CHAPTER - 8
THE SINGRIMARI SEDIMENTARY COLUMN,
AN INTROSPECTION OF THEIR STATUS AND HISTORY

8.1 INTRODUCTION

Reconstruction of the geologic history of any studied area, curving out a place for the lithounits in the geologic column etc. are some essential options particularly, in the study of ancient sediments. The area of interest in the present endeavour, Singrimari, bears enough potentiality in this regard and, going by the treatment meted out to the geology of this area so far (see 2.4), a clear cut restructurisation of the same is a necessity.

Acknowledging every possibility of a faulty construction, the present attempt seeks to categorise and compare the sedimentary column of this area based on field characteristics and analytical observations corroborated by minor palaeontological back-ups. Considering the fossillic records along with a perusal of the scant previous literatures, the present venture considers these rocks coeval with those of the Lower Gondwana times. Now, the problem lies regarding the slot in which these lithounits are to be fitted in the Standard Gondwana Column. At this stage comparison of the field plus analytical results with some established and published literatures regarding Lower Gondwana rocks are followed. A comparative study is not a problem owing to extensive and intensive study of all such units across the Peninsular India.

In this Chapter, the author attempts to:
I. highlight the salient features of the Singrimari Sedimentary Column, which by virtue of its geographical extensions look like an edge of a pre-existing basin, the western and bigger part of which is now sunked vide post-depositional tectonic plays
II. rejuvenate the Column by assigning to it a proper place in the Standard Gondwana Column and thereby bestow on it its Status in the light of in-vogue Gondwanic Concepts along with a look into the post-depositional scenario. It may be mentioned at this stage that although the whole Column bears many minor litho entities, it is only the two Sandstone types (see 2.2) which are considered from the view point of status by virtue of their dimensions.

It should also be mentioned at this stage that the genetical aspects of all observations, be it field- or, laboratory based is given the main thrust in this endeavour rather than summarising on field features only due to lack of requisite geographical extensions of the Sedimentary Column.
8.2 GENERALISED LITHO FACIES CODIFICATION OF THE SINGRIMARI SEDIMENTARY COLUMN

A sedimentary rock is not only a product of specific provenance and transport history but it is also a product of the environment of deposition, (Pettijohn, 1975). The sole task is to decode these imprints from the clasts. There have been many ways developed for reading and understanding the 'clast' history and, lithofacies analysis, (Allen, 1970, Miall, 1978, Reineck and Singh, 1980) is one amongst them. The key to the interpretation of facies is to combine observations made on their spatial relations and internal characteristics - lithology and sedimentary structures, (Middleton, 1978). A genetical explanation for an ancient phenomenon is always made by an analogy with that of modern happenings.

Despite variations, (not mappable) the N-S trending sedimentary column, (see 2.2.2) is dominantly arenaceous and, based on their characteristics they have been divided into two types i.e., A-type (Upper) and B-type (Basal) in order to compare and contrast between them. However, the smaller unmappable units cannot be neglected due to their genetical significance and as such, these smaller units like carbonaceous shale, siltstone and claystones which are exposed in the field have also been taken into consideration. Thus, following Allen's 1970 and Miall's 1978 scheme, 5 lithofacies have been recognised in the area and is depicted below base upwards.

<table>
<thead>
<tr>
<th>FACIES CODE</th>
<th>LITHOFACIES VARIATIONS BASE UPWARDS</th>
<th>SEDIMENTARY STRUCTURES</th>
<th>SIMPLIFIED INTERPRETATIONS</th>
</tr>
</thead>
<tbody>
<tr>
<td>Fl</td>
<td>Fine sand, silt, mud</td>
<td>Horizontal bedding, Fine lamination</td>
<td>Overbank or wanning flood deposits</td>
</tr>
<tr>
<td>Fsc</td>
<td>Silt</td>
<td>Blocky and slabby</td>
<td>Backswamp deposits</td>
</tr>
<tr>
<td>Fi</td>
<td>Fine sand with sediments, silt, mud</td>
<td>Horizontal bedding, Fine lamination</td>
<td>Overbank or wanning flood deposits</td>
</tr>
<tr>
<td>Sh (and Sp)</td>
<td>Sand (medium to very coarse, pebbly towards the base)</td>
<td>Horizontal bedding, cross-bedding (at patches)</td>
<td>Planar bedflow (L &amp; U flow regime)</td>
</tr>
<tr>
<td>C</td>
<td>Carbonaceous shale</td>
<td>Plants, mud films</td>
<td>Backswamp deposits</td>
</tr>
<tr>
<td>Sh (and Sp)</td>
<td>Sand (medium to very coarse, pebbly towards the base)</td>
<td>Horizontal bedding, cross-bedding (at patches)</td>
<td>Planar bedflow (L &amp; U flow regime)</td>
</tr>
<tr>
<td>Gm</td>
<td>Massive or crudely bedded gravel</td>
<td>Horizontal bedding, imbrication</td>
<td>Longitudinal bars, lag deposits</td>
</tr>
</tbody>
</table>

