Apatite for destruction

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Apatite offers many diverse applications in geochemistry, however, it has historically not been applied to studies of shock metamorphism caused by meteorite impact. Planar microstructures in apatite are reported here, and represent the first well-documented occurrence of shock microstructures in apatite. Detrital apatite grains were identified in colluvium and alluvium collected near shocked quartz-bearing shatter cone outcrops at the Santa Fe structure, a highly tectonized and eroded impact structure near Santa Fe, New Mexico; the impact conditions and original size (6-13 km) are currently poorly constrained [1]. The same sediment samples contain other detrital shocked minerals, including zircon, quartz, and muscovite [2-3]. A total of 166 detrital apatite grains were investigated by scanning electron microscopy, including examination of grain exteriors and polished sections using backscatter electron (BSE) imaging. Of these, 61 grains contained planar microstructures (61/166 = 37%). Most shocked apatites identified were from two colluvium samples, which averaged 37% (17/46) and 41% (43/105). Only 15 apatites were analyzed from modern alluvium, one of which was shocked (1/15 = 7%). Individual grains contain up to three sets of parallel, planar microstructures with variable spacing, mostly from 5-10 μm. Orientations of the planar microstructures are distinct from {0001} and {hki0} apatite cleavages, and form conjugate sets that appear to be in $\{10\bar{1}1\}$ orientation. The microstructures are open (dark in BSE), and are interpreted as fractures. The appearance and spacing of the planar microstructures are strikingly similar to planar fractures reported in shocked zircon [4].

The ubiquitous occurrence of apatite in igneous, metamorphic, and siliciclastic sedimentary rocks highlights the potential of using apatite in studies of shock metamorphism. While the relation of shock pressure and microstructure formation in apatite are not yet calibrated, the presence of shocked zircons in the sample sediment samples [3] indicates the apatite grains described here likely experienced shock pressures > 20 GPa.

[1] Fackelman *et al* (2008) *EPSL*. [2] Colon and Cavosie (2014) *LPSC*. [3] Lugo and Cavosie (2014) *LPSC*. [4] Erickson *et al* (2013) Am. Min.