ETH
Eidgenössische Technische Hochschule Zürich
Swiss Federal Institute of Technology Zurich

Correlation of the Upper Cretaceous magmatism and the related Cu-Au mineralization in Bulgaria and Serbia: the status quo

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1) Review of the magmatic Cretaceous evolution based on

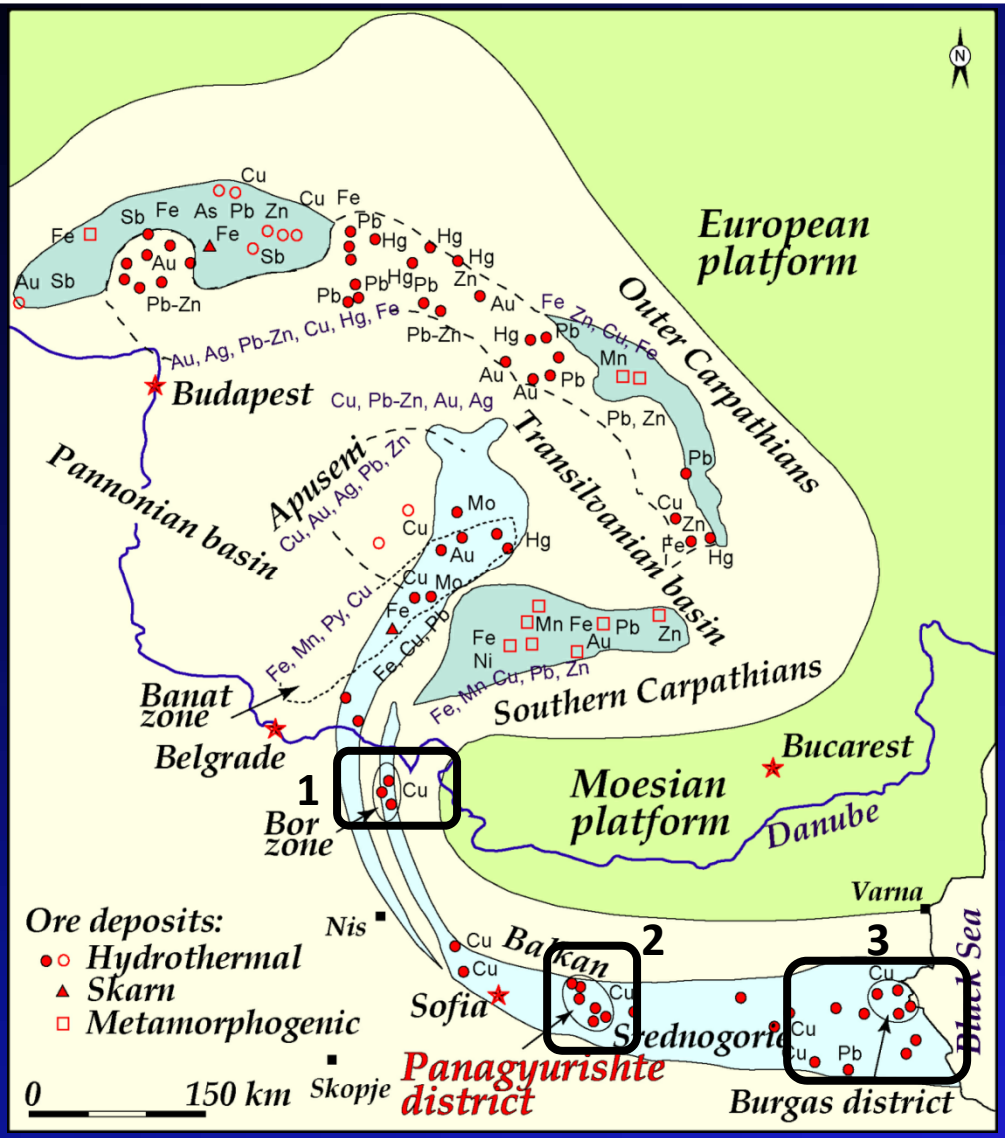
- Field work, mapping
- geochemical, isotope and U/Pb zircon data
- {GEODE program, SNF projects, SCOPES}

2) Aim of these projects:

- life time of the Cretaceous belt in different areas
- Eastern Serbia –Central Srednogorie {BG} – Eastern Srednogorie {BG}/ Svetos Georgiev
- important contributions to our understanding of time-scales and rates of magmatic processes
- link to the Cu-Au (PGE) prophyry, epithermal deposits ?

3) Open questions:

- discussion at the end

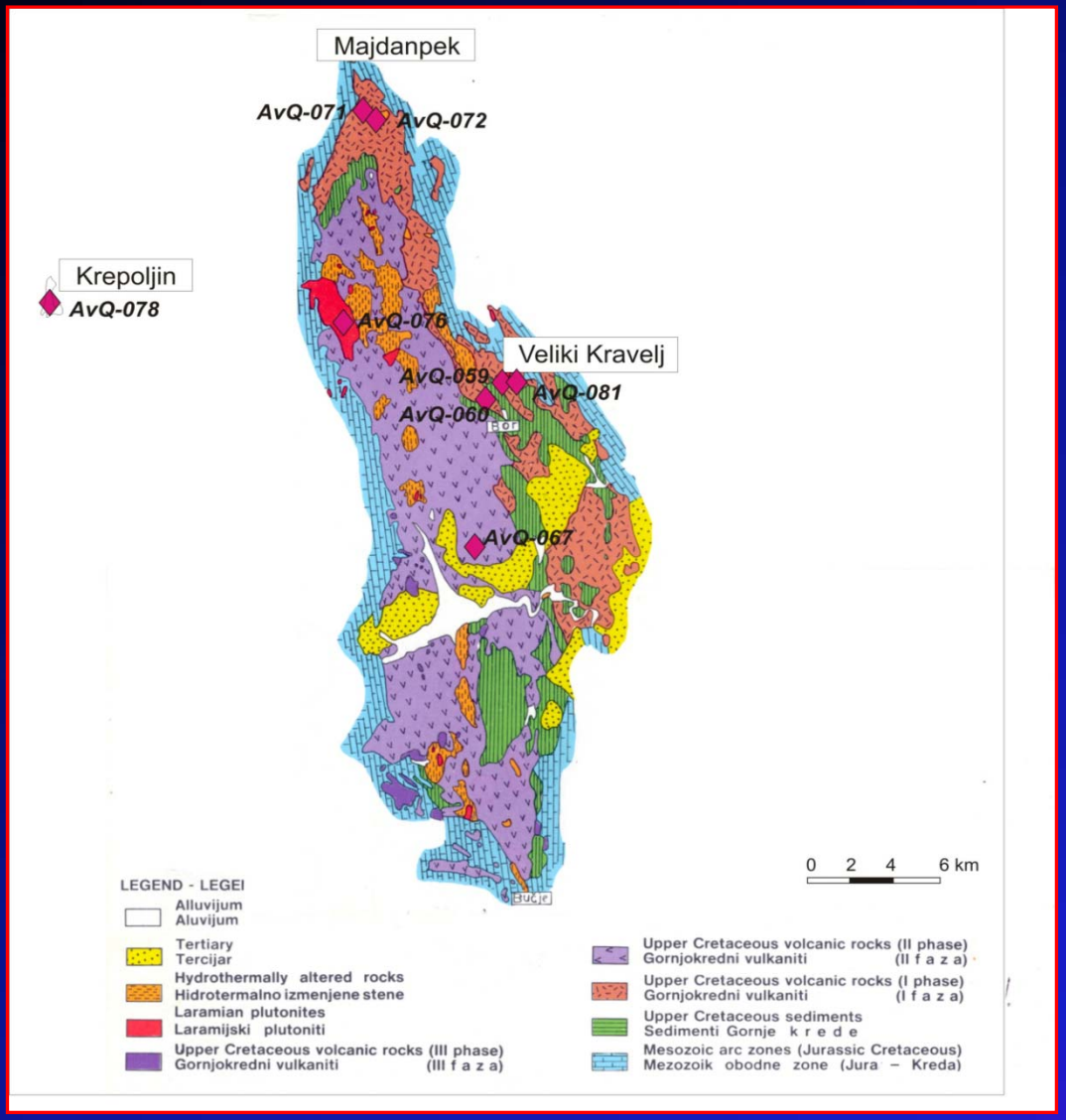


Apuseni Banatite Timok Srednogorie belt {ABTS} in SE Europe including different types of ore deposits

