Montanuniversität Leoben
Chair of Subsurface Engineering
Geotechnics and Underground Constructions
Head: Univ.Prof. Dipl.-Ing. Dr.mont. Robert Galler

A first overview of the legal and technical framework for the re-use of FCC's proposed excavated spoil material

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1. Introduction of PhD

- Started in September 2018 (until **August 2021**)
- Host university: **Montanuniversität** Leoben in **Austria**
- Part of CERN's **Austrian Doctoral Programme**

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- **Supervisors**
  1. Univ.-Prof. Dr. Robert Galler (1st PhD supervisor, Montanuniversität Leoben)
  2. Dr.habil. Michael Benedikt (2nd PhD supervisor, CERN/TU Vienna, FCC study leader)
  3. John Osborne (CERN supervisor, FAS section leader)

2. Legal framework: disposal classes

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France / *European Union*

- *Disposal classes (FR)*
- *Code de l'environnement & Code de commerce*
- *Waste Management Directive 2008/98/EC*
- *Commission notice on technical guidance on the classification of waste*

Switzerland

- *Disposal classes (CH)*
- *Guide pour la reutilisation des materiaux d'excavation non pollues*
- *Ordonnance sur la limitation et l'élimination des déchets (OLED)*
- *Richtlinie für die Verwertung, Behandlung und Ablagerung von Aushub-, Abraum- und Ausbruchmaterial (Aushubrichtlinie)*

Swiss disposal classes:

A: HCT $_{C10 / C40}$ < 50 mg/kg | HCT $_{C5 / C10}$ < 1 mg/kg | Cr $_{total}$ or Ni < 50 mg/kg

B: 50 mg/kg < HCT $_{C10 / C40}$ < 500 mg/kg | 1 mg/kg < HCT $_{C5 / C10}$ < 10 mg/kg | 50 mg/kg < Cr $_{total}$ or Ni

E: 500 mg/kg < HCT $_{C10 / C40}$ < 5000 mg/kg | 10 mg/kg < HCT $_{C5 / C10}$ < 100 mg/kg | 0,10 mg/kg < Cr VI < 0,50 mg/kg

E+: HCT $_{C10 / C40}$ > 5000 mg/kg | HCT $_{C5 / C10}$ > 100 mg/kg | Cr VI > 0,50 mg/kg

