LNEG contribution to the Alentejo Region Integrated Mineral Exploration Data Management

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MOSTMEG Project FINAL DISSEMINATION SEMINAR,
Évora University, Hercules Laboratory, 06/06/2024

LNEG

UNIVERSIDADE DE ÉVORA

CENTRO HERCULES
HERANÇA CULTURAL, ESTUDOS E SALVAGUARDA

MOSTMEG

LNEG geological surveys in the Alentejo

1 - Geological mapping

- Goals and mapping scale – 1/50,000, 1/200,000
- Regional scale maps – 1/200,000, 1/400,000
- Databases and background – GeoPortal
- Detail stratigraphy and tectonic setting
- Field work, logistics and land assessment
- Rock dating

2 - Mineral exploration surveys

- Green field areas
- Brown field areas
- Geophysical and geochemical surveys
- Mineralization studies

3 - Predictive mineral exploration mapping

- New challenges related with the new CRM Act

LNEG

Geology

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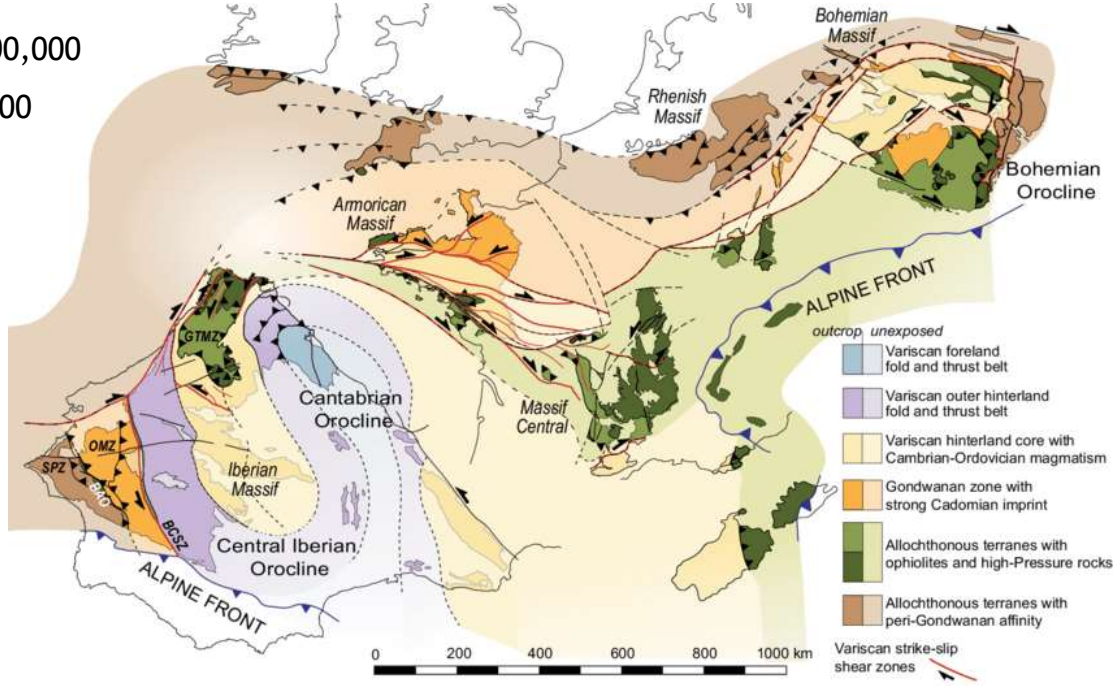

Martínez Catalán et al., 2007; Quesada et al., 2019

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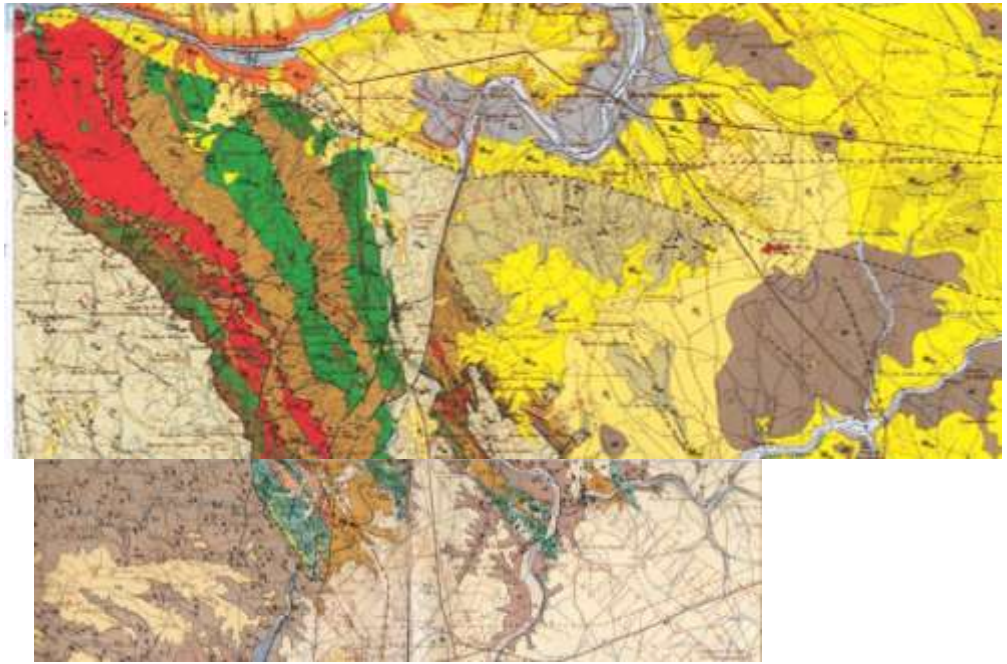
GeoPortal LNEG



Schermerhorn *et al.* 1987 Oliveira *et al.* 2010

Geology

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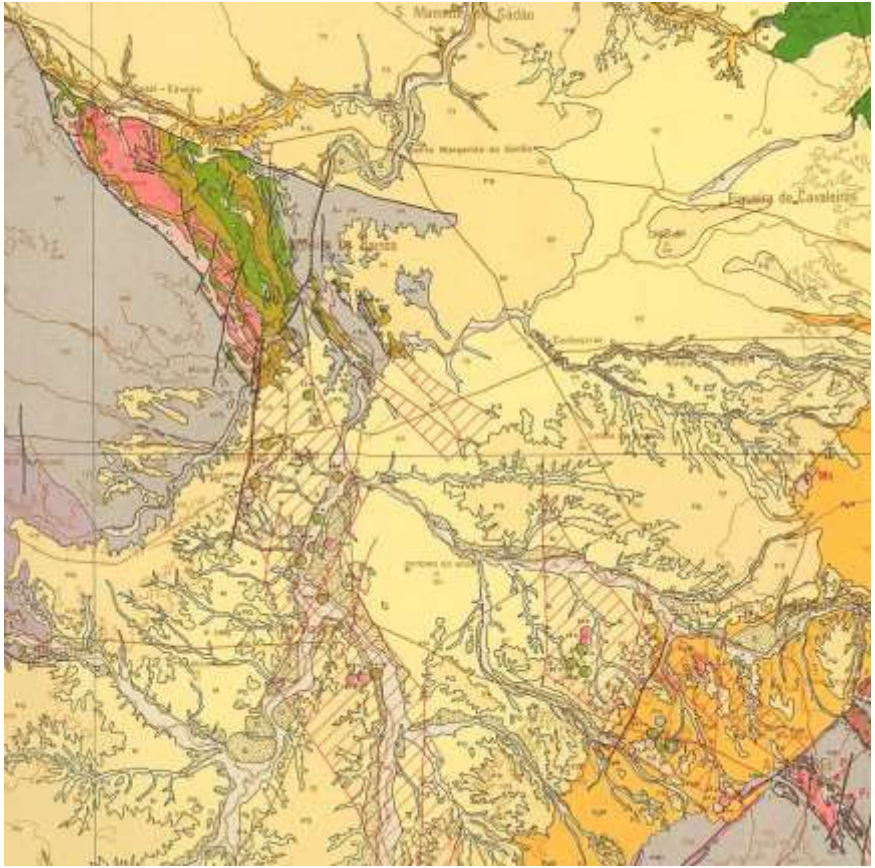
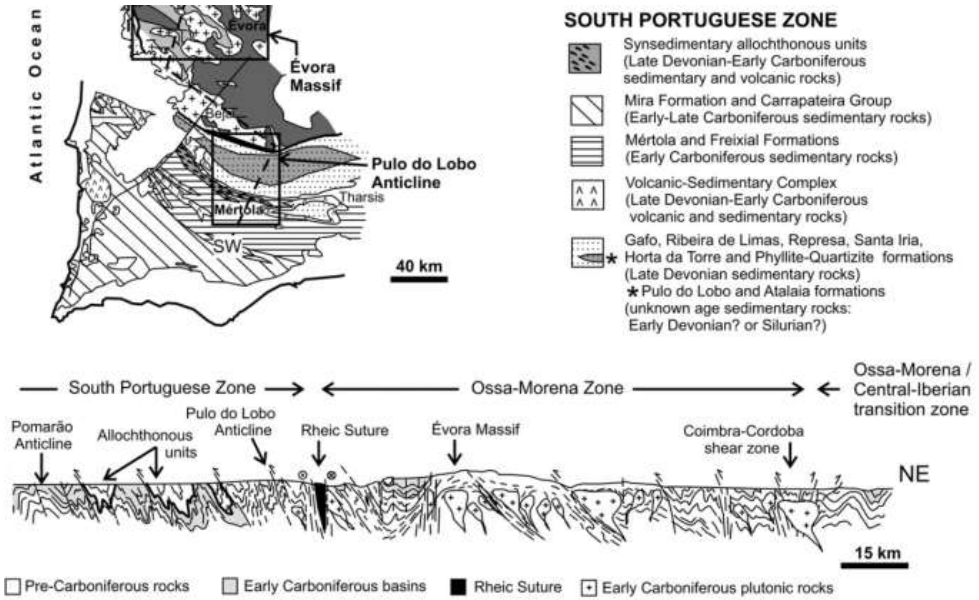
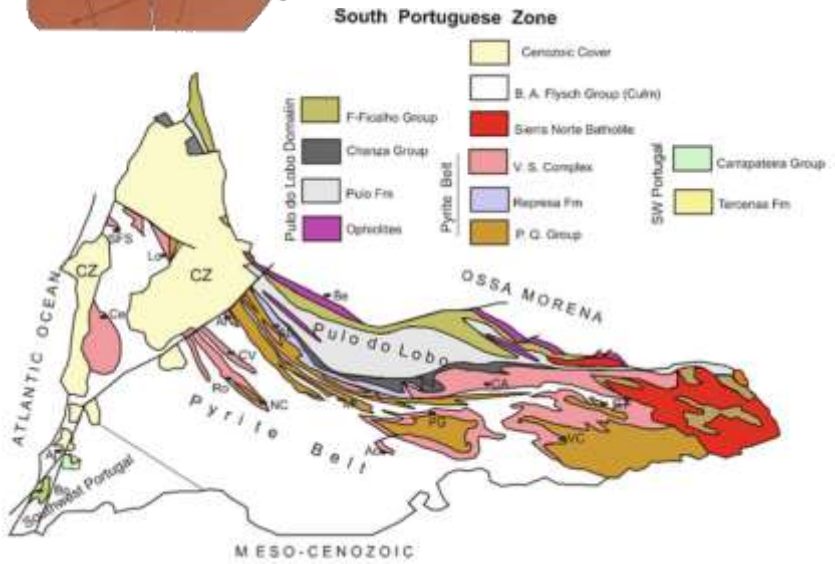


Oliveira *et al.* 1984

South Portuguese Zone

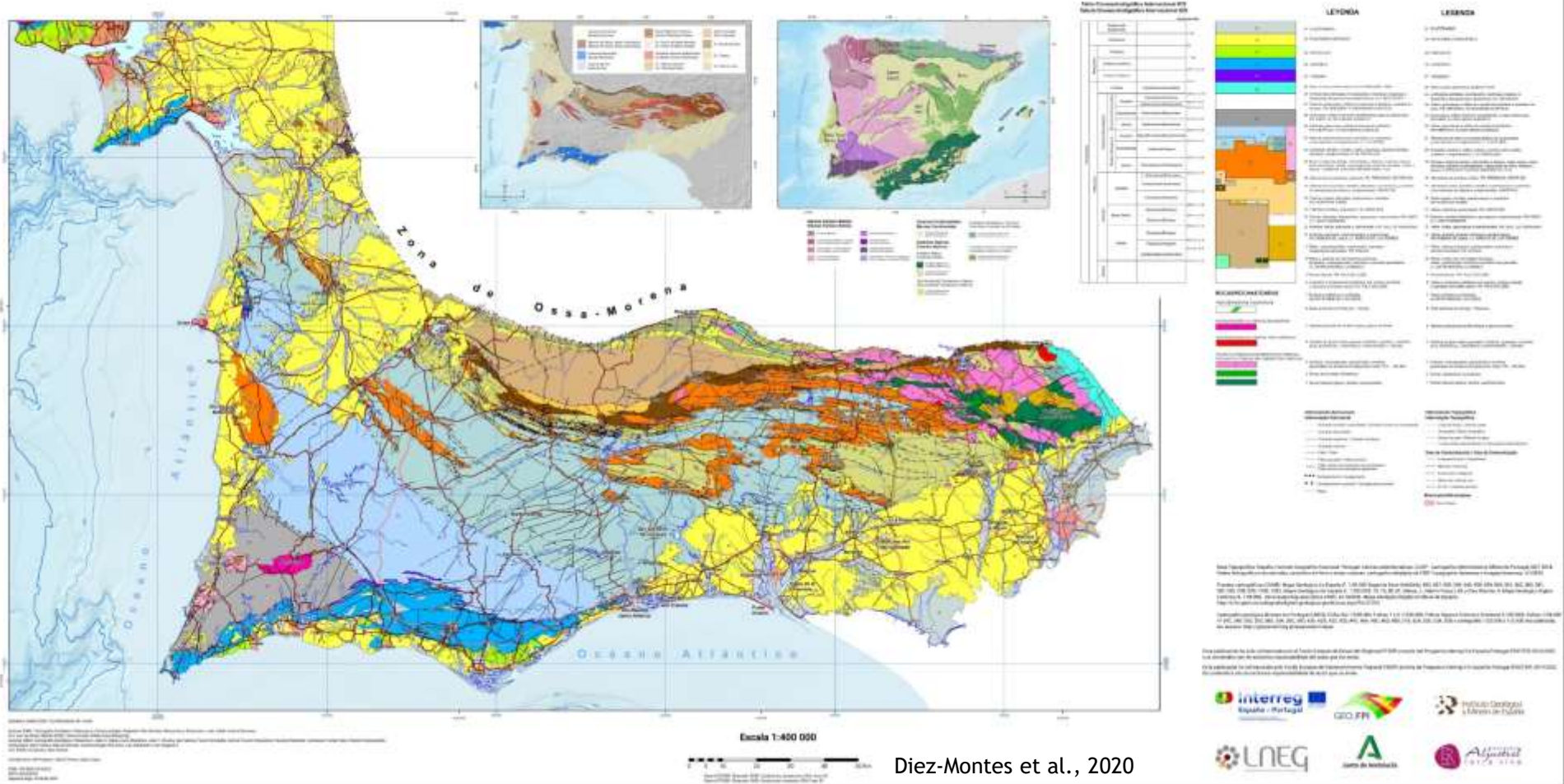


Pereira et al., 2012

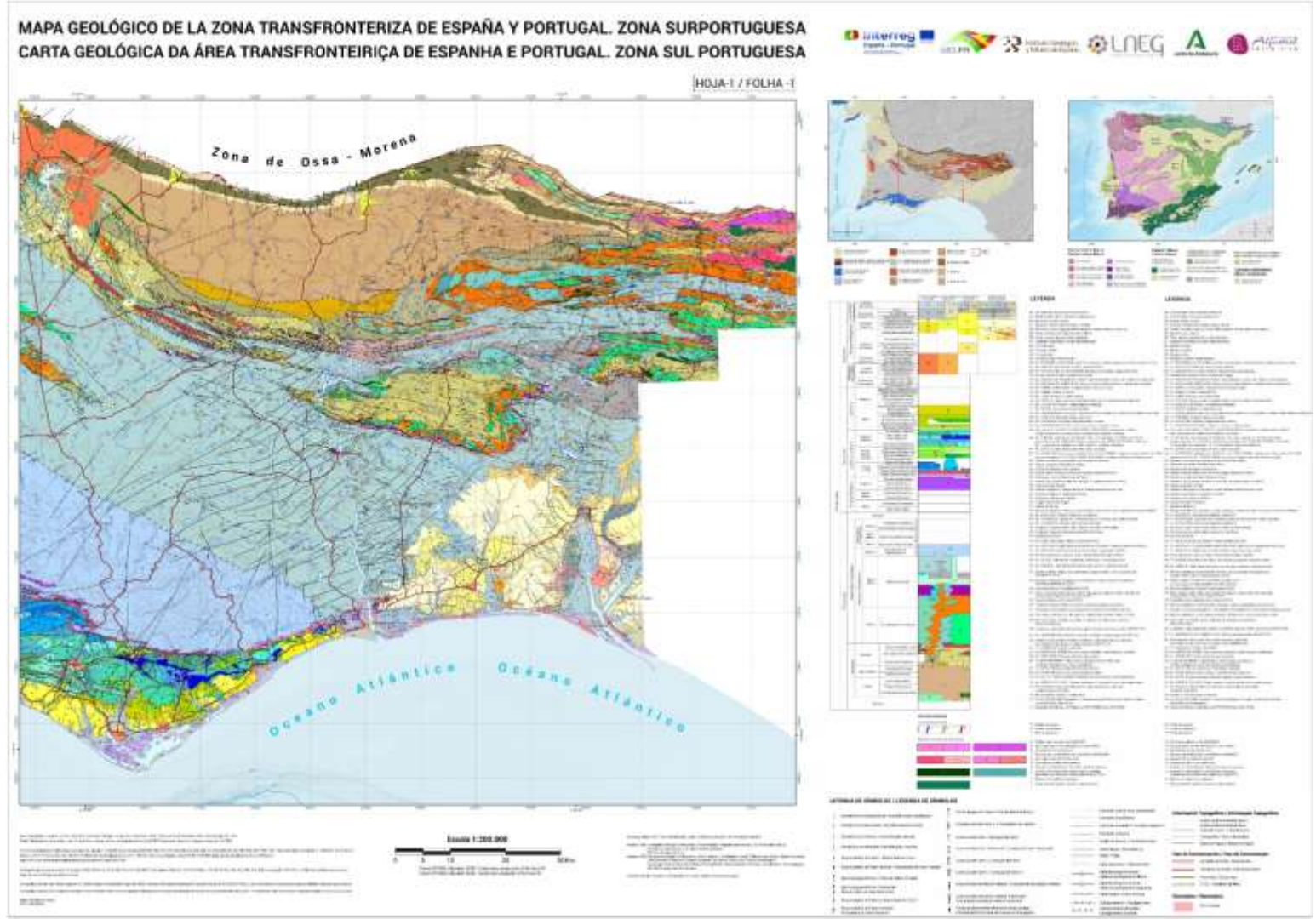


Oliveira et al., 2019

MAPA GEOLÓGICO DE LA ZONA SURPORTUGUESA . CARTA GEOLÓGICA DA ZONA SUL PORTUGUESA

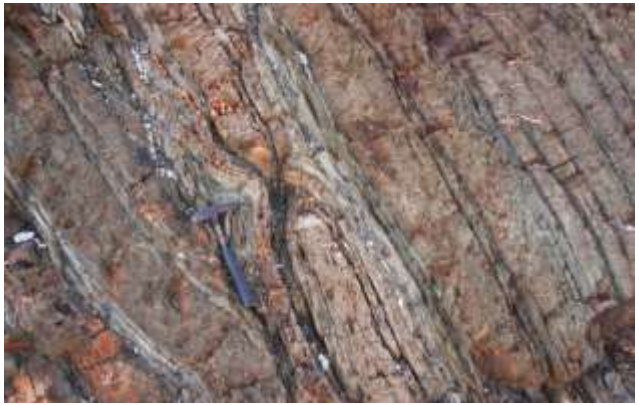


Diez-Montes et al., 2020



Diez-Montes et al., 2020

South Portuguese Zone



Gafo Formation (Late Devonian), Corte Gafo

Gafo Formation, Paymogo

Mértola Formation (Late Visean), Ribeira de Odeleite

South Portuguese Zone - paleontology

Nereite, Barranco do Homem Formation (PQG), Corte Pequena

Skolitos, V.G. Guizo, Phyllite-Quartzite Formation (PQG), São Domingos

Palynological studies on Carboniferous and Devonian sedimentary and volcano-sedimentary sequences (microfossils), *e.g.* Pereira et al., 2008, 2010, 2012, 2014, 2018, 2021; Mendes et al., 2020, 2021

Posidonia becheri, Mértola Formation, Baixo Alentejo Flysch Group (BAFG)

Goniatite, Mértola Formation (BAFG), Ribeira de Bens

Calamites, IC27 km5, Mértola Formation (BAFG)

South Portuguese Zone

Guadiana river valley SW-NE section (Serra Branca-Canais):
VSC (Tournaisian-Late Visean),
Freixial Fm. (Late Visean),
PQ Formation (Late Famennian)

South Portuguese Zone

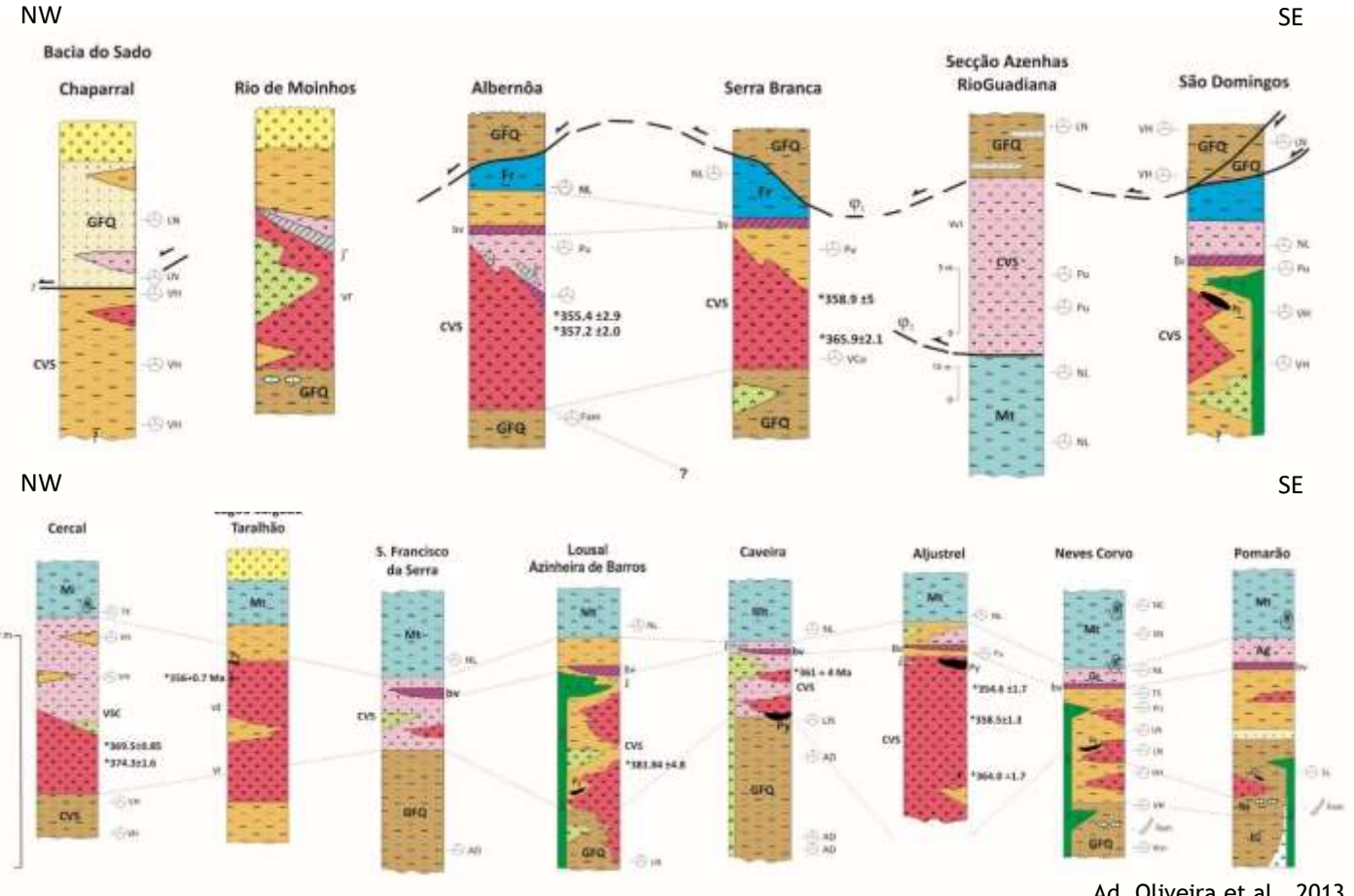
Chança rhyolite (Tournaisian)

