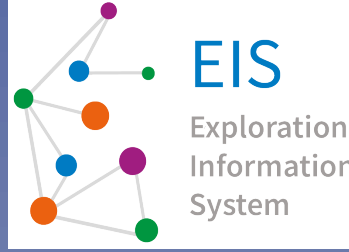


The Iberian Pyrite Belt as a Strategic Source of "Green" and Critical Minerals: The Co Enrichment in VMS

Gonzalo **Ares**, Carmen **Conde** and Fernando **Tornos**

Instituto de Geociencias (CSIC-UCM), 28040, Madrid (Spain)

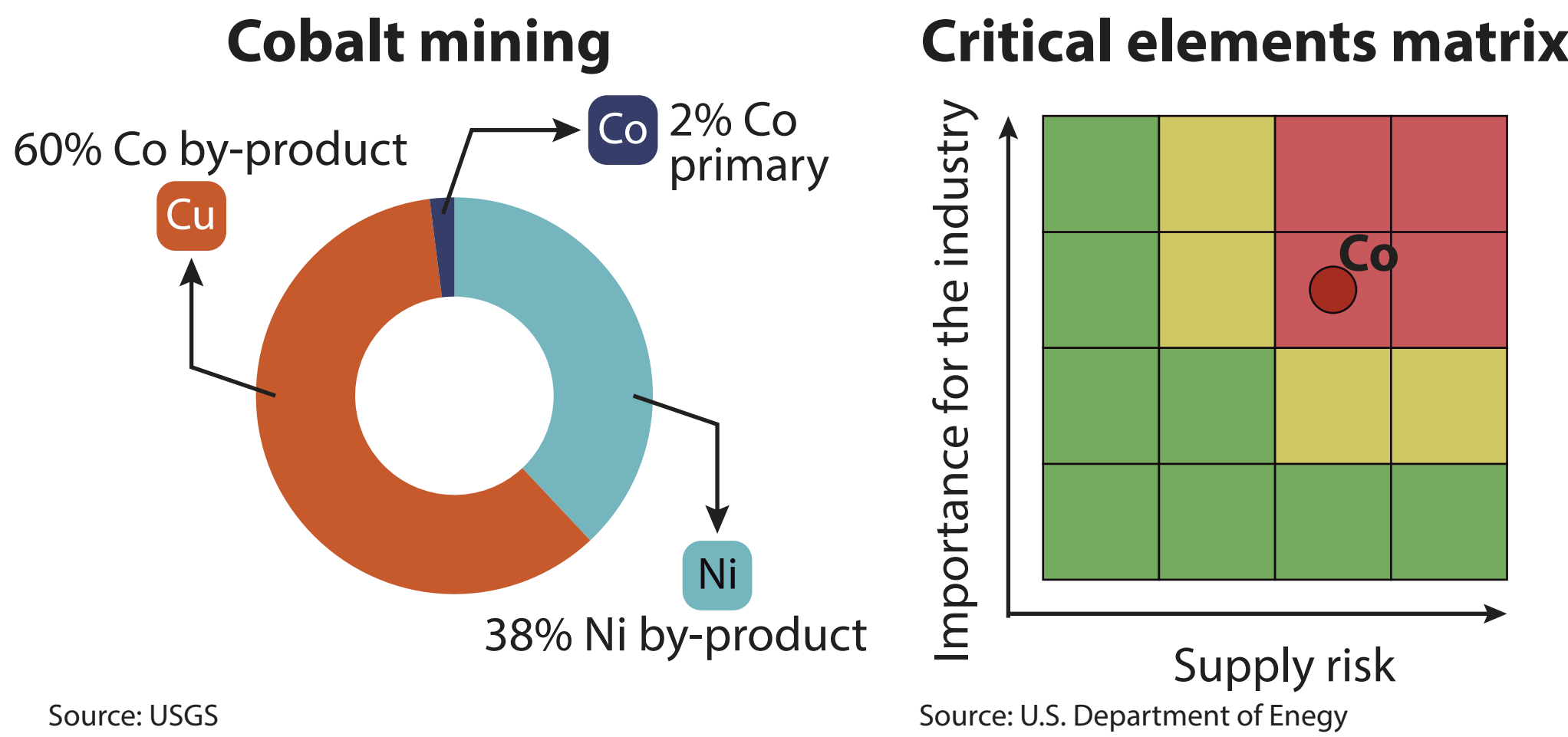


Introduction

The volcanogenic massive sulfides (VMS) of the Pyritic Belt (FPI) are characterised by their high pyrite content, in some cases enriched in base (Cu-Pb-Zn) and precious metals (Au and Ag), and exceptionally, secondary Cu (Las Cruces).

