Chapter 11

MUDLUMPS AT THE MOUTHS OF THE MISSISSIPPI RIVER

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INTRODUCTION

Mudlump is a popular name for the upswellings of clay which commonly form islands near the mouths of the Mississippi River passes. These features usually are associated with the bars at the river mouths. The bars are localized sedimentary deposits formed where the river waters enter the relatively still Gulf of Mexico. At present the mudlumps are found within a few thousand feet of the mouth of North Pass, Pass A Loutre, Northeast Pass, Southeast Pass, old Balize Bayou, South Pass and Southwest Pass. Mudlumps appear to be a phenomenon unique to the Mississippi River Delta for they are unreported from any other locality.

Mudlumps occur either as islands or submarine prominences. The exposed portions of the island type range in size from small pinnacles to a maximum area of about twenty acres. The average island studied has an area of several acres. These island lumps, because of their striking appearance, constantly changing location, and proximity to the entrance channels of the river, have excited speculation since the earliest days of navigation into the Port of New Orleans. In this region of low relief, with normal elevations of less than two feet, the vertical mudlump cliffs five to ten feet high are the most prominent features to be seen. Adding to an illusion of considerable height, some lumps are capped with low, conical mud springs or "mud volcanoes". From vents at the summits of the cones, glistening, highly fluid mud is discharged, accompanied by varying quantities of gas. Now recognized as secondary features, these springs for years have been prominently considered in hypothesizing modes of origin of the mudlumps.

The more numerous submarine mudlumps differ from the island type only in their position beneath the water surface. For years these submerged lumps on the bars and near the entrance channels have constituted navigational hazards. As early as the year 1839 the Corps of Engineers' dredge Balize spent a month and a half in an attempt to remove a submarine mudlump in the mouth of Northeast Pass (Jones, 1841:83).

One of the most significant characteristics of the mudlump islands is their continually changing size and appearance. The lumps often alter radically in a few weeks, and sometimes emerge from the water and attain prominent size within a few days. It has long been noted, and recently verified through detailed work, that mudlump growth is accelerated during and immediately after high-river periods. During the high river of 1949-1950, great changes occurred in the mudlumps of all the important passes.

