CRM POTENTIAL OF EU SEDIMENTARY BASINS: INSIGHTS ON ESTONIAN PHOSPHORITES AND BLACK SHALES

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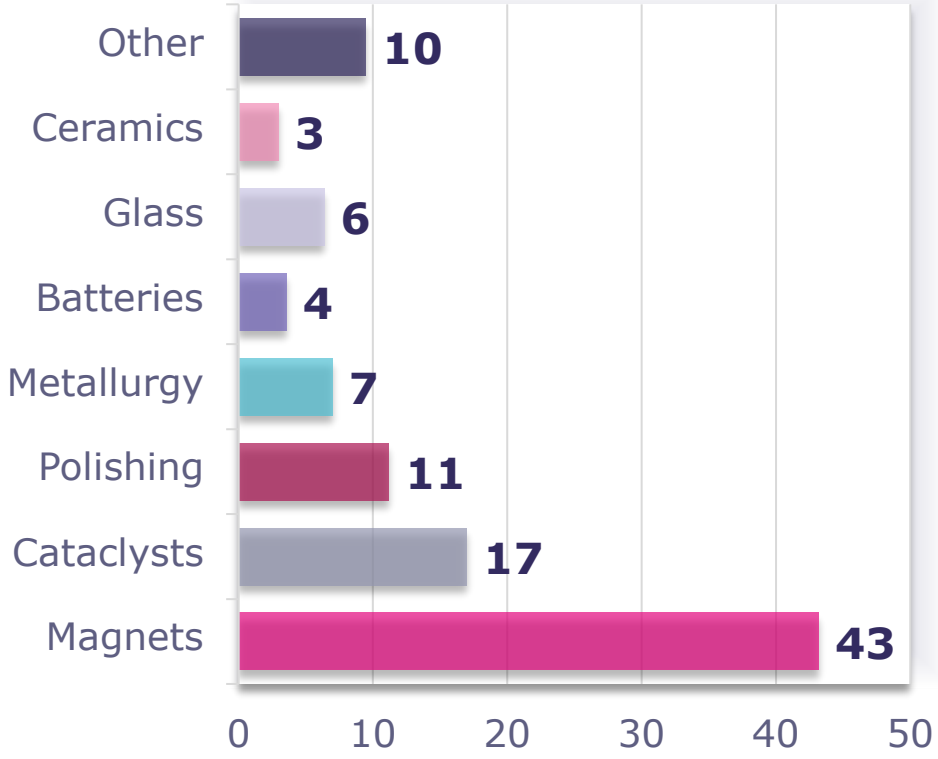
EGU General Assembly 2025

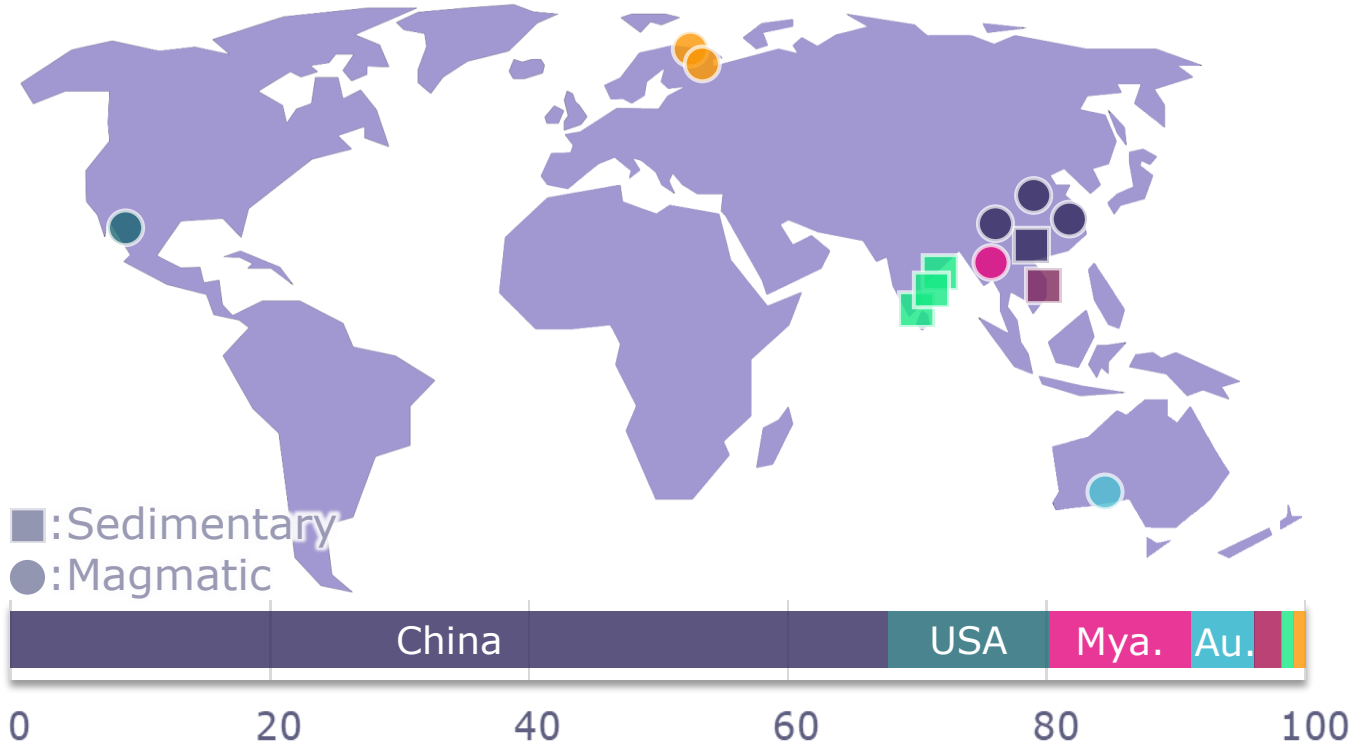
CRM challenges in EU

REE:15 Lanthanides, plus Y and Sc
CRM for the energy transition, high supply risk for EU

Global REEs consumption per sector (%)



Exploited REE deposits and 2023 production shares

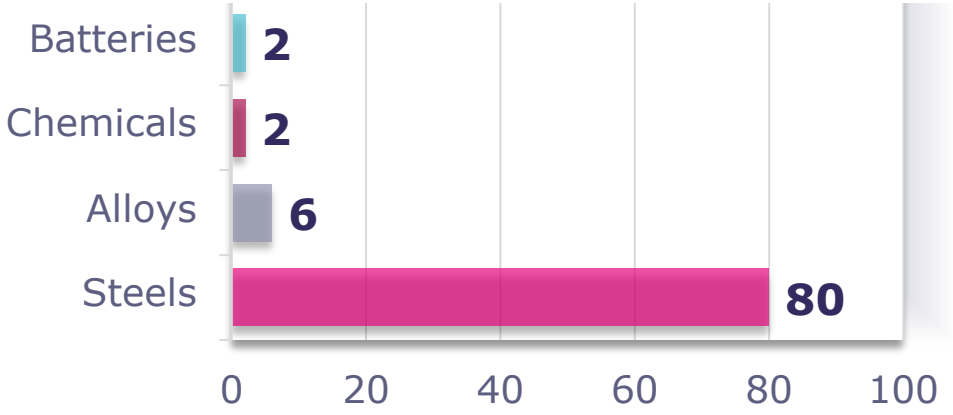


Depletion of high-quality deposits | Limited sources of Nd-Pr-Dy
Raising interest in phosphorites ores as REE sources

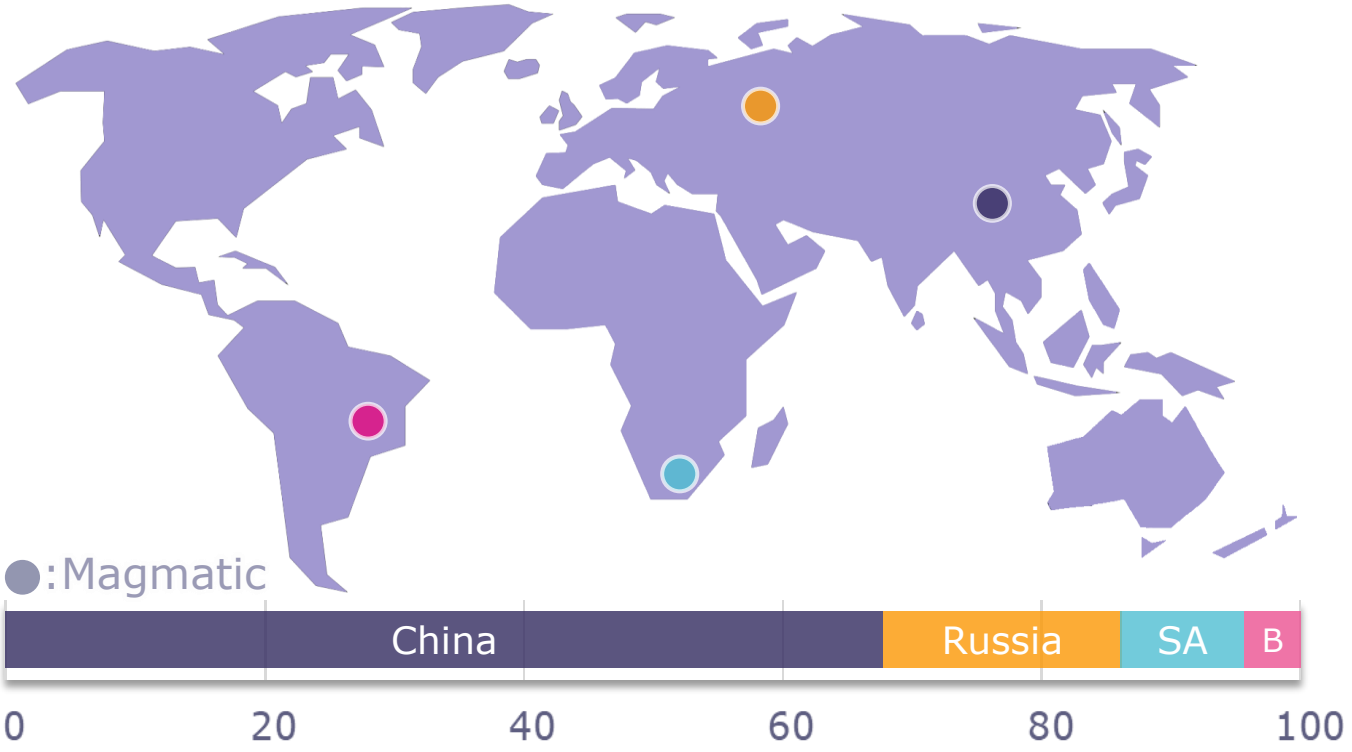
CRM challenges in EU

V produced from titano-magnetite: $Fe^{2+}(Fe^{3+},Ti)_2O_4$
CRM for the energy transition, medium supply risk for EU

