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Geology and Strain History of Rocks Exposed around Village Modi, North East of Gogunda, Udaipur District, Rajasthan

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Abstract:** The rocks exposed around village Modi,NE of Gogunda , Rajasthan includes metapelites, quartzites and metaultramafics. Lithologically the rocks of this area belong to deep sea facies condition (Jharol formation, Aravalli Supergroup, Udaipur, Rajasthan). Structural Analysis of rocks reveals subjected to the area has been subjected to three phases of deformation. The second deformation (AF2) is the most dominant structural event which has controlled the whole outcrop pattern. The strain analysis suggest that the initiation of $AF_1$and AF_2 deformations took place by buckling followed by flattening resulting in Class IC (flattened parallel folds)
***Keywords:** Aravalli Supergroup, Meta Ultramafics, Udaipur, Rajasthan.*

I. INTRODUCTION

The rock types exposed towards NE of Gogunda belongs to Aravalli as well as Delhi Supergroup out of which the former covers greater part of the area. These rocks have been involved in complex superposed deformation and thus selected for the study of detailed geological and structural behavior of rocks. The present work has also revealed a detailed study of meta-ultramafics exposed in the area regarding to its tectonic, stratigrapic status and strain history of rocks. The area selected for the study is about 40 sq. km and has been mapped on 1:10,000 scale. This mapping has revealed a lot of details about the behavior of the small scale structural elements of deformed layers, structrural geometry and strain history of the area which is briefly discussed in this paper.

A. Geological Setting

The geological details of the present area of investigation are given in the Fig.1. Stratgraphically, the rocks of the area belongs to Jharol formation of deep sea facies sequences of Aravalli Supergroup (Roy, et.al., 1991). According to GSI (1981),also rocks of Jharol Group are exposed around village Modi,and Chippala. This includes garnet-mica schist and meta-ultramafics with thin inercalatory bands of quartzite. On the western margin of the area, rock types of Delhi Supergroup are exposed which includes mainly quartzite. It belongs to Kelwara Formation of Gogunda Group (GSI, 1981).
The stratigrapic succession of the rock of the area is given in table1.

Table1: Stratigraphy of the area around Modi

Delhi Super Group	Gogunda Group	Kelwara Formation Antalia Formation Richer Formation	Kelwara Formation exposed	Quartzite
-----------------Structural discordance-----------------				
Aravalli Super Group	Jharol Group	Samlaji Formation Goran Formation	Goran Formation exposed	Quartz veins/ meta-ultramafics associated with Quartzite/mica-schist & garnet-mica schist
-----------------Unconformity(not exposed)-----------------				
Banded Gnessic Complex		not exposed		Exposed further south near Bagdunda (chauhan,1983)
Nomenclature as per GSI(1981).				NE of Gogunda Udaipur, Rajasthan

