GEOMORPHIC EVOLUTION OF BAP RANN, PHALODI, RAJASTHAN, INDIA

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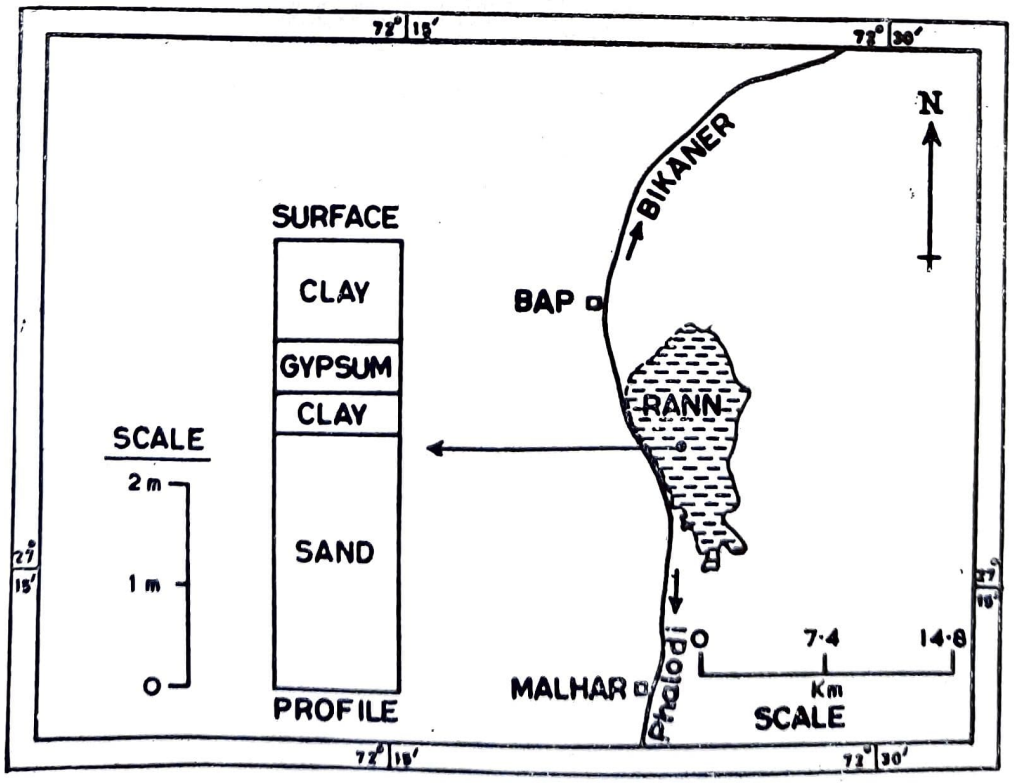
ABSTRACT

The origin and geomorphic evolution of Bap Rann (playa) and other important landforms around Bap Village have been studied. The rann seems to have been formed by the process of deflation and represents an earlier base level of erosion, i.e. a topographic depression in a nearly flat desertic country. The nature of sediments from the rann indicates fluviolacustrine conditions.

INTRODUCTION

The desertic regions of Rajasthan are characterised by the presence of numerous ranns and lakes. The importance of these ranns is mainly due to the presence of common slat in some of the lake beds, as almost every rann contains brine in different concentrations. These shallow saline depressions are distributed mainly in Jaisalmer, Pokaran, Barmer, Bap, Jodhpur, Pachpadra, Sambhar, Didwana and Sujangarh areas of the Rajasthan Desert. Out of these, Sambhar, Pachpadra, Pokaran, Bap, and Didwana ranns are well known for the production of salt.

Bap Rann is located near Bap Village (27° 25′ N: 72° 20′ E) on the Phalodi-Bikaner Highway (Map-1). It is a large, shallow, subcircular basin, aout 70 sq km in area developed over the eroded surface of basement rocks. In general, the area around the rann is marked by a nearly flat terrain, like most of the desert regions



Map-1. Location map of Bap area, showing the postition of the rann and a section of the sediments.

of Rajasthan. Only at some places relief develops due to the presence of small mounds of ancient rocks and gullies on the margins of the flat erosional surfaces.

GEOLOGY

Ever since OLDHAM (1886) reported the Bap Boulder Bed near Bap Village, the geology of the area gained importance in Indian geology. However, detailed work has been done only during recent years regarding the nature, age and stratigraphic position of the Bap Boulder Bed and Badhaura Formation. Although these aspects do not form a part of the present study the lithological characteristics of the various formations were utilized in understanding the landforms and their distribution pattern.

