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UNIVERSIDADE DE
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DE TRÁS-OS-MONTES
E ALTO DOURO

Geotechnology for sustainable development and environment protection

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Geotechnology research cluster of the Centro de Geociências

- Fosters the use of technology to help solve problems related with:
 - the geological environment;
 - resources availability;
 - geotechnics.



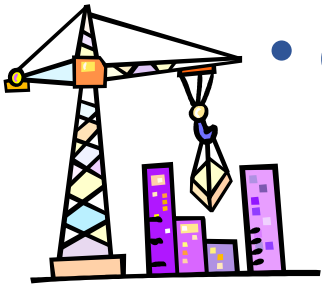
Geological resources

- The **increase** of the **world population** and the **higher living standards** requires more **resources**, imposing new challenges.
- The **availability**, exploitation, transformation and use of **geological resources and raw materials** are increasingly stressing societies, the economy and the environment.
- All **geological resources** are primarily extracted from the Earth surface.



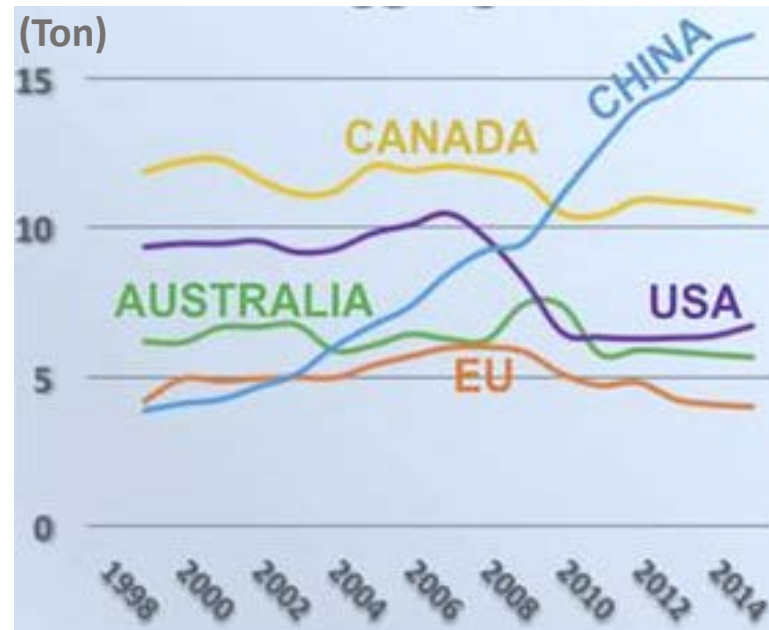
Geological resources

- We depend on buildings and infrastructures:
 - houses;
 - schools;
 - hospitals;
 - roads, railways;
 - bridges;
 - airports;
 - conference centers...

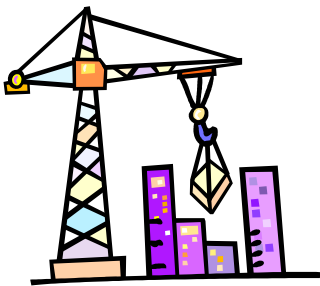


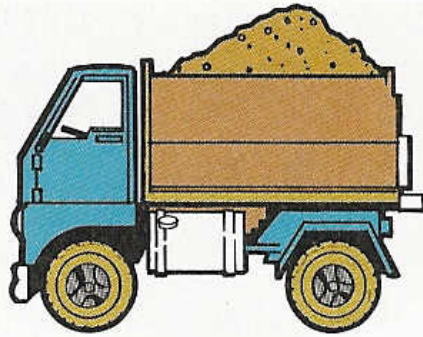
Geological resources

- Requiring large quantities of geological materials.

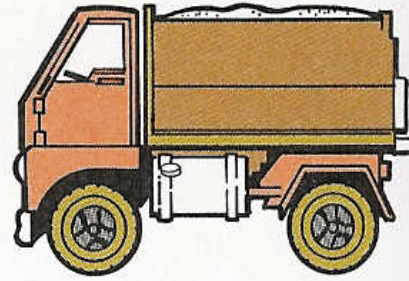


Aggregate production per capita (Langer B., 2018).



