Faixa Piritosa Ibérica, uma região mineira europeia com elevado potencial para jazigos de metais básicos

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Iberian Pyrite Belt

An important European Mining Region

The Iberian Pyrite Belt:

- IPB is a **world famous metallogenic base metal province** characterised by giant massive sulphide deposits (>200Mt) associated with a **Volcano-Sedimentary Complex** of Upper Palaeozoic age (350 M years).
- IPB is shared by the **Portuguese Alentejo and Spanish Andalusia regions**, where **90 massive sulphide deposits are know**, some unexploited, some of them intensely mined since Roman times.
- Presently the **Neves Corvo mine** (Castro Verde) is the biggest extractive project, producing **Cu** (Zn, Sn) concentrates (~2,2Mt/year). **Aljustrel mine** restarted the activity in 2008, exploiting Moinho and Feitais Zn ores (~1,8Mt/year).
- Most of the IPB old **mines are abandoned and present negative environmental impacts**.
- **Rehabilitation projects** are in development at Aljustrel mine by EDM.

The European Network of MINING REGIONS

"IBERIAN PYRITE BELT, NEW SUSTAINABLE DEVELOPMENT POLICY IN THE EUROPEAN COMMUNITY"

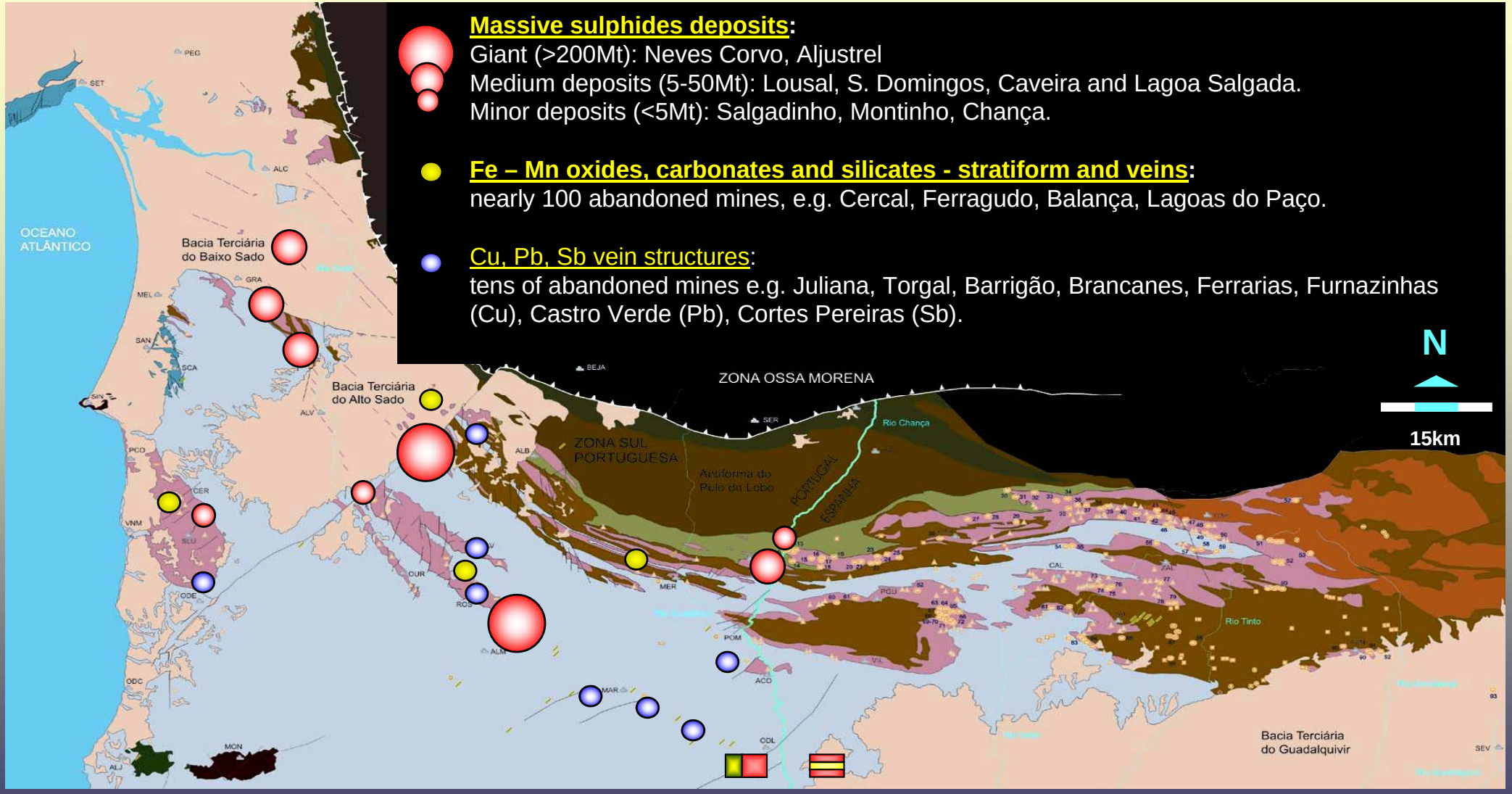
- The presence of **active mining** is an important factor for exploration.
- **Green mine projects** (e.g. Neves Corvo) shows the compatibility between ore exploitation and nature protection.
- **LNEG regional office** improves exploration companies to a direct contact with the complex IPB geology (best areas for research and exploration, exploration methodologies, etc).
- **Old mining projects** have important negative environmental impacts.
- The improvement of the **geological knowledge** would be reflected in a more sustainable exploration models and methodologies.
- **Mining and geological heritage** programs are important to mining site rehabilitation

The European Network of MINING REGIONS

Matos & Martins 2006

Iberian Pyrite Belt

(Oliveira 1990, Barriga *et al.* 1997, Carvalho *et al.* & Leistel *et al.* 1998, Matos *et al.* 2000, 2004, 2006)



Iberian Pyrite Belt: ore types

Veins

- Late- Variscan to Eo- Alpine **mineralized faults**
- **Vein type structures**, up to 250000t (very small dimension)
- Tree main systems: **Cu, Pb-Ba, Sb (Au)** + quartz + carbonates
- Examples: **Barrigão, Ferrarias, Fortes, Brancanes, Porteirinhos, Cortes Pereiras**
- Exploited in the XIX century, evaluated in the 1930's and 1950's
- Associated with the Flysch Group and VS Complex, sparse distribution

Ferrarias CM1 borehole, tectonic breccia + chalcopyrite and carbonates, Matos et al. 2003

1 cm

Manganese and iron oxides

- Related with **Volcano Sedimentary Complex jaspers horizons**
- **Stratiform and vein type structures**, (small to medium dimension)
- Barite as sub-product at Cercal Rosalgar mines
- Examples: **Cercal, Ferragudo, Balança, Aljustrel (Feitais, Mangancha)**
- Exploited in the XIX century, until 2001 in Portugal

Cercal mine, Matos e Rosa 2001

Massive sulphides

- Volcanogenic hosted massive sulphides, associated with the **Volcano Sedimentary Complex hydrothermal submarine activity**

- **Type of occurrence (stratiform and singenetic):** exhalative massive sulphides; shallow subsurface replacement of muds/shales or coherent felsic volcanics

- **Pyrite** is the main sulphide (> 90 % of the total sulphide minerals). Locally significant amounts of **sphalerite, galena** and **chalcopyrite** can occur.

