Research Paper

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Deformation of The Basement Gneissic Complex of The Assam Meghalaya Craton in and Around Sumer -Nayabunglow Area, Meghalaya, India

Geology

KEYWORDS : Basement Gneiss, deformation, Sumer, Nayabunglow

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ABSTRACT

The Basement Gneissic and Migmatitic Complex of the Assam Meghalaya craton near Sumer and Nayanbunglow area of Meghalaya underwent four phases of deformation. The tight isoclinal F1 folds with S1 axial planar cleavage and L1 fold axis lineation represents the earliest phase of intense compression. The F1 folds exhibits Class 2 and Class 1c geometry and refolded to open asymmetrical F2 folds with S2 axial planar cleavage and L2 fold axis lineations. The F1 and F2 are coaxial and F2 axial planar cleavage of S2 dips to the north. The third phase of deformation is weak and F3 folds with large wavelength and low amplitudes have axial planar cleavage dips to the southwesterly direction. All the three phases of deformation exhibit ductile phases of deformation and fold shapes reflect the competency contrast in the folded layer and the embedding medium. The fourth phase of deformation is brittle and the contarctional and extensional joints with small scale shear zones are ubiquitous.

Introduction

The Sumer-Nayabunglow area of Ri-Bhoi District of Assam Meghalaya Plateau (Sarma and Dey,1996; Sarma et al, 1998) covers a part of the Assam Meghalaya craton (**Fig.1**). The Assam Meghalaya plateau is an ancient landmass which was separated from the Indian Peninsular shield by the Garo-Rajmahal trough fault. (Pascoe, 1950; Ermenco et al, 1969). An intra-cratonic depression or an extension basin was created during the Precambrian time where thick pile of sediments deposited and got metamorphosed on a regional scale. The metasedimentaries constituted what is known as Shillong Group of rocks which unconformably overlies the Basement Gneissic and Migmatitic Complex (BGMC). The Shillong Group of rocks are first intruded by the epidiorites or metadolerites and further intruded by the granitic magma forming some plutons towards the waning phase of the Proterozoic period. The investigated area is bounded by the Survey of India toposheets 78°/13 and 78°/14 of 1:50,000 scale and latitudes 25°39 N to 25°47 N and longitudes 91°50E to 92°E longitudes.

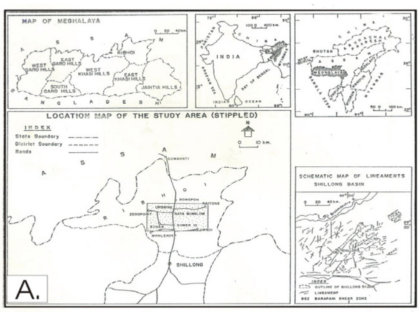


Fig.1. Position of Meghalaya and in NE India (shaded); location map of the study area (stippled) and Lineament map of shilling basin (schematic)

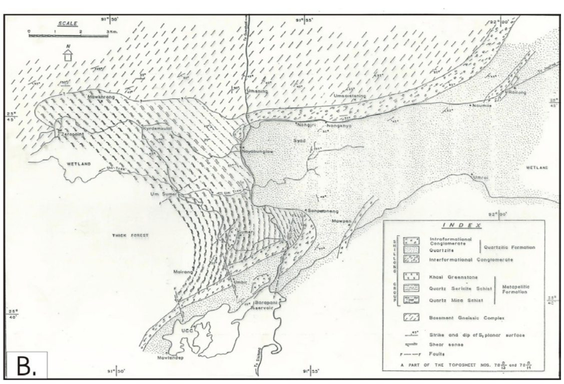


Fig.2a.Geological map of the Sumer-Nayabunglow area of Meghalaya

The gneissic rocks form he basement (BGMC) of the studied area is a complex structural amalgam showing evidences of superposed deformation and associated polymetamorphism (Fig.2). On the small scale the region may be characterized as a mosaic of blocks each having a specific tectonic style. The structural complexity of the area can be systematically studied and referred as deformation phases where the planar and linear structural elements provide excellent scope for undertaking a regional structural analysis of the area. In the present paper, we are reporting the dominant ductile and brittle phases that have affected the rocks and kinematics involved in the formation of these structures.

