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FIG. 1, MARCH, 1962

THE RUNN OF CUTCH[1]

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ABSTRACT

The Runn of Cutch probably achieved notoriety because of the phenomena associated with a large earthquake on June 16, 1819. Once in the public eye, the area has been referred to by many geologists. The Geological Survey of India has made it clear that the Runn is not flooded by sea water during the wet monsoon as claimed by Lyell and others. On the contrary, the area has a gradient which is normal for alluvial plains. The water on the Runn is normal rain water with salt from the Runn surface. The phenomena associated with the 1819 earthquake are to be expected when unconsolidated material is shaken and settles in a more tightly packed arrangement. Historical review indicates that a large bay north of Kutch was filled, within historical time, with debris brought by the Luni and Bunass rivers and especially by the Indus. The material of the Runn of Cutch is recent alluvium.

INTRODUCTION

Today any unique feature of the earth's surface is given careful scrutiny; often those who claim that the feature is unique also receive careful scrutiny. Thus, when the Runn of Cutch was presented as an area which is subject to annual floods of sea water during part of the year but which is a very arid area during the rest of the year, it seemed to the writer that a literature study was justified. The immediate references gave the following information: Grabau (1924, p. 617) describes the Runn as an area "where the sea temporarily floods part of the delta" and calls this "an aberrant type of the marginal epicontinental sea." Lyell describes "That singular flat region called the Runn of Cutch, near the delta of the Indus, which is 7000 square miles in area . . . . It is neither land nor sea, but is dry during a part of every year, and again covered by salt water during the monsoons. Some parts of it are liable, after long periods, to be overflowed by river water" (1855, p. 346). He states that "during the monsoons, when the sea runs high, the salt water driven up from the Gulf of Cutch and the creeks at Luckput overflows a large part of the Runn" (1853, p. 463). The index map (fig. 1) shows that the sea would have to sweep many miles inland to cover 7000 square miles. More detailed study shows that the sea does not flood large parts of the Runn, and that other misconceptions have become widely believed.

The geography of the Runn has been described at various times for nearly twenty-three centuries. During this geologically short time great changes have taken place, changes which indicate how the Runn has evolved to its present condition. I believe a consistent picture of the Runn can be given without calling upon extraordinary processes.

The Runn of Cutch (Run, Ran, Rann, which is a descriptive term for a type of ground, of Kutch, Katch, Kach'h, Kachche, probably from the Sanscrit Kachchha meaning bad, vengeance) is on the west coast of India north of Bombay (fig. 1). Cutch was a province of India during the British administration. The Runn is a structural basin, and the surface of the basin has remained approximately at sea level throughout the last few centuries. During the Nineteenth Century, various explanations were advanced for its peculiar characteristics; the most reasonable of these seems to be that of William Blanford (1869), who interpreted the Runn as a basin filling up with sediment from inflowing streams. The level of the Runn was maintained, according to his view, by occasional tectonic sinking of the immediate area.

With respect to Blanford's suggestion, three factors should be considered: source of the sediment, space for the sediment, and source of the energy to move the sediment.