Neves Corvo ore (Photo F. Barriga)

Algares gossan (massive sulphide oxidation)

IBERIAN PYRITE BELT

The Mining Life Cycle in the province:

2009 AC

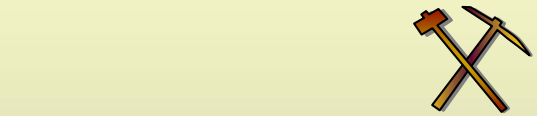
90 massive sulphide deposits

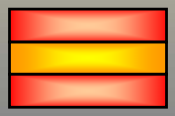
>2500Mt Py

Matos et al. 2008

Mining Life Cycle...

Exploration › **Mining** › **Re-Mining** › **Post-Mining** › **Abandoned**





Lagoa Salgada	Neves Corvo	Aljustrel	São Domingos	Montinho
Salgadinho			Lousal	Mn mines
			Caveira	Cu mines
			Chança	
Las Majadas	Las Cruces	Aguas Teñidas	Peña de Hierro	San Miguel
Castielejitos		La Zarza	Tharsis	Others...
		Cerro Colorado	Rio Tinto	

Mine / ore deposit

RUMYS

Iberian Pyrite Belt

Pyrite Route

"5000 Years Of Mining"

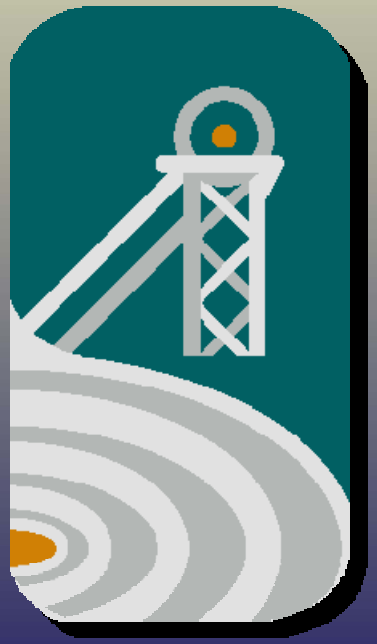
Objectives:

- **Definition of** geo- eco- mining **routes. Heritage promotion by websites, newsletters, papers, books, maps**
- **Technical support to current** IPB museums **– e.g. São Domingos, Aljustrel and Lousal mines;**
- **Development of a** transnational network of IPB mining sites, regions:

Alentejo
Algarve

Huelva (Andalusia)
Mancomunidad Cuenca Minera
Mancomunidad Andevalo Minero

Iberian Pyrite Belt



· 5000 Years of Mining ·

Exploring IPB…

Portuguese Geological Survey

<u>Companies</u>:

Somincor

Lundin, AGC, Redcorp, Iberian Resources,

Northern Lyon, Maepa,

Amax, Asarco, Billiton, BP, BRGM, Conasa,

EDM, ELF, EMSC, Lea Cross, MEI, Minaport, Mason,

Portuglobal, Redfern, SPE,

SEREM, SMS, Peñarroya, Rio Tinto, SMRA, Utah

Portuguese Geological Survey team at Lagoa Salgada LS3 borehole (1992)

Exploring the IPB Portuguese Sector

Geology key guides

- Mining areas – **detail research around know deposits**
- Hydrothermal alteration – **chlorite, silica, sericite**
- Sulphide remobilization –**veins, fissural/stockworks**
- **Felsic volcanics** – breccia zones, proximal facies
- **Black shales** – disseminated ore, veins
- Cherts, jaspers, barite
- Fault zones, shear zones
- Horsts and grabens

Exploring the IPB Portuguese Sector

Exploration tools

GEOPHYSICS TOOLS

Ground geophysics:

- Gravimetry
- Magnetometry
- Electromagnetic methods (EM37, TEM, UTEM)
- Resistivity
- Inducted polarization, vertical electrical sounding
- Magneto-telluric
- Seismic
- Mise-à-la-masse and down-hole surveys

Airbone geophysics:

- Magnetometry
- Radiometry (U, Th, K, total count)
- Electromagnetic

GEOCHEMISTRY TOOLS

Multielementary analysis:

- Stream sediments
- Soils
- Outcrops and cores

Laboratory techniques:

- ICP - MS
- INAA
- *Aqua regia, Enzyme Leach, Mobile Metal Ion*
- XRD
- XRF
- Atomic absorption
- Colorimetry
- ...

OTHERS:

- Remote sensing
- Luck...

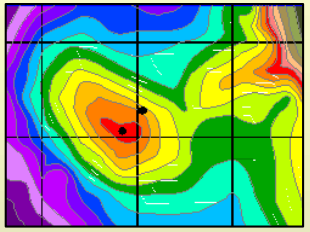
Exploring the IPB Portuguese Sector

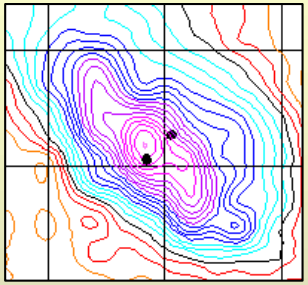
Metho-dology

Exploration permit/ Objectives

Geophysics Geochemistry Geology

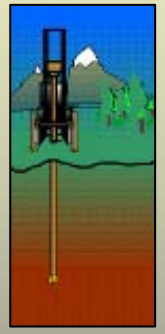
Target selection





Detail study

Drill program



Area evaluation

Abandon

Ore deposit characterization, metalogenetic model

Reserves measurement

Feasibility

Mine!

New project

IPB geological heritage at LNEG:

>200km exploration boreholes at Aparis, Aljustrel, S. Luís, Alfragide sites - estimated value 20M€!

