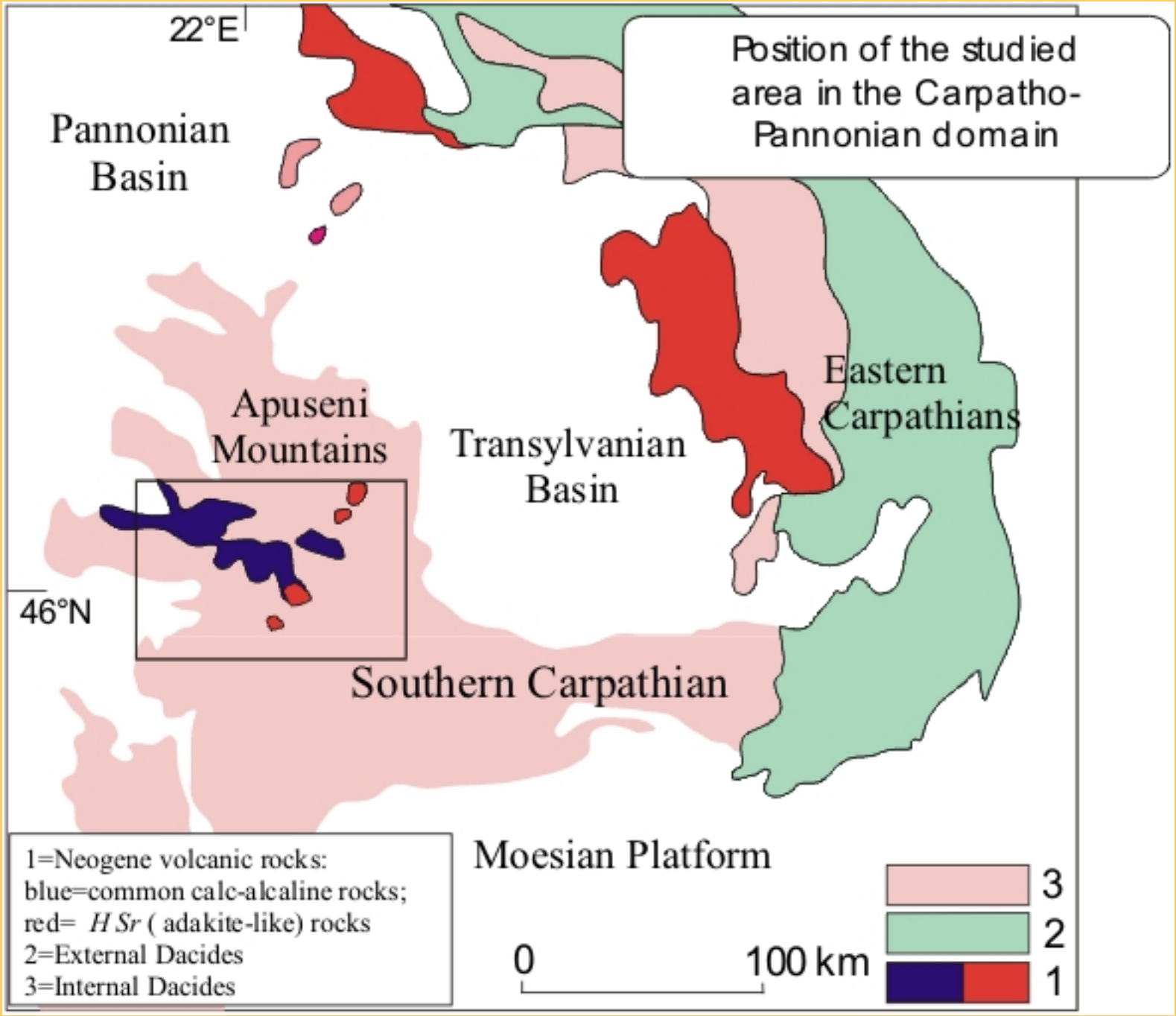
- Location of area

- Age and time space – evolution of magmatic and metallogenetic activity in the Apuseni Mountains

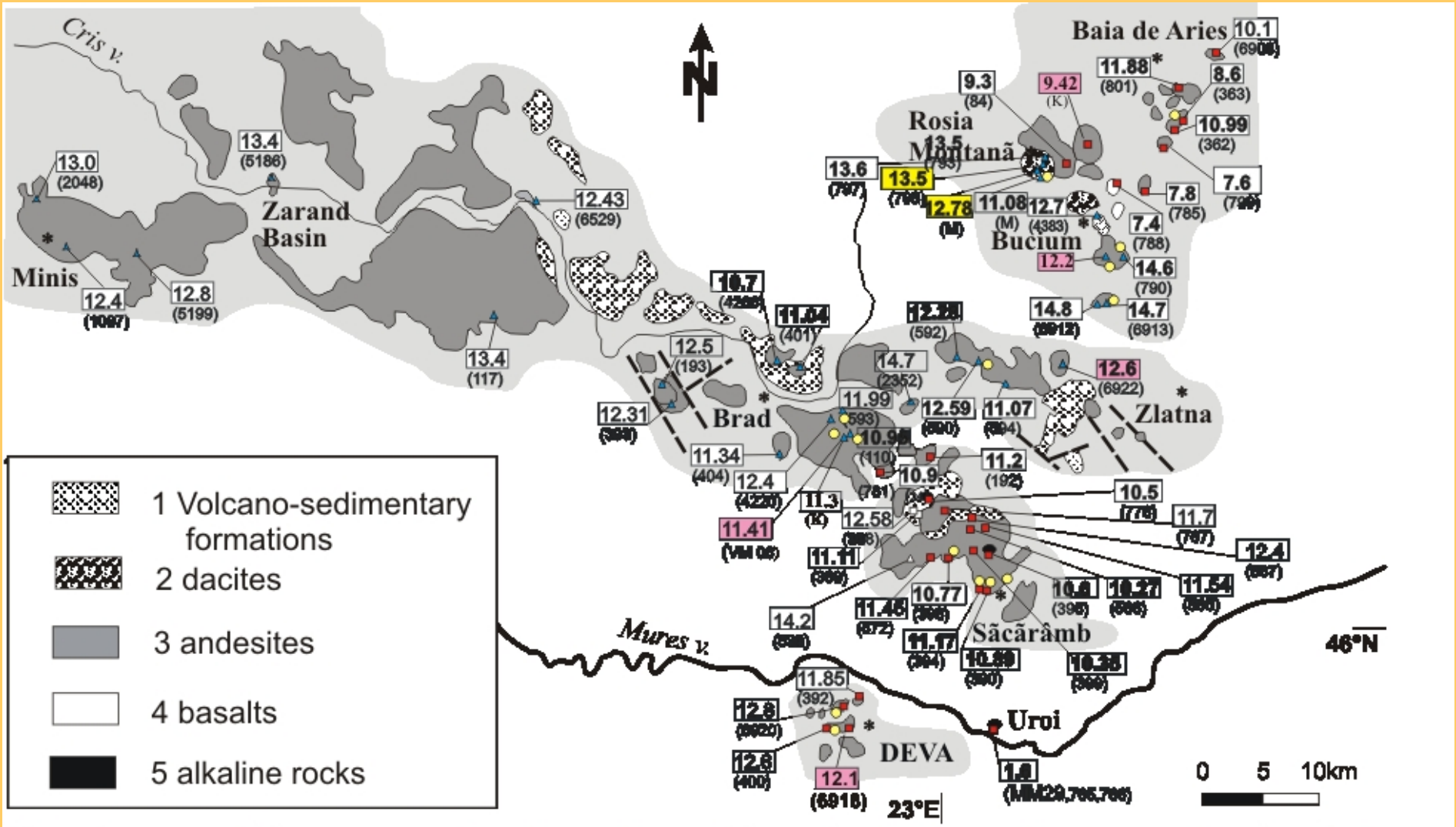
- Magmatic sulfide melt inclusions
  - Data acquisition parameters
  - Number of analysis/structures
  - The shapes of the magmatic sulfide melt inclusions
  - The textures of sulfide grains in magmatic sulfide inclusions
  - The contents of different elements in magmatic sulfide melt inclusions

