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Channel Pattern as Signature of Neotectonic Movements – A Case Study from Brahmaputra Valley in Assam

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ABSTRACT

Spatial characteristics of drainage geometry of Brahmaputra river and its tributaries were studied based on visual interpretation of IRS 1B imagery (on 1:250,000 scale) and topographical maps of different periods. Observed features of drainage lines alongwith possible mechanism of their formation in terms of neotectonic adjustment are discussed. It is inferred that selected stretches of Brahmaputra river viz. between Dibrugarh and Jorhat and between Guwahati and Goalpara may represent channels with active boundaries that have restricted/controlled the width of sinuous lines of discharge of the river within the valley. Local tilting of ground, lying to the south-east of Brahmaputra river, between Noa Dihing and Burhi Dihing rivers, may explain some of the observed features of these drainage lines. Movement along some lineaments in recent past has occurred. This inference is based on the evidence of adjustment of several drainage lines viz. Dihing, Burhi Dihing, Dikrang, and Mora Bhareli rivers and displacement of rocks of younger age.

Introduction

The area transgressed by the river Brahmaputra along with the adjoining sub Himalayan tract is susceptible to neotectonic activities. Earlier observations on drainage lines and associated morphostratigraphic surfaces have indicated unmistakable imprints on neotectonic movements on these geological entities (Duara & Chatterjee, 1977; Viswanathan & Chakraborti, 1977).

The northern side of Brahmaputra river valley is fringed by Siwalik rocks of sub Himalayan belt, while to the south eastern fringe of the valley, are the Naga hills, forming a long belt of 10-40 km wide and

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has been termed as the "Belt of Schuppen". To the south of valley, rocks of the belt of Schuppen are exposed. The upper Assam valley is divided by a central basement high, which forms the north-eastern continuation of Mikir hills massif. The axis of basement high lies close to the southern bank of Brahmaputra river in upper Assam. The northern most thrust, which marks the plain hill boundary, is known as Naga thrust (Rath *et al.*, 1994). Geoseismic section (Murthy & Sastri, 1981) prepared across the Brahmaputra valley reveals number of faults that run through rocks, comprising Dihings, Tipam and Surmas. Geomorphological studies carried out in Brahmaputra basin, has led to delineation of four geomorphic surfaces (including recent flood plain), characterised by terraced landscape which fades off down the valley (Viswanathan & Chakraborti, 1977). Studies carried out in the Brahmaputra valley by various workers have indicated that the basement tectonic have played an important role in moulding the present configuration of the valley (Baruah & Bhattacharya, 1981; Murthy & Sastri, 1981).

The stretch of Brahmaputra river selected for present study extends from Dibrugarh (Lat./long. 27°30'; 94°55') in the east to Dhubri (Lat./long. 26°01'; 90°00') in the west, covering about 800 km length of the river. The present study, which is based on identification of different linear features or lineaments on satellite imagery aims at synthesizing the observed drainage characteristics in terms of possible neotectonic movement, if any, in the area. IRS 1B B/W images and FCCs (1:250,000) have been used for visual interpretation. In addition, topographical sheets (on 1:250,000 and quarter-inch scale, 1926 edition) have been used for the purpose of comparing the drainage lines.

Results and Discussion

The observed spatial characteristics of the drainage lines and their interpretation in terms of neotectonic movements, are briefly discussed below:

The Brahmaputra river follows a sinuous course in the stretch lying between 92°00' and 93°30' with its convex bends appear to be truncated by the enveloping lines of the sinuous belt. The width of the belt remains constant throughout the stretch (Fig. 1). Between Dibrugarh and Jorhat and between Guwahati and Goalpara, numerous braided channels of Brahmaputra river are restricted to a well defined zone with two discrete enveloping lines.

Three rivers, namely Noa Dihing, Burhi Dihing and Dibru, join the Brahmaputra river from south (Fig. 2A). Dihing and Burhi Dihing flow parallel to each other upto Waket (96°00' : 27°30') and after that they start to diverge away from each other. While Burhi Dihing shows channel avulsion from east to west, Noa Dihing and Dibru show evidence of avulsion of channel from west to east. All the three rivers have palaeo courses which extend upto the trunk river.