Volcanogenic sediments, Achada da Mina Member, Pomarão (VSC 342.4 Ma)

Algares VMS deposit (Aljustrel)

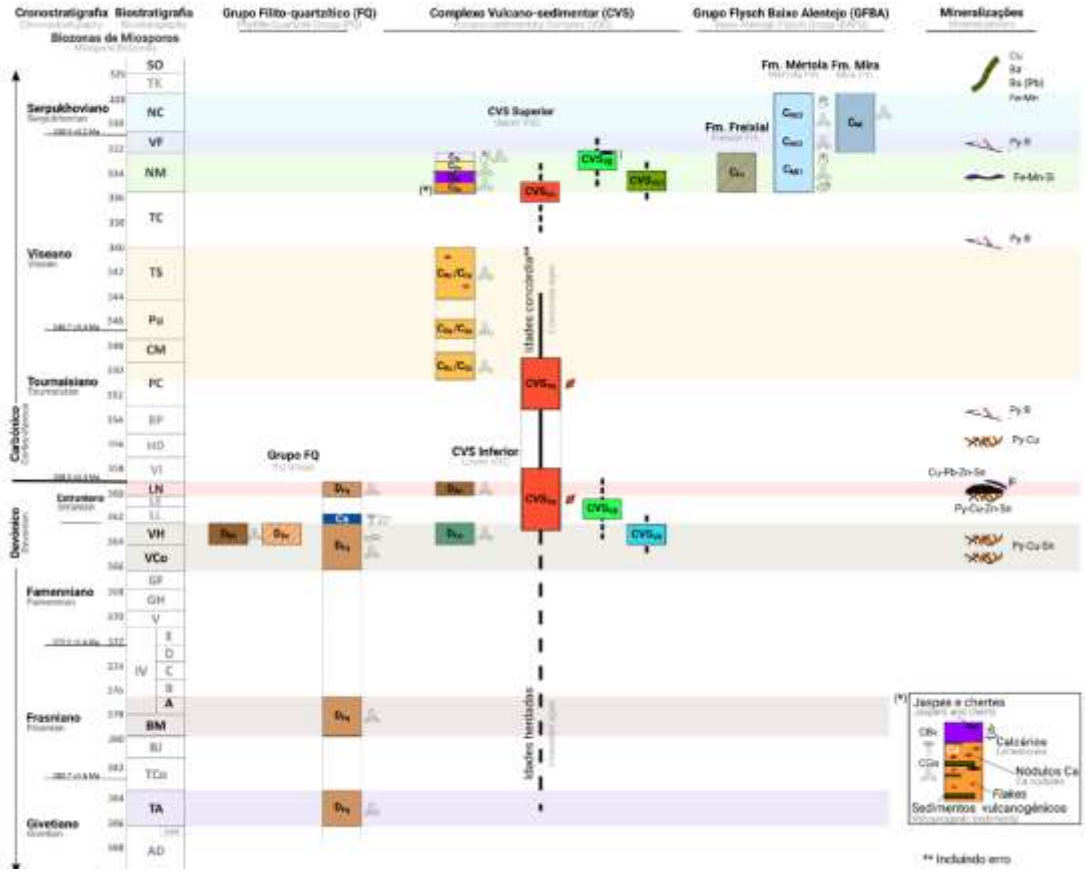
Volcanoclastic breccia (VSC), Serra Branca

Iberian Pyrite Belt



Ad. Oliveira et al., 2013

Neves-Corvo mine region – high resolution stratigraphy



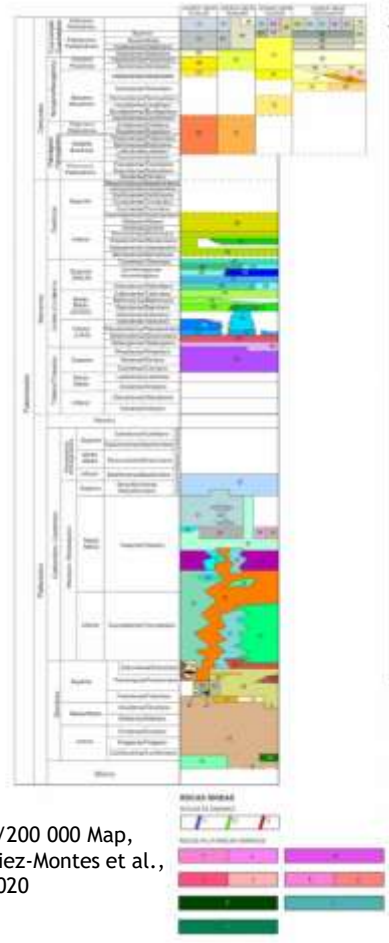
Matos et al., 2020

Neves-Corvo Lombador primary layering in zinc rich massive ore

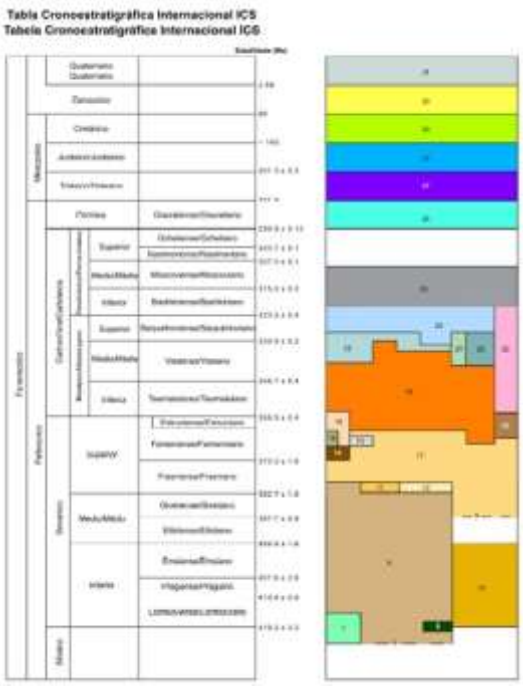
Iberian Pyrite Belt

Formation	Member	Age	References
Volcano-Sedimentary Complex (Famennian – Late Visean)			
Brancanes	Brancanes	Middle late Visean	Oliveira et al., 2004, 2013b; Pereira et al., 2008
Godinho	Godinho	Middle late Visean	
Borra de Vinho	Borra de Vinho	Middle late Visean	
Touril	Achada da Mina	Early Visean?	Boogaard, 1969; Oliveira et al., 1992; Oliveira & Silva, 2007
	Corte Machado	Early Visean?	
	Varjotas	Tournaisian?-Early Visean?	
	Xistos Negros	Early Tournaisian?	
Grandaços	Grandaços	Middle late Visean?	Oliveira et al., 2004, 2013; Pereira et al., 2008
Paraiso	Paraiso	Late Tournaisian-Early Visean	Schermerhorn et al., 1987; Leitão, 1998; Matos et al., 2010
Graça	Graça	Early-Late Visean	Oliveira et al., 2004, 2013b; Pereira et al., 2008
Gavião	Gavião	Middle-Late Tournaisian	Schermerhorn et al., 1987; Matos et al., 2010; Relvas et al., 2011
Ribeira de Cobres	Ribeira de Cobres	Early-Late Visean	Oliveira et al., 2013b
Xistos São Luís	Xistos S. Luís	Famennian-Strunian	Pereira et al., 2008
Lousal-Caveira	Lousal-Caveira	Strunian	Matos et al., 2014
Cerqueirinha	Cerqueirinha	Strunian?	Boogaard, 1969; Oliveira et al., 1992; Oliveira & Silva, 2007
Neves	Neves	Strunian	Oliveira et al., 2004, 2013b; Pereira et al., 2008, 2021
Corvo	Corvo	Famennian	
Phyllite-Quartzite Group (Early Givetian-Strunian)			
Filito-Quartzítica	Filito-Quartzítica	Early Givetian-Strunian	Pereira et al., 2008, 2021
	Nascedios	Middle Famennian-Strunian	Boogaard, 1969; Oliveira et al., 1992; Oliveira & Silva, 2007
	Eira do Garcia	Famennian	
	Barrancão	Late Famennian	Oliveira et al., 2013a, 2013b
	Corona Superior	Famennian-Strunian	Pereira et al., 2008, 2012; Matos et al. 2014
	Corona Inferior	?-Early Givetian	Pereira et al., 2008, 2012; Matos et al. 2014
Barranco do Homem	Barranco do Homem	Famennian	Oliveira et al., 2005, 2006; Pereira et al., 2008; Faria et al., 2015
Vale Parreira	Vale Parreira	Famennian	Mendes et al., 2020

Matos, 2021



1/200 000 Map, Diez-Montes et al., 2020



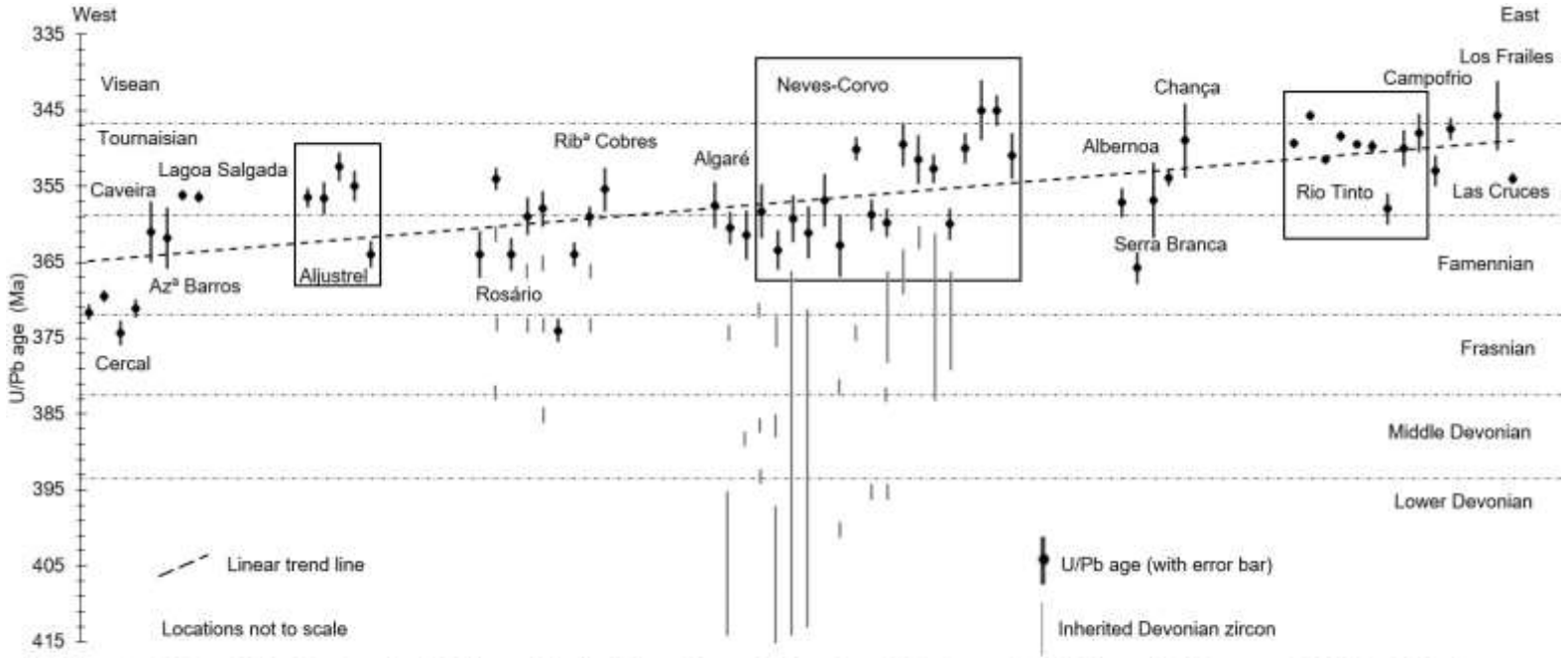
1/400 000 Map, Diez-Montes et al., 2020

Iberian Pyrite Belt

PQG Sequences:	Fm./Unit/Member	Age	Referrences
Upper PQG	Forno da Cal limestones	Lower Famennian	Boogaard & Schermerhorn, 1981
	Nascedios limestones	Mid Famennian – mid Strunian	Boogaard, 1963, 1967; Oliveira et al., 1992, 2006; Oliveira & Silva, 2007; Pereira et al., 2008
	Eira do Garcia Member	Famennian	Boogaard, 1963; Oliveira & Silva, 2007
	Barrancão Member	Late Famennian	Oliveira et al., 2013, 2016
	Upper Corona Unit	Late Famennian - Strunian	Pereira et al., 2008, 2012; Matos et al., 2014
	Barranco do Homem Fm.	Late Famennian	Oliveira et al., 2005, 2013; Pereira et al., 2008; Faria et al., 2015
	Vale de Parreiras Fm.	Mid-late Famennian	Mendes et al., 2020; Pereira et al., 2020
Lower PQG	Lower Corona Unit	? - Lower Givetian	
Lower PQG – Upper PQG	Phyllite-Quartzite Fm.	? (Lower Givetian) - Strunian	Oliveira et al., 2013; Pereira et al., 2008, 2021

The Represa Fm. (late Famennian) can be correlated with the Upper PQG
Matos et al., 2023

Iberian Pyrite Belt felsic volcanic rocks (Albardeiro et al., 2023)



Nesbitt et al., 1999 (Los Frailes); Barrie et al., 2002 (Lagoa Salgada, Aljustrel, Campofrio, Las Cruces); Dunning et al., 2002 (Campofrio); Rosa et al., 2009 (Cercal, Caveira, Azinheira de Barros, Aljustrel, Ribeira de Cobres, Albernoa, Serra Branca, Chança); Valenzuela et al., 2011 (Rio Tinto); Oliveira et al., 2013 (Rosário, Ribeira de Cobres); Solá et al., 2015 (Algaré, Neves-Corvo); Mello et al., 2017 (Rio Tinto); Rosa et al. (unpub., Neves-Corvo).

Iberian Pyrite Belt

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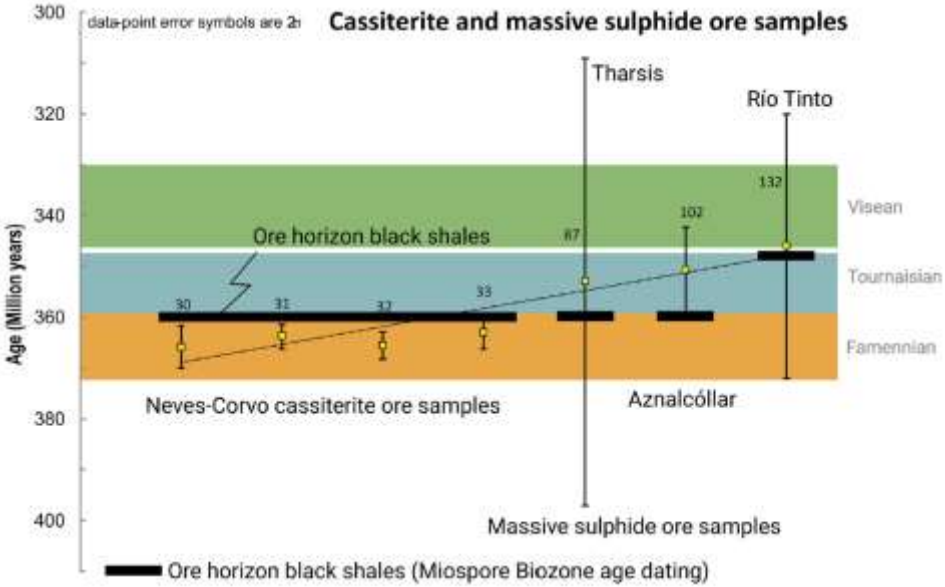
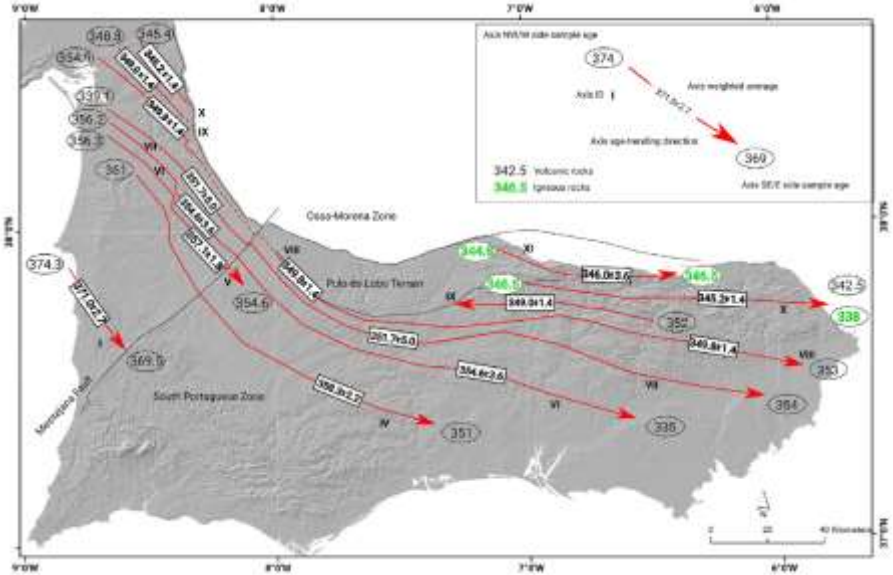
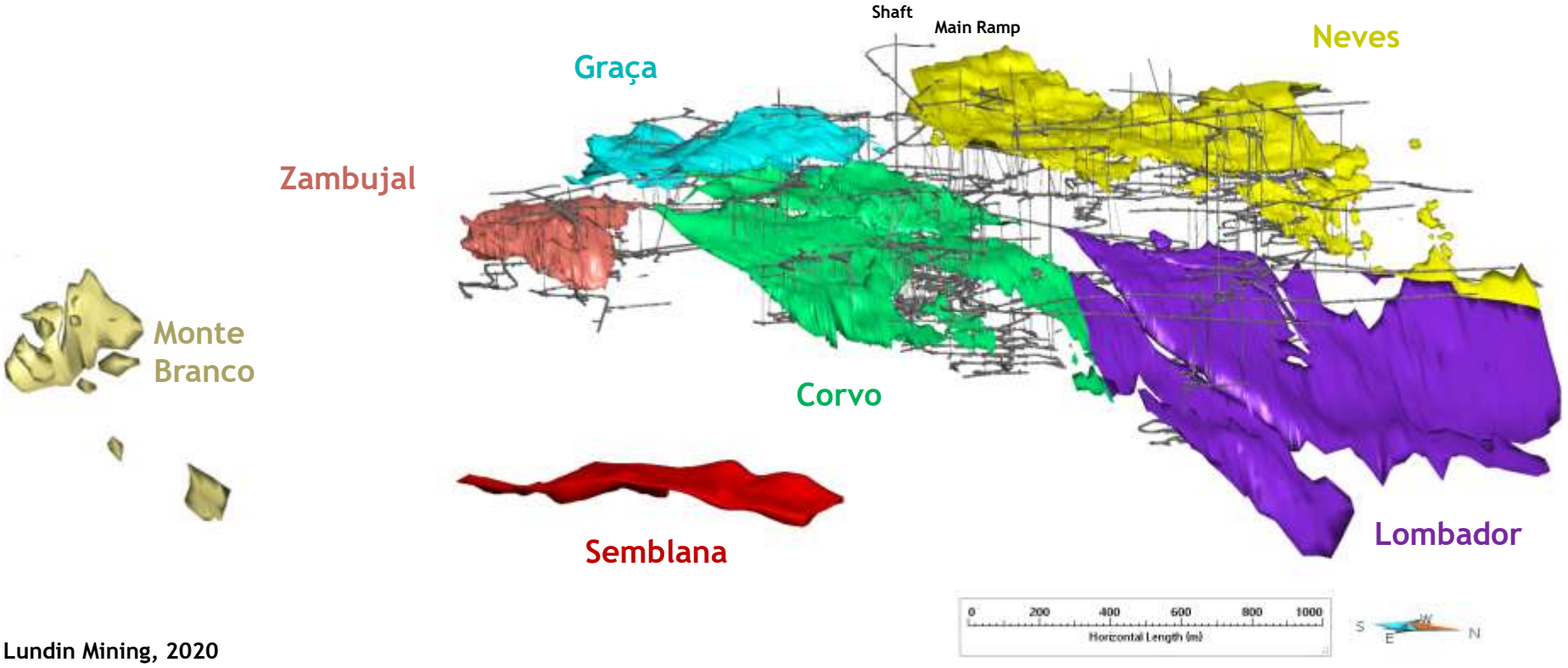


