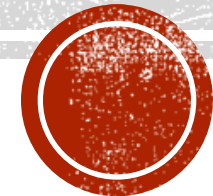


MICA ONTOLOGIES, METADATA, TRIPLESTORE, AND DDG: AN OVERVIEW

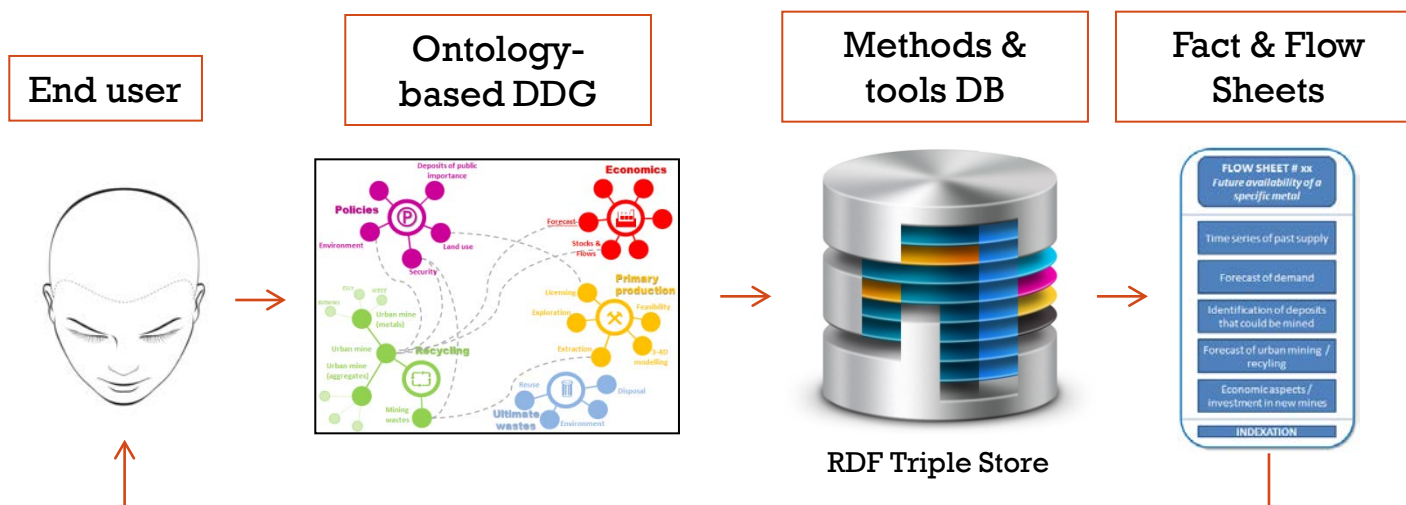
WP6: The European Raw Materials Intelligence
Capacity Platform (EU-RMICP)





- **The MICA Main Ontology from a thematic point of view and associated ontologies (BRGM), and the metadata related to data sources (BGS)**
- **The WP6 Fact/Doc/DefSheet production and supervision (BRGM/GTK),**
- **The MICA ontologies from a technical point of view (LIG), and the TripleStore development = the database for Methods and tools descriptions (GEUS)**
- **The Dynamic Decision Graph (DDG) and the navigation/visualization interface (JRC)**

- **The Main ontology:**
- In MICA, the **Main Multidimensional Ontology**, represents the **Domain of questions** an end user may have about Mineral resources / Raw materials.
- It is used for supporting a Dynamic Decision Graph (DDG) which allows the end user to navigate & visualize the database content and the relationships between the different techniques, and to search for the most appropriate method(s) and tool(s) to use for resolving his problem.



- A reminder about ontologies

An ontology allows specifying in a formal language (machine understandable) the concepts of a domain of interest and their relationships.

(A conceptualization being an abstract, simplified view of the world that we wish to represent for some purpose).

- The development of the Main ontology

- Based on the results of the WP2 workshop in Copenhagen related to the possible end-users questions (Expert vision);
- Exploitation by BGS of this survey: 'Mapping of WP2 questions to WP3 topics' and set up of a first list of DOMAINS of interest;
- Further exploitation by BRGM in collaboration with all WPs: redefinition of domains and distinction between concepts and data, definition of the perimeter (first approach) and of the granularity (several sub-concepts levels)... Characterization of the relations between domains, concepts and sub-concepts (collaboration with LIQ)...;
- Development of more generic, transversal ontologies (Space and time, the 'Law', Commodities, Value supply chain);
- First identification of the FactSheets to develop – in addition to WP4 production – and the introduction of the DocSheet/DefSheet concepts.

- **The Main ontology:**

Covers 8 domains:

D1 PRIMARY RESOURCES

D2 SECONDARY RESOURCES

D3 INDUSTRIAL PROCESSING AND TRANSFORMATION

D4 RAW MATERIALS ECONOMICS

D5 CRITICAL RAW MATERIALS

D6 RAW MATERIALS POLICY & LEGAL FRAMEWORK

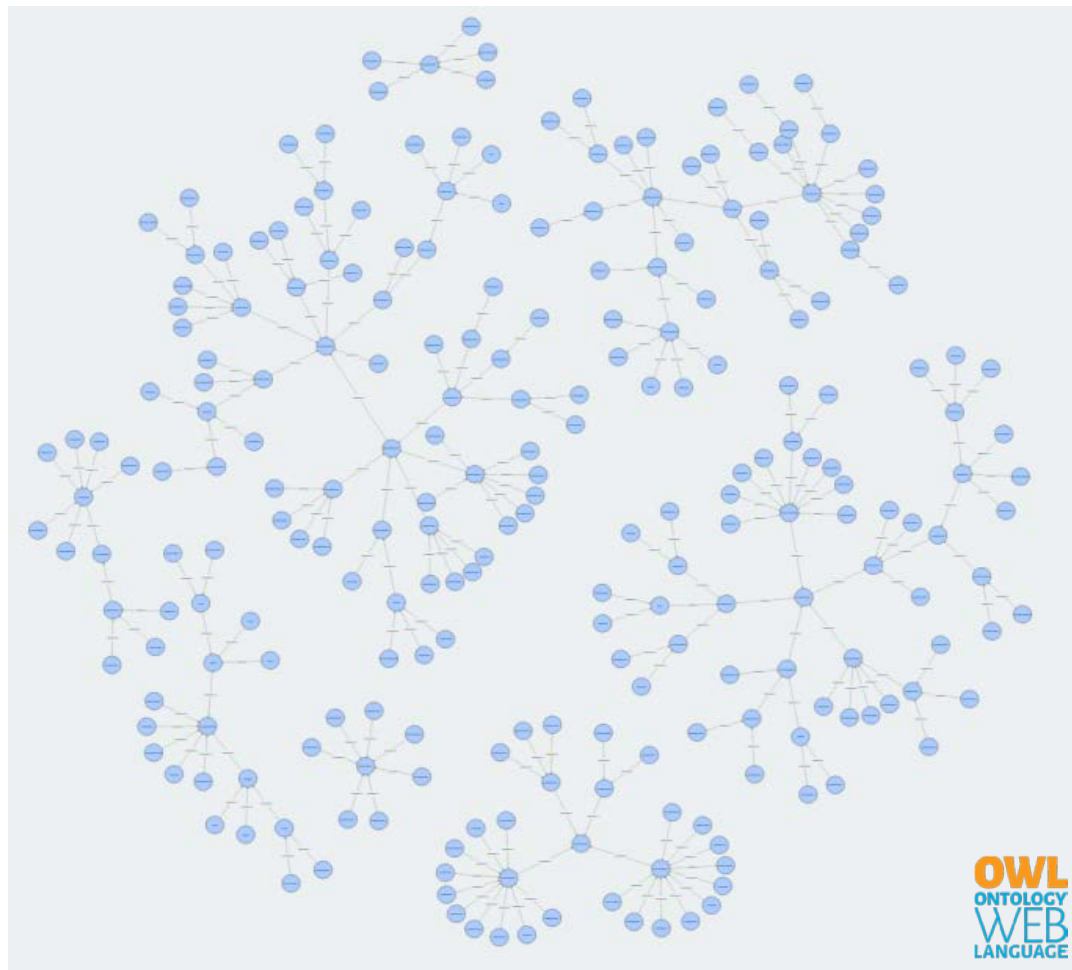
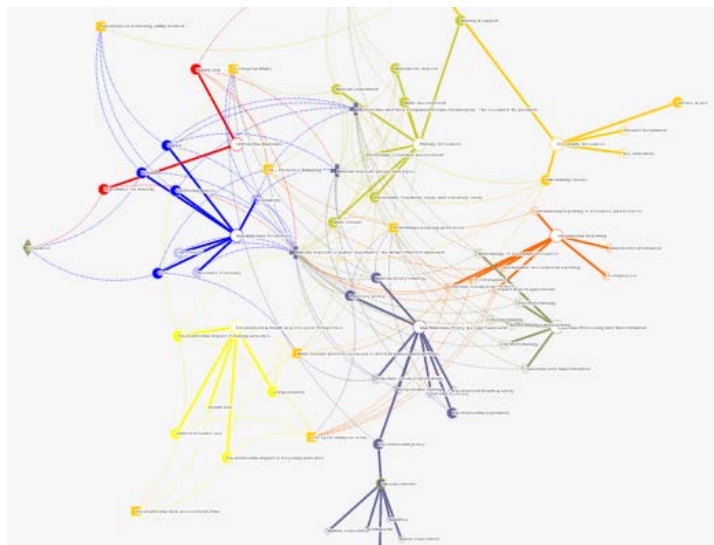
D7 ENVIRONMENT & HEALTH IN A LIFE CYCLE PERSPECTIVE

D8 INTERNATIONAL REPORTING

▪ **The Main ontology:**

The 8 domains represent:

- 47 concepts of level 1;
- 89 concepts of level 2;
- 76 concepts of level 3 and
- 37 concepts of level 4.

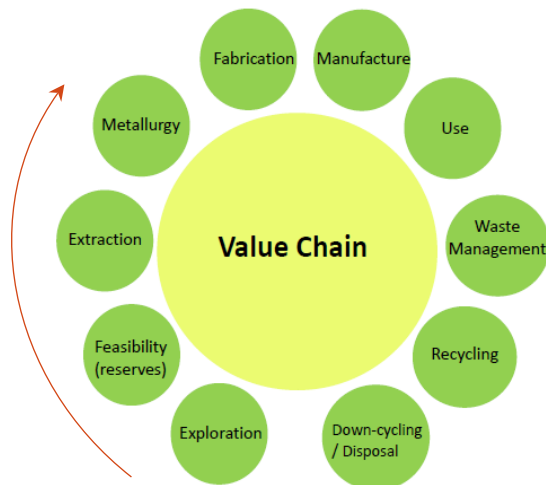


Overview of the MICA Main ontology in WebVOWL, showing the 8 Domains and the 249 concepts of various levels. Overview in the MICA DDG with the FS & DS.