Global V consumption per sector (%)

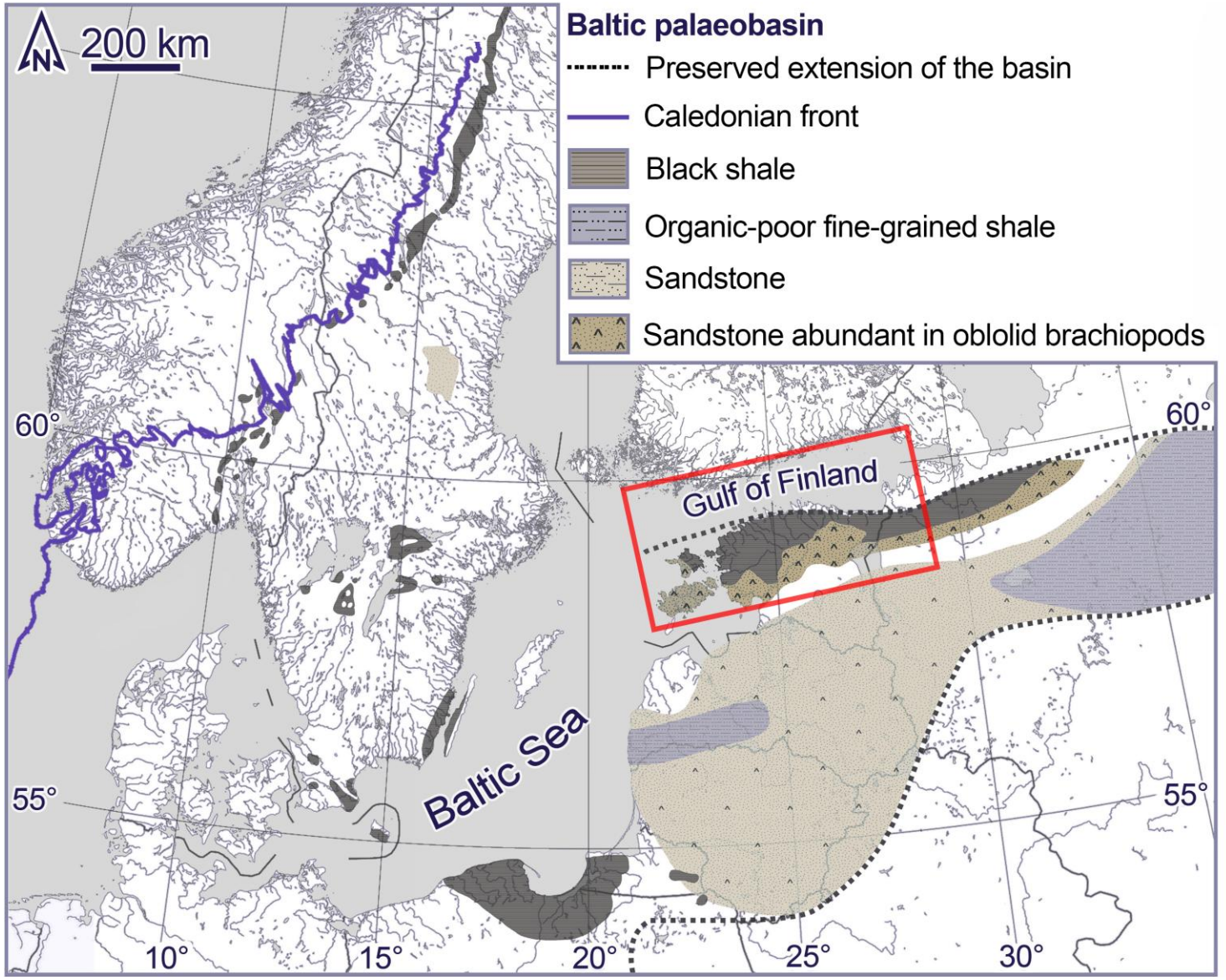


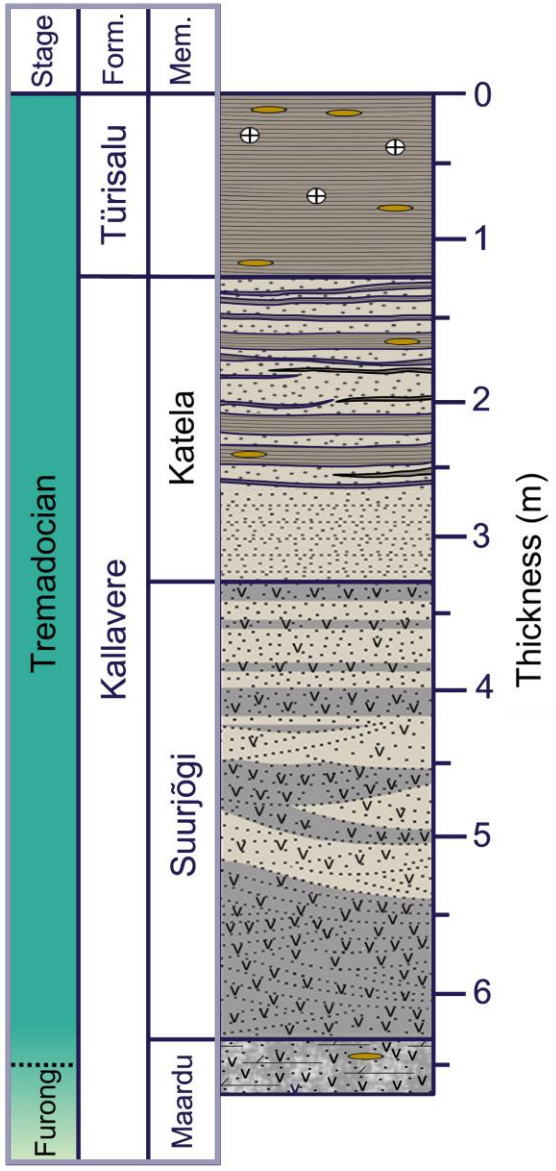
Exploited V deposits and 2021 production shares



Increasing demand for vanadium redox battery (VRB)
Construction sector, strength-steels (Ferro-vanadium)

