

239

Geomorphology of the Gulf of Kutch

B G WAGLE

National Institute of Oceanography, Dona Paula, Goa 403 004

Received 26 February 1979

Based on the analyses of 678 km of echosounding carried out during 2nd cruise of *RV Gaveshani* it is found that a prominent geomorphic feature demarcated in the Gulf of Kutch is the axial E-W running narrow depression with scarps and a very rough to rugged surface. The sea bed of the Gulf is divided into 3 distinct morphologic units—even, uneven and rough. The major axial depression may have been the result of scouring action by bottom currents on a channel following a tectonic feature. The even topography is originated due to the recent sediments brought down by rivers. The uneven and rough surface may owe its origin primarily to tectonic instability later accentuated by abrasion and erosion due to high velocity tidal currents. This surface probably coincides with a tectonic zone of weakness where the abrasion and erosion can easily carve out the present irregular topography. Finally it is possible that the sea surface was exposed during lowered sea levels and the topography recorded may represent the relict topography.

RV Gaveshani carried out a reconnaissance marine geological survey of the Gulf of Kutch in March 1976 (Fig. 1). The survey consisted of echosounding, shallow seismics and magnetics followed by bottom sampling by grabs, snapper and dredgers. In addition hydrographic casts, current and sound velocity measurements were also made at several stations. The survey tracks commenced as close to the shore as the depths of water and sea conditions permitted and were run across the Gulf to obtain the best possible coverage. The positions were obtained by radar fixes.

Echosounding was continuously carried out on a Kelvin and Hughes MS-45 (30 kHz) or a Simrad EQ echosounder along tracks totalling 678 km.

The Gulf of Kutch because of its peculiar shape is marked by high tides, the average tidal range at Okha and Kandia is 3.06 and 5.89 m respectively. The associated tidal currents are fairly strong, reaching 4-5 knots in the open Gulf near the mouth. High tidal range and associated tidal currents are an effective geological agents and would have played a significant role in sedimentation and shaping the floor of the Gulf.