Stratigraphic Succession

Marh Formation	(Palaeogene)	Alternating grey to green sandstone
Badhaura Formation	(Lower Permian)	
Bap Formation		Alternations of boulder clay, sandstone and varved clays.
Nagaur Formation	(Early Cambrian)	Red sandstone, highly current bedded with pebbles of ryolite at places.
Bilara Formation	(Pre-Cambrian)	Limestone bedded to massive and cherty with stromatolites.

So far, little is known regarding the geomorphology of the various regions of Rajasthan Desert. RODE (1964) described the evolution of the desert on the basis of his sheet hypothesis. AHMAD (1969) studied the origin and geomorphology of the desert. PANDEY (1969) has dealt with the various aspects of the arid zone geomorphology. These studies are mainly regional in approach. However, the detailed studies of smaller geomorphic units are required for the better understanding of the various aspects of the desert geomorphology. In view of this fact, PANDEY AND CHATTERJEE (1970) discussed the genesis of the ranns near Jaisalmer and ANAND-PRAKASH (1980 a, b & c) described the geomorphic evolution of landforms around Jaisalmer, geomorphic evolution of Lik River south of Pokaran and ranns near Pokaran, Rajasthan, respectively.

Recently, AGARWAL *et al.* (1980) carried out Quaternary studies in Rajasthan using various parameters and have provided useful information regarding climatic and ecological conditions during the Quaternary Period. They have suggested that the sediments in the Malhar Rann (near Jodhpur) were deposited under fluctuating hydrological conditions. However, the detailed geomorphic studies have not been carried out in the area so far.

During the field seasons of 1979-80, the author studied the geomorphology of the Bap area with a view to understand the origin and evolution of the rann which is discussed in the following account.

GEOMORPHOLOGY

The area is mainly characterised by a nearly flat terrain with the extensive development of gently sloping erosional surfaces (desert plains) and the saline basin.

Only at places where these surfaces have been gullied some relief has developed. However, a small but significant limestone ridge breaks the monotony of the flat topography near Badhaura Village about 8 km south-west of Bap. Apart from this ridge a few scattered and isolated patches of older rocks are also seen rising above the flat surfaces, like inselbergs, presenting a typical desertic landscape.

The area around Bap is characterised mainly by the following landforms :

1. Limestone ridge
2. Desert plain (erosional surface/pediment)
3. Rann (Salina/playa, deflation basin, etc.)
4. Sand dunes
5. Drainage

1. *Limestone ridge*

It is a low continuous ridge of limestone present south-west of Bap near Badhaura Village (27° 20'N : 72° 16' 50" E). This ridge is characterised by an upper portion of cliffs and a lower portion of debris slope. The slope gradually merges with the desert plains mostly covered by a thin veneer of gravel coated with red iron oxide forming bajadas. These plains are developed on both sides of the ridge covering extensive areas.

2. *Desert plain*

Desert plains form the most extensive landform in the area. These gently sloping plains are mostly covered by gravel, coated with red iron oxide presenting desert varnish and can also be termed as bajadas or pediments as they end up near the ridges at the contact with the debris slope wherever present. Over this plain surface the Bap playa has developed. The plain also provides a suitable surface for the formation of dunnes. It is gullied only near the margins and rarely the traces of channels are seen over this surface.

3. *Bap Rann*

Rann is an important feature of the area which can also be termed a depression, saline basin, Salina, salt flat, playa, etc. The economy of the area mainly depends upon this feature as the salt is being extracted from its bed and is the main business of the local population.

The rann is a large shallow basin (about 10 km × 7 km) developed over the plain surface with converging drainage lines towards its centre. A stream with a prominent but dry channel joins the rann from south-west. It feeds the rann during rains. In general, the rann surface can be described as an almost level plain formed due to the deposition of the sediments under water from the marginal areas. For most part of the year the rann remains dry. It gets filled only after the sufficient rainfall.

A profile studied almost from the centre of the rann (Map-1) has shown the presence of the basement red coloured, current bedded, soft sandstones (Nagaur Formation) at the depth of 4.4 m. This depth also formed the brine level during the month of April 1979. The basement sandstone is overlain by a 2.5 m thick sand layer, which forms the basal part of the profile sediments. It is succeeded by a 1.9 m thick laminated clay layer of greenish grey colour with white salt bands. The surface of the rann is characterised by the presence of mud cracks.

