Establishing the European Geological Surveys Research Area to deliver a Geological Service for Europe

EUROLITHOS European Ornamental Stone Resources

European Ornamental Stone Resources

Deliverables D4.1 – D4.2

Working version of the directory containing information from selected countries and Guideline for using the Directory

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1. INTRODUCTION

The Work package 4 of the EUROLITHOS project aims to develop a European "identity card" for ornamental stone to form the core of a European directory, which will represent the technical characterization of each stone. The Directory of Ornamental Stones will provide basic information regarding the composition of each stone, physical – mechanical properties, quality and "performance in use" criteria. This ornamental stone knowledge base will be under the umbrella of the existing European Geological Data Infrastructure (EGDI).

1.1 Scope and purpose

This document is the deliverables D4.1 and D4.2 – "Working version of the Directory containing information from selected countries M36" and "Guidelines for the Directory M36".

Main objectives of the Work Package 4 are to develop a pilot (aided by the IP) and establish a working directory for selected partner countries, accompanied by guidelines. There are many stone "libraries" and databases in the world which are being digitalized step - by - step. However, most of them are presently still under development or there is no accessibility. In addition, data from private companies display promotional materials (companies, suppliers) and contain a trade name of the materials and not a name according to EN 12440 – Denomination Criteria. Thus, the WP4 will create a harmonized database of the broad range of information available on ornamental stones which will be made public through the GeoERA information platform.

2. EUROLITHOS DIRECTORY

Eurolithos creates input to information platform of relevance to ornamental stone which includes database on specific stone types – directory of ornamental stone properties. The Eurolithos directory deals with the definition content of the "identity card", precisely the use of names and terminology, petrographic information, geological context, physical – mechanical properties, geochemical properties, performance criteria. It investigates and exploits existing standards and the need for additional data, which feeds into the D6.1, definitions and requirements for the IP (M0-6). It intends to establish structure for data delivery and storage, and connection to Atlas and other databases.

The purpose of the directory is to create pan-European databases with coordinated structure for data storage and comparability of their features, and to publish the directory for selected partner countries, accompanied by guidelines.
Figure 1 depicts the structure of the Eurolithos project and the cooperation between the work packages to establish a European Natural Stone information platform.

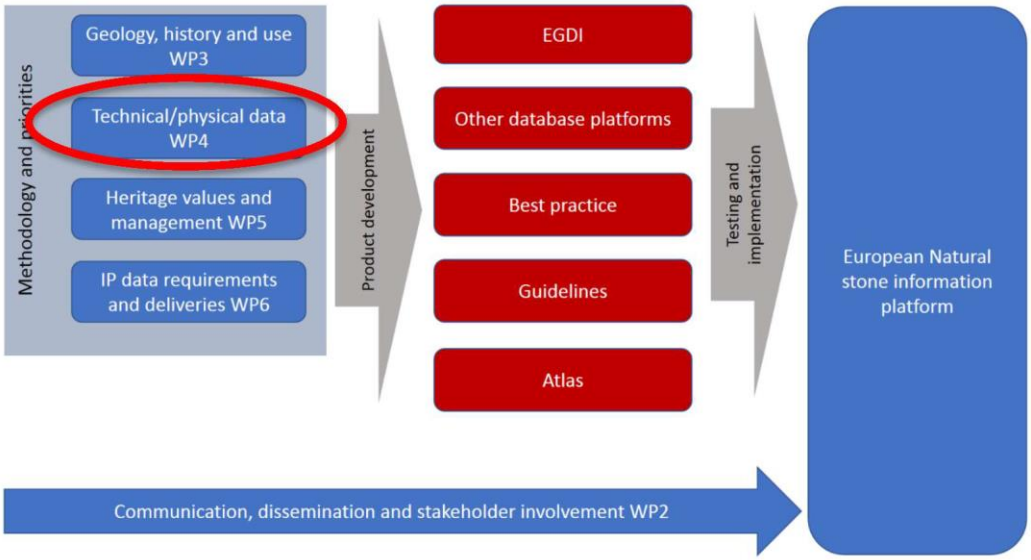

Figure 1: Structure and workflow of the Eurolithos project

3. THE DIRECTORY FRAMEWORK

The WP4 addresses one of the three main challenges, which is the need for a harmonised directory, or "identity card" for Ornamental stone. Thus, it focuses on the collection of data and the evaluation from active ornamental stone quarries for establishing a relevant evaluation database.
The framework of the directory consists of the "identity card" of each ornamental stone concerning the name of the stone according to the European standard EN 12440: Natural Stone – Denomination Criteria, its commodity type for distinguishing the main kinds of ornamental stones (i.e. marble, granite, limestone, etc) and its lithology (i.e. calcitic marble, gneiss, travertine, etc) and its typical colour based on the corresponding code list of Stone colours, according to the guidelines given in the context of Deliverable D.3.2, as well as its place of origin.
The "identity card" provides also information about petrography, mineralogical composition, physical – mechanical properties and chemical properties of each ornamental stone. Physical – mechanical properties determination is crucial for a

stone type, in order to specify its potential applications. Furthermore, data concerning geological setting of each stone quarried and applications, uses or heritage, are included in the Eurolithos Directory of Ornamental Stones.
For this, all partners are asked to provide a list of the ornamental stones quarried in their country with all the above information, for the Eurolithos Directory while this list could be updated in the future.

4. GUIDELINE FOR THE DIRECTORY

The template for filling in the characteristics for each ornamental stone described previously in the Directory framework in paragraph 3, is given in word document file which will be converted to portable document format (pdf) presented in paragraph 5. This pdf-downloadable factsheet for each unique ornamental stone should be uploaded to the corresponding egdi production repository in order for the database to be created. In particular the required information for filling in, are the following:

Name of natural stone: based on the European Standard EN 12440: Natural stone – Denomination Criteria which aims to unify the designation criteria of natural stone varieties, maintaining the traditional names and introducing terms of petrologic nature, typical colour and place of origin. The name of the natural stone may be its traditional or commercial name, and corresponds to a particular type of rock with a specific place of origin.
Short description: including a representative photograph and the macroscopic characterization of the ornamental stone. The macroscopic description should include the colour, the rock structure (joints, bedding, stylolites, etc), grain size, macroscopic cracks, pores, cavities, weathering and alteration, macrofossils, xenolithic or autolithic inclusions.
Commodity: referring to rocks of igneous, sedimentary or metamorphic origin and precisely, basalt, granite, limestone, marble, sandstone, slate, miscellaneous ornamental stones (as demonstrated in Table 5 -Deliverable 3.2: Country-level and European-level Atlas templates for harmonized data).
Lithology: correspondingly, detailed information about the vocabulary of lithology is presented in Deliverable 3.2. For example, calcitic marble, dolomitic marble, dolomite, travertine, dolomitic limestone, andesite, monzonite, greywacke, schist, serpentinite, etc are common lithologies used as ornamental stones.
The link which provides the vocabulary of commodity and lithology of ornamental stones is the following:
https://data.geoscience.earth/ncl/geoera/eurolithos/CommodityCodeValue

Typical colour: means the range of colour that a stone variety shows which is obtained by a visual impression under shadow natural light. Partners have suggested a list of stone colours that they considered relevant to be part of the Eurolithos Code List of Stone Colours. Thus, the typical colour of each stone should be selected according to the new created list of colours.

Place of origin: is the location of the area or quarry from where the ornamental stone is extracted, including the Country, the County/District or Province, the Municipality/Community and the City/Town or Village.

Geological Setting: providing the relevant geological map and information about the geology of the area where the ornamental stone is quarried referring also to the geological age and unit as well as to production data.

Application, use and heritage: brief description of uses and applications of each stone in remarkable constructions, either historical (i.e. monuments, ancient buildings, statues, etc.) or new structures including relevant photographic record of examples.