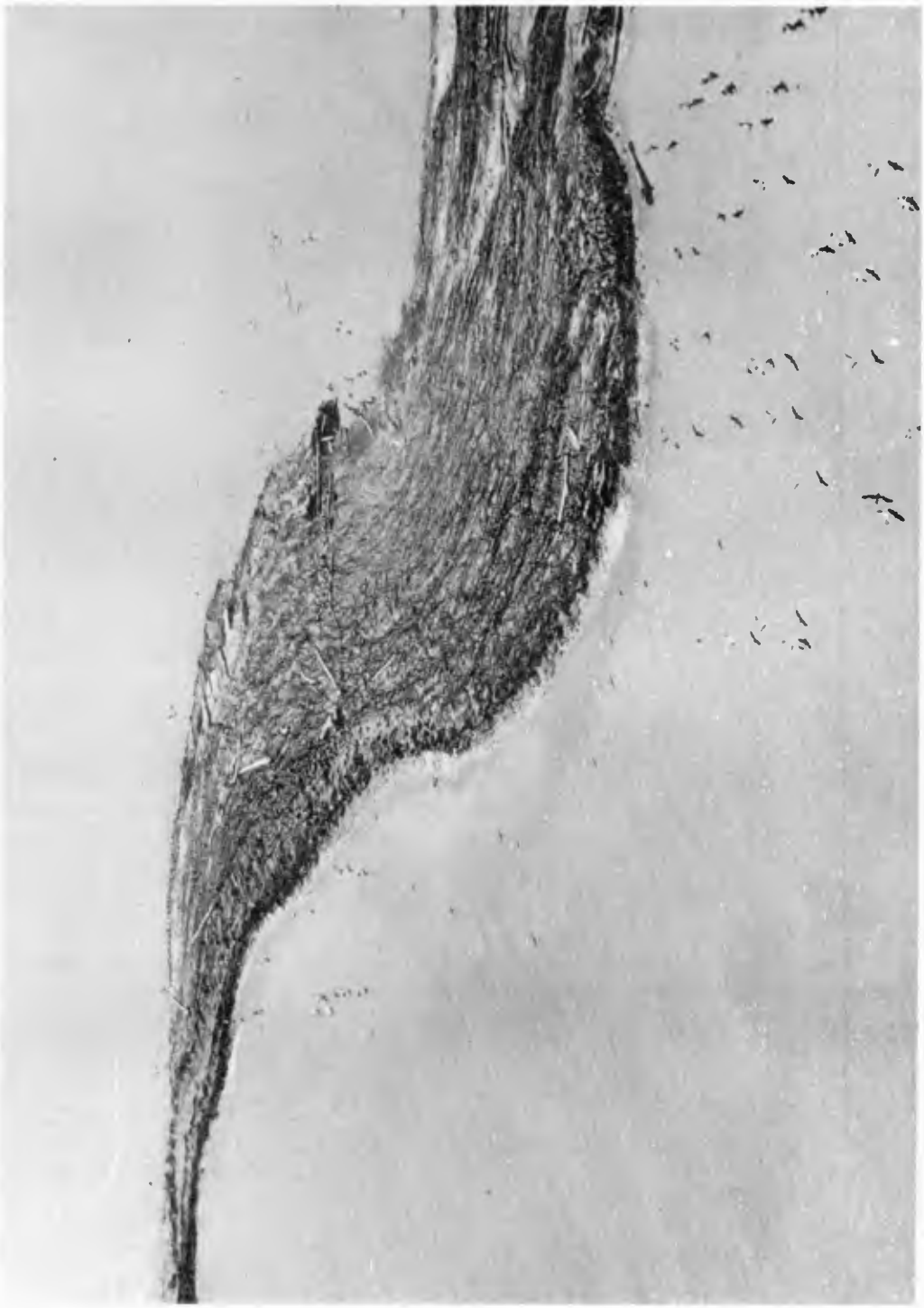

Fig. 1. Aerial photograph of mudlump at the mouth of North Pass showing typical furrowed surface appearance.

The mouth of Pass A Loutre, for example, was carefully studied and mapped at the end of November, 1949. A return trip in April, 1950, revealed that many of the previously noted lumps had been uplifted and enlarged. In addition, two new mudlump islands had been formed, 120 and 250 feet in length, respectively. Both of these new lumps had been uplifted at least eight feet in the intervening four-month period.

The mudlumps are composed of fine-grained sediments, clay predominating. The abundance of clay definitely affects the weathering properties of the island material. At or below sea level, the wet, tenacious clay is practically unerodible. Uplifted into islands, the clay dries, shrinks, cracks, and is readily attacked by rainfall or storm waves. Daily tidal variations allow the Gulf waves to undercut the drying clay, resulting in the formation of cliffs and wave-cut benches. During the summer and fall, uplift of the lumps is negligible, and wave action reduces the area of the high-standing portions. Renewed uplift later elevates the benches, with the result that many mudlumps show raised, wave-cut platforms which can be correlated with periods of mudlump activity.

Many lumps show excellent stratification, with alternating thin layers of clay and silt. Others, non-stratified, are composed of very fine but poorly sorted sediment. The surface of some mudlumps is extremely rough and irregular, with numerous crevasses a foot or more in depth running the length of the island (Fig. 1). This furrowed appearance has been appropriately compared with a freshly plowed field. Most of these fissures are tension cracks, but some are faults having vertical displacement. There is always an escape of gas from these fissures, most noticeable when they are filled with rain water. Inflammable gas in minor quantities is characteristic of mudlump areas, where it escapes from the fissures or the vents of the mud cones.

REGIONAL SEDIMENTATION

There is a close relationship between the sedimentary characteristics of the mouths of the river, and the origin and growth of the mudlumps. The entire Lower Delta is a complex mass of sediment deposited by a series of ever-changing distributaries, which carry an enormous amount of water and sediment to the Gulf of Mexico. The greater part of the sediment consists of silt and clay and is deposited chiefly on the bar in front of the mouth, and laterally on the low or submerged natural levees. Most of the finer-clay-sized particles remain in suspension and are carried beyond the bar where they gradually settle to the bottom.

For purposes of convenience, the Lower Delta may be divided into two parts:

1. The easternmost Pass A Loutre area which is essentially unaffected by the works of man.

2. The South Pass and Southwest Pass areas which have been so modified by jetties and dredging as to necessitate separate consideration.

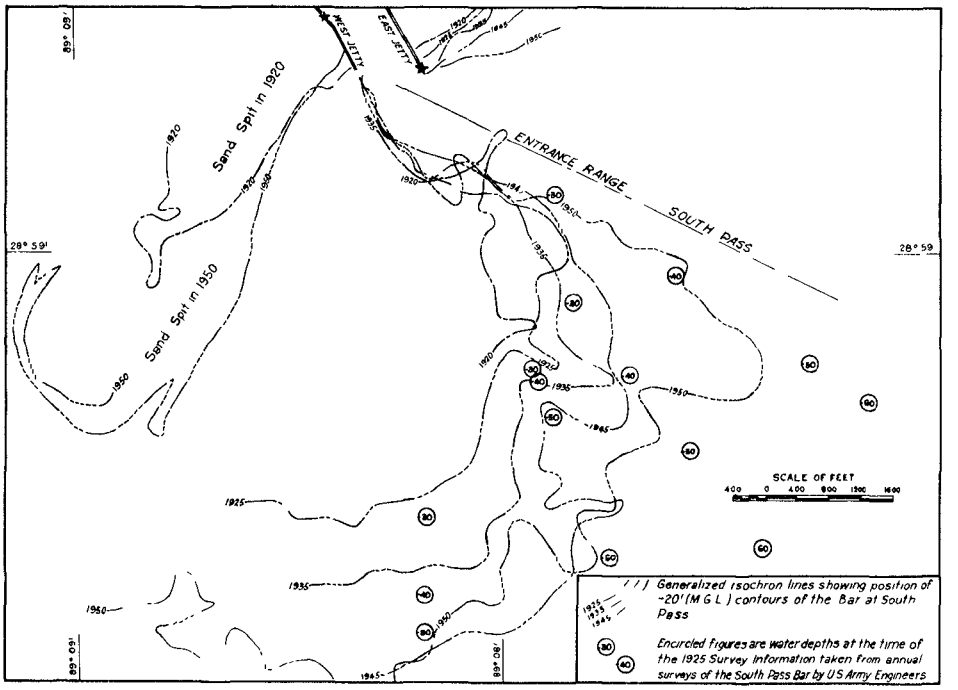

Fig. 2. Advance of the bar at South Pass, 1920 to 1950.

