ILL RESEARCH PROPOSAL

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Experiment Title :	Proposal Number
Quantitative texture analysis of po ly−mineralic naturally deformed roc ks, developed under different metam orphic conditions. From pre−Alpine	**5−26−162**

Proposer (to whom correspondence will be addressed)

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New neutron user? **No**
New ILL user? **No**

Co−proposers (mark the main proposer in each laboratory with an asterisk)

Name and first name	Laboratory	Country
CHATEIGNER Daniel *	**CRISMAT/ISMRA, CAEN**	**France**
OULADDIAF Bachir	**ILL, GRENOBLE**	**Institut Laue−Langevin**

Local contact(s) : **OULADDIAF Bachir**

Suggested keyword number **5−26**

This proposal is :

[x] A new proposal.
[ ] A continuation proposal.
[ ] A resubmission.

The main research area of your proposal is

[ ] Biology [ ] Chemistry [ ] Physics [ ] Materials [ ] Methods and instrumentation
[ ] Engineering [ ] Soft condensed matter [x] Other : Structural Geology and geophysic

Industry : **NOT Related to industrial applications**

Instrument required	Days	
D20	**7**	eulerian craddle
D1B	**7**	

Requested starting time :

1. Jan/Feb 2. Mar/Apr 3. May/Jun
4. Jul/Aug 5. Sep/Oct 6. Nov/Dec

Unacceptable Dates :

Sample availability **already available**

Sample description

Substance/Formula : **Fe, Mg, Al, K, Na silicates**

Mass (in mg) : **500**

Size (in mm3) : **2**

State : **polycristalline**

Surface area : **15**

Space group : **C2/m**

Unit cell dimension :	a = **5**	b = **7**	c = **12**
T (k) = **273**	α = **90**	β = **90**	γ = **107**

Sample container :

Safety aspects

No danger associated with sample.

Is there any danger associated with the proposed sample or its preparation at ILL ?

[ ] Yes [ ] Uncertain [x] No If Yes or Uncertain, please give details of the risks asociated :

Is the sample a transuranium sample [ ] Yes [x] No

Experimental details

Energy / wavelength range : **2.52**

Resolution in energy or wavelength :

Range of momentum transfer :

Resolution in momentum transfer :

Sample environment equipement (supplied by ILL)

Environment equipment : **ambient**
eulerian craddle

Temperature range (stability) : **ambient**

Pressure range : **ambient**

Magnetic−field strength (stability)

Is there any danger associated with ancillary equipement ? [ ] Yes [ ] Uncertain [x] No
If Yes or Uncertain, please give details of the risks associated :

To be filled in by ILL

Sample environment code	Comments by Health Physics Officer and Safety Engineer
A X	

Abstract

Recent works on Quantitative Texture Analysis (QTA) of naturally deformed rocks have shown that QTA is a powerfull tool to get insights on mechanical/mineralogical evolutions of rocks, during their geodynamic evolution under different tectonic settings (e.g. subduction, rifting,). The relationships between metamorphic and mineralogical evolutions of minerals and their deformation history can be revealed by QTA and minero−chemical studies of metamorphic rocks. Amphiboles are widespread in different metamorphic terrains (i.e. rocks) and due to their wide mineralogical compositions can be stable within most of the pressure and temperature ranges characterizing different geological environments. They can be thus used to compare mechanical behaviours under different P−T conditions. The detailed description of textures of rocks may be also used to link mechanical and mineralogical proprieties of rocks to their geophysical response. Recent works have also shown that the most powerful tools are X−rays diffraction (XRD), electron backscattering diffraction (EBSD) and neutron diffraction. The neutron diffraction technique is the only capable of direct study large volume of rock

Scientific Background

Quantitative texture analysis has become an important tool in geology since it revealed to be useful in different fields: it has been used to describe the anisotropy of fabrics [1, 2, 3*, 4, 5*], the phylogeny of molluscs and fossils [*6*], in geophysics [7]. Several techniques have been used to carry out texture analysis: optical U-stage has progressively been complimented by X-ray and neutron diffraction experiments, and more recently by the local electron back scattering diffraction. During different geodynamic processes (e.g subduction or rifting) rocks undergo large deformations, often related to metamorphism. Amphiboles are suitable minerals to be studied to deepen the knowledge on rock mechanic and relationships between deformation and metamorphism (i.e. the history of the rocks). These information are also fundamental in order to interpret the anisotropic seismic wave propagation within the crust.