---

(121)
Enlisted and described below are the lithofacies varieties encountered in the field with a little bit of write up based on their genetical traits.

I. The sequence begins with massive or crudely bedded gravel facies, (Gm) representing transportation due to high current velocities and deposition as channel lags. Generally, these sort of deposits accumulate by vertical accretion on longitudinal bars and are either horizontally stratified or, imbricate - a case which is seen in the present area. The coarser clasts had their provenance in a Precambrian terrain whereafter they went through a large scale physical assault prior to their deposition. However, based on roundness observations, nothing can be said on the length of transportation. From the on-field 'clast' features of parallelism and imbrication, it seems to be a manifestation of a turbidite like situation or a case of flash flood under a braided alluvial setup, (Harms et al. 1982). Fining upward of grain size indicate deposition by a single current system with progressively diminishing energy.

II. Overlying the aforesaid facies are medium to coarse grained sandy - often pebbly facies, (Sh and, Sp) type showing mainly sporadic horizontal and cross bedding (the foresets of which dip towards north) which is indicative of a continued influence of active hydrodynamism. While these activities took place under the upper flow regime (F > 1) conditions in the main, sporadic cross beddings indicative of a lower flow regime may be attributed to bedform irregularities or, fluctuations in the flow strength.

III. Following up the aforesaid facies type is a minor litho entity of carbonaceous shale facies, (C) showing plant and mud films. Although smaller in scale, this unit depicts a contrasting hydrodynamic influence on the area. With field evidences showing the carbonaceous shale layer in sharp contact with the underlying coarse facies, generally it is theoretically hard to believe the influence of such contrasting hydrodynamic influence if a temporal hiatus is not considered. But, it is seen that this unit which generally depicts a passive hydrodynamism or, stagnancy follows an active regime. In nature, such situations are seen in case of anastomosing rivers, (Smith and Smith, 1980) in the backswamp areas or, due to shifts of a braided river say, like the frequent (9 times) westward shifts of the river Kosi of Bihar in its upper reaches, (Holmes, 1978). However, it may also be mentioned that sub-environments of a braided river include some lakes and minor overbank facies (Pettijohn et al. 1973). Lakes, overbank or the flood plain in the recessive period may bear passive hydrodynamic status too. As such, these sites
may bear enough potentiality for deposition of these shales. Whatever it may be, the flow intensity progressively decreased with time and was considerably reduced during deposition of the carbonaceous unit suggesting stagnation of the depositional area allowing vegetal accumulation under reducing conditions, a fact also substantiated by the pyritic concentrations. Intermittent arenaceous influx within the carbonaceous shale layer indicate temporal fluctuations in the environmental settings at that time.

IV. Following up the aforestated facies type, there is again revival of conditions leading to the deposition of facies types like Sh and Sp in the main. These are indicative of a truncated cyclicity quite possible under a braided setup. One may also interpret them as a result of channel wandering and intermittent tectonism, (Casshyap, 1970).

V. Fine sand (with sporadic sedimentary pebbles), silt and mud, (FI) comprise the finer lithofacies entity in this area which looks like representing inter-channel overbank facies of a flood plain where local muddy environment of reducing nature was prevalent where deposition of fine clay took place. This unit being in contrast with that of the coarser facies shows anastomosing or meandering characteristics. All these features could have been due to a change in the fluvial nature and, are products of seasonal increment. Definitely a slackening of energy took place base upwards. Moreover, could the sporadic sedimentary pebbles seen at the base of these sandstones (having physical similarity with the upper portions of the Basal Sandstones) be due to a localised hiatus?

