

# MINATURA 2020

Mineral Deposits of Public Importance



## Desenvolvendo o conceito suporte a um novo enquadramento Europeu para os depósitos minerais

*“Developing a concept for a European minerals deposit framework”*

- **Área temática H2020-SC5-2014** (*Growing a Low Carbon, Resource Efficient Economy with a Sustainable Supply of Raw Materials*”; *“Mineral deposits of public importance”*)
- **36 meses; 1Fev15**
- Líder: **MinPol**, Agência Internacional para a Política Mineral (Áustria)
- **Consórcio internacional de 24 parceiros de:**
  - 16 Estados-Membros da UE
    - Áustria, Bélgica, Croácia, França, Hungria, Itália, Irlanda, Países Baixos, Polónia, **Portugal**, Roménia, Eslováquia, Eslovénia, Espanha, Suécia e Reino Unido
  - 3 Estados não-membros
    - Bósnia e Herzegovina, Montenegro, Sérvia



## **Desenvolvendo o conceito suporte a um novo enquadramento Europeu para os depósitos minerais** *“Developing a concept for a European minerals deposit framework”*

- Desenvolver o conceito "Depósitos Minerais de Importância Pública" (DMIP);
- Desenvolver/testar/validar metodologia para mapeamento e subsequente salvaguarda dos DMIP, garantindo acesso aos mesmos;
- Avaliar as possibilidades e propor medidas/orientações conducentes à inclusão dos DMIP num quadro harmonizado (UE) de regulamentação;
- Desenvolver uma visão pan-europeia, incluindo nos resultados o maior número possível de situações;
- Contribuir para uma possível directiva europeia sobre DMIP.

# Main objectives – Portuguese team work

Using the internally agreed MDoPI concept as a starting point, the **main goal** is to:

- **Develop a criteria densification able to categorize mineral resources** (according to the available geological knowledge) and support a “safeguarding decision” for MDoPI mapping.

**The criteria should serve any kind of mineral resources** (from various types of ores to different sets of industrial rocks/minerals and ornamental stones).

**The criteria should also be fulfilled by the available databases** (often to much fragmented and non-harmonised).

**The criteria should be enough dynamic (flexible)**, incorporating qualitatively (or semi-quantitatively) some figures that are not currently available in a different way.

**The criteria should balance the economic, environmental and social dimensions after a previous (and independent) assessment made on the basis of geological information and knowledge.**

# Starting point

- ***MDoPI concept*** (21<sup>st</sup> January meeting):
  - ***“A mineral deposit is of public importance where information demonstrates that sustainable exploitation could provide economic, social or other benefit to the EU (or the member states or a specific region/municipality).”***
- **Databases of variable extension, covering differently exploration and exploitation results of various ores, industrial rock/minerals and ornamental stones.**
- **Quite variable perception of what should be (or not) safeguarded;** an inter-relationship between what is of public *importance* and of public *interest* should be attempted.
- **Often, the available information is limited to relatively isolated points (or small) areas scattered in a large region.** Could we interpolate this kind of information? Under what conditions?

# The Reasoning Behind the MDoPI Classification & Mapping

- Let us denote the available geological information for each “site” (from critical outcrops to mineral resources differently evaluated) as *LGK*.
- The past, on-going or foreseen exploitation could be assessed by means of a set of criteria pondering equally the economic (*Ec*), environmental (*Ev*) and social (*SDA*) dimensions.
- Therefore, a general ranking can be established by means of:

$$MDoPI_r = n LGK + m(Ec + Ev + SDA)$$

- The empirical parameters *n* and *m* are debatable, but considering that the fundamental feature is the “safeguarding for future access/use” of a mineral resource, **the *LGK* should be the prevailing factor**; thus,  $n > m$ . Furthermore, scaling the range for a maximum value of 10 and assuming  $n = 5.5$ , the resulting *m* equals 1.5. This means that in an ideal case where each factor is one (*i.e.*  $LGK = Ec = Ev = SDA = 1$ ) the relative weight of the economic (*Ec*), environmental (*Ev*) and social (*SDA*) dimensions is 4.5:

$$MDoPI_r = 5.5 + 4.5 = 10$$

which seems reasonable in comparison with the 5.5 weight of *LGK*.

# The Reasoning Behind the MDoPI Classification & Mapping

- **The first equation allows categorise the “site”** (from critical outcrops to mineral resources differently evaluated) in a scale from 1 to 10.
- **The level of geological knowledge (LGK), as well as the economic (Ec), environmental (Ev) and social (SDA) dimensions, are assessed by means of a set of independent, but complementary, criteria** (see next slides).
- Facing a MDoPI ranking list and intending a MDoPI map, the next challenge should be the **threshold**: what will be the minimum (acceptable) score to figure in the map?
- After, the challenge consists on the search for the **interpolation model**.
- **Each map produced will represent a “photogram” for each commodity or industrial rock/mineral, therefore valid for a relatively short time frame and considering the available information at a given time.** This stresses the need of recurrently re-assess the “state-of-the-art” in function of updated information.
- **Adding the MDoPI areas for relevant commodities or industrial rock/minerals existing in a given region, a bulk MINATURA map will emerge naturally following a “bottom-up” approach, i.e.** from local to national (and further to trans-national) scales.

