

The diversity of geochemical types of Erzgebirge granites and their potential to be related to hydrothermal uranium deposits

Or why the Erzgebirge U district is so well endowed?

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The Erzgebirge uranium district

The Erzgebirge area represents **the largest uranium district for hydrothermal granite-related deposits in the World**

Despite the small size of this district, about 70 km large,

its uranium resources are much larger than the global uranium granite-related resources estimated in the French segment of the Variscan Belt

over more than 700 km.

(H) U DEPOSITS RELATED TO HYDROTHERMAL FLUIDS

II-2 Hydrothermal-Granitic U deposits in the world

128 deposits in UDEPO data base

Most deposits in the Variscan Belt of Europe

Production (1950-2000): ~ **250,000 t U**

→ **Germany: 103,000 t**

→ **France: 50,000 t**

→ Czech Republic: 56,000 t

→ Spain-Portugal: 30-40,000 t

→ China: 10,000 t (?)

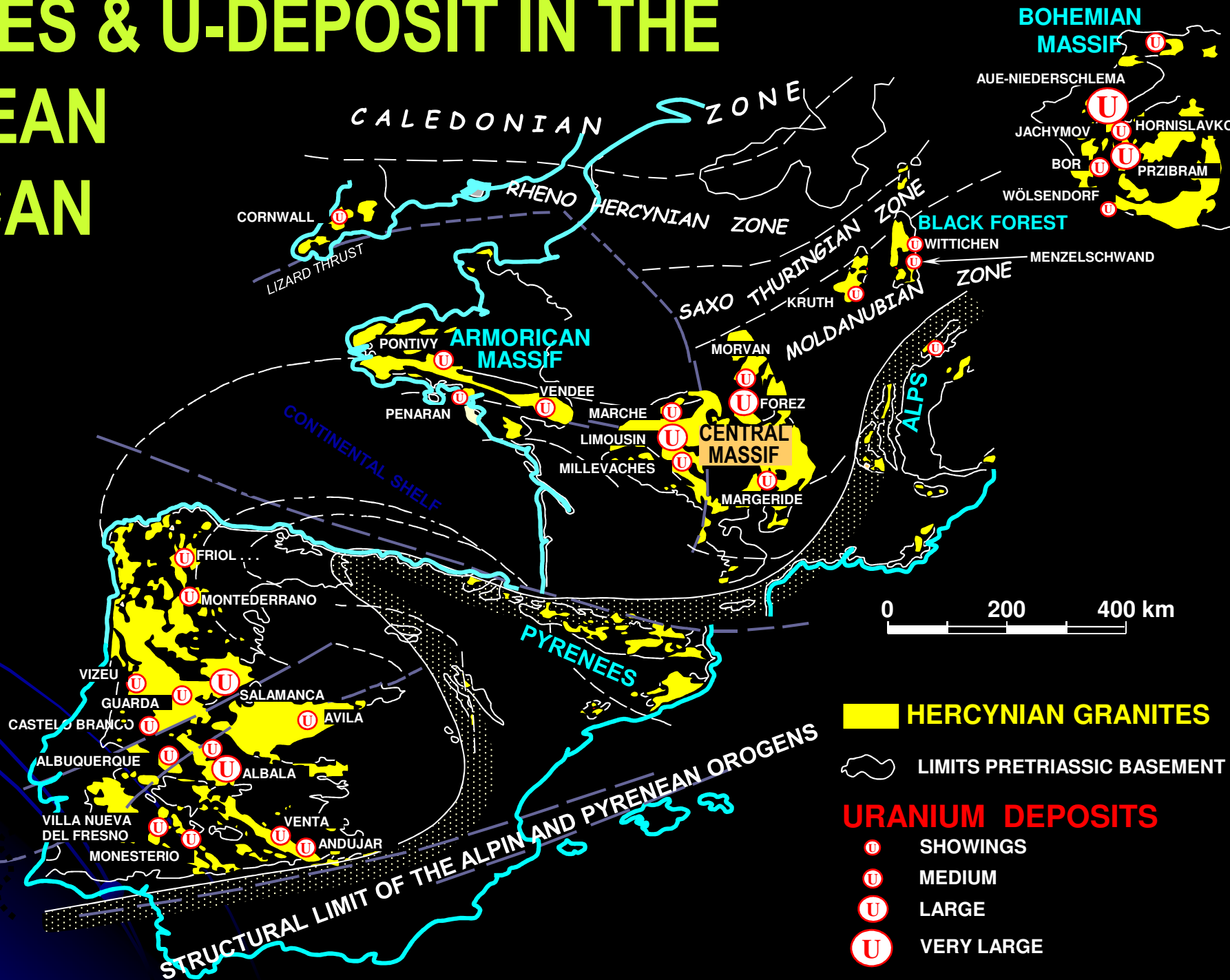
Presently only a small production in China x100 t U

Ressources in Algeria, Argentina, Egypt, USA, Bulgaria, Serbia, Russia, ...

