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# Flowing pattern of Saraswati River: A link with lineaments in Haryana, Rajasthan and Gujarat

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## ABSTRACT

The several rivers were originated from Himalayan's glaciers during the vedic periods. Saraswati River was also one of them, flowed from Himalaya to Rann of Kutch (Gujrat) which gave rise to a great vedic civilization. Surface signatures like lineaments, faults and joints which represent the crustal fractures of deep seated nature have been studied to know the flowing path history of rivers. There are several lineament structures in Haryana, Rajasthan and Gujarat and these structures formed by volcanism and plutonism during Archaezoic to Cenozoic periods. Malani Igneous Suite (MIS) is the third largest felsic magmatism in the world and spreads in Northwestern Rajasthan and Southwestern Haryana of India. The Malani magmatism is controlled by NE-SW trending lineaments. The Sirohi and Jhunjhunu lineaments are located at Eastern boundary of the MIS and Ganganagar lineament is located at Western boundary of MIS. These lineaments of Rajasthan are extended to Haryana and showing NE-SW trends. Large numbers of minor-intermediate-major lineaments are observed in Haryana which created a way to surface for magma extrusion and produced an extension for malani rocks. LANDSAT imageries have been used to locate the former River courses in the plains and beneath the Thar Desert upto the Rann of Kutch by geoworkers and identified the existence of palaeo-river valleys and major structural trends (lineaments) in the region. Geological setup along the flowing course of ancient saraswati river can be used to understand the history of palaeochannels of the river with reference to their dimensions and present connectivity with the aquifers having good quality of waters.

**KEYWORDS:** Lineaments, Malani Igneous Suite, Rajasthan, Haryana, Saraswati.

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## INTRODUCTION:

The Saraswati River flowed during 6000-3000 BC and originated from the Bandapunch Massif (melting glaciers of Garhwal Himalaya). The course of River through the foothills via Adibadri, Bhavanipur, and Balchapur and flowed through the plains of Punjab, Haryana, Rajasthan and Gujarat and at last, finally fall into the Arabian Sea at the Great Rann of Kutch [1,2].

Saraswati river shifted their courses may be because of many reasons which are disappearance or disintegration of river, river piracy, steady decline of waters culminating in drying up of their beds, are all typical responses to tectonism (uplift, faulting, subsidence, tilting), earthquakes, adverse climate and other natural events [3,4] . A number of workers explained the existence of palaeo-river valleys and identifying major structural trends (lineaments) in these region [4, 5].

Firstly, time Hobbs[6] coined 'lineaments' term as curvilinear features on the earth's surface. The lineament structures on the surface can be used as representative of subsurface structural behavior in form of geological, geomorphological and geophysical data. In the present scenario, the extensions and distribution of linear structures is being widely studied by satellite and airborne techniques. Lineaments are defined as surface expressions of faults, fractures, continental margins and submarine ridges[6, 7, 8, 9, 10, 11]. Lineaments in Rajasthan and Haryana area studied and identified with Malani Igneous Suite (MIS) structures and these lineaments follow the NE-SW trend. Several workers attributed that Saraswati River migrate their course because of tectonically rise of Delhi-Hardwar ridge and uplift in the Aravallis [12, 13] and Structural control over the migration of Saraswati river [14] .Great Indian desert and adjacent parts of western Rajasthan area is dissected by several lineaments, some of which (e.g. Luni–Sukri lineament) were reactivated during Pleistocene–Holocene period bringing about alignment of Saraswati with Ghaggar [15]. Sirohi, Jhunjhunu and Ganganagar lineament are located at Western boundary of MIS and these lineaments of Rajasthan are extended to Haryana and showing NE-SW trends. The aim this paper is to attract the attention of geoworkers towards the application of linear structures for palaeochannels studies.

## DISCUSSION:

Most of the lineaments are interpreted by the geoworkers globally, lineaments controlled drainages which are sharply deflected by the lineaments are interpreted as deflected drainages. Significant of lineaments in river channels are crests of ridges or boundaries of elevated areas, drainage lines, coast lines and boundaries of geological formations. Geomorphology and drainage patterns control the lineaments and are recognizable on satellite images and digital topography.

**Case study 1.**The Bighorn Mountains are a mountain range in northern and southern mountain in the United States, forming a northwest-trending. There is structural break between pyrope and Bigborn

Mountains; both are affected by Tongue river lineament [16]. This lineament reveals that flow was directed westward along the lineaments some of the channels must have been diverted South into northern.

2. Western Amazon Basin near Manaus (South America) have three tectonic component :Ariaú Graben, Castanho-MamoriGraben and Manacapuru Basin. The Ariaú Graben and Castanho-Mamori Graben is a NE-SW rectangular asymmetric feature, faulting along NW-SE, NE-SW and N-S, represented by the relief and drainage lineaments along the same directions whereas the Manacapuru Basin corresponds to the depression and north and south by E-W strike-slip faults and to the east and west by NE-SW normal faults, plunging NW and SE. In this area, the sudden change of the course of the Solimões River is caused by faults, marking the boundary of the Manacapuru Basin. The important role of neotectonics in controlling the fluvial morphology and sedimentation processes of the western Amazon Basin.

