The Paleogene Richmond Formation of Jamaica: Not an impact-related succession

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James speculated that Paleogene 'flysch-wildflysch' deposits of the Caribbean region may all have a related genesis associated with one or more bolide impacts. The principal arguments used to promote this idea were: (1) that many successions may have been dated incorrectly and are actually related to the end Cretaceous (K/T) event and/or other bolide impacts; and (2) common olistostromes may have been transported by impact-related phenomena. The deposits discussed by James included the Richmond and Font Hill formations of Jamaica. The Richmond Formation of the Wagwater Belt is Paleogene, not Cretaceous, and olistostromic blocks are a common feature of the sedimentary succession of Jamaica. No extraterrestrial event need be invoked to support their deposition.

Contents

Introduction

Based on a so-called "comprehensive bibliography", James (2005, p. 29) recently speculated that Paleogene 'flysch-wildflysch' deposits (assuming that such terminology can be transplanted from the Alps; Wyatt, 1986, p. 119) of the Caribbean region may all have a related genesis associated with one or more bolide impacts. Either at least some of these sedimentary successions have been incorrectly dated and "… all relate to the K/T impact" or "Perhaps more than one impact occurred" (James, 2005, p. 42). The potential influence of poorly refined stratigraphy was noted (p. 41): "If allochthonous material is abundant and autochthonous matrix is scarce or lacks fossils, the units will receive erroneously older ages and/or large age ranges." He suggests that "Units that have not received recent stratigraphic study should be revisited" (p. 29, abstract), in part echoing Ager (1993, pp. 1-25) on the persistence of sedimentary facies.

Herein, we demonstrate that one of the 'flysch-wildflysch' couplets discussed by James (2005), the Richmond and Font Hill formations of Jamaica, has provided ample evidence that its deposition post-dated the end Cretaceous (K/T) event, occurred under 'normal' conditions of sedimentary accumulation and need not be related to any

extraterrestrial impact, whatever the age. Obviously, such a synthetic study, examining numerous sedimentary successions from Barbados to Guatemala and Cuba to Peru (James, 2005, table 1), relied heavily on published accounts. James referred to Trechmann (1924), Burke & Robinson (1965) and Robinson *et al.* (1972) as sources of information on the Richmond Formation, a venerable trio of publications, yet ignoring the many papers providing new data on these units that have been published over the past 35 years.

The base of the Richmond Formation

Using data provided by both calcareous nannofossils and larger benthic foraminifers, Jiang & Robinson (1987) demonstrated that deposition of the Richmond Formation ranged from the Early Paleocene in the eastern part of Jamaica (Rio Grande Valley) (= their Moore Town Shales or Formation; see discussion in Pickerill & Donovan, 1991, pp. 20, 22) to Early or earliest Middle Eocene in the Wagwater Belt. In the same volume, and based mainly on the evidence of foraminifers, Scott (1987) extended the age of part of the succession in the Rio Grande Valley back to the Maastrichtian or latest Campanian. Robinson & Jiang (1990) did not consider the Moore Town Formation to be older than Early Paleocene (NP2; Danian). A Danian age for the lowest part of this succession was supported by Fluegeman (1998) based on the evidence of planktonic and benthonic foraminifers.

The references cited by James (2005; see above) considered the Richmond Formation *sensu stricto* of the Wagwater Belt, undoubtedly of Paleogene (Eocene) age (Jiang & Robinson, 1987, pp. 46-47; Robinson, 1994, fig. 6.5). It is only in this region that the Richmond Formation is overlain by the Font Hill Formation (Robinson, 1994, fig. 6.5). There has been no suggestion that the Richmond Formation of the Wagwater Belt extends into the Cretaceous (cf. Sohl, 1967). James (2005, p. 29) noted Trechmann's (1924) report of limestone clasts bearing Cretaceous rudists in the base of the formation, but such occurrences are demonstrably reworked (allochthonous) fossils (Trechmann, 1924, pp. 9-10; Chubb, 1971, p. 195; Pickerill *et al.*, 1995, p. 194); they do not indicate a Cretaceous age for this part of the Richmond Formation.

It is also relevant to note the lack of any indication of catastrophic deposition of the Richmond Formation. This is best demonstrated to the common reports of diverse, autochthonous trace fossils in this succession (e.g., Pickerill & Donovan, 1991; Pickerill *et al*., 1992, 1993; Pickerill & Mitchell, 1999; Donovan *et al.*, 2005).

Exotic blocks in the Jamaican Paleogene

"Many deposits contain extremely large olistoliths and are described as 'catastrophic' records of 'violent' deposition" (James, 2005, p. 43). These deposits include the Font Hill Formation, which contains olistostromes of "Upper, coarse[-grained] breccias of the Richmond Formation. Exotic masses of the Richmond Formation, and Wagwater Conglomerate" (James, 2005, table 1). Yet, such occurrences need not be associated with orogeny or, as suggested by James (2005, p. 43), an extraterrestrial impact.