VI. Interwoven with the aforestated fine grained facies lies a minor unit of silt, (Fsc) showing blocky and slabby bedding. Characteristics of this unit indicate a period of inactivity compared to the earlier stages. Perhaps accumulation took place in a backswamp setup. This unit which apparently looks unfossiliferous might have had oxidising influence on it.

VII. Repetition of the FI facies type without sedimentary pebbles represent the youngest deposits of this column.

In short, the sedimentary column of Singrimari, based on field evidences, look to be a reflection of fluvial regime in which hydrodynamic activism was in a decreasing trend base upwards although cyclicity of activism is seen towards the earlier stages of deposition. The fluvial regime seem to transgress from braided to anastomosing or, meandering base upwards and there might have been a localised hiatus between the Basal (B-type) Sandstones and the (Upper) A-type Sandstones.
8.3 LABORATORY BASED SUBSTANTIATION OF THE FIELD ASPECTS

Included here are certain field features substantiated by some enlisted laboratory findings which have been considered in construction of a depositional model for the Sedimentary Column.

1. Display of truncated cyclothem like features in the B-type (Basal) Sandstones, presence of two distinct pebbly layers in them and, the presence of same features in a very finer scale in the A-type (Upper) Sandstones indicate unstability of the depositional setup at the early stage and amelioration of the same later on.

2. Detailed petrographic and heavy mineral studies indicate a basement uplifted Continental-Block Provenance for both the Sandstone types in general. Indications of unstability of the whole setup at the earlier stage and a rapid deposition of detritus is vindicated by survival of the rock fragments along feldspars. However, towards the later stage, there is a decline in the abundance of both rock fragments and feldspars and thus a gradual 'cleansing up' of the distributions is seen.

3. Discrimination diagrams based on major oxide analyses show tectonic settings of ACM and CIA and are indicative of deposition nearer to the plate boundary. Normally for such sandstones, the provenance is not stable.

4. Coarser clasts of quartzites, amphibolites and quartzofeldspathic gneisses indicate about their provenance types.

5. Rock slides and heavy mineral counts indicate the provenance as a Precambrian terrain which was dominantly medium to high grade metamorphic followed by igneous, imprints of which are more distinct in the B-type (Basal) Sandstone. Moreover, considering the c-axis trend of the clasts, their imbricate nature as well as foreset inclination of the crossbeds, the provenance seems to be somewhere in south.

6. Fossillic records in the carbonaceous shale layers indicate a Lower Gondwana age. The fossillic records of species of *Glossopteris, Vertebraria, Schizoneura, Calamites* plus certain palynomorphs like *Gnetaceae pollenites, Verticipollenites, Divariscus, Alisporites, Marsupipollenites, Lophotroiles* etc. within the whole Sedimentary Column indicate a Lower Gondwana time frame of deposition for the same.

7. Pyritic concentrations in the shales within the B-type (Basal) Sandstones and Fe-laminations within the A-type (Upper) Sandstones.

8. A distinct reducing condition is also evident from the organic carbon variations. Moreover...
fluctuations in the oxidation state is also reflected by metal ratios like Ni/Co.

5. Fining upward features of both the sandstone types, sporadic cross-beddings indicate a fluvial genesis for the Column.

Textural attributes of both the Sandstone types show strong tendency of clogging in a riverine field where, in a broad spectrum besides the typical fluvial process, various other formative processes in varying degrees were in operation during the different stages of sedimentation. Energy level was distinctly higher during deposition of the Basal Sandstones and there was also a source control effect which seem to have degraded during deposition of the Upper Sandstones. The mode of transportation of the Basal Sandstones was rapid and turbid while that of the Upper Sandstones was slower and graded. While the B-type Sandstones show affinity towards a braided setup, the A-types show more maturity and inclination towards a delta front zone (read, anastomosing or meandering influence) by virtue of their energy level, size factor and sorting.

8.4 DEPOSITIONAL MODEL OF THE SINGRIMARI SEDIMENTARY COLUMN

Based on all the aforestated field and laboratory findings, the present attempt seeks to configure a depositional model, (F-8.1) for the Singrimari Sedimentary Column. It should be mentioned here that areal extent of the attempted depositional model is far larger than the exposed sedimentary column which is considered as the backbone of this venture. Moreover, this has the influence of literatures on Gondwanic reconstruction in this part of the world, excerpts of which are spelt out in the later part of this Chapter.

