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LNEG
Laboratório Nacional de Energia e Geologia, I. P.

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INSPIRE data harmonization of mineral resources: contribution of MINERALS4EU project

A practical example of data harmonization

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Outline

1. Introduction
2. The Project Minerals4EU
3. The EU-MKDP
4. Data harmonization of mineral resources (Portugal)
5. Minerals4EU (INSPIRE compliant) Web Feature Service implementation
6. Final considerations

1. Introduction

Why do we need mineral resources?

Mineral resources support society at different levels, depending on their technological development, and strongly impact on the economic, societal and environmental sustainability pillars.

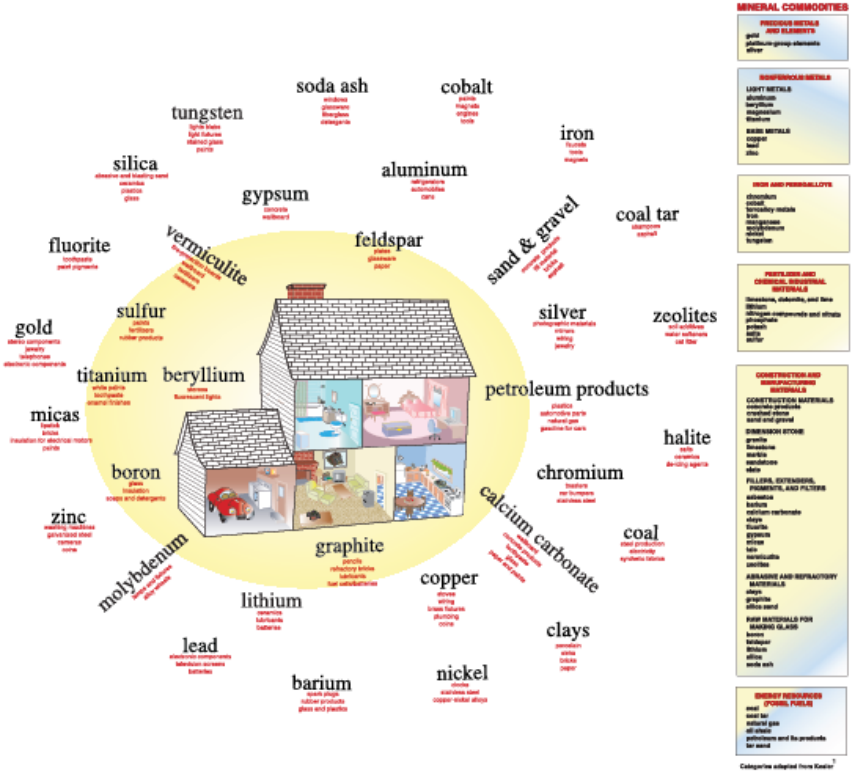


Image from: Frank, Dave, Weathers, Judy, Galloway, John, 2001, Mineral resources; out of the ground...into our daily lives: U.S. Geological Survey Open-File Report 01-360, https://pubs.usgs.gov/of/2001/0360/

For a sustainable use of mineral resources

To accomplish these goals:

- **improve** European **mineral resources knowledge base**

Stakeholder platform European Innovation Partnership on Raw Materials (**EIP RM**) was implemented

- **reduce** EU's consumption of **primary raw materials** promoting **efficient** use of the resources by the use of **secondary raw-materials** and **recycling**

Several projects developed within the EU-FP7 and EU2020 financial programs, such as **OneGeology-Europe, ProMine**, **EuroGeoSource,**……..**Minerals4EU**

- increase the networking between the national geological surveys to facilitate the **exchange of information** and improve the **interoperability** of data

Legal framework:

- INSPIRE Directive
- Raw Materials Initiative
- Mining waste directive

Main goals:

- Permanent minerals intelligence network for Europe (WP2) supplying data, information and knowledge
- Minerals Knowledge Data Platform (the EU-MKDP) and a web portal to provide geospatial harmonized data (WP5)
- European Minerals Yearbook with statistical information (WP4)
- Foresight studies related to the access to mineral deposits, recycling and efficient use of the resource and zero waste (WP6)

Two years project structured in six WPs - **LNEG** participated actively in WP4, **WP5** and WP6 - (ended on August 2015).

3. The EU-MKDP

First pan European raw materials knowledge base

Provides end-users full access to **complete information** related to the whole mineral **resources value chain**

from **primary sources** to **waste streams**, from **exploration** to **production** and **trade**, from **estimates of resource availability** to **foresight studies** on raw materials supply and demand in the EU…….

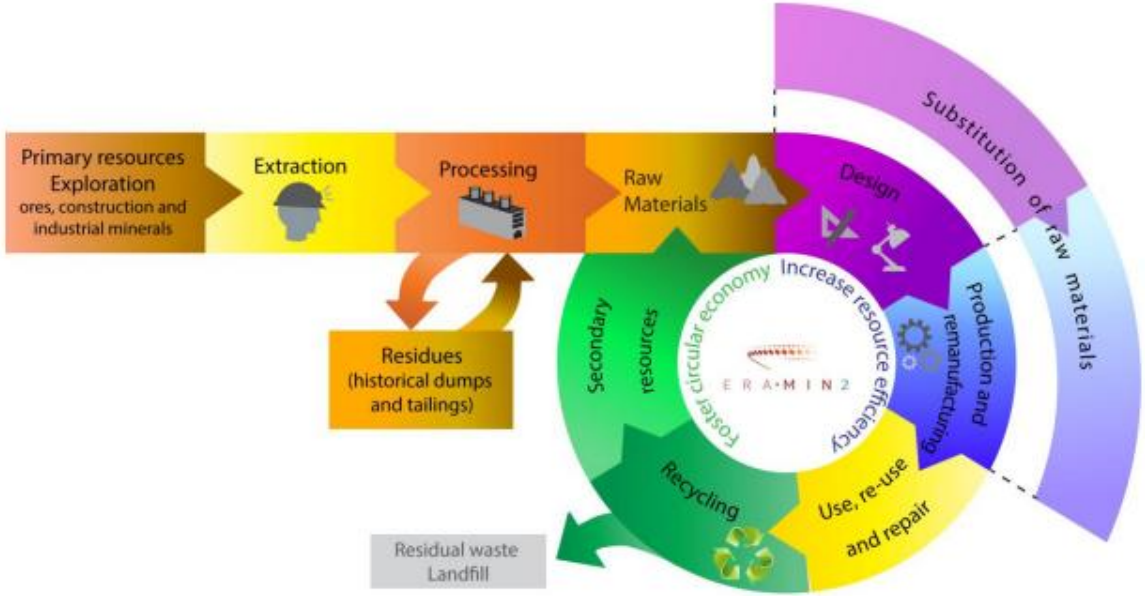


Image from https://www.era-min.eu/sites/default/files/publications/era-min_research_agenda.pdf

Cassard, D., Tertre, F., Tulstrup, J., Vuollo, J., Tomas, R., Capova, D., Sinigoj, J., Delfini C & Burlet, C. 2014. The Minerals4EU Knowledge Data Platform: implementing INSPIRE data models in the first pan-european raw materials knowledge base. INSPIRE Conference 2014. Aalborg, Denmark, 16-20 June (2014)

Based on harmonized data models and terminologies developed by the two major ongoing activities related to data interoperability:

- All the regulatory and technical framework for the construction of the Spatial Data Infrastructure in Europe (**INSPIRE**).

