

A scanning electron micrograph (SEM) showing a complex, three-dimensional structure of mineral crystals. The crystals are elongated and angular, with sharp edges and flat surfaces. They are interconnected, forming a dense, porous network. The background is a fine, fibrous mesh of smaller crystals or mineral fibers. The overall appearance is that of a highly textured, crystalline material.

Mining the Future

Challenge Competition - Overview

Mining the future

part of WP 3 - Integrate Europe

- WP3 optimizes the collider and infrastructure layout and placement.
- This includes resource efficiency and the management of environmental aspects from the beginning onwards.
- Particular focus is put on developing a plan to manage the about **9 million m³** of excavation materials,

Resource efficient sub-surface engineering, State-of-the-art:

- Today, in the EU countries and in Switzerland, excavation materials are considered “waste”.
- For commercial re-use, the materials need to be re-classified.
- This process is administratively complicated, linked to technical constraints and is costly, rendering re-use not economically viable.

Importance of proper muck handling

- **cost reduction** due to reuse of excavated material
- **environmental effects**
 - less disposal space needed
 - less quarries necessary
 - less transport leads to reduced emissions

Overall goal: (Re-)use as much excavation material as possible to deposit as less as necessary!

Overview of the challenges



Technical

- Tunnel advance method, - length, -diameter
- Site organisation
- Material yield parameters
- Material analysis
- Processing technology



Geological

- Geological situation
- Chemistry/ mineralogy/ strength properties of excavated materials
- Customer specifications
- Processability



Legal

- Ownership
- Waste law
- End of waste character



Economic

- Supply and demand
- Raw material price vs. landfilling costs
- Transport route/ -range to customers / landfills

We are focusing on ...



Technical

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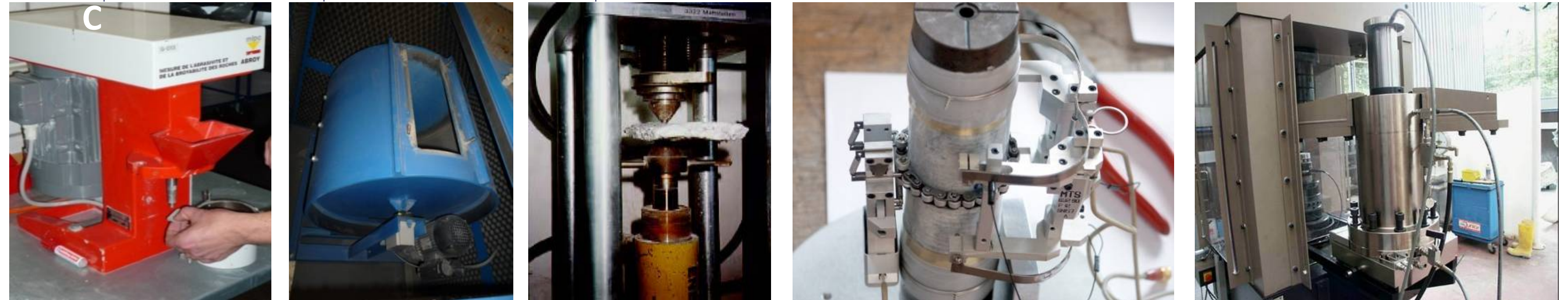
Economic

- Supply and demand
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The principle procedure

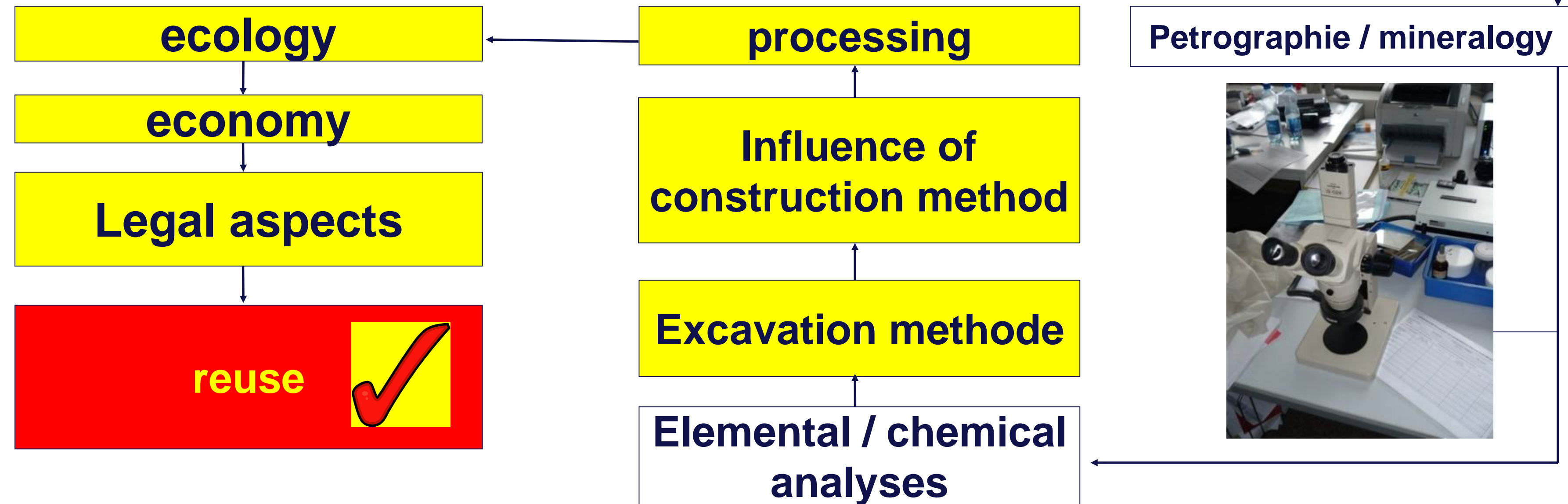
to provide data regarding properties of excavated material, numerous tests are performed.

