

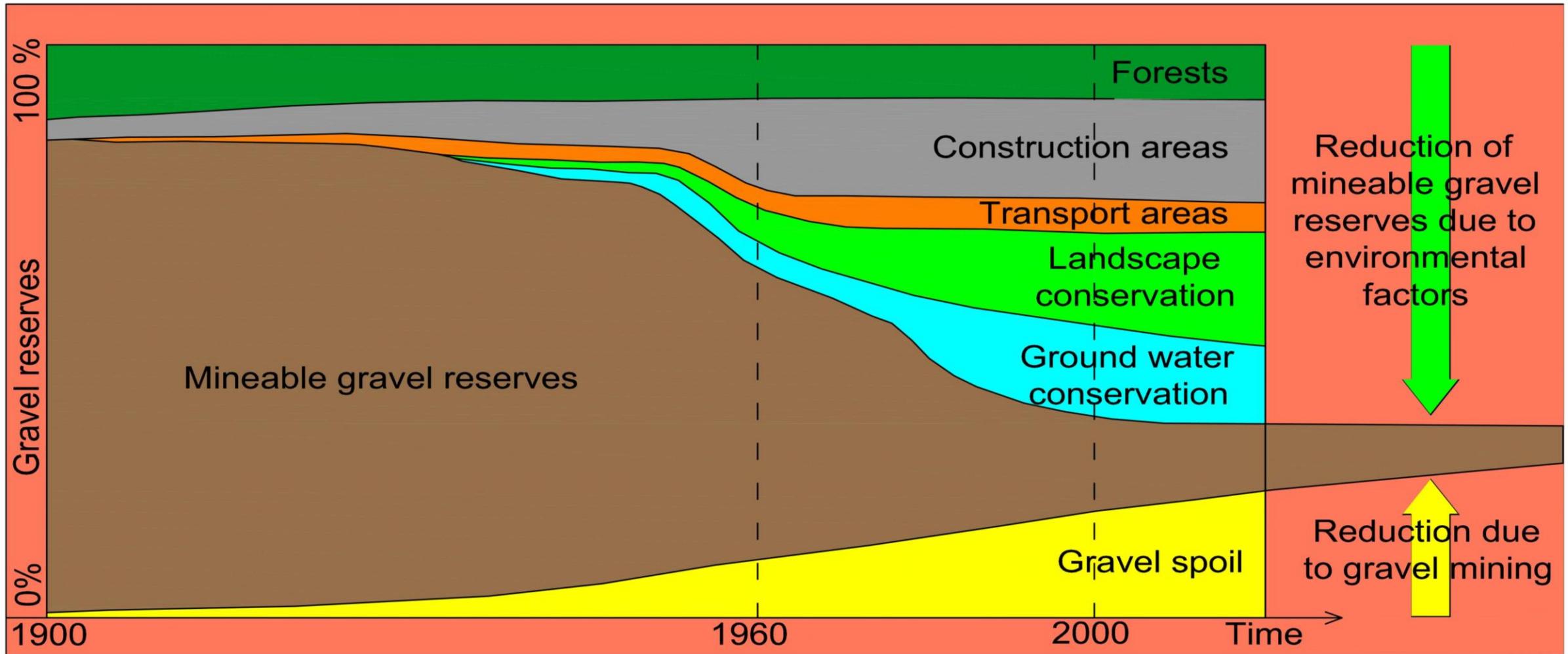
Excavation Material Use Strategy

Prof. Dr. Robert Galler

Chair of Subsurface Engineering, Montanuniversität Leoben, Austria



(according to Kündia et al.. 1997. and Jäckli & Schindler. 1986. modified)



Thus the **main objectives** for the (re-)use of excavated mineral resources from underground construction sites include:

- find the **maximum utilization** for mineral resources from the underground construction industry
- additionally **supply** construction sites **outside** of the underground project with mineral resources
- **supply specific industry** with mineral resources such as the steel, ceramic and glass industries
- find an **economic optimum** for the material management of underground construction sites
- minimize the environmental pollution by **optimised material processing** and transport
- **reduce CO₂-production** within underground construction sites
- **reduce landfill** capacity for depositing excavation material
- production of **zero waste** out of underground construction projects

