

# A new digital European data layer on shallow subsurface lithology derived from IHME 1500 information

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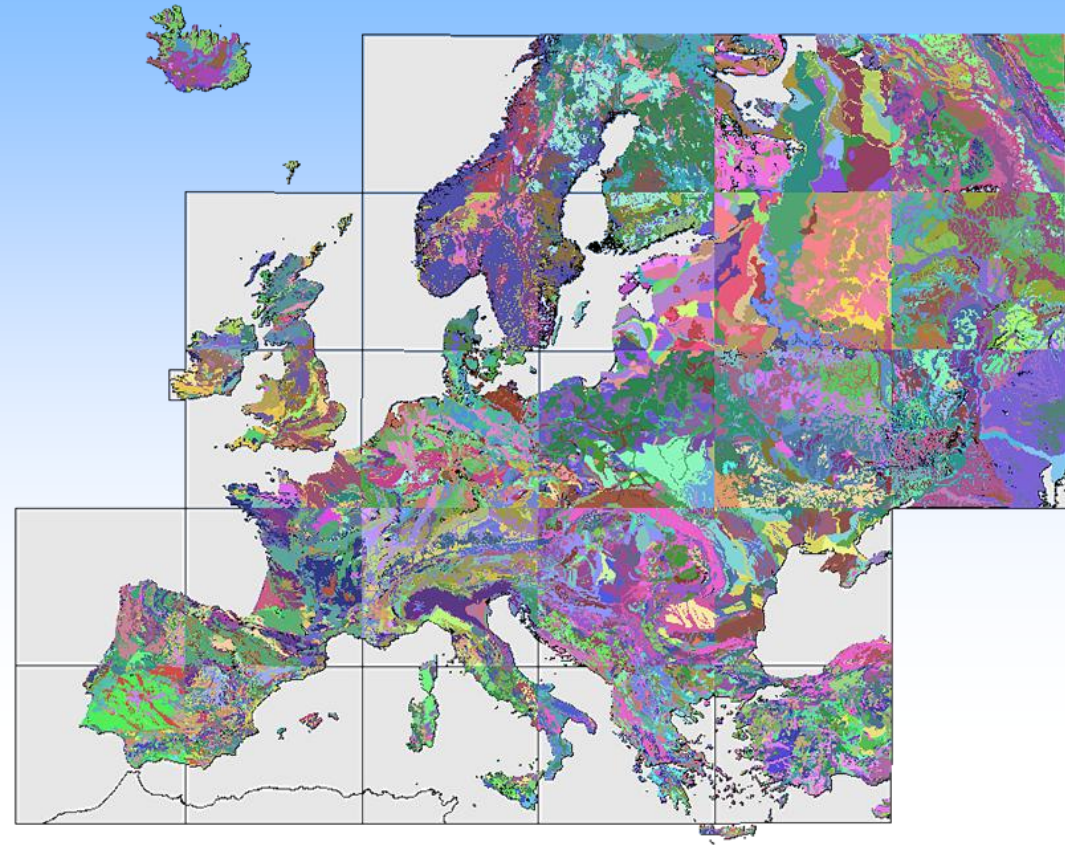
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- Data situation IHME 1500 lithology
- Constraints for geometrical aggregation of sheet lithological classes
- Geometrical sheet lithology class aggregation
- Proposed general taxonomy for IHME lithology
- Semantic class aggregation and hierarchical class grouping
- Conclusions

# Data situation IHME 1500 lithology

- 25 Sheets with specific lithological taxonomy
- Digital geometric dataset harmonized
- Semantic dataset: 1290 classes
- Geometric dataset: 1287 classes
- 1244 sheet classes can be related to 1057 English lithological descriptions from semantic dataset



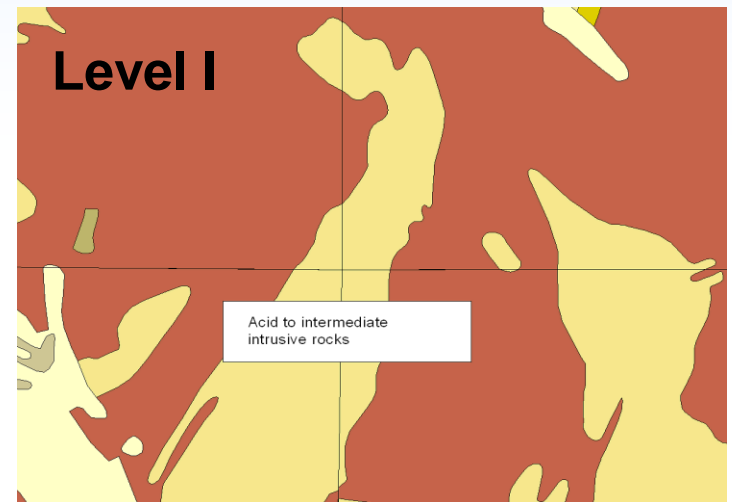
# Constraints for geometric class aggregation

