

Geological Setting and Study of lava flows around Shivna River Basin in Madhya Pradesh (India)

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Abstract

Geologically, the Shivna river basin region is occupied by rock formations of different geological periods. It is characterized by the presence of the Kharip/Semri Group of Vindhyan Super Group (Proterozoic), and Deccan Traps (Upper Cretaceous to Lower Eocene) developed under a capping of the Laterite and Alluvium (Pleistocene to Holocene). The constituent flows in the Deccan are mainly of two types, namely, pahoehoe and 'aa' types, the former being predominant in the East west and south, whereas the 'aa' types is prevalent in northeast of the Shivna river Basin. The present study is mainly confined to geological Setting and Study of lava flows around the Shivna River Basin, North Western Region of Madhya Pradesh.

Keywords: Deccan traps, Lava flow, Lithology, River Basin, Sandstone, Stratigraphic.

Introduction

In India, Madhya Pradesh and Rajasthan are those regions which are generally facing the problem of water supply in many of their parts resulting in the situation of dearth in such areas. Shivna River becomes almost dry during summer duration and the study basin area results in the position of shortage of water supply (Bamniya, 2016).

The hydrogeomorphology of the Shivna River basin is a modest endeavour to elucidate the action of running water distressing the features of the landscape termed widely a fluvial geomorphology. The investigation of the basin characteristics reveals various litho structures and process of landforms assessment both innate and human induced (Bamniya, 2016).

Study Area

The Shivna river Basin area lies between Latitudes 23° 32' to 24° 15' N and Longitudes 74° 47' E to 75° 22' E (Survey of India, Toposheet No 46 I/13 and 14, 46 M/1, 2 and 5, 45 L/16, 45 P/4,7 and 8 on the scale of 1: 50,000, Fig.1). Shivna River originates from the Sevna village, (23° 42'30.6" N: 74° 48' 91.4" E) at an elevation of about 524 m. in Pratapgarh District of Rajasthan, Shivna River is a main tributary of Chambal River, which extends over 103.4 km covering parts of (Mandsaur and Ratlam district) Madhya Pradesh and (Pratapgarh district) Rajasthan, Shivna River Basin covers a total area of 3361.52 sq.km.

Regional Geology

Physiographically, the area lies on the Malwa plateau. geologically the area Consist of Vindhyan Supergroup of Mesoproterozoic age and is grouped under Kharip/ Semari group, followed by Deccan Traps of upper Cretaceous to Lower Eocene, Laterite and Alluvium of Pleistocene to Holocene age.

Geologically, this region is occupied by rock formations of different geological periods. The Binota Shale is the lower most unit of the Kharip/Semari group it comprises grey shale with thin beds of white and pink clay and is conformably overlain by grey and pink Sandstone, The Jiran Sandstone which occurs as inliers in the Deccan Trap west of Basin. Bari Shale overlies confirmably the Jiran Sandstone. Quartzitic sandstone and quartzite (Kaimur Group), Shale and Sand stone (Rewa Group) shale and limestone (Bhander Group) represents the Upper Vindhyan (Khan et.al.1992).