Historical data (Marcoux et al., 1996; Tornos et al., 1998), as well as detailed pyrite studies (Conde et al., 2021) indicate that some of these deposits are significantly enriched in Co (>300ppm) making them a potential source of extraction (Tharsis, Sotiel, Concepción, Valverde, etc.).

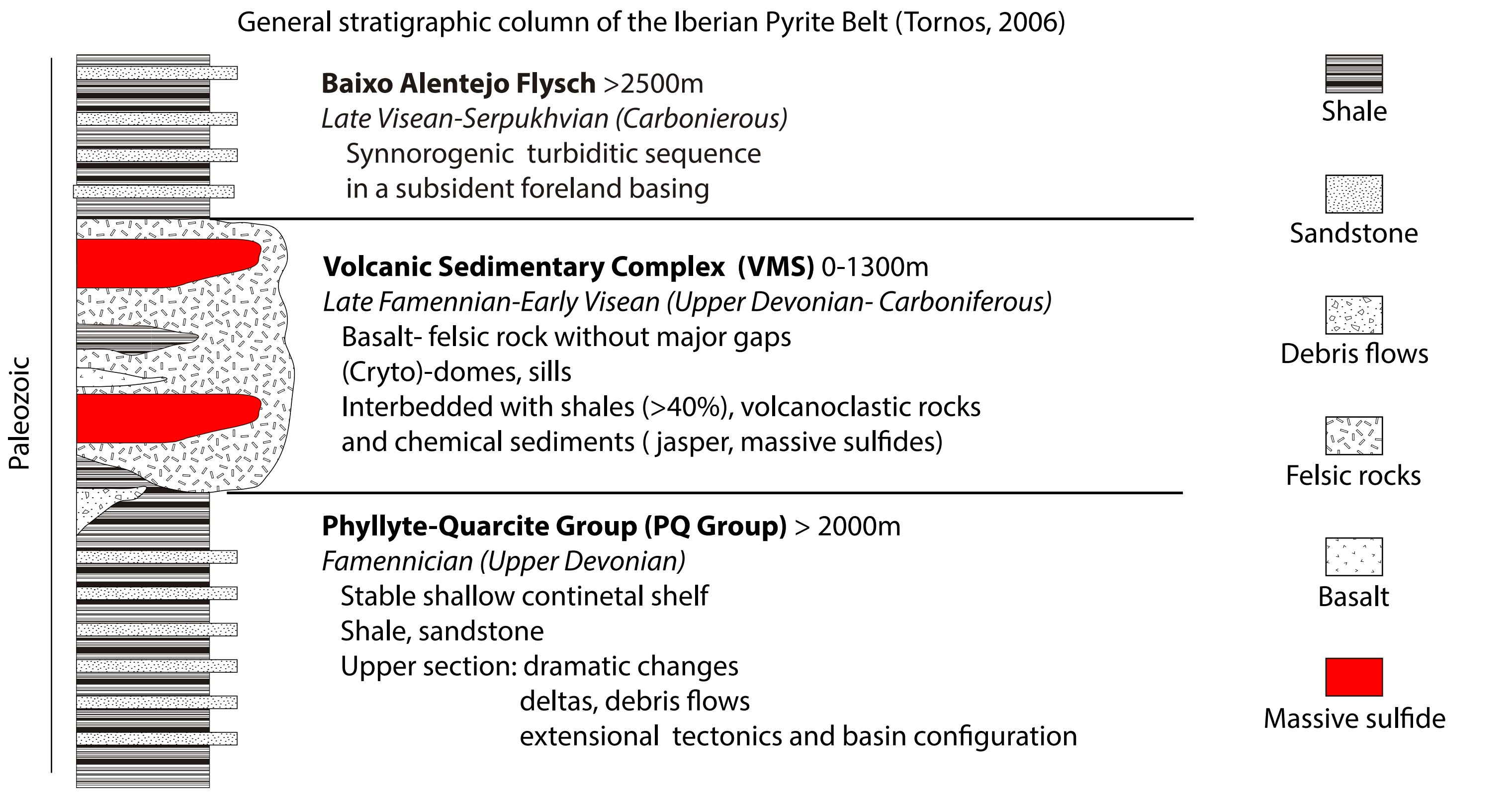
However, this information is very scattered, scarce and poorly contrasted. This study improves our knowledge on where are the Co grades located at deposit scale. Where is cobalt preferentially concentrated (shale-hosted vs volcanic-hosted deposits and different zones of the massive sulfide vs stockwork) and in which phases and how it occurs. If it is as discrete phases, nano inclusions or as solid solution in other phases, very likely pyrite. This study has been carried out with pXRF, EPMA, LA-ICPMS analysis and μ XRF elemental mapping.