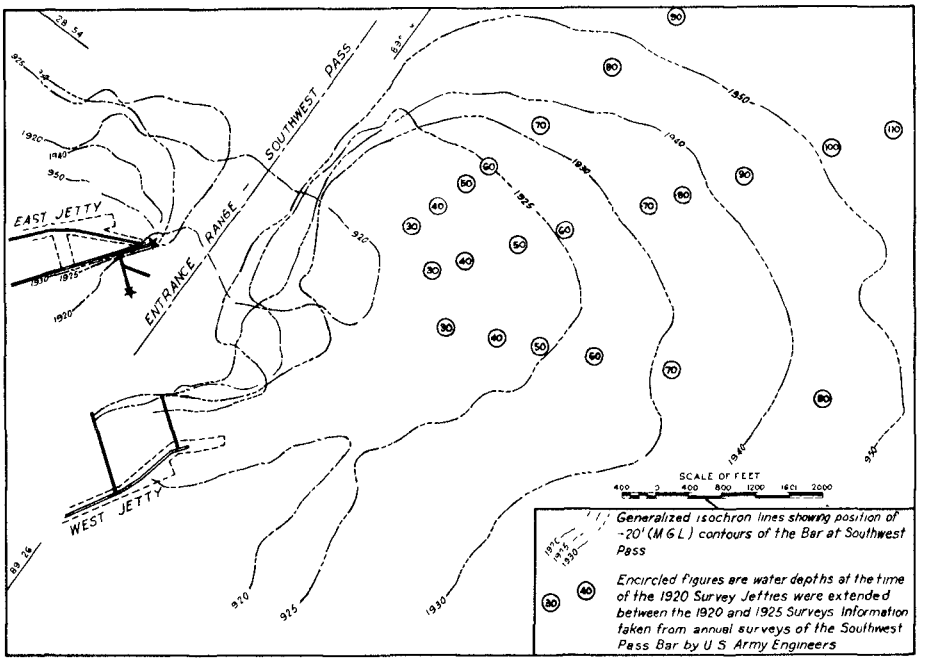

Fig. 3. Advance of the bar at Southwest Pass, 1920 to 1950.

Sedimentation in the Pass A Loutre region follows the general laws of nature. It is affected primarily by the type and amount of sediment, gradient of the stream, character of the Gulf at the position of discharge, and the effects of near-shore currents. The near-shore or littoral currents in the vicinity of the Delta have not been studied in sufficient detail to establish their effectiveness as transporting agents. It is known, however, that the prevailing winds in this area cause surface water circulation which is similar in effect to a littoral current. The eastern channels face almost into the prevailing wind, with the result that sediments are spread fanwise across the entire eastern front of the region. Northeast Pass and Southeast Pass are almost tied together by a long spit which completely blocks these two channels to navigation, even by shallow-draft boats.

On the other hand, the presence of the jetties, supplemented by occasional dredging, has caused a drastic change in manner and result of sedimentation at South and Southwest passes. These confined channels are much deeper and, as compared with the other passes, are essentially static. Captain Eads, by the construction of the South Pass jetties, confined the mouth of the river, with a resultant deepening of the channel across the bar. His results were eminently successful except that he did not recognize the importance of the prevailing wind currents in causing an excess of deposition on the central and western side of the channel bar. By shifting the bearing of the entrance channel twenty degrees to the east, this difficulty has subsequently been overcome. It is important to this study to recognize the fact that at South and Southwest passes, the majority of sedimentary deposition occurs on the western side of the bar. (Figs. 2 and 3). This fact is clearly shown by the development of a long spit or hook extending westward from the end of the west jetty at South Pass. Such a spit has not developed at Southwest Pass for two reasons: First, the angle made by this pass with the prevailing wind is different and the sediment is carried westward into much deeper water. Second, the jetties at Southwest Pass have not been in existence long enough for the surrounding Gulf water to become shoal.

MUDLUMP STRUCTURE

In the course of this investigation, some twenty-five mudlump islands were mapped and studied in detail. For brevity, in discussing their structural nature, a hypothetical example will be employed to typify mudlump characteristics.

The representative mudlump is elongate, the ratio of length to breadth being 3 or 4 to 1, and characteristically is sigmoidal or S-shaped. When exposed at low tide, the wave-cut bench surrounding the island has an area equivalent to or greater than the high-standing portion. Maximum elevations occur along the wave-formed cliffs which flank a lower central area (Fig. 4). The wave-cut bench is composed of alternating thin layers of clay and silt, which dip away from the central part of the island at angles of five to forty-five degrees. The cliffs are composed of stratified sediments which dip slightly, from zero to ten degrees, toward the center of the island. Therefore, these oppositely inclined dips define