Target areas

1: Timok, Serbia
2: Panagyurishte, Bulgaria
3: Eastern Sredn., Bulgaria

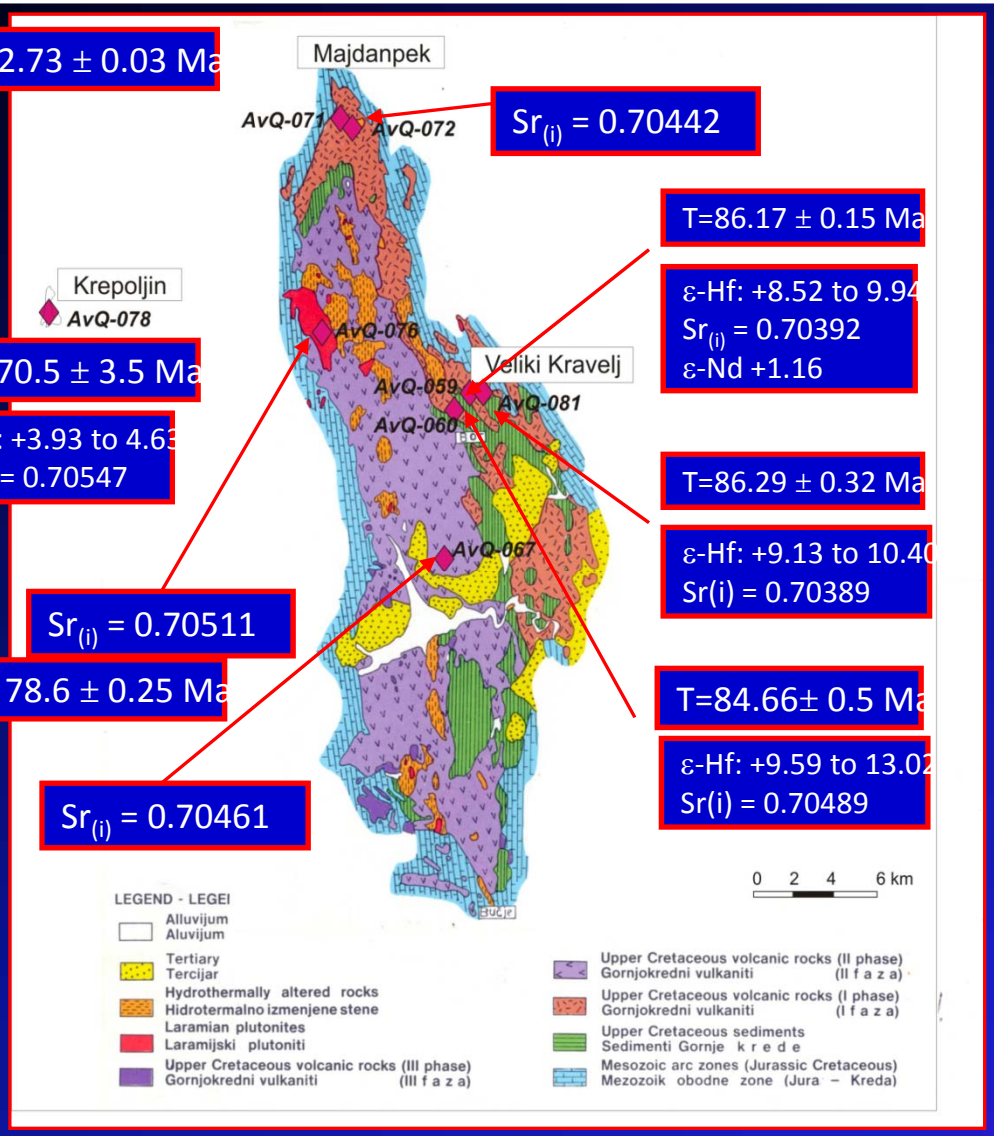
Sketch map modified by *Kouzmanov, 2002*



Detailed geological map of the Timok unit in Eastern Serbia including sample localities

Samples are selected from:

Phase 1: AvQ081, 059
Phase 2: AvQ072,071,067
Phase 3: AvQ076

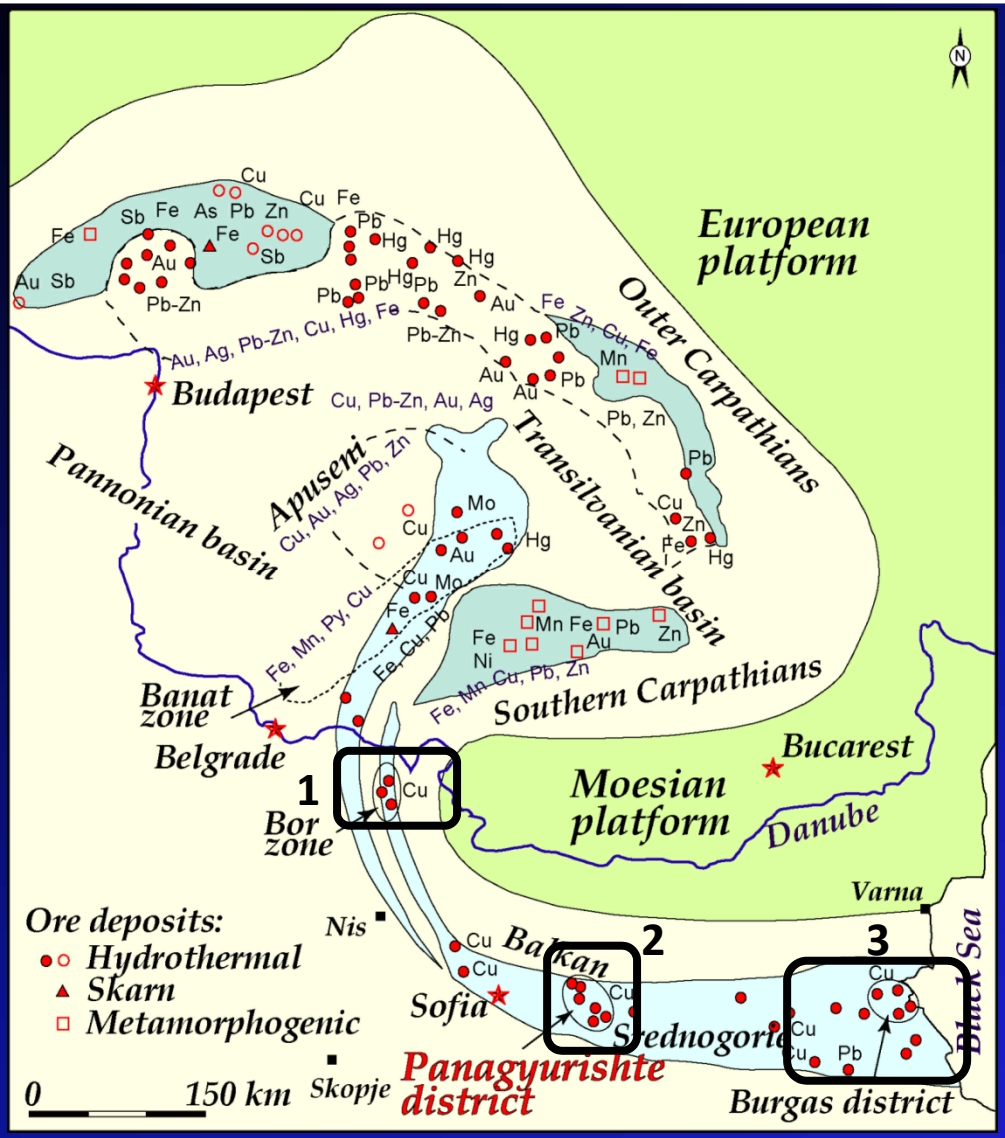


1.Phase:
Maximum *life span* of the *of volcanic activity* in TMC - 2.5 Ma for Veliki Kravelj
Amph-andesites (86.29 ± 0.32 Ma)
Timozites (84.66 ± 0.50 Ma)

2. Phase:
no volcanic age available,
Inherited Pb in all zircons
But crosscutting dyke:82.05 ± 0.25Ma

3. Phase:
intrusion ages between 82.73 and 78.6 Ma

ore bearing magmatism in one single deposit (Veliki Krevelj) extended **max 0.6 Ma**
pre-ore Amph-andesites:
86.29 ± 0.32 Ma,
"post-ore" diorite porphyry:
86.17 ± 0.15 Ma



