



GEOLOGY AND FLUVIAL GEOMORPHOLOGIC CHARACTERISTICS OF SIROHI AND ABU ROAD BLOCKS, DISTRICT SIROHI, RAJASTHAN

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ABSTRACT Fluvial geomorphology is a sub-discipline of geomorphology that investigates how flowing water shapes and modifies Earth's surface through erosional and depositional processes. In the present paper an attempt has been made to study the fluvial geomorphology of the Sirohi and Abu Road blocks of Sirohi district, Rajasthan. The study area has five major rivers namely West Banas (Abu Road block) and Krishnavati, Kameri, Kapal Ganga and Bandi (Sirohi block) which are having dendritic type of drainage pattern. A large number of fluvial geomorphic features have been recorded in the study area which have been developed both by erosional and depositional processes. These include: floodplain, river valley, ravine, meander, confluence, terraces, natural levee, braided stream, riffle, gully, pot holes, plunge pool, cut bank, stream pool, point bar, mid-channel bar, transverse bar, side bar towhead etc.

KEYWORDS : Geology, Geomorphology, Fluvial Geomorphology.

Introduction of the Study area:

The Sirohi district is situated in the South West of Rajasthan between the parallels of 24°20' and 25°17' North latitude and 72°16' and 73°10' East longitude. It covers geographical area of about 5136 sq.km. The district comprises of 5 tehsils, namely:- (1) Sirohi, (2) Sheoganj, (3) Reodar, (4) Abu Road, (5) Pindwara. These tehsils are also established as panchayat samities of the district. A large part of the district is a vast semi desert plain, characterized by undulating topography and marked by isolated hills and chains of hillock forming the eastern and south-western extending Aravalli range in the east. The Gurushikhar peak in Mount Abu region is 1722 meter above mean sea level, this is the highest point in the State. Average annual rainfall (1977-06) of the district is 769.2mm. The irrigation in the district is dominantly made through wells/tube wells. Groundwater is the main source for irrigation, and is utilized through dug wells, DCB's (elaborate), and tube wells. Canal irrigates only a small area in the region. Important irrigation projects in the district are West Banas, Sukli, Selwara, Angor, Kameri, Swaroopsagar, Kailashnagar, Mandar Nallah etc. Present study is focused on two blocks of Sirohi district namely: Sirohi and Abu Road. The Sirohi block is having 84 villages and covering an area of 1105 sq.km while the Abu Road block is having 92 villages and covering an area of 876 sq.km.

The groundwater in the district occurs under water table conditions both in unconsolidated and consolidated formations. Its occurrence is controlled by topography, physiography and structural features of the geological formations. The movement of ground water in rocks is governed by size, openness, interconnection and continuity of structurally weak planes while in unconsolidated rocks, while in consolidated rocks ground water movement takes place through pore spaces between grains. Water bearing properties of different aquifers of the region, are described in the present study.

Major hydrogeological units in the district are- (a) phyllites and schists (b) rhyolites and granites and (c) older and younger alluvium.

Geological Characteristics of the area:

Regional geology of Sirohi district and adjacent areas had been described by few of the earlier workers like Blanford (1877); Hackett (1889); Oldham (1893); Coulson (1933); Heron (1917, 1935); Raja Rao et al. (1971) etc. In recent years the geology of the district is discussed in detail by GSI (1980), Sharma (1996), Roy and Jhakar (2002) Sharma (2004), de Wall et al., (2014); Kapasiya et al., (2017); Pande et al., (2017) etc. Geologically, the Sirohi district forms the southwestern part of the Delhi Supergroup and Malani rocks. The eastern and the central parts of the district are occupied by the metasediments of the Delhi Supergroup and Sirohi Group, These are intruded by mafic and ultramafic rocks and granites of different ages i.e. Sendra-Ambaji Granite (~1000 Ma to 850 Ma.), Erinpura Granite (~1000 to 735MA.) and Malani Igneous Suite of rocks (~750 Ma.).