- IUGS - Committee for the Management and Application of Geosciences Information (IUGS-CGI) - and represented by the projects **GeoSciML** (http://www.cgi-iugs.org/tech_collaboration/geosciml.html) and **EarthResourceML** (http://www.earthresourceml.org/).

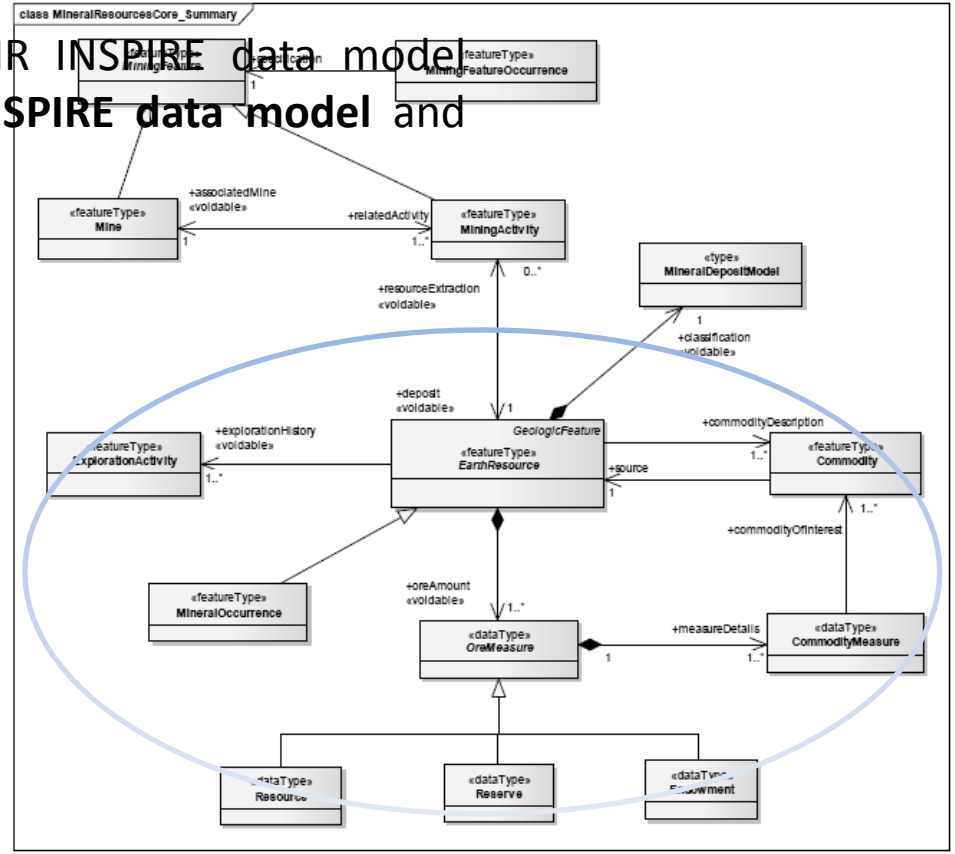
Cassard, D., Tertre, F., Tulstrup, J., Vuollo, J., Tomas, R., Capova, D., Sinigoj, J., Delfini C & Burlet, C. 2014. The Minerals4EU Knowledge Data Platform: implementing INSPIRE data models in the first pan-european raw materials knowledge base. INSPIRE Conference 2014. Aalborg, Denmark, 16-20 June (2014)
VUOLLO, J., SIMONS, B., LAXTON ,J. , CASSARD, D. and SEYMON ,A. EarthResourceML v.2.0 – an upgrade of the CGI-IUGS earth resource data model due to INSPIRE Data specification. 34th International Geological Congress 2012. Brisbane, Australia, 5-10 August (2012)

MR INSPIRE data model

The mineral resources INSPIRE data model is organized around two broad categories of information:

- the description and location of **mines** and **mining activities** and
- the description and location of **mineral resources**, including their classification, resource and reserve estimations , as well as a description of the main commodities.

❖ In the **minerals4EU data model**, the MR INSPIRE data model corresponds to the **core (mandatory) INSPIRE data model** and integrates 19 tables.



Source: D2.8.III.21 INSPIRE Data Specification on Mineral Resources – Technical Guidelines" version 3.0

EarthResourceML and GeoSciML data models

EarthResourceML describes the geological features of **mineral occurrences**

their **commodities**, **mineral resources** and **reserves**, **mines** and **mining activities**, and the production of concentrates, refined products, and **waste materials**

GeoSciML describes the **geological data**

Both standards have been used as the basis for the INSPIRE Geology/Mineral Resource core data models

In the **Minerals4EU** data model correspond to the **EarthResourceML Data Model** and **INSPIRE Extension** and cover 15 distinct tables.

- Responding to RMI and Mining Waste Directive requirements:
  - ❖ waste deposits location
  - ❖ waste material type and related environmental risks
  - ❖ type of product resulting from the mining activity
- Expanding the description of rock and mineral products (Earth material from **GeoSciML)**