- Individual description of sheet lithological classes comprises lithological, genetic, abstract, stratigraphic and local terminologies
- Aggregation of sheet classes is conducted solely on geometrical class properties (e.g., spatial relationships and sizes of sheet-specific classes)
- Geometrical data structure is maintained (e.g., sheet-specific polygon classes are not levered)
- Existing taxonomy is maintained (e.g., no new class descriptions are introduced)
- Aggregation workflow allows for incorporation of additional classes and tracking of aggregation levels without loose of information

# Geometrical class aggregation: Stage I

## Generation of intersection-free classes over the whole mapped area

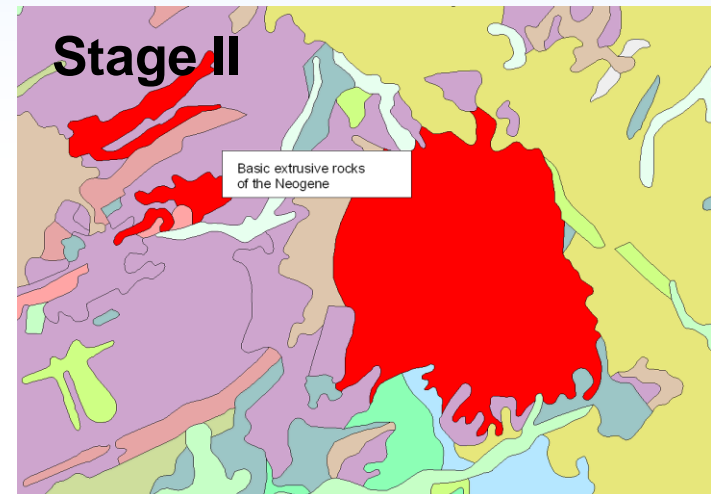
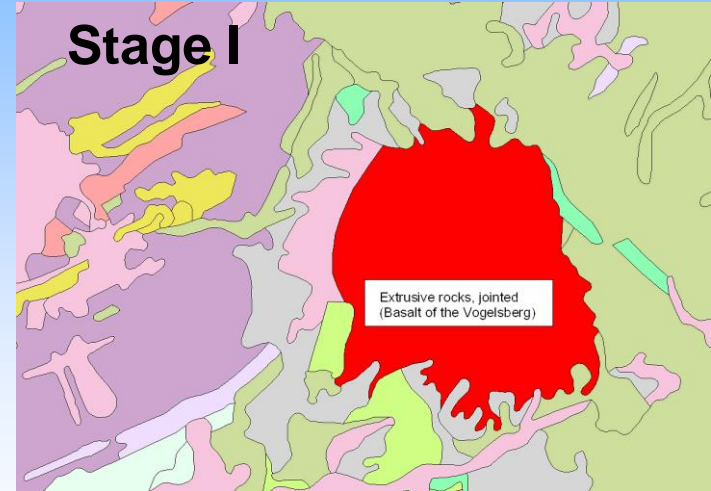
- Aggregation of sheet classes with high taxonomic similarity only separated by map borders
- Class descriptions assigned from largest class avoiding local/stratigraphic/genetic descriptions when possible
- Results in 751 classes