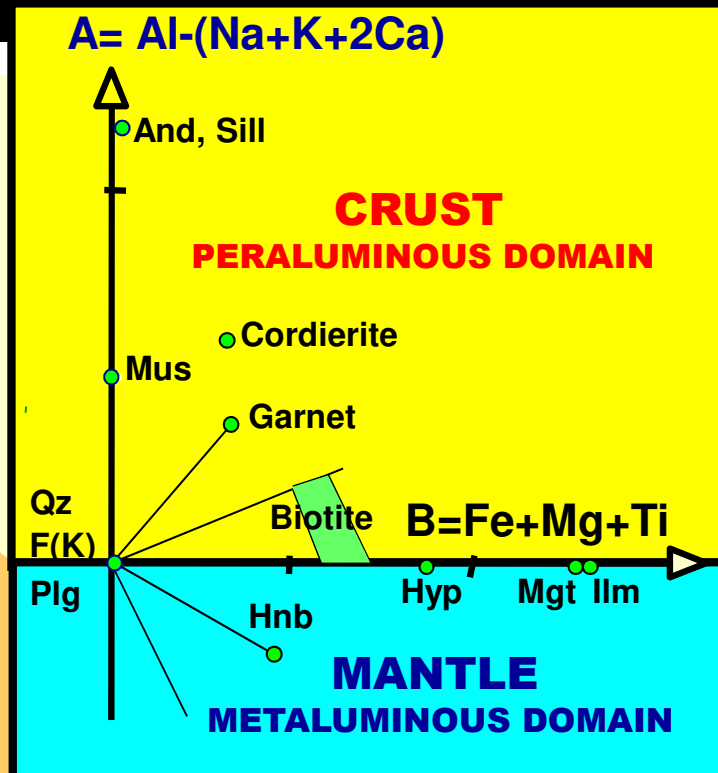
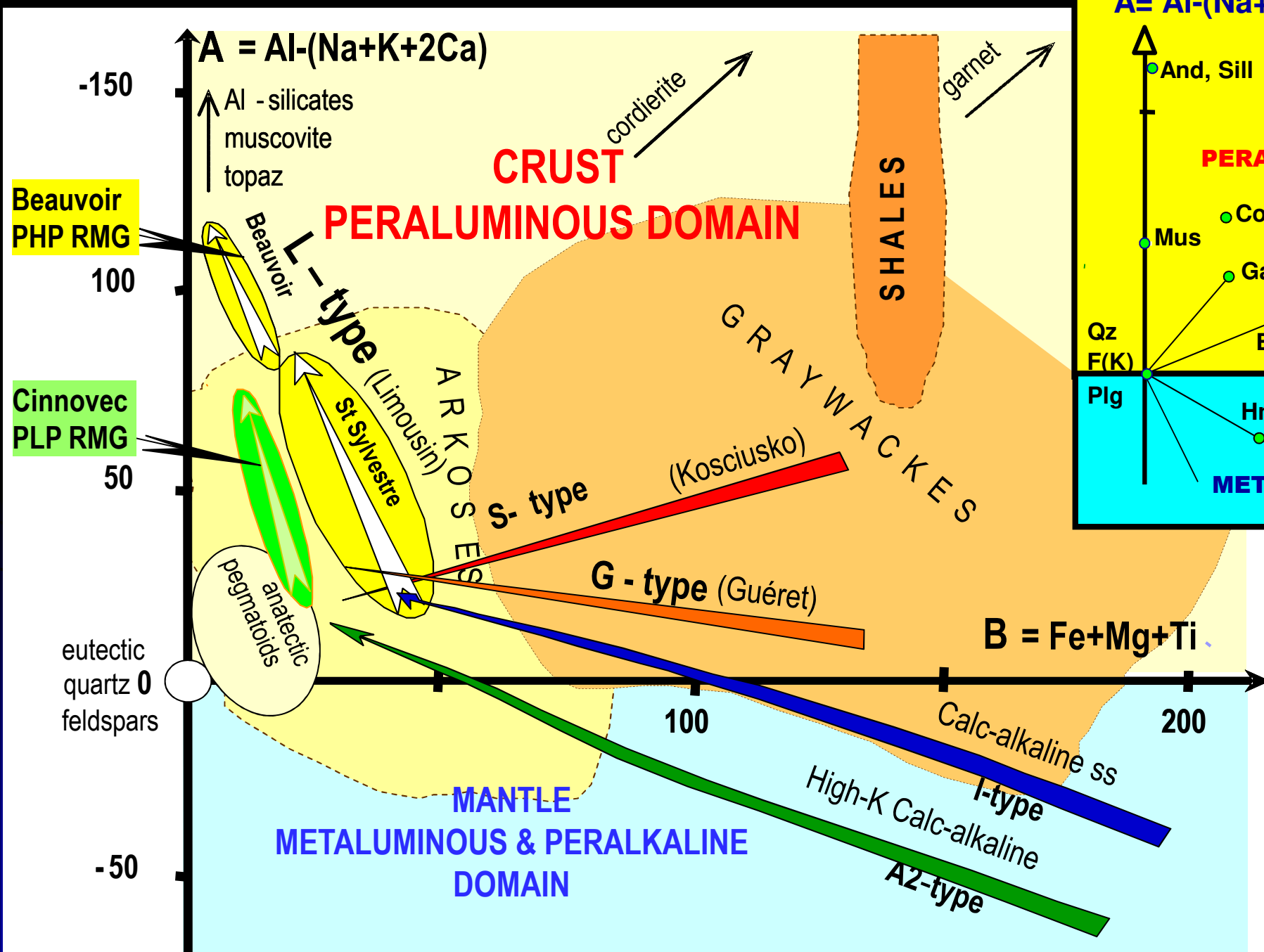
Major (HG) hydrothermal-granitic U deposits

Deposit	Country	Resources	Grade	Status
Niederschlema-Alberoda	Germany	95 600	0.25	Mined-out
Pribram District	Czech Republic	30.000	1.0	Mined-out
Timgaouine	Algeria	12.270	0.21	Dormant
Xiazhuang District	China	12 000	0.20	Mined-out
Tinef	Algeria	11.750	0.075	Dormant
Jachymov District	Czech Republic	10.000	1.20	Mined-out
Margnac-Pény	France	9.900	0.25	Mined-out
Abankor	Algeria	9.130	0.32	Dormant
Alameda	Spain	8.855	0.039	Exploration
Oberschlema	Germany	7.945	0.30	Mined-out
Mina Fe	Spain	7.200	0.055	Mined-out
Lantian	China	7.160	0.171	Mined-out
Bois Noirs	France	6.920	0.27	Mined-out
Bernardan	France	6.610	0.56	Mined-out
Gornoye	Russia	6.200	0.245	Development

