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ERA-MIN2

RESEARCH & INNOVATION PROGRAMME ON RAW MATERIALS
TO FOSTER CIRCULAR ECONOMY

ERA-MIN Joint Call 2019 (EU Horizon 2020 ERA-NET Co-
fund Project ERA-MIN2, Grant agreement N° 730238)



General overview of the MOSTMEG project

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On behalf of the MOSTMEG consortium



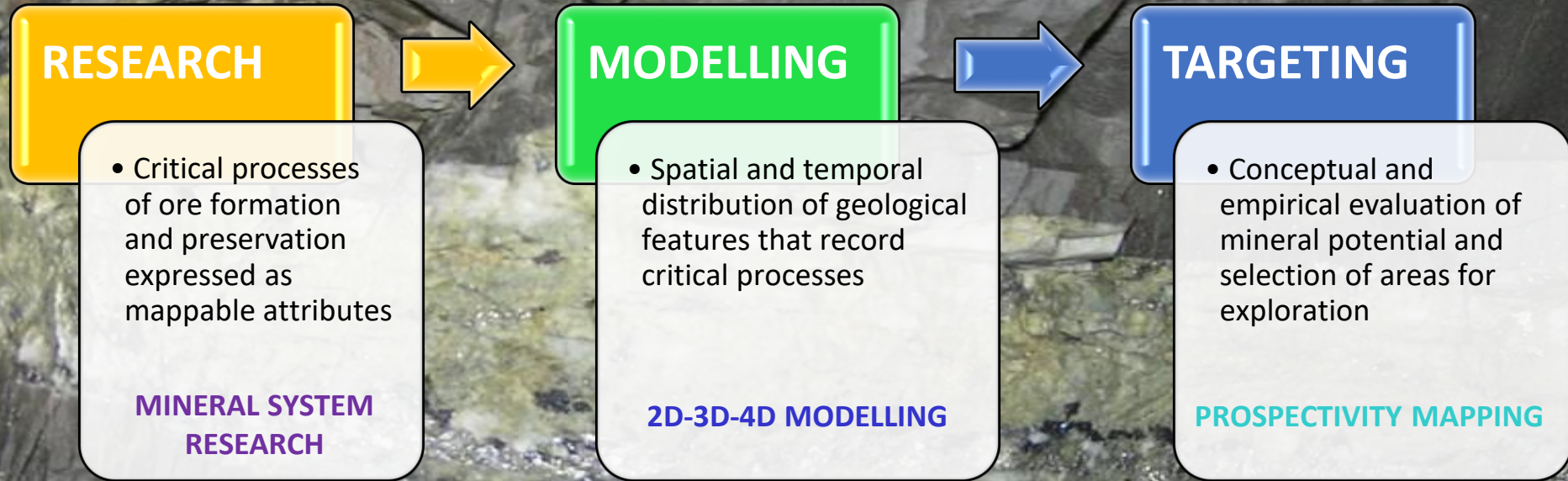
Predictive models for strategic metal rich, granite-related ore systems based on mineral and geochemical fingerprints and footprints

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Consortium



Project Summary

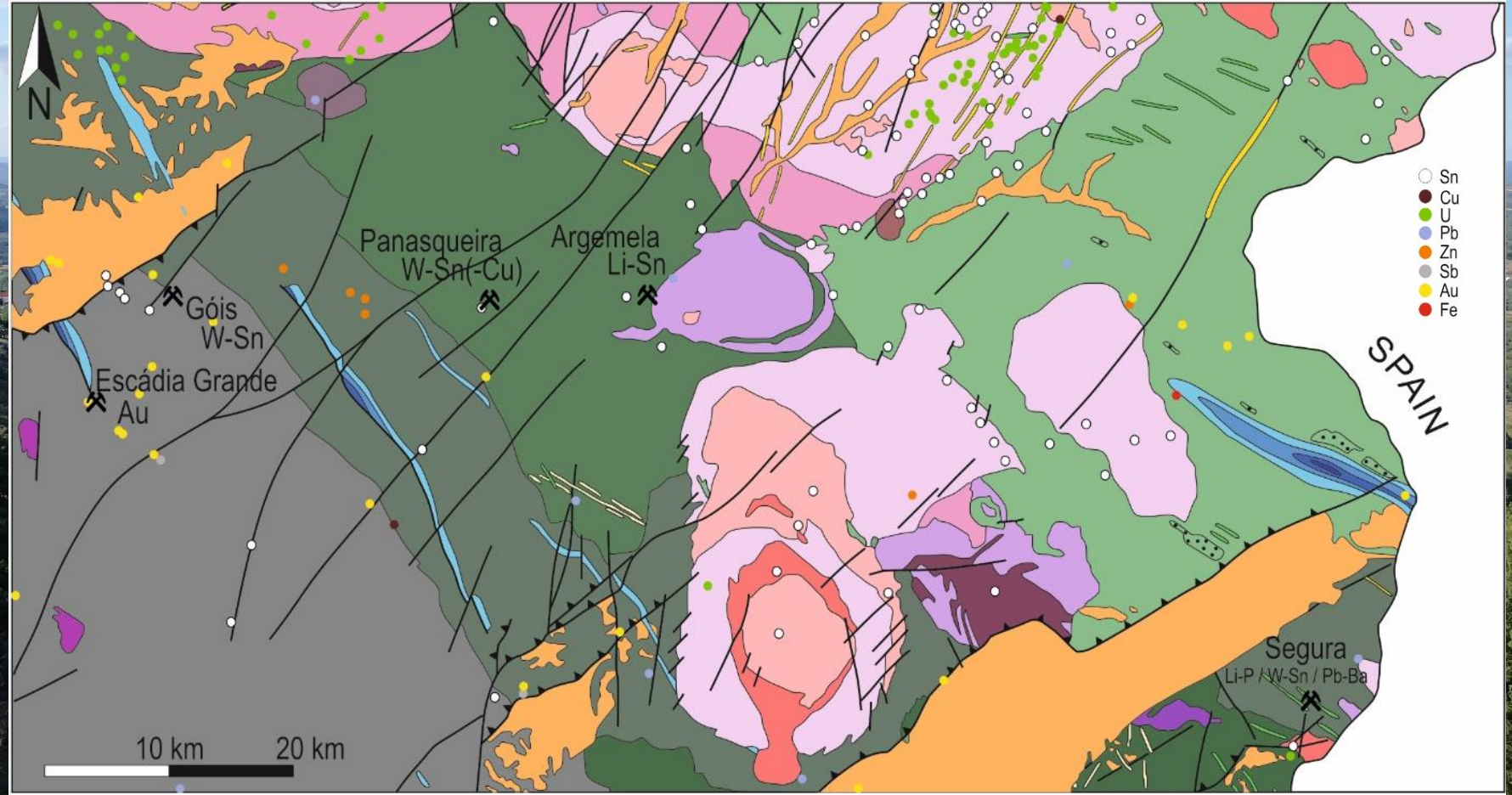


MAIN GOAL

The MOSTMEG project intends to develop and validate predictive models for strategic metal rich, granite-related ore systems. To this end, some concepts and exploration strategies were (and are being) refined, combining mineral and geochemical criteria that can be used as pathfinders or vectors to mineralization centres.