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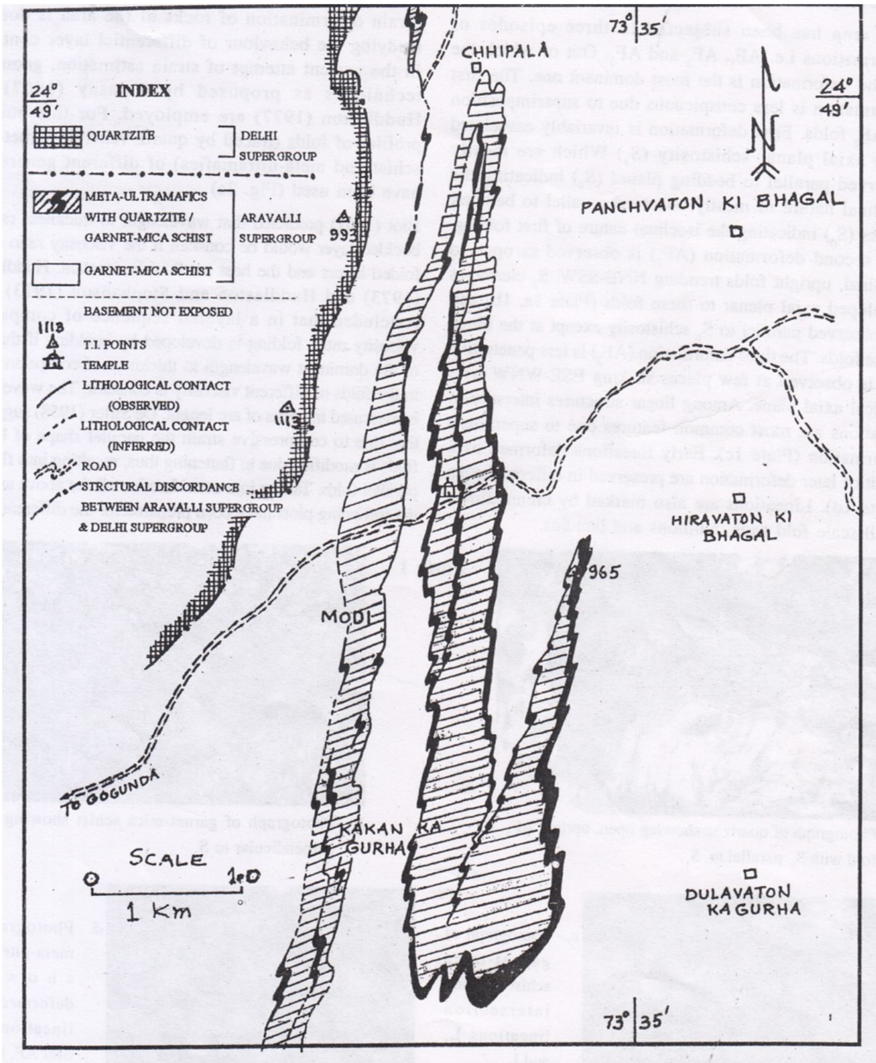

Fig. 1 Geological Map of the area around Modi, Distt. Udaipur, Rajasthan

B. Structural Setting

The Area has been subjected to three episodes of deformations i.e. AF_1, AF_2 and AF_3. Out of which the second deformation is the most dominant one. The first deformation is less conspicuous due to superimposition by AF_2 folds. First deformation is invariably associated with axial planer schistostity(S_1) which are mostly observed parallel to bedding planes(S_0) indicating the isoclinal nature of mostly observed parallel to bedding planes(S_0) indicating the isoclinals first folding. The second deformation (AF_2) is observed as open to isoclinal, upright folds trending NNE-SSW. S_2 cleavages developed axial planar to these folds (Plate1a,1b) and are observed parallel to S_1 schistostity except the hinge of the folds. The third deformation (AF_3) is less penetrative and is observed at few places striking ESE-WNW with vertical axial plane. Among linear structures intersection lineations are most common features due to superposed deformation (Plate 1c). Early lineations deformed as a result of later deformation is preserved in different rocks (Plate 1d). Lineations are also marked by crenulations, small –scale folds axes, mullions and boudins.

C. Strain History

Strain determination of rocks of the area is done by studying the behavior of different layer contrasts. In the present attempt to strain estimation, geomertic techniques as proposed by Ramsay (1967) and Huddleston (1977) are employed. For this purpose profiles of folds (traced by quartz veins in garnet-mica schist and meta-ultramafics) of different generations have been used (Fig.2a)

Biot (1961) predicted that wavelength to thickness ratio of buckled layer would be constant if the viscosity ratio of the fold layer and the host medium is constant. Huddleston (1973) and Huddleston and Stephanson (1973) have concluded that in a layered