A southern basement uplifted zone of a Continental-Block Provenance acted as a source of detritus for the N-S trending Singrimari Sedimentary Column. This unstable provenance site resourced the detritus which was transported in a rather flash flood like mode by a braided channel. The Basal (B-type) Sandstone happens to be one such longitudinal bar of this channel (F-8.1a). In the field, we get to see two truncated fining upward cycles within this unit interlived within which is a layer of carbonaceous shale. These cycles are moreover made prominent to the eyes by the pebbly layers. The basal pebbly layer mark the first episode of upliftment of the provenance. The interlived layer of carbonaceous shale mark the westward migration or shifting of the braided channel, (F-8.1b). Queries like, "Could these shales be overbank facies?" also comes to the mind at this stage because overbank facies constitute a minor subenvironment of a braided channel. However, the author disregards such a situation as an
overbank facies would have a seasonal influence. The time span of a seasonal influence is too short to justify the characteristics of the fossillic records which does not look detrital. Definitely the time span of westward migration, shifting or abandonment of this site was of a magnitude in which the fossillic finds completed at least part of their life cycle. The in-between arenaceous influx which one gets to see in the form of sandstone lenses within the carbonaceous shale are reflections of volatility of the depositional basin. However, factors like spatial and temporal dimensions of the carbonaceous shale unit, pyritic specks, fluctuations in the oxidation state, post-depositional tectonic plays etc. might have been responsible for aggravation of an already depleted palaeofloral community. Revival of pebble deposition and the younger fining upward cycle is a manifestation of the second upheaval of the provenance and eastward migration of the channel, (F-8.1c). The aforesaid conditions led to the deposition of the Basal (B-type) Sandstones. Afterwards came a stage of basinal upliftment which could be ascertained by the presence of lithified sedimentary pebbles at the base of the Upper (A-type) Sandstones. This hiatus also changed the depositional setup which became somewhat mature. Amelioration of the earlier vibrant state and a change in the fluvial nature could be seen from the fine grained nature of this upper unit. Fining upward cycles with claystones and Fe-laminations in it looks to be seasonal increment of a channel in a matured terrain. But what was the nature of this channel? Meandering or anastomosing? These questions come to the mind because of the fact that both the Sandstone units are related to each other temporally in a Column and not spatially as the way one would find such deposits while following a river from its younger to mature stages. One thing is for certain that it was some sort of a tectonism which led to the amelioration of the earlier vibrant state of the depositional setup and, a change of the fluvial nature. The channel now could have been an anastomosing or meandering one, (F-8.1d). The author considers a probable anastomosing channel option also going by its definition which classifies it as a lowly sinuous, bifurcating and a 'host' of massive to finely laminated sandstones (showing fining upward cycles) with mud rich sections, (Smith and Smith, 1980. Putnam and Oliver, 1980). Thus it may be suggested that channel morphology, hydrodynamics, provenance, gradual decline in the topographic profile controlled the nature of both the Sandstone types. While the basal unit is a reflection of braided influence, the upper unit is due to an anastomosing or meandering channel.

8.5 STATUS OF THE SINGRIMARI SEDIMENTARY COLUMN

Stratigraphic position of the Singrimari Sedimentary Column in the Standard Gondwana Column.
has been a controversial matter, (see 2.4). The present attempt seeks to bestow on these rocks their Status based on the studies made so far along with, comparison of the same with that of published studies from eastern central part and Pranhita-Godavari basin of Peninsular India where the geological setup looks to be similar. It may be mentioned that the thrust of this classification is based mainly on objective and inferred aspects of sedimentological and field characteristics.

Characteristics of the Singrimari Sedimentary Column indicate its closeness to the Damuda Group. While the Basal (B-type) Sandstones look similar to a part of the Karharbari Formation, the Upper (A-type) Sandstones show affinity to the Upper Barakars in particular. Enumerated below are certain published findings which are in consonance with that of the present study. The bold underlined statements are conclusions from the present study and the reasonings enlisted below are based on published findings which bear similarity with that of the present study.