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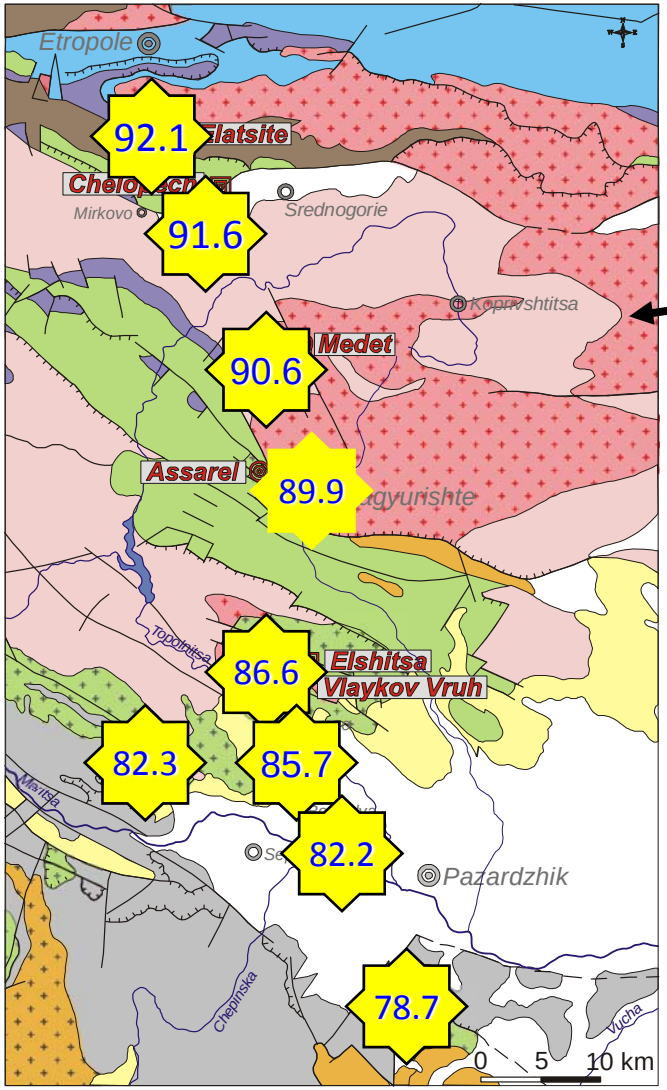
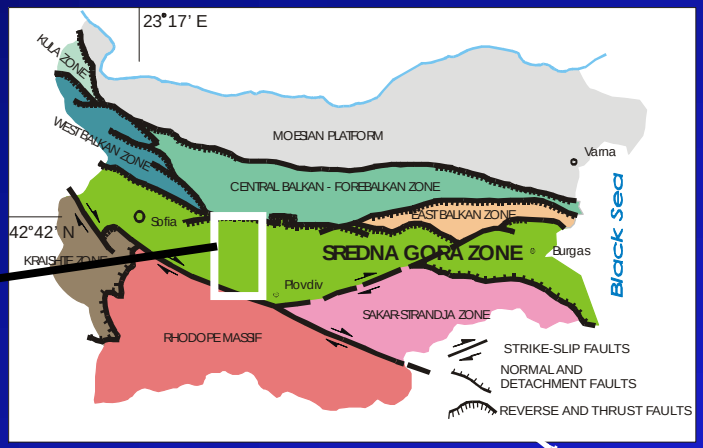
Geological setting



Legend

- Quaternary
- Neogene sediments
- Paleogene sediments and volcanites
- Paleogene granites
- Upper Cretaceous sediments and volcanites
- Upper Cretaceous granitoids
- Jurassic sediments
- Triassic sediments
- Paleozoic granitoids
- Lower Paleozoic metamorphites
- Rhodopean type metamorphites
- Srednogorie type metamorphites
- faults
- trusts
- porphyry type deposit
- epithermal type deposit

Geological map after Cheshitev et al., 1989

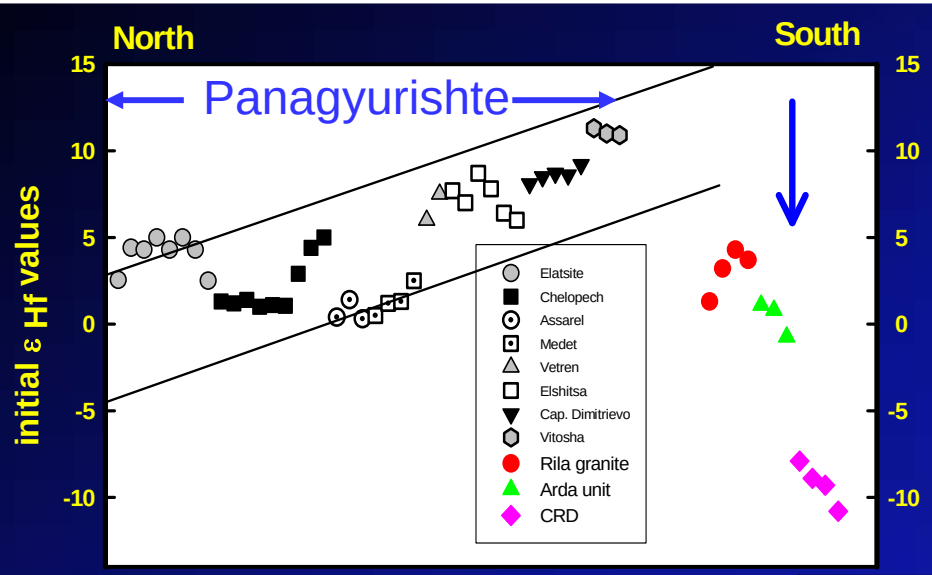


Main tectonic zones after Ivanov with the position of Srednogorie zone

General youngling of magmatism from 92.3 Ma in the north (Elatsite) to 78 Ma in the south (Capitan Dimitrievo) (Von Quadt et al., 2005) – total **14 Ma**

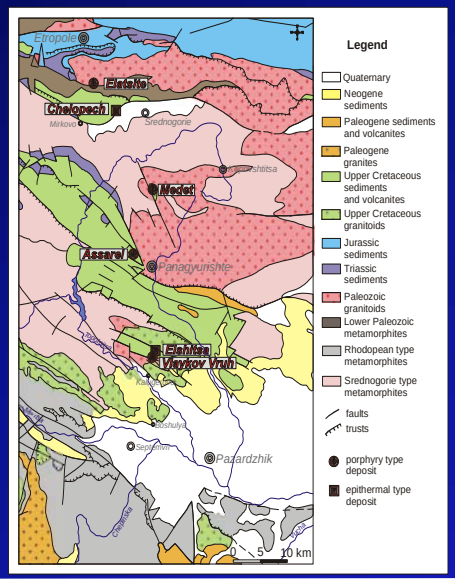
Life span of the ore formation:
6 Ma {92.3 – 86.6}

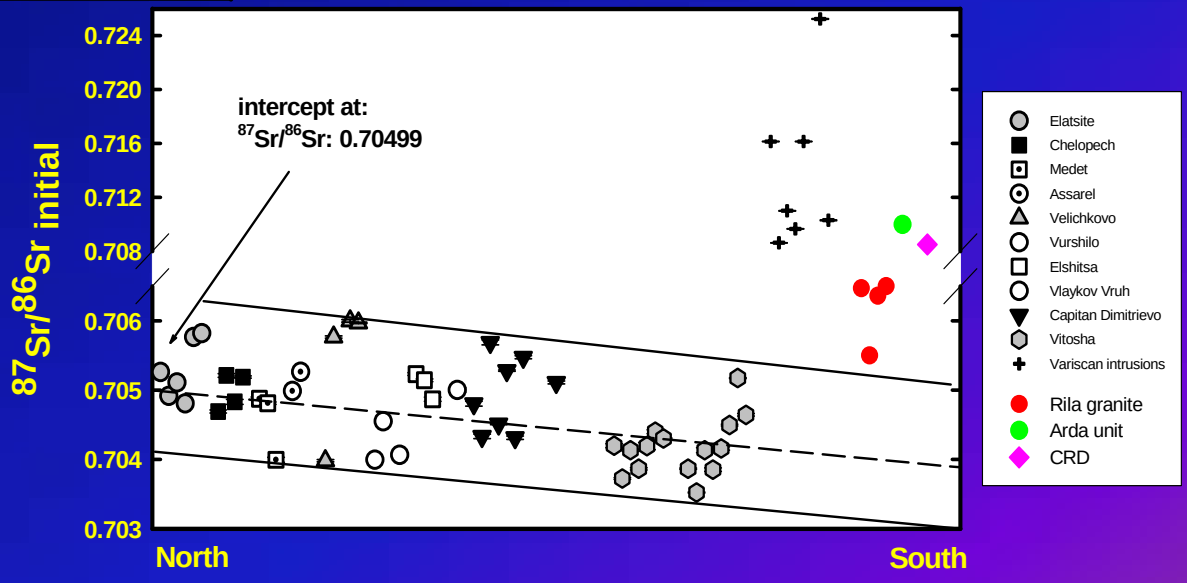
Life time of one single porphyry deposit:
Elatsite: **< 0.9 Ma**