- Conclusions

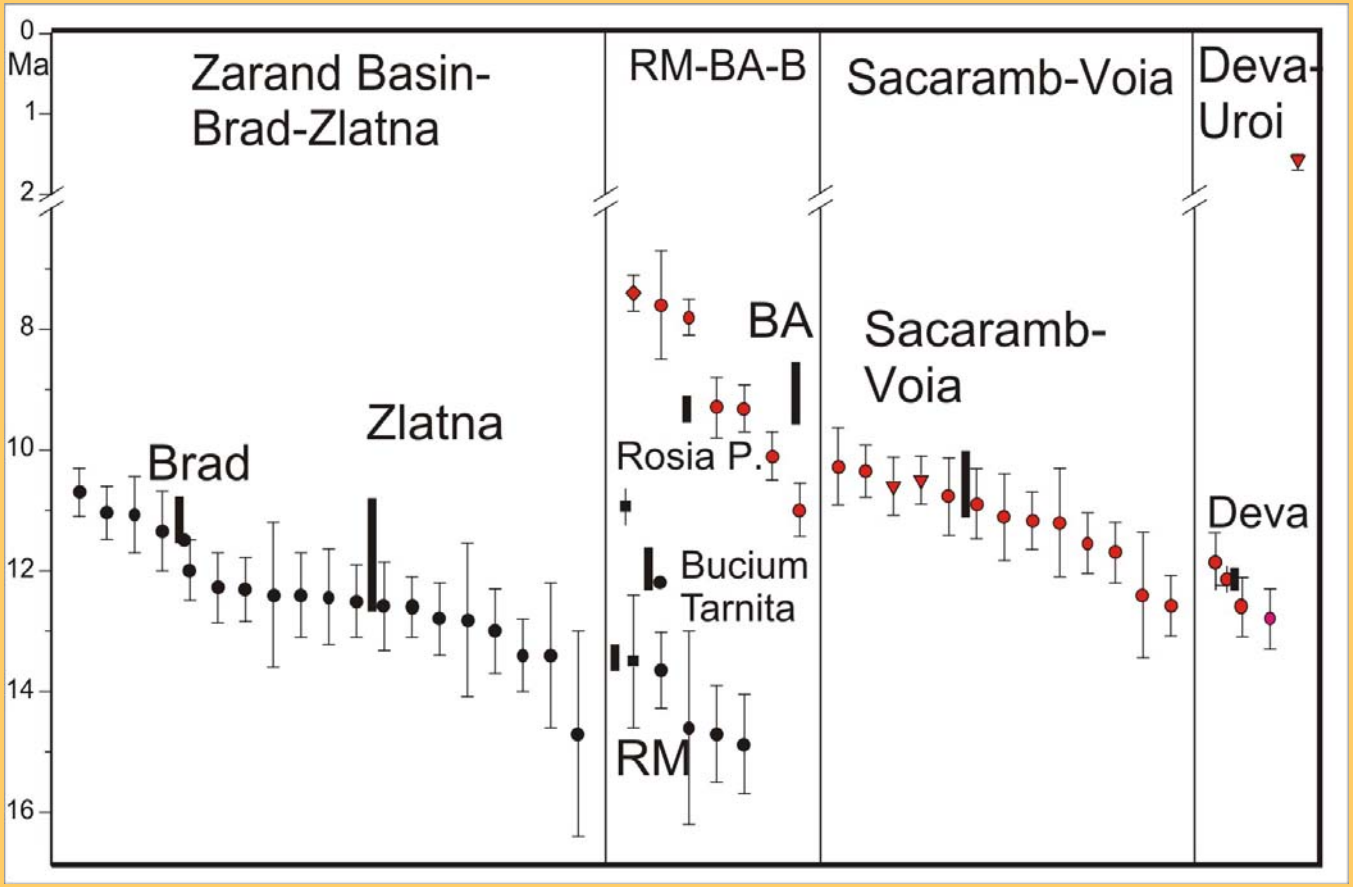

22°E
Position of the studied area in the Carpatho-Pannonian domain
Pannonian Basin
Apuseni Mountains
Transylvanian Basin
Eastern Carpathians
46°N
Southern Carpathian
Moesian Platform
1=Neogene volcanic rocks:
blue=common calc-alcaline rocks;
red= HSr (adakite-like) rocks
2=External Dacides
3=Internal Dacides
0
100 km
3
2
1

AGE AND TIME-SPACE EVOLUTION

- Neogene magmatic rocks in the Apuseni Mts. range in age from 14.8 to 7.4 Ma old. Our compozition range from basalt-andesite to dacites, prevailing andesites with varia mineralogical compozition; some alkaline species also occur.
- The first volcanic products are represented by dacite tuffs, poorly developed, hosted by Globigerine bearing marls (Badenian-Langhian)
- The main episode, represented by calc-alkaline medium to high- K quartz andesites with amphibole, pyroxene ± biotite to dacite, has beginning around 15 Ma with an explosive character giving a widespread volcano-sedimentary formation, inter-bedded whit Spirialis bearing marls.
- Two intrusive activities evens, forming magmatic complex structures with high-density necks and shallow intrusive bodies are distinguish by corroboration of K-Ar, paleomagnetic data and spatial distribution.
- First ones, represented by calc-alkaline medium- K quartz andesites with amphibole, pyroxene ± biotite, spatially developed in Zarand-Brad-Bolcana-Zlatna-Rosia Montana-Bucium area run between 14.7 – 11 Ma, showing a progressive clockwise rotation (60˚ at 14 Ma to 28˚ at 13 Ma).
- The second one, represented by calc-alkaline medium to high- K quartz andesites with amphiboles, biotite ± pyroxene, developed between 12.8 – 7.4 Ma, without paleo-magnetic rotation, display an enlarged area to Deva - Sacaramb and Baia de Aries – Rosia Montana. The main products here are “adakite-like” calc-alkaline rocks. Small bodies (10.5 Ma) with alkaline features (trachyandesites, microdiorites) in Sacaramb area and basaltic andesites (7.4 Ma) in Rosia Montana-Bucium area with distinct geochemical signature are the latest products in respective districts.
- The last episode display an alkaline character and occur only in Uroiu Hill (1.6 Ma), after a gap about 6 Ma, on different geostructural context.



Sketch map of Neogene volcanic rocks and locations of analised samples for their ages. All ages are in Ma (boxed) and sample number in brackets. Blue triangles = common calc-alkaline rocks; red square =H Sr andesites (adakite-like)calc-alkaline rocks and alkaline rocks; age of Rosia M mineralisation; age of porphyry cop. mineralisation; location of samples analised for Magmatic Sulfide Inclusions.



Time evolution of volcanic activity in the South Apuseni Mountains and presumed age of mineralization for specific areas (thick bars)(after Rosu et al. 2004, with modifications). Black symbols are normal calc-alkaline rocks, red symbols are H-Sr (adakite-like) calc-alkaline rocks; squares=dacites;circles=andesites; diamond=basalts andesites; triangle=alkaline rocks. Ages from Pécskay at al., 1995; Roşu et al., 1995-2004; Kouzmanov et al., 2005,2006; Manske et al., 2004.

Our data suggest three main time intervals for mineralization processes:

- the first, at the boundary Badenian/Sarmatian (13.5 -12.8 Ma) in Rosia Montana area,

- the second, largely developed at regional scale between 12.5-10 Ma (Middle Sarmatian-Upper Pannonian)

- the third, between 9.5-8.5 Ma at the Rosia Poieni and Baia de Aries (Pannonian)

Magmatic sulfide melt inclusions

- Data acquisition parameters - LA-ICPMS

- Number of analysis/structures

- The shapes of the magmatic sulfide melt inclusions

- The textures of sulfide grains in magmatic sulfide inclusions (petrographic observations)

- The contents of different elements in magmatic sulfide melt inclusions

Data acquisition parameters

Isotopes :

- Session I ^{27}Al, ^{57}Fe, ^{86}Cu, ^{62}Ni,^{95}Mo, ^{197}Au
- Session II ^{27}Al, ^{57}Fe, ^{49}Ti, ^{86}Cu, ^{62}Ni, ^{107}Ag, ^{125}Te, ^{197}Au

Dwell time per isotope (ms):

- I ^{27}Al/10ms, ^{57}Fe/10ms, ^{86}Cu/10ms, ^{62}Ni/20ms, ^{95}Mo/20ms, ^{197}Au/50ms