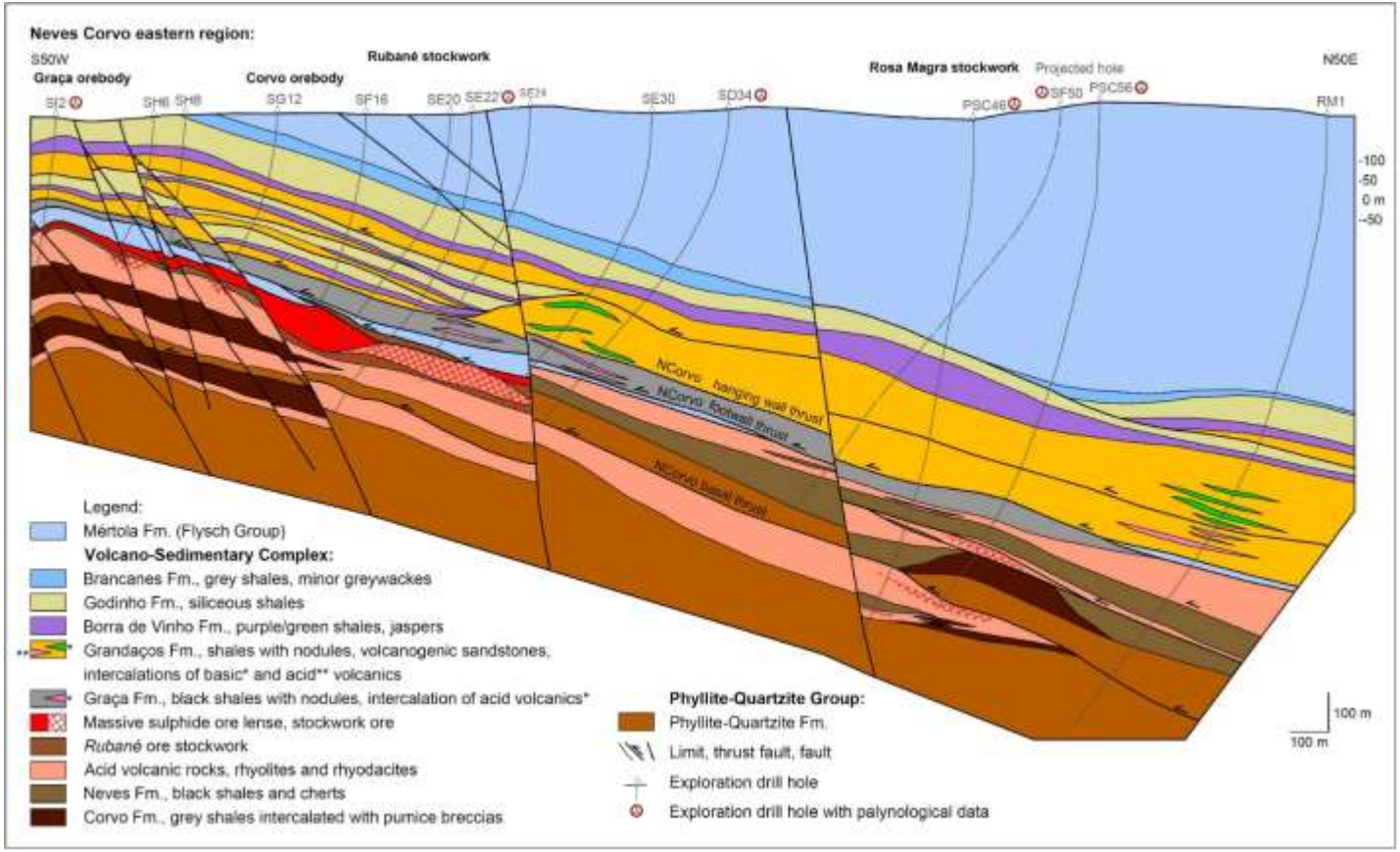


Neves-Corvo mine



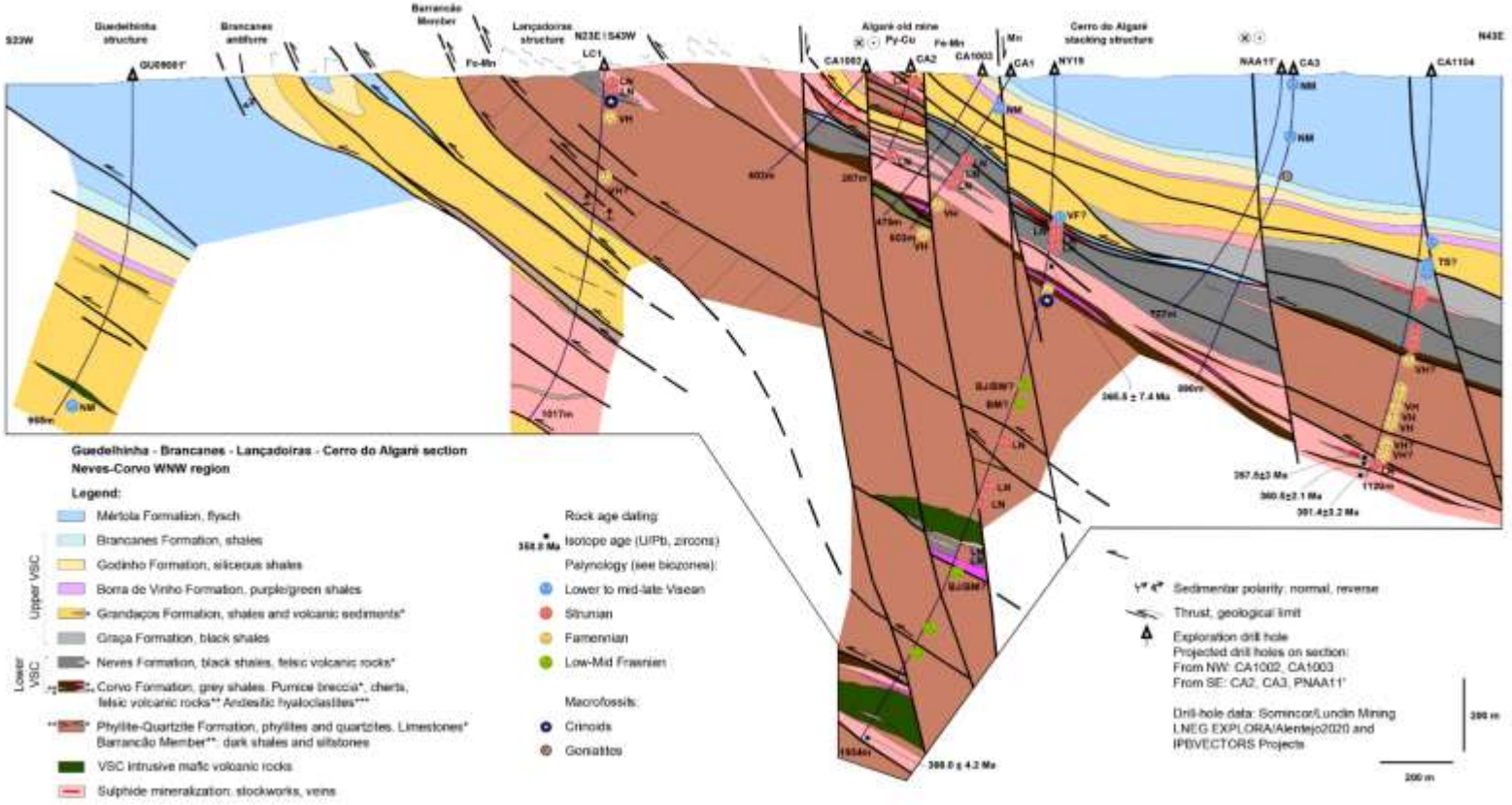
Lundin Mining, 2020
in Matos et al., 2020

Massive sulphide mineralizations – ore deposit setting, folding and tectonic



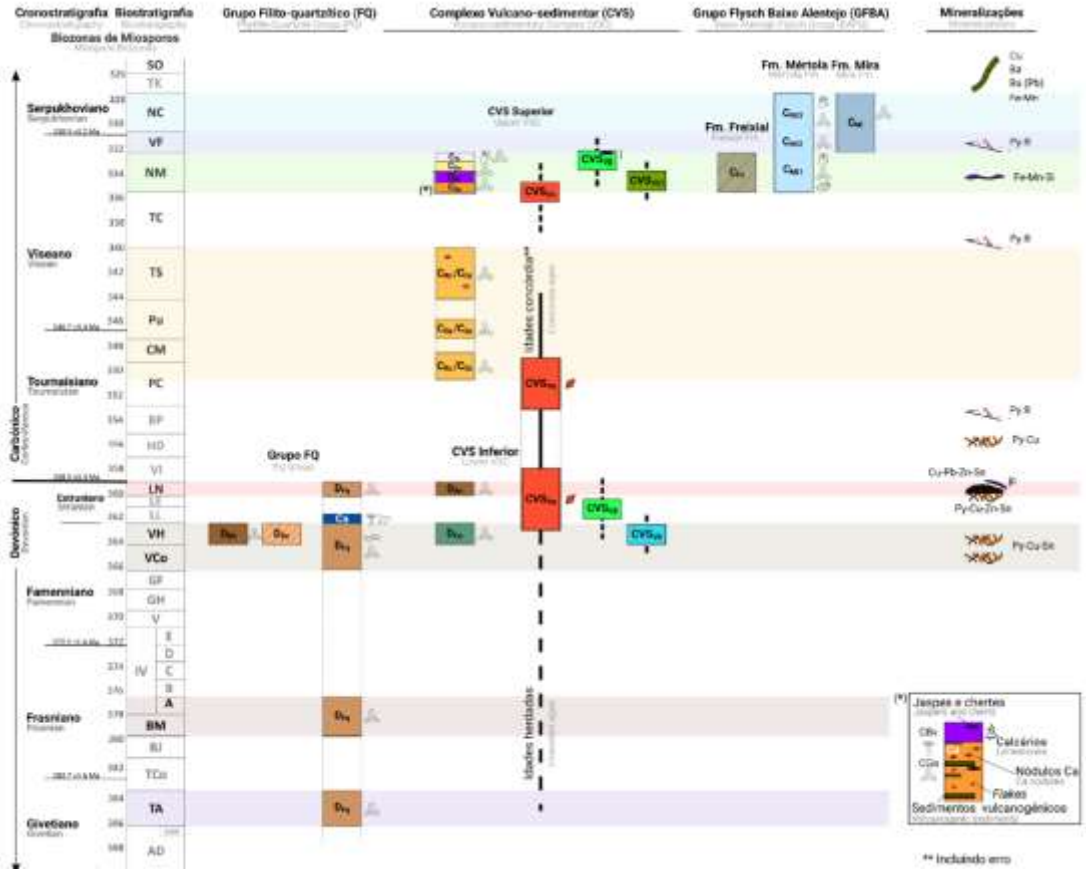
Somincor/Lundin Mining, Pereira et al., 2021

Massive sulphide mineralizations - ore deposit setting, folding and tectonic



Pereira et al., 2023
Matos et al., 2023

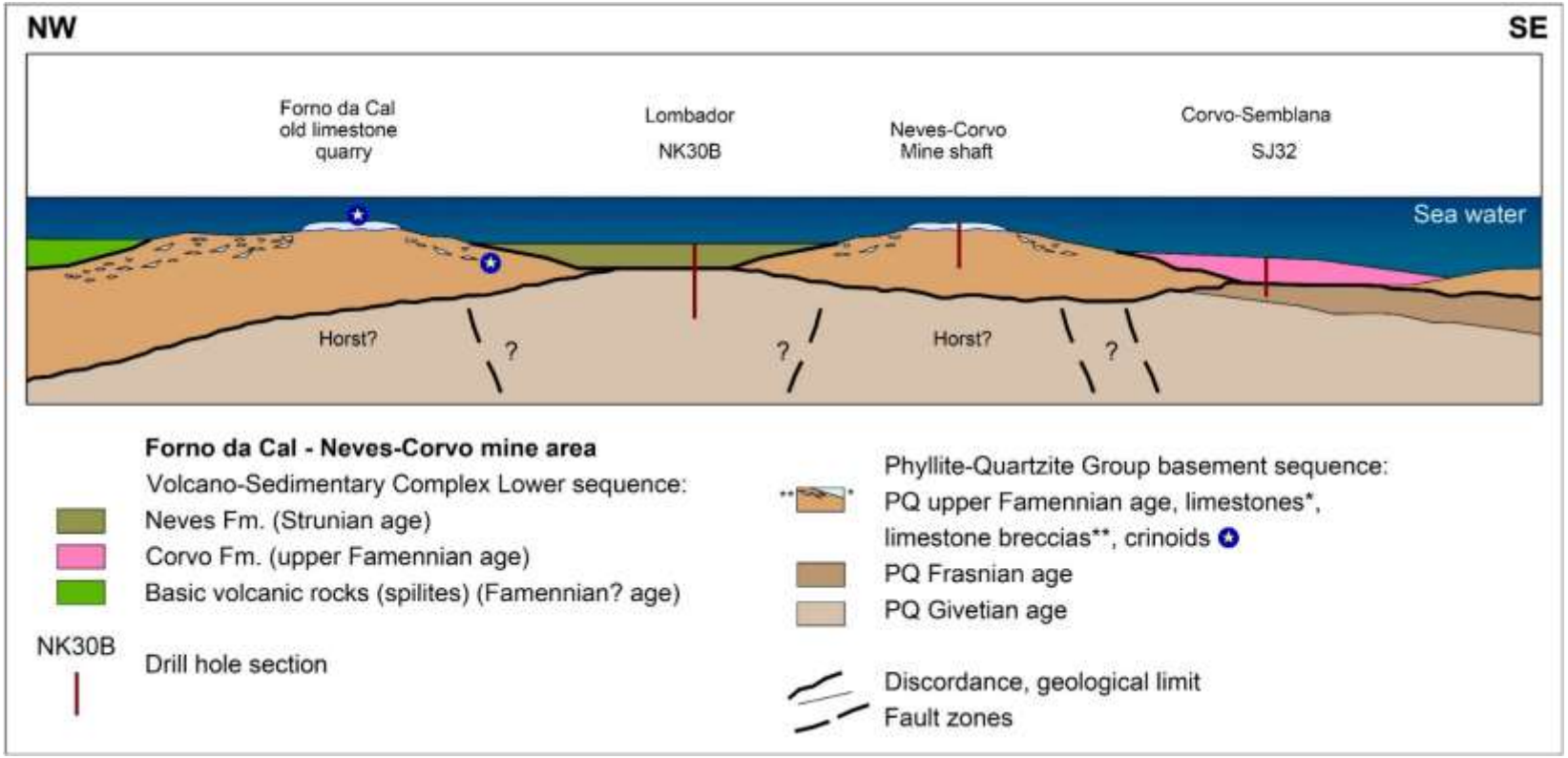
Neves-Corvo mine region – high resolution stratigraphy



Neves-Corvo Lombador primary layering in zinc rich massive ore

Matos et al., 2020

Neves-Corvo PQ basement study

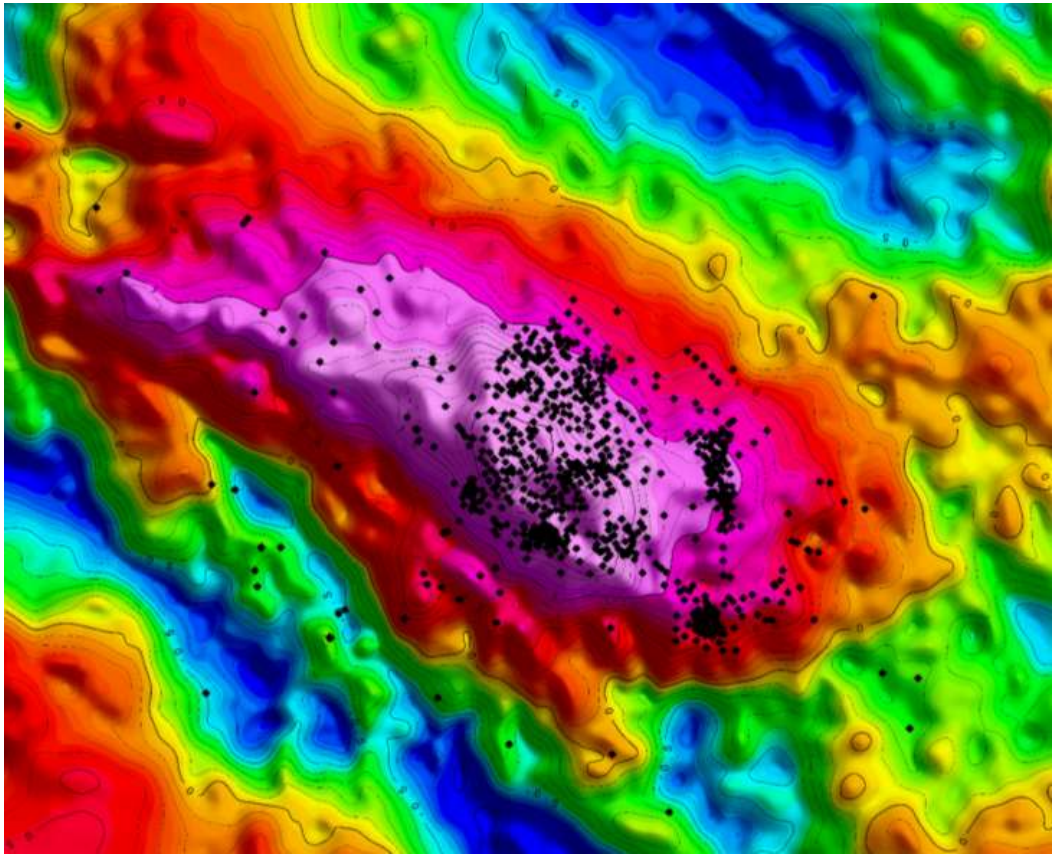


Mendes et al., 2020

LNEG Mineral Exploration

2 - Mineral exploration surveys

- Green field areas
- Brown field areas
- Geophysical and geochemical surveys
- Ore horizon and mineralization studies



Neves-Corvo Residual Gravity Anomaly
LNEG - Lundin Mining EXPLORA Project
Marques et al., 2019; Matos et al., 2020

LNEG

EXPLORA
NEVES-CORVO

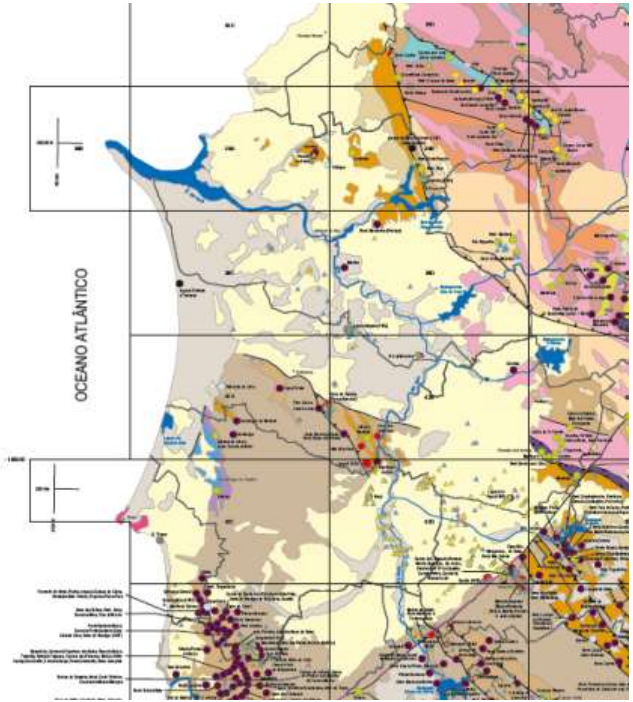
Green Field Areas

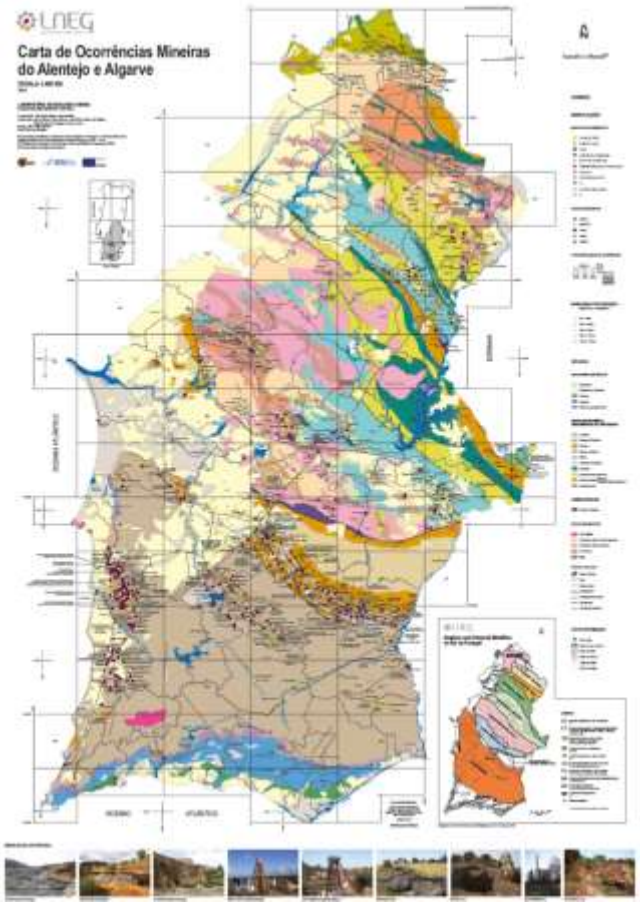
Exploration at regional scale:

- Alentejo and Algarve mining occurrences 1/400 000 map

  (Matos & Filipe Eds, LNEG 2013, Inverno et al., 2020, www.lneg.pt)

  - 650 mineral occurrences
  - 1200 exploration drill holes



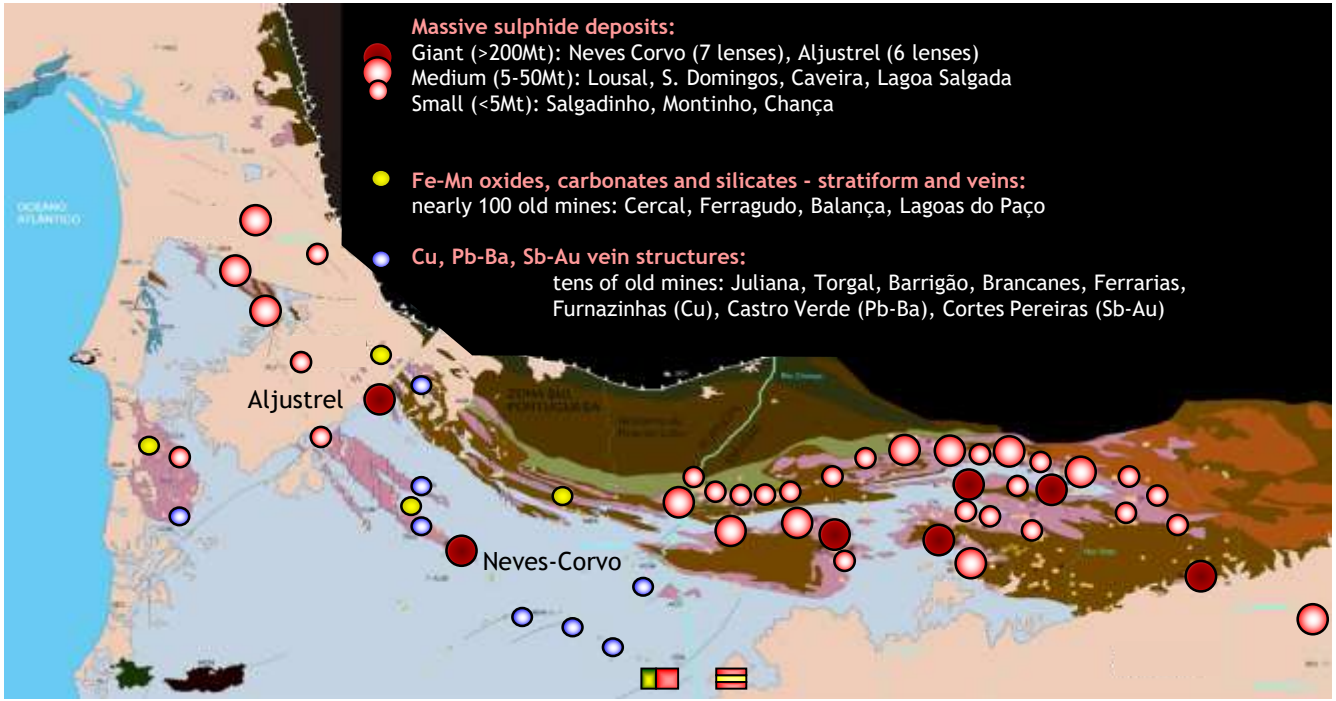


LNEG

Green Field Areas

Mociços (Cu), Ossa-Morena Zone

Iberian Pyrite Belt



Matos *et al.* 2008, 2020

Inverno et al., 2020

Iberian Pyrite Belt

- Since the 1960´s becomes a common and continuous activity promoting geological, geophysical (seismic, gravimetric, electro-magnetic, down hole surveys) and geochemical (rock, soil, stream) surveys. Drill hole programs (locally >1500 m depth)
- **Portugal**: LNEG R&D projects focused in IPB regional and near mining areas; thematic databases; Aljustrel drill core shed (CEGMA - Centro de Estudos Geológicos e Mineiros do Alentejo)
- **Spain**: Andalusia Government ***2030 Mining and Exploration Strategy***. IGME databases and Peñarroya drill core shed

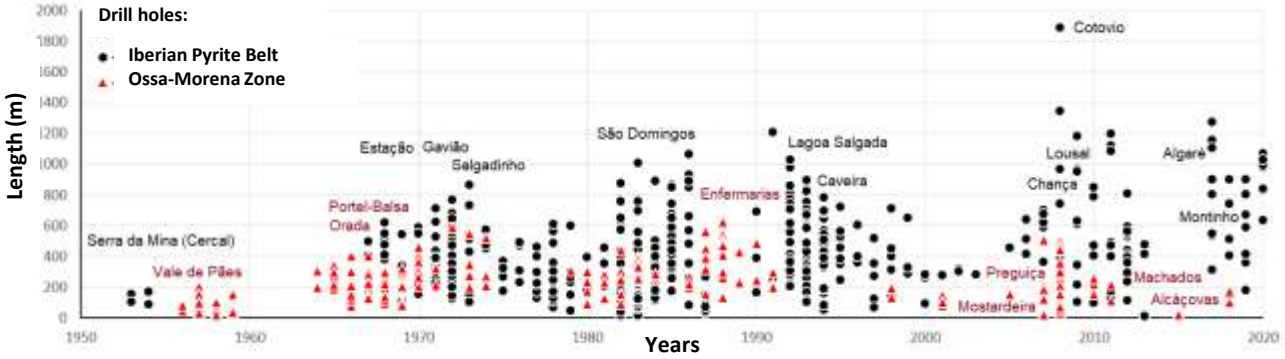
Almina EM survey, 2022

Aljustrel facilities, UAV photo Sara Santos (LNEG)

LNEG support to exploration programs - green field:

- 1/400,000 scale mapping: geology, gravimetry, magnetometry, radiometry and Cu soil geochemistry
- R&D surveys with mining companies - ore horizon high resolution stratigraphy
- Aljustrel drill core collection (relog programs) + soil and stream sample collections (e.g. FRX analysis)
- CEGMA 2.0 2019-2023 (1,6M€)
- Aljustrel drill core shed:

  June 2024 – 200 km!



