

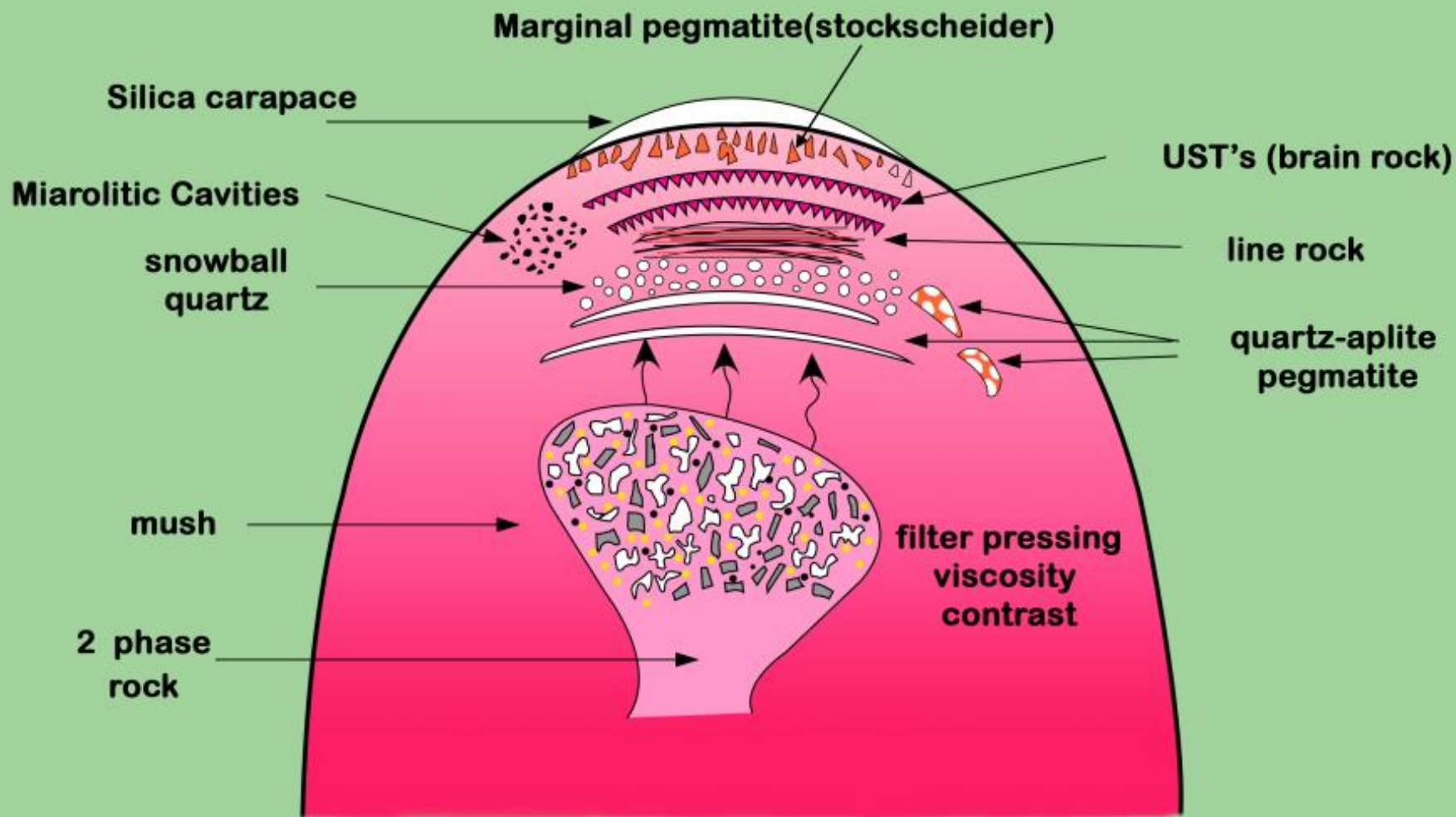
Magmatic Cupola Textures Observed at Intrusion-Related Mineral Deposits in Mongolia



- Formation of UST's and Silica caps
- UST's - Mongolian Examples
- Magmatic Silica Caps - Mongolian Examples
- Exploration Implications



Western Gobi Desert, Mongolia



Schematic section illustrating various cupola textures

UST's

UNIDIRECTIONAL SOLIDIFICATION TEXTURES

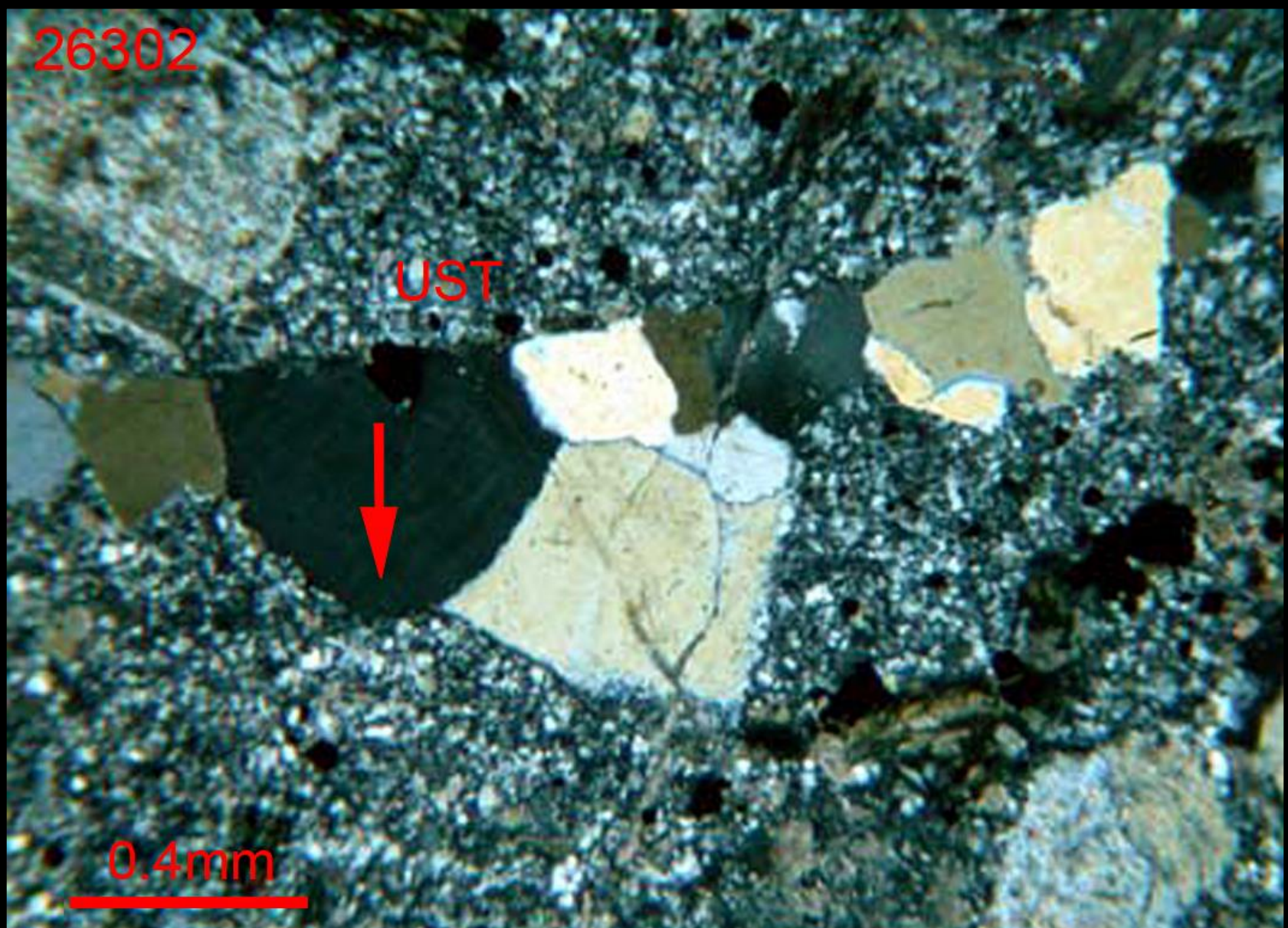




View of cupola at Umnu Hutul
(large hill in the foreground), Western Mongolia



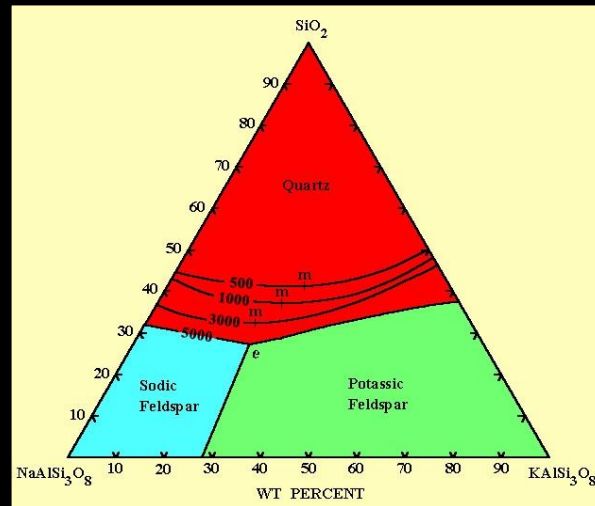
Parallel UST Bands



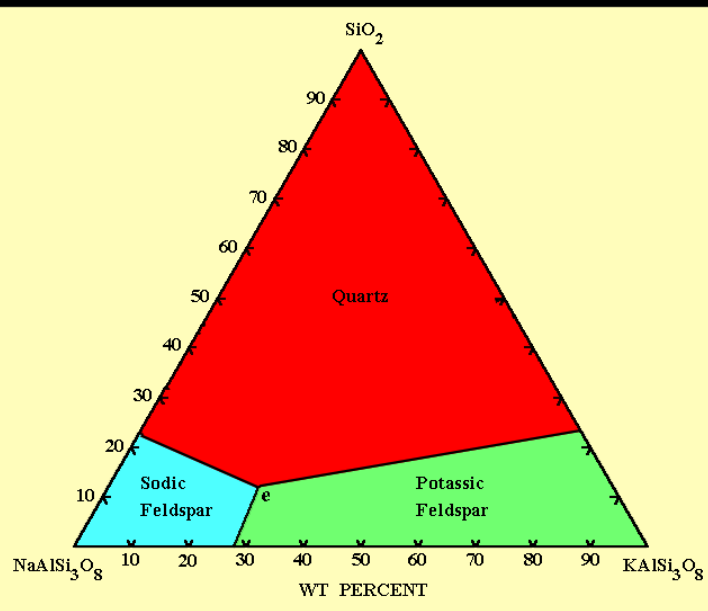
UST – Khongor porphyry deposit, South Gobi, Mongolia

0.8 % Cu and 0.15 g/t Au

The quartz stability field is pressure dependent

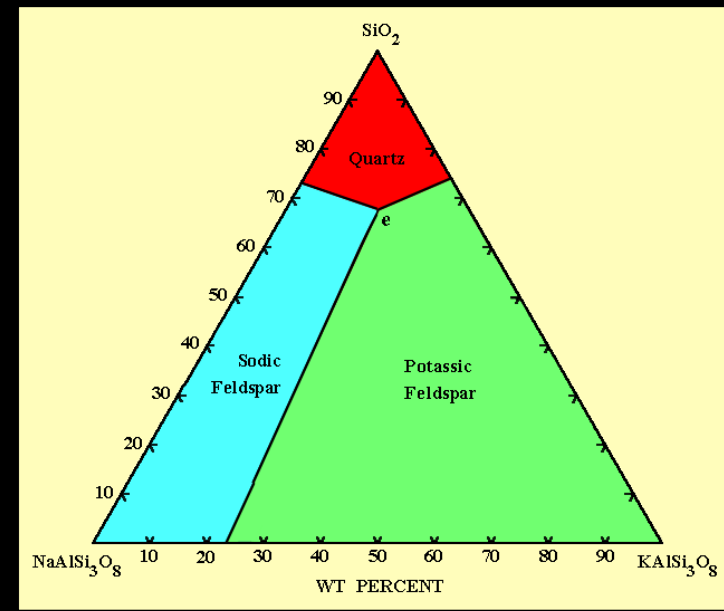
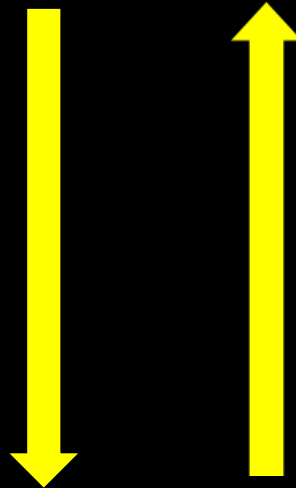