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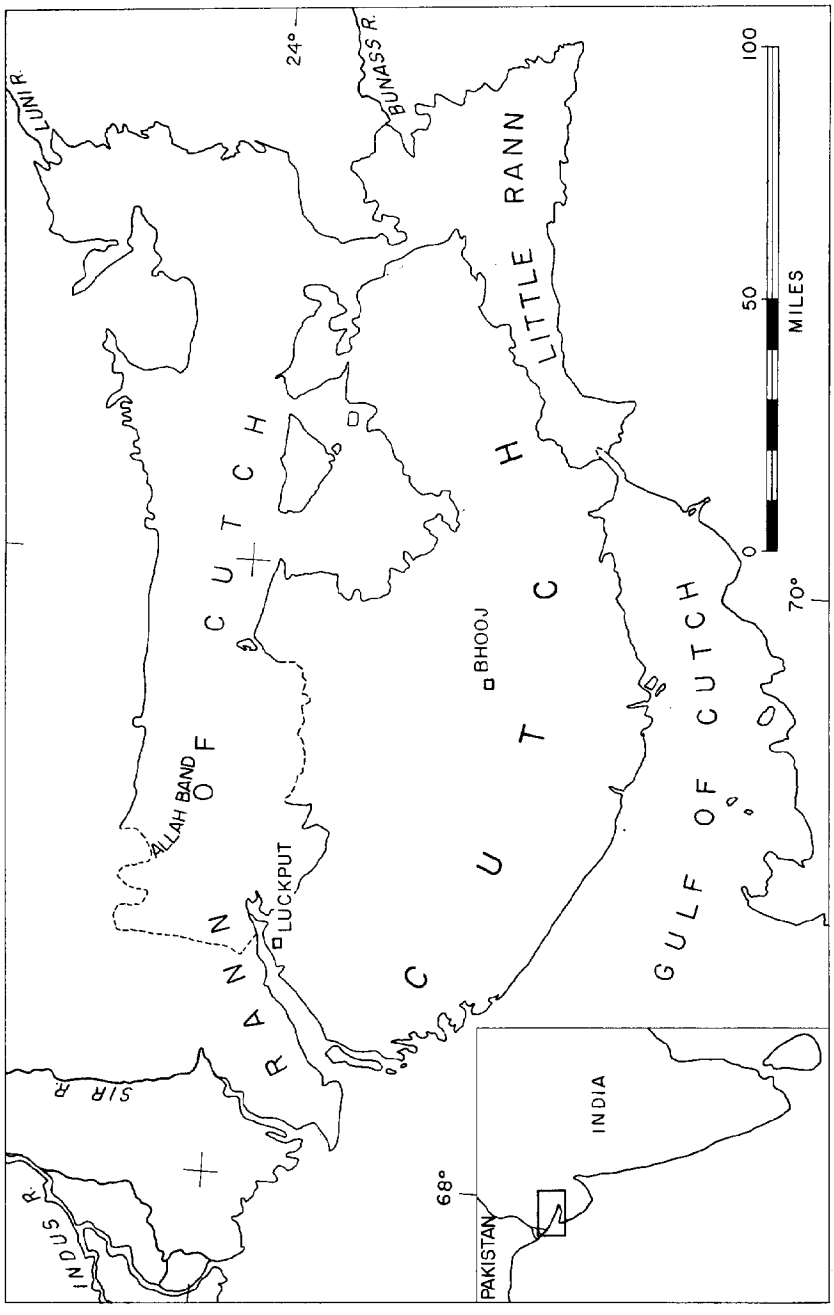

FIG. 1.—Index map of the Runn of Cutch, modified from the Geologic Map of India, Sheet 1, 1877, with permission of the Director, Geological Survey of India.

In the light of these factors, the supposed unique features of the Runn can be assessed.

THE LITERATURE

The Runn is divided geographically into the Lesser and the Greater Runn. The latter is approximately 150 miles east-west and 50 miles north-south. The Lesser Runn extends south from the eastern end of the Greater Runn and is no more than a third as big. The Runn has a total area of about 7000 square miles (Lyell, 1855, p. 346). In the language of the people, this area is divided according to the type of vegetation and type of land surface. R. D. Oldham (1926, p. 81) explains the local use as follows: "Three forms of surface are recognized in the region of the Runn. The first, known as *rann* . . . gives its name to the whole tract; the second, known as *dhoi* or *bet*, is a sandy soil, free from salt, bearing a growth of grass, and occasionally stunted trees and bushes, is found round the margins of the Runn and rising, as islands of various size, from the surrounding tract of *rann;* the third, known as *kalar* . . . may be regarded as a transition between the *rann* and *dhoi*, it is less impregnated with salt than the *rann* and bears some scattered vegetation. . . . The distinction between *rann* and *dhoi* is evidently due to the fact that all vegetation on the former is killed by the periodic flooding, which keeps the surface soil impregnated with salt." A. B. Wynne (1869, p. 52) states that the salt encrustation is usually one or two inches thick, and Frere (1870, p. 188) describes "many square miles . . . covered with a solid cake of hard transparent ice-like salt, from a couple of inches to in some cases 2 feet in thickness." Concerning this general area, an Arabian writer of 1361, to whose description I will return, gives this image: "no bird ever flapped its wings over it, not a tree was to be seen, not a blade of grass, not even a miserable noxious weed," and Sivewright, who quotes the Arab (1907, p. 531), says this applies equally well today.