# Geometrical class aggregation: Stage II

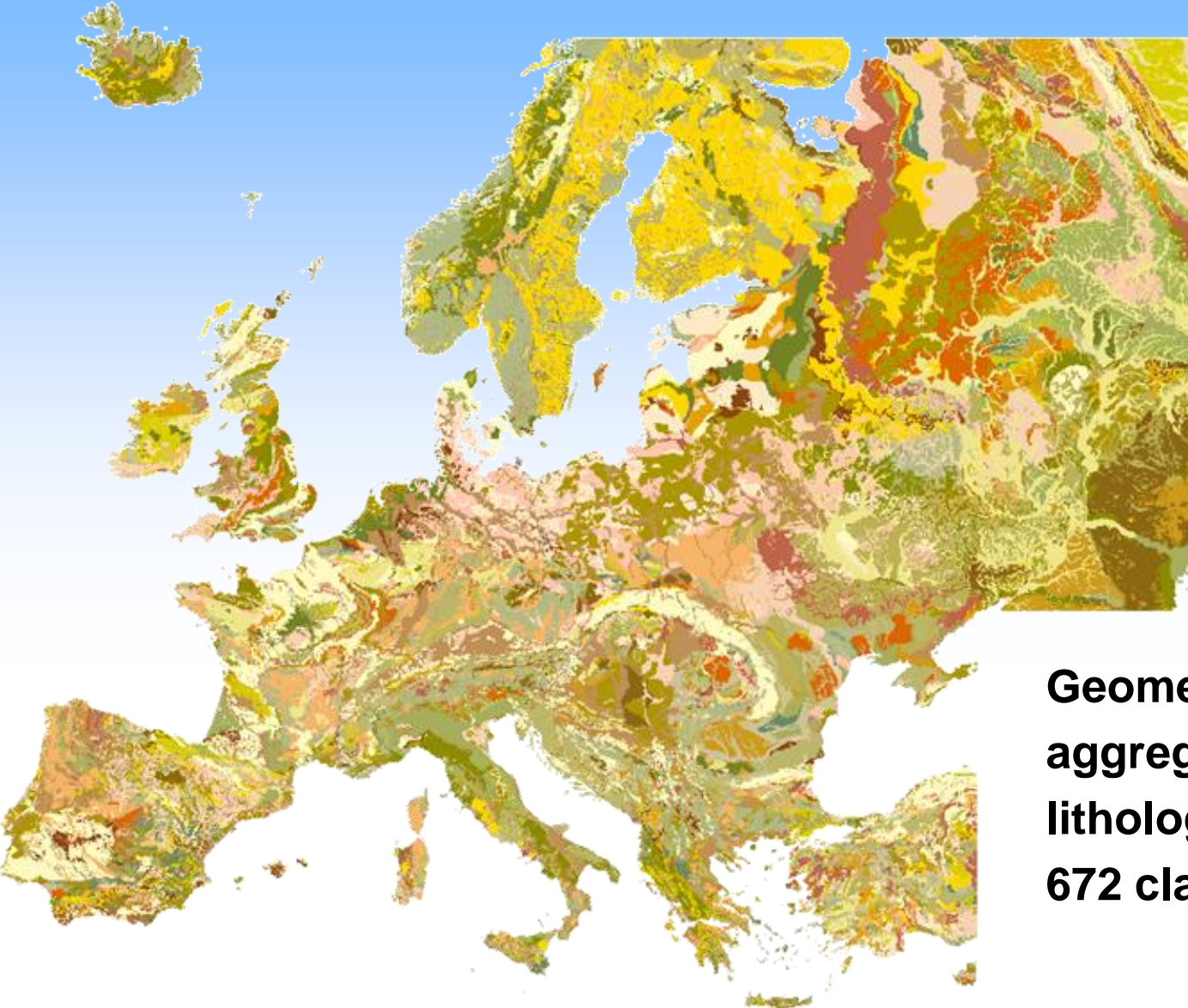
## Elimination of island classes and very small classes

- Sheet classes consisting of only one polygon (island classes) are merged with larger regional classes with similar descriptions
- Sheet classes  $< 100 \text{ km}^2$  are merged with larger regional classes with similar descriptions
- All 79 treated classes represent local varieties of regional lithologies
- Results in 672 classes





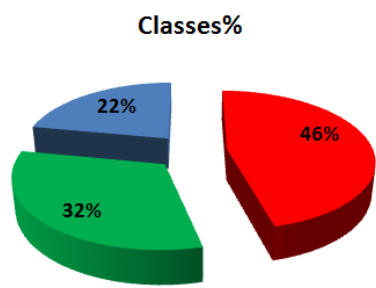
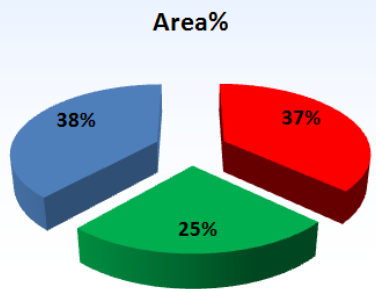
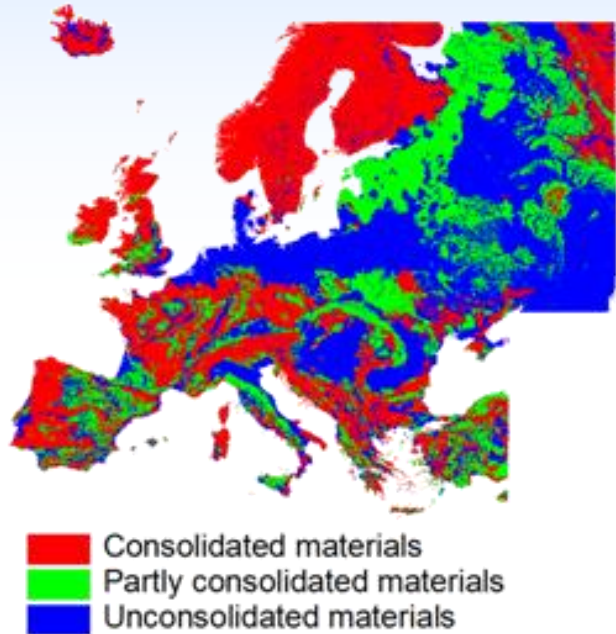
# Geometrically aggregated IHME 1500 lithology



**Geometrically aggregated IHME 1500 lithology comprising 672 classes**

# Proposed general taxonomy for IHME 1500 lithology

- IHME lithology describes material compositions of the uppermost aquifer systems throughout Europe (e.g., both consolidated and unconsolidated lithologies are incorporated).
- Highest aggregation level is a ternary map rendering spatial distribution of consolidated, partially consolidated and unconsolidated geologic materials.





