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Lithostratigraphy of the Grange Inlier, Westmoreland, Jamaica

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ABSTRACT. The lithostratigraphy of the late Cretaceous succession (mid Campanian to early Maastrichtian) exposed in the Grange Inlier of western Jamaica is formally described based on detailed geological mapping at a scale of 1:12,500. Five new formations are recognised: Cabartia Formation, a succession of poorly sorted conglomerates interbedded with sandstones; Grange Formation, a thick unit of mudstones with thin sandstone and conglomerates units in the upper section; Glenbrook Formation, a thin bed of dense micritic to rubbly limestone to sandstone; Williamsfield Formation, alternating beds of pebble conglomerates and sandstones; and the Strawberry Formation, a sequence of red weathering sandstones, mudstones and conglomerates. Type sections are designated for each formation. Based on biostratigraphy and lithological comparisons, the succession in the Grange Inlier is considered to have correlatives in the Lucea, Green Island, Sunderland, St. Ann's Great River and Central inliers of Jamaica.

Key words: Cretaceous, Grange Inlier, Jamaica, lithostratigraphy, rudist.

1. INTRODUCTION

The Grange Inlier is one of four Cretaceous inliers situated on the Hanover Block in western Jamaica (**Figure 1**). It is situated within the parish of Westmoreland, surrounded by karstified White Limestone, and forms the upper parts of the drainage basins of the Cabarita, Dean, and Negril rivers.

Chubb (in Zans et al., 1963) provided a brief description of the succession, but no lithostratigraphic names were introduced. It was described as consisting of chiefly tuffaceous, red weathering shales that dip towards the south-west. Chubb also described the collection of an exceptionally large specimen of *Barrettia gigas* Chubb (which was placed in the genus *Whitfieldiella* by Mitchell, 2010), from a rudist limestone in a road-cut between Bath Mountain and Glenbrook. van Dommelen (1971) described the rudists from the limestone of the Grange Inlier and

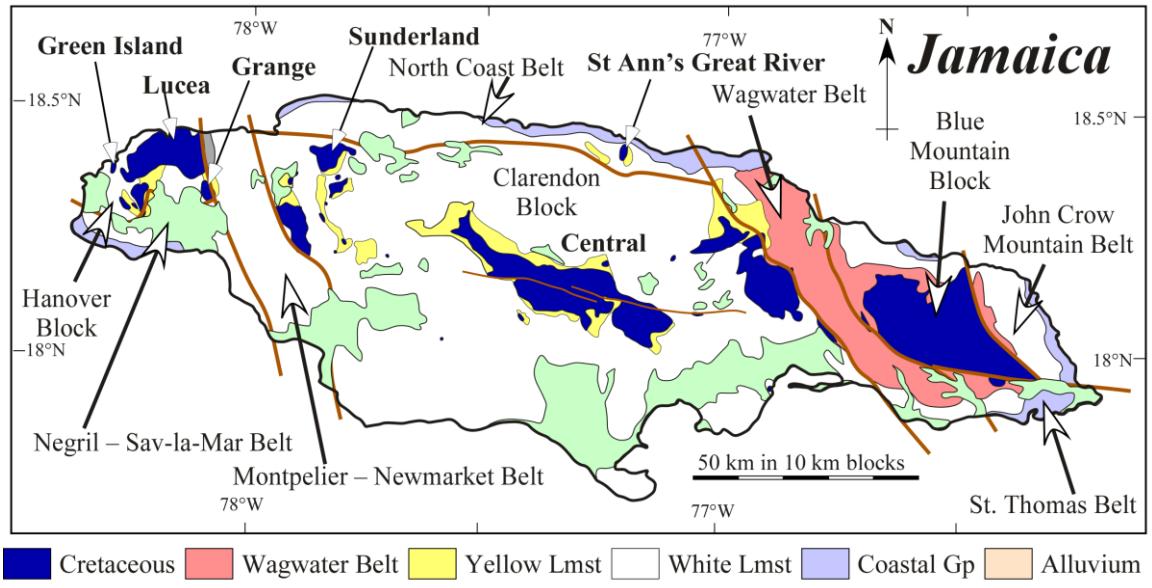

Figure 1. Map of Jamaica showing distribution of inliers on the tectonic (block and belt) map of Jamaica. Shown are the inliers (Grange, Green Island, Lucea, Sunderland, St Ann's Great River and Central) mentioned in the text.