Normal conditions



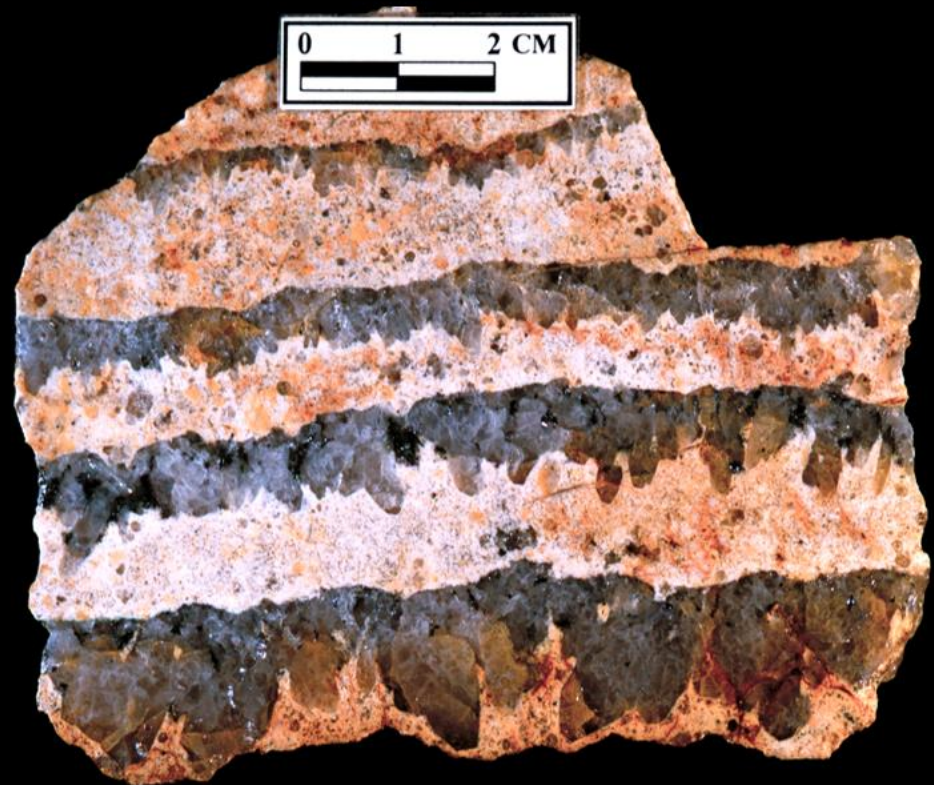
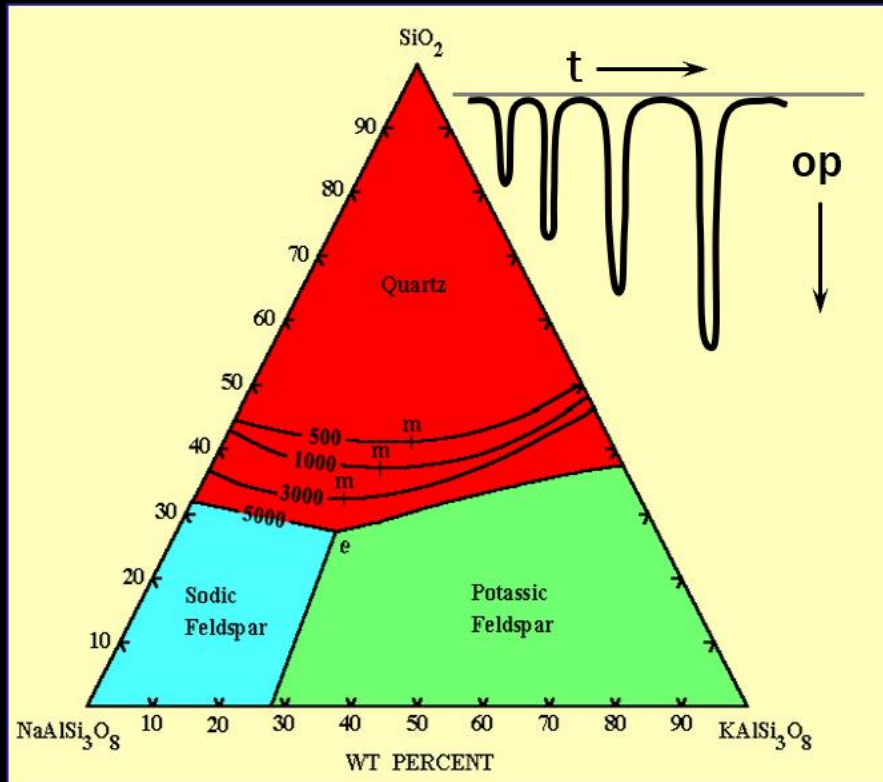
Overpressured

Volatiles
Pressure



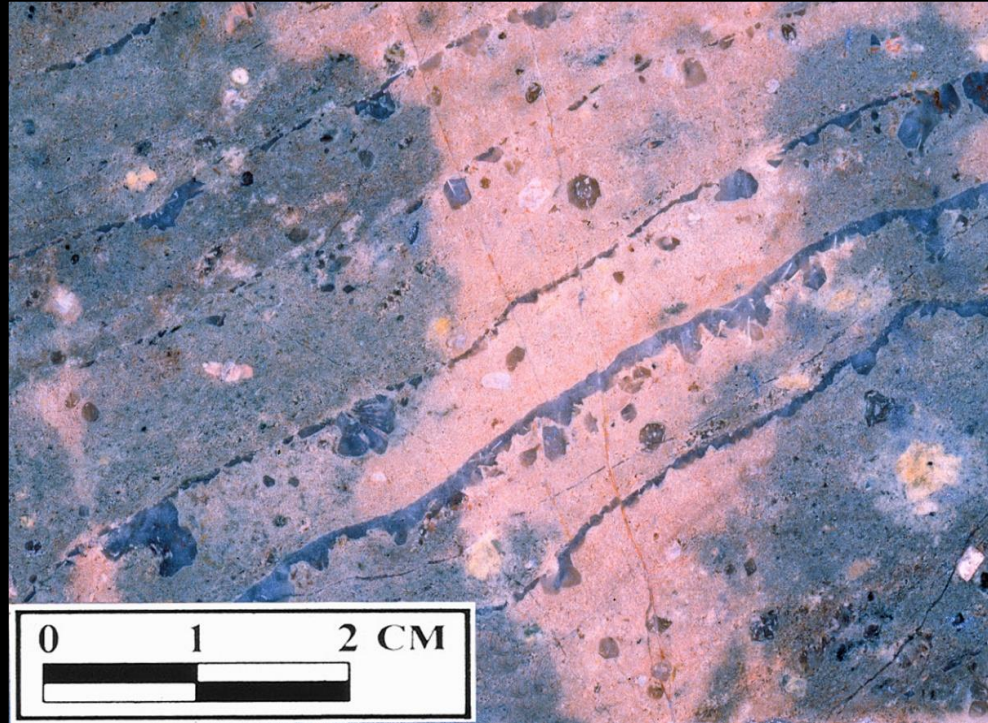
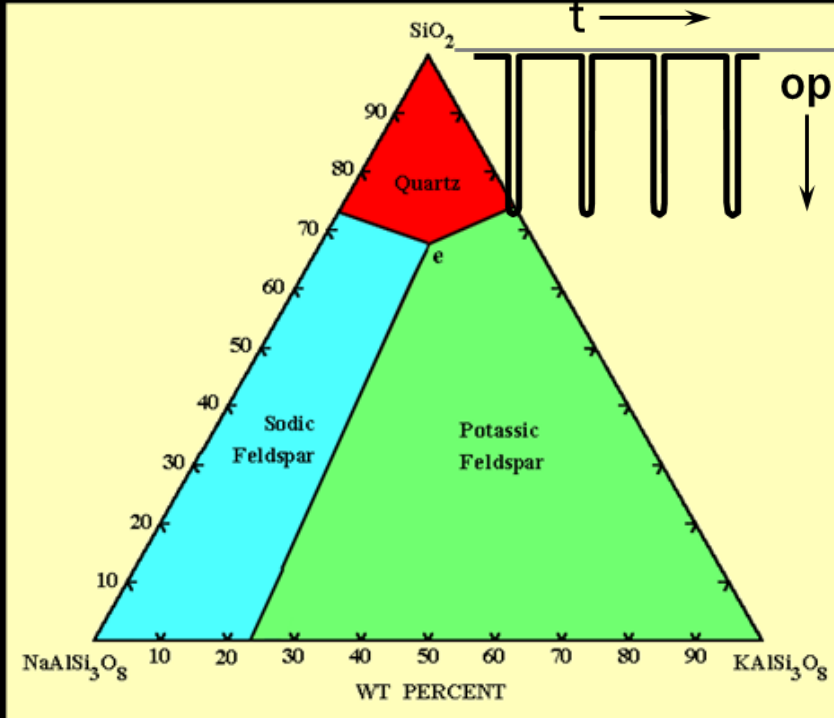
Underpressured

Increasing rhythmic overpressuring



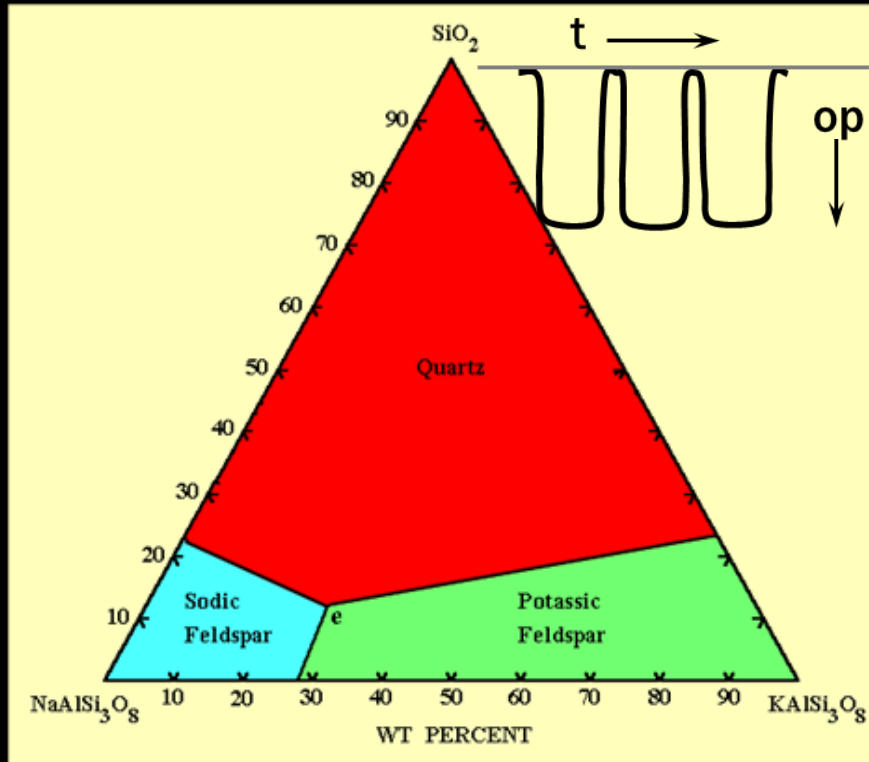
Anticlimax Mo deposit, Canada

Very limited periods of rhythmic overpressuring



Red Dome porphyry Cu-Au deposit,
North Queensland, Australia

Entended periods of overpressuring



Tsagaan Chulut Au deposit, Northeast Mongolia



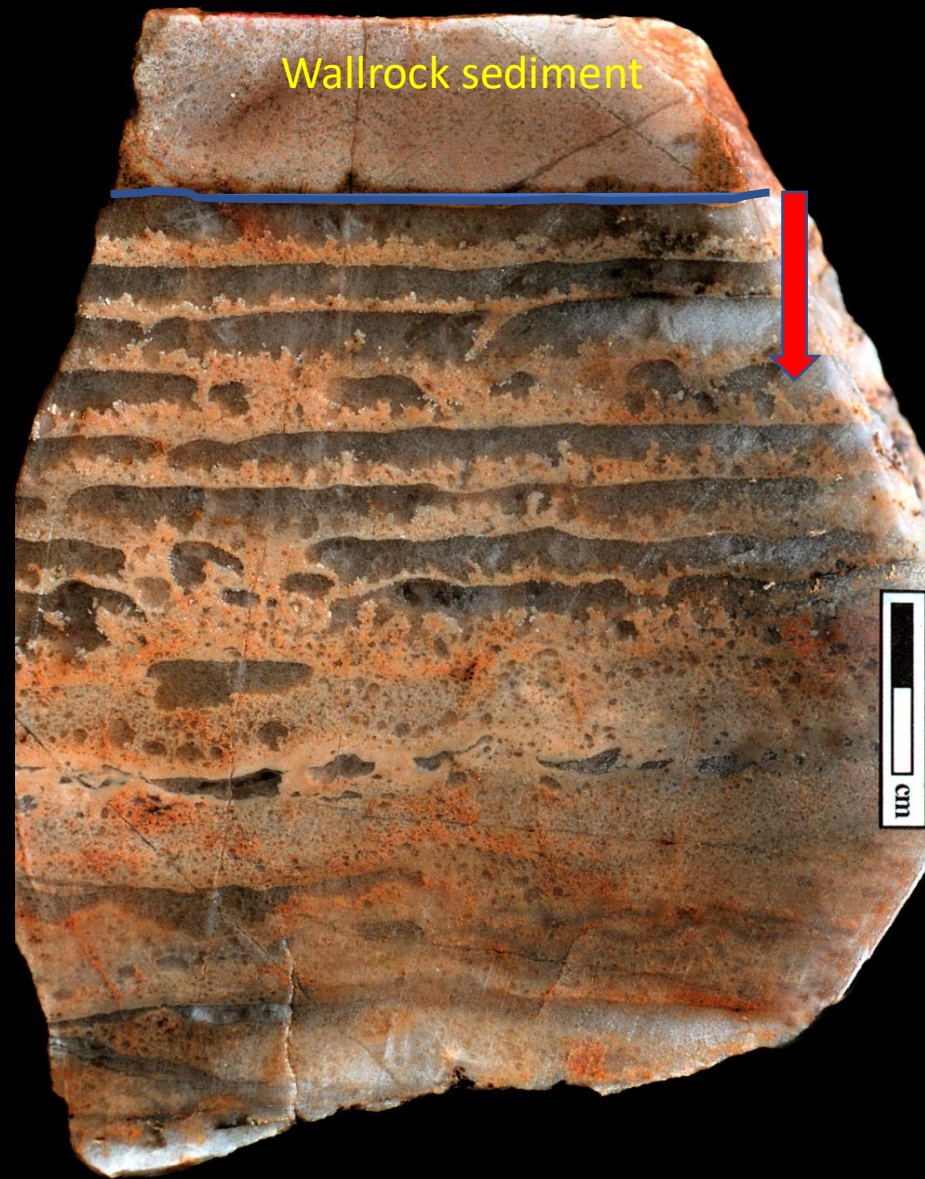


Location of the Umnu Hutul REE UST cupola, western Mongolia



Photo T.Sant

UST's in an aplitic cupola, Umnu Hutul, Western Mongolia



UST's in an aplitic cupola, Umnu Hutul, Western Mongolia



“Atoll” texture USTs, Umnu Hutul REE-bearing cupola, western Mongolia.