The Runn is such a disagreeable place that even the local people rarely venture away from the two trails which cross the Runn, as shown on Wynne's (1872) excellent map. Alexander Burnes (1839, p. 308), who claims "of the Runn of Cutch I am not aware of any other account having been published," says that it is not saturated with water except at certain periods, that it has no weeds or grass except on the islands, that it has a "bed, which instead of being slimy, is hard, dry, and sandy, of such a consistency as never to become clayey . . . a vast expanse of flat, hardened sand, encrusted with salt sometimes an inche deep" (Ibid., p. 317). Sivewright (1907, p. 533) describes the silt of the Lesser Runn as follows: "This silt, when wet, becomes clayey." Burnes quotes (1839, p. 325) from MacMurdo's papers (1823) "The Run has every appearance of the sea having shortly withdrawn from it . . . ". He also quotes papers of one R. M. Grindlay who is said to have written in 1808: "The sun was completely obscured by . . . light sand, of which the dry part of the Run is composed" (Ibid., p. 326). Sivewright (1907, p. 529) writes of "dust storms [which] last for months and obscure the features of the country." The Imperial Gazetteer of India (1908, p. 77) states that the average rainfall for Cutch is twelve inches, but that in 1900 less than two inches fell. Wynne (1872, p. 5) states that the rainfall was about one inch in 1848 and nearly thirty-five inches in 1862.

It is clear that the Runn is a very flat area, sandy, mostly encrusted with salt in those areas where trails cross it, generally hard and dry during the northeast (dry) monsoon and generally more or less flooded with salt water during the southwest (wet) monsoon which comes during the months of May to October (Wadia, 1926). Most of the Runn is devoid of vegetation, but some parts have grass or even small trees and bushes. The location of the *rann* areas and the *bet* areas changes over a period of years, perhaps in one consistent direction, but probably not (Oldham, 1926, p. 98).

To explain the present features of the Runn it is necessary to reach back to Alexander's military raid into India. At that time (325 B.C.) seven islands "lay off the western coast of Hindustan. . . . These islands, as such, have long ceased to exist; they are now joined up together and with the mainland. . . . Five of these one-time islands are now called collectively Cutch" (Sivewright, 1907, p. 518). Sivewright gives an account of an explorer of about the third century A.D. who said of the shore between

Cutch and Sind (to the north): "The sea in both [the big and little Rans] is shallow, with continual eddies, and eddies in shoal water extending a great way from shore, so that vessels are frequently aground before they come within sight of land" (1907, p. 529). He further refers to an Arabian historian of 1361 A.D. who described the area as a marsh (Ibid., p. 531). The Imperial Gazetteer of India gives much the same information, saying that the islands were out of sight of land in Alexander's time.

Thus it is seen that the Runn has become land during historical time. On June 16, 1819, a severe earthquake occurred, the effects of which were noted in more detail than those of any previous severe earthquake anywhere. Some information concerning the Indus River should be inserted here in order to explain the importance of the earthquake.

"Previous to the battle of Jarra, in 1762, the eastern branch of the Indus, commonly called the Phurraun, emptied itself into the sea, by passing the western shores of Cutch" (Burnes, 1839, p. 308). Following the battle of Jarra, the ruler of Sind built dams across the Phurraun so that no water of the Indus normally entered the area of the Runn. However, at intervals of some years, when the monsoon was particularly strong, or when there was an exceptional flood from some other cause, these dams were swept away, and the Runn was flooded to a greater degree than during the usual yearly inundation (Ibid., p. 310). The yearly inundation of the Lesser Runn was effected by the Bunass and Luni Rivers, which enter the Runn from the eastern highlands, and especially by direct rainfall. Sivewright says: "The silt of the Greater Ran is unmistakably an Indus valley deposit; that of the Lesser Ran is as easily recognized as the black cotton soil of its source of origin in Kathiawar" (1907, p. 533). In his remarkable work concerning the Indus, Carless says, "I find, by a rough calculation, that the Indus conveys to the sea annually 10,503,587,000 cubic feet of mud, and this would cover a space $8\frac{1}{2}$ miles square to a depth of 4 feet" (1838, footnote on p. 356). This would cover 7200 square miles to a depth of 92 feet in 2300 years; in the Runn of Cutch the Luni and Bunass Rivers would contribute some debris. Today the Indus turns sharply to the west at Hyderabad in Sind in its present course to the sea. Perhaps in earlier times the entire river poured into the estuary which has become the Runn. It is not far from the normal expectation to claim that the Indus certainly gave half of its discharge to the Runn at various times while the huge area of its delta was being built.

The Indus is one of the greatest rivers of Asia and drains high mountains composed of relatively soft rocks. Not only is the river subject to heavy rainfall during the wet monsoon, but also the mountain valleys are commonly dammed by landslides, so that lakes are formed. When the dams give way, very destructive floods pour into the main valleys farther south. Wadia (1926, p. 32) believes that these floods carry perhaps as much as one hundred times more debris downstream as the same amount of water distributed throughout the year. Oldham (1917, figure on p. 95), on the basis of a geodetic traverse of the Indo-Gangetic Plain, maintains that the entire area from the Himalaya south to the highlands of central India is a tectonic basin filled with alluvium brought down from the mountains. Carless (1838) includes in his survey of the delta of the Indus River an area rather greater than one would expect. Wynne suggests that the entire plain might be considered a delta of the Indus; he says, "To whatever causes the great plains of Sind and the coast plains of Western India are due, that of the Runn may also be ascribed. Its origin must be traced further back than the formation of the deltas of the Indus and the other neighboring rivers" (1872, p. 28).

