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COLUMNAR STRUCTURE IN LIMESTONE

by

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II.—Columnar Structure in Limestone.

By E. M. Kindle.

Columnar structure, though very rare in sedimentary beds, is not altogether unknown in argillaceous sediments.[1] In limestones only one example of this structure has ever come under the writer's notice[2]. This occurs in a bed of Silurian limestone on Temiscouata lake in eastern Quebec. This structure is believed to be here a consequent of special conditions of sedimentation. So much remains to be learned about the factors of sedimentation involved in the formation of the various types of limestone that any deductions or inferences regarding them which may be made from physical features merit consideration as well as the structures themselves.

The pronounced columnar structure of the limestone shown in Plate II is comparable with that found in basalt, but the columns are perhaps less regular in the number and width of the sides. The columns vary rather widely in the number of faces shown, five to seven being a common number. One side of a column may have a width two or three times that of an adjacent side. The faces or sides while roughly plane show more or less irregularity of surface. The columnar limestone is a dark blue, hard, fine textured rock. It leaves a fine argillaceous and siliceous residue when dissolved in acid. The rock shows on a weathered surface

[1]Salisbury, R. D., Columnar structure in subaqueous clay, Science, new ser., vol. 5, 1885, p. 287.

[2]The structure called stylolites which is sometimes referred to as columnar structure (Geology of Canada, 1863, pp. 631–633) is unrelated to that under consideration here.

numerous, thin, paper-like lines of sedimentation—thin laminæ of argillaceous limestone alternating with less argillaceous bands; the limestone splits up freely on weathering into columns at right angles to the bedding, but it displays very little tendency to split along the bedding planes. A large number of these detached columns of limestone, with a length of from 10 inches to 24 inches, are scattered along the front of the ledge. A very thin sheet of dark argillaceous and carbonaceous matter, usually about one-fourth of an inch thick, separates the faces of adjacent columns. An approximate estimate by Mr. R. A. A. Johnston places the carbon in this material at about 3 per cent. This thin, black film is essentially free from lime, affording no reaction with hydrochloric acid, although the faces of the columns adjacent to it effervesce vigorously with acid. The laminæ of the limestone do not pass through this thin wall but stop abruptly on either side of it. The presence of this dark argillaceous partition between the faces of adjacent columns is a feature which distinguishes this structure from that characterizing the columnar structure of basalt. It distinguishes it also from joint structure, thus indicating an origin independent of the agencies which produce either joint or basaltic columnar structure. The bed of columnar limestone occurs in a region where orogenic agencies have acted vigorously. The horizontal stresses developed by these agencies have resulted locally in shortening one diameter of the columns and in changing the original vertical relations of these to the bedding by several degrees. The effects of deformation are indicated by the inclination and slight flattening of the columns shown in Plate II. In most specimens observed the columns are vertical to the bedding.

The structure described and illustrated by Plate II and Plate III, fig. 1, occurs in the lower two-thirds of a bed of limestone at the base of Mount Wissick on the shore of Temiscouata lake opposite Cabano, Quebec. The stratigraphic relations of this limestone are indicated in the following section which represents only a small portion of the Mount Wissick section.

Mount Wissick section.

		Feet.
E.	Argillaceous limestone with corals and other fossils	35
D.	Bluish grey sandstone with fossils	50±
C.	Finely laminated blue limestone with columnar structure in lower two-thirds[1]	40±
B.	Red and green shale	18+
A.	Green, shaly, fine textured sandstone probably in part of volcanic origin. Saucer-structure (mud-cracks) well developed	50±

The beds of columnar limestone occur, as will be seen from this section, in a series in which sandstone and shale deposition alternated with limestone deposition, each in turn prevailing long enough to build 20 to 50 feet of beds. The three lower divisions of these beds, including the columnar limestone, are very sparingly fossiliferous where not entirely barren. The lowest bed exhibits a striking example of a variety of sun-cracked beds in which the margins of the irregularly rounded plates have warped upward, giving them a saucer like appearance. Littoral conditions of deposition are thus indicated for the sandy shale 20 feet below the limestone under consideration.

The limestone of bed "C" is a continuation or recurrence of the littoral conditions, indicated by the sandy shale, in the opinion of the writer. If viewed only from the surface of the strata, the columnar structure of the limestone is not evident, and the mud-crack origin of the polygonal figures appears clear. Columnar structure, however, is not ordinarily associated with mud-cracks and the reason for the association of the two which this interpretation indicates requires consideration. The factors believed to be responsible for this association of columnar structure and mud-cracks can be advantageously considered in the light of some observations made by the writer on mud-cracks on the shores of the Bay of Fundy.

[1]The columnar structure of this bed was first noted by Logan in 1863 (Geol. of Can. p. 421). It was again mentioned by Bailey and McInnes in the detailed section of Mount Wissick, published in 1889 (Geol. Surv. of Can., new ser., vol. III, pt. II, p. 31M.