# Proposed general taxonomy for IHME 1500 lithology

- To further group the geometrically aggregated and in terms of degree of consolidation partitioned lithologies, class descriptions have to be translated into a universal taxonomic scheme.
- Taxonomic scheme to be applied to both consolidated, partially consolidated and unconsolidated lithologies establishing an hierarchical structuring of major and minor components describing complex aquifer materials

$(\text{Mat\_U}_1, \text{C}_1), \dots (\text{Mat\_U}_n, \text{C}_n)$  [and]  $(\text{Mat\_C}_1, \text{U}_1), \dots (\text{Mat\_C}_n, \text{U}_n)$  [with] (specifics)

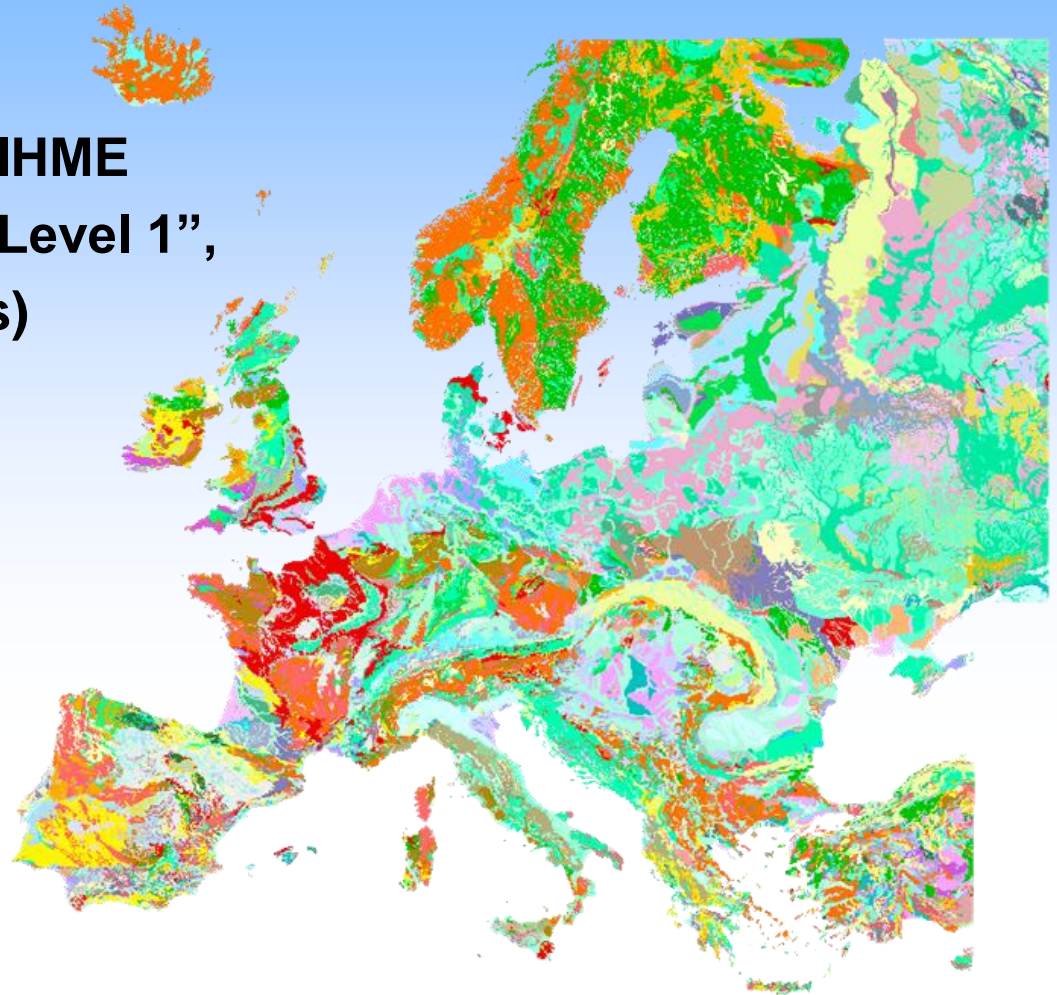
**Mat\_U**: Unconsolidated materials, **Mat\_C**: Consolidated materials

(e.g., “*Clays, marls and sandstones, limestones with gypsum*”)