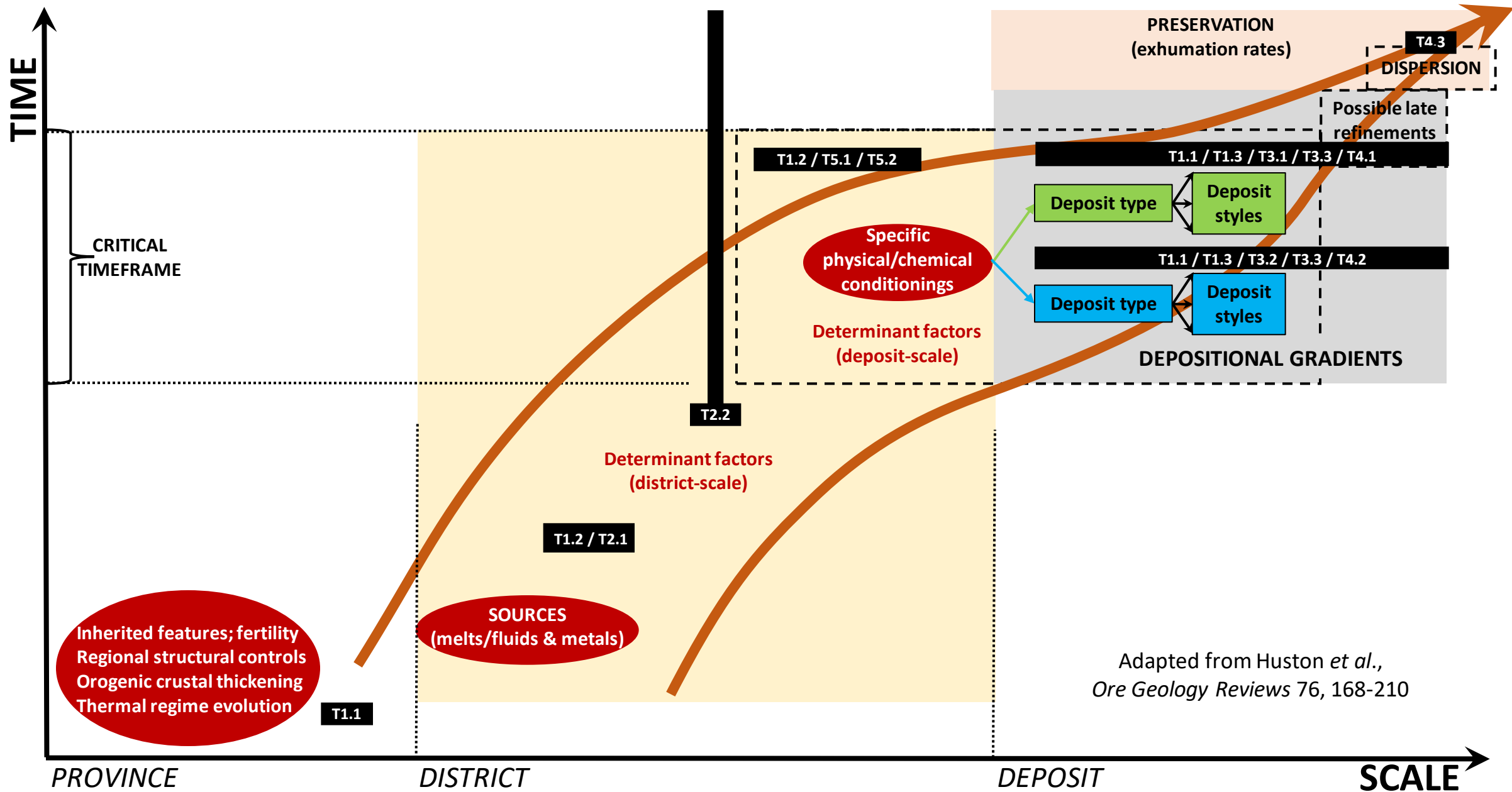
Several case studies were examined in MOSTMEG, typifying brownfields of different types of granite-related ore systems and promising greenfields for their occurrence.

These case studies, distributed across the **Segura-Argemela-Panasqueira-Góis (SAPG) belt**, illustrate common scenarios in the Iberian Variscides.

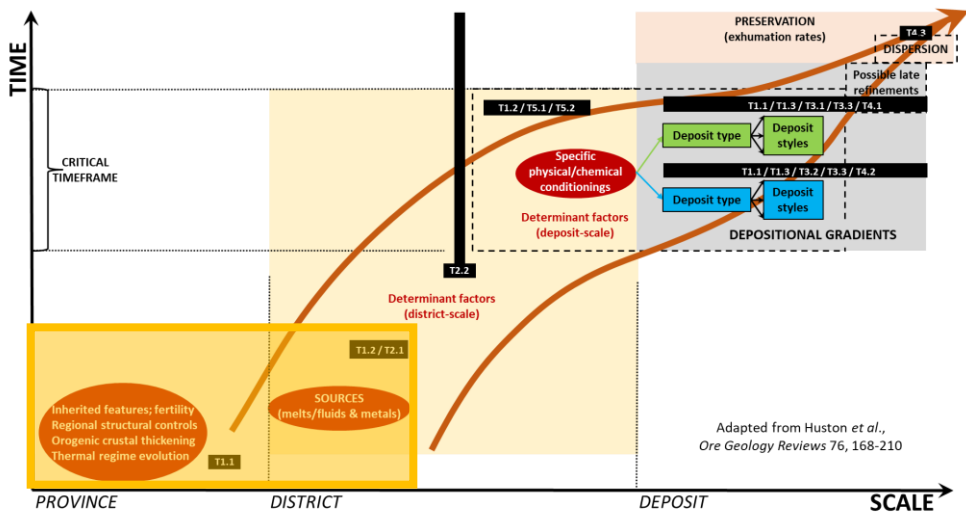


Simplified after the official, 1:500.000 Geological Map (LNEG). Mineralization occurrences as in SIORMINP (LNEG)

General view of the SAPG belt from Monsanto to the WNW



Adapted from Huston *et al.*,
Ore Geology Reviews 76, 168-210



The **pre-Ordovician metasediments**, mostly resulting from the dismantling of a Cadomian magmatic arc, are:

