

## BOOK REVIEW

**DEFORMATION OF EARTH MATERIALS - AN INTRODUCTION TO THE RHEOLOGY OF SOLID EARTH** by Shun-Ichiro Karato. Cambridge University Press, UK (2008), 463p. Price: US\$90.

This book involves an interdisciplinary approach between earth and materials science. It includes a description of materials science of deformation of minerals and rocks and application of the same to geological and geophysical problems. The book is divided into 3 parts – I, II and III. Part I entitled “*General Background*” incorporates fundamentals of continuum mechanics such as stress and strain, thermodynamics and phenomenological theory of deformation. Part II of the book is entitled “*Materials Science of Deformation*”. This part incorporates chapters on elasticity, crystalline defects, experimental techniques for study of plastic deformation, brittle deformation, brittle-plastic and brittle-ductile transition, diffusion and diffusional creep, dislocation creep, effects of pressure and water, physical mechanisms of seismic wave attenuation, deformation of multi-phase materials, grain size, lattice-preferred orientation, effects of phase transformations and stability and localization of deformation. The description of each aspect is quite exhaustive and not only incorporates details of materials science of time-dependent deformation, and basic properties of materials characterizing deformation, but also includes information about the physical principles controlling microstructural development. Part III of the book is entitled “*Geological and Geophysical Applications*”. This includes chapters that discuss composition and structure of earth’s interior, inference of rheological structure of earth from time-dependent deformation, inference of rheological structure of earth from mineral physics, heterogeneity of earth structure, seismic anisotropy and its geodynamic implications.

From a student’s point of view, the book provides many

important fundamentals incorporated in a single book. The topics covered in parts I and II that include stress, strain, different failure criteria (laws), deformation mechanism maps, flow laws and allied aspects are part of *Structural Geology* syllabi at undergraduate and postgraduate levels in various Indian Universities, Institutes and Colleges. The book will therefore, be useful for undergraduate and postgraduate students. It will also be useful for students of courses such as *Tectonics and Geodynamics* in various teaching institutes. However, from an advanced reader’s and researcher’s perspective, the strength of the book is in Part III, which contains the application of fundamentals discussed in Parts I and II to geological and geophysical problems. This includes, amongst many other topics, aspects such as stress/strain distribution in deformation of materials beneath a moving plate, bending plate and convecting melting, strength-depth profiles for the crust and upper mantle, high-resolution seismology, maps and figures giving results of high-resolution velocity tomography for areas such as upper mantle and subduction zones.

An interesting aspect of the book is the inclusion of problems with solutions, which will be very useful to students and researchers seeking to enhance their understanding of fundamental processes involved in deformation of earth material. The list of references is very exhaustive and up-to-date. Students and academicians in teaching and research institutes within India will be definitely benefited by the book.

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**THE ASIAN MONSOON CAUSES, HISTORY AND EFFECTS** by Peter D. Clift and R. Alan Plumb. Cambridge University Press, UK (2008), 285p.

About three billion people in Asia depend on monsoon precipitation for water and changes in this precipitation influence agriculture, economic activity and public health. Therefore, accurate forecasting of monsoon rainfall has wide socio-economic implications on the densely populated

Southeast Asia. Reliable forecasting of the monsoon depends on how best we have understood the forcing factors of monsoon. In this context Peter Clift and Alan Plumb have written a book on “The Asian Monsoon Causes, History and Effects”.

This book consists of 6 chapters: Chapter 1 contains a good introduction on circulations of global atmosphere in general and tropics in particular. By using space based observations authors have presented the rainfall variations during four seasons over south Asia and in the Indian Ocean, which was not possible until now due to limited rain-gauge observations.

Chapter 2 presents two important issues to set in the monsoon initiation: (i) start of India-Asia collision around 45-50 Ma and subsequent uplift of Tibet Plateau over large area have caused highest pressure gradient between Indian Ocean and Asia, which initiated monsoon in the Asian region, and (ii) closure of the Indonesian gateways between the Pacific and the Indian Ocean was one of the most important events to affect the oceanographic and climate in South Asia. Synthesis of monsoon evolution on tectonic time scale is presented in Chapter 3. The evolution of monsoon is traced by using several proxies such as *Globigerina bulloides* abundance, fluxes of calcium carbonate, opal and benthic foraminiferal biofacies. In addition to marine proxies, continental records of weathering history of Himalayas, South China based on the neodymium isotope records and aeolian dust records are used to discuss the evolution of Asian monsoon on tectonic scale. Although, all the records presented in this chapter do not clearly show the initiation of monsoon in particular time, majority of records do show that initial intensification of monsoon started around Miocene-Oligocene boundary ~24-22 Ma. It has been shown clearly in this chapter that some the events of monsoon strengthening and weakening were linked to global climate change events, and hence the variability of monsoon on tectonic scale should not be linked only to tectonics.

Chapter 4 presents several results on monsoon variability, mostly based on marine records. The main focus has been laid on the role of solar energy variations driven by long-term fluctuations in the Earth's orbit around the Sun. The role of 100 kyr cycle after 1 Ma in controlling East Asian winter monsoon is reasoned out very well and the summer monsoon which controls continental aridity, is more closely tied to the 21 ky precession cycle. In a latter section of this chapter authors have presented recently published data on the cave deposits from China and Oman,

wherein very high resolution monsoon variability could be traced. Another interesting point made in this book is that monsoon effect on global climate as a result of large variation in the amount of water vapour introduced into the atmosphere over large part of south and southeast Asia. In this chapter, the difference between Indian monsoon and East Asian monsoon could have been discussed in more elaborate way, since these two monsoons behaved very differently during glacial over last 1 Ma. Temporal changes in the strength of the Asian monsoon represent a dramatic example of the widely occurring and apparent synchronous climatic events seen in different oceans, and which coincide with the Dansgaard-Oeschger climatic variations seen in the North Atlantic. The impact of monsoon rainfall on the erosion of continental crust in the monsoon influenced regions is described in Chapter 5.

Authors have followed a good approach in linking monsoon variability during Holocene to the ancient civilization of India in Chapter 6. Variability of monsoons at decadal to centennial time scale based on tree rings, ice cores, lake deposits and speleotherms are presented, a weakening phase of monsoon after early Holocene resulted in drying of the continent which correlates with increasing cultural sophistication. It is suggested that increasing environmental stress was an important trigger for the start of agriculture and formation of the first urban culture. These cultures collapsed around 4200 years BP at a time of rapid monsoon weakening, owing to direct negative impact on regional agriculture and more indirectly through changes in river system. Similarly, it is highlighted that monsoon climatic variations since 2200 BC have played a key role in allowing populations to prosper or, alternatively causing crisis and societal disintegration. Changes of several Chinese dynasties as well Mogul Empire in India correlate with periods of weakening summer monsoon rains.

This book provides a good synthesis on temporal variability of monsoon on different time scales and its impact on tectonics, erosion and ancient civilization with good illustrations. Students and researchers who wish to launch a research on monsoon should read this book.

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