# **SIGNIFICANTLY:**

**Exploration surveys should not be limited to areas classified as MDoPI.**

These surveys are compatible with the large majority of land uses and that restriction, not being technically defensible, is counterproductive because it prevents the test and validation of innovative models that could trigger new discoveries and increase the areas classified as MDoPI.

$$MDoPI_r = 5.5 LGK + 1.5(Ec + Ev + SDA)$$

**Level of Geological Knowledge**  $LGK = \sum_{i=1}^4 (k_i G_i) QDA$

**Economic Dimension**  $Ec = \sum_{j=1}^5 (k_j Ec_j) QDA$

**Environmental Dimension**  $Ev = \sum_{l=1}^7 (k_l Ev_l) QDA$

**Social Development & Acceptance**  $SDA = \sum_{w=1}^5 (k_w SDA_w) QDA$

**QDA (Qualitative Data Assessment):**

1.00 ← Complete and reliable

0.00 ← No data available to support a credible assessment

# Level of Geological Knowledge

$$LGK = \sum_{i=1}^4 (k_i G_i) QDA$$

**$G_1$  (Background Geological Information & Knowledge – *known or unknown mining/quarrying districts*):**

1.00: Excellent

0.75: Very Good

0.50: Good

0.25: Acceptable

$$(0.20 \times G_1) QDA$$

**$G_2$  (Regional Exploration Information & Knowledge – *poorly- to well-known mining/quarrying districts*):**

1.00: Excellent

0.75: Very Good

0.50: Good

0.25: Acceptable

$$(0.30 \times G_2) QDA$$

**$G_3$  (Past Exploitation Information & Knowledge – *known mining/quarrying districts*):**

1.00: Excellent

0.75: Very Good

0.50: Good

0.25: Acceptable

$$(0.20 \times G_3) QDA$$

**$G_4$  (Comprehensive, Up-to-Date Information & Knowledge – *single specific tract*):**

1.00: Excellent

0.75: Very Good

0.50: Good

0.25: Acceptable

$$(0.30 \times G_4) QDA$$

# Level of Geological Knowledge

$$LGK = \sum_{i=1}^4 (k_i G_i) QDA$$

$$LGK = [(0.20G_1)QDA] + [(0.30G_2)QDA] + [(0.20G_3)QDA] + [(0.30G_4)QDA]$$

**$0.75 < LGK \leq 1.00$  : Very high**  
 **$0.50 < LGK \leq 0.75$ : High**  
 **$0.25 < LGK \leq 0.50$ : Acceptable**  
 **$LGK \leq 0.25$ : Insufficient**

IDENTIFIED RESOURCES		UNDISCOVERED RESOURCES		
Demonstrated		Inferred	Probability Range	
Measured	Indicated		Hypothetical	(or) Speculative
Reserves		Inferred Reserves	+	
----- -----				
Marginal Reserves		Inferred Marginal Reserves		
----- -----			+	
Demonstrated Subeconomic Resources		Inferred Subeconomic Resources		
----- -----				

Includes nonconventional and low-grade materials

# Economic Dimension

$$Ec = \sum_{j=1}^5 (k_j Ec_j) QDA$$

*Fostering a (social & environmental) responsible mining activity*

**$Ec_1$  (Intrinsic Value of a Specific Tract, given the natural attributes):**

1.00: Very high, including CRM production (appraisal on the basis of modern feasibility studies)

0.75: High, including CRM co- or by-products (appraisal on the basis of modern feasibility studies)

0.50: Reasonable (appraisal on the basis of modern pre-feasibility studies or on old evaluations)

0.25: Minor (appraisal on the basis of modern pre-feasibility studies or of old evaluations)

$$(0.25 \times Ec_1) QDA$$

**$Ec_2$  (Mining/Quarrying Lifetime Within a Specific Tract):**

1.00: Long-term integral exploitation, minimising wastes and residues

0.75: Medium to long-term integral exploitation, minimising wastes and residues

0.50: Medium-term exploitation

0.25: Short-term (Predatory exploitation)

$$(0.20 \times Ec_2) QDA$$

**$Ec_3$  (Contribution of an Active Operation to the Added-Value Chain of Mineral Products):**

1.00: Strong articulation with an existent domestic cluster of mineral transformation/benefiting and end-products manufacturing

0.75: Moderate to acceptable articulation with an existent domestic cluster of ...

0.50: Feeble articulation with an existing (and growing) domestic cluster of ...