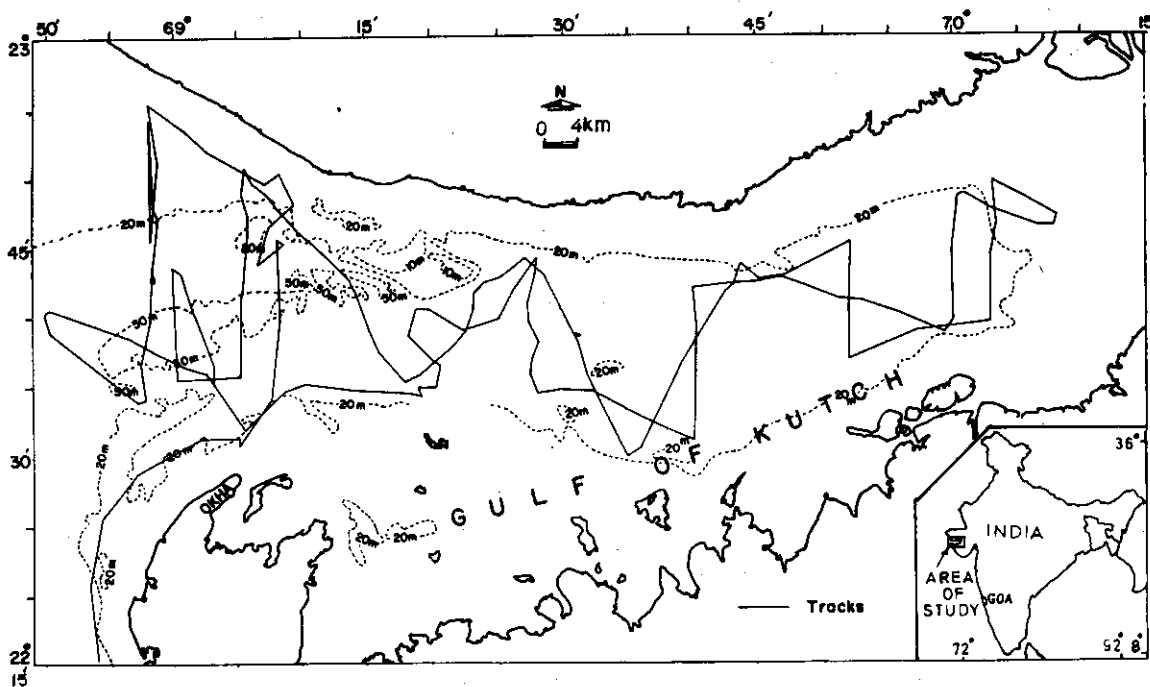


Fig. 1—Survey track lines in the Gulf of Kutch

Geological Setting

The Gulf of Kutch lies between the northern coast of Kathiawar peninsula and the southern coast of Kutch district. The southern shores of the Gulf are marked by a low level coastal plain with indentations, deep inlets, a number of offshore islands and several river mouths. The northern shores of the Gulf is fronted by numerous sandy shoals. On the mainland as well as the islands marshes exist side by side with occasional rocky cliffs 2 to 3 m high. Ahmad¹ considers these features to be indicative of a submerged coast line. Coral reefs and oyster beds are also reported near the islands².

The geomorphological studies of Kutch show that the present topography is very young and that there has been very late uplift. Four plains of erosion have been recognised in the Kutch, viz. Paleocene, post-Paleocene, post-Miocene and early Quaternary³.

The Gulf is bounded on the south by the Deccan Traps which lie disconformably over the Mesozoic sediments and are in turn overlain by Paleocene volcanoclastic sediments with a disconformity⁴. On the northern side of the Gulf in the interior Kutch the pre-Cambrians are exposed in patches and these are overlain by a complete sedimentary sequences from Jurassic to Pleistocene. The Jurassics out crop in 3 E-W trending anticlinal ridges, cover a large area and their thickness is estimated to be 1950 m. The overlying marine Tertiary formations represent a shelf facies and attain a thickness of 600 m in the southwest⁵. These are bordered to the south by Deccan Traps while on the north lies the saline marsh of the Rann of Kutch.

Results and Discussion

Sediment distribution in the Gulf of Kutch—Extensive occurrences of rock are reported from the Gulf of Kutch especially in the central part, sediment is largely confined to the margins of the Gulf. Apparently the high tidal ranges in the Gulf generate powerful currents which are not conducive to sediment deposition. Petrographic and foraminiferal studies of the rock samples indicate that these consist of calcareous sandstones. These sandstones extend from the mouth to the centre of the Gulf and cover a large part of the seabed⁶. Recent study of the Gulf of Kutch sediments⁷ reveals that the sediments consist of light grey silt and clay and patches of fine sand. The sediments are poor to extremely poor sorted, the skewness is highly variable and there is no relation to either the texture or mean size of the sediment.

Geomorphology—The Gulf of Kutch is aligned approximately E-W; it is about 50 km wide at the entrance with the width decreasing gently eastward along its length till about 70°20' E where it starts abruptly narrowing. The southern coast is fringed by numerous dead coral reefs, islands and extensive mud

flats which dry at low tide. In contrast, the northern coast is fringed by tidal flats only. At the head of the Gulf is the Rann of Kutch, a desiccated region, which is inundated during the SW monsoon. A number of prominent shoals (Ranwara, Lushington, Gurur, Samiyani) are present in the Gulf. These features could be due to resistant rocks capping on topographic highs remnant from an earlier phase of terrestrial erosion or to the structural highs in the bedrock or a combination of both.

Hydrographic charts of the Gulf and a study of the echograms of Cruise II of *RV Gaveshani* indicate that the Gulf is relatively shallow basin and the maximum depth recorded is about 70 m. The topography is very irregular for about 75 km from the entrance to the central Gulf; further east the depths decrease gradually towards the head and the bottom changes from rock, sandy clay to clayey silt.

