Some Reflections on *Sahyadri* and the Indian Monsoon

The Geological Society of India had its Annual General Meeting at Goa in November, 2003 under the auspices of the National Centre for Antarctic and Ocean Research (NCAOR), Department of Ocean Development, and Fellows of the Society were exposed to the enormity of the work awaiting oceanographic research and its utility.

Geologists in general have shown little interest in different aspects of ocean exploration but the basic fact remains that the economic prosperity of the country is primarily dependent on the timely arrival and even distribution of rainfall, and all factors relating to its origin, variability and predictability are extremely important. A multi-disciplinary effort involving oceanographers, meteorologists, atmospheric scientists, geomorphologists, biologists, palaeontologists, isotope chemists and other related disciplines is long overdue. The Geological Society of India, as a follow-up of its Annual General Meeting at Goa, is planning to hold a Workshop at Bangalore with the object of bringing together all active workers in the field of monsoon research in order to assess the present state of knowledge about the Indian monsoon and, hopefully, chart out a course of future action aimed at getting a clearer picture.

Several interesting papers have appeared recently dealing with one or other aspects of monsoon predictability and the orographic control exercised by the *Sahyadri*, the mountain range flanking the western margin of the Peninsula. Among these, three significant contributions having a bearing on the patterns of distribution of Indian summer monsoon rainfall are selected for special mention.

Predictability of the Indian Summer Monsoon

The first of these is a paper by Iyengar and Raghu Kanth in *Current Science* (25th October, 2003, p.1189) which is very interesting in as mcuh as it formulates a new empirical model 'based on a novel approach to time series analysis'. The authors claim that their new model is 'capable of statistically forecasting seasonal rainfall value one year in advance.' It is of special interest as this new model had been able to account for the drought of 2002. As remarked by the reviewer, who has provided a summary, the proposed model marked a substantial improvement in the predictive ability regarding the Indian summer monsoon. Availability of fresh data could make the model more refined and forecasting made more precise.

Biological Diversity and Tectonic Activity

The second paper – also published in *Current Science*, v.82, No.1 (10 January, 2002, pp.76-81) – is by Kathuria and Ganeshaiah who address evidences for linking biodiversity observed in the *Sahyadri* with tectonic activity. The authors, in this paper, have analysed distribution of biodiversity on a global scale and inferred that biodiversity is the result of altitude variation, which can only be brought about by recurring tectonic activity. In India,

apart from the Himalayan belt, the authors point out that the *Sahyadri* shows the greatest biological diversity and that within the *Sahyadri* range there are certain 'hotspots' showing high degree of variation. Biological diversity is stated to be at the maximum in the hills north and south of the Palghat Gap.

Uplift History of the 'Sahyadri'

The third contribution is not a research paper but a Memoir on '*Sahyadri* – the Great Escarpment of the Indian Subcontinent' published by the Geological Society of India (Gunnell and Radhakrishna, 2001). The Memoir contains several papers reviewing the morphological evolution of this remarkable landform marking the western border of India.

Unlike the Himalaya which is tectonic raised to the present elevation by the coming together of two tectonic blocks, the *Sahyadri* of the Peninsula has long been considered to be a relict of an ancient tableland remaining unaffected by any later tectonic activity. Recent geomorphological studies have, however, indicated that the peninsular block owed its present position to uplift and the *Sahyadri* represents the western edge of an elevated plateau subject to marine denudation and erosional modification on a vast scale. This seaward facing escarpment and one of the steepest environmental gradients in the tropics, is believed to have formed as an effect of a rift in the Deccan Trap Volcanic Province. The formation of the scarp and its retreat eastward is considered to be the combined effect of erosion resulting in the removal of vast quantities of rock and its deposition in the Arabian Sea which is being compensated on the landward side by uplift . The extremely youthful character of the *Sahyadri* landscape with its steep gorges and water-falls is indicative of rejuvenation and uplift in mid-Tertiary to recent times. Based on these studies a statement has been made that the *Sahyadri* is as young, if not younger, than the mighty Himalaya, although the causes for their tectonic uplift are different.

The above three contributions have been picked out for special mention purely on the novelty of approach – something new and of special significance. Iyengar and Raghu Kanth, for example, have set out a new model for predicting the course of monsoon rainfall. Ganeshaiah and his group of research workers studying the distribution of animal and plant species in the *Sahyadri* have put forward the novel view that biodiversity is related to tectonic activity on a global scale. The Memoir on *Sahyadri* and the several papers included therein emphasize the important role played by erosion on a massive scale and the consequent redistribution of crustal loads leading to uplift of segments of the *Sahyadri.*

Sahyadri and the Indian Monsoon

The *Sahyadri* has played an important role in fashioning the climate of India and the timing of elevation of this mountain range is therefore crucial to our understanding the periodicity and predictability of the Indian monsoon. Of the three publications, the first two appeared in '*Current Science*' and the editor of that Journal, realizing their importance,

singled them out and provided a brief but excellent review of both in the section '*In this Issue*'. Normally such contributions opening new paths and giving a new orientation to research should excite and create an intellectual ferment among those interested in the subject. Our research community, however, appears to have ignored them altogether. Indifference tends to kill all initiative and the labour taken in developing a theory that goes unnoticed causes a sense of frustration and has a devastating effect on the researcher.

