[PS]Micropalaeontological Reconnaissance of the Rockly Bay Formation, Tobago*

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Abstract

In 2012, Centrica Energy undertook an onshore site survey in Tobago at the Cove Point Industrial Estate. The onshore survey entailed the drilling numerous boreholes to a maximum depth of 40 metres. Boreholes generally encountered a thin limestone layer followed by a mudstone sequence that, in Core BH030, was ascribed to the Rockly Bay Formation. It was sampled every three metres. Most samples were barren, but a few yielded a rich benthic assemblage of *Bulimina exilis* and *Bulimina marginata* with lesser *Cassidulina laevigata, Lenticulina rotulata, Brizalina subaenariensis mexicana, Brizalina transluscens* and *Eponides regularis.* Planktonic foraminifera were rare in these samples. This indicates at maximum a water depth of considerably less than 200m and probably as shallow as shallower middle neritic (20–100 m). *Bulimina exilis* is indicative of relatively unchanged organic matter reaching the seafloor. The organic source may have come from the palaeo-Orinoco plume. A single specimen of *Asterigerina* sp. in the sparsely fossiliferous sample from 8.5 m might presage the development of clearer water.

The common occurrence of the benthic species *Bulimina marginata* indicates a Late Miocene or younger age. In contrast, the presence of the planktonic foraminifera *Globorotalia crassaformis* indicates an Early Pliocene to Recent age (= planktonic foraminiferal Zone N18 [*Globorotalia margaritae margaritae* Subzone] or younger. A single specimen of *Sphaeriodinellopsis seminula* at 8.5 m confirms an age no younger than mid Pliocene (*Globorotalia miocenica* Zone, *Globigerinoides trilobus fistulosus* Subzone, N20). Thus, an Early to Middle Pliocene (N18–N20) age is invoked.

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Introduction

Tobago lies immediately east of the North Coast Marine Area (NCMA, Figure 1). Knowledge of its Miocene and younger geology is paramount to understanding the stratigraphy of the NCMA (Figures 2, 3). The subsurface micropalaeontology of the onshore Rockly Bay Formation is little known. It was characterised by Ringerwole et al. (2012) as being muddy, fossiliferous, marine carbonate, but at the surface is represented primarily by orange-brown sands and laterally equivalent muds, in which the invertebrate macrofauna comprises the barnacle *Megabalanus tintinnabulum* (Linnaeus) *sensu lato,* oystersgastropods, regular echinoids, crabs and sharks (Donovan et al., 2001, Donovan, 2010). Vertical burrows in the muds suggest that littoral to shallow sublittoral depostition. Donovan (2010) suggested that the Rockly Bay Formation is a transgressive unit of sediment derived from nearby basalts. The formation's base is not seen at Rockly Bay, but a basal conglomerate overlain by disarticulated mollusc valves is exposed in nearby Little Rockly Bay. Donovan wrote that, "apart from the two fossiliferous horizons mentioned, the Formation is barren of marine microinvertebrates." This poster examines the micro-fauna in the ~36 m Borehole 30 at Cove Point Industrial Estate.

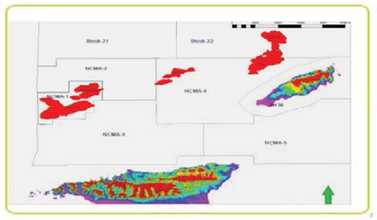

FIGURE 1: Tobago relative to the North Coast Marine Area (NCMA)

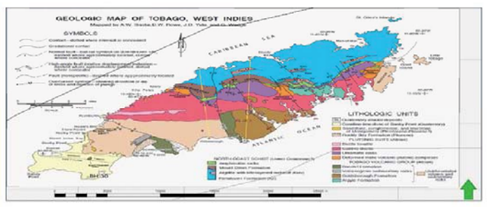

FIGURE 2: Geological map of Tobago showing the location of Core BH-30

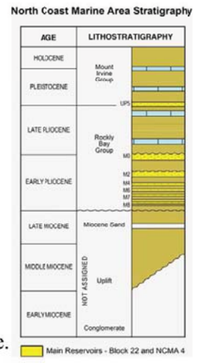

FIGURE 3: General stratigraphic chart for the NCMA. Note the the M reservoirs were previously considered Miocene. The UP5 reservoir (Upper Pliocene 5) is now considered Pleistocene.