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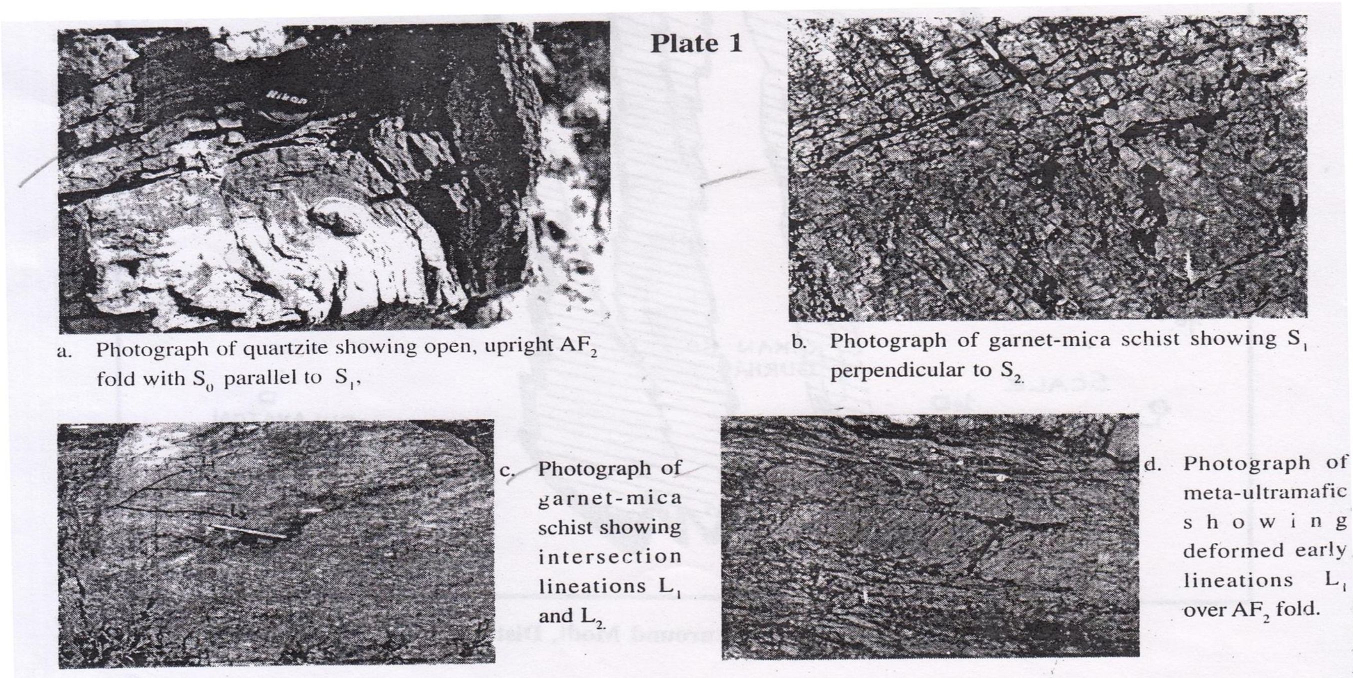
sequence of comparable viscosity ratio, folding is developed by buckling if the ratio of the dominant wavelength to thickness of competent layer in the holds of different viscosity is constant. The wave length is measured in terms of arc length. De Sitter (1958) suggested that due to compressive strain the parallel shape of buckle folds is modified due to flattening thus, resulting into flattened parallel folds. Taking into consideration all the above aspects, the following plots have been prepared for the different folds.