Aerial view of the quartz UST cupola at Kharaatyagaan, Central Mongolia



(photo-J.Erdenebayar)

Outcropping UST zones at Kharaatyagaan cupola, Central Mongolia

(photo-J.Erdenebayar)



Outcropping UST zones at Kharaatyagaan cupola, Central Mongolia



Three dimensional UST's , Kharaatyagaan cupola, Central Mongolia

High silica rock unit

(a)

Contact of layers and multilayered sequences consisting of crenulate quartz (UST) and quartz eyes porphyry

(b)

Layers and multilayered sequences consisting of crenulate quartz (UST)

(c)

dendritic and micrographic alkali feldspar-quartz intergrowths

(d)

Mineralised quartz vein bearing quartz eyes porphyry

(e)

Mineralised quartz vein and fluorite veins

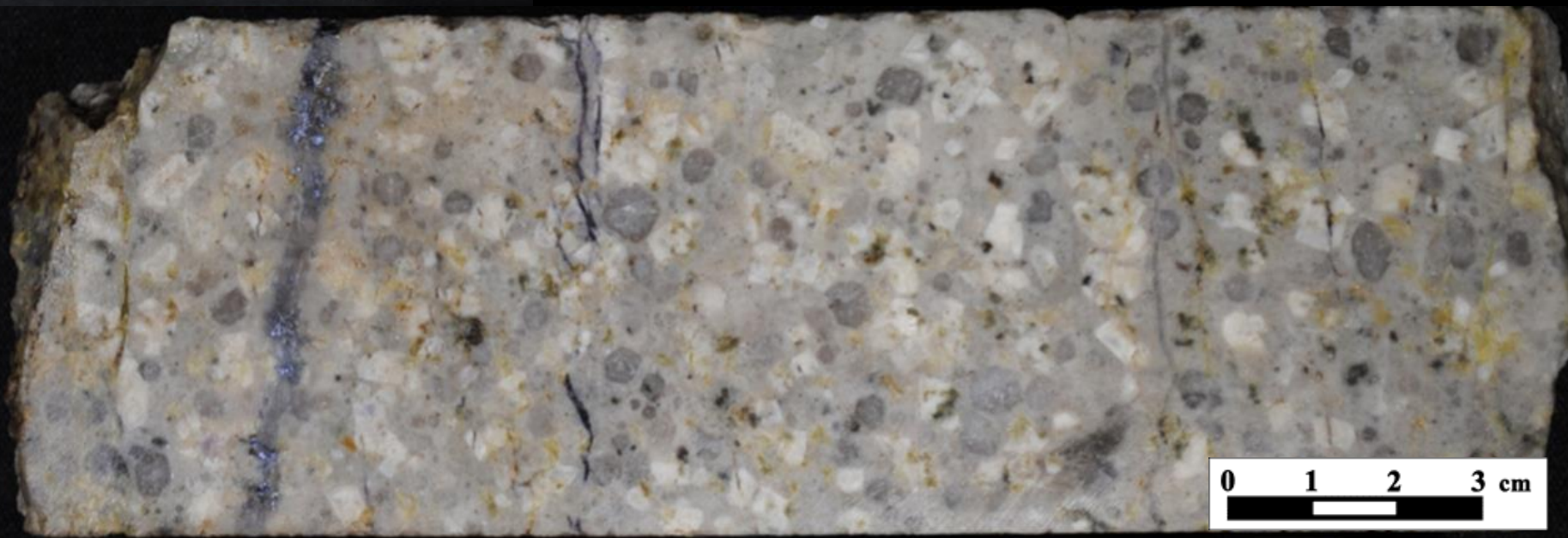
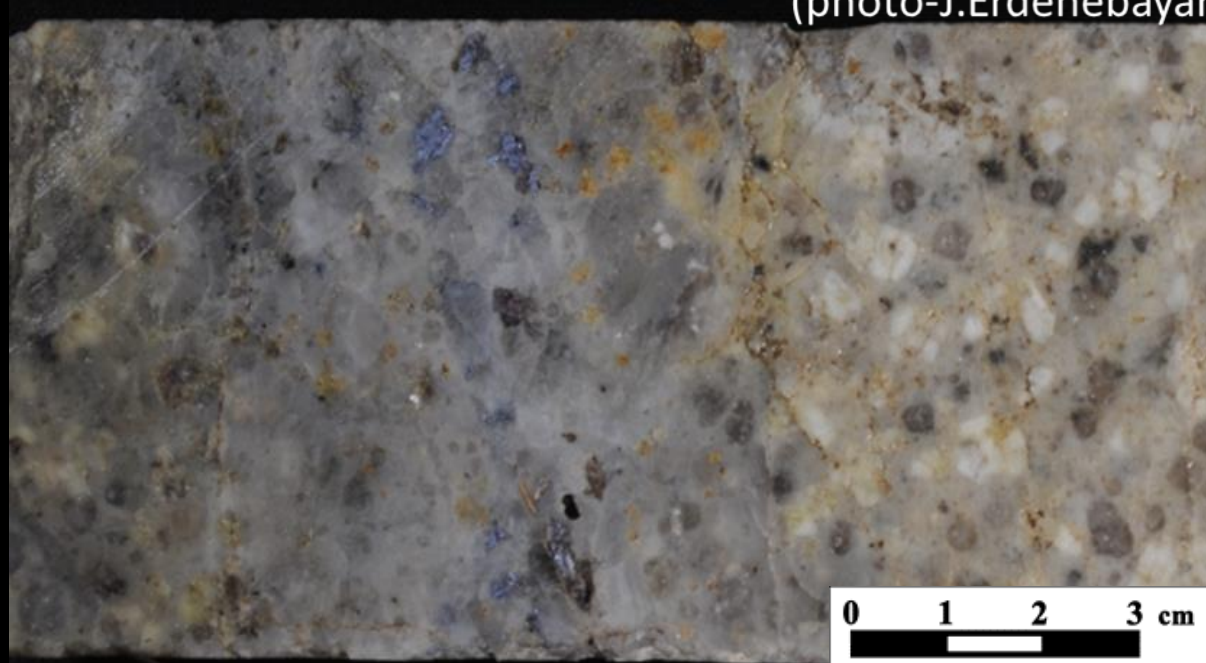
(f)

(photo-J.Erdenebayar)

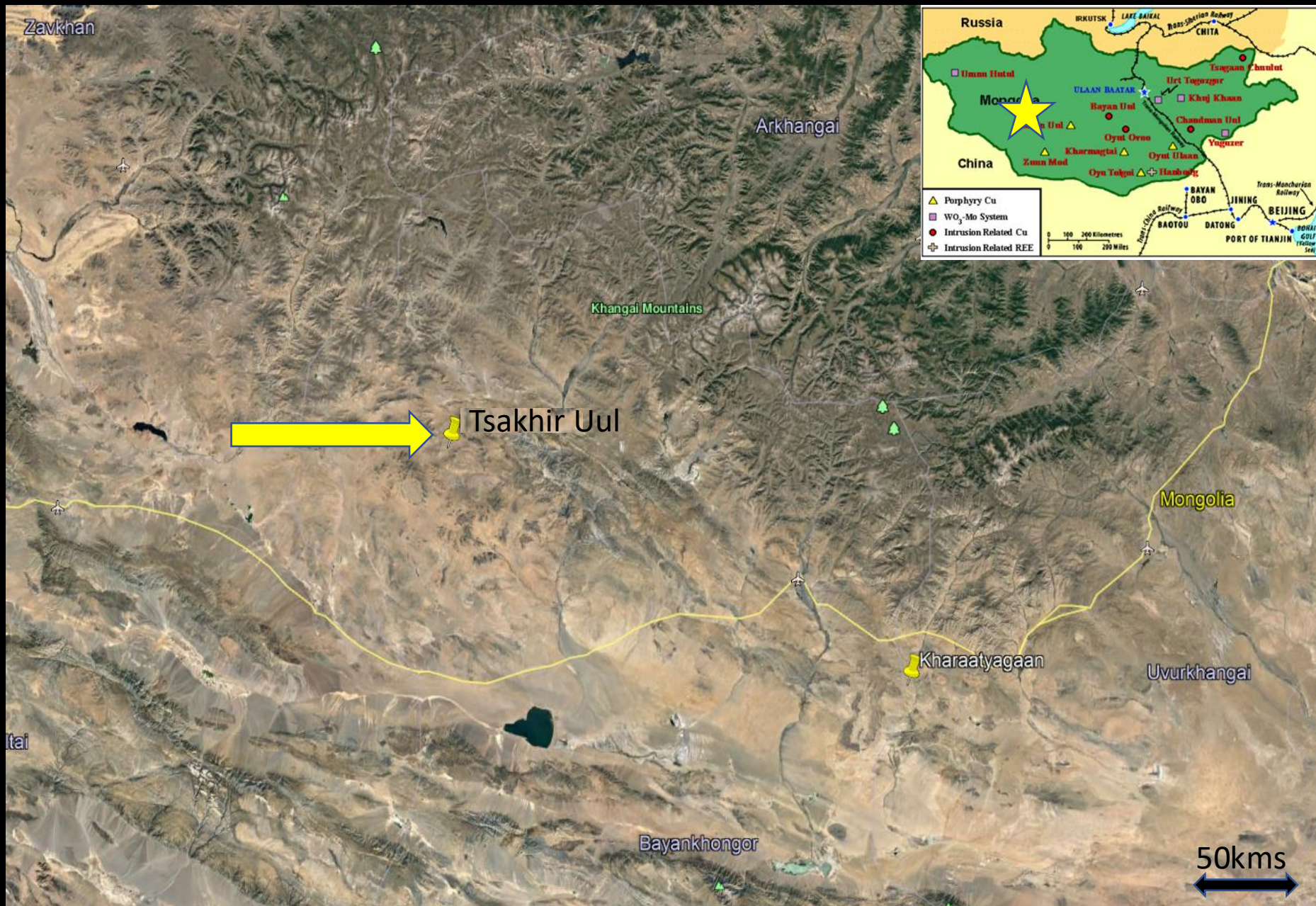
(Erdenebayaar, 2018)

Rock types and UST's, Kharaatyagaan tungsten-tin district, Central Mongolia

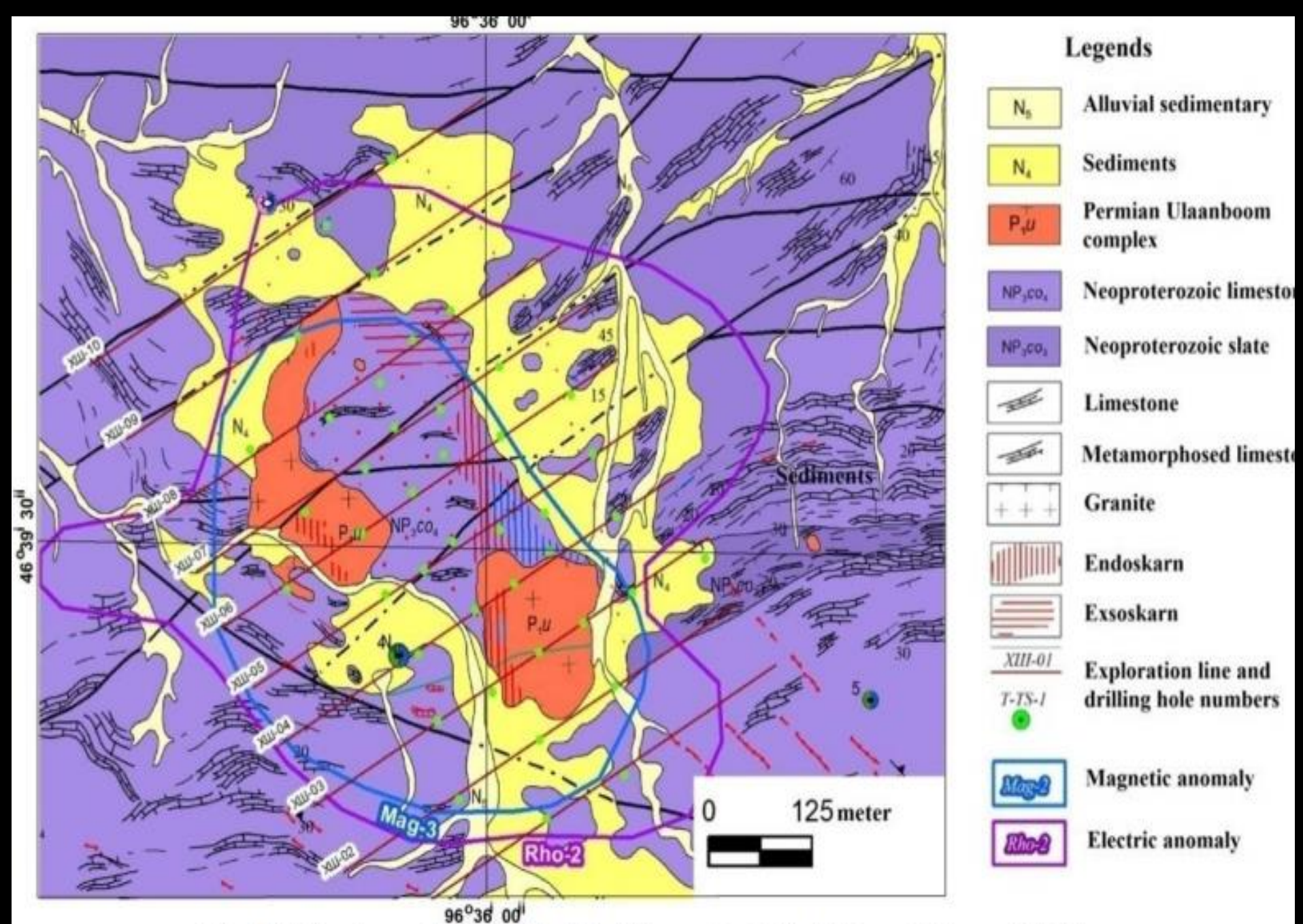
(photo-J.Erdenebayar)

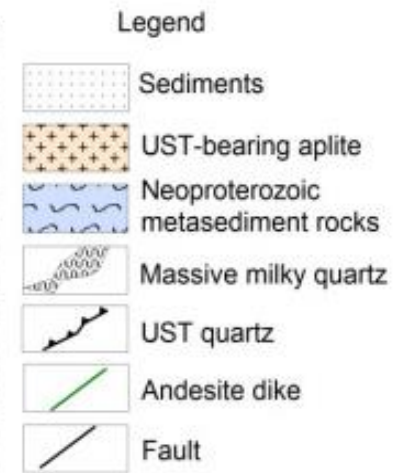
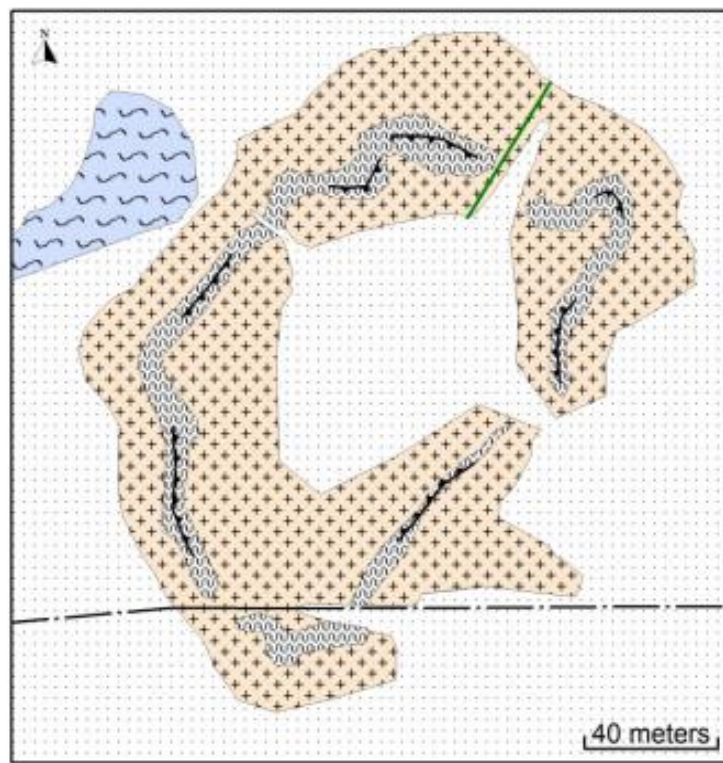