In recent years, the demand for cobalt has escalated while the global supply chain for this element is still unstable

Geology of the Iberian Pyrite Belt

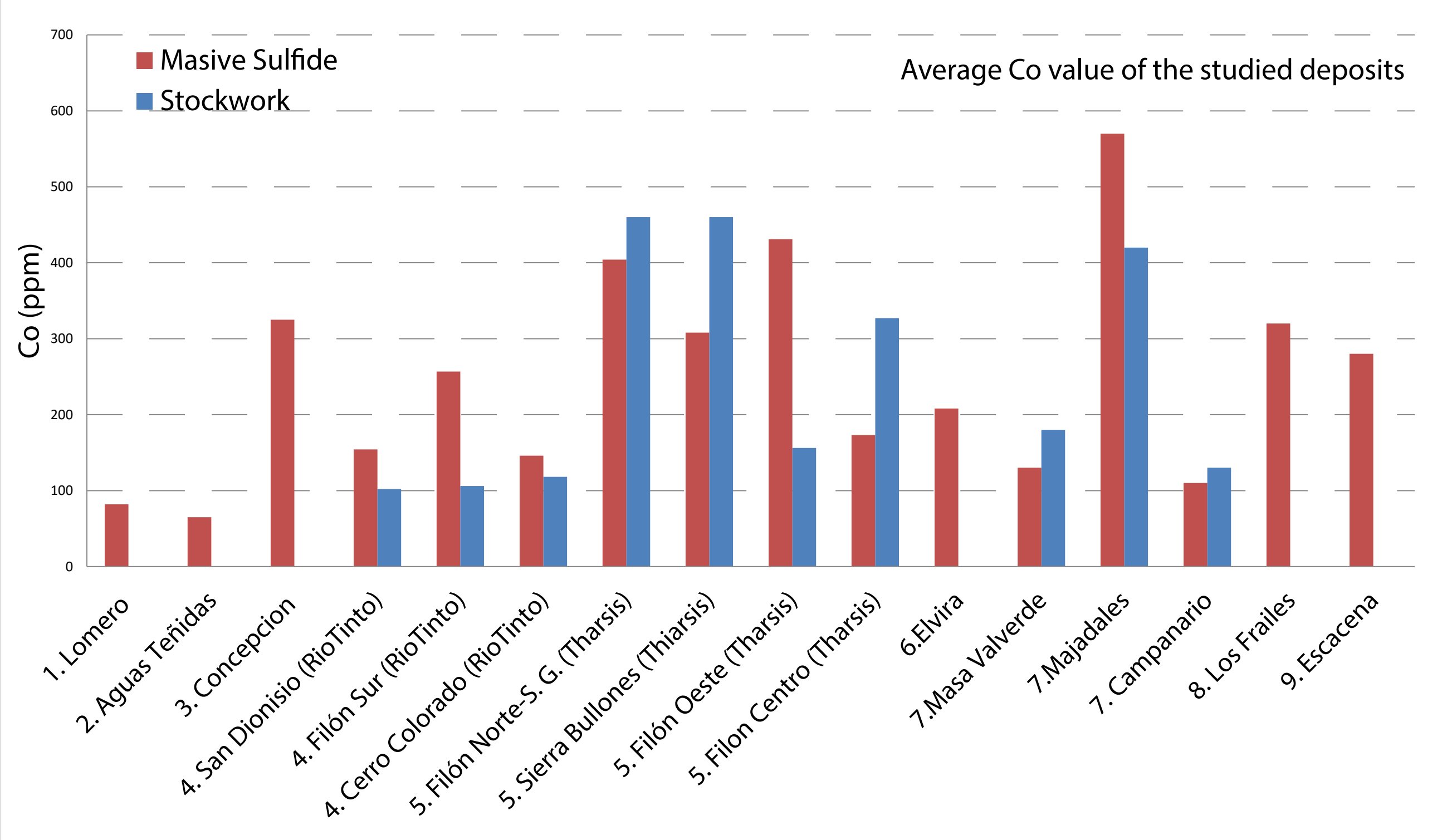
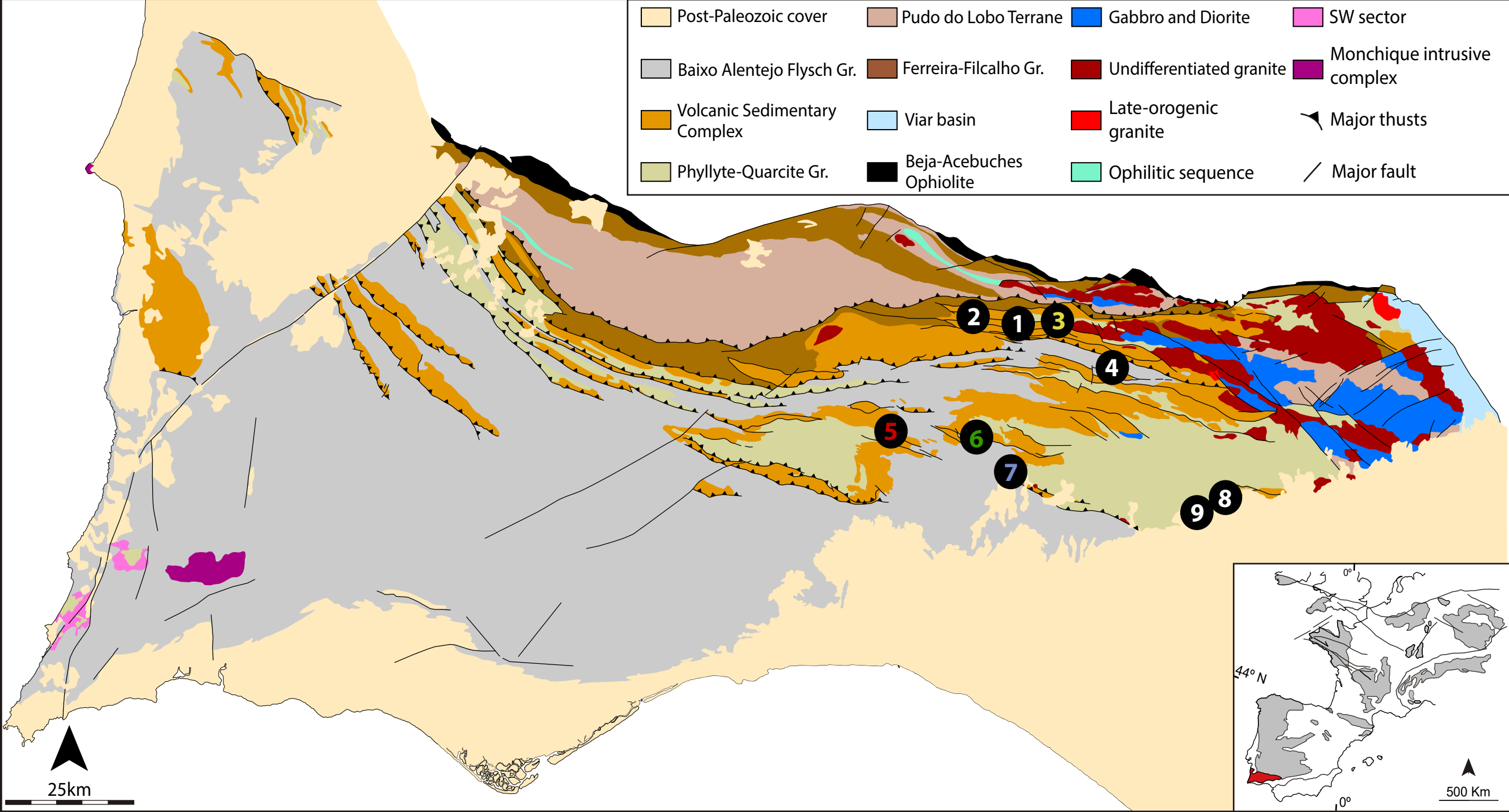
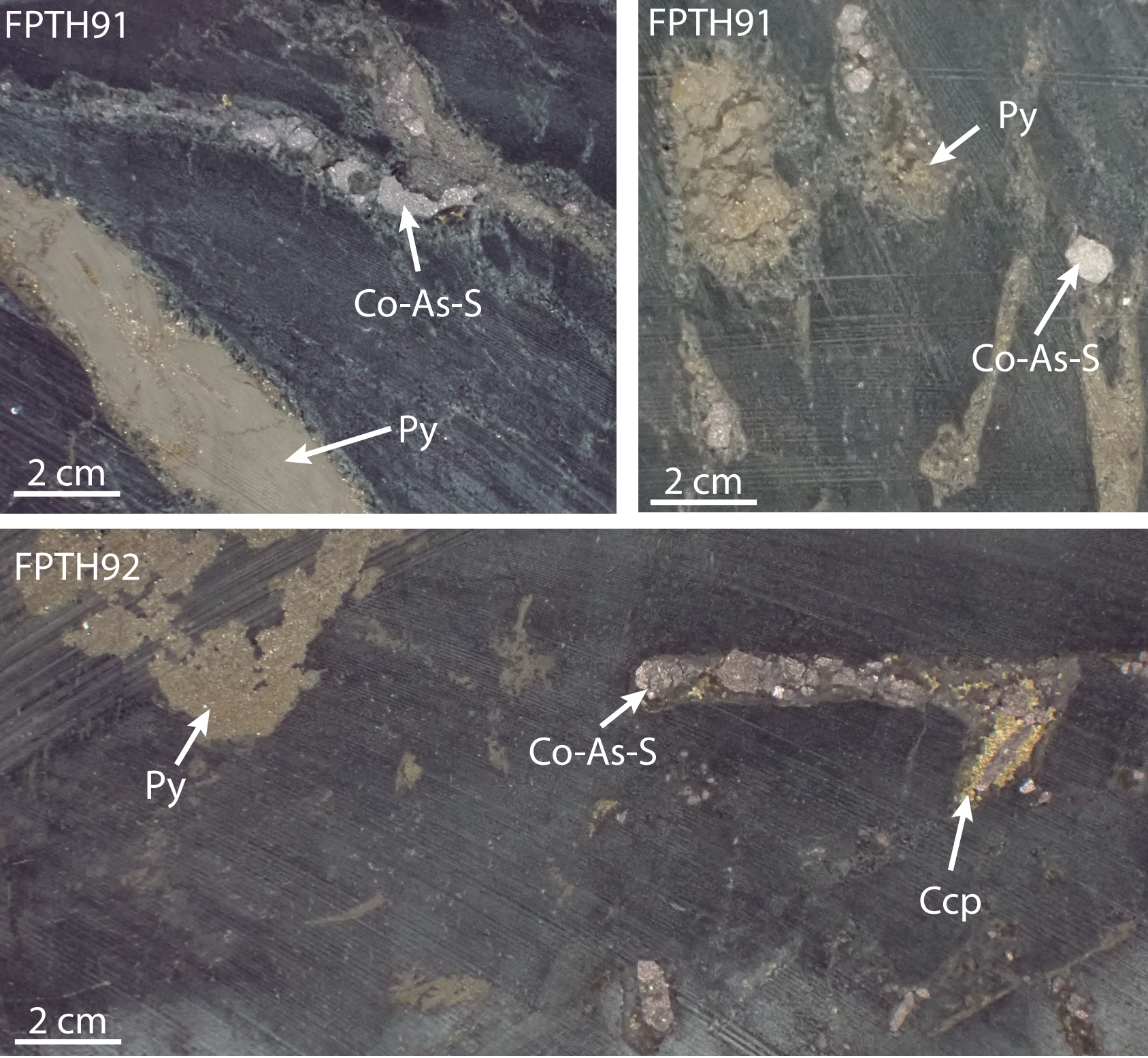
The IPB is one of the three areas of the South Portuguese Zone, the southernmost terrane of the Variscan Belt of Iberia. Deposits in the IPB can be classified into two types: deposits in the southern area, these deposits share features such as large tonnages, the stratiform morphology, a shortage of base and precious metals and the abundance of sedimentary structures. On the other hand, most of the VMS in the northern part are hosted by a felsic volcanic sequence with only minor shale. These deposits are interpreted as formed by the stratabound replacement of porous or reactive volcanic rocks. In general, these ore bodies are smaller in size and have higher base and precious metal grades.