I. The Singrimari Sedimentary Column is equivalent to a part of the Damuda Group.

(a) The Damuda assemblage taken vertically as a whole represent an excellent example of fining upward megacycle where the coarse grained detritus progressively becomes fine grained and thicker cross-bedding units become thinner from the base (Karharbari) to the top (Raniganj) of the sequence. Within this megacycle are repeated cyclical sequences of small and intermediate scale, (Mehta, 1964. Niyogi.1966, Casshyap.1977)

(b) In terms of mineralogy of detrital fractions, the ‘Damuda’ exhibits a remarkable ‘cleansing up’ of Sandstones from Karharbari up to Raniganj times. Karharbari is mainly lithic arenite to lithic wacke with detrital feldspars (potassic) progressively increasing upward at the expense of lithic fragments. The succeeding Barakars and Barren Measures show little change in the mineralogy. However, feldspar content in the Raniganj is very much reduced perhaps because of their fine grained nature, (Casshyap, 1977).

(c) The inferred evolutionary stream profile implies that with time, relief was reduced and sediment supply curtailed and, as a result shore-line from the north possibly moved southward during the Raniganj time so that the alluvial plain was more like a coastal plain rather than a delta, (Chandra, 1970b).

(d) The progressive decline in channel sandstone and increase of fine clastics through time
from Karharbari up to Barakar and down the palaeoslope in each basin is suggestive of progressive maturity of source land owing to prolonged erosion due to amelioration of climate and without pulses of uplift and, increase in channel sinuosity through space and time as sedimentation progressed, (Casshyap and Tewari, 1988).

2. **The Basal (B-type) Sandstone is equivalent to a part of the Karharbari Formation.**
   (a) The conglomerate facies rapidly merge into multistorey and multilateral coalescing channel bodies of pebbly and gritty to coarse and medium sandstone, similar to the facies characterising distal alluvial fans. The bulk of the succeeding Karharbari consists of fining upward asymmetrical cycles in which the lower sandstone member exceeds the upper shale and coal. The sandstone facies characterised by cosets of planar and trough cross beds has been attributed to longitudinal and transverse braid bars. Thin bodies of shale capping the channel sandstones represent vertical accretion during shifting and abandonment of the channel, (Casshyap and Khan, 1982b, Tewari and Casshyap, 1983, Casshyap and Tewari, 1984).
   (b) Steeper slopes on account of earlier periodic uplifts became the site for braided and anastomosing Karharbari streams to transport abundant bed load. Associated distal fan facies represented by pebbly coarse arkose to subarkose is indicative of rapid deposition and rapid subsidence. Rapid subsidence and frequent shifting of braided channels should have prevented development of thick peat swamps to produce only thin impersistent and split coal seams such as those which characterise the Karharbari Formation, (Casshyap and Tewari, 1988).

3. **The Upper (A-type) Sandstone is equivalent to a part of the U. Barakar Formation.**
   (a) Upper Barakar Formation in the Chintalapudi sub-basin, Godavari Valley, Andhra Pradesh comprise fine grained feldspathic sandstone to subarkose with heavy minerals like garnet zircon, opaques, rutile, monazite, apatite and tourmaline in a decreasing order of abundance along with siltstone and claystones, (Lakshminarayana, 1995)
   (b) As sedimentation progressed, the topography of the source land located to south-east of each basin, progressively became mature. The 'Gondwana Streams' consequently underwent progressive metamorphosis in channel from braided, moderately sinuous (anastomosing) to meandering, to deposit the lower, middle and upper Barakar sediments.
respectively. At this stage the expanded basins areally became unified into longitudinal alluvial plains, apparently larger than their present limits. The sinuous to meandering Barakar rivers loaded abundant mixed and suspended load flowed on gentle palaeoslope from south-east to north-west. The resultant sediments are characterised by progressive increase in fine clastic facies through time from lower to upper Barakar and along the length of the basin downstream, (Casshyap and Tewari, 1988).

At this stage, we compare the lithostratigraphic subdivisions from many basins and find a sort of conformity of the present area with those of the East Bokaro Basin, (cf Khan, 1986). Based on this and as shown in the chart below, we may class the Upper (A-type) Sandstones of the present area as part of the Upper Barakars and the Basal (B-type) as part of the Karharbari Formation.