▪ **The Main ontology:**

Is accompanied by 4 transversal, more generic ontologies (TrOnto) which allow the end user specifying some fundamental 'Search' parameters: where in the supply chain, which commodities, what the law says and where geographically (EU level, national level...) and when (past/present/future):

- A COMMODITIES TrOnto;
- A EU_DIRECTIVES TrOnto (*link to MIN-LEX*);
- A SPATIAL_TEMPORAL TrOnto →
- A VALUE_SUPPLY_CHAIN TrOnto ↓



CONCEPT LEVEL1	CONCEPT LEVEL2	CONCEPT LEVEL3	CONCEPT LEVEL4	CONCEPT LEVEL5
SPATIAL				
	Scale			
		Global level		
		Continental level		
			Europe	
				EU 15
				Non-EU 15
				EU 28
				Non-EU 28
			Asia	
			North America	
			South America	
			Oceania	
		National level		
			EU Member State	
			Non-EU Member State	
		Regional level		
			NUTS 1	
			NUTS 2	
			NUTS 3	
		Local level		
			LAU 1	
			LAU 2	
		Site level		
	Continental vs. marine			
		On-shore		
		Off-shore		
TEMPORAL				
	Geological			
	Historic			
	Recent past (10 years back)			
	Present			
	Future	Near future (T < 5 years)		
		Long term (5 < T < 30)		
		Very long term (T ≥ 30)		

Converted to ISO 19139 XML using ISO codes lists, INSPIRE code lists and MICA SKOS ontologies.

Queryable through public CSW service, (you can harvest too :)

Records exportable
in a number of
formats; such as RDF

```
rdmf:RDF
1 <?xml version="1.0" encoding="UTF-8"?>
2 <rdf:RDF xmlns:rdf="http://www.w3.org/1999/02/22-rdf-syntax-ns#"
3   <dcat:Catalog xmlns:dcat="http://www.w3.org/ns/dcat#"
4     rdf:about="http://metadata.bgs.ac.uk/mica">
5     <dct:title xmlns:dct="http://purl.org/dc/terms/" xml:lang="en">MICA</dct:title>
6     <dct:description xmlns:dct="http://purl.org/dc/terms/" />
7     <rdfs:label xmlns:rdfs="http://www.w3.org/2000/01/rdf-schema#" xml:lang="en">MICA (Mineral
8     <foaf:homepage xmlns:foaf="http://xmlns.com/foaf/0.1/">http://metadata.bgs.ac.uk/mica</foaf
9     <void:openSearchDescription xmlns:void="http://www.w3.org/TR/void/">http://metadata.bgs.ac.
10    <void:uriLookupEndpoint xmlns:void="http://www.w3.org/TR/void/">http://metadata.bgs.ac.uk/n
11    <dct:publisher xmlns:dct="http://purl.org/dc/terms/"
12      rdf:resource="http://metadata.bgs.ac.uk/mica/organization/0"/>
13    <dcat:themes rdf:resource="http://metadata.bgs.ac.uk/mica/thesaurus/external.place.regions"
14    <dcat:themes rdf:resource="http://metadata.bgs.ac.uk/mica/thesaurus/external.theme.inspire-
15    <dcat:themes rdf:resource="http://metadata.bgs.ac.uk/mica/thesaurus/external.theme.MICAOnto
16    <dcat:themes rdf:resource="http://metadata.bgs.ac.uk/mica/thesaurus/external.theme.Commodit
17    <dcat:themes rdf:resource="http://metadata.bgs.ac.uk/mica/thesaurus/external.theme.micadata
18    <dct:language xmlns:dct="http://purl.org/dc/terms/">eng</dct:language>
19    <dcat:dataset rdf:resource="http://metadata.bgs.ac.uk/mica/resource/Zakhyntos2_TF_PS"/>
20    <dcat:record rdf:resource="http://metadata.bgs.ac.uk/mica/metadata/Zakhyntos2_TF_PS"/>
21  </dcat:Catalog>
22  <foaf:Organization xmlns:foaf="http://xmlns.com/foaf/0.1/"
23    rdf:about="http://metadata.bgs.ac.uk/mica/organization/0">
24    <foaf:name>Mineral Intelligence Capacity Analysis</foaf:name>
25  </foaf:Organization>
26  <skos:ConceptScheme xmlns:skos="http://www.w3.org/2004/02/skos/core#"
27    rdf:about="http://metadata.bgs.ac.uk/mica/thesaurus/external.place.regions">
```


- What are the rubrics of a FactSheet?
- FactSheets and DocSheets are annotated and indexed over the Main ontology and transversal ontologies

FactSheet

Scope (conceptual model & main characteristics)

....

Range of relevant applications or topics

....

Data needs, databases

....

Model used

....

System and/or parameters considered

....

Time / Space / Resolution / Accuracy

....

Indicators / Outputs / Units

....

Treatment of uncertainty, verification, validation

....

Main publications / references

....

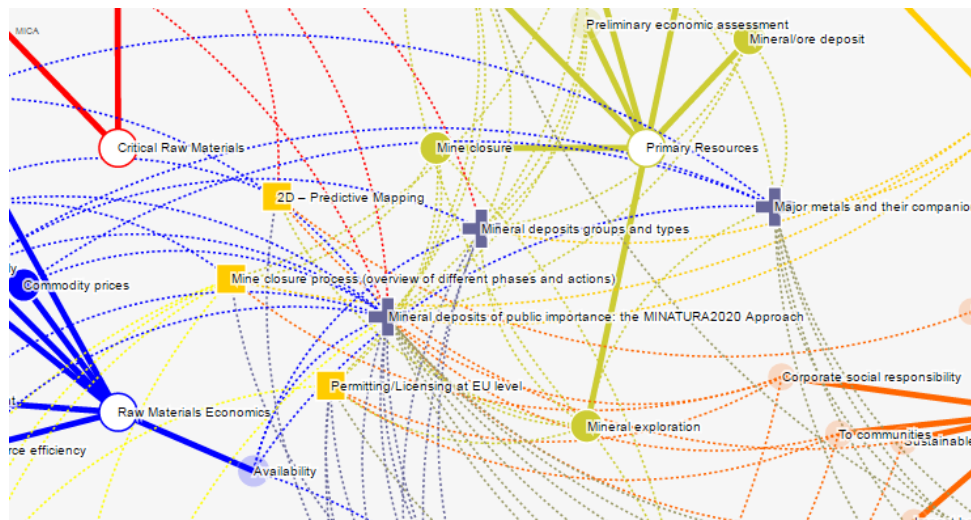
Related methods

....

Key relevant contacts

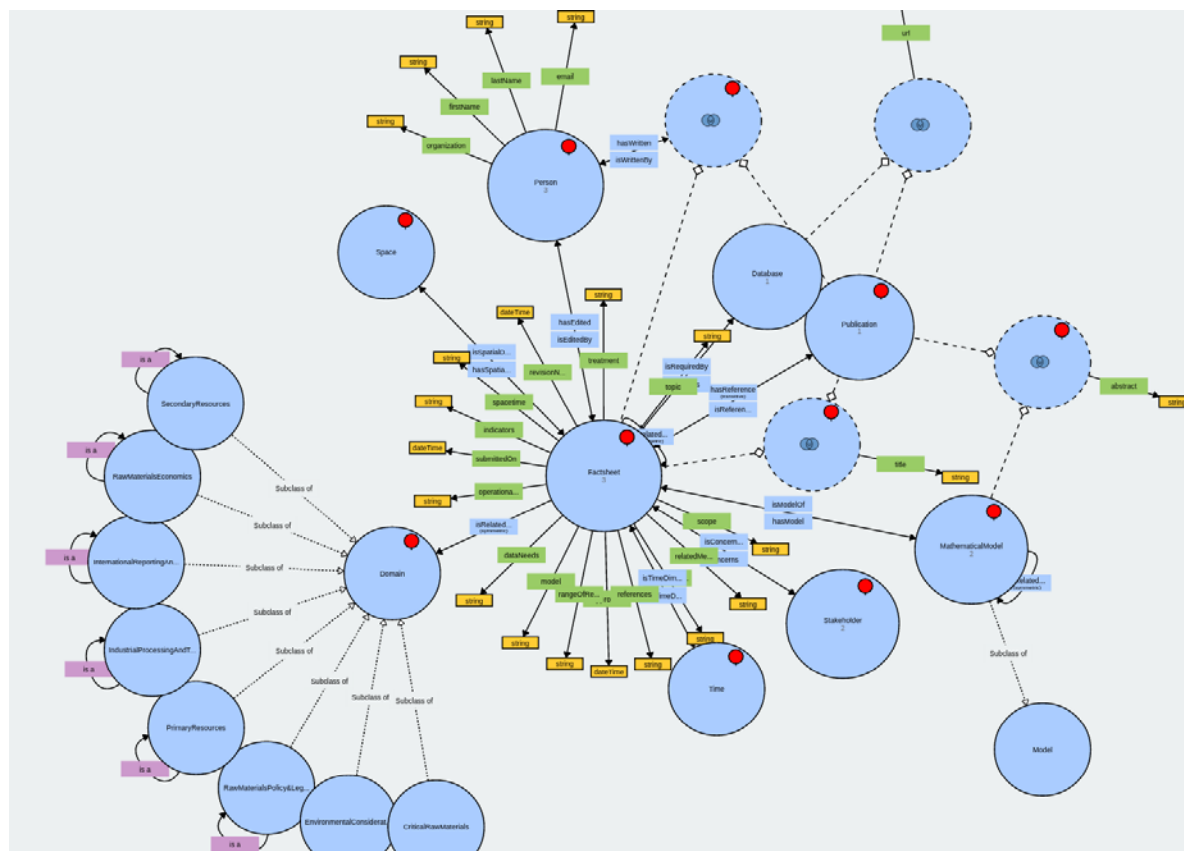
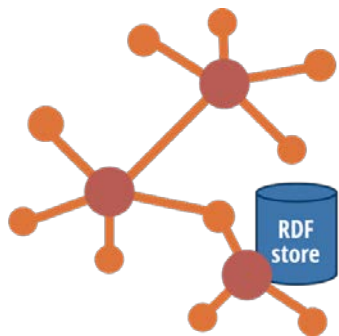
....

INDEXATION



- FactSheets are also modeled with an ontology. This ontology is seen as a template used to create individual factSheets. In conjunction with the domain and transversal ontologies it is used to index and retrieve relevant factSheets to solve a user query.