Petrography: including photographic record of a thin section of each stone (i.e. microphotograph) and microscopic description which includes fabric, constituents, discontinuities, alterations. The petrographic classification is assigned to each stone using the European Standard EN 12670: Natural stone – Terminology, which establishes the terminological bases for geological and petrologic definitions of natural stone and its classification.

Mineral composition: is determined by the petrographic examination according to EN 12407, and it identifies the main, subordinate or accessory minerals composing the natural stone (i.e. calcite, quartz, feldspar, dolomite, mica, orthoclase, etc).

Physical-Mechanical properties: Test methods are carried out at the laboratory to determine physical–mechanical properties mainly in compliance of European Standards EN or other relevant Standards (i.e. ASTM), being fully harmonized with the current practice in EU Member–States. The main physical–mechanical properties proposed for the Eurolithos Directory to form the "identity card" of an ornamental stone, are shown in Table 1.

Chemical properties: including the main elements (i.e. SiO_2, Al_2O_3, Cao, MnO, LOI, etc), the trace elements (i.e. V, Cr, Mn, Ni, Cu, Sr, As, Ag, U, etc) and the rare earths (i.e. La, Ce, Pr, Nd, Eu, Lu, etc).

During the uploaded process of each pdf, point location or rectangle of a wider area with corner coordinates should be chosen for each ornamental stone. *x & y coordinates of each stone* should be given according to specific coordinate system (using decimal degrees wgs84), determining the position of the area where the stone is quarried, as precisely as possible.

Table 1: Main physical-mechanical properties and corresponding EN Standards

Physical-Mechanical properties	EN Standard
Apparent density	EN 1936
Real density	EN 1936
Open porosity	EN 1936
Total porosity	En 1936
Water absorption at atmospheric pressure	EN 13755
Water absorption coefficient by capillary	EN 1925
Uniaxial compressive strength	EN 1926
Flexural strength under concentrated load	EN 12372
Flexural strength under constant moment	EN 13161
Frost resistance	EN 12371
Abrasion resistance	EN 14157
Resistance to ageing by thermal shock	EN 14066
Resistance to salt crystallization	EN 12370
Breaking load at dowel hole	EN 13364
Slip resistance	EN 14231
Rupture energy	EN 14158
Thermal conductivity	EN 1745

Use of the data provided

In the case of mineral composition, physical-mechanical properties and chemical properties, the figures given in the directory should be considered as indicative only, unless link to traceable laboratory data is provided.

5. TEMPLATE FOR OUTPUTTING ORNAMENTAL STONE'S CHARACTERISTICS

The final version of the template for outputting all the aforementioned information concerning the characteristics of each ornamental stone is presented in the following pages. The corresponding created pdf for each stone, updated to the EGDI repository, will be downloadable. The same files will be also included in a printable edition of an Atlas of European Ornamental Stones.

EUROLITHOS European Ornamental Stone Resources

GeoERA RAW MATERIALS

Unique Name

Alternative name 1

Alternative name 2

Picture of stone surface; either 1) use scale on photo, 2) use the black box below, 3) indicate approximate scale in the black box below

scale

Short description:

Commodity (vocabulary)	Lithology (vocabulary)	Typical colour (code list)	Place of origin			
			Country	County / District / Province	Municipality / Community	Place/town / Village

Figure 1: Contents of the template for displaying characteristics of the ornamental stone (first page)

EUROLITHOS

GeoERA

Geological setting

Map showing geological setting

Geology:

Production:

Geological age: Geological period/era and/or exact age

Geological unit: Geological unit name

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Figure 2: Contents of the template for displaying characteristics of the ornamental stone (2nd page)

EUROLITHOS

GeoERA

Application, use and heritage

Description:

Picture showing example o fuse; it is possible to have several examples

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Figure 3: Contents of the template for displaying characteristics of the ornamental stone (3rd page)

EUROLITHOS

GeoERA

Petrography

Photomicrograph, thin section or other

Description:

Source of information:

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Figure 4: Contents of the template for displaying characteristics of the ornamental stone (4th page)

EUROLITHOS European Ornamental Stone Resources

GeoERA RAW MATERIALS

Mineral composition

If no accurate number, use MM=main minerals, SM = Subordinate minerals, AM=accessory minerals

Mineral 1 (%)	Mineral 2 (%)	Mineral 3 (%)	Mineral 4 (%)	Mineral 5 (%)	Mineral 6 (%)	Mineral 7 (%)
Mineral 8 (%)	Mineral n (%)					

Source of information:

CC BY

Figure 5: Contents of the template for displaying characteristics of the ornamental stone (5th page)

EUROLITHOS

GeoERA

Physical properties

Apparent density (EN 1936) kg/m3	Open porosity (EN 1936) % vol	Water absorption at atmospheric pressure (EN 13755) % wt	Uniaxial Compressive strength (EN 1926) MPa	Flexural strength under concentrated load (EN 12372) MPa

Real density (EN 1936) kg/m3	Total porosity (EN 1936) % vol	Water absorption coefficient by capillary (EN 1925) (g/m2 x s0,5)	Flexural strength under constant moment (EN 13161) MPa

Frost resistance (EN 12371)				
Technological Test (Test A)				Identification Test (Test B): Number of cycles completed prior to stone failure
Flexural strength (EN 12372) after freeze-thaw cycling, MPa	Number of cycles	Uniaxial compressive strength (EN 1926) after freeze-thaw cycling, MPa	Number of cycles	

Resistance to ageing by thermal shock (EN 14066)			
Change in dynamic modulus of elasticity (increase: +; decrease: -) %	Change in open porosity (increase: +; decrease: -) %	Change in ultrasound pulse velocity (increase: +; decrease: -) %	Change in flexural strength under conc. load (increase: +; decrease: -) %

Abrasion resistance (EN 14157)			Resistance to salt crystallisation (EN 12370)	Breaking load at dowel hole (EN 13364)	
Method A - Wide Wheel Abrasion Test, mm	Method B - Böhme Abrasion Test, $cm^3/50cm^2$	Method C - Amsler Abrasion Test, mm	Change in mass (increase: +; decrease: -), %	Breaking load, N	Thickness of the test specimens, mm

Slip resistance by means of the pendulum tester (EN 14231 / CEN/TS 16165)			Rupture energy (EN 14158), Joule	Thermal Conductivity (EN 1745), W/m·K
Tested surface finish	Slip Resistance Value — SRV			
	Dry test condition	Wet test condition		

Source of information:

CC BY

Figure 6: Contents of the template for displaying characteristics of the ornamental stone (6th page)

Chemical properties

Main elements

SiO_2 (%)	Al_2O_3 (%)	Fe_2O_3 (%)	TiO_2 (%)	MgO (%)	CaO (%)	Na_2O (%)	K_2O (%)	MnO (%)	P_2O_5 (%)	SO_3 (%)	LOI (%)

Trace elements

V (ppm)	Cr (ppm)	Mn (ppm)	Co (ppm)	Ni (ppm)	Cu (ppm)	Zn (ppm)	As (ppm)
Sr (ppm)	Cd (ppm)	Ba (ppm)	Pb (ppm)	Be (ppm)	Rb (ppm)	Bi (ppm)	U (ppm)
Sc (ppm)	Y (ppm)	Th (ppm)	Sb (ppm)	Ta (ppm)	Nb (ppm)	Zr (ppm)	Sn (ppm)
Ag (ppm)	B (ppm)	Mo (ppm)	W (ppm)	Ga (ppm)	Ge (ppm)	Se (ppm)	Cs (ppm)
Tl (ppm)							

REE

La (ppm)	Ce (ppm)	Pr (ppm)	Nd (ppm)	Sm (ppm)	Eu (ppm)	Gd (ppm)	Tb (ppm)
Dy (ppm)	Ho (ppm)	Er (ppm)	Tm (ppm)	Yb (ppm)	Lu (ppm)		

Methods applied and source of information:

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Figure 7: Contents of the template for displaying characteristics of the ornamental stone (7th page)

EUROLITHOS

GeoERA

Sources of more information

Type of information	Name of provider	URL
This data sheet		
Non-commercial directory		
Commercial directory		
Scientific publication		
Other publication		

Compiled by:		Logo

Figure 8: Contents of the template for displaying characteristics of the ornamental stone (last page)

ANNEX A - AN EXAMPLE:
FACTSHEET FILLED IN FOR THASSOS CRYSTALLINA SEMI WHITE

Thassos Crystallina Semi White

Scale 1:1

Short description: Medium grained semi white calcitic marble with large calcite crystals.