- II ^{27}Al/10ms, ^{197}Au/10ms, ^{57}Fe/10ms, ^{197}Au/10ms, ^{49}Ti/10ms, ^{197}Au/10ms, ^{86}Cu/10ms, ^{197}Au/10ms, ^{62}Ni/10ms, ^{197}Au/10ms, ^{107}Ag/10ms, ^{197}Au/10ms, ^{125}Te/10ms, ^{197}Au/10ms. (total ^{197}Au=70ms)

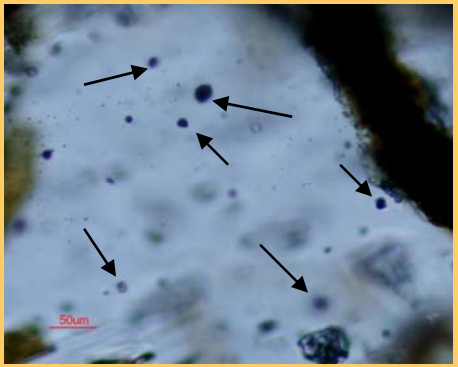
Number of analysis/structures:

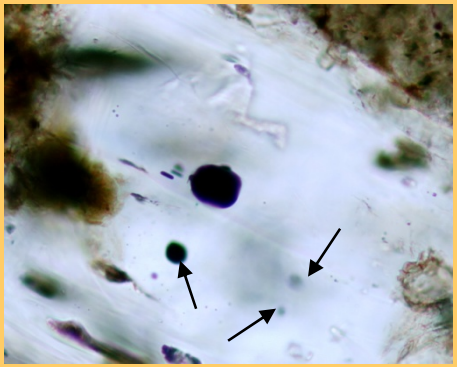
Bucium: pre-ore= 20
Bucium Tarnita: post ore= 6
(porphyry copper)
Rosia Montana: post ore=3
Zlatna:post-ore=13
Barza: V Arsului: pre-ore= 5
V Morii: syn?/post ore=5
(porphyry copper)
Ciresata: post ore=10

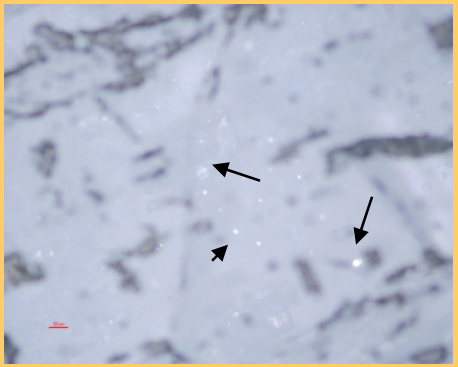
Deva : pre-ore=26
(porphyry copper)
Sacaramb: pre-ore=20
Baia de Aries: pre-ore=14

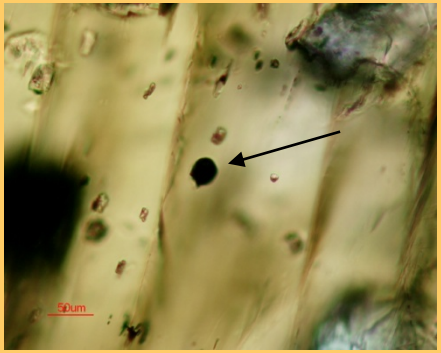
TOTAL = 134

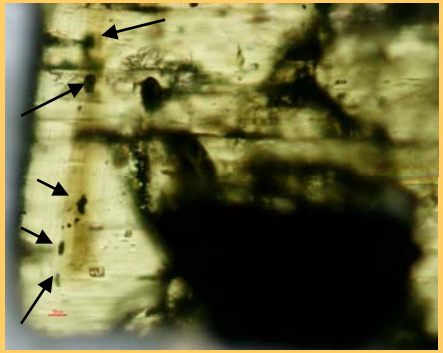
The shapes of the magmatic sulfide melt inclusions in plagioclase and amphiboles

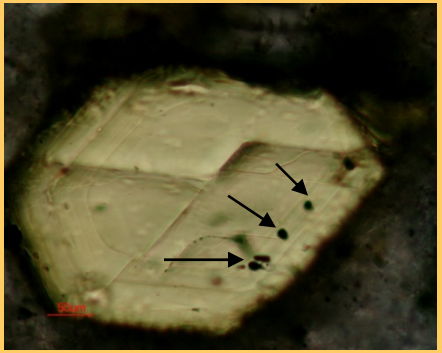


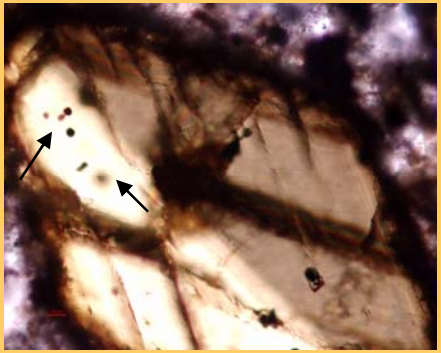


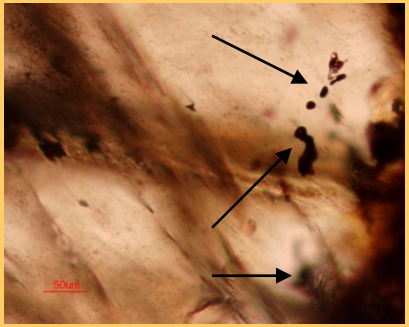


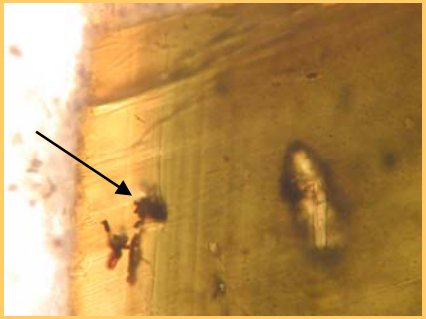


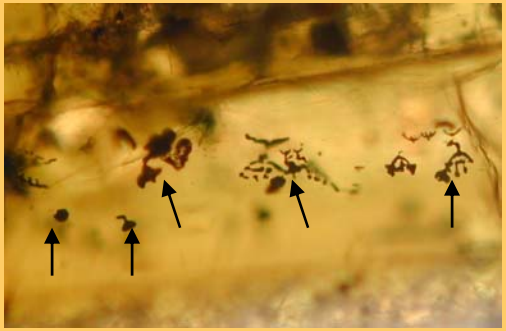


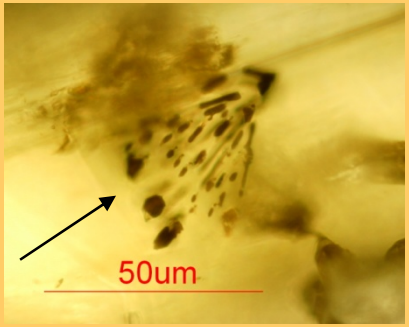












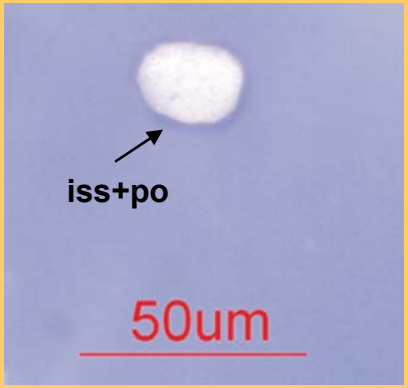
The textures of sulfide grains in magmatic sulfide inclusions

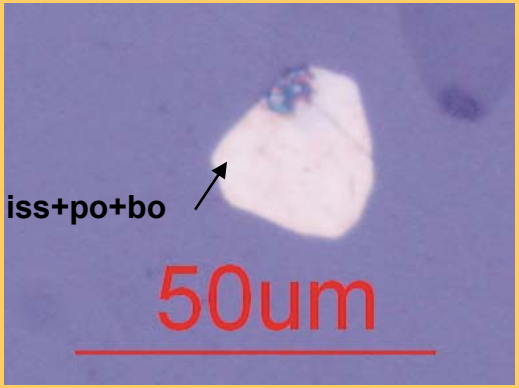
Petrographic observations on polished surface show that magmatic sulfide inclusions enclosed in phenocryst of plagioclase, amphibole and Fe-oxides occur as spherical, ovoid blebs, polygonal shapes, worms, etc . Usualy, there are two or more mineral phases in each magmatic sulfide inclusions.