FactSheet model showing the properties between the different classes or concepts



FS & DS production

Next step: to set up an agreed procedure at project level to:

- 1 – enter FS and DS in the system;*
- 2 – review the texts;*
- 3 – check (and improve if necessary) indexation over concepts and sub-concepts.*

WP6 RMICP DEVELOPMENT

REQUESTED BY	FactSheet (F) or Doc/Def Sheet (D)	TITLE	AUTHOR(S)	ORGANIZATION
WP6	D	Standard classification codes or Minerals reporting standards - CRIRSCO, UNFC...	Guillaume Bertrand	BRGM
WP6	D	Major metals and their companion metals metallogeny (DocSheet) (# types of mineral deposits, # types of associated metals...)	Laurent Bailly	BRGM
WP6	F	EIA (Environmental Impact Assessment)	George and Christodoulos Hadjigeorgiou	GSD
WP6	F	Multi-agents method	Fenintsu Andriamasinoro	BRGM
WP6	F	Data reconciliation method	Jacques Villeneuve	BRGM
WP6	F	Exploration phases (overview: # phases, # methods)	Gerry Stanley	GSI
WP6	D	Exploration phases: time, costs & surfaces	Guillaume Bertrand	BRGM
WP6	D	Mineral deposit types and groups (DocSheet)	Daniel Cassard	BRGM
WP6	F	Mining wastes characterization (parameters to be considered)	Gerry Stanley	GSI
WP6	D	SLO & CSR (Social license to operate, corporate social responsibility) (DefSheet)	Gerry Stanley	GSI
WP6	D	Panorama of the European MR Industry (DocSheet)	Gerry Stanley	GSI
WP6	F	# types of drilling	Pedro Delgado	IGME Spain
WP6	F	# types of mining operations	Mauro Lucarini	ISPRA
WP6	F	2D predictive mapping (see Carranza review)	Bruno Tourlière	BRGM
WP6	D	Strategic, critical, high-tech, rare and minor metals (DefSheet)	Daniel Cassard	BRGM
WP6	D	Permitting/Licensing at EU level (DocSheet)	Daniel Cassard	BRGM
WP6	F	Mine closure process (overview of # phases and actions)	Daniel Cassard	BRGM
WP6	D	Substitution: the CRM-InnoNet vision (DocSheet)	Daniel Cassard	BRGM
WP6	D	Deposits of public importance: the MINATURA2020 approach (DocSheet)	Daniel Cassard	BRGM
WP6	D	Criticality (DefSheet)	Daniel Cassard	BRGM

C13 f* How is a recovery level of waste equipment other than recycling?

		T	U	V	W	X	Y	Z	AA	AB	AC	AD	AE	AF	AG	AH	AI	AJ	AK	AL	AM	AN	
		MAIN ONTOLOGY DOMAINS																					
		D3 INDUSTRIAL PROCESSING AND TRANSFORMATION					D4 RAW MATERIALS ECONOMICS					D5 CRMs		D6 RM POLICY & LEGAL FRAMEWORK									
		Mineralurgy of secondary res.	Hydrometallurgy	Electrometallurgy	Pyrometallurgy	Biometallurgy	Ind. rocks transformation	Availability	Supply	Demand	Investment	Cost	Commodity prices	Resource efficiency	Supply risk	Importance for industry	Land use policy	Environ. legislation	Environ. policy	Mineral policy/strat.	Environ. health & safety	Circular economy	
1	EUQ = End User Query																						
2																							
3	Developments needed regarding WP2 list of questions X = Possible FACT sheet? (updated 03/05/2016)																						
4																							
5	How can we collect information for product/building passports?																						
6	Relevant regulatory frameworks at national levels?																X	X	X	X	X		
7	How big is the in-use stocks of different CRMs in Europe?														D5	D5							
8	How much is expected to be reused or recycled?	X	X	X	X	X								X			X	X	X	X			
9	When do policies and value chains need to be developed?													X									X
10	What is the future availability of a specific metal?							X	X				X		X								
11	What are new main primary and waste sources of In, PGMs, Ga, Ge?	X	X	X	X	X		X	X	X	X	X	X		D5	D5							
12	How is a recovery level of waste equipment other than recycling?																						
13	What is the recycling level of large and small household appliances?																						X
14	What is the recycling and recovery level of IT and technology equipment?																						X
15	Are there and how accurate are the codes of WEEE in the EU?																						
16	Which minerals will become critical in 30 years and where can we find them?							X	X	X	X	X	X		X	X							
17	Should the EU invest/investigate in getting more mines in Europe?							X	X	X	X	X	X		X	X	X	X	X	X			X
18	Should the EU invest in appropriate infrastructure and know-how?																						
19																							

The next steps:

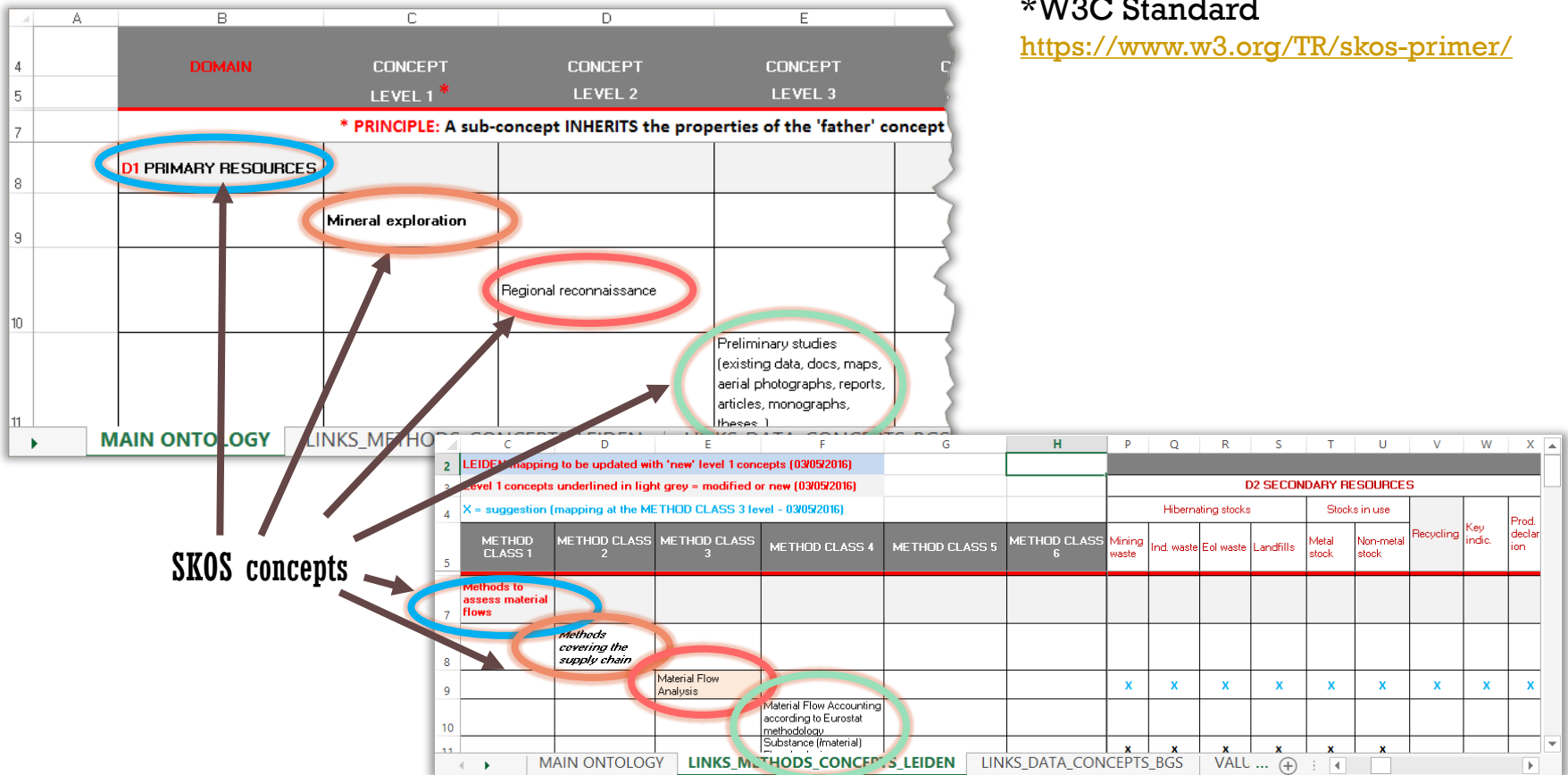
- To improve the mapping of questions over the main ontology, particularly over concepts of lower levels (2, 3 and 4);
- To check which Fact/DocSheets are missing for answering all questions;
- To finalize ASAP the list of questions with WP2...
- **START the development of FlowSheets scenarios.**

Necessitates ALL MICA Experts involvement

- Simple Knowledge Organization System (SKOS)* used to formalize knowledge.

*W3C Standard

<https://www.w3.org/TR/skos-primer/>



*** PRINCIPLE: A sub-concept INHERITS the properties of the 'father' concept**

DOMAIN	CONCEPT LEVEL 1 *	CONCEPT LEVEL 2	CONCEPT LEVEL 3
D1 PRIMARY RESOURCES	Mineral exploration	Regional reconnaissance	Preliminary studies (existing data, docs, maps, aerial photographs, reports, articles, monographs, theses, ...)

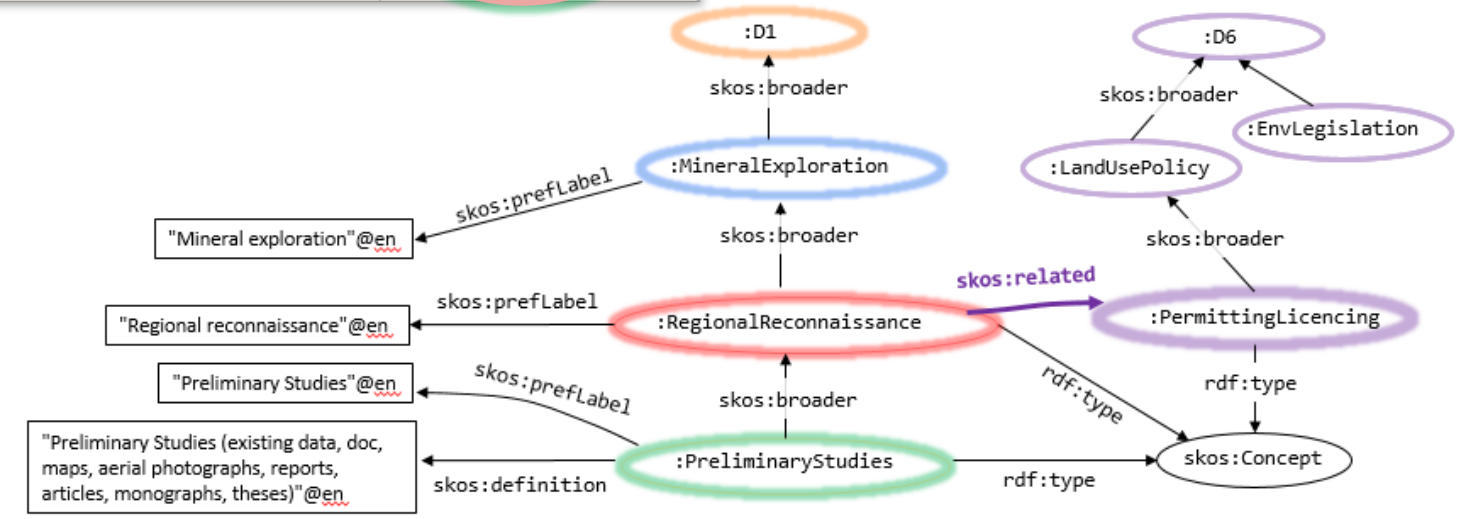
D2 SECONDARY RESOURCES						Hibernating stocks					Stocks in use			Recycling	Key indic.	Prod. declar. ion
METHOD CLASS 1	METHOD CLASS 2	METHOD CLASS 3	METHOD CLASS 4	METHOD CLASS 5	METHOD CLASS 6	Mining waste	Ind. waste	Eol waste	Landfills	Metal stock	Non-metal stock					
Methods to assess material flows	Methods covering the supply chain	Material Flow Analysis	Material Flow Accounting according to Eurostat methodology			X	X	X	X	X	X	X	X	X	X	X