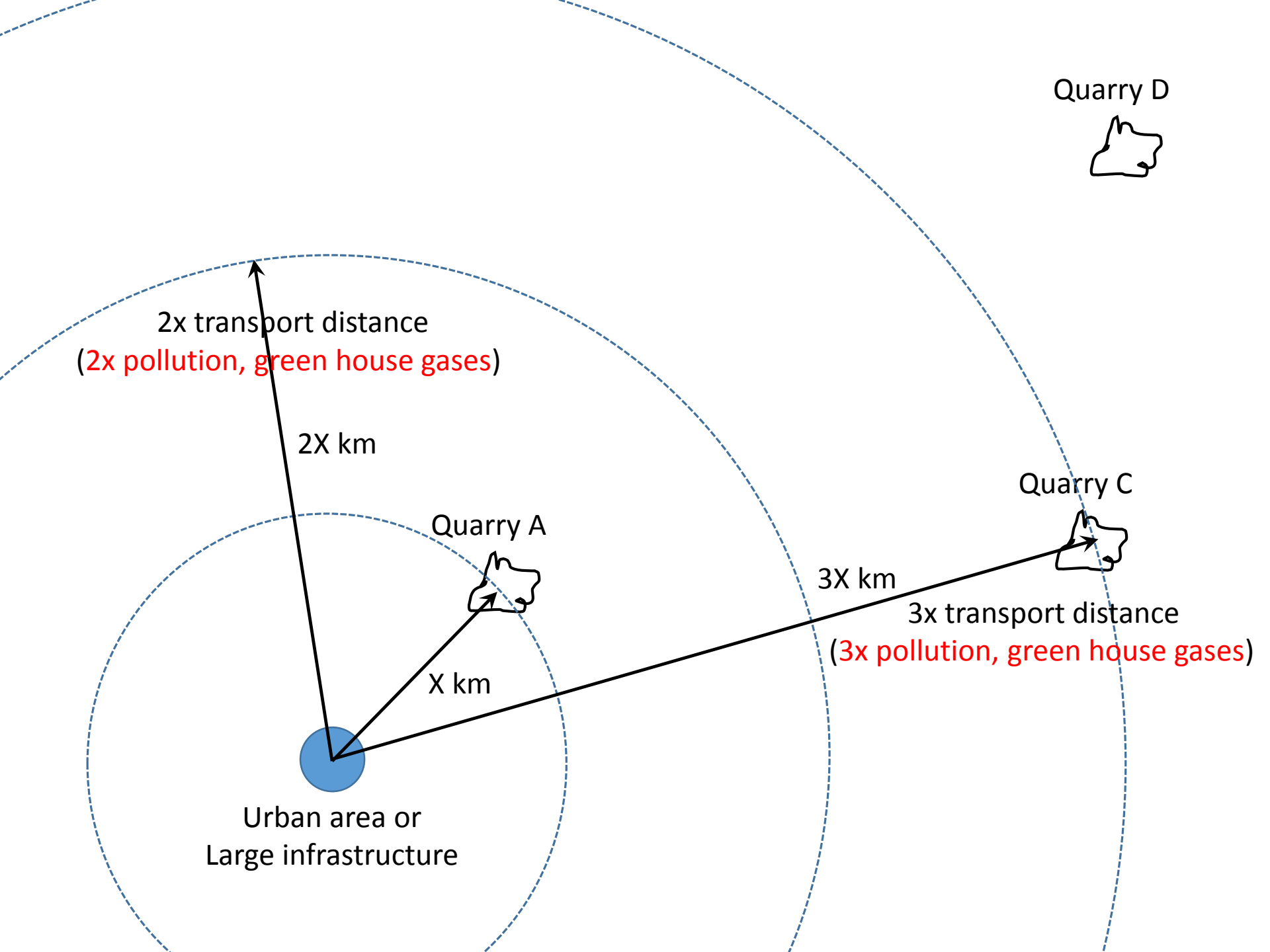


Crushed stone
4,200 kg



Sand and gravel
2,900 kg

Construction type	Aggregates required (m ³)	Truck trips (approx. 10 ton/trip)
New house	300	<i>30</i>
School	2 300	<i>230</i>
Motorway (1 km)	23 000	<i>2 300</i>
Railway-TGV (1 km)	7 000	<i>700</i>
Sports stadium	>200 000	<i>20 000</i>



Quarry D



2x transport distance
(2x pollution, green house gases)