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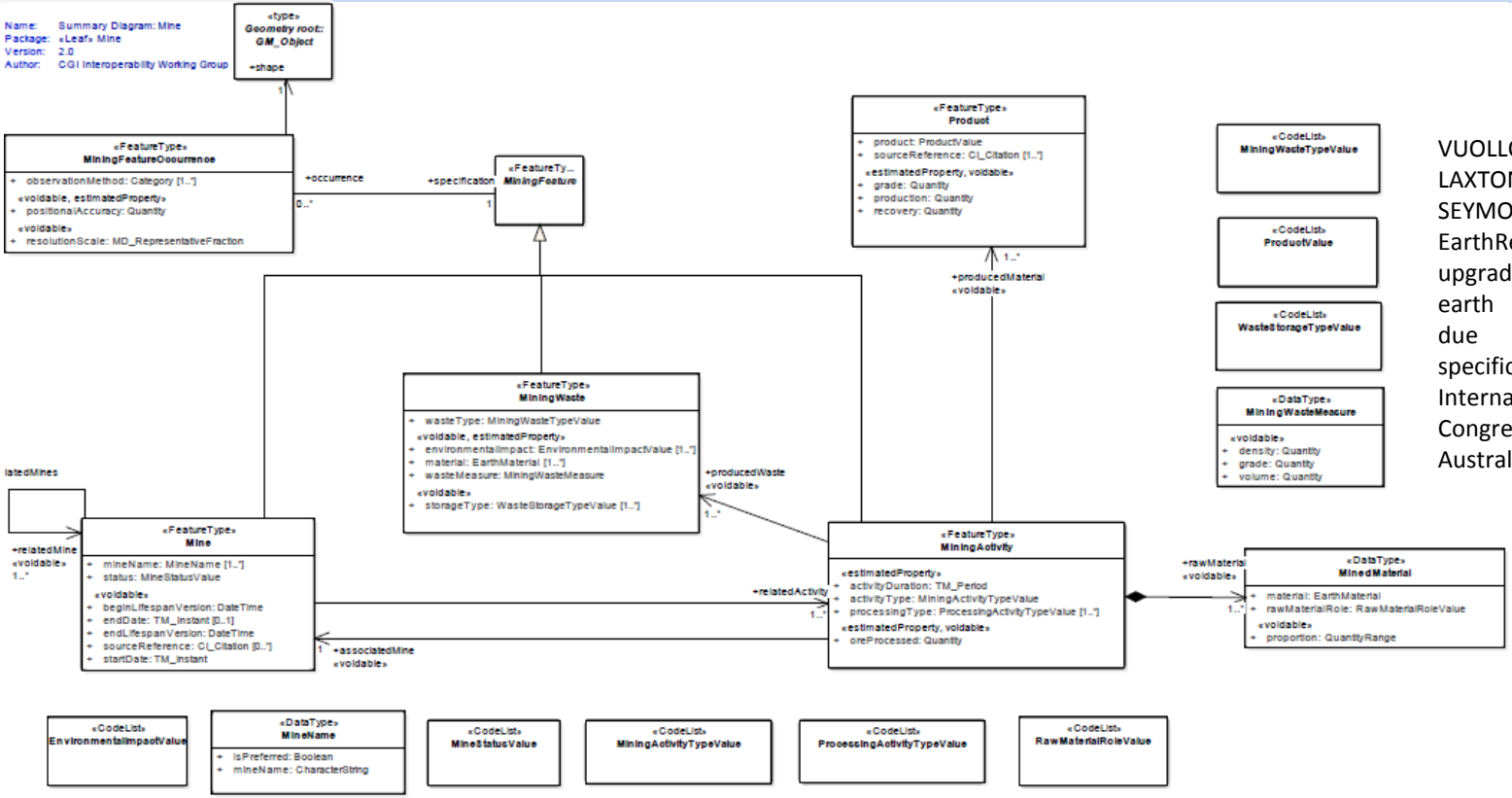
3. The EU-MKDP EarthResourceML and GeoSciML data models



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Source: Mine summary diagram from EarthResourceML version 2.0. (http://www.earthresourceml.org/)

Minerals4EU extensions

Minerals4EU extensions:
9 tables for additional information

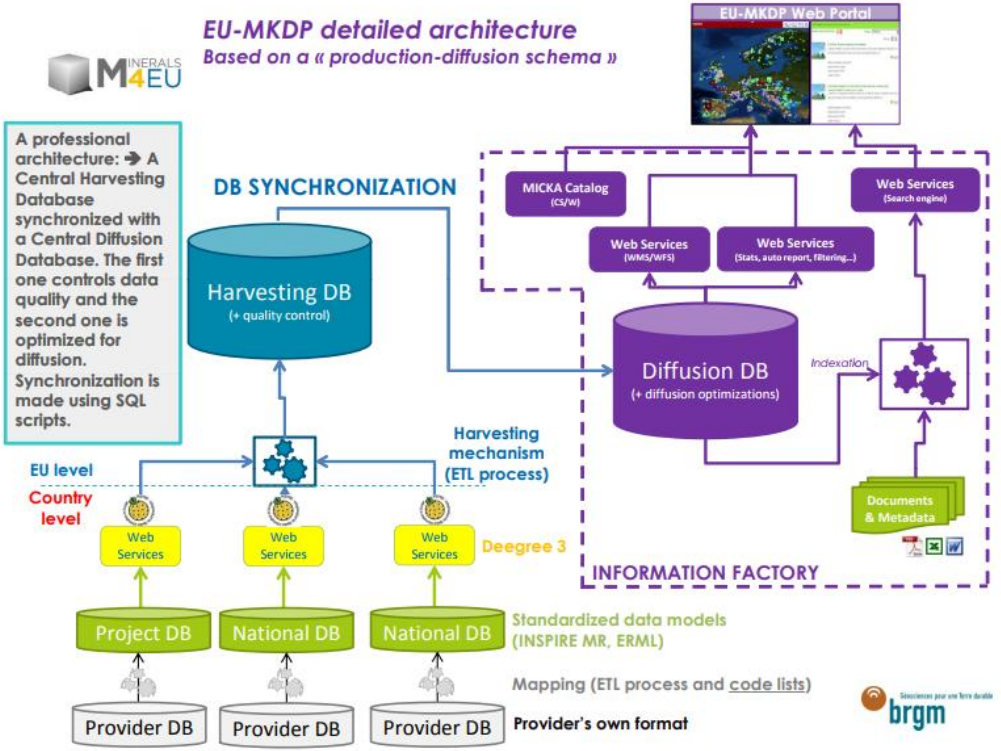
3. The EU-MKDP Distributed system architecture

Based on high-level interoperability standards was founded on the advances made in former projects - **ProMine** and **EuroGeoSource**.

1. The **national level**, from which each country provide data - a WFS INSPIRE compliant - for the Harvesting System

2. The **central Harvesting System** reads the data from WFS and stores it in the **Harvesting Database**. The data is subsequently delivered to the **Diffusion System**

3. The **Diffusion Database** is updated regularly with data from the Harvesting Database. It is optimized for diffusion of the data and for the computation of requests to the services.