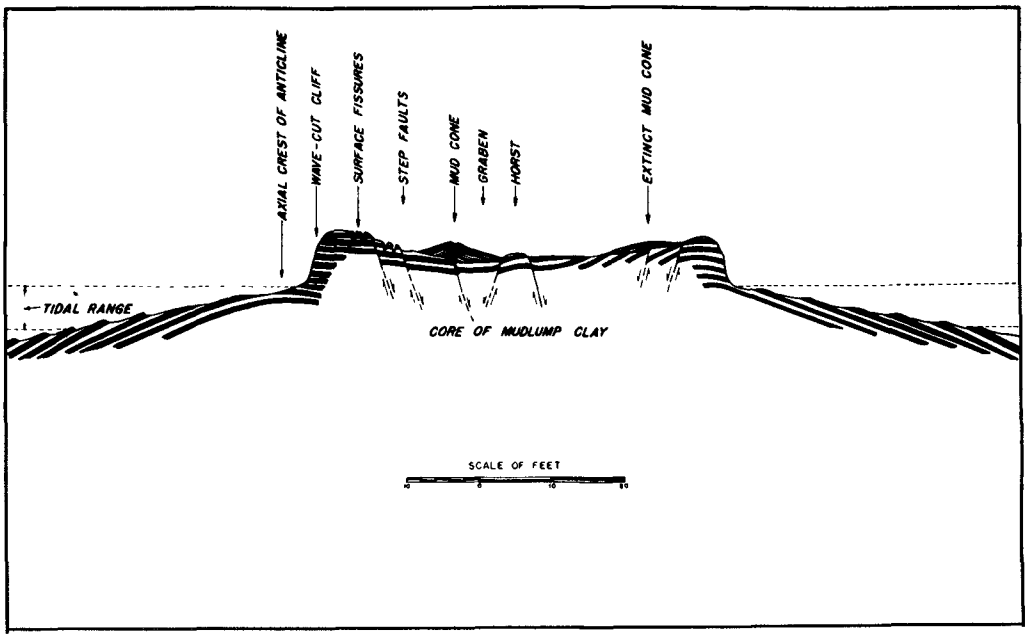

Fig. 4. Schematic cross section of typical mudlump, indicating stratigraphic and structural characteristics.

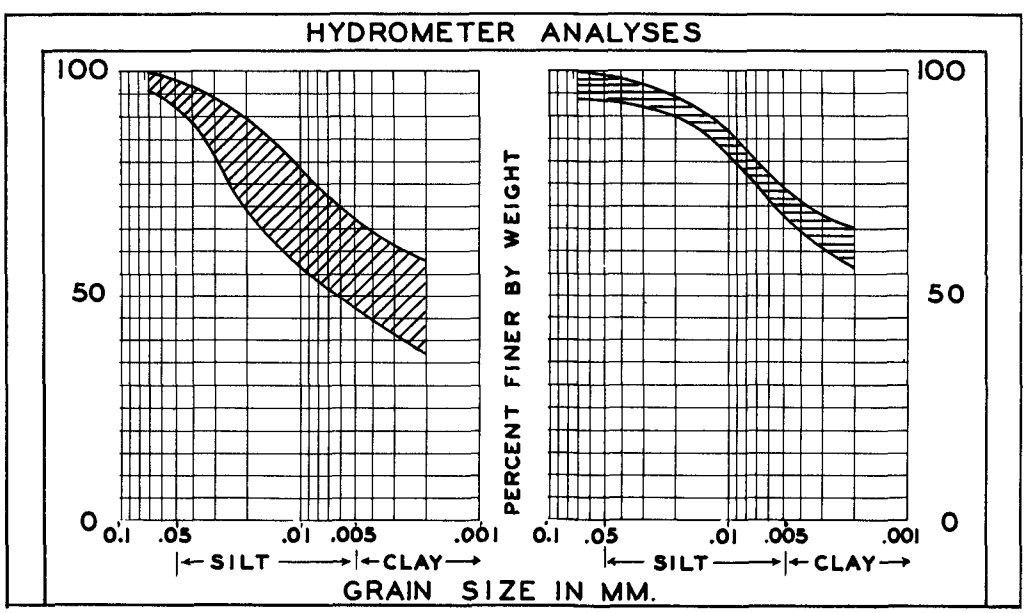

Fig. 5. Grain-size analyses of stratified sediment capping and flanking mudlump islands.

Fig. 6. Grain-size analyses of deep-seated mudlump clay.

the crest of a low anticline or upfold. This anticlinal crest extends completely around the periphery of the elongate island. The explanation of this peripheral anticline lies, not in the formational upswelling of the mudlump, but in the accompanying sinking of the central part of the island.

As the mudlump material is forced upward, the overlying sedimentary layers are stretched until accumulating tensional forces are sufficient to cause rupture. This rupture takes the form of several normal step-faults generally parallel to the elongate dimension of the island. These faults are usually along one side of the mudlump though occasionally they can be seen on both sides, with the formation of a central graben or down-dropped area. As the mudlump sediments are poorly indurated, the faults commonly develop a braided, branching pattern. The vertical displacement or throw of these faults ranges from a fraction of an inch to over six feet, the average being three to six inches. Within the graben area, the stratified sediments are highly irregular and confused, with the occasional formation of small horsts or upthrust blocks, and the development of numerous tensional fissures. Rainfall, collecting within the lower central area of the lump, often develops small temporary ponds. Rain wash spreads a minor quantity of fine sediment over the floor of the ponds, frequently obscuring the structure of the central part of the island.

