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A shock-induced polymorph of anatase and rutile from the Chesapeake Bay impact structure, Virginia, U.S.A.

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Abstract

A shock-induced polymorph (TiO_2 II) of anatase and rutile has been identified in breccias from the late Eocene Chesapeake Bay impact structure. The breccia samples are from a recent, partially cored test hole in the central uplift at Cape Charles, Virginia. The drill cores from 744 to 823 m depth consist of suevitic crystalline-clast breccia and brecciated cataclastic gneiss in which the TiO_2 phases anatase and rutile are common accessory minerals. Electron-microprobe imaging and laser Raman spectroscopy of TiO_2 crystals, and powder X-ray diffraction (XRD) of mineral concentrates, confirm that a high-pressure, α-PbO_2 structured polymorph of TiO_2 (TiO_2 II) coexists with anatase and rutile in matrix-hosted crystals and in inclusions within chlorite. Raman spectra of this polymorph include strong bands at wavenumbers (cm^{-1}) 175, 281, 315, 342, 356, 425, 531, 571, and 604; they appear with anatase bands at 397, 515, and 634 cm^{-1}, and rutile bands at 441 and 608 cm^{-1}. XRD patterns reveal 12 lines from the polymorph that do not significantly interfere with those of anatase or rutile, and are consistent with the TiO_2 II that was first reported to occur naturally as a shock-induced phase in rutile from the Ries crater in Germany. The recognition here of a second natural shock-induced occurrence of TiO_2 II suggests that its presence in rocks that have not been subjected to ultrahigh-pressure regional metamorphism can be a diagnostic indicator for confirmation of suspected impact structures.

Keywords: Phase transition, anatase, rutile, polymorph, shock metamorphism, Chesapeake, impact, crater