The people of Cutch believe that the Runn was once a bay, with harbours along its edges (Burnes, 1839, p. 319). Wadia (1926, p. 31) says, "Even within historic times the Rann of Cutch was a gulf of the sea, with surrounding coast towns, a few recognizable relics of which still exist." Similar information is given by Frere (1870, p. 193). The 1819 earthquake is said to have spewed up great quantities of mud and water and pieces of iron and ship's nails along the edges of the Runn, especially in the southern part (Burnes, 1839, p. 321).

Although the earthquake is discussed in

several references, MacMurdo's (1823) description is the only eye witness account. Apparently the earthquake raised an earthen mound about fifty miles long in an east-west direction and a mile wide, with a steep face on the south side but no perceptible slope on the north. Oldham (1926, p. 93) states that the mound—Allah Band in fig. 1—was at first about thirty feet high, but that in subsequent weeks minor shocks reduced its height to ten feet. As no slope was visible from the north, Suess (1892) and Wynne (1869) concluded that there was no real uplift on the north, but that all the movement was down on the south. Nelson (1846) and Oldham (1898) maintained that there were movements up on the north as well as down on the south. The Imperial Gazetteer of India (1908, p. 77), speaking of the Allah Band, says, "Early observers speak of it as an upheaval of the surface. But from the north side there is little sign of any rise in the land; and a few years after its formation (1826), the flood waters of the Indus, keeping their former course, forced their way through the dam. These two considerations would seem to show that the apparent height of the bank, as seen from the south, is to some extent due to the fall in the level of the land in that direction." A large lake formed on the south side of the Allah Band, completely submerging the small village of Sindree in about eighteen feet of intensely saline water. The land in the vicinity is so flat that the lake extended as far as the eye could see both east and west. It was later determined to be more than thirty miles in diameter (Burnes, 1839, p. 311; Oldham, 1926, p. 87).

The local people, much upset by the event, told interesting tales of the activities of nature at the time of the first shocks, just before seven P.M. (MacMurdo, 1823, p. 90). MacMurdo was then a British Army officer, stationed in Bhooj, Cutch. Thomas Oldham, in his list of Indian earthquakes (1883), tells of the natives claiming that "The volcano called Denodur burst into action, and the shocks ceased," but then points out that his personal inspection of the hill failed to reveal any evidence of volcanism, either old or new. This volcanism was said to have occurred on June 20. Oldham further states, "In the Runn of Cutch, numerous jets of blackish, muddy water were thrown out from fissures, and cones of sand, 6 and 8 feet high, were thrown up." Burnes says, "the earthquake . . . made numerous cracks and fissures in the Run; and I state, on the authority of eye-witnesses, that immense quantities of black muddy water were ejected from these openings for a period of three days, and that the water bubbled out of the wells of the tract bordering the Run, called Bunee, till it overwhelmed the country in some places with six, and even ten feet of water" (1839, p. 321). Frere, on the other hand, speaks of water level going down at the time of the earthquake, and attributes this to a general rise of the land north of the Allah Band (1870, p. 193). He also mentions mud volcanoes on the coast of Sind.

MacMurdo stated that "buildings situated on rock were not by any means so much affected by the earthquake as those whose foundations did not reach to bottom of the soil. . . . As far as it comes under our notice, the face of nature has not been much altered by the shocks. The hills, which are most likely to show its effects, . . . have in no instance, to my personal knowledge, suffered more than having had large masses of rock and soil detached from their precipices. . . . The rivers in Cutch are generally dry (excepting in the monsoon), or have very little water in them. Native accounts seem to confirm the fact of almost the whole of their beds having been filled to their banks for a period of a few minutes, and, according to some, for half an hour. They are said to have subsided gradually. I was not in the way of observing this part of the phenomenon, but have no reason to doubt it. . . . It is remarked that rivers in the valleys, and those with sandy beds, were alone affected. Wells everywhere overflowed, many gave way and fell in, and in numerous places spots of ground in circles of from twelve to twenty feet diameter threw out water to a considerable height, and subsided into a slough. I frequently met with them in their sloughy state. The color of the waters gave great alarm to the natives, many of whom affirmed that the rivers had run in blood, doubtless from the color of the soil through which they had been forced. . . . There cannot be a doubt of all the Runn

land having during the shock sent forth vast quantities of water and mud" (1823, p. 99–103).

