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Although the earth's processes are part of the geologic continuum, since the beginning of the modern age, the rate of change has accelerated faster than any time in the geologic past, primarily because of the human perturbations. Modelling and prediction of earth processes have now become part and parcel of Earth science research. Indeed, we have traversed a long way from James Hutton and Charles Lyell, and the archaic world of traditional straight-jacketed fields of geology. The earth processes are no longer considered as timeless and they have gained a real-time status. This shift in perception coincided with the opening up of the exciting frontier of earth system science, offering us a unique insight of the earth's dynamic processes and their inter-relationships. Each volume of *Annual Review of Earth and Planetary Sciences* reflects these epochal changes of interdisciplinary perception that are taking place in the field of earth sciences. The 2001 review is no exception; as they are wont to do, the editors of this volume have collected articles on a wide range of topics related to solid earth, hydrosphere and atmosphere and planetary bodies, prepared by leading experts in the field. Although the topics range from atmospheric processes to the late Ordovician mass extinction, the underlying theme of the present volume is centred on the 'interactions between the fluid and solid

In his prefatory article, dedicated to the memory of William M. Kaula, a pioneering researcher in earth and planetary sciences, G. Schubert (University of California) chronicles his eventful scientific career, which was dominated by mantle dynamics and planetary physics. In this article, he deals with the similarity of evolutionary processes of the earth and other planets. His career launch coincided with the momentous upsurge on planetary research. He explains how he got caught in the frenzy of activity in late 1960s, as the plate tectonic revolution had raised many questions that needed to be answered. Comparative planetology is the focal theme of another paper in this volume, which discusses the giant dike swarms that occur on the earth, Venus and Mars (Ernst *et al.*). Study of dike swarms in other planets contributes to our understanding of the common characteristics of major volcano-tectonic processes on the earth as well as other planets. Another paper on planetology (Durham and Stern) discusses the tectonics of icy planets of the outer solar system and compares it with tectonics of the hotter planets. In fact, the research initiatives in comparative planetology have picked up steam in the recent years, many fundamental questions on the evolution of planets will be taken up and new discoveries are on the horizon, as Schubert predicts in his introductory article.

Statistics reminds us that in the 20th century alone, humans have used ten times more energy than during the whole of the rest of the millennium; the industrial output increased 13-fold. Truly mind-boggling numbers! The impact of these activities on environment must be enormous. Studies do indicate that the atmospheric composition has considerably altered due to accelerated industrial and agricultural activities. Crutzen and Lelieveld give an overview of the anthropogenic influences on the chemistry of the atmosphere. The biggest hazard seems to be chlorofluorocarbon emission, which resulted in ozone depletion in polar stratosphere. This is a serious issue because ozone is largely responsible for the protection of biosphere against harmful UV radiation. Reversing this trend is a major challenge before the world. During the last decade, the atmospheric scientists have improved their ability to understand stratospheric ozone through a combination of field observations, laboratory experiments and computer modelling. The article ends with a call for increased understanding of atmospheric processes and improved methods of data-gathering. In another article in this volume, the impact of human activity in affecting the carbon fluxes from the soil to the atmosphere and its consequences, is discussed (Amundson). The global soil carbon reservoir is sensitive to climate and human perturbations. We are yet to resolve the questions regarding how the human activity has changed the natural soil-cycling rates and net fluxes of CO_2 from the soil to the atmosphere. It is suggested that land-use practices leading to increased tillage seen in the tropics, is likely to release more carbon and may be a seriously contested view from the perspective of developing countries. Atmosphere figures in Tanimoto's article too; here as a source for quasi-continuous excitation of the earth oscillations. This insightful review addresses the kind of mechanism that generates these modes. After more than 60 years since the initial attempt by Benioff and others in 1959, it is now confirmed that these are excited mainly by the atmospheric turbulence. That they are not just earthquake-related, has been viewed with skepticism for a long time. The critical evidence came from the observation of seasonal variation in the data, because seasonality is usually not associated with solid earth processes.

Michael Manga writes about usefulness of springs for studying a range of sub-surface processes – techniques and methods for measuring of isotope traces, water chemistry and temperature. Rosemary Knight outlines the usefulness of ground penetration radar (GPR) as a technique to obtain high-resolution image of the dielectric properties of top few tens of metres of the earth. Although the radar imaging technique is being widely used on mapping contaminants in groundwater, it can also be used in other geological applications, including active tectonic and archaeological studies. But the author's specialization appears to be the GPR application on contaminant hydrology, and she has not ventured into other areas of application. One chapter (Lucas) in this volume deals with the role of plants in weathering processes. This article focuses on the importance of maintaining the delicate balance between the biological activity and soil development. Jean-Daniel Stanley discusses the problems in sustaining the health of deltas in the wake of increased population. An important input in this assessment is the knowledge on how deltas have evolved, obtained through high-resolution dating.

The earth had been under cold spells several times in the geological past. Late Carboniferous and Early Permian climatic changes are the themes of the article by Di Michele and others. In many ways, the events during this interval are comparable to climatic changes that occurred

during the Pleistocene, an interval closer to human existence, characterized by expansion and contraction of glaciers. Peter M. Sheehan addresses the Late Ordovician mass extinction event, which caused destruction of 85% of marine species. It was one of the greatest extinct events of the Phanerozoic, triggered again by a spell of glaciation. Understanding the climatic reversals of the past may help the scientists to work out the mechanics of the present global climatic system and the possibilities of rapid shifts that may be expected in the future. We seem to follow a new aphorism in palaeoclimatic studies: the past is the key to the future, somewhat inverting the original geologic dictum, 'the present is the key to the past'.

The existence of the earth's core was first inferred by R. D. Oldham, one of the great geoscientists who worked in India in the early part of the 20th century, based on his observation that compressional-wave amplitudes decrease drastically beyond epicentral distances of 100°. However, workings of the earth's inner core remained an enigma for a long time. But by studying seismic waves that pass through the inner part of the earth, scientists are able to get a rare glimpse of this region. Jereoen Tromp's review covers the aspects of recent research focused on the earth's inner core. The findings suggest the existence of inner core that is anisotropic and heterogenic. Further studies based on the seismological constraints suggest that the inner core rotates at a slightly different rate than the mantle. The latter findings may lead to better understanding of the earth's magnetic field, a phenomenon that provoked Einstein to qualify it as the 'great unsolved mystery of physics'. Another enigma associated with the deeper part of the earth is the possible abundance of hydrogen in the earth's core, an issue addressed in this volume by Williams and Hemley. It appears that hydrogen cycling from the upper part of the earth's crust to the core through subduction processes, is an active phenomenon. The present volume does not have many papers on tectonism, *per se*. One exception is the tectonic study of Japan Island Arc (Taira), which provides insight into the orogenesis and continental evolution.

Each of the articles in the present volume gives a thorough review of the subject matter, supported by quality figures and colour plates. An exhaustive reference list is given at the end of each chapter. The subject index appears to be adequate. The 2001 *Annual Review* is recommended for all students and researchers who are interested to get up to date information on the earth system processes, more specifically on the interactions of fluid and solid earth.

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