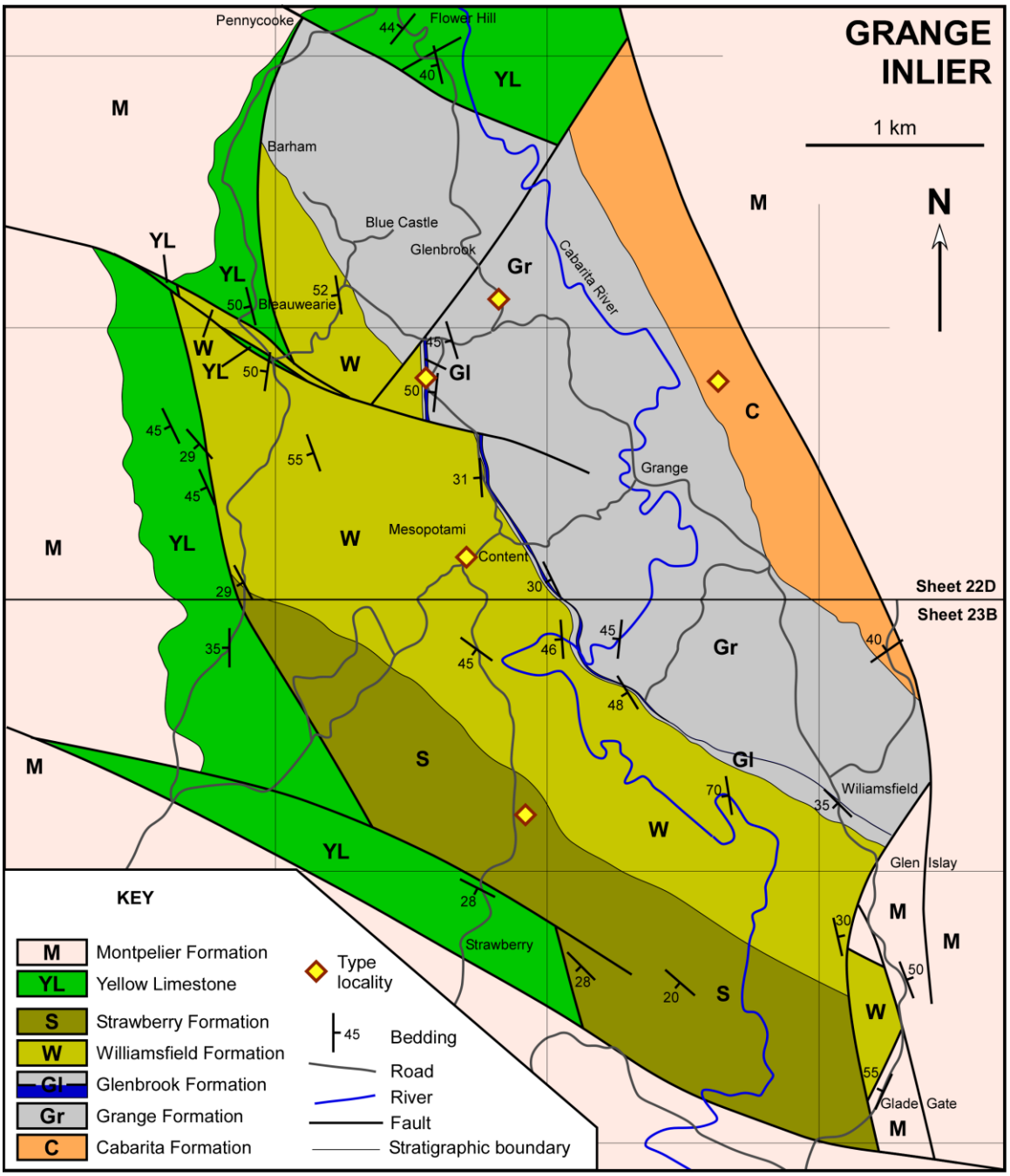

Figure 2. Geological map of Grange Inlier, Westmoreland, Jamaica

Krijnen (1972) described larger foraminifers from the same unit. Meyerhoff and Kreig (1977) provided a description of the succession in the inlier, using the lithostratigraphic terms Green Island Formation and Hanover Formation, taken from the Lucea and Green Island inliers, respectively. Their Hanover Formation exhibited a succession of mudstones overlain by Inoceramus shales, and was succeeded by the limestone of the Green Island Formation. The limestone was in turn overlain by a succession of red weathering beds. Krijnen et al. (1993) described a succession of biostromal and bioclastic calcarenites and rudist rubble beds, underlain by a thick sequence of shales, and overlain by thick sandy sequences with intercalated horizons of conglomerates. In this paper we formally erect a series of formations in the Grange Inlier, describe them, nominate type

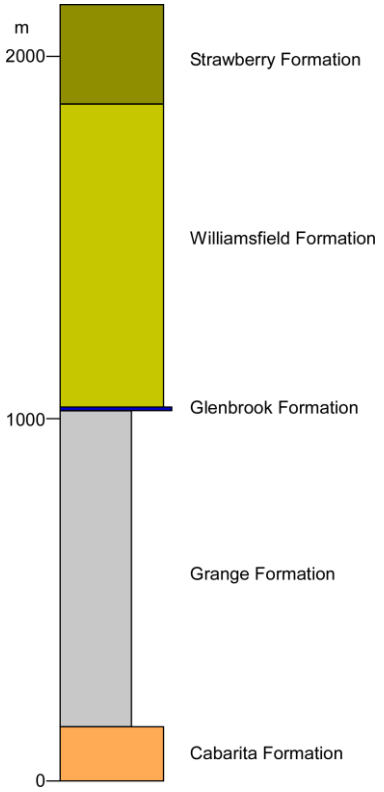

Figure 3. Simplified stratigraphic column for the Cretaceous rocks of the Grange Inlier. Colours as in Figure 2.

sections, and compare the succession in the inlier with those in other parts of Jamaica.

2. METHODOLOGY

The rocks exposed in the Grange Inlier were mapped for four days from 13th to the 16th of February, 2008, undertaking road and field transects by walking. The 1970 series (1:12,500 scale) topographic maps (Jamaican Survey Department) were used as base. The boundaries of the inlier were also mapped and their nature evaluated. Representative collections of fossils were made where they occurred and samples of mudstones were collected for an analysis of the planktic formainifers.