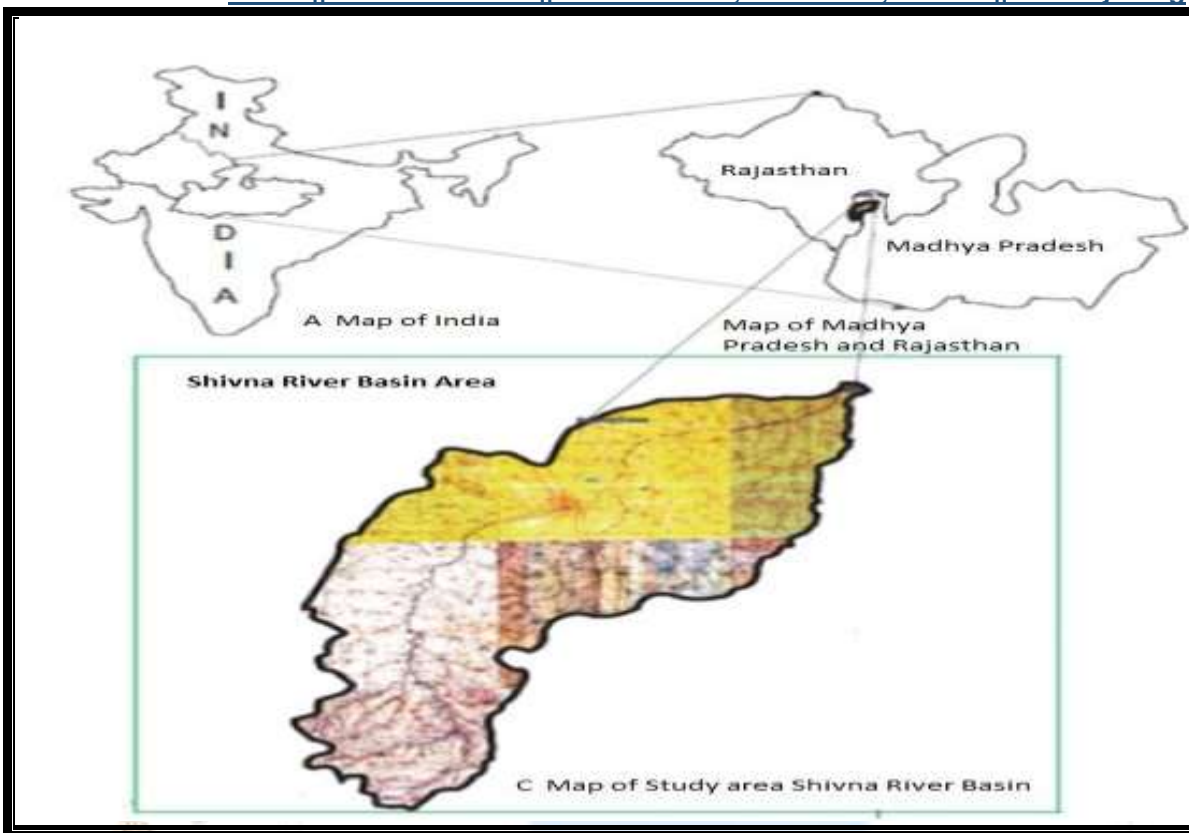


Fig 1. Location Map of Shivna River Basin, North Western Region, M.P., India.

Deccan Trap constitute one of the important stratigraphic groups and occur as isolated outcrops covering an area of 5, 12,000 sq. km in parts of Maharashtra, Gujarat, Madhya Pradesh and Andhra Pradesh. The Traps are comprised mainly of series of lava flows and volcanic products such as ash, tuffs, and breccias and also inter trappean beds occurring in between two lava flow. The generalized geological succession of Deccan Trap is given in Table 2.

Table 2: -Generalized Geological Succession of Deccan Traps in Indian Region (after Krishnan, 1968, 1982).

		Unconformity
Upper Eocene	:	Nummulitic Limestone of Surat and Baroch
Upper Traps (450 m) thick	:	Mumbai and Kathiawar, with numerous intertrappean beds and layers of volcanic ash.
Middle Traps (1200 m) thick	:	Central India and Malwa, with numerous ash beds in the upper portion and Partially devoid of inter-trappeans.
Lower Traps (150 mm) thick	:	Central Provinces and eastern area; with inter trappean beds, but rare ash beds.
		Unconformity
Lameta formation/Bagh beds Jabalpur formation/older rocks		

The basaltic lava flows of Cretaceous-Eocene age with subordinate inter-trappean sediments have been grouped into Deccan Trap. In Madhya Pradesh, The Deccan Trap occupies more than half of the total area of the state. The trap comprises horizontal to sub-horizontal lava flows and forms a flat-topped terraced plateau. Maximum of 48 such flows are exposed between the elevation of Tasdin hill of Satpura ranges (1,033m) and Khalghat on Narmada River bed (138 m) in Khargone District, comprising a total exposed thickness of 895 m in the southern escarpment of the plateau. The constituent flows in the Deccan are mainly of two types, namely, pahoehoe and 'aa' types, the former being predominant in the west, where as the 'aa' types is prevalent in east and northeast. Compound pahoehoe types dominate the lower sequence of the Deccan trap pile. The presence of inter-terppean sedimentary rocks and red clay, weathered flow top in the form of red bole, weathered bottom of the flow to green earth, palaeo-weathering of upper part of the flow. In Madhya Pradesh, The Deccan lava flows have been classified into three groups, viz. Malwa, Satpura and Amarkantak groups. Malwa Group in malwa plateau and in southern Narmada valley is represented by a total