Geotechnical Parameters



some standardized tests

- chemical and mineralogical analysis (contents, reactivity, solubility in water)
- UCS, young's modulus, poisson ratio
- hardness and roughness
- grain size distribution
- geometric characteristics (shape, flakiness, etc.)
- abrasion and wearing tests (Los Angeles, LCPC)
- water absorption, freezing and thawing
- porosity, permeability, density



Actually samples of HL-LHC construction site at CERN are analysed.

Fields of application

hard crystalline rock

- many fields of application
- likely to use without processing

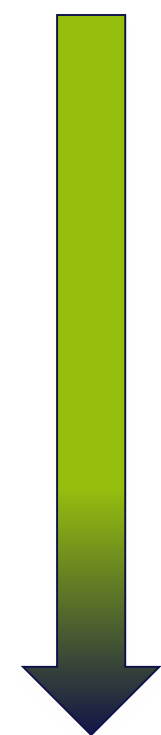
soft/loose sedimentary rock

- less possibilities of usage compared to hard rock
- Based on the expected lab-data also more difficult to dispose

fault zone material

- mineralogy changes within a very short distance
- a consistent application of this material is not possible

Matching and Classification



Class 1:	Use as construction material on site (Aggregates for innerlining-, tubing concrete and shotcrete, annular gap mortar, base layers, asphalt...)
Class 1a:	Use as construction material off site (railway ballast, ...)
Class 2:	Use as industrial material (gypsum-, brick-, cement-, glass-, abrasive-, chemical industry, ...)
Class 3:	Material for landscaping: dam fill, backfilling, embankment, ...
Class 4:	Deposition (landfilling thresholds)

aggregates for concrete

Since a big amount of concrete is necessary during the construction of tunnels, it is very likely to use the excavation material for aggregates – **if they are suitable**. Some basic requirements given in EN 12620-2002:

temporary construction site purposes

- For most projects there is a need to implement constructional actions at the beginning such as establishing stable foundations for the plant, constructing access roads, achieving noise and dust protection
- A temporary road pavement in the tunnel itself is likely to be built with muck.

possible usage of molasse material?

- i. (temporary) construction site purposes
- ii. embankments, foundations and landfill
- iii. erosion, shore and slope protection
- iv. earth dams, dams for flood protection
- v. aggregates for agriculture
- vi. backfill for landscape rehabilitation
- vii. **Others?**