2X km

Quarry A



X km

Urban area or
Large infrastructure

Quarry C

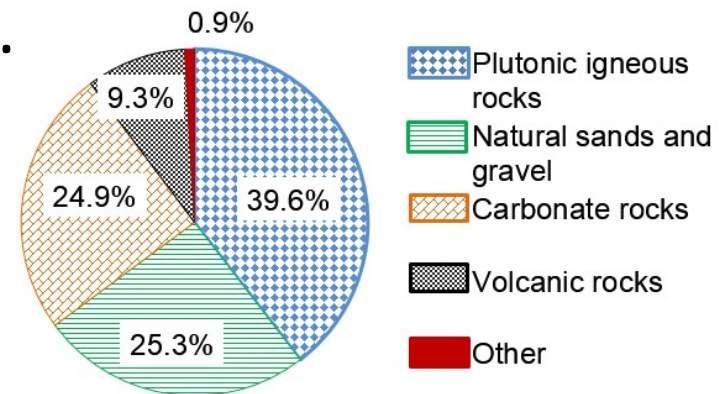
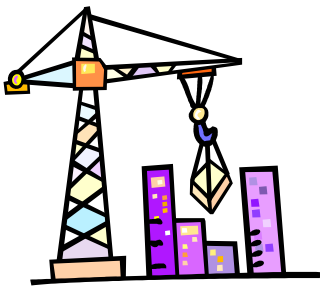


3X km

3x transport distance
(3x pollution, green house gases)

Geological resources

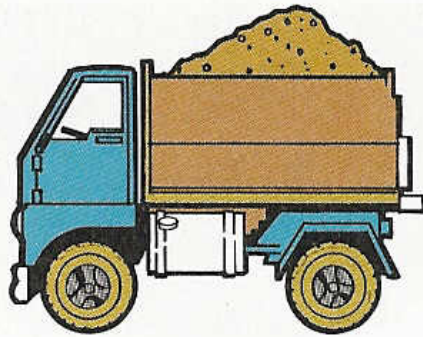
- Distances around 50 km can double the prices of the raw material (e.g. sand, aggregates).
- Efficient use of local raw materials minimize energy consumption due to smaller transport distances, allowing environmental benefits.



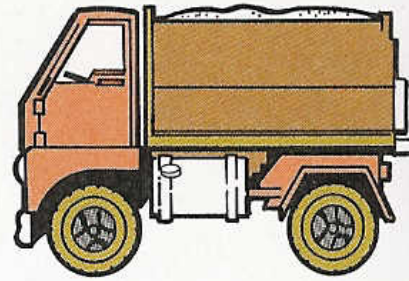
Distribution of **production centers** in **Portugal**, by rock group of **aggregate** (Castelo Branco, Quinta-Ferreira and Fernandes, 2017).

Planning

- Planning is the most important task for good environmental management.
- Only can be successful with the mastering of a large number of factors, that we would like to stress:
 - the **availability** of suitable raw materials;
 - the **environment preservation**;
 - the **social** and **economic** conditions;
 - the physical **environment**.
- The selection of a construction material should always be done choosing the best balance between the environment constraints and the overall costs.



