RESOURCE ATLAS OF KERALA: (Centre for Earth Science Studies, Trivandrum)

Maps serve the purpose of consolidating a vast amount of basic data and presenting such data in a form which is at once striking and easy to grasp. Attractive, informative maps are a necessary part of our education. Most of the so called text books which have flooded the market in recent years have very few maps included in them. Those which find an entry are crudely drawn and are least likely to attract the attention of students.

In the above context, we warmly welcome the excellent series of maps published by the Centre for Earth Science Studies, Kerala and brought together as the Resource Atlas of Kerala. There are in all 132 maps in colour with explanatory text, illustrating features like climate, geology, mineral resource, water resource, forests, agriculture, population, irrigation, fisheries, tourism etc. The maps are very well produced in pleasing shades of colour.

Our only criticism is about the unwieldy size of the Atlas. A more handy volume would have catered to the needs of a large number of the student community. Their need is urgent. Now that the basic data has been gathered, it should be possible to bring out a more handy and popular version of the Resource Atlas of Kerala. In our opinion, other States should follow the example set by Kerala and come forward with improved versions of maps representing the natural resources of their respective States.

The Centre for Earth Science Studies and all those responsible for the production of this most useful compilation are to be congratulated on an excellent piece of work done. The Atlas should become available in all libraries and educational institutions throughout India.

B. P. RADHAKRISHNA

GEOLOGY OF THE BHUTAN HIMALAYA: By Augusto Gansser, Birkhauser Verlag, Basel, (1983), 181 pages, figures 139—Geological map of Bhutan Himalaya, 90 photographs.

The *Geology of the Bhutan Himalaya* by Gansser is the result of investigations during his five expeditions to Bhutan from 1963 to 1977. The book incorporates important geological information from the sub-Himalaya to the Tethys-Himalaya of Bhutan and is of great interest to all those connected with the Himalaya.

The book is divided into 12 chapters A-L, the last chapter (L) contains selected bibliography, subject index and abstract. Broadly the geological description in the book follows the physiographic divisions, from the Sub-Himalaya to Lower Himalaya and the Tethys Himalaya. Gansser records that the three-fold division of the Siwaliks is not easily recognisable in Bhutan. Biswas *et al* (1979) of the Oil and Natural Gas Commission of India have, however, shown that the Siwaliks can be divided into three mappable formations on the basis of gross lithological characteristics.

The Bhutan Lower Himalaya is in continuation with the Sikkim Lower Himalaya and in most aspects these two sectors appear comparable. In the tectonic sequence, the Siwalik belt is succeeded towards north by the discontinuous strips of Permo-Carboniferous unit of Damudas followed by the controversial Diuri Formation, the

Baxa and the Daling-Shumar belts and demarcated to the north by the Main Central Thrust. The Diuri Formation, first reported by Nautiyal *et al* (1964), is termed as the Late Precambrian-Cambrian tilloid deposits by Gansser. It seems to be similar to the 'Ranjit Pebble Slate' of the Sikkim Himalaya than to any other older boulder slates.

The Baxa Formation is no longer correlated with Krol as earlier suggested by Nautiyal in 1964. Gansser has preferred to limit the Baxa to those horizons which contain mostly dolomite, limestone and calcareous shale. Broadly, these carbonate belts in the Lesser Himalaya represent an orthoquartzite-carbonate association with prolific stromatolites and are everywhere underlain by a sequence of purple quartzite-shale with abundant to rare volcanic rocks. In the opinion of the reviewer the sequence of purple quartzite and shale with some basics, stratigraphically below the Baxa, should be retained as an infra-Baxa formation in order to facilitate inter-regional correlation with other such formations like the Sundernagar Group of Himachal Himalaya.

Gansser is right in considering the Samchi of Nautiyal *et al* (1964) as unnecessary. The Shumar Group takes care of the thick sequence of argillite, phyllite and quartzite which is remarkably similar to the Daling Group and, therefore, the term Daling-Shumar Group by Gansser is a good compromise. Gansser's objection to the use of the term Thungsing quartzite is justified, as it forms part of the Shumar Group.