Matos et al., 2023

LNEG support to exploration programs - green field:

Iberian Pyrite Belt	**Massive sulfides and stockworks**	
	Lagoa Salgada, Caveira, Lousal, Salgadinho, Montinho, Estação e Gavião (Aljustrel), São Domingos, Chança	
	Fe, Mn oxides	
	Serra da Mina, Lagoas do Paço	
Ossa-Morena Zone	**Massive sulfides + magnetite associated with metadolomites and meta volcanites**	
	Enfermarias, Preguiça, Portel, Balsa	
	Magnetite	
	Orada, Vale de Pães	
	Veins structures (Cu)	
	Alcáçovas, Mostardeira, Miguel Vacas, Defesa das Mercês	

Matos et al., 2023

Iberian Pyrite Belt, VMS discoveries in Portugal

Ore deposit (region)	Year	Company/Survey	Exploration methodology
Moinho (Aljustrel)	1955	Mines d' Aljustrel	Turam
Feitais (Aljustrel)	1963	Mines d' Aljustrel	Gravimetry
Estação (Aljustrel)	1968	Serviço Fomento Mineiro[1]	Gravimetry
Gavião (Aljustrel)	1970	Soc. Mineira Santiago	Gravimetry, geology
Salgadinho (Cercal)	1974	Serviço Fomento Mineiro[1]	Gravimetry
Neves (Neves-Corvo)	1977	SPE-SEREM-EDMA	Gravimetry
Lombador (Neves-Corvo)	1988	Somincor	Gravimetry, geology
Lagoa Salgada (NW)	1992	Inst. Geológico e Mineiro[1]	Gravimetry, magnetotelluric, vertical electrical sounding, geology
Rio Moinhos stockwork	1995	Inst. Geológico e Mineiro[1]	Gravimetry, magnetometry, vertical electrical sounding
Chança stockwork	1994	CONASA	Gravimetry, geology
Montinho stockwork	2001	Atlantic Copper	Gravimetry
Caveira East stockwork	2002	Atlantic Copper	Gravimetry
Lousal stockwork	2008	AGC	Gravimetry

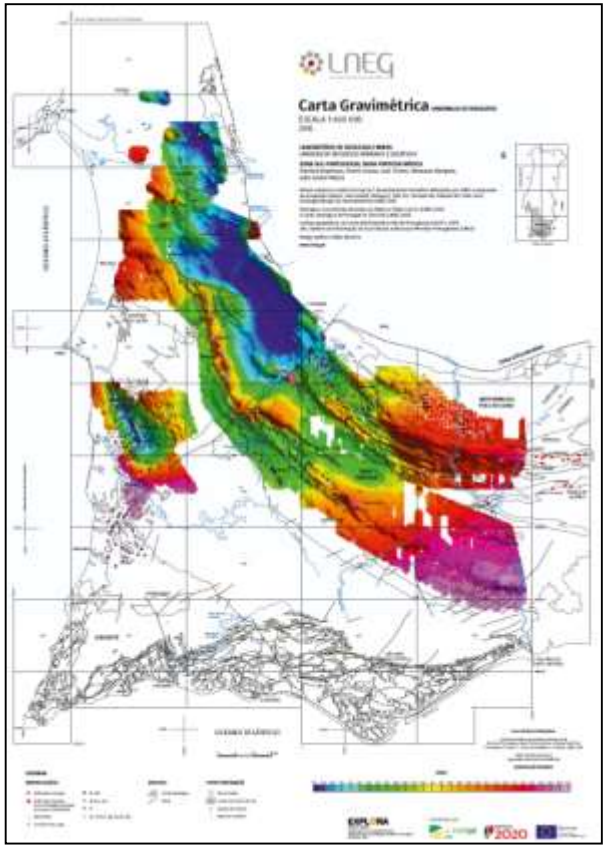
1 – Portuguese Geological Survey (actual LNEG), Matos et al., 2020

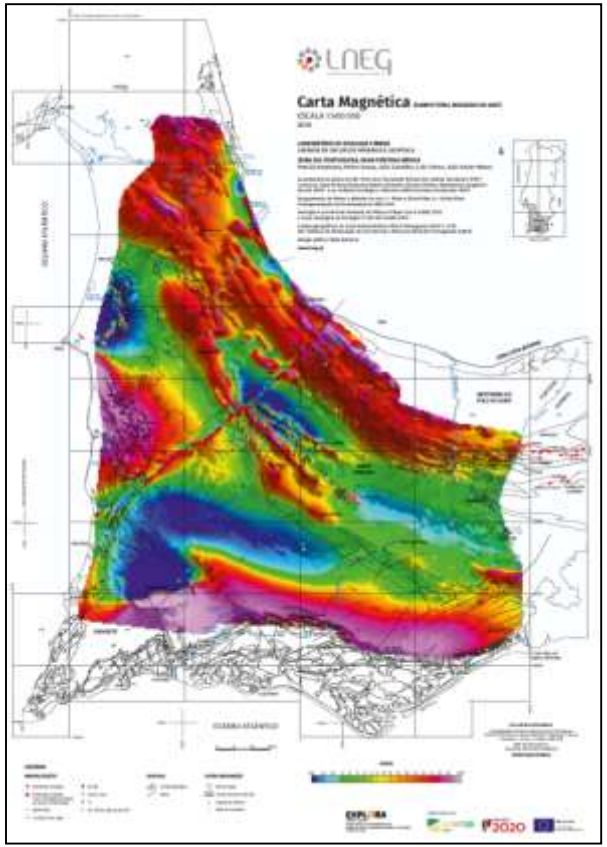
Iberian Pyrite Belt, VMS discoveries in Portugal

Ore deposit (region)	Year	Company/Survey	Exploration methodology
São Domingos stockwork	2010	AGC	Geology, gravimetry
Semblana (Neves-Corvo)	2010	Somincor/Lundin Mining	Electromagnetic
Serrinha stockwork	2010	Maepa-Avrupa (LNEG[1])	Electromagnetic (IP), soil, geochemistry, geology, gravimetry
Monte Branco (Neves-Corvo)	2012	Lundin Mining	Gravimetry
Sesmarias	2014	Maepa-Avrupa	Electromagnetic, gravimetry
Lagoa Salgada (Central)	2017	Redcorp-EDM-Ascendant	Electromagnetic, gravimetry
Lombador North (Neves-Corvo)	2022	Somincor/Lundin Mining	Electromagnetic, gravimetry, seismic

1 – Portuguese Geological Survey (actual LNEG), Matos et al., 2020; Matos, 2024

Iberian Pyrite Belt regional 1/400,000 mapping





Geophysics

Data processing/modelling

Gravimetric map (Bouguer 2.6 gcm^{-3})

- > 300,000 gravity points (ground surveys): LNEG, Adaro, Geoconsult, Minaport, SAP, EMSC, Soc. Mineira Rio Artezia, Rio Tinto Zinc

Magnetic map (IGRF removed)

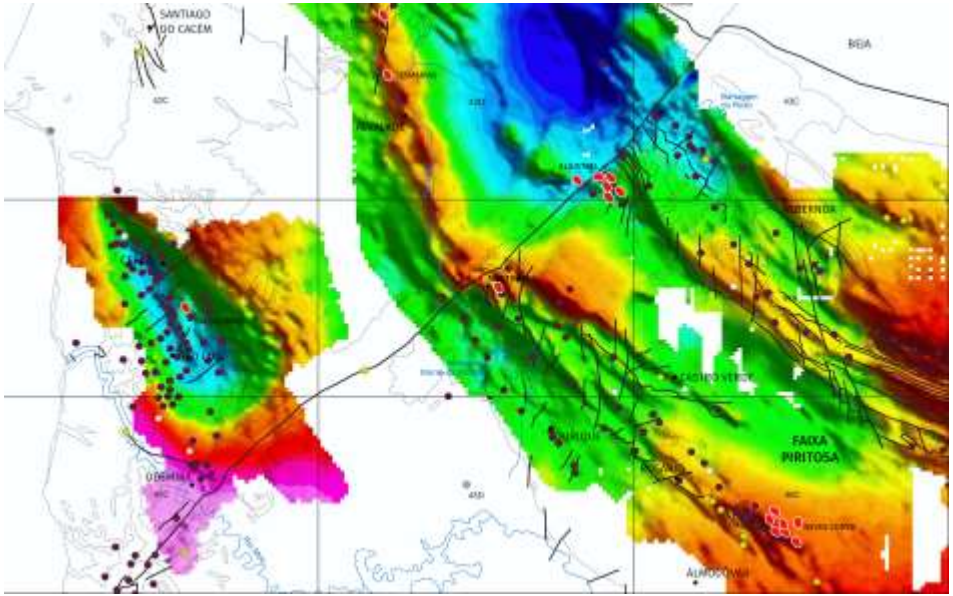
- Airborne surveys: Rio Tinto/SMRA (Geoterrex 1991): 500 m, 250 m lines/90 m alt.; Minaport/EDM/ Pirites Alentejanas (Urguhart-Dvorak 1991): 200 m lines/ 100 m alt.; IGM(LNEG) (Sanders Geophysics 1997) 500 m, 250 m lines/90 m alt.

Represas et al., 2016, Matos et al., 2020

Iberian Pyrite Belt regional 1/400,000 mapping

EXPLORA NEVES-CORVO

Geophysics
Data processing/modelling



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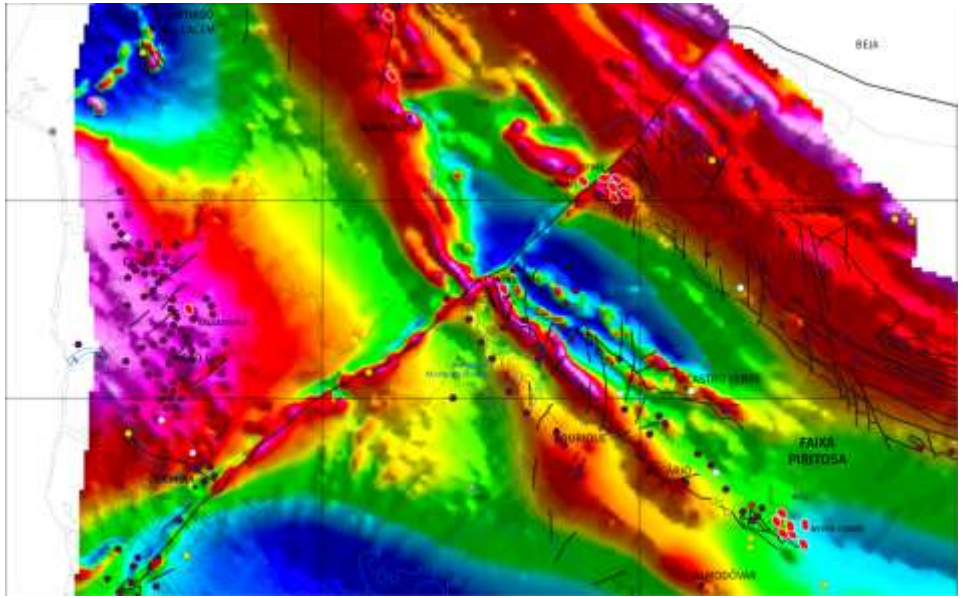


Magnetic map (IGRF removed)

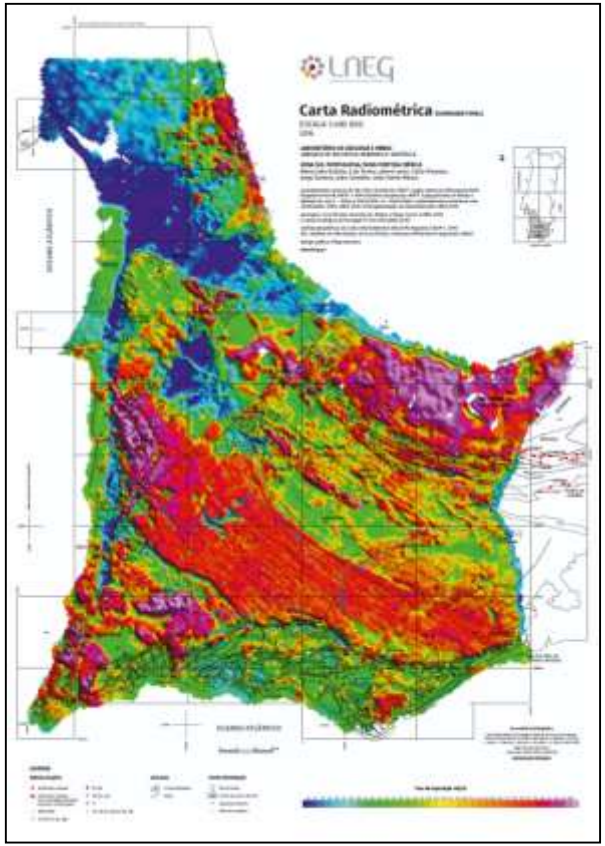
Represas et al., 2016, Matos et al., 2020

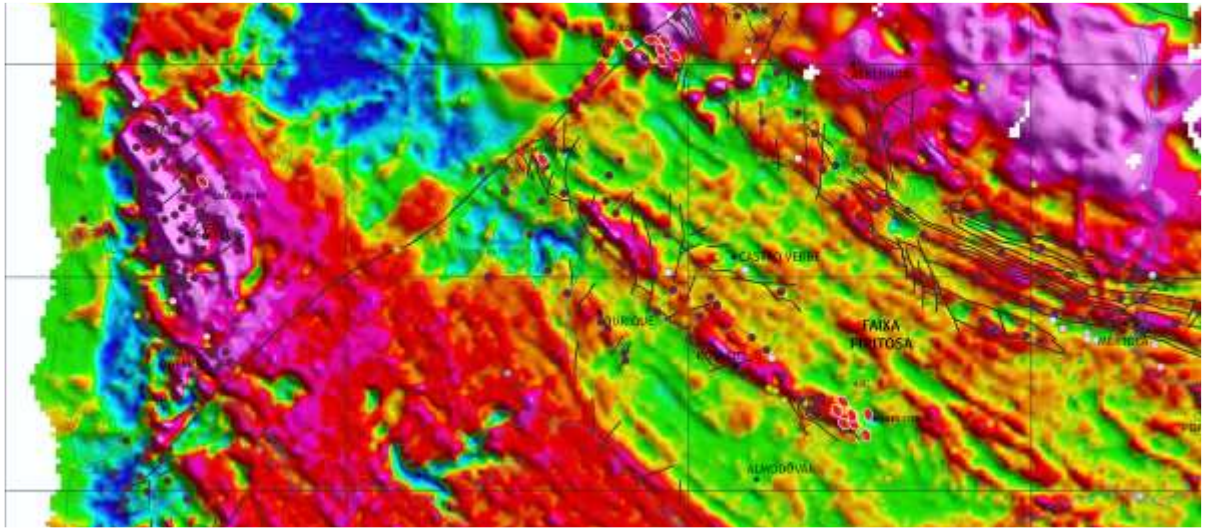
LNEG

Iberian Pyrite Belt regional 1/400,000 mapping

EXPLORA NEVES-CORVO

Geophysics
Data processing/modelling





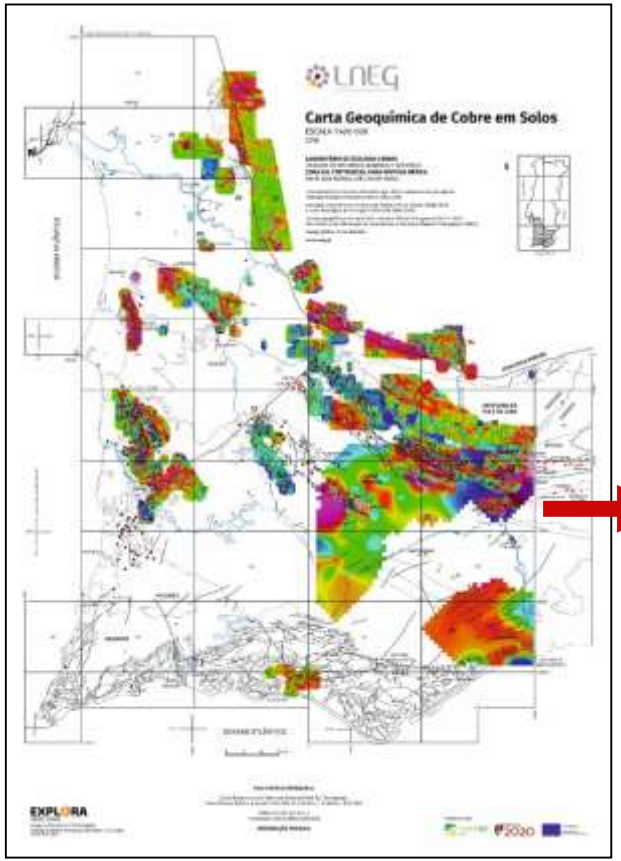
Radiometric map (Natural Radioactivity)

- Airborne surveys: Rio Tinto/SMRA (Geoterrex 1991): 500 m, 250 m lines/90 m alt.; Minaport/EDM/Pirites Alentejanas (Urguhart-Dvorak 1991): 200 m lines/100 m alt.
- Ground surveys: LNEG 2010

Batista et al. (2016), Matos et al. (2020)

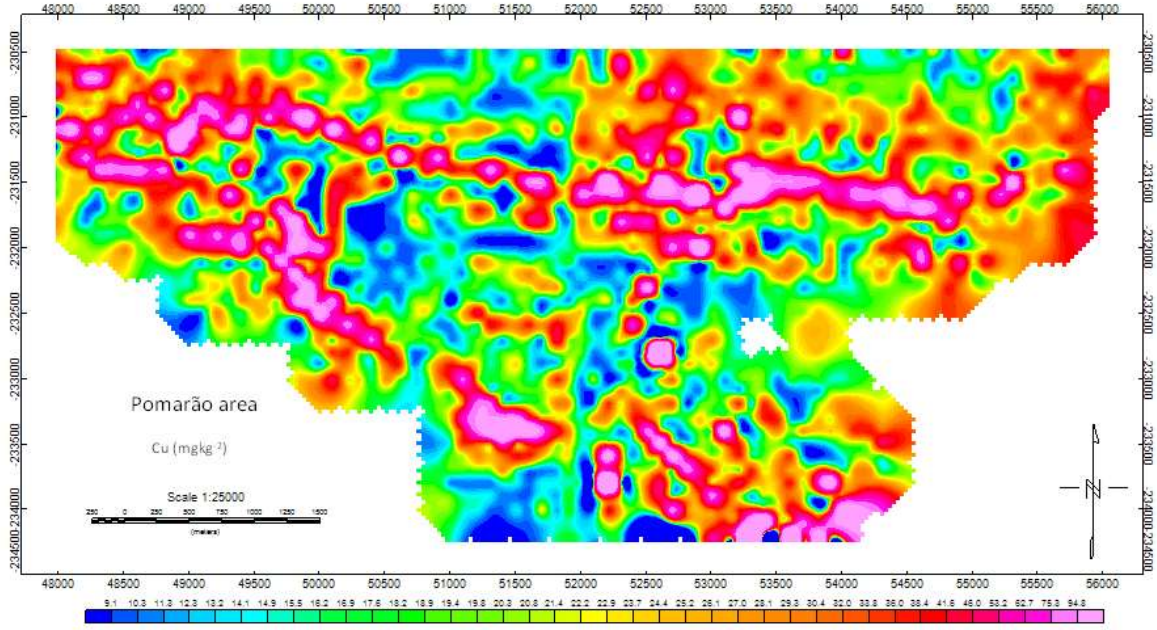
LNEG

Iberian Pyrite Belt regional 1/400,000 mapping

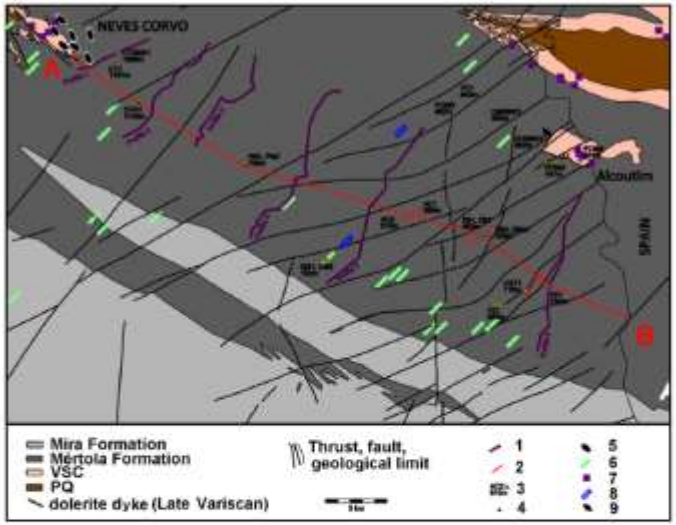


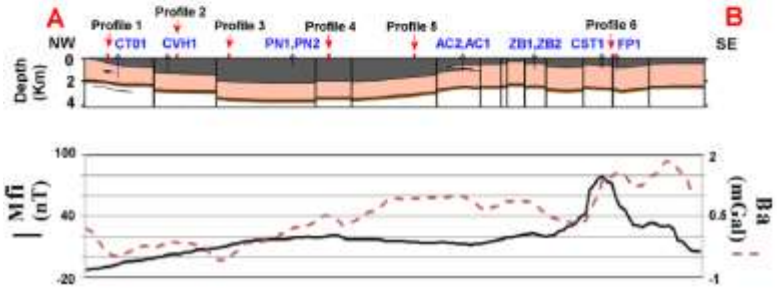
Copper Soil Geochemistry

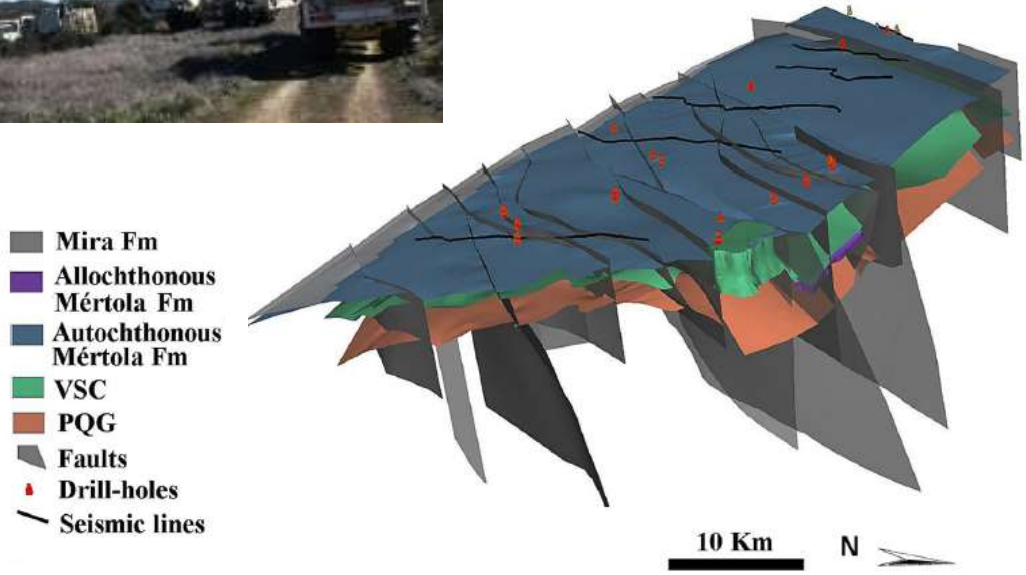
- LNEG and Mining Companies surveys, ~20 cm depth samples
  Batista, 2003, Batista & Matos, 2016, Batista et al., 2020