0.25: Lacking of articulation due to an inexistent domestic cluster of ....

$$(0.20 \times Ec_3) QDA$$

**$Ec_4$  (Relevance to Domestic Market, Reducing the EU Dependence in Mineral Imports):**

1.00: Very high

0.75: High

0.50: Moderate

0.25: Trivial

$$(0.20 \times Ec_4) QDA$$

**$Ec_5$  (Significance in Exports Trade (outside EU)):**

1.00: Very high

0.75: High

0.50: Moderate

0.25: Marginal

$$(0.15 \times Ec_5) QDA$$

## Economic Dimension

$$Ec = \sum_{j=1}^5 (k_j Ec_j) QDA$$

***Ec***

$$= [(0.25Ec_1)QDA] + [(0.20Ec_2)QDA] + [(0.20Ec_3)QDA] + [(0.20Ec_4)QDA] \\ + [(0.15Ec_5)QDA]$$

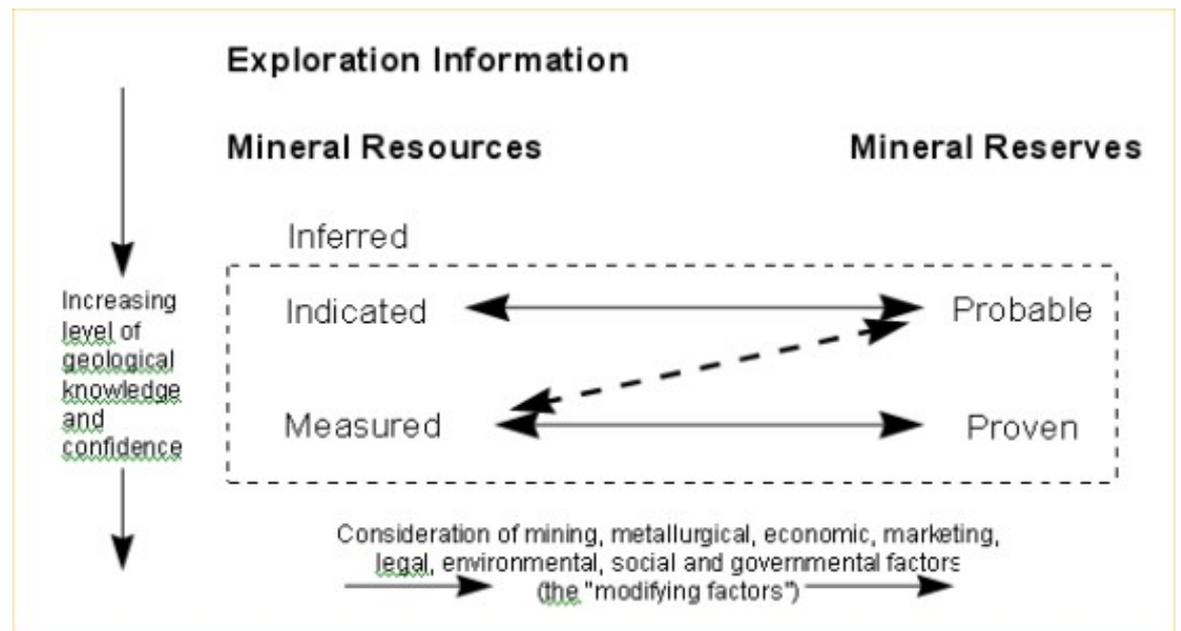
**$0.75 < Ec \leq 1.00$ : Economic, World-Class deposit, naturally noteworthy at EU scale**

**$0.50 < Ec \leq 0.75$ : Economic, of National/Regional significance**

**$0.25 < Ec \leq 0.50$ : Sub-economic to marginally economic; eventually significant at Local Level**

**$Ec \leq 0.25$ : Non-economic**

Cumulative Production	IDENTIFIED RESOURCES		UNDISCOVERED RESOURCES		
	Demonstrated		Inferred	Probability Range	
	Measured	Indicated		Hypothetical	(or) Speculative
ECONOMIC	Reserves		Inferred Reserves		
MARGINALLY ECONOMIC	Marginal Reserves		Inferred Marginal Reserves	+	
SUBECONOMIC	Demonstrated Subeconomic Resources		Inferred Subeconomic Resources	+	
Other Occurrences	Includes nonconventional and low-grade materials				



# Environmental Dimension

$$Ev = \sum_{l=1}^7 (k_l Ev_l) QDA$$

## **$Ev_1$ (Compatibility of Mining/Quarrying Operations in a Specific Tract With Other Natural Values):**

1.00: Compatible with no specific requirements besides those inherent to a responsible exploitation activity

0.75: Acceptable under conditions easily achieved

0.50: Acceptable under highly demanding conditions

0.25: Hardly compatible to incompatible

$$(0.20 \times Ev_1) QDA$$

## **$Ev_2$ (Impact of Past Exploitation Activities in a Specific Tract):**

1.00: Inexistent or negligible

0.75: Minor to moderate but chiefly overcome through natural attenuation processes

0.50: Significant but extensively minimised via well-succeeded rehabilitation programmes

0.25: Significant to severe, not satisfactorily minimised or addressed so far by any rehabilitation programme

$$(0.20 \times Ev_2) QDA$$

## **$Ev_3$ (Comparative Impact With Other Land Uses or Economic Activities (existent & projected) in a Specific Tract):**

1.00: Lower

0.75: Equivalent

0.50: Slightly higher

0.25: Clearly higher

$$(0.10 \times Ev_3) QDA$$

## **$Ev_4$ (Mining Impact OR Foreseen Disturbances in Natural Flows in a Specific Tract):**

1.00: Low

0.75: Acceptable

0.50: Moderate

0.25: Strong

$$(0.15 \times Ev_4) QDA$$

## **$Ev_5$ (On-going OR Proposed Mitigation and Rehabilitation Measures in a Specific Tract):**

1.00: Effective measures, easily implemented and of low-cost maintenance, not requiring systematic monitoring