GRANITES & U-DEPOSIT IN THE EUROPEAN VARISCAN BELT

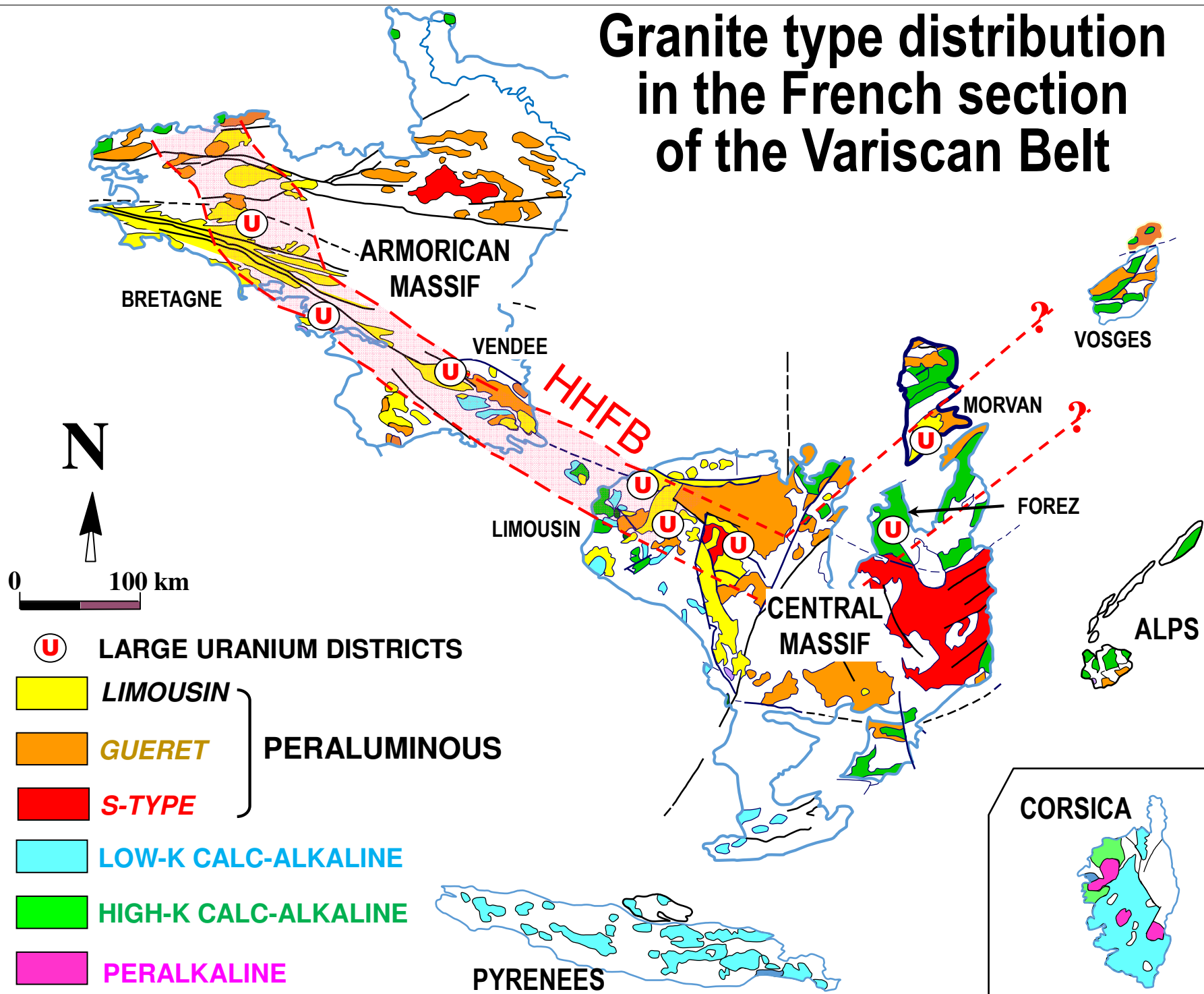


THE VARIOUS TYPES OF PERALUMINOUS GRANITES

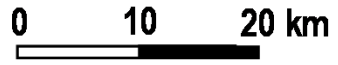
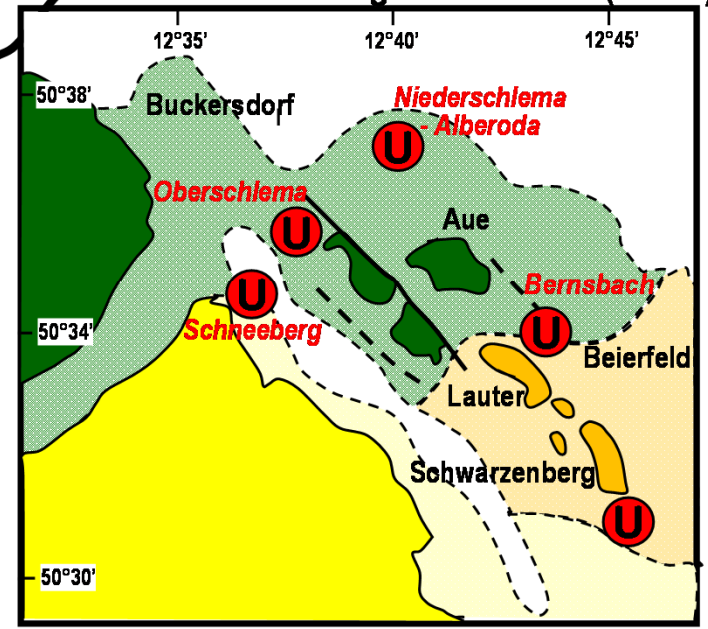
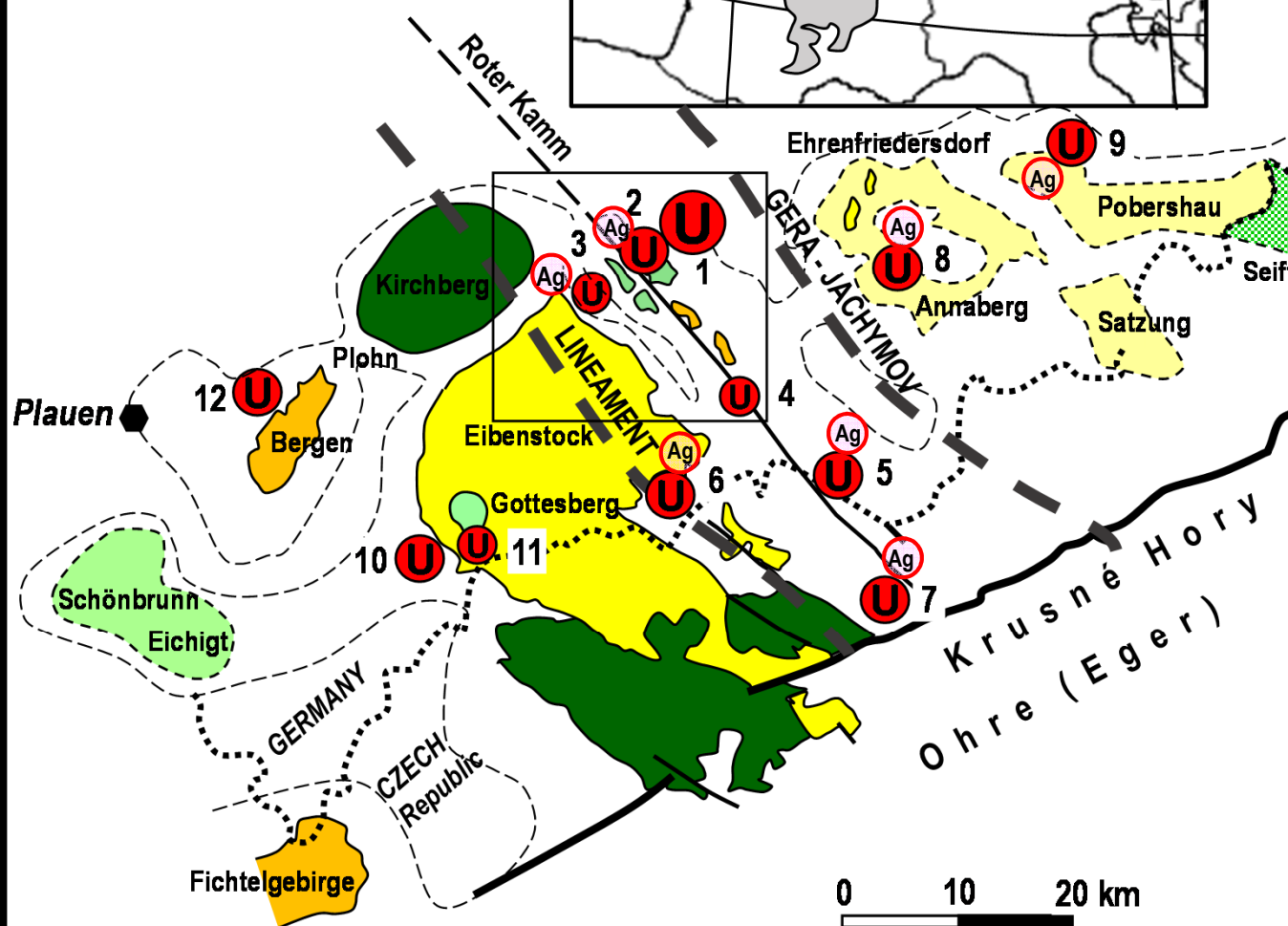
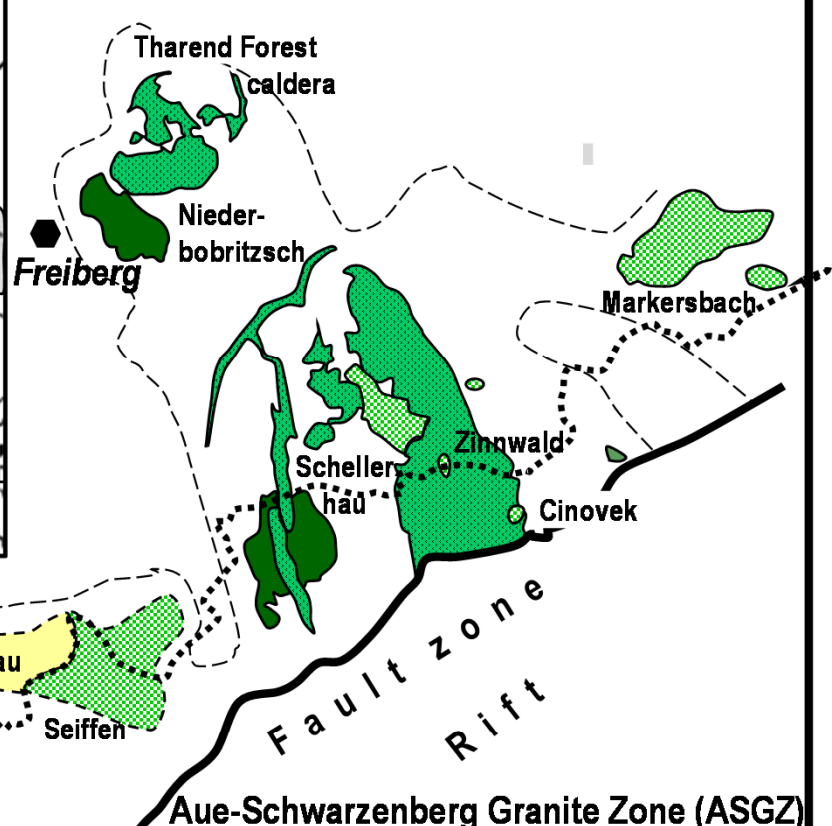
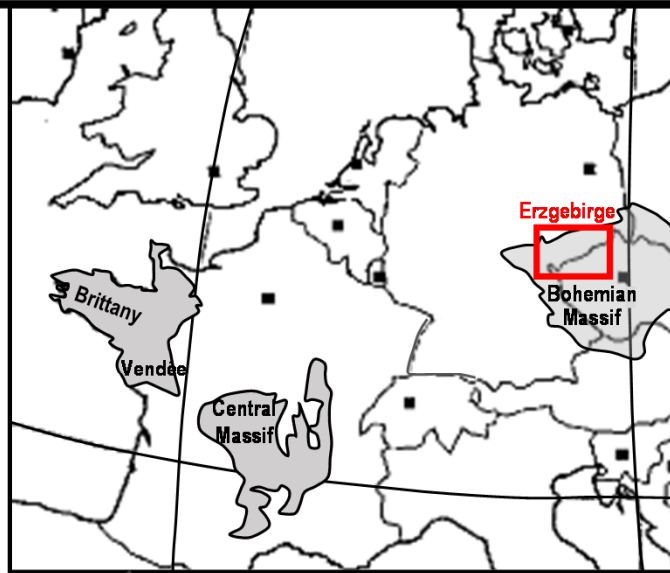