Between Dibru and Burhi Dihing there is an abandoned palaeochannel which runs westerly through Duliajan (95°16' : 27°17' 30") in contrast to the north-westerly trend of the present day lines of discharge of the same rivers. Along the stretches of

Namsang-Talpani and Namphal-Namsang, Burhi Bihing river shows evidences of shortening of the line of discharge and numerous neck, chute and meander cut-off.

Present channel of Dibru follows more or less straight course having smaller amplitude compared to its palaeochannel with larger amplitude. Barik pani, a tributary joins Burhi Dihing at Namsang in an upstream direction. The drainage characteristics of Noa Dihing and Dibru (in the east) and Burhi Dihing (in the west) may have formed in response to changes in slope concomitant with uplift of the median ground lying between Burhi Dihing and Dibru rivers.

Parts of Disang river (between north of Nizara and Namrup) and of Burhi Dihing (between Kheram Hika and Namsang) fall on a west-north-westerly trending line; and further west around Sibsagar, depression along the left bank of Brahmaputra lie on one side of this line.

Dikrang nala in its upstream section flows easterly and at around Hatkhola takes a sharp bend and then follows a straight, south-easterly path upto Brahmaputra river. Apparent displacement of sub Himalayan rocks along a south-easterly trending lineament is evident. A palaeochannel of Dikrang nala appears to the south of the bend and happens to lie in strike continuity of upper (northern) part of the river.

These three linear drainage lines appear to be lineament controlled. In case of Dikrang, abandoning of palaeochannel at Harmati may be explained by recent reactivation of the lineament (with apparent displacement of rocks of Siwalik age) at least in its south-eastern part and thereafter Dikrang has followed a lineament controlled channel for some distance and beyond which it again follows the regional slope (towards south).

The two above lineaments appear to converge around Jorhat. Here Brahmaputra shows an apparent shift along the north-westerly lineament.

Reactivation along a west-north-westerly lineament may explain the observed behaviour of drainage lines of Disang and Burhi Dihing. Baruah and Bhattacharya (1981) suggested that a fault zone near Jorhat trends westerly and follows the course of Brahmaputra river for some distance and abruptly turns west-north-west around south of Halem in Darang district and may possibly continue upto the foothills.

Study of old toposheet (surveyed 1926) indicates that Brahmaputra used to flow westward at Pasalbari, west of Guwahati, which was subsequently (in 1986 imagery) replaced by a flow that swings toward north before changing again to a westerly course. The north-south stretch of the course falls in line with drainage courses of Chaolkhoa and Kulsi rivers (Fig. 2B). The observed change in course of Brahmaputra river at this point may be explained by reactivation of the north-south lineament along Chaolkhoa and Kulsi rivers, between 1926 and 1986. Although no evidence of movement of the ground is apparent, ground check may provide possible clues for this movement.