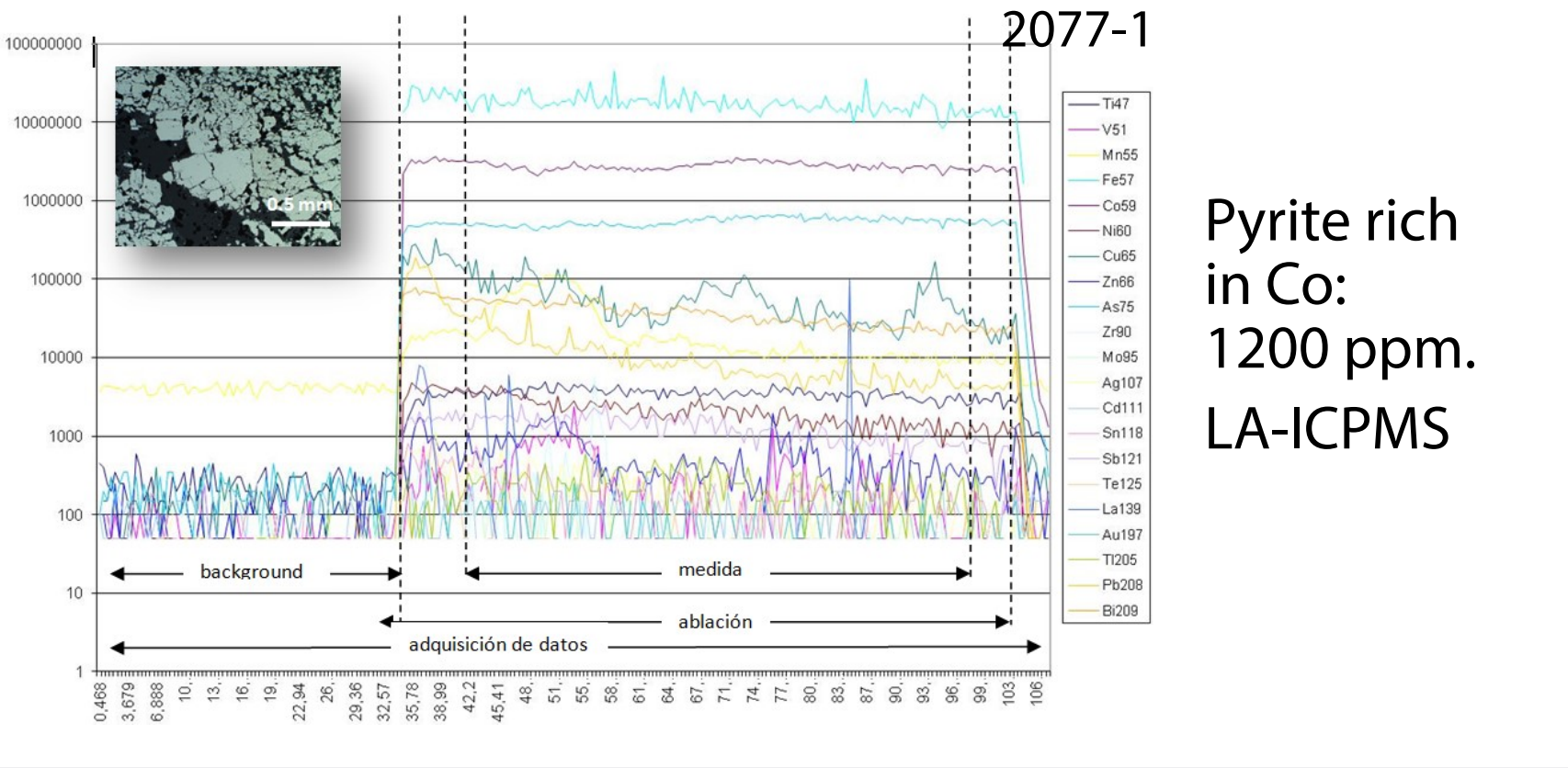
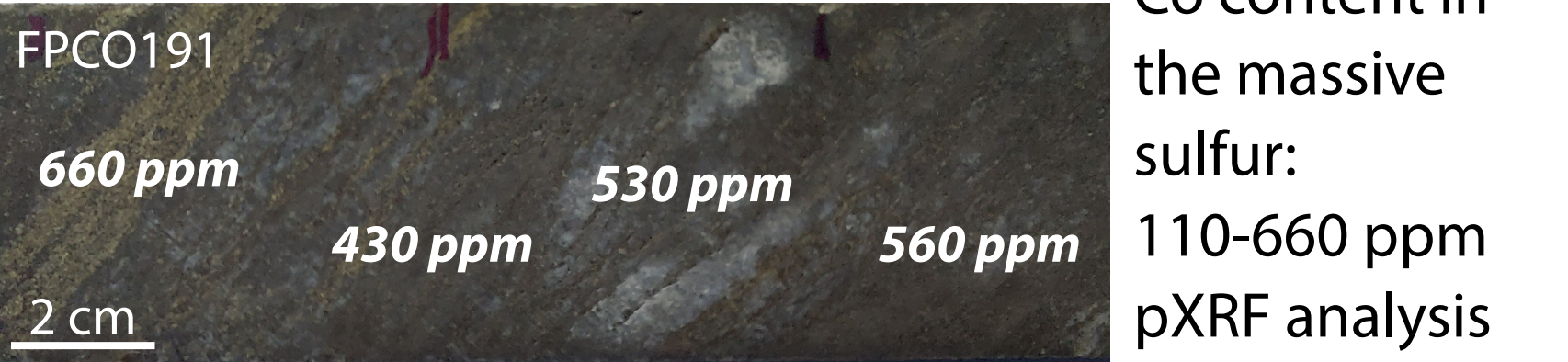
Cobalt study on a regional scale