Ossa Morena Aparis (Barrancos) copper mine in the 1950´s

A new drill store project (1000km) is being study by LNEG.
The infrastructure will be integrated in the new
CEGMA – Centro de Estudos Geológicos e Mineiros do Alentejo
A regional technical and research unit

Iberian Pyrite Belt exploration boreholes:
22 holes > 1000 m depth (maximum 1888m)
37 holes 800m – 1000m depth

Exploring the IPB Portuguese Sector

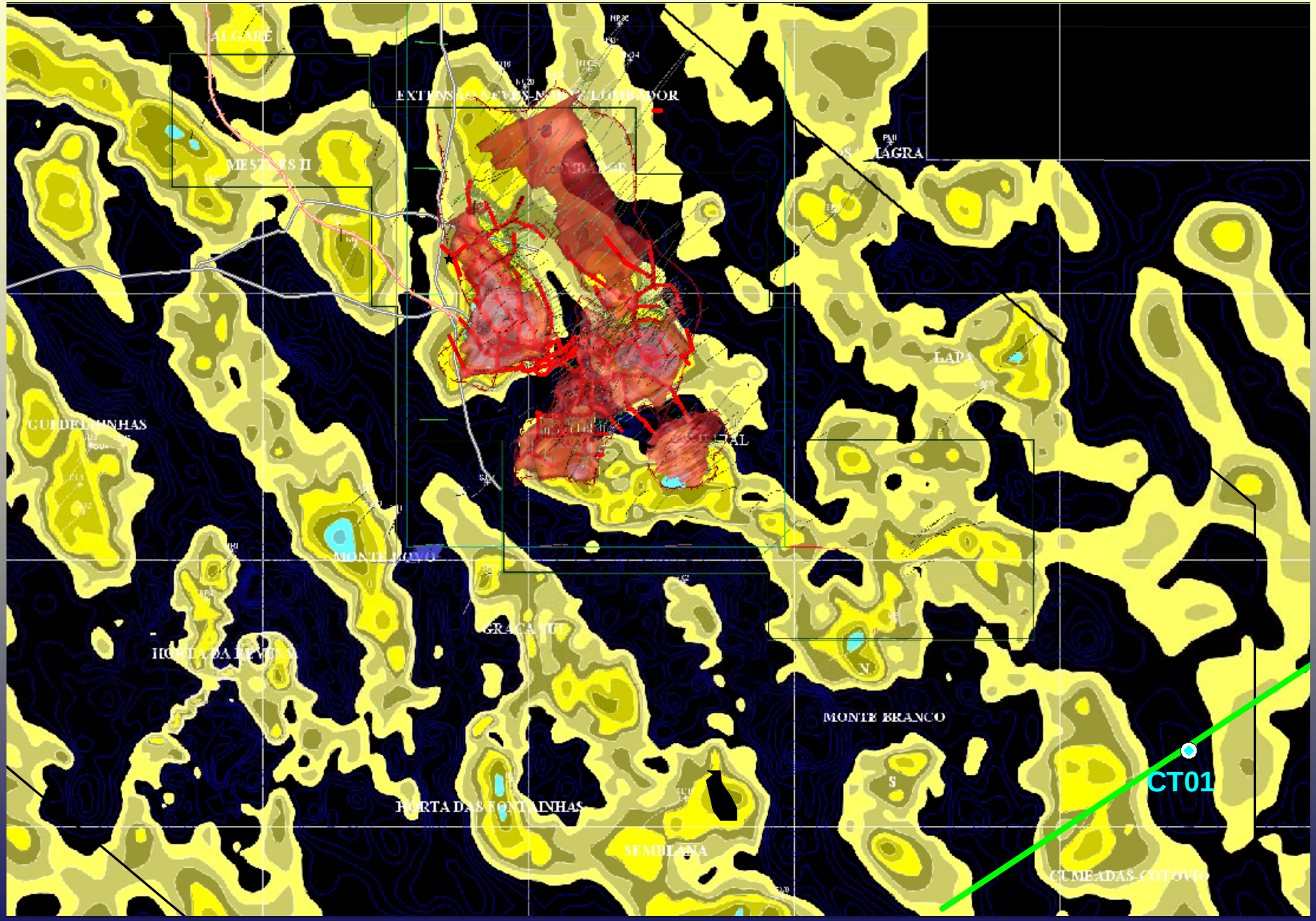
Residual gravimetry