Source: http://www.minerals4eu.eu/index.php/downloads/presentations Cassard, D. & Tertre, F. Work Package 5 The EU-MKDP (Minerals Knowledge Data Platform). Minerals4EU Final Conference, Brussels, Belgium, August 25, 2015

3. The EU-MKDP Vocabularies

EarthResourceML Vocabularies

Collection of terms	Concept scheme metadata	SPARQL endpoint
Commodity Code	v2016.01	sparql
Earth Resource Expression	v2016.01	sparql
Earth Resource Form	v2016.02	sparql
Earth Resource Material Role	v2016.01	sparql
Earth Resource Shape	v2016.01	sparql
End Use Potential	v2016.01	sparql
Environmental Impact	v2016.01	sparql
Exploration Activity Type	v2016.01	sparql
Exploration Result	v2016.01	sparql
Mine Status	v2016.01	sparql
Mineral Occurrence Type	v2016.01	sparql
Mining Activity	v2016.01	sparql
Processing Activity	v2016.01	sparql
Raw Material Role	v2016.01	sparql
Reporting Classification Method	v2016.01	sparql
Reserve Assessment Category	v2016.01	sparql
Resource Assessment Category	v2016.01	sparql
UNFC Code	v2016.01	sparql
Waste Storage	v2016.01	sparql

Source: http://resource.geosciml.org/

Semantic interoperability was promoted through the use of controlled vocabularies from INSPIRE Core Data Models and EarthResourceML v.2.0 model embedded in the EU-MKDP data model

Recommendations from the IUGS / CGI Geosciences Terminology Working Group (GTWG)

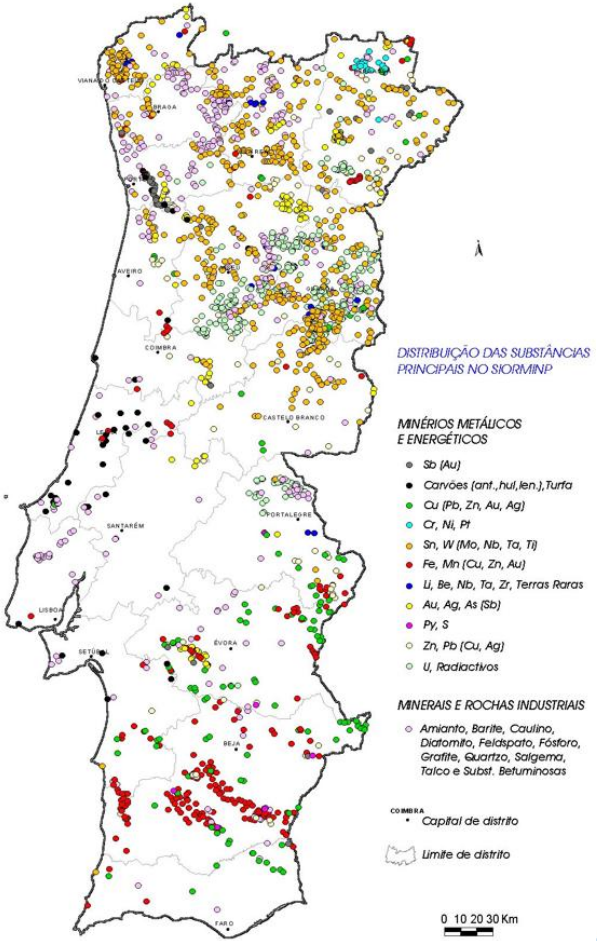
Results from **previous projects** namely **EuroGeoSource** and **ProMine**.

14 codelists from INSPIRE/EarthResourceML;
8 codelists from EarthResourceML;
1 codelist from INSPIRE,
1 codelist from EarthResourceML/Census,
1 codelist from Commission decision,
1 codelist from IMA,
4 codelists from GeoSciML and
3 codelists from INSPIRE/ GeoSciML.

VUOLLO, J., SIMONS, B., LAXTON ,J. , CASSARD, D. and SEYMON ,A. EarthResourceML v.2.0 – an upgrade of the CGI-IUGS earth resource data model due to INSPIRE Data specification. 34th International Geological Congress 2012. Brisbane, Australia, 5-10 August (2012)

4. Data harmonization of mineral resources (Portugal)

Source data: SIORMINP



Designed and created to broaden **geoscientific**, **technical** and **economic knowledge** on **mineral occurrences**, **resources** and **reserves** by:

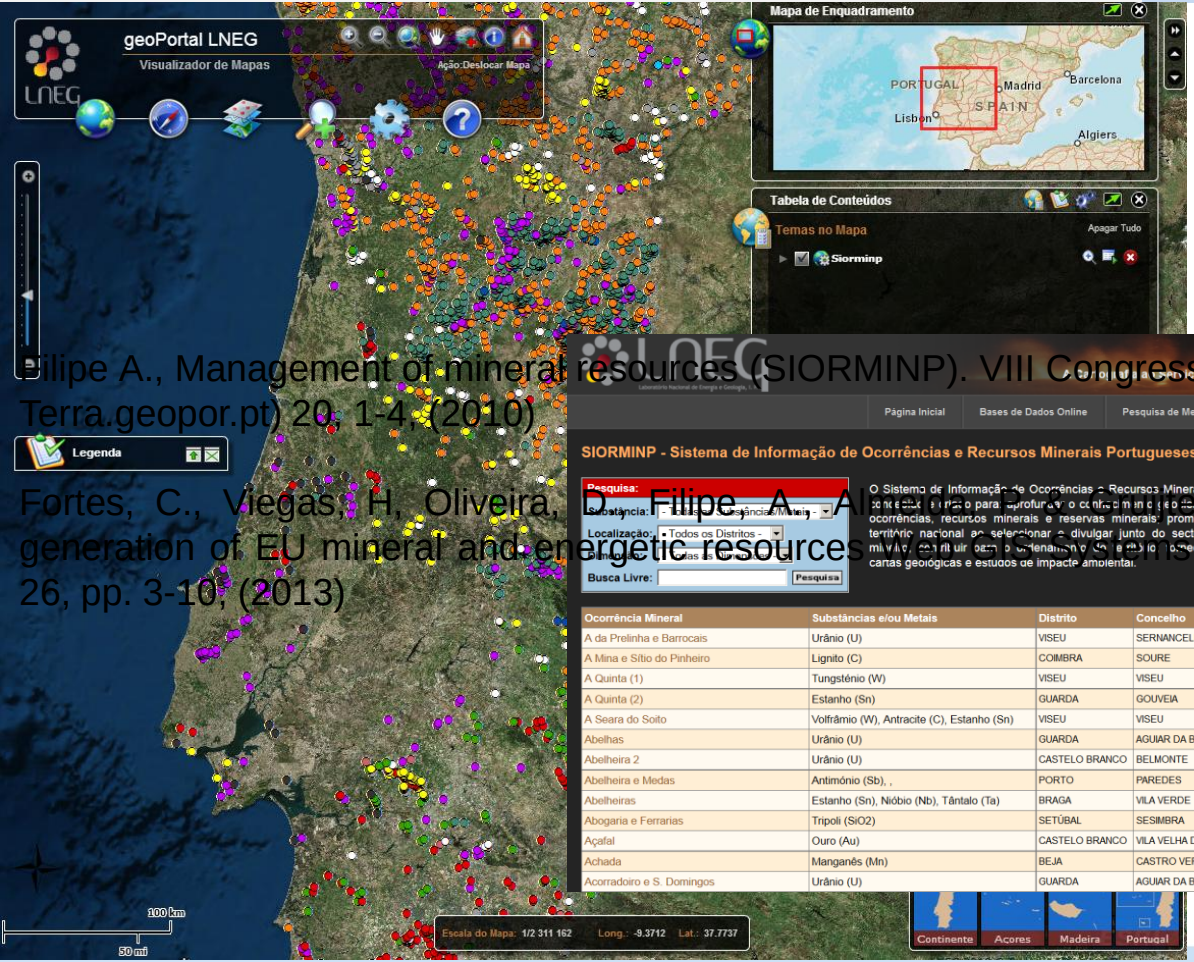
- supplying information for **geological maps**
- contributing for the **mining development** and its **sustainability**, by selecting and diffusing information regarding areas with mineral extraction potential to exploration companies
- supporting an efficient **land use planning**