no. of 28 basaltic flows with an average thickness of 15 to 20 m in a vertical column of 590 m, occurring between 170 and 760 m above msl (Jain, 2006).

Table 3: -Generalized sequence of Malwa Group (Malwa Plateau)

	Formation	Thickness	Description
Malwa Group	Bargonda Formation	100 m	Six fine grained moderately porphyritic 'aa' type basaltic flows with an intertrappean bed at 660 m above m.s.l.
	Indore Formation	80 m	Four dark grey fine grained sparsely porphyritic and columnar jointed flows with an intertrappean bed at 560 m above m.s.l.
	Kankaria- Pirukheri Formation	80 m	Five fine to medium grained and moderately porphyritic flows
	Kalisindh Formation	145 m	Seven fine grained and sparse to moderately porphyritic flows mega porphyritic flow at the top
	Mandaleswar Formation	105 m	Five fine grained and porphyritic 'aa' type flows with a mega porphyritic flow

Deccan Traps (Malwa group) comprise to Basaltic flows which have been grouped into Kalisindh and Kankariya – Pirukhedi Formations. The Kalisindh Formation consist of 3 'aa' flows which are fine grained and non-porphyritic. The flows have a vesicular top. The Kankariya – Pirukhedi Formation contains 5 'aa' flows which are fine grained and sparsely to moderately porphyritic. The upper 2 flows are Pahoehoe type flows and range in age from Upper Cretaceous to Eocene age. These lava flows are characterized by the existence of spheroidal vesicles. The lava flows are mainly consist of basalts and reveal variations in texture, mineralogy and vascularity.

Brown ferruginous laterite capping occurs over the Vindhyan and the Deccan Trap. The laterite is spongy and concretionary with small sandstone fragments and sand grains. Laterite on the Deccan traps is brownish, mottled, pisolitic, spongy and concretionary. Brown pink and grey lithomarge occurs below the hard crust of laterite. Alluvium occurs as a narrow belt along the major river courses. it comprises grey, compact, calcareous gravel bed, Sandstone and sub angular to subrounded fragments of basalt, laterite and chert. The flood plains on the banks of the Shivna rivers comprise sand and silt (Khan et.al.1992).

Results

Geology of Shivna River Basin area

Based on available information and present survey of the study area, the following stratigraphic succession has been worked out Table.1

Table1.Generalized Geological Succession of Shivna River Basin, North Western Region, Madhya Pradesh.

Period/Age	Stratigraphic status		Lithology
Pleistocene to Holocene	Recent		Alluvium and Laterite
.....Unconformity.....			
Upper Cretaceous to Eocene	Kankariya-Pirukhedi Formation	Deccan Trap	Basaltic Flows (5 aa and 2 Pahoehoe Types)
	Kalisindh Formation		Basaltic Flows (3 aa type)
.....Unconformity.....			
Neo Proterozoic	Semari/Kharip Group		Jiran Sandstone
			Binota Shale