3. RESULTS

A new geological map of the Grange Inlier is shown in **Figure 2**. The Grange Inlier is completely fault bounded with faulted contacts against white micritic limestone with chert bands (Montpelier Formation: Mitchell, 2004) to the north and east (Pennycooke), and impure marly limestones of the Yellow Limestone Group with luicinid bivalves, stick corals, foraminifers (*Fabularia gunteri* Applin & Jordan) and gastropods (*Campanile* sp.) to the west (Bath Mountain and Bleauwearie) and south (Strawberry).

The stratigraphic sequence is represented by some 2,150 m of sedimentary rocks (determined from geological cross-sections) that consist of mudstones, sandstones and conglomerates with one thin limestone. Five formations are recognized and formally named, following criteria set out in the International Stratigraphic Guide (Murphy and Salvador, 1999).

4. LITHOSTRATIGRAPHY

The rocks exposed in the Grange Inlier are believed to have equivalents in the other Cretaceous inliers of the Hanover Block (Meyerhoff and Kreig, 1977; Krijnen et al., 1993), but we introduce a separate lithostratigraphic scheme here (**Figure 3**) to prevent confusion in terms of spurious correlation or mixing of fossils in museum collections. Our scheme is shown in **Table 1**.

Cabarita Formation (new name)

Introduction. The name Cabarita Formation is introduced here for the oldest stratigraphic unit exposed within the Grange Inlier. It consists of pebble conglomerates interbedded with sandstones.

