CHAPTER - 9

SUMMARY AND CONCLUSIONS

The area of study in and around Singrimari is located on the NE portion of the toposheet no. 78G/14 and, is bounded by the geographical parameters of 25°40'N - 25°45'N and 89°54'E - 89°59'E. Geologically, the setup of the area bears a lot of significance and importance. It is the only area in the Assam-Meghalaya plateau where presence of Gondwana rocks are seen in sharp contact with the Precambrian basement, a feature quite common in the eastern part of Peninsular India - Bihar, Bengal and Orissa. Being a part of both Meghalaya and Assam and in the vicinity of Bangladesh it shows a lot of confluencing features in aspects like nature, geomorphology and demography. Topographically, sharp contact between a sea like alluvial tract towards west of the Phulbari-Tura-Mankachar road and a rugged denudational hilly tract towards east of the same is seen. Pervasive brittle deformational features exhibited by the rock types of the area is another feature to be taken note of.

A surveyed area of approximately 20 sq.kms. show a variety of litho-units from highly metamorphosed Precambrian basement to recent alluvium.

A conglomeration of seven different rock types comprise the Precambrian 'basement' for the overlying sedimentary column. Amongst them are quartzofeldspathic gneiss - granite gneiss, calc-silicate gneiss, amphibolite, migmatite, granites and vein rocks - quartzofeldspathic (pegmatitic in certain cases) and quartz veins. These rocks which exhibit inhomogeneity like planar-, linear-fabric, folds of minor importance, faults, fractures, pervasive joint planes, shearing etc apparently mark themselves as a ridge or, edge of a bowl trending a little bit arcuately NE-SW. Towards west and north-west of the same are disposed the sedimentary units. Gneissosity or, schistosity being the dominant planar fabric, the basement shows a generalised trend of NE-SW at moderate degrees with fluctuations between NNE-SSW to ENE-WSW owing to the later deformations marked by F_2 and F_3 folds.

The sedimentary column starts with a southerly pinching pebbly sandstone having a conglomeratic character towards the base. Two distinct truncated cycles mark this basal sandstone unit which have been marked out as B-type Sandstone. This poorly sorted and physically inhomogenous arenaceous unit comprising of gneissic, amphibolitic and quartzite pebbles show a maxima of their orientation towards N10°E to N30°E and dip at a maximum
inclination of 20° towards west. This buff-brown, friable-compact (occasionally gritty) unit further host thin layers of carbonaceous shale which shows pinching and swelling characteristics. Entombing palaeofloral remnants of Permo-Carboniferous times, the shaly unit shows the impact of brittle deformation in a vindictive manner. Step-like slipage towards west, mylonitisation and, formation of Jhama (?) nearer to the basic intrusives are testimonials of the same. A grey and compact layer of siltstone seems to act as a demarcator between the basal (coarser) sandstones and the upper (fine) northerly pinching sandstones. However, presence of sporadic and distinct sedimentary pebbles towards the base and north of this finer arenaceous unit may be due to a temporal hiatus in between. This younger unit which has been marked out as A-type Sandstone in the field entombs minor claystone and Fe-laminations within it.

Towards north of the area are seen E-W to ENE-WSW trending long bodies of mafic, melanocratic, granular-aphanitic rocks which are intrusive (dolerite) by nature. Exposed in the form of spheroidal boulders, these bodies show minor protrubations on both sides of their generalised trend. Cutting mainly the pebbly sandstones, this unit shows two varieties - coarser and finer. The finer variety is located along the protrubations and seem to bear zeolite (?) like incrustations sporadically.

Further deposition in this area is seen in the form of alluvium.

Basement and intrusive studies highlight a lot about their intrinsic characteristics Petrographically, the quartzofeldspathic gneisses are dominantly granodioritic in composition and, exhibit several mineralogical and textural criterias of partial melting while, texturally amphibolites show enormous evidences of metasomatism and, calc-silicate rocks retain the signs of retrogression. Physical criterias indicate attainment of metamorphic equilibrium for the basement under amphibolite facies and, the metamorphic conditions surpassed atleast the experimental curve of muscovite breakdown reaction of Storre and Karrotke (1971)

The doleritic dykes show textural variation from centre to the border of the exposures Geochemical features of the basic dykes indicate it to be basaltic, tholeiitic and quartz normative. This unit which clearly hint about crystal fractionation of the same seems to have been emplaced in a crust of continental setting. While doing so, a sort of contamination also took place along the borders as is evident from the K/P ratios.

