Foreword

The Earth and Planetary Sciences section of the Platinum Jubilee volume contains a set of invited papers on topics of contemporary significance ranging from an exploration of the solar system to important physical and chemical processes that occur within the earth, on its surface, and in its atmosphere and oceans, particularly over the Indian and adjoining terrains. These new developments have imparted a better understanding to the evolution of two important earth phenomena that impact human culture in profound ways: earthquakes and the Indian monsoons.

Although the first Indian mission to the moon happened half a century after the first satellite circled round the moon in 1959, important scientific contributions have continued to emerge in the interim from researches in India on meteorites and lunar samples. Amongst these are the discoveries of the signatures of ancient solar activity embedded in meteorites and of the characteristics of solar wind, solar energetic particles and galactic cosmic rays over time scales of millions of years. These are described in the article by **Goswami and Murty**. Beginning with the early solar system, the authors discuss some of the studies carried out in India to obtain a chronology of the origin and early evolution of the solar system, and conclude with questions to be addressed by future Indian missions to the Moon, Mars, as well as comets and asteroids.

As in the case of planetary exploration, recent advances in data acquisition on earth vibrations produced by earthquakes have stimulated a number of incisive computational developments which make it possible to perform surface wave tomography to obtain the mantle shear wave structure and *via* its associated temperature field, the lithospheric thickness which are thought to control the tectonic architecture of continents. In their paper, 'The deep structure of continents', **McKenzie and Priestley** use this approach to determine the lithospheric thickness beneath north American, African, Asian and Australian cratons exposing a rather surprising result that the lithosphere beneath Tibet is very thick, implying that the continental collision process operating there may have been responsible for creating the thick lithosphere beneath older cratons. The paper on Indian lithosphere by **Vinod Gaur** also uses surface wave tomography at an even higher resolution over much of the Indian continent, the Himalaya-Tibet region and the Bay of Bengal, along with crustal structure inverted from receiver functions to create the shear velocity structure beneath a large part of India and its mantle lithosphere. These images are then used to integrate the various cratonic elements that constitute the Indian shield as well as its collision zone with Tibet, into a coherent framework, the latter additionally illuminated by studies of shear wave birefringence.

Another perspective of this collision process, during the period extending from 65 to 45 million years before present, and the Deccan volcanism, is provided by fossil data from different parts of the Indian subcontinent. **Bajpai**, in his article, presents evidence of how these events influenced the appearance, evolution and dispersal of several modern life forms. This article also describes what fossil records have to say about the relationship between Deccan volcanism and the cretaceous-tertiary (K-T) mass extinctions.

If one were to pick the most important phenomenon of the earth system that influences the well-being of the large number of people living in the Indian subcontinent, it would almost certainly be the Indian summer monsoon, the provider of water to the subcontinent. Understanding the variation of this phenomenon with time has been a challenge, and the puzzle is not solved. The last three articles of this collection look into this puzzle. Exploring the proxies of palaeomonsoon intensities in earth archives, notably tree-rings, speleothems, and deep sea sediments,

Tiwari *et al* present, in their paper, a chronology of monsoon variability over the past 30,000 years. These results provide insightful pointers to understanding the structure of natural variability in monsoon intensities on centennial to millennial time scales.

It is well known that interaction between the ocean and the atmosphere plays an important role in influencing temporal evolution of the monsoon. The most prominent interaction on the global scale is the one that occurs over the Pacific: the El Niño Southern Oscillation, or ENSO for short. An important tool in the hands of meteorologists and oceanographers today is a suite of coupled ocean-atmosphere models that have been used to elucidate the variability of twentieth century global atmosphere and oceans. **Rajeevan and Nanjundiah** discuss the success of the coupled models in simulating the observed ENSO–Indian monsoon relationship. One of the points that they highlight is the inadequacy of these models to capture the northward seasonal migration of the Inter-tropical Convergence Zone over the north Indian Ocean and surrounding lands. The authors discuss possible reasons for this, and in the process, bring to the fore the extremely complex nature of the monsoon phenomenon.

It turns out that there is a phenomenon similar to the ENSO which occurs over the Indian Ocean. Discovered only about a decade ago, this phenomenon, the Indian Ocean Dipole (IOD), is discussed by **Vinayachandran *et al*** in the last article of this collection. It describes the physical processes involved in the development of the IOD, and its impact on the region. Roughly, half of its occurrences has been linked to occurrence of ENSO in the Pacific. We do not know what triggers the IOD in the absence of ENSO. What is clear, however, is that the IOD influences a wide region from East Africa to Australia, including the Indian Summer Monsoon.

We thank the authors for their unstinting and painstaking efforts to write these comprehensive articles.

Archana Bhattacharyya
Satish Shetye
Vinod Gaur