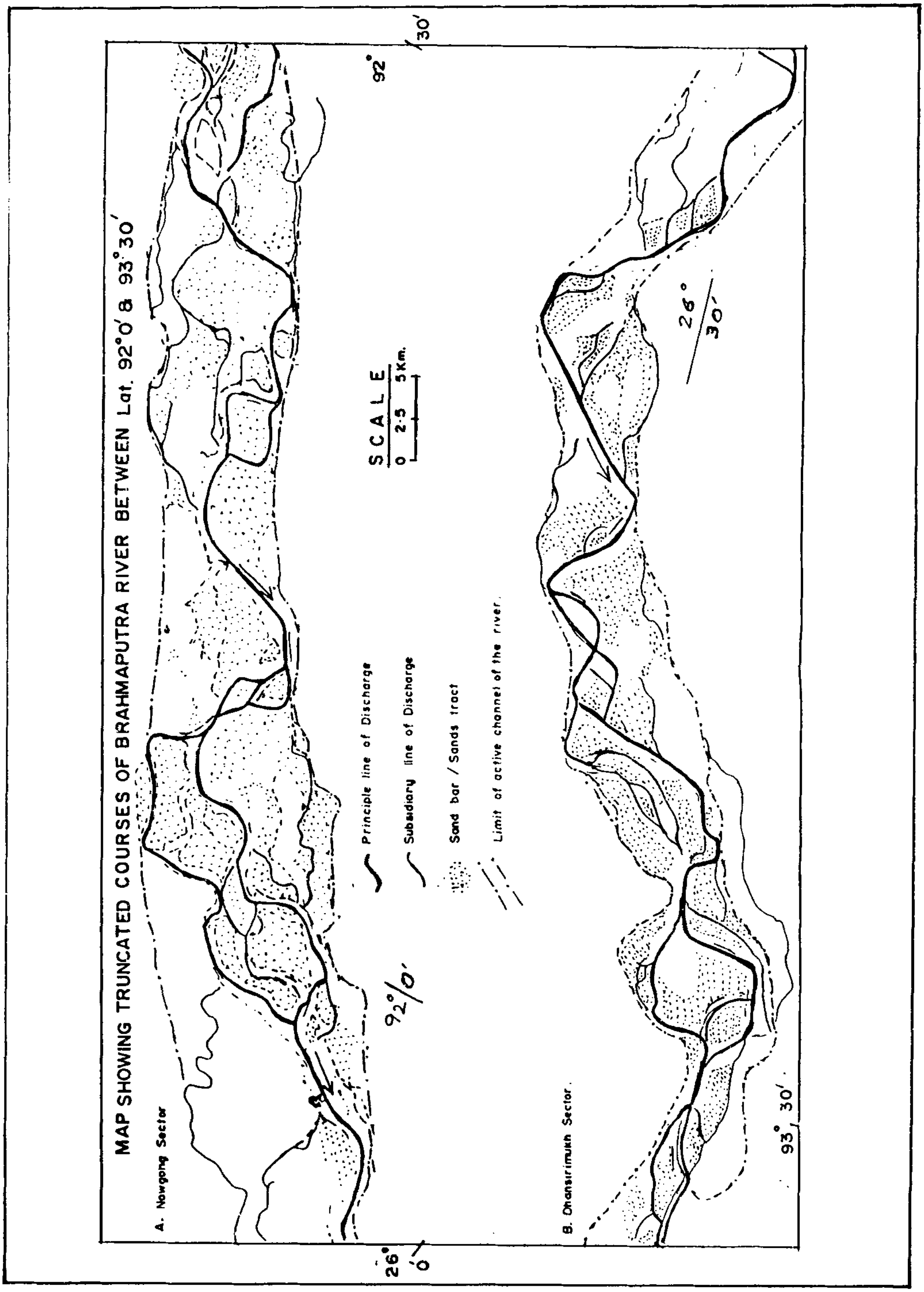
MAP SHOWING TRUNCATED COURSES OF BRAHMAPUTRA RIVER BETWEEN Lat. 92°0' & 93°30'
A. Nowgong Sector
B. Dhansirimukh Sector.
SCALE
0 2·5 5 Km.
Principle line of Discharge
Subsidiary line of Discharge
Sand bar / Sands tract
Limit of active channel of the river.
92°/0'
92°
30'
26°
0'
26°
30'
93° 30'