Mineral classification

1

Minerals that can be used with little effort and have few requirements

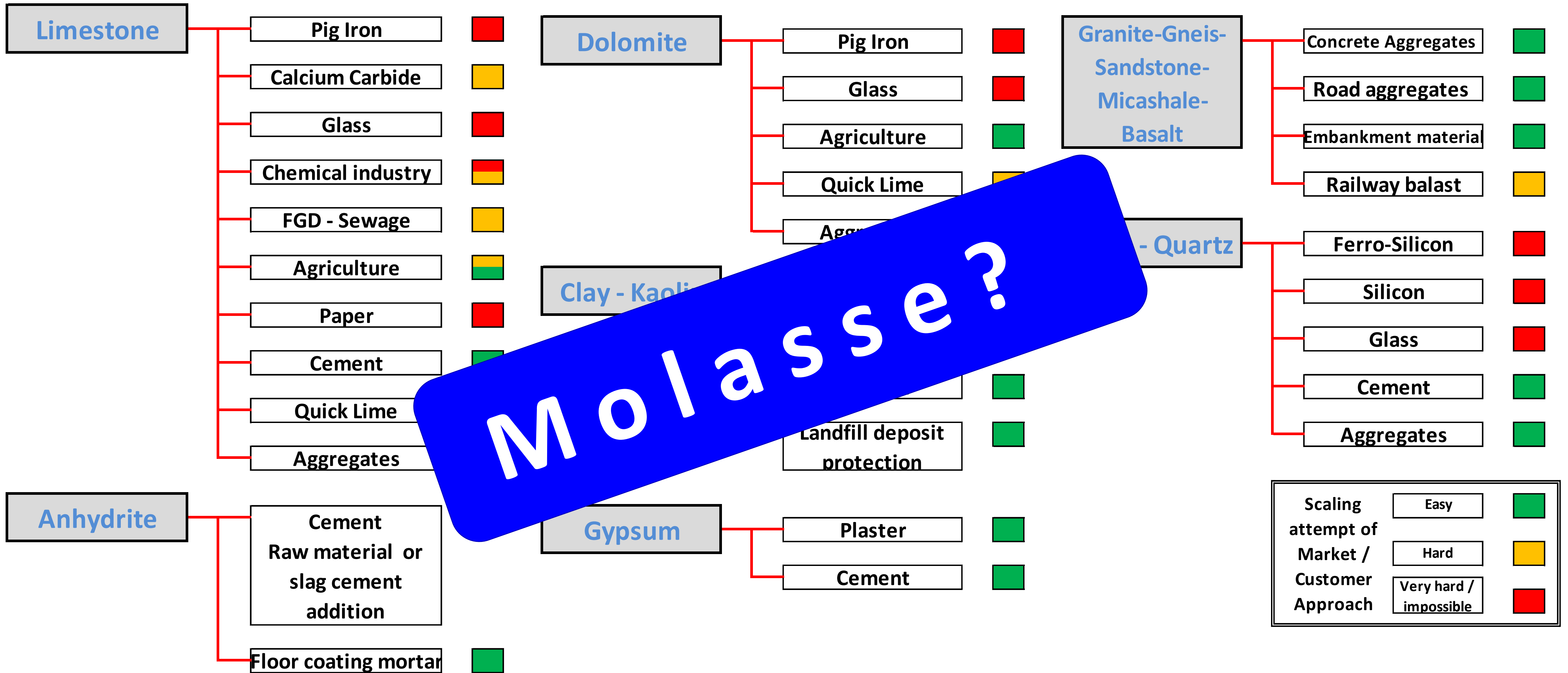
2

Minerals that can be used with medium to large effort so that requirements can still be met

3

Minerals that can only be used with great effort, since their requirements can hardly be met

Mineral Classification



The “Mining the Future Future^{CC-BY-ND}” competition

- Considering the goals of circular-economy to use and **re-use materials in this project wherever appropriate, economically viable and where it leads to a added value for the society**, the international FCC collaboration decided to launch a Challenge-based Innovation Competition to identify **credible means for the innovative re-use of the molasse materials** that are expected to be encountered during the construction phase.
- **Goal** of this international competition is to **identify technologies and processes that help reducing the amount of excavated materials that will have to be disposed in landfills.**
- **Competition aims at identifying new products and services** that can be used in the course of this construction project.
- **Technologies need also to have the potential to be used in comparable endeavours** for a long-lasting period.
- A **jury of internationally renowned experts** from subsurface-engineering, excavation materials re-use, and innovation management will **accompany the competition over a period of about one and a half years** to select the most promising proposal.
- **Winner** of the competition is **awarded the development of a business model** for the new product or service or to protect the intellectual properties of the proposed re-use approach.
- The **award-ceremony** will be done in connection with a related **scientific conference** at **ZaB – Zentrum am Berg**, the underground 1:1-scale research center (www.zab.at) in Austria.

The “Mining the Future Future^{CC-BY-ND}” competition

- ! The prevalent material in the region is sedimentary rock called “**molasse**”
- ! So far, no industrial use case has been documented for the “molasse” material, **six different types of heterogeneous sedimentary rock** predominantly found in the perimeter of the **100 km long FCC** underground infrastructure.

Parameters will be made **openly available at Zenodo** for the benefit of government agencies, researchers and companies **world-wide** in order to propose innovative processes that can **turn the “molasse”** sediment into a **valuable resource** for commodity applications with **economic added value** and to **reduce the environmental footprint of subsurface construction projects**.

In view of the infrastructure construction project

- 1) **environmental impact reduction** and
- 2) **cost optimisation,**

the **open international competition** will evaluate proposals for **innovative re-use of molasse excavation material**.

The award is based on

- 1) technical feasibility, minimum Technology Readiness Levels (TRL): **2: Formulate concept,**
- 2) economic viability,
- 3) social value and
- 4) project relevance aims at facilitating the innovation process up to TRL **4: Validate in lab**

The related **excavation management plan** is considered to be **preliminary**, since specific management processes, the economic viability and the environmental benefits of the envisaged excavation materials use cases **depend strongly on the precise subsurface investigations**, the evolution of legal frameworks in the EU and Switzerland and the response of companies to market surveys, all of which are expected to evolve after this H2020 project ends.



Thank you
for your attention

Questions?