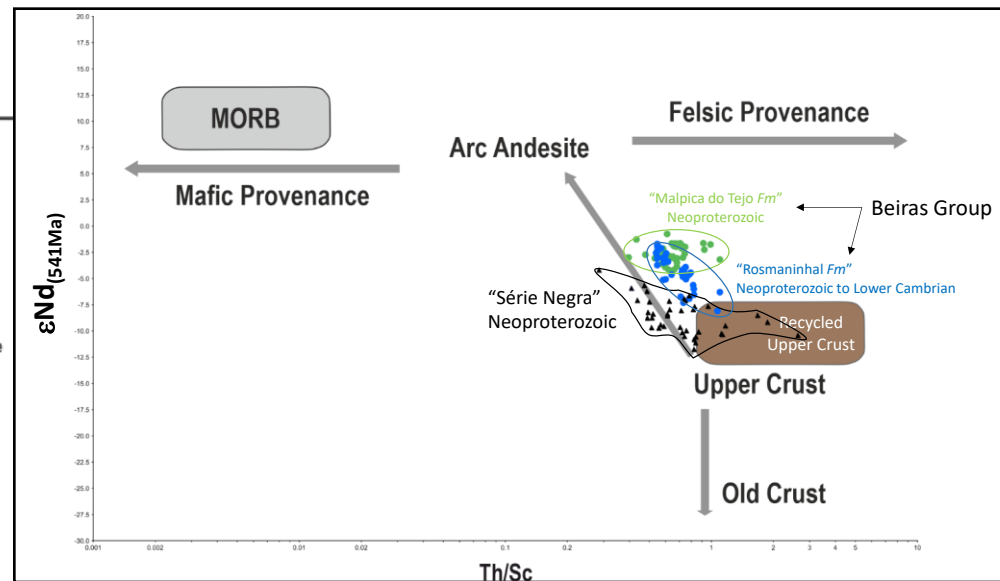
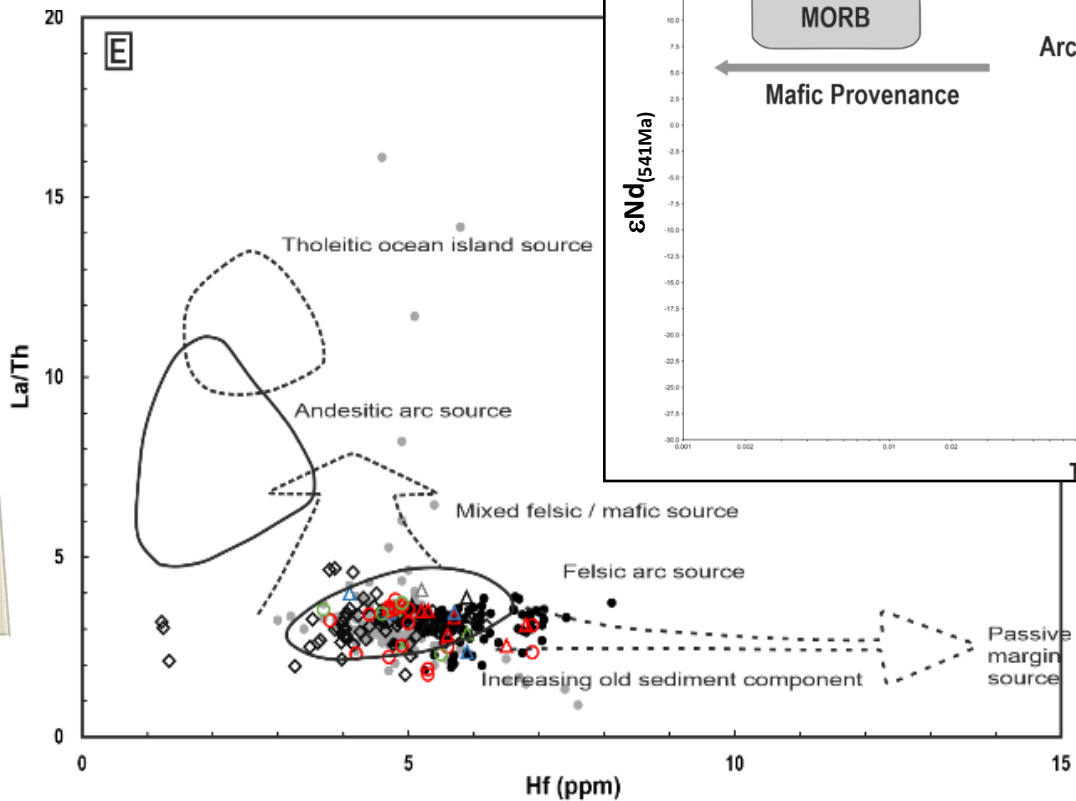
- i. Recrystallized under P-T conditions of greenschist facies;
- ii. Affected by many shear zones; and
- iii. Intruded by voluminous Ordovician and Carboniferous-Permian (Variscan) plutons and different arrays of dykes.

