## Frontline geological research

**Annual Review of Earth and Planetary Sciences 1989.** Vol. 17. George W. Wetherill, ed. Annual Reviews, Palo Alto, USA, 1989, 526 pp. $ 53.

In the first article, Prof. Kiyoo Wadati reminisces about his interest in deep-seated earthquakes (depth >300 km) and related phenomena. Deep-seated earthquakes are of interest because of their close association spatially with subduction zones. The mechanism of their formation is an outstanding unsolved problem. Himalayan geologists will be interested in the article by Okay on Alpine Himalaya Blue Schists. These blue schists too are characteristic of subduction zones in a high-pressure–low-temperature environment and their study is expected to throw light on the collision history of the Himalaya.

Another interesting article is that of Veizer, who has traced the history of strontium isotopes in seawater through time. This study has great significance in the dating of Cenozoic sediments. We are informed that $^{87}Sr/^{86}Sr$ values have the potential to yield stratigraphic resolution of about 1 Myr. The correspondences between geologically assigned ages and strontium isotope ages for the last 80 Myr are stated to be satisfactory and it is claimed that this potential can prove superior to biostratigraphical zonation and that this new tool can be applied advantageously to sparsely fossiliferous sequences.

An interesting study is that of 'magneto fossils'—biogenic magnetite in sedimentary rocks carrying natural remnant magnetism (NRM), which has made it possible to have a detailed calibration between biostratigraphic and magnetic polarity time-scales. The implications of this discovery for the understanding of early evolution of life are immense. Paul McMillan describes the technique and instrumentation in respect of the application of Raman spectroscopy in mineralogy and geochemistry and discusses future directions for Raman and Raman-related laser spectroscopy. At present Raman spectroscopy is utilized in solving problems in physics and chemistry but its application to problems of mineralogy and geochemistry is new. McMillan makes reference to resonance Raman, hyper-Raman, stimulated Raman and coherent anti-Stokes Raman spectroscopy (CARS).

Those interested in unravelling crustal structure will find the article by Mueller and Ansorge on the 'Crustal structure of Western Europe', based on a study of numerous seismic profiles, interesting, since the region shows the oldest Precambrian areas of Fennorandia, the Caledonian and Hercynian belts of Central Europe and the currently active region of the Mediterranean sea. The bewildering complexity with its innumerable age province and tectonic characteristics, compared to the relatively young oceanic crust, is very well brought out.

Diamonds are unique products formed at great depth in the earth. Recent work has shown them to be extremely old. They are the best candidates for ascertaining the character of the ancient upper mantle. Ozima, in his article 'Gases in diamonds', reviews the state of our knowledge about the age of diamonds and recent results on the isotopic composition of helium, neon and argon trapped in diamonds.

R. C. Newton has an important paper on 'Metamorphic fluids in the deep crust'. He discusses the key issue of episodicity versus secular activity of fluids. Citing the example of the South Indian granulites he points out that major high-temperature recrystallization event is characterized by persuasive fluid action around 2.5 Myr ago. He examines the possible source for the fluids and prefers a source in the upper mantle. The $CO_2$ heat advection, according to him, was more important in the Archaean because of high proportion of ferrous carbonate in subducted sediments and faster abduction rates. Granulite facies metamorphism is largely the result of mantle-derived volatiles.

Of interest to palaeontologists is the review by David Webb on 'Faunal dynamies of Pleistocene mammals'. Pattern of immigration, evolution and extinction of mammals in North America, especially during the last 50,000 years, are analysed. These studies are expected to offer a substantial field for comparative evolutionary studies that bridge the geological and ecological scales.

In the wealth of information in this volume are many seeds of future research. A matter of regret is the comparative lack of interest of earth scientists in India in these fields of frontline research. In the entire volume, I could pick up references to the work of only a couple of Indian authors. There is greater need for research effort on our part and a perusal of this volume is expected to furnish the necessary impetus for identifying problems of research.

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## Reviving Deccan Trap

**Deccan Flood Basalts.** Geological Society of India Memoir No. 10. K. V. Subbarao, ed. Geological Society of India, Bangalore, 393 pp. Rs 450.

Deccan Trap represents a renowned flood basalt province of India, which formed close to the Cretaceous-Tertiary (K–T) boundary. It has been receiving intermittent and rather rudimentary attention all these years. In such a context, the present volume represents a great leap forward in interpretive geology and an important milestone in international endeavour. A host of British and American scientists have collaborated with K. V. Subbarao and other Indian scientists to create a new understanding of Deccan Trap. This volume is among a series of outstanding Memoirs of the Geological Society of India brought out through the dedicated efforts of B. P. Radhakrishna, the editor of the Society's *Journal*. Subbarao deserves all praise for organizing the field workshop and for editing this volume.

The introduction to the volume is a summary of the proceedings of the workshop by Subbarao. Recent advancements in Deccan Trap studies, with emphasis on causes of eruption (Reunion hotspot activity) and geomorphic expression of plateau basalt provinces, are outlined by K. G. Cox. An interesting controversy is whether the flood basalts poured out in one or two million years (Duncan and Pyle) or four to five million years (Courtillot *et al.*, Pande *et al.*). This has relevance to faunal extinction at the K–T boundary, triggered by bolide impacts (?).

