be commended for bringing out a series of monographs and other contributions on marine bioresources. In this series, the centre has published this handbook as a field guide for identification of common marine invertebrates. In these days of liberal support for studies and research in biotechnology and biodiversity, identification of common invertebrates is of great importance. Hence, the Fernandos must also be complimented for bringing out this handy and useful field guide.

The handbook includes a brief description and a good labelled hand-drawing for each species. It provides guidelines for species-level identification of 250 species. Among these, ten species belong to Coelenterata, 12 to Ploychaeta, 43 to Crustacea, as many as 124 to Gastropoda, 42 to other molluscs and 18 to Echinodermata. No reason is given for the greater focus on Mollusca and for the exclusion of sponges, isopods and amphiobods, although the authors have clearly indicated that this field guide is not exhaustive. It must be mentioned that for about 143 species, useful common names are added. Details on habitat and size of the animal are also given, although it is not clear whether the given size refers to length of diameter of the animal in such case like the crabs, clams and sand-dollars. Interesting information on breeding habits, economic importance of polymorphic traits and oviparity in some snails (e.g. *Clithon*, p. 92) is also included. In his Foreword, V. Sampath has also commended the book.

However, a large number of unattended editorial corrections must be indicated: The field guide suffers from interspersed mosaic descriptions of telegraphic statement, phrases and complete sentences. Wrong expressions are not uncommon. For instance, for the description of a single species, i.e. *Dromia dehanni* (p. 50), a statement like 'All species are marine...', is not understandable; the same is repeated on p. 56. Examples for spelling and other mistakes are: '*Diopatra*,, is a very common genera' (p. 25); '*Cyprea moneta* maily live on inter-tidal reef flats...' (p. 117). While describing one or more species belonging to the same genus, as in the case of four species of *Panulirus*, the key characters which are useful to critically distinguish one species from other, must have been included.

Despite these avoidable errors, the field guide is a useful contribution and is recommended for zoology students, research scholars and others.

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Annual Review of Earth and Planetary Sciences 2002. Raymond Jeanloz *et al.* (eds). Annual Reviews, 4139 El Camino Way, Palo Alto, CA 94303-0139, USA. vol. 30, 593 pp. Price not mentioned.

Twenty-nine specialist authors have written 16 review articles for this volume. The quantity of recent information contained here is further evidence that, as in other areas in the last few years, the expansion of knowledge in the earth and planetary sciences has been rapid, and the pace is accelerating. The era of generalist earth scientists is over. Any one reviewer may not be expected to comment knowledgeably on all or even most of the articles in the volume. I present below, my idiosyncratic views on some of the articles.

Since all the articles contain substantial multi-disciplinary material, it is difficult to classify them unambiguously under categories such as geology, geophysics, geochemistry, geohydrology, etc. For example, titles of three articles contain the term 'fossil'. But they cannot be grouped automatically under palaeontology, and hence geology, because they contain copious references to geochemical, geophysical and planetary science concepts and techniques.

The theme of earthquake prediction is highlighted in this volume through an article by Keilis-Borok. Charles Richter wrote in *Elementary Seismology* published in 1958 that 'Prediction of earthquakes in any precise sense is not now possible. Any hope of such prediction looks toward a rather distant future. Cranks and amateurs frequently claim to predict earthquakes'. Reliable earthquake prediction is still a gleam in the eyes of seismologists. However, seismologists from Japan, the erstwhile USSR and the US made earthquake-prediction research acceptable in the 1960s. Keilis-Borok published his first article on the theme in 1964. His 2002 article is primarily a review of the work of a team at the Russian Academy of Sciences. The first part of the article re-emphasizes the importance of the topic. It also presents the view that, on the timescale of 10^2 years or less relevant to this problem, the lithosphere behaves as a nonlinear, hierarchical dissipative system and strong earthquakes are critical phenomena in this system. The main part of the article recalls four prediction algorithms developed by the above-mentioned team. All are based on suitable analyses of seismic activity data, i.e. latitudes and longitudes of epicentres, depths of foci, times of occurrence, and magnitudes of earthquakes of a region or the earth as a whole, as the case may be. It may be recalled that seismic activity is one of a host of time-dependent fields whose observations may be potentially useful for earthquake prediction. The aim of each algorithm is to identify, from the available seismic-activity data, time windows during which there is increased probability of earthquake occurrence. A prediction is successful if an earthquake does occur during an identified window. A prediction has failed, if an earthquake does not occur during a window or if it occurs outside the identified windows. Their record of successes is impressive. Current predictions are posted at http://www.mitp.ru and http://www.phys.ualberta.ca/mirrors/mitp. Keilis-Borok's passionate commitment to the cause of earthquake prediction is evident.