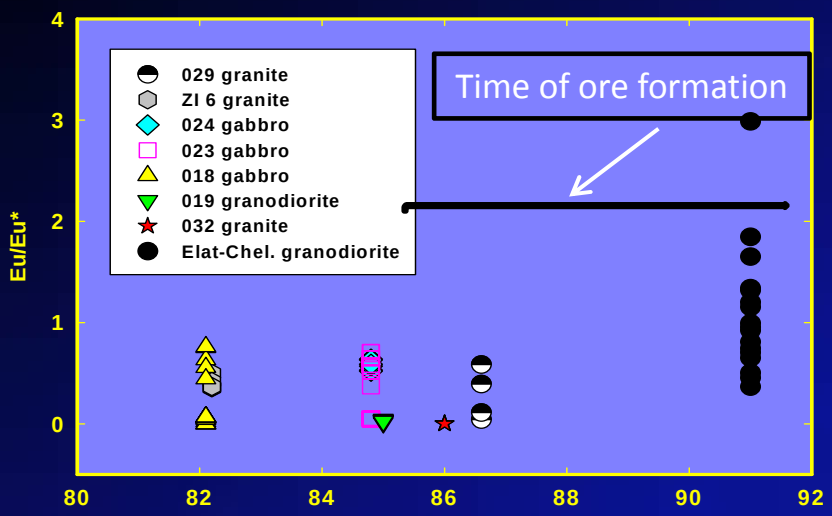


Tracing:
ε-Hf value increasing from +2 (Elatsite) to +11 (Vitosha);

break of this trend further to south: decreasing to +2 (Rila) and -10 (CentralRhodopianDome)

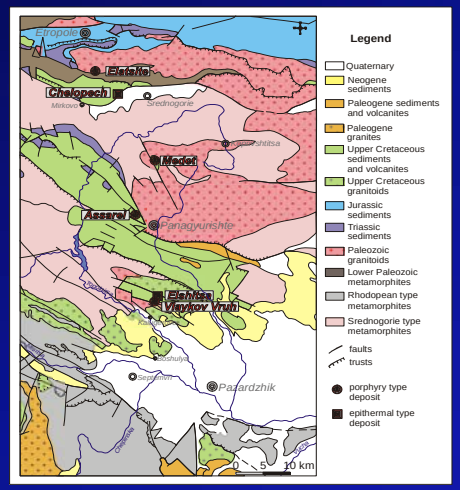


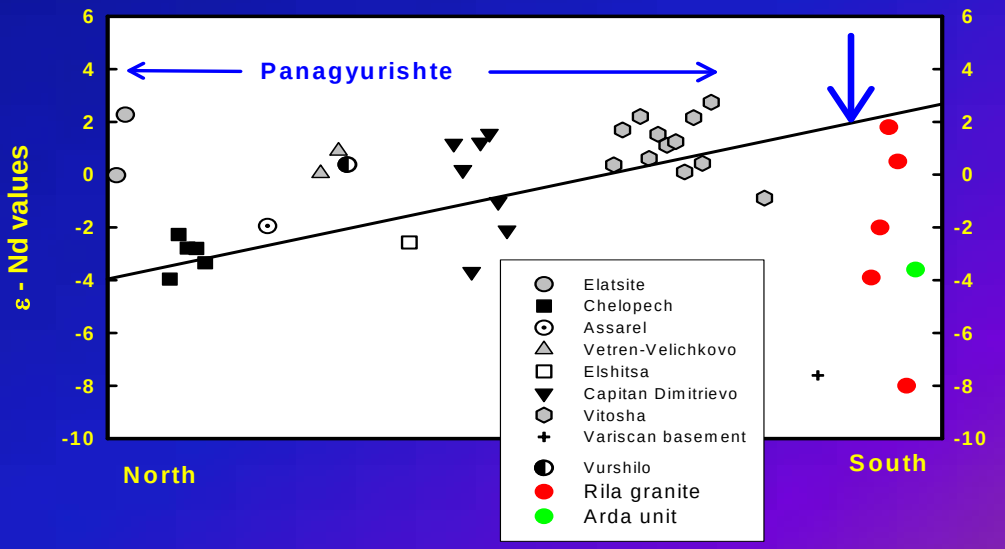


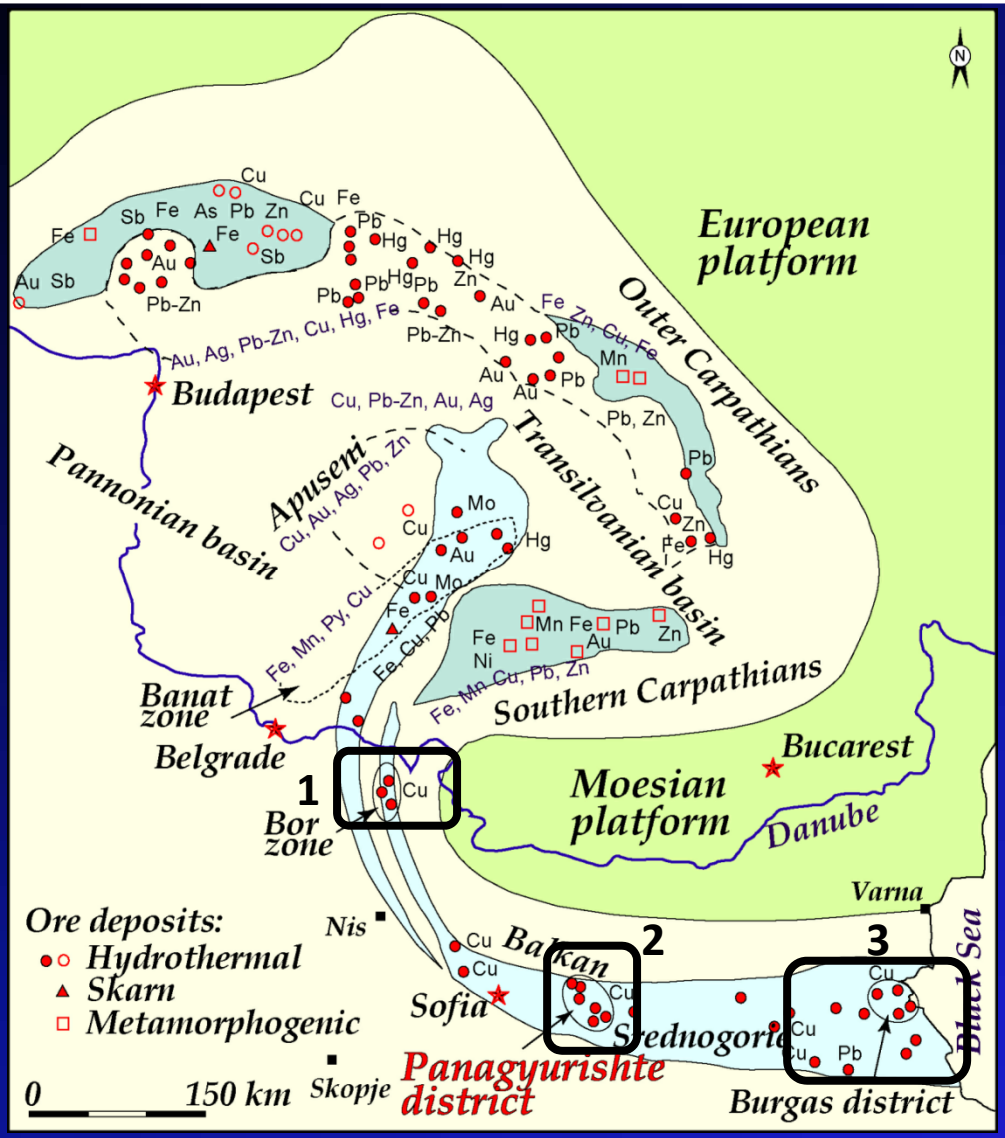


Eu/Eu* : in one magma system
„higher“ values – more mantle input
„lower“ values – higher crustal input

ε-Nd values during Cretaceous time:
Increasing from north to south { -4 - +2};
break further to south - decreasing towards the CRD