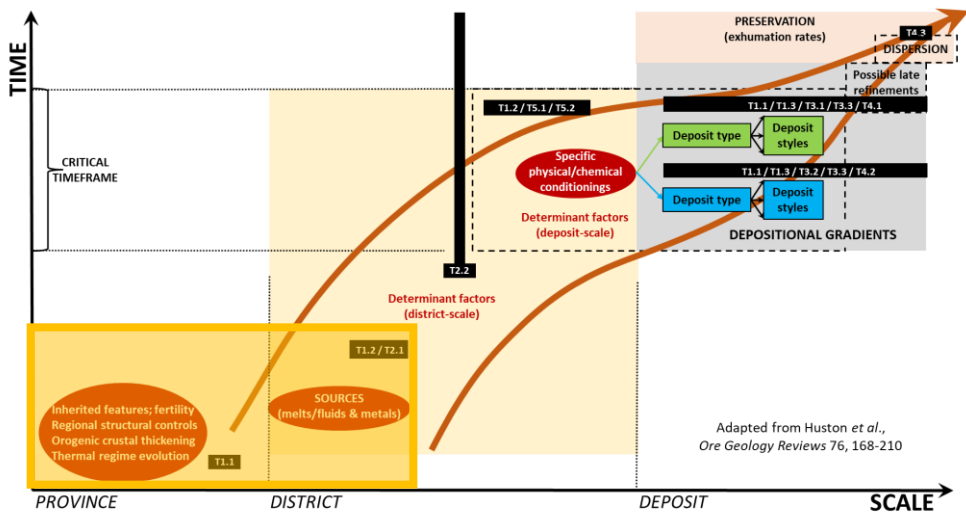
Inherited features

- Fertility
- Regional structural controls

Sources

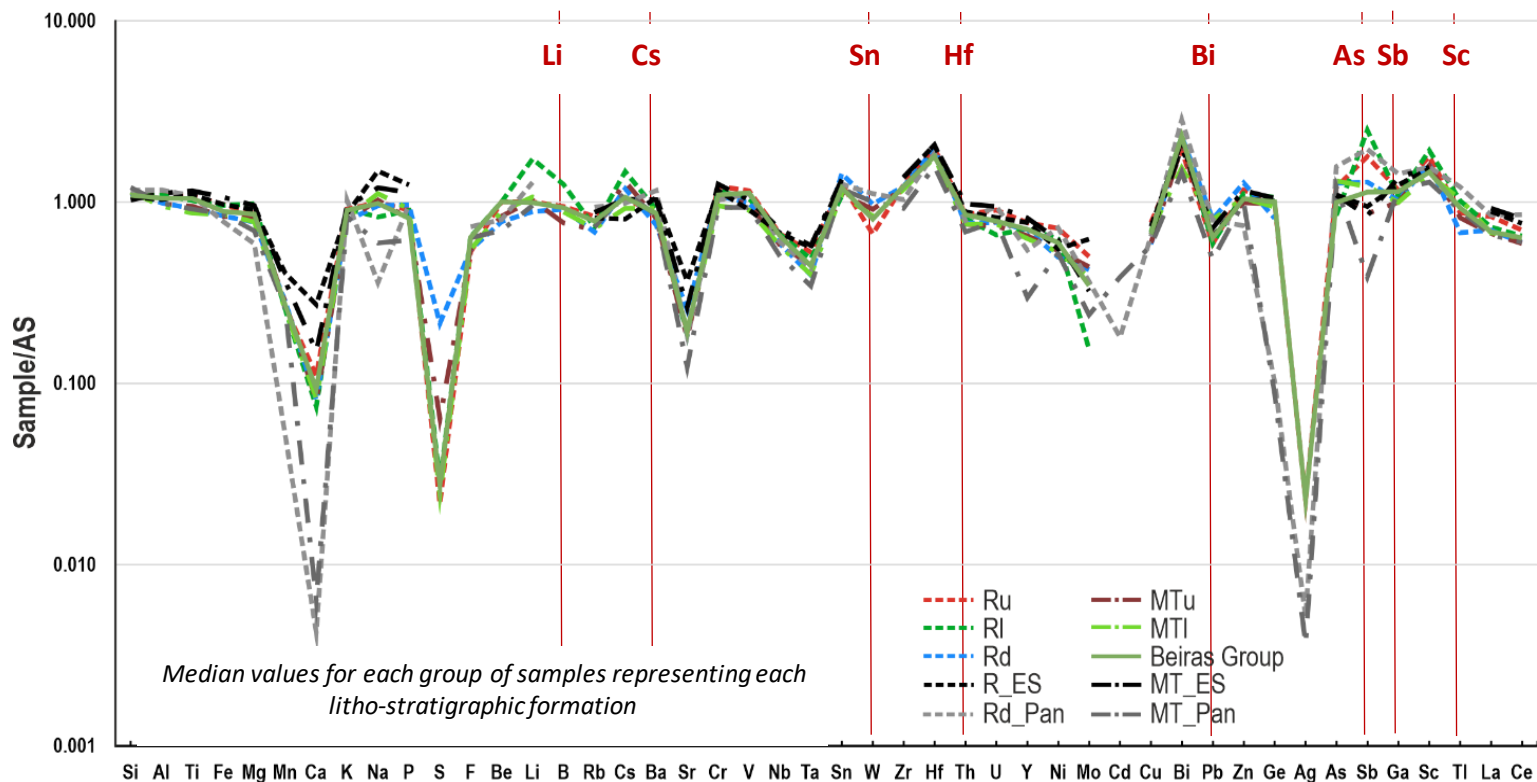
- Melts/fluids & metals

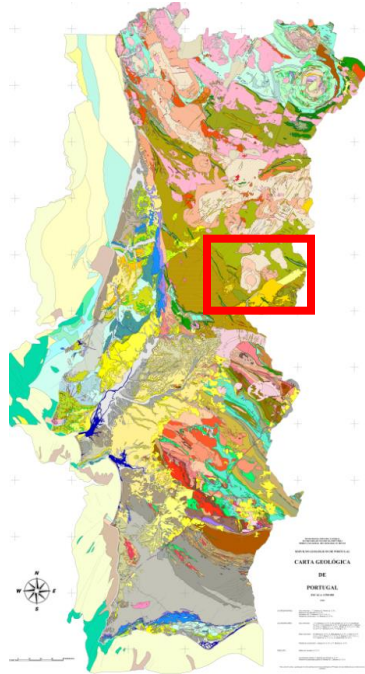




The **Average Shale-normalized composition of pre-Ordovician metapelites** denotes variable enrichments in Li, Cs, Sn, Hf, Bi, As and Sc.

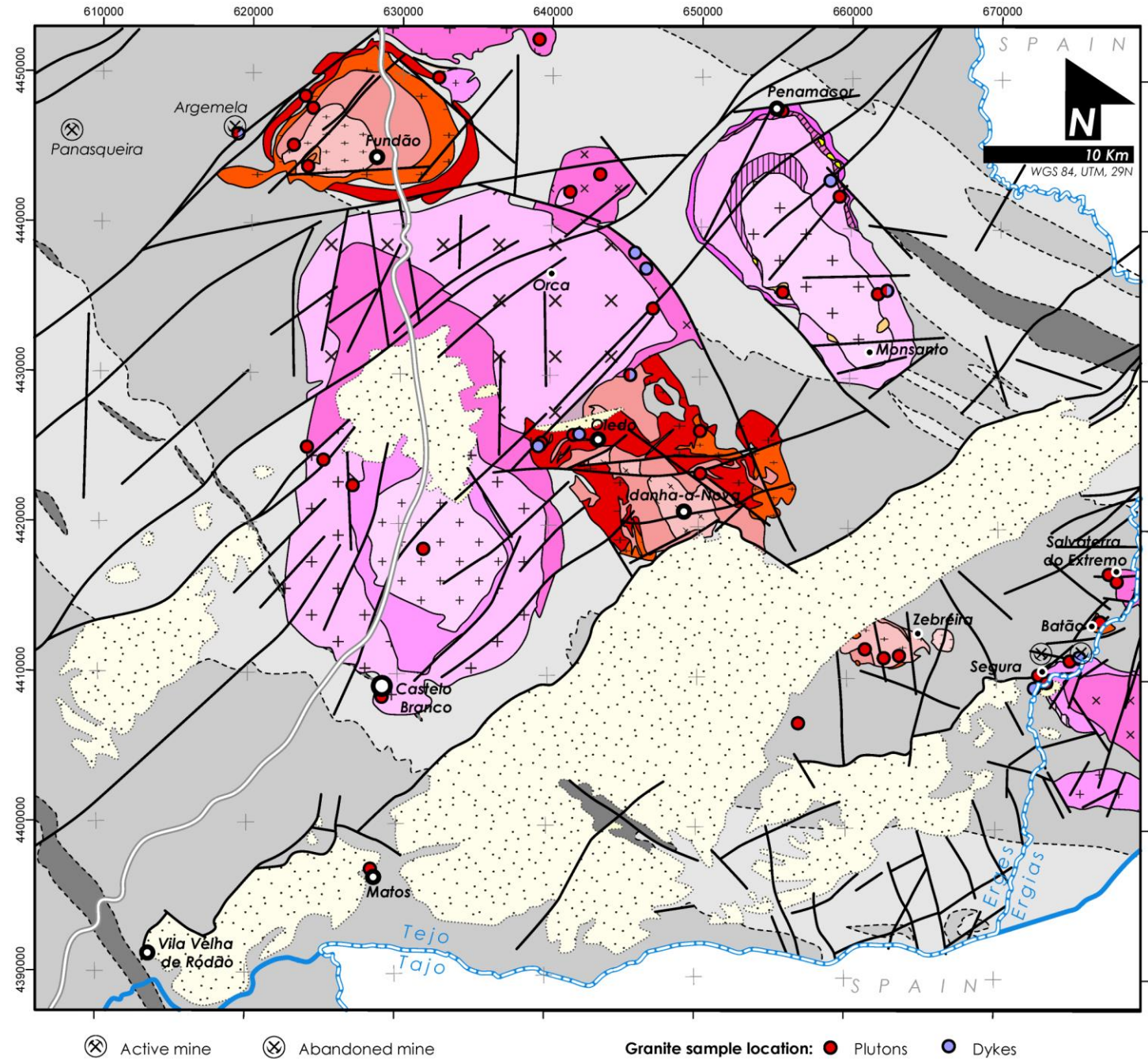
- Inherited features**
 - Fertility
 - Regional structural controls
- Sources**
 - Melts/fluids & metals

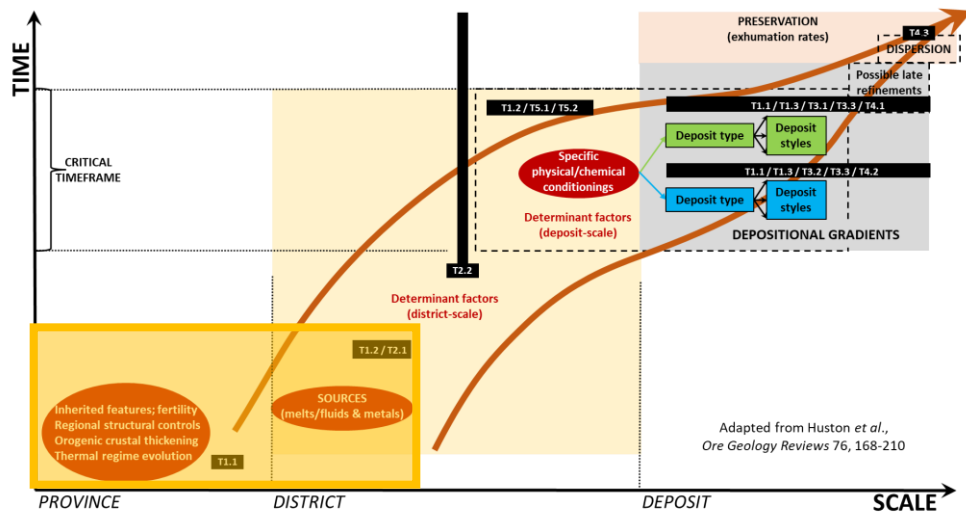




Ore-forming systems exclusively related to Variscan granite suites (pink colours):

- i. Highly peraluminous S-type, calc-alkali to alkali-calcic and magnesian to ferroan rocks;
- ii. Emplacement constrained by crustal-scale discontinuities;
- iii. Protracted magmatic activity.