Fig. 1

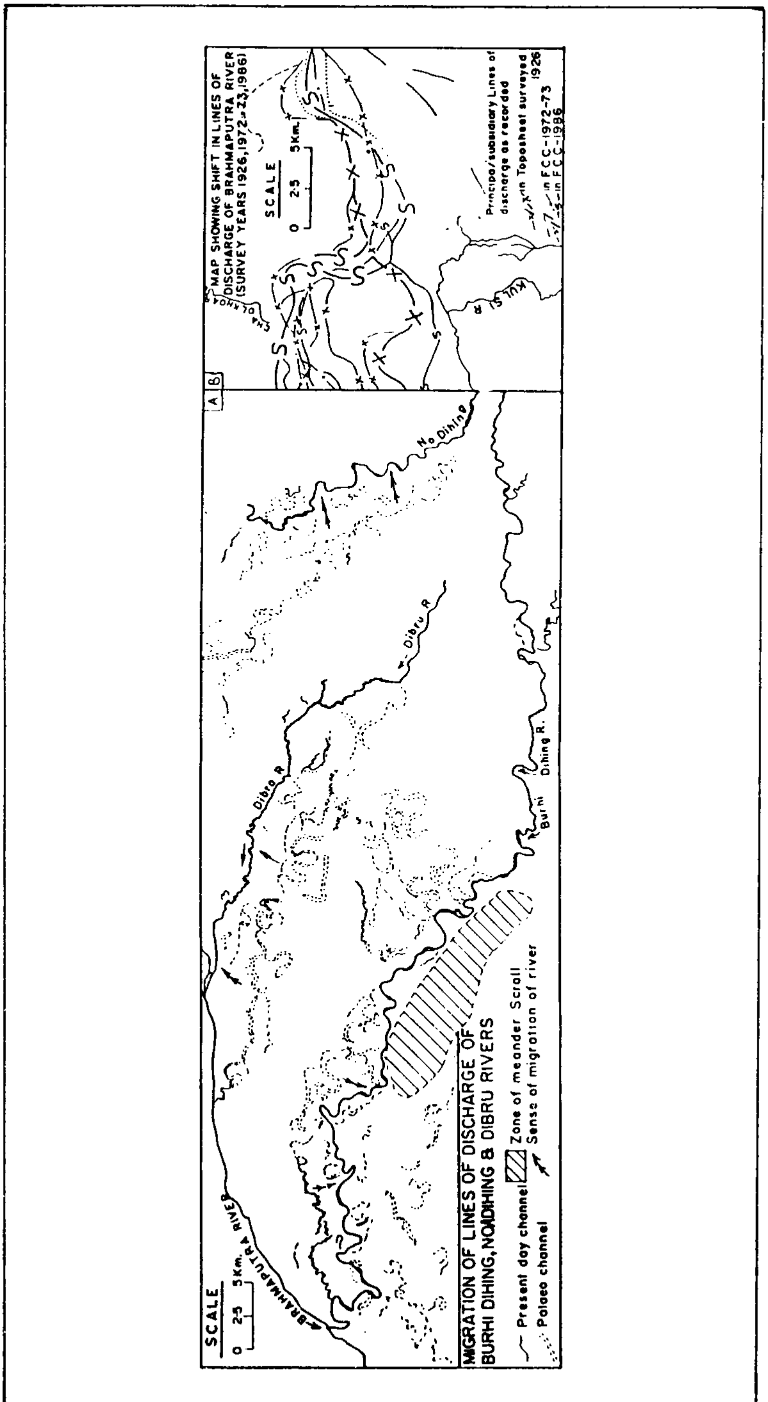
SCALE
0 2·5 5Km.
BRAHMAPUTRA RIVER
Dibru R.
No Dihing
Burhi Dihing R.
MIGRATION OF LINES OF DISCHARGE OF BURHI DIHING, NOADIHING & DIBRU RIVERS
Present day channel
Palaeo channel
Zone of meander Scroll
Sense of migration of river
A
B
MAP SHOWING SHIFT IN LINES OF DISCHARGE OF BRAHMAPUTRA RIVER (SURVEY YEARS 1926,1972-73,1986)
KULSI R

Fig. 2

Northwest of Guwahati a number of tributaries viz. Chaolkhoa, Pathimari etc. show successive elbow bends to the west and the westerly components of the drainage lines lie on common linear zones. These linear zones may represent an east-west lineament parallel to Brahmaputra river and pass through alluvial tracts dotted with marshes, swamps and inland lakes, which suggest possible reactivation of the lineament in recent times.

Two rivers Kalang and Diha, both of which originate in the backswamp of Brahmaputra and lie on the same line to the south of Brahmaputra river, flow in opposite directions. Dika joins Brahmaputra in upstream direction (east of Tezpur).

Dika comprises of alternate meandered and straight (non-meandered) sections. Successive meandered sections show well defined meander belts. North-eastward tilting of the ground through which Dika river is flowing may explain the drainage features of these two tributaries.

Present day course of Mora Bharali follows a south-easterly path while a palaeochannel which starts from Chapaguri used to follow a southerly course along the master slope and could be traced upto Brahmaputra river.