Mud or gas vents develop along the faulted periphery of the island, often resulting in the formation of mud cones. Mud is discharged in a broad, thin sheet from the lowest side of the mud-vent rim. Eventually the low side is built up and the direction of flow changes. The first flow then dries, shrinks and forms the typical mud-crack pattern. At a later time this flank of the cone is again covered with thin mud, and the initial mud cracks become filled. In this manner, the entire surface of the cone gradually increases in height with the development of rude stratification. After the cone becomes two or three feet high, hydrostatic pressure becomes great enough to cause the mud and gas to break through at another point along the fissure, forming a new vent. Losing its source of supply, the original vent rapidly deteriorates into a low mound. The structural nature of the depressed central area of the mudlump islands is often difficult to determine because of the masking affect of these mud vent flows.

In considering this hypothetical mudlump, a relatively simple case has been postulated. Field examinations have shown that although most mudlump islands have these common features, their dissimilarities are equally as striking. A major difference concerns their manner of formation. One type appears to have undergone a slow, gradual uplift. This is shown specifically by a low, flat, relatively undisturbed surface. Fissures are few and faults show only minor displacement. Due to the flat domal surface, the area exposed above water varies radically with the fluctuating tides.

In direct contrast is another extreme type of mudlump whose features are indicative of very rapid, violent formation. The entire mass is so

extensively fissured as to make walking difficult. Many of the fissures are two to three feet in depth and filled with soft, unconsolidated mud. On this type lump, the faults often show extreme displacement, in one case amounting to over six feet of throw. A further diagnostic characteristic is the presence of sheer cliffs both above and below water level.

With such diverse behaviors during origin, it is natural to expect variations in the structural characteristics of the islands throughout their life span.

Another factor which complicates the structure of mudlumps is the rejuvenation or re-elevation of pre-existing islands. Secondary uplift of a mudlump seldom is uniform throughout its extent. Because of this off-centered warping, the island is tilted and deformed, often with resulting secondary faulting. The uplifted wave-cut bench, in such a case, indicates accurately the amount and location of maximum re-elevation. Original dips of the stratified sediments are also affected by subsequent uplifts, often being completely reversed in direction.

MUDLUMP SEDIMENTS

In the course of this study, an attempt has been made to use the sedimentary characteristics of the constituent material as criteria for determining the internal structure and method of formation of the mudlumps. The results have been only partially satisfactory. Another aim of the sedimentary study has been to determine the site of deposition of the fine-grained sediments which ultimately form the mudlumps. This has been successfully accomplished.

Many mechanical analyses were made of the stratified sediments which flank and often cap the uplifted mudlumps. The range of these analyses is shown plotted on Fig. 5. Clay content averages between 45% and 65%, the remainder being silt with a small percentage of very fine sand. This should be compared with Fig. 6 which is the range of six samples taken from a deep bore hole on one South Pass mudlump. Analyzed samples taken at 20 feet intervals from five to 100 feet indicate that the deeper material is consistently finer in composition. This constitutes the often mentioned <u>mudlump clay</u> of the literature. It is very similar to the stratified mudlump material, but has a higher clay content and proportionately lower silt content.

Mudlumps occur on or near the bars at the mouths of the River passes. Bar sediments are composed essentially of crudely stratified silt and clay materials. During periods of high river, the bar increases in size by the addition of great quantities of fine material. During the ensuing low-water period, through extended winnowing action, the finer, clay-sized particles are in great part removed and spread in a thin sheet over the area seaward from the bar.

Therefore, the resulting bar sediment is a poorly-sorted material, predominantly silt, with a smaller proportion of clay and still less sand.

Similarly, the sediment seaward from the bar is poorly sorted, but has a relatively higher proportion of clay, with less silt and essentially no sand. The term "pro-delta" clay, as applied by Fisk (1944:59), might apply to these sediments. This finer material, sampled by drag-line several miles out from the river mouths, corresponds closely with the material which has been called mudlump clay. This similarity is corroborated by a separate study of mudlump microfauna made by Andersen (1950). It was found that microfossils incorporated in the South Pass mudlumps almost duplicate those forms currently being trapped in the sediments of the continental shelf beyond the mouths of the passes. Establishment of the deep water origin of these microfossils indicates an uplift of some 350 to 400 feet for the mudlump clay material in which they occur. The stratified sediment which flanks or caps the uplifted mud islands likewise is very similar to the stratified bar material.

MUD VENTS AND GAS VENTS

Mud and gas springs have long been considered an integral part of mudlump activity. Associated with every mudlump mapped during this study have been one or more vents, some discharging mud and building cones, others discharging only gas. The close correlation between vent and lump has caused earlier workers to associate the former with the mode of formation of the latter. Many have postulated that continuous mud flows have built up the island in the same manner that lava flows build up a volcanic island. It has been shown, however, that there is a difference between the stratification of the mudlump body and that of the mud cones which often cap the islands. Furthermore, field studies have indicated that the mud or gas vents most commonly occur along observable faults in the mudlumps. As the faults are primary features formed by the uplift of the mudlump material, the vents in following the fractures must be secondary.