Oceanic islands such as those of the Caribbean commonly have narrow shelves and steep slopes. It is a feature of sedimentary successions deposited in the deep water around

such islands that they include exotic material derived from the shallower water and even terrestrial environments of the adjacent island. Large exotic blocks in these sedimentary deposits, correctly called erratics deposited by gravitational processes (Bennett *et al.*, 1996) and seen in modern deeper water environments as outrunner blocks (Prior *et al.*, 1982), do not need an extraterrestrial influence to do what gravity already does and very efficiently, too. Large exotic blocks are a feature of deeper water deposits of the Jamaican Cenozoic (Donovan & Pickerill, 1997), including the Early Eocene Richmond Formation (Pickerill *et al.*, 1995), the Middle Eocene Font Hill Formation of the Yellow Limestone Group (Robinson, 1965), the Eocene Lloyds Member, Montpelier Formation of the White Limestone Group (Robinson, 1967), the Early Miocene Montpelier Formation (Portell & Collins, 2004, p. 111) and the Upper Pliocene Bowden Formation (Pickerill *et al.*, 1998). Further, that large exotic blocks can be transported by terrestrial processes is demonstrated by the occurrence of clasts as big as a house in the beds of Jamaican rivers such as the Rio Grande.

The derivation of clasts from shallow into deep water deposits is also ably demonstrated by the fossil record of the Antillean islands (Donovan, 2002; Donovan *et al.*, 2003). Although smaller than an olistostromic block, such allochthonous occurrences are commonly easily recognised as being disharmonious with the evidence otherwise provided by palaeontology, sedimentology and ichnology. The derived shallow water (Skelton *et al.*, 1994) clasts of the Maastrichtian rudist *Titanosarcolites* found in the Early Eocene Richmond Formation are thus not just disharmonious with respect to time, but are also at variance with ichnological and sedimentological evidence for deep water deposition (Pickerill *et al.*, 1995). Although not strictly related to the present argument, a more spectacular, albeit younger, example is the occurrence of terrestrial and shallow water gastropods with planktonic pteropods in the Upper Pliocene Bowden shell bed, deposited in at least 100-200 m (Pickerill *et al.*, 1998).

Conclusions

Herein, we consider one Antillean 'flysch-wildflysch' association discussed by James (2005) and fail to find supporting evidence for his idea that they may be related to a bolide impact, particularly the one associated with the end Cretaceous event. The Richmond Formation of the Wagwater Belt is Paleogene, not Cretaceous, and olistostromes and slide blocks *sensu lato* are a common feature of the island's sedimentary succession. No extraterrestrial event need be invoked to support their deposition; rather, it is a feature of oceanic islands with narrow shelves and steep slopes. We thus find no support in the Jamaican geologic record for the speculations of James (2005).

We also note that the "comprehensive bibliography" of James (2005, p. 29) was no such thing, ignoring the last 35 years of published reports on the Richmond and Font Hill formations, of which there are many; sixteen are cited herein. The obvious gaps in the bibliography of James (2005) do not inspire confidence in any of his speculations as applied to other parts of the Caribbean region.

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References

Ager, D.V. 1993. *The Nature of the Stratigraphical Record (3rd edition).* Wiley, Chichester: xiv+151 pp.

Bennett, M.R., Doyle, P. & Mather, A.E. 1996. Dropstones: their origin and significance. *Palaeogeography, Palaeoclimatology, Palaeoecology,* **121**: 331-339.

Burke, K. & Robinson, E. 1965. Sedimentary structures in the Wagwater Belt, eastern Jamaica. *Journal of the Geological Society of Jamaica,* **7**: 1-10.

Chubb, L.J. 1971. Rudists of Jamaica. *Palaeontographica Americana,* **7** (45): 161-257.

Donovan, S.K. 2002. Island shelves, downslope transport and shell assemblages. *Lethaia,* **35**: 277.

Donovan, S.K. & Pickerill, R.K. 1997. Dropstones: their origin and significance: a comment. *Palaeogeography, Palaeoclimatology, Palaeoecology,* **131**: 175-178.

Donovan, S.K., Pickerill, R.K., Portell, R.W., Jackson, T.A. & Harper, D.A.T. 2003. The Miocene palaeobathymetry and palaeoenvironments of Carriacou, the Grenadines, Lesser Antilles. *Lethaia,* **36**: 255-272.

Donovan, S.K., Renema, W. & Pickerill, R.K. 2005. The ichnofossil *Scolicia prisca* de Quatrefages from the Paleogene of eastern Jamaica and fossil echinoids of the Richmond Formation. *Caribbean Journal of Science,* **41**: 876-881.

