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BEACH ROCK IN THASOS ISLAND; A CASE STUDY

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Abstract: *A beach rock formed on a small open bay of the south coast of Thasos is examined. It is built up of thin layers slightly seewards diping with carbonate clastics, quartz, feldspars and lithic fragments as the main constituents. The cement is a high-Mg calcite. According to existing evidence the formation of the beach rock is geologically very recent and is still going on. A well expresed polarity of the formation was observed, between its more compact, well cemeted and presumably older seaward parts and the berely beginning to cement and probably newer landward parts.*

INTRODUCTION

Near shore formations, known as «beach rocks», are not unusual features of tropical and subtropical low shores (Fairbridge 1968). A wealth of such formations have been described from many places in Greece (Mistardis 1952, 1956, 1963, 1972, Boekschoten 1962, 1963, Higgins 1960, Ρουμπάνης 1971, Alexandersson 1969, 1972, Μαρῖνος & Συμεωνίδης 1972, Δερμιτζάκις & Θεοδωρόπουλος 1974).

The name «beach rock» denotes subhorizontal layers of cemented clastics formed in situ near a shoreline.

The genetical processes leading to the formation of beach rocks are still disputable. The cementation takes place through $CaCO_3$ precipitation, although there is no general agreement as to whether it comes from sea water (Ginsburg 1953, Kuenen 1933, Cloud 1959), or from groundwater (Field 1919, Russel 1959, 1962, 1963, Russel & McIntyre 1965, Hanor 1978), or as a result of the mixing of groundwater with sea water near the water table in the intertidal zone (Boekschoten 1962, 1963, Trichet 1965, Bloch & Trichet 1966). Also biological activity of algae and bacteria may be responsible for the cementation of the loose beach clastics (Delay 1924, Cloud 1952, Kaye

1959, Maxwell 1962). However, it is possible that all these mechanisms, each whith different importance in various cases, could contribute to the formation of beach rocks.

The aim of this study was to examine lithologicaly a certain case of a beach rock. It is based upon descriprive features, independent of any specific scheme of beach roch genesis. It should be stressed that the results and conclusions of this study cannot be claimed to be of general validity. However, they may be of use as starting working hypotheses in future studies of similar formations.

PHYSIOGRAPHY OF THE BEACH ROCK STUDIED

The beach rock has developed along the shoreline of a small open bay, facing to the south, about 3 km to the west of Limenaria on Thasos island. Similar beach rocks have also formed in nearby bays. At the studied site the beach rock displays all the typical characteristics of such formations. It is built up of a sequence of thin layers diping slightly seawards (Plate I, α, β). The layers continue for 3 to 5 m into the sea, where they end abruptly revealing the thickness of the whole formation, which is between 1 and 3 m. The layers consist of cemented clastics.

It was found that there exists an obvious polarity as to the degree of compactness of the material. Thus, the more compact parts were found seawards and the looser material landwards. The beach rock material near the landward fringe of the formation was extermely friable and in some cases it was difficult to finger the bordeline between the beach rock and the lithologicaly similar loose sand and gravels of the beach. The hue of the formation in such cases prooved to be a good guide, the beach rock beeing generally darker. In some places the creeping movement of the waves on the swash zone has excavated erosional furrows on the beach rock elongated perpenticularly to the shoreline (Plate I, d).

The features of the beach rock studied give the impression that a continuous formation of layers is going on and that beach rock genesis is starting by incipient cementation of loose material just at the landward front of the formation. This implies that the seaward parts of the beach rock are relatively older and that the formation of the beach rock is contemporaneous with eustatic subsidence. One could imagine the landward front of the beach rock, where the beginning of cementation takes place, as mooving slowly landwards, while the formed beach rock subsides slowly and is flooded by the sea, It is an open question whether the abrupt ending of the beach rock seawards indicates the beginning of an eustatic subsidence that still goes on.

LITHOLOGY

For the lithological study of the beach rock a traverse perpenticular to the shoreline was selected, from the landward fringe of the formation to a point on it that stayed submerged 20 cm under the sea level at low tide (Fig. 1). Eleven oriented samples were selected across the traverse at intervals of 1 m.

