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INERTWASTE

# Using various artificial soil mixtures to restore dry grasslands in quarries

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GAGNERAUD CONSTRUCTION

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IRD Institut de Recherche pour le Développement FRANCE

anrt association nationale recherche technologie

Cifre Conventions

# INTRODUCTION: QUARRY REHABILITATION

- 2 700 quarries in France

- In France : ~380 millions / tons granulates are extracted / year, only 6.6% (25 M/T) from recycling processes
- In Région Sud : ~23 millions / tons granulates are extracted / year

and ~ 4 M/T from inertwaste recycling processes

- Consumption : 7 tons / inhabitant / year !

…and only 24 kg of cheese / inhabitant / year

- Regulatory obligation to redevelop quarries:
  most often requirements relating
  to the landscape and biodiversity

# Introduction: quarry rehabilitation

- Requires soil
- Soil may have been discarded, used elsewhere or stockpiled (lowering its quality)



Raw quarry material



Arable soil from abandoned fields

- Industrial process inert waste : from 0/30 grading screening between 15,000 and 20,000 tonnes per year
- low nutrient and organic contents, low mycorrhize, poor soil structure, low water storage
→ often insufficient for successful revegetation

- Surface materials resulting from stripping to reach the area to be mined represent around 300,000 tonnes
- high nutrient contents, seedbank of undesirable species (ruderal and exotic invasive species)  not adapted for success restoration of nutrient poor vegetation with high species diversity
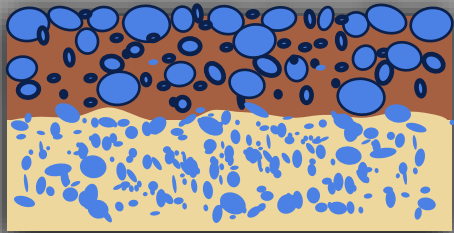
# Study area: La Crau plain
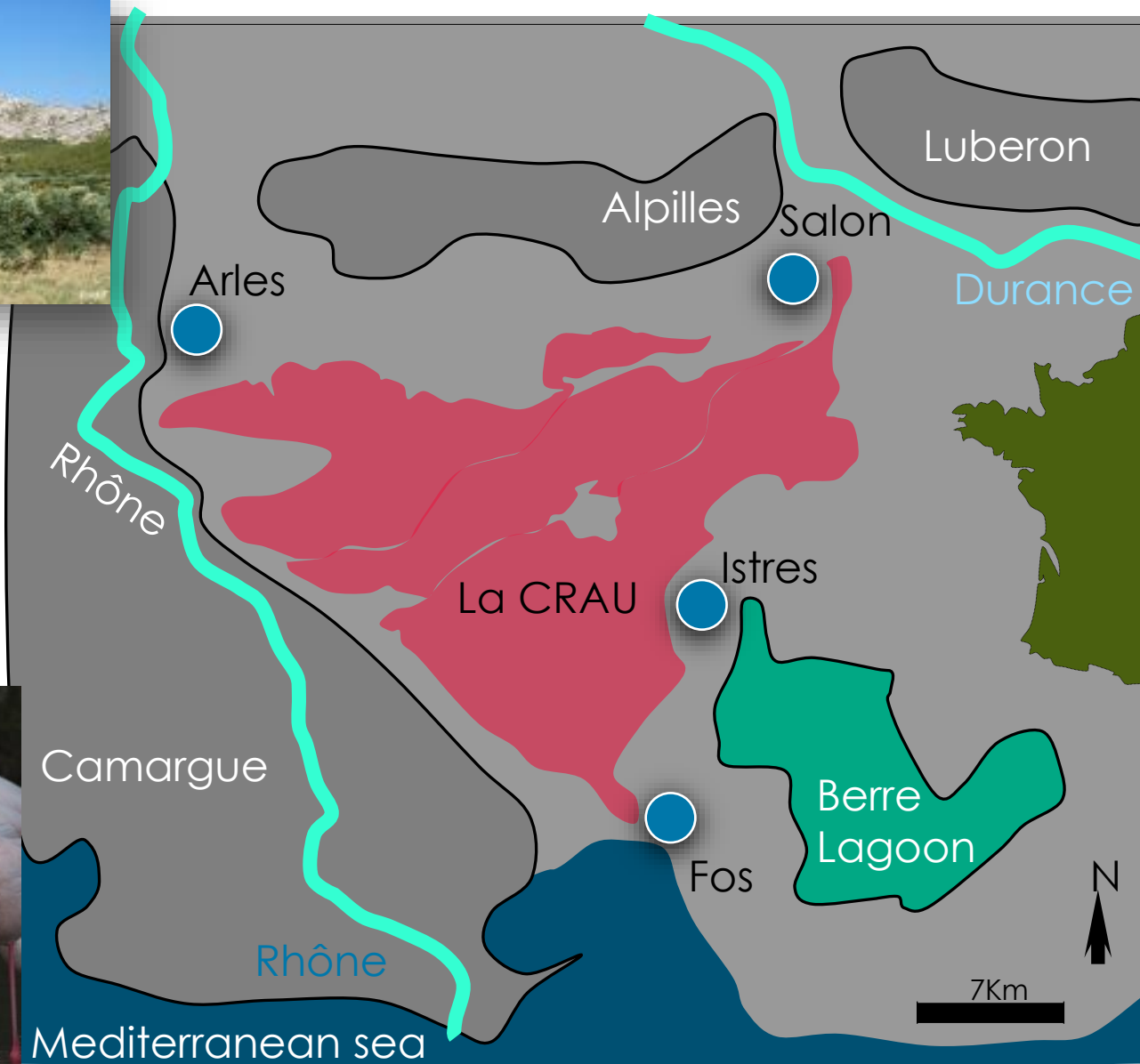
# La Crau dry grassland = reference ecosystem