SIORMINP geospatial information :

- categorization of mineral occurrences and resources
- regional and local geology
- mineralogy
- past mining licenses
- mining activity
- commodities

4. Data harmonization of mineral resources (Portugal)

SIORMINP in LNEG Geoportal



Ocorrência Mineral	Substâncias e/ou Metais	Distrito	Concelho	Categoria
A da Prelinha e Barrocais	Urânio (U)	VISEU	SERNANCELHE	Mineral não-económica
A Mina e Sítio do Pinheiro	Lignito (C)	COIMBRA	SOURE	Recurso mineral medido
A Quinta (1)	Tungsténio (W)	VISEU	VISEU	Mineral
A Quinta (2)	Estanho (Sn)	GUARDA	GOUVEIA	Mineral
A Seara do Soito	Volfrâmio (W), Antracite (C), Estanho (Sn)	VISEU	VISEU	Mineral
Abelhas	Urânio (U)	GUARDA	AGUIAR DA BEIRA	Recurso mineral medido
Abelheira 2	Urânio (U)	CASTELO BRANCO	BELMONTE	Mineral
Abelheira e Medas	Antimónio (Sb), ,	PORTO	PAREDES	Mineral
Abelheiras	Estanho (Sn), Nióbio (Nb), Tântalo (Ta)	BRAGA	VILA VERDE	Mineral
Abogaria e Ferrarias	Tripoli (SiO2)	SETÚBAL	SESIMBRA	Recurso mineral medido
Açafal	Ouro (Au)	CASTELO BRANCO	VILA VELHA DE RÓDÃO	Mineral
Achada	Manganês (Mn)	BEJA	CASTRO VERDE	Mineral
Acorradoiro e S. Domingos	Urânio (U)	GUARDA	AGUIAR DA BEIRA	Mineral

SIORMINP data has been stored in MS Access databases with own design/architecture and vocabulary, based on a **relational model** in which **each mineral occurrence or resource** is connected to a wide set of auxiliary tables

In **2009**, was **integrated** in the LNEG's **geoportal**. In **2010** a WMS was created with data from SIORMINP (http://geoportal.lneg.pt/).

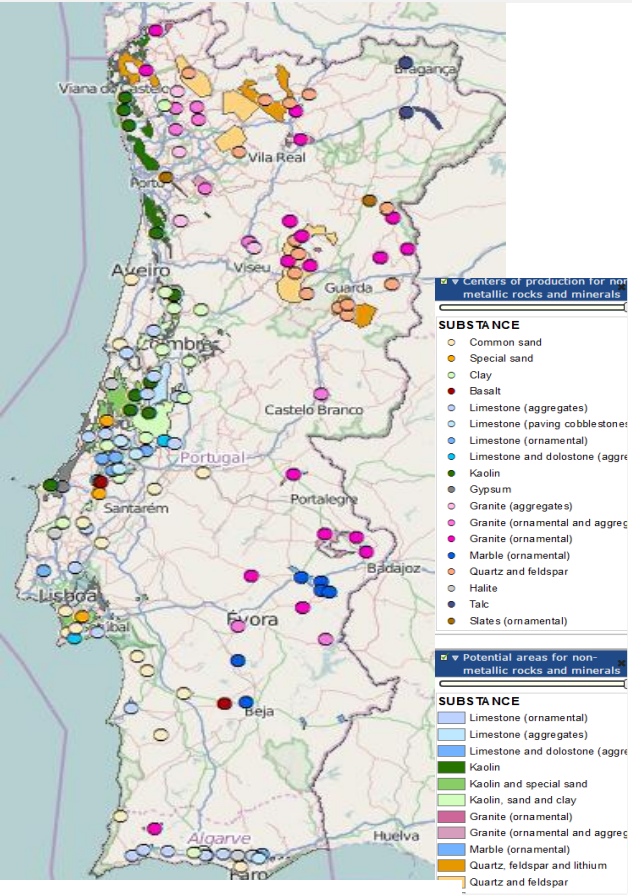
But SIORMINP database was mostly kept in MS Access.

Filipe A., Management of mineral resources (SIORMINP). VIII Congresso Nacional de Geologia e Terra (http://e-Terra.geopor.pt) 20, 1-4, (2010)

Fortes, C., Viegas, H, Oliveira, D., Filipe, A., Almeida, S., EUROGEOSOURCE - the new generation of EU mineral and energetic resources information system using cloud computing, Comunicações, nº 26, pp. 3-10, (2013)

4. Data harmonization of mineral resources (Portugal)

Source data: Previous projects



http://maps.eurogeosource.eu/

In the scope of **EuroGeoSource (EGS)** SIORMINP data was harmonized according to general rules set by the INSPIRE specifications as well as the EGS datamodel, and published using OGC compliant Web services.

Minerals4EU data model was based on **EGS** data model and vocabularies, being however much more complex.

Source data from EGS

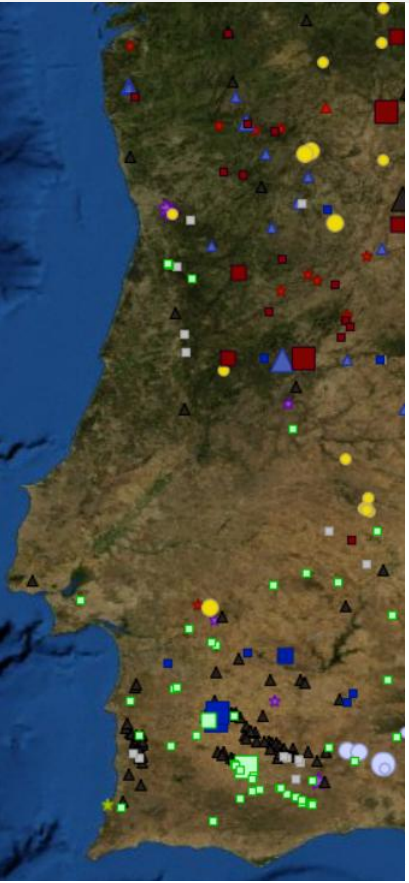
- mineral occurrences
- mines
- mining activity
- ore measure
- comodities
- earthresource material
- rock material
- mineral
- alteration description…….