Materials and Methods

Borehole 30 (Figure 4) yielded ~36 m of sediment, all ascribed on lithostratigraphic grounds to the Rockly Bay Formation. It was where possible sampled at 3 m intervals. The uppermost part comprised an indurated coral limestone that could not be sampled for microfauna. The samples were washed over a 63 µm mesh to remove silt and clay, and the residue picked for foraminifera (Figure 5). Specimens were identified using Brady (1884), Phleger and Parker (1951) and Drooger (1953). The age ranges of the planktonic foraminifera from Kennett and Srinivasan (1983) and Bolli et al. (1984). Ages are expressed using the N Zones of Blow (1969). Palaeodepths were determined using

$$\text{Depth (n metres)} = e^{(81.9 + \%P)/24},$$

where %P is the percentage of the total assemblage as planktonic foraminifera.

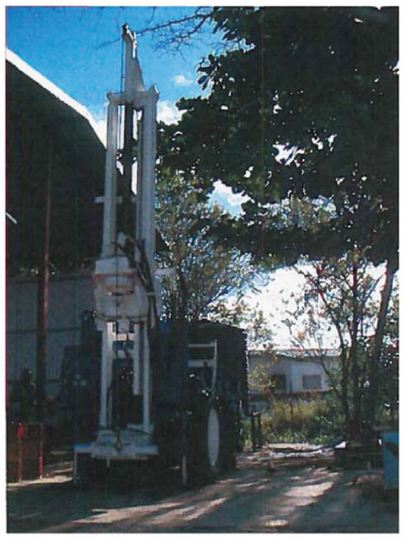

FIGURE 4: Drilling for Core BH-30, Cove Point Industrial Estate

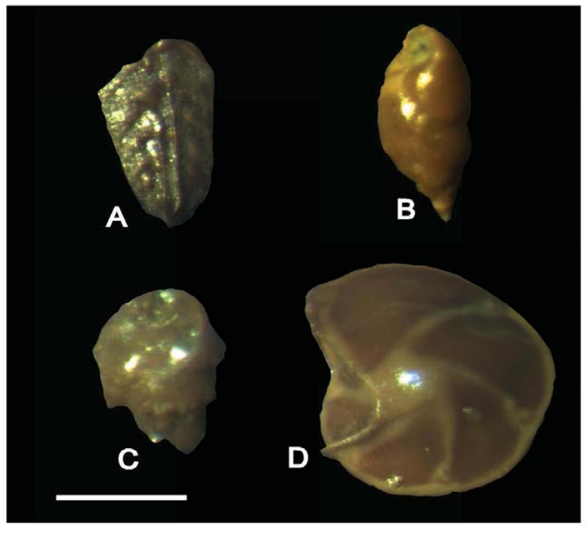

FIGURE 5: Benthic foraminifera from Core BH-30. A. *Bolivina subaenariensis westermanni,* B. *Bulimina exilis.* C. *Bulimina marginata.* D. *Lenticulina alatolimbata.* Scale bar = ~125µm (A–C), 250 µm (D).

TABLE 1: Foraminifera from the Rockly Bay Formation.