Granite type distribution in the French section of the Variscan Belt

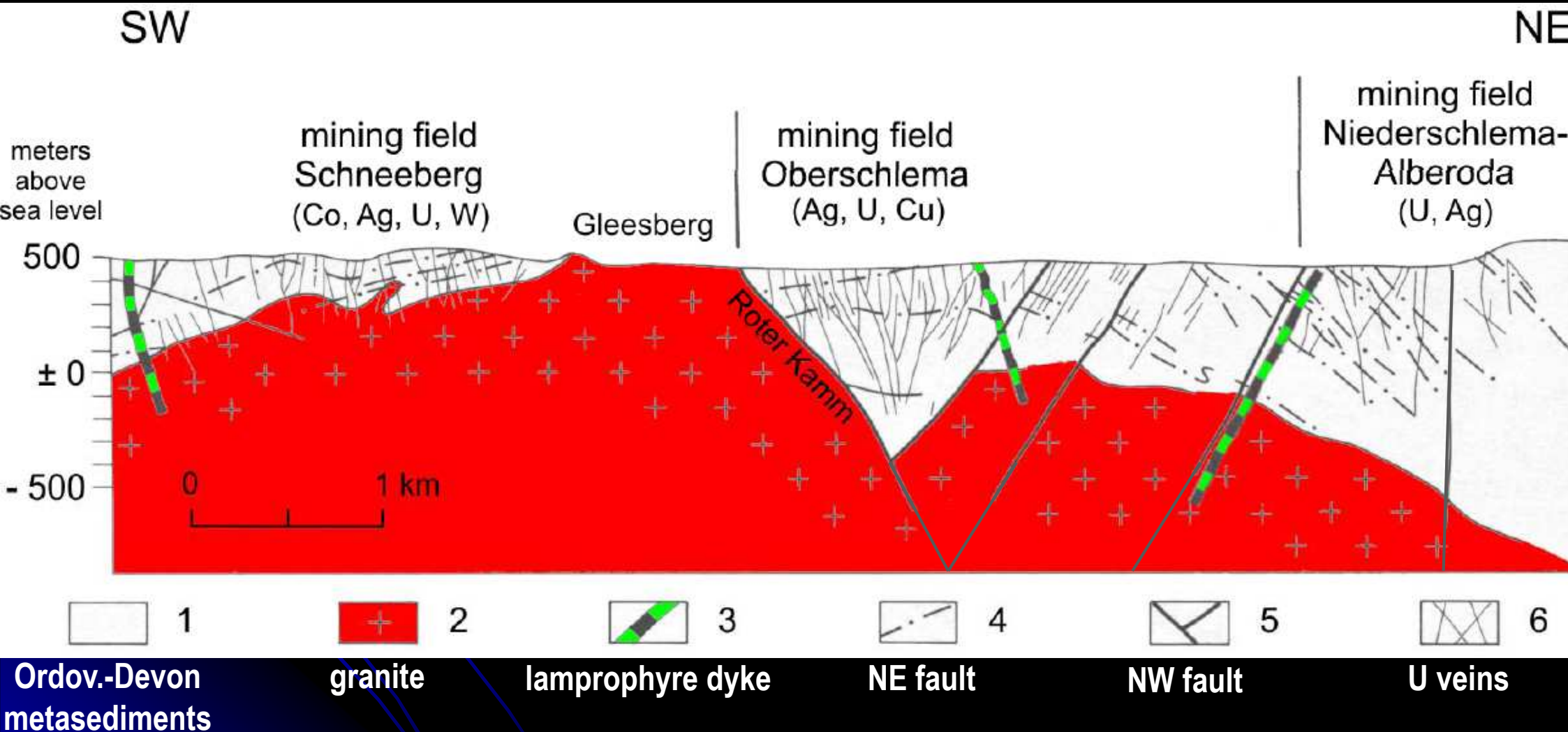
URANIUM DEPOSITS ARE ASSOCIATED ONLY WITH SOME SPECIFIC TYPES OF GRANITES



- Medium-F, low-P biotite granite
- High-F, low-P Li-mica granite
- Intermediate to felsic volcanic rocks
- High-F, medium-P Li-mica granite
- Low-F, two-mica granite
- Low-F, biotite granite
- Hidden granite contact
- U Uranium deposits