Spoil volume comparison

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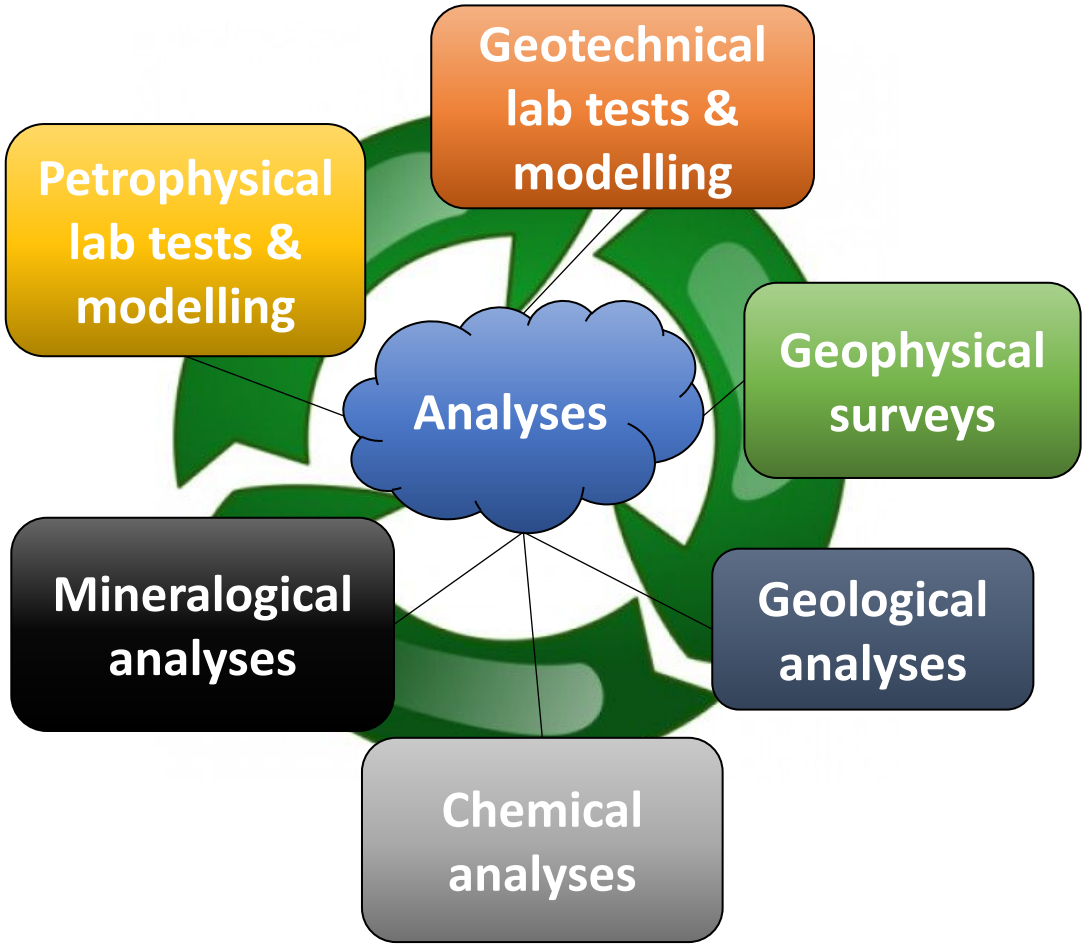
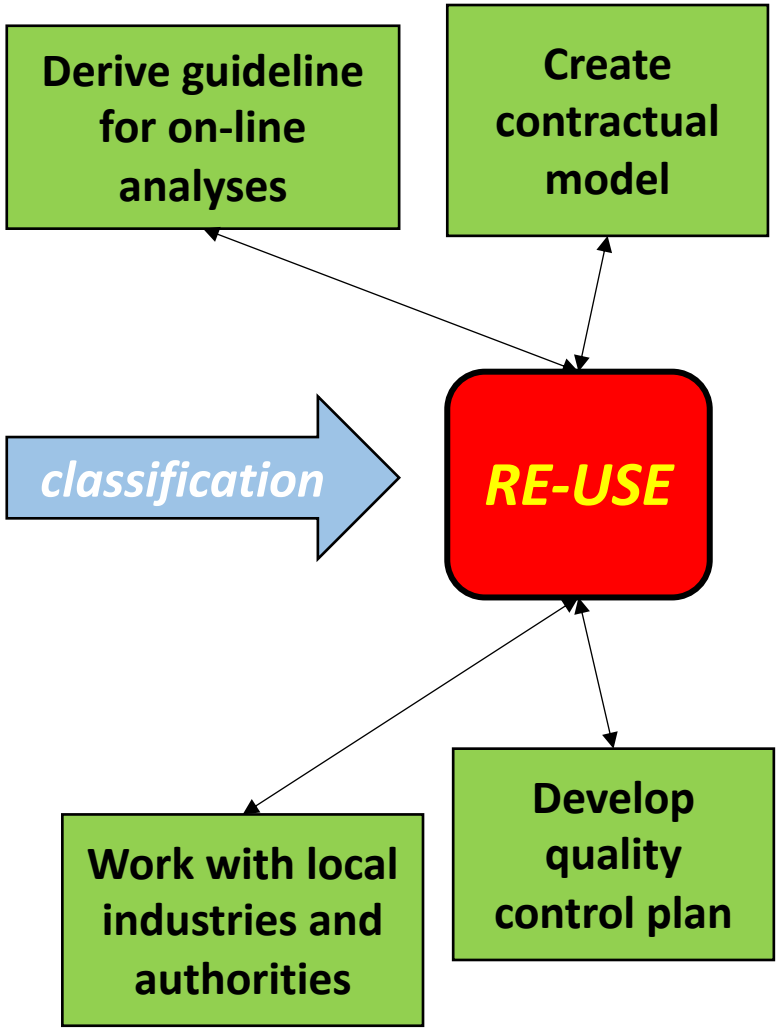
9.1 mio. m^3 of spoil material


Geotechnical lab tests & modelling
Petrophysical lab tests & modelling
Analyses
Geophysical surveys
Mineralogical analyses
Geological analyses
Chemical analyses


Derive guideline for on-line analyses
Create contractual model
classification
RE-USE
Work with local industries and authorities
Develop quality control plan