# Semantic class aggregation: Translation (“Level 1”)

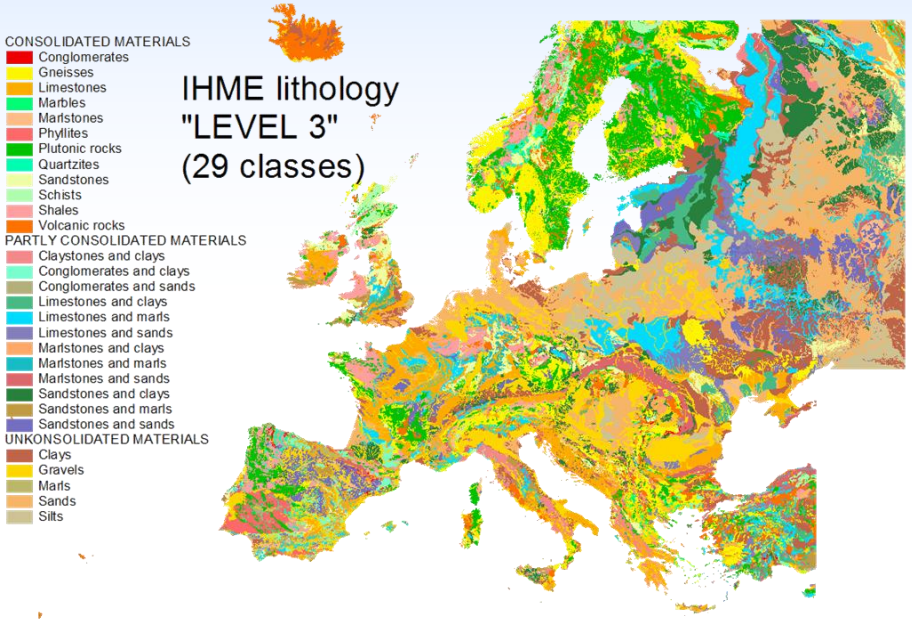
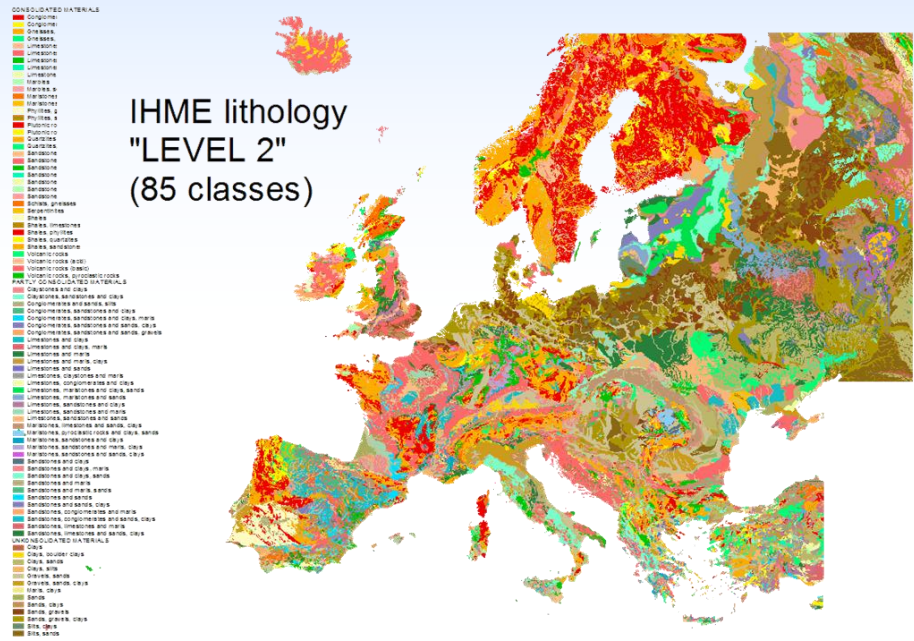
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Translated IHME lithology (“Level 1”, 204 classes)



