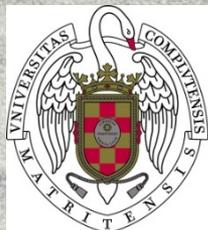


Behavior of crushed rock aggregates used in road construction exposed to cold climate conditions

Ana Patricia Pérez Fortes; Elena Kuznetsova; Sara Anastasio;
Svein Willy Danielsen



SUMMARY

- **Crushed aggregates used on surface asphalt pavements: Overview**
 - ✓ Properties of aggregates used on asphalt mixtures
 - ✓ Petrography applied to aggregates technology
- **Cases of study: Norway vs Spain**
 - ✓ Climate conditions on Norwegian and Spanish roads
 - ✓ Materials and methods
 - ✓ Norwegian aggregates under optical microscope
 - ✓ Spanish aggregates under optical microscope
 - ✓ Results
- **Conclusions**

CRUSHED AGGREGATES USED ON SURFACE ASPHALTS: OVERVIEW

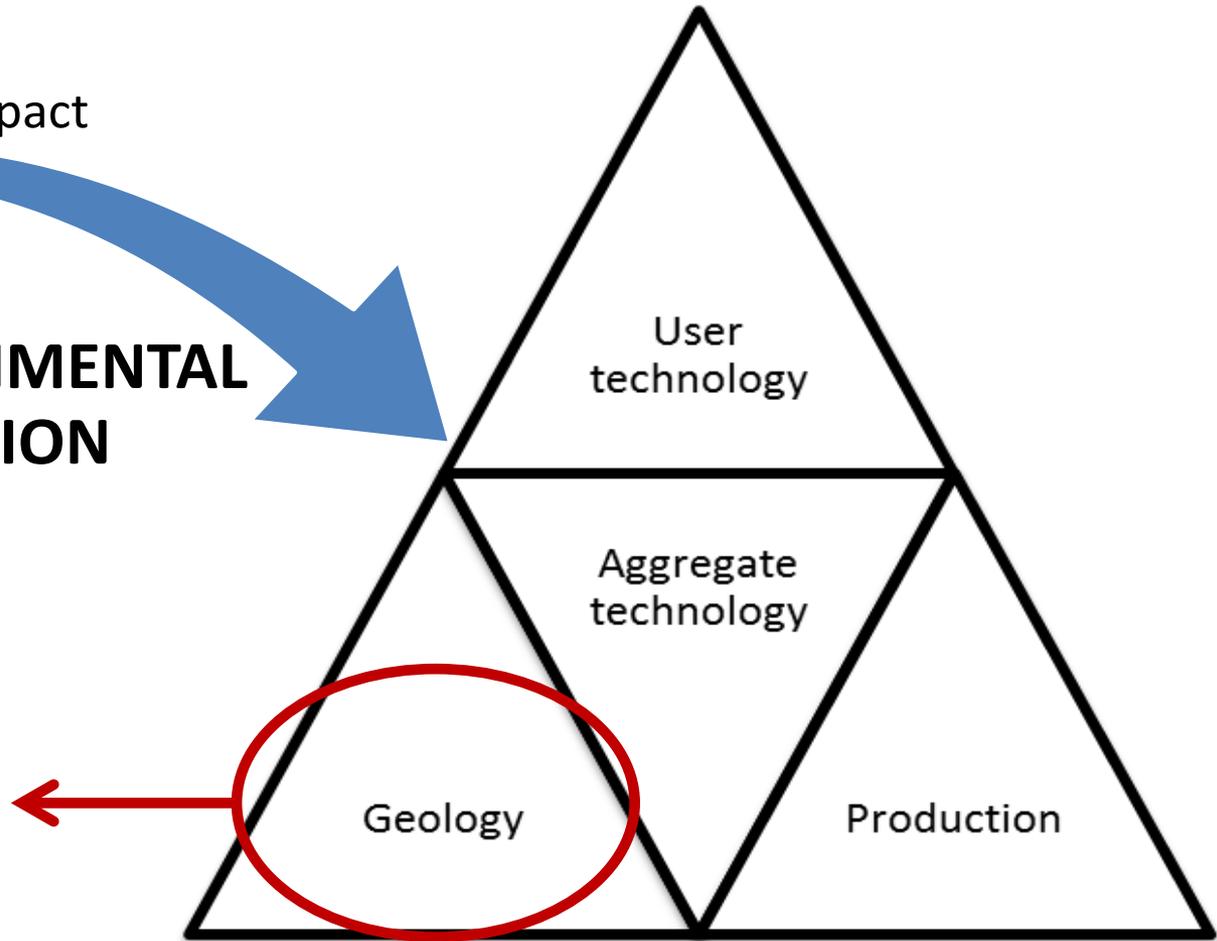
AGGREGATES MARKET

- Economic crisis
- Environmental impact

**COSTS AND ENVIRONMENTAL
IMPACT REDUCTION**



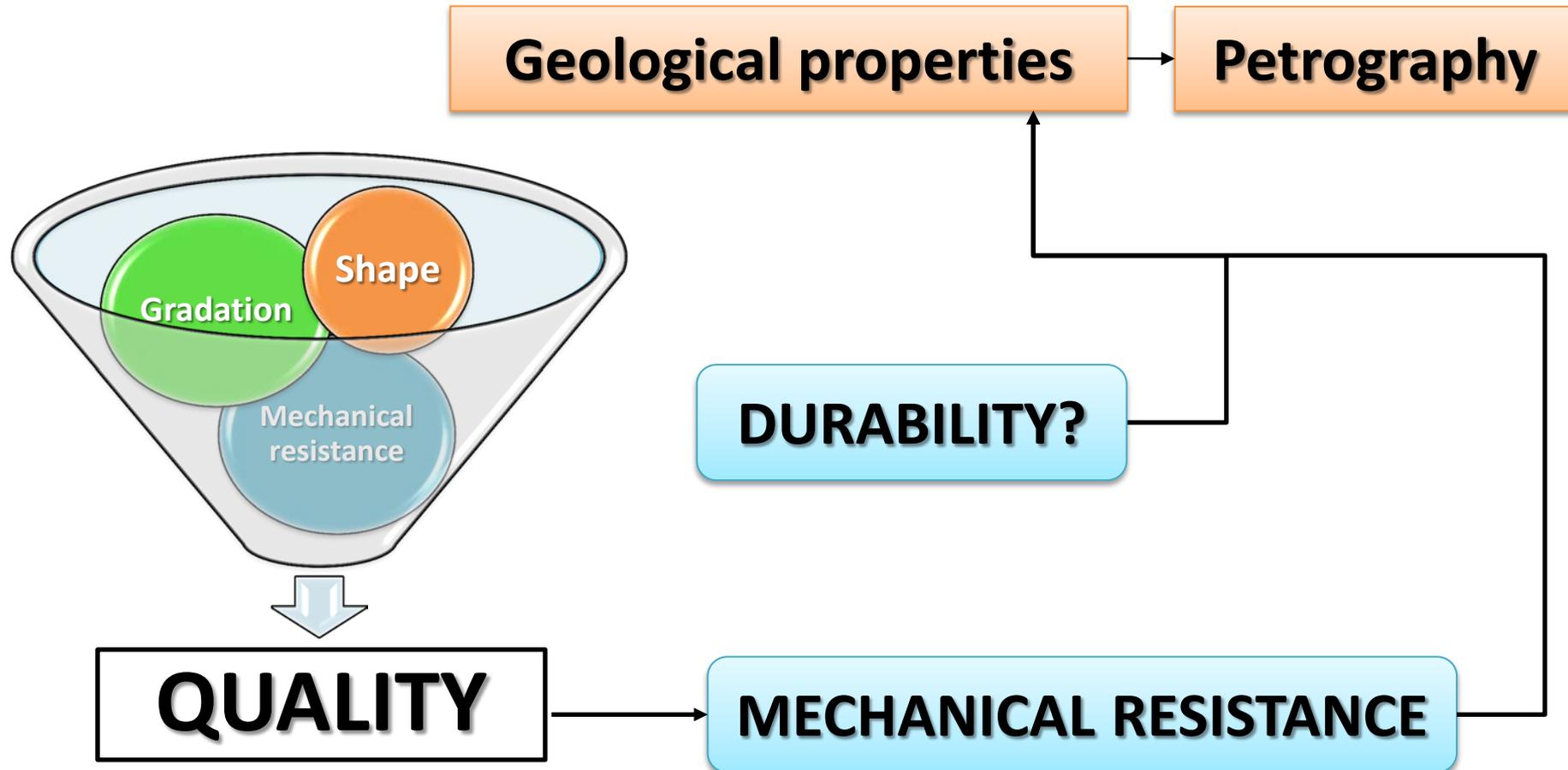
HOW TO LINK?