Commodity (vocabulary)	Lithology (vocabulary)	Typical colour (code list)	Place of origin			
			Country	County / District / Province	Municipality / Community	Place/town / Village
Marble	Calcitic marble	Semi White	Greece	East Macedonia and Thrace	Thassos	Theologos

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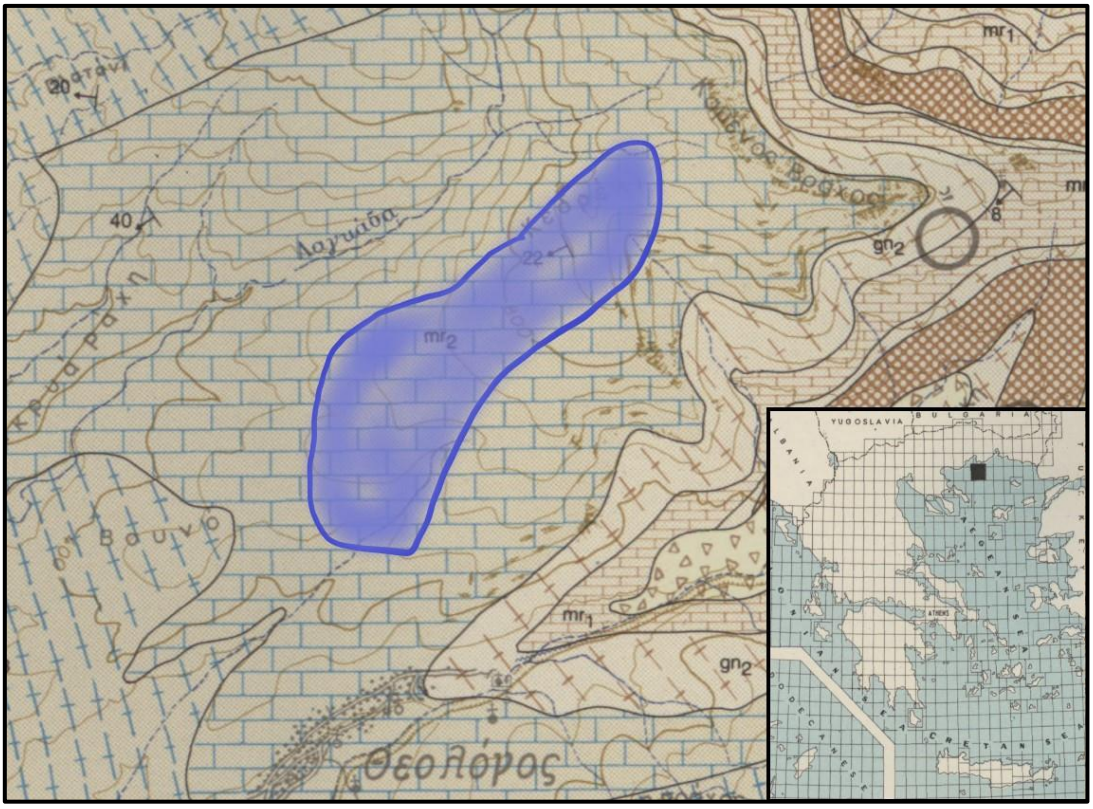
Geological setting



Geology: Thassos Crystallina Semi White (blue curve) is a metamorphic rock belonging to the carbonate marbles of Rhodope Mass area, which is part of the region of East Macedonia and Thrace.
(Source: Geological Map of Greece 1:50000, Thassos Sheet).

Production: The most important quarry area is near the village of Theologos, in the central part of the island of Thasos.

Geological age: -
Geological unit: Metamorphic system

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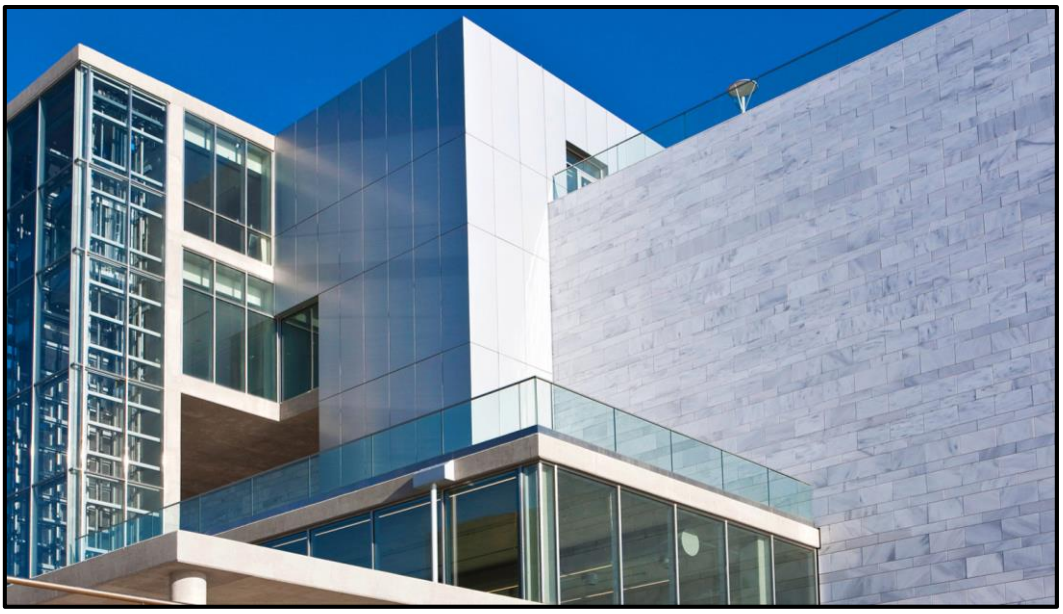
Application, use and heritage

Description: Thassos Crystallina Semi White marble has been used in various construction projects. It provides a high reflection of sunlight and holds its cool temperature, making it perfect suitable for claddings in warmer regions. Being a marble with high strength properties, it is suitable for interior and exterior use, wall cladding, flooring, stairs, and other design projects.



Thessaloniki Concert Hall: External Cladding finished in October 2010.

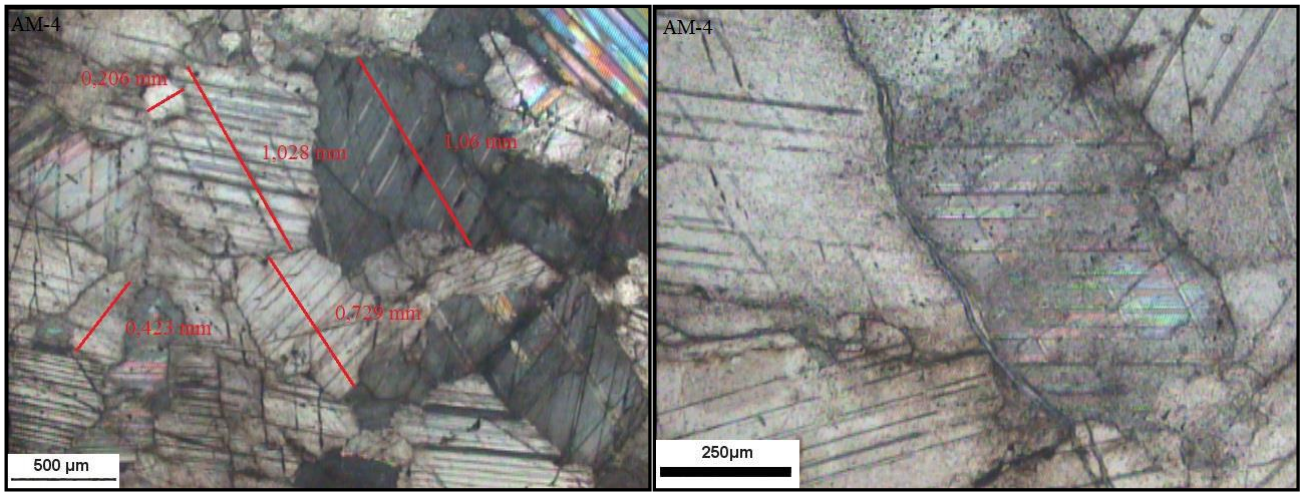
(photo: http://www.tch.gr/)

Pavement recreation with Thassos Crystallina Semi White marble.