3. Technical framework
b) Sampling

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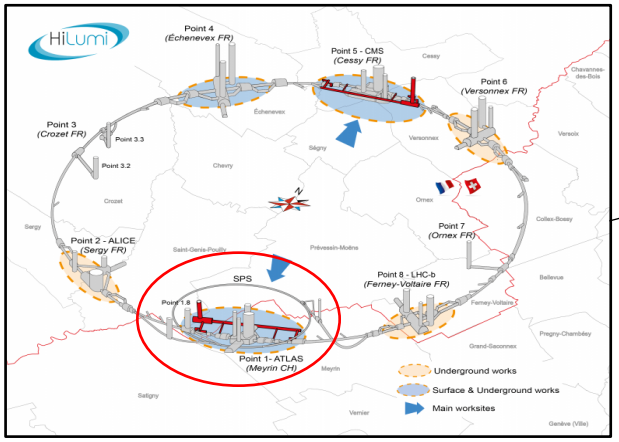
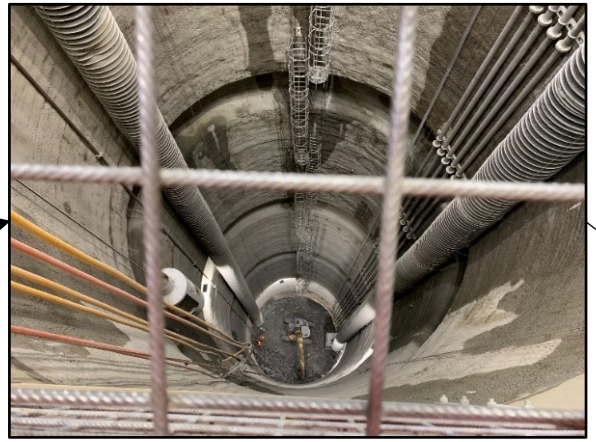
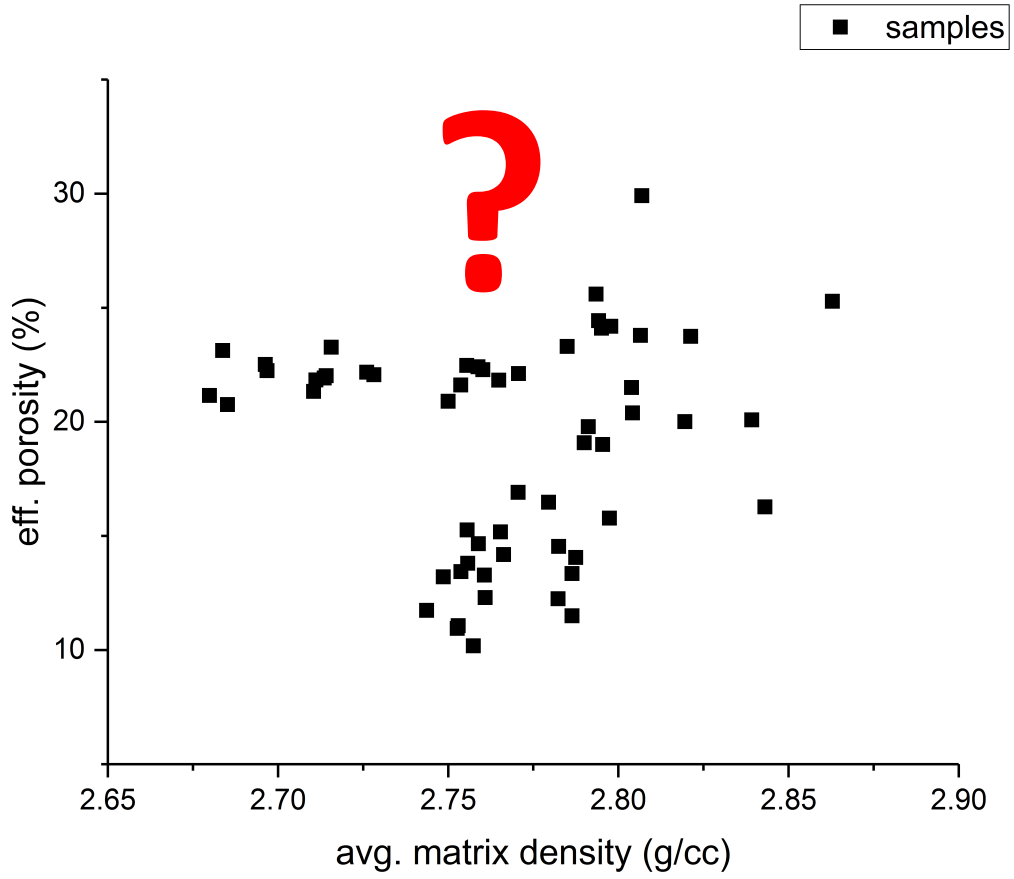
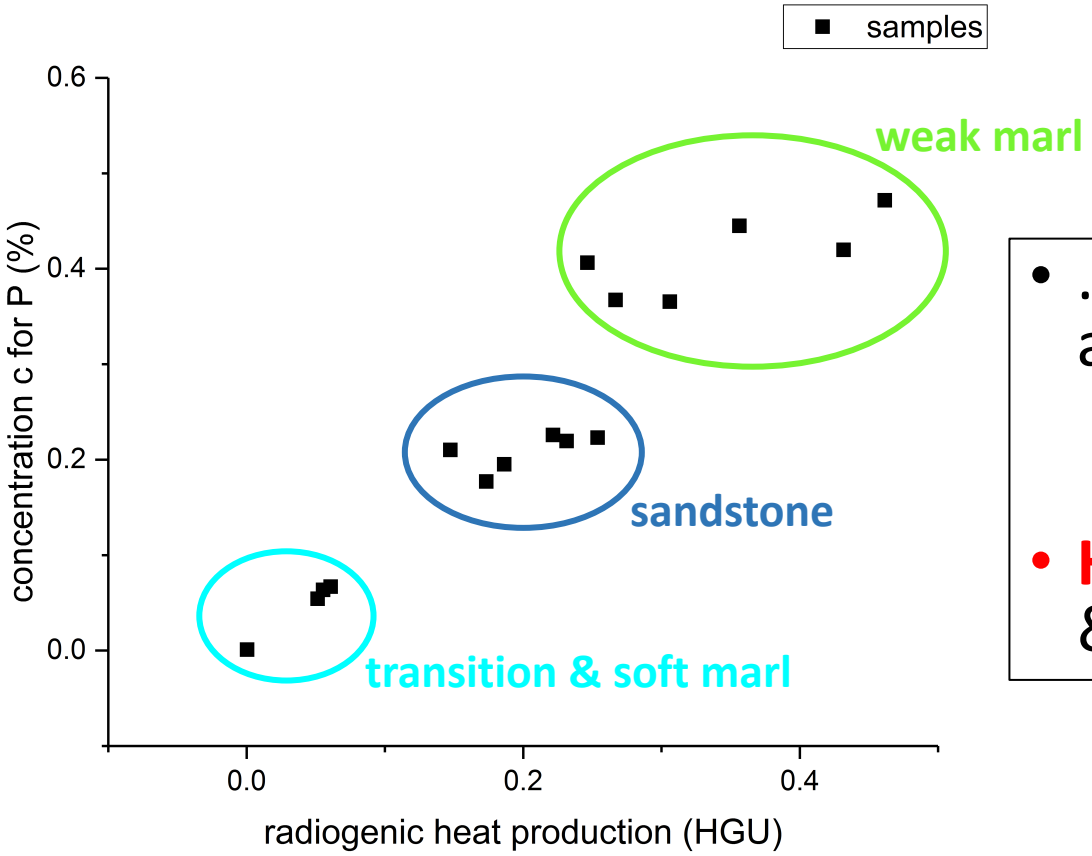