# Semantic class aggregation: "Level 2" and "Level 3"

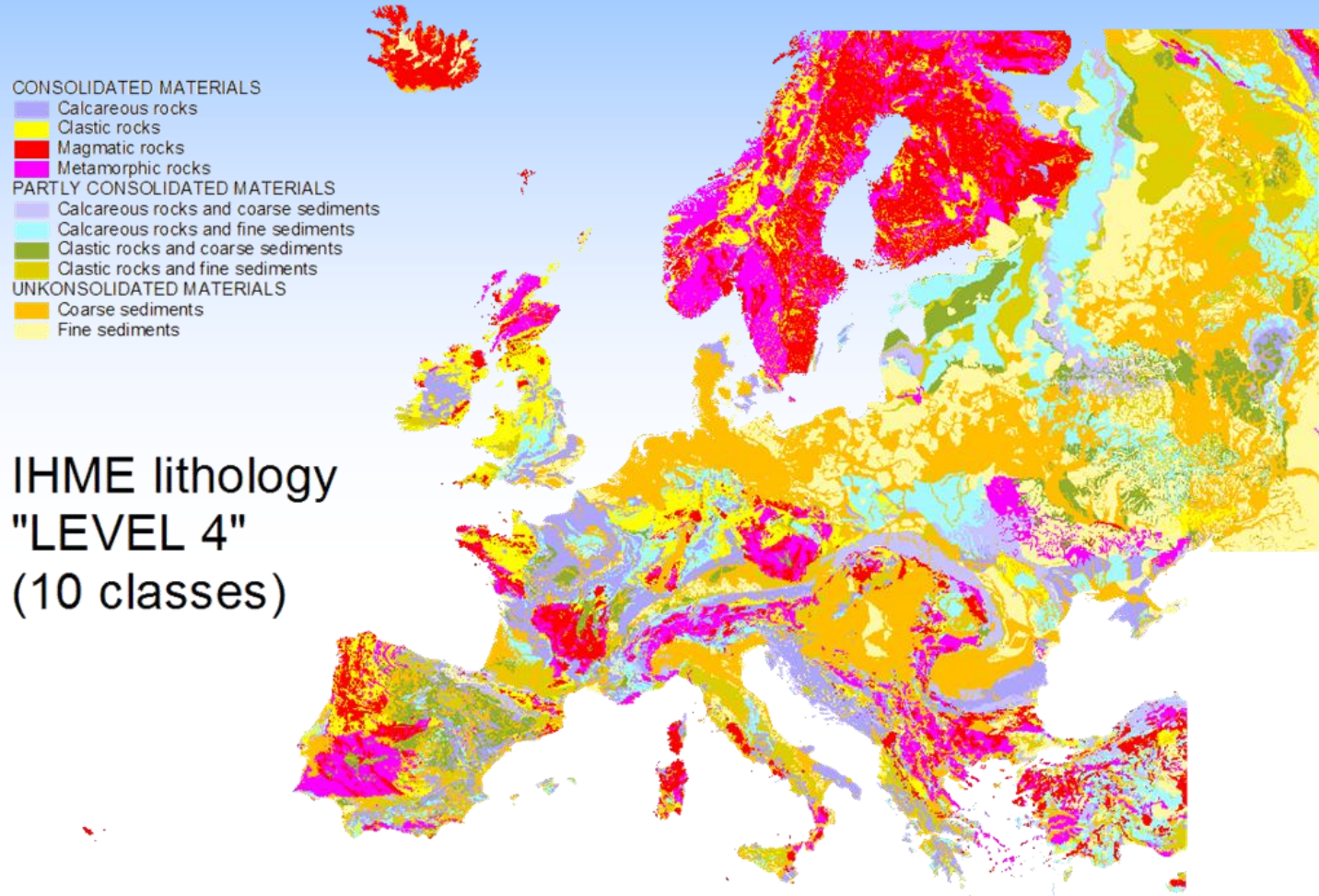
- "Level 2": Allows only two components, classes > 1000 km<sup>2</sup>, no classes in only one sheet (85 classes).
- "Level 3": Only allows for major component descriptions (29 classes)





# Semantic class aggregation: Grouping ("Level 4")

- Lithologies at highest IHME aggregation level (29 classes, "Level 3") were grouped in 10 lithological supergroups



IHME lithology  
"LEVEL 4"  
(10 classes)



# Semantic class aggregation: Consolidated lithologies

LEVEL 1 (n = 92)	LEVEL 2 (n = 38)	LEVEL 3 (n = 12)	LEVEL 4 (n = 4)	
Limestones	Limestones	Limestones	Calcareous rocks	
Dolomitic limestones				
Limestones (jointed, karstified)				
Limestones, marlstones				
Limestones, sandstones				
Limestones, shales				
Marlstones, claystones				
Marlstones, sandstones				
Marlstones, claystones with gypsum and salt				
Marlstones, claystones, shales, phyllites				
Marlstones, sandstones	Marlstones	Marlstones		
Conglomerates				
Conglomerates, sandstones				
Conglomerates, sandstones				
Conglomerates, sandstones, cherts, shales, dolomitic limestones, ophiolitic series				
Sandstones, phyllites, quartzites				
Sandstones				
Sandstones, claystones				
Sandstones, claystones, marlstones, limestones with gypsum				
Sandstones, conglomerates			Conglomerates	Conglomerates
Sandstones, conglomerates, shales, quartzites				
Sandstones, conglomerates, claystones, shales, marlstones				
Sandstones, limestones, shales, lignites				
Sandstones, marlstones				
Sandstones, marlstones, limestones, volcanic rocks (basic)				
Sandstones, shales				
Sandstones, shales, limestones				
Sandstones, shales, conglomerates, phyllites, volcanic rocks (basic)				
Sandstones, siltstones, claystones, limestones	Sandstones	Sandstones		
Sandstones, siltstones, claystones				
Sandstones, siltstones, claystones with gypsum				
Shales				
Shales, limestones				
Shales, phyllites				
Shales, quartzites				
Shales, sandstones				
Shales, sandstones, conglomerates				
Shales, sandstones, cherts, volcanic rocks			Shales	Shales
Plutonic rocks (acid to intermediate)				
Plutonic rocks (acid to intermediate, gneisses)				
Plutonic rocks (acid)				
Plutonic rocks (basic to intermediate)				
Plutonic rocks (basic)				
Volcanic rocks (jointed)				
Volcanic rocks				
Volcanic rocks, shales, sandstones, conglomerates, claystones, limestones				
Volcanic rocks, sandstones, shales, dolomitic limestones	Plutonic rocks	Plutonic rocks		
Volcanic rocks (acid)				
Volcanic rocks (acid to intermediate)				
Volcanic rocks (basic)				
Volcanic rocks (basic to intermediate, ophiolitic series)				
Volcanic rocks (basic to intermediate)				
Pyroclastic rocks				
Volcanic rocks, pyroclastic rocks				
Pyroclastic rocks, volcanic rocks, marlstones				
Volcanic rocks (acid), pyroclastic rocks, sandstones, shales			Volcanic rocks	Volcanic rocks
Gneisses, mica schists, amphibolites				
Gneisses, mica schists, migmatites				
Gneisses, plutonic rocks (acid)				
Marbles				
Marbles, schists, quartzites				
Phyllites, gneisses, shales, sandstones, volcanic rocks				
Phyllites, schists, quartzites				
Quartzites				
Quartzites				
Quartzites, conglomerates, sandstones, shales (jointed)	Gneisses	Gneisses		
Quartzites, conglomerates, phyllites, shales				
Quartzites, sandstones, shales, volcanic rocks				
Quartzites, sandstones, shales, limestones				
Quartzites, sandstones, shales				
Quartzites, sandstones, phyllites				
Quartzites, sandstones				
Schists, gneisses				
Serpentinites, ophiolitic series			Schists, gneisses	Schists
Serpentinites				
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Serpentinites				