Constraints to fertility of granite melts further involved in the ore-forming processes imposed by:

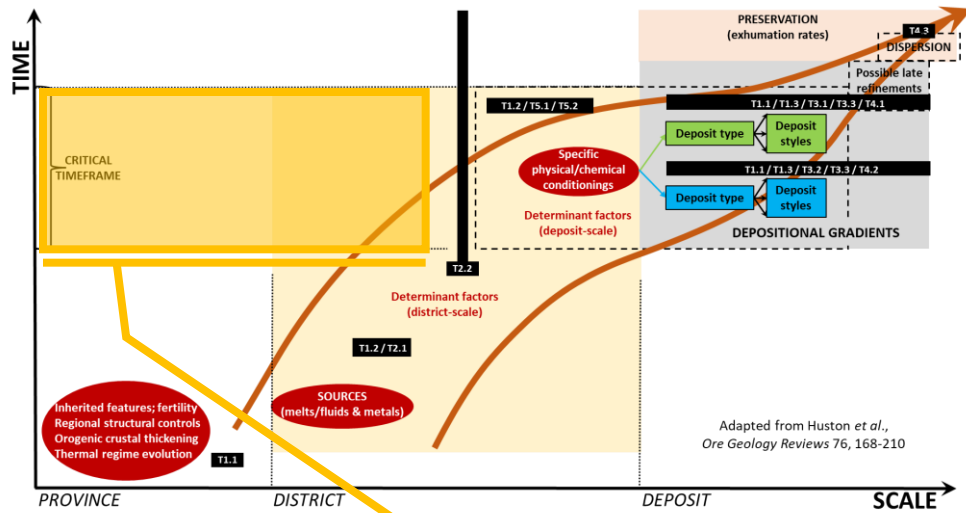
- **Chemical composition of (metasedimentary) protoliths, determining variable enrichments in metals of interest;** and
- **Degree of partial melting and possible multiple extractions under different T conditions.**

Inherited features

- Fertility
- Regional structural controls

Sources

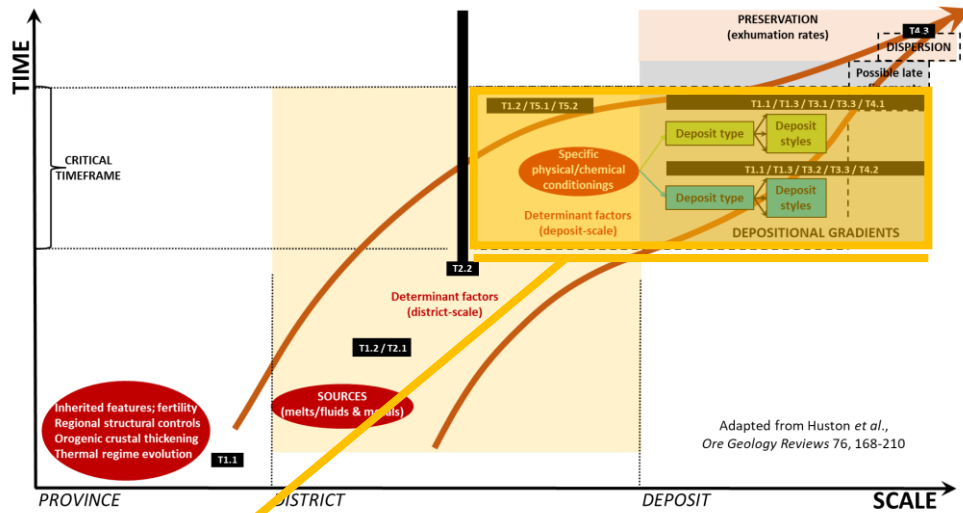
- Melts/fluids & metals



The geochronological data obtained confine the mineralizing events within the surveyed belt to ca. 310-290 Ma, peaking at ≈ 300 Ma.

Critical timeframe

- U-Pb Concordia ages, zircon
- Ar-Ar Plateau ages, muscovite
- Other methods being explored to better constrain the geothermochronological evolving path



Deposit-scale features

Determinant factors

- Melt composition
- Differentiation path

Specific constraints

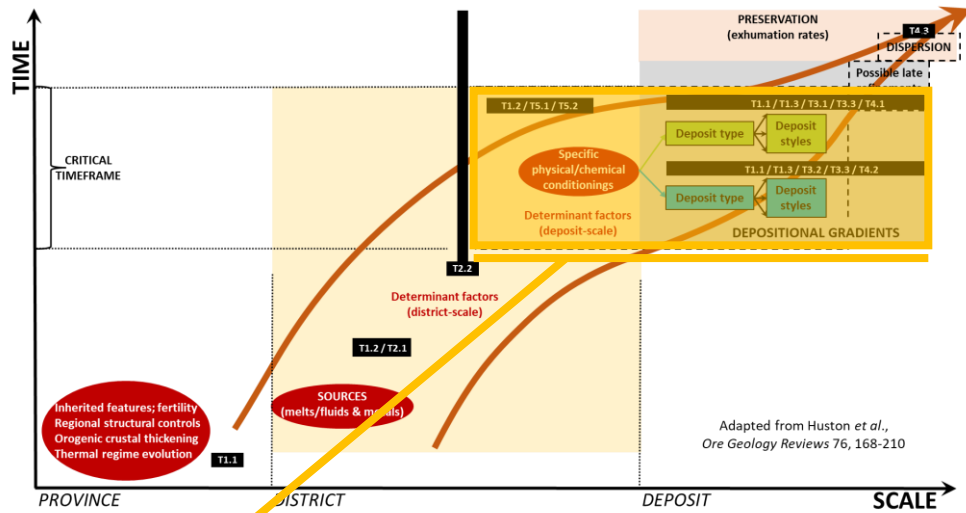
- Protracted magmatic-hydrothermal activity
- Structural control of lodes

Percentage of partial melting

Temperature of partial melting, *higher* ($\approx 800\text{ }^{\circ}\text{C}$) in Sn-related granites than in W-related granites ($\approx 750\text{ }^{\circ}\text{C}$);

Strongly differentiated, ferroan and Na_2O -rich leucogranites indicate the most promising targets.