SKOS concepts

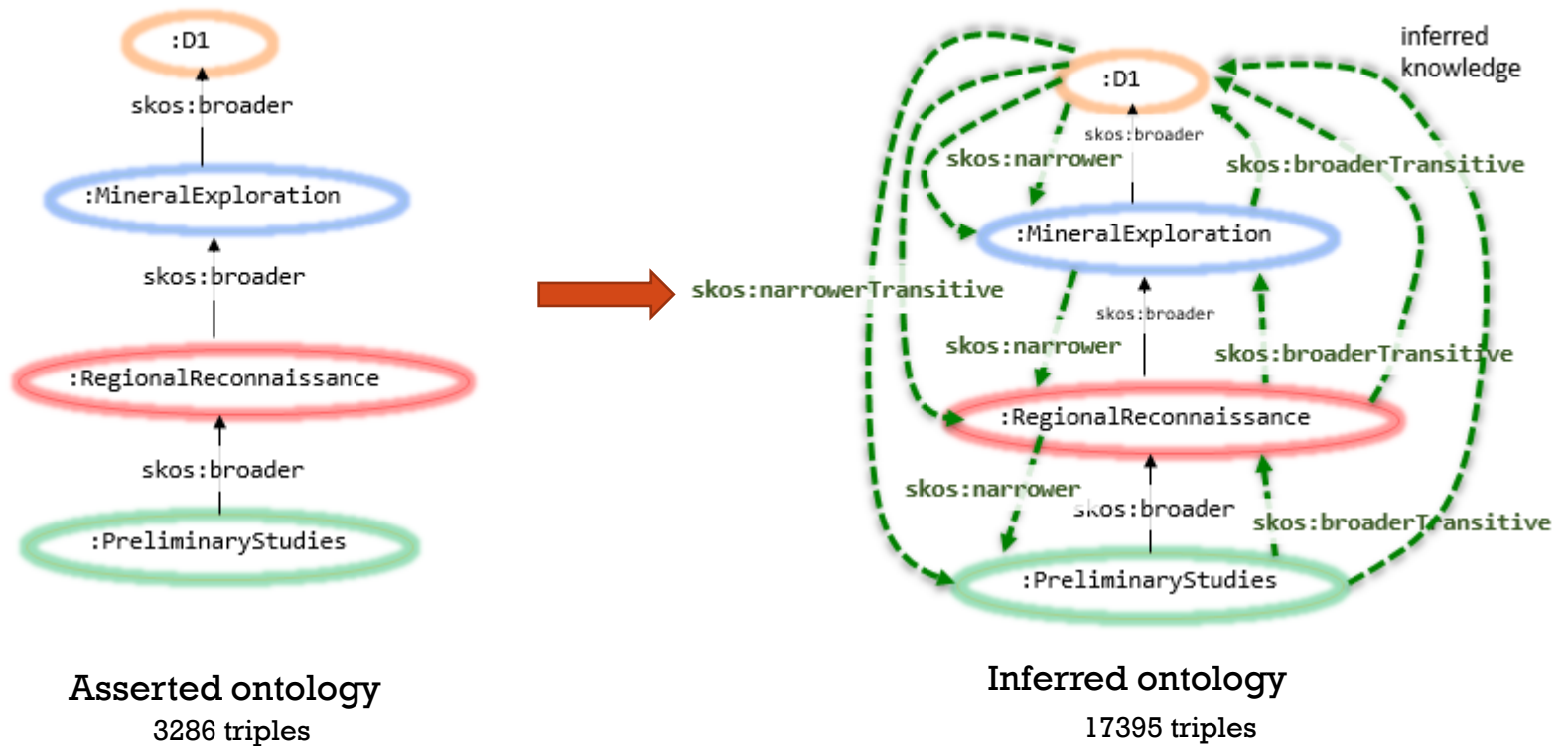
	DOMAIN	CONCEPT LEVEL 1 *	CONCEPT LEVEL 2	CONCEPT LEVEL 3	CONCEPT LEVEL 4
4					
5					
7	* PRINCIPLE: A sub-concept INHERITS the properties of the 'father' concept				
8	D1 PRIMARY RESOURCES				
9		Mineral exploration			
10			Regional reconnaissance		
11				Preliminary studies (existing data, docs, maps, aerial photographs, reports, articles, monographs, theses.)	
	MAIN ONTOLOGY	LINKS_METHODS_CONCEPTS_LEIDEN	LINKS_DATA_CONCEPTS_BGS		

RELATED DOMAIN	CONCEPT	RELATIONSHIP
	RDC1	
D4	RAW MATERIALS ECONOMICS / Exploration	
D6	RAW MATERIALS POLICY & LEGAL FRAMEWORK / Permitting / Licensing	