Mediterranean dry grassland
Shaped by 10,000 yrs of interactions between:
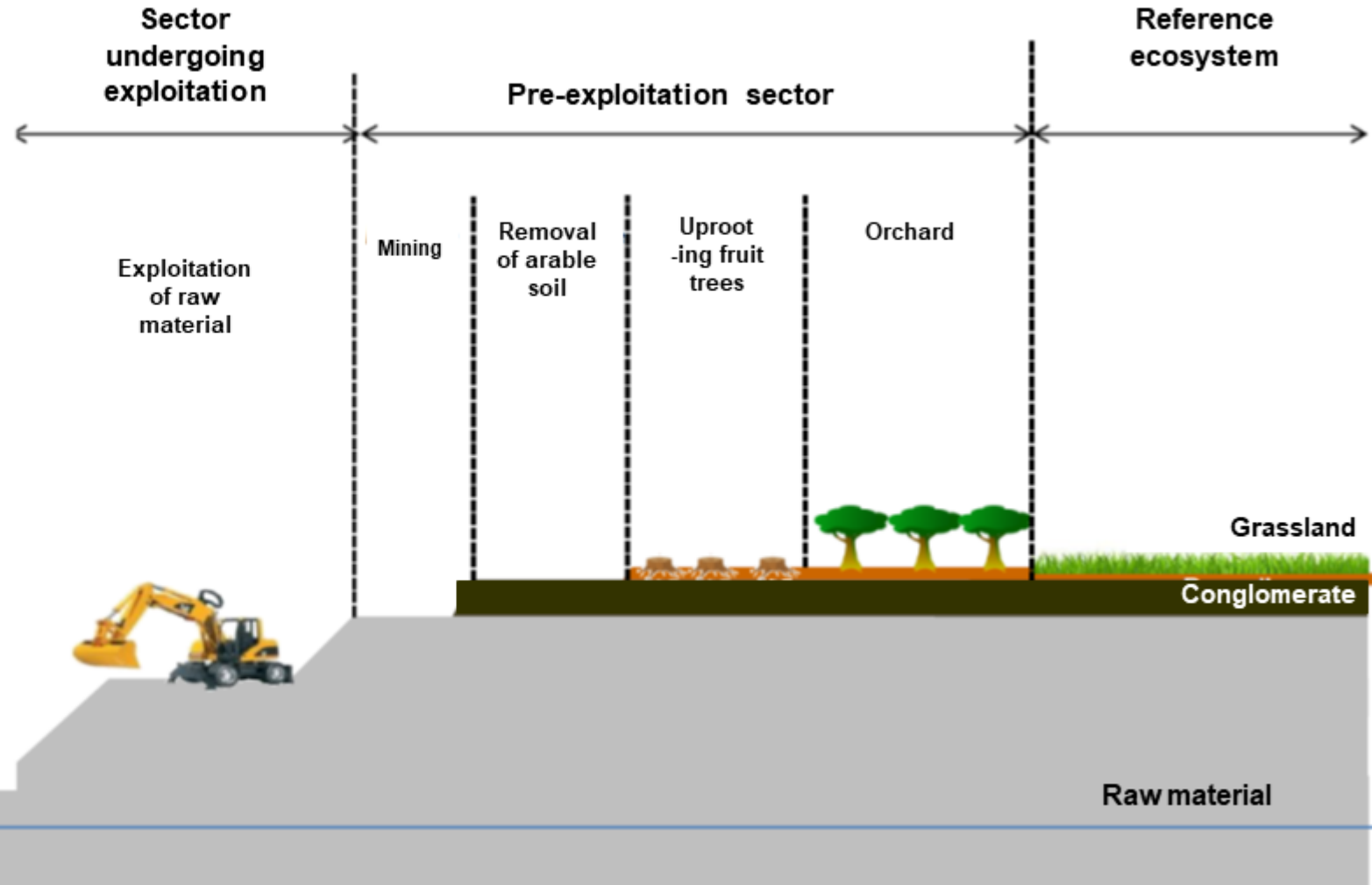
- Mediterranean climate