3. The flowing pattern of Chenab River near Raoli, Lahulspiti District, and Himachal Pradesh, India is affected by two set of lineaments [17]. The major river is controlled by one set of lineaments and other river channel, Nallah is controlled by another set of lineaments, additionally lower order streams are controlled by lithology, as a result they have sub-parallel, parallel & dendritic pattern.

In the light of above significantly features of lineaments, we are apply this study also on saraswati river course is NE–SW which follows the direction of lineamemts of Haryana, Rajasthan and Gujarat. Saraswati flowed along a channel as the Ghaggar river (presently identified in Haryana) considered as Saraswati's upper part and as a Hakra River in Rajasthan is considered as lower part and Nara in Sind[1, 18] (Figure 1).

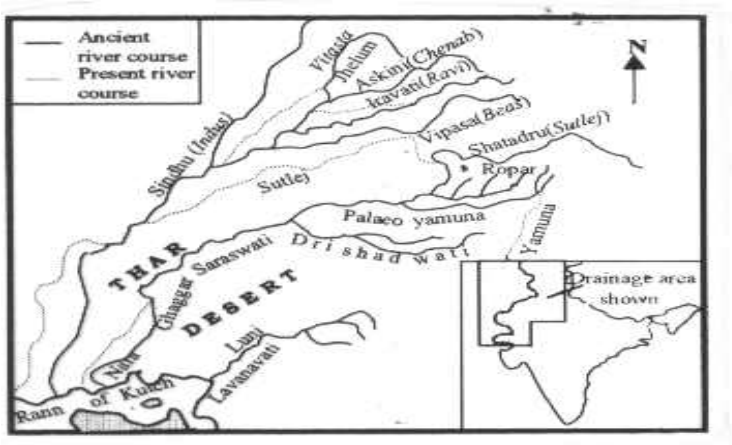


**Figure 1.River system in North Peninsular India[1.]**

The lineaments of Haryana, Rajasthan and Gujarat give an idea about a stunning association traversing the rock types of assorted ages (Fig.2 & 3). Fig.2 indicates that all lineaments trend NNE-SSW to NE-SW and follows the trend of Aravalli fold axis, which have limited length extent up to

30 km. In Rajasthan and Gujrat, the charcters of these lineaments is linear and curvilinear expressions which are vary from 2 km to more than 1000 km.

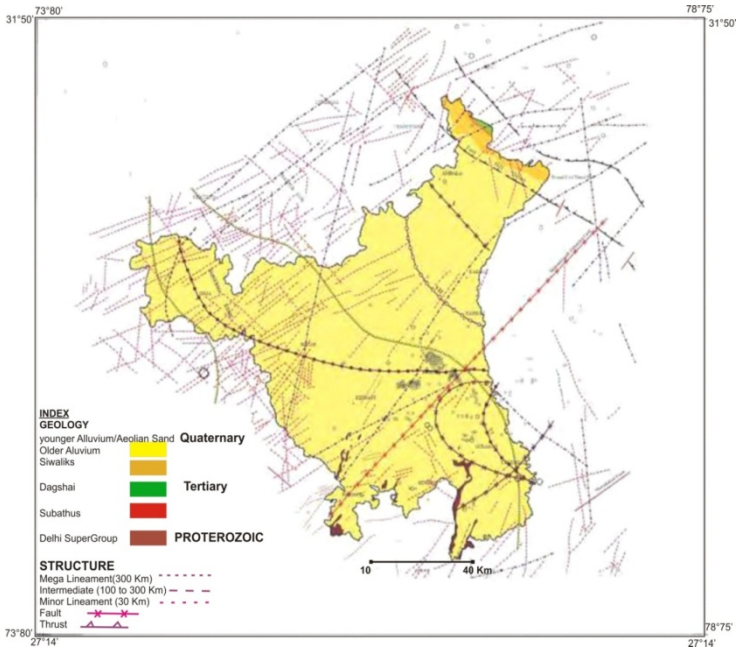


**Fig. 2. Seismotectonic map of Haryana (GSI, 2016)**

After the study of geology, structure, magmatism, mineralization and deep geophysical characteristics of the River, many lineaments discussed by – Ray [18], Sharma[10], Bakliwal and Ramasamy [14, 15] in Rajasthan and Gujarat. The alignment of these lineaments are primarily aligned in NNE-SSW, NW-SE and ENE–WSW directions, systematically disposed / placed and regionally control the geology of the area and significantly in the tectonic evolution of the different sedimentary basins from Proterozoic to recent times [14]. Few names are of these lineaments in Rajasthan and Gujrat is Udaipur – Sardarpur, Rakhabdev Lineament, Kishangarh – Chhipri Lineament, Pisangan – Vadnagar lineament, Sadri – Palanpur lineament, Sirohi – Disa lineament, Luni – Sukri lineament, west coast lineament, Jaisalmer – Barwani lineament, Ajmer – Sandia lineament, and Raisinghanagar – Tonk lineament[20]. Worldwide, the studies of palaeochannels significantly for identifying high-yielding freshwater zones.