Description. The formation consists of a sequence of poorly sorted, matrix-supported conglomerates. Clast sizes range from pebbles to cobbles, and the clasts are subrounded to rounded. Clasts are predominately composed of igneous rocks (largely andesites), but also contain a few limestone clasts and some rhyolitic banded ash flow tuffs.

Table 1. Lithostratigraphic scheme for Grange Inlier

Meyerhoff and Kreig 1977	Krijnen et al., 1993	Herein	Age
Red weathering beds	Sandy sequence with conglomerates	Strawberry Formation	Early Maastrichtian
		Williamsfield Formation	Mid Campanian
Green Island Formation	Biostromal and bioclastic calcarenites and rudit rubble beds	Glenbrook Formation	
Hanover Formation	Thick clay sequence	Grange Formation	
?	?	Cabarita Formation	

Type locality. The type locality of the formation is situated on the track that runs east from the northeast of Grange (**Figure 2**). Here the upper part of the formation is exposed beneath the Grange Formation.

Age. The formation has yielded no fossils and is assigned to the mid Campanian based on its stratigraphic position below the Grange Formation.

Thickness. The formation has a minimum thickness, as determined from a geological cross-section, of at least 150 m just to the northeast of Grange. The base of the formation is not seen.

Relationship with other units. The Cabarita Formation is the oldest unit identified in the inlier and is in faulted contact with the Montpelier Formation of the White Limestone Group to the east and is overlain conformably by the Grange Formation. The presence of pebbles of rhyolitic ash flow tuffs suggests a similarity with the Pell River Conglomerate of the Lucea Inlier (Schmidt, 1986).

Grange Formation (new name)

Introduction. The name Grange Formation is introduced here for an extensive succession of mudstones in the area around and along strike from Grange. These have previously been referred to as the Hanover Formation (Meyerhoff and Krieg, 1977).

Description. The mudstones generally weather red, but are dark grey when fresh. In general, no sedimentary structures are preserved, and even bedding is invariably not visible. In the upper part of the formation some thin units of sandstone and conglomerate are present.

Type locality. The type locality for the formation is along the road from Grange to Glenbrook (**Figure 2**) where mudstones typical of the formation crop out.

Other localities. Exposures are also seen north and northeast of Williamsfield and also along the Cabarita River just to the south of Grange. The formation is also exposed along the main road from Grange to Content.

Age. The upper part of the formation has yielded inoceramid bivalves (Schmidt 1986) and planktic foraminifers (identified in this paper). This planktic foraminiferan assemblage includes *Globotruncana bulloides* Cushman & Ten Dam, *Globotruncana linneiana* (d'Orbigny), *Heterohelix navarroensis* (Loeblich), *Heterohelix carinata* (Cushman), *Heterohelix planata* (Cushman), and *Laeviheterohelix pulchra* (Brotzen), indicating an early to mid Campanian age.

Thickness. The thickness of the formation determined from geological cross-sections is approximately 875 m in the vicinity of Grange.

Relationship with other units. The Grange Formation has conformable contacts with the underlying Cabarita Formation and the overlying Glenbrook Formation.

Glenbrook Formation (new name)

Introduction. The name Glenbrook Formation is introduced here for a thin sequence of limestones, fossiliferous sandstones and mudstones that contain an abundant fauna of rudist bivalves. The name 'Glenbrook' has been associated with the outcrops of this formation since the work of van Dommelen (1971) and Krijnen et al. (1993).

Description. The lithology of the formation is variably ranging from dense micritic limestone to cobbly or rubbly limestones to fossiliferous calcareous sandstones. A thin unit of mudstone occurs above the limestone. In the limestones and fossiliferous sandstones, rudist bivalves are common to abundant and corals also occur at some localities.

Type locality. The type locality of the formation is along the road from Glenbrook to Bleauwearie (**Figure 2**).

Other localities. Exposures occur just below the church by the bridge at Williamsfield (with a fauna of solitary corals), and to the southwest of Grange along a path to the Cabarita River (which contains rudists and corals).