Alyki Ancient Quarries of Thassos Crystallina Semi White marble.

CC BY

Petrography



Description: Photomicrograph of thin section, showing calcite crystals and veins filled with calcite of sencondary origin.

Source of information: Hellenic Survey of Geology and Mineral Exploration

Mineral composition

If no accurate number, use MM=main minerals, SM = Subordinate minerals, AM=accessory minerals

Calcite (%)	**Apatite (%)**	**Sphalerite (%)**				
100	AM	AM				

Source of information: Hellenic Survey of Geology and Mineral Exploration

Physical properties

Apparent density (EN 1936) kg/m^3	Open porosity (EN 1936) % vol	Water absorption at atmospheric pressure (EN 13755) % wt	Uniaxial Compressive strength (EN 1926) MPa	Flexural strength under concentrated load (EN 12372) MPa
2710	0,2	0,1	71	10,6

Real density (EN 1936) kg/m^3	Total porosity (EN 1936) % vol	Water absorption coefficient by capillary (EN 1925) (g/m^2 x s^{0,5})	Flexural strength under constant moment (EN 13161) MPa
-	-		

Frost resistance (EN 12371)				
Technological Test (Test A)				Identification Test (Test B): Number of cycles completed prior to stone failure
Flexural strength (EN 12372) after freeze-thaw cycling, MPa	Number of cycles	Uniaxial compressive strength (EN 1926) after freeze-thaw cycling, MPa	Number of cycles	
7,9	48			

Resistance to ageing by thermal shock (EN 14066)			
Change in dynamic modulus of elasticity (increase: +; decrease: -) %	Change in open porosity (increase: +; decrease: -) %	Change in ultrasound pulse velocity (increase: +; decrease: -) %	Change in flexural strength under conc. load (increase: +; decrease: -) %
-		-	

Abrasion resistance (EN 14157)			Resistance to salt crystallisation (EN 12370)	Breaking load at dowel hole (EN 13364)	
Method A - Wide Wheel Abrasion Test, mm	Method B - Böhme Abrasion Test, cm^3 / 50cm^2	Method C - Amsler Abrasion Test, mm	Change in mass (increase: +; decrease: -), %	Breaking load, N	Thickness of the test specimens, mm
-	20	-	-	1400	3

Slip resistance by means of the pendulum tester (EN 14231 / CEN/TS 16165)			Rupture energy (EN 14158), Joule	Thermal Conductivity (EN 1745), W/m·K
Tested surface finish	Slip Resistance Value — SRV			
	Dry test condition	Wet test condition		
			5	-

Source of information: Hellenic Survey of Geology and Mineral Exploration

Chemical properties

Main elements

SiO_2 (%)	Al_2O_3 (%)	Fe_2O_3 (%)	TiO_2 (%)	MgO (%)	CaO (%)	Na_2O (%)	K_2O (%)	MnO (%)	P_2O_5 (%)	SO_3 (%)	LOI (%)
<0,10	<0,10	<0,10	<0,10	0,60	51,80	3,90	0,18	<0,05	-	-	42,70

Trace elements

V (ppm)	Cr (ppm)	Mn (ppm)	Co (ppm)	Ni (ppm)	Cu (ppm)	Zn (ppm)	As (ppm)
0,3	27	25	2,0	12	3,0	24	2,7
Sr (ppm)	Cd (ppm)	Ba (ppm)	Pb (ppm)	Be (ppm)	Rb (ppm)	Bi (ppm)	U (ppm)
170	0,7	46	5,5	0,2	18	<0,1	0,2
Sc (ppm)	Y (ppm)	Th (ppm)	Sb (ppm)	Ta (ppm)	Nb (ppm)	Zr (ppm)	Sn (ppm)
18	3,5	0,5	1,1	3,0	4,7		
Ag (ppm)	B (ppm)	Mo (ppm)	W (ppm)	Ga (ppm)	Ge (ppm)	Se (ppm)	Cs (ppm)
Tl (ppm)							

REE

La (ppm)	Ce (ppm)	Pr (ppm)	Nd (ppm)	Sm (ppm)	Eu (ppm)	Gd (ppm)	Tb (ppm)
Dy (ppm)	Ho (ppm)	Er (ppm)	Tm (ppm)	Yb (ppm)	Lu (ppm)		

Methods applied and source of information: Hellenic Survey of Geology and Mineral Exploration

Sources of more information

Type of information	Name of provider	URL
This data sheet	Hellenic Survey of Geology and Mineral Exploration	https://www.eagme.gr/
Non-commercial directory		
Commercial directory		
Scientific publication		
Other publication	Thessaloniki Concert Hall	http://www.tch.gr/

Compiled by:	**Hellenic Survey of Geology and Mineral Exploration (H.S.G.M.E.)** https://www.eagme.gr/	

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ANNEX B:
GUIDE FOR UPLOADING

Eurolithos uploading directory documents (pdf)

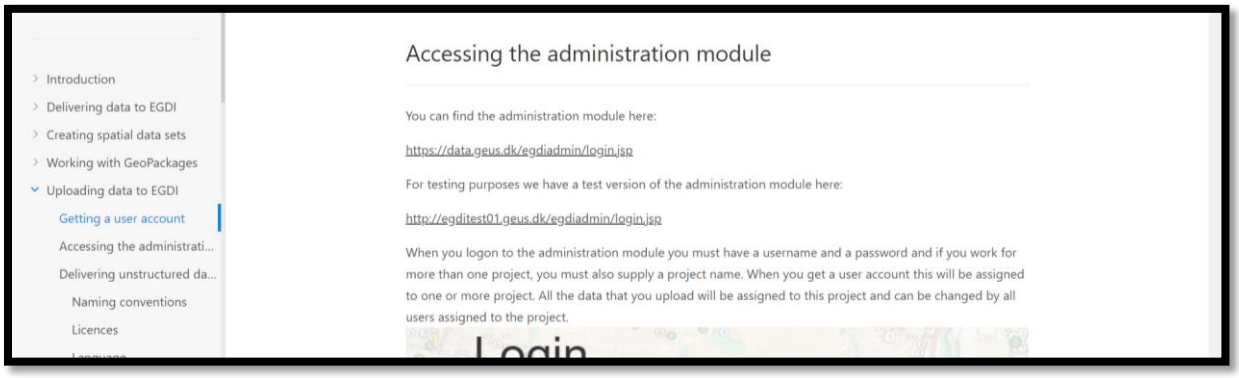
Description/tutorial:

http://egdi-public.gitlabpages.geus.dk/egdi-documentation/#/main-content/AdministrationModule

Get access/login rights

Send name and email to Project Lead, who will pass that on. When you have got confirmation, you can continue. (Note: As default, PL ask for access to both test and production Version).