Aims

The proposed experiment aims to study the textures of amphiboles collected in different places of the Alpine chain and in different lithologic types. We propose to study amphiboles developed under **High Temperature (~ 650-750°C)/ Low Pressure (~ 4-6 kbar)** conditions during **pre-Alpine rifting**, and have been collected within the Austroalpine domain of the Central Alps, and amphiboles developed under **Low Temperature (< 550°C) / High Pressure (>20 kbar)** during the **Alpine subduction**, collected in the Sesia-Lanzo Zone (Western Alps). The neutron diffraction technique allows a better statistic if compared to X-Rays and EBSD, leading to a better definition of the Orientation Distribution Function [8]; neutron diffraction also allows to access large volumes [9, *5*] in a shorter time (~ 18-20 hours/sample) if compared to X-Rays (~ 54 hours/sample) and to reveal new important insights in solving geological problems [*4*] Natural materials (i.e. rocks) are mainly composed by two or more minerals characterized by low symmetry; this implies that each diffraction pattern sums the contributions of different mineral phases, often leading to strong overlapping peaks within a smaller range of 2θ values, due to the large wavelength used. In order to lower the amount of rejected data the texture analysis has been classically done on monophasic rocks [e.g. *10*; 11].

Results of preliminary work

Preliminary work on these samples (optical microscopy, SEM and X-Rays) has shown that these rock are characterized by a well developed mineral foliation and lineation developed under different metamorphic conditions. Such amphiboles are completely re-crystallized under the new metamorphic conditions. These are optimal conditions for the proposed experiment and textures could be directly related to the palaeo-strain field and metamorphic conditions.

Samples and estimated time

Many samples are already available (more than 100). They represent different mesoscopic geological structures developed during the Jurassic rifting and the Mesozoic subduction. In order to quantitatively study polymineralic rocks we need enough samples to compare amphibole-rich to amphibole-poor rocks to separate the contribution of each mineral phase. Using D1B in 2001 and 2002 we needed 60-80 seconds for each acquisition, depending on number of phases involved in overlapping. In order to cover the entire Orientation Space we need 1368 scans (from 0 to 355° in phi and from 0 to 90° in chi, with 5° steps), which means at least18-30 hours/sample taking into account also the machine time; considering a minimal number of samples as 15 we should need 12-19 days at D1B (**18-30 hours * 15 samples = 12-19 days**). For this reason and the below described reasons we consider D20 optimal beamline to really start the study of naturally deformed polymineralic rocks.

Why ILL is necessary

From the above description of the research context, the wide interest shown by the results obtained using neutron diffraction in solving geological problems [e.g. *12*; 13] and the better statistic reachable thank to neutron diffraction, we consider the **ILL necessary** to our experiment. Moreover, in order to lower the acquisition time and to decrease the number of data lost we also consider the use of the **D20** beamline as necessary; D20 allows passing 10 times more samples in the same time then D1B. D20 also allows ranging theta at higher values with respect to D1B which a primary needing if polymineralic materials are studied.

References:

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Publication

Proposal: **5−26−162** **Council:** 10/2002

Title: Quantitative texture analysis of poly−mineralic naturally deformed rocks, developed under different metamorphic conditions. From pre−Alpine

This proposal is a new proposal

Researh Area: Other

Industry: **Not related to industrial application**

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New ILL user? No

Local Contact: OULADDIAF Bachir

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D20	7
D1B	7

Publication:

– Quantitative texture analysis of naturally deformed glaucophanites under eclogite facies conditions (Sesia−Lanzo Zone, Western Alps): comparison between x−ray and neutron diffraction analysis. Michele Zucali, Daniel Chateigner, Mattia Dugnani, Luca Lutterotti and B. Ouladdiaf. 2002. In: Deformation Mechanisms, Rheology and Tectonics: Current Status and Future perspectives. Geological Society, London, Special Pubblications, 200, 239−253.

– The grid−work texture of authigenic microcrystalline quartz in siliceous crust−type (SCT) mineralized horizons: Textural parameters by optical microscopy, SEM, and X−ray powder diffraction. 2002. G. Camana, D. Chateigner, G. Artioli, M. Zucali. 2002, American Mineralogist´s, 87, 8−9, pp. 1128−1138

– Quantitative texture analysis of naturally deformed glaucophanites under eclogite facies conditions (Sesia−Lanzo Zone, Western Alps): comparison between x−ray and neutron diffraction analysis. 2002 Michele Zucali, Daniel Chateigner, Mattia Dugnani, Luca Lutterotti and B. Ouladdiaf. Ill Report (Annual Report 2001), 54−55.