The principles of aggregate technology (Danielsen and Kuznetsova 2015)

CRUSHED AGGREGATES USED ON SURFACE ASPHALTS: OVERVIEW

- PROPERTIES OF AGGREGATES USED ON ASPHALT MIXTURE



CRUSHED AGGREGATES USED ON SURFACE ASPHALTS: OVERVIEW

- PETROGRAPHY APPLIED TO AGGREGATES TECHNOLOGY**

PETROGRAPHY

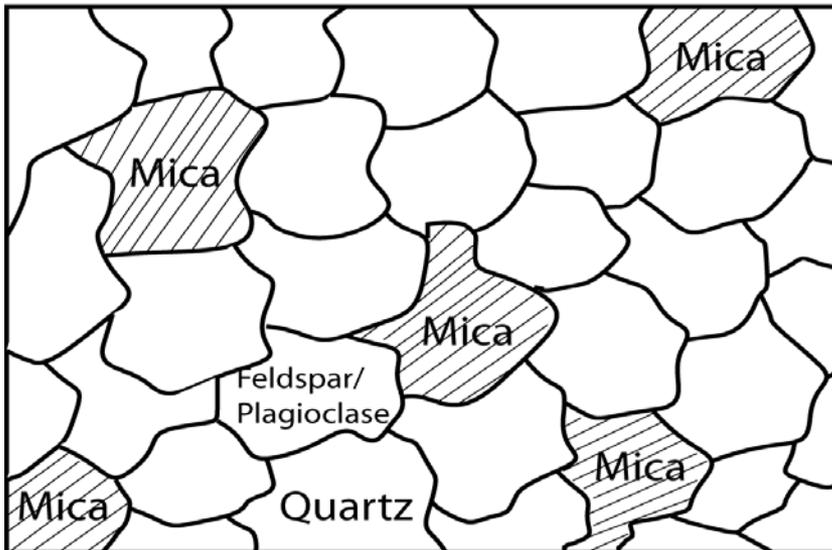
=

Mineralogy

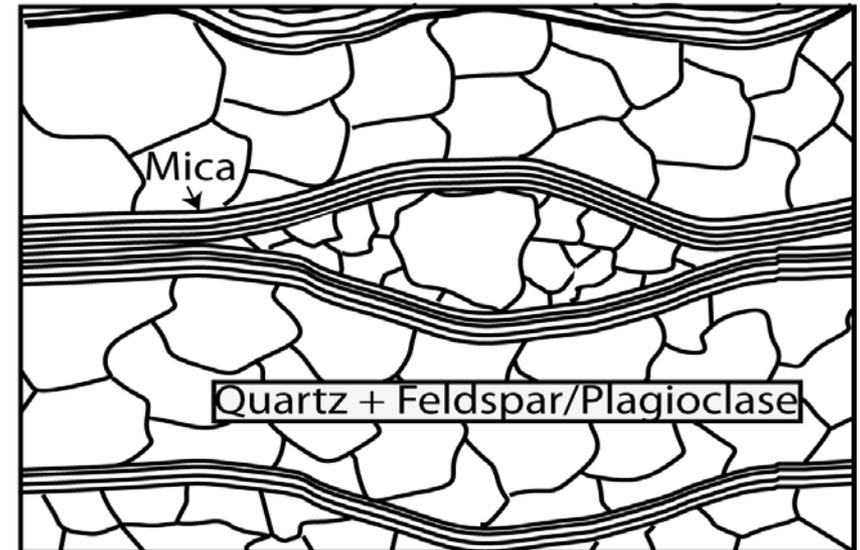
+

Structure

GRANITE



SCHIST



Similar mineralogy but different structure = Different material behavior

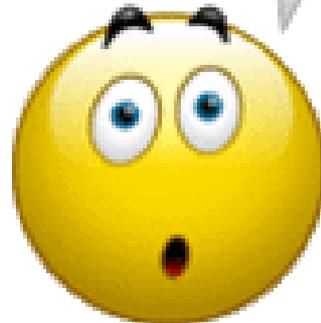
CASES OF STUDY: NORWAY VS SPAIN

- **CLIMATE CONDITIONS ON NORWEGIAN AND SPANISH ROADS**

WINTER MAINTENANCE



SPAIN?



NORWAY?

CASES OF STUDY: NORWAY VS SPAIN

- MATERIALS AND METHODS**

NORWEGIAN AGGREGATES	SPANISH AGGREGATES
Meta-greywacke	Amphibolite
Meta-gabbro	Para-gneiss and schist



PETROGRAPHIC ANALYSIS
(CEN 2010)



LOS ANGELES TEST
(CEN 2010)