Ordovician Baltic paleobasin



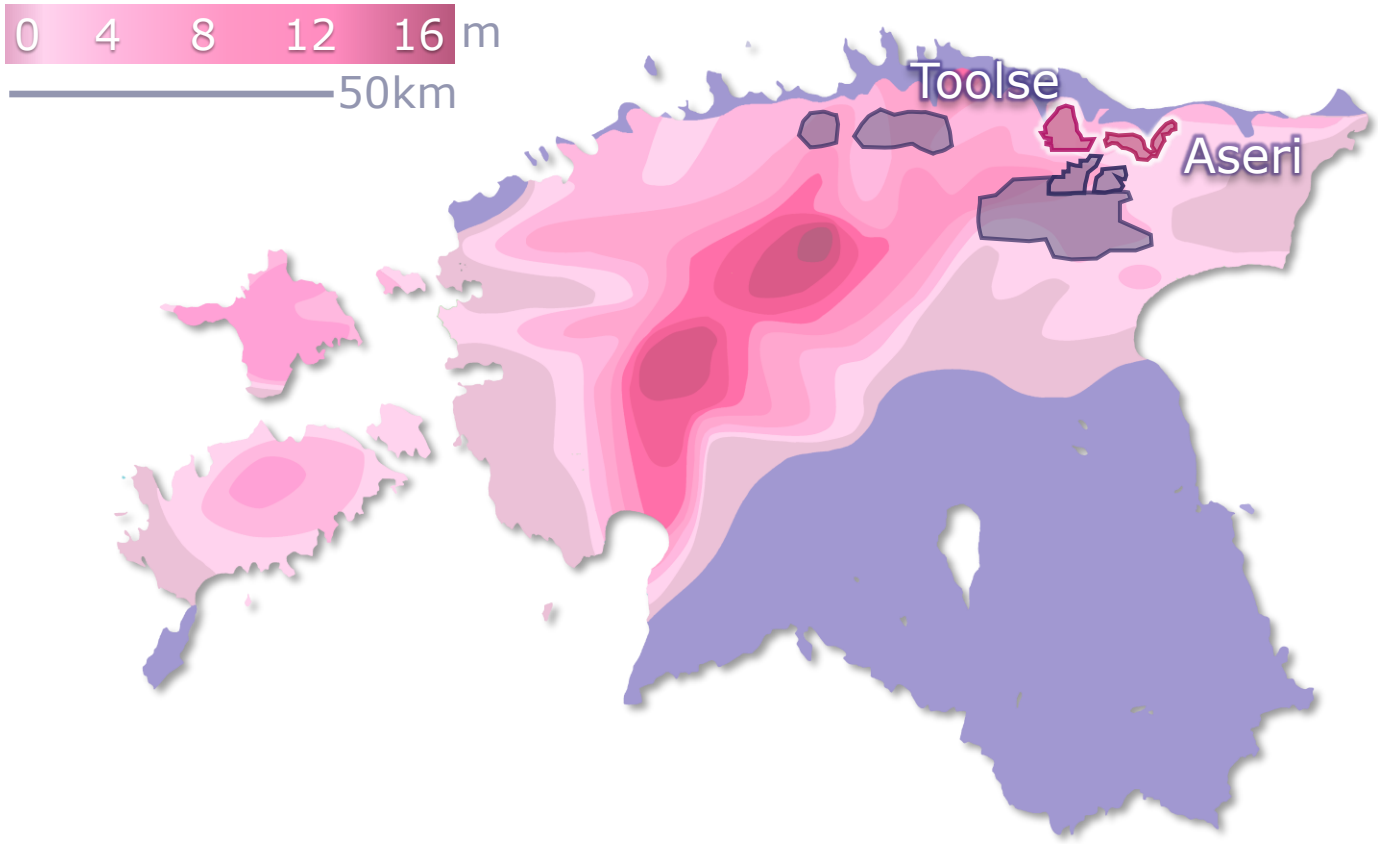


Ordovician Baltic Paleobasin and average Lower Ordovician profile in Toolse

High-volume, low-grade ores: unconvential sources

Estonian formations

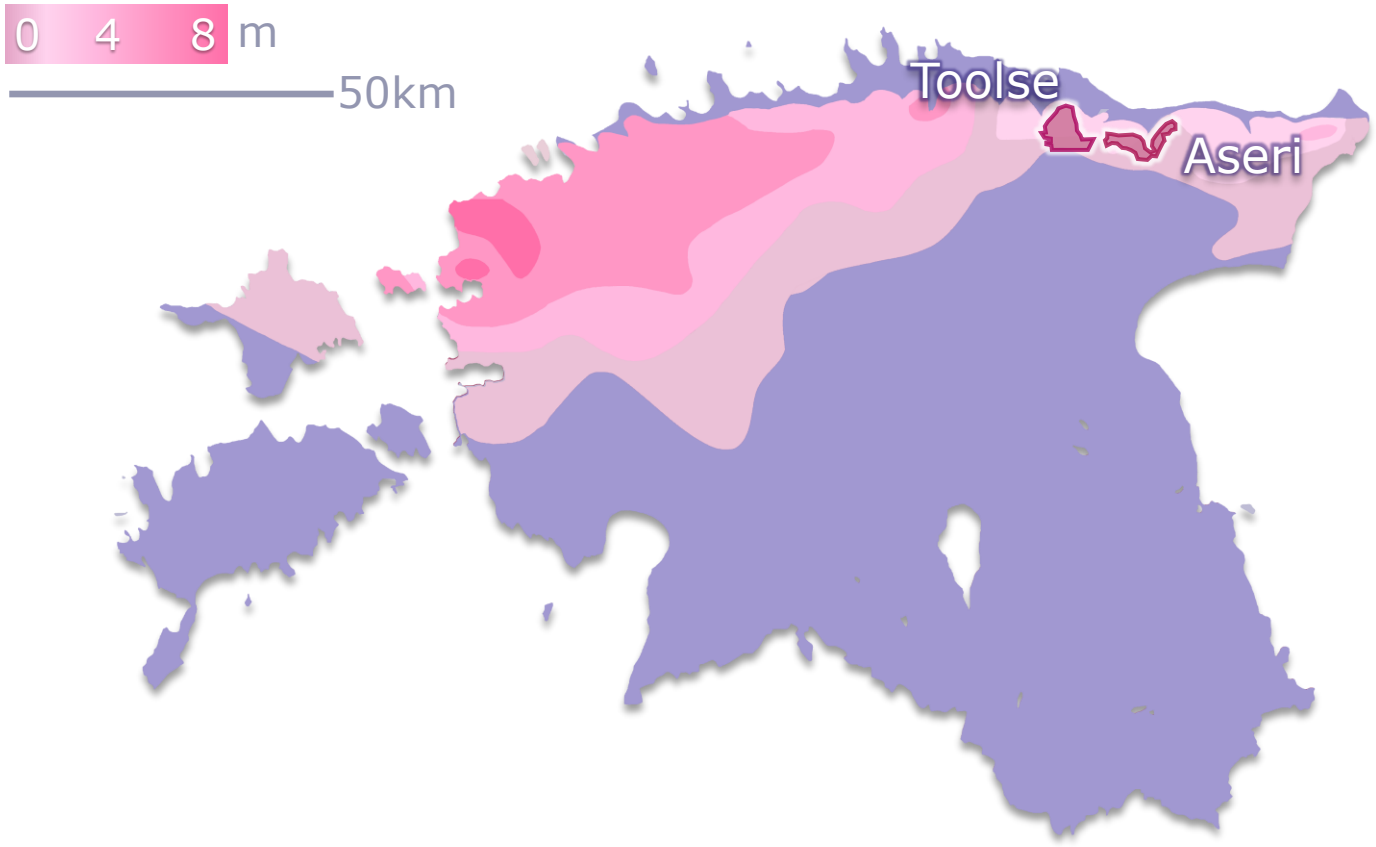
Thickness of the shelly phosphatic formation and targeted zones



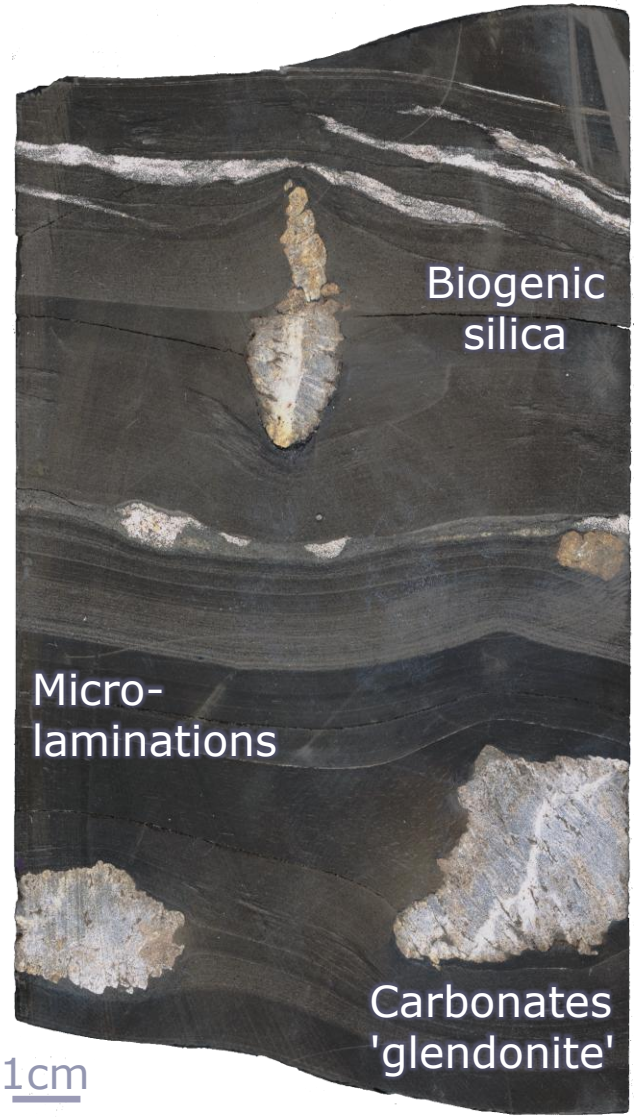
- Apatite-mineralised shells in sandstone. Opportunities for REE and P in the EU. Approximately $\pm 3^{12}$ t resources.
- **REE extraction as P by-products**