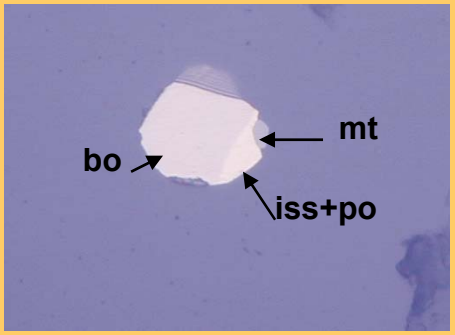
According to the variations in oxygen fugacity, sulfur fugacity, iron activity in the host magma, the immiscible liquids of monosufide solid solution crystallized by quenching as:

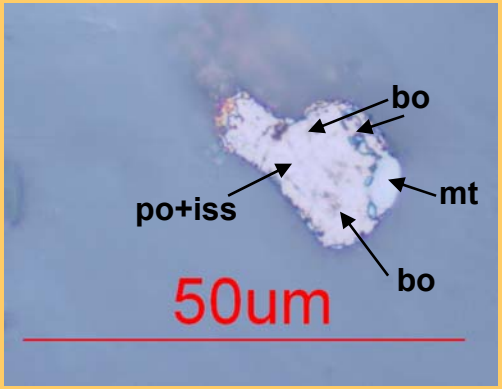
- pyrrhotite (po);
- pyrrhotite (po)+intermediate solid solution (iss) [po is not homogenous in composition];
- pyrrhotite (po)+chalcopyrite (cpy) + bornite (bo);
- chalcopyrite (cpy) + bornite (bo);
- sulfides+Fe-oxides.

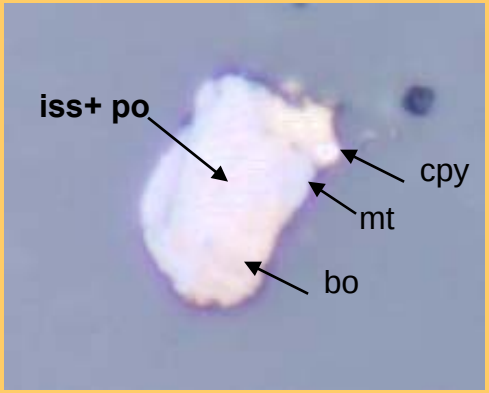
The textures of sulfide grains in magmatic sulfide inclusions (II)

