The late Eocene Chesapeake Bay impact structure – Status of research, insights, and implications

J. W. HORTON, JR., G. S. GOHN, AND D. S. POWARS

U.S. Geological Survey, 926A National Center, Reston, VA 20192, USA (whorton@usgs.gov)

This is an overview of studies since 2000 by the USGS Chesapeake Bay Impact Crater Project and the ICDP-USGS Chesapeake Bay Impact Structure Deep Drilling Project. The ~35.5 Ma Chesapeake Bay impact structure (CBIS), on the Atlantic margin of Virginia, USA, may be Earth's best preserved large impact structure formed in a siliciclastic, continental-shelf environment. The 85-km-wide structure formed in a layered target (seawater-sediments-rock), has an inverted-sombrero shape (deep central crater surrounded by a shallower annular trough), and is well preserved beneath postimpact sediments. Saline ground water in the CBIS affects water resources in an area of urban growth.

In 2000-2003, USGS drilled the Watkins School corehole just outside the structure, and the North, Langley, and Bayside coreholes in the annular trough, at 43, 39, 36, and 25 km from the center. These cores revealed (top to base) polymict sedimentary breccia interpreted as ocean-resurge deposits, target sediments modified by liquefaction, injection, and extensional structures, and unshocked Neoproterozoic basement. The sedimentary breccia contains shocked quartz and impact-damaged, mixed-age microfossils. In 2004, USGS drilled and partly cored the Cape Charles test hole on the central uplift, 1 km from the center. It revealed suevite, impact-melt clasts having a meteoritic component, a shock-induced TiO_2 polymorph, and hydrothermal alteration. Gravity, magnetic, seismic, and magnetotelluric surveys delineated the central uplift, moat, and outer margin. Numerical models simulated the inverted sombrero using strength contrasts of weak over strong layers.

In 2005-2006, the ICDP-USGS Eyreville coreholes were drilled to 1.77-km depth in the moat (deepest part) of the central crater, 9 km from the center. They cored (top to base) postimpact sediments, allogenic sedimentary breccia and sediment megablocks, granite megablock(s), sediment with lithic blocks, suevite and lithic impact breccias, and brecciated schist and pegmatite with breccia veins [1]. Studies by seven science teams will allow unprecedented understanding of a shallow-marine impact and its consequences. Topics include impactor type and relation to other late Eocene impacts (Popigai?), tektite formation, shock-pressure variations with depth and lithology, layered-target influence on cratering, resurge dynamics, unknown target basement, environmental consequences and hazard implications, hydrothermal conditions, source of contained ground-water brines, subsurface microbial diversity, and habitats unique to impact structures.

Reference

[1] Gohn, G.S. *et al*., (2006), *Eos* **87(35).** 349, 355.

Pre-Variscan Barrovian metamorphism in the eastern part of the Slavonian Mountains, Tisia Unit (NE Croatia): Application of quantitative phase diagrams and monazite age dating

PÉTER HORVÁTH[1], DRAŽEN BALEN[2], FRITZ FINGER[3], BERNHARD HUMER[3], BRUNO TOMLJENOVIĆ[4] AND PÉTER ÁRKAI[1]

[1]Institute for Geochemical Research, Hungarian Academy of Sciences, H-1112 Budapest, Budaörsi út 45., Hungary (phorvath@geochem.hu, arkai@geochem.hu)

[2]Faculty of Science, University of Zagreb, HR-1000 Zagreb, Horvatovac bb, Croatia (drbalen@geol.pmf.hr)

[3]Abteilung Mineralogie, Universität Salzburg, A-5020 Salzburg, Hellbrunnerstrasse 34, Austria (Friedrich.Finger@sbg.ac.at, Bernhard.Humer@sbg.ac.at)

[4]Faculty of Mining, Geology & Petroleum Engineering, University of Zagreb, Hr-1000 Pierottijeva 6, Croatia (bruntom@rgn.hr)

Petrological investigations, quantitative phase diagram modelling and monazite dating were carried out on medium-grade metamorphic rocks from the Kutjevačka Rijeka transect in the Slavonian Mts., Tisia Unit (NE Croatia). Micaschists contain complex zoned garnets with Mn-rich cores and Ca-rich rims. Mn decreases steadily from core to rim, but there is an abrubt increase in Ca between core and rim. This complex zoning was not observed in garnets from intercalated paragneisses and amphibolites. Quantitative phase diagrams and garnet composition isopleths using bulk rock compositions revealed that the garnet cores formed at 584-592^{o}C and 6.4-7.8 kbar. For establishing the PT conditions responsible for garnet rim formation the composition of the garnet cores was removed from the bulk data and a new effective bulk composition was established. Using quantitative phase diagrams, mineral isopleths and thermobarometric methods we calculated peak PT conditions of 600-660 ^{o}C and 11-12 kbar for the garnet rim and the matrix assemblage of biotite, muscovite, plagioclase and quartz. Staurolite mentioned in the literature was not observed in this study and the application of quantitative phase diagrams contoured for H_2O mode isopleths supports our opinion that during the retrograde PT path the rock did not pass staurolite-bearing fields. PT conditions for the intercalated paragneisses and amphibolites are the same as for the micaschists.

The Th, U and Pb contents of yttrium-rich accessory monazites indicate a pre-Variscan (428 ± 25 and 444 ± 19 Ma) age for the medium-grade metamorphism. These data are 70-100 Ma older than previously published mica Ar-Ar and K-Ar ages from the study area.

This study was financially supported by the Hungarian National Science Fund (OTKA, grant number F047322 to PH) and by the Croatian Ministry of Science, Education and Sports, Projects 119-1191155-1156 (DB) and 195-1951293-3155 (BT).