IPB regional surveys, seismic profiles at Neves-Corvo SE area



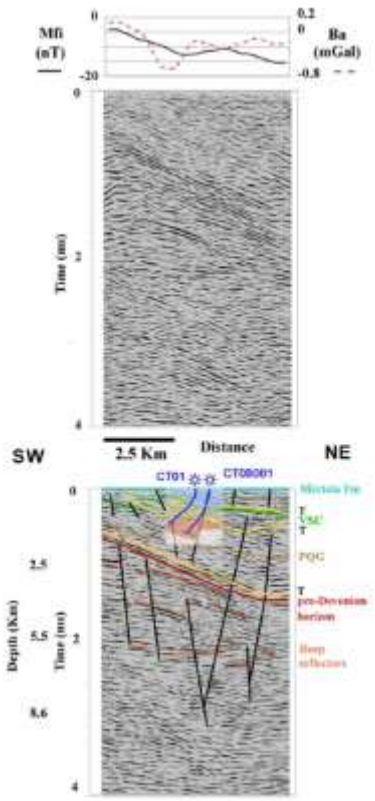


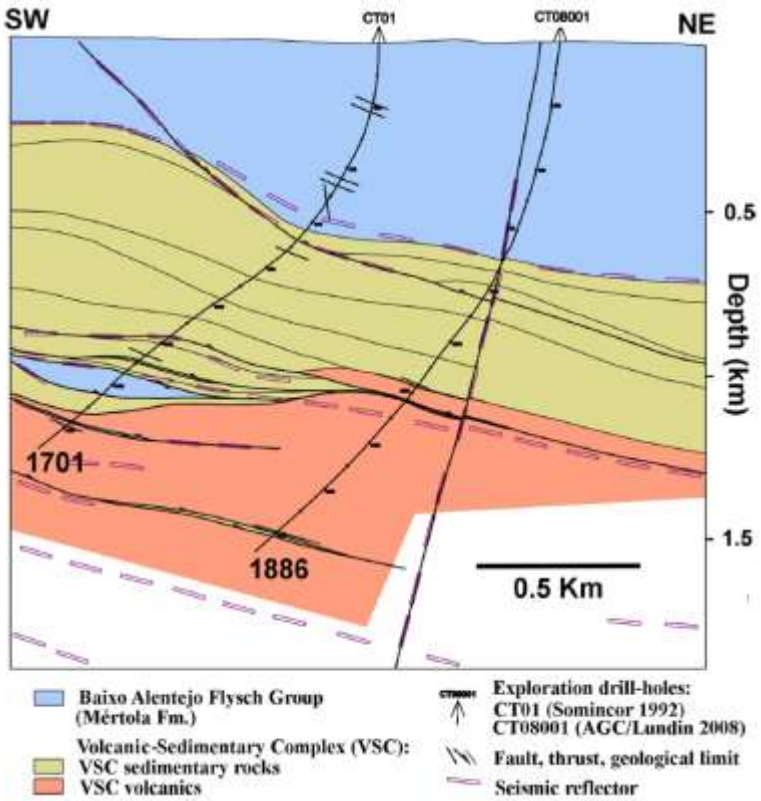


3D Model of the Neves-Corvo – Alcoutim area, PROMINE Project, Inverno et al., 2015, Carvalho et al., 2017

LNEG

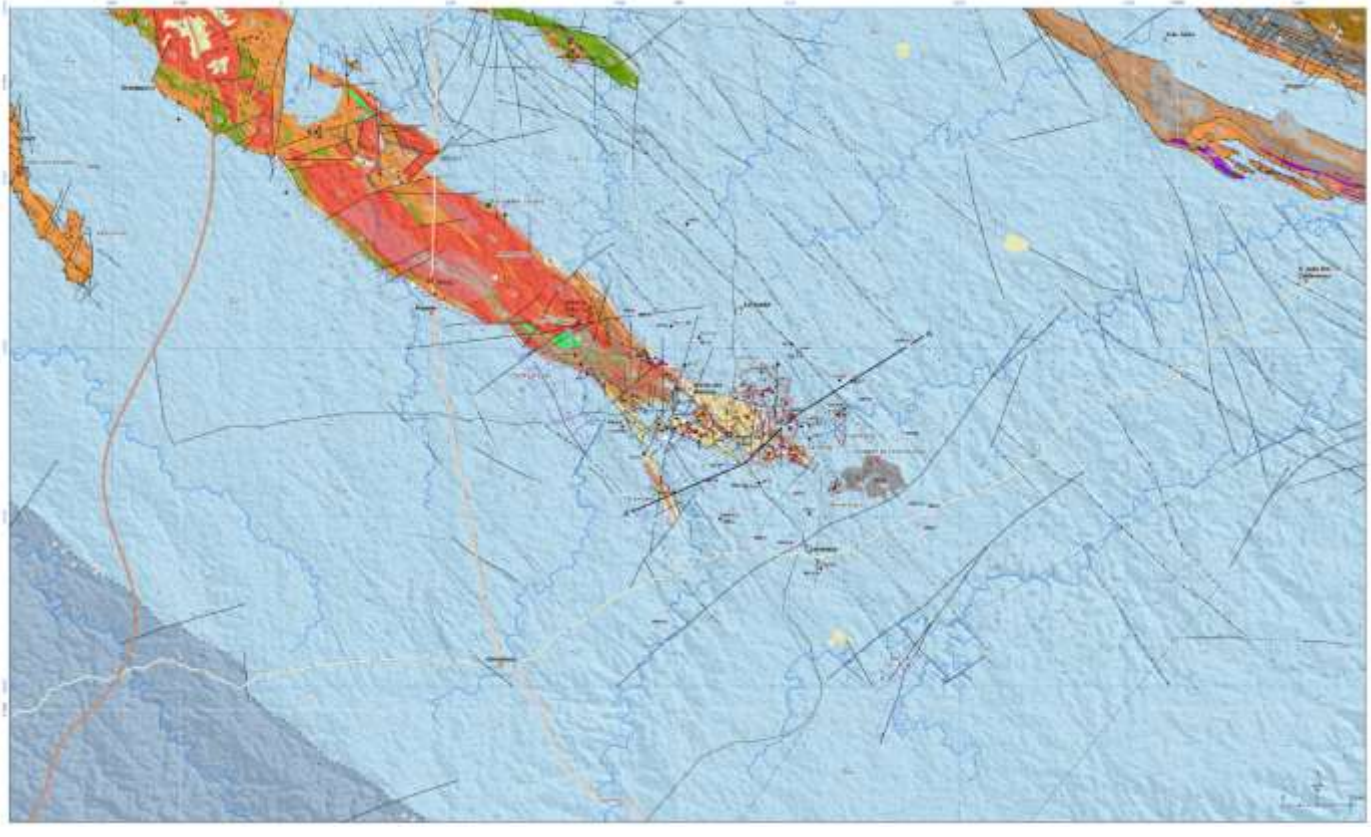
Iberian Pyrite Belt regional surveys - Promine Seismic Profiles at Neves-Corvo SE area





Cotovio Geological section,
PROMINE Project,
Carvalho et al., 2017

Neves-Corvo mine region 1/50.000 - geology and mineral occurrences



Geology

Mapping, logging

Almodôvar Geological Map 46C
Oliveira et al. (2016)

Previous geological maps
Asarco (1996), Billiton-Minaport (1993), Leca et al. (1983), SFM (1950's-1970's)

Mineral occurrences

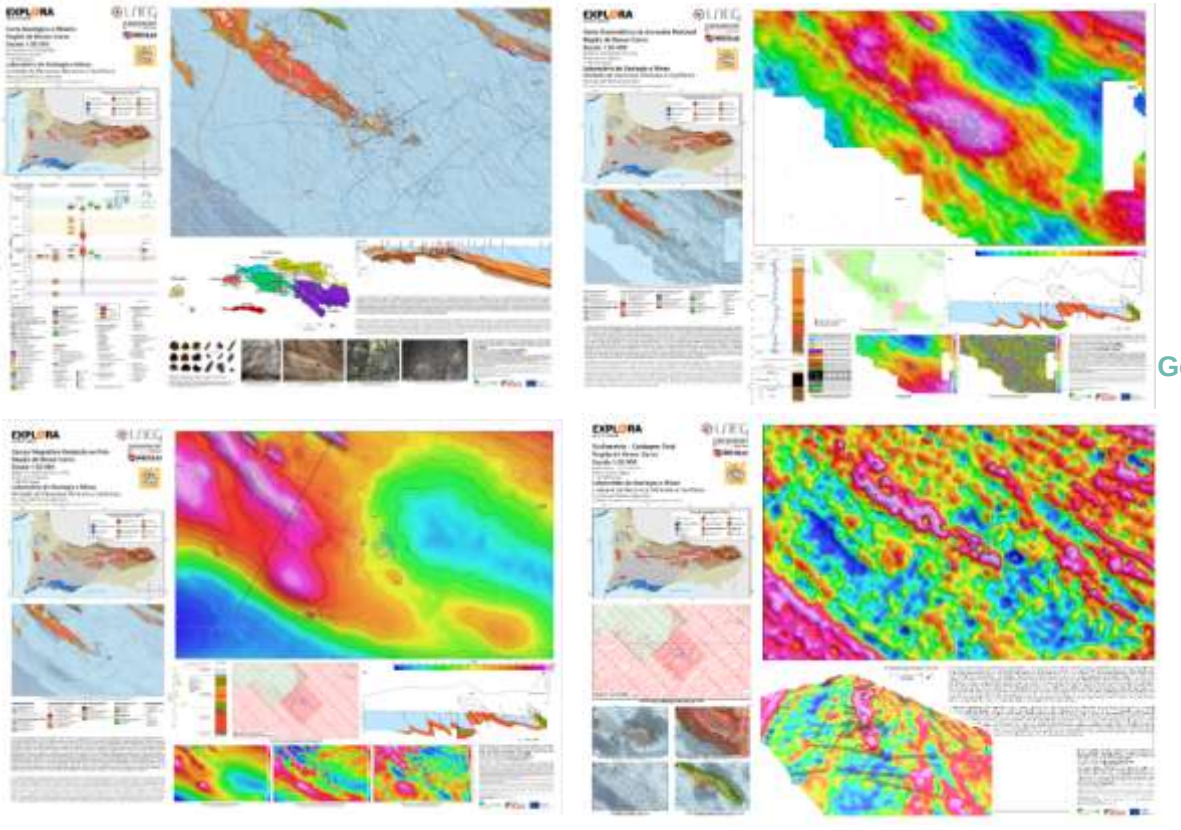
Drill hole database

Lundin Mining massive ore mapping

Geophysical data interpretation

Matos et al., EXPLORA 2020

Neves-Corvo mine region, 1/50,000 maps



Geology
Mapping, logging

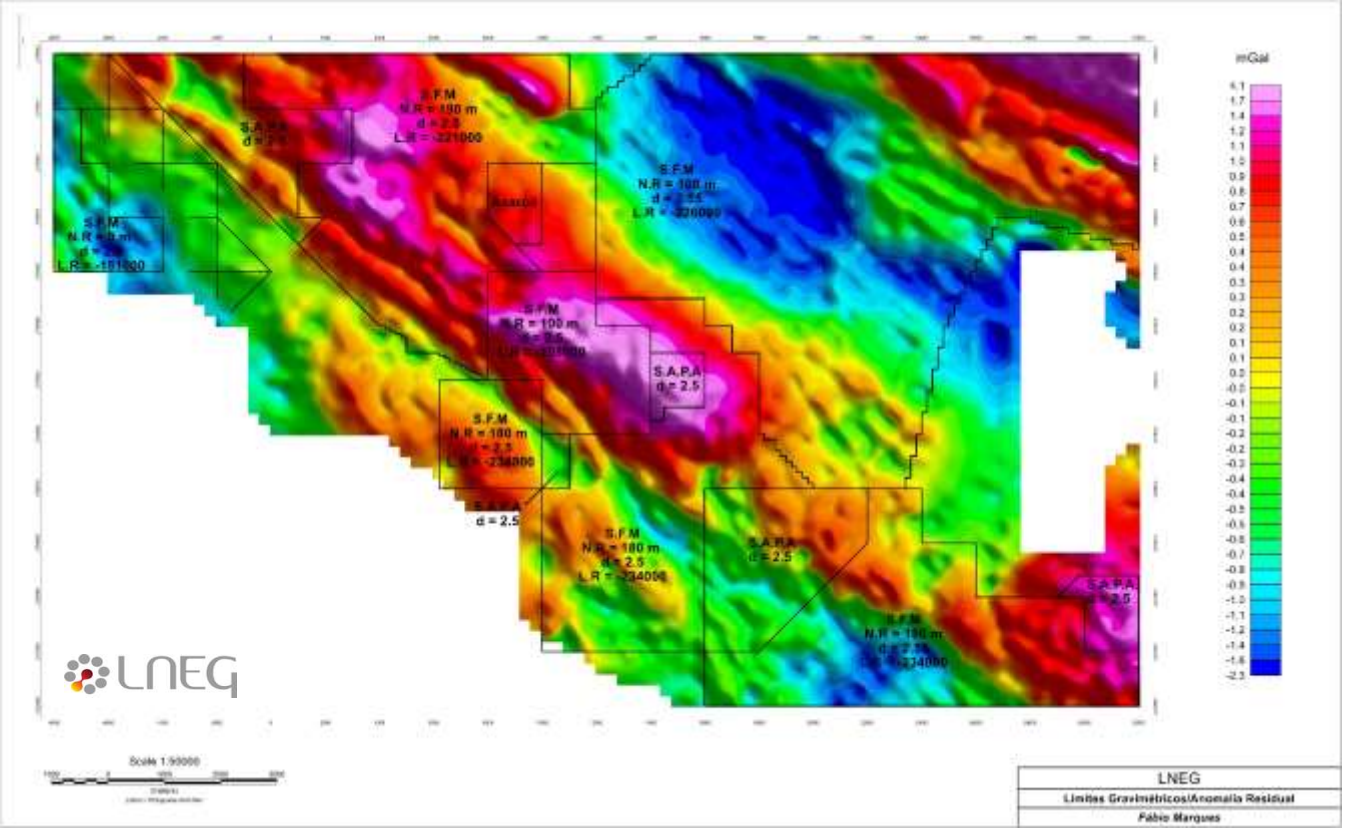
Palynology
Sedimentary rock dating

Geochronology
Volcanic rock dating

Geophysics
Data processing/modelling

Geochemistry
Soil, rock

Neves-Corvo mine region 1/50,000 - gravimetry



Geophysics

Data processing/modelling

Gravity land surveys:

Serviço de Fomento Mineiro, 1960s-1990s: grid 200 m x 200 m and 50 m x 50 m, NS/EW

SAPA – NE-SW profiles, spacing 200 m

Asarco 1994-1995, spacing 200 m x 100 m

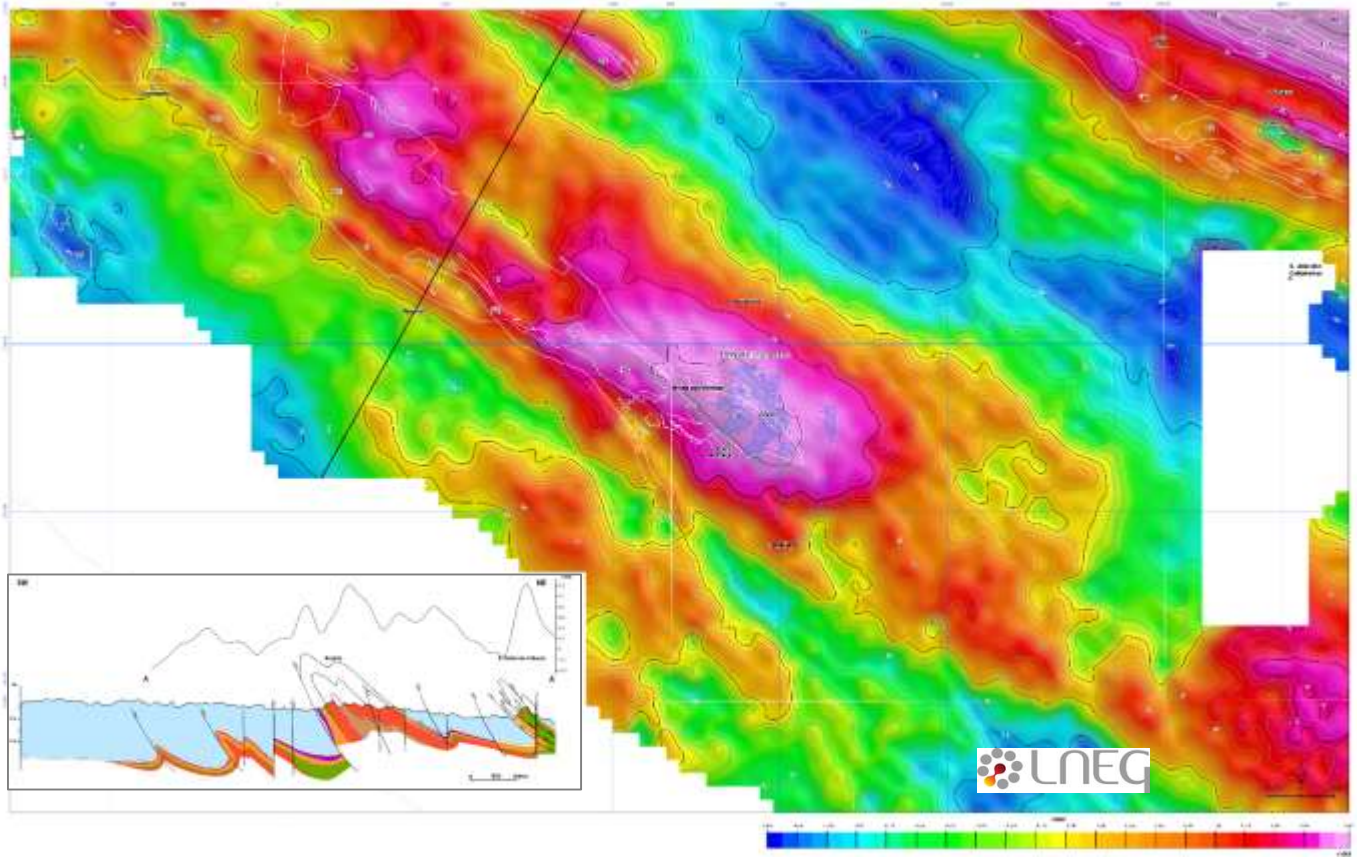
Marques et al., 2019, 2020

Neves-Corvo mine region 1/50,000 - gravimetry

EXPLORA NEVES-CORVO

Geophysics

Data processing/modelling



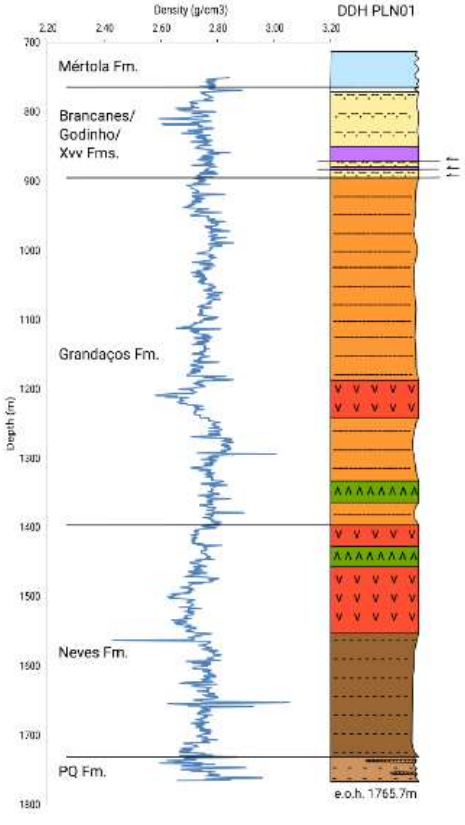
- **Residual Gravity map**
  Marques et al., 2020

Neves-Corvo mine region 1/50,000 - gravimetry

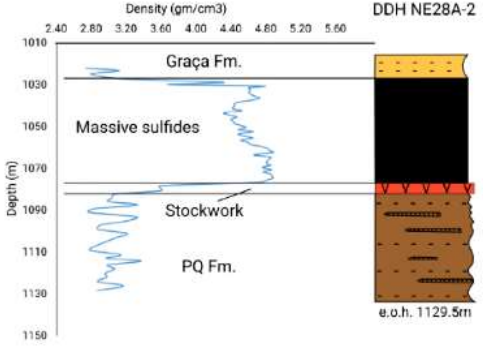
EXPLORA NEVES-CORVO

Unidades Geológicas / Geological Units		Mínimo / Minimum	Máximo / Maximum	Média / Average	DesvPad / StanDev	n / n
Fm. Mértola / Mértola Fm.		2.02	2.86	2.72	0.13	1858
Fm. Brancanes / Brancanes Fm.		2.57	2.99	2.76	0.06	231
Fm. Godinho / Godinho Fm.		2.39	2.83	2.71	0.05	477
Xistos Borra de Vinho / Borra de Vinho Shales		2.4	2.85	2.75	0.06	178
Fm. Grandaços / Grandaços Fm.		2.58	3.01	2.76	0.05	799
Fm. Graça / Graça Fm.		2.72	2.8	2.77	0.03	11
Vulcânicas félsicas / Felsic volcanic		2.57	3.11	2.74	0.06	1970
Fm. Neves / Neves Fm.		2.68	2.87	2.8	0.03	63
Vulcânicas máficas / Mafic volcanic		2.61	2.93	2.8	0.05	134
Sulfuretos maciços / Massive sulfides	Corvo	2.4	5.6	4.53	0.28	13288
	Graça	2.77	5.43	4.49	0.27	4178
	Lombador	2.47	5.3	4.59	0.28	4260
	Neves	2.66	5.41	4.54	0.29	15340
	Zambujal	2.5	5.39	4.64	0.25	5800
Stockwork	Rochas félsicas / Felsic rocks	2	4.97	3.07	0.39	59200
	Xistos / Schales	2.1	4.89	3.08	0.36	33900
Espilitos / Spilites		2.63	2.84	2.75	0.04	38
Fm. Filito-quartzítica / Phillite-quartzite Fm.		2.56	3.22	2.79	0.07	428

