SECONDARY CRATERS FROM THE CHESAPEAKE BAY IMPACT.

C. Wylie Poag, U.S. Geological Survey, 384 Woods Hole Road, Woods Hole, MA 02543-1598 USA.

Despite the near ubiquity of secondary craters on other planetary bodies, secondary craters have not been documented on Earth. The numerous simple terrestrial craters (<5 km in diameter) identified so far are interpreted to be primary craters. Nor have secondaries been previously reported to be associated with known complex or multiringed structures.

The Chesapeake Bay primary crater (85-km-diameter) is unusually well preserved, because it is relatively young, it formed under water, and it occupies a basin characterized by relatively rapid postimpact marine sedimentation [1]. This advantageous setting appears also to account for the presence nearby of at least 23 smaller fault-bounded excavations, which I interpret to be secondary craters. The 23 secondaries can be identified north and northwest of the primary crater on two of the multichannel seismic reflection profiles that help define the Chesapeake Bay primary crater. A seismostratigraphic analysis of these profiles, calibrated with lithostratigraphy and biostratigraphy from nearby outcrops and bore holes, highlights the structural and stratigraphic contrasts between the normal succession of sedimentary coastal plain rocks and those of the inferred secondary craters.

The closest secondary crater is 20 km from the primary crater, whereas the farthest is 85 km away; all secondaries are outside the seismically identifiable periphery of the continuous ejecta blanket. Relatively undisturbed, flat-lying, coastal plain formations separate the secondaries from each other and from the primary crater. Five secondary craters (C-1 through C-5) are imaged by north-south seismic profile T-1-CB, where it crosses Chesapeake Bay near the mouth of the Potomac River. Secondaries C-1 through C-5 have similar general characteristics, except for varying apparent diameters and depths. Each crater is marked by clearly expressed rim escarpments constructed by *en echelon* (presumably concentric) normal faults, which dip into the craters. The rim faults truncate horizontal, parallel, continuous to subcontinuous reflections, which represent the same sedimentary target rocks disrupted by the primary impact (Lower Cretaceous to lower Eocene siliciclastic sediments and middle Eocene bioclastic limestone). Inside each secondary crater, seismic reflections are chaotic or incoherent. I interpret these to represent impact breccia, equivalent to the Exmore breccia, which fills the primary crater. The postimpact formations (mainly middle Miocene to Quaternary sediments) thicken and sag into all five secondary craters on this profile.

Eighteen similar small craters (P-1 through P-18) are distributed along a 110-km segment of profile T-11-PR, which extends from the northern rim of the primary crater up the Potomac River to a location near the town of Colonial Beach. Though many features of the Potomac (**P**) secondaries are similar or identical to those of the CB (**C**) secondaries, some differences can be noted. For example, eight of the **P** secondaries have well-developed, raised, sedimentary rims, in contrast to the lack of raised rims on the primary crater. Perhaps the most important difference, however, is that some of the normal faults of the **P** secondaries disrupt the surface of the crystalline basement (P-5, 7-10, 13, 14, 17, and 18). Furthermore, the basement surface along the Potomac River profile is cut by eight reverse faults of 100 m or more vertical displacement (lateral displacement is unknown), seven of which display underthrusting to the west. The basement, as well as the entire preimpact sedimentary section at P-18, has been thrust into two anticlinal folds. This dates the thrusting as late Eocene, coincident with the primary impact. I interpret the reverse faults to be early products of compressive shock radiating from the primary Chesapeake Bay impact. Most of the reverse faults, however, appear to have been reactivated as normal faults during later stages of ejecta bombardment and deformation of the secondary craters.

Apparent diameters of the secondary craters range from 0.4 km to 4.7 km, and average 1.9 km; only four have apparent diameters greater than 3 km. Apparent depth of the secondaries (measured from sedimentary lip to crater floor) ranges from 50-710 m, averaging 370 m; in six of the secondaries, the entire preimpact sedimentary section has been excavated and replaced by impact breccia. Breccia fill ranges from 30 m to 680 m in apparent thickness, and averages 266 m.

Stratigraphic and structural characteristics of the 23 secondary craters coincide with the general features of simple primary craters (as opposed to complex craters). The principal difference is the apparent lack of overturned flaps (though they may be too small to be resolved on our profiles). This is not surprising, however, because the impacts took place in the late Eocene ocean, and there is ample evidence that oceanic impact craters lack these features, probably as a result of more extensive slumping of their water-saturated walls and of hydraulic erosion resulting from collapse of the oceanic water column [2,3,4,5].

The characteristics of the Chesapeake Bay secondary craters also are in general agreement with the features of secondary craters observed on other planetary bodies [6]. They occur in distinct clusters, or perhaps chains, and their apparent diameters fall within the expected ranges relative to the diameter of the primary (less than 10% of the diameter of the Chesapeake Bay primary crater).

Acknowledgments: I am grateful to Texaco, Inc., for providing the multichannel seismic reflection profiles upon which this analysis is based.

References: [1] Poag, C.W., *Sed. Geol*. 108, 45-90, 1997. [2] Kieffer, S.W., and Simonds, C.H., *Rev. Geophys. Space Phys.*, 18, 143-181, 1980. [3] Roddy, D.J., Schuster, S.H., Rosenblatt, M., Grant, L.B., Hassig, P.J., and Kreyenhagen, K.N., *Int. J. Impact Eng.*, 5, 525-541, 1987. [4] Mckinnon, W.B., *Geol. Soc. Am. Sp. Pap*. 190, pp. 129-142, 1982. [5] Poag, C.W., and Poppe, L.J., *Mar. Geol*., 145, 23-60, 1998. [6] Melosh, H.J., *Impact Cratering - A Geologic Process*, pp.1-245, 1989.