Nelson, who appears to have been MacMurdo's commanding officer, gives the following information: On June 25, 1819, a guide under MacMurdo traveled across the Runn from Sind to Cutch; at least twenty miles of the trip, the guide's camel was waist-deep in water; there are said to be two earthquakes every year in the area (1846, p. 103).

CONCLUSIONS

It seems clear that the Runn was shaken, that a good deal of water appeared in an unspecified way, and that the Runn south of the Allah Band moved downward, whether the land north of the fault (?) moved upward or not. Because of the severity of the earthquake (felt in Nepal according to Thomas Oldham's catalogue of Indian earthquakes published in 1883), the attention of the world was focused upon the point of origin and the surrounding country. Thus many wrote about the area without sufficient basis. Note the following quotations and the explanations supervening.

Frere says that "The surface [of the Runn] is apparently, for all practical purposes, a dead level. . . . When the surface is dry, so imperceptable is the slope, that a shower of rain falling on the hard, polished surface, neither sinks in nor runs off, but lies, like a vast slop, on the plain, and may sometimes be seen moving along before the wind, till it gradually dries up by evaporation" (1870, p. 184). It is not denied that there are places where rain would accumulate in salt pans, to a limited extent. However, the wind must be from the northeast if the ground is dry, for the only other wind, from the southwest, brings rain for months. Thus the wind always blows toward the sea after the occasional storm. In fact, Sivewright (1907) states flatly that the Runn has a west slope rising six inches per mile from the sea to at least twenty miles inland. Thus the wind blows the water downhill to the sea.

Lyell says that "during the monsoons, when the sea runs high, the salt-water driven up from the Gulf of Cutch and the creeks at Luckput over flows a large part of the Runn, especially after rains, when the soaked ground permits the sea-water to spread rapidly" (1853, p. 102). Yet during the southwest (wet) monsoon, all the creeks and rivers entering the Runn from higher ground are flooded, but the sea is not observed to rise more than four feet at the most (Oldham, 1926, p. 81; Sivewright, 1907, p. 527). A rise of the sea of four feet is clearly not sufficient to flood the Runn which is over one hundred miles long and rises ten feet in the first twenty miles.

If the sea does not bring the salt, from what source is it derived? Frere states that among the "Various theories . . . put forward to account for these thick sheets of solid salt, on a perfectly level surface of dry sand and clay . . . the most probable and most consistent with observed facts appears to be, that it is formed by the gradual evaporation of the intensely salt water which is always present in the subsoil, and which oozes to the surface by capillary attraction or under pressure, from rain in the upper country, and from high tides in the creeks which intersect the plains where the sheets of salt are found" (1870, p. 188). This seems reasonable to me. Frere observes that the salt sheets are said to be in the western part of the Runn; the rest has not been observed by him.

The surface of the Runn is too smooth to be a raised sea floor. Wynne (1872, p. 28) says, "The surface of the Runn differs much from that beneath the neighboring sea as shown by the Coast Survey Chart, on which are marked decents of 84 feet within less than a mile, besides various inequalities which do not exist upon the Runn." Frere (1870, p. 196) notes that regardless of the method of deposition of material on a delta there will always be some relief, but that the Runn has no minor surface relief. He believes "that the constant recurrence of surface agitation from earthquakes, especially during the time when the surface is annually covered with a couple of feet of water, supplies exactly the kind of cause which would account for the uniformity of level. We have evidence that under the action of an earthquake mounds of such sandy soil as that of the Runn melted down, as it were, into the water which then covered the Runn, and that in place of the mound there

is now the usual, firm, smooth level of the rest of the Runn. There seems no reason why the same sort of process, frequently repeated, should not obliterate all traces of creeks and water courses, and reduce the Runn to the surface which we now find. The Runn is, in fact, a great basin . . . subject to frequent earthquake agitation." Perhaps a general settling of the loose alluvium because of the shock accounts for the large amount of water expelled during the 1819 earthquake.

Thus I conclude that the source for the sediment is the drainage basin of the Indus River, and less importantly from the Luni and Bunass Rivers. The space where this sediment collected was a bay about twenty-three centuries ago. The energy to bring the sediment was supplied by the Indus River, and the energy to smooth the surface was supplied by frequent earthquakes, some of which have been severe. No need has been found to call upon extraordinary processes. The Runn of Cutch is extraordinary, however, because it has *been observed* to change from marine bay to alluvial plain in a geologically short time, and without any complications from Pleistocene changes in sea level.

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