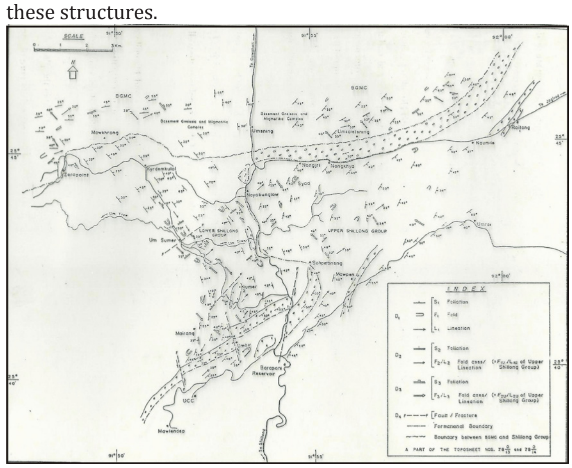


Fig.2b.Structural map

Sequences of deformation

The rocks of the BGMC have undergone a total of four phases of deformation. However, the different deformation episodes are characterized by style of folding in the marker layers rather than the other planar and linear structures.

First phase deformation

Folds (F_1) Folds of the first phase deformation are preserved in the competent layers embedded in the quartzofeldspathic gneissic host. They are the earliest representation of the folding episode in the form of tight isoclinal to tight appressed F_1 folds tectonically attenuated and sheared out in the form of boudins (Fig.3d) and have been floated in the form of tectonic fish within he foliated matrix. They are thicker in the hinge part and thinner in the limbs and belong to Class 2 or more close to Class 1c type of folds (Ramsay, 1967). F_1 folds show both dextral and sinistral vergences, inter-limb angle ranging between 5° to 20°. They are associated with highly penetrative axial planar cleavages (S_1) which is parallel or sub parallel to the compositional layering (So) except the fold hinges where S_o and S_1 intersect at an angle of 40° to 70°. Large limb of the F_1 folds showthin limbs and thickened limbs and high amplitude wavelength ratio. Sometimes they also show pinch and swell structure (Figs.4a and b) and the boudinaged layer indicate pre to post boudinaged plastic deformation. Rhombic and rectangular boudins are also observed (Figs.3b and d). Rotation of the boudinaged layer indicates a layer parallel sinistral shear and a non coaxial bulk deformation. The exposed fold hinges show modest plunge either to NE/SW and the orientation of the fold axis changes due to later deformation.

The discontinuity of the layers (S_0), their thickening and thinning sheared out behaviors and the complete absence o he original primary structures should be due to intensive transposition of layers.

S_1 is the most pervasive fabric and is synkinematically parallel to the F_1 fold hinges where S_1 cut S_0 at high angles. The attitudes of S_1 vary greatly due to the superposition of the later deformation (**Fig.3d**). In the quartzofeldspathic gneisses the the S1 foliation is defined by elongate platy and flaky minerals like mica s while the hornblende defines the S_1 in amphibolites .

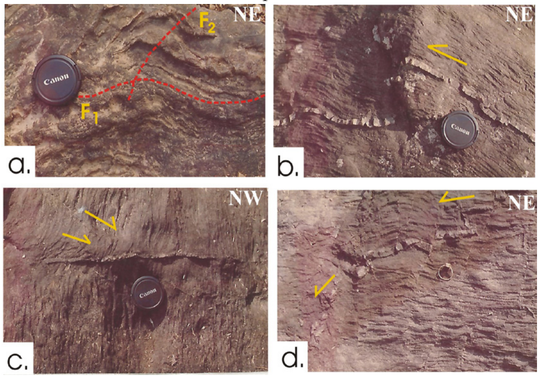
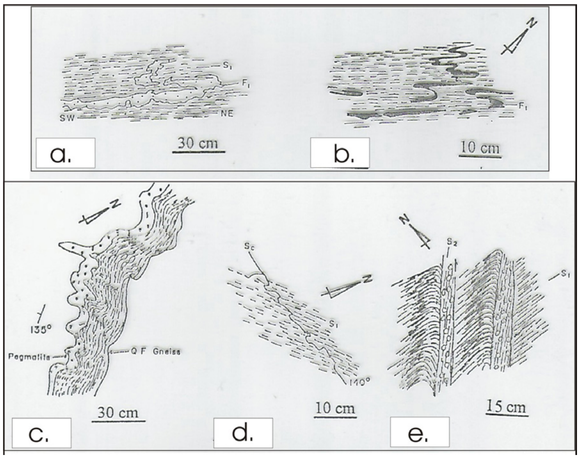


Fig.3 a. Quartzofeldspathic gneisses of Unsning area. F_1 and F_2 folds are shown b. well developed S1 planes of quartzofeldspathic gneisses transected by sinistrally rotated quartz filled shear plane from Umsning areas c. same as 3b., but the shear planes maintain enechelon tenancy and host rock dextrally rotated d. Sinistral displacements of quartz veins.

Highly penetrative linear structure is designated as L1 and is defined by mineral lineation F_1 fold axis lineation, intersection of S_1 and S0lineation, pinch and swell structures and boudin axis lineation.

