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Report:

Although quartz is a usual crystal which has been known and used by man since the Antiquity, it is always the subject of many questions: so in addition to the properties of the α–β transition, we are presently also studying the puzzling properties of some natural quartz crystals found in the Alps. We have started a few years ago, structural studies of these crystal using the hard x-ray set-up of ILL, which indeed gave interesting results. To make further progress we have performed on October 11 some exploratory x-ray topography at room temperature on two puzzling kinds of quartz crystals found in the Alps: twisted and macromosaic quartz [1].

- Twisted quartz or gwindel, as this is called in Switzerland, is a moderately rare but spectacular crystal structure which is found in two mountain ranges of the earth, Alps and Urals. Gwindels are formed of an aggregation along a common X axis of bipyramidal prismatic quartz elongated as usually along their Z axis ; however the successive crystals rotate by a few degrees around their common X axis. For a typical gwindel of 10 to 15 cm length along X axis, the total rotation is between 20 and 50°. Although they have been investigated by several European mineralogist during the 19 and 20t^{h} centuries, their structure and condition of growth has never been understood. In 1937, the Russian mineralogist Laemmlein [2], working on twisted crystals from the Alps and Ural, understood that gwindel formation occurs in two successive stages : there is first the puzzling formation of an helicoïdal plate with a continuous twist along the X axis ; then in a second stage, macromosaic individualised prismatic crystals grow along the already twisted Z directions. The existence of these two structures was confirmed in 1987 by the work of Kuzmina et al. [3]: they observed by x-ray diffraction on a plate cut in a gwindel, that the central part had a continuous rotation while the external part had a macromosaic structure.

- Macromosaic prismatic quartz are far more numerous. However due to a more discrete appearance, they were first mentioned only in 1930 by Weil [4], while their extensive presence in the Alps was realised only in 1951 with the systematic study of Friedlaender [5]: using mostly optical measurements, he found that most of the quartz crystals found in the central granitic mountains of the Swiss Alps are not single crystal but have a mosaic structure with large grains of cm size with relative rotations in a range of a few degrees. He also performed the only previous X-ray study on this structure: he observed the splitting of the diffracted Laue spot when a fine x-ray beam was incident on a mosaic grain boundary. A characteristic feature of Alpine macromosaic quartz is that these crystals present on the prismatic faces, well defined suture lines, roughly parallel to the Z axis. In 1986, Vollenweider [6] discovered that Swiss macromosaic quartz crystals often have an average macroscopic twist (around 0.8°/cm) around the Z axis. The presence of mosaic quartz in Urals was noted in 1937 by Laemmlein [2], but it seems that this was no more reported in recent Russian literature.

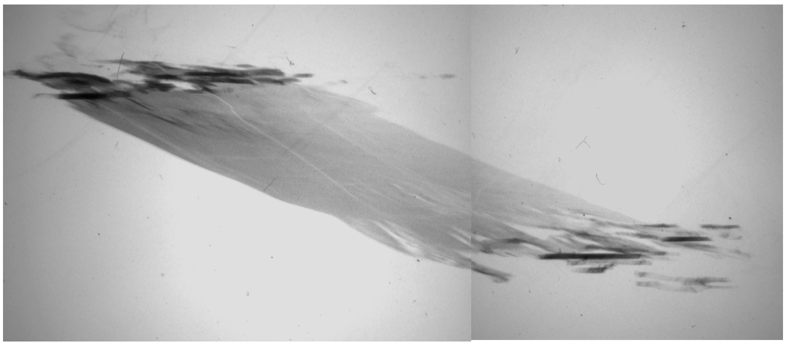
Our first results were obtained by high energy x-ray diffraction on a Swiss macromosaic crystal and on a Mont Blanc gwindel [7]. During the present synchrotron test of quartz crystal at room temperature, we obtained rather spectacular results on a few other Alpine quartz:

We studied one macromosaic quartz from Mont Blanc, which is indeed formed by several grains incorporated in a common structure with grain rotations of a few degrees. A central grain of about 3cm length is nearly perfect, and a picture of its surface is given by the x-ray topography. The smaller surrounding crystals have more complex structure, often presenting a twist around the Z axis (around 0.5°/cm).

We have also look at 3 gwindels samples : a complete gwindel of 8 cm length and a plate cut perpendicular to the X axis (both from the Bern museum) and a « closed » gwindel from a private collector : this is a rare occurrence of the first stage of growth, reduced to a nearly perfect helicoidal plate. Indeed the 3 samples showed an internal continuously twisted seed, surrounded (as expected) by an external shirt of macromosaic crystals (reduced to a few small nuclei for the closed gwindel). Fig. exhibits an observation performed in the center of the complete gwindel. This picture was obtained with a x-ray beam close to the Y axis: the oblique grey band corresponds to the homogeneously twisted plate in the centre of the crystal; on the two external sides, there are some black macromosaic grains.

Although this is rather classical x-ray topography, a high energy source is needed to observe (without cutting) massive crystals of a few cm thickness. The use of fine beams is also often useful to analyse structural details. However the observation of twisted crystals, is not classical and specific observation methods may be useful.

Clearly the existence of large crystal twist in quartz gwindels is a surprising features, which in the past was noted in several mineralogic and crystallographic books, but which remains fully mysterious considering its geologic occurrence and their crystallographic formation.



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