MUDLUMP ORIGIN

Many earlier workers have proposed theories concerning the development of mudlumps. Some of the ideas have been excellent deductions, while others have been only speculations. In order to be acceptable, any proposal made must be in complete accord with all of the available evidence. A list of factual observations must include the following:

1. Mudlump islands are known to occur only at the mouths of the major river delta.

2. Mudlump islands occur only at the mouths of those Mississippi River channels discharging into deep water. Mudlump development has never been reported from:

   a. Baptiste Collette Bayou and distributaries.
   b. Cubits Gap distributaries - including Main Pass.
   c. Distributaries from the Crevasse into Garden Island Bay.
   d. Distributaries from the Jump into West Bay.

   These four distributaries all discharge into shallow water.

3. Where mudlumps do occur, they commonly have a right bank location. The one major exception to this rule at the present time is at Pass A Loutre.

4. Both island and submarine mudlumps are found associated with bar deposits at the river mouths (Figs. 7 and 8).

5. Mudlumps develop on the deep-water side of the bar, and retain their position while the extending bar envelops them.

6. The submarine mudlumps in process of development, are shown by surveys to be elongate parallel to the edges of the bar deposits.

7. Bar deposits grow rapidly during river flood stage, and are reduced in size by winnowing action during low river stage.

8. The growth of new island mudlumps may occur as a slow and gradual uplifting process, or it may be a rapid and violent upheaval. The gradual growth occurs during normal seasons, while the violent growth usually follows periods of heavy flood.

9. Secondary uplift of mudlump islands is most pronounced following times of high river stage.

10. Most mudlump islands discharge gas and/or mud through vents or fissures.

11. Mud vents and fissures are genetically related.

12. The discharge of gas and mud is noted to be heavier during times of high river than during other seasons.

The disappearance of mudlumps is a slow process of weathering and wave erosion. The rapidity of the process depends upon the degree of shelter of the mudlump location, the sedimentary composition of the mudlump and the amount of rejuvenation of the island by secondary uplift.

The only conclusion consistent with the factual evidence is that mudlump growth and bar development are complementary processes. The close correlation between increase in bar size and increase in mudlump activity precludes postulating any other mode of origin for these features.

The sequence of events leading to the emergence of a mudlump island is schematically represented in Fig. 9. During Stage A, the river distributary deposits sediments in three transitional zones:

1. A near-shore, massive bar deposit chiefly sandy silt.

2. A thin layer of silty clay grading seaward into

3. a thin layer of plastic clay.

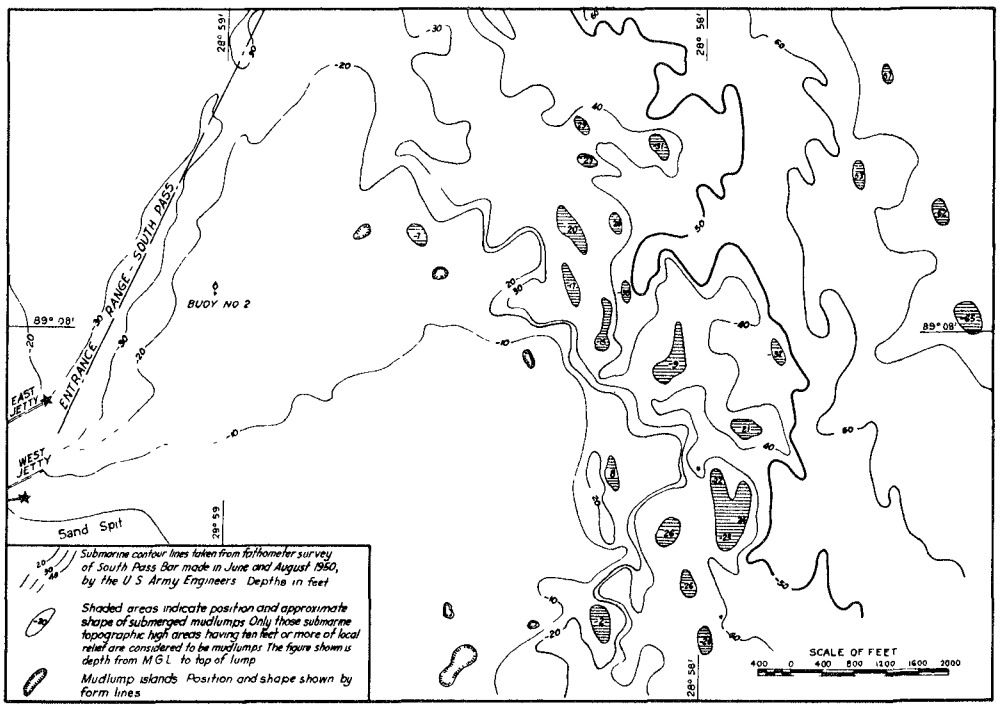

Fig. 7. Map of the bar at South Pass. Submarine mudlumps shown as shaded areas.