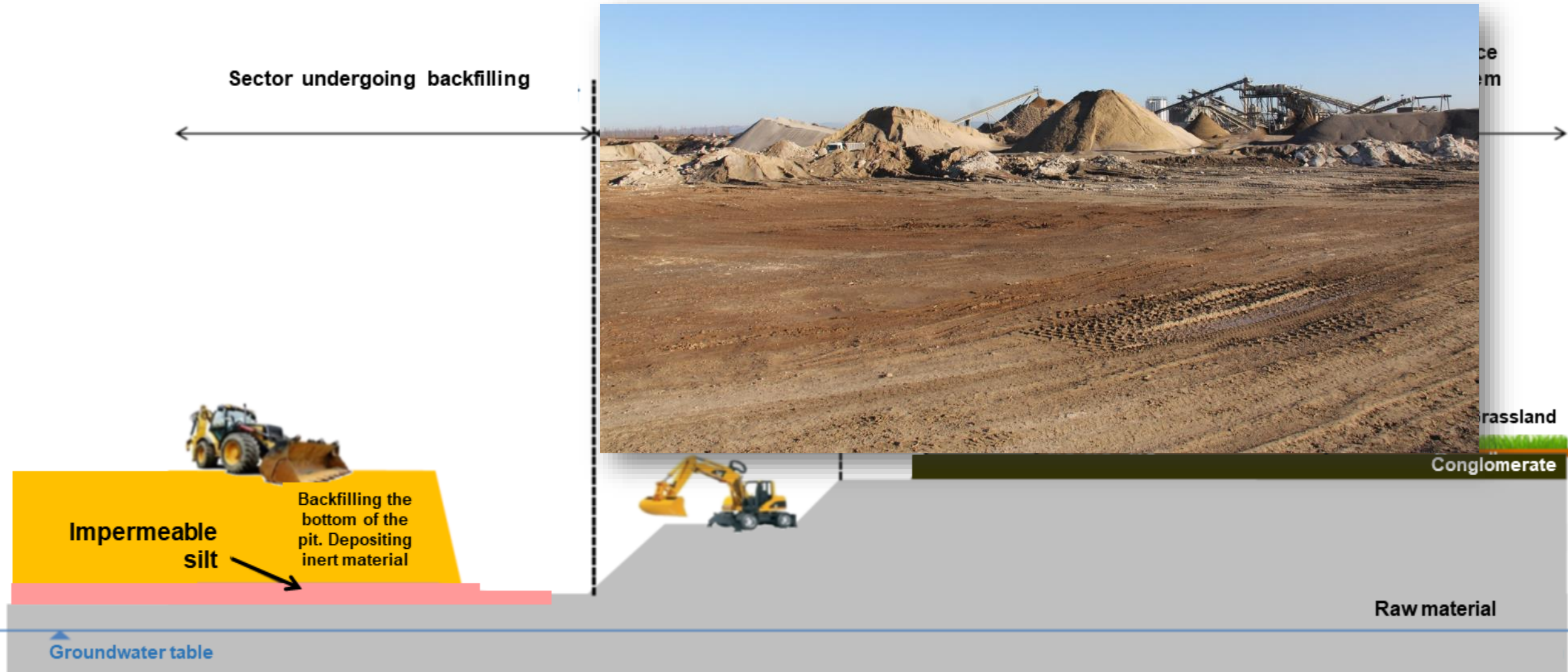- Mediterranean red soil

- Sheep grazing

# Quarries: from exploitation to rehabilitation



During exploitation in 1983

# Quarries: from exploitation to rehabilitation

# Quarries: from exploitation to rehabilitation
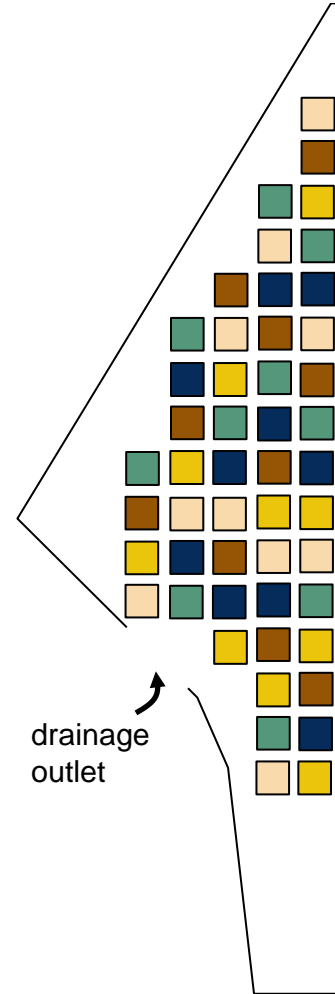
Raw quarry material

Arable soil from orchards

January 2016

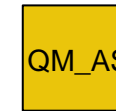# Experimental design