Water saturation along with the availability and relative abundance of P and F ($\pm\text{B}$), *might regulate the development of certain Li-bearing mineral assemblages.*



Deposit-scale features

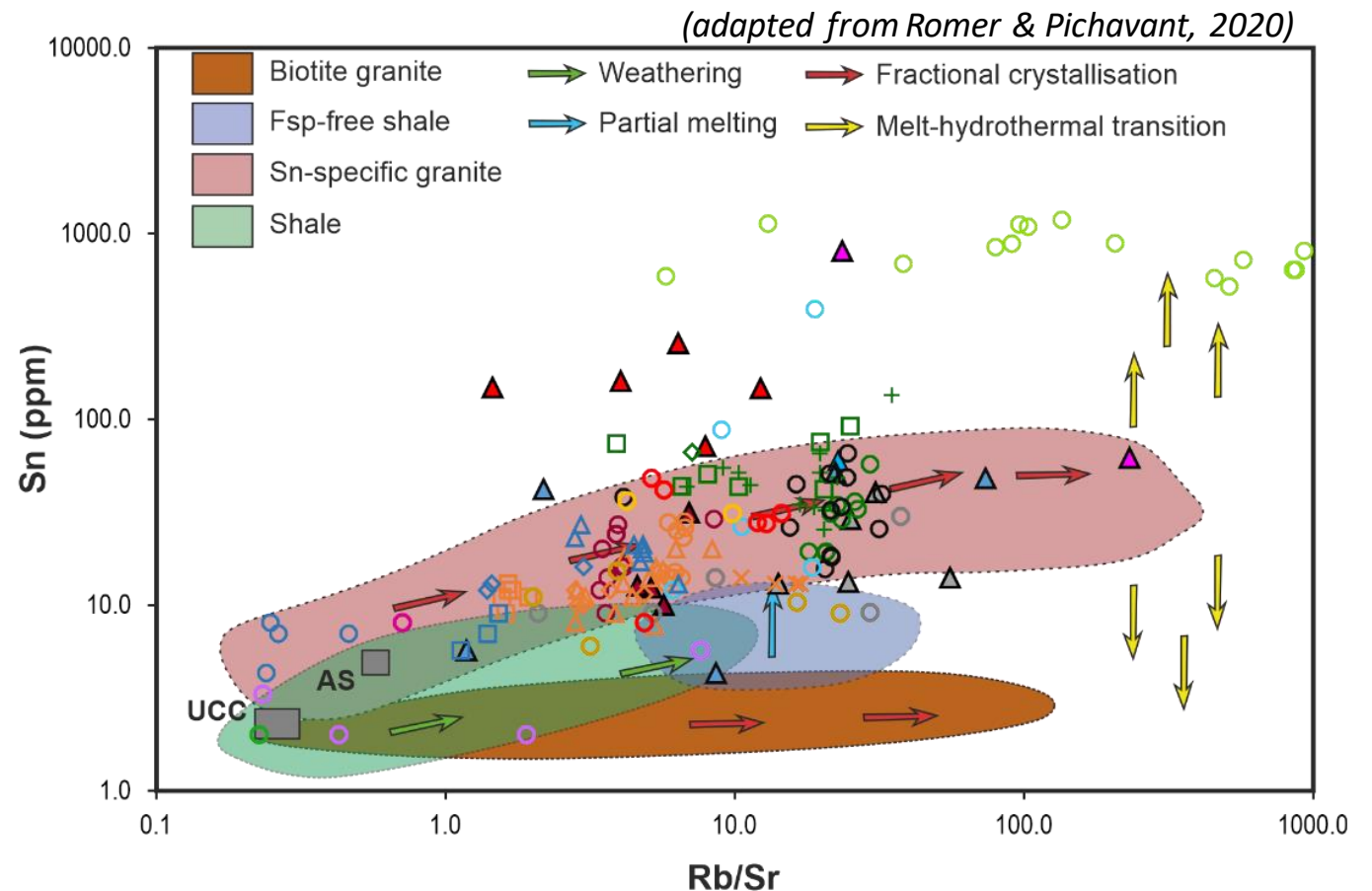
Determinant factors

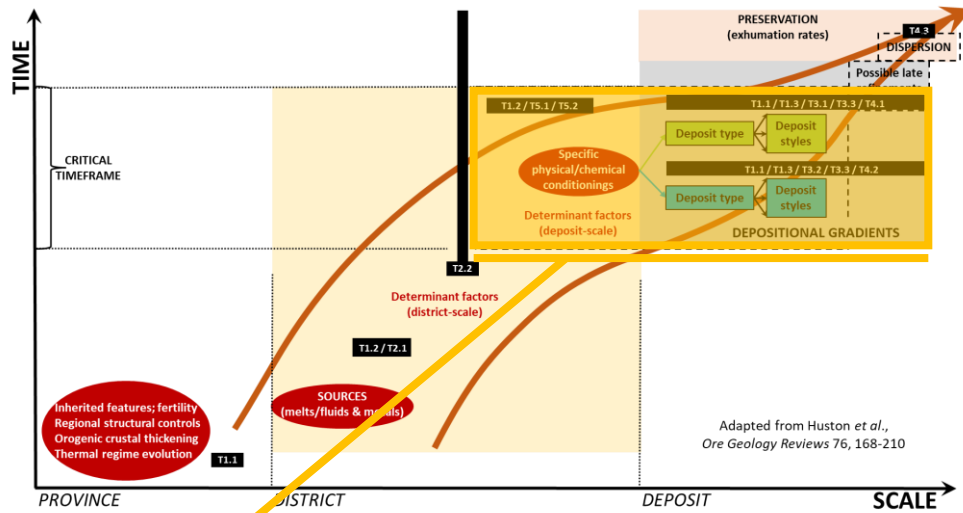
- Melt composition
- Differentiation path

Specific constraints

- Protracted magmatic-hydrothermal activity
- Structural control of lodes

The strongly differentiated and ferroan Variscan leucogranites and related magmatic-hydrothermal ore-forming processes can be traced by Nb/Ta, K/Rb, Y/Ho, Sr/Eu, Eu/Eu*, Zr/Hf, and Rb/Sr ratios, besides other geochemical criteria (TE_{1,3}).





The **composition of several minerals** in different settings, including contact metamorphic aureoles encircling “fertile” granites, are **being successfully tested as finger- and footprints** to different mineralization types.