Quartz-wolframite veins, Kharaatyagaan district, Central Mongolia



Location of Tsakhir Uul UST Mo occurrence, western Mongolia

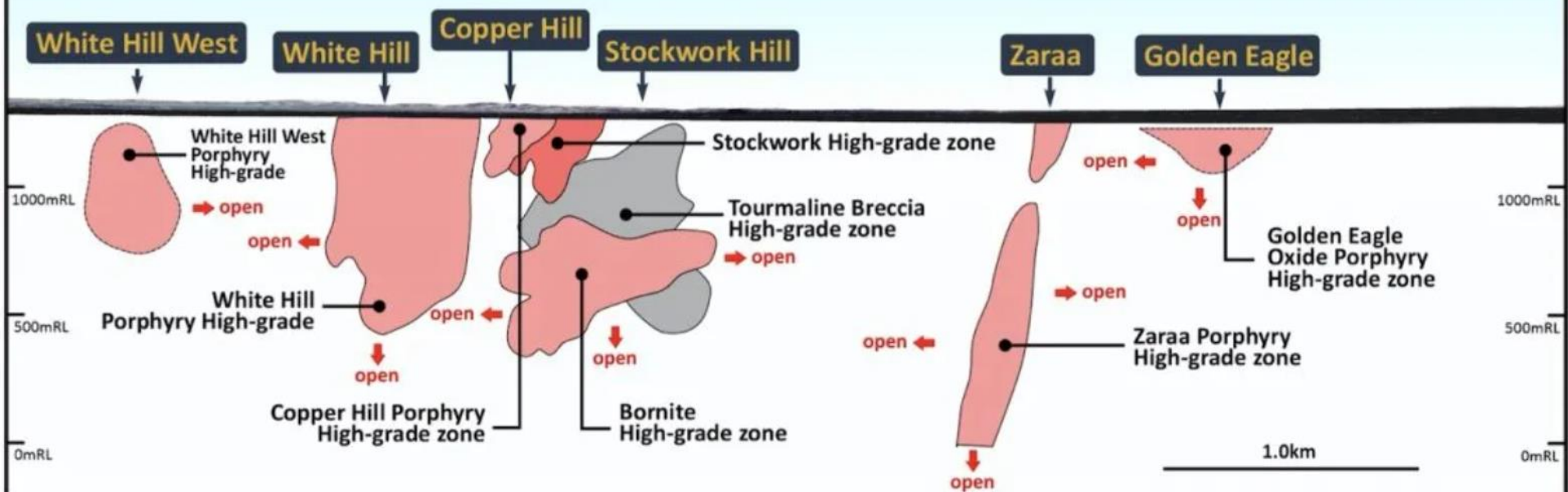




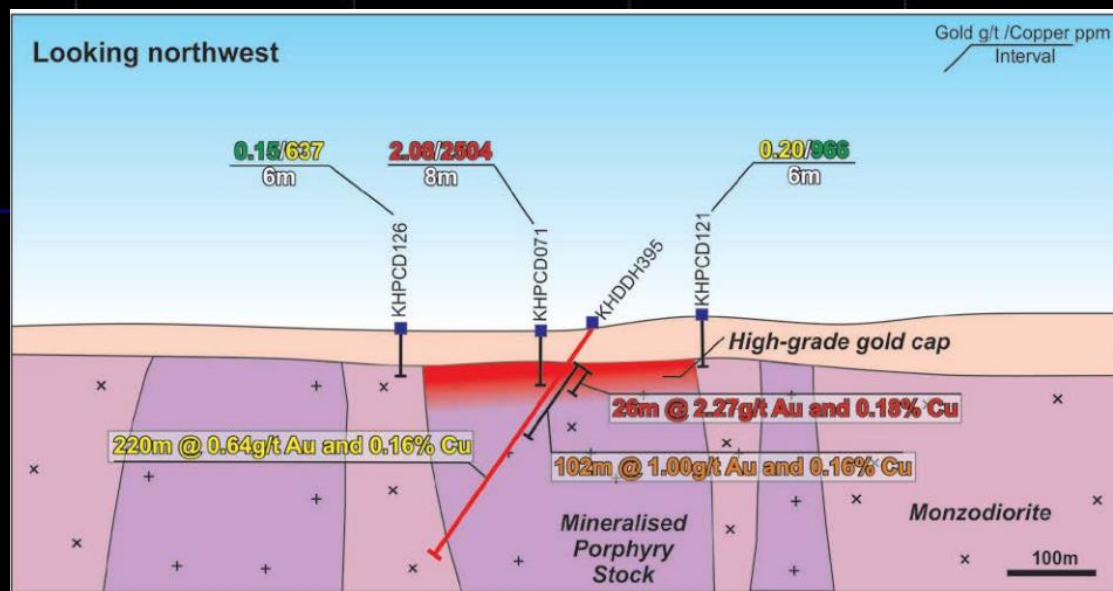
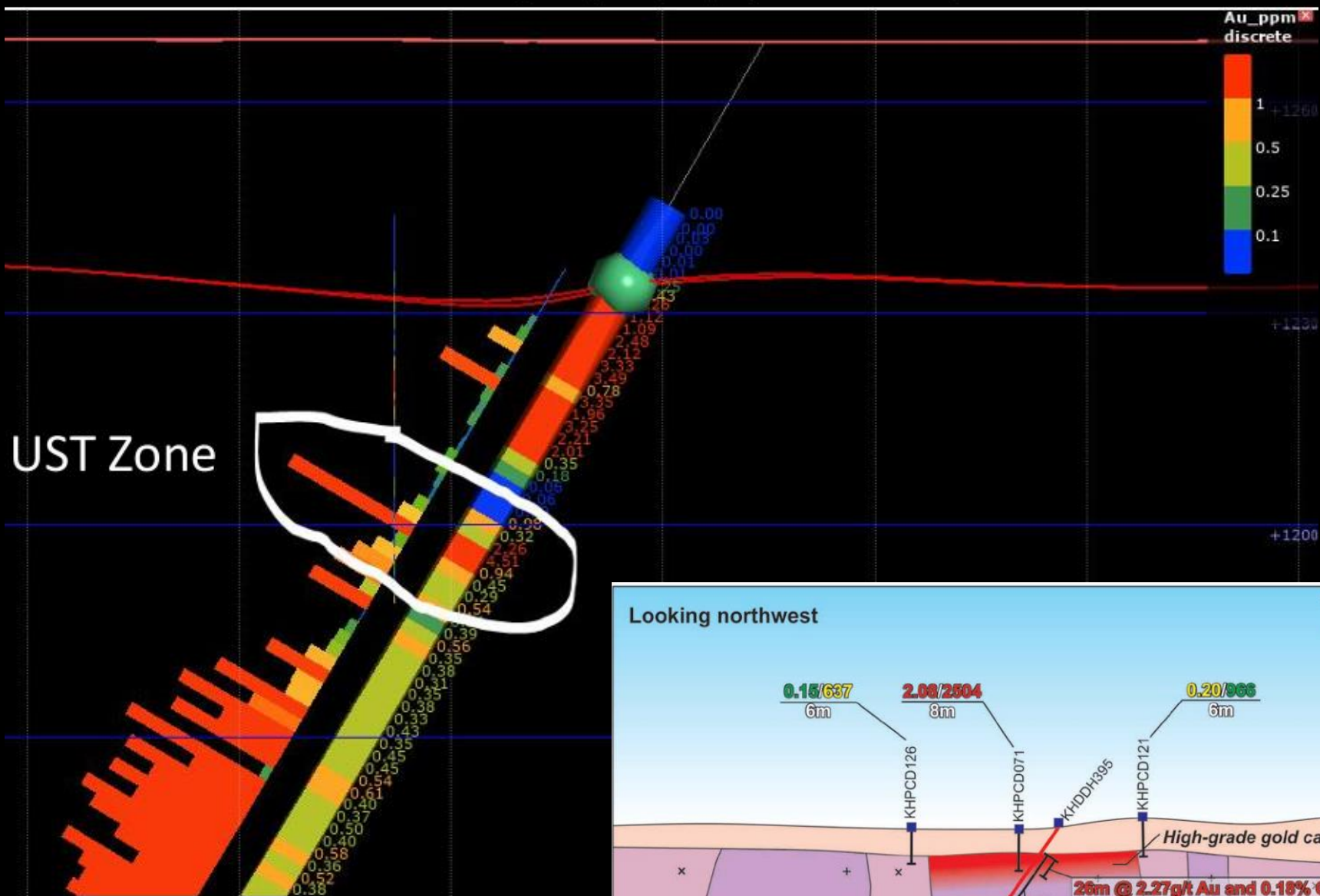
The UST occurrence at the Tsakhir Uul Mo deposit, Western Mongolia (From Erdenebayer, 2016)

