CHAPTER VI
MODELS FOR ARCHEAN - PROTEROZOIC PLATE TECTONICS BASED ON STRUCTURAL AND OTHER EVIDENCES - A REVIEW
6.1 Introduction

There has been a great deal of acrimony and debate whether the plate tectonic processes operating today and like those believed to have been operated even during early phanerozoic, did operate in the past or not especially during the precambrian. One of the strongest arguments in favour is the Huttonian principle of uniformitarianism. It is also believed that the rates of motion of plates during the precambrian were perhaps much faster than at any time during the phanerozoic, principally because of a much thinner continental crust. A large amount of geochemical, isotopic age data and petrotectonic assemblages are now available for the Aravalli Range rocks, on the basis of which several kinds of models are being proposed that bear similarity to the presently operative plate tectonic processes.

As far as the area under investigation is concerned, the Ajabgarh group sequence of rocks represent pelagic deep sea sediments, according to S.chanthawong and Mern (1984) which were deposited in a leptogeosynclinal basin over the basic oceanic crust, which has been metamorphosed into orthoamphibolites, hornblende-pyroxene granulites and serpentinites.
The Barotiya sequence, therefore, represents this predominantly basic volcanic or oceanic crust of the Ajabgarh group, dominant throughout the Delhi Supergroup rocks, in the entire Delhi fold belt of Rajasthan. Sychanthawong and Merh (1984) suggested subduction beneath the Indian plate in India-Africa collision in more advanced stages, supported by high pressure - low temperature assemblage. According to them the quartzite boudins of Barr Horizon kept forming throughout, during the M1 and M2 metamorphic episodes, and the two deformational events F1 and F2 (Sychanthawong et al., 1989). They suggested that Malani volcanics were a naturally corollary to this and that the oceanic crust generally occupied the central core of the fold belt with ortho-amphibolites and serpentinites together with hornblende granulites.

Sychanthawong and Desai (1977) have related Alwar group to a miogeosynclinal assemblage and correlated the plate tectonic set up with the metallogenic epochs as well. Sychanthawong and Desai (1977) and Sychanthawong and Merh (1984) have involved a model of the initial subduction involving activation type of orogeny and later one of collision type, in contrary to the views of other authors (Sinha Roy 1989, Sinha Roy and Mohanty 1988) invoking a model of an island arc type (see also Sen 1981).

6.2 Theoretical Background

The Rajasthan region in general contains remnants of 3.5 Ga old Archean crust (McDougall et al., 1983) and the
cratonization of this is believed to have occurred about the time 2.5 Ga as suggested by the isotopic data obtained by Choudhry et al. (1984) and Gopalas et al. (1979a, 1979b). The Archean cratonization event was followed by an accretionary event (Sinha Roy 1984, 1988).

Sen (1981) presented a very elaborate plate tectonic model on the basis of metallogenic epochs for the whole time span of the late Archean, but, in particular the whole time span of the Proterozoic. Sinha Roy (1984) presented a complete possible sequence of crustal interactions in Rajasthan during the proterozoic period.

6.3 Evidence in Support of proto-plate Tectonics

The principal evidences for the plate tectonic type process having operated in the Aravalli-Delhi fold belt are enumerated below.

6.3.1 The 3.5 Ga old Archean type crust reported from the Banded Gneissic complex east of Udaipur by McDougall et al. (1983) is suggestive of mantle depletion during the formation of the early crust.

6.3.2 A large number of granite bodies, some syn- and other post-kinematic with reference, either to the Aravalli orogeny or the Delhi orogeny, suggest the typical subduction process operating, and the acid magma rising to give rise to granitic plutons or even the acid volcanics and tuffs,

6.3.3 The presence of a suture zone extending from Sant Rampur in Gujarat state to north of Udaipur, though discontinuously, along the entire central axis of the orogenic belt, occupied by ultrabasic rocks such as serpentinites, dunites, pyroxenites etc., representing part of the equivalent of modern day ophiolites.

6.3.4 The blue schist facies metamorphism consisting of transitional glaucophane, lawsonite, stilpnomelane on the western flank of the orogen in Sirohi District of Rajasthan. Thus, the presence of paired Metamorphic belts, typical of the island arc setting as reported from the type area in Japan (e.g. See Sinha Roy and Mohanty 1988) is confirmed.