Deposit-scale features

Determinant factors

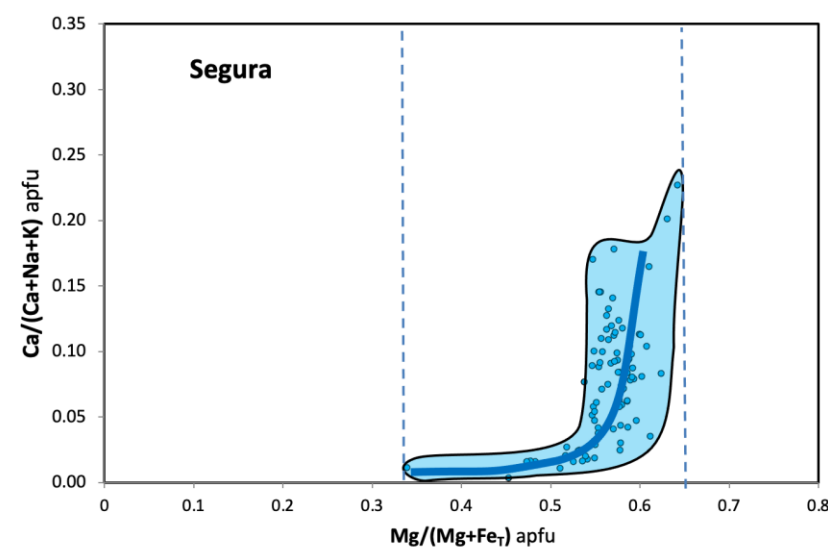
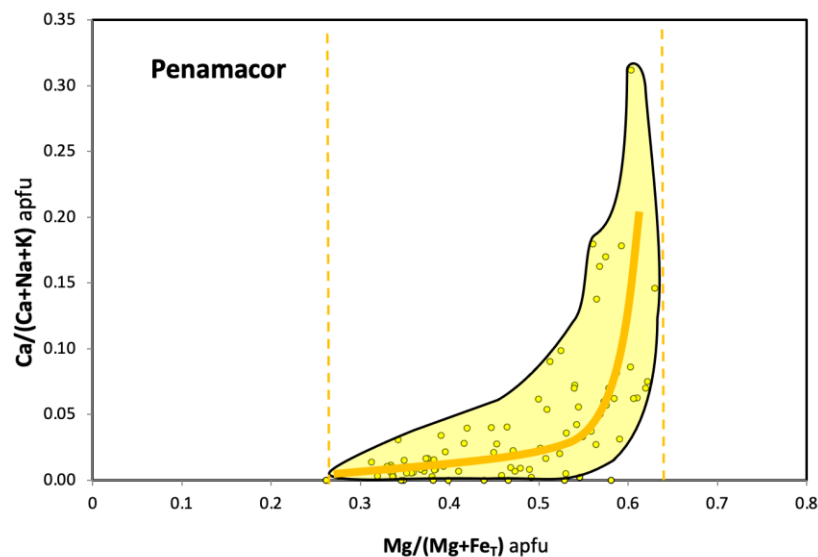
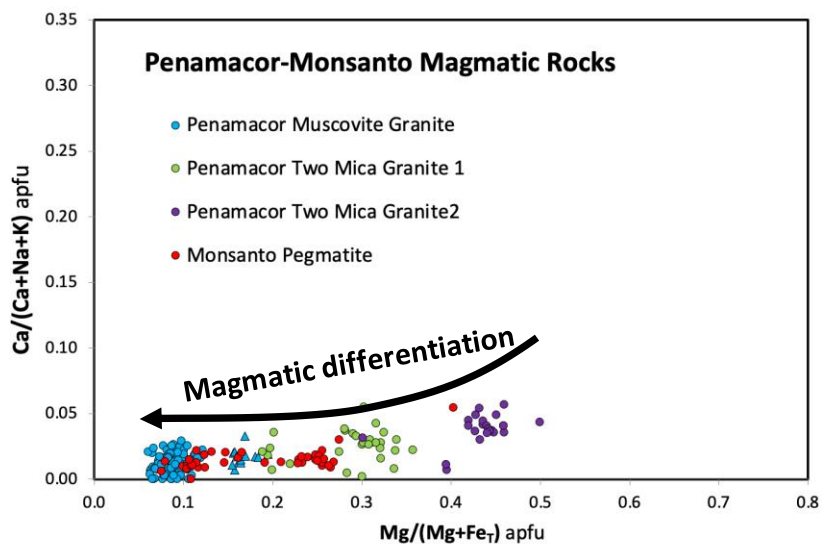
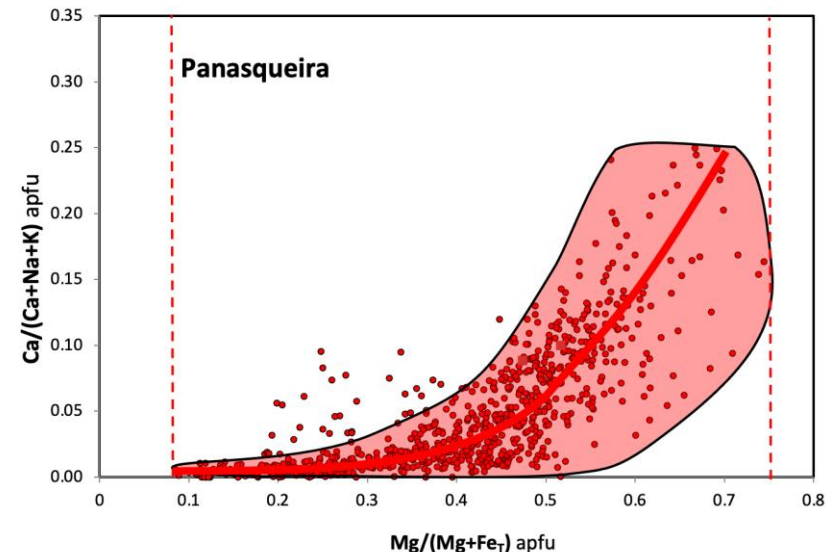
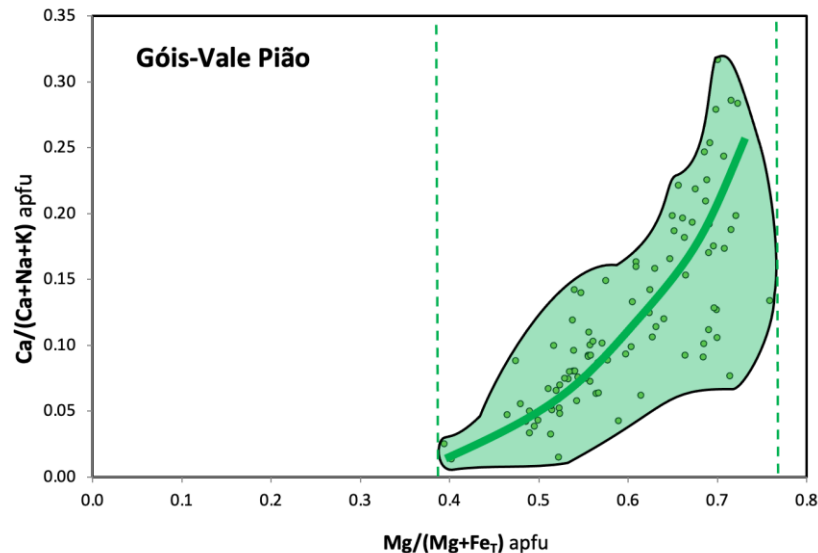
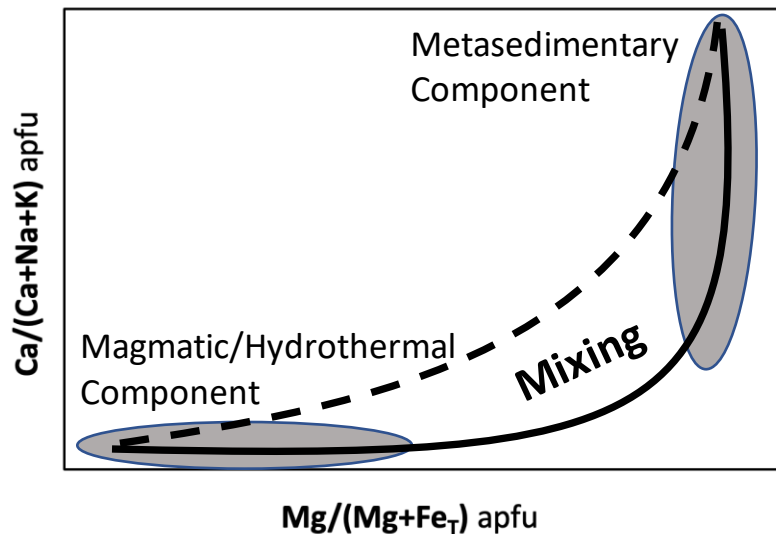
- Melt composition
- Differentiation path