<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Upper Barakar</td>
<td>Medium to fine sandstone, interbedded with siltstone, carbonaceous shale with thin impersistent coal seams.</td>
<td>Fine grained sandstone, siltstone and claystone.</td>
</tr>
<tr>
<td>Lower Barakar</td>
<td>Very coarse to medium sst. Associated with fine clastics and coal seams. Proportions of sandstone-shale equal.</td>
<td></td>
</tr>
<tr>
<td>Kaharbari</td>
<td>Conglomerate, pebbly-coarse sandstone, occasional lenses of fine sandstone, shale and coal.</td>
<td>Pebbly sandstone (occasionally conglomeratic) with carbonaceous shale.</td>
</tr>
</tbody>
</table>

8.5.1 GONDWANIC RECONSTRUCTION AND SINGRIMARI - A LOOK INTO THE HISTORY

Gondwanic reconstruction has emerged as a global obsession and, very little accessible terrain on the surface of our earth bearing these rocks have been left un-attended (Chandra, 1996). The present write-up puts forward some of the salient findings of eminent workers available to the author with a motive to see if the area of Singrimari can be fitted to any of the in-vogue conclusions made in the light of Gondwanic reconstruction. The reasons sprout from facts like:

(I) Singrimari happens to be the only exposed area in the Assam-Meghalaya plateau bearing Lower Gondwana rocks.
(II) The lithologic setup of the area in and around Singrimari bears some resemblance with that of the Peninsular India exposures.

(III) Other Northeast Indian exposures of Lower Gondwanic rocks from the Arunachal Himalayas exude a marine influence while the present study have vindictively shown a fluviatile genesis for the Sedimentary Column of Singrimari.

(IV) Considering disparity of the Singrimari rocks with that of the Arunachal Gondwanas and their similarity with that of the Peninsular Gondwana exposures, one thing that beckons the mind is to logically surmise the isolation and relation of this small patch of rocks with its counterparts.

It should be mentioned that the present write-up excludes some features like sedimentology, depositional environment and palaeontology from its concern while making this effort.

8.5.1.1 Indian occurrence of Gondwana rocks

Sedimentary sequences representative of the Gondwana Supergroup in the Indian Peninsula occurs mostly as outliers within elongate depressions on the Precambrian Shield. These basins are arranged en-echelon in three principal belts, namely Koel-Damodar Valley basins, Son-Mahanadi Valley basins and Pranhita-Godavari Valley basins, so called because of their association with that of the modern river valleys.

The Gondwana Supergroup in India collectively represents nearly 6000 m. thick sediments, though a complete succession from base to top is not exposed at any one place. Their exposures are further delimited by blankets of Deccan Traps (in western India), Gangetic alluvium (in the east); in the later case, they have been reported from Purnea in north Bihar and Bogra in Bangladesh. As a rule, the Gondwana rocks are gently dipping; locally where affected by faults or folds, dips of strata become steeper, (Casshyap, 1977).

8.5.1.2 Provenance and Palaeodrainage of the Gondwana rocks

From the available evidences, it has been inferred that the western part of the present day region of the Bay of Bengal was a landmass before the breakup of the Pangea. The Ninety-east Ridge which lay in the middle part forming a water divide between India and Australia and the adjacent landward regions which now lie in the Bay of Bengal and west Australia basins, like the Wharton Basin, formed the catchment regions which flourished with thick growth of vegetations and contributed to the main source of Gondwana coal deposits found in India and
Australia, now preserved in fault bounded grabens, (Desikachar, 1977).

The Gondwana sequences are blessed with abundant imprints of palaeodrainage in the form of pebble-grain imbrication of conglomerates, structural features like cross-bedding, ripple marks, erosional river channels, embedded fragments of vegetal matters in fine grained sandstones etc. and, as such palaeocurrent deduction has not been a problem. (Sengupta, 1966; Ghosh et al., 1969; Srivastava, 1970; Jhingran, 1970; Casshyap and Quidwai, 1971; Kumar and Bhandari, 1973; Ahmad et al., 1976). Conclusions arrived from numerous such studies are that palaeodrainage during the Talchir depositional phase was dominantly northerly. The river system developed at the termination of the glacial deposits till Jurassic was dominantly northwesterly with minor deflections both towards west and north. However some palaeoslope reversals towards south took place in the east coast during Lower Jurassic to Lower Cretaceous times. (F & 2).