# Semantic class aggregation: Partly consol. lithologies

LEVEL1 ( n = 87)	LEVEL2 ( n = 35)	LEVEL3 ( n = 12)	LEVEL4 ( n = 4)
Limestones and sands	Limestones and sands	Limestones and sands	Calcareous rocks and coarse sediments
Limestones, conglomerates, sandstones, marlstones and sands	Limestones, marlstones and sands		
Dolomitic limestones, marlstones, siltstones, sandstones and sands	Limestones, sandstones and sands		
Limestones (sandy), sandstones and sands, silts	Marlstones, limestones and sands, clays		
Limestones, sandstones and sands, gravel	Marlstones, sandstones and sands, clays	Marlstones and sands	
Limestones, sandstones and sands, clays	Limestones and clays	Limestones and clays	Calcareous rocks and fine sediments
Limestones, sandstones and sands, clay with gypsum	Limestones and clays, marls		
Limestones, sandstones and sands, silts, clays	Limestones, conglomerates and clays		
Marlstones, limestones, sandstones and sands, clays, marls	Limestones, marlstones and clays, sands		
Marlstones, sandstones and sands, clays	Limestones and marls	Limestones and marls	
Clays and dolomitic limestones	Limestones and marls, clays		
Clays, siltstones and clays	Limestones, claystones and marls		
Limestones and clays, fine sands	Limestones, sandstones and marls		
Clays, marls and limestones	Marlstones, pyroclastic rocks and clays, sands	Marlstones and clays	
Limestones, conglomerates, sandstones and clays	Marlstones, sandstones and clays	Marlstones and marls	
Clays, sands and dolomitic limestones, marlstones, sandstones	Conglomerates and sands, silts		
Dolomitic limestones, marlstones and clays with gypsum	Conglomerates, sandstones and sands, clays		
Limestones, marlstones and clays, sands, silts with gypsum	Conglomerates, sandstones and sands, gravels		
Clays and limestones, sandstones	Sandstones and sands	Sandstones and sands	Clastic rocks and coarse sediments
Clays, sands, gravels, marls and limestones, sandstones, conglomerates, pyroclastic rocks	Sandstones and sands, clays		
Limestones, sandstones, conglomerates, ophiolitic series and clays	Sandstones, conglomerates and sands, clays		
Pyroclastics and marls	Sandstones, limestones and sands, clays		
Dolomitic limestones and marls	Claystones and clays	Claystones and clays	
Marls and limestones	Conglomerates, sandstones and clays		
Dolomitic limestones and marls, clays	Conglomerates, sandstones and clays, marls		
Dolomitic limestones and marls, clays with gypsum	Sandstones and clays		
Limestones, ophiolitic series and marls, clays	Sandstones and clays, marls	Sandstones and clays	
Marls, clays and limestones with gypsum and anhydride	Sandstones and clays, sands		
Limestones, claystones, sandstones, conglomerates and marls, sands	Sandstones and marls		
Marls and claystones, limestones	Sandstones and marls, sands		
Limestones, calcarenites, sandstones and marls	Sandstones, conglomerates and marls	Sandstones and marls, sands	
Limestones, sandstones and marls	Sandstones, conglomerates and marls		
Limestones, sandstones, siltstones and marls	Marlstones, pyroclastic rocks and clays, sands		
Limestones, shales, sandstones and marls	Marlstones, sandstones and clays		
Limestones, siltstones, sandstones and marls, clays	Marlstones, sandstones and marls, clays	Marlstones and marls	
Marls and limestones, sandstones	Conglomerates and sands, silts	Conglomerates and sands	
Marls, clays, sands and limestones, sandstones	Conglomerates, sandstones and sands, clays		
Clays, sands and marlstones, pyroclastic rocks with gypsum	Conglomerates, sandstones and sands, gravels		
Marlstones, sandstones, conglomerates with lignites and clays	Sandstones and sands, clays		
Marlstones, sandstones, limestones and clays	Sandstones, conglomerates and sands, clays	Sandstones, conglomerates and sands, clays	
Marlstones, sandstones and marls, clays	Sandstones, limestones and sands, clays		
Silts, clays, sands, gravels and conglomerates	Claystones and clays		
Conglomerates, sandstones, limestones and sands, clays	Claystones, sandstones and clays		
Conglomerates (calcareous), sandstones and sands, clays, gravels	Conglomerates, sandstones and clays	Conglomerates and clays	
Conglomerates, sandstones and gravels, sands	Conglomerates, sandstones and clays, marls		
Calcareous and sands	Sandstones and clays		
Sandstones, shales, sandstones and clays	Sandstones and clays, marls		
Sandstones, clay and sandstones	Sandstones and clays, sands	Sandstones and clays	
Sandstones, silts, clays and sandstones	Sandstones and marls		
Sandstones, siltstones, conglomerates and clays	Sandstones and marls, sands		
Sandstones, shales and silts	Sandstones and marls, sands		
Sand, clays and sandstones, conglomerates	Sandstones and marls, sands	Sandstones and marls, sands	
Sand, silts, clays and sandstones	Sandstones, conglomerates and marls		
Sandstones, shales and sand, clay	Sandstones, conglomerates and marls		
Sand, clay and sandstones, limestones	Sandstones, limestones and sands, clays		
Sand, clay, marls and sandstones, phosphorites, lignites	Claystones and clays	Claystones and clays	
Clays and claystones, marlstones	Conglomerates, sandstones and clays		
Clays and shales (combustible)	Conglomerates, sandstones and clays, marls		
Clays and claystones, sandstones, conglomerates	Sandstones and clays		
Clays, sands, gravels, marls and claystones, sandstones, conglomerates	Sandstones and clays, marls	Sandstones and clays, marls	
Clays, marls and sandstones, conglomerates	Sandstones and clays, marls		
Clays, marls and sandstones, siltstones, limestones	Sandstones and clays, marls		
Clays, marls and sandstones, siltstones, limestones with gypsum	Sandstones and clays, marls		
Sandstones and clays, marl	Sandstones and clays, sands	Sandstones and clays, sands	
Clays, sands and sandstones	Sandstones and marls		
Clays, sands and sandstones with gypsum	Sandstones and marls, sands		
Clays, sands, gravels and sandstones with gypsum	Sandstones, conglomerates and marls		
Clays, sands, marls and sandstones, shales	Sandstones, limestones and marls	Sandstones, limestones and marls	
Marls and sandstones	Sandstones, conglomerates and marls		
Marls, sands, clays and sandstones	Sandstones, limestones and marls		
Marls, clays and sandstones, conglomerates, limestones with gypsum	Sandstones, limestones and marls		
Sandstones, shales, conglomerates, limestones and marls			
Marls and sandstones, limestones with gypsum			
Marls and sandstones, limestones, claystones			