Second phase deformation

The second phase of deformation reached its maximum intensity by a NW-SE trending compressive stress leading to the formation of up and down facing folds of upright nature throughout the area and restricted to mesoscopic scale only.



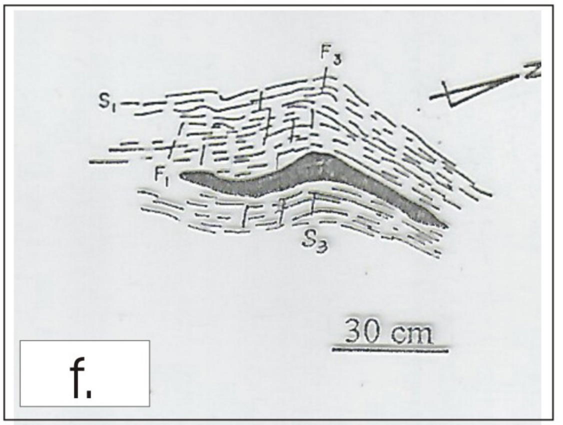


Fig.4 a. F_1 folds in quartzofeldspathic gneisses marked by quartzofeldspathic layer showing pinch and swell structure near Zeropani area, b. F_1 folds are marked by mafic layer in the same location, c. folding of the pegmatite layer behave independently and the associated quartzofeldspathic gneiss also show similar fold pattern, d. SC foliation transecting original foliation near Zeropani, e. slip along the short limbs of F_2 folds result in the emplacement of pegmatite vein with sinistral sense f. S_1 and S_2 shown by amphibolites enclosed within the quartzofeldspathic gneisses near Umsning.

F_2 folds are open and developed on compositional banding or gneissosity as well as on the axial planar foliations S_1 (Figs.3.a and b). They display low amplitude wavelength ratio and are characteristically Class 1B folds with rounded to sub-rounded hinges (Fig.3). Axial planes of F_1 and F_2 folds show coaxial relationship. The F_2 axis plunges 35° to 70° either to NE or SW. The axial plane of F_2 folds are mostly subvertical and show upright nature. Deviation of the orientation of F_2 folds at the contact zones of the basement gneisses and the overlying Shillong Group of rocks is tectonic rather than defining an erosional contact between them.

orientation of vein quartz. Intersection L_1 and L_2 is occasionally observed and they make very low angle and can be referred as coaxial.

Third phase deformation

The third phase of deformation is comparatively of low intensity and has deformed all the earlier structures. F_3 folds are studied in two contrasting settings either as small folds in the limbs of the earlier F_2 folds or as outcrop scale wraps with a general asymmetric pattern (Fig.4e).The axial pane orientation of F_3 folds are orthogonal to the axial plane orientations of the F_2 folds. The F_3 axial plane (S_3) trends NW-SE and dips steeply towards SW. The superposition of F_3 over F_2

The extensional crenulation cleavage associated with F_2 micro folds are typically developed in north of Nongkhya area where gneisses are underlained by Shillong Group of rocks. In amphibolites, the development of S_1 is defined by axial plane fracture cleavage Fig 4a. Near Kyrdemkulai, comparatively small patch of amphibolites is observed where small scale crenulations are observed which are mimicked by vein quartz, transected by another set of vein quartz defining axial planar orientations (Figs 4c, d and e).

Lineations D_2 deformation are defined by intersections of S_1 with S_2, fold axis and created type -1 dome and basin interference pattern of Ramsay, 1967. Mineral lineation defining L_3 are less frequent and only quartz veins of enechelon type with orientation coinciding axial pane s of F_3 folds are observed at places like Zeropoint and Mawkhrong.

Fourth phase deformation

Features relating to fourth phase deformation are a brittle phase

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constituted by fractures and joints, faults of both extensional and contractional type and small scale shear zones restricted to centimeter scale (**Fig.3d**). Kink folds with NS kink planes, Ns trending near vertical shear planes, minor reverse faults with dextral geometry are classified under D_4 brittle deformational event.

Conclusions

The Basement Gneissic Complex (BGC) of the area around Sumer and Naya-Bunglow of Meghalaya, suffered four phases of deformation. These phases are responsible for the development of different generations of folds, foliation and lineations and the over printing relation of the younger phases over the earlier are observed. The fourth phase is a brittle phase with the development of the faults and shear zones of various dimensions. The generalized trend of the (BGC) is NE-SW near Umsning with local variation to nearly E-W in Zeropoint and Kyrdemkulai area. Strike direction of BGC roughly corresponds to the regional trend of the litho associations of the gneisses and the dip direction varies either to south- east or to north -west or to nearly north. Such variations are due to the effect of tectonic deformation under various phases.

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