Measuring devices



- **No clear distinction** of material possible > extremely heterogeneous
- To **choose different parameters**…



- …use **natural radioactivity** as an indicator instead
  - Potassium, Uranium & Thorium concentrations
- **However**: is this sufficient & easily applicable?

- Samples (P1, shaft & cavern) contain:
  - 39-59 % of quartz (SiO_2)
  - 9-18 % of bauxite (Al_2O_3)
  - 4-8 % of hematite (Fe_2O_3)
  - 5-13 % of lime (CaO)
  - 0.1-4 % of Na_2O, K_2O, TiO_2
  - Traces of U, P, Th & Be (ppm-range)

Important for **industries** in future

- Chrome (total): μ = 129.66 mg/kg, σ = 36.15 mg/kg > **CLASS B**
- Nickel: μ = 106.95 mg/kg, σ = 27.98 mg/kg > **CLASS B**
- Hydrocarbons (C10/C40): vary between values of 11 & 1200 mg/kg > up to **CLASS E**

4. Conclusions & outlook

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Conclusions

- **Laws, regulations & guidelines** > driving & **restricting force**
- Main components: quartz, bauxite & hematite
- Geological **heterogeneity** > impedes classification
- **Concentrations** of Ni, Cr & HC > different disposal classes
- **First** possible **aggregates** for concrete production, base layers, railway ballast, asphalt or industrial use as **mineral resources**

Outlook

- **More sampling (more data)** to validate **heterogeneity**…
- …with **different parameters**
- …and to **verify** application for **different aggregates**
- **Evaluate possible patterns** within data (e.g. increasing values with depth?, depositional history?)
- Derivation of **spoil classification plan** & final classification
- Dependency on excavation methods

Thank you!