6.3.5 The Wedge-shaped outcrop of the Aravalli region showing typical broadening to the South and tapering to the north represents a typical aulacogen or rift that failed to develop fully.

6.3.6 Extreme mylonization and ductile shearing at both the margins of the belt suggestive of the underthrusting and overthrusting of the crust, typical of a plate tectonic set up.
6.3.7 Presence of the Malani suite of acid volcanics suggesting a volcanic response in the Marwar plain to the plate tectonic processes operating during the Precambrian period.

6.3.8 The presence of the Mangalwar Complex (Gupta et al. 1980), consisting of tonalite gneisses, migmatites, amphibolites and fuchsite bearing quartzites, suggests a typical very old greenstone belt type succession during the Archean (Sinha Roy 1984).

6.3.9 The presence of Hindoli group (Gupta et al. 1980) is a typical turbidite sequence with the bimodal volcanics, suggesting the presence of a younger generation belt that postdates the Mangalwar group (Sinha Roy, 1984).

6.3.10 The evidences of the processes similar to the Wilson cycles are believed to have operated (Sinha Roy 1988), in the Aravalli-Delhi belt. The sequence involving ensialic rifting, generation of oceanic crust and its consumption through the protorozoic, are suggested by Sinha Roy (1936).

6.3.11 The geochemistry of Phulad basic rocks and Deogarh amphibolites suggests that they are derived from the island arc type and ridge tholeiites. This possibly represents offshoots from the principal island arc type and tholeiite ridge positioned elsewhere in the range (Gangopadhyay et al. 1984), near the subduction zone since phulad rocks are low K-tholeiites.
6.3.12 The granites such as Sendra and Erinpura, but particularly the former, are of S type, as suggested by their geochemistry (Pandian and Verma 1986, Gangopadhyay et al. 1984). These were, therefore derived by partial melting of the continental crust near the subduction zones. This may have been responsible for the emplacement of these granites.

6.3.13 The stretching lineations which are downdip near Barr, suggest the over-thrusting of the Ajabgarh rocks, and are clearly suggestive of a \( \text{NW} \) ward plate motion or westward polarity. The Barr itself represents a high angle thrust fault related to a westward subduction.

6.4 Present Status of the Evolutionary Sequence

present status of the summary of events in the precambrian of Rajasthan -

This may be given in a sequential manner as follows -

(i) Evolution of older greenstone belt such as the Hindoli belt, the Mangalwar belt. Mantle depleted crust suggested.

(ii) The cratonization event is placed at the Archean - proterozoic boundary marked by the emplacement of Berech granite (2.5 Ga Crawford 1970, Gopalan et al. 1979a, 1979b, Choudhry et al. 1984).

(iii) Ensialic rifting and deposition of the Aravalli sediments and volcanics in an epicontinental sea
(Roy and Paliwal 1981). These sediments consists of BIF and volcanics in Pur Banera area, and BIF and other metasediments in the Jahajpur area (Sinha Roy 1989). The Aravalli rocks in the type area consists of a deep water facies, west of the Madar Kharpina line and a shallower water facies - turbidite -flysch sequence, with basal Bebari volcanics together with a conglomerate to the east.

(iv) Aravalli orogeny begins, the subduction of the Aravallian plate begins to the west.

(v) Generation of ultrabasic rocks, tightly folded along the suture zone near Kherwara-Rikhab Dev and Sant Rampur. The subduction occurs below the Delhi island arc to the west. Sedimentation begins in the back-arc Delhi basin. The Jahajpur and Pur-Banera areas get tightly folded.

(vi) Arc-continent collision with operation of a double subduction system to the east and west of the Delhi island arc.

(vii) Back arc collision with the arc, with developing early dipping subduction zone getting ruptured and forming a part of the mantle. The easterly dipping subduction zone steepens and intrusion of Erinpura granites along the western flank of the orogen takes
place, with the development of a future back arc basin of limited extent in the Sirchi Punagarh-Barr area.

(viii) The back arc basin gets deformed and Malani rhyolites are extruded as a result of westward subduction. This last event marks the proterozoic-phanerozoic boundary.

6.5 Metallogenic Epochs in relation to Evolution of the orogen

The evolutionary trends as suggested under 6.4 above are systematically related to the metallogenic epochs in Rajasthan, in space and time. The workable base metal mineralisation is always restricted to the eastern and western margins of the belt. But it has been shown to be intimately related to the deformation events and accompanying metamorphism, and also subduction-obduction processes operating at a given time in the history of evolution of this belt.