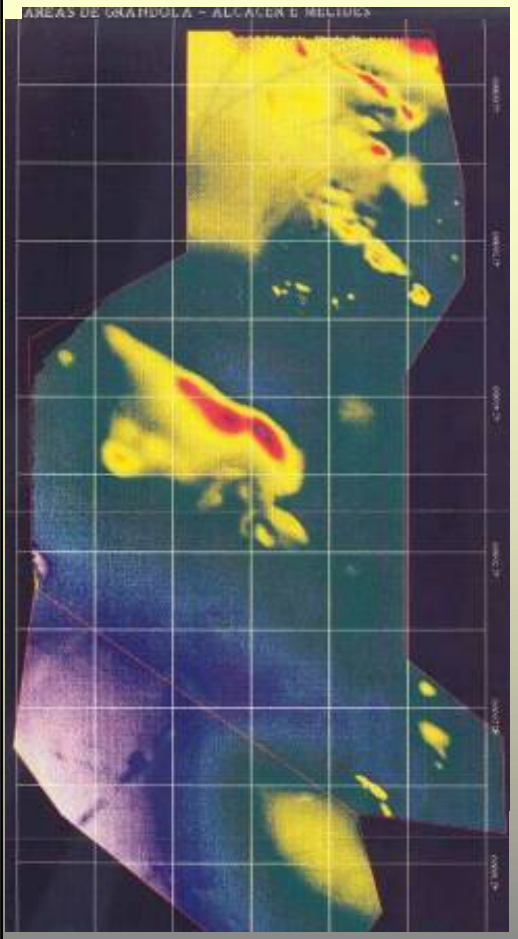
Ad. Bob Carmichael 2006

Somincor/ Lundin

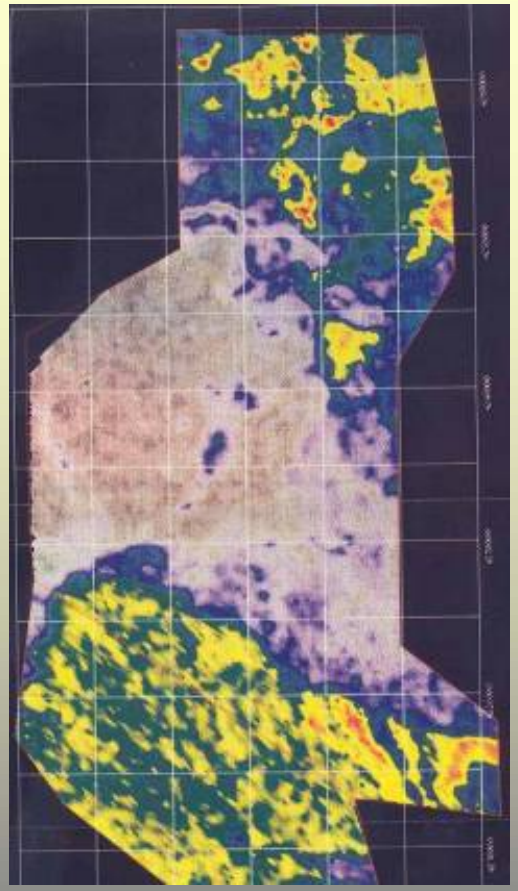
ENMR Workshop Aljustrel

Exploration potential – Neves Corvo extension





Magnetic field



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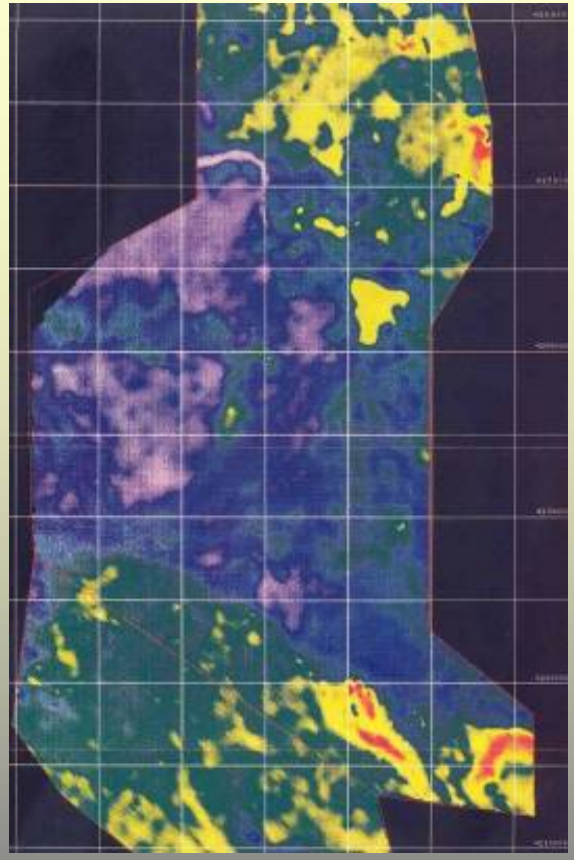

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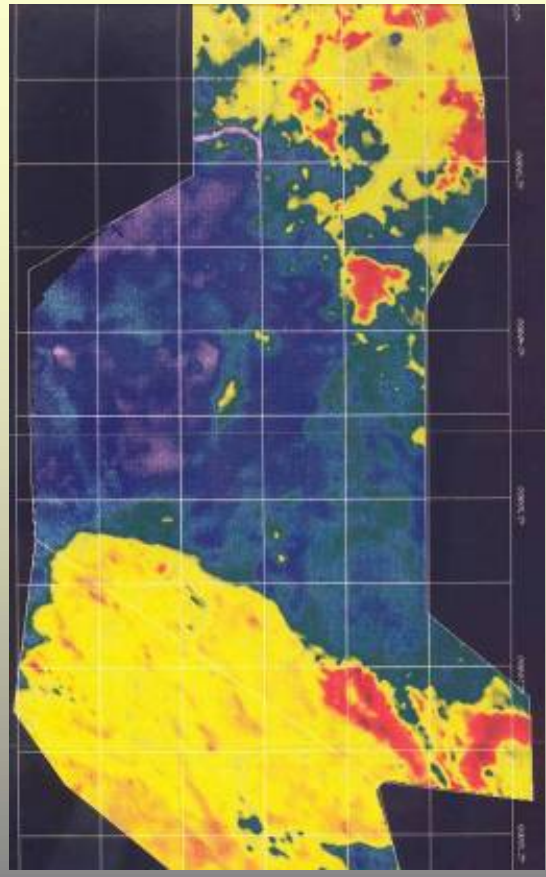
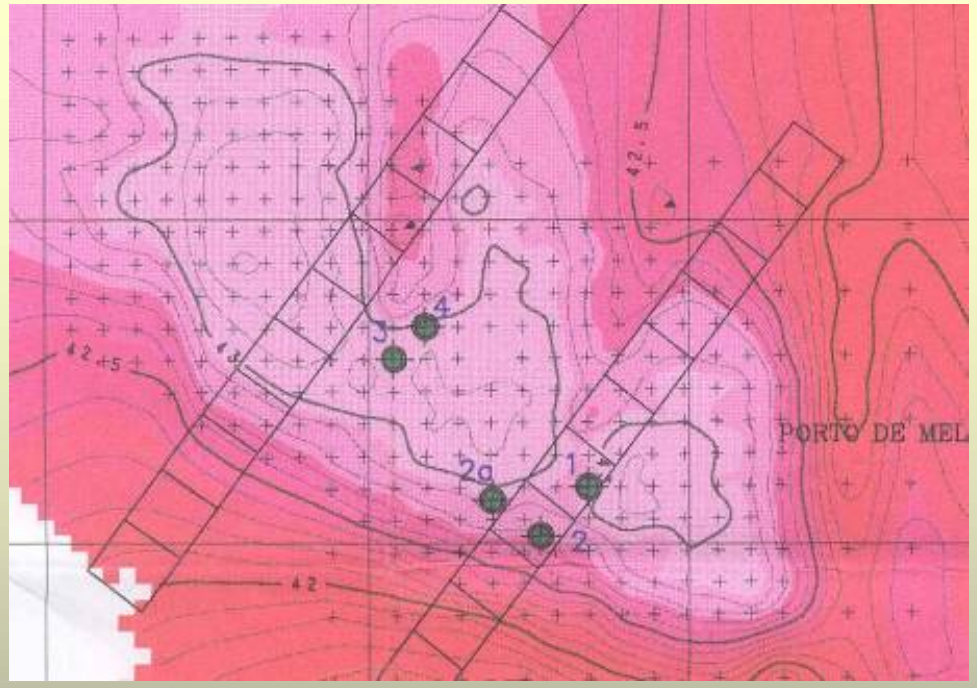
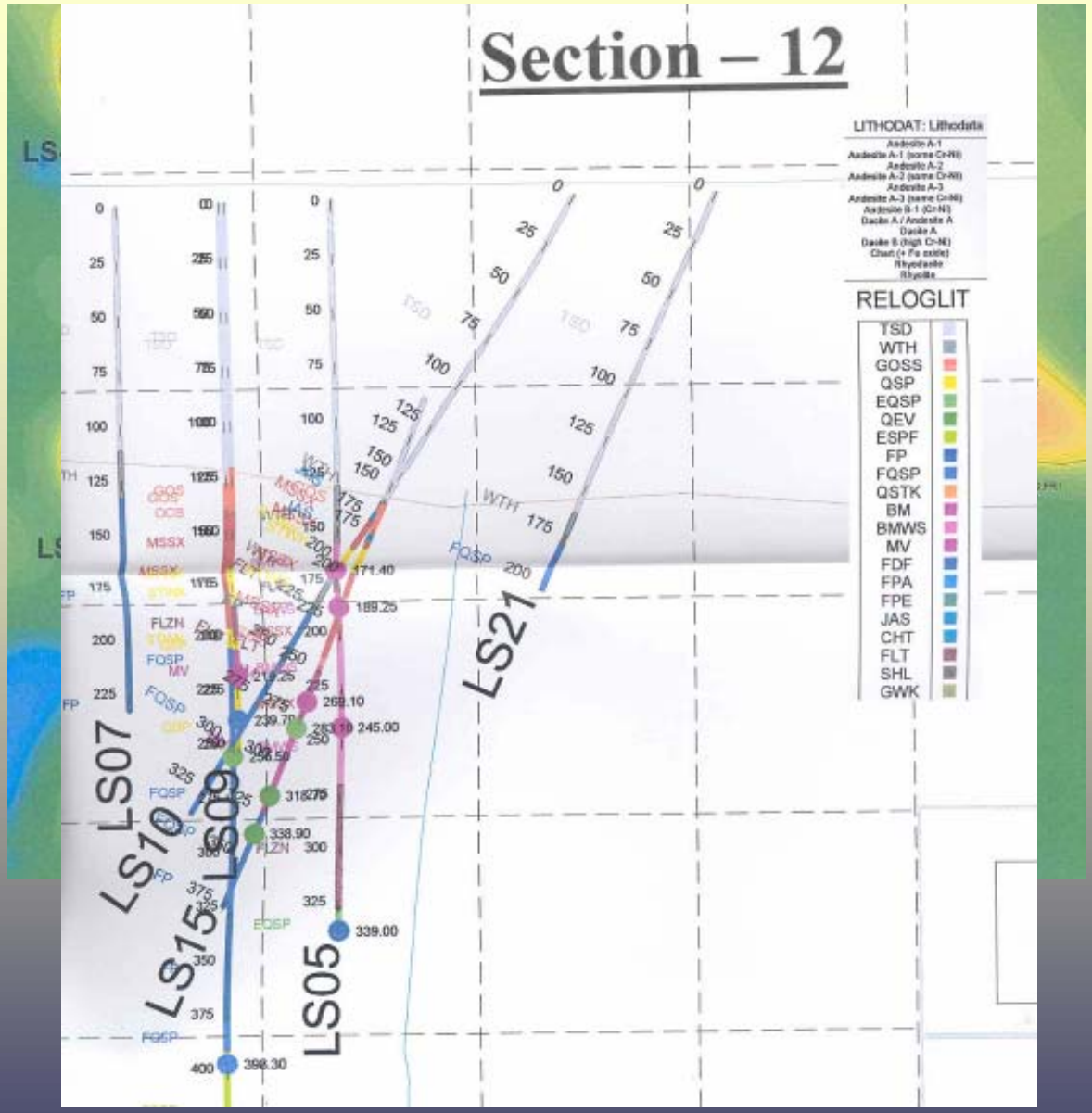


