MICROSTRUCTURAL CHARACTERISTICS OF SHOCKED QUARTZ FROM EJECTA OF THE SUBMARINE MJØLNIR IMPACT STRUCTURE, BARENTS SEA; F. Langenhorst[1] and H. Dypvik[2]; [1]Institut für Mineralogie, Museum für Naturkunde, Humboldt-Universität Berlin, Invalidenstr. 43, D-10115 Berlin, Germany; [2]Department of Geology, University of Oslo, P.O. Box 1047, Blindern, N-0316 Oslo, Norway.

Summary. In this study, shocked quartz from a coarse-grained bed of a continuous corehole in the Barents Sea has been investigated with transmission electron microscopy (TEM) in order to verify the impact origin. The coarse-grained bed is interpreted as ejecta layer of the nearby Mjølnir impact structure. The TEM investigations reveal the presence of fresh and altered PDFs, mechanical Brazil twins, and numerous dislocations. These observations do not only confirm the impact origin but also indicate additional deformation of shocked quartz by a tectonic event.

Introduction. The Mjølnir structure located in the central Barents Sea (N 73°48´; E 29°40´) is a bowl-shaped, 40 km wide structural anomaly with a central peak. It is estimated to be of Jurassic/Cretaceous age and occurs in a water depth of 350 - 400 m beneath a 400 m thick cover of younger sediments [1]. The structural and morphological characteristics are compatible with a complex impact crater. If this interpretation is correct, Mjølnir is a rare example of an identified submarine impact crater [1]. Recent seismic reflection data as well as the discovery of an Ir anomaly and shocked quartz grains in a conglomeratic bed at level 47.6 m of the nearby, continuous corehole 7430/10-U-01 (30 km north-northeast of the rim) strongly support the impact hypothesis [2]. In order to verify the impact origin of this bed, one potentially shocked quartz grain, 0.5 mm in diameter, has been studied with transmission electron microscopy (TEM).

Results and Discussion. At the optical scale, the quartz grain displays irregular fractures and four differently oriented, closely spaced (< 5 µm) sets of planar deformation features. Planar fractures are absent.

TEM examination of the quartz grain reveals a very complex microstructure, characterised by several dislocations, dislocation loops, amorphous lamellae, twins, and areas consisting of fine-grained (< 0.1 - 0.2 µm), polycrystalline quartz. The dislocations are more or less homogeneously distributed. Their presence indicates that the quartz grain has probably experienced a tectonic deformation event. Dislocation loops occur only in a high density along certain planes (Fig. 1). This feature is known for altered quartz grains from impact lithologies and has been termed "dislocation bands" [3]. Dislocation bands result from post-shock recrystallization of fresh, amorphous PDFs [4], which also occur to a lesser extent in the grain (Fig. 2). It is not yet understood why amorphous PDFs can coexist with strongly modified PDFs. Twins are oriented parallel to the basal plane and are decorated with partial dislocations. These characteristics are compatible with mechanical Brazil twins which are known to be diagnostic for impact [3, 4]. Fine-grained, polycrystalline quartz aggregates occur in the form of small (< a few µm) patches. They could result from post-shock recrystallization of amorphous areas in the shocked quartz grains.

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Conclusions and Outlook. The preliminary results of this TEM study confirm the impact origin of the coarse-grained bed from corehole 7430/10-U-01 and support the interpretation of this bed as impact ejecta of the Mjølnir crater. Moreover, it turned out that the quartz grain had experienced a shock-metamorphic and tectonic overprint. Further, comprehensive TEM investigations on shocked material are certainly necessary to unravel the hiatus and conditions of these events.

References. [1] Gudlaugsson S.T. (1993) *Geology, 21*, 291; [2] Dypvik H. et al. (1996) submitted to *Science*; [3] Goltrant O. et al. (1992) *Physics Earth Planet. Int., 74,* 219; [4] Grieve et al. (1996) *Meteoritics*, in press.

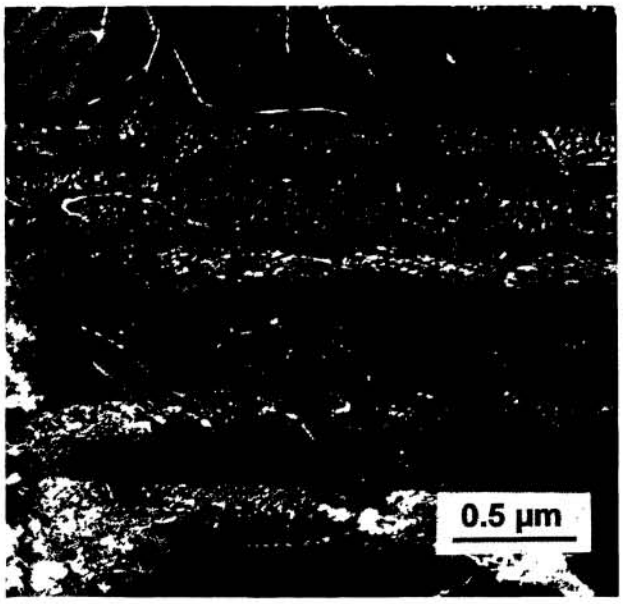

Fig.1. Dark-field image of altered PDFs consisting of numerous dislocation loops.

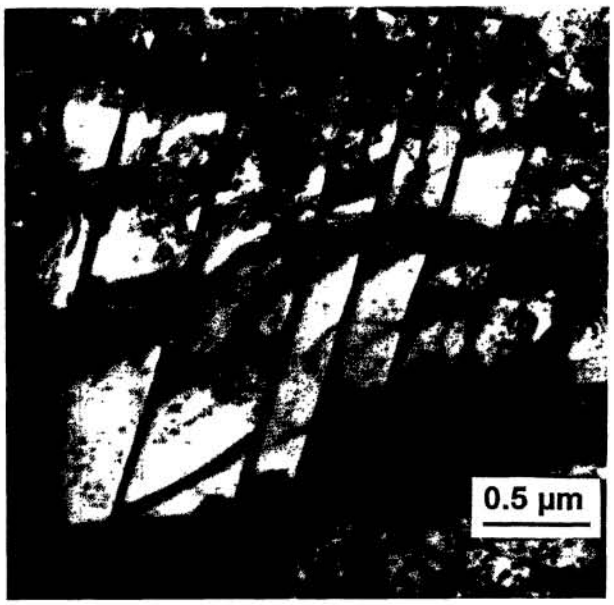

Fig. 2. Bright-field image of a set of fresh, amorphous PDFs.

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