Cross section of the Schlema-Schneeberg U district



late-Variscan
magmatic-hydrothermal

(310 – 260 Ma)

- W-Mo association (W) Pechtelsgrün/Vogtland, Zschorlau
- Sn-W-Mo-Bi-Li-F association (Sn, W, Mo, Li, Bi) Altenberg, Zinnwald, Krupka, Sadisdorf, Pobershau, Geyer, Ehrenfriedersdorf, Eibenstock, Gottesberg-Mühlleithen
- Sn-Cu-Ag association (Sn, Cu, (Ag)) Seiffen, Hora Svaté Kateřiny
- quartz-polymetallic sulfide association (Pb, Zn, Cu, Ag, Sn, Au) Freiberg
- carbonate Ag-Sb association (Ag, Pb, Zn, Au, Sn?) Brand-Erbisdorf

KKU

▪ uranium-pitchblende-quartz-carbonate association (U) Schlema-Schneeberg, Johanngeorgenstadt

▪ fluorite-quartz association (fluorite) Schönbrunn/Vogtland

MgU

▪ dolomite-U-pitchblende-selenide association (U) Niederschlema, Pöhla-Tellerhäuser

post-Variscan
(magmatic?) hydrothermal

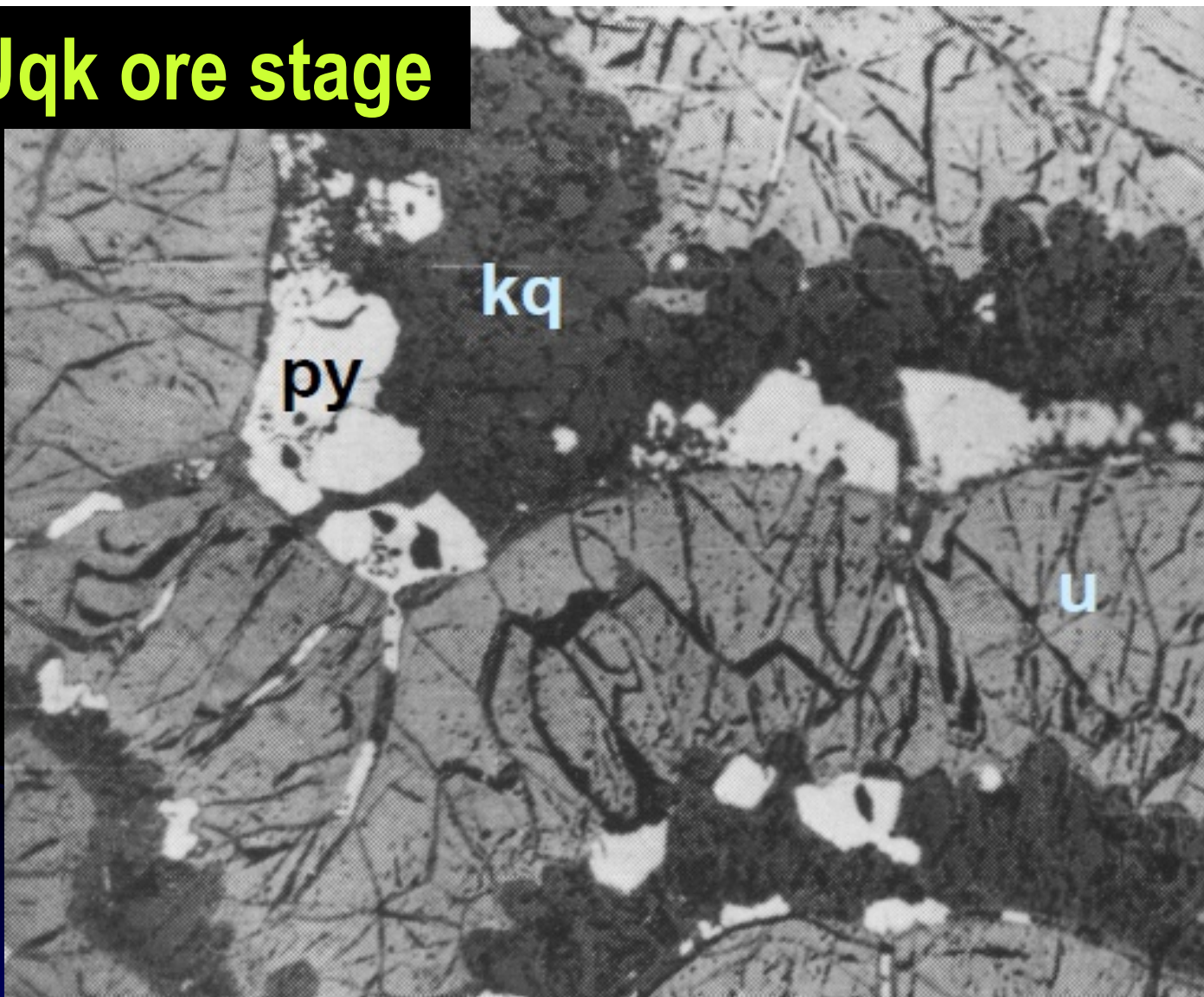
(200 – 100? Ma) BiCoNi

▪ hematite-barite association (Fe, barite) Pobershau, Bösenbrunn/Vogtland

▪ barite-fluorite-sulfide association (fluorite, barite, Pb, Ag) Schönbrunn, Zschopau

▪ Bi-Co-Ni-As-Ag-U association (Ag, U, Co, Ni) Schneeberg-Oberschlema, Marienberg, Annaberg, Johanngeorgenstadt, Jáchymov