Near Mer-Mundwara in Sirohi block younger igneous rocks (~65 Ma) have also been reported. Further, major part of the Sirohi district is also covered with quaternary and recent alluvium and blown sand. Geology of the Abu Road and Sirohi blocks reveals that the basement rocks in Abu Road block Sirohi block it are older granitic gneisses having tectonised sheared contact with cover metasediments.. Rocks of Sirohi Group and Mundwara alkaline complex are not exposed in the Abu Road block. A comprehensive geology of the Abu Road and Sirohi blocks are given in Table 1 (After GSI, 1980).

Table 1 : Generalized Geology of Abu Road and Sirohi Blocks (After GSI, 1980; Sharma 2004; Schöbel, et al., 2017)

Time framework		Abu Road Block	Sirohi Block
Quaternary to Recent		Alluvium and Aeolian sand	Alluvium and Aeolian sand
Tertiary	Mundwara Alkaline Suite		Synite Gabbro Picrite Basalt Tuff
Neoproterozoic	Sirohi Group= Malani Magmatism		Jalore/Mirpur granite Felsic /Basic Dykes Younger Conglomerate Arkose Silicic tuffs Felsic volcanics Basic Volcanics Conglomerate
	Younger Erinpura Granite (850 Ma)	Erinpura Granite	Erinpura Granite
	Sirohi Group	Mica-Schist, Phyllite Sendra-Ambaji Granite and older granite	Carbonaceous phyllite Marble, Calc silicatest Mica-Schist, Phyllite Quartzite
Mesoproterozoic	Delhi Supergroup	Calcite marble Calc-Gneiss Phyllites Quartzite Basic volcanics	

Riffle: A riffle is a shallow landform in a flowing channel. These are almost always assessed at a very low discharge compared to the flow that fills the channel (approximately 10–20%), and as a result the water moving over a riffle appears shallow and fast, with a wavy, disturbed water surface. The water's surface over a riffle at low flow also has a much steeper slope than that over other in-channel landforms (*Leopold and Gordon, 1957; Wyrick et al., 2014*). In the area at number of places within the major rivers and tributaries the riffles have been observed (Photograph 7).

Gully: A gully is a landform created by running water, eroding sharply into soil, typically on a hillside. Gullies resemble large ditches or small valleys, but are meters to tens of meters in depth and width. When the gully formation is in process, the water flow rate can be substantial, causing a significant deep cutting action into soil (*Charlton, 2008*). At numerous places the gullies have been noticed in the area (Photograph 8).

Pot Holes: These are small depressions in the rocky beds of the river. Potholing or pothole-drilling is the mechanism through which the grinding tools (fragments of rocks, e.g. boulders and angular rock fragments) when caught in the water eddies or swirling water start dancing in a circular manner and grind and drill the rock beds of the valleys like a drilling machine. They thus form small holes which are gradually enlarged by the repetition of the said mechanism. The potholes go on increasing in both diameter and depth. In the river bed of West Banas fifteen potholes have been reported (Photograph 9).

Plunge Pool: It is (plunge basin) is a deep depression in a stream bed at the base of the water fall. It is created by the erosional forces of falling water on the rocks at fall's base where the water impacts (Stephen, 2009). In the area plunge pools have been observed at twelve places in Abu hills and Sirohi hills (Photograph 10).

Cut bank: A cut bank, also known as a river cliff is the outside bank of a water channel which is continually undergoing erosion. They are shaped much like a small cliff, and are formed by the erosion of soil as the stream collides with the river bank (Stephen, 2009). In the area at several places within the major rivers and tributaries the cut banks have been noticed (Photograph 11).

Stream Pool: It is a stretch of a river or stream in which the water depth is above average and the water velocity is quite below average. In the area at six places in the river bed of West Banas, the stream pool has been observed (Photograph 12).

Point Bar: A point bar is a depositional feature made of alluvium that accumulates on the inside bend of streams and rivers below the slip-off slope. They are crescent-shaped and located on the inside of a stream bend (*Charlton, 2008*). In the area at numerous places within the major rivers and tributaries the point bars of variable size have been observed (Photograph 13).

Mid Channel Bar: These are the land form within a river having high elevation than the surround area. These bars are elongated in the direction of flow and form at the centre of the channel. They grow by the accumulation of finer material both in an upward and in a down stream direction (Church and Jones, 1982). In the present area at thirty three locations the mid channel bars of various shapes and sizes have been observed within the river beds and tributaries (Photograph 14).