Total count

SMRA AIRBORNE SURVEY (1991)





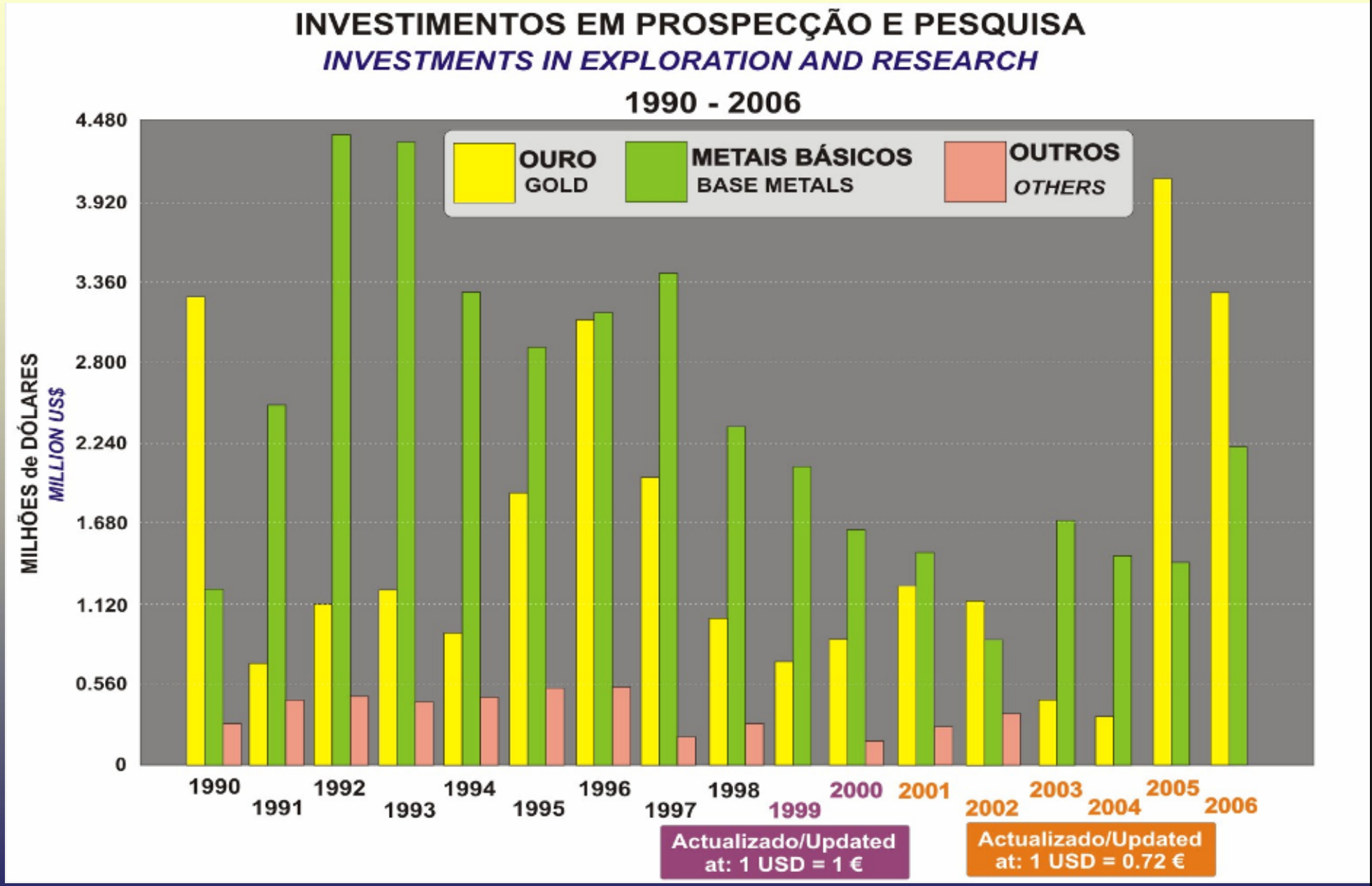
Working without geological models…

(IPB Exploration Companies Final Reports, LNEG Archives)