Access uploading

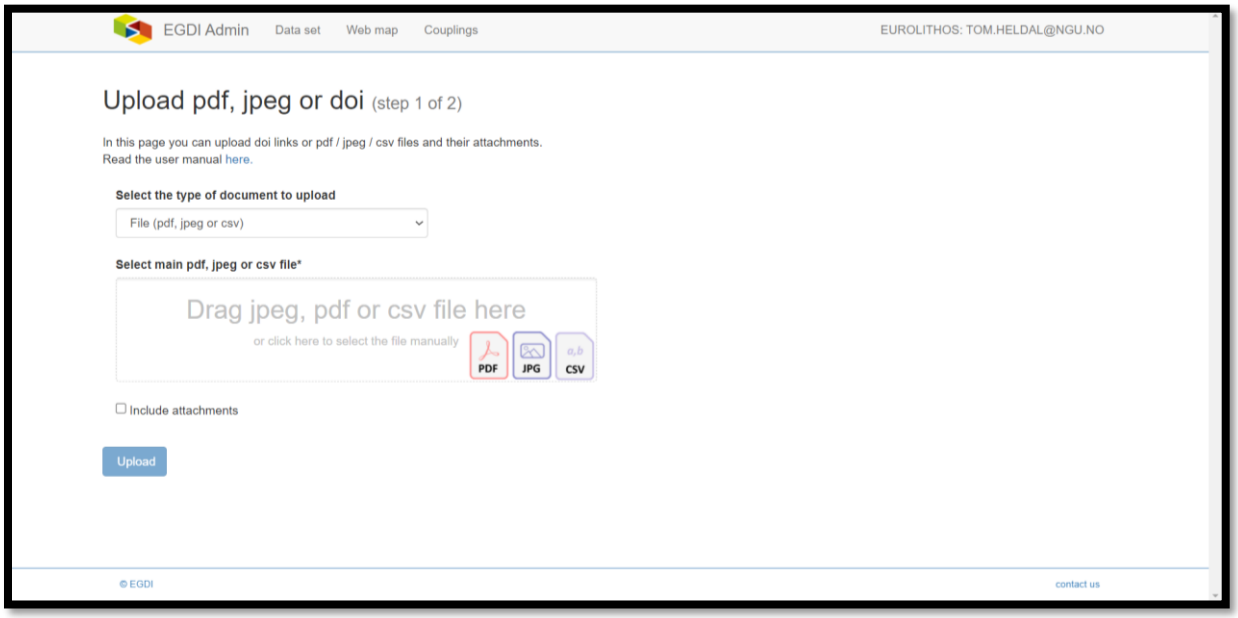


First, in the guidelines, choose between administration module (openly published to EGDI) or test version (for trial and testing without publishing).

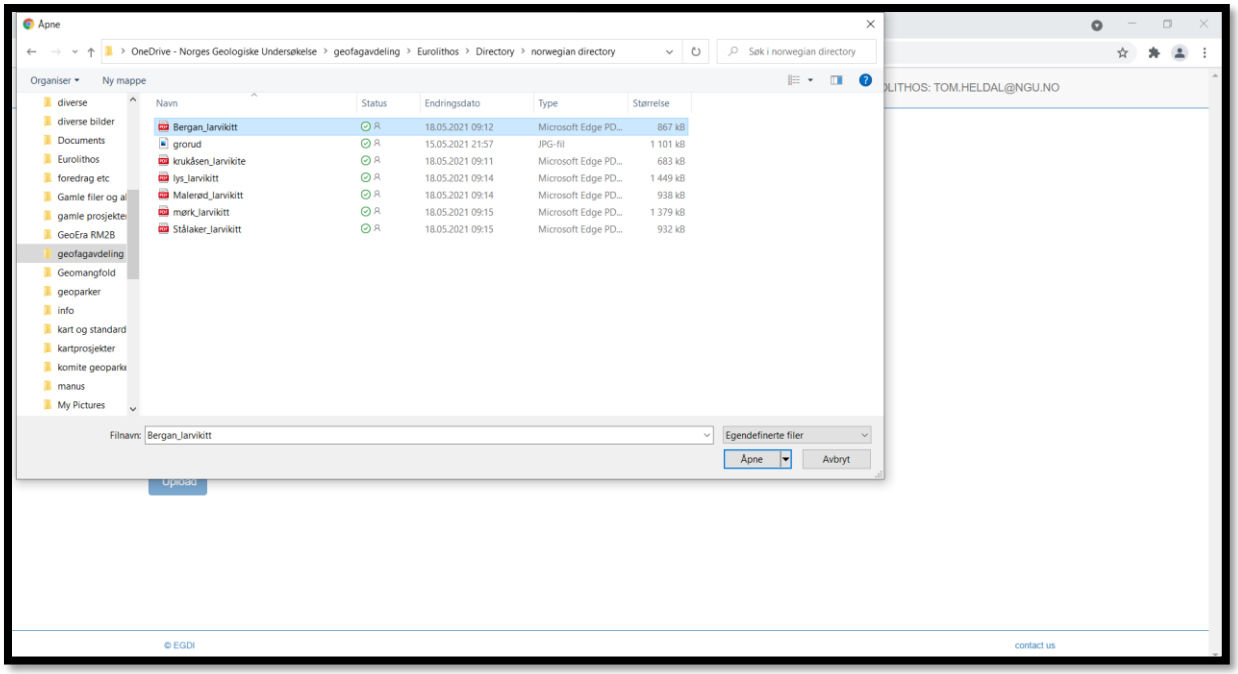
Note: Data uploaded to the EGDI test repository is for test purposes only. To make the data public the pdf's must be uploaded to the production repository once testing is concluded.

Start uploading (same for both versions)

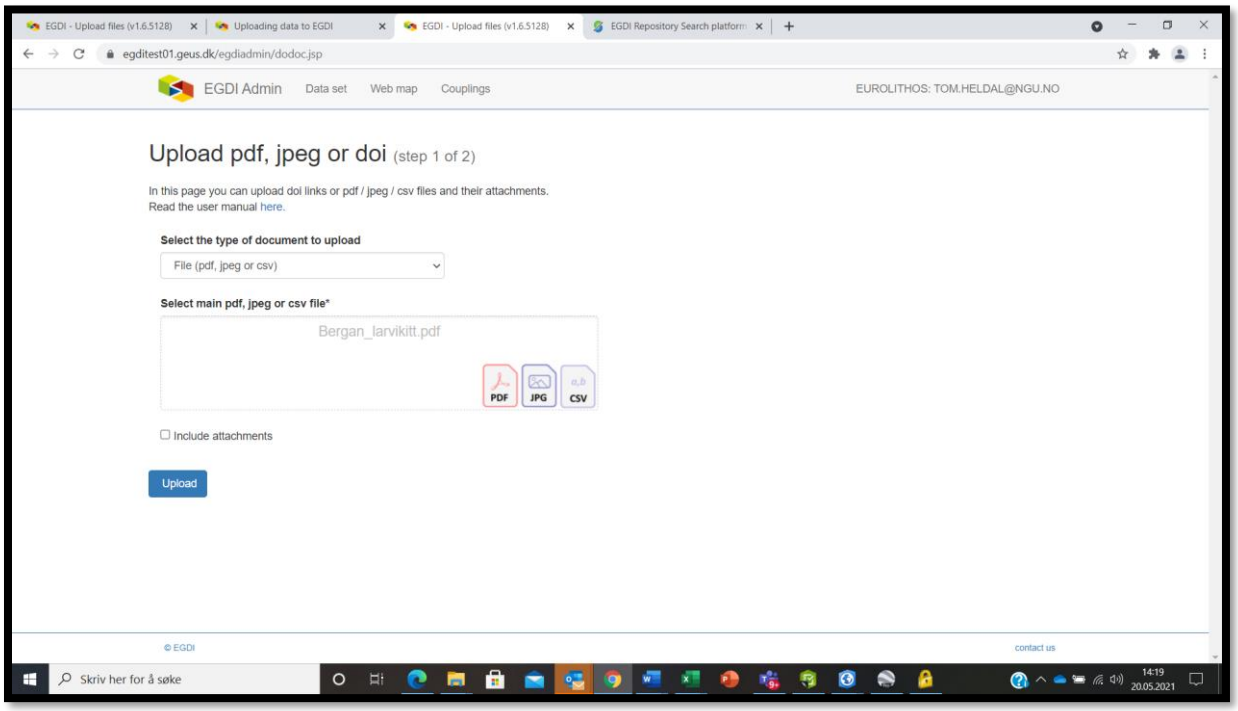
You will see this screen with your name top right. You have two options. Upload or edit documents



You will see this screen. Click on pdf.