CASES OF STUDY: NORWAY VS SPAIN

- MATERIALS AND METHODS**



**Open-graded
mixture
(SPAIN)**

70 cycles

**Dense- graded
mixture
(NORWAY)**

10 cycles

**FREEZE-THAW CYCLES
WITH SALT**

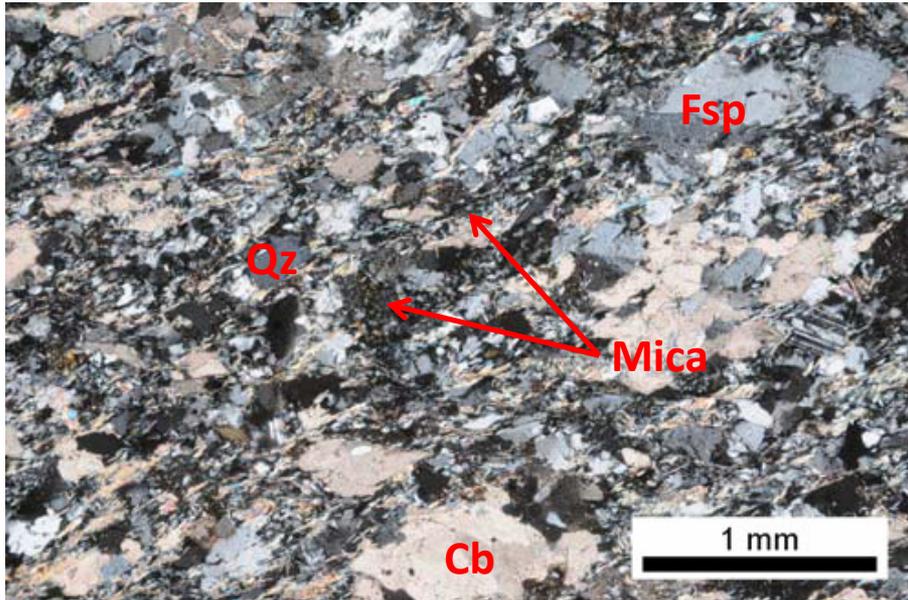


**CANTABRO TEST
(CEN 2007)**



CASES OF STUDY: NORWAY VS SPAIN

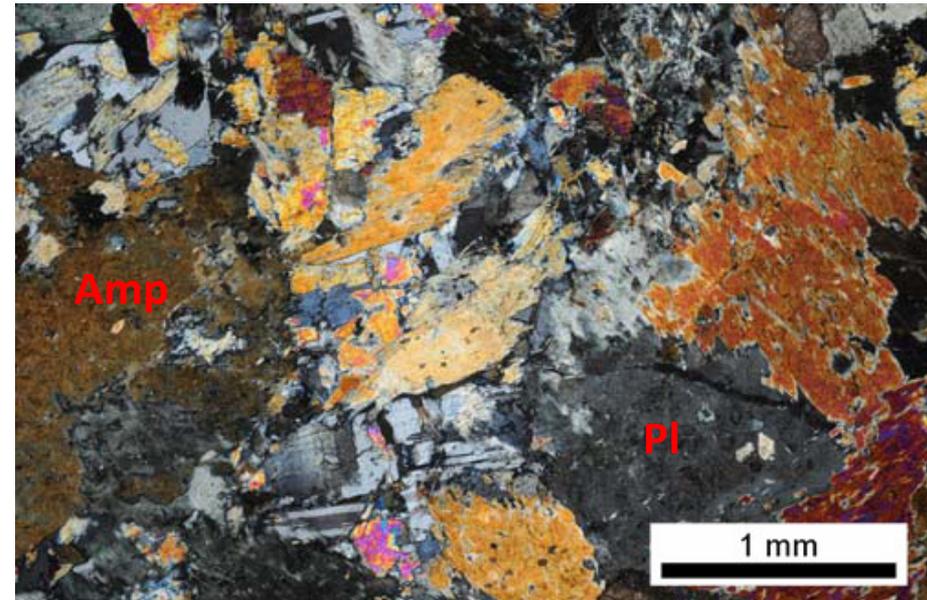
• NORWEGIAN AGGREGATES UNDER OPTICAL MICROSCOPE



