CHARACTERIZATION OF NATURAL BUILDING GRANITIC STONES

Malfilatre C.[1], Chauvin A.[1], Boulvais Ph.[1], Hallot E.[1], Gapais D.[1], Poujol M.[1], Pallix D.[2], Michel F.[2]

[1] Géosciences Rennes, UMR 6118, CNRS/Université Rennes 1, Campus de Beaulieu, 263 av. du Général Leclerc, CS 74205, 35042 Rennes cedex

email : claudine.malfilatre@univ-rennes1.fr

[2] Centre Technique des Matériaux Naturels de Construction 17 rue Letellier 75015 Paris

EGU2011-6148

INTRODUCTION

- Market of building stones = worldwide economic activity
  In France (2009) : sales turnover ~ 631.1 M€ for ~ 470 000 m^3 of extracted stones
  Granitic stones: ~ 27% of this volume
- Industrial uses: historical monuments, construction and renovation old buildings, art buildings, tombstones...
- Important international competition (relative low cost working force and transport, counterfeit)
  Foreign commercial "analogues" of French building stones are identified by local industries
- In this context, it can be important to be sure of the origin of the rocks in order to have a guaranty of quality. Fake stones do not have the same properties (e.i. mechanical resistance) as their original counterparts

↳ Restoration of historical monuments: use the same materials or materials as close as possible to the original ones

Louvigné, France

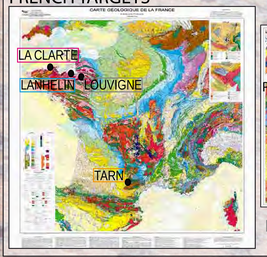
Lanhélin, France

Quintana, Spain

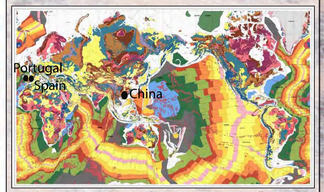
654, China

SAMPLE GRANITIC ROCKS LOCATIONS

FRENCH TARGETS



COMMERCIAL "ANALOGUES"



Portugal: Douro Valley A & B

Spain: Quintana de la Serena QE; Extramadure region SP1; Porriño regionPORR

China: Fujian region 654 & 603

APPROACH AND PROBLEMATICS

DEVELOP A METHOD OF CHARACTERIZATION OF BUILDING STONES integrating the problem of spatial scale

For petrological reasons, a given magmatic rock (= a building stone) at the scale of an intrusion is likely homogeneous

For geological reasons, rocks from different intrusions and of different ages are not expected to be similar

This work consisted in quantifying the homogeneity at different scales (batholith, plutonic intrusion, and quarry) of 4 French targets (La Clarté, Louvigné, Lanhélin and Tarn) which are also compared to their respective foreign commercial "analogues" (Porriño, QE, A, B, 654, SP1 and 603)

DISCRIMINATE BETWEEN 2 STONES OF DIFFERENT ORIGIN DESPITE SIMILAR APPEARANCE

ANALYTICAL METHODS

PETRO-GEOCHEMICAL TOOLS
- Texture, modal analysis, majors, traces elements and isotopes -

MEASUREMENTS OF MAGNETIC PROPERTIES
- Natural Remanent Magnetization, susceptibility, anisotropy,...-

STATISTICS
-Principal component analysis...-

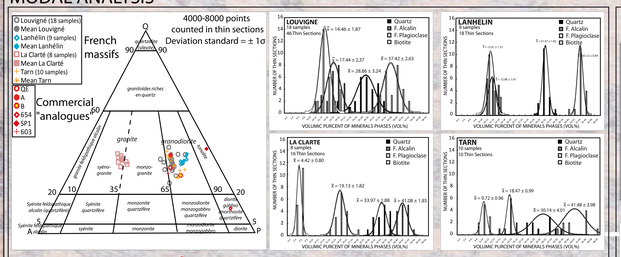
↳ "identity card" of each French target

ESTABLISH AN OPTIMAL COMBINATION OF TOOLS

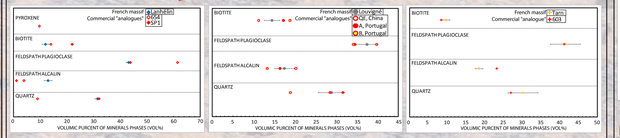
PERFORM A PRINCIPAL COMPONENT ANALYSIS (PCA)

