# CHAPTER VIII

# R E S U M E

## GENERAL

The Garampani area, upon which this account dwells, was not mapped and investigated in the past. This geologically important terrain of the Kumaon Himalaya posed a number of problems of structure and stratigraphy, and as the reader must have found on perusing this thesis, the investigations of the present author have revealed much. Earlier workers thought that the entire terrain to the north of Naini Tal right up to South Almora thrust was occupied by the slates and quartzites of Nagthat formation. But the author

has shown for the first time that the rocks of the area consisted not only of Nagthats but also of Blaini and Infra-Krol formations.

With the help of the field and laboratory studies, he could successfully work out the correct stratigraphy and structure of the area.

STRATIGRAPHY

The study area forms of part of the south-eastern extremity of the Auden's Krol belt lying to the north of Naini Tal. Its rocks compare farly well with the type area in Simla. It is for this reason that the author has relied on Auden's nomenclature in working out the stratigraphy of the study area. His inferences are also based to a certain extent on the work of Heim and Gansser in the Naini Tal area. But in matters of details, the author has differed much from these previous workers. The most important aspect on which the author has differed from Heim and Gansser is that of the stratigraphic age of the various formations.

The author has arrived at the following stratigraphic succession:

| | |
|---|---|
| Carbonaceous and purple slates, silty slates and pebbly quartzites | Infra-Krol |
| Purple and carbonaceous slates with limestones<br>Gray slates and quartzites (interbedded)<br>Pebbly quartzites, sub-graywackes with thin slaty layers | Blaini |
| Foliated Traps | |
| - - - - - - - - ? Unconformity - - - - - - - - - | |
| Quartzites and slaty phyllites<br>Limestones with slates,<br>Slates interbedded with quartzites<br>Sheared granites and granophyres | ? Nagthat |

The Blaini-Infra-Krol sedimentary sequence rests over the foliated traps, while the Nagthat sequence is considered older to the traps. It is not clear whether the trappean rocks form a part of the Nagthat sequence or they represent a post-Nagthat volcanic igneous activity. O.K. Shah has found these rocks in the Bhowali-Bhim Tal area to be of spillitic nature, comprising submarine lava flows and tuffaceous beds associated with graywackes. It is not unlikely that these typically represent geosynclinal volcanism heralding and preceding the deposition of the Krol group (Blaini-Infra-Krol-Tal sequence).

The above rock succession forms a regional anticlinal structure, which is the north-western extension of the Bhowali anticline. The north-eastern limb of this fold has been truncated by the Ramgarh thrust such that the older Nagthats are now seen resting over the younger Blainis and Infra Krols.

The Nagthat formation, comprising the older group of sediments, indicate a geosynclinal sedimentation prior to the volcanic activity which is now represented by the foliated trap rocks. The post-Nagthat dipositional history is more clear. A significant feature of the Blaini-Infra-Krol deposition is the relative shallowness of the basin right from the beginning. The entire sequence typically represents deposition in a marginal basin, basement of which was Nagthat. So far as the bouldery and pebbly beds of Blaini are concerned, they are not glacial or fluvio-glacial. They appear to be shallow water turbidites. The slate sequence in the lower part of the Infra-Krols, suggests a comparative deepening of the basin. On the other hand, the upper Infra-Krol deposition indicates shallowing again.

So far as the stratigraphic age is concerned, these unfossiliferous rock formations have always posed a serious problem. For the Krol group sequence, there are some references available to fix its possible age, but as regards the underlying Nagthat formation, the problem of fixing its age has been rather difficult. The author has taken the entire succession to the north-east of Ramgarh thrust as Nagthat formation and considered it broadly equivalent to the Jaunsars, which in turn, following the previous opinions, could be taken to be of age anywhere from Ordovician to Devonian.

The foliated traps have been provisionally kept between the two groups of geosynclinal sequences i.e. the Nagthat formation and the Krol group, with a likelihood of these mafic effusives representing the earliest event in the miogeosyncline which was the site of the deposition of Blaini-Infrâ-Krol sequence.

The age of the Krol group, based on many evidences, including palynological and micropalaeontological by some previous workers, have been taken as ranging from Permo-carboniferous to Lower Cretaceous. Accordingly, the author has assigned following stratigraphic age to

the rocks of the study area.

| Formation | | Age |
|---|---|---|
| Infra-Krol | - | ? Permian or Triassic |
| Blainis | - | Permo-Carboniferous |
| Foliated Traps | - | Upper Carboniferous |
| Nagthat | - | ? Ordovician to Dovonian |

STRUCTURE

The structure of the area has been worked out for the first time, and it has come out to be quite interesting. The author could successfully establish the structural pattern, taking help from the excellent mapping of his colleagues in the areas to the south and south-east.

Structurally, the most prominant feature is the existence of a macroscopic anticlinal structure extending NNW-SSE (Garampani-Bardau Malla anticline). This structure is in fact, the northern extension of the Bhowali anticline.

The north-eastern limb of this anticline is truncated by a major reverse fault (Ramgarh thrust). The south-western limb of the anticline, is much distorted by the superimposition of folds whose axial planes are roughly E-W. The rocks to the north and north-east are seen affected by yet another generation of folds - N-S to NNE-SSW. The Ramgarh thrust is younger to the E-W folds but older to the NNE-SSW flexures.

Pucker lineations related to all the three fold episodes, are sporadically encountered. Based on a systematic field study and geometric analysis of foliation trends and lineations, the author has worked out a structural history comprising three major fold events. The earliest folding ($F_1$) is represented by the large anticlinal structure that extends NNW-SSE across the area. The existing distorted shape of this anticline is on account of the superimposition of later folds of two generations ($F_2$ and $F_3$) on its two limbs. The $F_2$ (E-W) folds are prominently developed on the south-western limb while the $F_3$ (NNE-SSW) flexures are common on the north-eastern limb.

The Ramgarh thrust developed after $F_2$ but prior to $F_3$. This major dislocation has intrigued previous works. Most took it to be equivalent to Garhwal or Almora thrust, appearing again due to folding. The author has however, established that as Merh has rightly stated, the Ramgarh thrust is in no way related to the Almora thrust, but it is a dislocation of the nature of a big reverse fault that developed close after the $F_2$ during the Krol thrust movement.

The author has for the first time successfully traced this dislocation further west beyond Khairna. Previous workers found it easy to trace this thrust from Ramgarh northwestward upto Khairna bridge, but further, it always deluded them. The author found that the thrust runs from Khairna northward for 2.5 km along the Kuchgad stream, and then takes a westerly trend, following the northern slopes of the Lodiakhan ridge. From east to west, this thrust progressively cuts the younger members of the Nagthat formation also.

## CONCLUDING REMARKS

The structural pattern, fold history and stratigraphy of the study area, that have emerged

from the author's investigation, throw considerable light on the various major geological events of the Kumaon region. In fact, the author's results provide for the first time valuable data that fill the numerous gaps in the existing knowledge about the geology of this part of the Kumaon Himalaya.