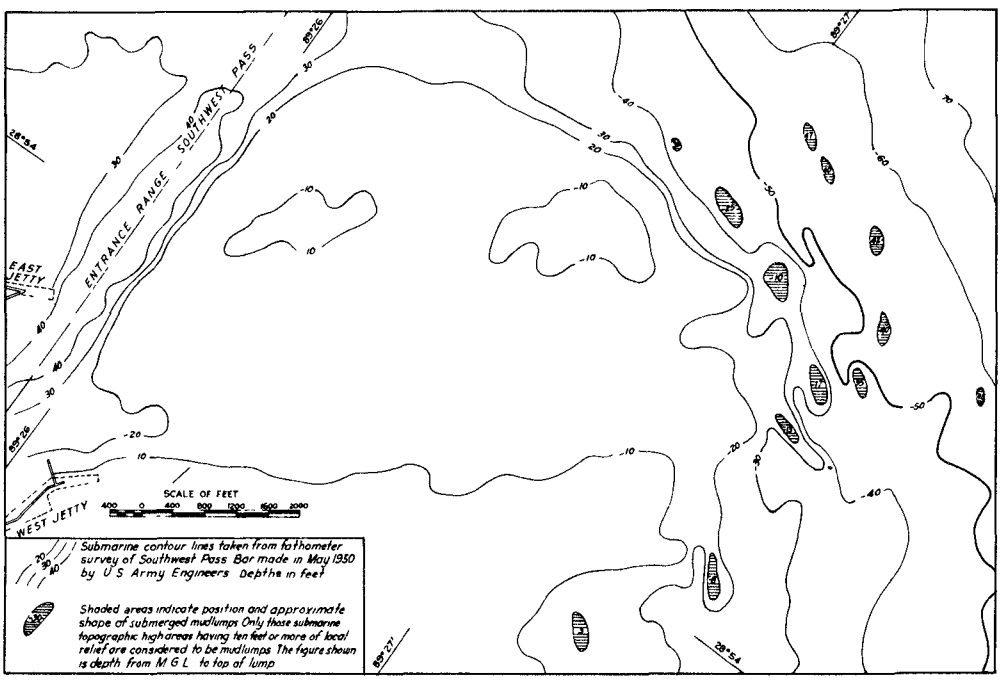

Fig. 8. Map of the bar at Southwest Pass. Submarine mudlumps shown as shaded areas.