A major breakthrough is the regional stratigraphic classification of Deccan

basalts into Subgroups and Formations based mainly on reconnaissance and chemostratigraphy. This has largely superceded all earlier attempts at local and regional correlation. The reconnaissance geological map of Subbarao and Hooper will be a valuable source of reference, in spite of its oldish get-up. Detailed stratigraphic accounts, geochemical data and statistical analysis of Deccan basalts are presented in good papers.

Petrogenetic studies have veered round to the view of picrites being cumulates rather than primitive liquids (Beane and Cooper). The melts were probably generated at 10–15 kb at 35–45 km depths from N–MORB-type mantle (Sen). Papers on petrogenesis have dealt with the role of mantle metasomatism and AFC in the evolution of Deccan basalts. Mineralogy of mantle nodules from alkaline basalts, zeolites in traps, giant plagioclase basalts (GPB) and mafic dyke swarms have also been covered in good measure.

There are also valuable papers on magnetic studies, DSS studies, gravity and magnetic studies, and structure of the continental margin. In an editorial entitled 'Welcome intensification of interest in Deccan flood basalts' (*J. Geol. Soc. India*, April 1989), B. P. Radhakrishna called for multidisciplinary studies on plateau uplift, laterite, bauxite and black soil formation, and relevant studies to meet human needs like soil and groundwater resources, as well as utilization of zeolites. The present volume addresses most of the fundamental problems and signifies a major landmark in Deccan Trap studies, including advances in chemostratigraphy, petrogenesis and the plate-tectonic framework.

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## Tell-tale features

**Regional Geophysical Lineaments: Their Tectonic and Economic Significance.** Geological Society of India Memoir No. 12. M. N. Qureshy and W. J. Hinze, eds. Geological Society of India, Bangalore, 1989. 305 pp.

The scientific importance of regional geophysical lineaments was highlighted at the Indo-US Workshop on Regional Geophysical Lineaments and their Tectonic and Economic Significance (Bangalore, 19–27 April, 1987). This volume includes the presentations and discussions at the Workshop, and the resolutions and recommendations agreed upon by the participants. A rapidly evolving technology in the geosciences as the specialised, it has been dealing with the isolution inhancement, recognition and tectonic interpretation of geological lineaments in regional geophysical data field.

The generally accepted definition of a lineament is that it is a regional-scale linear or curvilinear feature, pattern or change in pattern that can be identified in a date set and attributed to a geologic formation or structure. Regional lineaments extending over distances of hundreds of kilometres have been observed for many years. The subsurface extent of lineaments is highly variable but those extending over hundreds of kilometres are likely to be related to major subsurface structures. In recent years interest in lineaments has been revived because of the increasing availability of geophysical maps. Furthermore, interest in lineaments has been generated by the evolving concepts dealing with plate tectonics. Now-a-days the availability of two-dimensional geophysical data in digital form has fostered the application of a variety of filters employed in the identifying and interpreting lineaments.

Some of the papers, e.g. 'Lineaments: a timely changed of a waning Illusion' (K. Watson, US Geological Service) and 'Suture zones' (E. M. Moores, University of California), are thought-provoking, and present an overview as well as the concepts of suturing related to plate tectonics since the formation of crust from pre-Archaean times. The contributions from Indian geoscientists are rather broad-based, incorporating the available data from the peninsular to the extra-peninsular, Himalayan region. Qureshy *et al.* and Thakur have attempted to collate the data on mega-lineament structures in the Himalayan region and their geophysical characteristics. An attempt has been made to explain more than 2000 km of crustal shortening in the post-collisional phase exhibited by near-doubling of the crust along the thrust structures in the Himalaya. The initial collision line is conventionally interpreted along the Indus–Tsangpo Suture. It has been contended that the Himalayan mountain chain developed entirely within the advancing Indian subcontinent and attained its present landscape during the last 20 million years. There has also been an attempt to correlate the Himalayan megalineaments with the Caucasus region. The tectono-magmatic history of their development and the mineralization of economic mineral deposits have been studied (A. K. Sinha and A. G. Jhingran, *Himalayan Geology*, vol. 7, WIHG, Dehradun). In the paper by Burke and Sengor on regional lineaments and continental evolution, it is emphasized that many of the world's most spectacular lineaments mark major strike-slip fault zones and some of the most prominent of these fields are related to continental collisions. Many contributors discuss the use of Landsat and Magsat data in the interpretation of geophysical lineaments. Gravity lineaments jointly demarcate the tectonic boundary. Positive gravity anomaly has been found to be in association with rift zones and mobile belts whereas negative gravity anomalies are seen over regions of ensialic anatexis evolving intracontinental subduction, sedimentary basins and younger granitic plutons. The lineament analysis of the coastal belts of peninsular India is a significant contribution from the Oil and Natural Gas Commission. A contribution from the Geological Society of India presents tectonic implications of geophysical lineaments. The concluding paper by Mabey (Utah Geological and Mineral Survey, Salt Lake City, Utah, USA), summarizes the significant mineralization associated with structures expressed in the northeast-trending and gravity lineaments in central Idaho. It is also reported that geophysical lineaments also occur in association with linear structures with deformed mineralized zones within sedimentary rocks.

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