Qz = Quartz; Fsp = Feldspar; Cb = Carbonate

Meta-greywacke

- ✓ Medium to fine grain-size
- ✓ Orientated structure
- ✓ **LA test = 19**



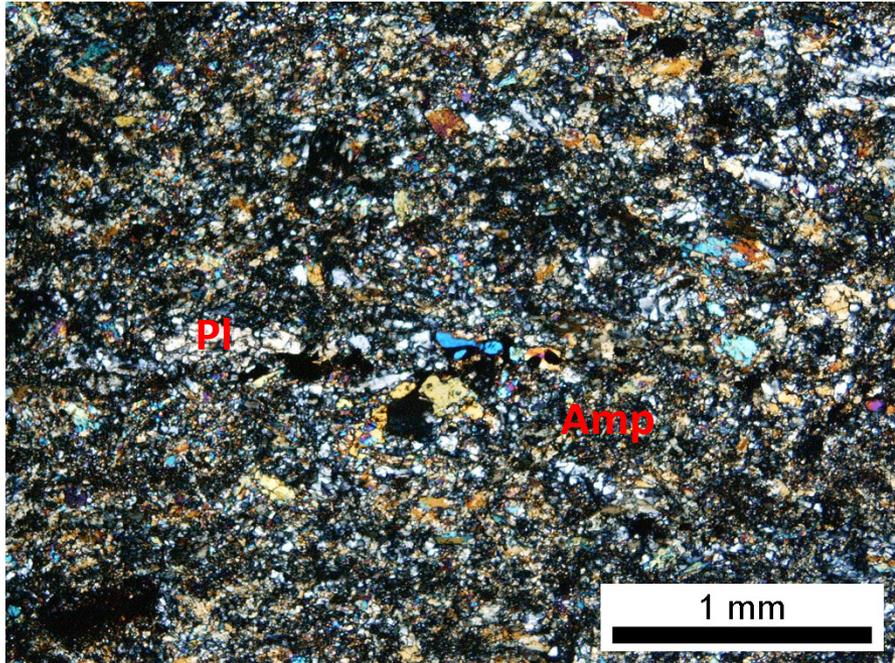
Amp = Amphibole; Pl = Plagioclase

Meta-gabbro

- ✓ Medium to coarse grain-size
- ✓ Massive structure
- ✓ **LA test = 14**

CASES OF STUDY: NORWAY VS SPAIN