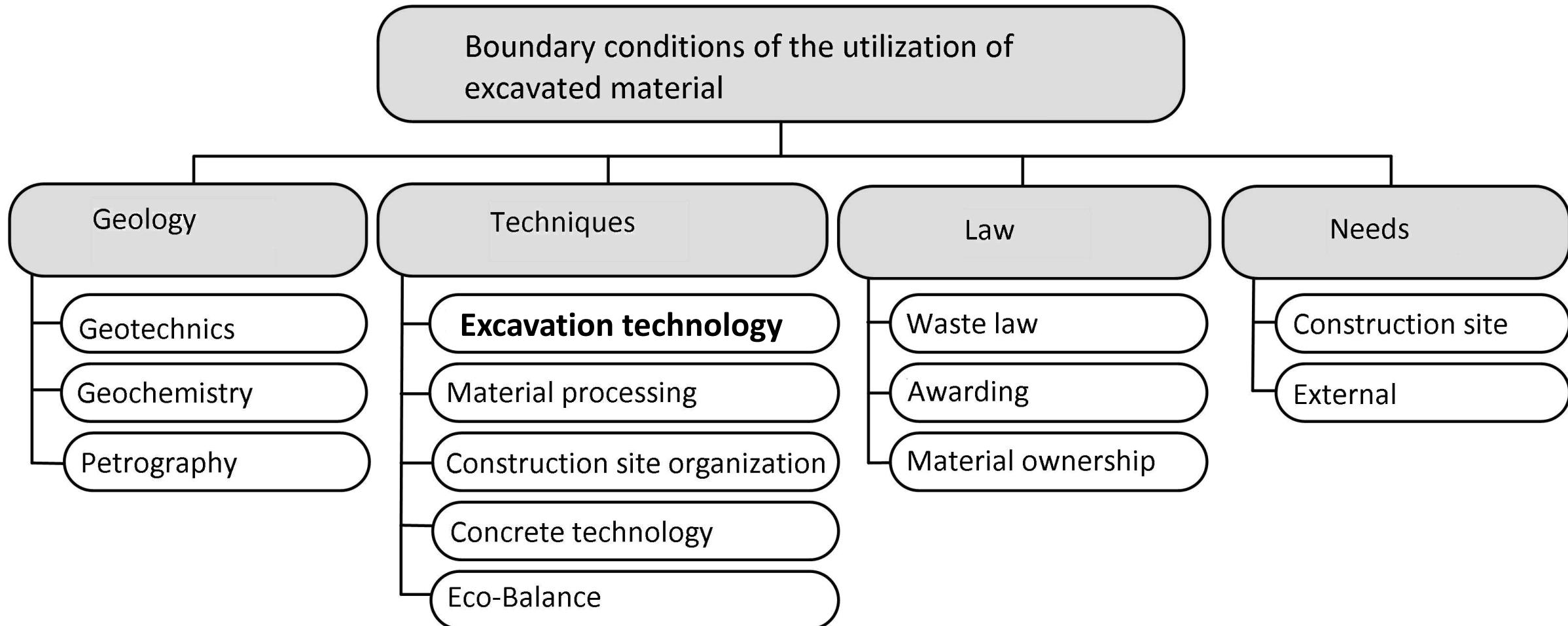
Parameter	Norm
Grain shape key figure FI	ÖNORM EN 933-3
Platness index SI	ÖNORM EN 933-4
largest grain	ÖNORM EN 933-1
Grading curves of the aggregates	ÖNORM B 4710-1
bulk density	ÖNORM EN 1097-6
fine proportion	ÖNORM EN 933-1
Sand equivalent value (SE)	ÖNORM EN 933-8
methylene blue value (MB)	ÖNORM EN 933-9
mussel shell content	ÖNORM EN 933-7
Resistance to fragmentation (LA coefficient)	EN 1097-2
impact fragmentation value	EN 1097-2
Polishing value (PSV)	EN 1097-8
Abrasion value (AAV)	EN 1097-8
Nordic abrasion coefficient (AN)	EN 1097-9
Micro-deval coefficient (MDE)	EN 1097-1

Requirements for aggregates for concrete

Content of water-soluble chloride ions	ÖNORM EN 1744-1
Content of acid soluble chloride ions	ÖNORM EN 1744-5
acid soluble sulphate content	EN 1744-1
Total sulphur content	EN 1744-1
Humus	EN 1744-1
fulvic acid	EN 1744-1
Carbonate content of the aggregates	B 4710-1
Shrinkage due to drying of the aggregates	EN 1367-4
water absorption	EN 1097-6:2013
Water absorption as preliminary test for frost-thaw cycle resistance	EN 1097-6:2013
Frost-thaw cycle resistance	ÖNORM EN 1367-1
Frost-thaw change with simultaneous exposure to salt	EN 1367-6
magnesium sulfate value	EN 1367-2
Alkali Silica Reactivity	ÖNORM B 3100
flour contents	B 4710-1
Core moisture Wk	ÖNORM B 3303
bulk density	EN 1097-3
angularity of fine aggregates	EN 933-6
Flow coefficients ECS	EN 933-6
Percentage of partially or wholly broken grains and rounded grains	EN 933-5