SKOS concepts

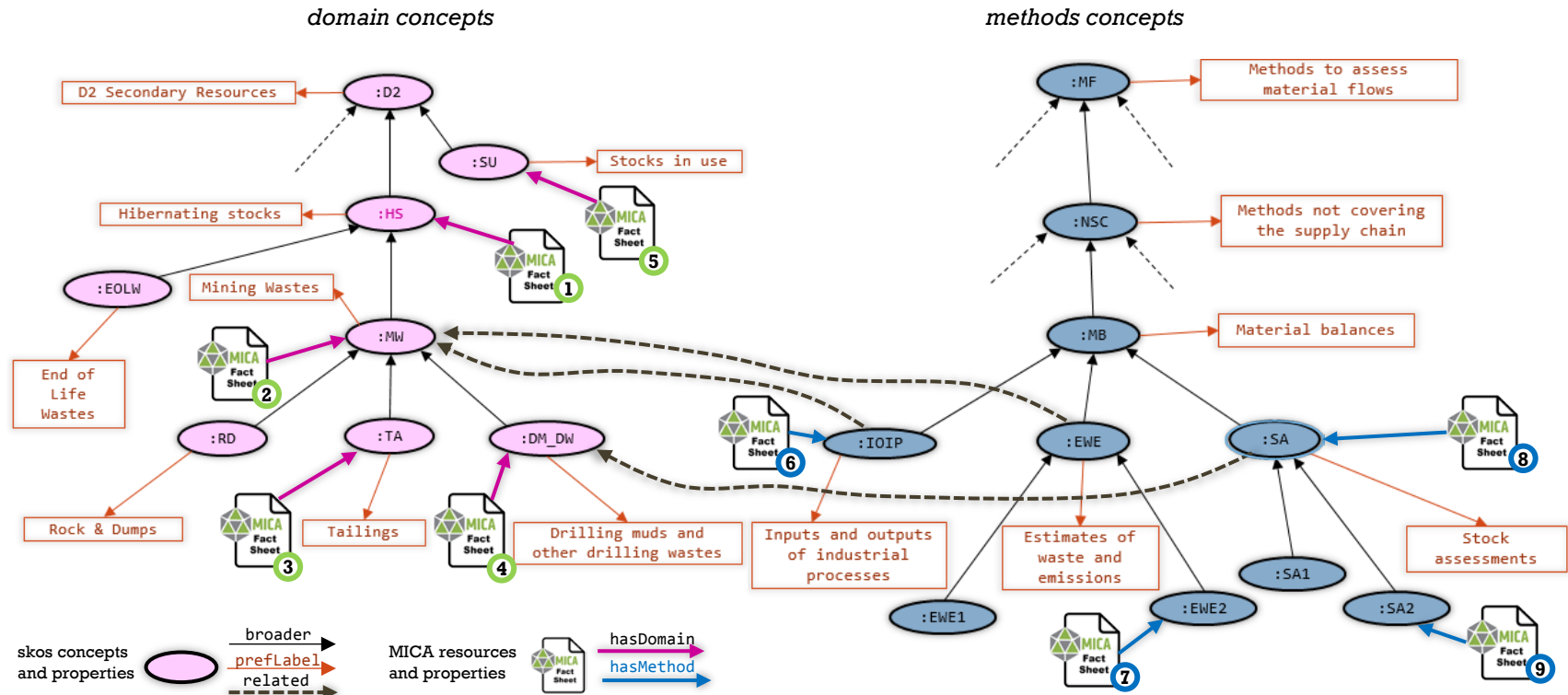


- derive new knowledge from asserted knowledge



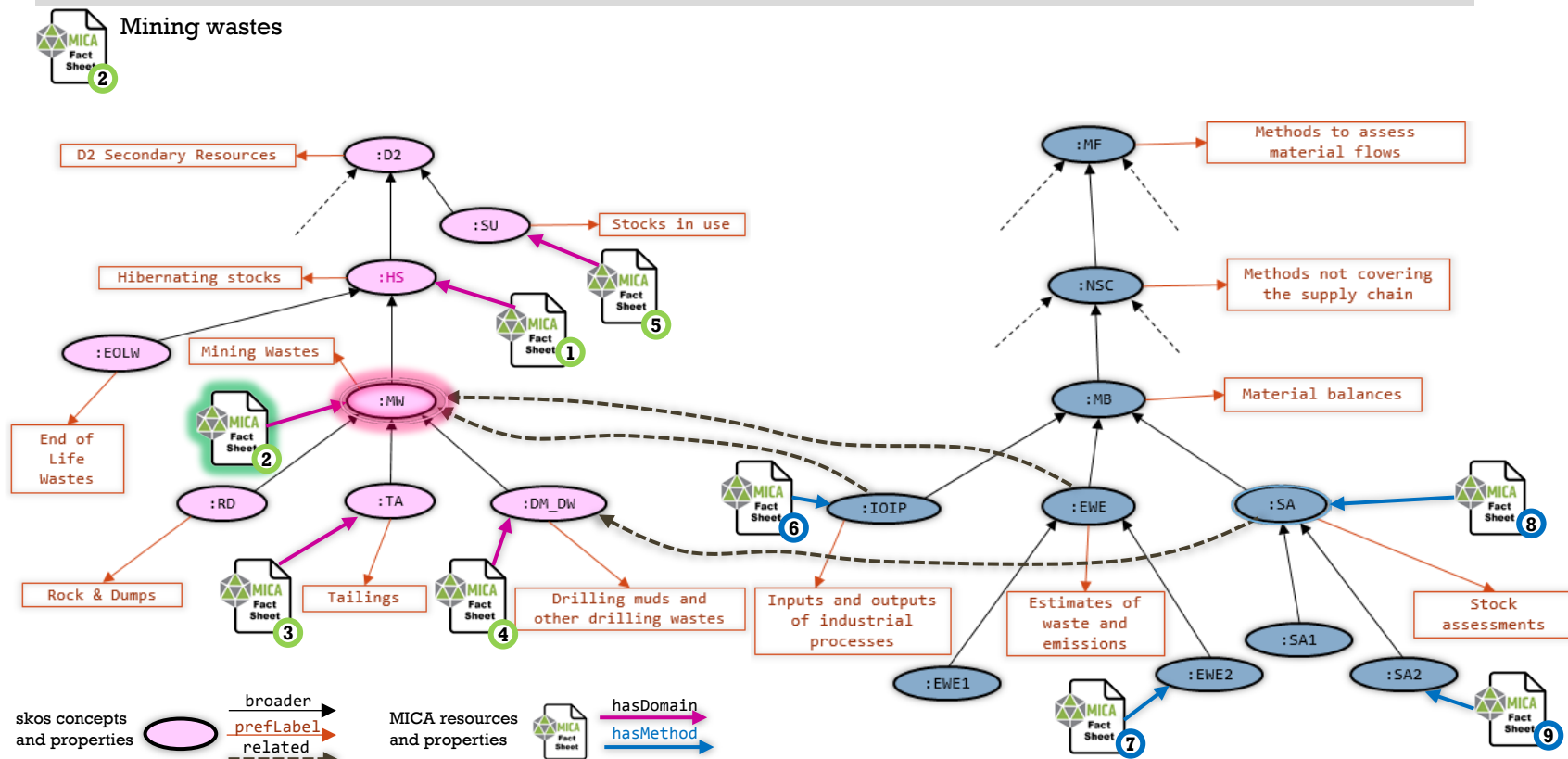
- Concepts hierarchies (and inferences) can be exploited to perform queries

find all factsheets about "Mining Wastes"



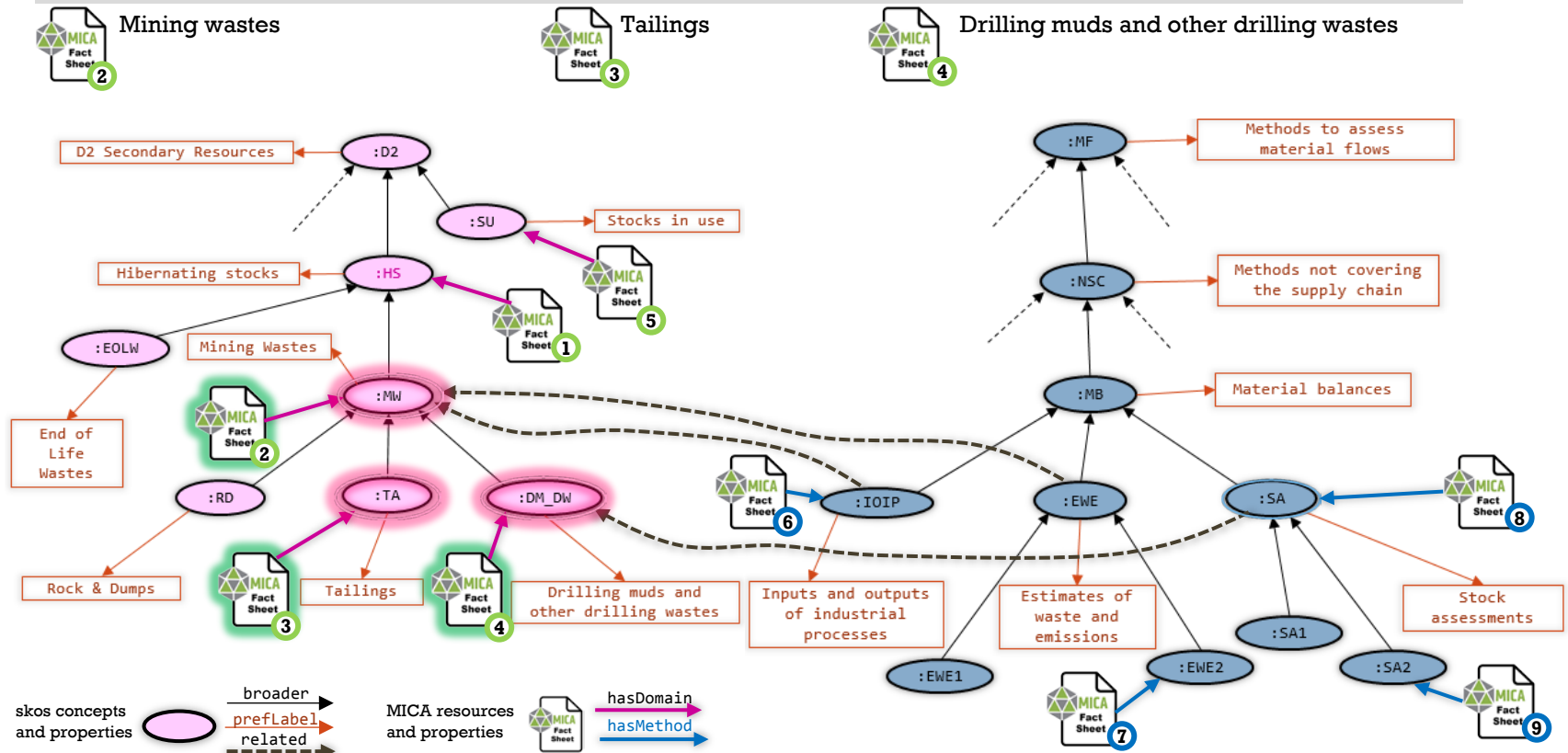
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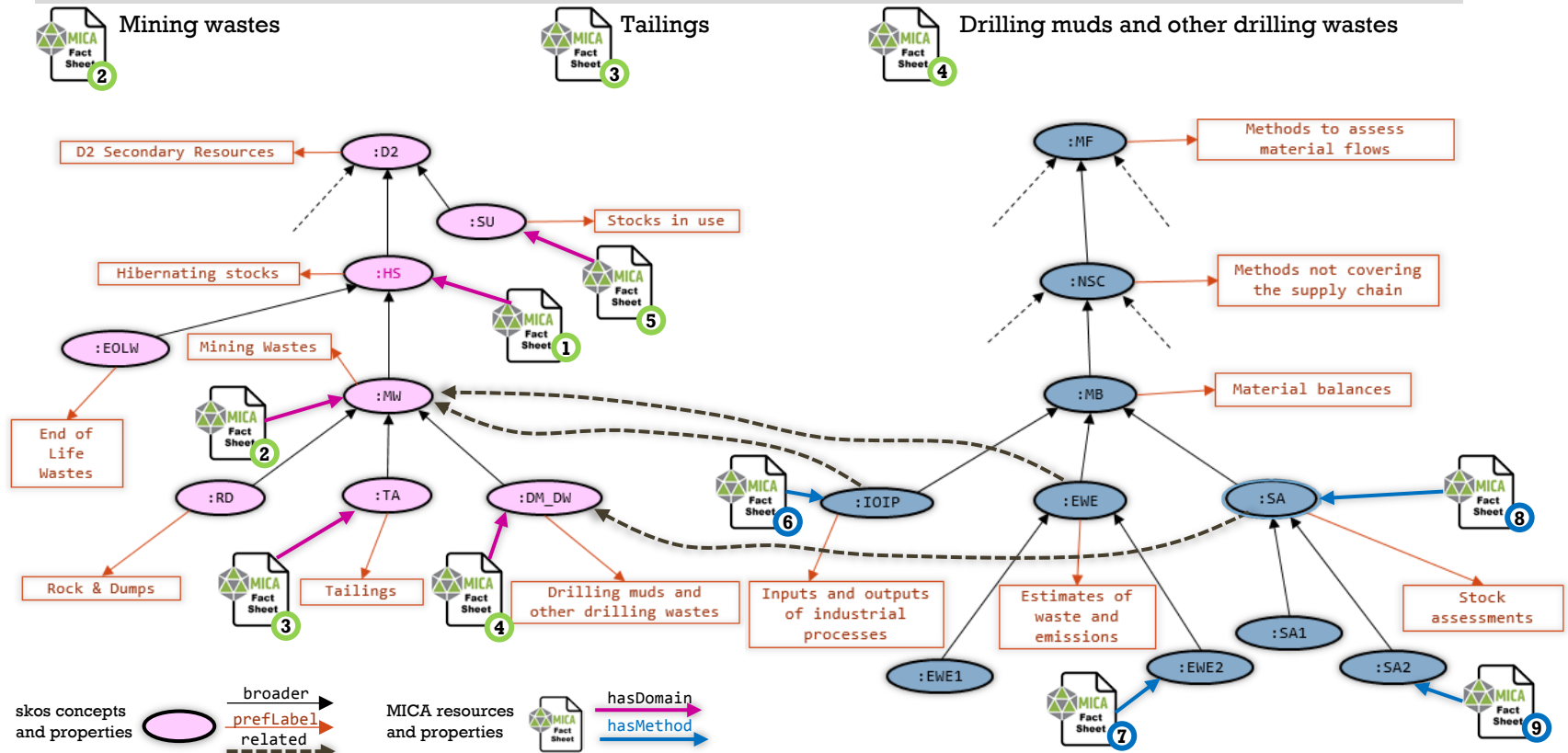
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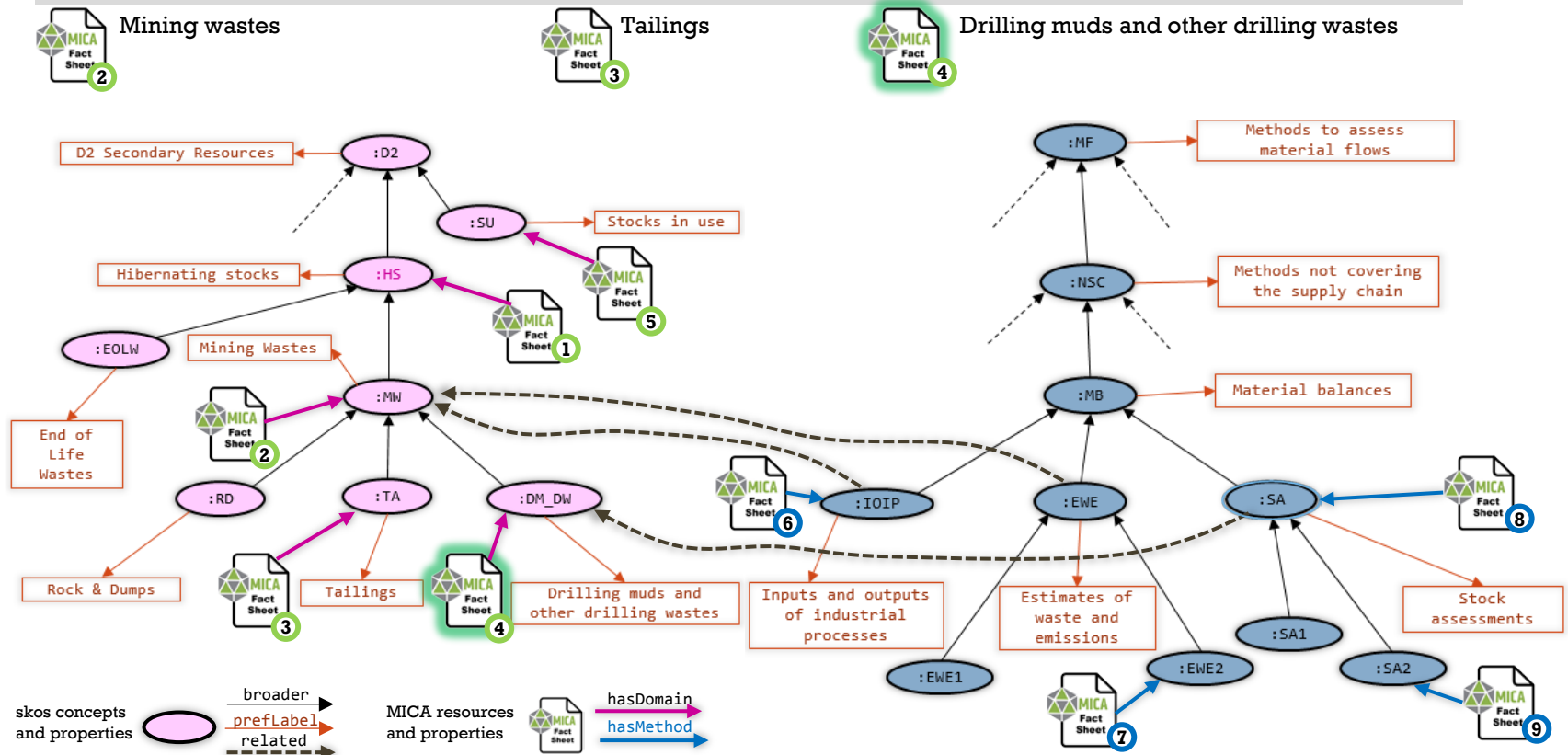
- Concepts hierarchies (and inferences) can be exploited to perform queries