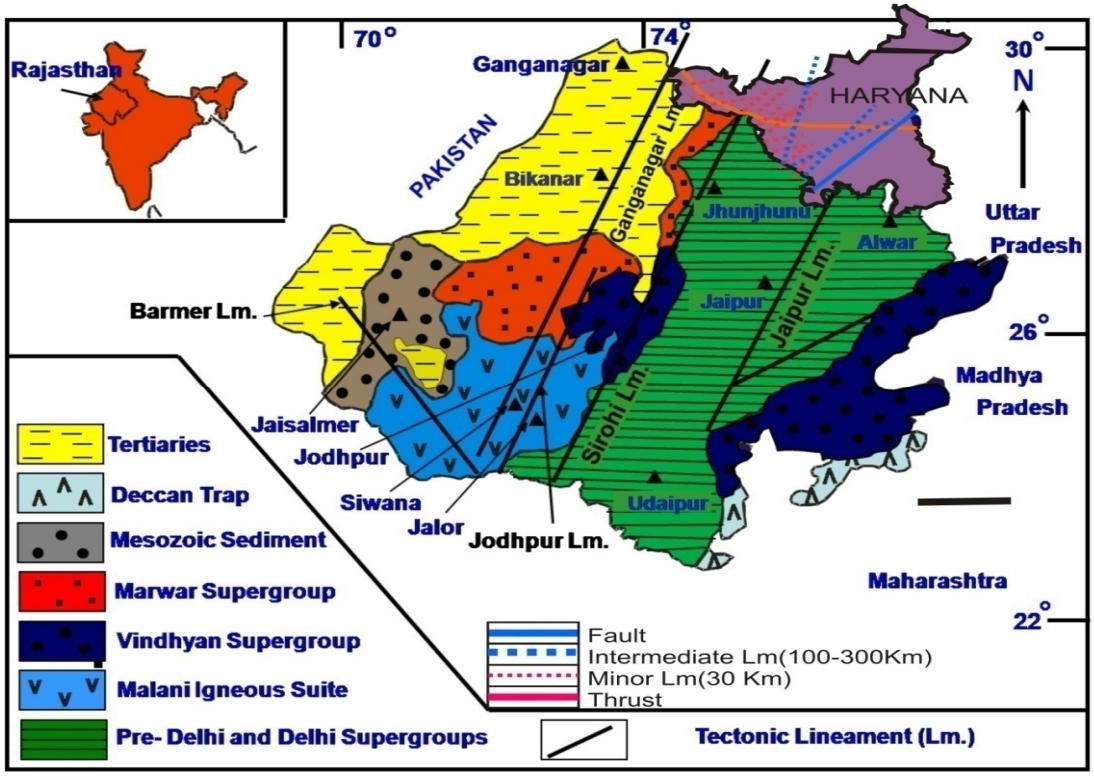


**Fig. 3. Geological Map of Rajasthan and Haryana showing the aerial extent of the Malani Igneous Province. Also showing the major tectonic Lineaments (Lm.) (modified after Pareek [23] ).**

Lineaments study of Luni River given information about its superimposing the drainage, tectonic, hydrogeological map, groundwater potential[21] and gravity contour maps and prepared the Rose diagrams[22]. Major lineament trends in Jaisalmer Basin (Fig. 3) suggest the general trend of palaeochannels of Saraswati River system is controlled by NE–SW to ENE–WSW. A plethora of intermediate and minor palaeochannels are aligned along these trends in rajasthan and Gujrat. The linearity of the river suggests that it was mainly following the major deep-seated week zones in the region. Saraswati river was a potent for a considerable period causing flood, depositing huge volume of sediments and forming a delta. After understand the Geological setup along the flowing course of ancient saraswati river can be used to understand the history of palaeochannels of the river with reference to their dimensions and present connectivity with the aquifers having good quality of waters.

**Significant** of lineaments in specify basement terrains for groundwater occurrence, alluvial fields or river terraces, karst fileds and identifying different information about geological settings, for example type of drainage network (pattern) can indicate general geological setting, higher resolution images for identifying landslides, identify dyke intrusions and selection for engineering projects such as dams, association with earthquakes, etc.

## CONCLUSIONS

The Malani Magmatsm is controlled by NE-SW lineament structure in Haryana, Rajasthan and Gujrat also which are traversing by dissimilar ages and rocks during Archaezoic to Cenozoic periods. These lineaments considered as extreme impactful in tectonic evolution of different sedimentary basins and formed by volcanism and plutonism. Extension of Malani rocks in Rajasthan and Haryana and major structural trend also identified in Gujrat. The same course of Saraswati river in thses areas signify to identify palaeochannels and contribute to find the channelising the ground water schedule and connectivity with the aquifers having good quality of waters.

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