Chapter Three

Structural Elements

Before attempting a detailed structural analysis of the area it is perhaps relevant to describe in brief the different structural elements that have been observed in the field. The structural elements may be broadly divided into two groups: (1) The planar structures and (2) The linear structures based on the character of the elements.

Planar Structures:

The following different planar structures have been
observed: (a) Bedding, (b) Cleavages, (c) Joints. The first two have been studied with greater emphasis. The different planar structures (leaving joints) are designated here as $S_1$, $S_2$ and so on, following a chronological order. Bedding, being a primary structure assumes the first place. The cleavages developed in these rocks are very distinctly seen in the metasediments of this area. Besides these there is a well-developed gneissic foliation seen in the gneisses of the Banded Gneissic Complex.

**Bedding.**

As the bedding plane is a primary structure and first to have formed it is designated as $S_1$. This is recognised in the pelites (phyllites) by the compositional banding and grain size variation. In the quartzites it is sometimes very hard to recognise (the quartzites north-east and north-west of Rama). Often the quartzites occur as huge structureless masses and nothing seems to be present in them. On the other hand some of the quartzites show very distinct bedding, current structures like ripples, cross-beds and sometimes sole marks can be seen on the bedding surfaces. In the limestones quite often the bedding is unrecognisable. When siliceous layers are present in them they stand out from the general surface producing grooves and furrows. This grooving has helped in the recognition of bedding. Intercalations of
pelitic layers in the limestones when present have helped to establish bedding.

**Cleavages.**

These are exceedingly well-developed in the pelites and meta-volcanics. In limestones and quartzites the cleavages are not distinct. The cleavages that are recorded in these formations are not actually in these rocks but in the intercalated pelites.

The cleavages definitely are not all one and the same. There is good indication of three sets being present, but the strike variation is very little. The most prominent of these has a north-south orientation. Sometimes it is possible to see all these cleavages in a single outcrop. Since the angular variation between these cleavages is very small, it is not always possible to place them in the chronological order when only one of them is seen in an outcrop.

In the Banded Gneissic Complex, the gneisses show foliation. It is shown by a separate symbol in the map to differentiate it from other cleavages measured in schists, etc. of the complex.

In the meta-volcanics also cleavages are beautifully developed. Huge slabs are chiselled out parallel to the cleavages in these rocks for building purposes.
Joints.

Joints are well-developed in all rock types except in some crushed zones in the quartzites and arkoses. There is quite a variation in the attitude of the joint surfaces and it is definite that they are related to the folding episodes.

Linear Structures:

Cloos (1946) has defined lineation as a descriptive non-genetic term for any kind of linear structure within a rock. He has described 13 different kinds of lineations and classified them as primary and secondary, the tectonic lineations being all classified as secondary and the non-tectonic ones as primary.

In the present area most of the lineations that have been measured and recorded are tectonic lineations. In the pelites some primary lineations are present but not many measurements could be made on them because of their sparse development.

In the secondary lineations (which from now on will be referred to only as lineations) there is a great variety and they are designated here as \( L_1 \), \( L_2 \) and so on. Unlike the case of planar structures, there is no implication regarding the order of development of these lineations in the numbering. These are arranged in an order based on the commonness or
prominence of a particular lineation rather than the order in which they have formed. This scheme is adapted for the purpose of a general description. It will be difficult to follow a chronological order for it is not always easy to establish it and secondly during a single folding episode different kinds of lineations can develop in different rock types.

The following linear structures were measured and recorded:

1. Lineation 1 - \( L_1 \), Intersection of bedding and cleavage
2. Lineation 2 - \( L_2 \), Axes of minor folds
3. Lineation 3 - \( L_3 \), Puckers (wrinkling, crinkling)
4. Lineation 4 - \( L_4 \), Intersection of cleavages
5. Lineation 5 - \( L_5 \), Mullions
6. Lineation 6 - \( L_6 \), Pebble elongation
7. Lineation 7 - \( L_7 \), Striae and grooving
8. Lineation 8 - \( L_8 \), Mineral streaking

**Lineation 1** - Intersection of bedding and cleavage.

In pelites and quartzites quite often bedding and cleavages are seen together and in all such cases the intersectional lineation can be very distinctly seen. The lineations here are in the form of traces or streaks of one plane in the other. These can be observed on the cleavage surface or the bedding surface. Where no such traces can be seen the bedding and cleavage attitudes are measured and the attitude and plunge
of the intersection line is recorded. These lineations can reflect different fold axes and is directly related to the cleavage concerned.

**Lineation 2** - Axes of minor folds.

Minor folds are well-developed in the phyllites and in the phyllite-quartzite sequence. The axial planes and fold axes have been measured and recorded.

**Lineation 3** - Puckers, wrinkling.

This is quite a dominant lineation in the pelitic rocks (phyllites) and meta-volcanics (which are rich in micaceous minerals). These are invariably observed on cleavage surfaces and sometimes two sets of lineations are seen on the same surface, bent early lineations of this kind are not uncommon.

**Lineation 4** - Intersection of cleavages.

This lineation is again most commonly seen in the Aravalli pelites and meta-volcanics where more than one cleavage are developed. Sometimes within the domain of a hand specimen two or three cleavages can be very distinctly seen. In such cases intersection cleavage lineations are observable.

**Lineation 5** - Mullions.

Wilson (1953) has distinguished three kinds of fold
mullions which he termed them as (a) cleavage mullions, (b) bedding or fold mullions, and (c) irregular mullions. Excellent examples of these have been described by him near Oykelbridge in the Highlands of Scotland.

All the three kinds of mullions have been observed in the present area but cleavage mullions are the most abundant of all. On weathered outcrop the rock breaks into small thin elongated slabs. The attitudes of the mullions have been recorded.

**Lineation 6** - Pebble elongation.

This lineation is confined to the conglomerate bands associated with the arkoses and quartzites.

**Lineation 7** - Striae and grooving.

These are seen only in fault zones and are of a limited extent. These are present in the arkoses and quartzites (Delhis).

**Lineation 8** - Mineral streaking.

These streaks are of micaceous minerals and are observed on cleavage surfaces in phyllites and meta-volcanics and are rarely seen.