

Sulu Sea Basin - Spratly Islands multi-ring basin: Possible doublet crater from middle Miocene binary oblique impact?

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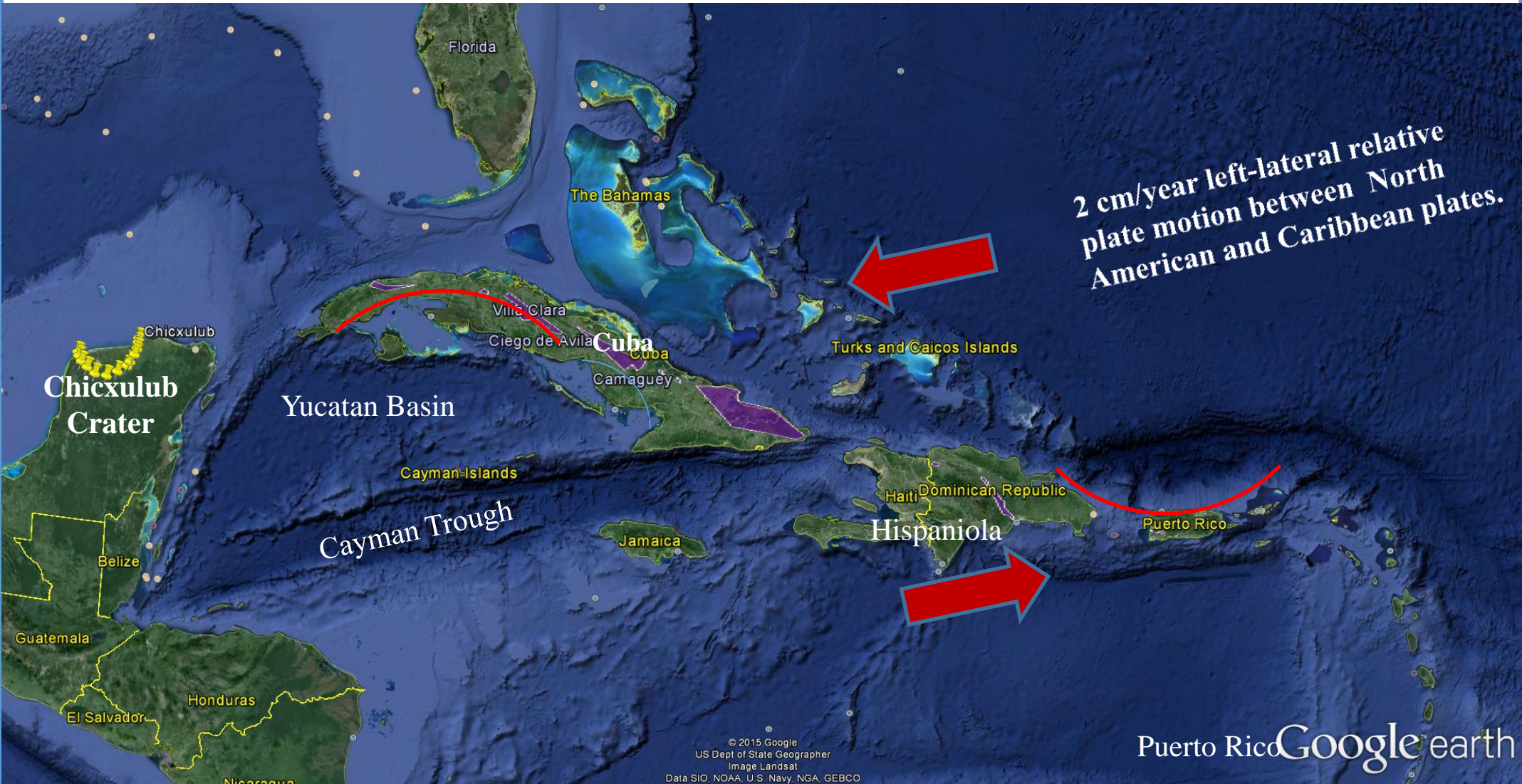
Evidence for an Oceanic KT Boundary Impact

Geochemical evidence for oceanic crust/upper mantle in the KT impact layer is inconsistent with excavation/ejection of exclusively continental crust by the KT boundary impact suggesting a crater in addition to Chicxulub.