Crushed stone
4,200 kg



Sand and gravel
2,900 kg



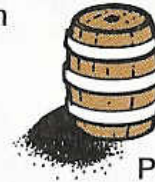
Salt
180 kg



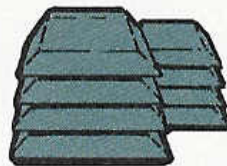
Gypsum
94 kg



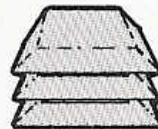
Phosphate
170 kg



Potash
22 kg



Iron ore
260 kg



Aluminum
22 kg



Lead
5 kg



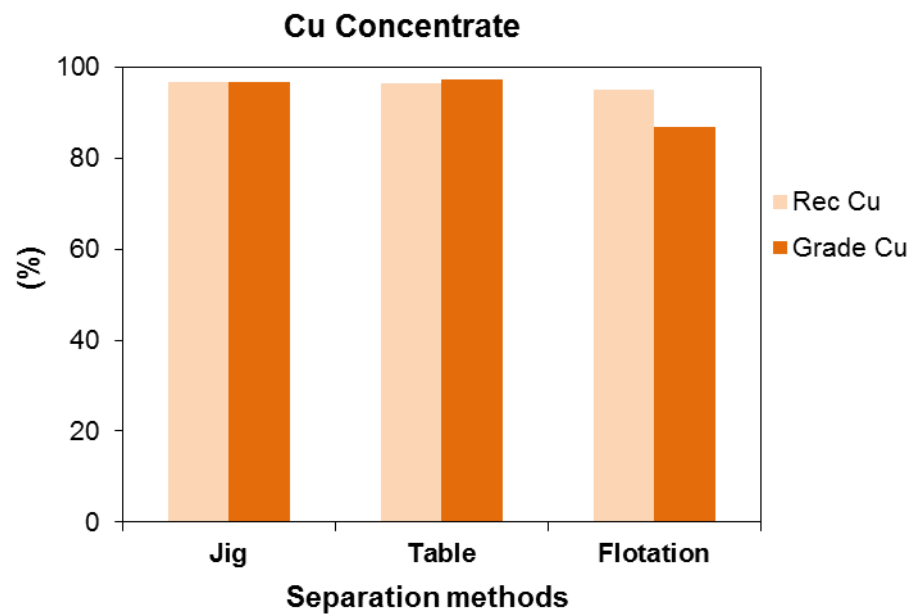
Copper
9 kg



Zinc
5 kg

Circular economy

- Research is being developed to find and propose new solutions for sustainable exploitation of resources in extractive industry complemented by mineralogical, petrographic and geochemical characterization of raw materials and geological resources.
- **Circular economy** is fundamental for resources usage and a central question in our research, e.g.:
 - reuse of construction and demolition waste;
 - separation of plastics mixtures;
 - separation of copper and plastics from electrical cable waste.



Modelling of Natural Fracturing

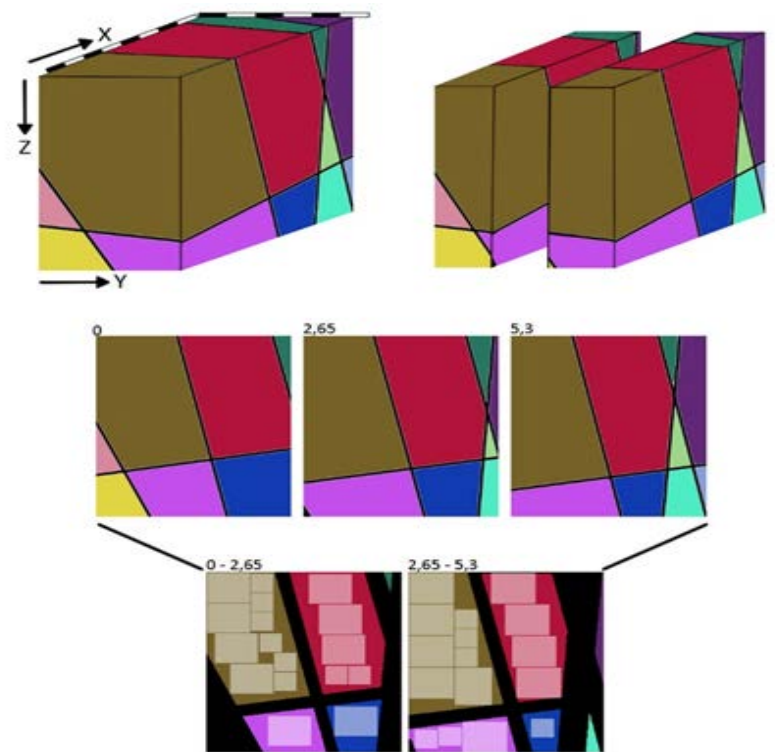
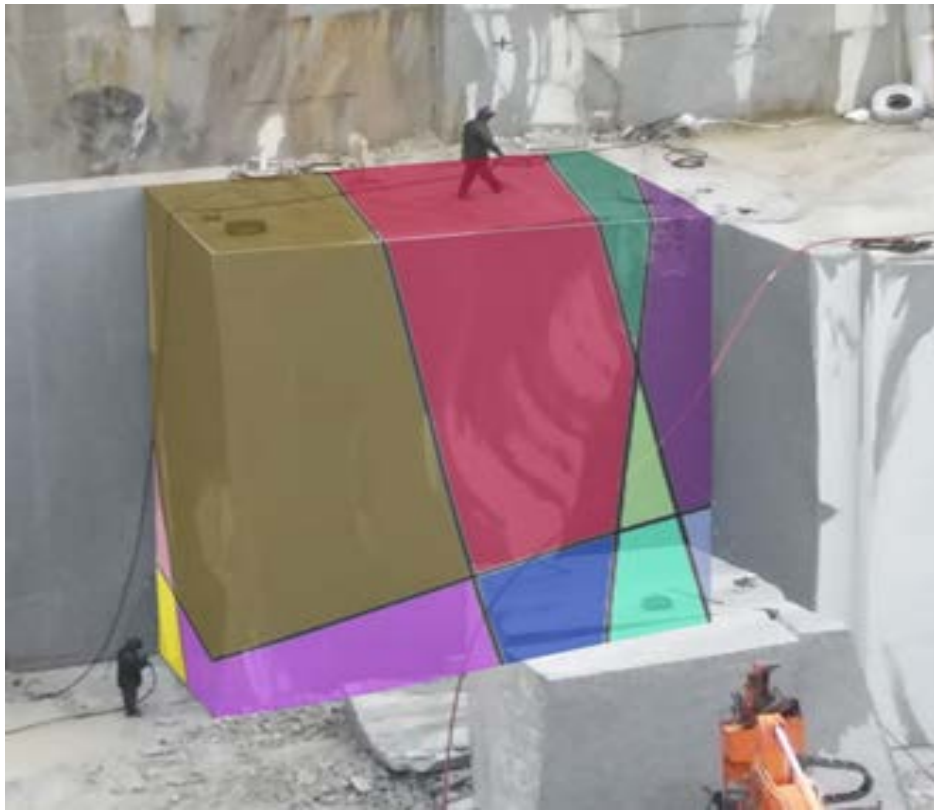
- Photogrammetric modelling allows the construction of 3D quarries models.
 - The dense point clouds of the quarry fronts obtained are analyzed allowing:
 - measuring fracture planes that would otherwise not be accessible
 - spatial and integrated analysis of fracturing at quarry scale.