A number of major geomorphic features can be identified in the Gulf. The prominent among these is an elongated ENE-WSW trending depression with very steep slopes and very rough to rugged surface extending from the entrance to the Ranwara shoals. Since the depression approximately follows the axis of the Gulf this may be a deep tidal scour channel or a channel following a tectonic feature. Depths > 60 m are found within this channel and the deepest water is found SW of Ranwara shoals. Similar though smaller depressions lie within the 50 m isobath between the major depression and Ranwara shoals. A number of scarps (Fig. 2) with a relative elevation of 6 to 32 m are seen at the sediment free seabed of the Gulf. These scarps may extend towards the head of the Gulf buried in sediments. Since the tracks were widely spaced the trend of these scarps can be generalized on the basis of trend of the 20 and 50 m contours on the chart. On this basis it is inferred that the trend of these scarps is E-W and WNW-ESE which coincides with those of the major lineaments and major faults and regional strike of the area. The scarps may represent fault scarps forming the walls of a channel in the bed rock—perhaps formed due to tectonic instability during quaternary sea level fluctuations later accentuated by tidal scour.

In addition to these, other prominent geomorphic features observed are extensive eroded terraces with relatively flat floor (Fig. 3, profile e), domal smooth surfaces (Fig. 3, profile d), and sharp pinnacles of 10 to 25 m height.

Based on the study of echograms the floor of the Gulf can be divided into 3 distinct morphologic units: even, uneven and rough (Fig. 4). The region of even topography has very little or no variations (< 2 m), typical of sediment covered seabed (Fig. 3, profile a). The area covering the eastern margins of the Gulf