Uqk ore stage



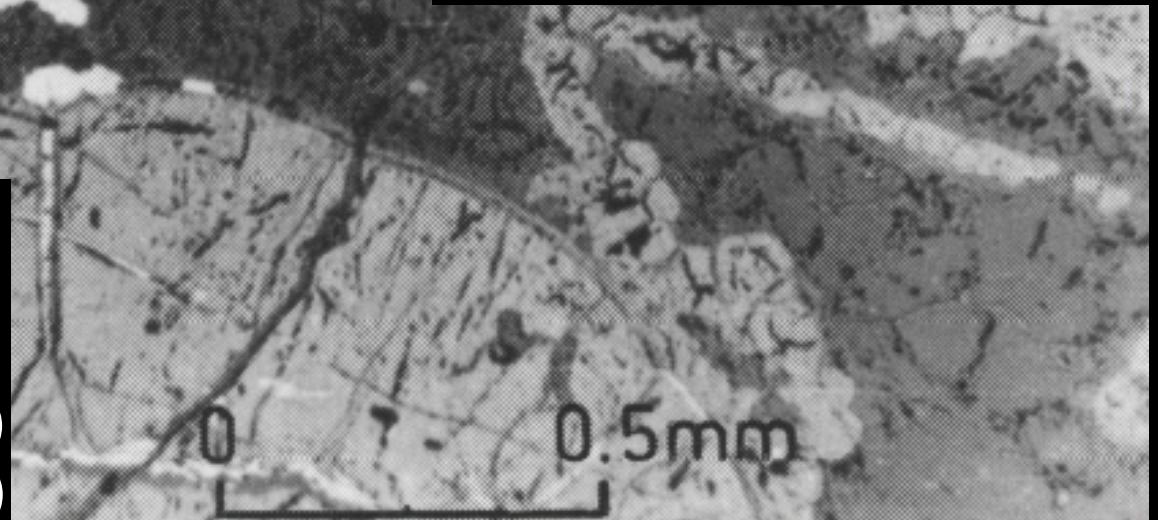
(Seifert, 2007)



Botryoidal pitchblende

**Kammquarz rhythmic growth (kq)
+pitchblende (u) + pyrite (py)**

Niederschlema-Alberoda (polished section)
(pict. Veličkin et al., 1983, in Schuppan et al., 1994)



mgu ore-Stage



**Pitchblende + pink dolomite + ankerite
Niederschlema (shaft 371)**

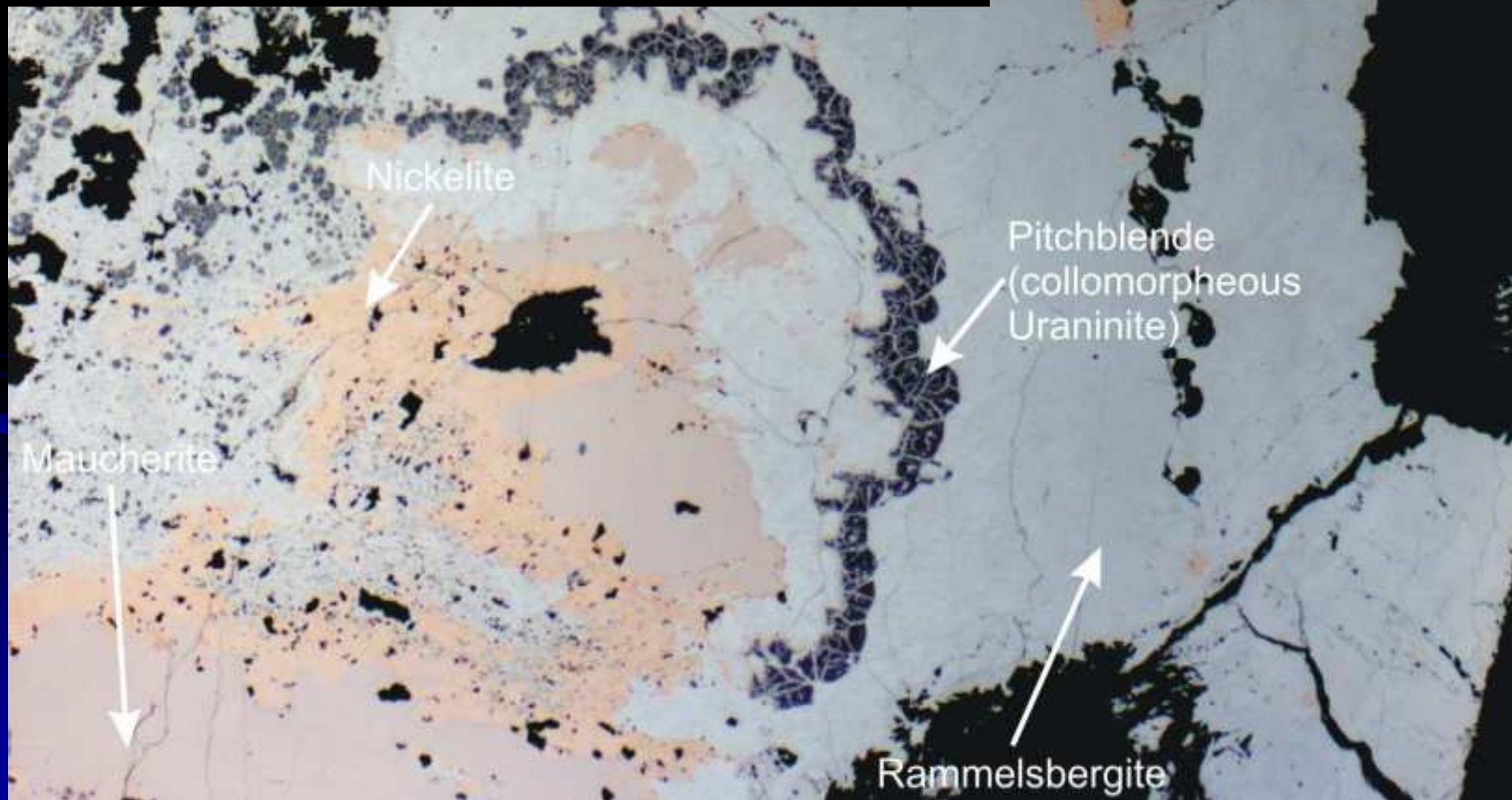
(Wismut GmbH collection, picture Th. Seifert, 2007)

