ESRF	**Fxperiment title:** Synchrotron X-ray topographic study of the angular distortion of the lattice and dislocation distributions in ice single crystals from the 3523m. Vostok ice core (Antarctica)	**Experiment number:** HS-404
Beamline: ID 19	**Date of Experiment:** from: 30/10/97 to: 02/11/97	**Date of Report:** 28/07/1998
Shifts: 9	**Local contact(s):** J. BARUCHEL,	*Received at ESRF :*

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Report:

The study of the deformation of glacier ice is a topic of growing interest in relation to the flow of polar ice sheets. Several deep ice cores were recently retrieved in Greenland and Antarctica. A 3,623m long ice core was recently recovered at Vostok in East Antarctica. It provides information on the past climate over timescales extending to more than 400,000 years.
Very large ice single crystals of about 50 cm were found below 3,000m where the temperature is near the melting point. This large grain size appears to be related to the occurrence of continuous recrystallization during the slow deformation of ice by dislocation glide. The opportunity of analyzing the dislocation microstructure within . these single crystals by Synchrotron X-ray topography at ESRF was taken.

Monochromatic beam projection topographs obtained with basal diffracting planes during the first experiment done in november 1996 (HS 100) were interpreted as twist basal sub-boundaries (cf Users'meeting, 1997). More precise information on the angular distortion of the lattice in large ice single crystals from the Vostok core was obtained during this three days experiment.

Synchrotron X-ray topography at ID 19 beam line was used on large ice single crystals from the Vostok ice core. Diffraction projection and section topographs with basal and prismatic diffracting planes were obtained on centimetric samples.

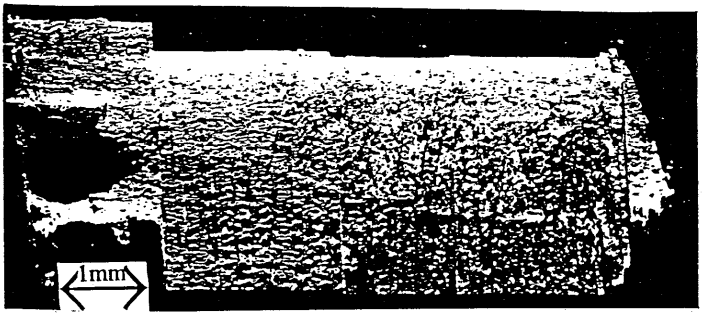

FIGURE 1

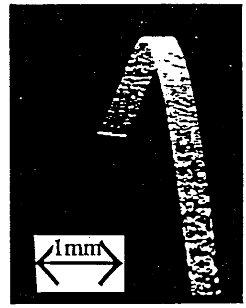

FIGURE 2

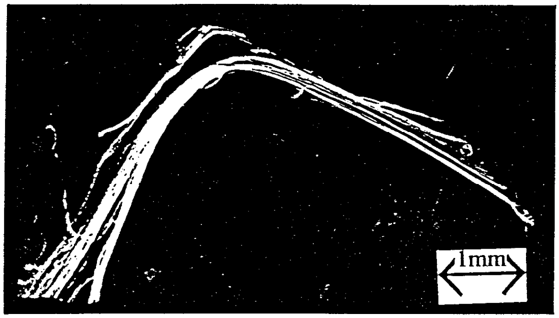

FIGURE 3

Figure 1 shows a projection topograph with the (0002) diffracting plane on a single crystal from the depth of 3286m at Vostok (Antarctica). The image represents a part of a thin tube with the symmetry axis along the c-axis. This 3D structure is clearly displayed on the section topograph given in **figure** 2. Rocking curves do not exhibit the presence of sub-boundaries, but indicate a continuous misorientation within this crystal by dislocations. Topography images with the prismatic diffracting planes shown in **figure** 3 represent the projection of tubes of different diameters observed with the basal diffracting planes and not sub-boundaries as deduced from previous measurements with other X-ray sources. Since the diffracting volume is the same with basal and prismatic reflections, we can conclude that that there is no significant distortion of the lattice around the c-axis. Such a structure should be produced by the bending of the ice crystal by isolated basal dislocations. The shape of diffracting images should be related to the deformation state of ice within the ice sheet.
The assumption made after the first experiment on the presence of twist sub-boundaries is therefore not confirmed.
By assuming that the angular distortion of the lattice is produced by isolated basal dislocations, the dislocation density can be calculated. A value of the order of lx $10^{10}/m^2$ is obtained in the Vostok ice single crystals at 3286m. It is compatible with that deduced from the modelling of the deformation of ice along this deep ice core (De La Chapelle et al., 1998).

The variation of the dislocation microstructure with depth and the temperature within ice sheets has been studied during the three days experiment done in february 1998 (experiment number: HS 557).

De La Chapelle S., 0. Castelnau O., Lipenkov V. and Duval P., 1998, *J. of Geophysical Res.* 103, B3 p; 5091-5105
P. Duval, Arnaud L., Baruchel J., Brissaud O., De La Chapelle S., Hondoh T. and Louchet F., *Users'Meeting Workshop,* Grenoble, Nov. 21, 1997
P. Duval, Arnaud L., Baruchel J., Brissaud O., De La Chapelle S., Hondoh **T.,** Louchet F. and Ocampo J. *One year of X-ray imaging, mainly on ID19,* ESRF, Nov. **22,** 1997