In the Aravalli Supergroup rocks, the most workable deposit is the Rampur-Agucha Pb-Zn deposit, hosted in rather high grade sillimanite-graphite-garnet schists, biolite schists and amphibolites and gneisses. Hence, it is generally inferred that this may be deposited within the basement Archean complex. The mineralisation is associated within a canoe shaped synformal structure over quite a short strike length of nearly 2 kms. Copper and arsenopyrite are
subordinate. Another important Pb-Zn (with Ag) deposit occurs in the Aravalli rocks, east of Udaipur, near Zawar. A third belt is the Rajpur-Dariba belt and finally the Pur-Banera belt. The first two of these are devoid of copper, occur close to the margin of the orogen proper. The latter contain copper, but are away from the immediate margin of the orogen. This suggests a spatial disposition of copper only in rocks away from the central part of Aravalli belt, while that of Pb-Zn near to the central axis. Such a disposition may suggest the depth of the subduction zone to the east being greater as one goes east from the central axis of the orogen. In general, copper is found at the margin of the basement cover interaction while Pb-Zn at a distance much inside and away from the contact, well within the Aravalli basin proper.

Phosphorite mineralisation together with that of Uranium is not particularly related to the plate tectonic processes and are not therefore mentioned here.

In the overlying Delhi supergroup sequence, the basement mineralization is found principally in two belts, one the Khetri belt and the other Ajari-Basantgarh - Ambaji-Deri deposit, the two occur at the NNE and SSW ends of the belt.

Sporadic base metal occurrences are reported from the area in between but are of local importance and
practically not workable such as the Bajte deposit in Ajmer district.

In the Khetri belt proper, copper mineralization is preponderant and the Pb-Zn is very sporadic. In the Ajari-Basantgarh-Rohere-Pitdi Section, Cu-Zn deposits are found. In the Ambaji Leri area of Gujarat Cu-Zn-Pb are found. Thus NNE to SSW, there is a tendency for the deposit to become more polymetallic in nature as the grade of metamorphism of host rocks becomes progressively lower from high grade amphibolite schists in the NNE to green schist in the SSW.

Besides the base metal mineralization in the Delhi belt, the mineralization of wolframite-Scheelite-Cassiterite and fluorite is also found in the Delhi belt. Out of these the first two minerals of tungsten are found in veins and veinlets in the area under investigation. These can be more or less continuously traced along the zone of skarn rocks to about 10 kms to 15 kms NNE of Giri. An account of these forms a subject matter for a separate chapter in this dissertation.

Along the eastern margin the base metal mineralization in the Aravalli rocks is generally of Pb-Zn type and is devoid of copper (except at the Aravalli/BGC sheared contact) formed under 5.4 kb pressure and 550°C temperature (Deb 1980). On the other hand, the western margin is characterised by spatial disposition of base metals with
Cu deposits formed under 6-8 kbs pressure and 650°C temperature. The pressure regime was in the higher range. In the Basantgarh area the Pb-Zn mineralization is related to high pressure (about 8-9 kbs while low temperature 350-400°C) which also explains their association along strike with blue-schist facies metamorphism.

Thus, there appears to be a definite control in space and time, of basemetal mineralization. Most of the Pb-Zn deposits are related to the Aravalli rifting during early Proterozoic (Ga 1.7 to 1.9 Ga) and to the Aravalli subduction (Ga 1.5 to 1.7 Ga) while the copper deposits and Cu-Pb-Zn deposits are related to the Aravalli subduction as well as Delhi rifting (1.3 to 1.5 Ga). The magmatically related tungsten and tin deposits are related to the late phase of the Delhi subduction (0.7 to 0.9 Ga). The copper deposits found at the Aravalli BGC margin are generally the result of remobilization and belong to the Archean sequence and are as old as 2.9 to 3.1 Ga; just as some of the Fe found in Pur-Banera and Jahajpur sequence may be related to the Fe rich rocks within the Archean sequences, deposited into these groups during the period of Aravalli rifting. Fig. 6.1 clearly shows the variation of base metal deposits in space and time, in the form of triangular diagrams of Cu-Pb-Zn for Aravalli and Delhi Supergroups. The cyclicality with regard to each is noteworthy.
Fig. 6.1. Metallagenic epochs in time frame

- Zawar Group
- Rajpura-Dariba
- Occurrences around Bhilwara
- Maton
- Rampura-Agucho
  Aravalli Super-group

- Khetri Belt
- Basantgarh
- Ambaji
- Deri
  Delhi Super-group

Fig. 6.2. Granite emplacement in relation to plate tectonic events
6.6 Magmatic events in Space and Time

The various magmatic events in Rajasthan and particularly the intrusion of granites, can also be systematically related to the events summarised under 6.4.