WAGLE: GEOMORPHOLOGY OF THE GULF OF KUTCH

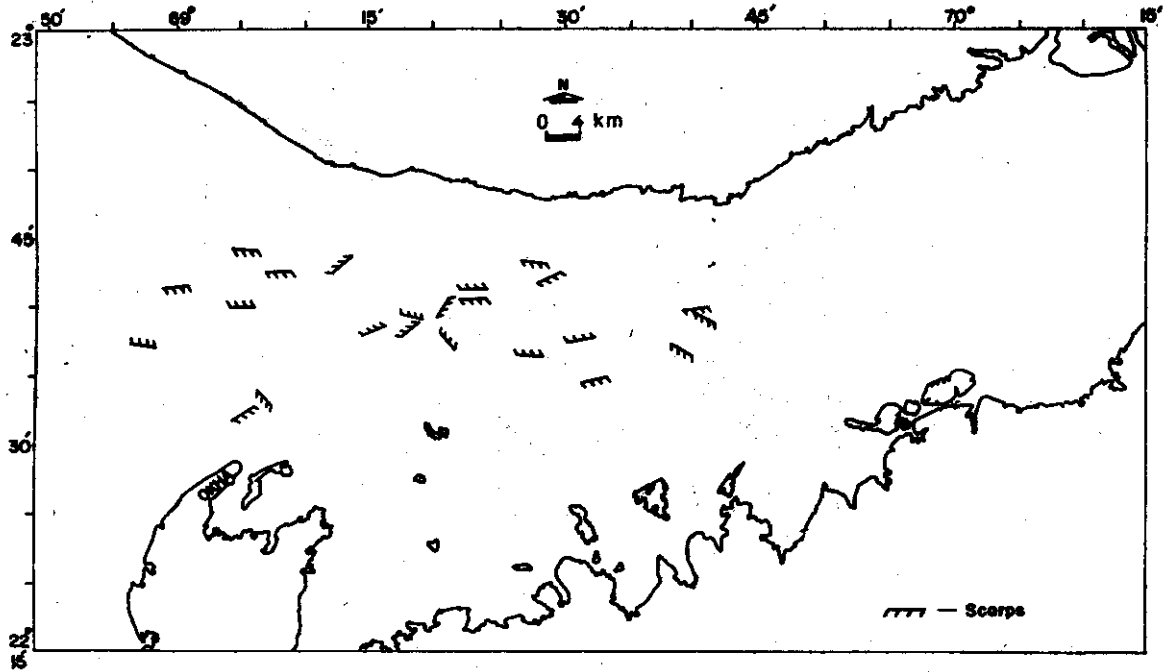


Fig. 2—Location of surface scarpes

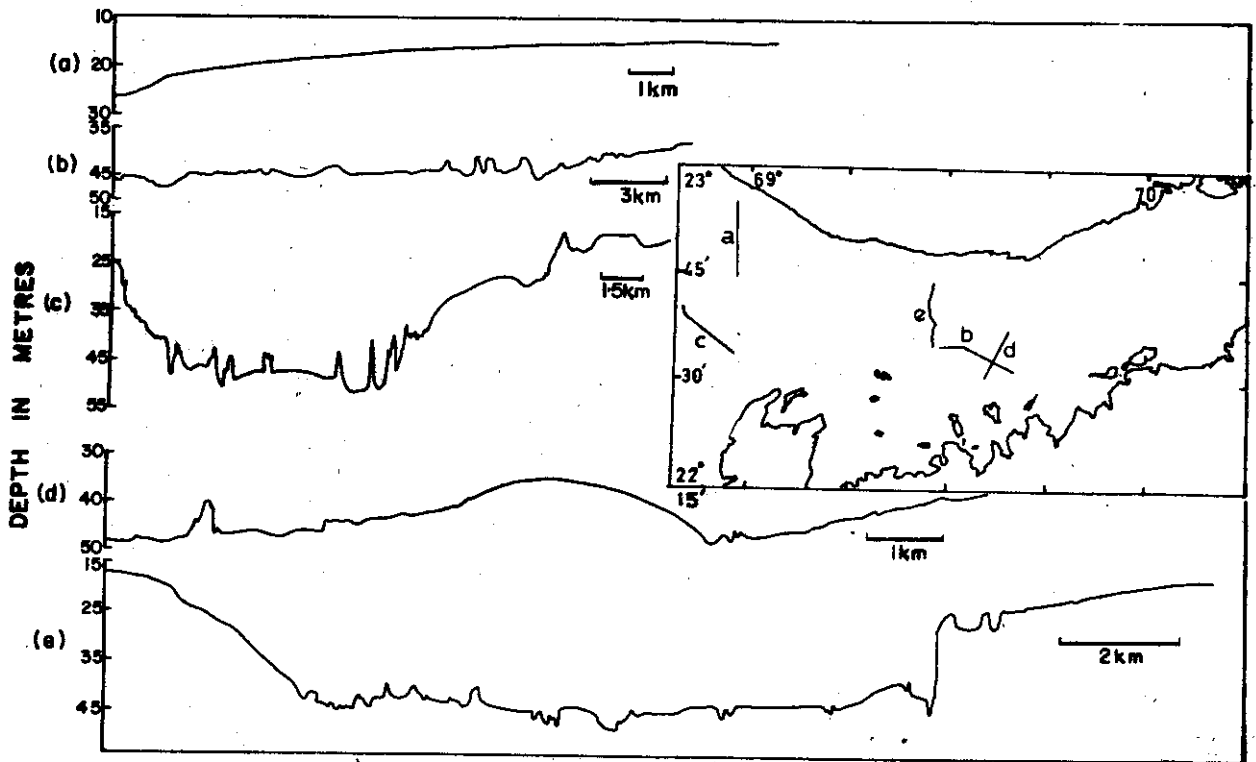


Fig. 3—Profiles across the Gulf of Kutch

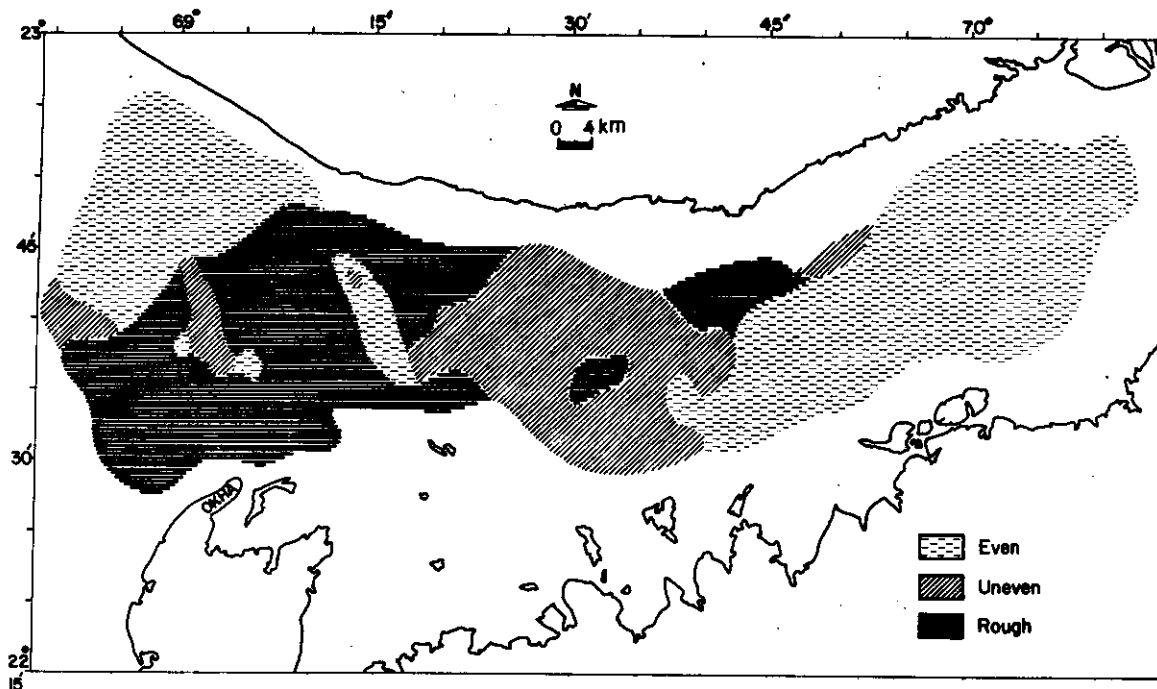


Fig. 4—Gross geomorphic subdivisions of Gulf of Kutch

extending from the north of Sikka Creek to the head of the Gulf and the northern margins are marked by even topography. The region of even topography is flat, gentle and smooth. The flatness of the surface is attributed principally to the land derived sediments masking the underlying topography. In the region of uneven topography the variations range approximately from 2 to 5 m (Fig. 3, profile b) and in the region of rough topography these range up to 25 to 30 m. The seabed in the area of rough topography consists of sharp pinnacles, ridges, valleys, etc. (Fig. 3, profile c). The region of rough topography extends from the southern side of the entrance to the Gulf to a distance of about 50 km. In the central part of the Gulf the topography is uneven with a small patch of rough surface. The distribution of uneven and rough topography mainly coincides with the area where rock is exposed on the seabed which extends to a distance of about 75 km in the central part of the Gulf.