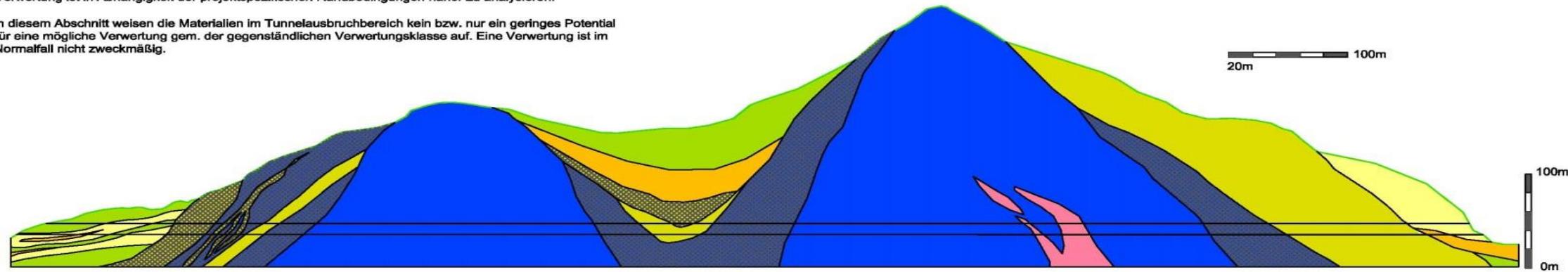
Specification in description of services (mandatory catalogue for concrete - ÖNORM B 4710-1:2018-01)

Parameter	Norm
compressive strength	ÖNORM EN 12390-3
largest grain	ÖNORM EN 12620
compaction measure	ÖNORM EN 12350-4
spread	ÖNORM EN 12350-5
blood tendency	ÖNORM EN 480-4:2006 02 01
heat generation during hardening	ÖNORM EN 12390-15
dwindling	ÖNORM EN 12390-16
tear strength class	ONR 23303
splitting tensile strength	ÖNORM EN 12390-6:2001
chloride content	ÖNORM EN 480-10:2009 11 01
bulk density fresh and hardened concrete	ÖNORM EN 12390-7:2001



Classes of possible reuse versus landfill classes including the probability of the prognoses in an early stage design

- in diesem Abschnitt weisen die Materialien im Tunnelausbruchbereich ein hohes Potential für eine mögliche Verwertung gem. der gegenständlichen Verwertungsklasse auf.
Im Normalfall ist eine Verwertung zweckmäßig, wobei die projektspezifischen Randbedingungen (Vortriebs- und Lösemethode, Materialbedarf, Transportwege, Wechselhaftigkeit, etc.) noch zu berücksichtigen sind.
- in diesem Abschnitt weisen die Materialien im Tunnelausbruchbereich ein mittleres Potential für eine mögliche Verwertung gem. der gegenständlichen Verwertungsklasse auf. Die Zweckmäßigkeit einer Verwertung ist in Abhängigkeit der projektspezifischen Randbedingungen näher zu analysieren.
- in diesem Abschnitt weisen die Materialien im Tunnelausbruchbereich kein bzw. nur ein geringes Potential für eine mögliche Verwertung gem. der gegenständlichen Verwertungsklasse auf. Eine Verwertung ist im Normalfall nicht zweckmäßig.



prognostizierte Verwertungsklassen



prognostizierte Deponieklassen (ohne Berücksichtigung von antropogenen Beeinträchtigungen durch Vortriebsarbeiten)

DE 1 (Bodenaushub)	30%-60%	0%-20%	80%-100%	20%-50%	80%-100%	0%-30%	80%-100%	20%-50%	40%-70%
DE 2 (Inertabfall)	40%-60%	80%-100%	0%-10%	50%-70%	0%-10%	10%-30%	0%-10%	50%-70%	30%-50%
DE 3a (Baurestmassen)				0%					
DE 3b (Reststoff)			0%			60%-80%		0%	
DE 3c (Massenabfall)					0%				
G (gefährliche Abfälle)					0%				