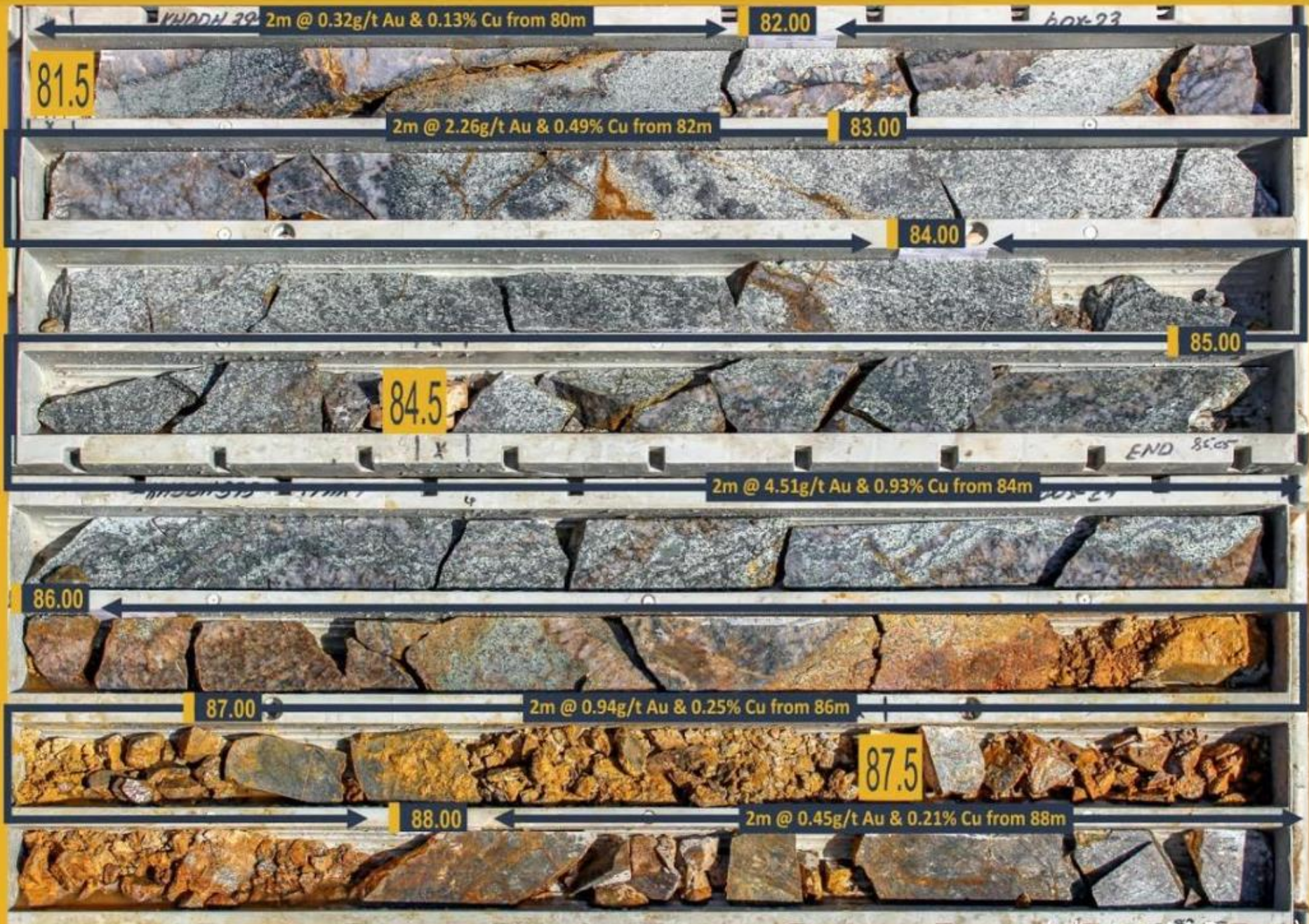


Kharmagtai - Mineralisation



KHDDH 395 Kharmagtai porphyry Au-Cu deposit

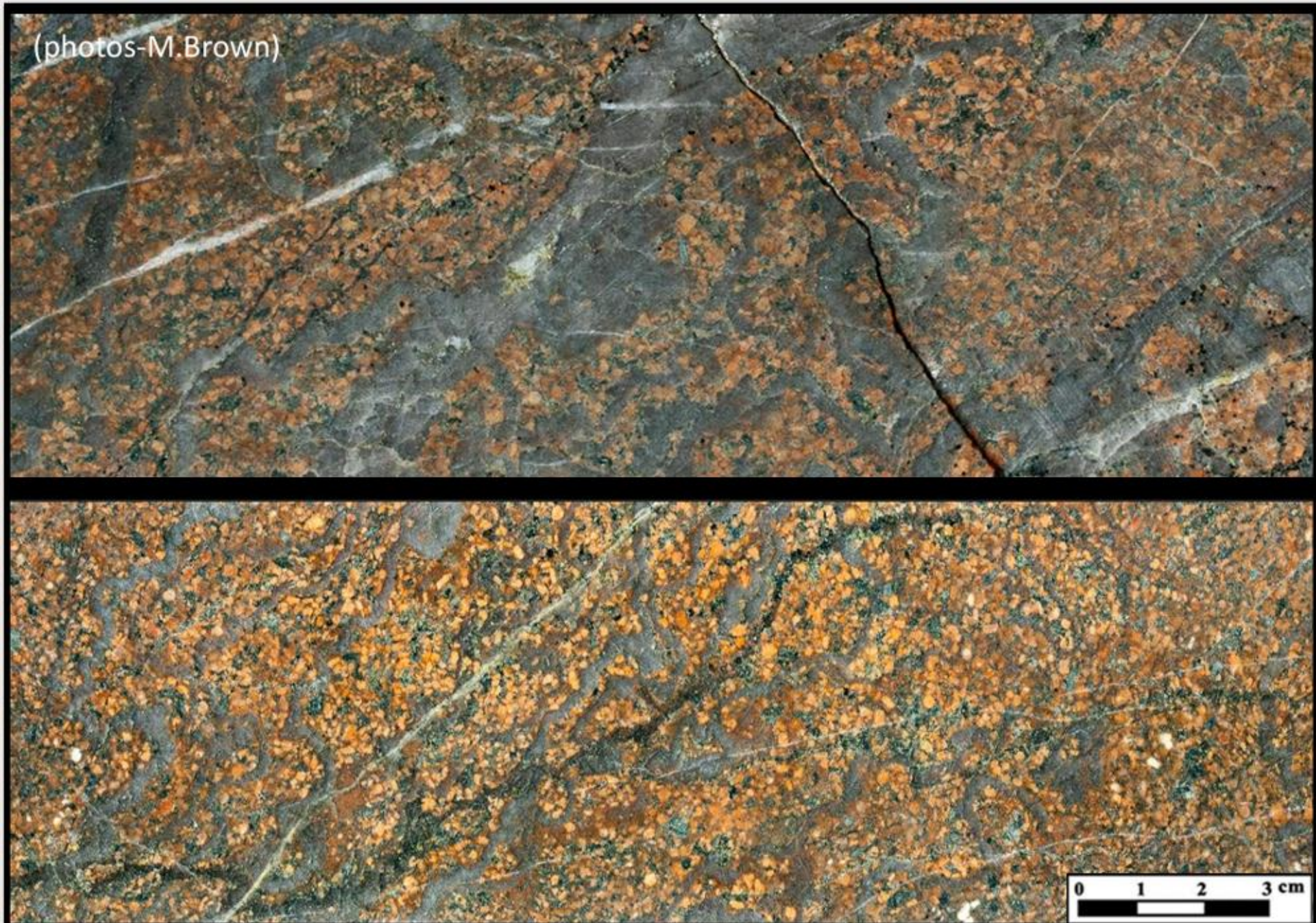




(photos-M.Brown)

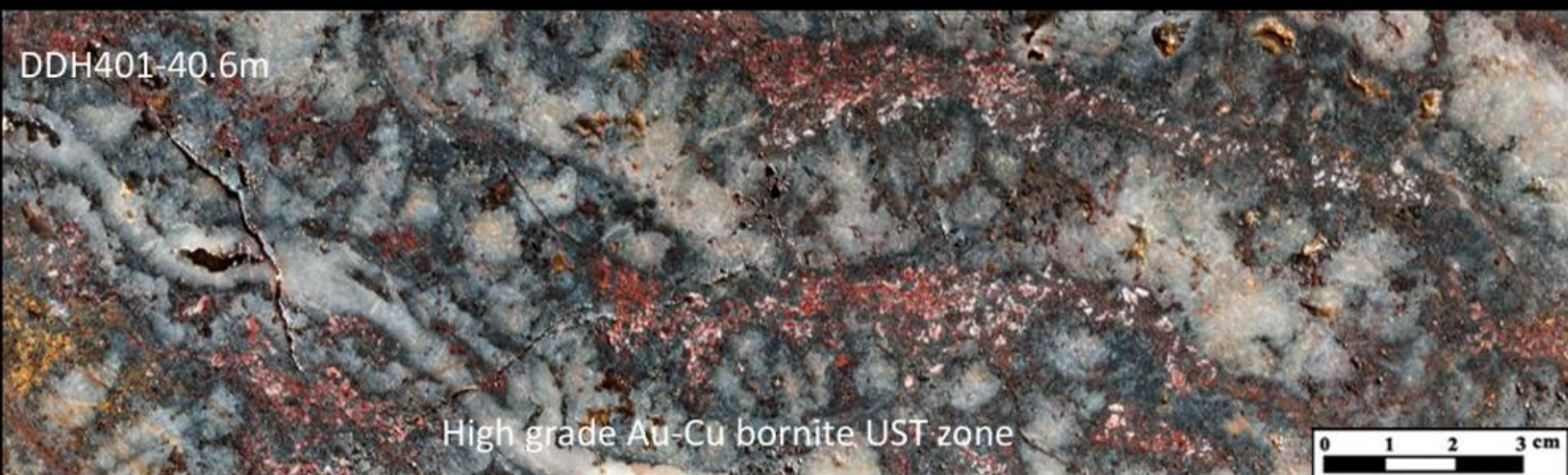
KHDDH 395 Kharmagtai porphyry Au-Cu 26m @ 2.7 g/t Au & 0.18% Cu

(photos-M.Brown)



Quartz-magnetite USt's Kharmagtai Au-Cu porphyry, South Gobi, Mongolia

(photos-M. Brown)



High grade UST bornite zone, Golden Eagle, Kharmagtai

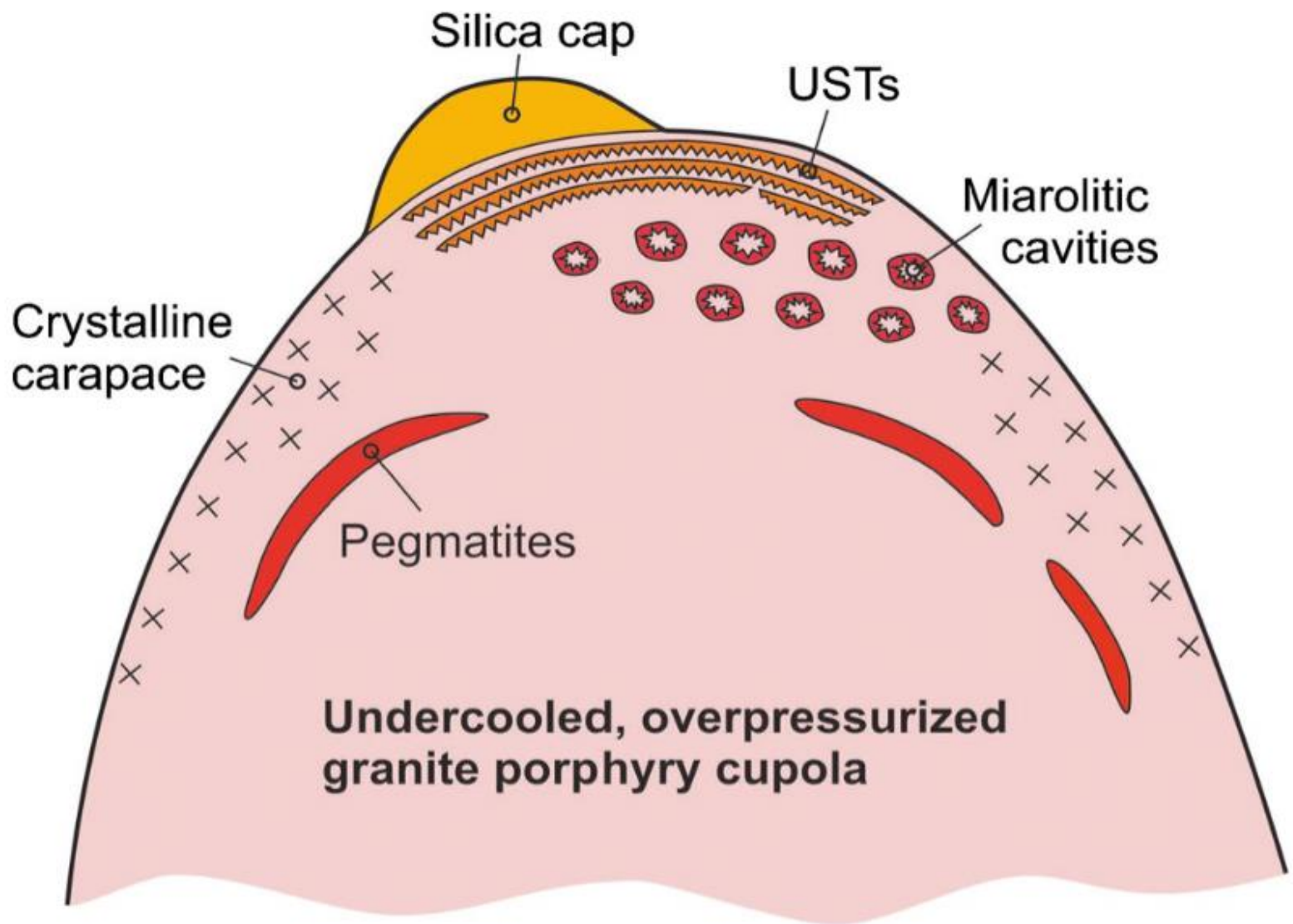


Fig. 2 Schematic diagram showing distribution of various early-stage magmatic textures in the apical zone of stock-like porphyry intrusions. Modified from Kirwin (2006)

(first described by Clarke, 1969)