Orthomosaic of quarry front obtained by photogrammetric modelling.

Discontinuity modelling and rock block geometry identification

- Based on block identification algorithms the modeling of random discontinuities and joint sets is done, determining the geometry of all blocks.



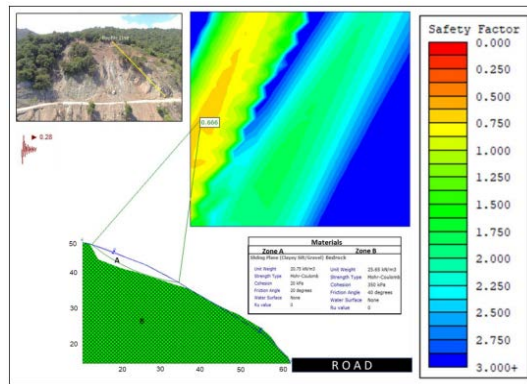
Strategic resources

- **Raw materials** should be declared **strategic resources** for the future:
 - assuring its **availability**;
 - can't be growed
 - they have to be mined
 - moderating its consumption;
 - must be **used efficiently, recycled and reused**
 - preserving the **environment**;
 - assuring its **quality**.



Slope Stability Assessment

- Assessment of potential unstable slopes in:
 - Portugal, Angola and Timor-Leste;
 - based on
 - field work
 - geomechanical classification systems
 - software
 - to prioritize
 - stabilization interventions
 - construction funds.



Research on the Geological environment

- Focused on:
 - **durability** of porous granites under **aggressive conditions**;
 - study, information, training, monitoring and mapping of **radon** in buildings;
 - **preservation of heritage buildings** related with:
 - the properties of **stones**
 - **old construction techniques** and image to **maintain cultural identity**
 - to **value the memory of know-how in traditional local arts**.

Rehabilitation of the Porta Férrea
(Iron Gate), University of Coimbra.

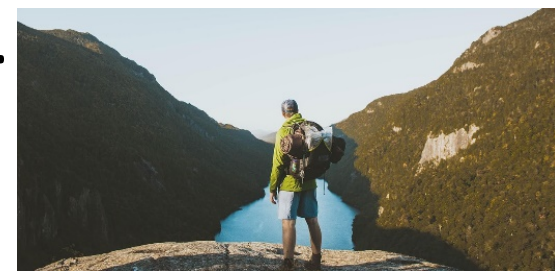


Research on the Geological environment

- Focused also on:
 - **hydromineral systems** and associated conceptual models, origin of the *mineral waters*, recharge areas, residence times and the nature of the hydraulic circuits *for its sustainability and protection*;
 - transference mechanisms of **phosphorus, metals and pesticides** among soils, sediments and water and their impacts on water quality in meso-scale hydrographic basins to *reduce the potential negative impacts*;
 - determination of *strontium* and *lead* isotopic signatures of wine and vineyard soils and *rocks-tracers of the provenience region*.

Geosciences and society

- Involvement of local population to the knowledge of his **natural heritage of geological nature**.
- Elaboration of thematic pathways relating to mining heritage.
- Dissemination of an **Open-Air Museum**, and implementation of visits of **schools**, and other institutions, of all types of **education**.
- Promotion of **geotourism** experiences.



Conclusion

- Geotechnology research and knowledge related with the geological processes and materials, are being used to promote sustainable development and environment protection.
- We all are the key to preserve the Earth:
 - seeking the best environmental performance;
 - avoiding and repairing damages;
 - reducing consumption, waste and costs;
 - recycling and reusing;
 - increasing environmental safety;
 - assuring the availability of resources in the future.

Acknowledgment

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