Bi-Co-Ni-U (As-Ag) stage: 130-90 Ma

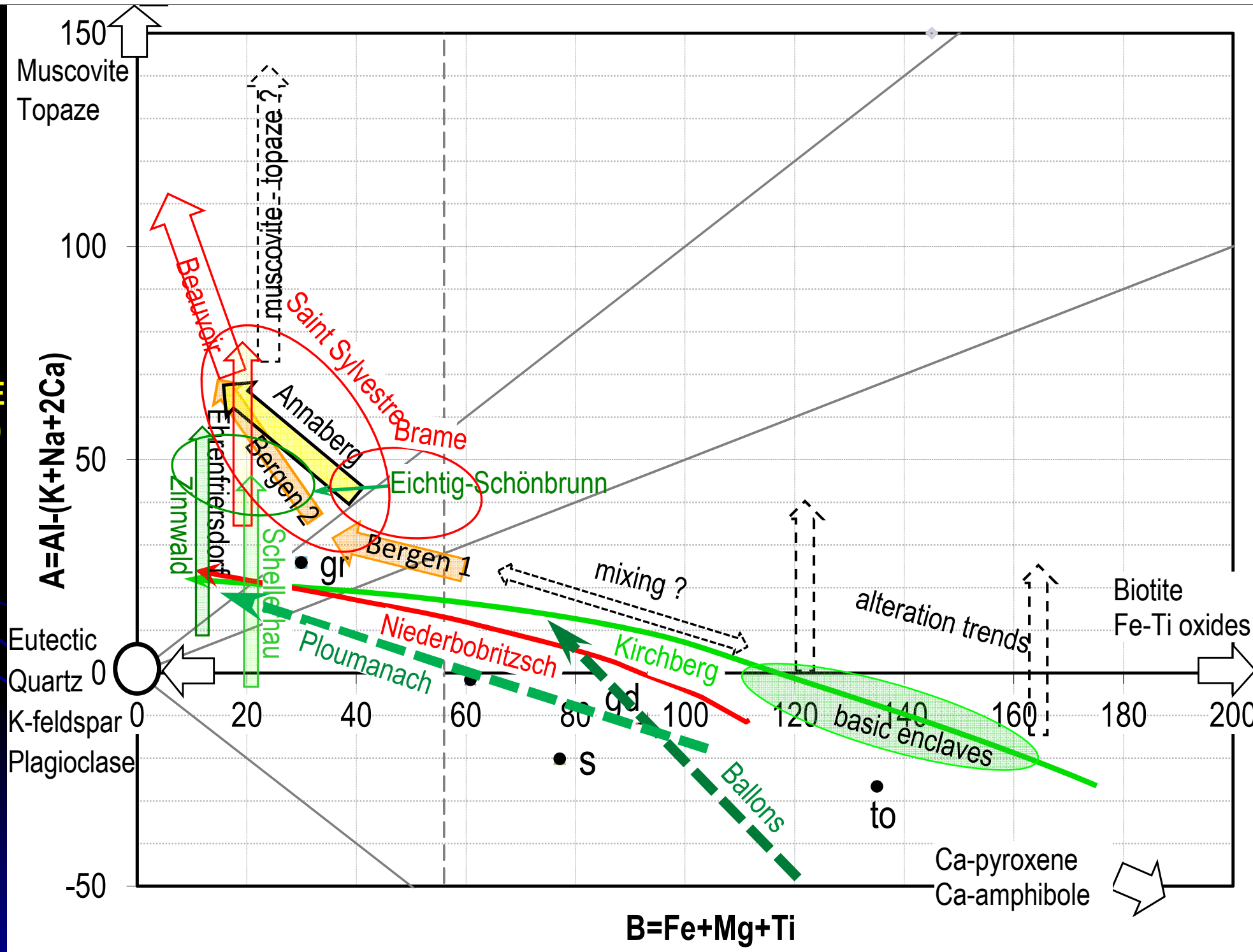
Pitchblende in rammelsbergite

Niederschlema-Alberoda district

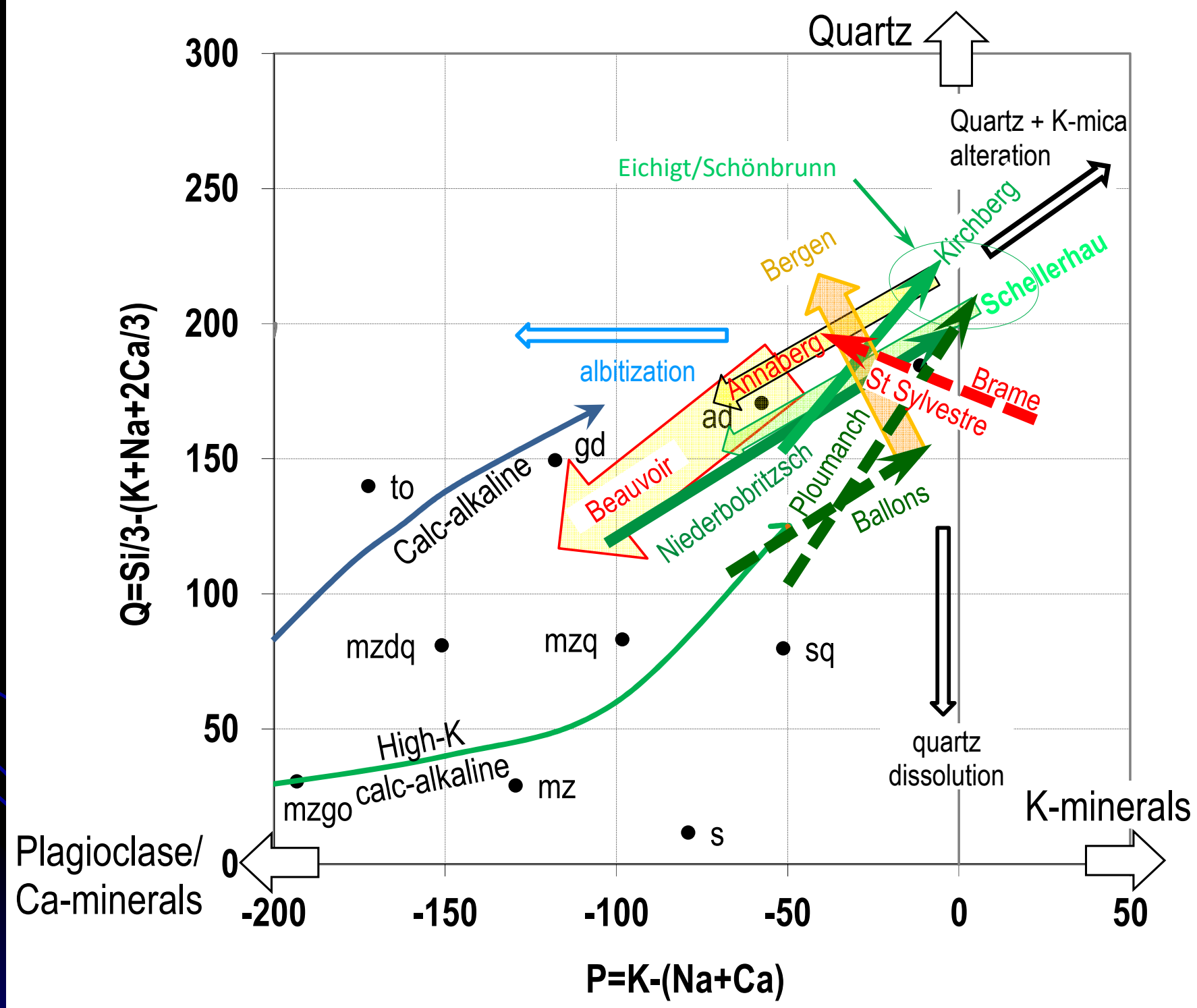
(polished section: Schlothauer, 2008, modified in Seifert 2008b)