Minerals4EU data model

- core INSPIRE data model
- EarthResourceML data model
- INSPIRE extension
- Minerals4EU extensions

4. Data harmonization of mineral resources (Portugal)

Source data: Previous projects



http://promine.gtk.fi/

For **ProMine** data from SIORMINP was harmonized to fulfill the requirements of the project that developed the first pan-European GIS-based database containing the known and predicted metalliferous and non-metalliferous resources (primary and secondary) of the EU.

Minerals4EU data model was based on **ProMine** data model and vocabularies to cover the requirements of Raw Materials Initiative and Mining Waste Directive .

Source data from ProMine

- mining wastes
- waste type
- wastestoragetype
- environmental impact.
- mining activity

Minerals4EU data model

- EarthResourceML data model
- INSPIRE extension

First step: accurate analysis of Minerals4EU datamodel and vocabularies (codelists)

Second step: identification of matching tables and fields within Minerals4EU data model and source data from former Eurogeosource and ProMine projects (INSPIRE compliants)

Three distinct situations were identified:

i) a **complete match** between INSPIRE codelists - **no need for further reclassification**

ii) a **partial match** - **partial need for reclassification**

iii) **no match** with CGI codelists - **need for reclassification**

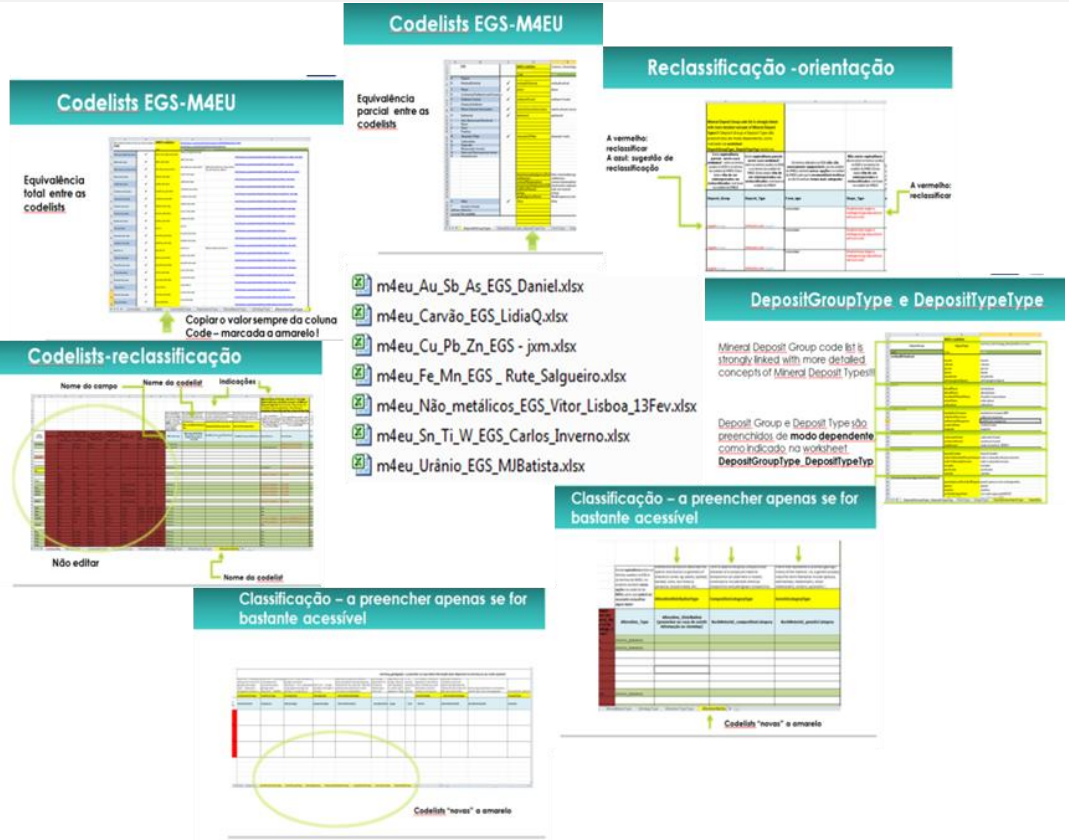
To be done by: Mineral resources experts

iv) classification of "new" data

- Data information from previous projects and SIORMINP was verified using excel files. No automatic transformation was applied.

4. Data harmonization of mineral resources (Portugal)

Reclassification and new data acquisition



Some excel files were distributed - by groups of substances - to the mineral resource experts.

- indicating which fields should be filled in for classification, which fields should be reclassified, which codelists should be used and contained some guidelines according to the project specifications, like classification of absent values into - “Unknown”, “Unpopulated” or “Withheld.

These files had already been created for the EuroGeoSource project and have been improved, updated and adapted to the Minerals4EU model.

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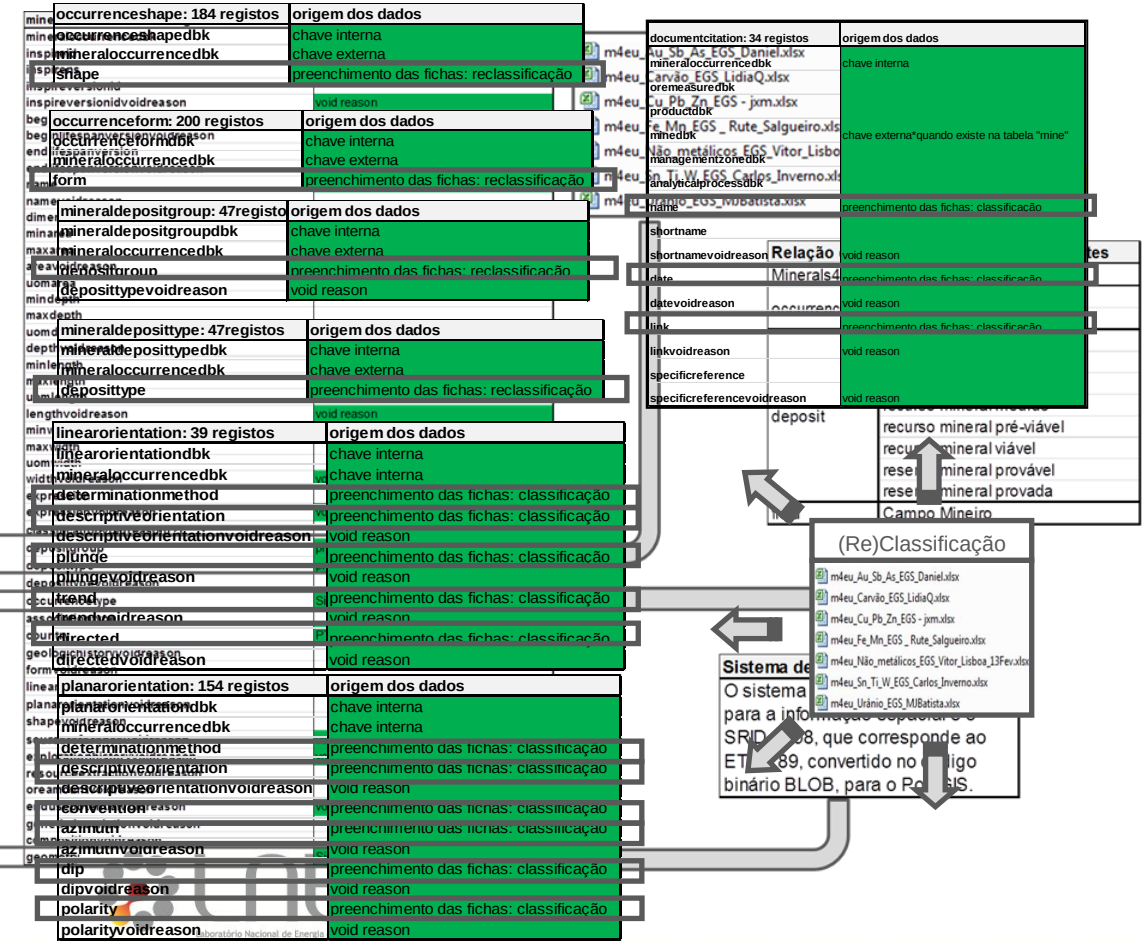
4. Data harmonization of mineral resources (Portugal)