Specific constraints

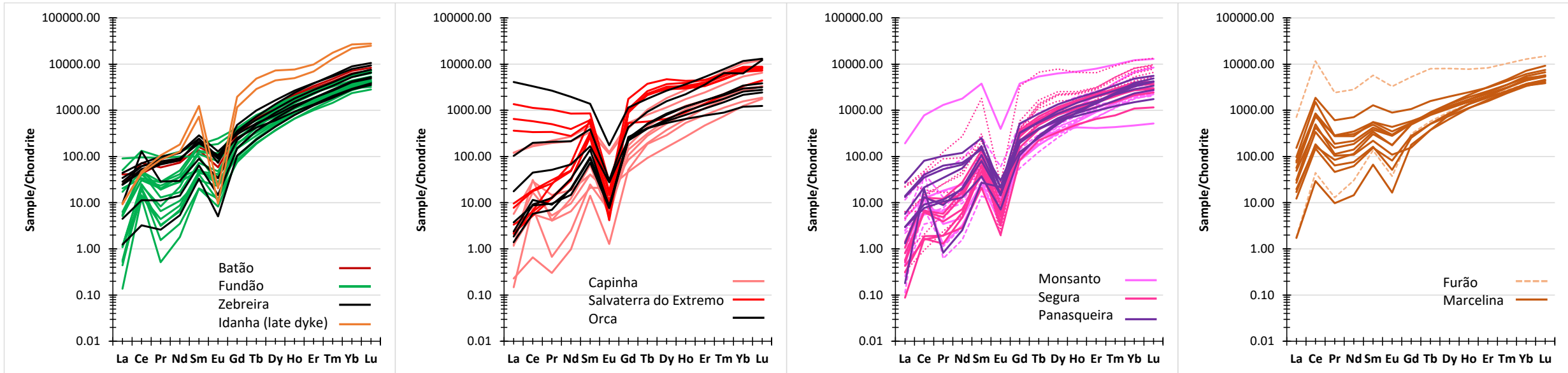
- Protracted magmatic-hydrothermal activity
- Structural control of lodes

That is the case of, e.g., tourmaline....

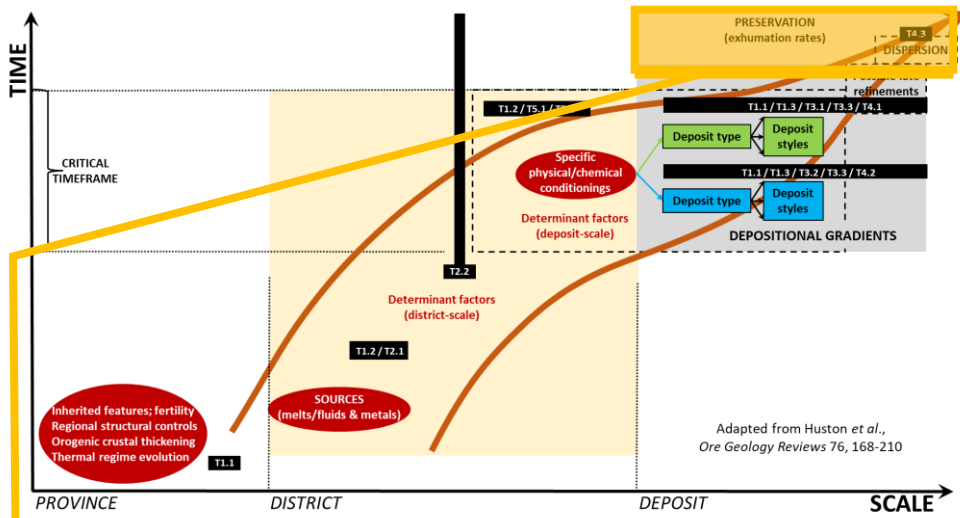
Assessment of Tourmaline Composition as a Vectoring Tool for Sn-W Deposits



... and zircon



- LREE-HREE fractionation + positive Ce anomaly + negative Eu anomaly in non-altered zircons from granite rocks;
- LREE enrichment, but keeping the typical Ce and Eu anomalies, in non-altered zircons from late porphyry rocks;
- LREE enrichment along with evident fading or elimination of Ce (and Eu) anomaly in zircon grains variably affected by HT hydrothermal processes, in addition to significant increase in U (or Th) and ^{204}Pb , denoting open-system behaviour during interaction with late (mineralized) reduced fluids.



The abundance and composition of alluvial cassiterite, wolframite, and scheelite produce anomaly haloes useful to geochemical exploration in the belt.

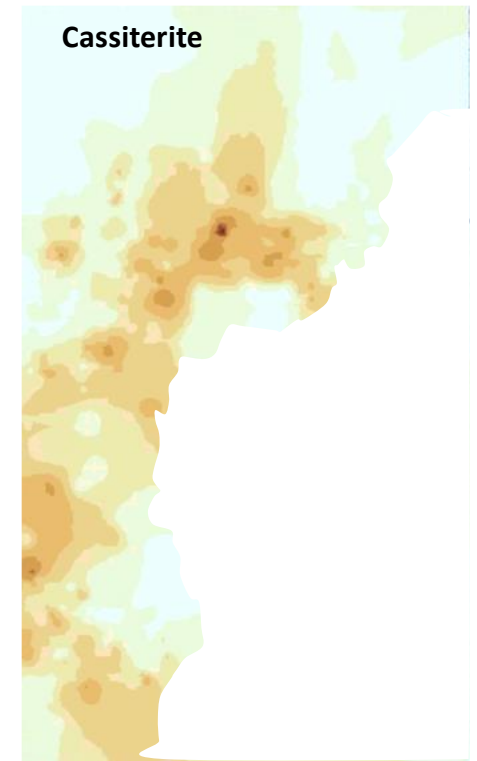
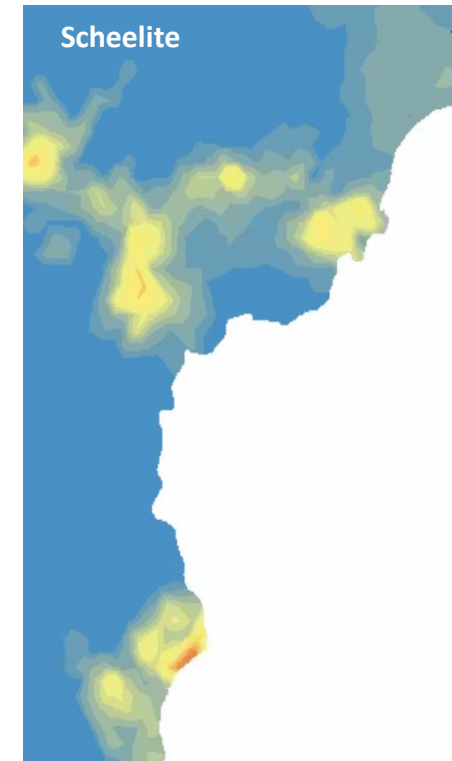
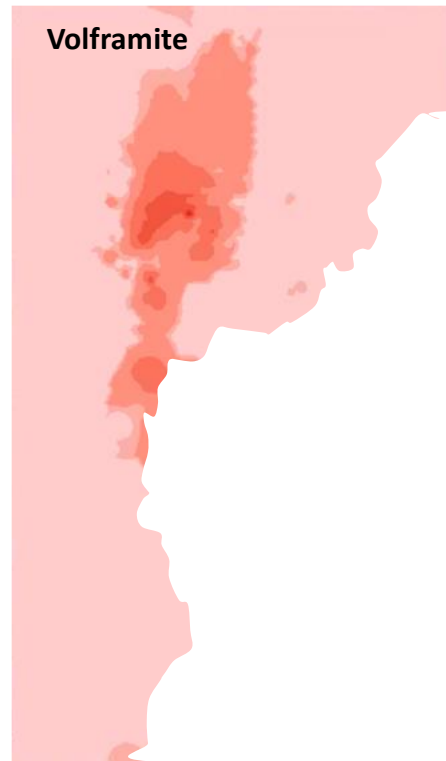
The same is valid for alluvial TiO_2 -polymorphs.

Preservation

- Exhumation rates
- Meso-Cenozoic evolution

Mineral exploration

- Geochemical indicators
- Mineral guides





General view of the Cabeço de Argemela quarry

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Thank you so much for your attention!

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