0.75: Suitable measures but requiring large initial investments, despite of affordable maintenance/monitoring costs

0.50: Acceptable measures but demanding an expensive maintenance and long-lasting systematic monitoring

0.25: Measures of dubious efficiency

$$(0.10 \times Ev_5) QDA$$

**$Ec_6$  (Land Use for Mining & Processing in a Specific Tract):**

1.00: Underground and small-scale processing facilities

0.75: Open-pit and small-scale processing facilities

0.50: Underground and large-scale processing facilities

0.25: Open-pit and large-scale processing facilities

$$(0.15 \times Ec_2)QDA$$

**$Ec_7$  (Mining Wastes/Residues Production and Buffering in a Specific Tract):**

1.00: Small amounts duly accumulated and buffered

0.75: Acceptable amounts duly accumulated and buffered

0.50: Significant amounts acceptably accumulated and buffered

0.25: Large amounts questioningly accumulated and buffered

$$(0.10 \times Ec_4)QDA$$

## Environmental Dimension

$$Ev = \sum_{l=1}^7 (k_l Ev_l)QDA$$

**$Ev$**

$$= [(0.20Ev_1)QDA] + [(0.20Ev_2)QDA] + [(0.10Ev_3)QDA] + [(0.15Ev_4)QDA] \\ + [(0.10Ev_5)QDA] + [(0.15Ev_6)QDA] + [(0.10Ev_7)QDA]$$

**$0.75 < Ev \leq 1.00$ : Low impact & Strong Compatibility**

**$0.50 < Ev \leq 0.75$ : Acceptable impact (solved with some correction measures) & Compatibility**

**$0.25 < Ev \leq 0.50$ : Moderate impact (mitigated with significant correction measures) & Tricky Compatibility**

**$Ev \leq 0.25$ : Considerable impact (non-mitigated suitably making use of known, or proposed, technologies/methods) & Problematical Compatibility**

# Social Development & Acceptance

$$SDA = \sum_{w=1}^5 (k_w SDA_w) QDA$$

## **$SDA_1$ (Mining Acceptance):**

- 1.00: Strong
- 0.75: Moderate
- 0.50: Sceptic to Apprehensive
- 0.25: Doubtfulness to Opposition

$$(0.20 \times SDA_1) QDA$$

## **$SDA_2$ (Compatibility With Other Land Uses):**

- 1.00: Strong
- 0.75: Good
- 0.50: Acceptable
- 0.25: Hardly compatible

$$(0.15 \times SDA_2) QDA$$

## **$SDA_3$ (Impact in the Settlement & Growth of Populations):**

- 1.00: Outstanding
- 0.75: Considerable
- 0.50: Moderate
- 0.25: Inconsequential

$$(0.15 \times SDA_3) QDA$$

## **$SDA_4$ (Impact in Direct/Indirect Jobs Creation & Welfare Rise):**

- 1.00: Noteworthy
- 0.75: Large
- 0.50: Moderate
- 0.25: Trivial

$$(0.25 \times SDA_4) QDA$$

## **$SDA_5$ (Wealth Improvement & Complementary with Other Economic Sectors):**

- 1.00: Remarkable, impacting national GDP
- 0.75: Significant at regional scale
- 0.50: Enough to stimulate local development
- 0.25: Marginal impacts

$$(0.25 \times SDA_5) QDA$$

## Social Development & Acceptance

$$SDA = \sum_{w=1}^5 (k_w SDA_w) QDA$$

***SDA***

$$= [(0.20SDA_1)QDA] + [(0.15SDA_2)QDA] + [(0.15SDA_3)QDA] \\ + [(0.25SDA_4)QDA] + [(0.25SDA_5)QDA]$$

**$0.75 < SDA \leq 1.00$ : Remarkable short to long term social development & strong social acceptance**

**$0.50 < SDA \leq 0.75$ : Significant short to medium term social development & moderate social acceptance**

**$0.25 < SDA \leq 0.50$ : Moderate short to medium term social development & acceptable levels of social distrust**

**$SDA \leq 0.25$ : Irrelevant social development & strong social suspicion**

# MDoPI categorization

$$MDoPI_r = 5.5 \sum_{i=1}^4 (G_i k_i) QDA + 1.5 \left( \sum_{j=1}^5 (Ec_j k_j) QDA + \sum_{l=1}^7 (Ev_l k_l) QDA + \sum_{w=1}^5 (SDA_w k_w) QDA \right)$$

1 – Lack of enough geological knowledge to support the limitation of any specific tract

2

3

4

5

6

7

8

9

10 – Specific tracts hosting active and well-succeeded exploitations triggering high social development and low environmental impacts, deserving strong public acceptance



Where to place the threshold ?

Could be  $\geq 4$   
(consequences?)

# Defining priorities and compatibilities

Given the criteria involved in the general assessment of *Ec*, *Ev* and *SDA* dimensions, their consideration together with *LGK* allow to define (objectively) priorities about the access/use safeguarding of specific tracts scored in the interval  $4 \leq \mathbf{MDoPI}_r \leq 10$ .