The massive silica cupola, Ravenswood Goldfield, North Queensland, Australia

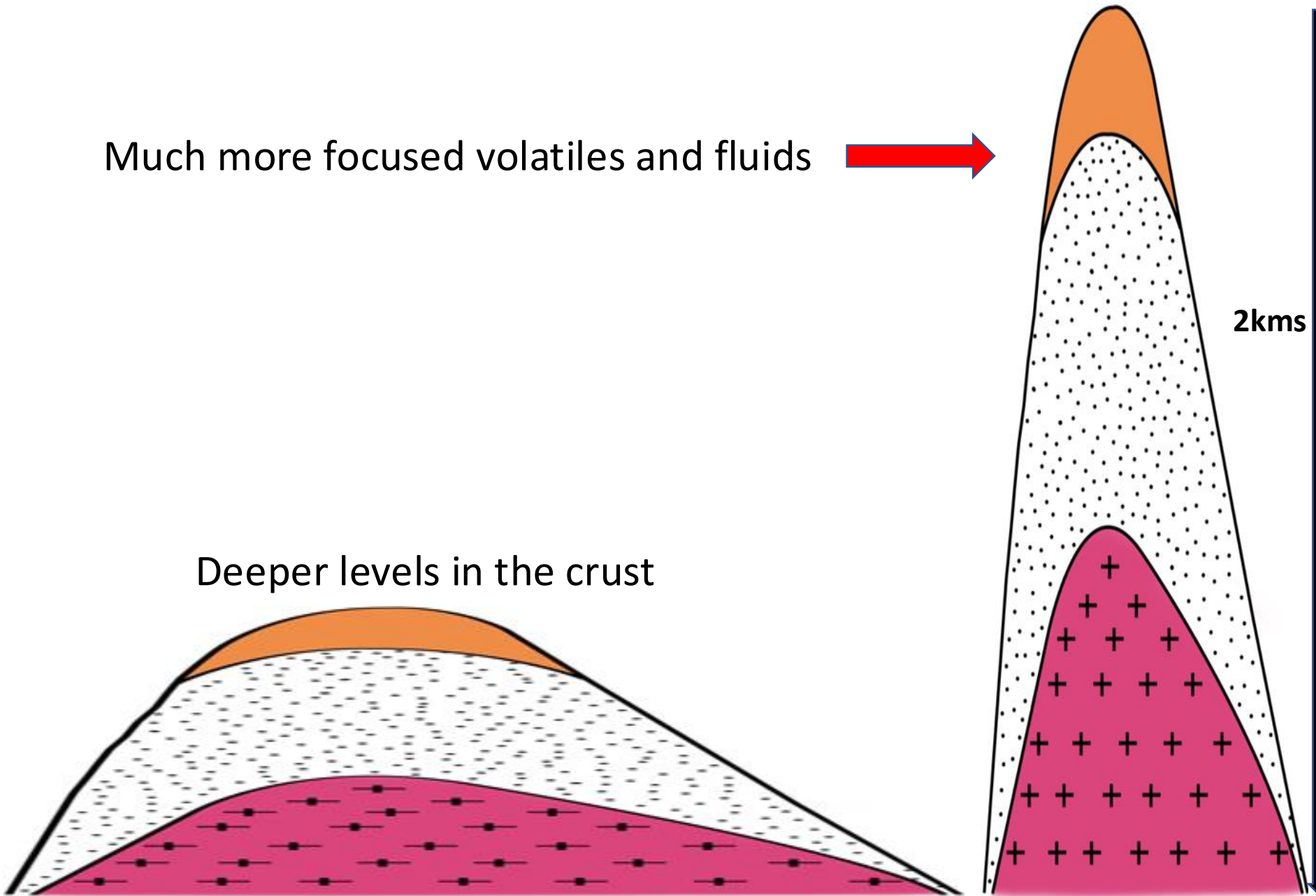
Much more focused volatiles and fluids



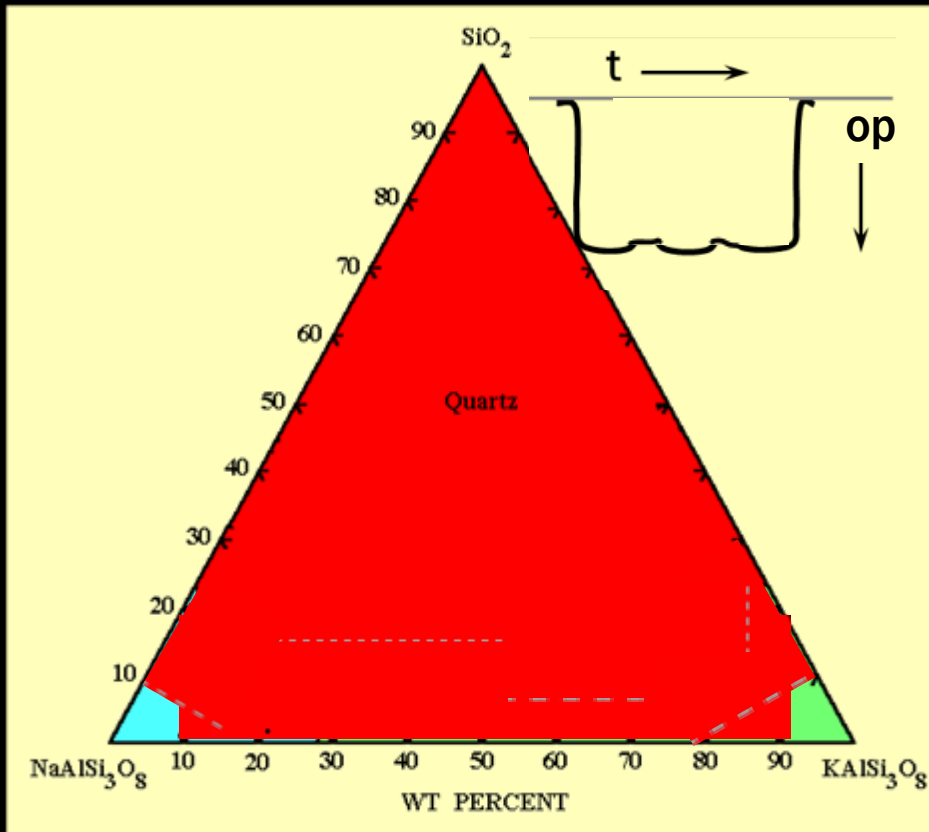
Deeper levels in the crust

2kms

Two very different cupola scenarios

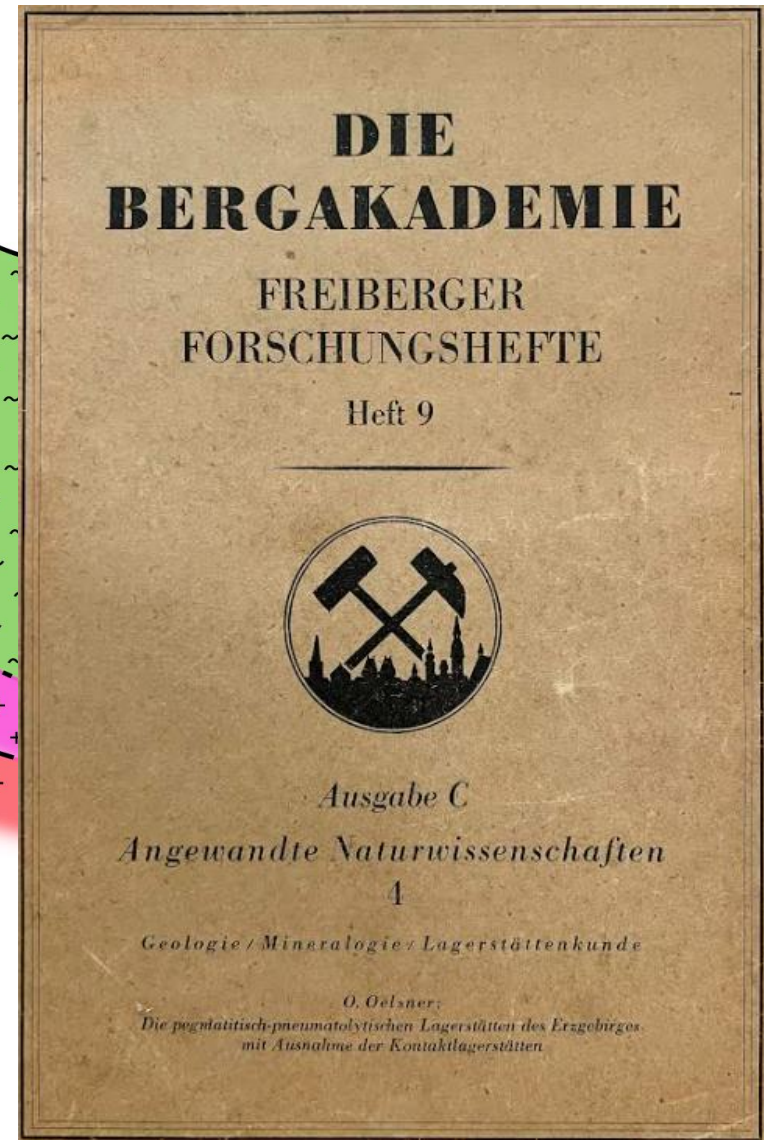
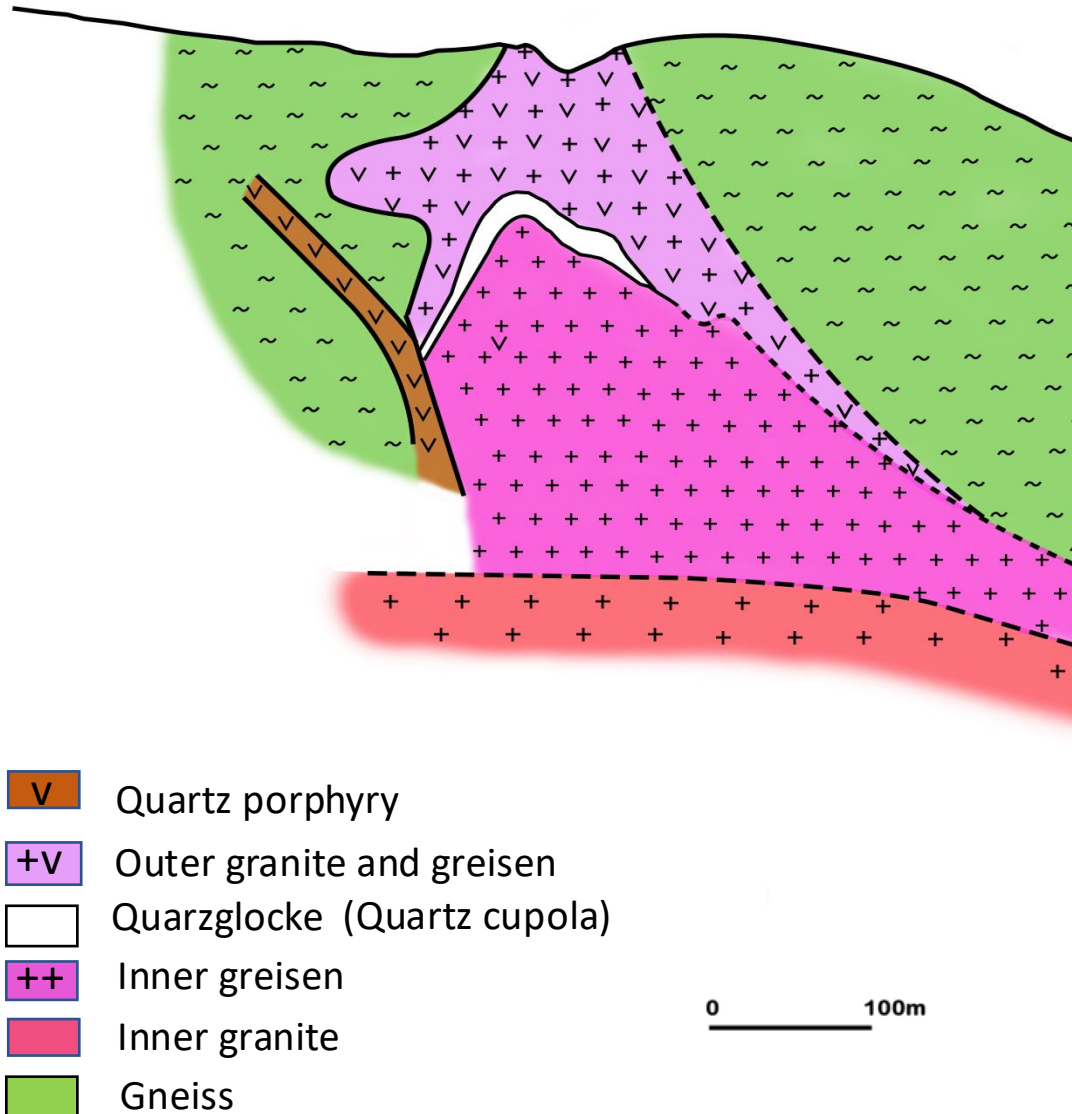


Formation of Silica Cupola Caps



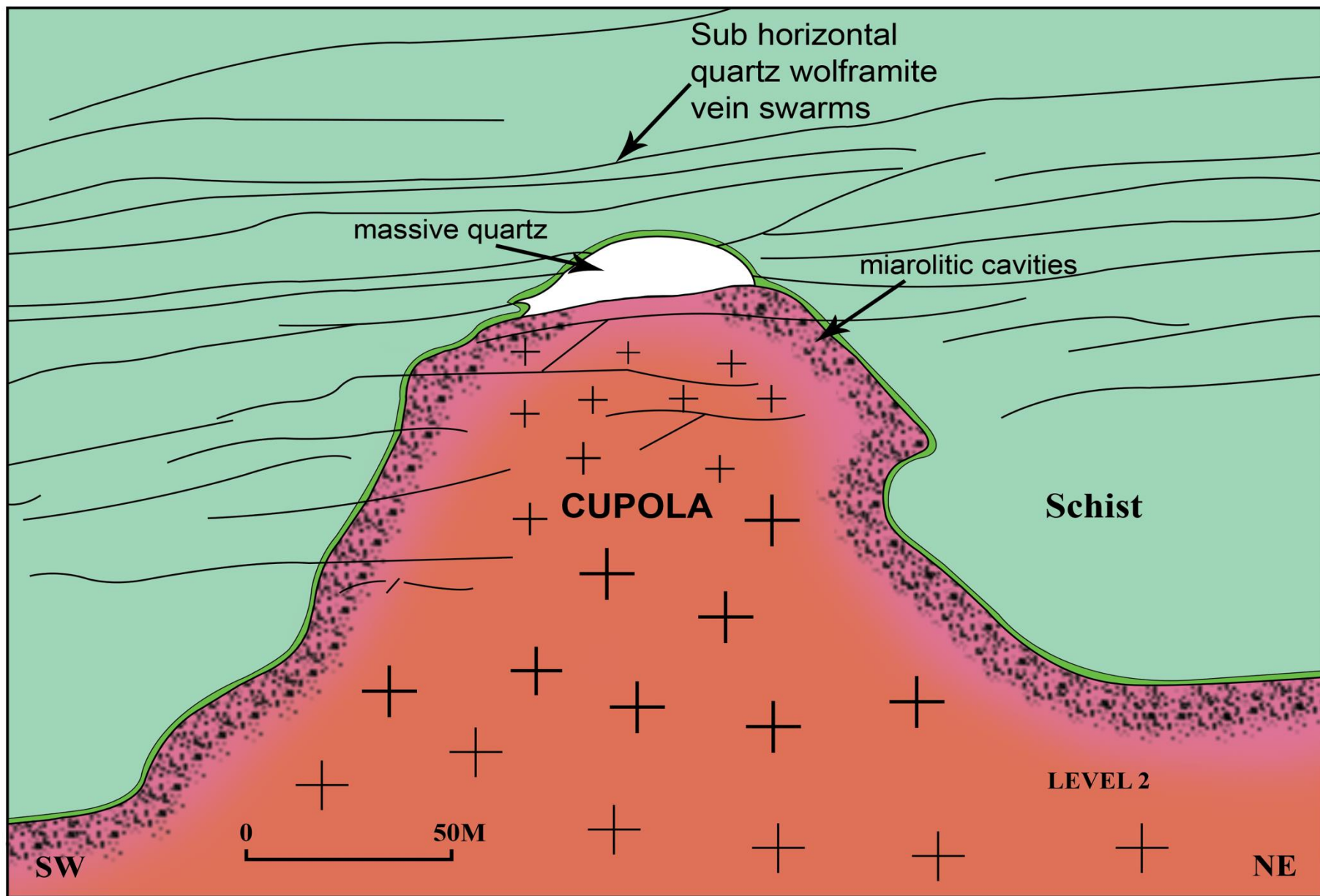
Massive magmatic quartz, Tsagaan Suvarga, South Gobi, Mongolia
(approximately 200m in diameter and 50m thick)

Silica Cap Examples

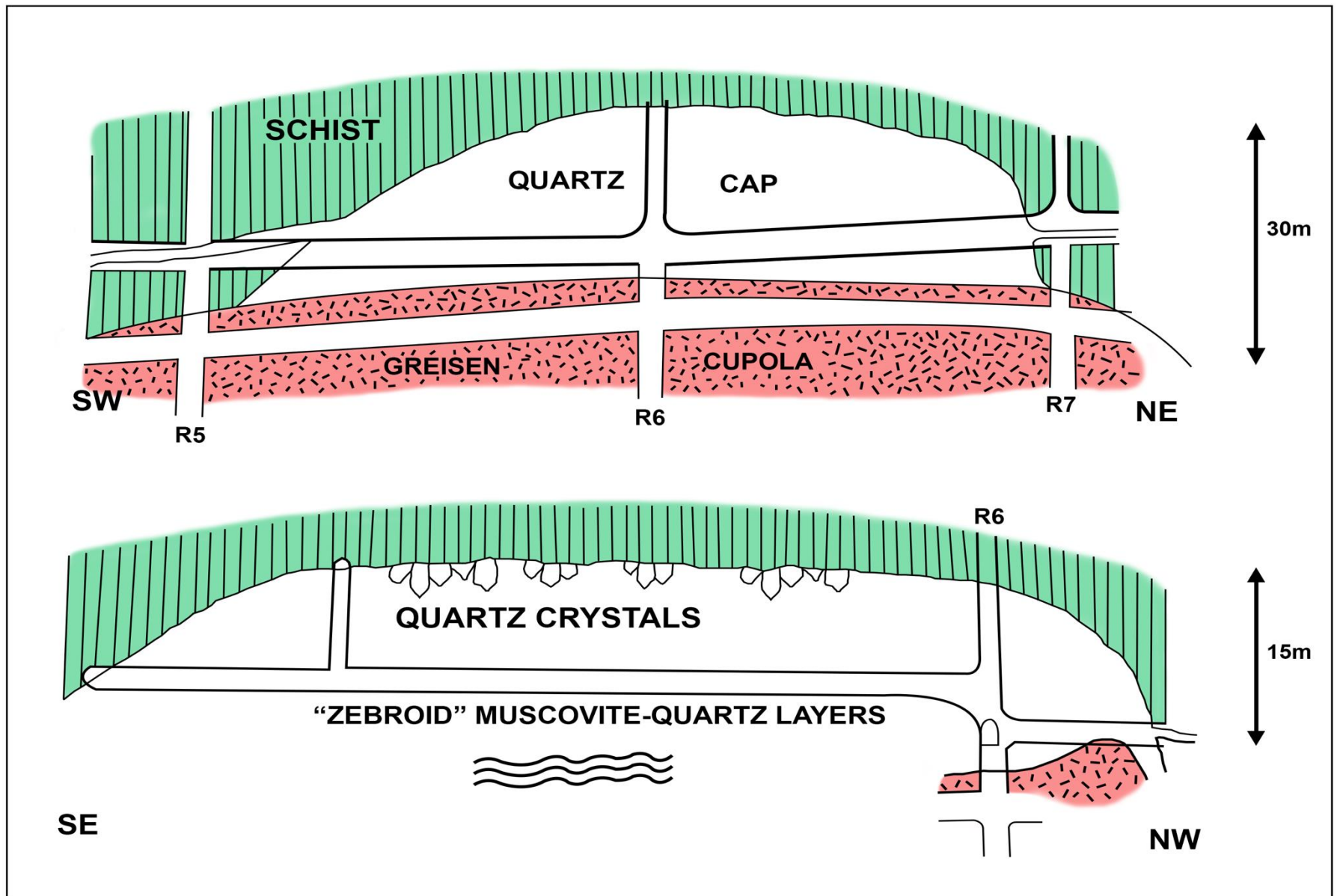


Sadisdorf mine cross section, Erzgebirge, Germany

(redrawn from Oelsner, 1952)