Mineralogical studies of the Singrimari Sandstones show their provenance in a continental block where the basement was not totally stable. The detritus was water laid prior to being
transported in from a nearby provenance where influence of wear and tear was less. However, presence of some sub-rounded to rounded grains may be attributed to abrasion history. Composition of both the sandstones may be matched with the underlying Precambrian basement, particularly, that of the basal variety. Nomenclature of both the distributions as mainly arkose is substantiated by a supply from either basement uplifted zones of a continental-block provenance or, climatic control.

The presence of lithic fragments and their key role in the distributions regarding status of nomenclature, climatic control or plate tectonic settings indicate a fluvial genesis for such fragments are easily destroyed on the beaches. Diagenetic, (particularly, pressure affect) is dominant in the B-type variety and is aided by their poorest sorting and size inhomogenities. Such affects are of small scale in the A-types.

The heavy minerals indicate the provenance of the distribution to be metamorphic in the main followed by acid igneous source. The presence and characters of more metamorphic minerals indicate that the sediments were derived mainly from medium to high grade regionally metamorphosed rocks. Mineralogical maturity of both the distributions is a post-depositional effect rather than pre-depositional.

With most of the characteristics of both the sandstone units being more or less similar the other differences like grain size, sorting etc may be attributed to their deposition in different temporal pulses by the same media with differing hydrodynamic attributes and sediment load.

Textural studies of the Singrimari Sandstones show presence of abundant finer population within the intergranular spaces. These fines presumably infiltrated into the intergranular network during various stages of sedimentation. Finer fractions play a decisive role in formulating the statistical character of the distributions particularly in case of the A-types. In case of the B-type distribution, the coarser ones seem to be playing the same role as the finer of the A-types. Either source control or, energy variation is responsible for these features. While energy variation seems to be better suited with the A-type distribution, in case of the B-type mixture both the options may be forwarded.

The A-type distribution is finer in nature, better sorted, positively skewed and leptokurtic. The B-types are more coarser than the A-types, poorer in sorting, slightly skewed and better sorted in the central portion. The energy conditions leading to their deposition was lower in case of the A-type distribution. The B-types were deposited by a higher energy level than the
former. However, the nature of the depositing media seem to be turbid in this case.

The mode of transportation for the A-types seem to be graded while that of the B-types might have been turbid or rapid.

Both the distributions show a strong tendency of clogging in the riverine environment in a broad spectrum where besides the typical fluvial process, various other formative processes in varying degree were in operation during the different stages of sedimentation. While the basal (B-type) sandstone show affinity towards a braided zone, the upper (A-type) unit show more maturity and inclination towards a delta front zone which seems to be influenced by the size factor, energy level and sorting.

Geochemical studies on the Singrimari Sandstones show both of them as silica rich yet immature as seen from the ratios like $\text{Al}_2\text{O}_3/\text{Na}_2\text{O}$ and $\text{SiO}_2/\text{Al}_2\text{O}_3+\text{K}_2\text{O}+\text{Na}_2\text{O}$. Presence of finer populations in both the distributions disturb their composition by contributing more $\text{Al}_2\text{O}_3$. This shifts the distributions to the 'graywacke' field.

Ratio like $\text{Mn}/\text{Fe}$ is indicative of a fresh water continental setup during deposition of these sandstones. Similarly, tectonic settings of ACM and CIA are indicative of sandstone deposition nearer to the plate boundary. Normally for such sandstones the provenance is not stable. A provenance composition of granitic by nature was derived from under arid climatic conditions.

Fluctuations in the oxidation state are reflected from metal ratios like Ni/Co. The basin of deposition was a fluctuating one as is seen from the organic carbon variations. A distinct reducing stage was there between the overall oxidised status of the whole sedimentary column.

Plant fossil (mega) finds in Singrimari are restricted to the carbonaceous shale unit due to absence of any other appropriate host rocks. Both leaf and stem parts have been discovered in the form of *Glossopteris browniana, Glossopteris stricta, Vertebraria indica Calamites cistum* and *Schizoneura gondwanensis*.

Representative samples from each of the lithounits show spore and pollen genera in the forms of *Gnetaceaepollenites, Verticipollenites, Dentalispora, Alisporites, Marsupipollenites, Cyclogranisporites, Divarisaccus, Latosporites, Parasaccites* and *Lophotriites*.