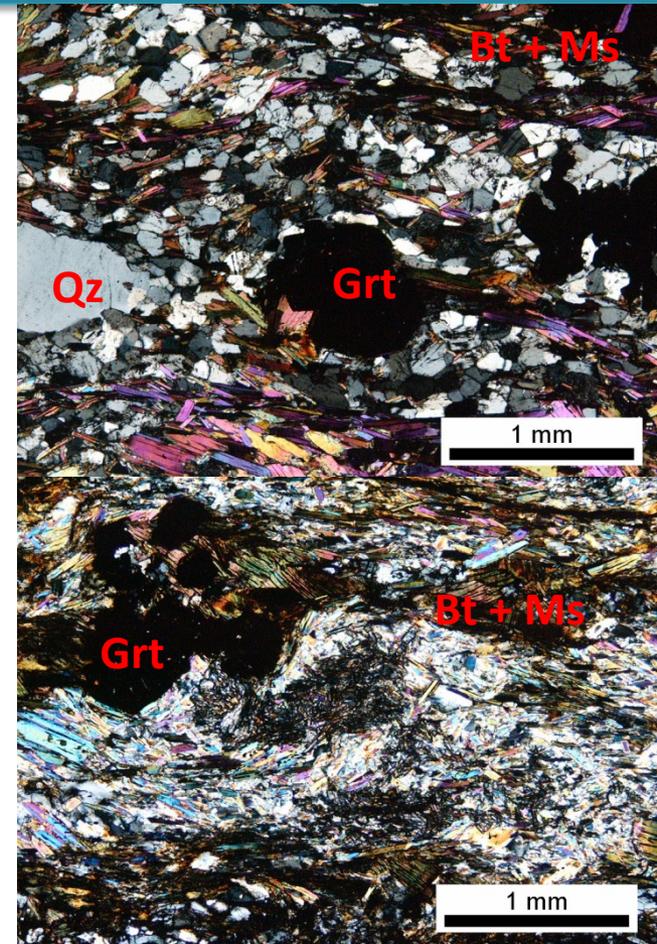
- **SPANISH AGGREGATES UNDER OPTICAL MICROSCOPE**



Amp = Amphibole; Pl = Plagioclase

Amphibolite

- ✓ Very fine to fine grain-size
- ✓ Massive structure
- ✓ **LA test = 9**



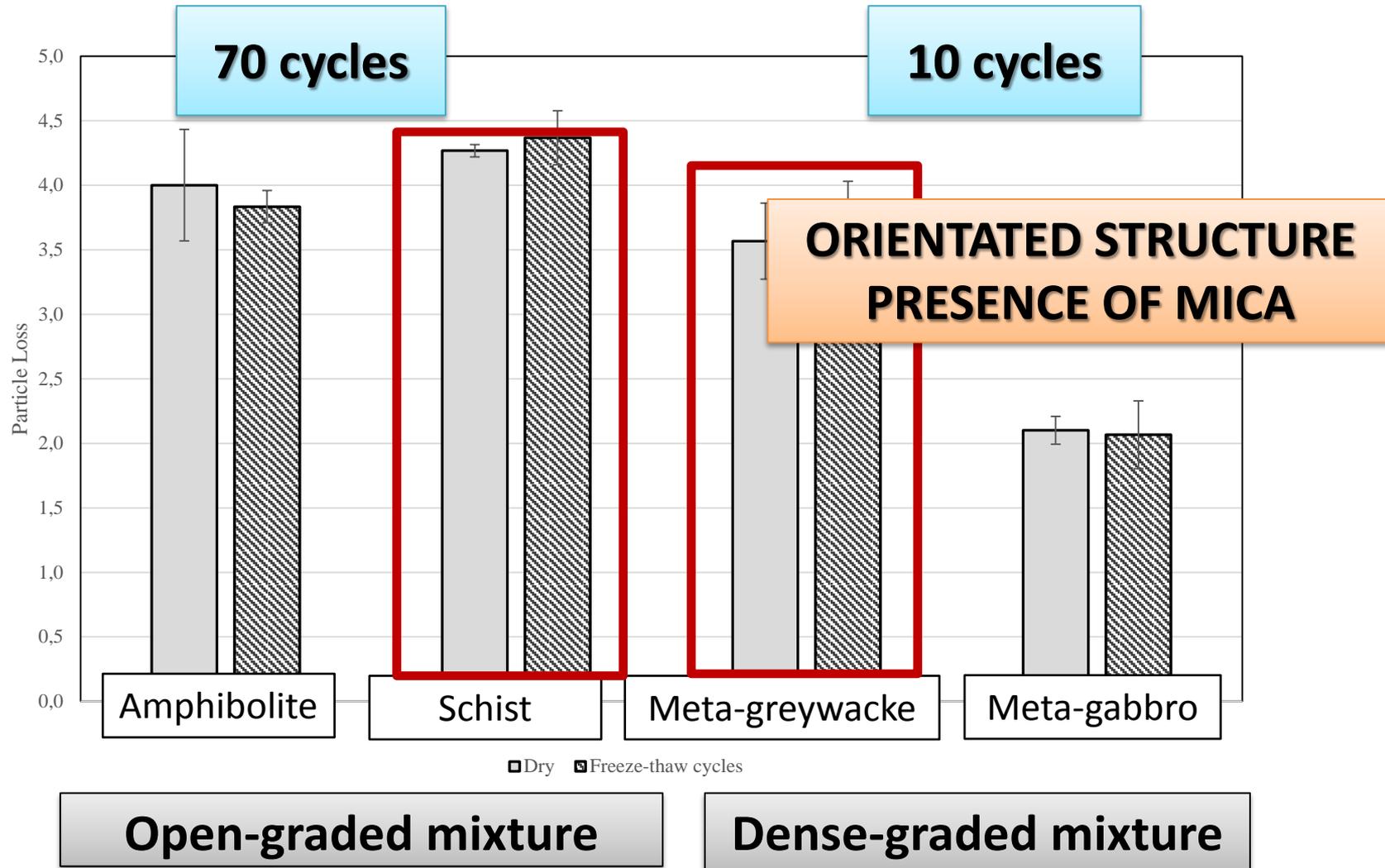
Grt = Garnet; Qz = Quartz; Bt = Biotite; Ms = Muscovite

Para-gneiss and schist

- ✓ Medium to coarse grain-size
- ✓ Foliated structure