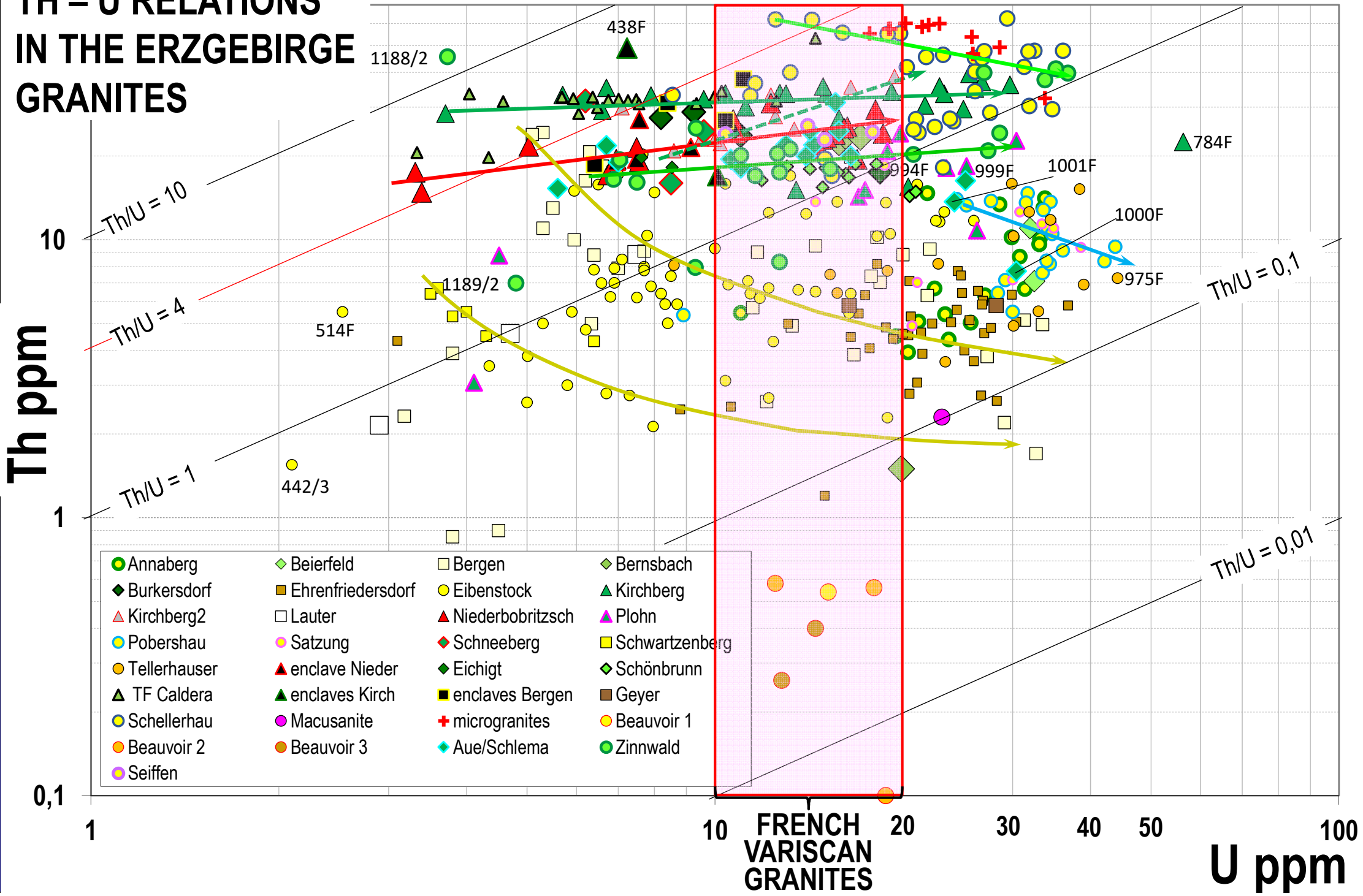
THE VARIOUS GRANITE TYPES ASSOCIATED TO URANIUM DEPOSITS IN THE A-B DIAGRAM



THE VARIOUS GRANITE TYPES ASSOCIATED TO URANIUM DEPOSITS IN THE QUARTZ - PLAGICLASE - K-FELDSPAR DIAGRAM



TH - U RELATIONS IN THE ERZGEBIRGE GRANITES



THE VARIOUS GRANITE TYPES OF THE ERZGEBIRGE

The 5 types of Erzgebirge granites define distinct fractionation trends, in chemical-mineralogical diagrams

They present a remarkable evolution of quartz & feldspars fractionation driven by increasing F-content of the melts, but without to be genetically related.

They can be regrouped into 2 major types :

- (i) **fractionated high-K calc-alkaline granites (A2 type)** with evolution trends rooted in metaluminous compositions
- (ii) **fractionated highly peraluminous leucogranites (L-type)** with fractionation trends presenting a more or less steep increase of their peraluminosity with the decrease of femic mineral content.

CONCLUSIONS (i)

Why the granites of the Erzgebirge district present such a large uranium endowment,

over a ten times smaller domain, compared to the French Variscan ?

(i) Specific types of granites well developed in the Erzgebirge are not known in the French segment of the Variscan Belt:

1 - Low-F biotite granites (e.g. Niederbobritzsch, Kirchberg) = high-K calc-alkaline (HKCa) granites in France (e.g. Ploumanach) but globally **more fractionated in the Erzgebirge.**

2 – Medium-F, low-P, biotite granites (e.g. Eichtig-Schönbrunn) = highly fractionated high-K calcalkaline granites, **not known in France**

3 – Low-F, two mica granites (e.g. Bergen), transitional between HKCa and L-type

4 – High-F, medium-P, Li-mica granites (e.g. Annaberg, Eibenstock) **richer in F and more fractionated than Limousin type in France, except the small Beauvoir RMG granite**

5 – High-F, low-P, Li-mica granites (e.g. Seiffen, Zinnwald), extremely fractionated high-K calcalkaline granites, **not known in France, except the small Chavance RMG granite**

CONCLUSIONS (ii)

(ii) Compared to the French Variscan granites, all Erzgebirge granite types are:

- more fractionated,
- richer in uranium
- with lower Th/U ratios, leading to a larger proportion of U hosted in uraninite

(iii) Among the 5 types of granites of the Erzgebirge 3 types are associated to U deposits (low-F biotite granites, low-F two mica granites, high-F medium-P Li-mica granites) for only one type in France the peraluminous two mica leucogranites (L-Type).

(iv) Erzgebirge U deposit are hosted in enclosing C-bearing metasediments whereas in France they are mostly intragranitic, except the small but rich Pen Ar Ran deposit

(v) In the Erzgebirge exploration and mining have been undertaken down to 2000 m

(vi) Three stage of U mineralization exist in the Ergebirge (KKU, MgU, BiCoNi)

(vii) Exceptional size of the Gera–Jachymov lineament (40 km large, >80 km long) compared to the Bonnac-Bellezane lineament in St Sylvestre granite (5 km large, 25 km long)

(ix) Different economic considerations during the sovietic occupation