Fluegeman, R.H. 2002. Planktonic and benthic foraminifera from the Moore Town Shales (Paleocene) at the Fellowship Bridge section, Portland, Jamaica. *In*: Jackson, T.A. (ed.), *Caribbean Geology: Into the 3rd Millennium: Transactions of the 15th Caribbean Geological Conference, 29th June - 2nd July, 1998, Kingston, Jamaica:* 149-154. The Press, University of the West Indies, Mona.

James, K. 2005. Palaeocene to middle Eocene flysch-wildflysch deposits of the Caribbean area: a chronological compilation of literature reports, implications for tectonic history and recommendations for further investigation. *Caribbean Journal of Earth Science,* **39**: 29-46.

Jiang, M.-J. & Robinson, E. 1987. Calcareous nannofossils and larger foraminifera in Jamaican rocks of Cretaceous to early Eocene age. *In:* Ahmad, R. (ed.), *Proceedings of a Workshop on the Status of Jamaican Geology:* 24-51. Special Publication of the Geological Society of Jamaica, Kingston.

Pickerill, R.K. & Donovan, S.K. 1991. Observations on the ichnology of the Richmond Formation of eastern Jamaica. *Journal of the Geological Society of Jamaica,* **28**: 19-35.

Pickerill, R.K., Donovan, S.K. & Dixon, H.L. 1992. The Richmond Formation of eastern Jamaica revisited - further ichnological observations. *Caribbean Journal of Science,* **28**: 89-98.

Pickerill, R.K., Donovan, S.K., Doyle, E.N. & Dixon, H.L. 1993. Ichnology of the Paleogene Richmond Formation of eastern Jamaica - the final chapter? *Atlantic Geology,* **29**: 61-67.

Pickerill, R.K., Donovan, S.K. & Dunn, J.T. 1995. Enigmatic cobbles and boulders in the Paleogene Richmond Formation of eastern Jamaica. *Caribbean Journal of Science,* **31**: 185-199.

Pickerill, R.K. & Mitchell, S.F. 1999. The graphoglyptid trace fossil *Spirorhaphe involuta* (de Stefani, 1895) from eastern Jamaica. *Journal of the Geological Society of Jamaica,* **33** (for 1998): 13-16.

Pickerill, R.K., Mitchell, S.F., Donovan, S.K. & Keighley, D.G. 1998. Sedimentology and palaeoenvironment of the Pliocene Bowden Formation, southeast Jamaica. *Contributions to Tertiary and Quaternary Geology,* **35**: 9-27.

Portell, R.W. & Collins, J.S.H. 2004. Decapod crustaceans of the Lower Miocene Montpelier Formation, White Limestone Group of Jamaica. *Cainozoic Research,* **3** (for 2003): 109-126.

Prior, D.B., Coleman, J.M. & Bornhold, B. D. 1982. Results of a known seafloor instability event. *Geo-Marine Letters,* **2**: 117-122.

Robinson, E. 1965. Tertiary rocks of the Yallahs area, Jamaica. *Journal of the Geological Society of Jamaica,* **7**: 18-27.

Robinson, E. 1967. Submarine slides in the White Limestone Group, Jamaica. *American Association of Petroleum Geologists Bulletin,* **51**: 569-578.

Robinson, E. 1994. Jamaica. *In*: Donovan, S.K. & Jackson, T.A. (eds.), *Caribbean Geology: An Introduction:* 111-127. University of the West Indies Publishers' Association, Kingston.

Robinson, E. & Jiang, M.-J. 1990. Paleogene calcareous nannofossils from western Portland, and the ages and significance of the Richmond and Mooretown formations of Jamaica. *Journal of the Geological Society of Jamaica,* **27**: 17-25.

Robinson, E., Lewis, J.F. & Cant, R.V. 1972. Field guide to aspects of the geology of Jamaica. *In:* Donnelly, T.W. (ed.), *International Field Institute Guidebook to the Caribbean Island-Arc System, 1970.* American Geological Institute, Washington, D.C.: 48 pp.

Scott, W. 1987. Age and provenance of the Richmond Formation of the Rio Grande Valley, eastern Jamaica. *In:* Ahmad, R. (ed.), *Proceedings of a Workshop on the Status of Jamaican Geology:* 52-68. Special Publication of the Geological Society of Jamaica, Kingston.

Skelton, P.W., Donovan, S.K. & Dixon, H.L. 1994. Palaeoecology of the late Cretaceous rudist *Titanosarcolites giganteus* (Whitfield) in Jamaica and Cuba: fiction and fact. *Contributions to Geology, UWI, Mona,* **1**: 27.

Sohl, N. 1967. On the Trechmann-Chubb controversy regarding the age of the 'Carbonaceous Shale' of Jamaica. *Journal of the Geological Society of Jamaica,* **9**: 1-10.

Trechmann, C. T. 1924. The Carbonaceous Shale or Richmond Formation of Jamaica. *Geological Magazine,* **61**: 2-19.

Wyatt, A. 1986. *Challinor's Dictionary of Geology.* University of Wales Press, Cardiff: xviii+374 pp.