Estonian formations

Thickness of the black shales and targeted zones

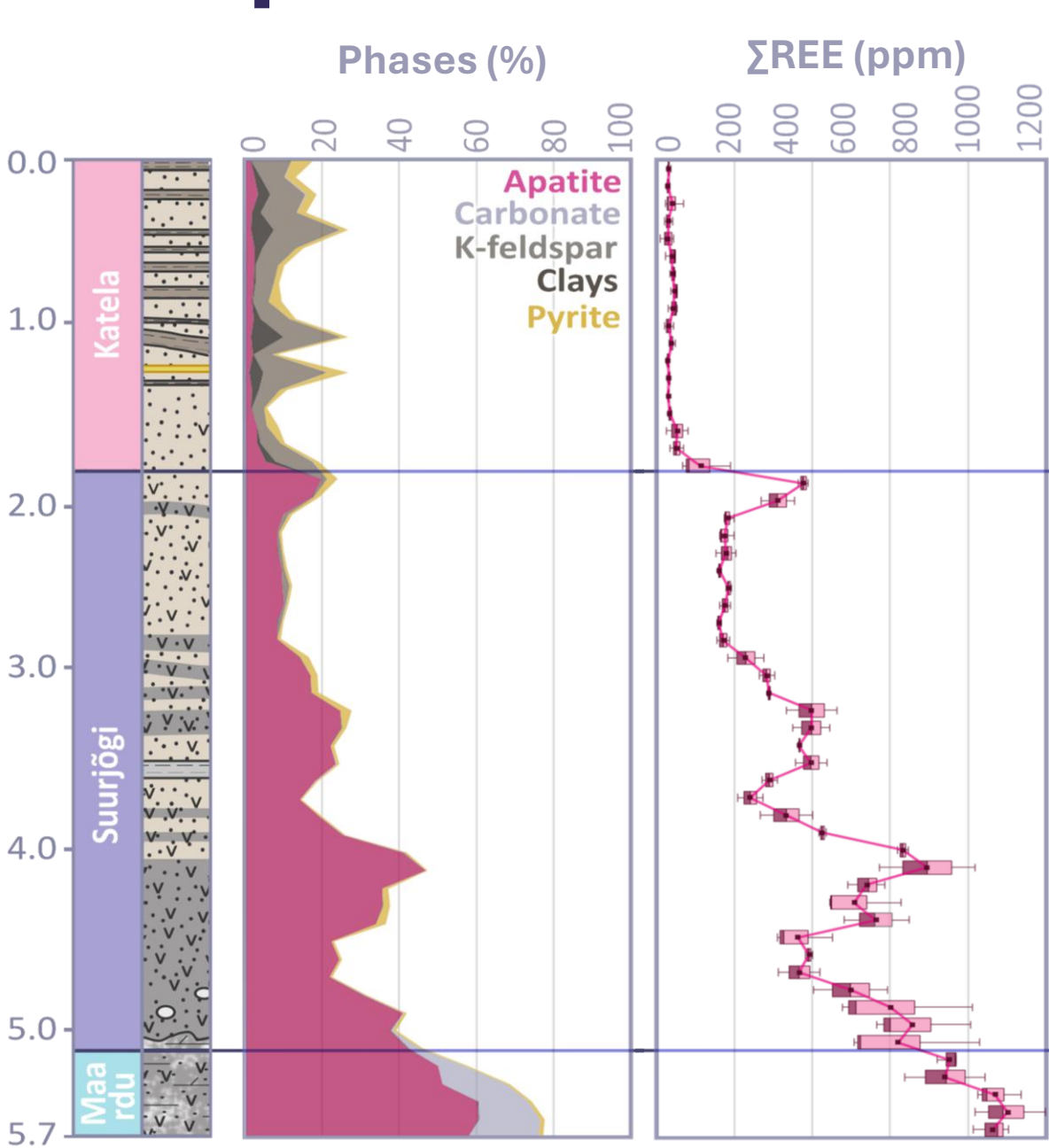


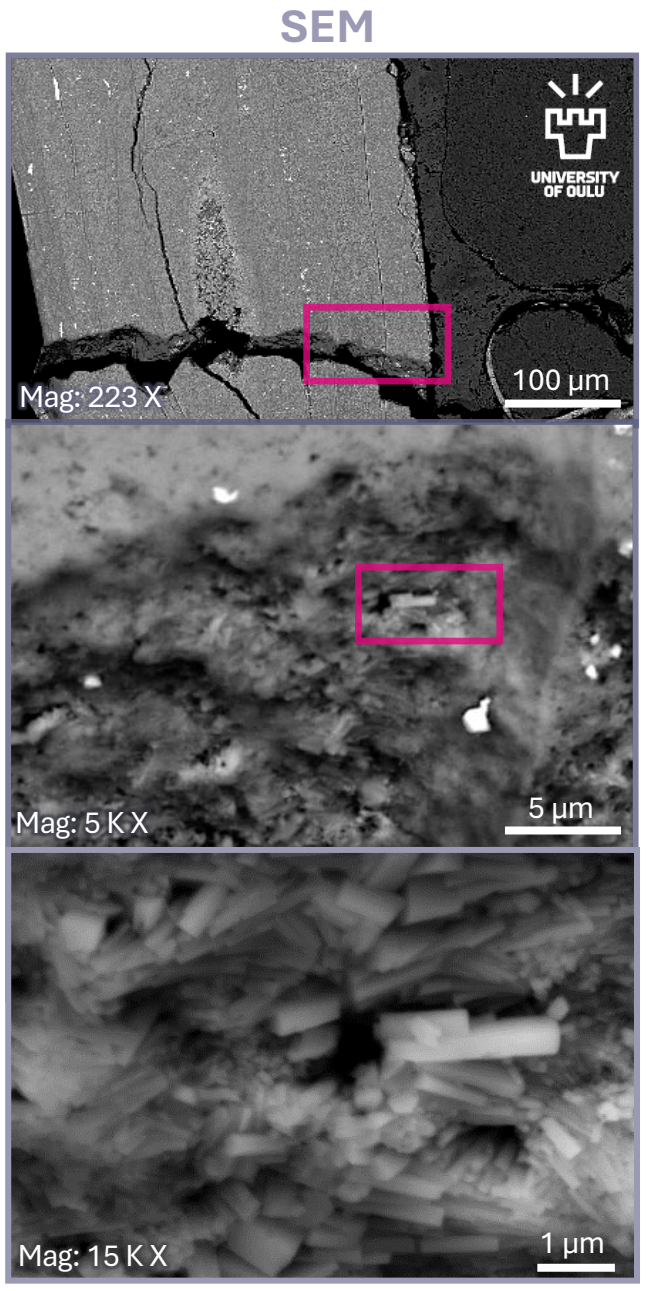
- Organic-rich, thermally immature mudstones. Formed under strong reducing conditions.
- **V-Mo-U** potentials in black shales.



Drill core from Toolse deposit

Phosphorites: Toolse model





∑REE: 600±200ppm
27% apatite.

Up to 1300ppm and
60% apatite.

Homogenous trends
at the scale of a deposit.

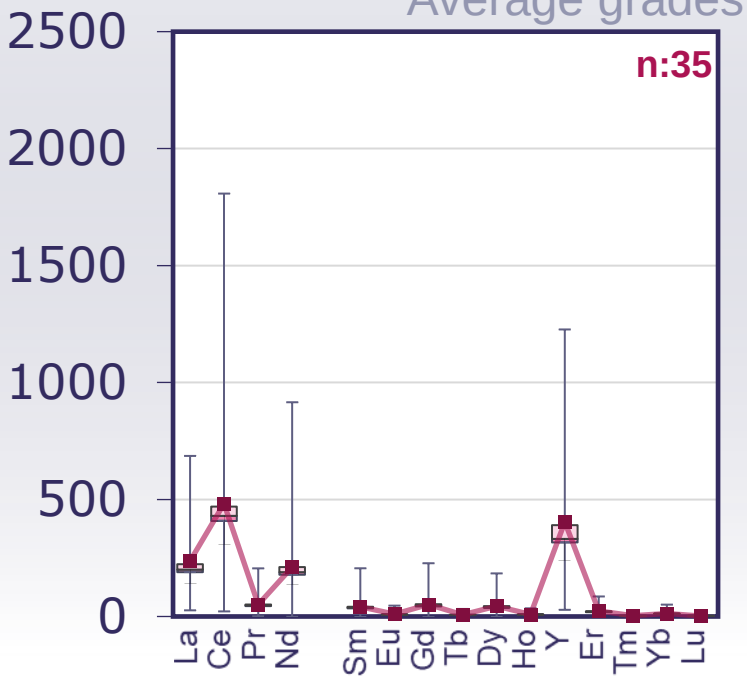
Apatite recrystallisation
and REE enrichement
during diagenesis.

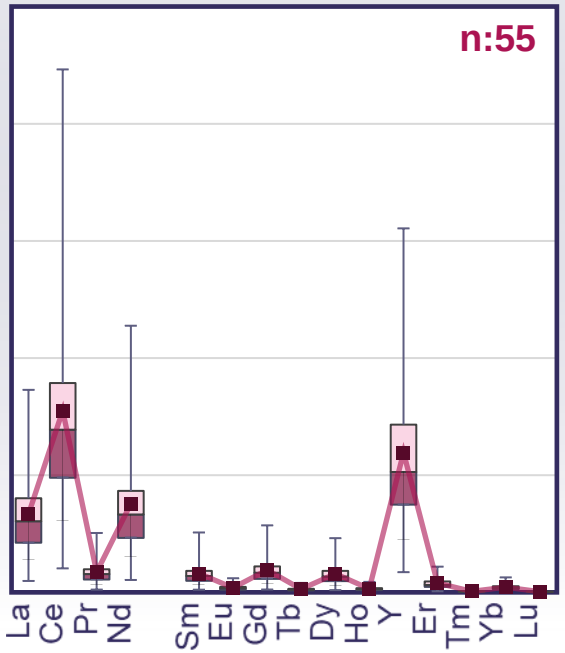
Different grade of over-
print/REE enrichement

Challenging quantification
REE below SEM detection
limits

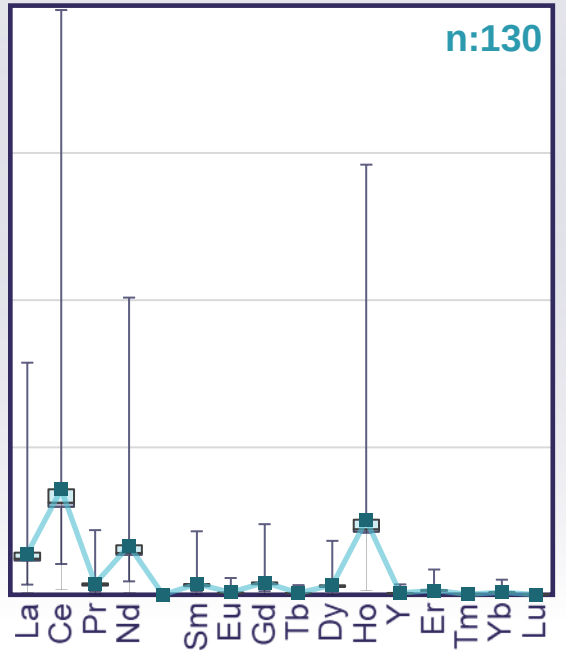
Phosphorites: REE assessement

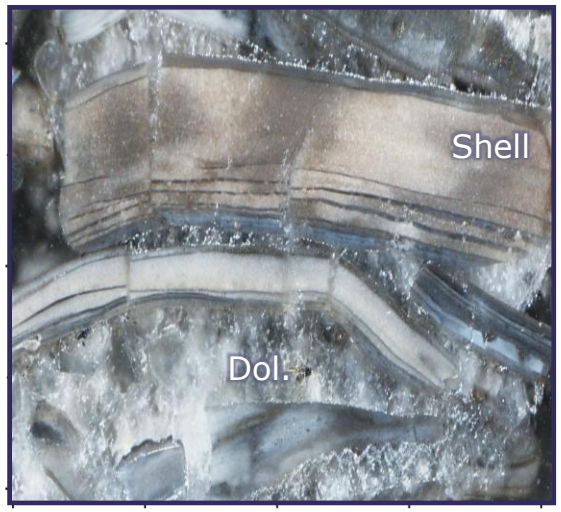
Average grades in Toolse (ppm)