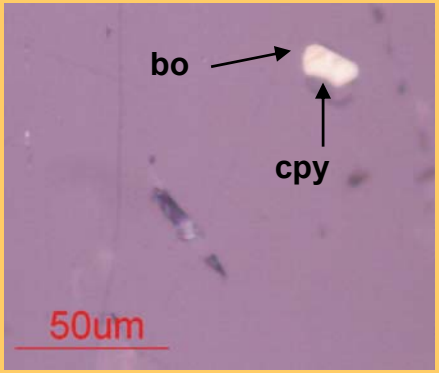


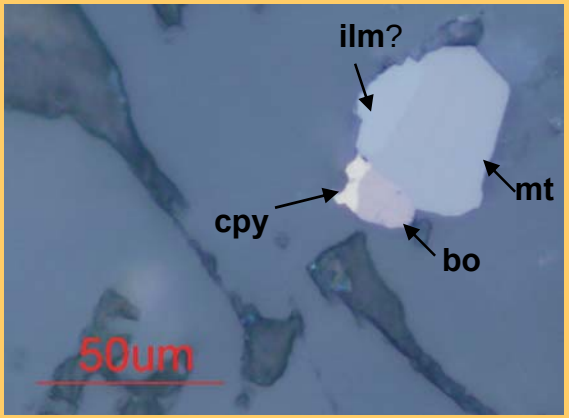


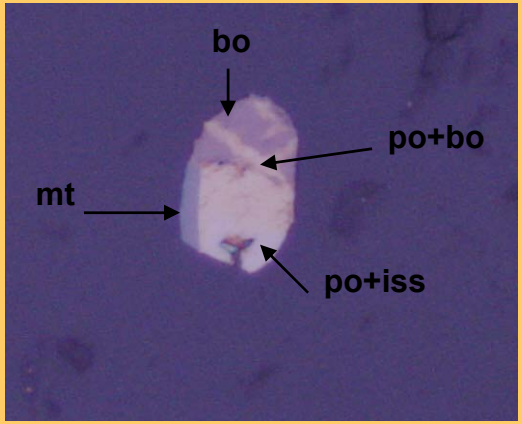


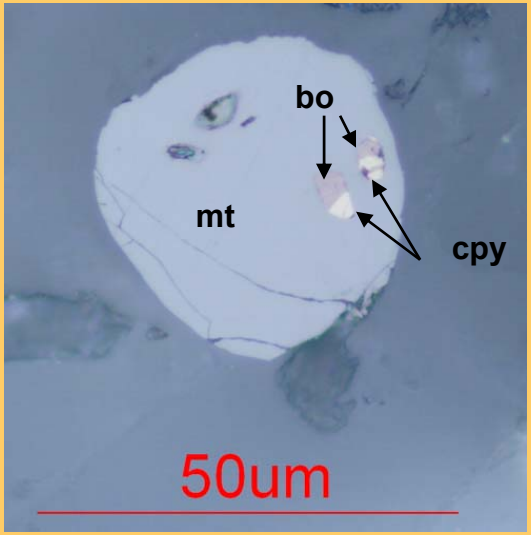


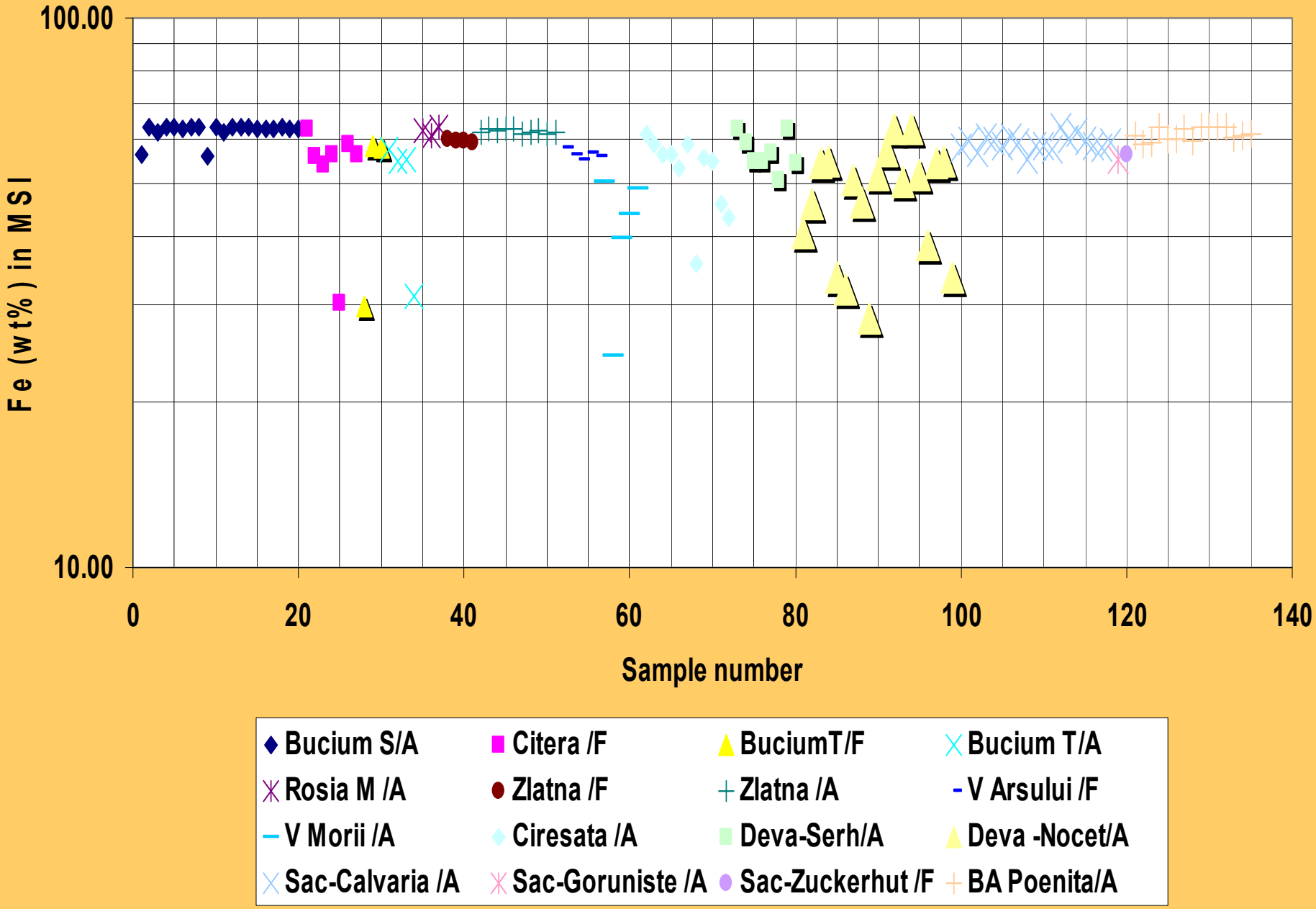


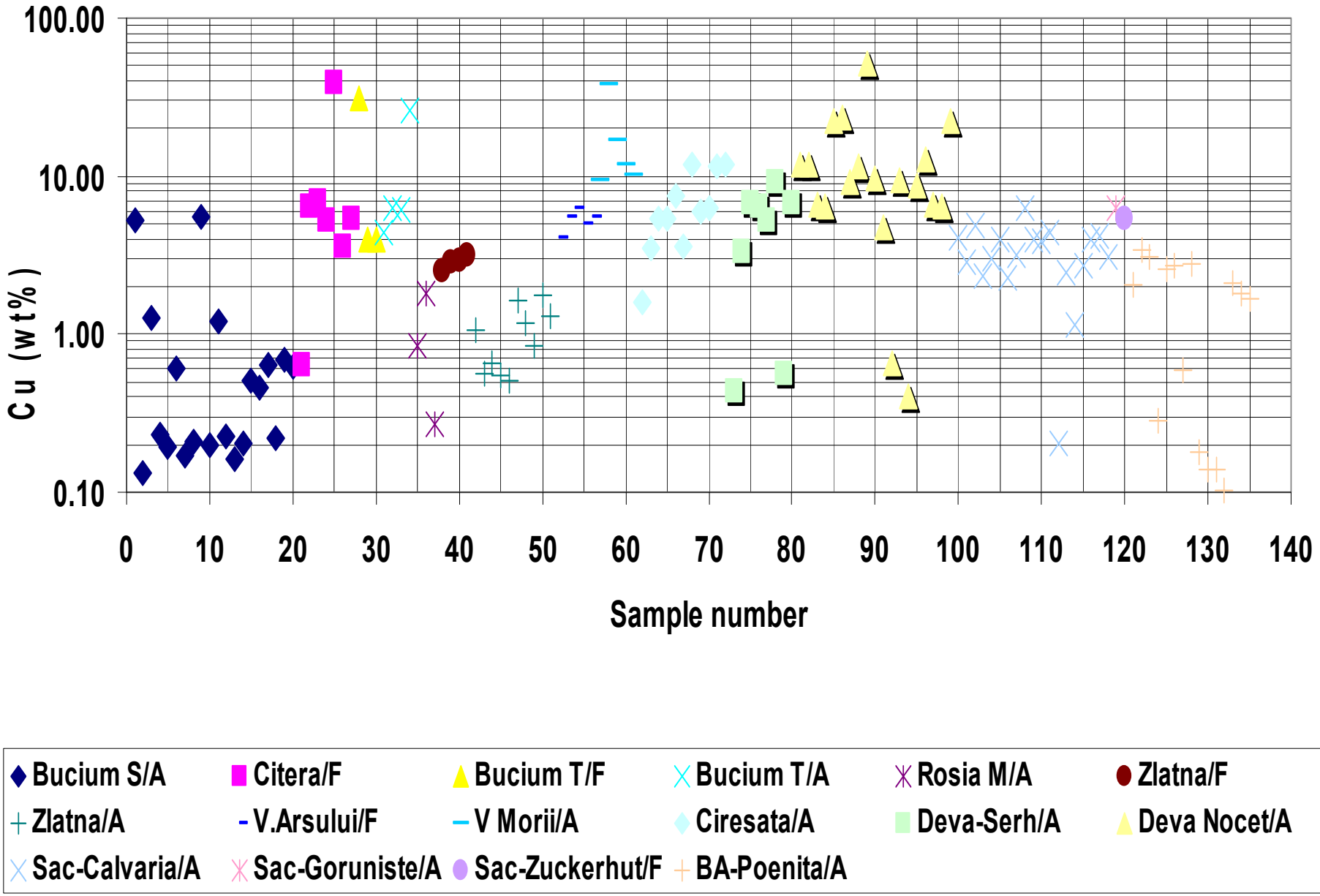


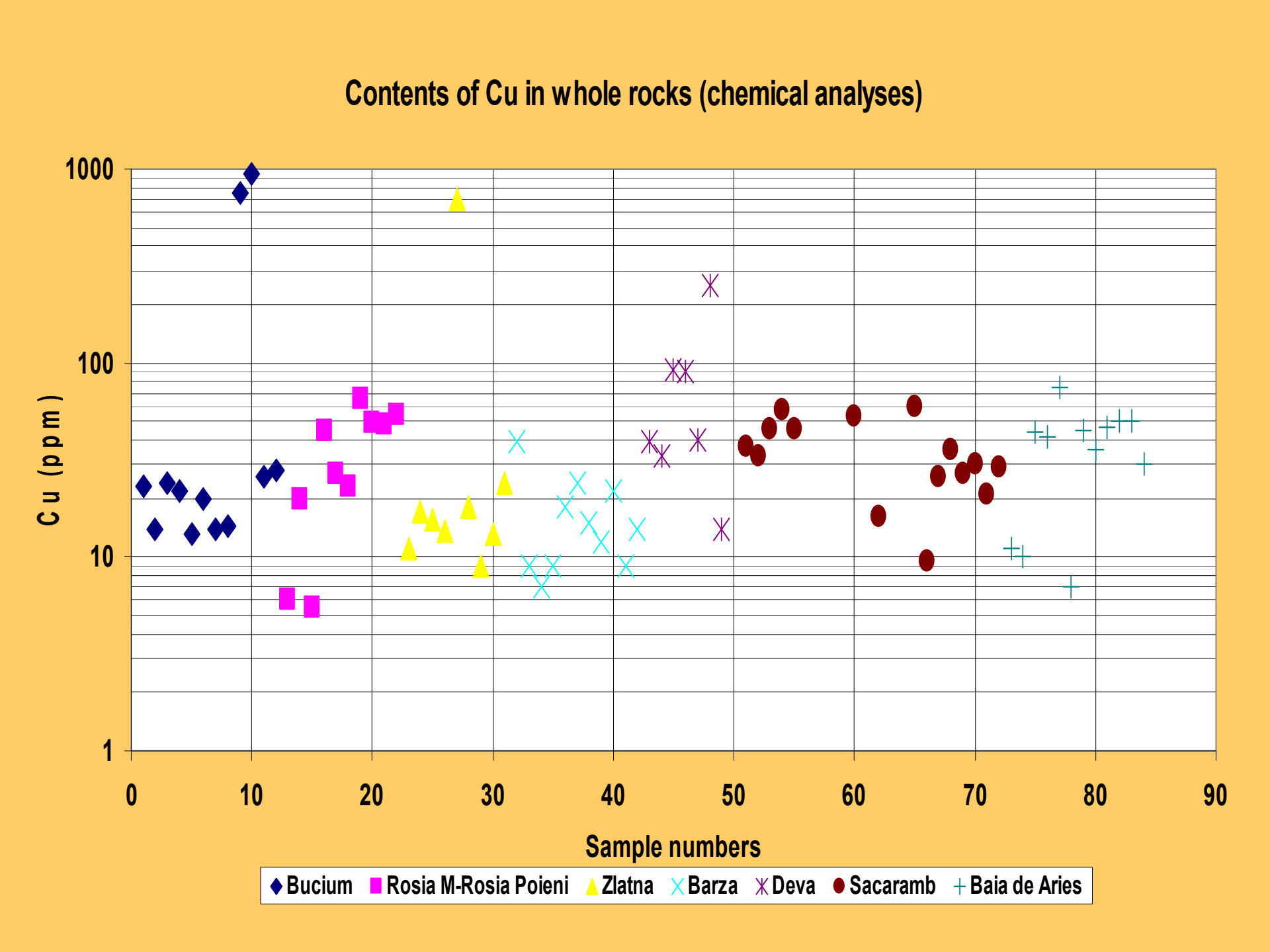


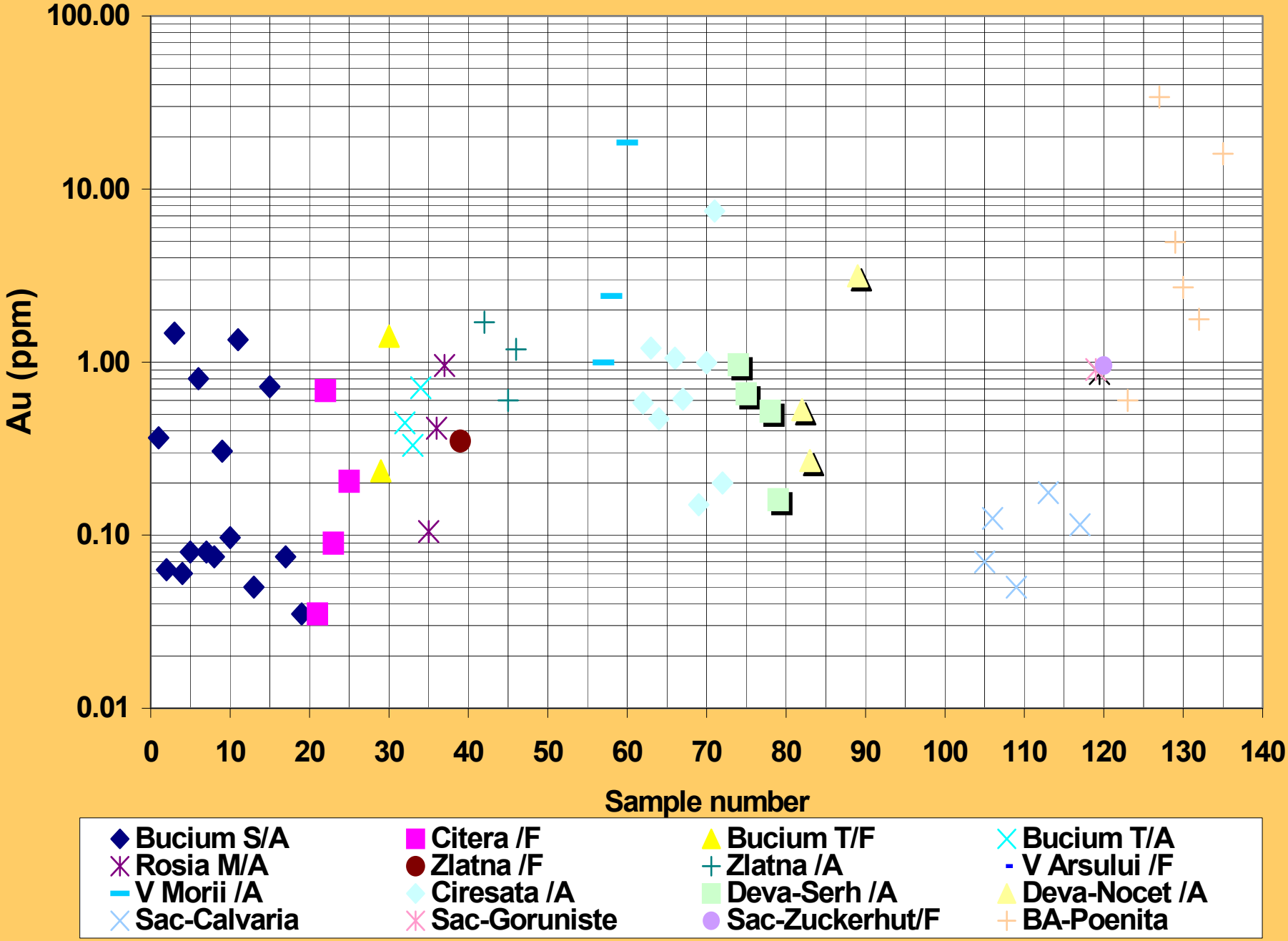