find all factsheets about "Mining Wastes" with factsheets about related methods



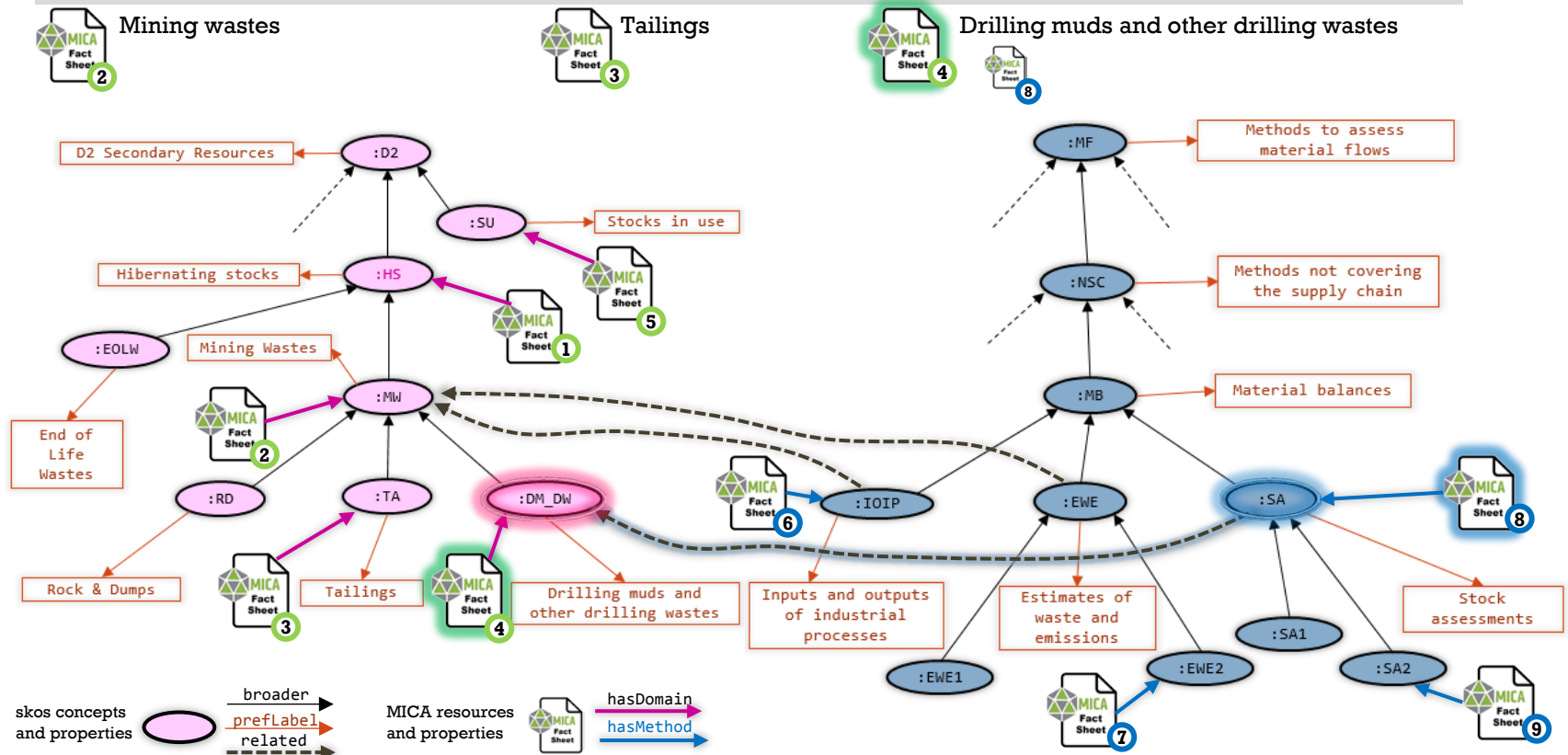
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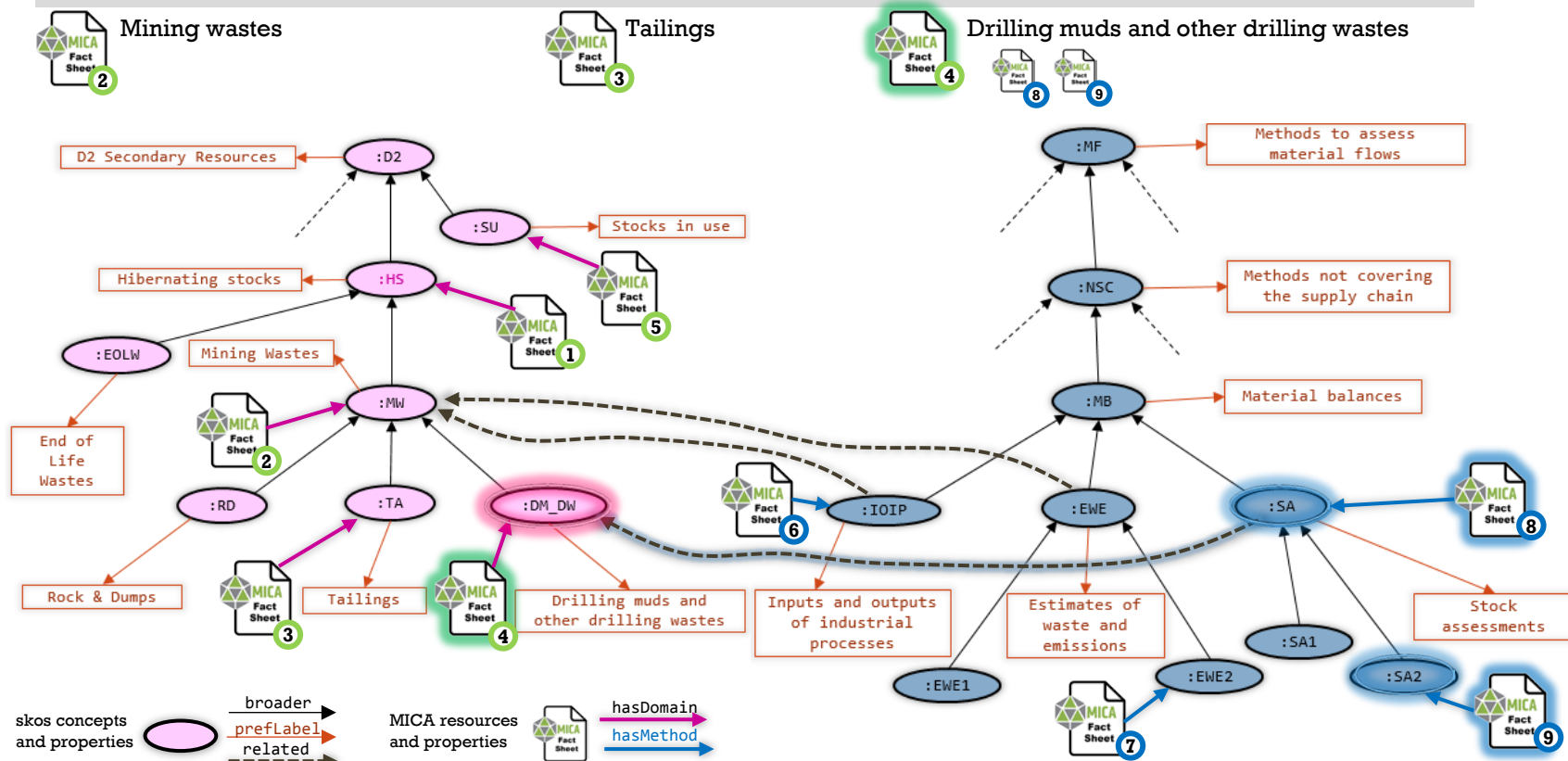
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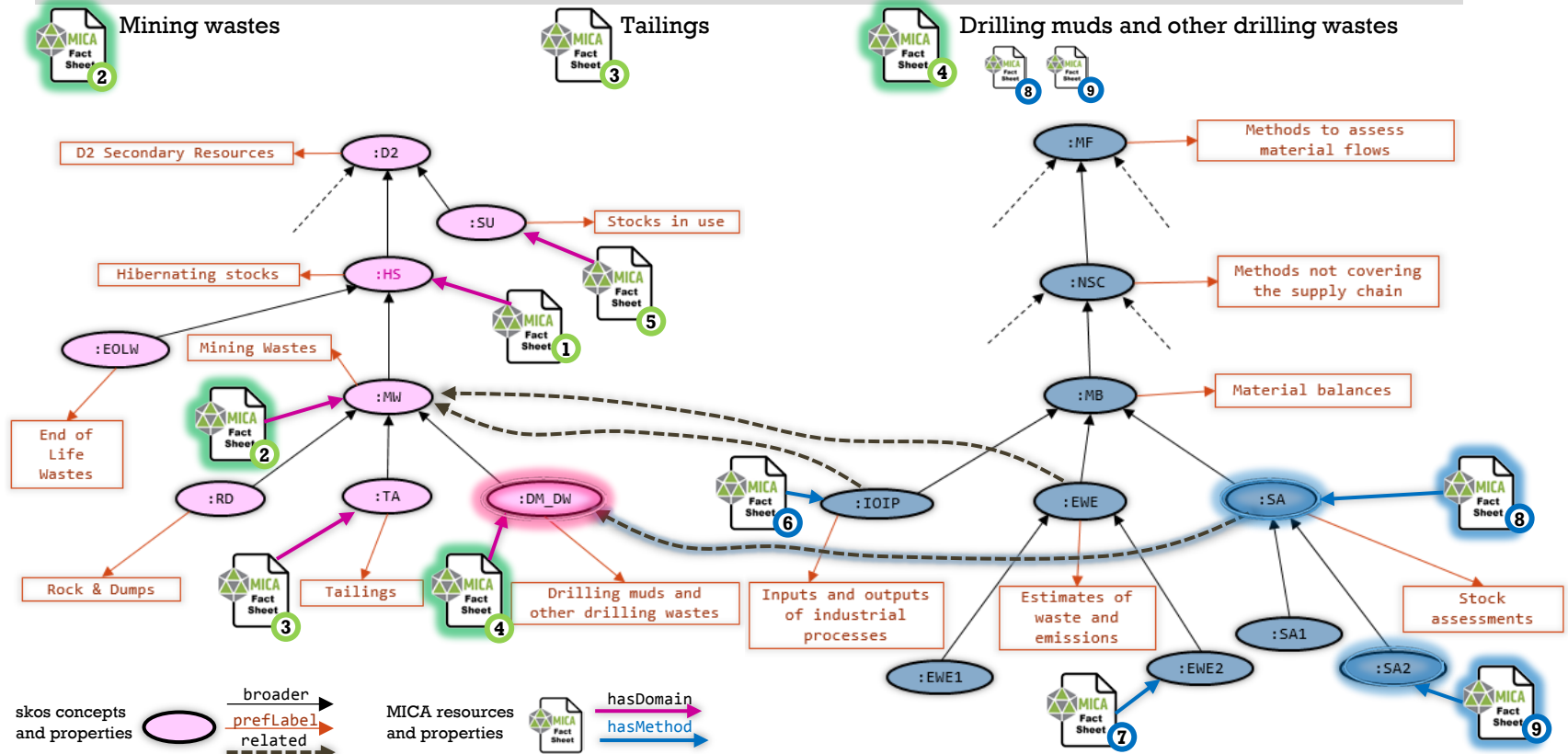
- Concepts hierarchies (and inferences) can be exploited to perform queries