The close of the orogeny during Archean by subduction or related processes is marked by the intrusion of granites such as Untala and Gingala, which give Rb/Sr age of 2.9 Ga (Choudhry et al. 1984). A series of granites which give radiometric ages ranging from the 2.7 Ga to 2.5 Ga, are the late K-Felspar granites which mark the cratonization period and indicate a rather static phase. Famous Berach granite is one of such granites, Ahar river granite being another. Some granites and alkaline rocks are related to the period of Aravalli rifting of Phase I and others, such as Darwal granite are related to the Aravalli rifting phase 2, at the close of the lower proterozoic. The Aravalli subduction and Delhi rifting were marked by the intrusion of granites, alkaline rocks (such as those of Kishangarh) and extensive basic volcanism. The granitic intrusions continued throughout the Delhi orogenic cycle of the middle to late proterozoic, beginning from approximately 1.7 Ga and ending at about 0.5 Ga. The Sendra Granite in the area under investigation is a granite related to Delhi subduction beginning at about 1.1 Ga. One variety of this is syn-to-late orogenic and older, and the other variety is post orogenic and
younger. The Erinpura Granites were late kinematic (0.9 to 0.5 Ga). The scheelite and wolfram mineralization in the area is however related to the extensive granitization during the subduction process, as the boudinaged granite sheets are found interbedded at Barr. This suggests that this granitization event slightly predates the Sendra complex development.

The pegmatite activity in the Aravalli belt is related again to two periods. None of the Archean pegmatite minerals have been dated, but Heron (1953) remarked that the Archean pegmatites contained K-felspar while pegmatites intruded at later periods into Aravalli and Delhi were devoid of K-felspar. This was a very sound observation. Excluding the Archean pegmatites, the pegmatites emplacement continued from the second phase of Aravalli rifting up to the close of Delhi orogenic cycle, spanning a time period beginning from 1.7 Ga onwards up to the end of proterozoic. Thus, pegmatites continued to intrude throughout the time span covered by both the orogenies. Fig. 6.2 schematically relates the granite emplacement periods with different events enumerated in section 6.4, in a general way and is modified from Sinha Roy (1988, Fig. 1).

6.7 Plate movements in Delhi belt

Within the Delhi belt proper, two different sedimentary sub-basins have been recognised - (a) a basin in the Alwar region (b) the principal south Delhi fold belt. It is
Fig. 6.3

(A) Khetri Rift, Alwar Rift, Sambhar Lake transform, intra-continental subduction, Sand mala granulites, Aravalli Fold Belt, Rikhob Dev/Kherwara/Sant Rampur Suture, 1.8 Ga.

(B) Khetri Fold Belt, Alwar Fold Belt, Sambhar Transform, Cratonised Basement, Aravalli Fold Belt, Rikhob Dev/Kherwara/Sant Rampur Suture, 1.4 Ga.

(C) Khetri, Alwar, Sambhar transform, Cratonised Basement, Aravalli Fold Belt, Cratonised Basement, Arc-Trench Folded, Arc Marginal Basin, 1.3 Ga.

(D) Khetri, Alwar, Cratonised Basement, Aravalli Fold Belt, Delhi Fold Belt, 0.8 Ga.