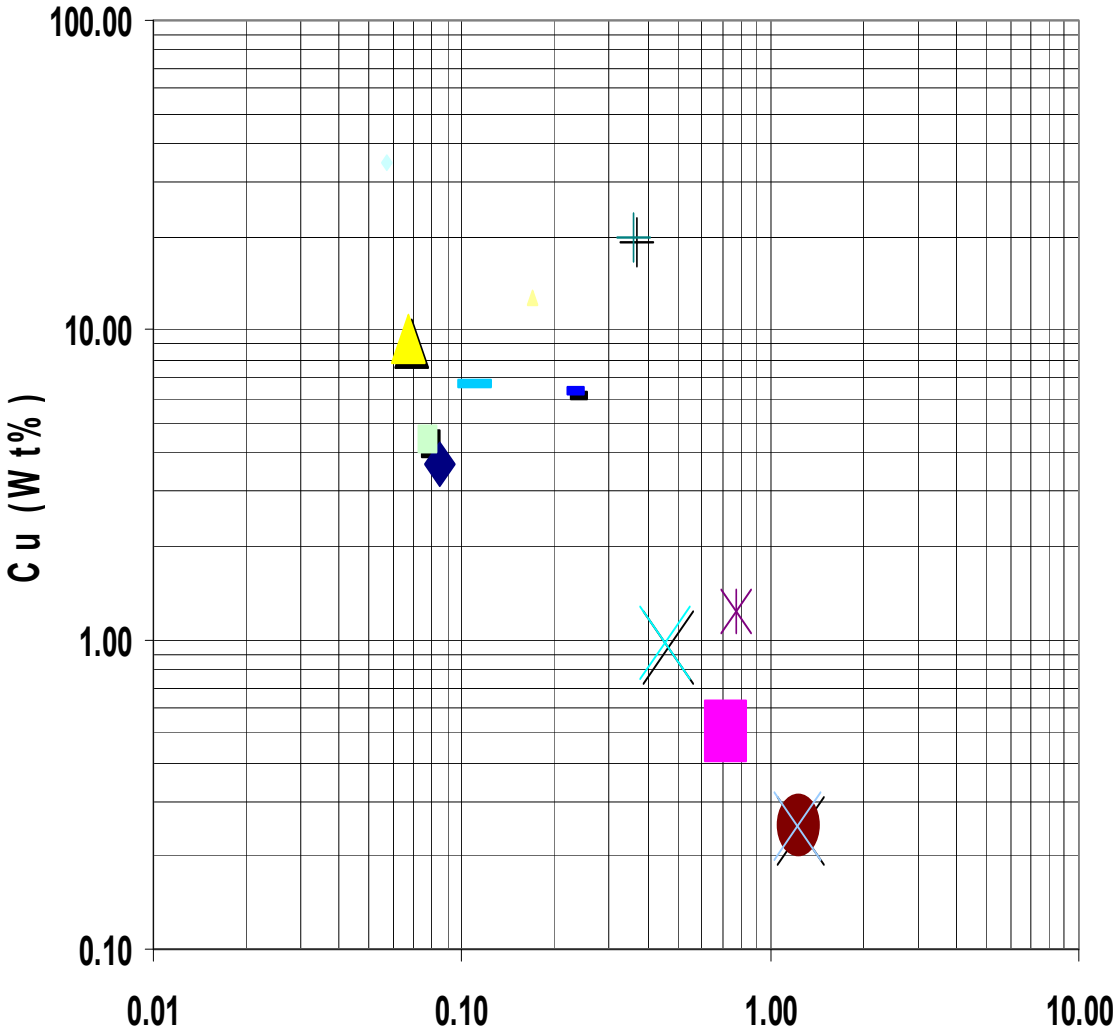

100.00
10.00
Fe (wt%) in MSI
0
20
40
60
80
100
120
140
Sample number
Bucium S/A
Citera /F
BuciumT/F
Bucium T/A
Rosia M /A
Zlatna /F
Zlatna /A
V Arsului /F
V Morii /A
Ciresata /A
Deva-Serh/A
Deva -Nocet/A
Sac-Calvaria /A
Sac-Goruniste /A
Sac-Zuckerhut /F
BA Poenita/A