This means that:

- The *LGK* dimension is **decisive** to support a accountable “safeguarding decision” on the future access to MDoPI; and
- The *Ec*, *Ev* and *SDA* dimensions are **essential** to objectively assist a verdict on “priority and compatibility with other uses” in land planning/management exercises.

Thus, a **three-level priority scheme** is proposed:

# Defining priorities and compatibilities

- **The safeguarding of specific tracts with  $MDoPI_r \geq 7$  is of first priority**, therefore justifying the primacy of mining/quarrying activities or detailed exploration surveys in that area over any other kind of land use.
- **The safeguarding of specific tracts with  $6 \leq MDoPI_r < 7$  is of second priority** and the land access/use should be preferentially, but not exclusively, assigned to exploration and/or exploitation works; alternative land uses are thus possible provided that they do not lead to partial or total sterilisation of the identified resources.
- **The safeguarding of specific tracts with  $4 \leq MDoPI_r < 6$  is of third priority** and the land access/use with different purposes should be planned and managed carefully, favouring the progression of exploration surveys whenever needed and avoiding circumstantial or long-lasting alternative land uses that can jeopardise further endeavours that may guide to viable mining/quarrying operations.

# **MDoPI mapping in Portugal; testing the *LGK***

Examined examples (so far!)

## Tungsten MDOPIr>4 | Portugal

Data Information		MDOPIr > 4	Relative Percentage
Total Mining Site Areas	385	104	27.01%

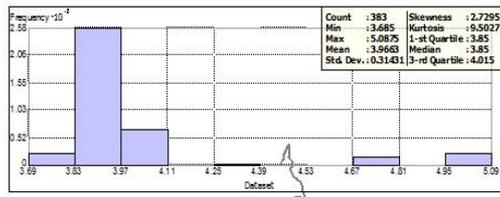
### MDOPIr\_W

- ◊ 3.69 - 3.99
- 4.00 - 5.09

### Substâncias

- |  |       |  |       |
|--|-------|--|-------|
|  | AuAgW |  | WAsAu |
|  | AuW   |  | WUAg  |
|  | BeW   |  | WBe   |
|  | PbAuW |  | WMo   |
|  | PbWSn |  | WQz   |
|  | SbWAu |  | WSbAu |
|  | Sn    |  | WSn   |
|  | SnTaW |  | WSnAg |
|  | SnW   |  | WSnBe |
|  | SnWTi |  | WSnCu |
|  | USnW  |  | WSnF  |
|  | UW    |  | WU    |
|  | W     |  | WAs   |

### MDOPIr Histogram and statistics



0 30 60 Kilometers

## Tungsten MDOPIr>4 | Portugal

Data Information		MDOPIr > 4	Relative Percentage
Total Mining Site Areas	385	104	27.01%

### MDOPIr\_W

- ◊ 3.69 - 3.99
- 4.00 - 5.09

### Substâncias

- |  |       |  |       |
|--|-------|--|-------|
|  | AuAgW |  | WAsAu |
|  | AuW   |  | WUAg  |
|  | BeW   |  | WBe   |
|  | PbAuW |  | WMo   |
|  | PbWSn |  | WQz   |
|  | SbWAu |  | WSbAu |
|  | Sn    |  | WSn   |
|  | SnTaW |  | WSnAg |
|  | SnW   |  | WSnBe |
|  | SnWTi |  | WSnCu |
|  | USnW  |  | WSnF  |
|  | UW    |  | WU    |
|  | W     |  | WAs   |

### Exploration and Exploitation Contracts since 2007

#### W ranking position in the contract

- |  |   |  |   |  |   |  |   |  |    |  |        |
|--|---|--|---|--|---|--|---|--|----|--|--------|
|  | 1 |  | 3 |  | 5 |  | 7 |  | 9  |  | not in |
|  | 2 |  | 4 |  | 6 |  | 8 |  | 14 |  | 16     |

0 30 60 Kilometers

## Tungsten Simple kriging MDOPIr | Portugal Specific Tracts (1360)



### Substâncias

- |       |       |
|-------|-------|
| AuAgW | WAsAu |
| AuW   | WAuAg |
| BeW   | WBe   |
| PbAuW | WMo   |
| PbWSn | WQz   |
| SbWAu | WSbAu |
| Sn    | WSn   |
| SnTaW | WSnAg |
| SnW   | WSnBe |
| SnWTi | WSnCu |
| USnW  | WSnF  |
| UW    | WU    |
| W     | WAs   |

