content of the plagioclases obtained from rocks of the bottom and top layer are similar.

Conclusions: From a study of the chemico-mineralogical correlations of the Rajmahal basalts it is concluded that the index of differentiation and the ratio of crystallines to non-crystallines are the two important factors which control such correlations. Further, when the rate of cooling is rapid there is not enough time for mutual adjustments of the solid and liquid phases, and as such a sharp contrast is left over between them represented by the phenocrysts and the groundmass or the former and the glassy-matter.

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THE SHELL STRUCTURE OF *INOCERAMUS* FROM THE UPPER CRETACEOUS BEDS NEAR ARIYALUR, SOUTH INDIA

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Introduction: A study of the shell structure of the giant pelecypod *Inoceramus*, collected from the grits and sandstones of Upper Cretaceous age at a depth of about 5 metres in a recently dug well, located at a distance of about 1300 metres west of Sillakkudi village (58 M/4; Lat. 11°4′27″ and Long. 79°0′4″) near Ariyalur, forms the subject matter of this paper. The specimen is incomplete; the length of the shell is about 25 cm, the height about 21 cm and the thickness about 9 cm. It is inequilateral and inequivalved. The shell material, which is at places broken and interrupted, is found on both the valves and is represented by thin calcareous material of 2 to 4 mm thickness.

Shell structure : The shell material is wholly composed of the ostracum, and both periostracum and nacreous layer are absent. The ostracum is represented by a prismatic layer of about 2 to 4 mm thickness and consists of an upper layer of about 2 to 3 mm thickness with a light grey colour and a lower one of variable thickness (maximum about 1 mm) with dark brownish-grey colour. Under the microscope, this layer is found to contain extremely well developed hexagonal prisms of calcite with tapering ends, measuring about 1.2 to 0.6 mm along length and 0.05 to 0.2 mm along breadth and separated by films of conchiolin (Figs. 1, 2). One unusual feature noticed is that, although the hexagonal prisms of calcite are all disposed with their long prismatic axes roughly perpendicular to the outer surface of the valve, their optic axes are invariably disposed nearly perpendicular to their prismatic axes and roughly parallel to the outer surface of the valve. As it is a fact that the prismatic axis of calcite invariably coincides with its optic axis, the discrepancy noted is explained by imagining that the original shell material was composed of hexagonal prisms of vaterite (μ - $CaCO_8$), subsequently inverted to calcite. As vaterite differs from calcite by being optically positive, it may be supposed that the shell was originally made up of hexagonal crystals of vaterite with their optic axes parallel to the prismatic axes and, during subsequent inversion, crystals of optically negative calcite have developed pseudomorphous after vaterite, with their optic axes making an angle of nearly 90° to the prismatic axes.

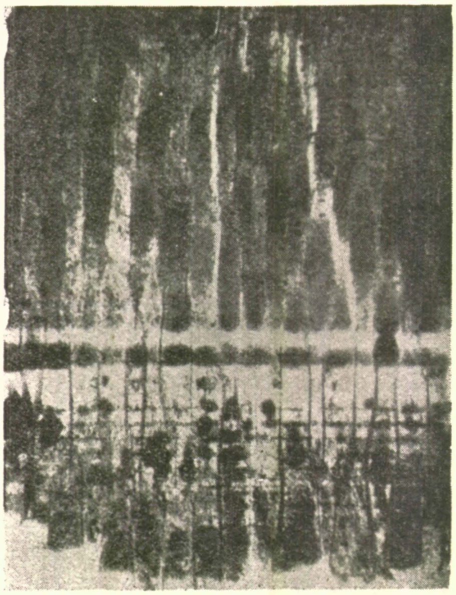

Figure 1. A photomicrograph of the shell material. Section cut transverse to the shell. Crystals of calcite are tabular with tapering ends and are separated by thin films of conchiolin. They show preferred orientation by being arranged parallel to one another and lying nearly perpendicular to optic axes. The dark-coloured portion (light grey in the hand specimen) contains numerous dusty inclusions of hematite and the light coloured portion (dark reddish-brown in hand specimen) contains thin bands and nearly-rounded inclusions of hematite. Ord. light (×30).