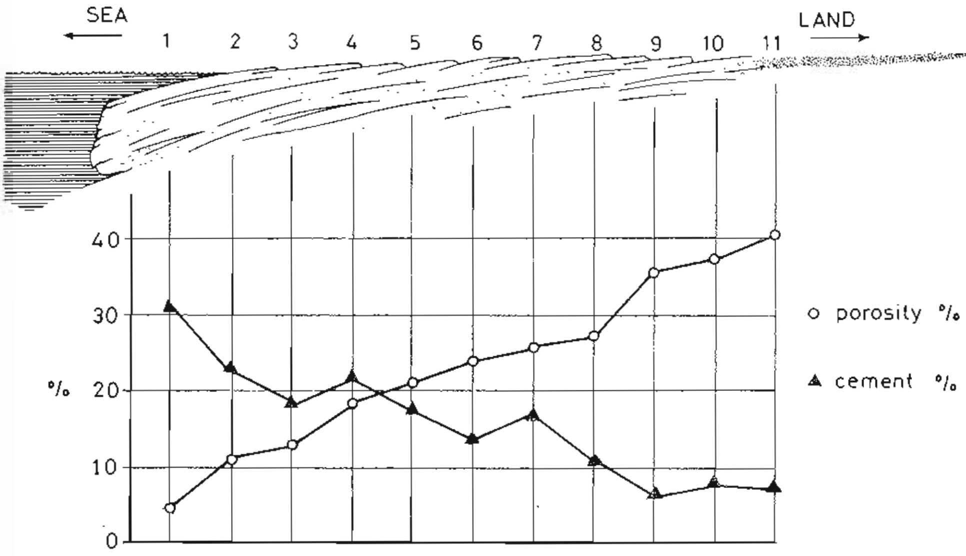


Fig. 1. Schematic section of the beaeh rock studied with the 11 sampling points. From the diagramm a well expressed polarity as the degree of cementation and the porosity of the material is obvious.

Two sections were cut from each sample perpenticular to the bedding plane and to each other. One of them was always perpenticular to the soreline, the other paraller to it. From these sections 22 petrographic slides (two for each sample) were prepared. For the more friable samples it was necessary to imbibe cerefully the material with melted Lakeside 70 before cutting, in order to preserve the texture of the rock.

The mineralogical composition of the samples was examined under the polarizing microscope and by the utilization of the Leitz integrating stage the composition of each sample was determined. The constituents found were clastic carbonates (and fragments of shells), quartz, feldspars (plagioclase and microcline), fragments of polymineralic rocks (mainly gneisses) and the cement. In small quantities were present mica or chlorite flakes and a few grains of pyroxene and kyanite. The composition of the samples is indicated in Table I.

TABLE I

Composition (volume %) of the colleeted samples of beach rock.

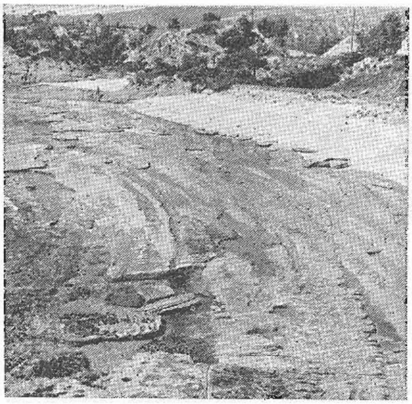
	Cement	Calcite	Quartz	Feldsp.	Rest*	Porosity
1	31,00	27,88	23,47	7,32	5,50	4,88
2	23,25	24,60	27,74	5,37	7,95	11,09
3	19,32	13,91	28,05	9,16	16,18	13,39
4	21,33	20,80	18,80	5,09	15,00	18,98
5	17,11	17,00	25,67	5,79	13,55	20,88
6	14,13	18,72	23,11	8,72	11,18	24,13
7	18,66	20,91	21,52	5,41	6,82	26,68
8	10,70	17,19	17,65	8,86	18,58	27,02
9	6,96	13,74	26,58	8,71	7,44	36,56
10	8,95	6,20	22,47	14,00	10,92	37,46
11	8,62	9,16	23,09	7,16	11,51	40,47

* Lithic fragments, pyroxenes, kyanite, mica and chlorite, shell fragments.