8.5.1.3 Opinions on tectonic setting during Gondwana sedimentation and igneous activities

Opinions are divided in this country about the tectono-sedimentary setting of Gondwana basins. Some believe that the strata originally constituted a sedimentary blanket covering nearly the entire Shield area and, subsequently downfaulted so that the outliers represent the denuded remains, (Gee, 1932; Ahmad, 1960). In contrast, others like Fox, 1931; Krishnan, 1965 believe that the strata were deposited originally in troughs or rift valleys. The latter concept is found untenable as in most basins, faults seem to be limited to one flank or part of a flank. (Chatterji and Ghosh, 1967) and, were actively sinking contemporaneously with Gondwana sedimentation. (Frakes et al., 1975).

According to Chatterji and Ghosh (1967), most of the boundary and marginal cross faults owe their origin to reactivation along pre-existing fault zones within the Precambrian basement while the intra-basinal faults are mostly antithetic in nature and were responsible for ameliorating the tensile stress of the sediments.

Structural fabric of the Indian Ocean vis-a-vis deposition in the Gondwana grabens with their associated structural elements on the Indian Plate mirrors a broad similarity in the orientation of weak zones on the crustal slab. Thus, the question arises in a natural way whether this broad similarity in structural pattern in both the places of observation is accidental or, has developed under the same phenomenon. The latter inference seems more reasonable. The Gondwana grabens on the Indian Craton and the underlying inferred deep zones of extension...
along the synthetic as well as antithetic fault pattern has probably been formed due to extension of the crustal slab as a result of tensional stress that operated perpendicular to the graben axis. Similar phenomenon were probably responsible for formation of the structure on the Indian Ocean floor. The extension of the crustal slab in both the areas might have taken place during the time of drifting of the Indian Plate in an anti-clockwise rotation with a probable centre of rotation being around the Pamir knot, (Ahmad and Ahmad, 1977, Dey, 1977).

Another feature of prime importance is the Narmada-Son Lineament which was regarded as a fracture of fundamental importance by West (1962). This feature reflecting the subcrustal structure had influenced deposition of the Gondwana rocks, (Auden, 1949) in the sense that all the major Gondwana grabens like the Mahanadi and Godavari are connected to it. It may also be mentioned that according to Roy (1977), the Narmada-Son Lineament has north-south trending arms in both its eastern and western extremities in the form of Salt-Range arm and Rajmahal arm. He further says that the Narmada-Son Lineament takes a northward rotation in the form of the Rajmahal arm and hits the eastern Himalayas. According to Naqvi et al. (1974) the Narmada-Godavari-Mahanadi rifts had developed by rejuvenation of junctions of Precambrian 'protocontinents' in the Indian Shield.

Inevitably, in such situations and scales of tectonic plays, igneous activities cannot stay subdued. However, it may be said that igneous activities affected more dominantly in the Damodar Valley Gondwanas than the other Valleys. Studies indicate that major faulting was followed by ultrabasic intrusions and these, in turn by dolerite dykes. While the former follows fault trends, the later does not. Palaeomagnetic and Age dating venture by Athavale and Verma (1970) and McDougall and McElhinney (1970) suggest a Upper Jurassic to Lower Cretaceous and, Cretaceous age for the Rajamahal, Sylhet and Rajamahendri Traps (all coeval). They were followed by the Dolerite intrusions which was later on succeeded by the Deccan Traps. All these intra-continental volcanic activities were influenced by the tectonic plays.

8.5.1.4 The Singrimari Gondwanas

In this column, certain assumptions and inferences based on the aforesaid compilations on "Gondwanic Reconstructions" are drawn to meet a point which may logically surmise the present day geographic isolation of the Singrimari Gondwanas from its counterparts.

It is certain that the Gondwana sedimentation was a global tectono-sedimentation
phenomenon. Although we see their alignments along certain major faulted grabens in India, these down-throws seem to be later or, pari-passu episodes catalysed by the global tectonic movements and sedimentation. The initial tectonic instability of the whole setup was later ameliorated by crustal maturity.