### Kriging W

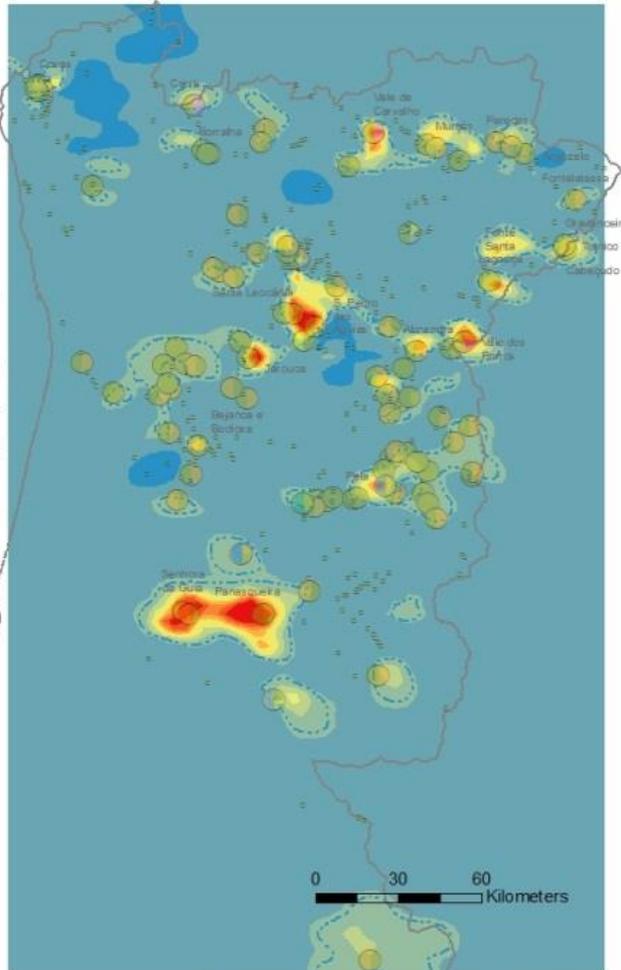
#### Prediction Map

Contour MDoPIr 4

----- 4

#### Filled Contours

- |  |                  |
|--|------------------|
|  | 3.685 - 3.82525  |
|  | 3.82525 - 3.9655 |
|  | 3.9655 - 4.10575 |
|  | 4.10575 - 4.246  |
|  | 4.246 - 4.38625  |
|  | 4.38625 - 4.5265 |
|  | 4.5265 - 4.66675 |
|  | 4.66675 - 4.807  |
|  | 4.807 - 4.94725  |
|  | 4.94725 - 5.0875 |



### MDoPIr\_W

- 3.69 - 3.99
- 4.00 - 5.09

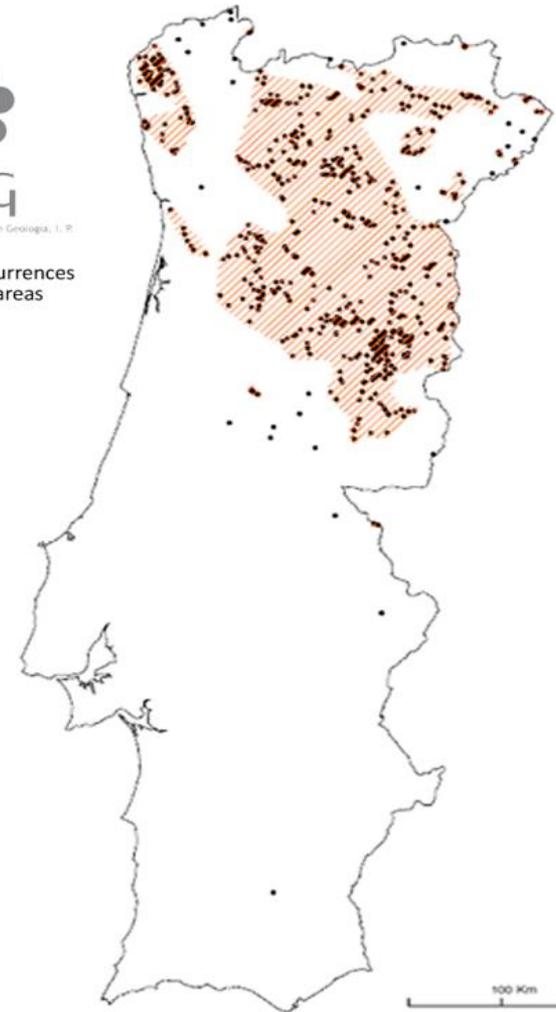
Data Information	MDoPIr > 4	Percent of MDoPIr > 4 covering Continental Portugal
Total Mining Site Areas	1360	325 7.81%



