Experimental report

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Proposal: **1-02-232** **Council:** 4/2018

Title: Texture-induced anisotropy as a seismic tectonic flow fingerprint

Research area: Other...

This proposal is a new proposal

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Samples: FeMgCaNaAlSiOH

Instrument	Requested days	Allocated days	From	To
D1B	15	0		
D20	4	4	15/09/2018	17/09/2018

Abstract:

We propose to quantify the texture of rocks collected from the lower crust. Those samples represent critical rheological sections of different orogens, which encompass deformation fabrics developed under high-temperature and high-pressure, and different stress levels. Quantitative texture analysis could help to understand not only deformation mechanisms, but also elastic anisotropy of the rock. The correlation between shape fabric, texture and elastic anisotropy is fundamental in understand tectonic flow in active geodynamics based on geophysical data. Neutron diffraction in combination with Rietveld method has emerged as the best technique to analyze large samples composed of low symmetry phases with enough statistics and resolution on such large grained samples. We propose to study 15-20 samples of lower crust rocks, formed during deep-sited processes at Pan-African (630-610Ma), Variscan (380-290Ma) and Alpine (100-30Ma) times. Selected rocks have been cut in approximately 1 cm3 samples allowing a large volume of crystallites to be analyzed even though a large grain-size (100-1000microns) is expected. D1B and D20 beam-lines are proposed for the experiment.

Experimental Report: 1-02-163

Texture-induced anisotropy as a seismic tectonic flow fingerprint

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The proposed experiment aims at quantify the texture of lower crust from two orogens of Europe (Alps and Iberian Massif) and the Pan-African orogen in Egypt. The selected rock samples, cut in cubes of approximately 1 cm3, will be investigated in terms of crystallographic preferred orientations of rock-forming minerals, using the approach already tested at ILL an elsewhere for similar rock samples [2]. The orientations of lattice planes will be used to calculate the Orientation Distribution Functions (EWIMV) of every rock-forming mineral [1,2]. Such calculation will be performed using Rietveld method as implemented in Maud software, successfully used for various solid materials among which rocks. We propose the study of selected high-T and high-P gneisses (15-20 samples) from regional scale shear-strain zones. The results will be used to calculate the elastic properties of the aggregates based on averages of single crystal properties over the ODF of each mineral phase, using BEARTEX. After calculating the contribution of each mineral phase to the intrinsic elastic properties, the different phases were combined, taking the relative volume fractions into account. Finally rock models with different proportions of minerals can be explored to account for the contribution of each phase to the seismic anisotropy of the aggregate [1, 2].

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As proposed we **successfully** quantified the texture of rock samples from lower crust from two orogens of Europe and one in Africa.
Part of the experimental time has been devoted to optimize the procedure balancing between data acquisition time and resolution and the solution of several problems related to data treatment with Maud. We obtained clear texture data from most of the samples with few exceptions, probably related with specific mineral phases as serpentine of other hydrated phases (Fig.1).