The uneven and rough surface may owe their origin primarily to tectonic instability later accentuated by abrasion and erosion due to high velocity tidal currents which not only act as strong abrasive agents but at the same time create the non-depositional environment.

This surface probably coincides with a tectonic zone of weakness where the abrasion and erosion by water could have easily carved out the present irregular topography. Finally it is possible that the sea surface is exposed during lowered sea levels and the topography recorded may represent the relict topography formed during the periods of lowered sea level.

Acknowledgement

The author expresses his sincere thanks to Dr S. Z. Qasim, Director, for critically reading the manuscript. He is indebted to Shri H.N. Siddiquie for constant guidance, helpful suggestions and constructive comments on the manuscript.

References

- 1 Ahmad E, *Coastal geomorphology of India*, (Orient Longman, Bombay) 1972, 222.
- 2 Fedden I, *Mem geol Sury India*, 2 (1884) 41.
- 3 Biswas S K, *Q Jl geol Min metall Soc India*, 43 (1971) 221.
- 4 Biswas S K & S V Deshpande, *J geol Soc India*, 14 (1973) 134.
- 5 Krishnan M S, *Bull natn Inst Sci India*, 38 (1968) 398.
- 6 Hashimi N H, Narayanan V & Wagle B G, *Mahasagar-Bull natn Inst Oceanogr*, 10 (1977) 9.
- 7 Hashimi N H, Nair R R & Kidwai R M, *Indian J mar Sci*, 7 (1978) 1.