(After Sinha Roy, 88)
therefore, envisaged that the Delhi sediments were contemporaneously (though not sensu stricto) being deposited into two subparallel rifts, an eastern Alwar rift and a western Khetri rift which was more extensive but was later disrupted by a prominent EW trending dextral transform fault passing through Sambhar lake, Jaipur and Daosa. This explains the disparity in the structural history and fold styles in the Khetri belt and the south Delhi fold belt (Naha et al. 1988). For example, the $F_4$ structures described in this dissertation are quite open in the present area and indeed in the entire south Delhi fold belt, but they are fairly close to tight in the region around Khetri. This suggests that deformation presumably began earlier at Khetri than anywhere else in the Delhi fold belt. This evolutionary history is similar to the double rift systems at the initiation of Aravalli sedimentation with small basins of Pur-Banera and Jahajpur occurring to the east of the principal Aravalli wedgeshaped aulacogen. The parallelism between the two kinds of phenomenon, more or less in similar pattern is shown in Fig. 6.3, and is presumably related to the pre-existing grain and directions of plate motions during the proterozoic. However, in case of the Aravalli rifts, Sinha Roy (1984) has pointed out a triple junction for the three Aravalli rifts, viz. the Aravalli proper, the Rajpur-Dariba-Bhinde-Pur-Banera Rift and the Jahajpur rift. The triple junction lay, just west of Nathdwara, marked by
intrusion of Darwal granite, from where Aravalli supergroup outcrop gradually widens to the south. The Aravalli volcanics contain the spinifex textured rocks, typical of the ridge ophiolite complex. The EIF related to Aravalli sedimentation is found in the Pur-Banera (magnetite more predominant) and Jahajpur sequences (limonite and hematite more predominant).

The Aravalli orogeny began about 1300 m.y. with under thrusting of the oceanic crust to the east, with the intrusion of Rikhabdev, Kherwara and Sant Rampur Ultramafics (Sen 1981). These, presumably mark a suture zone where part of the Aravalli aulacogen oceanic crust is preserved as obducted ophiolites. The Aravalli subduction changed during the course of the orogeny from ensialic in the north to ensiamatic in the south.

The Aravalli under thrusting opened up a rift system in the northern part of the present Delhi fold belt with double rifts as mentioned previously. Another rift opened up at a later stage, now forming the south Delhi fold belt. The rift systems were separated by a transform fault passing through Sambhar lake with present ENE-WSW orientation. The ENE trending lineaments or fractures presumably represent original transform segments which were reactivated at the close of Delhi orogeny to give an overall dextral shift along these, though the original displacement may have been
both dextral and sinistral. The direction was determined by the rate of spreading and the line of breakage of the original continent. There was an enormous volcanicity associated with the Delhi rifting which ranged from basic to acid. An island arc was formed with a marginal sea to the west into which volcanics and sediments accumulated. A westerly dipping subduction zone developed underneath the Arc. The Arc trench gap sediments were crushed, folded and attached to the Aravalli fold belt, or were overthrustted. The result of this was the distentional tectonics in the Aravalli region marked by intrusion of many granite bodies which give ages younger than Aravalli orogeny. A jumping of the south Delhi subduction zone is envisaged (Sinha Roy 1988) which consumed the marginal sea. The imprints of the blue-schist facies metamorphism in the Basantgarh area favour the Arc and marginal sea material collision (Sinha Roy and Mohanty 1988).

The Phulad to Devgarh rocks show the complete cross section of the lithology variations within the principal Delhi fold belt. In the east, the sequence is turbidite and is therefore, an accretionary trend sequence. The central section contains metamorphosed rhyolites, axenites, basalts with cherts and marbles and is intruded by granites, corresponding to the Sendra sequence of Heron. The western part consists of serpentinites pyroxenites, gabbroic rocks and sheeted dyke complex, suggesting an ophiolite melange.
and is an imbricated sequence with repetition. This sequence is the one of the area under investigation, i.e., the Barotiya sequence of Heron (1953). The Nandana marble which marks the boundary between the Barotiya sequence and the Sendra complex might represent a sea-mound located to the west of the magmatic Arc (Sinha Roy 1988).

The margin sea floor subduction caused the present thrust slivers which is repeated through a fault to the east. This subduction gave rise to high angle steep faults opposed to the principal subduction zone dip.