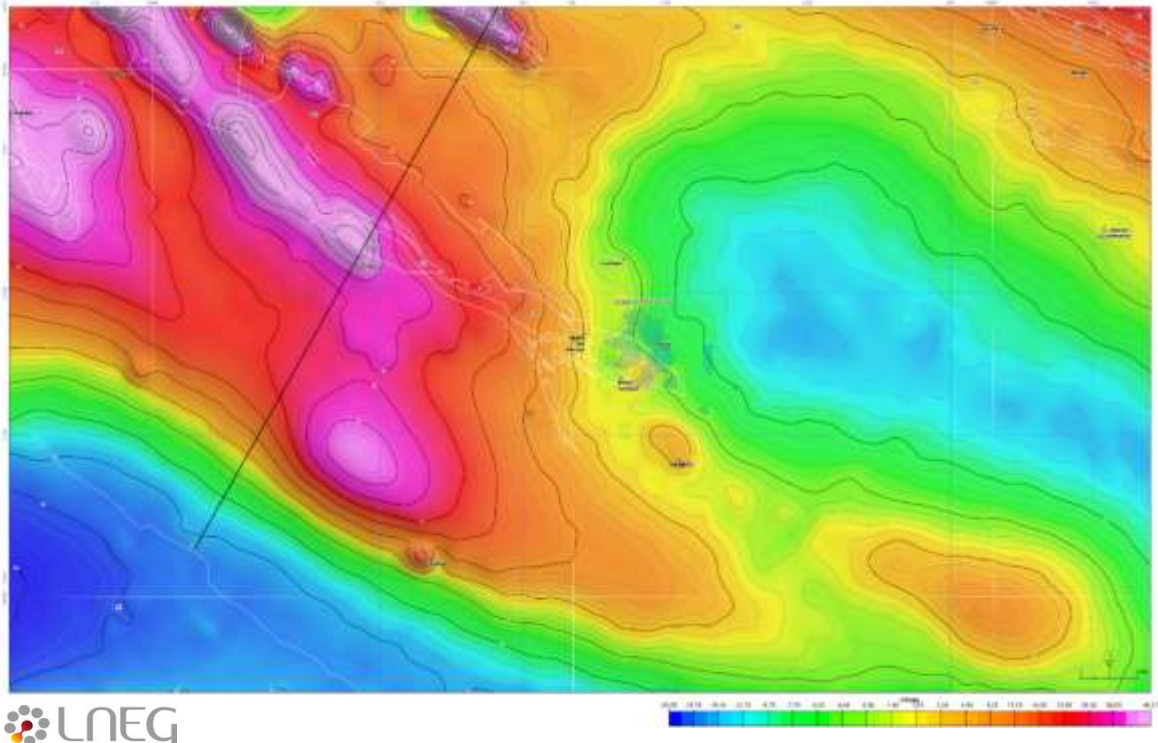
Densidades para a Região Mineira de Neves-Corvo
Densities of the Neves - Corvo Mining Region

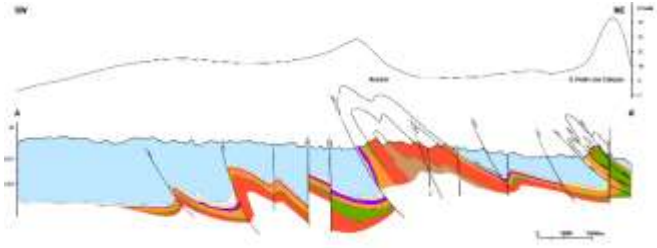


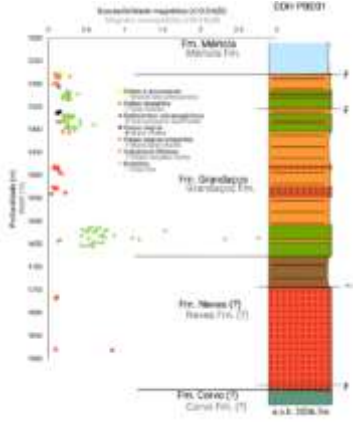
- **Rock density database**



Neves-Corvo mine region 1/50,000 - magnetometry



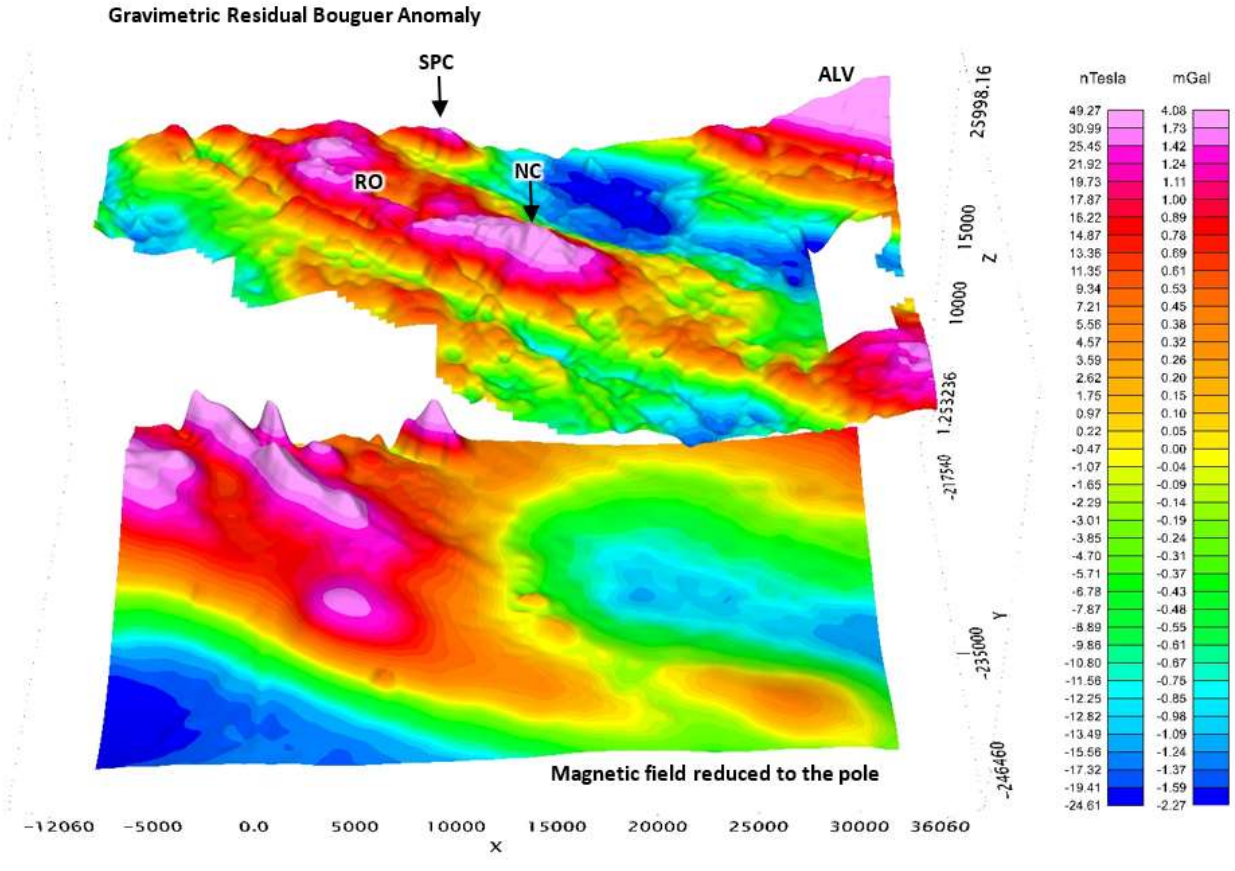




- **Magnetic field reduced to pole**
- **Magnetic susceptibility database**
  Marques et al., 2020

Neves-Corvo mine region 1/50,000 - geophysics

EXPLORA NEVES-CORVO



Geophysics

Data processing/modelling

NC – Neves-Corvo deposit
RO – Rosário antiform (VSC+PQ)
SPC – São Pedro das Cabeças (VSC)
ALV – Alvares region (VSC+PQ+Freixial)

Marques et al., 2019, 2020,
Matos et al., 2020

LNEG CENTRO HERCULES SOMINCOR

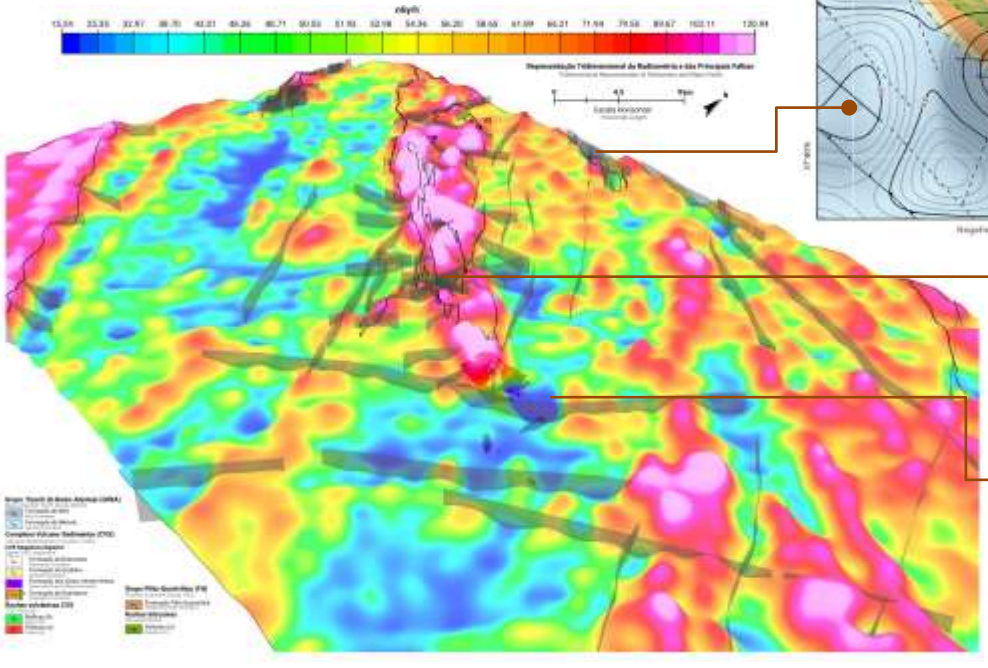
ALENTEJO 2020 PORTUGAL 2020

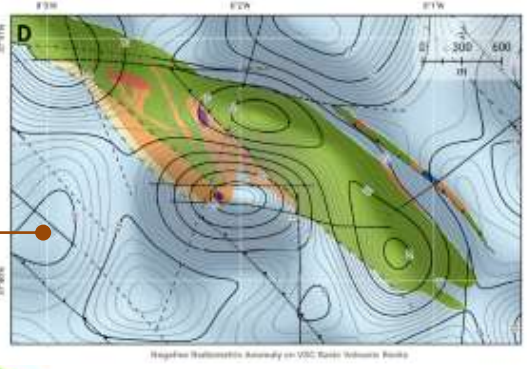
Neves-Corvo mine region 1/50,000 - radiometry

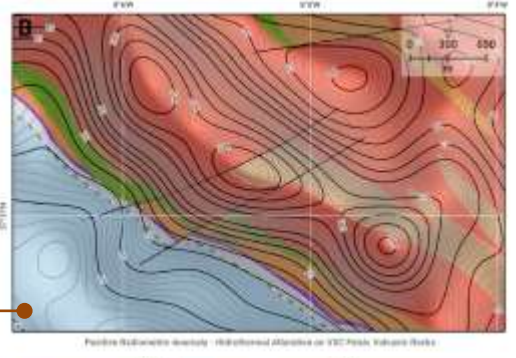
EXPLORA NEVES-CORVO

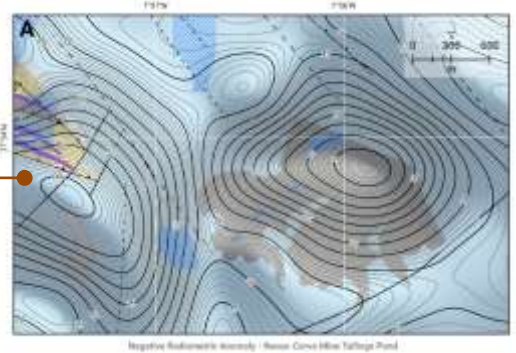
Geophysics
Data processing/modelling

- **Radiometric map (Natural Radioactivity)**
  Batista et al., 2020







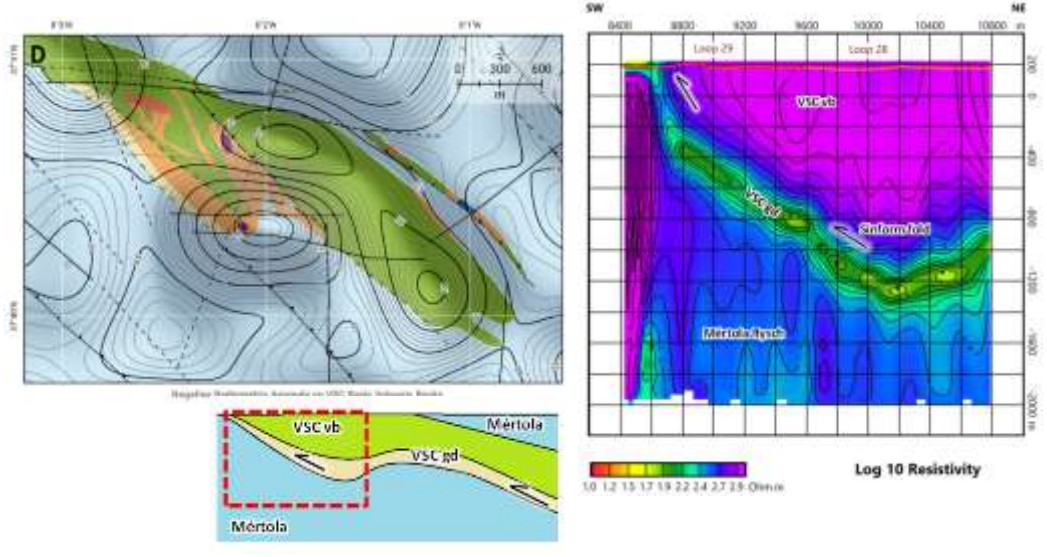


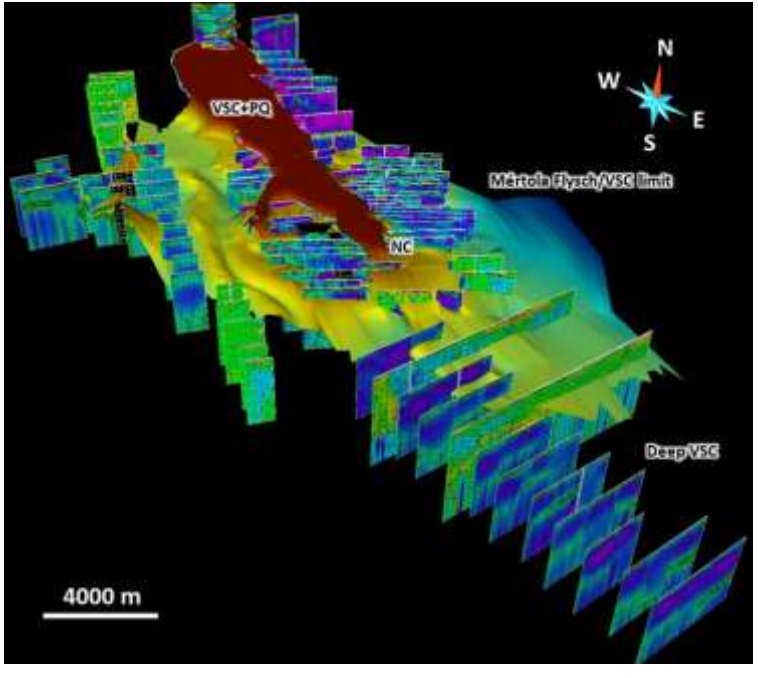
LNEG · CENTRO HERCULES · SOMINCOR · ALENTEJO 2020 · PORTUGAL 2020 · UNIÃO EUROPEIA

Neves-Corvo mine region 1/50,000 – radiometry and EM

- **TEM Profiles** (AGC/Lundin Mining)
- **Modelling of the Mértola Fm. footwall surface**
- **São Pedro das Cabeças model**

Batista et al., 2020, Carvalho et al., 2020, Dias et al., 2020, Matos et al., 2020





Neves-Corvo near mining scenario

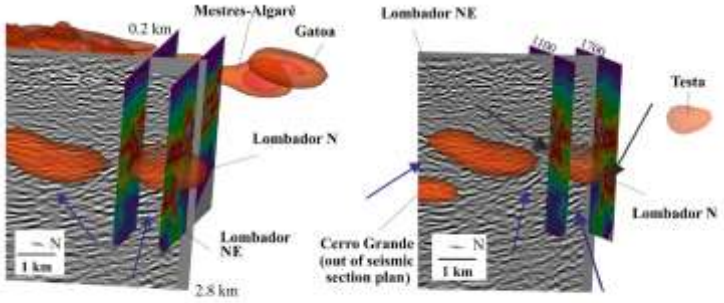


Figure 9. Correlation between 3D seismic cube, TEM reprocessed data (see location in Fig. 4c) and high-density anomalies of Lombador North obtained from the 3D constrained inversion (run# 3) for $d > 3.5$ g/cm^3 (orange with transparency) and $d > 4.3$ g/cm^3 (purple). TEM lines Lombador North 1700 and 1100 are shown. Arrows point to seismic reflectors (blue) and high-conductivity anomalies (black) associated with Lombador N gravity anomaly.

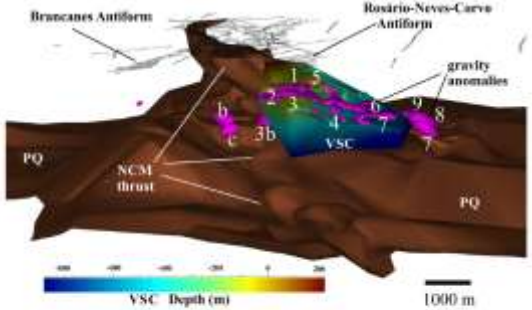


Figure 5. Gravity inversion results for the third series of runs compared with the surface of the top of lower VSC, built according to drill-hole logs and the top of PQ. It can be observed that high-density anomalies produced by the inversion and known deposits (pink bodies) are placed in the 3D model close to the TL/VSC and the Neves–Corvo main (NCM) thrust, as expected. Densities of > 3.7 g/cm^3 are shown. The geological contours and faults of Figure 1 are overlain. Some gravity anomalies have been labelled

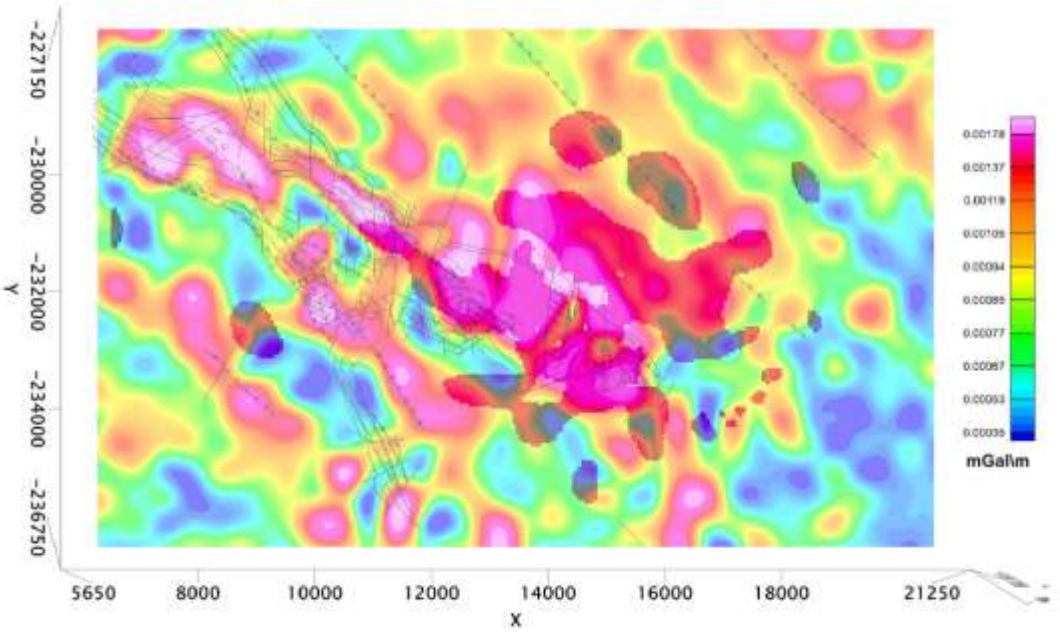


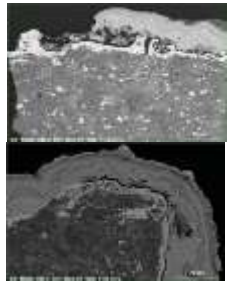
Figure 10. Results for the third run of the gravimetric inversion ($d > 3.5$ g/cm^3) overlaid by the analytical signal of the residual Bouguer anomaly map shown in Figure 2b. Geological contours of Figure 1b are also superimposed.