zugrundeliegende Prognosesicherheit



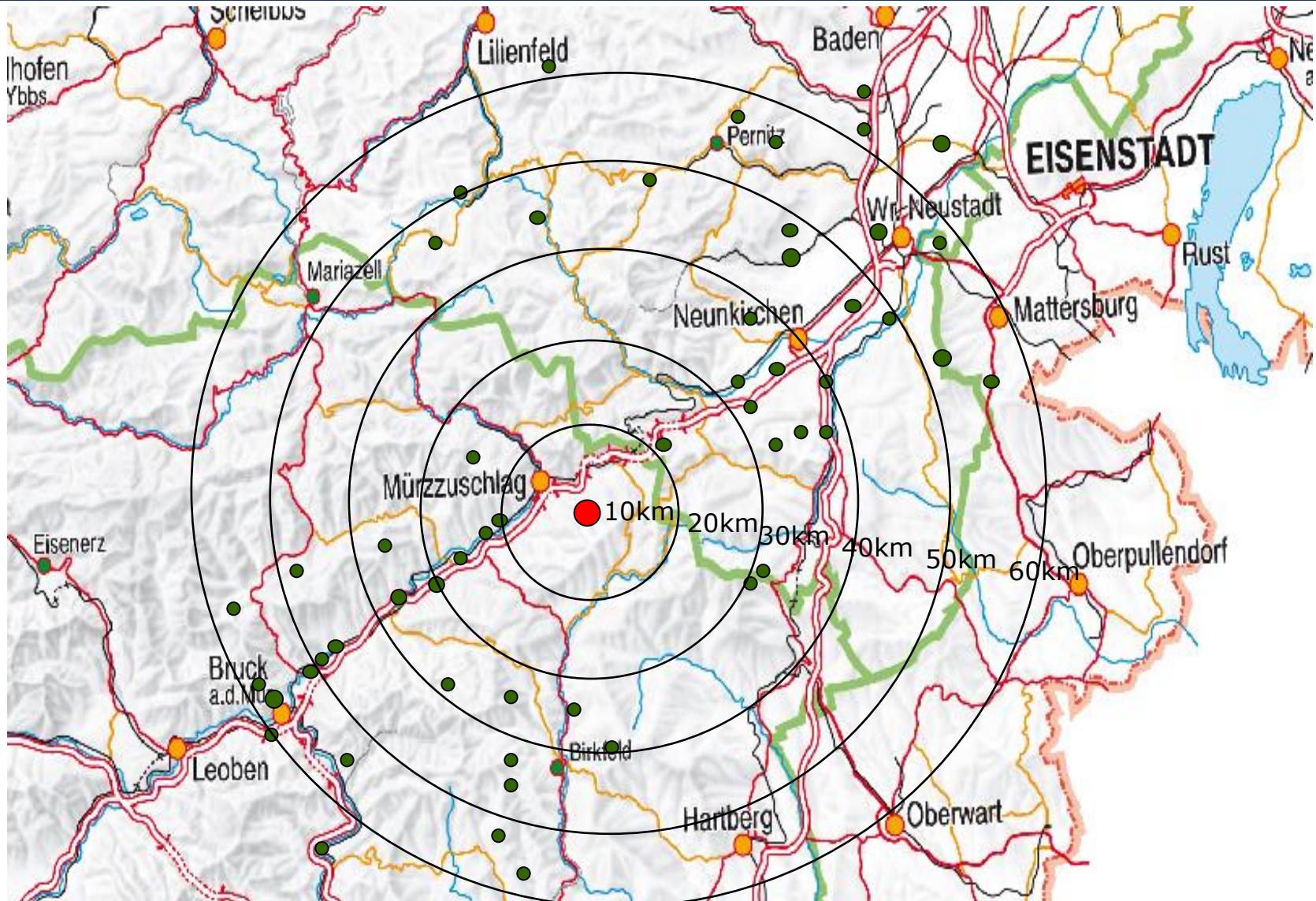
* Komplexität wird v.a. durch Heterogenität des Gebirges bestimmt. (Wechselhaftigkeit, Störungsbereiche, Einschlüsse, Ganggesteine, etc.)