J.B.S. Haldane, the famous geneticist who chose to spend the last years of his life in India, addressing scientists in Bangalore stated that the reason why science in India was developing with disappointing slowness is because of the reluctance of the scientists to criticize the work of the others, especially those with established reputations. Apart from this, there is hesitancy in recognizing good work and giving approbation to the author as a mark of encouragement. Unless such an atmosphere of scientific culture where good work is recognized by colleagues and appreciated is created, progress in improving the quality of research and status of our journals cannot be achieved. Good criticism is bound to create good science.

Research on Sahyadri – a neglected field

The most important area of relevant research is often the most neglected, particularly so in our country. Availability of water for growing food grains and even for drinking purposes, for example, is at grave risk, and yet only a few institutions are engaged in high quality research on the predictability of the Indian summer monsoon and the research is quite often shrouded in highly specialized language, intelligible only to a fortunate few. There is also no serious attempt at informing the educated public of the significance of the research being carried out on the predictability of the monsoon. Extending the knowledge gathered by our academic institutions to the larger educated community should receive higher priority. I have in mind something similar to what Prof. Roddam Narasimha has attempted in a recent issue of '*Resonance*', explaining in an understandable and lucid way the technology behind the art of flying. A similar account on the Indian monsoon is long overdue. Only specialists can write for general audiences and stimulate others to creative work. Undue importance is given to matters like interlinking of rivers rather than to basic research on rainfall, its distribution in space as well as in time, orographic control exercised by the *Sahyadri* and such other matters of great societal importance. There is for example, no precise information of the exact location and timing of the rift which caused the *Sahyadri* escarpment or of the rate of its recession through time. Doubts remain regarding the origin of the Palghat Gap – the only major break in the otherwise unbroken wall of the *Sahyadri*. The causes responsible for the peninsula experiencing repeated uplift is still shrouded in mystery as no satisfactory geophysical reason is as yet forthcoming to explain the uplift. We are in the dark about the nature of palaeoclimatic conditions in the Peninsula in the pre-rift-early Tertiary times, when *Sahyadri* was not in existence. Was rainfall uniformally distributed then, instead of being concentrated, as at present, on the western

side of the *Sahyadri* escarpment and making the rest of the peninsula a semi-arid tract? Satisfactory answers to such questions are not forthcoming. There is hardly any information on the sediment load carried by the rivers draining the *Sahyadri* to make an estimate of the rate of erosion and retreat of the escarpment. The role played by climate and tectonic activity on erosion and whether erosion rates have been uniform or varied is also not clear. Sediments accumulated in the sedimentary basins of the Arabian Sea are sure to yield sedimentological evidence of considerable value to trace the uplift history of the *Sahyadri*, but there is no sign of such studies being undertaken on a priority basis.

The existence of a west coast fault has been inferred, but not actually traced on the ground and a statement made that it is not a single fault, but broken into several segments separated by shears. The belief that a greater part of the Peninsula is aseismic is no longer valid and the periodical uplift of the segments, with their attendant faults and shears, may be one of the reasons for the seismicity experienced by the region. The fractures and fissures affecting the uplifted segments could be the pathways for movement of groundwater and its accumulation at as great depths of 1000 m in hard impervious rocks. These and other related studies have an important bearing on our better understanding of the vagaries of the Indian monsoon, on which the economy of India is so much dependant.

The monsoon is a widespread air-flow pattern characteristic not only of India but of south Asia and several other continents. It is the orographic control exercised by the *Sahyadri* and the Himalaya which has given it special significance in the Indian context and which therefore makes an issue of major concern.

The crest of the *Sahyadri* and the western side of the escarpment receiving rainfall upwards of 3000 mm within about sixty days is the largest source of fresh water. How to utilize a good part of this water which is running to the sea unutilized is a big challenge before our engineers and scientists. The idea of a garland canal to tap this water was thought of and found to be both impracticable and unsound to the environment. A series of large diameter tunnels across the Ghats and diverting the water eastwards to the semi-arid tracts is worthy of serious consideration. Unlined, except where necessary, such tunnels could effectively recharge groundwater reservoirs.

Construction of major dams or interlinking of rivers is no solution to our problem. Transferring of rain water to the large underground reservoir of unlimited extent which nature has provided is the best course open. How this should be accomplished and water made available where it is needed should be a most active field of research.

There is a glamour attached to the Himalaya as the king of mountains, attracting scientists from all parts of the world. Unfortunately *Sahyadri* has not merited equal attention but considering the importance of monsoon to the economic prosperity of the country, there is need for a multi-disciplinary effort to be initiated on a high-priority basis. The labour of those who are engaged in different aspects of this vital line of research needs to be recognised, encouraged and supported.

B.P. RADHAKRISHNA