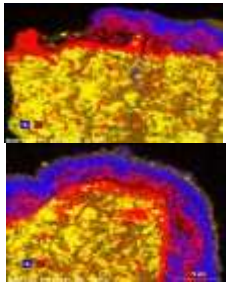
Marques et al., 2022

Geochemistry - EXPLORA European Patent

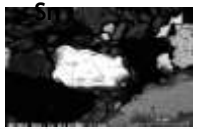
- **European Patent EP3809133 B1, 27.04.2022:** ***"EXPLORA - A method for characterizing underground metallic mineral deposits based on rock coatings and fracture fills"***
  - New mineral exploration technique that can be applied in volcanogenic massive sulfide provinces
  - LNEG and Hercules Laboratory (Évora University) joint research
  - Test areas: Neves-Corvo, Rosário, Aljustrel and Alvares, Morais et al., 2023

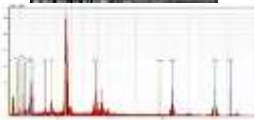
SEM-EDS
Sample 15 B



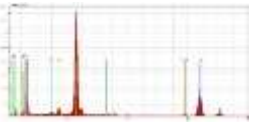


P10 - particle rich in S, Cu and S

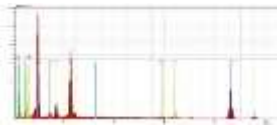




P11 - pyrite



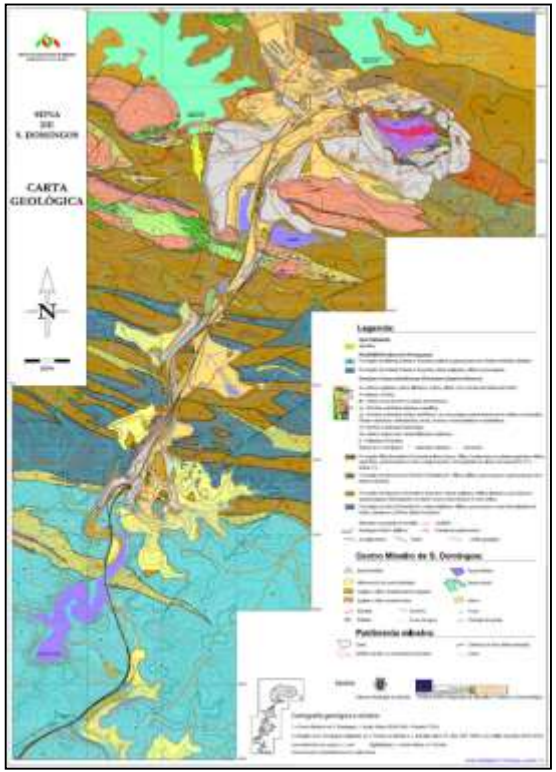
P13 - sphalerite

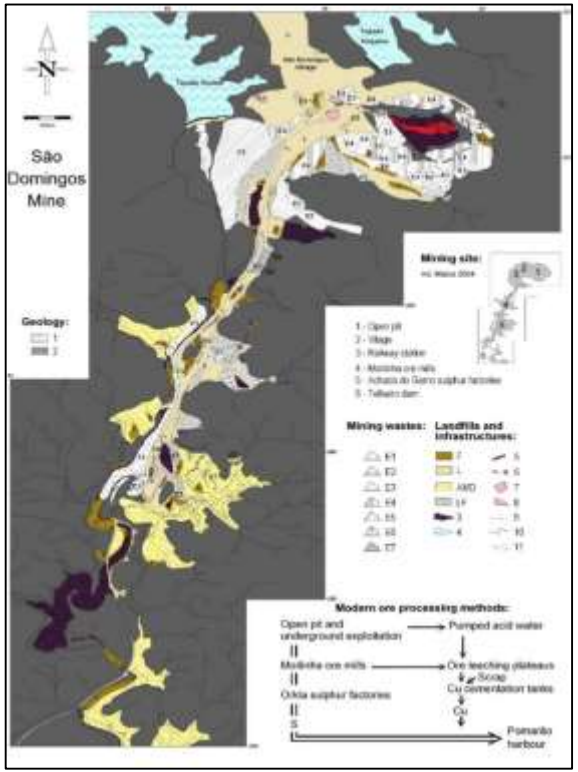


GSEU Project - São Domingos mine wastes

São Domingos mine,
Mason & Barry (1857-1966),
Rego 2004

São Domingos mine





São Domingos mine
Matos, 2004, 2021
Mateus et al., 2011

Mining wastes:

- Brittle pyrite ore
- Gossan
- Roasted ore
- Roman slag
- Modern slag
- Host volcanic rocks
- Host sediments
- Contaminated landfill
- Urban landfill
- Urban waste

LNEG

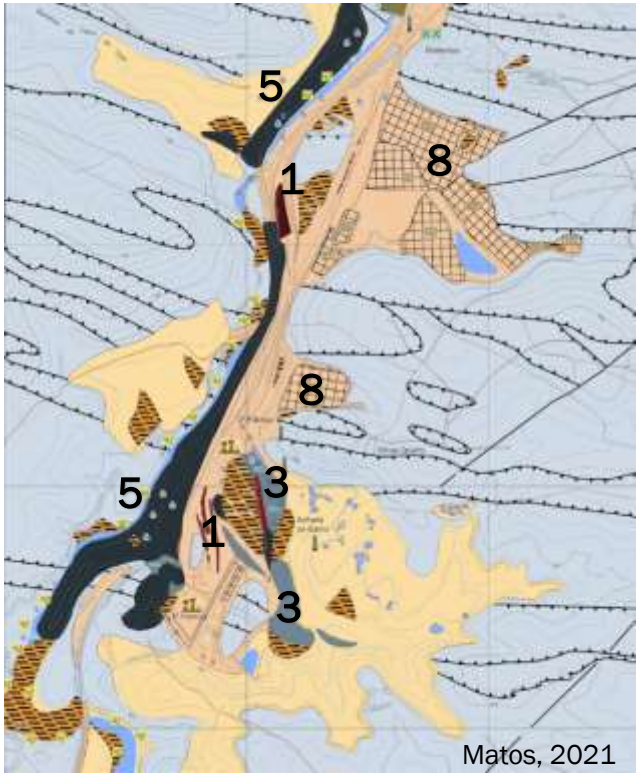
São Domingos mine

Mining wastes:

1. Brittle pyrite ore
2. Gossan
3. Roasted ore
4. Roman slag
5. Modern slag
6. Host volcanic rocks
7. Host sediments
8. Contaminated landfill
9. Urban landfill
10. Urban waste

LNEG

São Domingos mine



Matos, 2021

Mining wastes:

1. Brittle pyrite ore
2. Gossan
3. Roasted ore
4. Roman slag
5. Modern slag
6. Host volcanic rocks
7. Host sediments
8. Contaminated landfill
9. Urban landfill
10. Urban waste

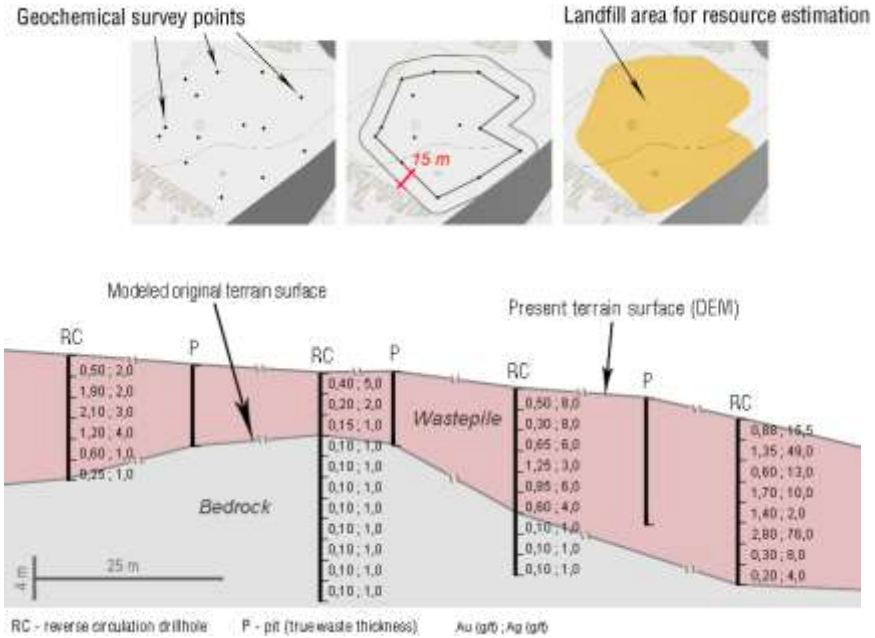
LNEG

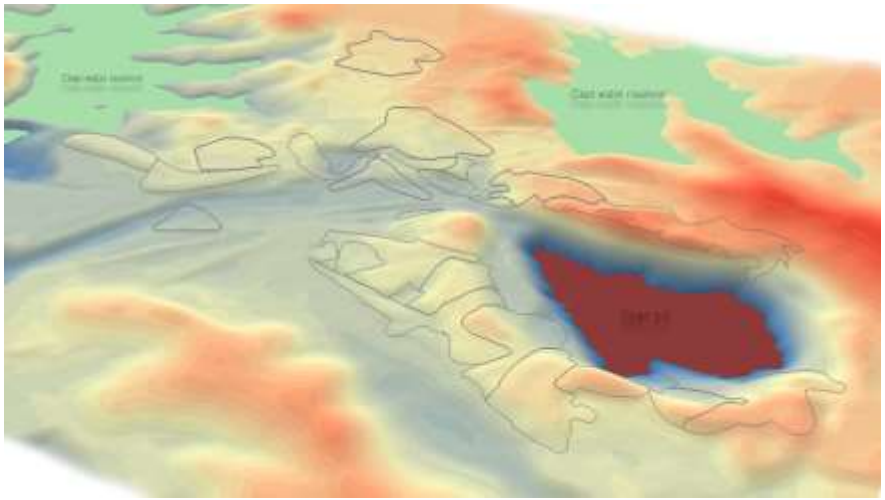
São Domingos mine

- Evaluation of the mine wastes located in the **São Domingos mine** northern sector (CONASA, 1990, 1991)
- 3D modelling and resource estimation (Vieira et al., 2016, 2020)
- Gossan, volcanic and sedimentary host rocks waste piles and landfill areas (Matos, 2004);
- **160 reverse circulation drill holes** (sampled in 2 m intervals);
- **162 pits** (1 to 3 samples per pit, up to 14 m depth);
- Irregular location (30 m)
- 1148 samples assayed for **Au** and **Ag**

São Domingos mine

São Domingos, mine Vieira, et al., 2016, 2020





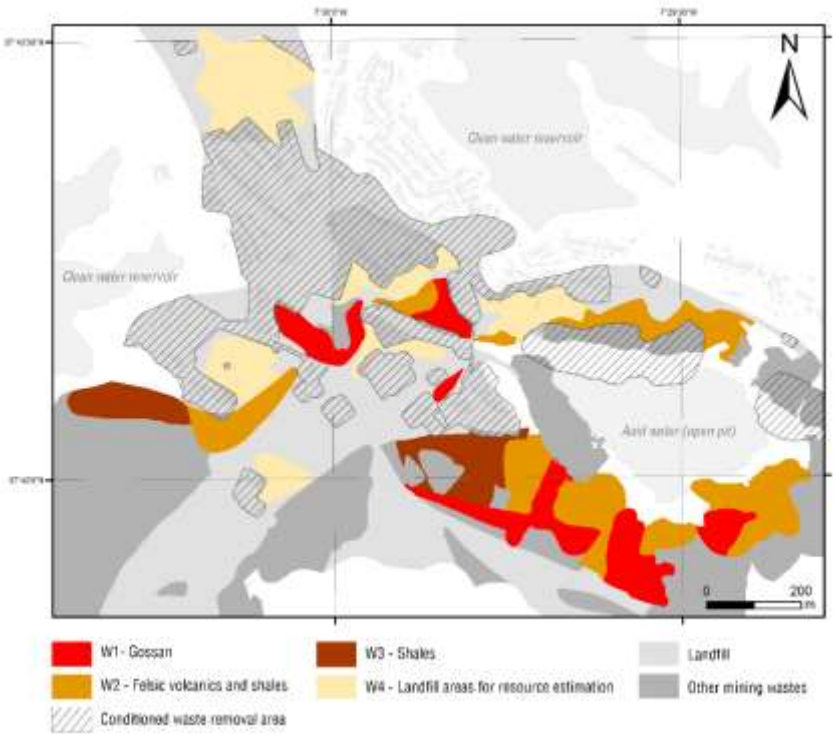
- Digital terrain model
- Waste pile and landfill constrains boundaries for block modeling.

São Domingos mine

São Domingos, mine Vieira, et al., 2016, 2020

Conditioned areas:

- Village edified over part of the mine wastes
- Legally protected industrial and heritage sites, e.g., roman galleries and slags, mining infrastructure
- Restricted waste removal areas (conditioned



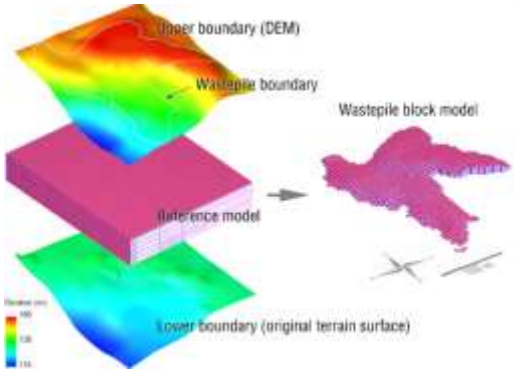
São Domingos mine

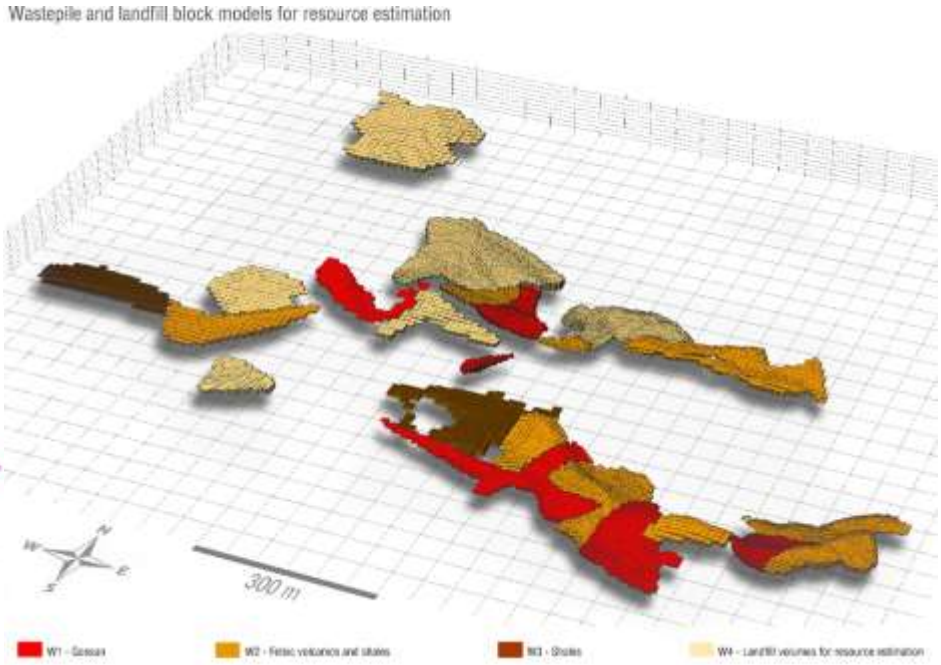
São Domingos, mine Vieira, et al., 2016, 2020

Modelling:

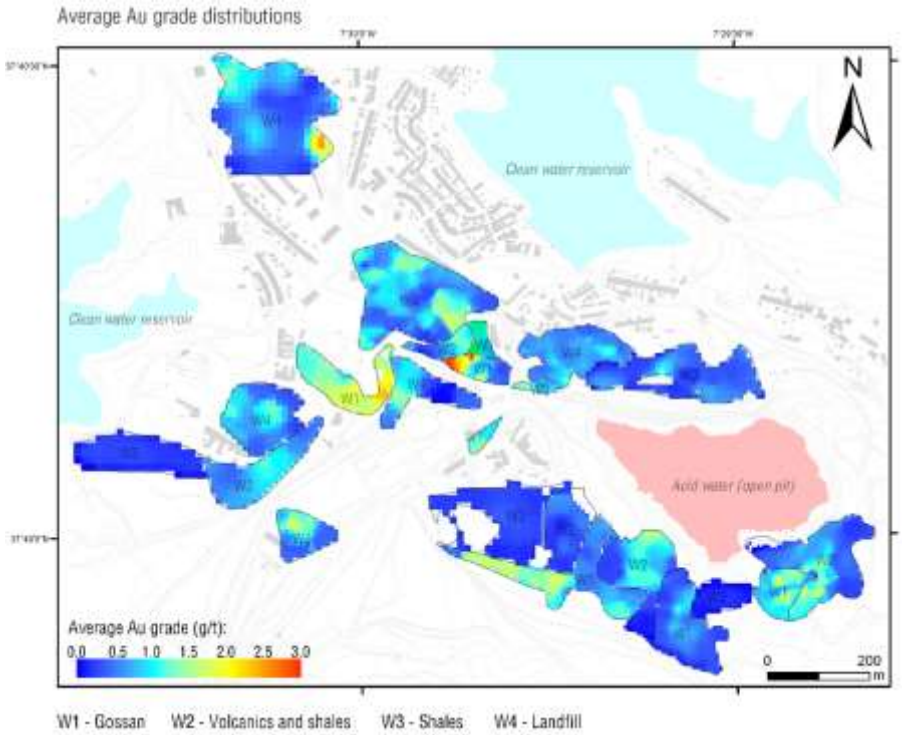
- All modeled wastes: **2,615,850 m³** - **3,979,800 t;**
- Unconditioned exploration wastes: **2,152,559 m³** - **3,305,100 t** (~17% reduction)

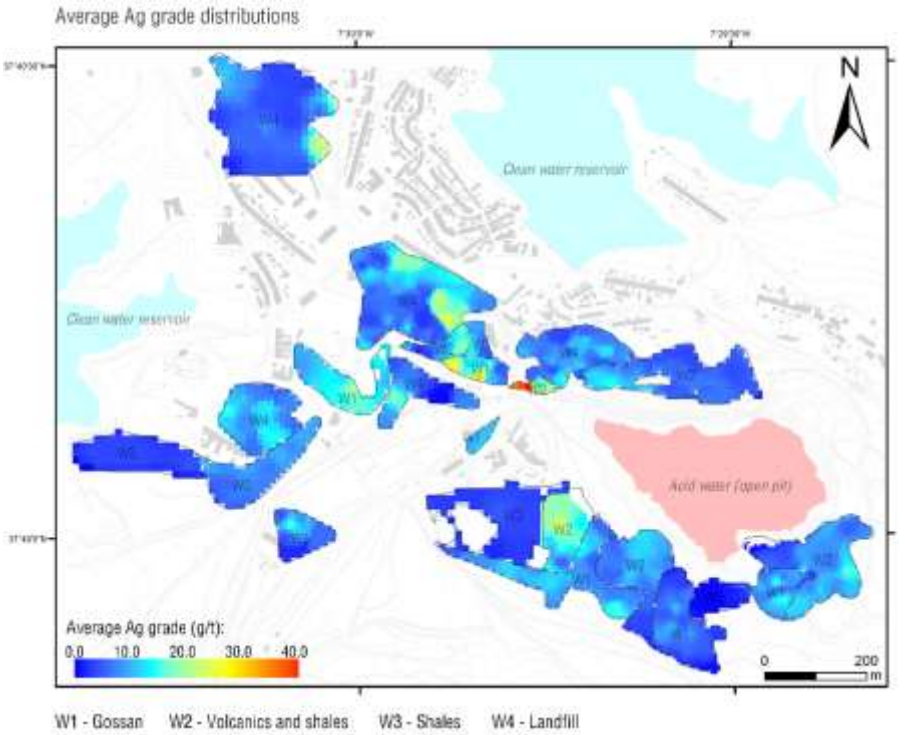
- Block sizes according the geochemical assay grids: 7 m – 12 m
- maximum waste thickness: 16 m





São Domingos mine





Scenario 1 - conditioned volumes - *high grade* wastes only (> 0.5 g/t Au) **2.38 Mt** @ **0.77 g/t Au** and **8.26 g/t Ag** (**59,489 ozt Au** and **633,488 ozt Ag**)

Scenario 2 - all volumes - both *high* and low grade wastes: **4.00 Mt** @ **0.64 g/t Au** and **7,30 g/t Ag** (**82,878 ozt Au** and **955,753 ozt Ag**)

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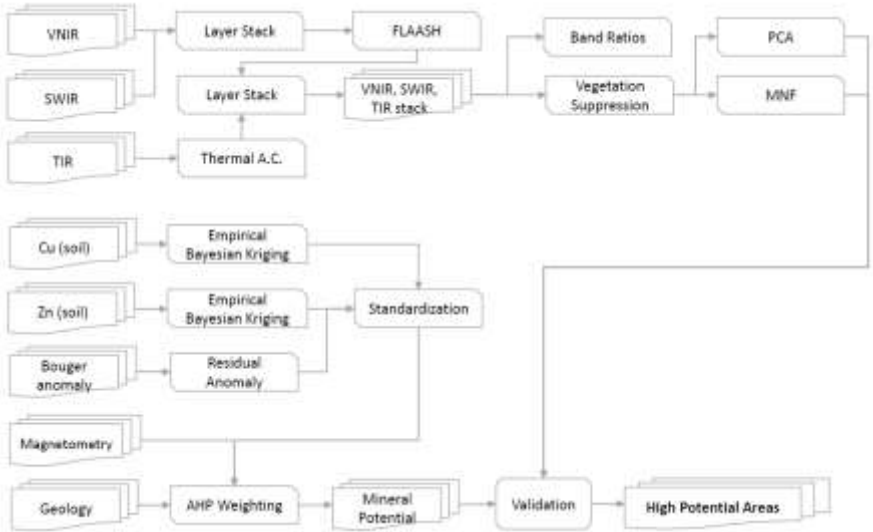
Case study: Ossa-Morena Zone Moura – Ficalho sector

3 - Predictive mineral exploration mapping



Gonçalves et al., 2019

Preguiça old mine open pit (Zn, Pb)

