Sédimentologie/*Sedimentology*

Sédimentation d'un mélange hétérogranulaire. Lamination expérimentale en eau calme et en eau courante

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Résumé — Ces expériences montrent qu'en eau calme, le dépôt en continu d'un sédiment hétérogranulaire, donne naissance à des *laminae* disparaissant avec l'accroissement de la hauteur de chute des grains dans l'eau, et apparemment de leur taille. La lamination se forme suivant l'inclinaison de la partie supérieure du dépôt. En eau courante, apparaissent dans le dépôt plusieurs types de lamination, voisins les unes des autres, parfois superposés.

Sedimentation of a heterogranular mixture. Experimental lamination in still and running water

Abstract — *The experiments demonstrate that in still water, continuous depositing of heterogranular sediments gives rise to laminae which disappear progressively as the height of the fall of particles into water, and apparently their size, increase. Laminae follow the slope of the upper part of the deposit. In running water, many closely related types of lamination appear in the deposit, even superimposed.*

Abridged English Version — I. INTRODUCTION. — The author has previously performed experiments on lamination of sediments, resulting from a periodic graded-bedding subsequent to deposit [1], that contribute to the explanation of lamination of various sediments and sedimentary rocks. These sedimentation experiments were conducted in still water with a continuous supply of heterogranular material. A deposit was obtained, giving the illusion of successive beds or laminae. These laminae were the result of a spontaneous, periodic and continuous grading process which took place immediately following the deposit of the heterogranular mixture. The thickness of the laminae appeared to be independent of the sedimentation speed but increased with extreme differences in the size of the particles in the mixture.

Where a horizontal current was involved, thin laminated superposed layers developing laterally in the direction of the current were observed. The object of the new complementary experiments described hereafter was to study, first in still water, the influence of the height of the fall of particles into water, and the influence of a slope on lamination in the deposit; secondly, in running water, at a higher rate of particle discharge than in the initial experiment, the incidence on the structure of the deposit.

These experiments were undertaken at the request of the author, by MM. Penquer, Guillaume and Bertinier, at the "Institut de Mécanique des Fluides de Marseille".

II. EXPERIMENTS. — 1. *Influence of the height of the fall on lamination in calm water.* — The first series of experiments was effected by a mixture of two types of sand, one white calibrated between 20-80 μ, the other, coloured with methylene blue with the calibrations increasing in size. It was poured from a variable speed screw distributor into a rectangular tube 200 × 150 mm × 4,7 mm deep, filled initially with 2 m of water, then with 4,7 m.

The proportions were varied: 1/3 for the coloured and 2/3 for the white sand at 2 m; 1/4-3/4 at 4,7 m. The flow varied from 35 to 170 cm^3/5 min., at 2 m, and at 4,7 m, it remained constant at 40 cm^3/min., then more slowly at 200-400 cm^3/hr.

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It was observed that the lamination in the deposit was present at 2 m, in any case, but at 4,7 m, it was only present with the highest flows, and disappeared as the flow diminished and the size of the coloured particles increased. This tended to prove that the disturbance of water, here caused by the falling particles, was a necessary factor to the segregation to take place into large and small particles giving an appearance of lamination (*Figs.* 1, 2 and 3).

2. *Influence of a slope on lamination in calm water.* — In the second series of experiments, the direction of the lamination formed in the sediments falling on a slope was observed. An aquarium was used, having the same dimensions as the PVC tube. The depth of water was 1,10 m. Successive experiments were performed on a slope of 6°, and then 15° (*Fig.* 4).

Laminae are parallel to the slope of the upper part of the deposit.

3. *Incidence of current water on lamination.* — The third series of experiments was performed in a recirculating flume: 10 m long × 29 cm deep × 0,5 m wide, equipped with a lateral transparent viewing window to observe the structure of the deposit. The water discharge could vary from 16 to 70 l/sec. At a speed from 0,4 m/sec. on, many closely related types of lamination, horizontal and cross, sometimes superimposed, appeared in the structure of the deposit, the configuration of which being dunes and ripples (*Figs.* 5, 6 and 7). On the upper surface of ripples, lamination could be observed (*Fig.* 8). The dip of cross-lamination seemed to depend upon the height of water above the deposit, therefore upon all parameters varying with it.

III. Conclusions. — 1. *Confirmation of experimental lamination.* — These experiments, in calm and running water, confirm that the continuous deposit of a heterogranular sediment can give rise to horizontal and cross lamination, provided that a minimum disturbance of water is involved. In calm water, laminae are horizontal or parallel to the dip of the upper part of the deposit induced by a basic slope. No penetration of coloured grains through the surface of the deposit was observed during these experiments, contrary to the observations made by the author during one of his initial experiments, which was certainly accidental.

In running water, horizontal and cross laminae were observed placed together and sometimes superimposed.

2. *Discussion of the possible mechanism of lamination.* — H. Campbell [2] has demonstrated that a dry flow of a mixture of powders gave rise to a segregation of particles of the same size. Such segregation, in calm and running water is induced by the disturbance of water, however slight. Lamination resulting from such segregation can therefore result either from the correlation between turbulence of water and the concentration at the level of the deposit, or from instability phenomena resulting from the sedimentary fall of a hyperconcentrated mixture, or from the conjugation of these two factors.

3. *Prospects.* — These results should be compared with flume experiments by Guy [3] and Williams [4], the object of which was not the study of structure, despite some remarks on it, but the configuration of the deposit. They should also be compared with the observations by McKee [5] of structures of sediment deposits from the Bijou Creek flood, where horizontal and cross laminae, similar to those of these experiments, can be observed. Thus, it would be necessary to pursue such experiments in larger flumes to reproduce flow sedimentation and study the variations of deposit structure with all determining parameters. These experiments, no doubt, can help to a better understanding of laminar sedimentation, both in deposits and in sedimentary rocks.