It is quite difficult to comment on many aspects of Singrimari due to its isolated occurrence and, constricted geographic dimension of the exposures. However the observed and inferred aspects of the present study mainly based on field characteristics, minor structural features, sedimentology, palaeobotany and doleritic intrusions urges one to correlate them with the eastern India Lower Gondwana rocks particular, from the East Bokaro basin and the Rajmahal basin although, there is a big gap in-between these exposures in the form of Bangladesh of which not much is known except the fact that alluviums dominate the settings. The author finds a support at this stage from the comments of Ahmad and Ahmad (1977), which states, “Eastward from the N-S trending Rajmahal Basin, coal has been reported from underneath the thick alluvium in Bogra and elsewhere in Bangladesh, (also reported by Islam, 1997). These beds could have been continuous with the Singrimari (Garo Hills) area where Gondwana beds are known to exist as the oldest formation exposed and their thickness is not known. Very little is known about the tectonic setup of these Bangladesh coal basins, but obviously they are outside the so-called rift valleys of the Indian Peninsula”. Now, if it is considered that Singrimari happens to be the edge of a basin having its extensions towards west in Bangladesh, the query that comes to the mind is regarding the direction of palaeoflow. Considering the pebble imbrications and sporadic structural features embedded in the Singrimari Sedimentary Column and, also considering the overall provenance direction of the Gondwanas it may be said that it was from south to north towards the shore. The author again finds a support at this stage from the comments of Dutta (1976), which states, “Judging by the occurrences of Lower Gondwana rocks in the Peninsula, it appears that these isolated outcrops were deposited in valleys of sluggish rivers which drained the land to the south and discharged the same into the Tethys - the Mediterranean sea”. From this, a relation between the fluvialite Singrimari Gondwanas and the marine Arunachal Gondwanas could be figured out. Probably the latter was induced to marine influence due to its vicinity to shoreline and, in-between even if there were any Gondwana exposures, they might have been covered up by the Brahmaputra alluvium. The moot question that comes to the mind is that what led to down-throw of the western pad of Singrimari? Is it due to a fault? This is because, immediately west of the north-south trending Singriman
exposures, these rocks could not be encountered till a depth of 200ft, (see 1.1) and surficially from this point starts the dominion of alluviums. If we consider the fact that small scale structures reflect large scale events, then it may be put forward that in the Singrimari exposures some N-S trending faults have been encountered which becomes catchy in the pervasive slip-planes (slipping west) of carbonaceous shale. This is indicative of the presence of a N-S trending fault in the vicinity of the area. Could it be related to a part of the Dhubri fault, (F-8.3)? Seismic surveys have delineated the Dhubri fault as a major N-S trending, deep-seated, sub-vertical fault, (Murthy and Sastri, 1981) which is responsible for abrupt southward deflection of the river near Dhubri, (Kumar, 1993). If abrupt absence of exposures in the western part of Singrimari is considered due to the aforestated reason then probably, it has a relation with the genesis of the Garo-Rajmahal Gap, because starting from the Dhubri fault westwards there are a number of such faults, such as the Teesta fault. Could it be due to large scale tectonic plays like say, the easterly subduction of the Indian Plate or sediment weight of the Bengal Fan, (Currey and Moore, 1974)? All these matters are far away from the scope of the present venture and the author restricts himself from making any further speculations.
STAGE 4
A MATURED TERRAIN, GENTLY SLOPING, SLOW TRANSPORTATION AND SEDIMENTATION BY A SINUOUS CHANNEL

STAGE 3
RECURRENCE OF STAGE-2 AND REVERSAL OR EASTWARD MIGRATION OF THE BRAIDED CHANNEL

STAGE 2
WESTWARD MIGRATION OF THE BRAIDED CHANNEL LEADING TO OPENING UP OF SWAMP OVERBANK AREAS WHICH INDUCED DEPOSITION OF CARBONACEOUS SHALE

STAGE 1
UNEVEN TERRAIN, UPLIFTED PROVENANCE, RAPID TRANSPORTATION & SEDIMENTATION BY A BRAIDED CHANNEL

LEGEND
US - UPPER SANDSTONE; Pb.L2 - UPPER PEBBLY LAYER OF THE BASAL SANDSTONE; CS - CARBONACEOUS SHALE; Pb.L1 - LOWER PEBBY LAYER OF THE BASAL SANDSTONE

F-8.1: GENERALISED SCHEMATIC REPRESENTATION OF A MODEL SHOWING PALAEOPROFILE, CHANNEL NATURE AND PATTERNS OF SEDIMENTATION OF THE SINGRIMARI SEDIMENTARY COLUMN
F-8-3 DISTRIBUTION OF LINEAR STRUCTURES IN WESTERN PART OF THE BRAHMAPUTRA VALLEY (after KUMAR, 1993). N.B.: LOOK AT THE LOCATION OF SINGRIMARI WITH REFERENCE TO THE DHUBRI FAULT.