** Anzahl der direkten Aufschlüsse je 1000lfm Tunnelachse bis auf Tunnelniveau und +/- 20m von der Tunnelachse entfernt.

Untersuchungsdichte: ■ gering ... < 5 Aufschlüsse**

■ mittel ... 5-20 Aufschlüsse**

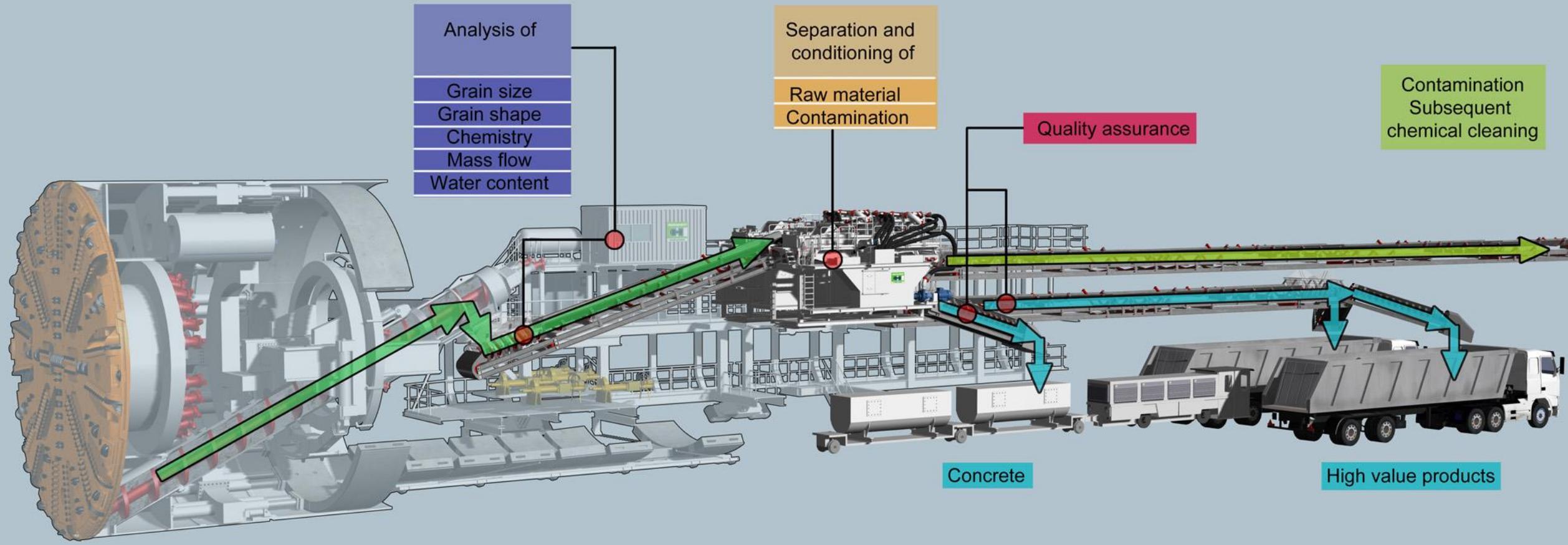
■ dicht ... > 20 Aufschlüsse**



- **What** is essential to be determined for a precise **material classification**?
- What is essential to be determined **when**?
- **How often** with respect to **national-specific** concrete standards, industrial minerals, landfill and sampling standards is the analysis to be done?
 - **Grain size / grain shape**
 - **Water content / moisture**
 - **Elemental composition**
 - **Mineralogical composition**
 - **Amount of mica minerals**
 - **Strength parameters**

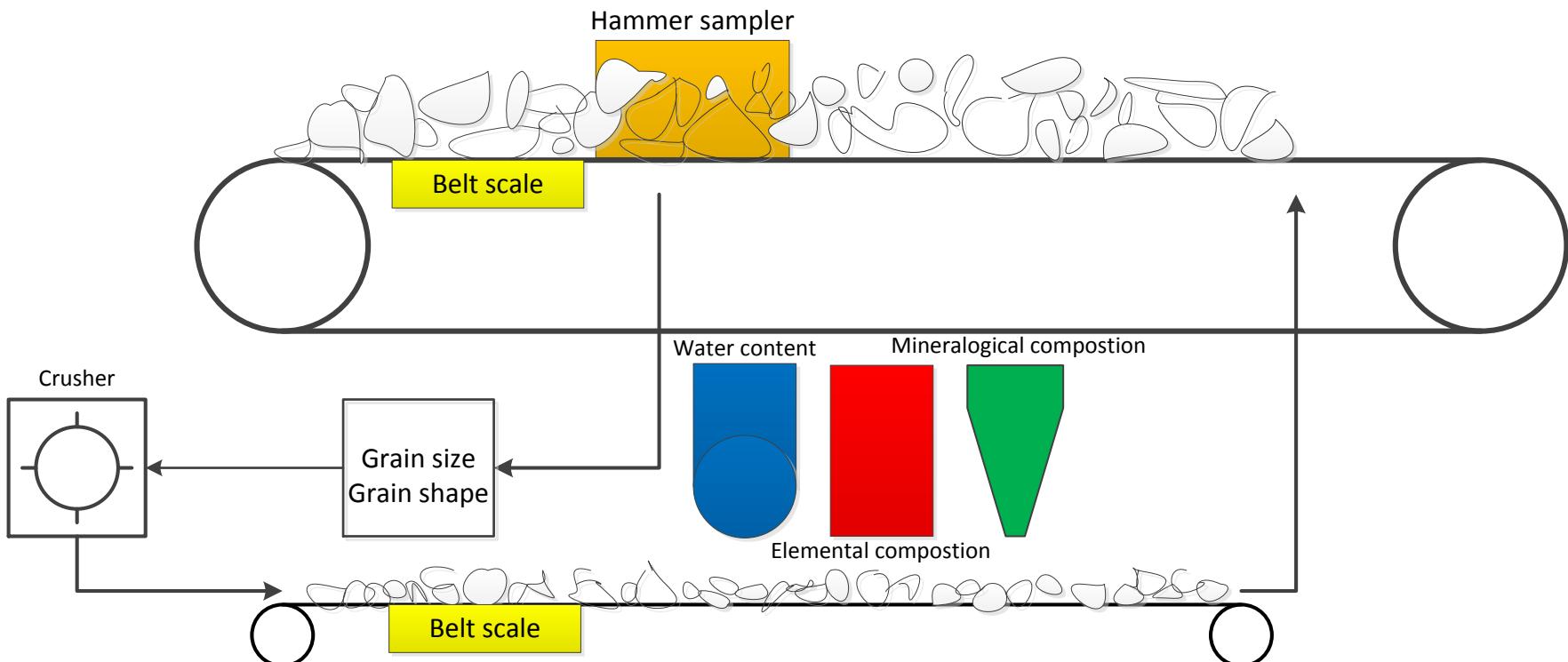
13	26.982	14	28.086	15	30.974	16	32.065	17	35.453	18	39.948
Al	SILIZIUM	P	SCHWEFEL	Cl	ARGON						

