Solid Earth Discuss., 4, C106–C111, 2012
www.solid-earth-discuss.net/4/C106/2012/


Solid Earth
Discussions

# *Interactive comment on* "In plain sight: the Chesapeake Bay crater ejecta blanket" *by* D. L. Griscom

**D.L. Griscom**

david_griscom@yahoo.com

Received and published: 30 March 2012

I thank Anonymous Referee #1 for his thoughtful comments, to which I respond to below one sentence at a time:

Referee #1: The claim seems to be that many of the near surface units are some kind of impactite blanket, as an alternative interpretation (the traditional view is marginal sediments reworked by streams during isostatic uplift of the Appalachian margin).

Author: (1) The present day sediments coastward of the Appalachian Mountains would not date from the uplift period, which took place in Permian time. Indeed, (2) workers at the U.S. Geological Survey (e.g., Poag, 1997) have determined the oldest terrigenous sediments above the basement rocks on the U.S. Middle-Atlantic Coastal Plain



to constitute a volume of non-marine silciclastic materials ∼400 m deep on the continental shelf dated as Lower-Cretaceous. (3) The sediments resting on the present-day Piedmont must be younger still and derived solely from the proto-Blue Ridge, which is presently devoid of the Devonian quartzite identified by Schlee (1957) and others in the upland gravels. The only source of Devonian quartzite available in recent times are accessible solely by the Potomac River in outcrops ∼100 km west of Great Falls, whereas (4) the rest of the streams and rivers on the Middle-Atlantic Coastal Plain originate on the Blue Ridge, which has relatively few quartzite exposures, and those generally date from Cambrian times. Moreover, (5) the ∼5 cubic kilometers of pebbles and cobbles of the upland deposits, which truly blanket the uplands of the Coastal Plane, bear absolutely no relationship to existing streams ... except as possible sources of transportable quartzite. So the mystery is this: How can there be such a huge volume quartzite pebbles and cobbles (with a Devonian component) east of the Blue Ridge? I have argued in Sect. 4.2 that (6) the only way that such copious amounts of Devonian sandstone could be found east of the present-day Blue Ridge requires positing that the Proto-Blue Ridge was once capped by these quartzites in approximately the same manner as the present-day Valley and Ridge Province (immediately to the northwest of the Blue Ridge) is capped by Silurian and Devonian quartzites. (7) The cited studies of Attal and Lavé (2006)* indicate that cobbles of the observed sizes could easily have been transported from the Blue Ridge to the target zone by rivers. Thus, (8) the fact that quartzite gravels of this nature are presently found in a landward annulus between 115 and 200 km from the center of the Chesapeake Bay Impact Structure (CBIS) can be reasonably explained by their (completely possible) original presence within the 400-m-deep non-marine silciclastic materials dated as Lower-Cretaceous identified as being in the target zone of the CBIS impactor (Poag, 1997). *Sorry, this was cited in the text but went missing from my References: Attal, M., and Lavé, J., 2006, Changes of bedload charactistics along the Marsyandi River (central Nepal): implications for understanding hillslope sediment supply, sediment load evolution along fluvial networks, and denudation in active orogenic belts: in Willett, S.D., Hovius, N., Brandon, M.T., and

Fisher, D.M., eds., Tectonics, Climate, and Landscape Evolution: Geological Society of America Special Paper 398, Penrose Conference Series, p. 143-171.

Referee #1: The makeup of these units doesn't make me hopeful - most of what he's showing are quartzose sediments with relatively coarse and well-rounded quartz pebbles and cobbles, not at all the kind of material you'd expect to find near the VA coast in the impact zone.

Author: Given that the present-day Blue Ridge cannot have supplied any Devonian quartzite at all, the referee is absolutely correct. Indeed, it was a mystery that these well-rounded quartzite gravels with a Devonian component are actually found anywhere east of the Blue Ridge, including where they are now – a mystery that I have solved in the manner described in the preceding comment.

Referee #1: I didn't see evidence that he's found shock features in the quartz, or the development of coesite, which would be classic indicators of impact origins.