- ✓ **LA test = 18**

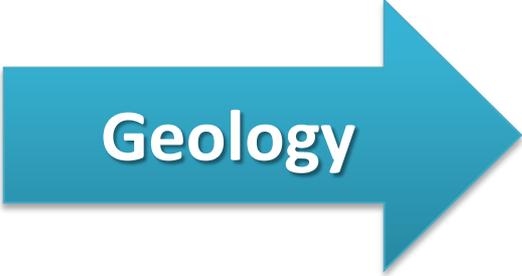
CASES OF STUDY: NORWAY VS SPAIN

- RESULTS FROM CANTABRO TEST BEFORE AND AFTER FREEZE-THAW CYCLES WITH SALT



CONCLUSIONS

Geology



Petrography
(mineralogy + structure)

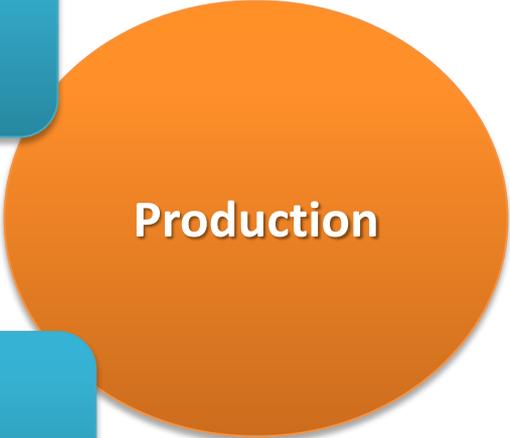
Quarry



**THANK
YOU**

Mechanical properties

Production



Asphalt mixture
(final use)