Pratical examples….deposit group

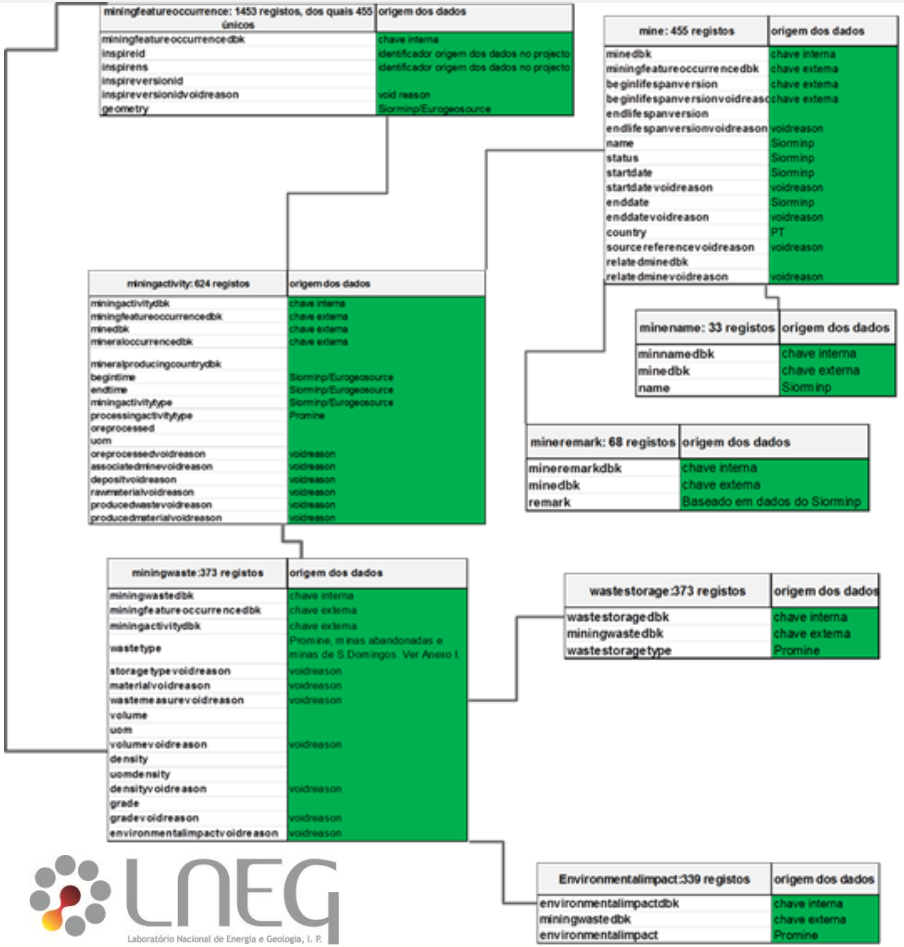


In general, classification very conditioned by the codelists … and many times leading to (too much) generic options.

- “deposit group” or/and “deposit type” codelists insufficiently comprehensive to describe correctly Fe-Mn deposits and kaolin deposits.

4. Data harmonization of mineral resources (Portugal)

Pratical examples….mining activity



- “mining activity” codelist insufficiently comprehensive not embracing hybrid classifications - open-sky and undergroung mining activity in the same mine.

- constraints within “miningactivity”, “mine” and “miningwaste" tables that require the "miningfeatureoccurrence“ identifier to be unique (geometry data).

Led to duplication of geometries

Geometry is represented in "mineraloccurrence" and "miningfeatureoccurrence“ and corresponds to the points of SIORMINP, which in turn represent centroids of mining concession areas. Reference system SRID 4258.

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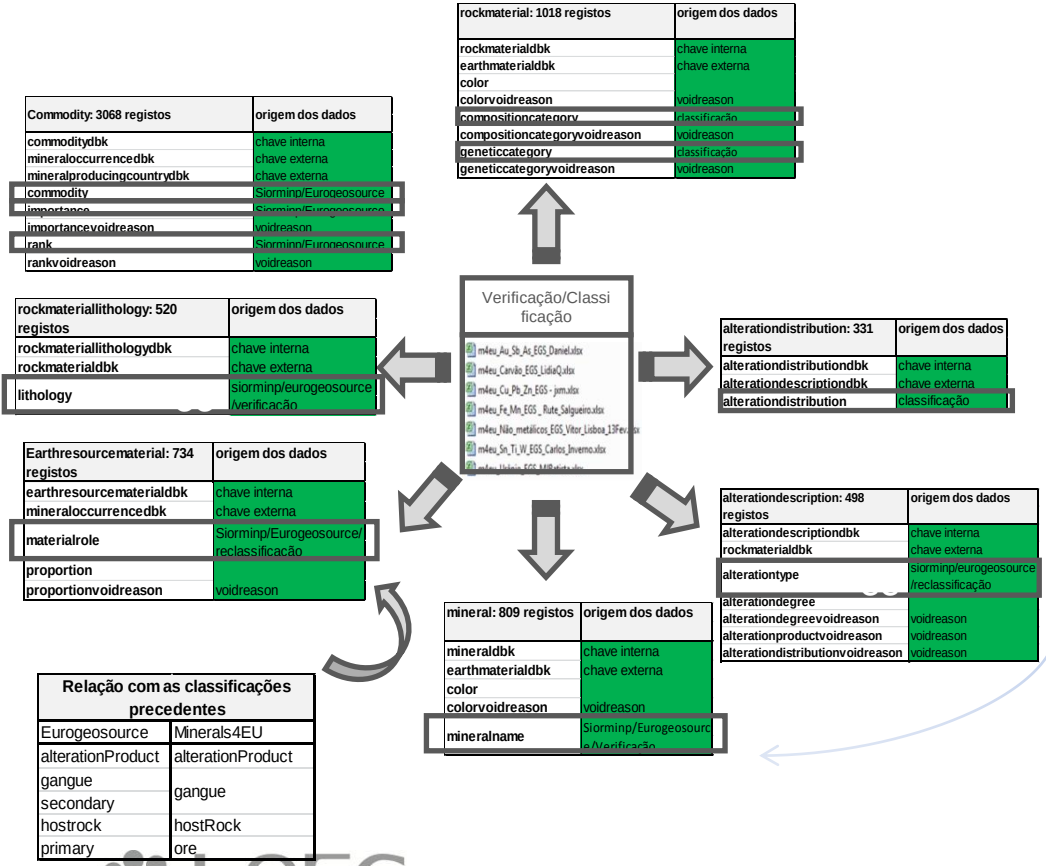
4. Data harmonization of mineral resources (Portugal)