100.00
10.00
1.00
0.10
Cu (wt%)
0
10
20
30
40
50
60
70
80
90
100
110
120
130
140
Sample number
Bucium S/A
Citera/F
Bucium T/F
Bucium T/A
Rosia M/A
Zlatna/F
Zlatna/A
V.Arsului/F
V Morii/A
Ciresata/A
Deva-Serh/A
Deva Nocet/A
Sac-Calvaria/A
Sac-Goruniste/A
Sac-Zuckerhut/F
BA-Poenita/A

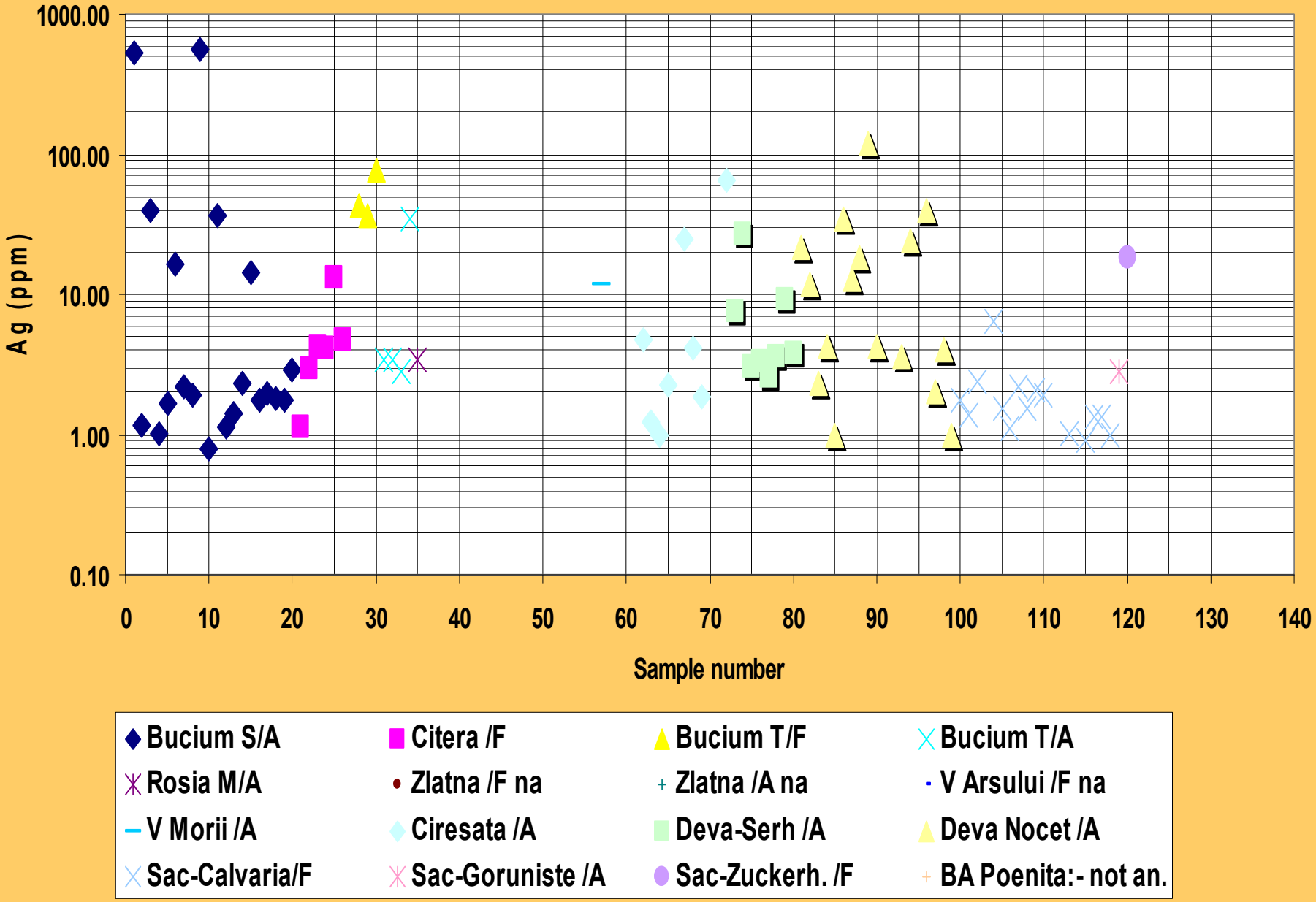

Contents of Cu in whole rocks (chemical analyses)
1000
100
10
1
Cu (ppm)
0
10
20
30
40
50
60
70
80
90
Sample numbers
Bucium
Rosia M-Rosia Poieni
Zlatna
Barza
Deva
Sacaramb
Baia de Aries

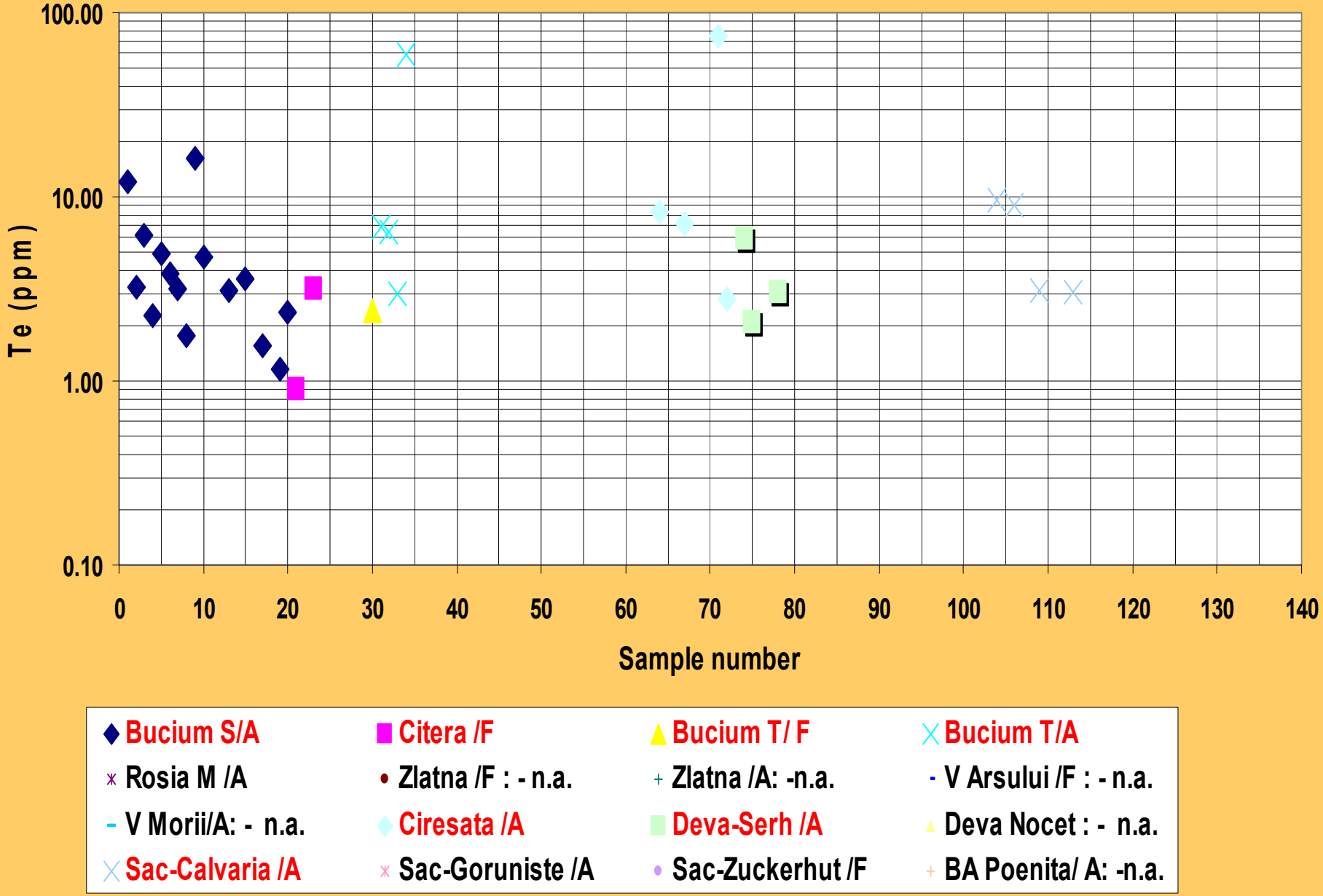

100.00
10.00
1.00
0.10
0.01
Au (ppm)
0
10
20
30
40
50
60
70
80
90
100
110
120
130
140
Sample number
Bucium S/A
Citera /F
Bucium T/F
Bucium T/A
Rosia M/A
Zlatna /F
Zlatna /A
V Arsului /F
V Morii /A
Ciresata /A
Deva-Serh /A
Deva-Nocet /A
Sac-Calvaria
Sac-Goruniste
Sac-Zuckerhut/F
BA-Poenita

