Planar Microstructures on the Shock-induced deformation twins in clinopyroxene from the aubrite Allan Hills 78113. Sz. Nagy[1] (ringwoodit@yahoo.com), A. Gucsik[2], S. Józsa[1], Sz. Bérczi[1], K. Ninagawa[3], H. Nishido[4]
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Introduction: Shock-induced physical and chemical changes in minerals are collectively called shock effects or shock metamorphic effects. This term is relatively broad and covers any type of shock-induced change, such as formation of lattice defects, phase transformations, decomposition reactions and resultant changes in physical and chemical properties [1]. The deformation and transformation effects largely arise during the compression phase of shock waves. The response of a mineral to shock compression largely depends on its crystal structure and composition. With the resolution of the optical microscope, two basic types of planar microstructures can be distinguished: Planar fractures (PF) and planar deformation features (PDFs). The progressive shock-pressure causes twins such as in feldspars, pyroxenes, and calcite [1,2,3,4]. The purpose of this optical microscopic study is to identify and characterize planar microdeformations especially in clinopyroxene as well as evaluate the shock stages in a ALH78113 sample (Fig. 1).

Sample: The ALH78113 sample is an aubritic type enstatite achondrite. The sample contains large enstatite grains up to 2.5 cm, and several dark clasts. The grains form a slightly brecciated texture. Olivine is also discernible in some parts of this sample. Microprobe analyses show that the pyroxene is iron free enstatite (FeO<0.1 wt%) with minor and variable amounts of CaO (0.2-0.6 wt%, average 0.5 wt%) [5].

Results: The single enstatite grains contain relatively high density of irregular fractures, and shows straight deformation twin lamellaes (Fig. 1). These twins are produced by shock wave propagation, and their have 10^0 of extinction angle relative to the host grain. The twins are 5-15 μm wide, and 10-100 μm long (Fig. 1). The planar microstructures are extending through the twin lamellae (Fig. 1). The microstructures are 1-3 μm long, and >1 μm wide. The spacing between two neighbouring microstructures is about 2 μm. However, we did not observe the high pressure polimorph of pyroxene nor pyroxene glass. Consequently, the sample may be classified to be in the low shock pressure regime. The observed microstructures have one set on the shock-induced twin lamellae. We assume, that the twins were produced earlier during the shock process, and the microstructures were produced later, both in the case of the planar fractures and planar deformation features.

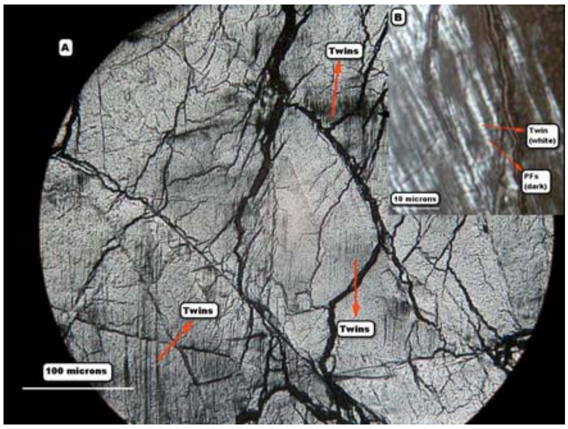

Fig. 1. *A, Shock-induced twin lamellaes in clinopyroxene. B, Planar microstructures on twin lamellae..*

The development of distinctive shock-metamorphic features such as PDFs in denser mafic minerals including amphibole, pyroxene, and olivine apparently occurs at higher pressures and over a more limited pressure range than in case of quartz and feldspar.
The most common shock effects observed in mafic minerals shocked at 30GPa are planar fractures, mechanical twins and regular comminution features. In general, mafic minerals in naturally and experimentally shocked basalts show only extreme comminution accompanied by the melting [3] only at relatively higher pressures. Consequently, our observed planar microstructures are planar fractures (PFs). According to the above-mentioned optical microscope observations of shock-induced twins and planar elements, the clinopyroxene was shocked to about 30GPa.

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