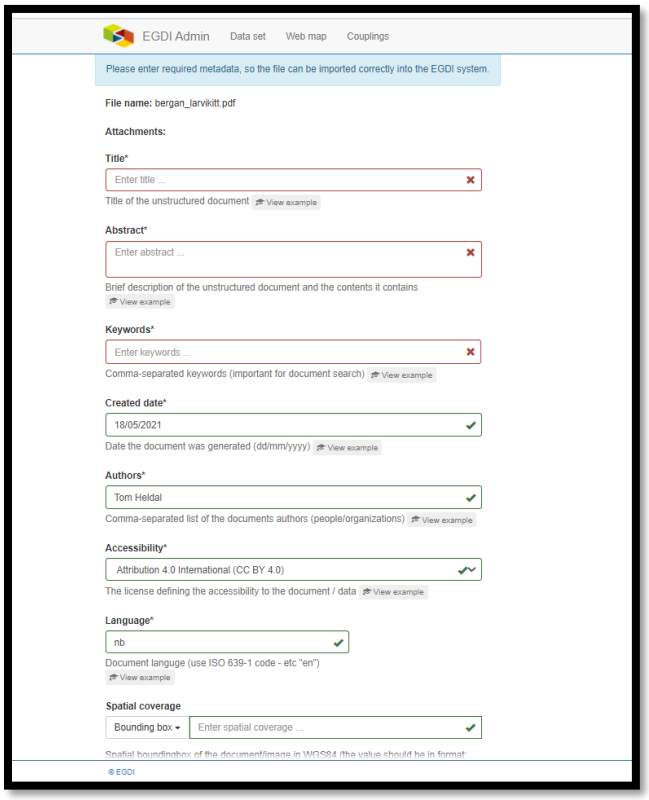
Find you file and open



You will then see your file name in the box. Click Upload.

You will now be asked to fill in metadata. More about this below.

Adding Metadata



You will see a list of metadata to add. Step by step below:

“Title” should be same as the main unique name you have decided.

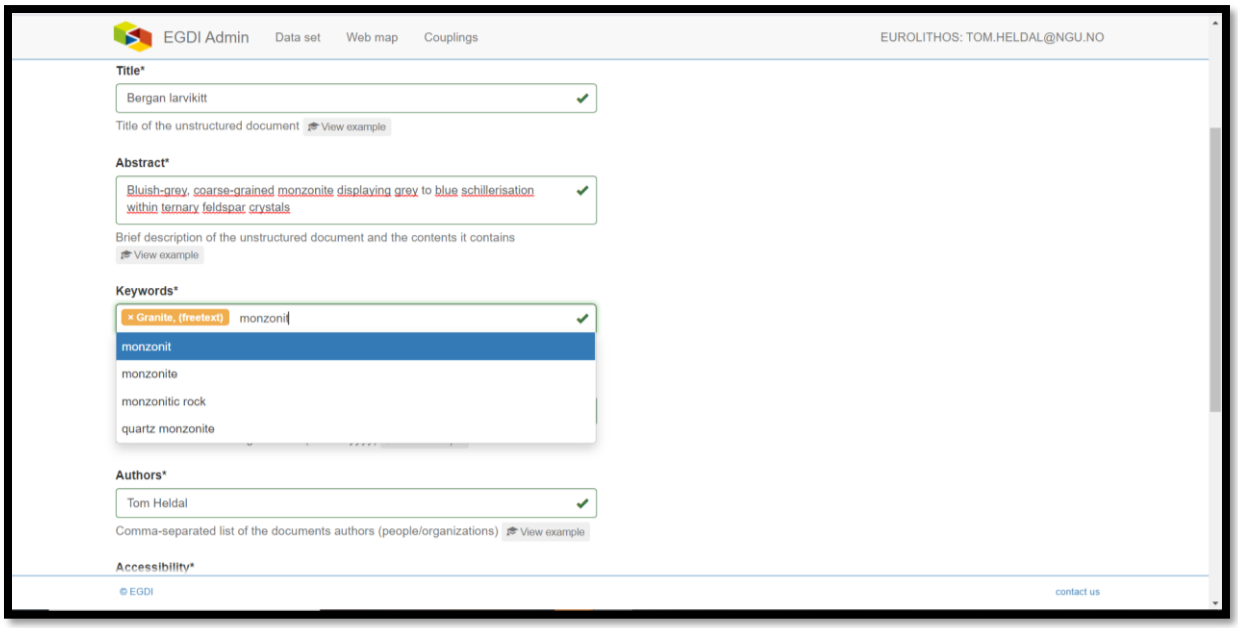
5 centimeters

Short description: Bluish-grey, coarse-grained monzonite displaying grey to blue schillerisation within ternary feldspar crystals. The image displays a polished surface.

Commodity (vocabulary)	Lithology (vocabulary)	Typical colour (code list)	Place of origin			
			Country	County / District / Province	Municipality / Community	Place/town / Village
Commercial Granite	Monzonite	Dark grey	Norway	Vestfold-Telemark	Larvik	Bergan

«Abstract» should be the generic part of short description.

“Key-words” should be commodity, lithology, colour and country. You may also include others if you like from specific needs.



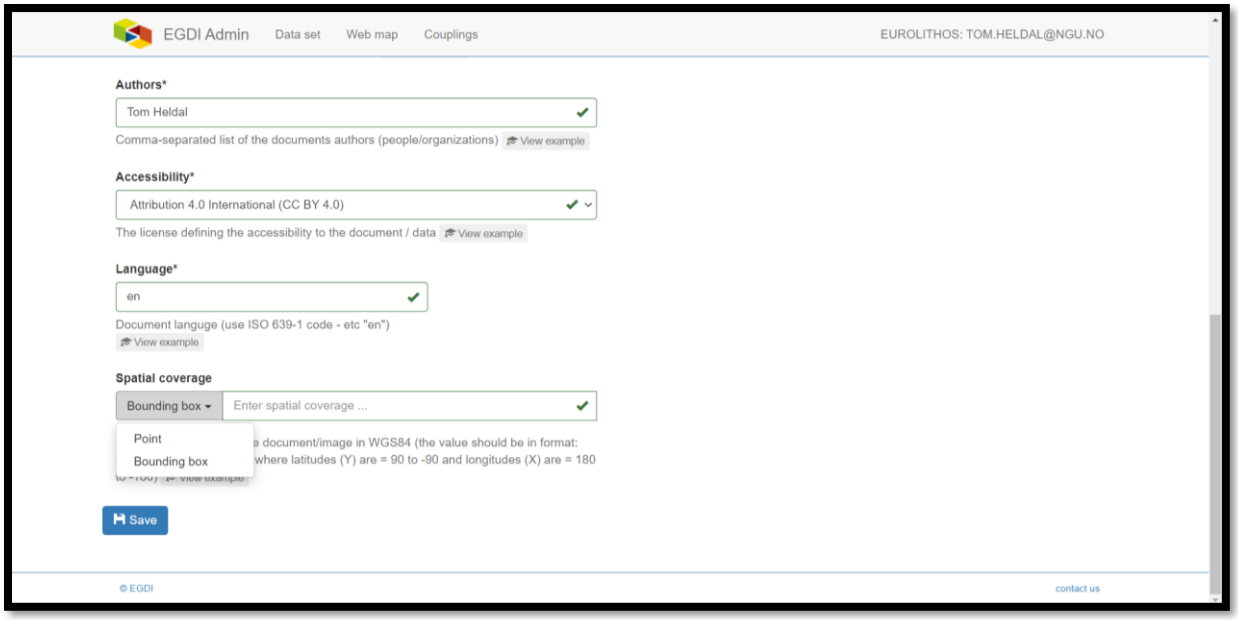
When you fill in keywords: there are terms in the different vocabularies, so if you write “monzoni” there will come up a list to choose from.