Exploring the IPB Portuguese Sector

Investments

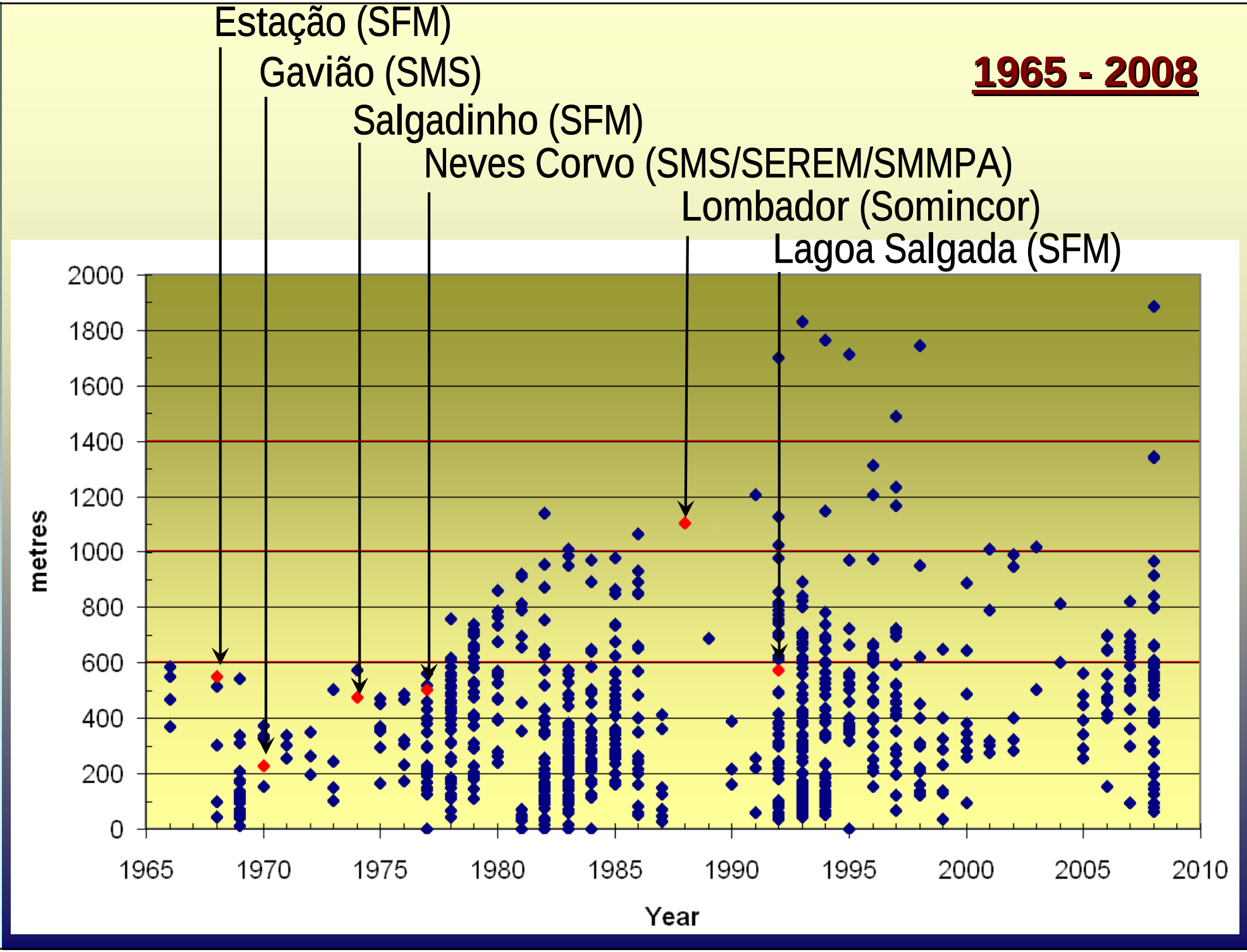
Source: DGEG 2006



Exploring the IPB Portuguese Sector

~800 Boreholes:
304km
30M€
>1400m (7)
1400-1000m (15)
1000-800m (37)
800-600m (94)
600-400m (175)
<400m (471)

Matos 2009
LNEG



Exploring the IPB Portuguese Sector

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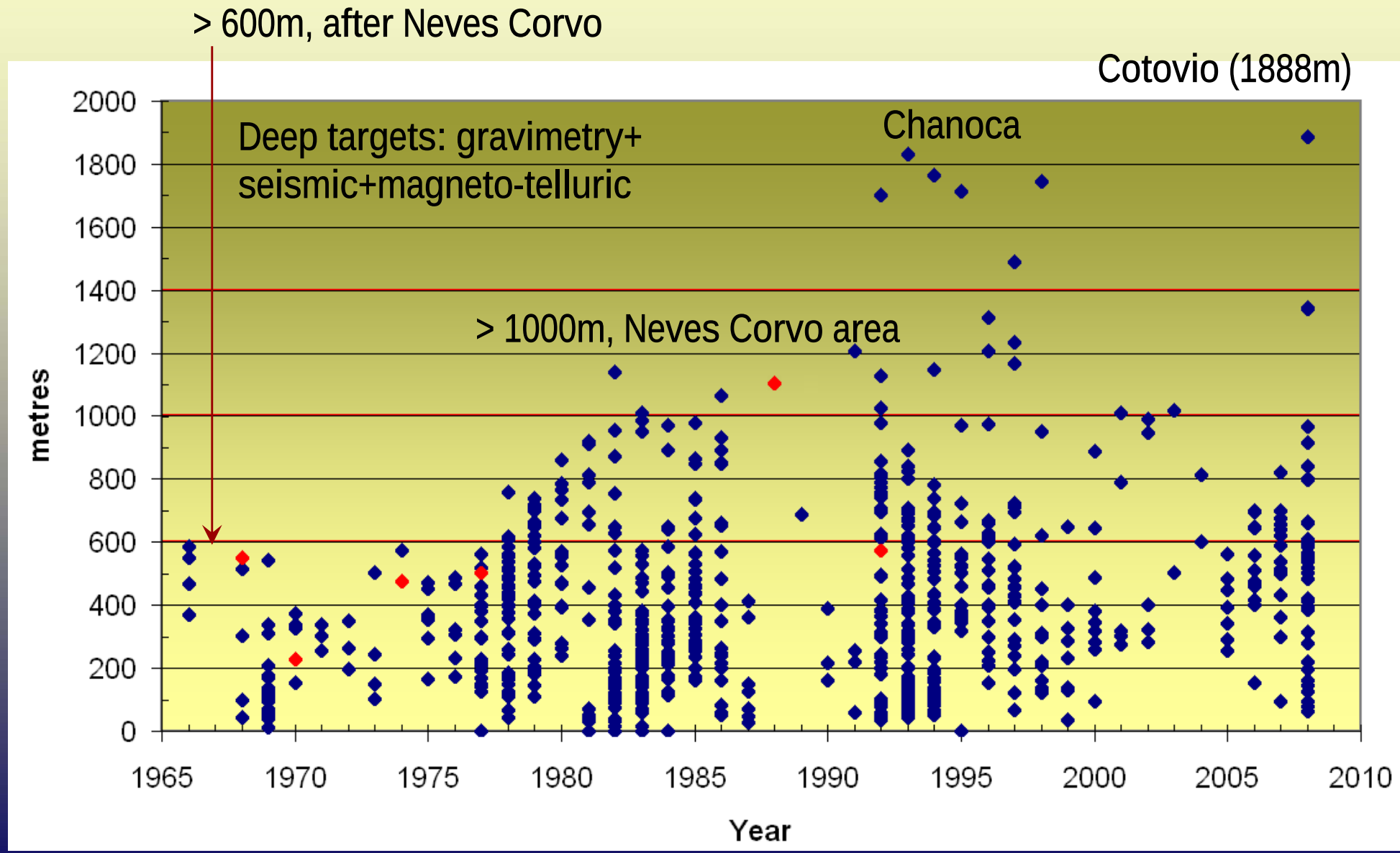
Matos 2009
LNEG

Boreholes > 1000m length: Somincor (21), Billiton (1)