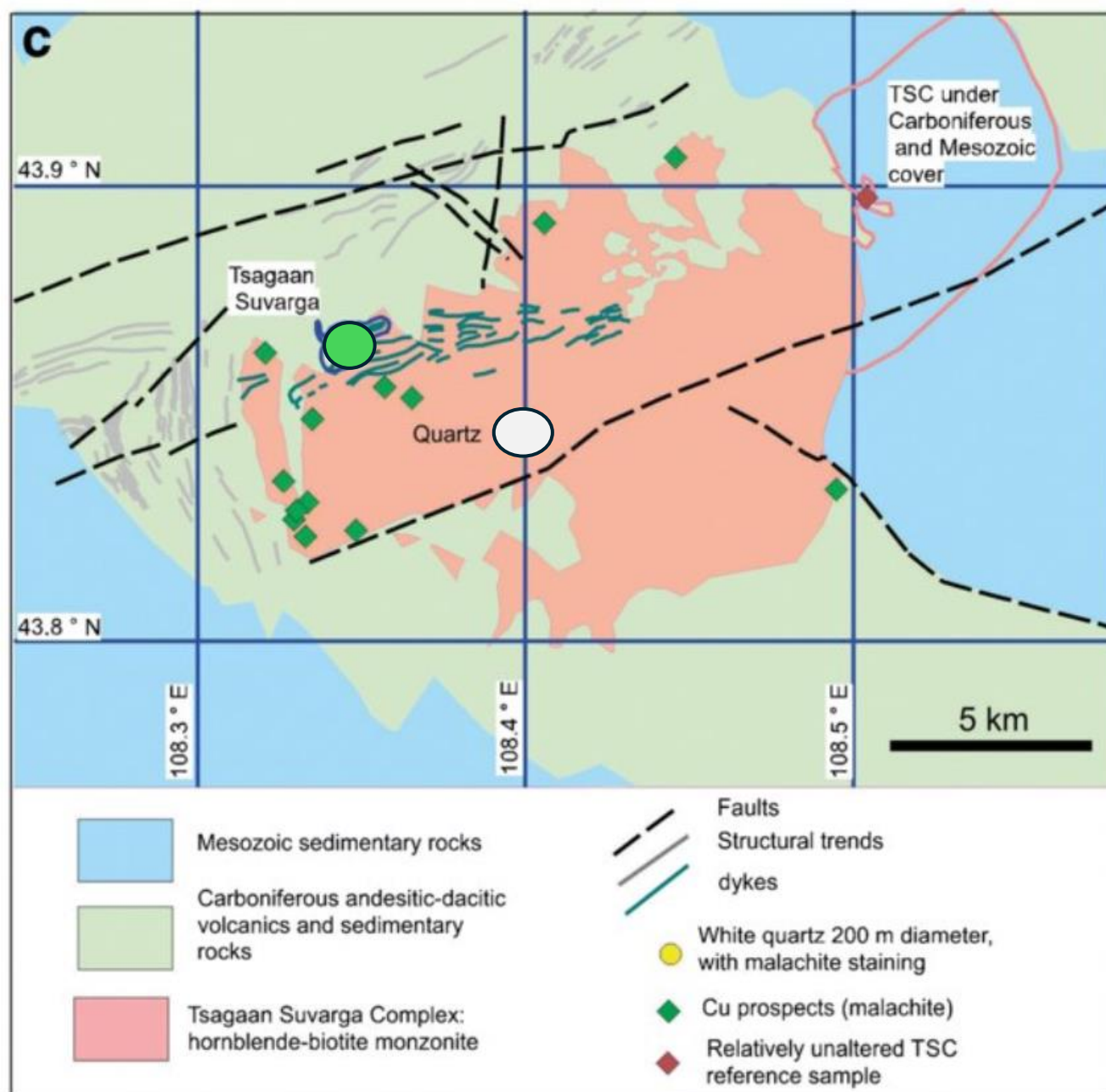
Schematic section illustrating the "Silica Cap" at Panasqueira, Portugal.
(from Kelly and Rye, 1979).



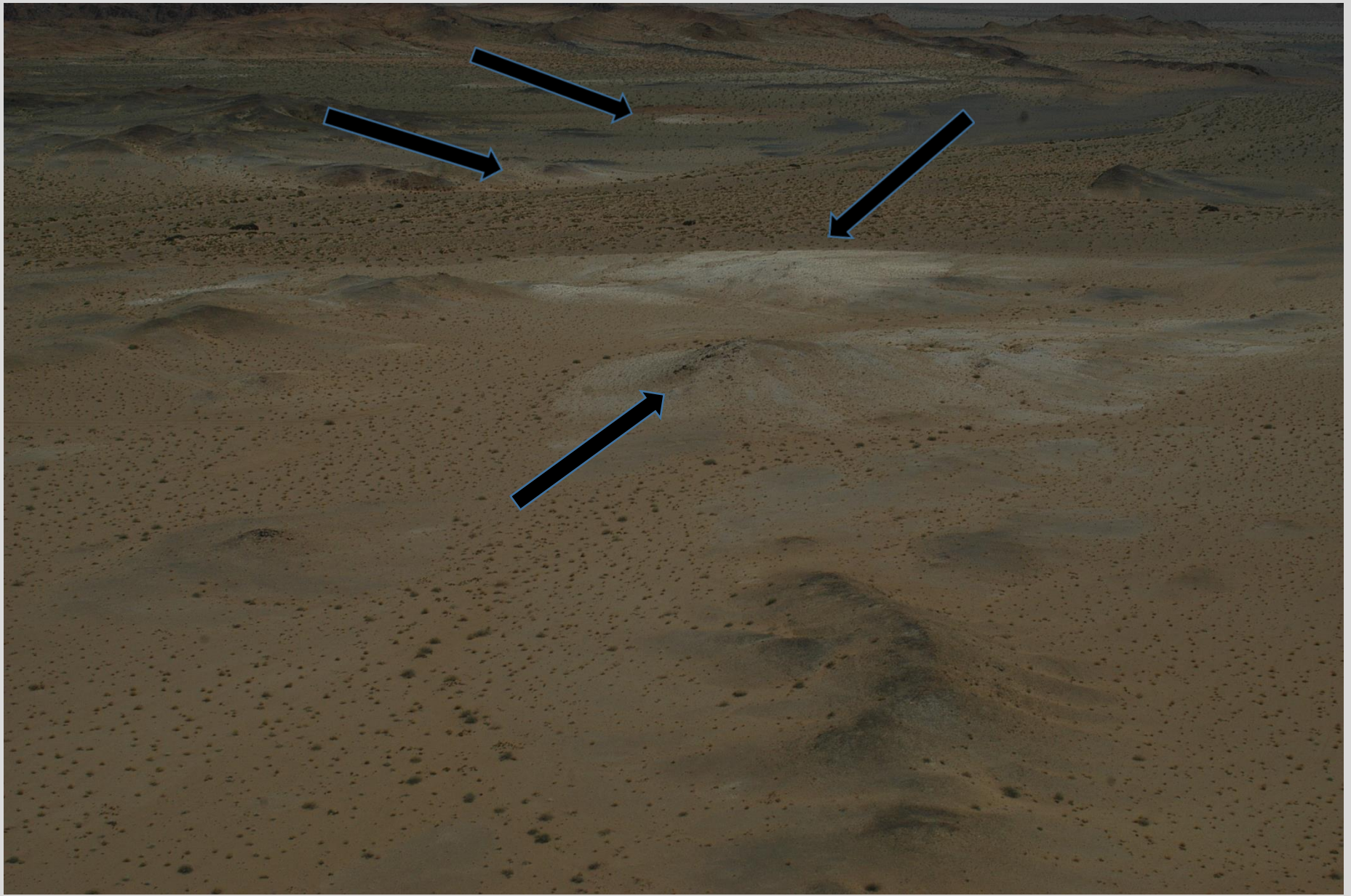
Schematic sections across the "Quartz Cap" at Panasqueira, Portugal. Incorporating text comments published by Kelly and Rye (1979)



Massive UST zone, Cupola zone, Panasqueira tungsten mine, Portugal.



Silica cap and porphyry copper deposit, Tsagaan Suvarga



Aerial view of massive silica outcrops, Zuun Mod, South Gobi, Mongolia.



Massive silica (quartz) outcrop, Zuun Mod, South Gobi, Mongolia



Weathered UST zone below massive silica, Zuun Mod, Mongolia



Massive silica UST transition, Zuun Mod, South Gobi, Mongolia

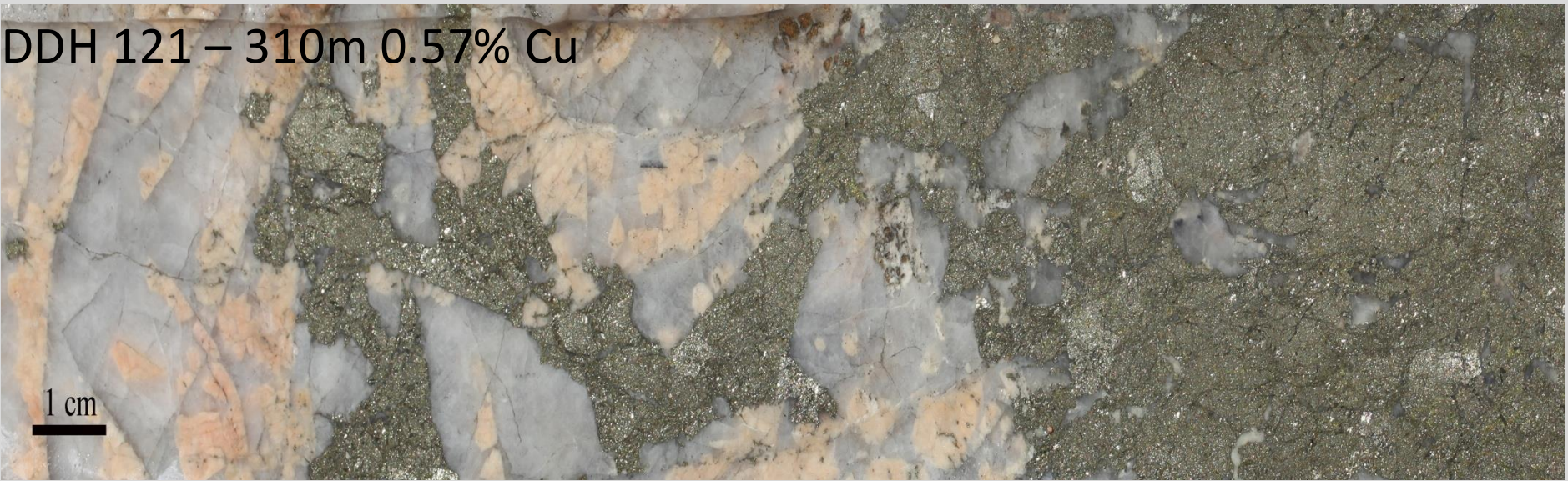
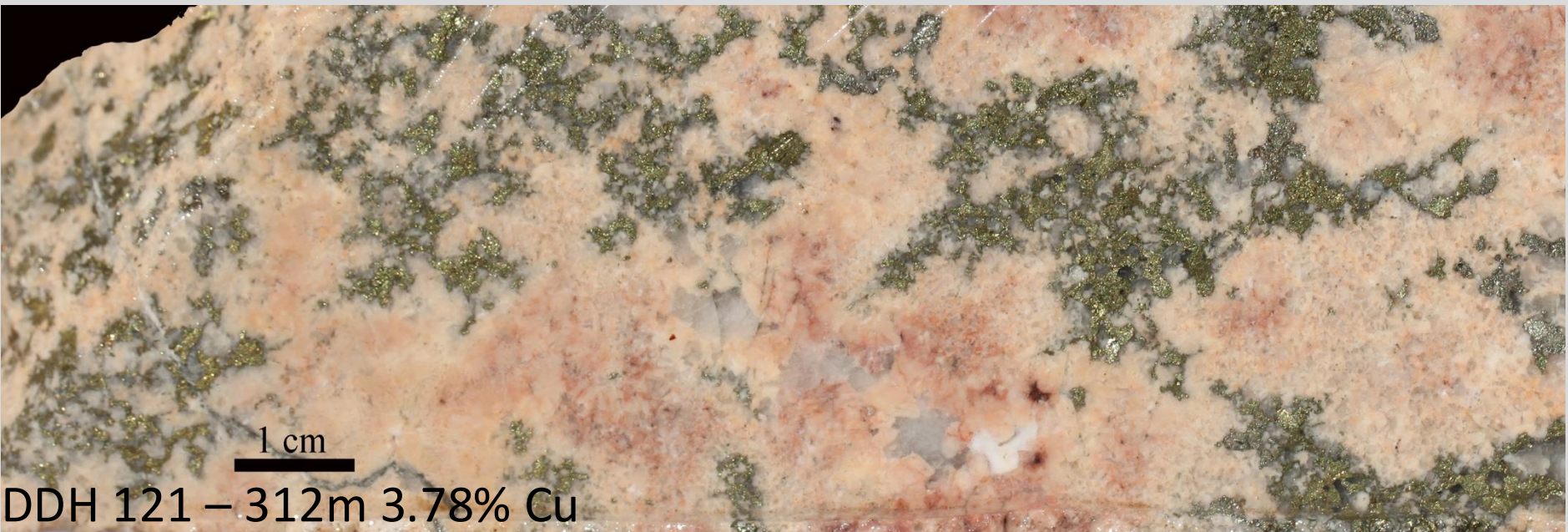
DDH 121 - - 308.8m

1 cm

DDH 121 - 320m

1 cm

Magmatic quartz-K spar cupola textures, Zuun Mod, Mongolia (photos J.LoGrasso).



Interstitial sulfides with magmatic quartz and K-spar, Zuun Mod (photos J.LoGrasso).