- Chicxulub Crater is located on ~35 km thick continental crust!
- Geochemical evidence for ejection of oceanic crustal/upper mantle [1-5] since publication of the Alvarez hypothesis in 1980 [6] resulted in the search for an oceanic impact site until Chicxulub crater was identified with the KT boundary impact in 1991 [7].
- KT boundary chromites are from Earth (not an asteroid or comet) and are likely of ophiolite origin! Cr isotopes recently determined by the Yin lab at UC Davis reiterate 1980s evidence for excavation/ejection of a mafic/ultramafic target rock component by the KT boundary impact.

A testable hypothesis is that oceanic crust and upper mantle rock, exposed as ophiolite in the Greater Antilles island chain, marks the rim of a roughly 700 km diameter impact basin deformed and dismembered from an originally circular form by at least 50 million years of left-lateral shear along the North American-Caribbean transform plate boundary (Olds, Sanborn, Teague, Yin submitted to Lithosphere). Relative velocity between the North American and Caribbean plates is ~2 cm/year (DeMets et al. 2010) or ~1000 km in 50 my (ignoring velocity variability). Corollary: Greater Antilles is the parent of a KT boundary doublet crater for which Chicxulub is the daughter.

Greater Antilles – Chicxulub KT Boundary Doublet Crater?



Ophiolites mapped as purple.

Alternative hypotheses include: 1) excavation of an unknown/unmapped suture in Yucatan platform basement (Kevin Burke personal communication), or 2) an additional small crater on oceanic crust (Manuel Iturralde-Vinent, Norm Sleep personal communication).

Suppose

- some large ophiolite rimmed basins are impact basins and in these cases ophiolite emplacement is a cratering mechanics phenomenon related to over-thrusting at the rim,

then

- ophiolite emplacement and/or ophiolitic melange formation plus emplacement might be equivalent to emplacement of extremely coarse ejecta and should reflect the age of impact.

Furthermore

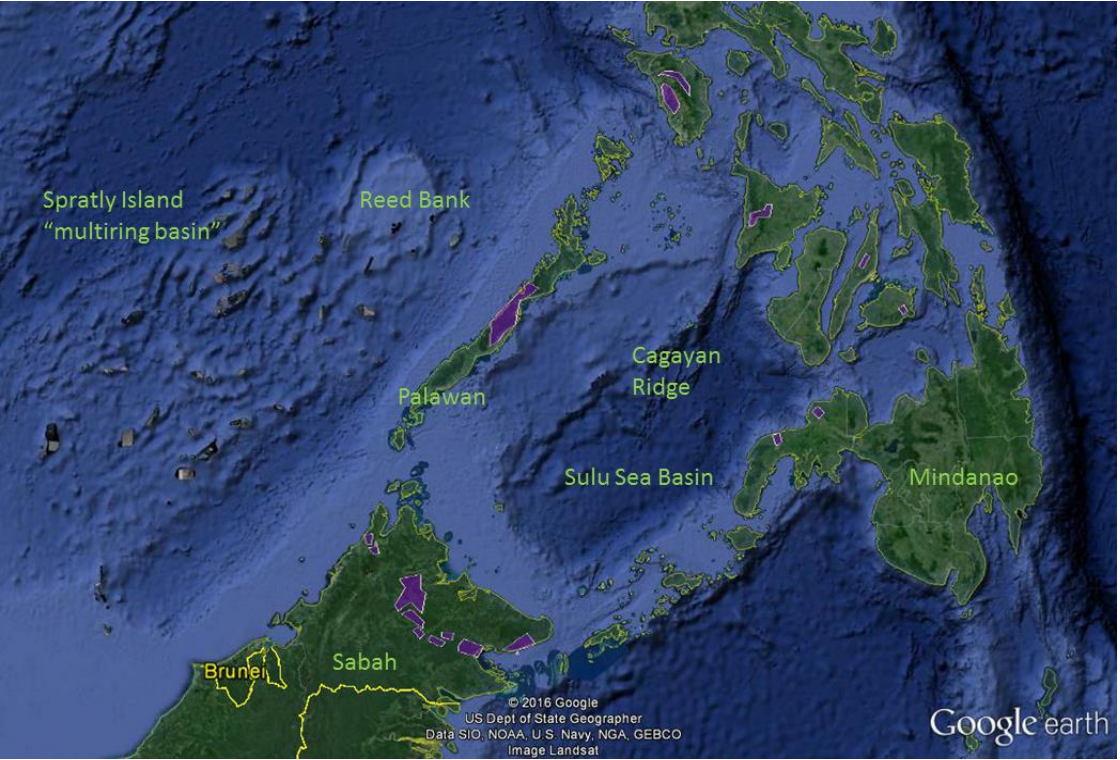
- impacts of such size should generate large amounts of impact melt resulting in
- spatial homogeneity of igneous basement age plus magnetization in contrast to spreading origins, and
- petrological/geochemical signatures which differ from typical MORB and BABB rocks (the latter generated by partial melting and subsequent eruption at mid-ocean ridges and back-arc basins).