Tharsis

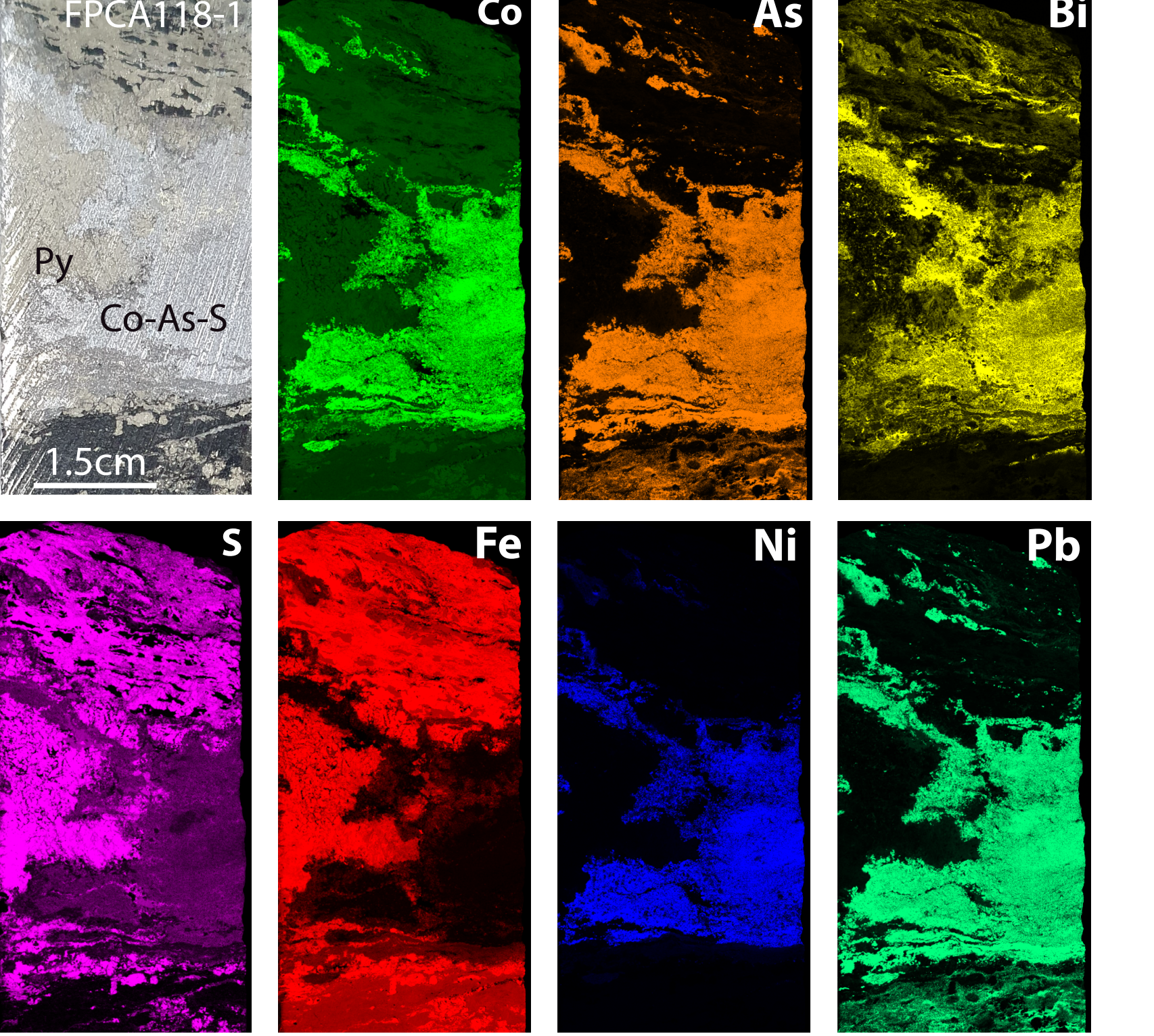
Stockwork in highly chloritized shale with veins of pyrite and discrete grains of Co-rich minerals (Co-As-S)



Concepción



Campanario



μ XRF elemental mapping showing the existence of cm-thick discontinuous layers enriched in Co in the stockwork of shale-hosted mineralization. Co-rich pyrite post-date earlier barren pyrite. Co-rich levels are positively correlated with Bi, As, Ni and Pb. Mapping represents qualitative distributions based on the intensity of the spectral line of the element.