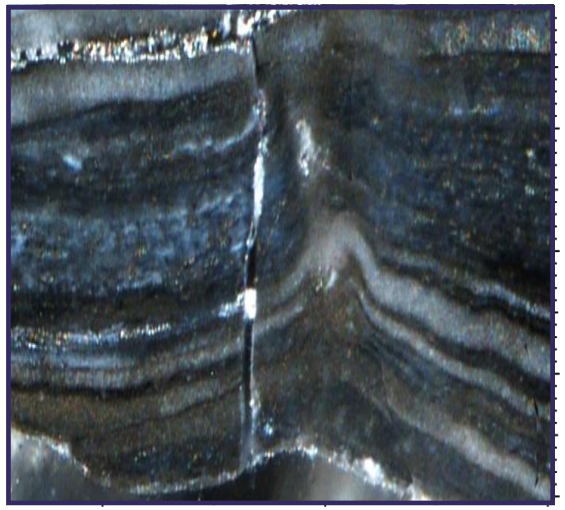


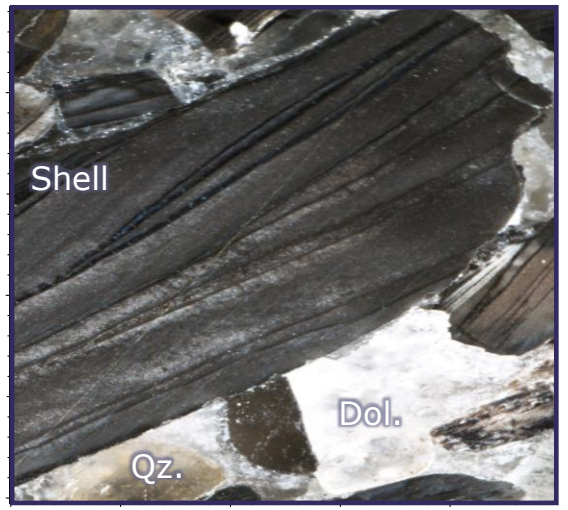


Altered apatite in Aseri









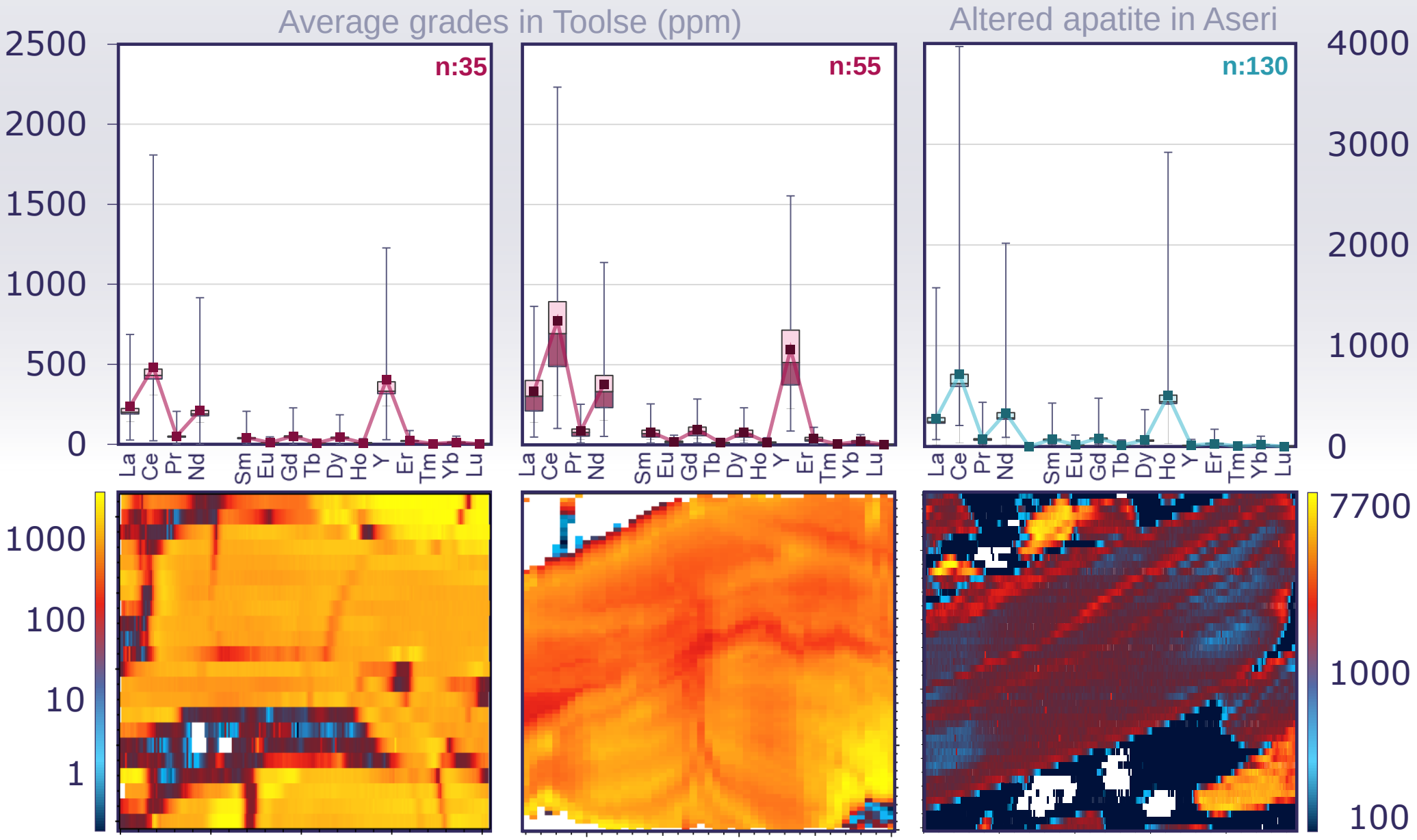
Microphotographs

LA-ICP-MS
semi-quantification

ΣREE Toolse:
≈ 2135±1190ppm
Up to 7300ppm

ΣREE Aseri
Up to 12760ppm
in altered edges

Phosphorites: REE assessement

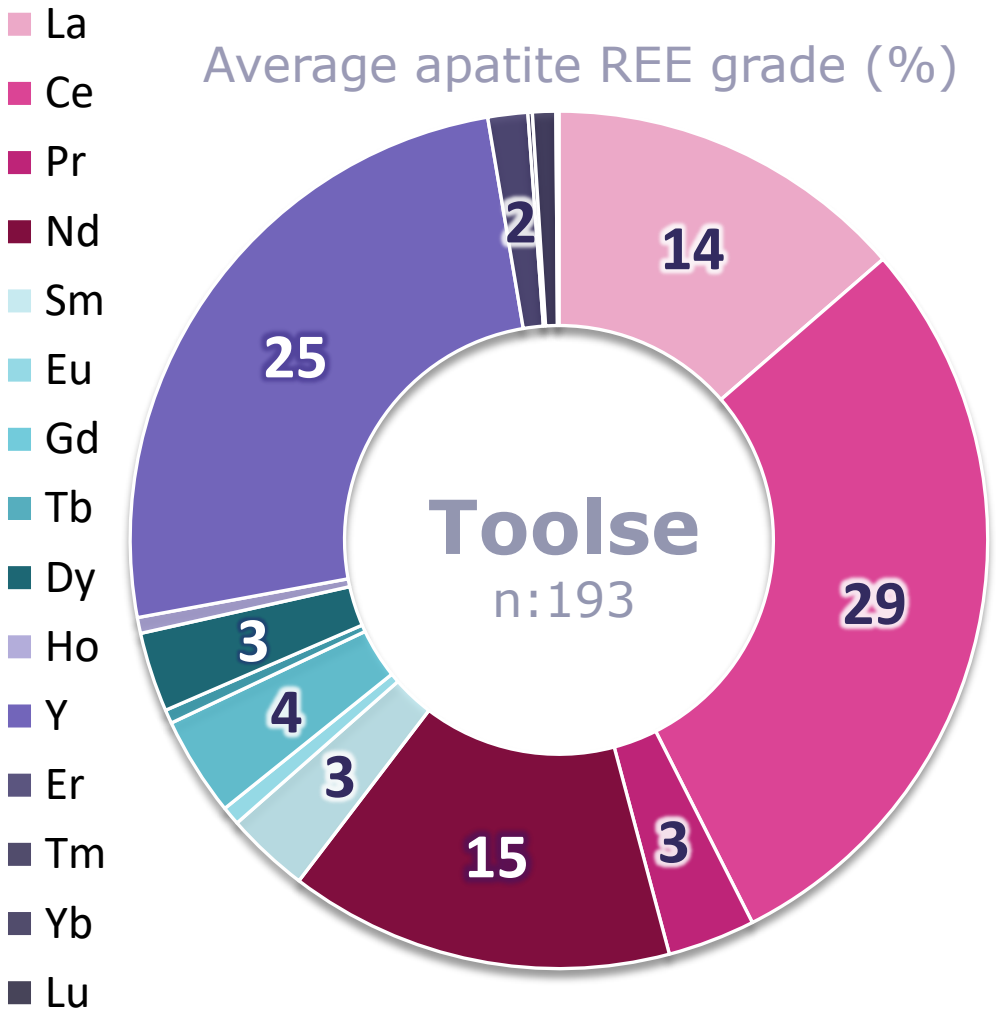


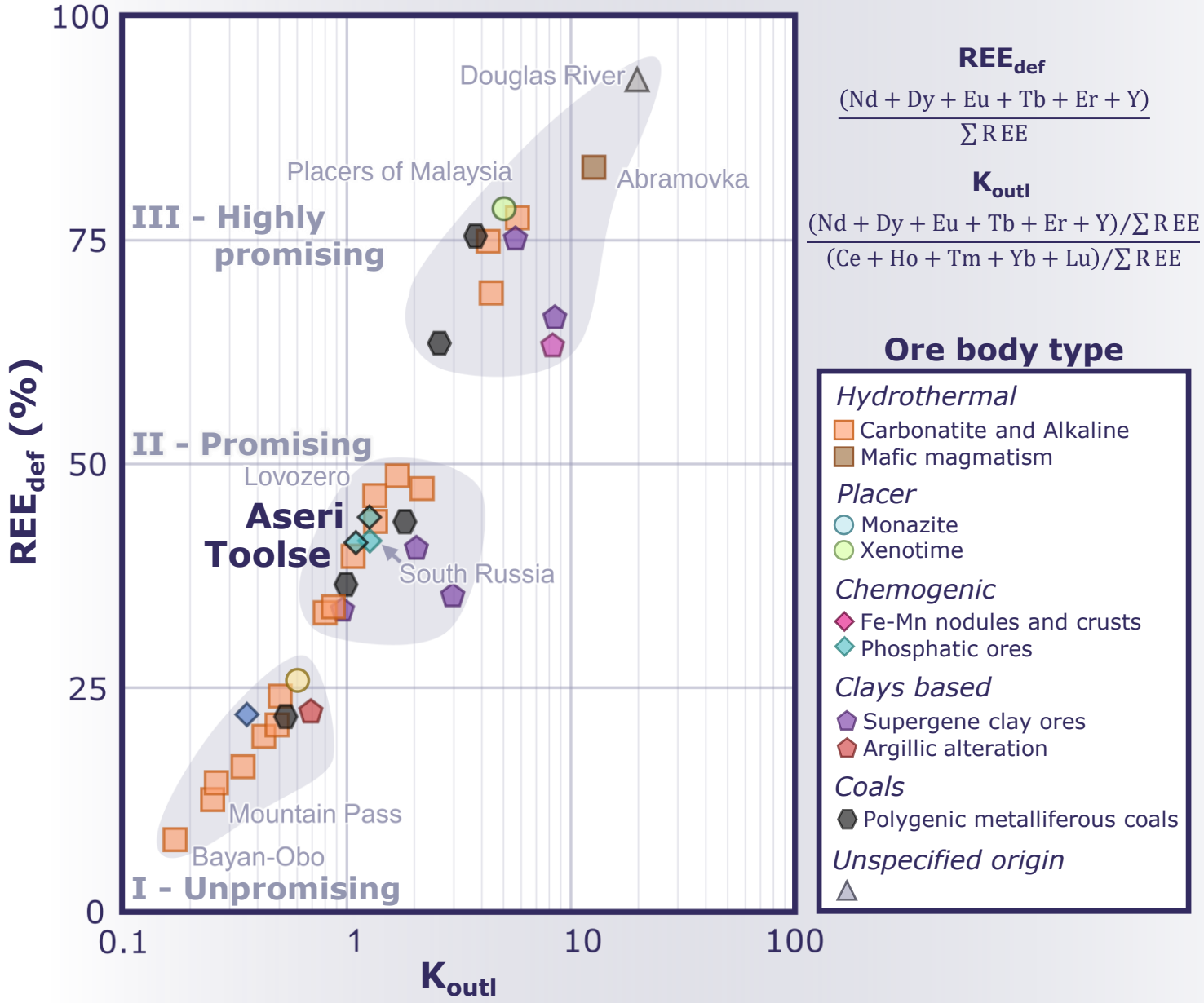
Ce maps (ppm), based on LA-ICP-MS Imaging. ECDF scale