4. *Sand dunes*

Mainly the barchan dunes are seen in the area, developed over the plain surface. At places the dunes have also been developed due to obstruction caused by the shrubs and at the base of the ridges. In comparison to the other areas of western Rajasthan, dunes are less developed around Bap.

5. *Drainage*

The area is almost devoid of any organized drainage system. However, a few channels are seen converging towards the rann from the sides. Out of these channels only one of about 10 m width is significant which joins the rann from south-west draining the Bilara limestone ridge area.

DISCUSSION

The geomorphic processes initially acted mainly in reducing the relief of the region, by eroding the higher and elevated parts into flat erosional plains, probably to the point of a local base level of the area. It seems that in the beginning of the geomorphic cycle the process of erosion was much faster than the present times. As it is evident that water is the most potent agent of mass wasting and transportation of the material, possibly the availability of water in the beginning of the cycle was considerably more resulting into the higher rates of weathering and erosion. The initial relief of the region, thus, was considerably reduced, leaving only some remnants of the ancient topography which are still in the process of peneplanation. The lithology of the rocks has also played an important role in shaping of the landforms as the sandstones of the Nagaur Formation were reduced to the plain surface much faster than the limestones of the Bilara Formation which are still forming a ridge.

After this stage, the area came under the influence of an active arid geomorphic cycle, which resulted in the development of various erosional and depositional landforms. Davis (1905) treated the arid cycle as a modification imposed over the humid cycle due to a change to aridity, one of his so-called climatic accidents. In the present area also, a similar change seems possible. Thus, with the beginning of the arid conditions as the supply of water became lesser and lesser, the channels became obliterated and the water started flowing in sheets, further smoothening the plain surfaces. It indicates that the surfaces (pediments) were initially carved mainly due to erosion, but gradually modified by the deposition of the gravel under sheet flow conditions. Further, the finer fractions of the sediments were blown away by the wind and formed sand dunes. This gravel, lying on the surface, then became coated with red iron-oxide, commonly known as desert Varnish giving a typical desertic landscape in the region forming bajadas. Near the margins, the plains are also gullied which indicates a possible rejuvenation of the area in recent geological past, like the Jaisalmer and Pokaran areas (Anand-Prakash, 1980 a, c).

Apart from these developments, the continuous process of deflation further carved various features characteristic of wind erosion, like small domes of ancient rocks, and deflation basin (depression), etc. The depression possibly represents the local base level of erosion in the area. This depression is known as Bap Rann presently under discussion.

In the final stages, it seems that the aeolian activity has almost completely buried the traces of earlier fluvial activity and a re-adjustment has reached in the area

between the erosional and depositional processes. As the process of deflation could not further erode and deepen the depression it came under the cycle of deposition, and the sediments started pouring into the basin along with the water from the surrounding areas. The shallow nature of the basin (about 5 m in depth) also supports the possibility of the rann being formed due to deflation.

The sedimentation in the basin started with the deposition of a sand layer (2.5 m) followed by a clay band (1.9m), which suggests that in the beginning the supply of water was considerably more to transport the coarser material. Gradually, the availability of water became considerably reduced. Therefore, only finer material could be transported into the basin which further indicates the advancement of desertic conditions and also the fluctuations in the water level of the lake. In general, these facts support the view of AGARWAL *et al.* (1980) that the sediments in the rann were deposited under fluvio-lacustrine conditions suggested on the basis of sedimentological studies. Later, the excessive evaporation resulted in the concentration of salts which has charged the nature of the basin from fresh water to a saline rann.

In the light of the above facts, the history of sedimentation in Bap Rann can be divided into two different phases. The first phase characterised by better rainfall conditions and the second which is still in continuation by drier conditions. Thus, in general, it can be concluded that the region has gone through an initial phase of better rainfall conditions and a later phase of dry conditions.

Apparently, Bap Rann closely compares with the Jaisalmer and Pokaran ranns but for the origin. The Jaisalmer ranns originated mainly due to the presence of a fault along the contact between the Jaisalmer and Baisakhi formations (PANDEY & CHATTERJEE, 1970; ANAND-PRAKASH, 1980a) and the Pokaran ranns owe their origin to the formation of a chain of discontinuous cuestas along the margins of an ancient basin having the hard and compact basement rocks (ANAND-PRAKASH, 1980c), while the Bap Rann is mainly a shallow depression formed due to the process of deflation representing an earlier base level of erosion.

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