The report by Gansser of dark grey carbonate beds *(Barsong unit)* containing Jurassic palynomorphs below the Main Central Thrust has many interesting possibilities. The Krol-Tal Formations of Himachal-Garhwal are the only units which carry a Mesozoic tag (also supported by palynomorphs) but they are now drawn into a vortex of palaeontological controversy. As the *Barsong unit* of Bhutan contains Lower Palaeozoic reworked fossils, a similar situation may exist in the Tal also, an aspect which needs the attention of workers in this field.

Gansser describes the Tethyan rocks of Bhutan from three major basins, the Lingshi in the northwest, Toma La-North Lunana in the northeast and the Tong Chu in Central Bhutan. In the Lingshi basin, the lower sequence over the pegmatitic muscovite granite is unfossiliferous, but the succeeding thick beds of limestone contain fossils of Silurian-Lower Carboniferous age followed by dark grey phyllite of Mid-Carboniferous-Permian age. The top sequence consists of 3000 m thick fossiliferous carbonaceous shale, slate, and quartzite of Mid-Jurassic to Cretaceous age. Recently plant beds with abundant flora of Rajmahal affinity, have been found by the Geological Survey of India in the Central and southeastern parts of Lingshi basin. The Shadug Formation, which Gansser considers as a tillite unit, has also yielded brachiopods, bryozoa, echinodermata of Permo-Carboniferous age. The unfossiliferous Cheka Formation needs more detailed classification based on lithostratigraphy. The Lingshi rocks are comparable with those of the adjoining Phari basin and also of Sikkim and Mount Everest areas.

It would appear that the Tethys of Bhutan is comparable more with the Nepal-Sikkim-South Tibet section than with the Kashmir-Himachal Kumaun in terms of lithostratigraphy. The crystalline rocks of Bhutan have received a wider coverage. They have been described with reference to definite sectors. Gansser discusses the difficulty of delineation of thrusts due to overprint of syn- to post-metamorphism. The Higher Himalaya of Bhutan like other higher reaches of Himalya is characterised by leucogranite intrusives in contact with calc-silicate and marble zones. The

leucogranites are restricted to the northern half of the main crystalline thrust sheets. The general mode of intrusion, age, petrological and geochemical composition of the leucogranites are surprisingly constant.

In the chapter on metamorphism, Gansser discusses in particular the metamorphism of the carbonate rocks, the pelitic rocks and the genetic relations of the leucogranites and the biotite granite. According to Gansser, the Bhutan Himalaya represents a complicated orogen which exposed old (Late Precambrian) crystalline basement with its related metasediments, later biotite granites, which were subsequently overprinted by Himalayan metamorphism. Apart from regional metamorphism, young (10-20 m.y,) leucogranites have locally produced pronounced contact metamorphism. The crystalline units with their intercalated pelitic sediments show an interesting metamorphic pattern varying from higher amphibolite to granulite facies.

In the chapter on the tectonics of the Bhutan Himalaya, the salient aspects of structures of various tectonic zones are discussed. Gansser has highlighted the newly redesignated Main Frontal Thrust along the southern margin of the Siwalik belt. Nakata's (1972) original term *Himalayan Front Tectonic Line* was perhaps preferable. The suffix *line* appears more appropriate to describe many of these frontal tectonic features including the so-called Main Boundary Fault. In the Himachal Himalaya also, the Siwaliks are thrust over the terraces along the Satlitta Thrust.

In the Himalaya, it is rather common that the younger supracrustal structures are controlled by deeper basement projections of the Indian Shield. Gansser records that the dominant N-S aligned fault pattern, the Darjeeling and the Shumar-Kuru Chu spur in eastern Bhutan may reflect an old but reactivated structural alignment of the Indian Shield. The structure of the Lesser Himalaya of Bhutan is equally complicated as in any other Lesser Himalayan sector. It is comparable in some respects to that of the narrow and compressed Shali structural belt in the NW Himachal Pradesh. The only missing element in Bhutan is the volcanic element.