Minimising fines loss during process

New crushing applications

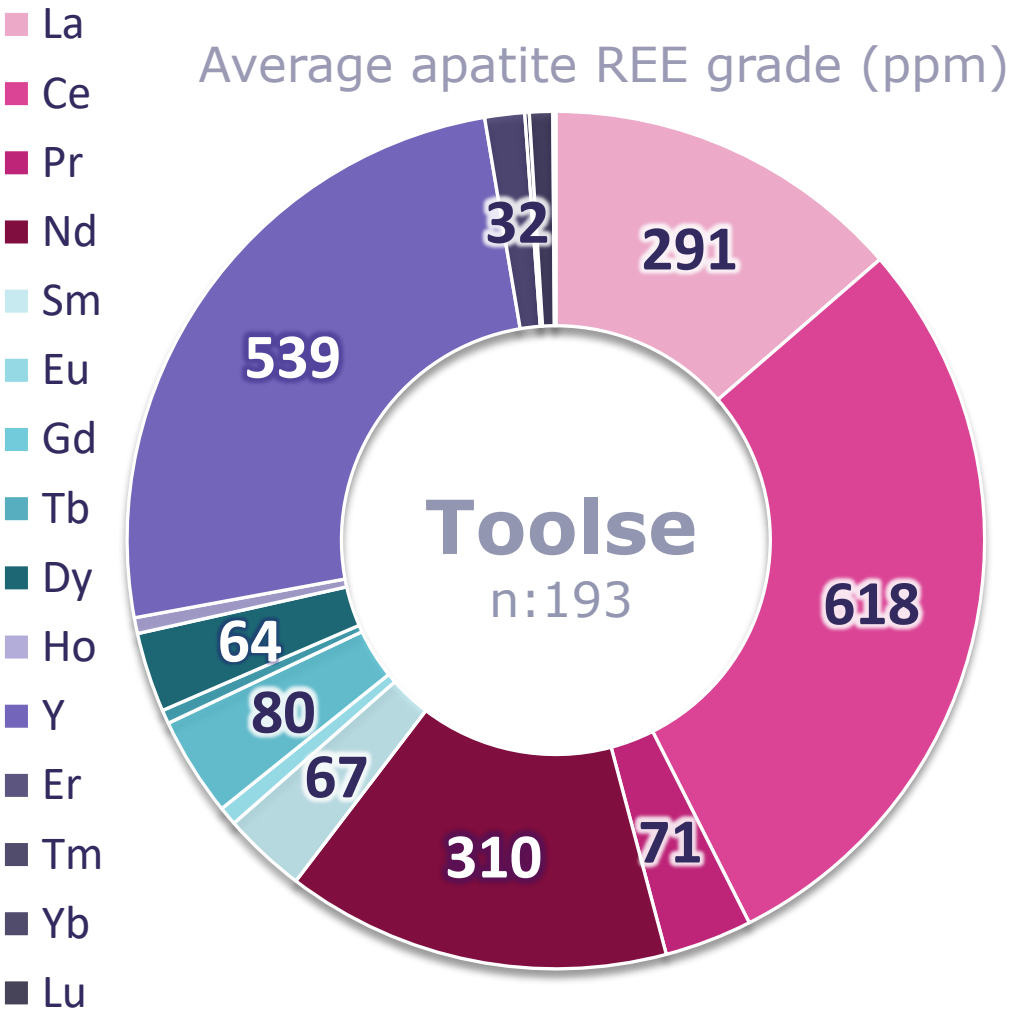
Ore assessment

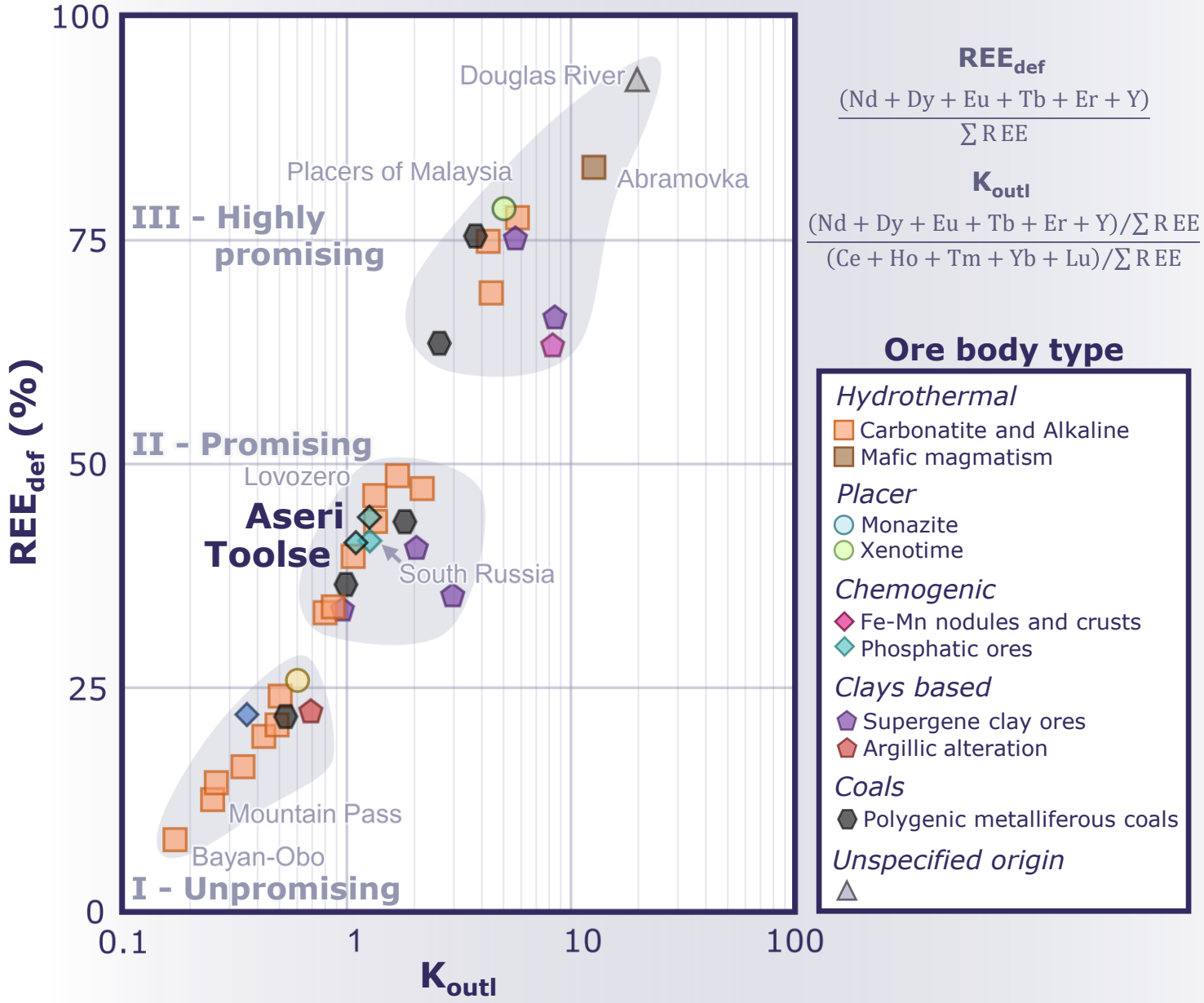




Importance of individual REE distribution for ore prospectivity
Interesting **Nd Dy Y** proportion compared to carbonatite ores (La-Ce)