At Black Rock, N.S., where these observations were made, the mud-cracks when made in the lower parts of the mud flats are obliterated by each tide owing to the heavy deposit of sediment left. In a higher zone which is under water for a shorter period, the mud-cracks are only partially masked by the sediment left by a falling tide. In a third and highest zone, mud-cracks may persist through several tides because of the shorter period of submergence and lighter deposit of sediment. The accompanying photograph of mud-cracks (Plate III, fig. 2) taken at Black Rock, is introduced here to show that mud-cracks formed on the higher portions of the littoral zone are not evanescent features requiring very special conditions for preservation as they are often assumed to be. The mud-cracks here shown lie between 3 and 8 feet below high tide and had been covered when photographed, by at least two tides. They had also been exposed to a heavy shower of rain immediately before the photograph was taken, and are cut across by resulting rills as shown in the photograph. Yet notwithstanding the deposit of sediment from two tides, the action of a strong current during ebb and flow, and the beating of rain, they remain distinctly outlined instead of being obliterated as might have been expected. A few days of cloudy weather would, of course, result in their obliteration by fresh sediment. There is no evident reason, however, why these mud-cracks which occupy the outer zone of tidal action might not, if they occurred in an arid climate, continue indefinitely to receive their daily deposits of sediment from the rising tide. So long as the mud-cracks were not obliterated by new sediment the recurrent daily shrinkage resulting from the exposure to the sun would be more likely to keep open the old cracks than to open new ones. The semi-permanent character which is assumed for the mud-cracks in an arid climate would produce the polygonal cracking of the beds which would eventually result in columnar structure being impressed upon each tidal deposit as it was laid down.

It is believed that the columnar structure of the limestone at Mount Wissick originated in this way. The shell of sediment surrounding each column strongly supports the inference that the columns are the result of mud-cracks which extended to a considerable depth and which were filled by sediment having a somewhat more argillaceous composition than the limy beds cut by the mud-cracks. The failure of the laminæ to cross this partitional material clearly indicates for it an origin later than the adjacent rock.

Explanation of Plate II.

Block of limestone showing columnar structure with two of the columns detached from the larger mass. The inclination of the columns is due to deformation and is not generally associated with the structure.

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Explanation of Plate III.

Fig. 1. Block of columnar limestone adjacent to the parent ledge. The columnar structure extends down about 20 inches in this block. Photograph by Olaf O. Nylander.

Fig. 3. Mud-cracks at Black Rock, N.S., which have been covered by two or more tides. Photograph by L. D. Burling.

FIG. 1.

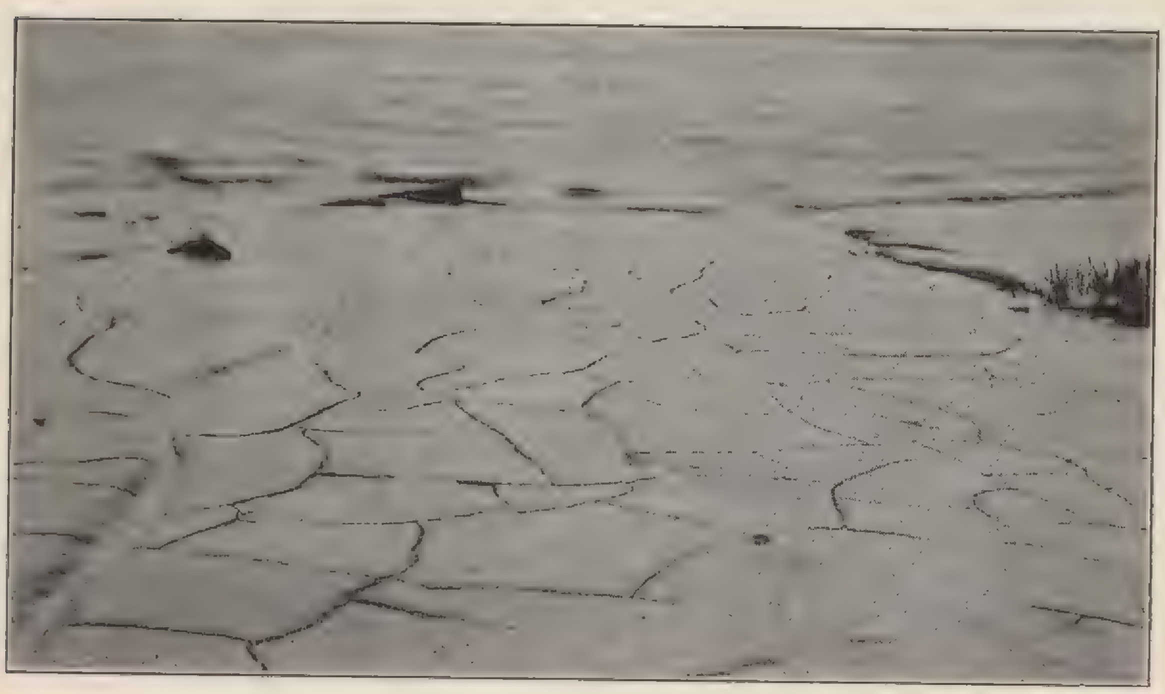

FIG. 2.

The first number of the Museum Bulletin was entitled, *Victoria Memorial Museum Bulletin Number 1.*

The following articles of the Geological Series of Museum Bulletins have been issued.

Geological Series.

1. The Trenton crinoid, Ottawacrinus, W. R. Billings; by F. A. Bather.
2. Note on Merocrinus, Walcott; by F. A. Bather.
3. The occurrence of Helodont teeth at Roche Miette and vicinity, Alberta; by L. M. Lambe.
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5. Notes on some new and old Trilobites in the Victoria Memorial Museum; by P. E. Raymond.
6. Description of some new Asaphidæ; by P. E. Raymond.
7. Two new species of Tetradium; by P. E. Raymond.
8. Revision of the species which have been referred to the genus Bathyurus (preliminary paper); by P. E. Raymond.
9. A new Brachiopod from the base of the Utica; by A. E. Wilson.
10. A new genus of dicotyledonous plant from the Tertiary of Kettle river, British Columbia; by W. J. Wilson.
11. A new species of Lepidostrobus; by W. J. Wilson.
12. Prehnite from Adams sound, Admiralty inlet, Baffin island, Franklin; by R. A. A. Johnston.
13. The origin of granite (micropegmatite) in the Purcell sills; by S. J. Schofield.