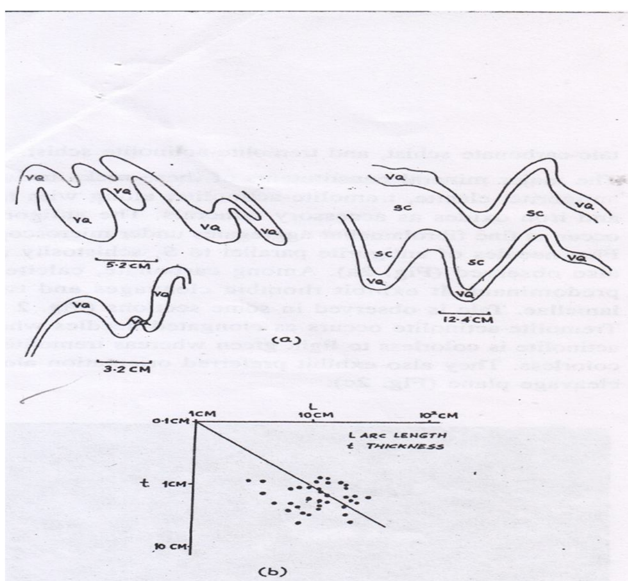


Fig.2 (a) :Profiles of AF_2 Folds traced by quartz Vein(Vq) in schistose rock(Sc)
(b) :Plots of arc length(L) v/s thickness(t) of $AF_1$and AF_2 folds.

Arc length (L) vs. thickness (t) plots of AF_1 and AF_2 folds (Fig. 2b) is prepared on log-log scale which shows that arc length is directly proportional to wave length pointing to buckling origin of folds (Biot, 1961; Ramberg, 1963; Naha et.al., 1977; Sharma et. al., 1988).

Different folds of AF_1 and AF_2 generations are chosen for the measurement of orthogonal thickness ($t_\propto$)at different limb dip ($\propto$).The $t_\propto$'/$\propto$ plots shows that majority of folds shows Class 1C geometry (i.e. flattened parallel folds)with Class 1B geometry at the hinge (Fig. 3a).Plots of t' $t_\propto$'/$\propto$ also give an idea about the apparent strain ratio $\sqrt{\lambda 2/\lambda 1}$.
The values shows a wide range from 0.1 to 0.5 for AF_1 and 0.1 to 1.0 for AF_2 folds
The range of $\sqrt{\lambda 2/\lambda 1}$values indicates that different folds underwent varying amount of flattening (Roy, 1978) Fig. 3c).
The φ/$\propto$ plots are prepared for the same set of folds for which $t_\propto$'/$\propto$ plots have been prepared. Here, also most of the folds satisfies the condition of Class IC geometry i.e $\propto > \varphi_\propto > \theta_2$ (Fig. 3b)

D. Origin of AF_1 and AF_2 folds:

Thus, the constant values of L/t ratio, nature of $t_\propto$'/$\propto$ and $\varphi_\propto/\propto$ plots, wide range of $\sqrt{\lambda 2/\lambda 1}$Values and different field evidences such as refraction of axial plane cleavages across layers of different comperency contrasts, occurrence of radial tension cracks at hinge of the folds in competent layers, and reversal of curvature at the hinge of folds all of them indicate that both AF_1 and AF_2 folds are initiated by buckling followed by flattening, normal to their axial surface.

E. Tectonic and stratigrapic status of metaultramafics of Jharol Formation:

The meta- ultramafics exposed in the area belongs to Jharol Formation of deep sea facies sequences; the emplacement of these rocks took place along an important lineament (Kaliguman Lineament). It is emplaced parallel to the Aravalli Quartzite striking NS to NE-SW. Moreover, it has participated in all the three deformation episodes (i.e. AF_1, AF_2, and AF_3).These evidences suggest that the emplacement of these lithounits took place contemporaneous with sedimentation but prior to Aravalli deformation.

II. CONCLUSION

The lithological aspects suggest that the rocks of this area are deposited in deep sea facies conditions (Jharol Formation). The area has been subjected to three phases of deformation. The second deformation (AF2) is the most dominant structural event which has controlled the whole outcrop pattern of the area. The strain analysis suggest that the initiation of both AF1 and AF2 deformations took place by buckling followed by flattening resulting in Class IC (flattened parallel folds).
The compressive strain ratio varies from 0.1 to 1.0. The metaultramafics exposed in the area is early Proterozoic in age and have been emplaced prior to Aravalli deformation (AF_1) in the associated lithounits.