Transverse Bar: These are lobe shaped with relatively steep down stream faces. These are commonly found where there is an abrupt channel expansion. These are not usually attached to the banks (Church and Jones, 1982; Robert, 2003). In the present area at around 11 places the diagonal bars have been reported (Photograph 15).

Side bars: These are the accumulation of sand, gravel, or other alluvial material along the edges of relatively straight sections of rivers. In the present area at several places the diagonal bars of various length and width have been reported.

Towhead: The term towhead or river island implies a little island or sandbar within a river and having a grouping of bushes or trees. In the present area at three places within the West Banas, the river island has been reported (Photograph 16).

Photograph 1: Seepage spring at Gomukh, Mount Abu



Photograph 2 : Waterfall at Matarmataji, Sirohi Block



Photograph 3: Google image of Flood plain of West Banas



Photograph 4: Google image showing meanders in West Banas and its tributaries



Photograph 5 : Google image showing confluence



Photograph 6 : Terraces along the bank of West Banas



Photograph 7 : Riffle within the bed of West Banas.



Photograph 8 : Gully erosion



Photograph 9 : Pot hole in river bed of West Banas



Photograph 10 : Plunge pool at the base of water fall



Photograph 11 : Cut bank within the tributary of West Banas



Photograph 12 : Stream pool within the tributary of West Banas



Photograph 13: Point bar at the river bed of West Banas



Photograph 14: Mid channel bar within West Banas river bed.



Regional Geomorphology:

Geomorphology is concerned with the study of landforms, with the forces and processes that have shaped them, and with the description and classification of various physical features on Earth. It is the study of Earth's physical land surface features, its landforms – rivers, hills, plains, beaches, sand dunes, and myriad others (Huggett, 2003).

Process geomorphology is the study of the processes responsible for landform development. Geomorphically, relevant processes generally fall into (1) the production of regolith by weathering and erosion, (2) the transport of that material, and (3) its eventual deposition.

Regional geomorphology of Abu Road block is hilly and categorized as structural hills. The West Banas river constitutes major drainage in the block, which originates from the Eastern slope of Abu hills. The pediments are exposed all along the hill slopes and plane areas. The Alluvial plain lies along the banks of the West Banas river and its tributaries. Ravine and river valleys are found within the Abu hills. The major part of the Sirohi block is covered by the pediments and buried pediments. Alluvial plains present along the rivers Kapalganga, Krishnawati, and Kameri rivers. The central and western part of the block is covered under hilly area.

Fluvial Geomorphology of Study Area:

Fluvial geomorphology is a sub-discipline of geomorphology that investigates how flowing water shapes and modifies Earth's surface through erosional and depositional processes (Splinter and Marstone, 2016). Fluvial geomorphology studies identify and quantify these processes, which are dependent on climate, land use, topography, geology, vegetation and other natural and anthropogenic influences. The study of rivers and their works has an important place in geomorphology, especially in fluvial geomorphology. The river channels play a key role in the development of fluvial landforms. The landforms created as a result of degradational action (erosion) or aggradation work (deposition) of running water is called fluvial landforms. These landforms result from the action of surface flow/run-off or stream flow (water flowing through a channel under the influence of gravity). The creative work of fluvial processes may be divided into three physical phases—erosion, transportation and deposition. It is observed that the majority of the landforms of the land-surface of the earth are of fluvial origin (Leopold, et. al., 1964; Knighton, 1998; Robert, 2003; Charlton, 2008). The fluvial geomorphic characteristics of the study areas are as under:

(a) Major Rivers and Tributaries:

The study area has five major rivers namely- West Banas (Abu Road block) and Krishnawati, Kameri, Kapal Ganga and Bandi (Sirohi block). These rivers are actually originated from the hills of Abu and Sirohi. Apart from these major rivers the important tributaries are Batriya nadi, Gabir nala, Sukli nadi, Bewaran nadi and Suket nadi (West Banas).