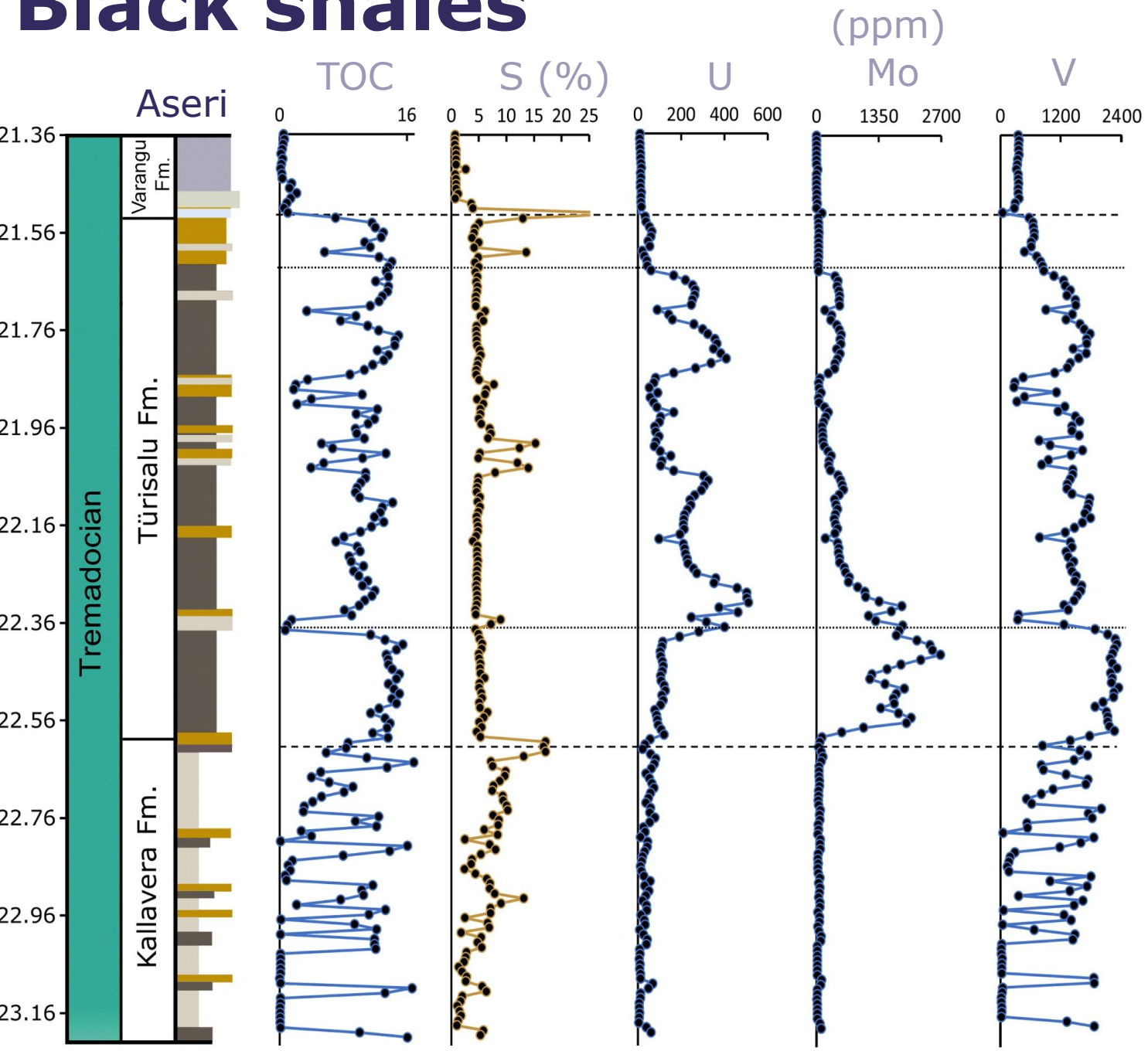
Ore assessment





Importance of individual REE distribution for ore prospectivity
Interesting **Nd Dy Y** proportion compared to carbonatite ores (La-Ce)