In the chapter on glaciation and morphology, Gansser describes various glacial stages, recent moraines and glacial lakes. He has recognised four main glacial stages.

In the final chapter, Gansser discusses the regional setting of Bhutan in the larger eastern Himalayan sector and Tibet. The Lesser Himalaya of Bhutan can be easily compared with that of Sikkim and Arunachal Pradesh. The crystallines above the MCT also have analogues in the eastern and western sides of Bhutan.

The Tethyan sediments continue towards Tibet up to the Indus-Yalutsangpo suture line. Gansser has drawn a section (Fig. 137) through this wider frame of Bhutan Himalaya down to the Moho level. It is difficult to understand the basis for extending the *Main Frontal Thrust* down to Moho even displacing the latter. MBF is shown in such a way as to indicate that the entire Lesser Himalaya has advanced along this fault, an aspect which had been criticised by Auden. It is extremely doubtful if along the MBF there has been any large scale movement.

This volume by Gansser represents an important addition to our knowledge about the geology of the Himalaya. Of late there is a tendency to relegate field observations to the background and give free scope to abstract models. The present volume under review is a welcome restoration of faith in field geology. The book is lavishly produced with numerous breath-taking views of the Himalaya.

Gansser has resorted to extensive panoramic field sketches, sections displaying high skill conveying more direct geological information. He has included, besides the main coloured gelogical map of the Bhutan Himalaya, the metamorphic, structural and glacial maps of Bhutan. The wider geological frame covers parts of Nepal, Sikkim, South Tibet, Bhutan and Western part of Arunachal Pradesh.

Gansser writes lucidly and presents important field observations in a straight forward manner. This wider coverage of field geology is so important but not always realised. This book should prove to be of great interest to every student of Himalayan Geology and should be widely read. It should form an important acquisition by all libraries where earth science is taught.

A.M.S.E. Wing,
Geological Survey of India
Bangalore.

S. V. SRIKANTIA

THE TRIAS AND ITS AMMONOIDS : THE EVOLUTION OF A TIME SCALE. By E. T. Tozer. Miscellaneous Report 35 of the Geological Survey of Canada, 1984. Price US dollars 9.60.

The above book focusses on the historical developments of the Triassic System in the last one and a half century. It deals with the stratigraphy and palaeontology of Triassic from begining till today with background of its workers, their biographies, their working approach, assorted historic side-lights at the time of field surevys, professional relationships among workers, brief resume of difficult expeditions in Arctic regions and Himalayas and also ethics of science and important rules of nomenclature in geology and palaeontology which sometimes caused confusion and misinterpretation. The status of the Triassic, as we see today, is the result of past researches and we all actually stand on our predecessors' shoulders.

The author, Dr. E. T. Tozer is Vice-Chairman of the Subcommission of Triassic Stratigraphy, Chairman of the Permian-Triassic Boundary and Member of the Triassic-Jurassic Boundary. His work of Canadian Arctic on Triassic and proposal of Triassic Time Scale of America are the classic works of the recent past. The publication under review though not a reference book, is definitely a guide to students and research scholars, and makes them understand what is actual Triassic System, what are its problems and how they are to be tackled. This also gives an overall picture of the distribution of Triassic in the world, palaeogeography of the Triassic and many related information. Seventeen chapters of the book summarise researches on every important region (Europe, Himalaya, America, Asia and others), and cover early work up to 1850, 1867-1902, first quarter of the present century, and recent progress and synthesis, which has reached to a stage when we can think of an uniform time scale for worldwide correlation. The text in general is meant to create interest and to understand Triassic by workers and students, but specific references and notes and Appendix for definition and interpretation of Triassic Series, Stages and Substages is specially added for the Triassic workers.

The publication also includes a number of maps, tables, illustrations and photographs. Maps of palaeography of Triassic Period, distribution of Triassic formations around the world, locations of famous Triassic sections and Tables of