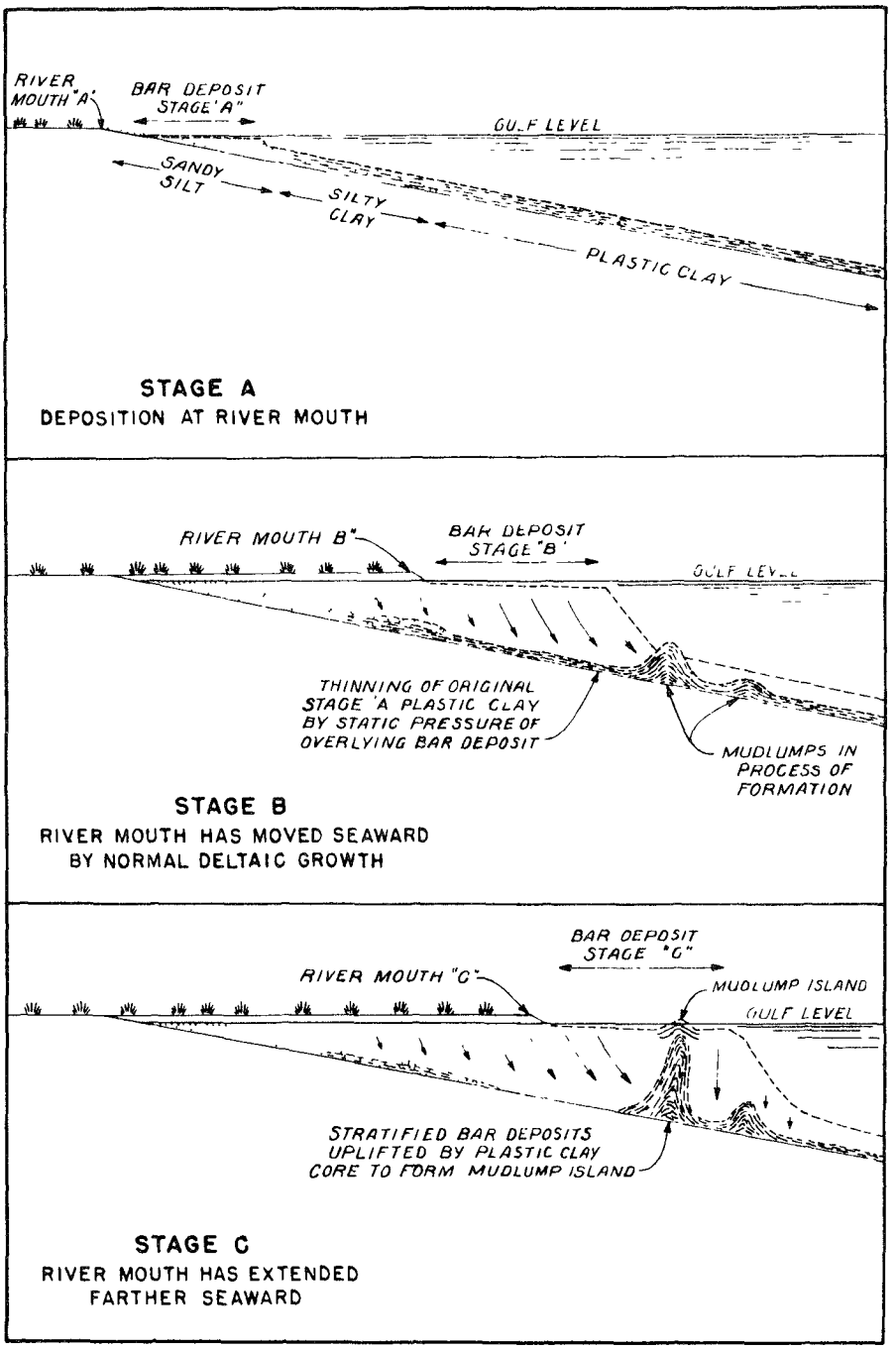

Fig. 9. Schematic diagram showing relationship between bar growth and mudlump development. Vertical scale greatly exaggerated.

As these zones are transitional, both laterally and vertically, they cannot be considered exact. They suffice, however, for purpose of illustration. The distributary continues to extend its mouth, spreading similar deposits and building the bar outward. At Stage B, the river mouth has moved seaward until the silty bar material is overlying the plastic clay layer of Stage A. Due to the static pressure of the bar and its slow forward movement, the plastic clay material is thinned and squeezed ahead. The forward edge of the bar has a relatively steep slope, and at that point the load pressure of overlying sediments is consequently smaller. It is at this place that the plastic clay breaks through to initiate upward mudlump growth. The bar, building forward, surrounds the small, incipient mudlump which becomes stabilized and is forced toward the surface (Stage C). In rising toward the surface, it uplifts the overlying sediments of the bar, which accounts for the stratified appearance of the flanks of many of the lumps. As soon as a mudlump has formed, it becomes localized due to the thick bar deposits around its flanks and the relatively thin deposits over its surface. With increasing static pressure and a sufficient supply of material, the mudlump clay may be forced to the surface.

There is also a good possibility that faulting plays a part in mudlump formation. The thick, localized bar deposits overlying the unstable, newly deposited sediments conceivably could result in a series of faults parallel to the bar front. Such faulting could establish the site of mudlump growth and would serve to break the clay stratum into a series of distinct units. This concept is in accord with the tendency toward the formation of numerous smaller lumps, rather than a few extremely large bodies. However, such an idea does not fall within the realm of factual evidence, and must be considered, at best, as a logical speculation.

Mudlumps are developed only on those passes which discharge into deep water, that is, those channels which approach the edge of the continental shelf. Apparently, only in deep water can the bar deposit become thick enough to exert static pressure of the magnitude necessary for causing flowage within the plastic clay stratum.

CONCLUSIONS

Mudlumps are a Mississippi River phenomenon, unreported from any other delta region. This is due to three important physical characteristics exhibited by the river:

1. The river discharges only fine-grained materials at its mouths. This consists predominantly of silt and clay with some sand.

2. The river discharges into a relatively still body of water. Longshore currents are not strong enough to prevent the formation of a massive bar deposit.

3. The mouths of the Mississippi River are much closer to the edge of the continental shelf than are most other major

delta-building rivers. The resulting steeper slope is favorable for the formation of a thick river-mouth bar.

These three conditions, occurring simultaneously, cause mudlump islands to develop. To the best of my knowledge, the Mississippi River has the only delta which exhibits all of these characteristics simultaneously.

Future mudlump activity at the mouths of the various passes tentatively can be predicted.

1. Southwest Pass will be the site of increased mudlump activity in the future. It will be concentrated on the west side of the entrance channel directly in front of the mouth of the pass. Because of the angle of divergence of the entrance channel, deep water will be east of the mudlump area. It is obvious that dredging must be continued at this pass in order to keep a channel across the bar.

2. South Pass has many mudlump islands at the present time and will continue to develop new lumps in the future. Activity will gradually move south and west of the present area of mudlumps. It can be stated with considerable assurance that mudlumps will not affect the South Pass entrance channel. However, it is probable that the jetties will ultimately have to be extended at this pass. The bar has reached tremendous proportions with respect to the volume of water discharged. It is rapidly encroaching upon the entrance channel and dredging soon may be necessitated.

3. The Pass A Loutre distributaries, Southeast and Northeast Passes and old Balize Bayou, have been affected in the past by mudlump activity but at the present time are almost completely blocked with sediment. It is unlikely that mudlump activity will be evident in these areas because the diminishing load of sediment will cause less static pressure. The mudlumps present in these areas are extremely old and are being incorporated into the marshland at the north and being eroded by wave action at the south.

4. The Pass A Loutre mouth has had a long and erratic history and has been affected continuously by mudlumps. It is hazardous to generalize because of the lack of factual information. Mudlump activity in 1876 closed Pass A Loutre to deep-draft ships. The 1950 mudlump activity necessitated marking a channel for fishing vessels among the numerous islands. It is likely that mudlumps will always affect this pass.

5. North Pass is a comparatively new distributary of the Pass A Loutre system. Its volume of water and sediment is increasing at the expense of Pass A Loutre and the other minor

distributaries. At the present time it is the only channel of this system which is open to navigation by moderate-draft vessels. As its sedimentary load increases, the resulting mudlump activity will also increase. It will probably follow the same pattern of development that has been exemplified by Pass A Loutre.

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