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The practices in earth sciences are rapidly changing – more and more data from multiple sources and diverse ways of thinking are brought to bear to solve complex problems. This paradigm shift followed the realization of the interrelatedness of the earth processes. Who would have thought about the coupling between climate and tectonics half a generation ago, or on the relation between the meteoritic impacts and the evolutionary contingencies? Resolution of such problems cannot be accomplished within the narrow confines of a single scientific subdiscipline. The more we want to understand the earth processes (ironically, the more you look, the more complex it gets), we find ourselves at the intersections of various scientific sub-disciplines. L. Anderson (Caltech) puts this nicely in the introduction to his recent book, *The New Theory of the Earth* (Cambridge University Press). He says, '...the question of origin, composition and evolution of the Earth requires input from astronomy, cosmochemistry, meteorites, planetology, geology, petrology, mineralogy, crystallography, fluid dynamics, material sciences and seismology. Advances in material sciences, statistics, chaos theory, thermodynamics, geochemistry and tomography make this appropriate time to update our theory of the earth'. The recent volume of the *Annual Review of Earth and Planetary Sciences* (2007), like many of the previous issues, embodies the spirit of the times.

The 2007 volume is the largest in these series, which contains 23 articles and a traditional prefactory article by an eminent earth scientist. In the introductory article, 'Isotope: from earth to the solar systems', Clayton reveals the high points in his scientific career, spanning more than half a century on the researches related to terrestrial as well as the extra-terrestrial stable isotope chemistry. The turning point in his career started when the Allende meteorite fell in New Mexico in 1969, yielding 2 tons of a primitive meteorite. In the same year the *Apollo I1* astronauts returned with 20 kg of lunar sample. He says, 'even a dyed-in-the-wool terrestrial geochemist could not resist the attraction of these goodies'. The years that followed saw the emergence of a large body of work by Clayton and co-workers that deals with chemical processes in the solar nebula leading to the formation of planets, satellites, asteroids and comets. This introductory article by a leading light of isotope geochemistry sets the stage for many of the subsequent papers in the volume, discussing either the application of the isotopic chemistry in understanding the palaeoclimate and its ramifications or on the recent advances in the analytical techniques – developments that have truly changed the face of the earth sciences in the recent years. The legacy of Clayton is also celebrated in two articles on planetary sciences in this volume – one, on the formation of the protoplanetary disk from the study of meteorites (by Edward Scott) and another on the crustal dichotomy on Mars – a fundamental physiographic and geologic divide between the southern and northern hemispheres (by Thomas Watters and others).

This volume has accorded much importance to climate science – an appropriate editorial decision as this issue coincides with the February 2007 release of the Intergovernmental Panel report. The article by Mann entitled 'The climate over the past two millennia' looks at the recently observed changes in a longer-term context. He concludes that the 20th century warmth is unprecedented and can be explained only by modem anthropogenic forcing. Carbon dioxide is the major contributor to the enhanced greenhouse effect. Thus understanding the carbon cycle, which in fact refers to the carbon exchanges within and between the atmosphere, the oceans, land and fossil fuels; the major issues being fossil-fuel burning and land-use changes and how much of the released carbon dioxide is taken up by the oceans and terrestrial ecosystems and what are the mechanisms – the subject matter of another article in this series (by Hougton). Continuing on the same vein, the article by Alley, however, has a thought-provoking subjective title, 'Wally was right: Predictive ability of the North Atlantic conveyor belt hypothesis for abrupt climatic change'. What he means is that William Broeker's theory that the ocean–climate system may abruptly change on a global scale remains valid, and before Broeker, climate change was thought to be gradual. Championed by Broeker as a major paradigm of climatic shift, the idea was both supported and criticized in equal measure. Twenty-five years later, Alley concludes that the original model and data are much stronger and the basic picture remains accurate. However, a note of caution is sounded in an article in one of the recent issues of *Science* (17 August 2007) that the earlier claim of substantial decrease of Meridional Overturning Circulation (MOC) in the North Atlantic is an overestimate.

Atmospheric brown clouds (which include tiny particles called aerosols) formed due to burning of fossil fuel and biomass are believed to have an impact on climate by altering the atmospheric absorption of solar radiation (see Ramanathan, V. *et al.*, *Nature*, 2007, **448**, 575–578). Lynch *et al.* go back in time (Mid-Tertiary) to evaluate the fire interactions with climate from the palaeorecord available in Australia. To give a flavour, these proxies include even the carbon isotopic concentration of emu eggshells! Their results imply close links between the fire and climatic instabilities over the geologic intervals. Tipple and Pagani describe the early origin of terrestrial C_4 photosynthesis – adaptations of plants to arid conditions. Again, a theme related to past climatic stresses due to global warming and increased concentration of carbon dioxide. We can see the marriage of classical palaeobotany with stable isotope geochemistry in the paper by Jahran *et al.* on a mid-Eocene fossil forest discovered north of the Arctic Circle.