In the case of a doublet crater resulting from oblique impact

- both member craters should record essentially the same approach angle and direction (azimuth).

Such considerations allow testing of the ophiolite rimmed impact basin hypothesis for the KT boundary Greater Antilles case and suggest how to look and test for additional large terrestrial impact basins.

Sulu Sea – Spratly Island Middle Miocene Doublet Crater?



Same scale as the Greater Antilles image to the left. Again, ophiolites are mapped as purple.

Conventional wisdom is that Greater Antilles and Sulu Sea ophiolite belts are sutures/extinct subduction zones. In the Greater Antilles case the Maestrichtian emplacement of the Moa-Baracoa ophiolite does not correspond to the Eocene collision of Cuba with the Bahamas Platform.

In the Sulu Sea case, an Eocene age determined for a metamorphic sole of the SW Palawan ophiolite does not fit the hypothetical middle Miocene impact event [14].

The ophiolite rimmed Sulu Sea basin and the Spratly Island multi-ring structure have roughly the same aspect ratios and long axis orientations, suggesting low angle oblique impact of a large binary object approaching from SW to NE or from NE to SW. Middle Miocene ophiolitic mélangé formation in Sabah suggests an impact age similar to Nordinger Ries crater and the Middle Miocene Disruption (extinction) event of about 14.5 my.

Problems:

- Impacts of Greater Antilles, Sulu Sea, etc. proportions should have produced global spherule beds several tens of cm thick rather than a few mm thick based on conventional rock-vapor scaling models. Pierazzo, Vickery & Melosh 1997, Cintala & Grieve 1998.
- KT boundary and Middle Miocene extinction events should have been much more severe with only deep ocean life surviving. Sleep & Zahnle 1998.
- Impacts resulting in Greater Antilles/Sulu Sea crater sizes are not expected subsequent to the Archean eon (2.5 by) based on conventional size frequency distributions from NEO counting and rocky planet crater counting. Ivanov 2008
- Apparent discrepancy from 14.5 my in igneous basement age (18 or 19 my) at ODP site 768 from leg 124. Huang et al. 1991.

To confirm impact origin search for and identify:

- A global impact layer in continuous Middle Miocene sedimentary sequences.
- Middle Miocene coarse ejecta layer proximal to the structures in oil and exploratory well cores in the South China and Celebes seas.
- impactites in exploratory drill cores from the Spratlys.
- high pressure and/or shocked mineral phases in Sulu Sea basin rim ophiolites: Can ophiolitic diamonds be found in chromitites from Palawan and Sabah [15]?
- Obtain spatially separated age and paleomag determinations on SE Sulu Sea igneous basement (and Yucatan Basin basement in the Greater Antilles case).

We speculate:

- Some but not all ophiolite belt segments mark rims of large terrestrial impact basins deformed to greater or lesser extent by, and serving as strain markers for, relative plate motions over geologic time.
- Greater Antilles/Chicxulub and Sulu Sea Basin/Spratly Island occurrences constitute doublet craters of similar size ratio and separation distance.
- Plate boundaries are formed and/or modified by such impacts.

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