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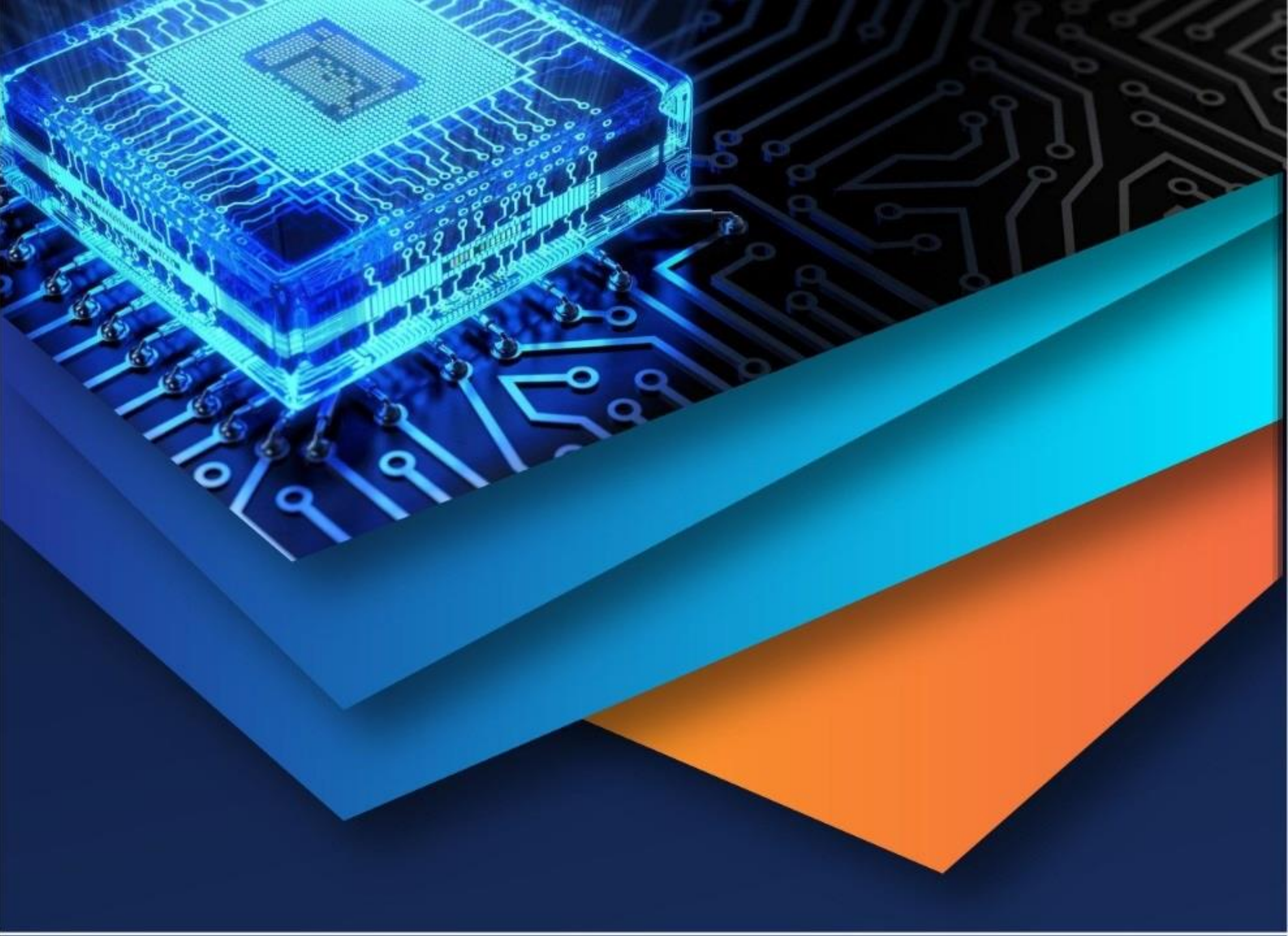

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