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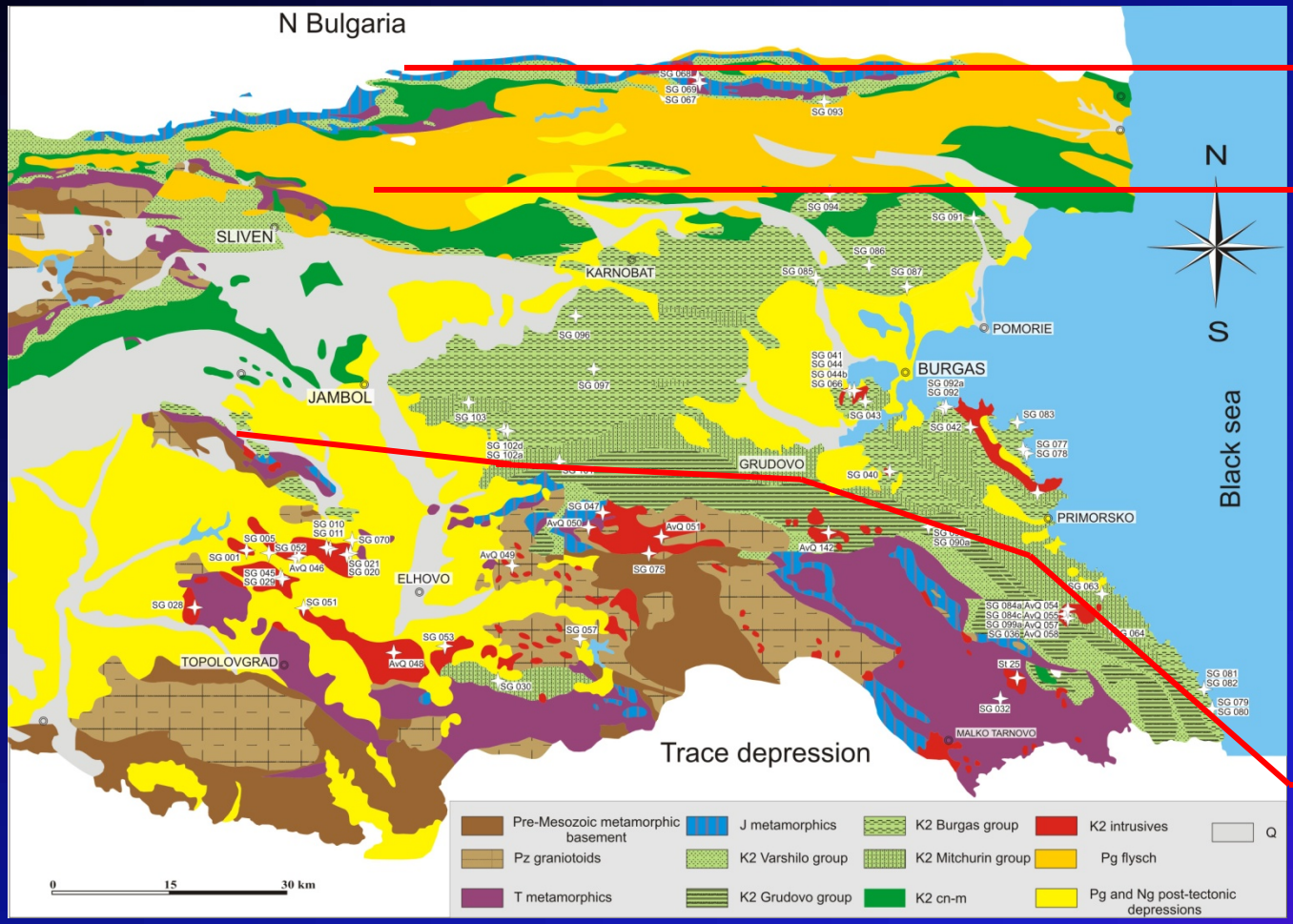