1965 - 2008

Neves Corvo Lombador mining boreholes not included



Exploring the IPB Portuguese Sector

~800 Boreholes:

Area distribution

>1400m
(7)

1400-1000m
(15)

1000-800m
(37)

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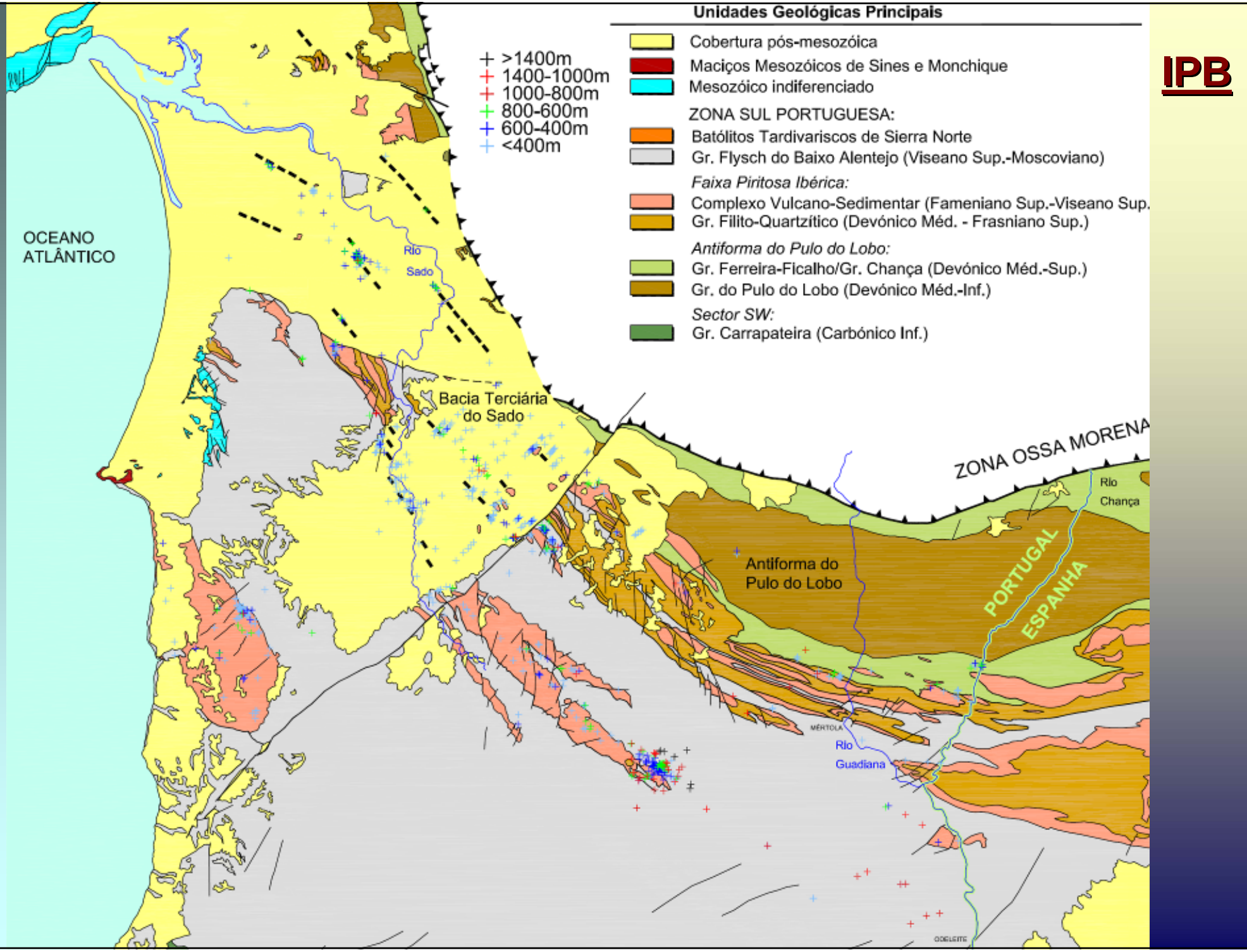
(175)

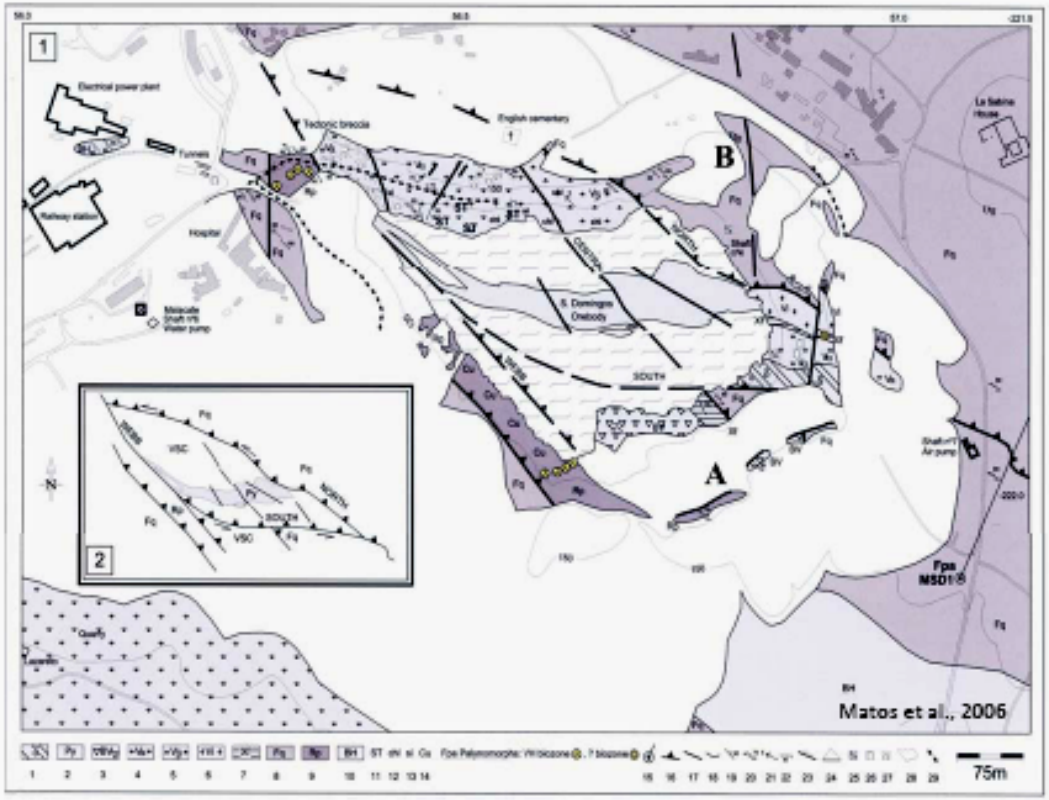
<400m
(471)