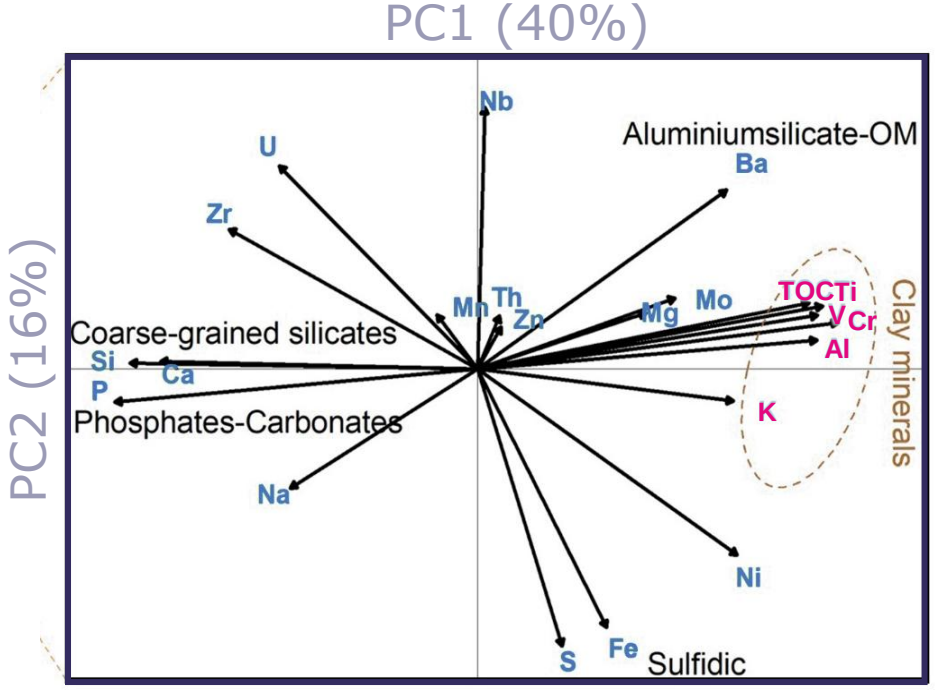
Black shales



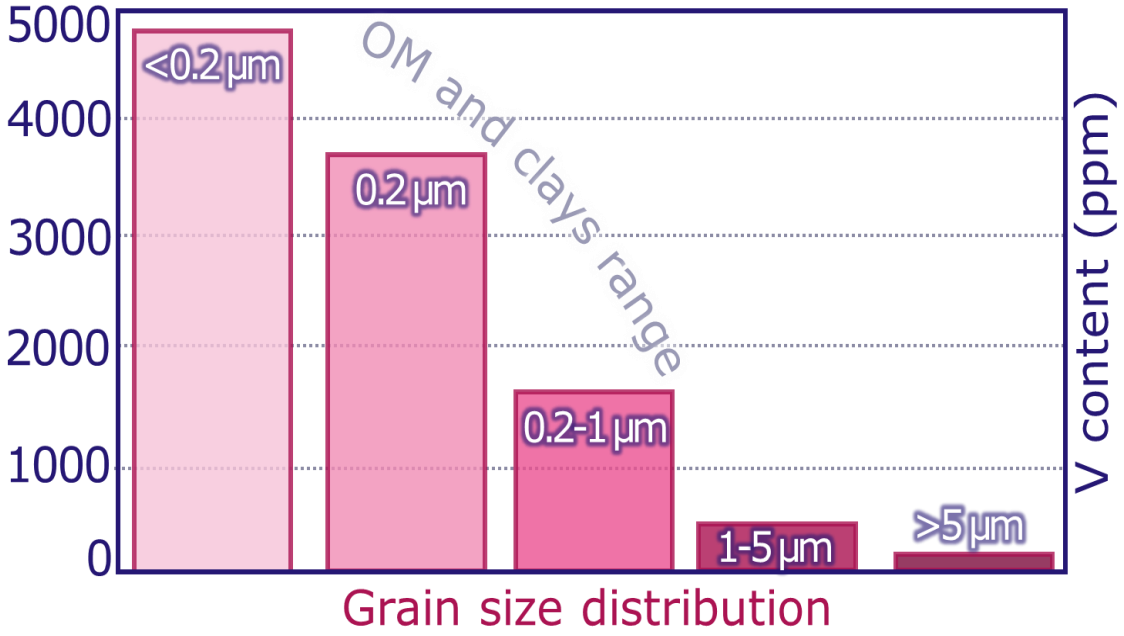
Polymetallic anomalies

V:>2000 ppm
U: >600 ppm
Mo: >4000 ppm
TOC: 15%

Clays and OM contributions



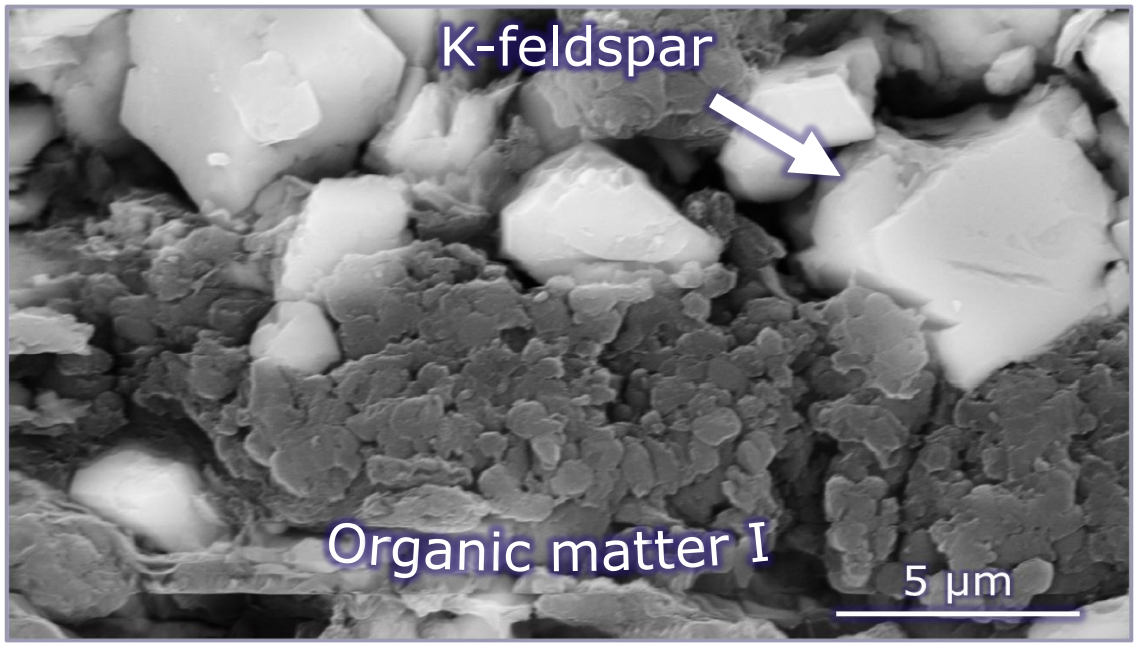
Black shales

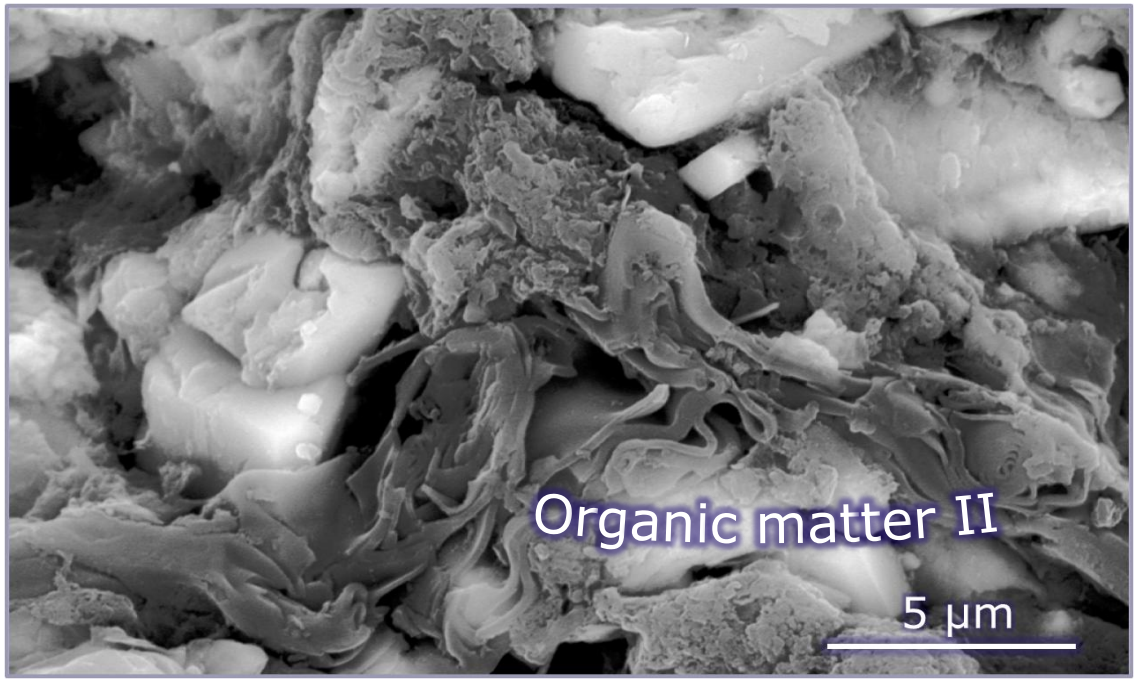


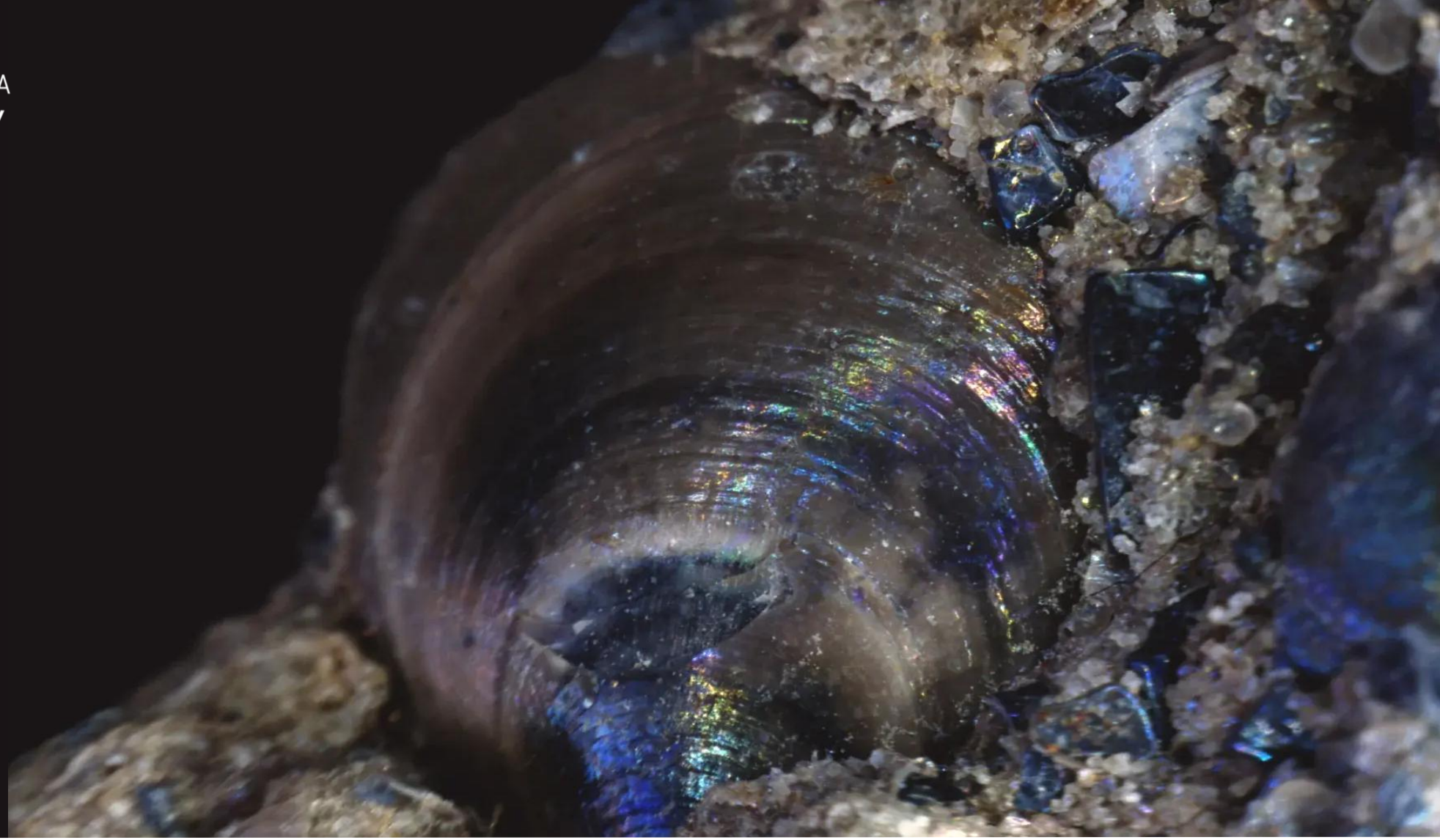
Finest fractions held most of the V, up to *5000* ppm; which correspond to the size range of **clays** and **OM**.

Textural analyses evidenced two types of amorphous OM: one forming clumped aggregate (I) and the other, flakes or filaments (II).

SEM







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REM Hub

EGU General Assembly 2025

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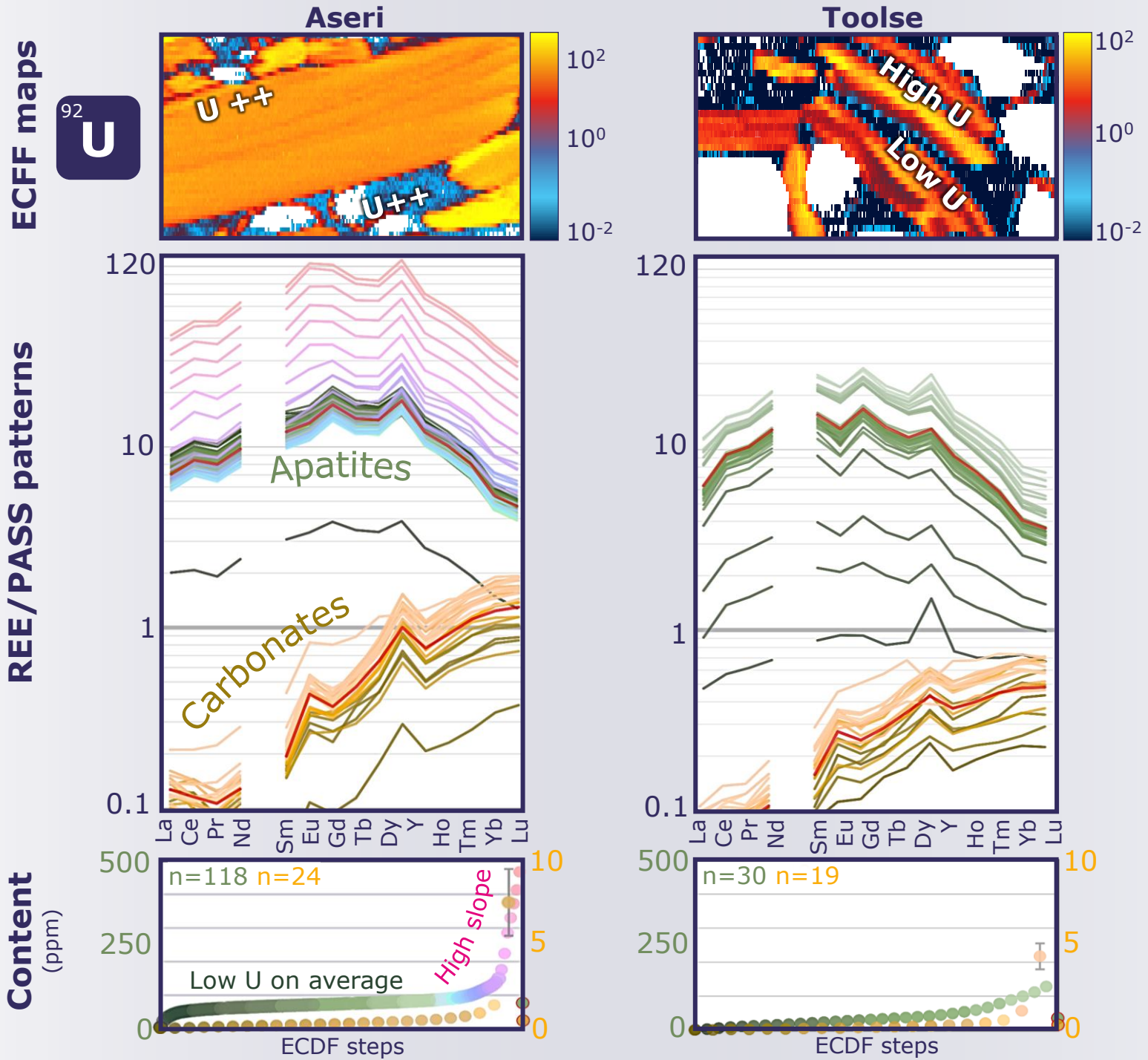
REE investigation

REE trends following U content in apatites and carbonates

- Specific REE enrichment on edges of altered fragments
- REE content up to 121-folds in Aseri: late alteration uptake
- Euxinic settings, lithogenic input

Altered edges and fragments (fines)



Phosphorites: REE assessement