find all factsheets about "Mining Wastes" with factsheets about related methods



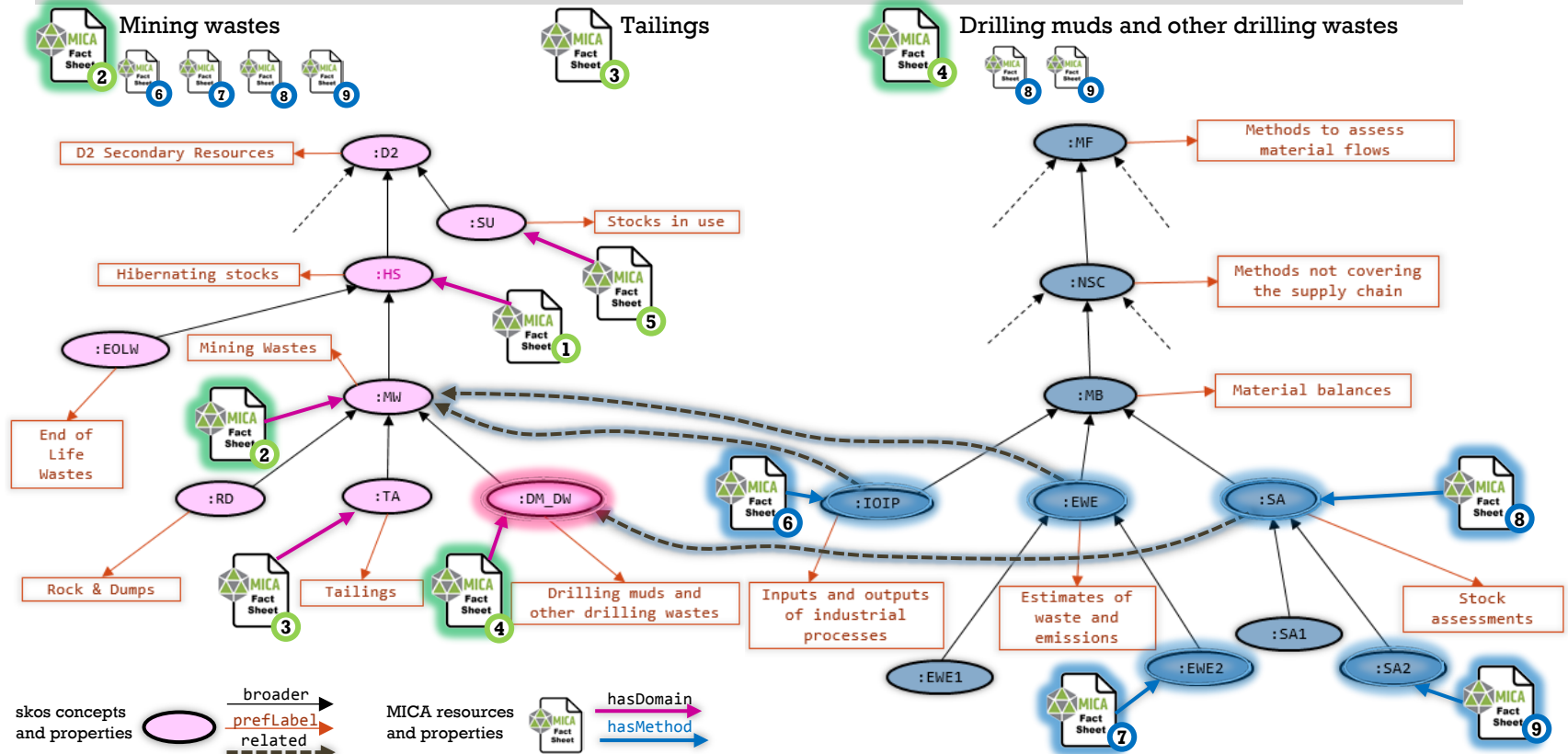
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find all factsheets about "Mining Wastes" with factsheets about related methods

