DIAGNOSTIC SHOCK FEATURES IN MONAZITE

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Monazite (La,Ce,Th)PO_4, is an important mineral for studying the Earth's crust because the combination of U, Th and a variety of other trace elements that can be incorporated into its crystal structure can be used to both date and fingerprint processes such as fluid flow and metamorphism. Shocked monazite has previously been identified from a variety of impact structures including Haughton, Canada [1], the Vredefort Dome, South Africa [2,3,4,5,6] and Araguainha, Brazil [7, 8]. Here we present the first systematic, quantitative microstructural characterization of shock features in monazite and describe those that are diagnostic of impact related deformation.

We have analyzed a suite of detrital shocked monazite [5,6] derived from the Vredefort Dome using electron backscatter diffraction (EBSD) and have identified a variety of deformation microstructures, many of which have not been previously described in monazite. The prominent microstructures found within the detrital monazite population are mechanical twins, which were found in twelve different orientations [9]. While deformation twins have been produced in monazite in lab experiments at ambient temperatures [10] and deformed lower crustal granulites [11], the majority of the shock-produced twins represent previously unreported deformation microstructures. Other deformation microstructures identified in the detrital monazite include planar deformation bands and strain-free neoblasts, the latter having previously been shown to date deformation [11].

The investigated monazite grains contain shock-twinned zircon inclusions that provide crucial empirical constraints on the formation of shock features in monazite. Shock twins in zircon require minimum pressures of 20 GPa, thus confirming a hypervelocity impact origin of the monazite microstructures [12]. The combination of shock deformed zircon inclusions with previously unknown deformation twins therefore supports the interpretation that these twins represent *bona fide* shock features in monazite, and require hypervelocity impact for their production. These results conclusively establish monazite as an indicator of shock deformation, and highlight its application for studying impact processes, furthermore, because monazite is a robust geochronometer, grains which preserve both diagnostic shock twins and neoblastic domains can be used to both confirm and date impact structures.

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