Zeitschrift: Eclogae Geologicae Helvetiae

Herausgeber: Schweizerische Geologische Gesellschaft

Band: 68 (1975)

Heft: 2

Artikel: Geology and paleontology of Soldado Rock, Trinidad (West Indies). Part I, Geology and biostratigraphy

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Kapitel: H: Conclusions : the geological history of Soldado Rock

DOI: https://doi.org/10.5169/seals-164394

6. The "very small *Neodiscocyclina*" of K.9454 (no. 7 in the chart) is in all probability *N. barkeri*, but identification of the specimens in this hard rock remains speculative. Also the common specimens listed as *N. barkeri* for K.10701 seem really to belong to that species, although these forms are abnormally small. On the other hand, the "very small *Neodiscocyclina*" in K.10712 (one vertical section, in hard limestone) does not necessarily represent that same species.

7. The abundant *Amphistegina* in the hard limestone Rz.247 (Bed 4) is presumably *A. grimsdalei* (no. 49), but identification is based on random sections only.

8. "Smaller Foraminifera" (no. 2) include benthonic and planktonic forms, also Globigerinidae et al. in general. Only where this latter group occurs in excessive quantities is it listed separately as "Globigerinidae s.l." (no. 14). Globigerinidae also flood the assemblage of Smaller Foraminifera in some of the pockets of the Athecocyclina reef limestone, which locally are lacking in Larger Foraminifera and are therefore omitted in the chart (P.J.1159, 1160; Cd.21).

The composition of the Smaller Foraminifera assemblages is highly variable. Miliolidae are locally common in the Ranikothalia limestone (K.10701, 10708; pebble in K.2951B), in Bed 11 (K.10712, 10719), in Bed 4 (Rz.247) and in the Asterocyclina marl, Bed 9a (P.J.1162, together with *Glandulina* and *Haplophragmoides*). Textulariidae s.l. may also be common in the Ranikothalia limestone (K.10701) and predominate in some of the samples of Bed 11 (K.10709, 10712). *Robulus* is a conspicuous genus in J.S. 1955 (Bed 11) and in several samples from the Asterocyclina marl (P.J.1146, 1147 and 1162). *Bulimina jacksonensis* was spotted in Bed 3 (K.2950), in Bed 10 (K.3677), in Bed 7 (K.2954, in combination with *Hantkenina alabamensis*) and in the Asterocyclina marl (K.1316, P.J.1162).

9. The Soldado section comprises three conspicuous mollusk horizons: in Bed 2, at the top of Bed 10 and in the upper (northern) part of Bed 11. As a rule, such shell banks do not contain a representative foraminiferal fauna, though in Bed 10 both megafossils and microfauna occur sometimes together.

In the foraminiferal samples listed in the "Distribution Chart", the mollusks (no. 4) are in general represented by fragments of medium-sized shells and a multitude of very small to microscopic forms. Rich agglomerations of tiny shells of both pelecypods and gastropods are, for instance, found in Bed 11 (K.10709, 10721, 10722; E.L.1440), in Bed 10 (K.10707), in Bed 9 (K.1499) and in the Asterocyclina marl (K.1316, 2651, 2854; the samples P.J.1146, 1147, 1161 and 1162 contain, in addition, innumerable minute "seeds" of either mollusks or ostracods, or both.)

H. CONCLUSIONS: THE GEOLOGICAL HISTORY OF SOLDADO ROCK

The Soldado section, in which Jacksonian Upper Eocene lies sandwiched between the Paleocene and beds carrying an early Middle Eocene fauna, has for a long time presented a confounding enigma.

The age of the Soldado Formation (Beds 1 and 2) has been firmly established as Paleocene by MAURY's mollusk fauna in Bed 2 and by the Larger Foraminifera in the remains of the disintegrated foraminiferal deposits which must once have covered those shell limestones. As for the stratigraphical sequence of these denuded Paleocene units, we have assumed that the encroachment of the transgressive Late Eocene sea on the Paleocene land first caused the topmost part of the cliff, the lagoonal Ranikothalia limestone banks, to collapse and to be redeposited as nearly undisturbed slump banks at its foot. Then, as the sea level rose, also the deeper situated parts of the covering beds were affected and carried off by wave action and currents and all the erratics were spread out over the sea bottom. Of those beds, the Dasyclad algae banks seem to have been most closely linked to the shell beds and are therefore considered the oldest. Between the Ranikothalia limestone and the Dasyclad algae deposit we have placed the Athecocyclina- and algae-reef limestone with its pockets of "orbitoids", echinoid debris and Globigerina ooze. But, as we have to do with reefal conditions which are subject to abrupt lateral changes, they may all be contemporary.