South Gobi gold-copper porphyry deposits, Mongolia

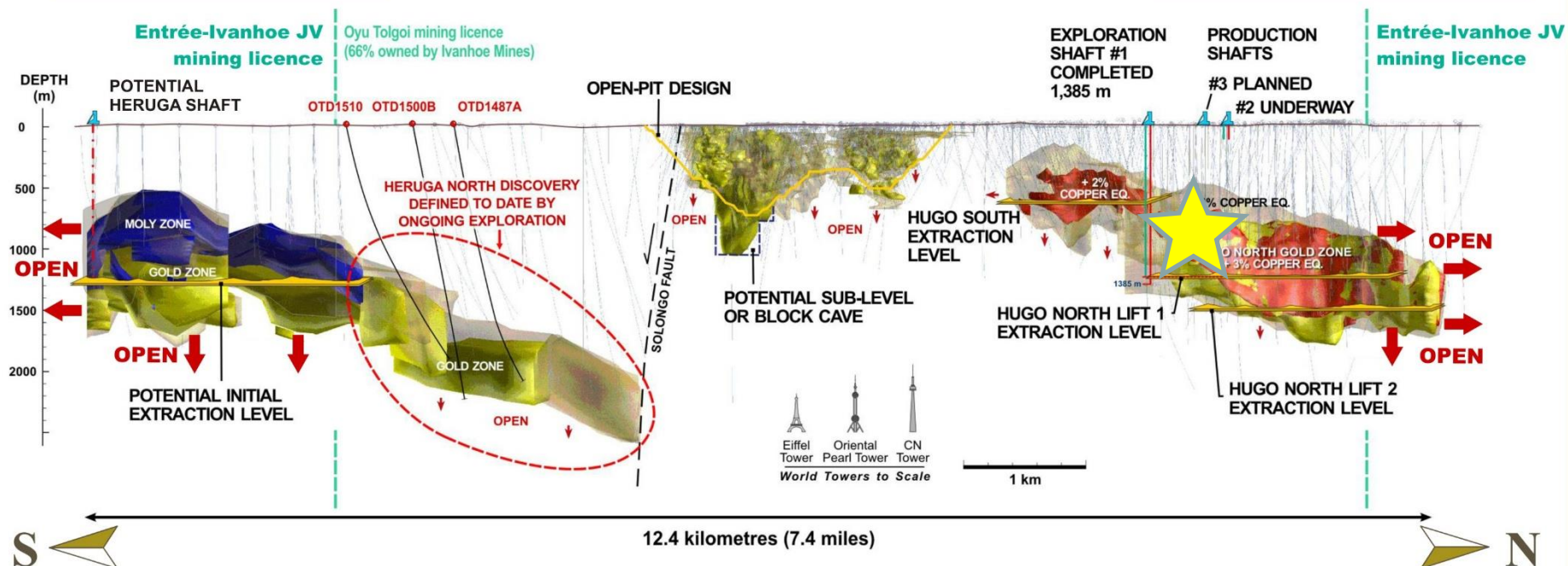
Oyu Tolgoi, South Gobi desert, Mongolia

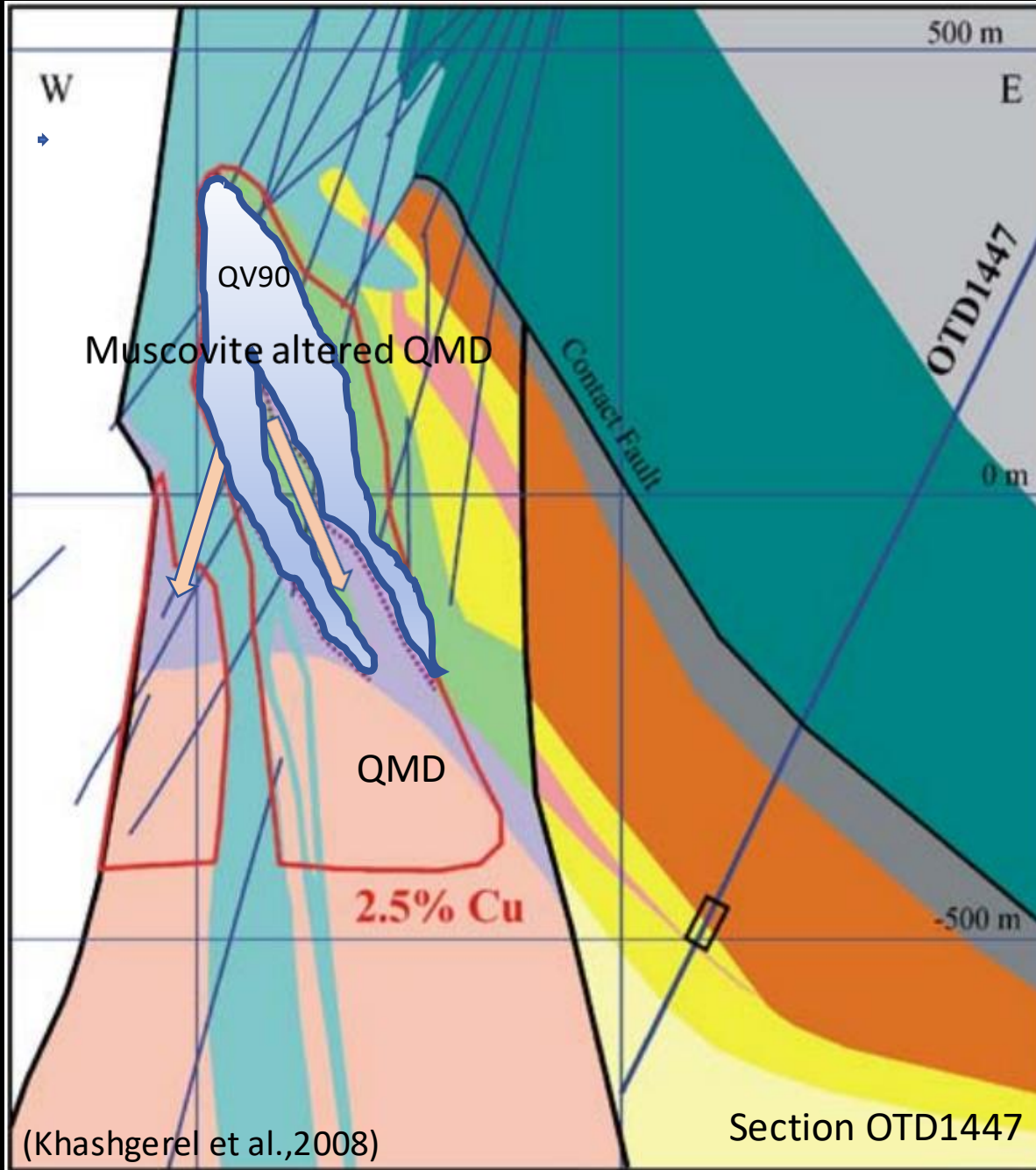


HERUGA DEPOSIT UNDERGROUND BLOCK-CAVE MINING

SOUTHERN OYU DEPOSITS OPEN-PIT MINING

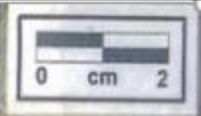
HUGO DUMMETT DEPOSIT UNDERGROUND BLOCK-CAVE MINING





High grade Cu zone (QV 90) in quartz monzodiorite cupolas, Hugo Dummett ore body, Oyu Tolgoi

(photos-C.Orssich)



Late-stage chalcopyrite in massive quartz (magmatic), QV 90 zone, Hugo Dummett, Oyu Tolgoi

(photos-B.Boldoo)



OTD3052-871m

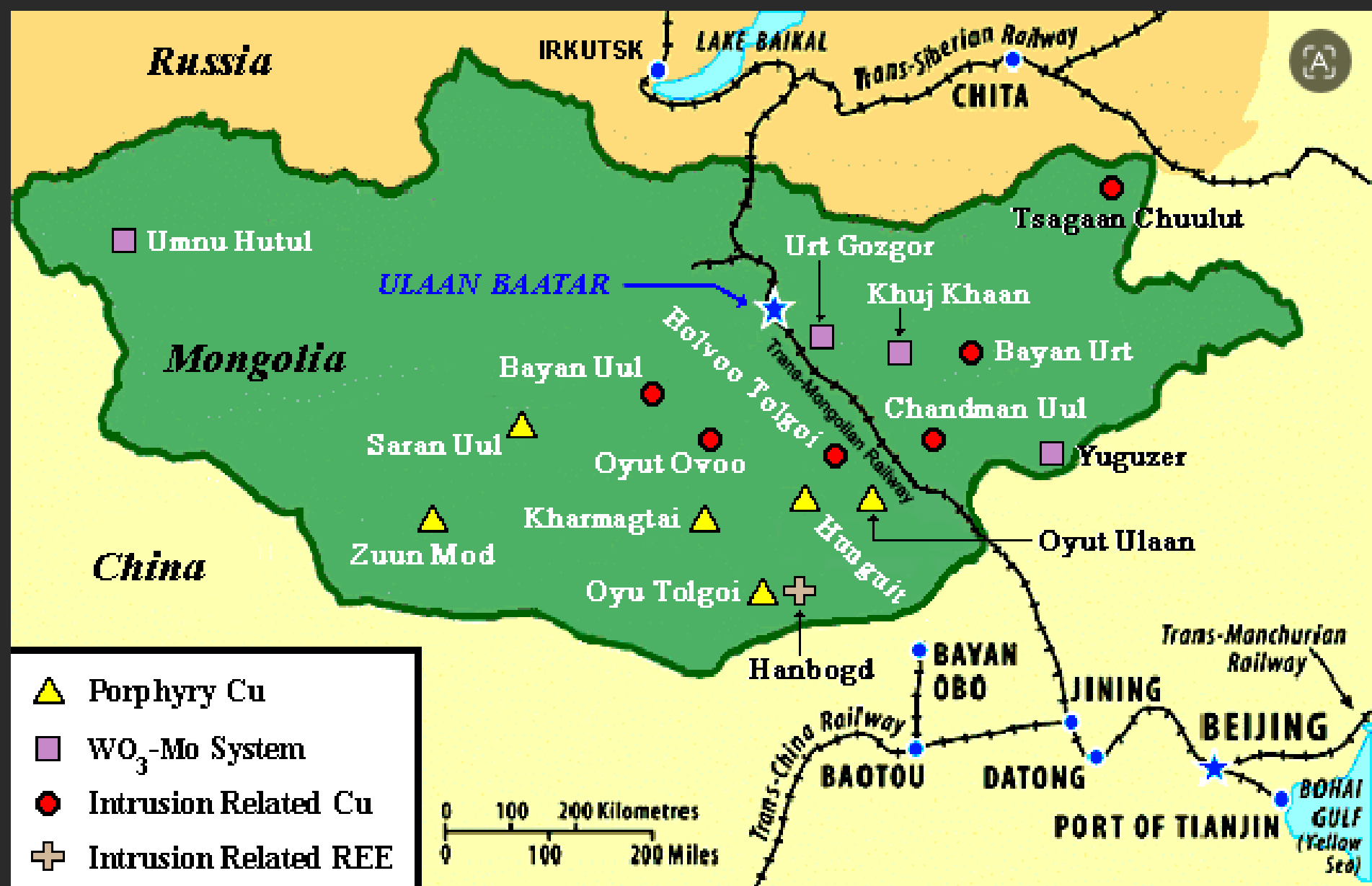


UGD891-193m



UGD786-204m





Cupola textures associated with selected Mongolian intrusion-related deposits

Silica Cap Examples

Porphyry Copper Deposits

Oyu Tolgoi, Tsagaan Survaga, Khongor, Zuun Mod, Briggs, Grasberg, Golpu?, Basay, North Parkes. Lone Star, Saginaw Hill, Sedimentary Hills

Intrusion-Related Gold-Copper Deposits

Lana Corina, Ravenswood, Tsagaan Chulut, Maria, Red Dome, San Lorenzo

Tungsten-Tin-Molybdenum Deposits

Panasqueira, Sadisdorf, Hubstock, Silsilah, Climax, Buckingham, Mt Unicorn, Max Yaguzer

REE-Fluorine Intrusions

Jabal Umm Al Suqian, Jabal Ablah

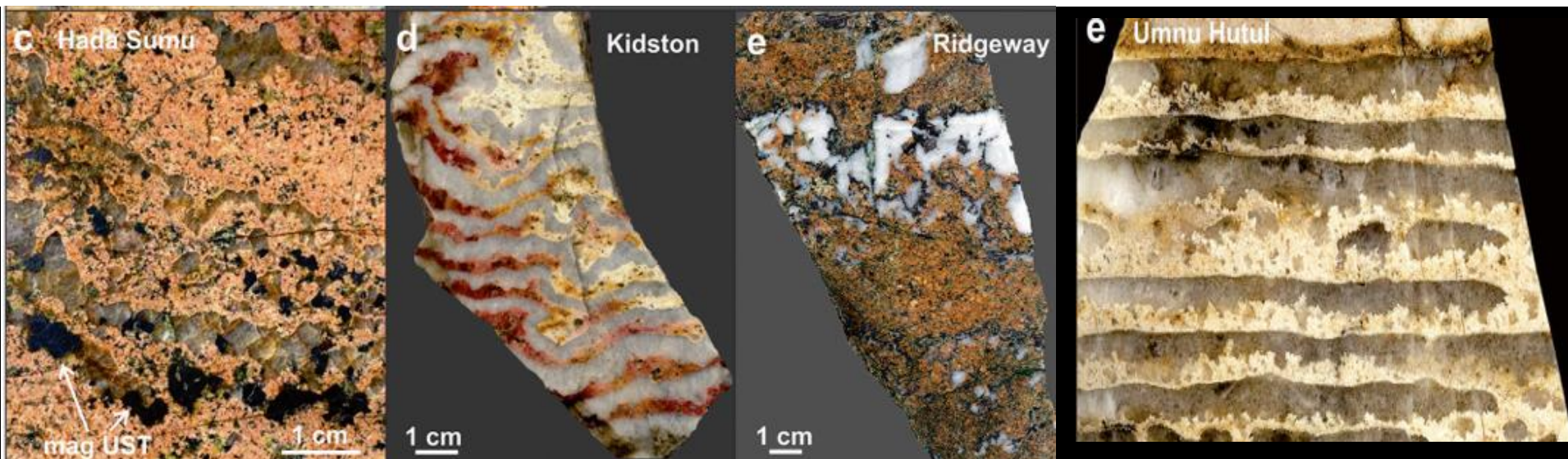
Closing Remarks

- UST's and magmatic silica caps are formed in felsic cupolas which have overpressured volatiles and fluids in a variety of metallogenetic systems
- They may be mineralized or unmineralized subject to the timing and conditions of the magmatic to hydrothermal transition
- UST's and magmatic silica caps are important district scale exploration vectors for intrusion-related ore deposits

ARTICLE

Textural characterization of unidirectional solidification textures related to Cu–Au deposits and their implication for metallogenesis and exploration

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