Please us this vocabulary for commodity and lithology:

project vocabularies (schmar00.github.io)

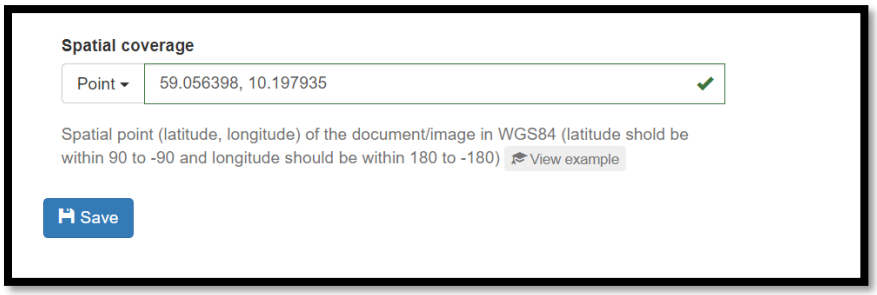
Please use this list for colours:

Ornamental Stones colour values
Beige
Black
Black-Green
Blue
Blue-Grey
Brown
Dark Grey
Green
Grey
Grey-Brown
Grey-Green
Light-Grey
Light-Pink
Multicoloured
Pink
Red
Reddish Brown
White
Semi-white
White-Black
Yellow



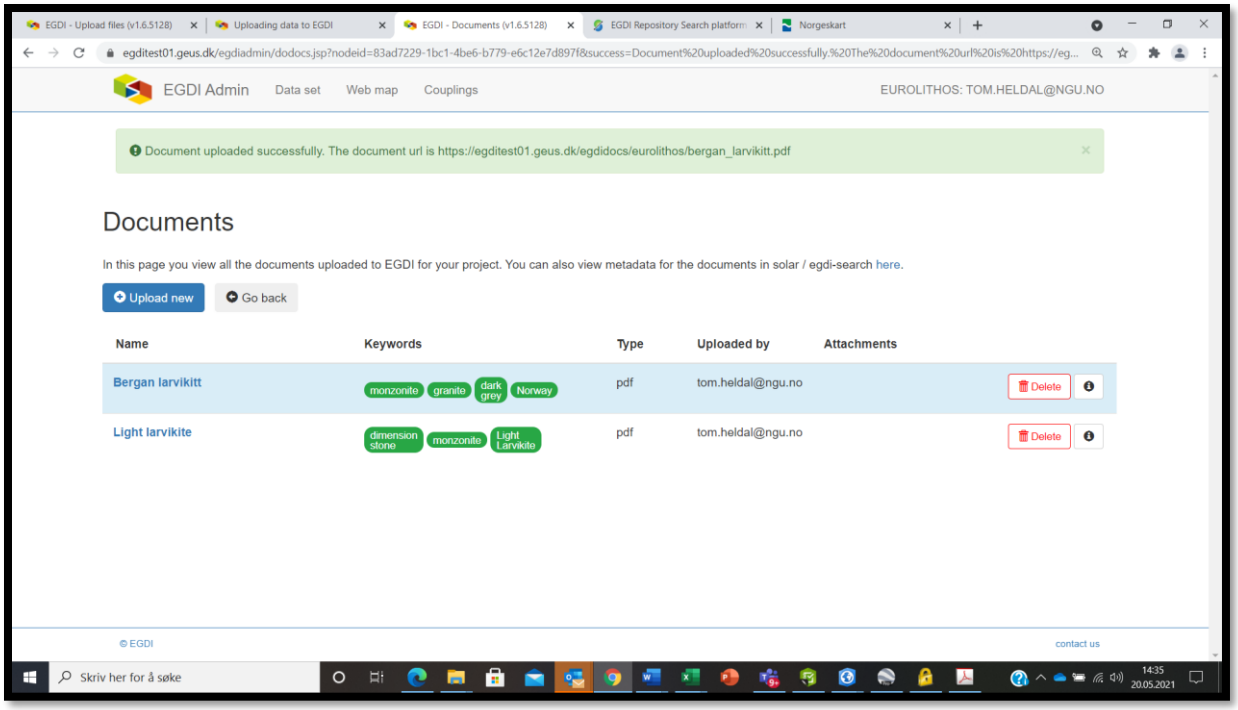
Location: you can choose between point location or rectangle of a wider area with corner coordinates.

Always use decimal degrees wgs84, and up to 6 decimals (remove last if you have seven decimals).



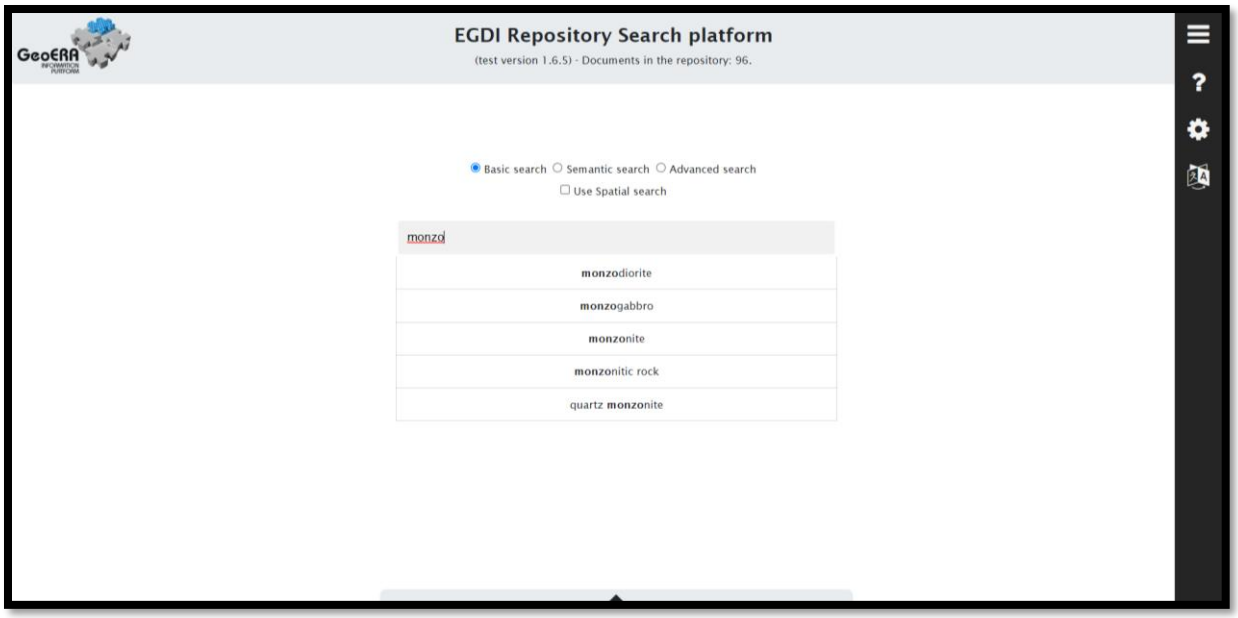
This is correct: North coordinate first, then East, separated by comma and space.

When finished, click “Save”.