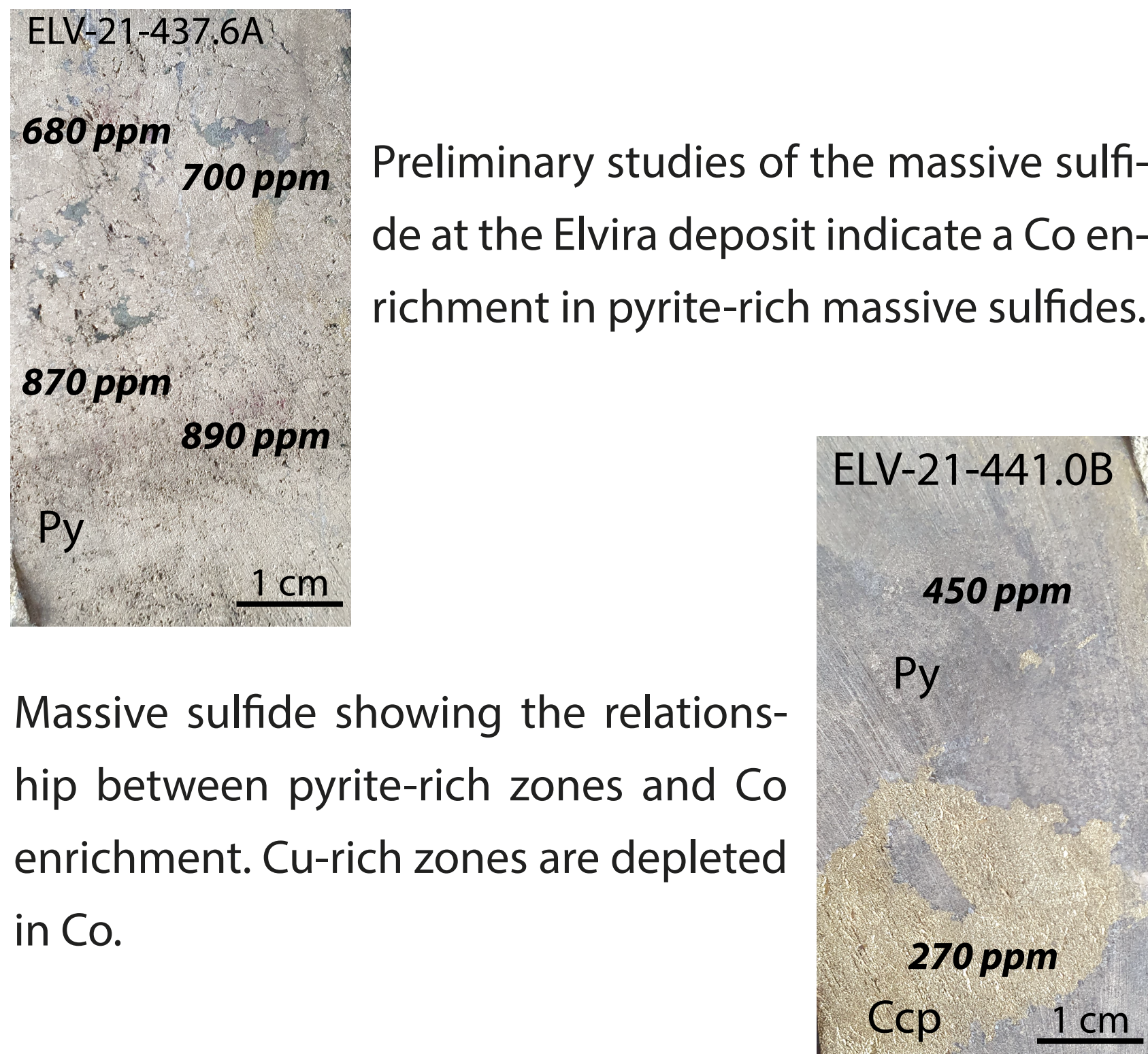
References

Conde, C., et al. (2021). *J. Iber. Geol.*, 47, 429-440.
Marcoux, E., et al. (1996). *Min. Dep.*, 31, 1-26.
Tornos, F., et al. (1998). *Min. Dep.*, 33, 150-169.
Tornos, F. (2006). *Ore Geol. Rev.*, 28(3), 259-307.

Acknowledgements

We would like to thank Tharsis Mining, Atalaya Mining, MATSA, Mineral Los Frailes and CLC for their collaboration and facilities in the sampling and geological study. This work has been funded by the Horizon Europe EIS project (contract 101057357).

Elvira



Massive sulfide showing the relationship between pyrite-rich zones and Co enrichment. Cu-rich zones are depleted in Co.

Discussion and preliminary conclusions

The distribution of Co is very variable at both regional and deposit.

Highest Co grades (1600-2100ppm) are found as discontinuous stratabound zones - dominantly in the uppermost stockwork of the shale-hosted deposits of the southern IPB.

Deposits in the northern IPB are depleted in Co (65-82 ppm). The only exception is the Concepcion mine, with average Co grade of 325ppm and maximum values around 1200ppm.

Detailed mineralogical studies and LA-ICPMS analyses have shown that Co can be found both as a trace element in sulfides (pyrite or chalcopyrite) in stoichiometric substitution or as independent phases such as cobaltite (CoAsS), glaucodot ((Fe_{0.5}Co_{0.5})AsS) and allocasite ((Co_{1-x}Fe_x)AsS).