Another unusual feature noticed is that the light grey portion of the shell appears dark coloured and the dark reddish brown portion colourlesss under the microscope (Fig. 1). There is, however, optical continuity of calcite prisms extending from the colourless to the dark coloured layers. The dark coloured portion consists of numerous finely dispersed inclusions of hematite, imparting a dark reddish brown coloration to the mineral in thin section; the colourless portion on the other hand, consists of thin bands and fairly large rounded inclusions of hematite. On analysis, it is found that the light grey portion contains 0.42% of Fe_2O_3, while the dark brownish-grey portion only 0.15% of Fe_2O_3.

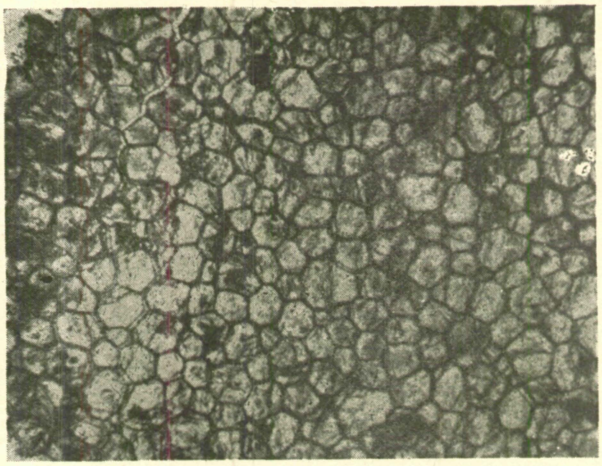

Figure 2. A photomicrograph of the shell material. Section cut transverse to the prismatic layer. Crystals of calcite show nearly hexagonal outlines and are separated by thin films of conchiolin. All the crystals of calcite show preferred orientation by being nearly parallel to the optic axes. Ord. light (× 38).

The light grey portion of the shell material is separated by hand picking and ground to a fine powder in an agate mortar. The powder is allowed to dry in a hot air oven for 3 hours at 105±5°C and the mineral is analysed by an adaptation of the method of Shapiro and Brannock (1962). The chemical analysis of the mineral is presented in Table I.

TABLE I

CHEMICAL ANALYSIS OF CALCITE

Oxide	Wt. %	Numbers of ions on the basis of 6 oxygens		
MgO	1.74	Mg	0.086	2.02
Fe_2O_3	0.42	Fe^{+3}	0.005	
CaO	54.27	Ca	1.924	
CO_2	44.00	C	1.988	
	100.43			

Analyst: K. R. Reddy

On determining the refractive index of the mineral along the ordinary ray by the standard immersion method, it is found that the ω value is a little less than that of pure calcite (1.658) and ranges from 1.631 to 1.645. In view of the mineral containing 1.74 per cent of MgO, the ω value should be 1.662 (Kennedy, 1947). The appreciable difference in the refractive indices of the mineral indicates that the chemical composition of the mineral varies slightly from crystal to crystal. The low refractive index along the ordinary ray of the mineral compared to that of true calcite may be ascribed by the supposition that calcite formed at the expense of vaterite shows minor departure in its crystal structure from that of true calcite.

Discussion: Vaterite is a relatively rare polymorph of calcite and has been recorded from the shells of certain young gastropods (Mayer and Weineck, 1932) and in a geological environment, from a calc-silicate rock at Ballycraigy, Northern Ireland (McConnell, 1960). The mineral has not so far been reported from the shell material of any pelecypod. Vaterite, although forms at ordinary temperature and pressure under certain conditions, is rather unstable and rapidly transforms to calcite or aragonite. From the experimental evidence furnished by Faivre (1946), it is noted that from a solution of $CaCl_2$ and Na_2CO_3, vaterite is precipitated between 60° and 35°C and calcite below 35°C. From the observation that the shell material was originally composed of vaterite, it may be concluded that the Upper Cretaceous seas in which the genus *Inoceramus* lived was warmer with temperatures ranging from 60° to 35°C. This conclusion is further supported from the chemical data of calcite, which indicates that the mineral is a solid solution of calcite and magnesite, the molecular per cent of the latter being 3.9 per cent. It is known that the chemical composition of Mollusca is remarkably uniform, the calcium carbonate being consistently very pure, and normally containing less than 1 per cent of other mineral compounds. The fairly high content of magnesite in the mineral may be taken as an evidence that the temparature of the waters in which the animal lived was fairly high (Hatch *et al.*, 1938).

From the complete absence of the nacreous or laminated layer and the preservation of the prismatic layer in the fossil, it may be supposed that the laminated layer was composed of aragonite and, as it is more easily dissolved than calcite, no trace of it is seen at present.

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