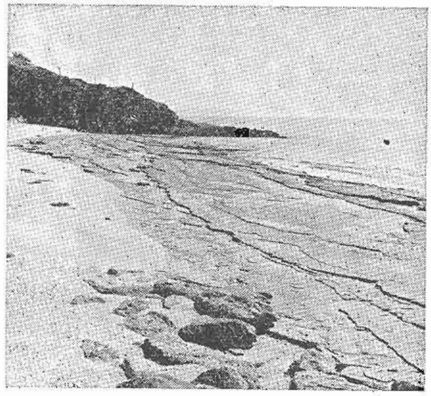
The presence of all the above constituent minerals is justified because all of them could easily have come from eroded rocks of the interior of the island (mainly from marbles and gneisses). Furthermore, a rich stock of almost all the rock types of the island exists just in the vicinity of the beach rock in the form of thick Plio-Pleistocenic conglomerates (Βορεάδης 1954).

Under the microscope the cement has the appearance of a crust (thiner or thicker according to the degree of cementation), covering the grains (Plate II). The crust of the cement consists of aggregates of very small grainy or accicular crystals, the later oriented perpenticularly to the surface of the grains. A small sample of the cement, enough for X-ray examination, was separated under the microscope. The X-ray diffractogramme revealed that the cement is a high - Mg calcite ($d_{104} = 2{,}99Å$). High - Mg calcites seem to be the common cement material in Mediterranean beach rocks (Alexandersson 1969).

Plate I

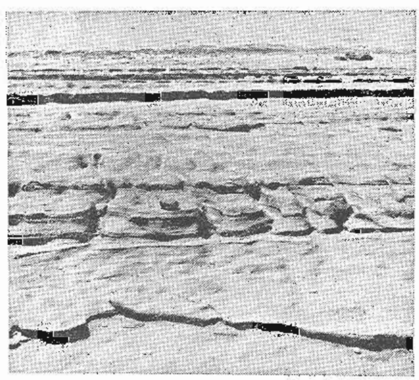


a. The beach rock studied. General view



b. The beaeh roek studied. General view.

c. Alternation of fine and eoarse grained elastics.

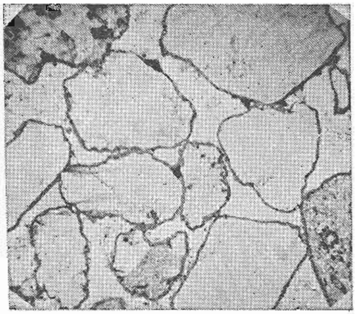


d. Erosional furrows on the beach roek elongated perpenticularly to the soreline.

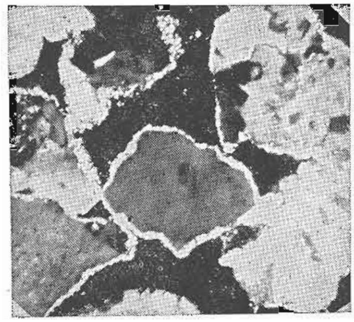
The mineralogical composition of the beach rock examined does not fit into any of the well defined groups of sedimentaty rocks. Somewhat loosely one could characterize it as a quartzitic-feldspathic-lithic-calclithitic rock.

By comparison with the schematic table of Powers (1953) the grains of the samples studied could be characterized as subangular to rounded and by comparison to the schematic diagram of Krumbein