Author: (1) The referee is right that the most unambiguous evidence for impact origins is to demonstrate shock features in quartz. However, it's a little known fact that shocked quartz, as it is classically identified by planar deformation features (PDFs) under a U-stage microscope, is rarely identified in well known ejecta deposits within a few crater radii of the center. Noted impact-crater geologist, Kevin Pope, once told me that, for materials now widely accepted to be ejecta from the 180 km-diameter Chicxulub crater on the Yucatan Peninsula, he had to pass approximately one cubic meter of sand under his microscope to find a single grain with a set of PDFs regarded as unambiguous evidence of impact shocking. So if you haven't found one doesn't automatically mean you are not dealing with crater ejecta. (2) It is ironic therefore that Kevin found a grain with at least 3 nonparallel PDFs in the very first slide ever inspected of quartz silt from a debris flow (which I have denoted as the Hollin Hills Diamicton) near Alexandria, VA. (N.B. No other grains with multiple PDFs were found, but only 2 or 3 additional slides were ever investigated.) Although the Virginia upland grain that Kevin found



(photomicrograph shown by Griscom et al., 2003) was not subjected to rigorous study on a U-stage, it can be regarded as "possible" or perhaps even "likely" evidence of impact origin. (3) A figure in Griscom et al. (2003) showing photomicrographs of quartz grains in a thin section of an upland-deposits that reveal fracture patterns closely matching those of a pair of photomicrographs of quartzite ejecta known to be from the Barringer Crater in Arizona found in (French, 1999) – another "possible" evidence of impact origin. (4) The abundant planar fractures of otherwise-well-rounded upland cobbles have no other explanation than being due to exposure to tensile waves in the interference zone of the CBIS impactor (Sect. 4.3). Quartzite, being a polycrystalline material has no natural cleavage plane and is known to splinter when shattered. My observation and quantification of planar fractures in the upland quartzite pebbles and cobbles (Fig. 7) constitutes definite evidence of impact. (5) The clasts found in the Hollin Hills Diamicton have no way of emplacement than by ejection from the CBIS crater. (6) The striated boulders found in the Bacons Castle Fm. are likely signatures of crater ejecta according to King and Petruny (2003). (7) Last but far from least, in Griscom et al. (2003) I proposed a non-classic indicator that the upland gravels were emplaced by impact. It goes like this: My colleagues and I demonstrated the hard, ruddy brown material welding together a fraction of the upland gravels comprises a 95%-pure ferrihydrite as the matrix of a matrix-supported breccia, with angular quartz grains as the majority of the clasts. Since the matrix of a matrix-supported breccia cannot possibly be created by ferric oxide precipitation from a water solution (without an antigravity machine) as canonically believed, these must therefore be melt-matrix breccias. But the only known melt-matrix breccias are of volcanic or impact origins. And by process of elimination (there are no known volcanic lavas composed of 95% iron oxide) these features of the upland deposits must be impactoclastic in origin. Can referee #1 (or anyone else) tell me what is wrong with this argument?

Referee #1: It's also not clear from this that he's tried to integrate his ideas into the other geologic processes that were clearly going on at the time (i.e, uplift, marginal sedimentation).

Author: My paper has integrated my ideas with a multitude of geological processes including especially those critically relating to the CBIS ejecta blanket shortly after it was created, a reality that has been totally ignored by Poag (1997) and others. Moreover, I have made several independent arguments all supporting the notion that the upland deposits are crater ejecta and it follows that they have lain pretty much where they are now for 35.4 m.y. So what you term "at that time" has to include myriad uplifts and subsidences over this immense time span. Although details of these many movements is outside the scope of the present paper, it is worth mentioning that the up-to-70-m vertical separations of the upland deposits near Richmond, VA, could well have been due to differential local uplifts after (or before) the impact (Sect. 6.2, Fig. 13b). As for marginal sedimentation, as I have explicitly discussed in this paper, this surely took place around the margins of the clay terraces armored on top by erosion resistant upland deposits-cum-CBIS-ejecta blanket.

Referee #1: And the fact that Pleistocene glaciation would have dumped a lot of pebbly-cobbly material where streams could transport it into the Bay points to the real potential for confusing what he would argue are older deposits with reworked glacial stuff.

Author: The Pleistocene glaciation's closest approach was north eastern Pennsylvania. And, if quartzite pebbles and cobbles were dropped into the Susquehanna River at Scranton (I don't know if many actually were), some of them could well have arrived at the crater rim only 60% smaller, according to Attal and Lavé's (2006) size reduction rate of 0.15% per kilometer – at least so long as the sea level remained lower than the floor of ancient Susquehanna at that point. (Transport of gravel southward of the mouth of the present-day Susquehanna has to have become much slower ever since the bay filled to its current size.) In any event, there is absolutely no way that glacial till could possibly have been deposited at the locations of the upland deposits, which are typically $\sim$60 to 110 m above present sea level. There is zero potential for confusion in this regard.

---



Interactive comment on Solid Earth Discuss., 4, 363, 2012.