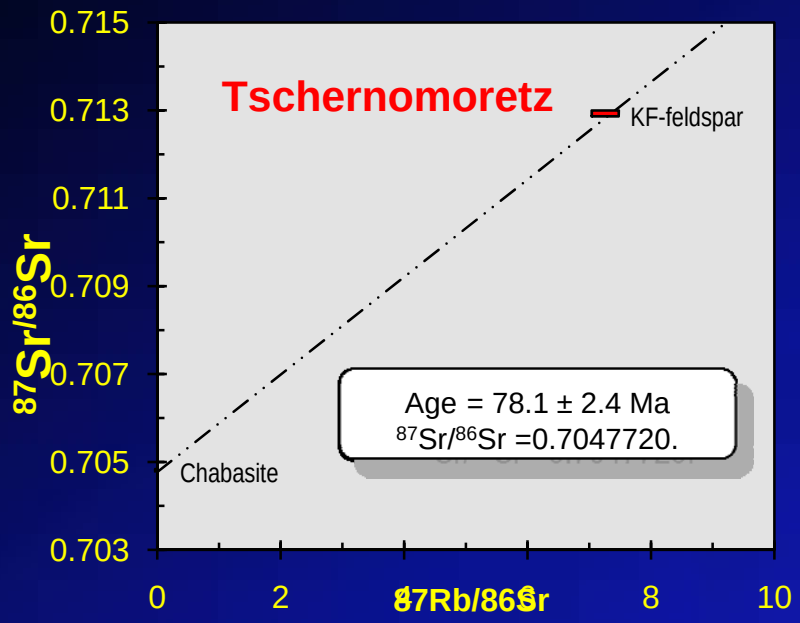
E Balkan

N Burgas

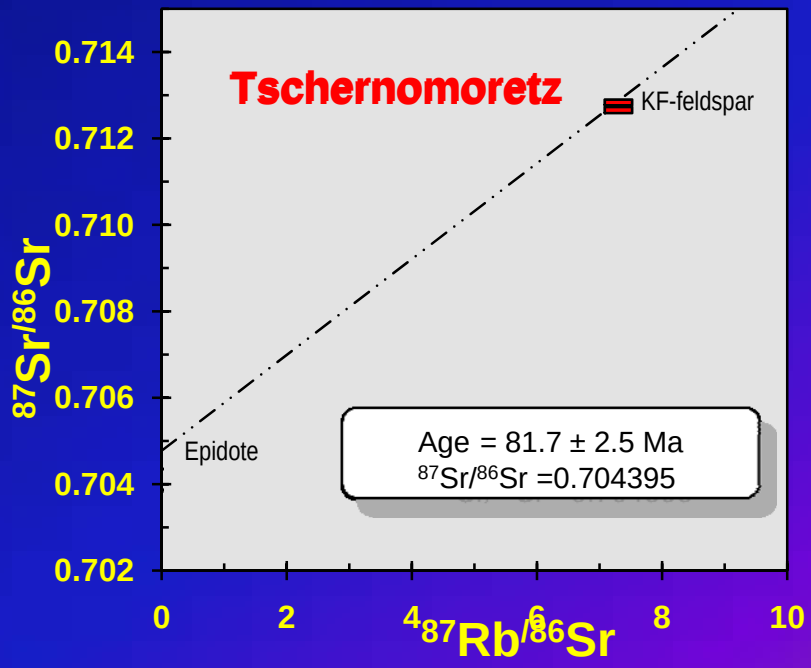
Yambol

Strandzha

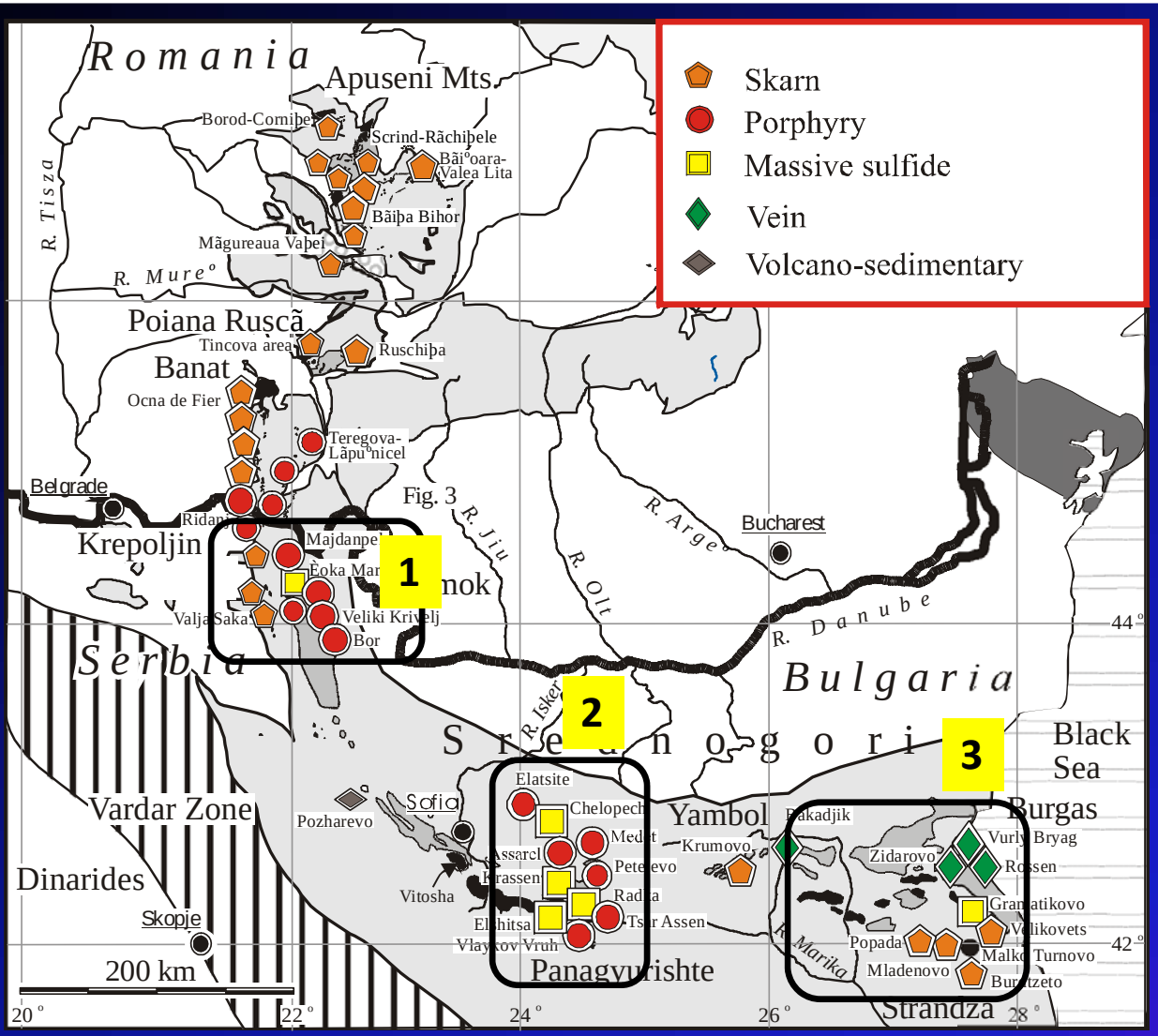
General geology of Eastern Srednogorie



Eastimation:
Time of the ore formation
In Eastern Srednogorie
79 – 81 Ma



Conclusion I

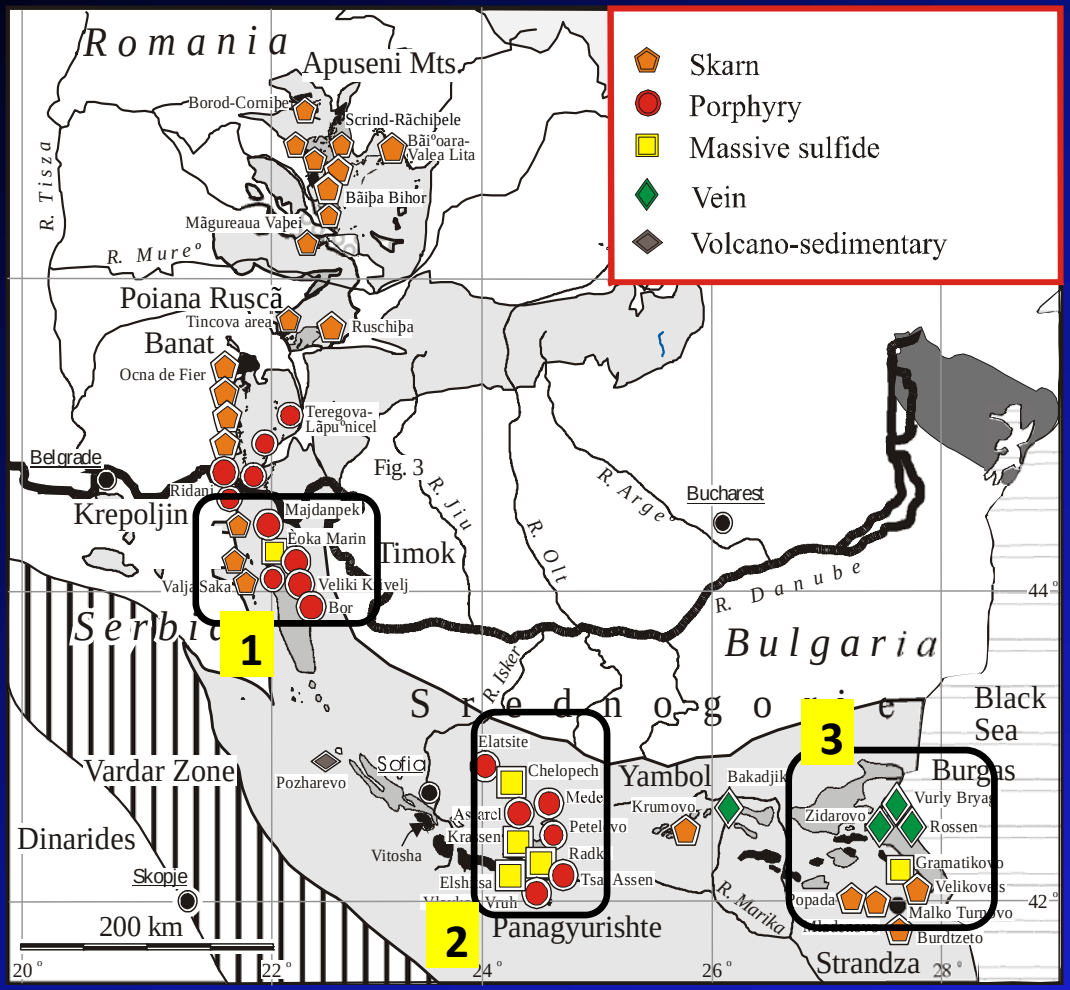


Area 1 – Timok unit
86 Ma – 78 Ma – magmatism {8 Ma}
Ore formation 86-82 Ma
Life time one magmatic system < 0.6 Ma

Area 2 – Timok unit
92 Ma – 78 Ma – magmatism {14 Ma}
Ore formation 92-86 Ma
Life time one magmatic system < 0.6 Ma

Area 3– Eastern Srednogorie unit
86 Ma – 78 Ma - magmatism
Ore formation ca. 81-79 Ma

Conclusion II



Magmatism:
86 – 78 Ma
Eastern Serbia{1} & EasternSrednogorie {3}

92 – 78 Ma
Central Srednogorie {2}

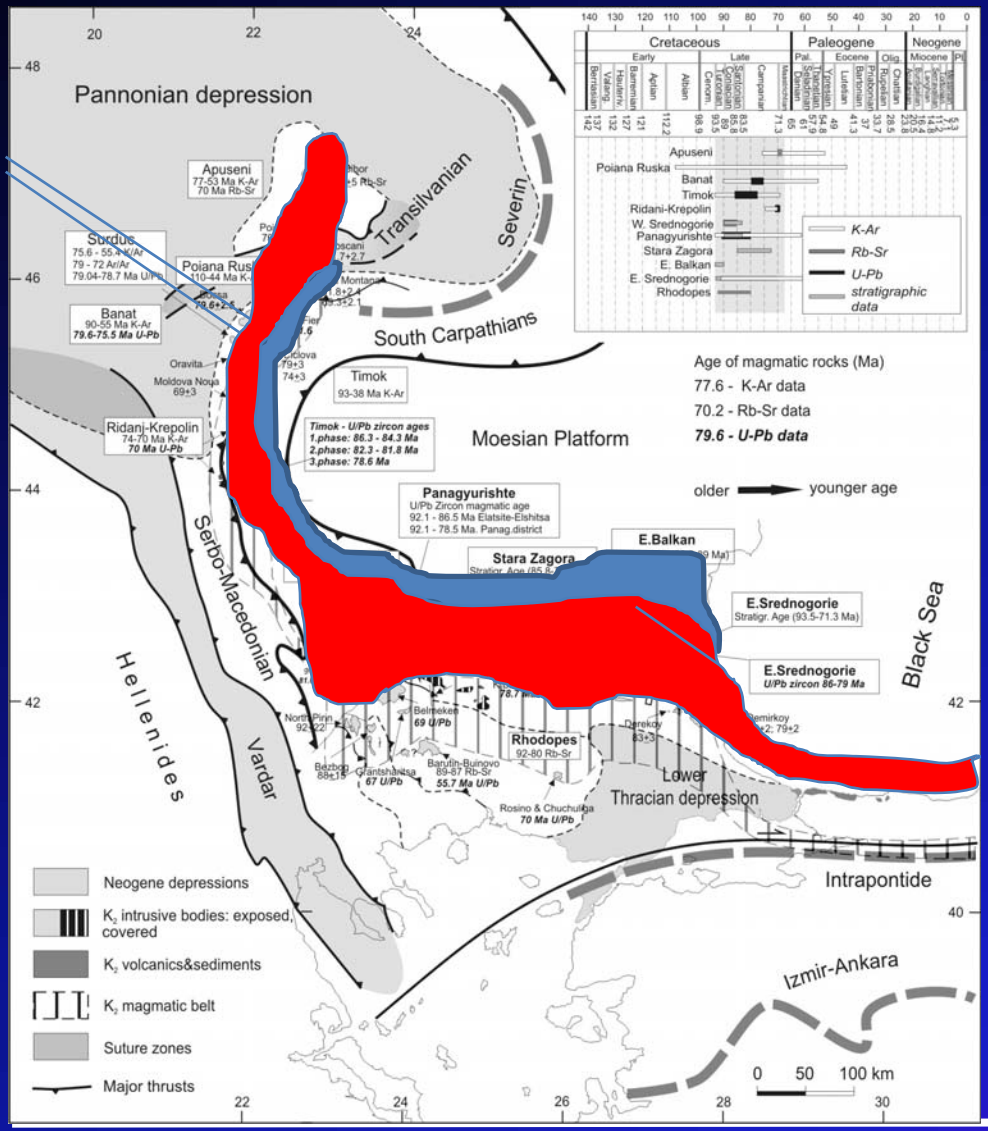
Life time of ore formation
4-6 Ma
Eastern Serbia {1} & Central Srednogorie {2}