Tributaries like Barai, Dighalmukh and Bharali follow more or less straight courses with north-north-westerly trend and join Brahmaputra river at slightly upstream direction. These tributaries may possibly be lineament controlled. Reactivation along certain segments of Bharali in recent time has rendered the Chapaguri channel of Mora Bharali abandoned and a new path was followed. Viswanathan and Chakraborti (1977) made significant observations on Jia Bharali basin, which include change in stream courses, abrupt termination of surfaces against the line of discharge of Bharali river and domed uplift and have suggested "presence of 'zone of weakness' passing between two surfaces viz. Rangapara and Bharali and Jia Bharali river flows through this graben".

Between 1960 and 1986, Subansiri river displays several shifts in lines of principal discharge. In addition the present day Subansiri follows south-westerly course upto Baghmara and then swings to a more westerly path parallel to Brahmaputra before it finally joins Brahmaputra. Adjustment of drainage lines to possible tilting of the ground may partly account for this feature of Subansiri river. Duara and Chatterjee (1977) "observed frequent shift of river courses within a short period of time, mostly by means of channel avulsion". They proposed a model of post-Pliocene tilt in the basin alongwith rapid built up of levee of Brahmaputra to explain the tendency of Subansiri river to migrate westerly. The westerly migration has been accentuated near the confluence with Brahmaputra, because of rapid built up of the levee of Brahmaputra.

More Manas, Manas, Champamati and Gaurang river which join Brahmaputra river from the north show offset of outfall points toward west. Similarly in the Dibrugarh – Jorhat sector, there are a number of tributary rivers which flow from the north and show offset of outfall points. In both the cases, eastward movement of the northern margin compared to Brahmaputra may explain the observed shift of outfall points.

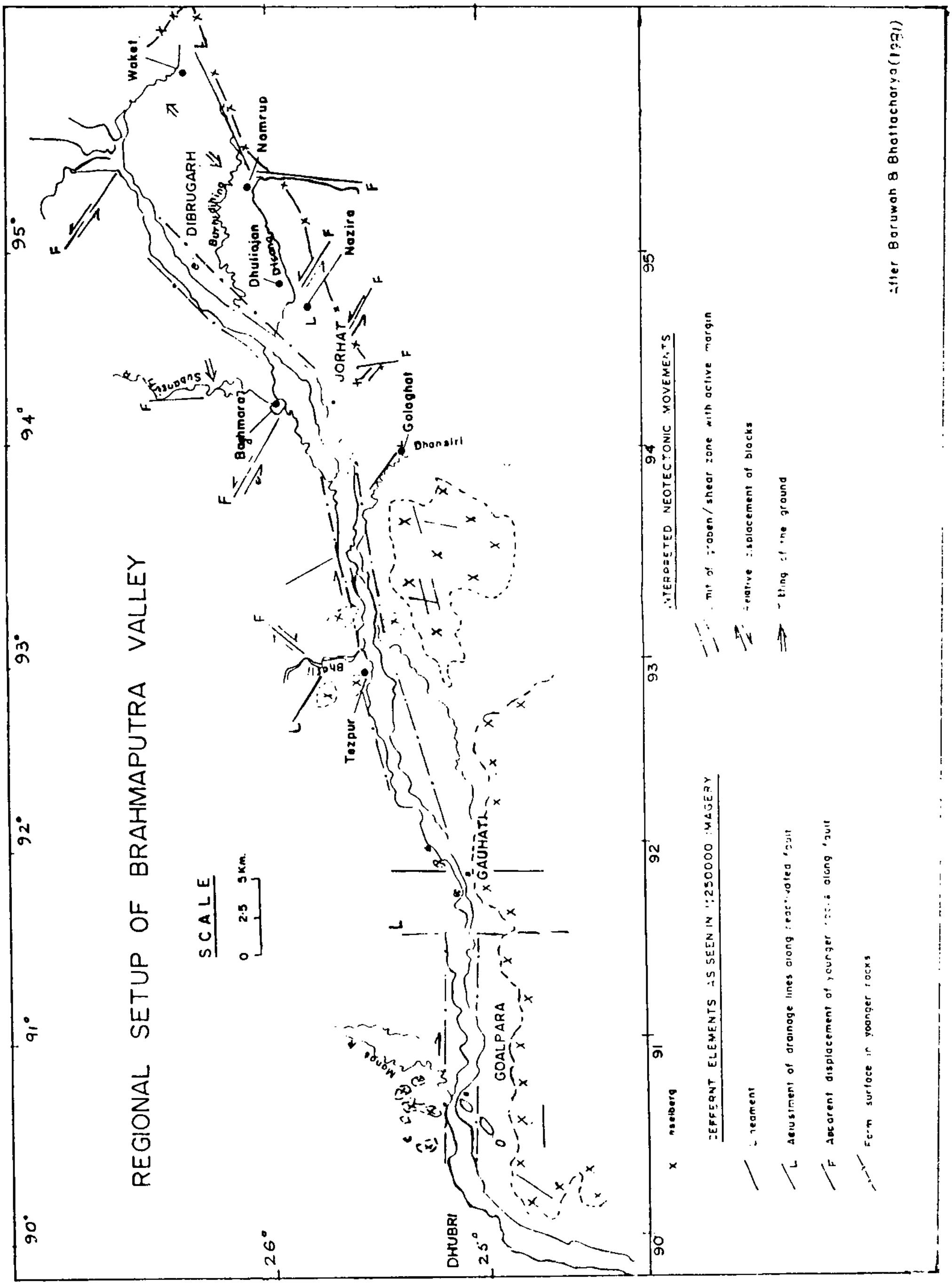
REGIONAL SETUP OF BRAHMAPUTRA VALLEY
SCALE
DHUBRI
GOALPARA
GAUHATI
Tezpur
Dhansiri
Golaghat
JORHAT
Nazira
Dhuliajan
DIBRUGARH
Namrup
Wakel
INTERPRETED NEOTECTONIC MOVEMENTS
DIFFERENT ELEMENTS AS SEEN IN 1:250000 IMAGERY
After Baruwah & Bhattacharya (1991)

