PS A Microtektite Horizon in the Miocene Cruse Formation of Southern Trinidad*

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Abstract

The Late Miocene Lower Cruse Member of the Cruse Formation on the Quinam Bay foreshore was sampled at 50 cm intervals and the samples numbered Qu-1 through Qu-23 from the top of the outcrop down. They were washed over a 63-µm mesh. Sample Qu-10 yielded 31 microtektites. These lacked micro-craters but showed a welded structure from accretionery impacts resulting from low-velocity collisions. These features, together with the low number of microtektites recovered, support a distal location relative to the impact crater. Four Miocene microtektite layers are known worldwide. Due to the lack of age diagnostic fossils in the Lower Cruse Member, it is not at present possible to say to which layer these microtektites belong. Nevertheless, they should be useful for at least local correlation, microtektite layers being chronostratigraphic horizons.

A microtektite horizon in the Miocene Cruse Formation of southern Trinidad

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Introduction

The products of a meteorite impact occur within the Upper Miocene Lower Cruse Formation of Southern Trinidad. When a large meteorite collides with the Earth, it melts both itself and some of the crust. Most melt stays in and around the impact crater, but ca. 1 vol% is ejected from the crater as cm- to mm-sized bodies. At distances >10 crater diameters, the ejecta comprise sub-millimetre, usually transparent, glassy bodies formed from melt and vapour-condensate droplets. We use the term 'microtektites' to describe such sub-millimetre bodies recovered from the Lower Cruse Formation.

Materials and Methods

The Lower Cruse Formation is exposed on the foreshore at Quinam Bay (GPS coordinates 0662697, 1113723; Figures 1 and 2). Half kilogram samples from this outcrop were taken at 50 cm intervals for a study of the agglutinated foraminiferal fauna (Wilson and Vincent, 2014, Figure 3), each sample being from a horizon ~4 cm thick. They were numbered Qu-1 through Qu-23 from the top of the exposure down. They washed over a 63 µm mesh to remove silt and clay, and then air dried. Sample Qu-10 contained millimetre to sub-millimetre bodies concluded, from comparison with published illustrations, to be impact ejecta. These were picked, mounted onto a card micropaleontological microscope slide, and counted.

To assess utltrastructural features, selected specimens were photographed using a scanning electron microscope. Because future studies will probably change the definitions as our knowledge of formation mechanisms grows, here we use the term microtektite to cover the objects we found.

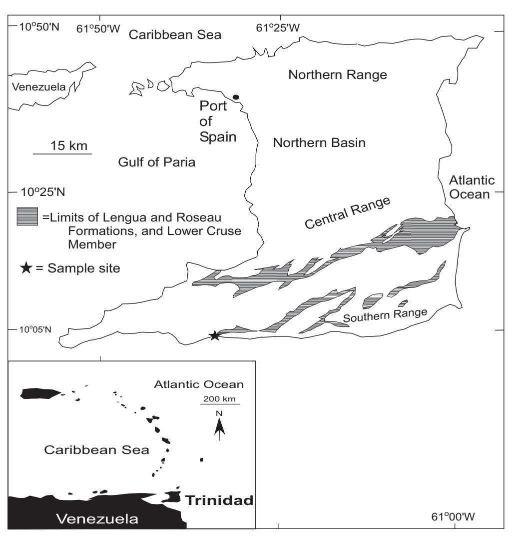

Figure 1: Trinidad and sample location

Age		Planktonic Foraminiferal Zones (after Bolli *et al*., 1985)	Plankton Rich	Plankton Poor
Miocene	Late	*Globorotalia humerosa*		* Cruse
		Globorotalia acostaensis		
	Middle	*Globorotalia menardii*	Lengua	(Hiatus)
		Globorotalia mayeri		Karamat
		Globigerinoides ruber	(Hiatus)	
		Globorotalia fohsi robusta	Cipero	Brasso
		Globorotalia fohsi lobata		
		Globorotalia fohsi fohsi		
		Globorotalia fohsi peripheroronda		

Figure 2: Stratigraphy of southern Trinidad and position of the microtektite horizon

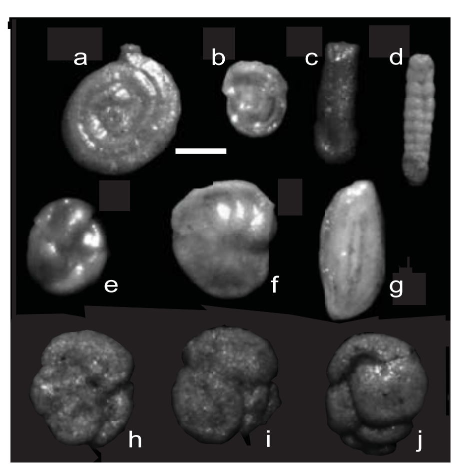

Figure 3: Agglutinated foraminifera from the Lower Cruse Formation

Results

The Lower Cruse microtektites are of a transparent, quartz-like material with a high refractive index and mostly ~0.5 mm across, but of varying shapes (Figure 4). Without geochemistry, it is not possible to tell if they came from the meteorite or melted crust. Most are spherical, but some are elongate and pyriform to dumbbell-shaped.