All the palaeofloral entities are characteristic of Permo-Carboniferous Gondwanic times. Stem forms of mega fossils are more prominent due to their resistant physical structure.
Singrimari miospores contain both pteridophytic spores and gymnospermous pollen grains. Miospores distribution is scarce and erratic but, they are also indicative of being a part of the Lower Gondwana times.

Examination of all thin-sections also show organic matter types like resinites, cuticles, biodegraded terrestrial organic matter, charcoal, finely divided organic matter and fungal spores. The palynofacies is found to be humic-terrestrial. Charcoal and woody parts indicate the kerogen type as Type III while spores and cuticles hint about Type II kerogen.

It is also seen that in this scarcely populated Column total organic content variation is catchy. Baring the carbonaceous shale layer in which total organic content is very high it is lower in case of the other units. Moreover, dominance of brown to black organic matter is indicative of a high temperature induced phenomenon. However, it is difficult to precisely ascertain the factors behind this temperature effect. It could be due to the baking effect of dolerite intrusions resulting in sporadic Jhama like transformation of the shaly layer in patches, tectonic plays, westward slippages in the shaly layers etc. Such features are restricted to the carbonaceous shale layer due to the nature of their physical composition and may be cited as a reason for destruction of many palaeofloral remnants even if they were present.

Rarity of fossillic remnants could be due to a braided (strong and wandering) environmental setup for the lower part of the sedimentary column. However, virtual scarcity of plant fossils (mega) and absence of miospores in a host like carbonaceous shale may be due to factors like the small thickness of this unit (a measure of the spatial and temporal dimensions), presence of pyritic specks, fluctuations in the oxidation state, overall dynamism of the depositional setup etc. Post-depositional tectonic plays further aggravated the situation. Further, absence of suitable host rocks in the upper part of the column may be cited as a responsible factor. However, this rarity is a reality which could at best be considered as an axiom.

The Singrimari Sedimentary Column 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.

Despite variations, (not mappable), the N-S trending sedimentary column following Allen's 1970 and Miall's 1978 scheme show five lithofacies base upward in the forms of massive or crudely bedded gravel facies, (Gm) - representing transportation due to high current velocities and deposition as channel lags, medium to coarse grained sandy - often
pebbly facies, (Sh and Sp) - where these activities took place under the upper flow regime (F>1) conditions in the main; carbonaceous shale facies, (C) - showing plant and mud films and indicative of shifting of the channel; further revival of Sh and Sp facies - representing channel wandering and intermittent tectonism; Fine sand (with sporadic sedimentary pebbles) silt and mud, (FI) facies - representing inter-channel overbank facies of a flood plain where local muddy environment of reducing nature or deposition of fine clay took place; silt, (Fsc) facies showing blocky and slabby bedding - indicative of a period of inactivity compared to the earlier stages; and repetition of FI facies type without sedimentary pebbles - representing 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.

A hypothetically constructed model on Singrimari sedimentation shows a southern basement uplifted zone of a Continental-Block Provenance acting as a source of detritus for the N-S trending Singrimari Sedimentary Column. This unstable provenance site resource 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. In the field, we get to see two truncated fining upward cycles of this unit interlived within which is a layer of carbonaceous shale. The basal pebbly layer mark the first episode of upliftment of provenance. The interlived layer of carbonaceous shale mark the westward migration or shifting of the braided channel, the time span of which (i.e., westward migration, shifting or abandonment of this site) was of a magnitude in which the fossillic finds completed at least part of their lifecycle. 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. 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. The aforesaid conditions lead 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. While the basal unit is a reflection of braided influence, the upper unit is due to an anastomosing or meandering channel.

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.

The observations and inferences 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 particularly, 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. It seems Singrimari happens to be the edge of a basin having its extensions towards west in Bangladesh. 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. From this, a relation between the fluviatile 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 down-throw immediately west of the north-south trending Singrimari exposures reflect influence of large scale tectonic features and events. Could it be related to a part of the Dhubri fault? The Dhubri fault is a major N-S trending, deep-seated, sub-vertical fault responsible for abrupt southward deflection of the river near Dhubri. If abrupt absence of exposures in the western part of Singrimari is considered due to the aforesated reason then probably it has a relation with genesis of the Garo-Rajmahal Gap.