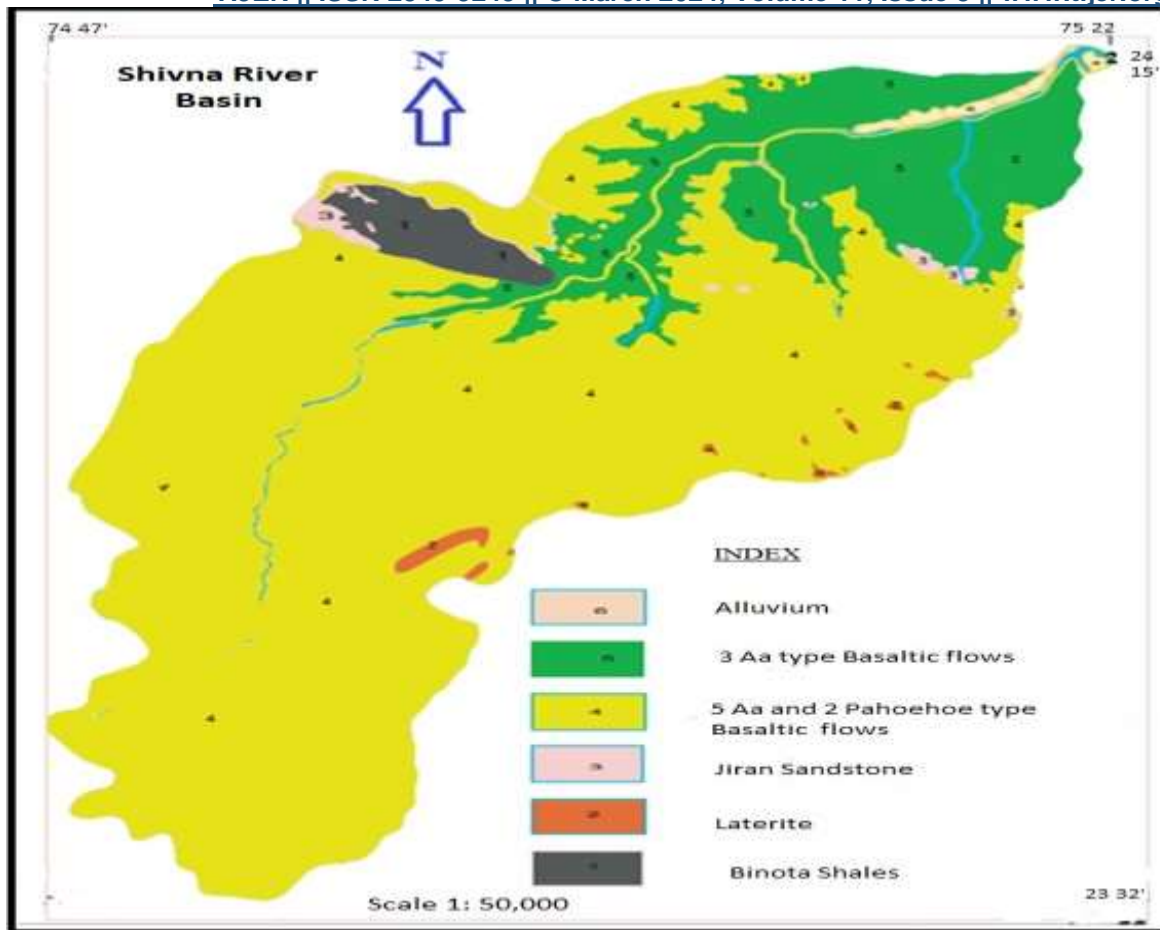


Fig 2. Geological map of Shivna River Basin, North Western Region, M. P.

The geological setting of area is characterized by development of rocks of different ages, ranging from Mesoproterozoic to Recent.

Kharip/Semari Group

Kharip/Semari Group constitutes the oldest geological formation in Shivna River Basin area. It is represented by Binota shale and Jiran Sandstone, which are well developed in the North-West sector of study area.

Binota shale

Binota shale is exposed along Mandsaur – Rewas Dewar a road, village Gogarpura ($24^{\circ} 08' N.-74^{\circ} 59' E.$), Pithhakheri ($24^{\circ} 07' N.-74^{\circ} 59' E.$), Ghatawda ($24^{\circ} 05' N.-74^{\circ} 58' E.$), Multanpura ($24^{\circ} 06' N.-75^{\circ} 00' E.$), Bugalari ($24^{\circ} 04' N.-75^{\circ} 00' E.$) and Damdkheraat ($24^{\circ} 03' N.-75^{\circ} 01' E.$) in Basin area. The shale is grey, white to pink and soft in nature. It reveals bedding planes vertical and inclined, fine grained, near Gogarpura village.