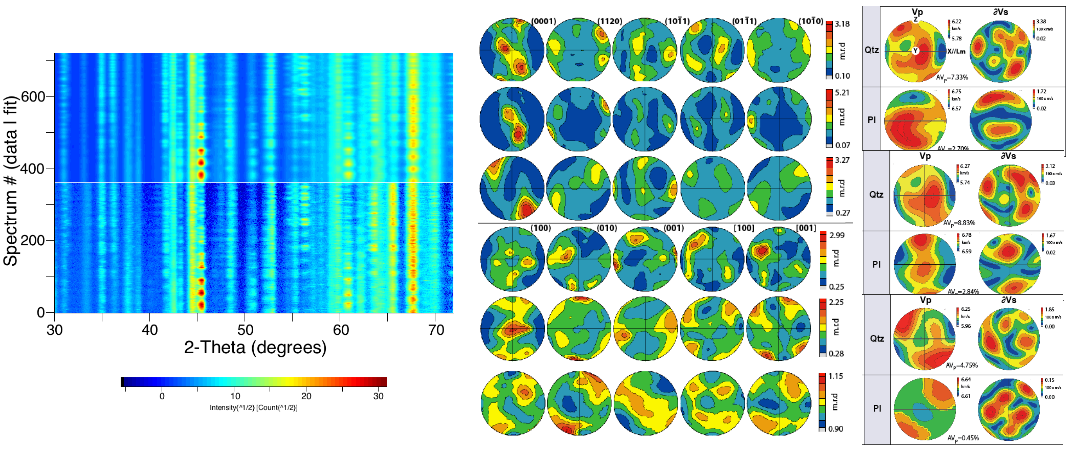

Figure 1: *(Left) Example Rietveld refinement with MAUD. Note variations in intensities reveal texture. (Center) Selected pole figures (Foliation/lineation reference system) of Quartz (top) and Plagioclase (bottom) from three granulites, as recalculated from ODF in BEARTEX (m.r.d. multiples of a random distribution). (Right) Texture-based polycrystalline models of compressive elastic waves (Vp) and birrefringence (dVs)*

Data acquisition

4 days beam time was initially allocated between 14/09/18-17/09/18. A technical problem in the beam path appeared the first day, so only some initial tests were conducted. Experiment started 15/09/18 not without problems. Spurious peaks overlapped every single pattern (Fig.2). Several tests were done with beamline scientist to check their origin, as well as strategies to deal with them in data refinement in MAUD. This took the day 15/09 and part of the 16/09. Afterward, a close inspection revealed that a Cd piece of the final path shield was not in place, and some diffraction from aluminum parts contributed to the pattern.

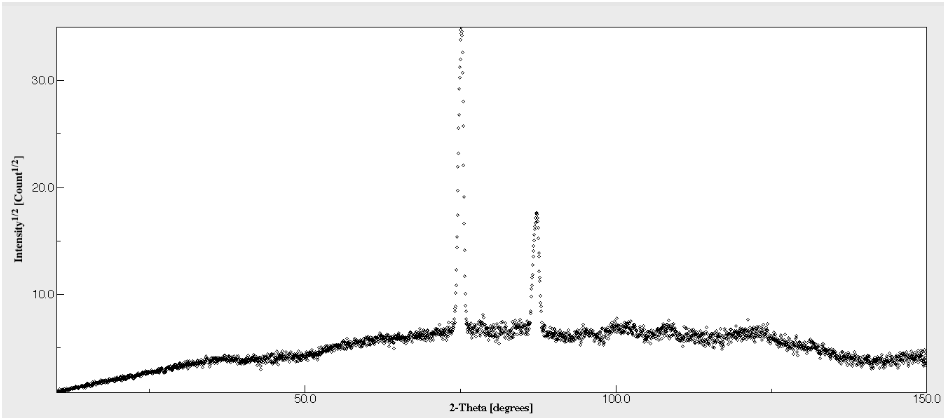

Figure 2: *Spurious peaks due to Al-shield issue.*

Overall, some experimental data were partially usable from 15 and 16/09/18. Real experiment started at 12:00 on 16/09/18.

In order to cover the entire Orientation Space we need 351 scans (from 0 to 350° in phi and from 0 to 90° in chi, 10° step). A 10s acquisition time per step were set after several tests, performed with and internal texture standard. Those tests returned an ideal performance of 1h/sample, about half experimental time required at D1B the past. However the real performance is far below. This was due to the eulerian cradle performance: on average, moving 1º takes ca. 17s. In our tests, and after optimization of the acquisition strategy, we needed about 2.5h/sample.

With those numbers we have compared signal-to-noise ratio (S/N) with D1B. Taking our texture standard (quartzite) already measured in D1B, S/N@D1B= 1527 and S/N@D20= 552. All those issues reduce the benefit of a higher flux at sample in D20. An upgrade is needed to exploit the full potential of D20 not only for texture (eulerian cradle engines upgrade) but also for other applications (S/N improvement). We will include some tests in the next cycles to refine our procedures and improve performance.

Conclusions

Nowadays, some refinement problems related with experimental issues have been solved and usable data included as part of a PhD thesis and ongoing publications. Excellent correlation between texture and elastic properties has been found for most of the analyzed samples. A selective upgrade of D20 is highly desirable, particularly eulerian cradle (engines/whole) and S/N ratio.

References

[1]Gómez Barreiro et al. 2015, J. Struct. Geol. 71: 100-111.
[2]Zucali et al. 2014. Geol. Soc. of London Spec. Pub.