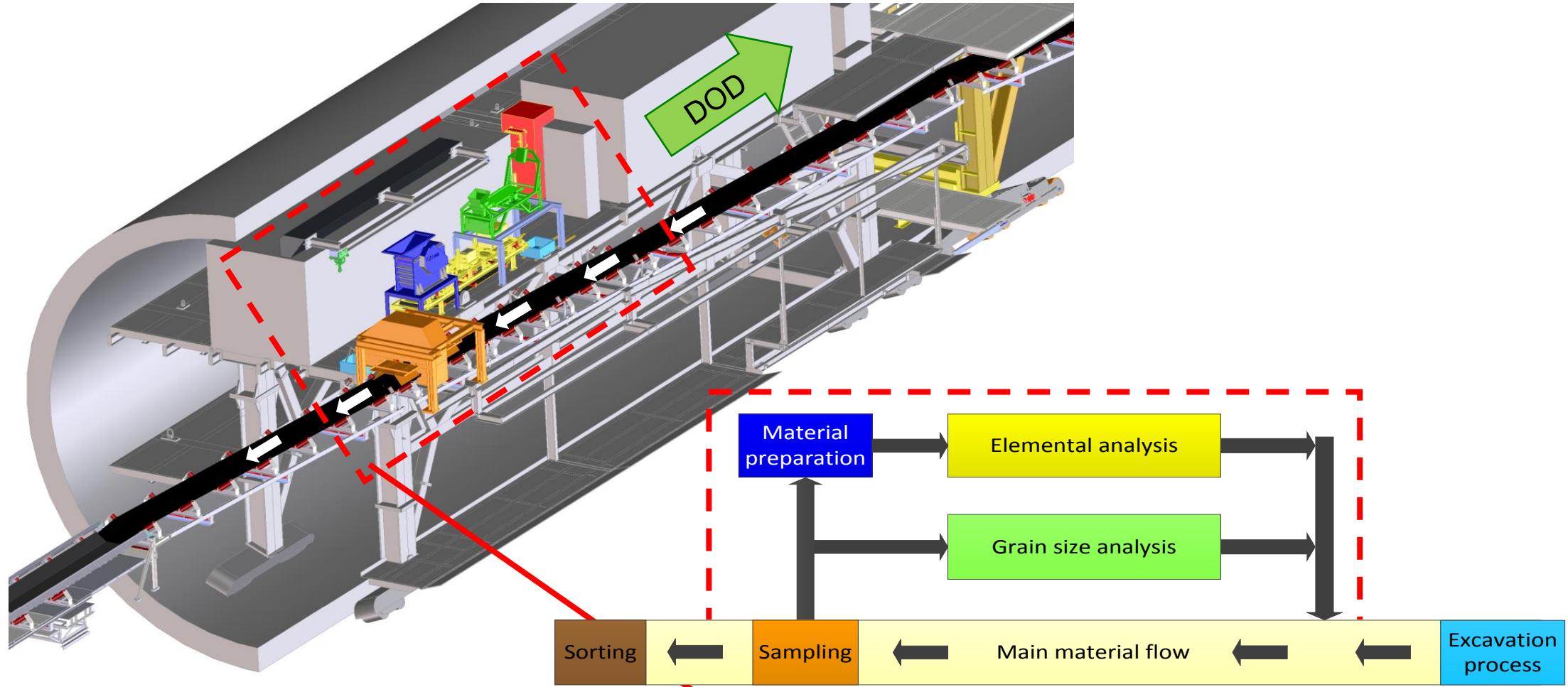




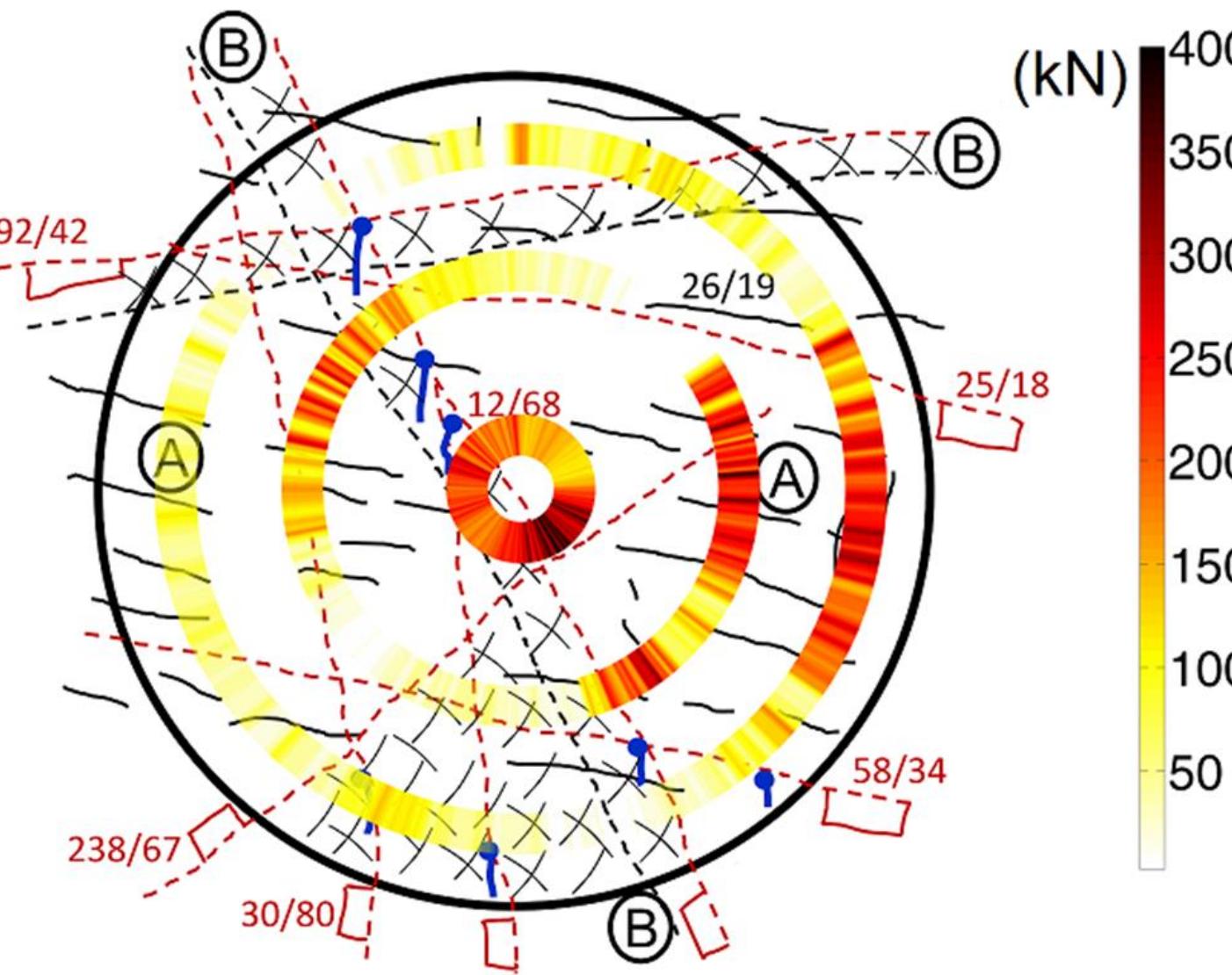
[Dragon 2015]

- Bypass fed by a sampler
- Crushing of the rock according to the requirements of the analysing systems
- Analysing systems on a bypass belt