The rest of the Soldado section (Beds 3 to 10, including the foreign body of Bed 11) has been correlated with the San Fernando Formation of Trinidad.

The transgression of the Late Eocene sea over a Paleocene coast shows clearly in the exposure on the Southern top of the islet. Bed 3 and 4 are seen to overlie the coquina of Bed 2 and are choked with reworked Paleocene material. Actually, the two are parts of one single deposit, different in lithological aspect only because of the nature of the foreign material they contain: slumped banks of limestone at the bottom (Bed 3), boulders of various origin in the upper strata which are called Bed 4. In themselves, these transgressive beds are nearly barren marls with lenses of silt and sand; only here and there a good foraminiferal fauna was swept into the rubble and preserved to prove their age. There are also traces of reworking from a younger, Middle Eocene, deposit that was exposed some distance away along the attacked coastline, but no larger remnants of that formation were found in the block conglomerate of Bed 4.

The section which follows (Beds 5 to 9, exposed in the 1938 trench) is an alternation of barren silts and highly fossiliferous marls. Beds 7 and 9 contain rich assemblages of Larger as well as Smaller Foraminifera which can be directly correlated with the Jacksonian Upper Eocene of the Vistabella Quarry in the San Fernando area of Trinidad. For Bed 7, the planktonics indicate the *Globorotalia cerroazulensis* Zone (= the *G. cocoaensis* Zone of BOLLI).

Up to this point, the section seems straightforward enough. The topographically overlying Bed 10, however, is not a continuation of this measured section. According to its foraminifera and echinoids, the age of this bed is without any doubt also Late Eocene, but instead of yielding at least the same fauna as Bed 7 and Bed 9, or perhaps even a still younger one comparable to that of the top part of the Upper Eocene of the San Fernando area, it suddenly drops back onto an older level. Even in such ideal complete populations of Larger Foraminifera as those preserved at K.1500 and K.3677, there is a total lack of the most typical index fossil of the Vistabella Eocene: *Helicosteginopsis soldadensis* (GRIMSDALE). The only explanation that can be given for this absence is that it did not yet exist at the time of deposition of Bed 10, not even towards the end when the fauna tended to change gradually with the advent of *Lepidocyclina "tobleri"*. In this respect, Bed 10 corresponds with Bed 4, the base of the transgressive Upper Eocene, and in a wider field with the basal transgressive silt of the San Fernando section, formerly exposed on the top of the hill called Mount Moriah before the road cut there got walled up. With the latter, Bed 10 also has in common the conspicuous abundance of *Lepidocyclina peruviana* and *Operculinoides soldadensis*, both species that are already fully developed in the Middle Eocene. In other words: both Bed 4 and Bed 10 represent the same Late Eocene transgression as observed in Trinidad and many other places, but the particular spot where Bed 10 was formed was in the open sea, whereas Beds 3–4 are nothing but a local deposit of shore rubble.

In 1938, KUGLER had already noticed a change of dips indicating a discontinuity of the section at this point and he placed a fault between Bed 9 and Bed 10. But in reality the abnormal contact has nothing to do with tectonics. The marl- and limestone-complex of Bed 10 is a slumpmass which has come to rest against Bed 9 with which it is only accidentally in contact.