# Semantic class aggregation: Unconsol. lithologies

LEVEL1 (n = 25)	LEVEL2 (n = 13)	LEVEL3 (n = 5)	LEVEL4 (n = 2)
Gravels, sands	Gravels, sands	Gravels	Coarse sediments
Valley fillings			
Gravels, sands covered by clays, silts	Gravels, sands, clays		
Gravels, sands, clays			
Sands	Sands	Sands	
Sands (glaucopitic)			
Sands, clays	Sands, clays		
Sands, silts, clays	Sands, gravels		
Sands, gravels			
Sands, gravels, boulders, clays, silts	Sands, gravels, clays		
Sands, gravels covered by clays, silts			
Sands, gravels, silts, clays			
Clays	Clays	Clays	Fine sediments
Clays, marls with gypsum			
Clays, boulder clays, silts, sands, gravels	Clays, boulder clays		
Clays, sands	Clays, sands		
Clays, sands, gravels	Clays, silts		
Clays, silts, sands			
Clays, silts, sands, gravels	Marls, clays	Marls	
Marls, clays			
Silts, clays, gravels, boulders		Silts, clays	
Silts, clays, sands			
Fine sands	Silts, sands		
Fine sands, silts, clays, gravels			

# Conclusions

- To build a harmonized lithological coverage from IHME lithological information, a 2-step procedure is proposed: 1. Geometrical aggregation, 2. Semantic aggregation using general taxonomy.
- General IHME lithology offers new opportunities for characterizing material properties of European aquifer systems.
- The presented semantic aggregation concept is so far only a draft that needs to be reviewed.
- A complete pan-European lithological dataset should be produced incorporating missing information from earlier (unpublished) IHME sheet drafts and using IGME 1500
- Digital availability of IHME 1500 lithology, IGME 1500 and (future) IQuaME 2500 offers new possibilities for cross-validation, further differentiation and combination of pan-European geological information.