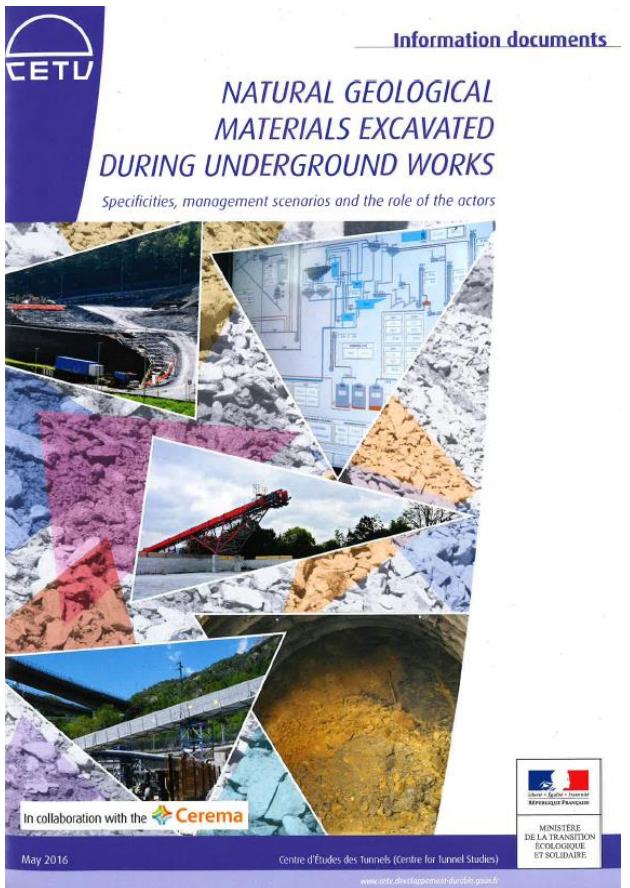


- Provide complete information about the project
- Provide a Material management system for the exchange and trade of excavated material
- Avoid disposal sites and with this at the same time avoid landfill cost
- Consider environmental impacts
 - by considering the choice of technology for extracting raw materials
 - by avoiding polluting production processes
 - How will the product get to customers?
 - How much energy will the product use?
- Prepare chemical characteristics and amounts of material classes
- Prepare mineralogical characteristics and amounts of material classes
- Prepare automatic update of predicted material amounts and classes

Verwendung von Tunnelausbruch

RICHTLINIE

OKTOBER 2015

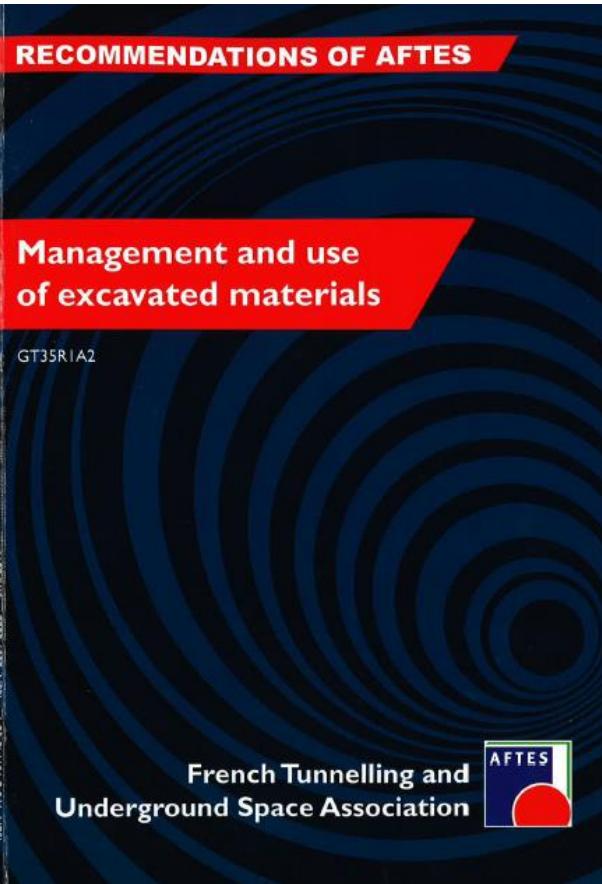
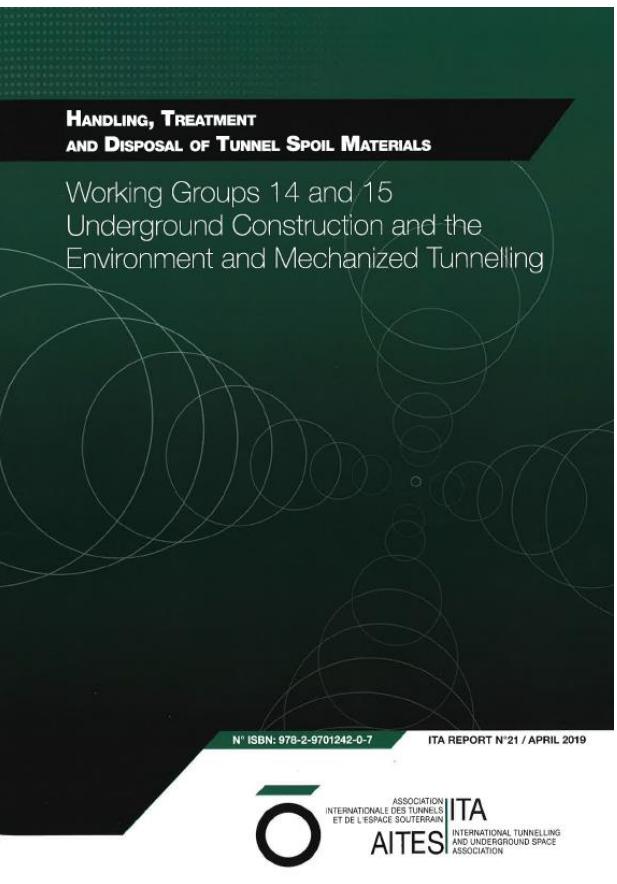


October 2015

May 2016

April 2019

April 2019



French Tunnelling and
Underground Space Association







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

Maximilian Haas
(SMB-SE-FAS)