QUANTITATIVE PETRO-GEOCHEMICAL APPROACHES

MODAL ANALYSIS



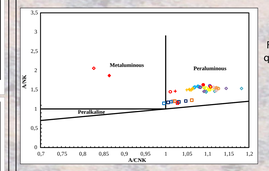
CHARACTERIZATION

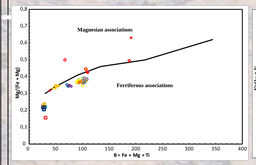


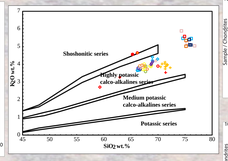
COMPARISON

GEOCHEMICAL ANALYSIS

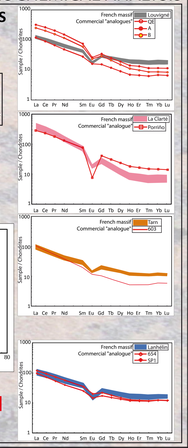
MAJORS ELEMENTS







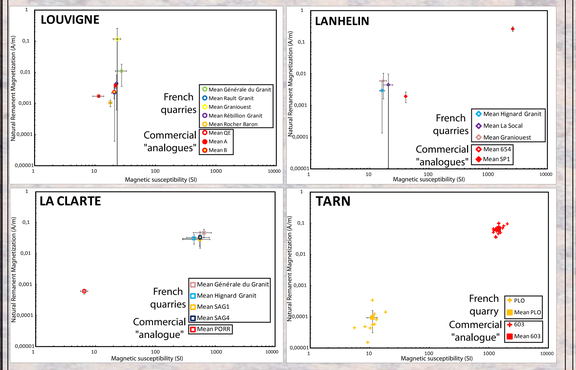
TRACES ELEMENTS



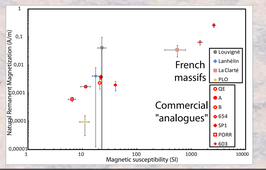
CHARACTERIZATION AND COMPARISON

MAGNETISM ANALYSIS

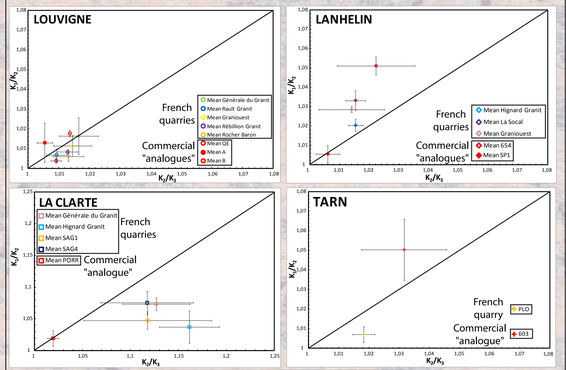
Natural Remanent Magnetization (NRM) & Susceptibility



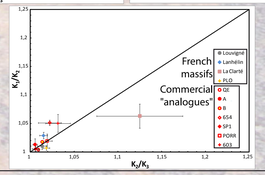
NRM
2G cryogenic magnetometer
X
Bartington susceptibility meter

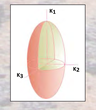


Anisotropy of Magnetic Susceptibility (AMS)

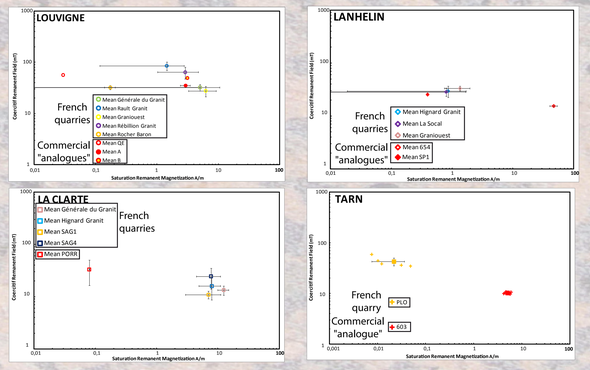


AMS
KLY3 (Agico) susceptibilimeter

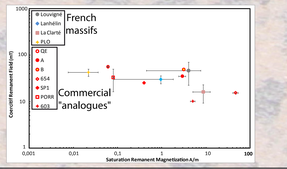




Isotherm Remanent Magnetization (IRM-Jrs & Hcr)

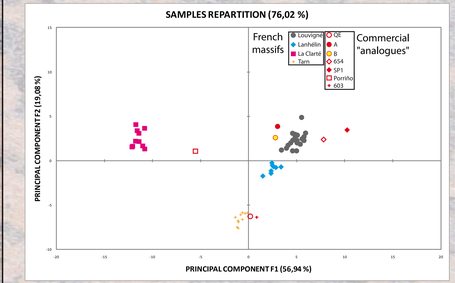


Jrs and Hcr
JR5- spinner magnetizer



CHARACTERIZATION AND COMPARISON

PRINCIPAL COMPONENT ANALYSIS



Raw PCA: 70 unselected variables on the 57 samples of all the analysed granitic rocks

Although raw, this combination of variables show that the methods used to characterize the granitic stones are relevant

Much better discrimination can be achieved by selecting a reduced number of variables and restricting comparisons to single rock

CONCLUSIONS

Combination of petrological, geochemical and magnetic analyses: robust to distinguish building stones from massifs of different history but also from massifs of the same age and the same geodynamic setting

Results are the first elements for the construction of a database for the characterization of French granitic building stones

Granitic stones extracted from a given massif can be distinguished from foreign building stones having comparable appearance

Traceability of the building stones used in historical monuments

Parlement de Bretagne, Rennes (35, France)

Protection and valorization of historical sites but also the geological heritage