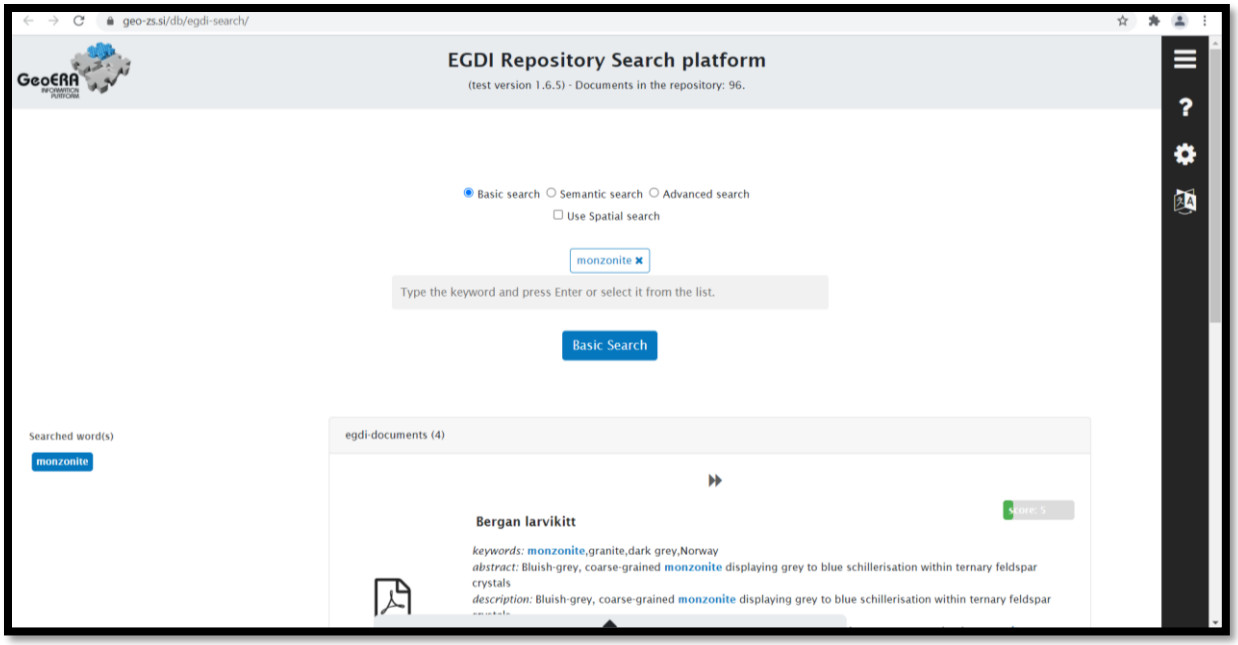


You have now one or several uploaded documents. You will see metadata on this list, keywords in green colour. If you click here after egdi-search you can search for your data.

Searching your data (or others')

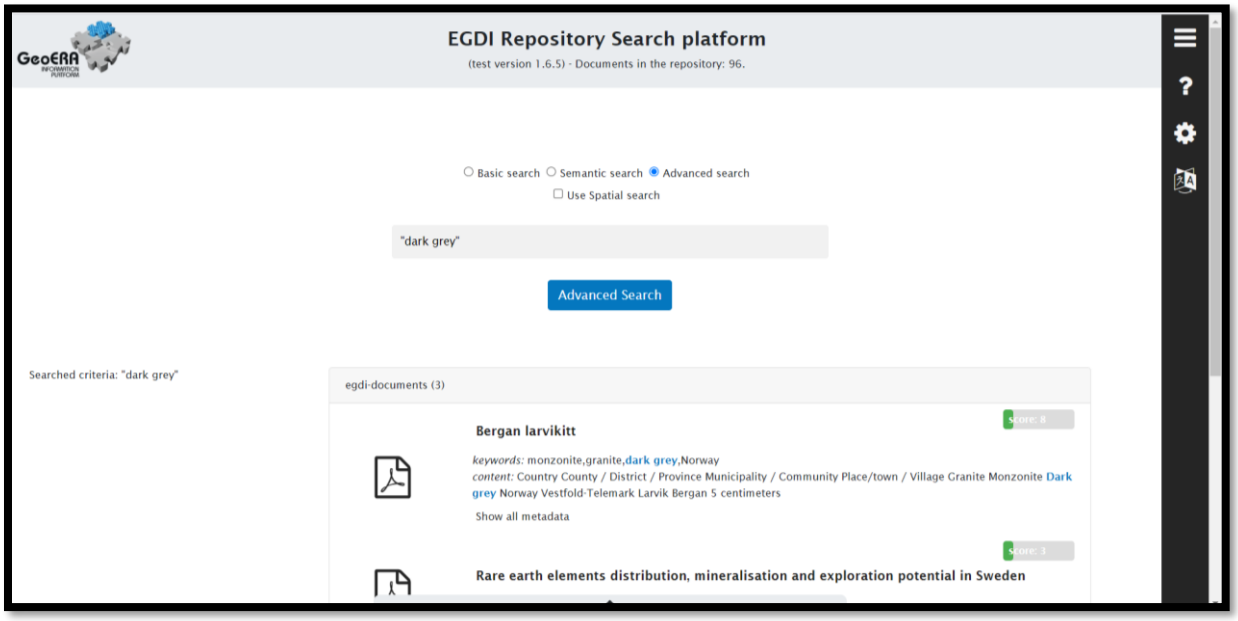


Start writing search term i.e. "monzonite" and click on the best suited



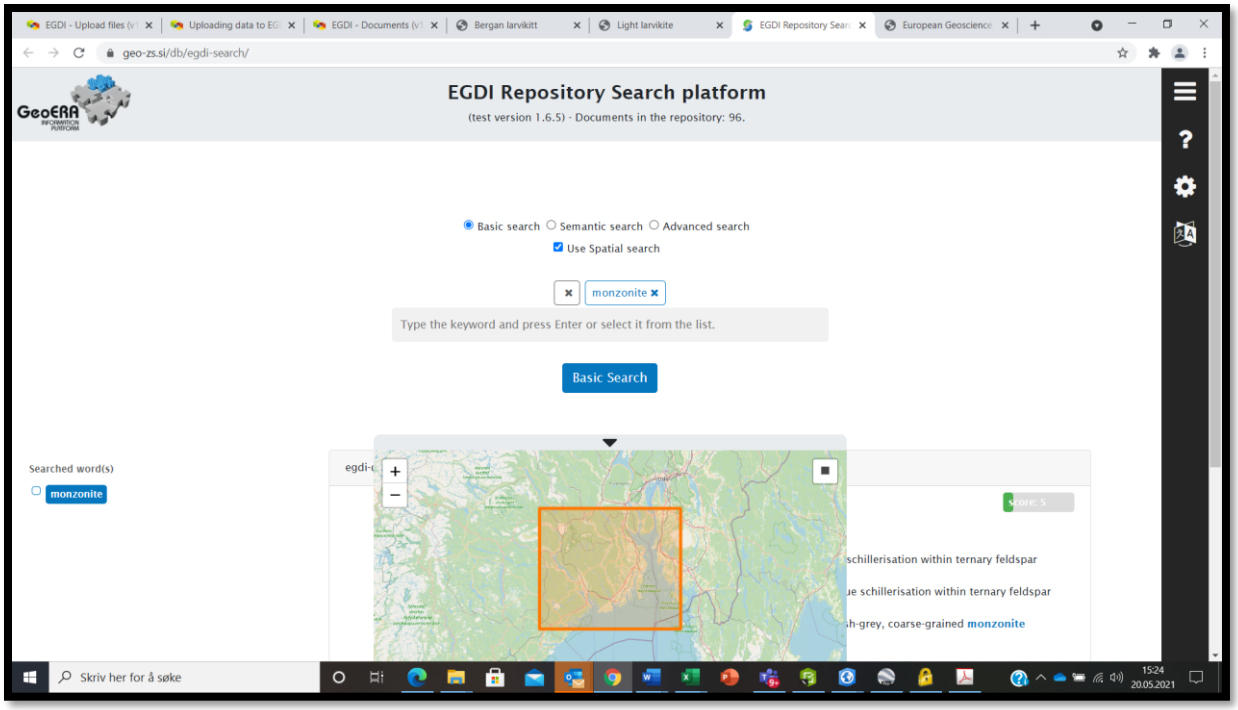
Here, you find the document and others with monzonite.

OR, you can choose advanced search:



That means for instance words not in standardized lists. Here, I have used exact term between " " for colour, and you get the document.

OR, we can combine terms with spatial areas:



Here, only the monzonite within the square on the map will be shown.