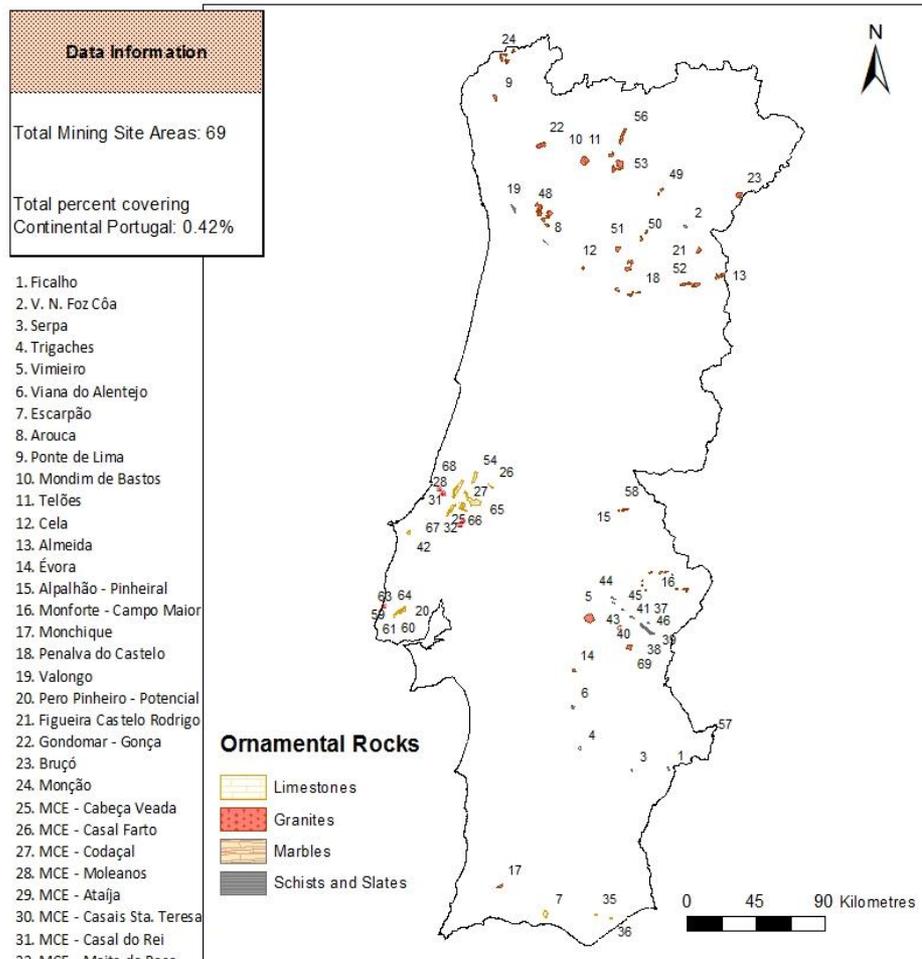
LNEG

Laboratório Nacional de Energia e Geologia, I. P.

Tungsten - Tin occurrences  
and potential areas



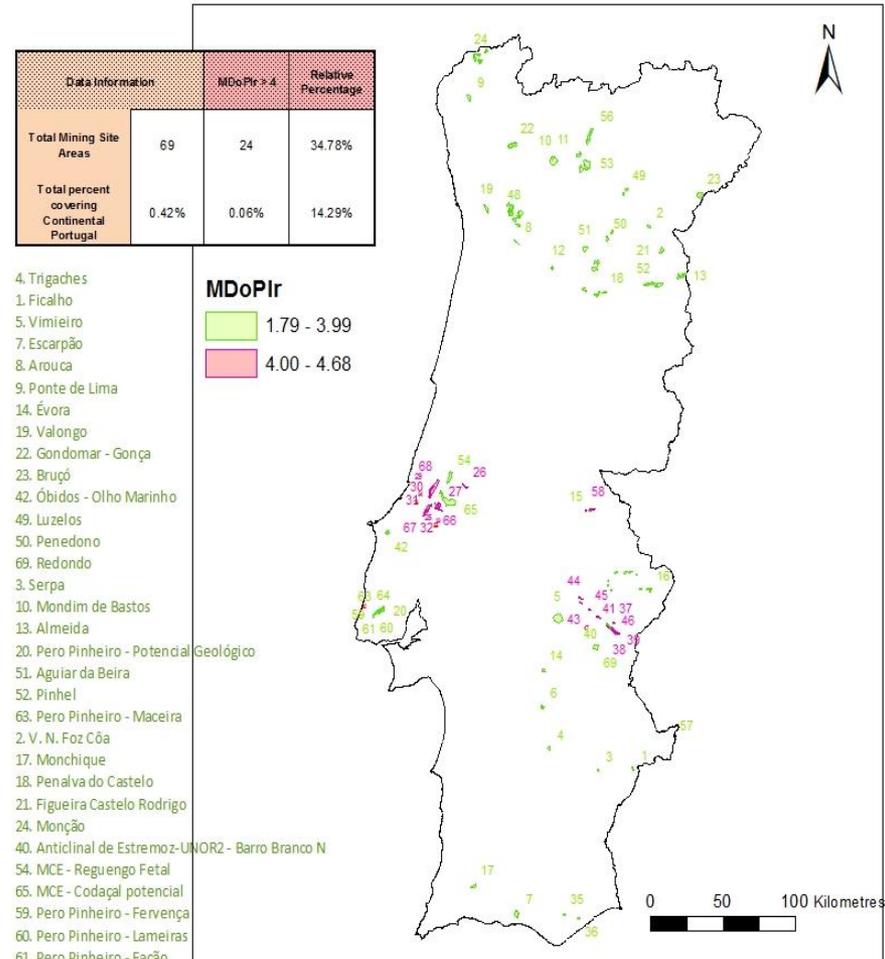
## Main Portuguese Ornamental Rocks Mining Areas