	Samples, metres below seafloor	5.5	8.5	11.45	14.5	16.45	17.45	20.45	23	26.4	29.45	31.68	35.5
Benthic foraminifera	*Ammonia sobrina*	0	0	0	0	0	0	0	1	0	0	0	0
	Ammonia sp.	0	0	0	0	0	0	0	0	0	1	0	0
	Asterigerina sp.	0	1	0	0	0	0	0	0	0	0	0	0
	Bolivina subaenariensis mexicana	0	0	0	0	0	0	3	1	1	11	0	0
	Bolivina subaenariensis westermanni	0	0	0	0	0	0	0	0	0	2	0	0
	Bolivina translucens	0	0	0	0	0	0	21	0	0	0	0	0
	Bulimina aff. *marginata*	0	0	0	0	0	0	69	0	19	0	0	5
	Bulimina exilis	0	0	0	0	0	0	124	0	1	59	0	0
	Bulimina marginata	0	1	0	0	0	0	64	0	19	26	0	9
	Cassidulina laevigata	0	0	0	0	0	0	30	0	0	0	0	1
	Cibicidoides floridanus	0	1	0	0	0	0	3	0	0	2	0	0
	Fissurina sp.	0	0	0	0	0	0	1	0	0	0	0	0
	Gyroidinoides cf. *soldanii*	0	0	0	0	0	0	19	0	6	9	0	0
	Lenticulina alatolimbata	0	0	0	0	0	0	11	0	3	0	0	0
	Marginulina sp.	0	0	0	0	0	0	0	0	0	1	0	0
	Pseudononion atlanticum	0	0	0	0	0	0	0	1	0	0	0	0
	Quinqueloculina seminula	0	0	0	0	0	0	3	0	0	0	0	0
	Uvigerina subperegrina	0	1	0	0	0	0	0	0	0	0	0	0
	Eponides regularis	0	0	0	0	0	0	0	0	1	0	0	0
	Cassidulina norcrossi australis	0	0	0	0	0	0	0	0	2	0	0	0
Planktonic foraminifera	*Globigerina quinqueloba*	0	0	0	0	0	0	0	0	0	1	0	0
	Globigerina sp.	0	1	0	0	0	0	7	3	2	0	0	1
	Globigerinoides ruber	0	2	0	0	0	0	0	0	0	4	0	0
	Globigerinoides trilobus immaturus	0	1	0	0	0	0	0	1	0	4	0	0
	Globorotalia crassaformis	0	0	0	0	0	0	1	0	0	0	0	0
	Neogloboquadrina dutertrei	0	0	0	0	0	0	1	1	0	0	0	0
	Sphaeriodinellopsis seminula	0	1	0	0	0	0	0	0	0	0	0	0
	Total benthic foraminifera	0	4	0	0	0	0	348	3	52	111	0	15
	Total planktonic foraminifera	0	5	0	0	0	0	9	5	2	9	0	1
	%P	n/a	55.6	n/a	n/a	n/a	n/a	2.5	62.5	3.7	7.5	n/a	6.3
	Suggested palaeodepth (in metres, computed for samples with >50 total specimens)	n/a	n/a	n/a	n/a	n/a	n/a	**34**	n/a	**35**	**41**	n/a	n/a

Results I: Age

Trechmann (1934) thought the Rockly Bay Formation to be Miocene, and Maxwell (1948:805) suggested an Upper Miocene to Pliocene age. Saunders and Muller-Merz (1985) used foraminifera to suggest a mid-Pliocene age, but palynology has suggested a Pleistocene age (R. D. Liska, written comm. in Jackson and Donovan, 1994:203).

The planktonic foraminifera recovered are listed in Table 1. The samples yielded the planktonic foraminifera *Sphaeroidinellopsis seminula* (N7–N20) and *Globorotalia crassaformis* (N19–N23), which together indicate a later Early to Middle Pliocene (N19–N20) age (= *Globorotalia margaritae evoluta* to *Globigerinoides trilobus fistulosus* Subzones).

Results II: Palaeoenvironment

- Most samples were barren of foraminifera, only three yielding >50 specimens. The values of %P for samples with >100 specimens indicate a shallow middle neritic palaeodepth.
- The occurrence of samples with a rich foraminiferal assemblage might have sequence stratigraphic significance, specimen-rich samples possibly representing flooding surfaces. However, more detailed analysis is required to verify this.
- The fauna is dominated by *Bulimina* spp., with lesser *Bolivina* spp. This indicates an organic-rich, mow dissolve oxygen environment. The source of the organic matter is uncertain. However, Tobago currently lies within the Orinoco plume (Figure 5), within which there is rich phytoplankton growth. A similar proto-Orinoco plume may have encouraged the development of the mid-Pliocene fauna.
- The specimens are coloured brown, presumably being stained by iron. This differs from the reddish, iron-stained fauna recorded from the modern Trinidad continental shelf by Wilson (2010). The iron staining the specimens in this study may be derived from the weathered, nearby basalts.

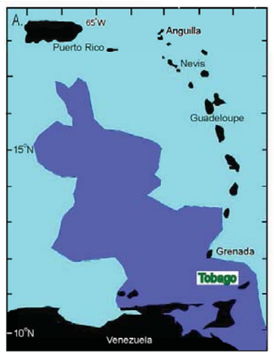

FIGURE 6: Tobago and the modern-day Orinoco Plume.

Conclusions

- Foraminifera are not evenly distributed through the Rockly Bay Formation, but concentrated a certain horizons.
- Planktonic foraminifera confirm the Formation as Middle Pliocene in age.
- The Formation was deposited at shallow middle neritic palaeodepths in water with low dissolved oxygen and high organic matter content.
- Iron staining of the foraminifera probably came from weathering of nearby basalts.

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