In Eastern Srednogorie {3}
2 Ma (81-79 Ma)

Life time one single porphyry deposit
< 0.6 – 0.9 Ma
Veliki Kravelj {1} & Elatsite {2}

Open questions:
- why do we have different time of the ore formation?
- time life or the ore formation is similar
- different periods of the Cretaceous magmatism, but we have a fixed end at 78 Ma in Timok and Srednogorie
- why no economic ore deposits between 82 – 78 Ma? Eroded?
- can we explain these observation with the change in the tectonic environment?

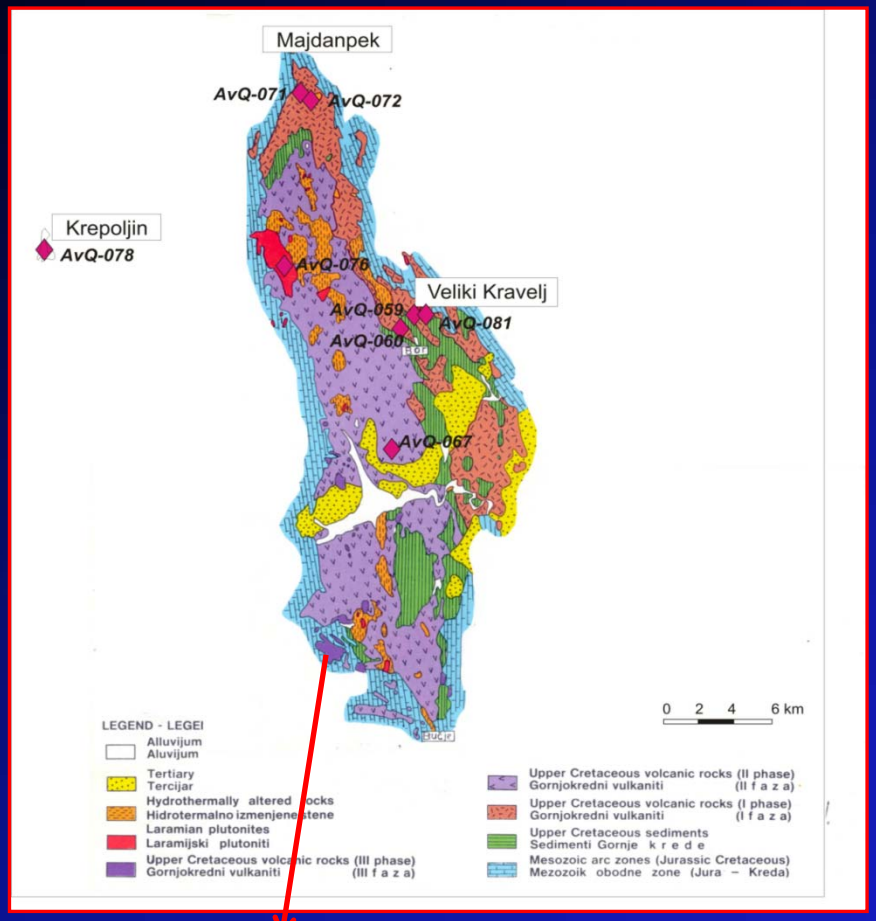
Conclusion III

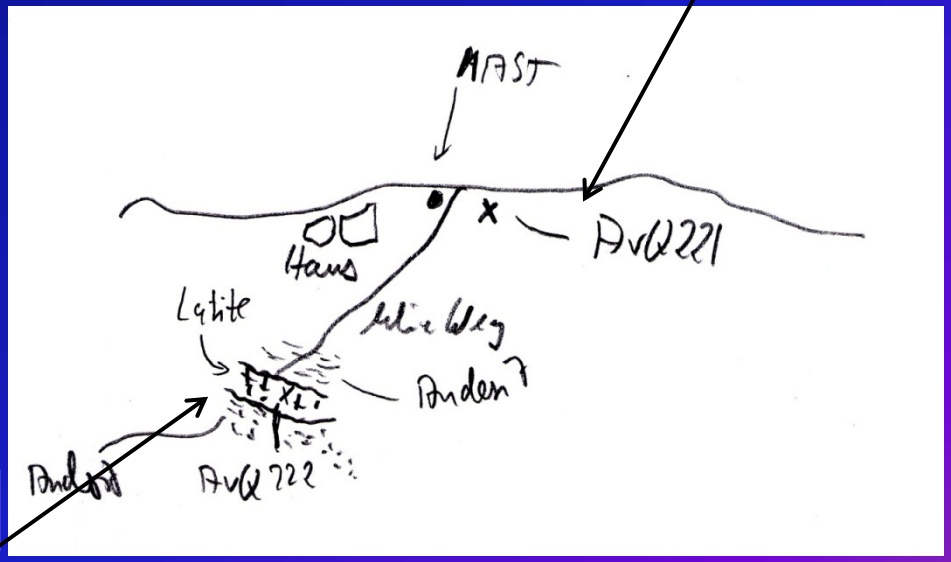


Cretaceous evolution extend in Bulgaria further to south {Rhodope Massif} and in Eastern Serbia further to west {Ridanj-Krepolin}

Locality: western rim of Boljevac/Serbia

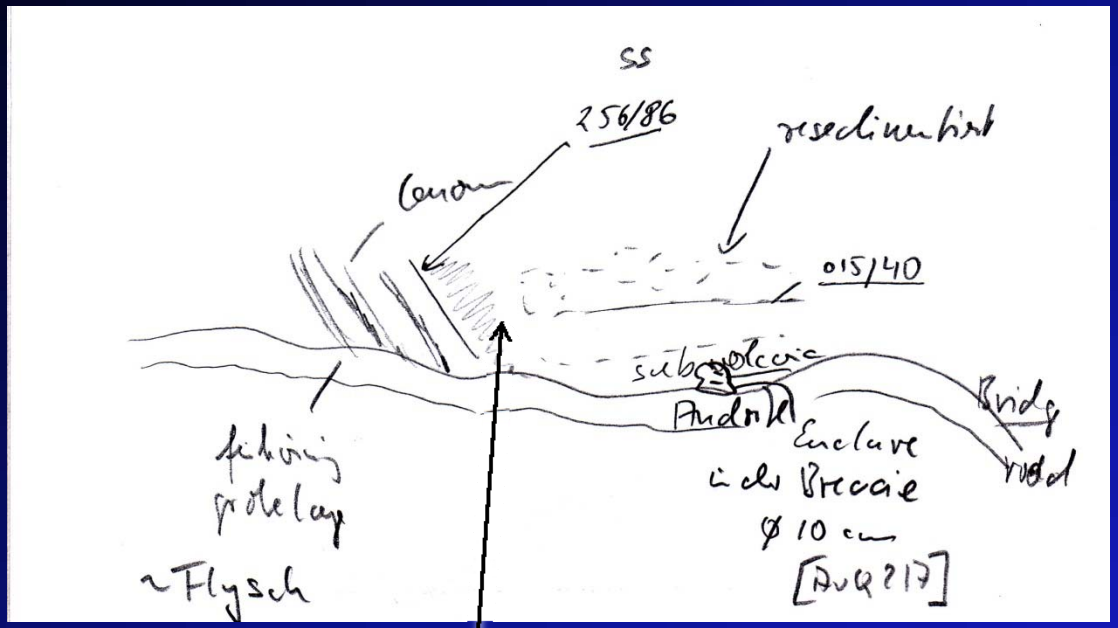
Avq 221: Andesite
U/Pb zircon
U‘ intersect age:
460 Ma