Fig. 3

Between Golaghat and its confluence with Brahmaputra river, the drainage line of Dhansiri river alongwith a number of neck and chute cut off form a well defined meander belt, bounded by two enveloping surfaces, having a width of 4 km. A lineament controlled drainage channel with tilting of ground in recent past may explain the drainage characteristics of the river.

Conclusion

Study of channel patterns of Brahmaputra river and its tributaries as observed in IRS 1B FCCs, has brought out certain instances of adjustment of drainage lines in response to various geological factors including neotectonic movement in the present area. While there are unmistakable records of neotectonic movements in some areas that may well explain certain drainage characteristics, changes in drainage pattern in some other areas may be correlated with possible adjustment of the ground to neotectonic movement. Further studies may provide clues to these issues of shifting of drainage lines in upper Assam (Fig. 3).

(i) Selected reaches of Brahmaputra river channel viz. between Dibrugarh-Jorhat and Guwahati-Goalpara may represent graben controlled channel with a component of strike slip displacement along the northern boundary of the river. The observed off-set of outfall points of some of the tributaries in Brahmaputra river may suggest a possible eastward displacement of the northern bank.

(ii) Tilting of ground, at least locally, may explain characteristics of certain drainage lines in south of Brahmaputra river; area around Digboi between Noa Dihing and Burhi Dihing rivers is an example of such tilting.

(iii) Reactivation/movement along some of the lineaments in recent past can be postulated from the evidences of readjustment of drainage lines and displacement of rocks of younger ages along these lines. Some of such drainage lines are part of Disang (between Nazira and Namrup), Burhi Dihing (between Kherom Hika and Namsang), Dikrang and Mora Bharali rivers.

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References

Barooah B C and Bhattacharya S K (1981). GSI Misc. Pub. No. 46, pp. 123-128.

Duara B K and Chatterjee B P (1977). GSI Misc. Pub. No. 32, pp. 205-227.

Murthy K V S and Sastry V V (1981). GSI Misc. Pub. No. 46, pp. 129-132.

Rath S, Bharali B and Sathi A K (1994). Offshore South-East Asia, Singapore (OSEA-94070).

Viswanathan T V and Chakrabarti C (1997). GSI Misc. Pub. No. 32, pp. 123-167.