

ESF Activity: Micro-Dynamics of Ice (MICRODICE)

Report for short exchange LGGE – SLF Davos

**Title : Measurements of crystal orientation in snow samples from the Antarctica traverse EXPLORE**

Reference number: 5185

Date of exchange visit: 17 - 21 september 2012

Host institution: WSL Institute for Snow and Avalanche Research SLF, Davos, Switzerland.

Montagnat M. (1) and Schneebeli M. (2)

(1) Laboratoire de Glaciologie et Géophysique de l'Environnement, CNRS / UJF-Grenoble1, St Martin d'Hères, France

(2) WSL Institute for Snow and Avalanche Research SLF, Davos, Switzerland.

The aim of this short exchange (5 days) was to measure the fabric and microstructure on snow samples extracted from different places along the EXPLORE traverse, Antarctica.

The samples were collected last winter by Martin Schneebeli in the frame of the French-ANR “EXPLORE” project led by J. Chappellaz, from LGGE.

Before the exchange, the samples were analysed by micro-tomography by Martin Schneebeli. From the 3D structure obtained thanks to these analyses, we selected several samples from the top of the snow mantle to two meters down.

During the exchange, these samples were filled with di-ethyl phtalate to keep their 3D shape (low density snow), then shaved into thin sections that could be analyzed using the Automatic Ice Texture Analyzer brought from LGGE.

Because of the long procedure to do the thin sections, only 19 thin sections were analyzed, extracted out of 7 samples (for each samples, a minimum of one vertical and one horizontal thin sections were performed).

Furthermore, for this first campaign of fabric measurements in Antarctic snow, we spent some time at verifying every step of the thin section procedure, and the fabric measurement.

For instance :

- before fabric measurement, it is necessary to dissolve the di-ethyl phtalate (which is birefringent and therefore polluted the data from snow crystals). This is done by adding a drop of tetraline, and holding the snow between two thin glass plates. We spent some time at verifying, under a binocular, that this procedure did not induce any major rotation or translation of the snow grains.
- The thickness of the thin section is a critical parameter as, when being much thicker than the grain size, the proportion of grain boundaries is large, and it reduces the amount of available fabric data. On the contrary, when being too small (below about 100 microns), the resolution of the fabric measurement is not accurate enough in vertical grains, biasing the data.

On every thin section analysed, the first observations are very encouraging with a good resolution (spatial and angular) of the fabric data, on a large enough number of grains (see figure).

To extract the fabric parameters (fabric strength, anisotropy factors, orientation tensor eigenvalues...) will be the next step as care must be given when treating the data.

We would like to recall that the precise measurements of the c-axis orientation in snow samples was made possible thanks to:

- the technique for extracting very thin section out of impregnated snow samples elaborated by Riche and Schneebeli (2012) at SLF, Davos,

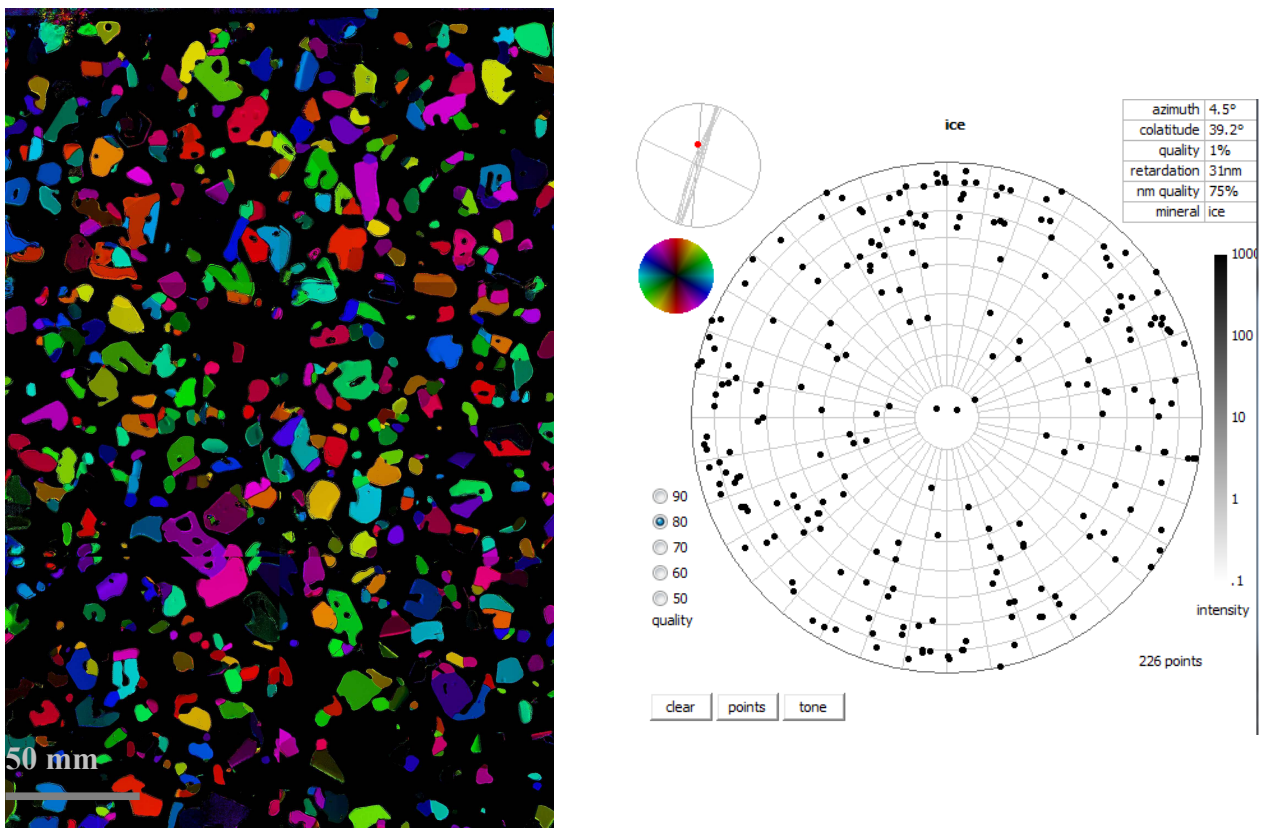
- the performance of the Automatic Ice Texture Analyser available at LGGE, Grenoble, (from Russell-Head company), with a 6.5 micron spatial resolution, and a 1-2° accuracy.

**Collaboration and expected on-going:**

This exchange will reinforce the on-going collaboration between SLF, Davos, and LGGE, Grenoble, in the frame of the understanding of the physical properties of polar snow and firn. This aspect of the collaboration is new (working on polar snow samples), and was made possible thanks to the participation of M. Schneebeli to the Traverse EXPLORE project led by LGGE.

A new and longer measurement period will be necessary in the year to come to be able to provide data all along the snow pits where samples were extracted. We will make connections with measurements of fabric in firn and deeper ice.

A publication will result from these original fabric measurements, and will be connected with the publication showing results of isotopes, dust, methane measurements performed in the same areas.



**Figure :** **Left** – Orientation-colored image of the microstructure of a sample extracted from a snow pit during the EXPLORE traverse, between the top and 2 meters down. The c-axis orientation color-scale is given by the colorwheel on the right. **Right** – c-axis orientation of 230 grains selected out of the microstructure on the left, Schmidt stereographic projection.

**Final budget :**

Travel Grenoble – Davos (train)  
5-day stay in Davos

230 CHF + 50 euros = 240.15 euros  
334.40 CHF (hotel) + 150 CHF (food) = 400.50 euros

Total

640.65 euros