(b) Drainage Pattern :

In geomorphology, drainage systems, also known as river systems, are the patterns formed by the streams, rivers, and lakes in a particular drainage basin. They are governed by the topography of the land, whether a particular region is dominated by hard or soft rocks, and the gradient of the land. A drainage basin is the topographic region from which a stream receives runoff, through flow, and groundwater flow. Over time, a stream system achieves a particular drainage pattern to its network of stream channels and tributaries as determined by local geologic factors. Drainage patterns or nets are classified on the basis of their form and texture. Their shape or pattern develops in response to the local topography and subsurface geology. In the present study area dendritic drainage pattern is the most common form and looks like the branching pattern of tree roots and in this pattern tributary joining larger streams at acute angle.

(c) Springs and Water Falls:

A spring is any natural situation where water flows from an aquifer to the Earth's surface while a waterfall is a place where water flows over a vertical drop or a series of drops in the course of a stream or river. In the present area perennial springs are rare however at few places seasonal springs (during rainy season) were encountered in the hilly areas of Mount Abu in Abu Road block. Only at one place i.e. "Gomukh" at Mount Abu one spring is reported. Here the small quantity of water is

flowing out. However, after rains the quantity got increased. The type of spring is of "seepage spring" and on the basis of water discharge, it can be classified as "7th magnitude spring i.e. 1 pint/min to 1 gal/min". This place now became a religious place and around the opening of the spring a cow-face has been constructed by the devotees (Photograph 1).

Similarly number of small sized water falls has been recorded within the hills of Mount Abu area in Abu Road Block and Bahrihata Hill in Sirohi block. Nearly 52 waterfall and 12 waterfalls of variable size have been observed in Mount Abu and Sirohi hills. Most of these water falls are rain-fed and came into existence during rainy season only (Photographs 2).

(d) Fluvial Landforms :

In the present study area a number of fluvial landforms have been identified which include both erosional as well as depositional categories. The descriptions of the important fluvial landforms noticed from the area are as under:

Flood Plain : A flood plain is an area of land adjacent to a stream or river that stretches from the banks of its channel to the base of the enclosing valley walls and experiences flooding during periods of high discharge (Goudie, 2004). In the area at several places all along the major rivers and tributaries the flood plains have been observed (Photograph 3).

River Valleys: The extended depression on ground through which a stream flows throughout its course is called a river valley. At different stages of the erosional cycle the valley acquires different profiles. At a young stage, the valley is deep, narrow with steep wall-like sides and a convex slope. The erosional action here is characterized by predominantly vertical down cutting nature. The river valleys of varied sized and length have been seen within the Mount Abu hills in Abu Road block.

Ravine : A ravine is a steep valley which is formed due to linear/dendritic fluvial erosion of loose unconsolidated and bare soils byes. In the area within the hills of Abu, at several places ravines are reported.

Meanders: A meander is defined as a pronounced curve or loop in the course of a river channel. The outer bend of the loop in a meander is characterized by intensive erosion and vertical cliffs and is called the cliff-slope side. This side has a concave slope. The inner side of the loop is characterized by deposition, a gentle convex slope, called the slip-off side (Neuendorf et. al., 2005; Charlton, 2008). In the area well develop meanders are observed in West Banas and its tributaries (Photograph 4).

Confluence : It is the meeting of two or more bodies of water. It refers either to the point where a tributary joins a larger river, (main stem), or where two streams meet to become the source of a river of a new name. In the area 11 major confluences in Abu Road block and 7 major confluences have been reported within the rivers West Banas, Kapalganga, Kameri and Krishnawati (Photograph 5).

Terraces: These are stepped benches along the river course in a flood plain. Terraces represent the level of former valley floors and remnants of former (older) flood plains (Fairbridge, 1968). In the area at many places along the major rivers and tributaries the terraces have been observed (Photograph 6).

Natural Levees: These are narrow ridges of low height on both sides of a river, formed due to deposition action of the stream, appearing as natural embankments. These act as a natural protection against floods. In the area at many places along the major rivers and tributaries the natural levees have been observed.

Braided Stream : These contain sediments deposited as numerous bars around which water flows in highly inter connected rivulets. They generally occur in river or stream having high sediment load. Braided channels are also typical of environments that dramatically decreased channel depth and consequently channel velocity. In the area all the rivers and major tributaries show the braided nature of stream.

Photograph 15 : Transverse bar in river bed Krishnawati**Photograph 16 : River island in West Banas****References:**

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