Pratical examples….mineral

"earthresourcematerial" and - "earthmaterial" contain information about the rocks and minerals associated with the mineral occurrence.

Regarding Minerals, codelist from IMA is too specific……no option representing "mineral groups" was available…… widely used in our data.

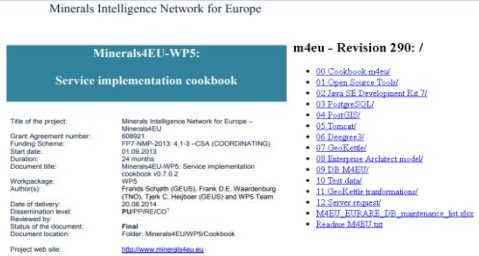
Led to forced classification: Tourmaline (schrol); Feldspar (albite); Apatite (fluorapatite); Mica (muscovite); Chlorite (clinochlore); Amphibole (ferrohornblende) and Carbonates (calcite).

5. Minerals4EU (INSPIRE compliant) Web Feature Service implementation

Loading data and publishing WFS

1. Creation of a virtual machine

2. Installation of the software stack following the cookbooks, software and scripts from the project.



http://http://data.geus.dk/svn/m4eu/

- PostgreSQL to implement the relational database;
- PostGIS for spatial objects support
- Apache Tomcat and Deegree to implement the WFS

3. Configuration of the PostgreSQL Web Feature Database

- SQL script files defining the Minerals4EU relational database model as **tables**, **views** and **codelists**.
- Degree Minerals4EU mapping file which describes how database tables are transformed to Minerals4EU GML.

4. Configuration of the Web Feature Server

5. Loading data into PostgreSQL database

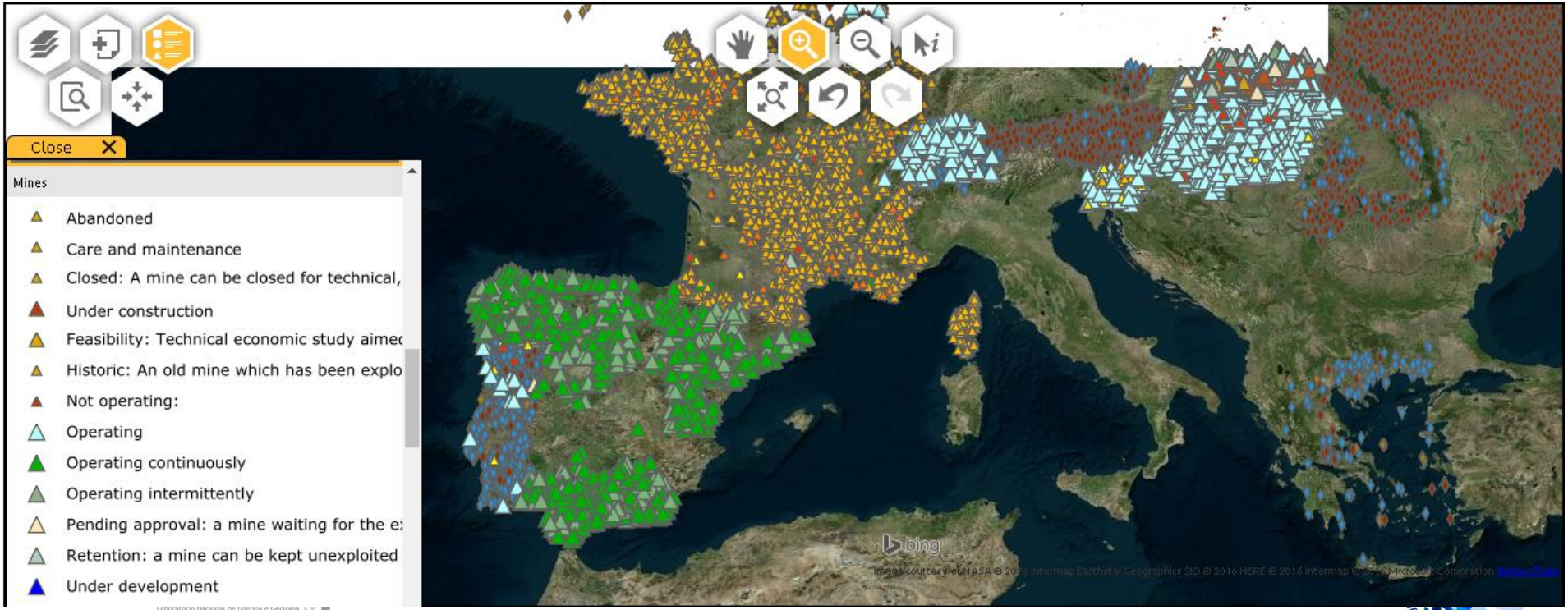
Running SQL scripts after compilation all xls tables with the harmonized data.

5. Minerals4EU (INSPIRE compliant) Web Feature Service implementation

Minerals4EU Portal

http://minerals4eu.brgm-rec.fr/minerals4EU/

HOME DATA SEARCH MAP VIEWER METADATA CATALOG YEARBOOK



Transformed and harmonized dataset from EuroGeoSource and Minerals4EU have been kept in virtual machines, serving the data for the respective projects within the respective datamodels and specifications.

Some actions are being currently undertaken in order to make this harmonised dataset available in LNEG's web portal, representing the **Mineral Resources INSPIRE-compliant dataset**.

Within these actions, the **harmonised dataset from Minerals4EU project** have been loaded into an **ESRI INSPIRE-compliant geodatabase** and will be published in the LNEG Portal in the near future…….

Thank you for your attention!