Jiran Sandstone

Binota Shale is conformably overlain by grey and pink Sandstone, which is known as the Jiran Sandstone occurring as inliers in the Deccan trap in Northwest of study Basin. The ridges of sandstone are developed in North-West sector of the Basin. The Jhiran Sandstone is hard, compact, grey with purple stains, and quartzitic at few places and ferruginous in nature.

The ripple marks have been observed in Jhiran Sandstone. The presence of minor inliers of sandstone within the Deccan traps is observed at Rewas-Dewara road

Deccan Trap

The Basin area predominantly occupied by different basaltic lava flows developed under a fairly thick blanket of black cotton soil/alluvial soil/laterite.

The important features of the flows are described in the following lines:

Lava Flow– 3 In the Basin area, the Lava Flow -3 overlies the Lava Flow -2 with the presence of red bole, which is visible at several places. The good exposure of flow 3 has been observed at many places including the village of Kachnara and Goutamnath (Fig. 3) showing well developed joints.

Lava Flow 2. Flow - 2 overlies the Flow -.1 with a fairly sharp contact. It is yellowish brown in colour, rather medium grained and weathered. In a well section at Nahargarh inconsistent layers of clay and zeolites with thickness of about 12 cm separating the two flows. It has been observed well section at Achera (Fig. 4).it has this flow has been observed at other places such as Songaria, Jagakheri and south-west of Dhabla. It is more or less identical to the vesicular part of Flow -1. The vesicular flow is overlain by a red boles band.



Figure 3. Photograph Showing distinction of Lava Flow-3 near village of Gautamnath.

Figure 4. Photograph of Basaltic Lava Flow -2 exhibiting the near village Achera.

Lava Flow 1: -This flow occurs at elevation of 416 m. (a.m.s.l.) along the Shivna River. This Flow is well exposed near Hingoria (Fig. 5), Patan Pipliya and others places. This flow is grayish dull in colour, fine grained, vesicular and with variable thickness.



Fig.5. Photograph exhibiting view of Lava flow 1 near village of Hingoria.

Red Bole

It is a weathered product of lava flows, which acts as criteria for distinction between two lava flows. In the study area red bole helps in the identification of two different flows from each other. The Red bole reveal as variation in thickness varying from 0.5 to 2.0 m.

Laterite

Laterite occurs as a cover of basaltic lava flow. It is cherry brown in colour, residual deposits of hydrated iron oxide. Laterite exposures occurs as isolated on the top of hillock namely along road of Rewas-Dewara, Botalganj and some patches in south-west Basin area. It is

hard in nature and showing well developed out crop. Laterite is now useful in brick industries.

Alluvium

The Alluvium deposit of recent age occurs as narrow linear belt along the Shivna River and its tributaries. Alluvium is characterized by fine to medium grained and admixture of fine silt and clay. The thickness of Alluvium is fairly thin in the area.

Discussion

The earliest account of the area was given by Hacket. C.A. (1881) when mapped mainly the western part of the area, he referred the pink and grey shale of the older formation to the Aravalli but the overlying sandstone as Delhi series. Later on, Jones, H.C. (1910) mapped the northern part of the area and doubtfully correlated inliers of quartzitic sandstone near Dhorwara ($24^{\circ}13':75^{\circ}10';45P/4$) and Diknio ($24^{\circ}10':75^{\circ}05';45P/4$) to the Aravalli series. However, in the Shivna River Basin area mapped by the present work the shale and sandstone (quartzitic) are seen to be conformation and pass from each other without hiatus. The sandstone (quartzitic) overlying the shale is similar to the other quartzitic sandstone inliers reported earlier as well as found while mapping. At a few places this patches of conglomerate overlies the sandstone. Thus, the conformable sequence of strata consisting of shale, sandstone and conglomerate seem to belong to one formation and is tentatively correlated with the Delhi Series. Roy chowdhary, M.K. (1955) correlated the shale and sandstone with the Binota shale of the Aravalli and the Jiran sandstone of the Delhi Series, respectively.