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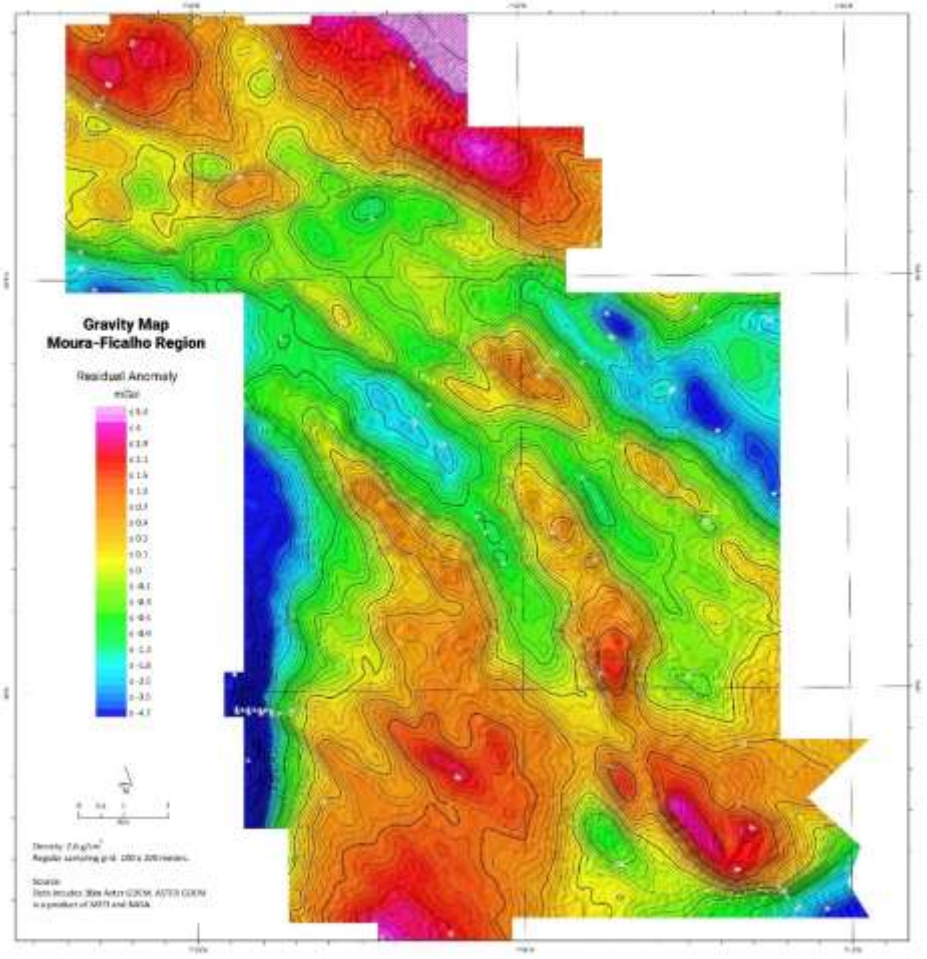
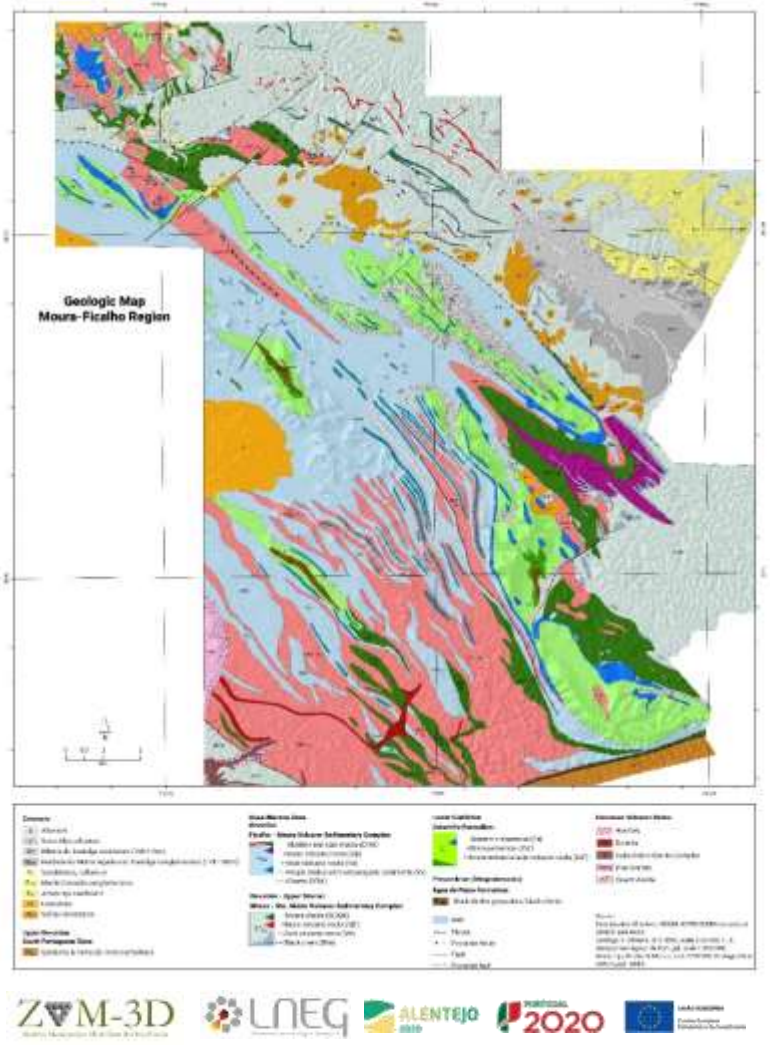
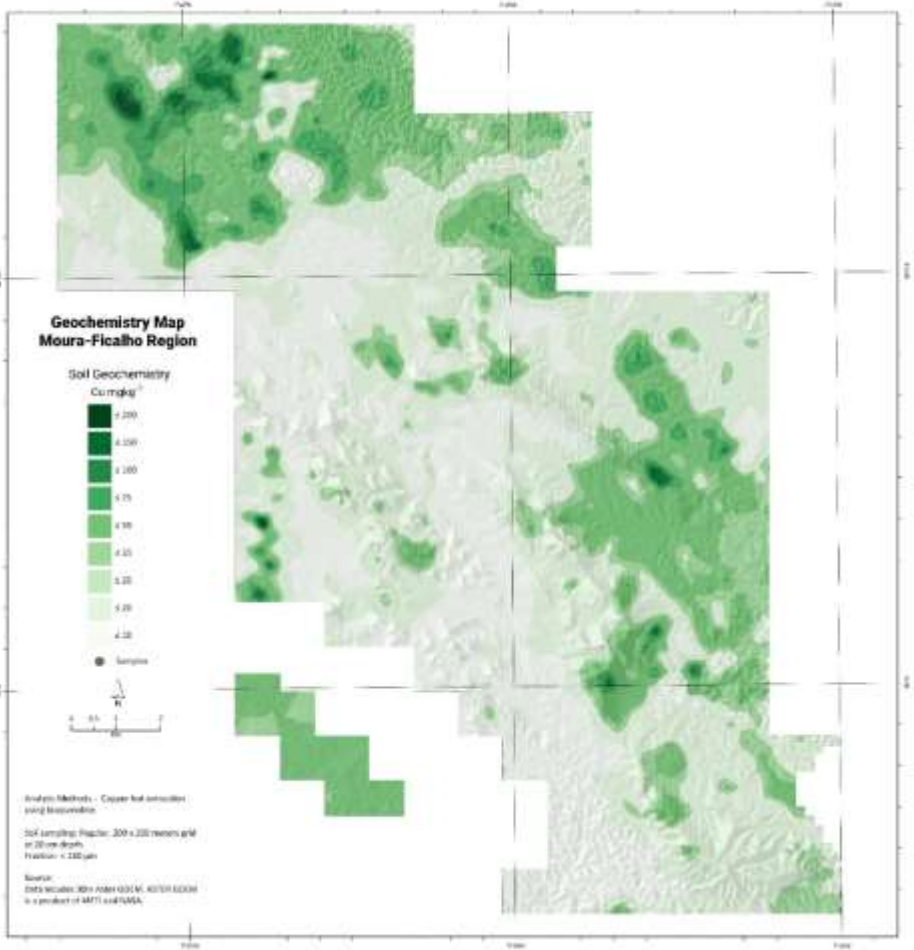
ZOM-3D
Modelos Metalogénicos 3D da Zona de Ossa-Morena

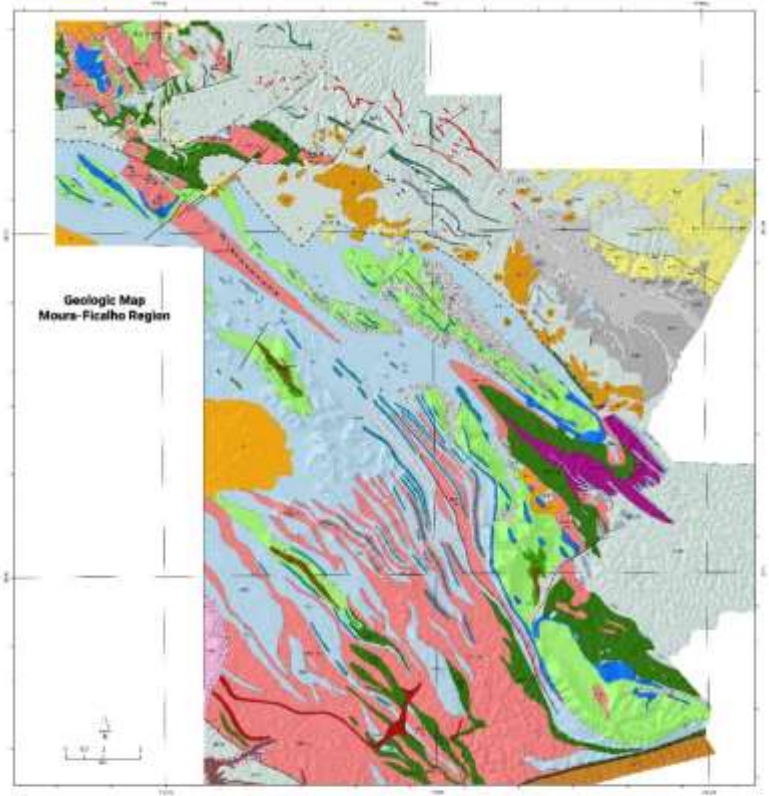
Moura - Ficalho (Zn, Pb) Gonçalves et al., 2019



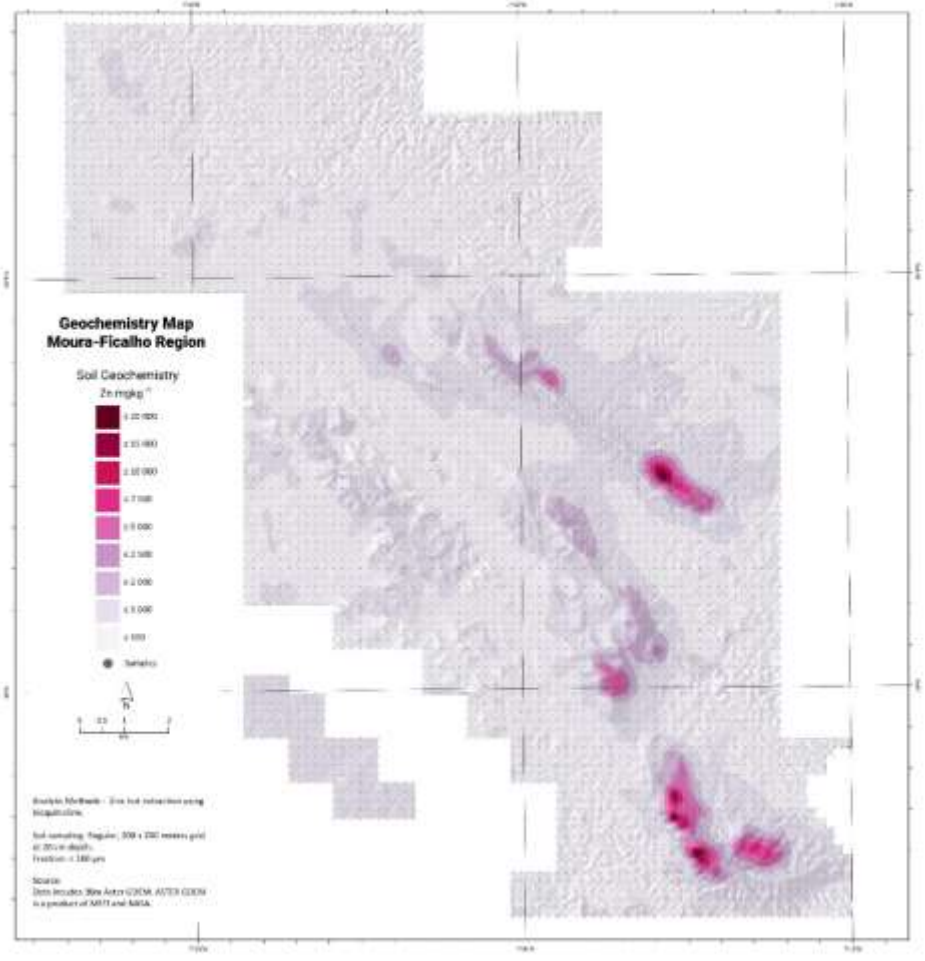


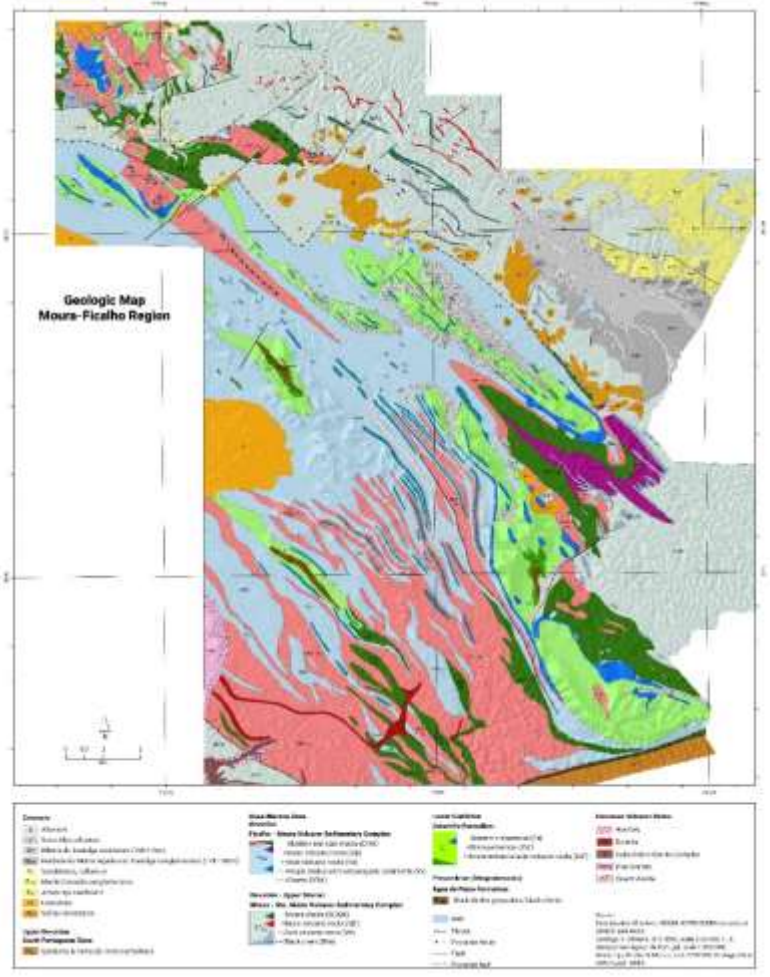
Moura - Ficalho (Zn, Pb) Gonçalves et al., 2019



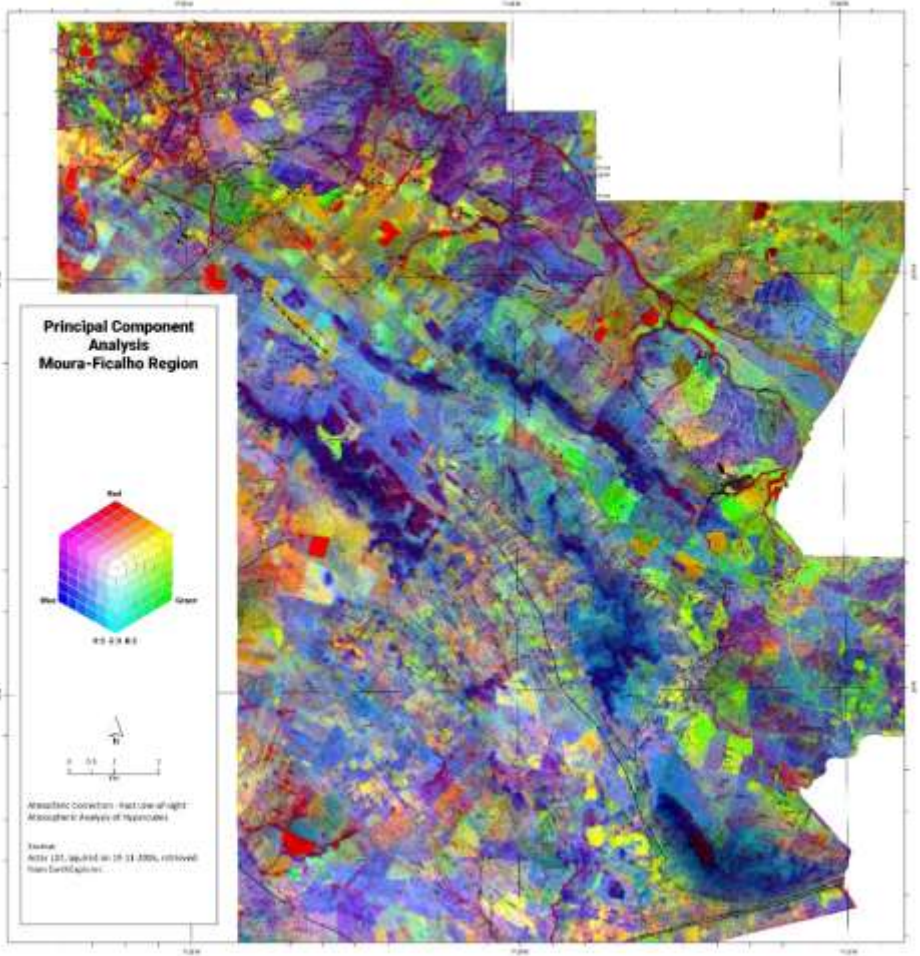


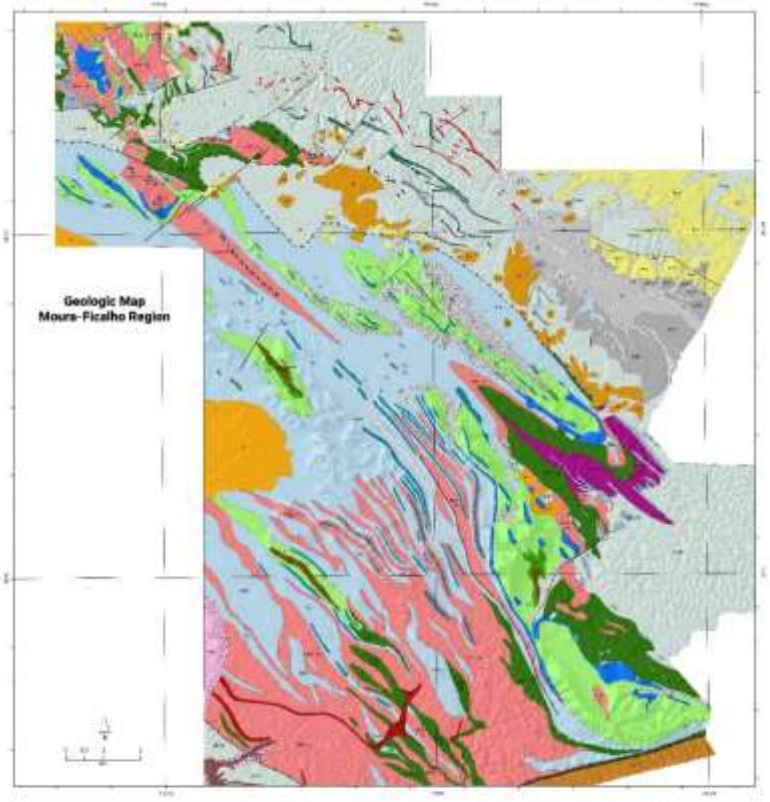
Moura - Ficalho (Zn, Pb) Gonçalves et al., 2019



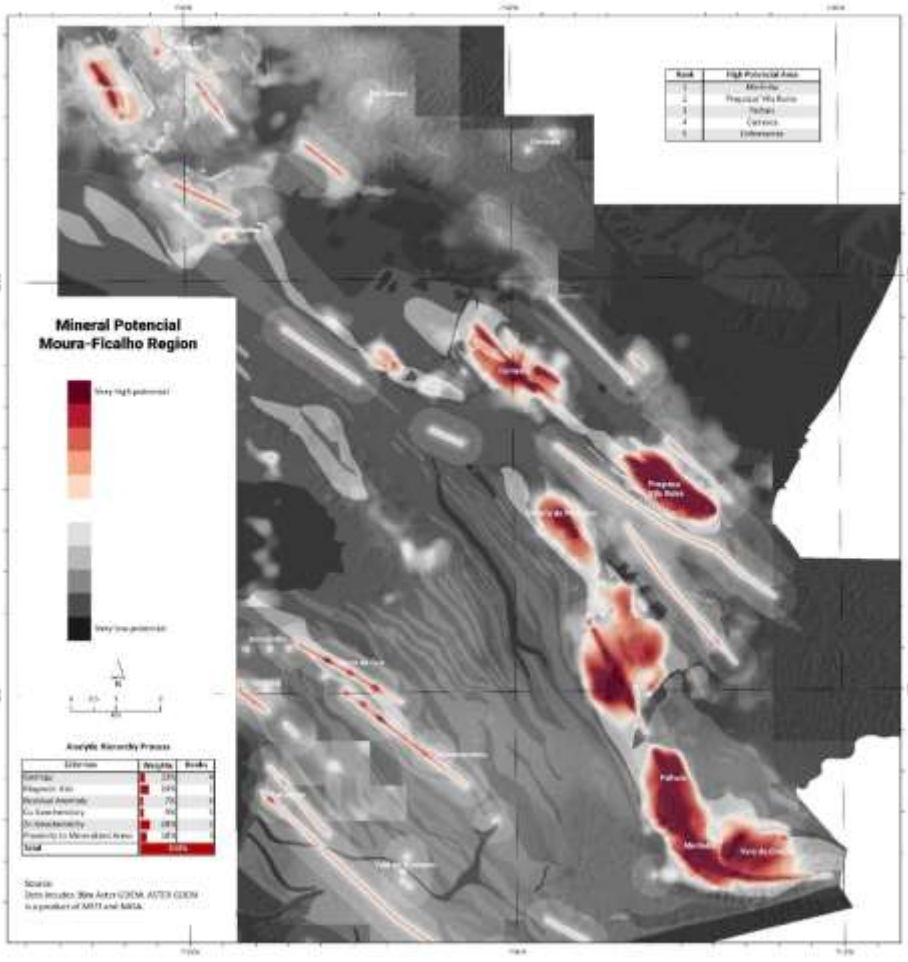


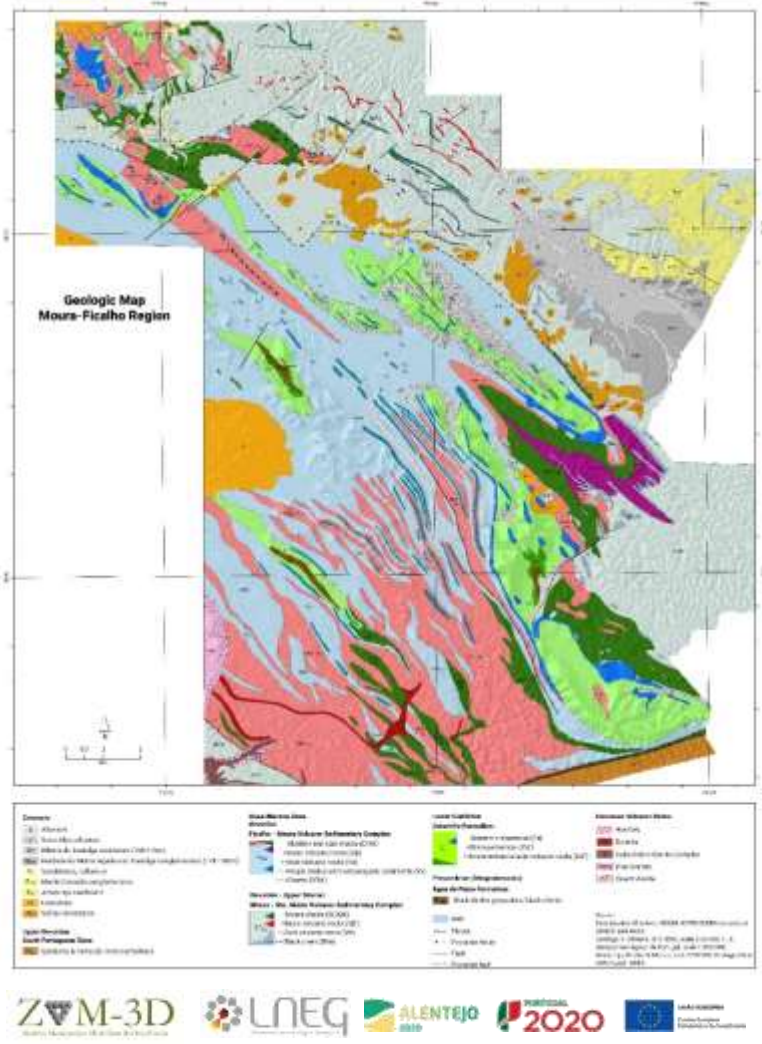
Moura - Ficalho (Zn, Pb) Gonçalves et al., 2019





Moura - Ficalho (Zn, Pb) Gonçalves et al., 2019





Final remarks

- New challenges – the EU CRM Act
- Alentejo mineral cluster – SRMs vs CRMs
- Raw data and online databases
- Near mining and green field exploration scenarios
- LNEG R&D – smart specialization with universities and mining companies
- Human resources

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Obrigado!