KYANITE: A NEW SHOCK-INDUCED HIGH-PRESSURE SILICATE PHASE FROM THE RIES CRATER.

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Introduction: Clasts of shocked garnet-cordierite-sillimanite gneisses from the fallout suevite of the Ries crater were studied in transmitted and reflected light. These rare graphite-bearing rocks in the suevite breccia show various shock phenomena and may contain high-pressure phases [1,2]. Among the garnetiferous rocks, a dense, very strongly shocked garnet-sillimanite restite (= 3.34 g/cm^3) contains sillimanite grains with high-refractive mineral aggregates at the edges or along internal fractures. Modally, the rock fragment is composed of about 40% sillimanite, 30% garnet, 10% biotite, 16% pinite, 0.5% ilmenite and 0.5% rutile. Calculated from breakdown temperatures of selective minerals the equilibrium shock pressure and temperature of the dense clast is estimated according to customary shock scales to ~60.0±3.1 GPa and ~850±100 ^{o}C. Although natural shock behavior of sillimanite from the Ries and the Canadian Haughton crater has been described in detail [3,4,5], the micron-sized, high refractive aggregates within the host sillimanite remained undiscovered. High-resolution scanning electron microscopy and Raman spectroscopy were used to determine the composition and structure of the tiny aggregates.

Results: Electron-microprobe analyses reveal that the high refractive aggregates and host sillimanite grains are identical in chemical composition. The Raman spectrum of the aggregates correspond to spectra of kyanite minerals with highest wavenumber mode at 949 cm^{-1} [6]. The thin kyanite borders around the sillimanite host show typical lattice-controlled shrinkage cracks because the shock-produced formations are approximately 10.5% denser than sillimanite [7]. Small-striped kyanite aggregates along the rims of adjacent, touching sillimanite grains are usually 0.5-2.0 m wide, whereas some roundish-shaped kyanite particles attain sizes of up to 10 m.

Sillimanite grains in the garnetiferous rock with wider interstices in the range of 2-10 m contain vesicular melt glasses and lathy microcrystals. Intense shock wave interactions in porous spaces resulted in partial melting of sillimanite at high temperatures in the range of 1300-1690 ^{o}C [8]. Adjacent kyanite aggregates along sillimanite rims are very likely back-transformed due to the influence of high post-shock temperatures.

Conclusions: Compared to kyanite in regional metamorphic rocks, the shock-produced kyanite shows unique textures due to the occurrence along grain boundaries and internal fractures of host sillimanite. Contrary to shock experiments on andalusite [9], high-pressure kyanite minerals can be formed in long-lasting natural impact events. After coesite and stishovite, kyanite is the third high-pressure silicate phase found in the Ries crater.

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