Prasad *et al.* (2010) characterized the surface structures of some microtektites in the Indian Ocean part of the Pleistocene Australasian strewn field. They found many with crater-like micro-impacts, but the also that the number of micro-craters per microtektite decreases with distance from impact crater. There are no micro-craters on the Lower Cruse microtektites, so the impact site was far from Trinidad.

Some microtektites show a welded structure (Figure 4B). This accretionary impact feature results from low-velocity collisions in which projectiles become splattered onto target surfaces. The number of microtektites recovered also supports a distal location. Only 31 microtektites were recovered from sample Qu-10. Prasad et al. (2010) recovered >4600 Australasian microtektites from the central Indian Ocean, ~3900–5000 km from the suspected impact site.

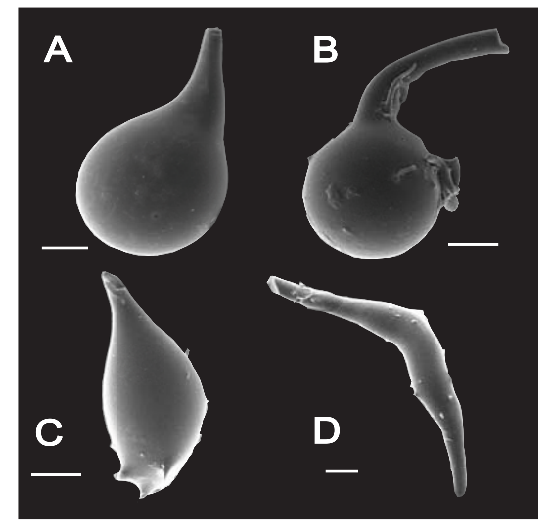

Figure 4. Selected microtektites from Quinam Bay, Trinidad. Scale bars: 200 µm in A, 50 µm in B, C and D.

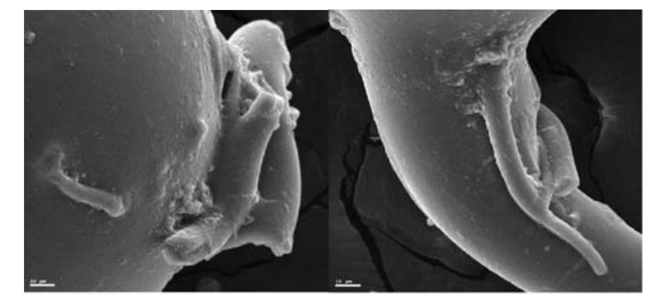

Figure 5. Welded features on microtektites from the Lower Cruse Formation. Scale bars 10 µm.

Discussion

Biostratigraphic correlation within the Cruse Formation is problematic. The formation contains mainly long-ranging agglutinated foraminifera. Planktonic foraminifera, most used for biostratigraphic correlation, are lacking.

Meteorite impacts being geologically instantaneous events, the microtektite layer in the Lower Cruse is a chronostratigraphic horizon that may prove useful in correlation.

Over 170 impact craters have been recorded on Earth, and >28 Cenozoic distal microtektite layers have so far been identified (Glass and Simonson, 2012). Petuch (2012) recorded four of Miocene age, three impacts [the Ries-Steinheim Binary Impact, Bavaria (14.5 Ma); the Puffin Impact, northwestern Australia (12 Ma); the Ewing Impact, abyssal equatorial Pacific Ocean (11.7 Ma)] occurring during the Middle Miocene Serravalian Stage and one [the Kara-Kul Impact, Tajikistan (5 Ma)] in the latest Late Miocene Messinian Stage.The Lower Cruse microtektites may be associated with the Tajikistanian Kara-Kul Impact, but geochemical work is needed to confirm this.

It might be objected that the Cruse microtektites are volcanigenic, not meteoritic, coming from the acid volcanoes of the Lesser Antilles. The ash from these volcanoes, however,is rough and angular (Horwell et L., 2003), not smooth and rounded. Alternatively, it may be suggested that they are reworked, coming from an Eocene source within the North American strewn field as found in Barbados. Chemical analyses would be needed to confirm this, but it is unlikely. There are no reworked Eocene fossils within the Quinam Bay outcrop. Furthermore, the rock in which the microtektites were found is a low energy mudstone in which palaeocurrents would have been too weak to transport such large bodies. Finally, the microtektites were found in one sample only. It is unlikely that reworking from an Eocene source would have produced such a concentrated horizon.

Conclusion

Some Cenozoic rocks of Trinidad either contain few foraminifera or primarily agglutinated ones of limited use in correlation. There are, however, 28 Cenozoic microtektite events worldwide. These have potential for chronostratigraphic correlation on Trinidad. High resolution sampling, such as conducted here for the Lower Cruse Formation, may unearth the records of other impact events in the Trinidadian sedimentary column and provide useful tie-points for chronostratigraphic correlations.

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