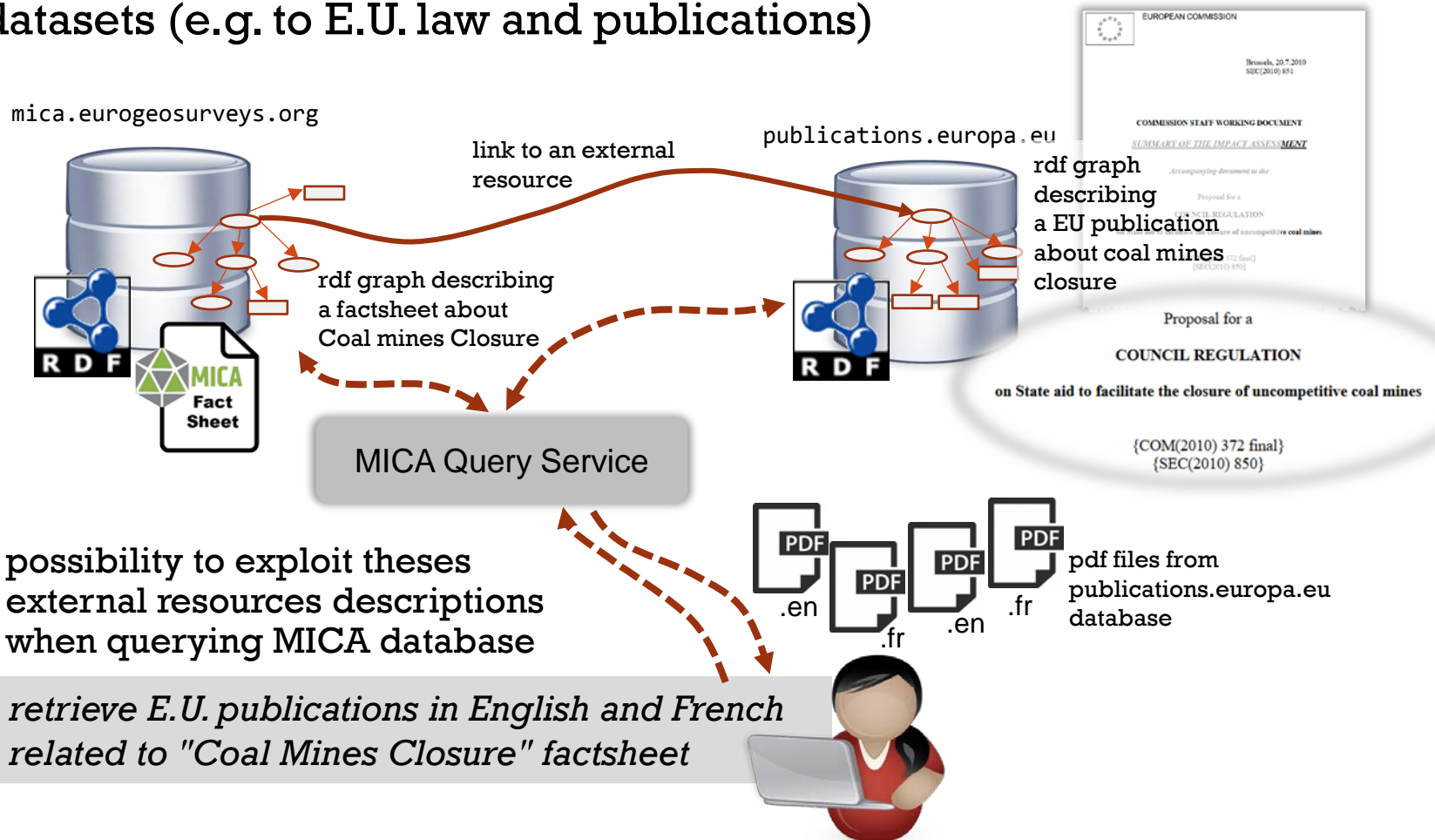


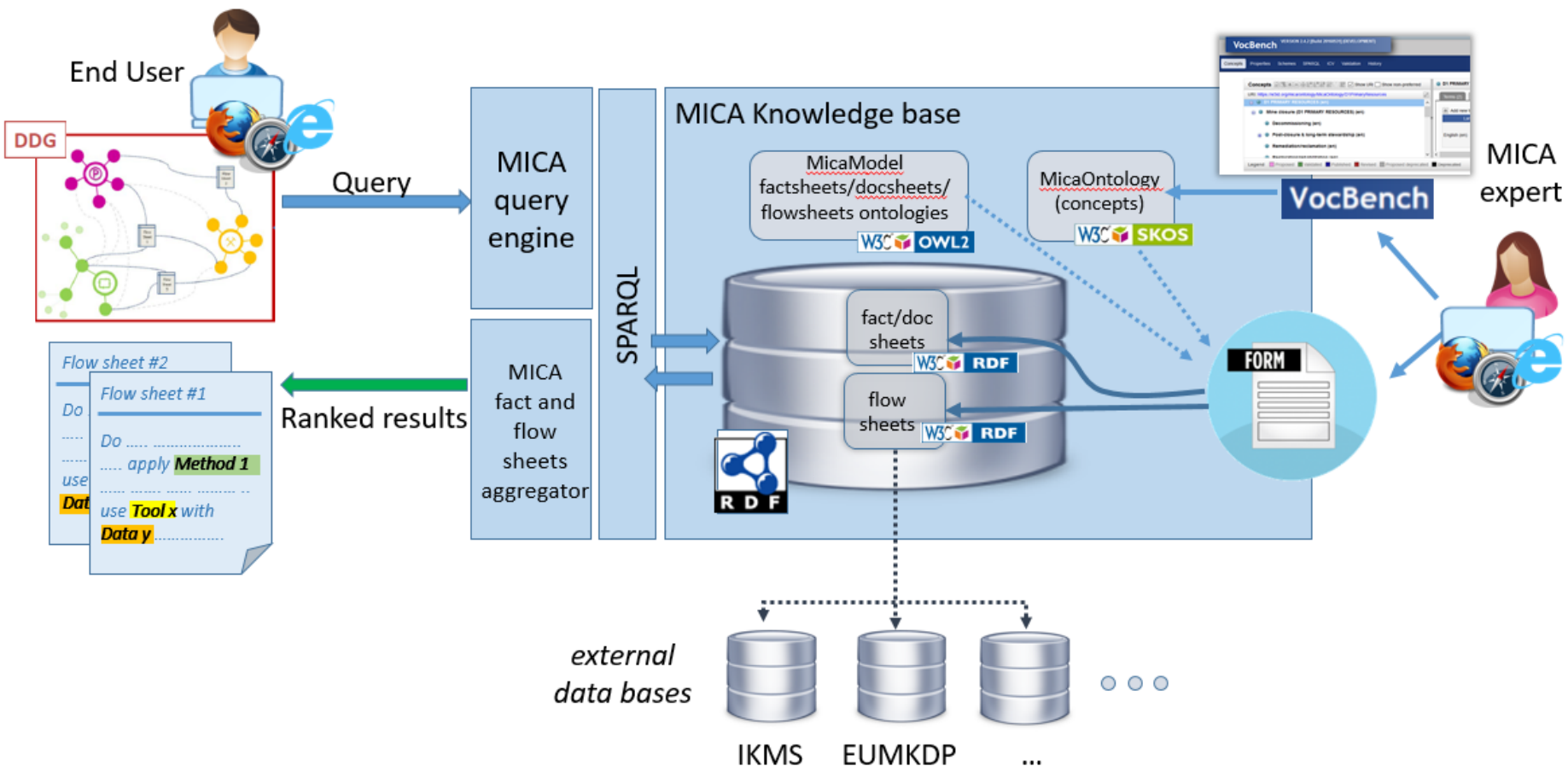
- Concepts hierarchies (and inferences) can be exploited to perform queries

find all factsheets about "Mining Wastes" with factsheets about related methods



- MICA resources can be linked with other resources from other datasets (e.g. to E.U. law and publications)





- SPARQL endpoints:

- select:

- <http://geusjuptest.geus.dk/fuseki/micatest/query>

- update:

- <http://geusjuptest.geus.dk/fuseki/micatest/update>

prefix mica:

<<http://www.mica.org/ontology#>>

describe ?object

WHERE {

?object a mica:Factsheet.

?object mica:hasDomain

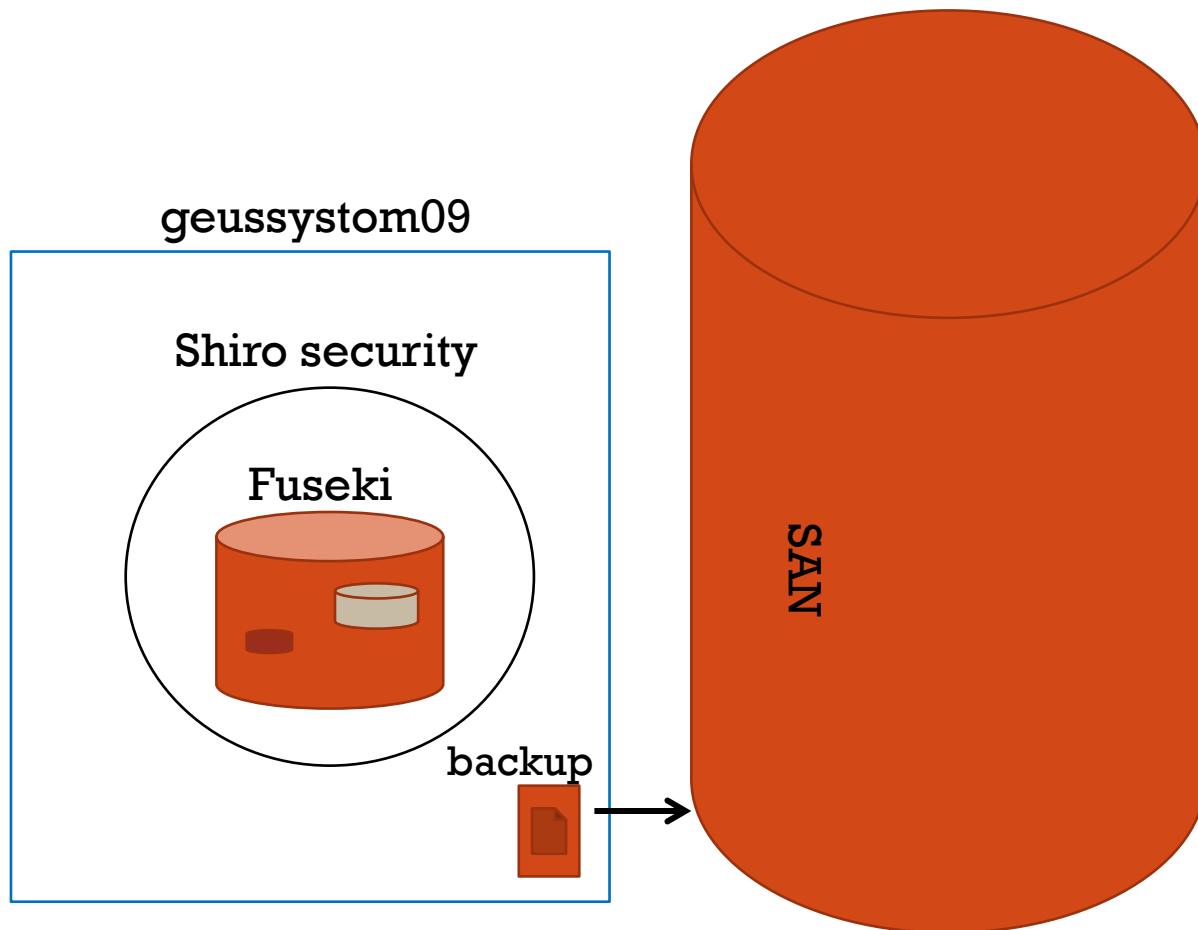
mica:PrimaryResources}

- Output: json/xml/csv

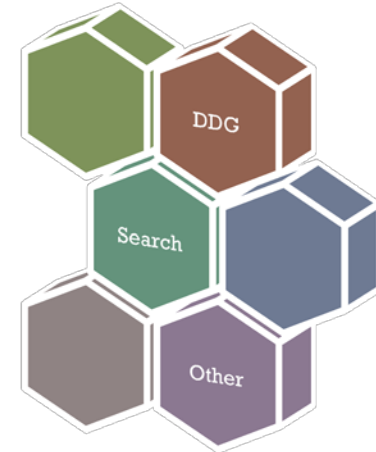
- Easy to

- Export/import

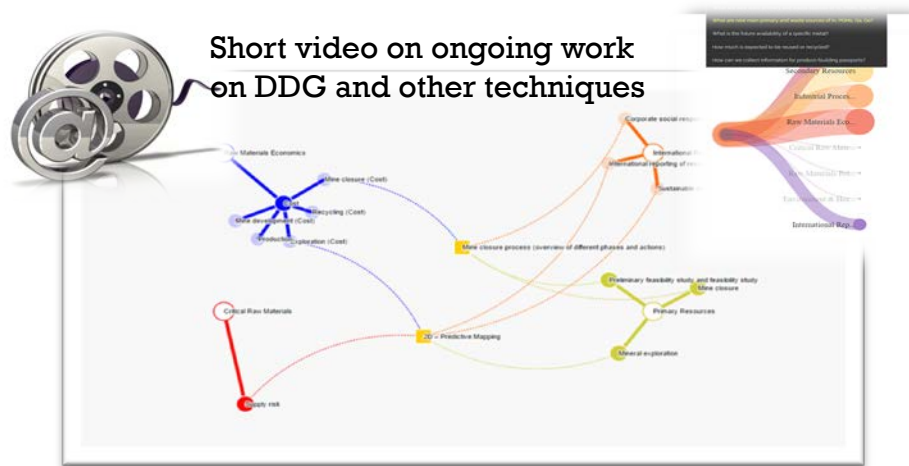
- Integrate into other projects using RDF



- Access to information through*
 - DDG
 - Search interface
 - Other visualization mechanism, stepwise guided tours, ...



- Presentation of the 1st DDG Prototype



- **Functionality – Your views on the prototype**
- **FactSheets – Granularity and how to tag them**
- **FlowSheet design and use/ access within the system**
- **Other entities: Description of and access to data and legislation**



MICA Mineral Intelligence
Capacity Analysis



Co-funded by
the European Union

THANKS A LOT FOR YOUR ATTENTION!



Geoscience for a sustainable Earth

brgm

Daniel Cassard and the WP6 Team
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