Systematic geological mapping in 1:63,360 scales in parts of Mandsaur district, Madhya Pradesh was carried out jointly by S.N. Bhattacharjee (Geologist) and R.L. Munshi (Geologist) in toposheet no. 45P/3 & 4 as per item No. 19 page no. 157 of the field programme of the Geological Survey of India, for the year 1967-68. Geological investigations in this region have been carried out by Geological Survey of India and Project, District Resource Map – Geology and Minerals M.P., Dr.A.A. Khan, N.P. Patel, R. Bharathi, A.K. Sahu (1992) have published geological account of Mandsaur region. The Shivna River Basin area is occupied by rock formations of different geological periods. The Binota Shale is the lower most unit of the Kharip/Semari group it comprises grey shale with thin beds of white and pink clay and is conformably overlain by grey and pink Sandstone, The Jiran Sandstone which occurs as inliers in the Deccan Trap west of basin represents the Upper Vindhyan.

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Conclusion

On the basis of field observations, the author has recognized different types of lava flows. The commonly followed characters for flow identifications have been adopted in the study.

1. Nature of the bedding plane and joint pattern.
2. The occurrence of red bole/ green bole horizon.
3. The existence of fragmentary or clinkery top of flow, just below the Upper flow unit.
4. The individual lava is recognized by upper vesicular basalt unit followed by the lower massive unit.
5. Difference in the weathering. Presence of weathered surface and resultant materials.
6. Lithological variations revealed by the differences in, the shape, size and nature of vesicles or porosity of rock.
7. The existence of secondary minerals that vary in type or proportion of mineral species.
8. Petrographical characteristics difference in texture and mineralogy.
9. The contact of lava flows exhibits following characteristic –
 - I. Sharp contact,
 - II. Presence of red bole or green ash bed, and
 - III. Inter trappen formation



Fig.6. Photographs of Basaltic lava flow exhibiting the characteristic features-

A -Fine grained grey basalt exposed near the village of Khatyakhedi.

B -Greenish white basalt with peculiar vesicles exposed near Village of Karnakhedi.

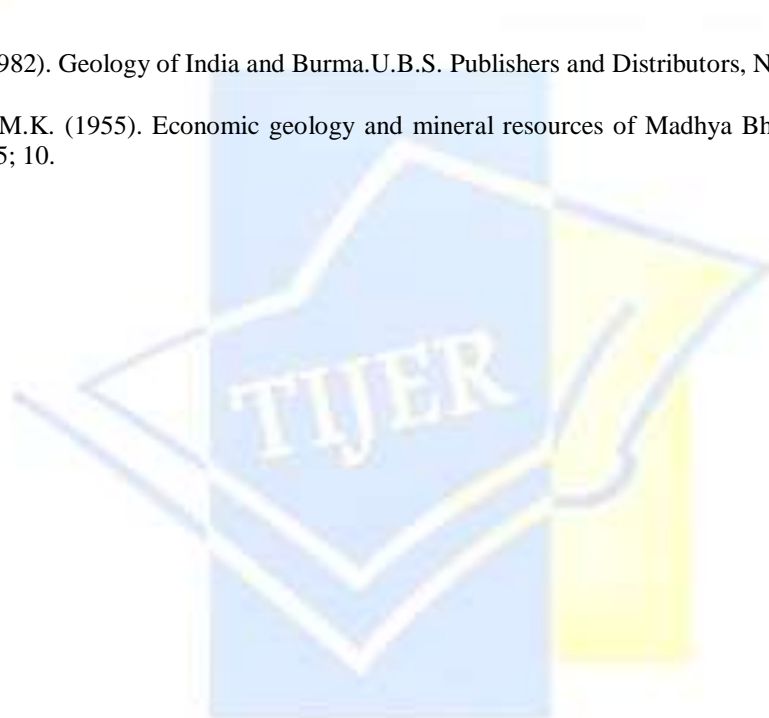
C -Dark grey fine grained basalt exposure observed near Village of Achera.

D -Fine grained grayish white basalt exposed near Village of Karju.

Conflict of interest- No Conflict of interest

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