**Fifty 5×5m plots**

drainage outlet

**Ten of each substrate mixture**

| | |
|---|---|
| QM | 100% raw QM = Quarry Material |
| QM_AS | 75% QM + 25% AS |
| HALF | 50% QM + 50% AS |
| AS_QM | 25% QM + 75% AS |
| AS | 100% AS = Arable Soil |
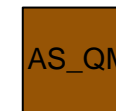
# Experimental design

**30–40-cm thick**

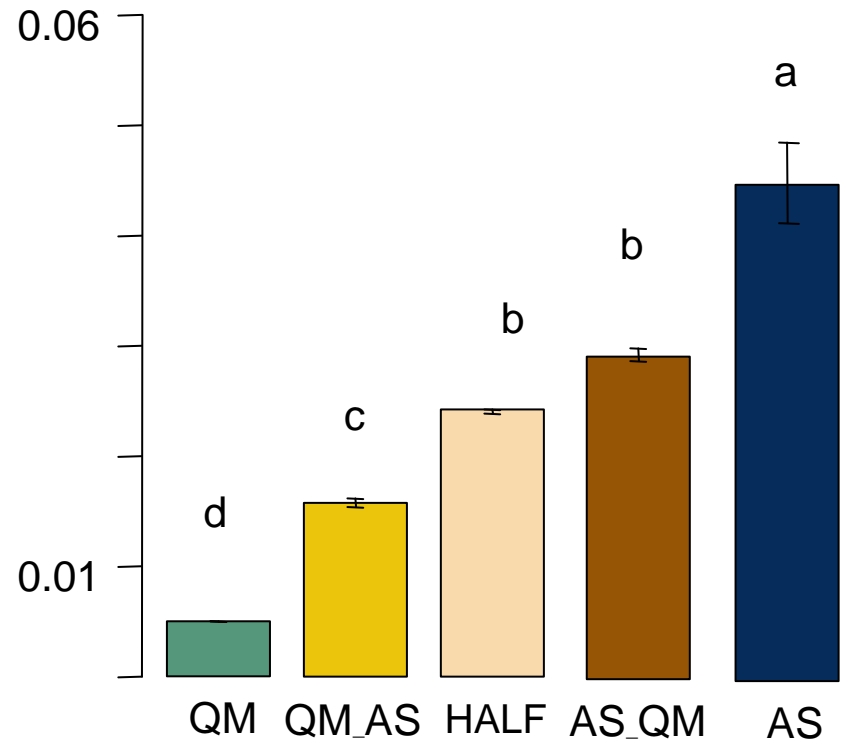**5 plots of each substrate mixture sown with *Brachypodium* (*B. retusum & B. hybridum*)**