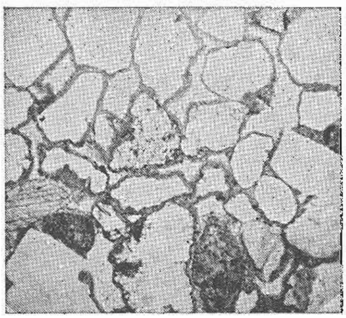
Plate II



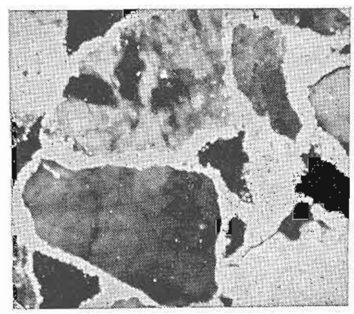
a 10x, Nicols-



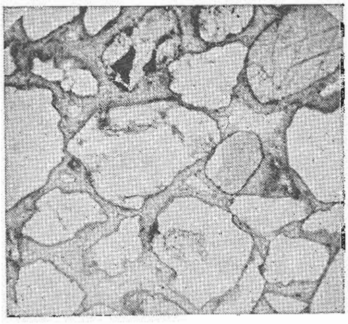
b 10x, Nicols†



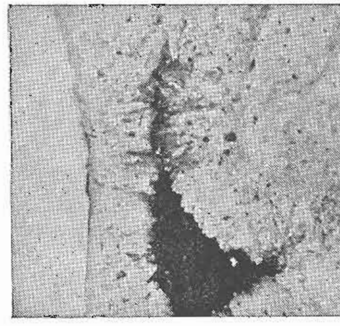
c 10x, Nicols-



d 10x, Nicols†



e 10x, Nicols-



f 45x, Nicols-

Sloss (1962), one could give them a degree of sphericity 0,6 - 1,0 and a degree of roundness 0,3 - 1,0.

The size of individual grains of the samples was between 1 and 10mm (Φ 0 to -3). Thus, the rock could be named as conglomerate. Sorting seems to be poor. The inhomogeneity of the grain size was obvious at each sample, even at each microscopic slide.

Grain size was measured by scanning each microscopic slide across two random but mutually perpenticular directions. The arithmetic mean of the sizes of the grains thus encountered was taken as the grain size of the sample. The grain size among the different samples was between 2 and 4mm. The size curves were generally platycurtic with negative skewness.

In the preceding description the hypothesis was put forward that beach rock genesis is a process starting at the landward front of the formation and continuing behind that front as the later moves landwards. As the beach rock becomes older the rock becomes more and more compact. This implies that cementation takes place continually and that a well-expressed polarity as to the degree of cementation exists between its landward and seaward parts. In the studied beach rock such a polarity is very well expressed (fig. 1).

If the above proves to be a characteristic pattern of all beach rocks it would certainly be of value in paleogeographic studies as orientation guide, wherever «fossil» beach rocks are involved.

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ΠΕΡΙΛΗΨΗ

ΛΙΘΟΛΟΓΙΚΗ ΜΕΛΕΤΗ ΜΙΑΣ ΠΕΡΙΠΤΩΣΕΩΣ ΕΜΦΑΝΙΣΕΩΣ «ΨΗΦΙΔΟΠΑΓΟΥΣ ΑΙΓΙΑΛΟΥ» (BEACH ROCK) ΣΤΗ ΝΗΣΟ ΘΑΣΟ

Ὑπὸ

Α. ΤΣΑΓΚΛΡΗ

(Ἐργαστήριο Ὀρυκτολογίας καὶ Πετρολογίας Παν/μίου Θεσ/νίκης)

Ἐξετάζεται ἡ φυσιογραφία καὶ ἡ λιθολογία ἑνὸς beach rock ποὺ σχηματίστηκε σὲ ἕνα μικρὸ ὅρμο τῆς νότιας παραλίας τῆς Θάσου. Ὁ σχηματισμὸς εἶναι στρωματώδης μὲ μικρὴ κλίση πρὸς τὴ θάλασσα καὶ μέγιστο πάχος περὶ τὰ 3 μέτρα. Τὸ πέτρωμα ἀποτελεῖται κυρίως ἀπὸ συγκολλημένα κλαστικὰ τεμάχια ἀνθρακικῶν, χαλαζίου, ἀστρίων καὶ τεμάχια πολυμίκτων πετρωμάτων. Ἡ συγκολλητικὴ οὐσία βρέθηκε ὅτι εἶναι πλούσιος σὲ Mg ἀσβεστίτης. Διαπιστώθηκε μία σαφὴς πολικότητα ὡς πρὸς τὸ βαθμὸ συγκολλήσεως τοῦ ὑλικοῦ καὶ αὐτὴ σχετίστηκε μὲ τὸ χρόνο γενέσεως τοῦ πετρώματος. Ἔτσι τὸ πρὸς τὴ θάλασσα μέρος τοῦ σχηματισμοῦ, ποὺ εἶναι τελείως συγκολλημένο, θεωρήθηκε παλαιότερο, ἐνῶ τὸ πρὸς τὴν ξηρὰ χαλαρώτερο νεώτερο.