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Sphene emotional: How titanite was shocked when the dinosaurs died

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ABSTRACT

Accessory mineral geochronometers such as zircon, monazite, baddeleyite, and xenotime are increasingly being recognized for their ability to preserve diagnostic microstructural evidence of hypervelocity processes. However, little is known about the response of titanite to shock metamorphism, even though it is a widespread accessory phase and U-Pb geochronometer. Here we report two new mechanical twin modes in titanite within shocked granitoids from the Chicxulub impact structure, Mexico. Titanite grains in the newly acquired International Ocean Discovery Program Site expedition 364 M0077A core preserve multiple sets of polysynthetic twins, most commonly with composition planes (K_1), = ~$\{\bar{1}11\}$, and shear direction (η_1) = <110>, and less commonly with the mode K_1 = {130}, η_1 = ~<522>. In some grains, {130} deformation bands have formed concurrently with shock twins, indicating dislocation glide with Burgers vector **b** = [341] can be active at shock conditions. Twinning of titanite in these modes, the presence of planar deformation features in shocked quartz, and lack of diagnostic shock microstructures in zircon in the same samples highlights the utility of titanite as a shock indicator for a shock pressure range between ~12 and ~17 GPa. Given the challenges of identifying ancient impact evidence on Earth and other bodies, microstructural analysis of titanite is here demonstrated to be a new avenue for recognizing impact deformation in materials where other impact evidence may be erased, altered, or did not manifest due to low shock pressure.