The volume, most significantly, draws attention to the impressive progress made in the stable isotope chemistry and climate science. Anbar and Rouxel discuss the growth in nontraditional stable isotope geochemistry of transition metals like Fe, Mo, Zn, and Cu as powerful paleoceanographic proxies. Rowley *et al.* present another example of the application of a stable isotope-based study. They discuss the quantitative estimation of palaeoaltitudes of mountain belts of the Himalaya and the Andes. They look at the isotopic composition of authigenic minerals, on the basis of the fact that $^{18}O/^{2}H$ values decrease in rainfall as elevation increases. There are also new approaches that rely on $^{12}C–^{18}O$ bonds in the calcite mineral lattice. Interestingly, application of these methods in the Himalaya and Tibet suggests that there has been no appreciable change in elevation for the Higher Himalaya since 20–15 million years. Whereas the aforementioned article uses climatic indicators to probe the geodynamics, Streckar *et al.* in their article look at the long-term coupling between climate and tectonism in the Andes of South America. They drive the point that sustained precipitation and erosion may influence the kinematics and locus of tectonic activity of the mountains. The interrelatedness of earth processes is emphasized also by Anderson, who reviews the little-known impact of glaciers – it controls both physical and chemical weathering rates and biological activity. Through these activities glaciers affect the biogeochemistry of the landscape systems and contribute to carbon cycling and organic carbon burial.

Casey and Rustad in their article, 'Reaction dynamics, molecular clusters, and aqueous chemistry', discuss the state-of-the-art and future prospects of quantum mechanical calculation in application to aqueous geochemistry. This approach is a pointer to the future, wherein the earth scientists would likely depend more on computational chemistry and simulation to identify pathways and rate laws for the reactions at mineral surfaces, as the information is better acquired through simulation rather than from experimentation or field sampling. In another area – the morphodynamics of the continental shelves and deltas, where direct observations are limited, Fagharazzi and Overeem show the efficacy of the computer models in simulating the processes of sediment distribution and flow characteristics that are governed by continuum approaches of fluid dynamics. In another article, Rayfield highlights the application of finite-element analysis – a standard tool of modern structural engineering to decipher the biomechanics of past and present organisms. Hughes makes a quantitative analysis of the trilobite body patterning in an exhaustive article. Major diversifications of trilobites occurred in Cambrian and Ordovician from the point of skeletal anatomy.

The volume includes papers that also highlight the power of geology as an interpretative science. There are two articles, both related to subduction zones. Ernst *et al.* review the structural assemblage and an interpretative tectonic evolution of the East Asian continental margin and the subduction zone – this is pure geology in action without the accompaniment of sophisticated equipment or laboratory analysis. One of the unique contributions of earth sciences to human knowledge is about deriving information from the geological past toward understanding the future. Satake and Atwater do precisely that in describing the analysis of shallow stratigraphy of the coastal zones fringing the active continental margins and how this information is used for deciphering the occurrence of previous tsunamis – a major input for tsunami hazard assessment. Another fundamental problem in geology is to understand the absolute time and duration of geologic processes. Two articles, one dealing with microprobing of monazite (Williams *et al.*), and the other on microsampling and isotopic analysis of igneous rocks (Davidson *et al.*) introduce the latest in the geochronology, thermobarometry, geochemistry and petrology of igneous systems. In the latter paper, improvements in the instrumentation in determining the isotopic composition of minerals at the sub-grain scale are also discussed. In another article on instrumentation, Snieder *et al.* discuss the new developments in noninvasive geophysical techniques to monitor biochemical processes and fluid transport. These techniques would be in demand when concepts like carbon sequestration are put to practice and it will become necessary to monitor leakages in the system.

Micklin examines the 'The Aral Sea disaster', a consequence of large-scale engineering modifications made in the surrounding areas during the Soviet years. The Aral Sea, a large lake situated in the Central Asia desert, for all practical purposes is disappearing fast primarily due to diversion of river inflow for irrigation purposes. This has resulted in turning that region into a dust bowl with devastating impact on the fishing stock. The article takes stock of the situation and examines lake restoration through major international efforts. The Aral Sea is a case study of a human-induced environmental disaster and a reminder of what thoughtless grandiose engineering projects can do to the environment. Skinner reviews the approaches and methods in medical geology. She draws attention to the links between the natural environment and human health, and the importance of geologic, geographic and climatic contributions to public health. Health crisis in the coastal region of Bengal due to arsenic content in groundwater is a case in point.

The articles in this volume range from climatic changes, application of quantum mechanics in geochemistry, characterization of pre-solar system minerals in meteorites to public policy. The inclusion of articles of immediate social relevance, appropriately related to the issue of global climatic changes in the backdrop of the release of the report of the Intergovernmental Panel, is to be taken also as a recognition of the changing times; gone are the mystifying days of a 'disinterested pure scientist' insulating herself/himself from big policy questions. Like in biological sciences (e.g. stem-cell research and genetic modifications), practitioners of earth sciences are constantly challenged by the questions of societal importance such as human-induced changes in the natural systems, environmental degradation, global climatic changes, natural hazards and depleting energy and other earth resources. Thus the present volume of the *Annual Reviews* reflects not only the latest in earth sciences, but also tries to equal the public perceptions of an application-oriented science. In these pages we see the maturation of earth sciences as a quantitative and predictive science built on the firm foundation of distinctive geological reasoning, as a powerful tool to understand nature.

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