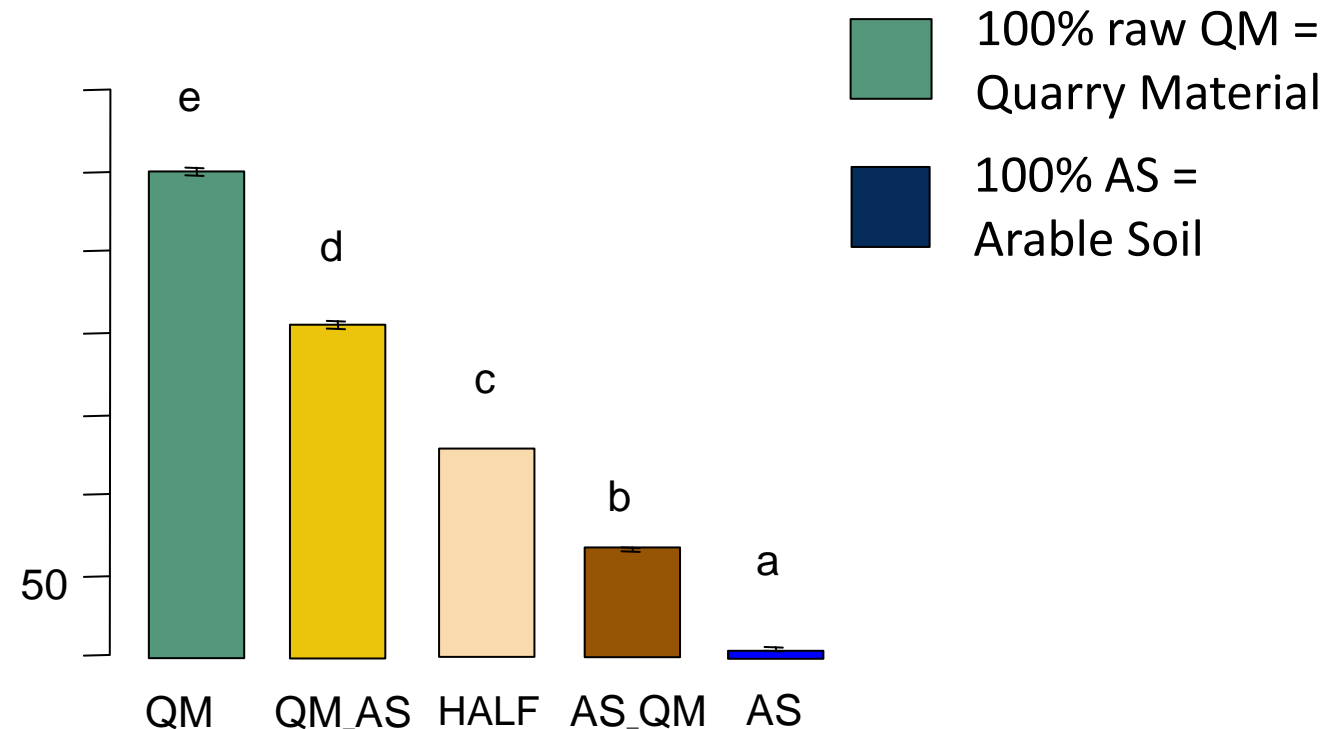**5 plots of each substrate mixture not sown**



**Vegetation surveys in 2×2 m plots**

# Results – soil parameters



P₂O5 (g/kg)
$X^2=0.22, p<0.001$

CaCO₃ (g/kg)
$X^2=0.50, p<0.001$

100% raw QM = Quarry Material

100% AS = Arable Soil

Substrate mixtures

Substrate mixtures

**Clay, Silt, OM, N, P, K, CEC**

**Fine sand, CaCO3**

# Conclusions

|  |  | Target species | | Non-target species | |
|---|---|---|---|---|---|
|  |  | **Richness** | **Cover** | **Richness** | **Cover** |
| QM | 100% raw Quarry Material |  |  | + low  + sown |  |
| QM_AS | 75% QM + 25% AS |  |  | + low  + sown |  |
| HALF | 50% QM + 50% AS | ++ high | + high | + low  + sown |  |
| AS_QM | 25% QM + 75% AS | ++ high | + high |  |  |
| AS | 100% AS = Arable Soil | ++ high | + high |  | + low  + sown |

high when not sown  +

Sowing *Brachypodium* - reduces the cover of both target and non-target species
                      - helps getting a grassland physiognomy closer to the reference

**Reduce sowing density?**

Thank you