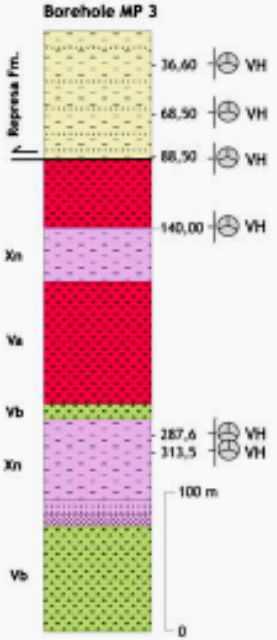
Matos 2009
LNEG

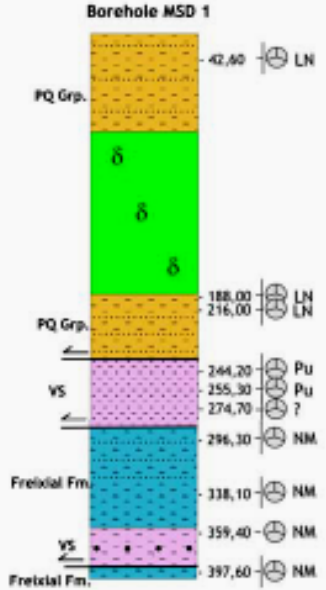


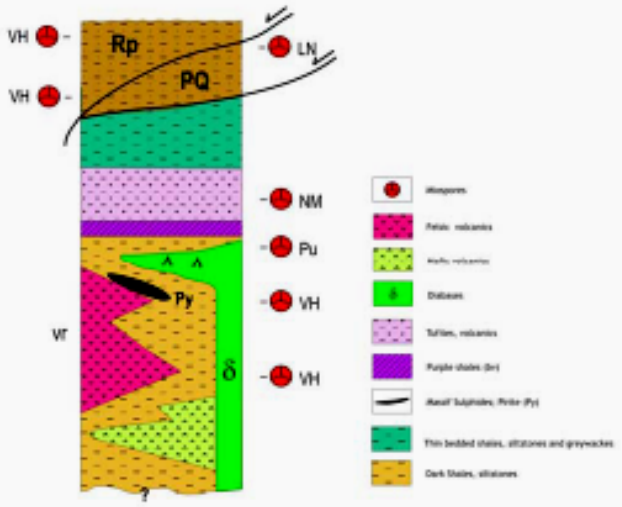
IPB

São Domingos mine region





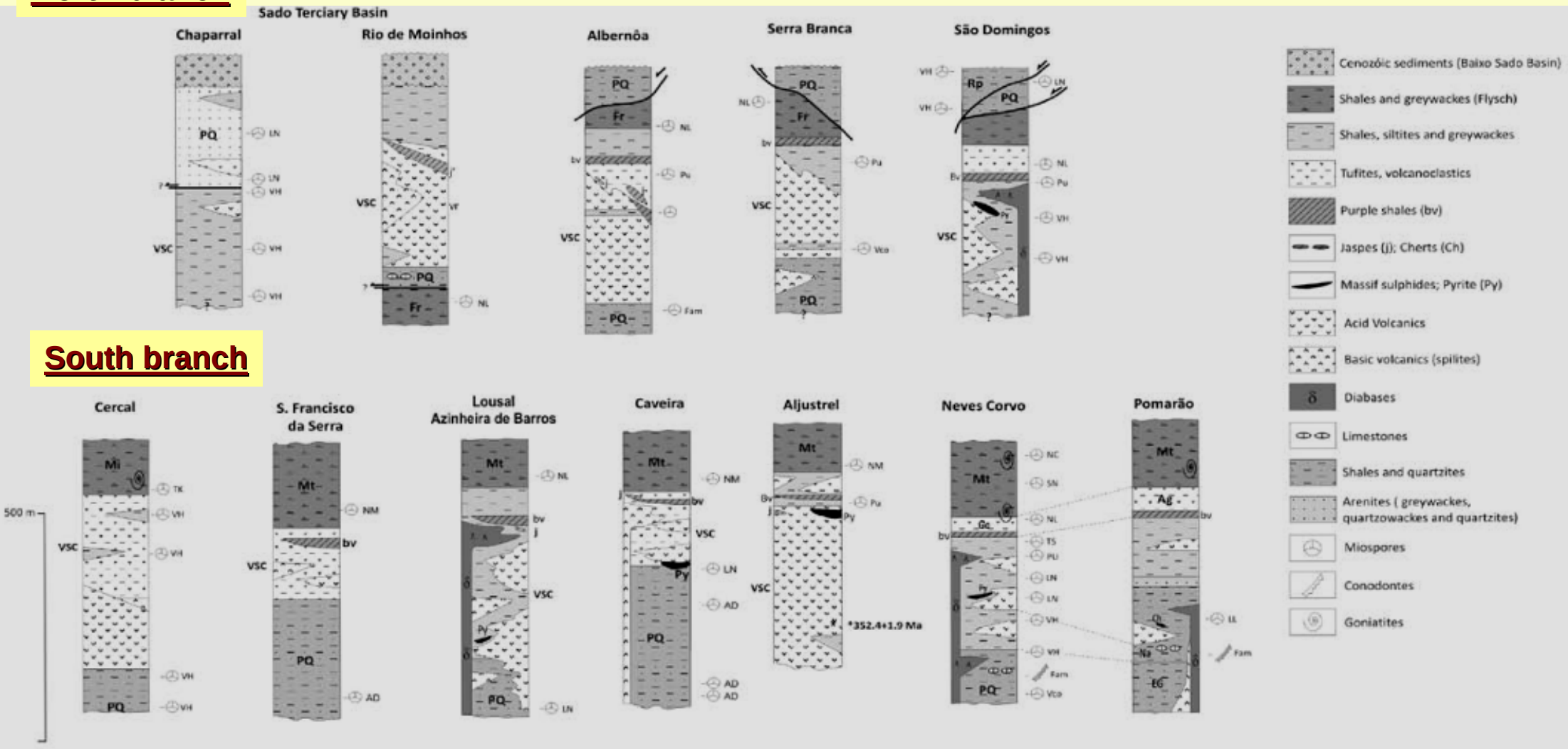




São Domingos open pit mapping and stratigraphic columns

Matos et al. 2006, Oliveira et al. 2006, Pereira et al. 2006, 2007, 2008

North branch



South branch

Fig. 6 Synthetic stratigraphic columns selected from the Pyrite Belt (adapt. OLIVEIRA et al., 2006).

IPB Stratigraphic columns Oliveira et al. 2006, Pereira et al. 2006, 2007, 2008

Conclusions – Iberian Pyrite Belt new goals:

Iberian Pyrite Belt

· 5000 Years of Mining ·

- Development of 3D **exploration geological and geophysical models** at regional and local scale, using **geological mapping**, bore-hole data, gravimetric, magnetic, radiometric and electric-magnetic data. Development of remote sensing studies;
- **Paleontological and stratigraphic study** of geological units to identify favourable age horizons;
- **Detail study of each deposit** focus on hydrothermal alteration and ore geological history favourable to metal enrichment (e.g. tectonic deformation, metal zoning, supergene alteration);
- Ore metal research (e.g. Au, Ag, In, Se, Co);
- Data integration using GIS database systems;
- Build the IPB Alentejo Region Research Centre -CEGMA