1. Ficalho
2. V. N. Foz Côa
3. Serpa
4. Trigaches
5. Vimieiro
6. Viana do Alentejo
7. Escarpão
8. Arouca
9. Ponte de Lima
10. Mondim de Bastos
11. Telões
12. Cela
13. Almeida
14. Évora
15. Alpalhão - Pinheiral
16. Monforte - Campo Maior
17. Monchique
18. Penalva do Castelo
19. Valongo
20. Pero Pinheiro - Potencial
21. Figueira Castelo Rodrigo
22. Gondomar - Gonça
23. Bruçó
24. Monção
25. MCE - Cabeça Veada
26. MCE - Casal Farto
27. MCE - Codaçal
28. MCE - Moleanos
29. MCE - Ataija
30. MCE - Casais Sta. Teresa
31. MCE - Casal do Rei
32. MCE - Moita do Poço
33. MCE - Pé da Pedreira
34. MCE - Salgueiras
35. Algarve - Mesquita
36. Algarve - Sto. Estevão
37. Anticlinal de Estremoz - UNOR2
38. Anticlinal de Estremoz - UNOR5
39. Anticlinal de Estremoz - UNOR4
40. Anticlinal de Estremoz-UNOR2 - Barro Branco N
41. Anticlinal de Estremoz-UNOR2 - Barro Branco S
42. Óbidos - Olho Marinho
43. Anticlinal de Estremoz - Sta. Vitória Ameixial
44. Anticlinal de Estremoz - Sousel
45. Anticlinal de Estremoz - Venda da Porca

46. Anticlinal de Estremoz - UNOR3
47. Anticlinal de Estremoz - UNOR1
48. Alpendorada
49. Luzelos
50. Penedono
51. Aguiar da Beira
52. Pinhel
53. Falperra
54. MCE - Reguengo Fetal
55. MCE - Covão Alto
56. Pedras Salgadas
57. Barrancos
58. Alpalhão - Potencial
59. Pero Pinheiro - Ferveença
60. Pero Pinheiro - Lameiras
61. Pero Pinheiro - Fação
62. Pero Pinheiro - P.Pinheiro Centro
63. Pero Pinheiro - Maceira
64. Pero Pinheiro - P.Pinheiro Leste
65. MCE - Codaçal potencial
66. MCE - Pé da Pedreira Potencial
67. MCE - Serra Candeeiros Sul
68. MCE - Serra Candeeiros Norte
69. Redondo

## Main Portuguese Ornamental Rocks Mining Areas by MDoPIr



4. Trigaches
1. Ficalho
5. Vimieiro
7. Escarpão
8. Arouca
9. Ponte de Lima
14. Évora
19. Valongo
22. Gondomar - Gonça
23. Bruçó
42. Óbidos - Olho Marinho
49. Luzelos
50. Penedono
69. Redondo
3. Serpa
10. Mondim de Bastos
13. Almeida
20. Pero Pinheiro - Potencial
51. Aguiar da Beira
52. Pinhel
63. Pero Pinheiro - Maceira
2. V. N. Foz Côa
17. Monchique
18. Penalva do Castelo
21. Figueira Castelo Rodrigo
24. Monção
40. Anticlinal de Estremoz-UNOR2 - Barro Branco N
54. MCE - Reguengo Fetal
65. MCE - Codaçal potencial
59. Pero Pinheiro - Ferveença
60. Pero Pinheiro - Lameiras
61. Pero Pinheiro - Fação
62. Pero Pinheiro - P.Pinheiro Centro
64. Pero Pinheiro - P.Pinheiro Leste
12. Cela
57. Barrancos
6. Viana do Alentejo
15. Alpalhão - Pinheiral
16. Monforte - Campo Maior
35. Algarve - Mesquita
36. Algarve - Sto. Estevão
11. Telões
48. Alpendorada
53. Falperra
56. Pedras Salgadas

41. Anticlinal de Estremoz-UNOR2 - Barro Branco S
43. Anticlinal de Estremoz - Sta. Vitória Ameixial
44. Anticlinal de Estremoz - Sousel
45. Anticlinal de Estremoz - Venda da Porca
55. MCE - Covão Alto
58. Alpalhão - Potencial
67. MCE - Serra Candeeiros Sul
68. MCE - Serra Candeeiros Norte
25. MCE - Cabeça Veada
26. MCE - Casal Farto
27. MCE - Codaçal
28. MCE - Moleanos
29. MCE - Ataija
30. MCE - Casais Sta. Teresa
31. MCE - Casal do Rei
32. MCE - Moita do Poço
33. MCE - Pé da Pedreira
34. MCE - Salgueiras
37. Anticlinal de Estremoz - UNOR2
38. Anticlinal de Estremoz - UNOR5
39. Anticlinal de Estremoz - UNOR4
46. Anticlinal de Estremoz - UNOR3
47. Anticlinal de Estremoz - UNOR1
66. MCE - Pé da Pedreira Potencial

# Major risks involved in the application of the $MDoPI_r$ algorithm

- **High variability of some criteria and sometimes their subjective characteristics**, in particular those depending on “market factors” (e.g. volatility of prices) or on “circumstantial political features”  
**Thus:**
  - **Available** A regular, thorough revision of the  $MDoPI_r$  scores considering up to date information should be ensured; in this respect, a triennial upgrading of MDoPI maps is highly recommended, assuming that databases will be subjected to continuous improvements.
  - **The way** Well-grounded studies about “public opinion” should also be promoted since they are a key-issue to ensure an objective appraisal of some criteria in *SDA* dimension.
- possible) launched. Instead, the application (and further refinement) of the  $MDoPI_r$  algorithm should be a matter of permanent concern of a committed and multidisciplinary-skilled team strongly connected with the group of experts responsible for the systematic upgrading of databases.

**Muchas Gracias**

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