Bed 11, the greatest of the puzzles because its old-type fauna is at variance with its high position in the section, has turned out to be an undisturbed formation of glauconitic foraminiferal limestones, sandstones and pure glauconite (Boca de Serpiente Formation), with an autochthonous fauna indicating that its deposition has taken place around the transition from the Early to the Middle Eocene. It is tempting to assume that Bed 10 represents the transgression over the older Bed 11 at a place where the attacked coast consisted mainly of Middle Eocene instead of Paleocene (more so because Bed 10 contains an enormous amount of reworked Middle Eocene foraminifera) and that the entire block is overturned. However, mechanically this is unacceptable as the delicate stratification of alternative limestones and soft calcareous marls exposed in the cliff of Bed 10 could not have survived such upsetting movements. What presumably happened is this: the Late Eocene sea did indeed transgress at this point over the Boca de Serpiente Formation, at first nibbling at it and causing considerable reworking of its washed-out fossils, but towards the end under-cutting the cliff to such an extent that a large mass of the formation slumped down onto the newly-formed sediment, right side up. The mylonite observed by KUGLER in 1938 in the steep wall at K.2652(D-1) furnishes the proof of slippage of Bed 11 onto Bed 10. Together, as one block, the two beds slumped afterwards against Bed 9.

The elusive Boca de Serpiente Formation has up to now nowhere been found in situ, although some deposits on the outskirts of the Caribbean Region can probably be correlated with it. The only other trace of it, apart from Soldado Rock, is a boulder of Proporocyclina tobleri limestone found in the Southern Range of Trinidad. The formation is not transgressive in nature as not a single reworked Paleocene fossil was found in Bed 11. The erratic elements that are found scattered in this area are lying *on* the formation, not *in* it; they were deposited there during the Late Eocene transgressive phase. The highly glauconitic sediment was laid down in quiet waters around the Paleocene rocks.

The relationship between the blackish-brown Asterocyclina marl (Bed 9a) developed along the SE shore of Soldado Rock to the section of Beds 3 to 9 is not yet fully understood. Both in the field and from its paleontology it has become clear that this Late Eocene marl is a separate unit and the youngest deposit on Soldado Rock. Lithologically, it is different and it is conspicuously poor in reworked material; the little of it that does occur is probably due to surface contamination from topographically higher older beds rather than to reworking during deposition. The planktonics continue to indicate the same age as given for the rest of the Upper Eocene: *Globorotalia* *cerroazulensis* Zone, lower rather than upper part. But in the Larger Foraminifera the hesitating appearance of such forms as *Helicocyclina paucispira* (BARKER & GRIMSDALE) and *Lepidocyclina subglobosa* NUTTALL expresses a tendency towards further phylogenetic development of the fauna, comparable to that in the highest unit of the Trinidad Upper Eocene where it merges into the Oligocene.

We are under the impression that the Asterocyclina marl is not simply the continuation of the sedimentary cycle of Beds 3 to 9. It rather looks as if not only Beds 10 and 11 form together one solid block, but that also the Southern part of Soldado Rock, composed of Beds 1 to 9, is a coherent block and that both these blocks, simultaneously but from different directions, have slumped into the quiet waters in which the Asterocyclina marl was being deposited. By then, Bed 9 must already have been sufficiently solidified to be included in the uplift and subsequent slump. This view would call for a slight local interruption in the sedimentation within the Late Eocene, a phenomenon that was not observed in Trinidad.

The general lack of coarse clastic material in the Soldado section and the widespread presence of glauconite are indications that the entire play of regressions and transgressions during the Paleocene and Eocene has taken place in an area of small steep-coasted islands and rocks. At the very beginning of the Middle Eocene the sea deposited limestone and glauconite banks around an island of Paleocene shell limestone which, in their turn, emerged at the next regression; during the great Late Eocene transgression the sea attacked this land of mixed Paleocene and Middle Eocene and covered it with several layers of marls and silts, after which the entire mass was uplifted to form a new island. Along its crumbling coast the Asterocyclina marl was formed around the big chunks of rock that had slumped back into the sea.

Finally, it should be kept in mind that the whole of Soldado Rock, including the Asterocyclina marl, is a rootless slipmass in the Miocene sediments of the bottom of the Gulf of Paria. This also applies to the disconnected rock ridges that emerge in its neighbourhood: Bed 12, which touches it, and the Pelican Rocks a little further South.

Acknowledgments

The authors are indebted to M. Helen Pollonais for retyping the manuscript, to P. Jung and R. Panchaud for obtaining additional samples from Soldado Rock, to P. M. Kier, H. H. Renz and J. B. Saunders for identification of echinoids and foraminifera, to P. L. Percharde for securing submarine samples, to Katherine V. W. Palmer for lending Maury's mollusks from the Boca de Serpiente Formation, and to W. Suter for preparing the photographs.

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