Age. The limestones of the Glenbrook Formation contain a rich assemblage of rudists and larger benthic foraminifers. The rudists include *Parastroma trechmanni* (Chubb), *Whitfieldiella gigas* (Chubb), *Whitfieldiella* sp., *Macgillavryia nicholasi* (Whitfield), *Plagioptychus* sp., *Mitrocaprina* sp. and antillocaprinids. This assemblage is comparable to that seen in the Green Island Formation in the Green Island Inlier, the Stapleton Formation of the Sunderland Inlier, and the Liberty Hall Formation of St. Ann's Great River Inlier (Chubb, 1971; Mitchell, 2010; Mitchell et al., 2011).

The larger foraminifer assemblage is characterised by *Pseudorbitoides trechmanni* Douvillé, which is also found in the Green Island and Stapleton formations of the Green Island and

Sunderland inliers, respectively. Given the similar rudist and larger foraminifer assemblages, they are clearly of similar ages and are placed here in the late Middle Campanian based on Jiang's (1993) study of the calcareous nannofossils of the Sunderland Inlier.

Thickness. The thickness of the formation is seen at outcrop and is only 10 m.

Relationship to other units. The Glenbrook Formation has conformably contacts with the Grange Formation below and the Williamsfield Formation above.

Williamsfield Formation (new name)

Introduction. The name Williamsfield Formation is introduced here for a sequence of brown weathering conglomerates above the Glenbrook Formation.

Description. The formation is characterised by alternating units of pebble conglomerate and sandstones. The conglomerates are represented by brown and grey, moderately well-sorted, pebble conglomerate. Clasts are subrounded to rounded and represented by abundant volcanic rocks (including rhyolitic banded ash flow tuffs), sandstones and mudstone rip-up clasts. Pebble imbrication is well-developed and indicates transportation towards the west. The conglomerates possess a sandstone matrix and locally grade upwards into medium- to coarse-grained sandstones. The interbedded sandstones are medium to coarse-grained and are concretionary in the lower section of the formation.

Type locality. The type locality for the formation is on the main road at Content (**Figure 2**).

Other localities. Exposures are seen at Glenislay and along the main road just south of Bleauwearie.

Age. The formation is unfossiliferous, but due to its conformable contact with the underlying Glenbrook Formation, it is likely to be of mid Campanian or early late Campanian age.

Thickness. The formation has a minimum thickness of as 840 m determined from geological cross-sections in the area of Dumblane.

Relationship to other units. The formation has a conformably contact with the underlying Glenbrook Formation.

Strawberry Formation (new name)

Introduction. The name Strawberry Formation is introduced here to represent a sequence of red-weathering sandstones, mudstones and conglomerates at the top of the succession exposed in the Grange Inlier.

Description. The formation consists of a series of red, medium-grained sandstones and mudstones, with a few conglomerate beds, that generally dip towards the southwest. The sandstones show lamination and trough-cross-bedding. The clasts in the conglomerates are pebble- to cobble-sized and are angular to sub-rounded. The mudstones are unfossiliferous.

Type locality. The type locality is situated in the hills to the north of the community of Strawberry (**Figure 2**).

Age. The formation is unfossiliferous, but on the basis of colour and lithology is attributed to the Maastrichtian based on comparisons with the successions in the Central Inlier (Slippery Rock Formation: Mitchell and Blissett, 2001; Mitchell, 2003) and Sunderland Inlier (Sheppards Hall Formation: Mitchell 2006).

Thickness. The thickness of the formation as determined from a cross-section is approximately 275 m in the area just north of the community Strawberry, although the top of the formation is not seen.

Relationship to other units. Both the Williamsfield and Strawberry formations consist of clastic rocks, the Williamsfield consisting of brown conglomerates, and the Strawberry Formation, of red-weathering sandstones, mudstones and conglomerates. This is a similar succession to those seen in the Central and Sunderland inliers where red-weathering conglomerates, sandstones and mudstones (Slippery Rock Formation; Shepherds Hall Formation) rest unconformably upon older Santonian and Campanian rocks.

It is worthy to note that the Glenbrook Formation (rudist limestone) is absent in the Hertford #1 oil exploration well to the south of the Grange Inlier, where Maastrichtian sedimentary rocks rest on an older Campanian sedimentary succession (see data in Verdenius, 1993).

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