3. Phase-Avq222 -U/Pb zircon: 31.66 Ma

Locality: Gamsigrad

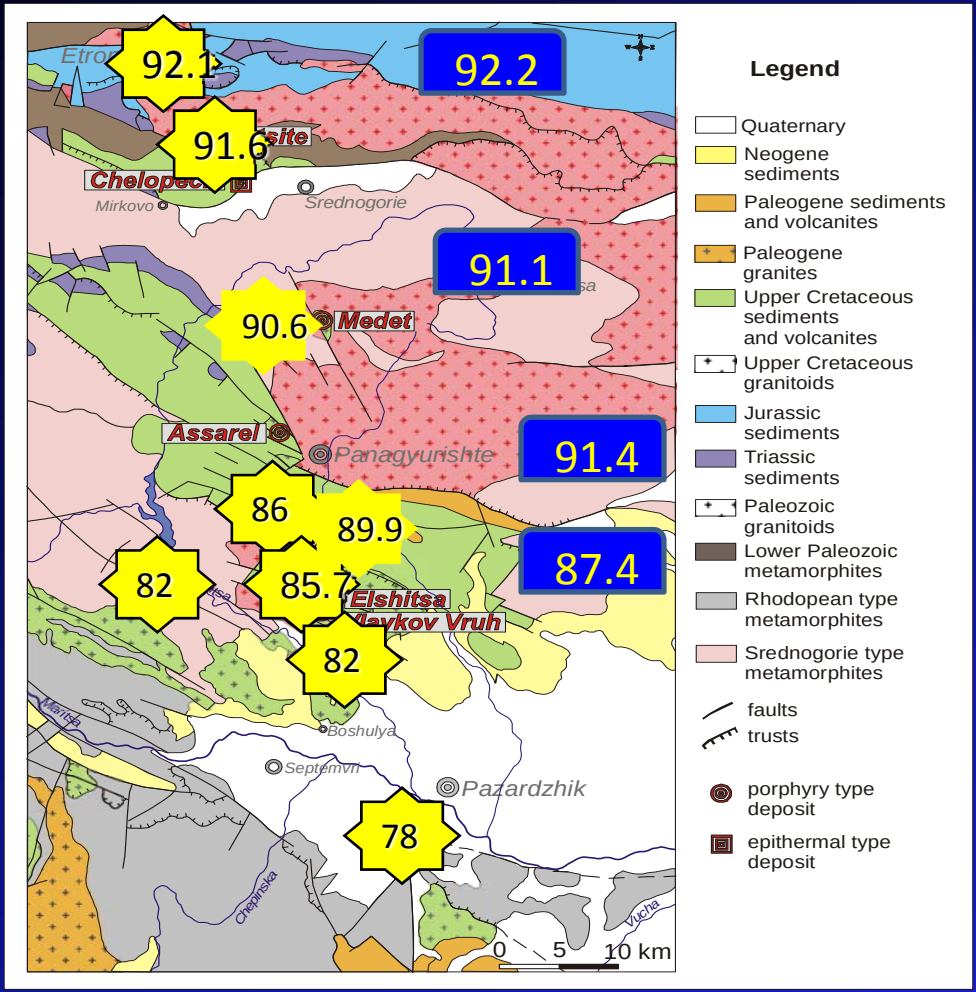


AvQ 217:
Enclave, andesitic rock
Resedimentated in Cenomanian sediments: U/Pb zircon age
84.5 Ma

Cenomian sediments:
Intercalated with volcanic rocks
Stratigraphic age
97 – 93 Ma/90Ma?

Open questions:
- Age of the sedimentation
- What do we know from the dead Fossils and plants?
- Magmatic intrusion
- Erosion
- Sedimentation – time??

Conclusion IV



Geological map after Cheshitev et al., 1989

A. Zimmerman, H. J. Stein, J. L. Hannah & D. Koželj , *K. Bogdanov &* T. Berza

Tectonic configuration of the Apuseni–Banat–Timok– Srednogorie belt, Balkans-South Carpathians,
constrained by high precision RE–OS molybdenite ages

Mineralium Deposita, 2007, online

?

74.6 +/- 0.4 Ma

76.5 +/- 0.4 Ma

72.7 +/- 0.4 Ma

U/Pb zircon ages

79.6 ± 2.5 Ma

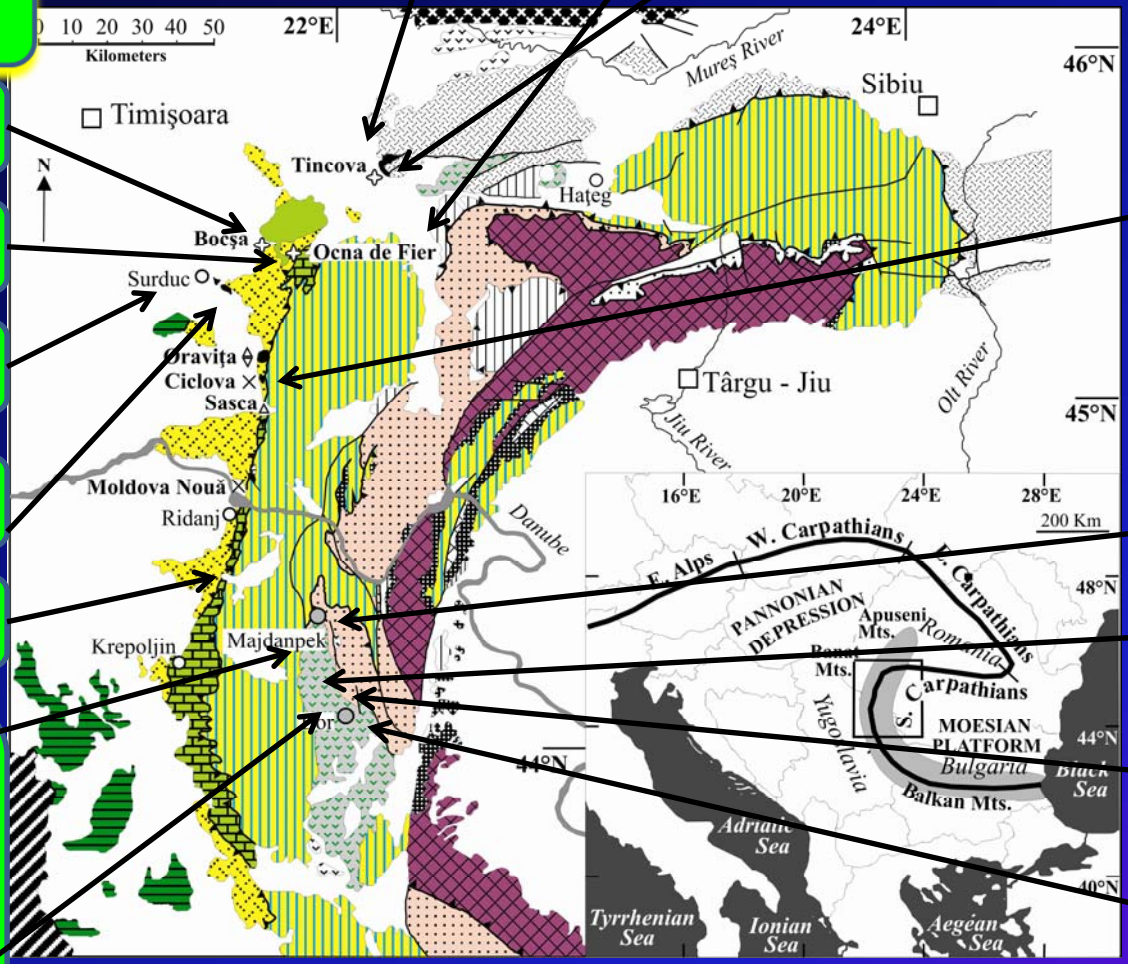
75.5 ± 1.6 Ma

79.1 ± 0.3 Ma

78.7 ± 0.2 Ma

70 ± 2.5 Ma

82.7 ± 0.05 Ma
78.6 ± 0.44 Ma
81.8 ± 0.5 Ma
82.3 ±0.35 Ma
86.17 ± 0.15 Ma
86.29 ± 0.32 Ma



Re/Os ages Molybdenite

82.7 ± 0.4 Ma

83.5 ± 0.4 Ma

80.7 ± 0.4 Ma

87.9 ± 0.5 Ma

86.1 ± 0.5 Ma