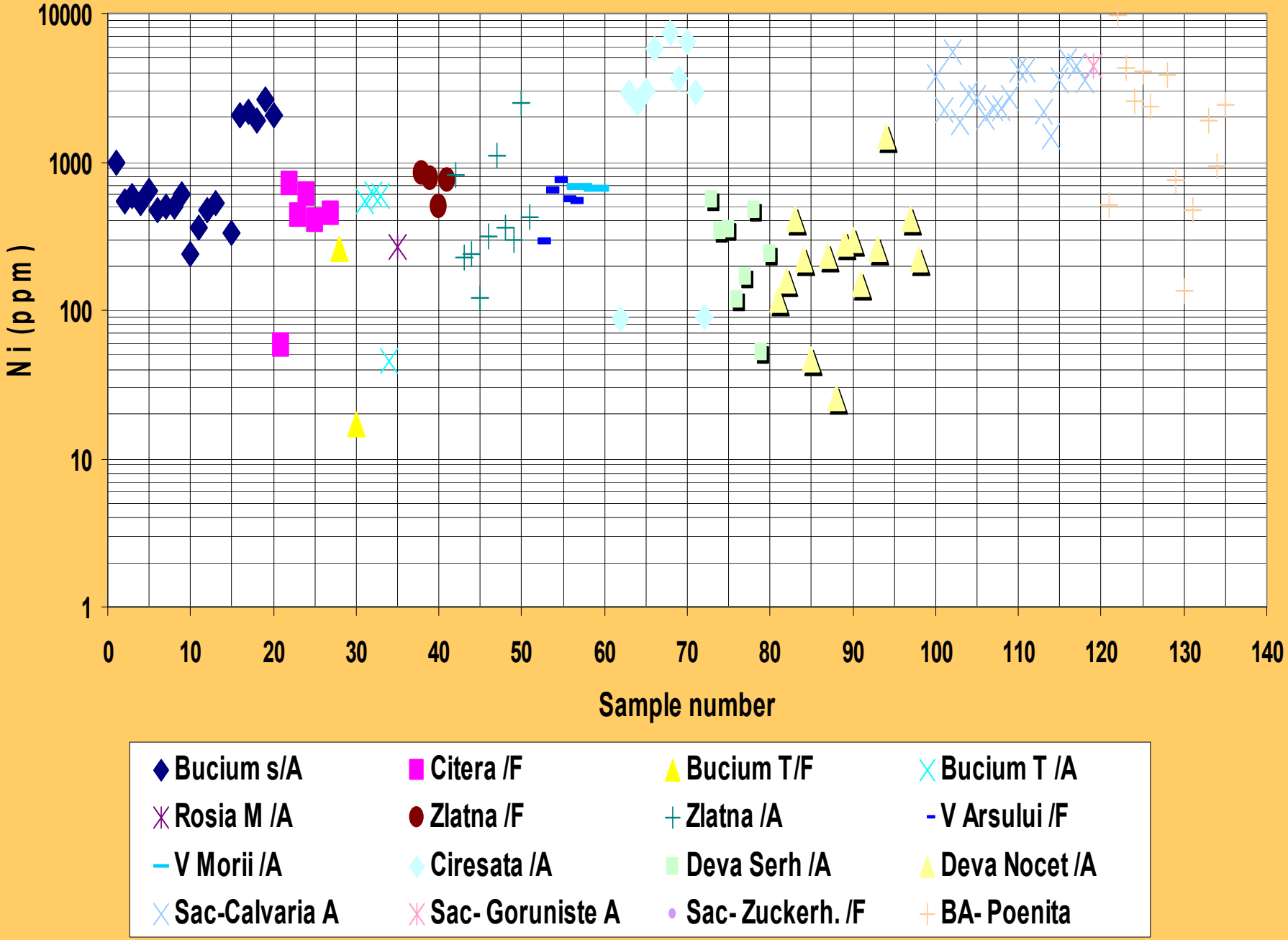
Cu-Au/Cu*10-4 ratio for magmatic sulfide inclusions (average values for pre-ore and post –ore intrusions) and porphyry copper deposits



- Bucium pre-ore (average)
- Bucium T ore
- Bucium T post-ore (average)
- Rosia Poieni-ore
- Zlatna post ore (average)
- V Morii - ore
- V morii-post ore (average)
- V Morii Ciresata-post ore (average)
- Deva-Serh pre-ore (average)
- Deva Nocet pre-ore (average)
- Sacaramb pre-ore (average)
- BA Poenita pre-ore (average)
- B. Allumbrera


1000.00
100.00
10.00
1.00
0.10
Ag (ppm)
0
10
20
30
40
50
60
70
80
90
100
110
120
130
140
Sample number
Bucium S/A
Citera /F
Bucium T/F
Bucium T/A
Rosia M/A
Zlatna /F na
Zlatna /A na
V Arsului /F na
V Morii /A
Ciresata /A
Deva-Serh /A
Deva Nocet /A
Sac-Calvaria/F
Sac-Goruniste /A
Sac-Zuckerh. /F
BA Poenita:- not an.


100.00
10.00
1.00
0.10
Te (ppm)
0
10
20
30
40
50
60
70
80
90
100
110
120
130
140
Sample number
Bucium S/A
Citera /F
Bucium T/ F
Bucium T/A
Rosia M /A
Zlatna /F : - n.a.
Zlatna /A: -n.a.
V Arsului /F : - n.a.
V Morii/A: - n.a.
Ciresata /A
Deva-Serh /A
Deva Nocet : - n.a.
Sac-Calvaria /A
Sac-Goruniste /A
Sac-Zuckerhut /F
BA Poenita/ A: -n.a.


10000
1000
100
10
1
Ni (ppm)
0
10
20
30
40
50
60
70
80
90
100
110
120
130
140
Sample number
Bucium s/A
Citera /F
Bucium T/F
Bucium T /A
Rosia M /A
Zlatna /F
Zlatna /A
V Arsului /F
V Morii /A
Ciresata /A
Deva Serh /A
Deva Nocet /A
Sac-Calvaria A
Sac- Goruniste A
Sac- Zuckerh. /F
BA- Poenita

CONCLUSIONS

- Our preliminary results regarding the contents of MSI in Fe, Cu, Au, Ag and Te shows variations at regional scale and in complex magmatic structures
- The contents in Fe (wt%) are typical for FeS (about 63 wt%); these values decrease when the Cu is present from moderate to low values in the magmatic structures including porphyry copper systems
- The Cu contents are usually up to 10wt%, with frequent values between 10wt.%-20wt.% and some times up to 40wt.% in the magmatic structures including porphyry copper systems, too
- In whole rocks from the same zone and magmatic strucures the contents of Cu range between 7 and 100 ppm
- The contents of Au range between 0.03 and 15 ppm; prevailing the values between 0.1 and 1 ppm
- The contents of Ag range between 1 and 100 ppm and for Te between 1 and 20 ppm
- The values of $Au/Cu*10^{-4}$ ratio for MSI from pre- and post-ore intrusions are different comparative with values of $Au/Cu*10^{-4}$ ratio porphyry copper ore deposits (one exception regarding post - ore MSI in Zlatna area)
- In present I prepare a new set of samples for MSI (double polished thin sections) at regional scale and especially from post ore intrusions