Presumably, the subduction zone was low dipping in the area and caused dilation (4ve) which mixed up the ophiolite melange with the thrust slices. The subduction of the back arc marginal oceanic region sequence caused another rift to open to the west, that is the rift extending from Sirohi to Punagarh, through the present area near Barr. The pillow basalts at Punagarh, the "fanglomerate" (Sinha Roy 1988) at Barr and turbidite flysch sequence at Sirohi. These rocks were deformed and attached to the principal Delhi belt by thrusts. The response of this was the extrusion of Malani rhyolites in the area to the west and also plutonic activity, such as the Jalar and Siwana granite bodies in the Marwar plain. The typical sequence of events is shown in Fig. 6.4.
PLATE TECTONIC CARTOON OF THE SEQUENCE OF VARIOUS EVENTS IN THE ARAVALLI–DELI PLATEAU. A– PARIJAT ARAVALI RIFT WITH VOLCANICS
B– PURI ANTE, C– JAMMEH, D– ARAVALI RIFT D– ARAVALLI SUTURE
E– ARAVALLI FOLD BLOC, F– SERRA GANITE G– SERRA GRANULITE
THRUSTING H– SERRA LAKAR PALA TECTONIC. I– DELHI RIFT J– DELHI TECTONIC
K– ARC TRENCH GAP POLLED, L– VOLCANIC ARC M– MARGINAL LATE ARC
BASEN E– SERA GANITE F– TECTONICS, G– ENTHE ARC SUBDUCTION
H– SERRA LAKAR RIFT, S– SERRA GRANULITE S1– MARGINAL BASIN SEQUENCE
T– OPHIOLITES U– THRUST V– ARC SEQUENCE W– TRENCH SEQUENCE
X– PALAM RHYOLITES

FIG 6-4
(After Sinha Roy, 1988)
6.8 **Principal Conclusions**

The principal conclusions that can be derived on the basis of review of the data available and various types of plate tectonic models suggested can be enumerated as follows:

(i) Comparisons possibly could be drawn between the older proterozoic Aravalli - Delhi fold belt and the present day phanerozoic orogenic belts, on the basis of petro tectonic assemblages, tectonic setting and magmatic-volcanic events. Even the Wilson cycle type of opening and closing of seas as envisaged by Sinha Roy (1988) and given in the above account could be recognised.

(ii) The GSC cratonized about 2500 Ga as suggested by the radiometric dates.

(iii) The Aravalli rifting was in the form of three rifts. The Aravalli proper, the Rajpur-Deriba-Pur-Banera-Bhinder rift and the Jahajpur rift, the triple junction being located close to the present position of Darwal granite north of Nathdwara. The sedimentation and volcanicity in the Aravalli proper protracted over a good time span while similar activity in the other two rifts was short-lived.

(iv) The Aravalli rift was compressed, and Rikhab Dev suture was formed by obduction of ophiolites after the Aravalli subduction had nearly ceased.
(v) From the available evidence, it appears that while subduction was predominant in the southern part of the Aravalli orogen, the intracontinental under-thrusting occurred in the north as substantiated by Sandmata Granulites (Sharma 1988, Sinha Roy 1988).

(vi) The Delhi rift opened in the north into Khetri and the Alwar rifts, and the Khetri rift and the south Delhi rift developed at a slightly later stage. The Sambhar lake fault represents the expression of the original major transform fault displacing the major south Delhi rift dextrally.

(vii) The ENE trending dextrally shifted faults in the present area and everywhere in the Delhi orogen, possibly represent original transform faults, and the original sense along them may be different depending upon the line of rupture. However, during orogenic compressions in NW-SE direction, the ENE trending faults assumed a dextral sense compatible with the $\sigma_{\text{max}}$ and some express only as fractures without any displacement noticeable along them.

(viii) The Delhi subduction gave rise to a volcanic arc and a marginal sea to the west. The Arc trench gap sediments and volcanics were thrust over the Aravallis during the Delhi subduction and the marginal sea sequence was compressed, folded and imbricated. This is the accretionary trench sequence.
(ix) The subduction of the back arc basin with its oceanic crust gave rise to Sendra complex and the Barotiya sequence with considerable, now steep faults that repeat the sequence.

(x) As a corollary to (ix), the Barr-Punagarh rift opened and was later converted into an ophiolitic melange.

(xi) The granites of all ages occur, but maximum number of granites are related to various subduction processes and their radiometric ages show them to be late-kinematic with reference to a given orogenic event.

(xii) The Barr zone proper represents the thrust related to compressional tectonics due to subduction of the back arc assemblage.

(xiii) The tungsten mineralization is presumably related to syntectonic granitization along the Barr zone and its vicinity and is restricted to skarns and can be related to the F1 deformation and associated metamorphism.

Thus, the south Delhi fold belt shows a typical westward polarity so that the Marwar plain has behaved like Tibet plateau during the Himalayan orogeny.

(xiv) The Malani acid volcanic suite and Erinpura granite are the responses of the marginal back arc basin subduction.