Fehler and Huang review recent progress on interpretation of seismic reflection data. Kirchhoff migration imaging has been improved by using multi-branched travel-timetables and assigning amplitudes and phases to waves along different ray paths. Progress in wave-equation imaging now allows phenomena such as focusing and diffraction to be taken into account for petroleum exploration.

Valentine *et al.* describe recent developments on numerical modelling of nonlinear multiphase fluid flows with heat transport and phase changes, by focusing on the modelling of fluid flows near an underground radioactive waste repository, two phase flows through random heterogeneous porous media, and fluid processes in magma systems of the earth. Two phase conditions near boiling point may exist close to packages of radioactive waste and may involve

nonlinear heat and mass interactions through fluid convection, thermal conduction and transport of latent heat in the vapour phase.

Poli and Schmidts review petrology of subducting lithospheric slabs. As a slab penetrates regions of increasingly higher pressure and temperature in the mantle, the contained chemical systems undergo continuous and discontinuous phase transformations. Recycling of volatiles is important for triggering mass transfer, melting and volcanism. Devolatilization of the subducted slab is a continuous process distributed over more than 300 km of the slab–mantle interface. Melting of the subducted crust is through fluid-absent reactions. Subducted slabs penetrate episodically into the lower mantle and sink down to the D″ region near the core–mantle boundary.

van Keken *et al.* discuss the evidence on mixing in the earth's mantle. The two extreme views at present are as follows: interpretations of geochemical diversity of mid-oceanic ridge and ocean–island basalts and models of chemical evolution of the earth favour a layered convection model in which a long-term boundary is assumed between a well-mixed but depleted upper mantle and a more primitive heterogeneous lower mantle. On the other hand, whole-mantle flow appears plausible in recent geophysical interpretations of seismicity, travel times of seismic waves, and the gravity field and the geometry of the geoid over subduction zones.

Smith and Peterson note that molecular and palaeontological data provide two independent means of estimating when groups of organisms evolved in the geological past. The results of the two approaches often agree reasonably. But there is disagreement on when mammal and bird orders originated and when major phyla originated. The discrepancy in dating bird/mammal origins reflects a global rock-record bias. Dates of origin of phyla are affected by biases in fossil preservation and problems of reading the molecular clocks.

According to Valentine, the origin and evolution of phyla cannot be tracked by available fossils from the period between the appearance of Metazoa ca. 720 to 660 million years (m.y.) ago, and crown bilaterian phyla ca. 530 to 520 m.y. ago. But molecular phylogenetics permits reconstruction of their branching topology, and molecular developmental evidence supports hypotheses for evolution of the metazoan genome during the rise of complex bodyplans (*sic*).

Morbidelli writes that recent numerical integration algorithms and advances in computer hardware have transformed solar-system dynamics into an essentially numerical discipline. It is now possible to study the evolution of planetary orbits on timescales comparable to the age of the solar system, compile statistics on evolution of thousands of near-earth asteroids and comets from their source regions to their elimination, and simulate planetary accretion and the early phase of the chaotic evolution of the solar system. Thus, although the present distribution of the planets and their orbits does not constrain the number, mass and location of primordial (planetary) embryos, it appears that the primitive solar system may not have been similar to our present one.

Brown reviews the recent literature on Pluto and its satellite Charon, discovered in 1978. Both are members of a vast population of icy bodies beyond Neptune. Seasonal variations occur at Pluto's surface. The surface composition of Charon is similar to that of icy satellites of the giant planets, rather than that of Pluto.

The volume also contains useful review articles on simulations of the geomagnetic dynamo, implications of extra-solar planets for views on planet formation, geologic structure of the uppermost oceanic crust at fast-to-intermediate-rate spreading centres, stream flow necessary for environmental maintenance, the vast hot microbial biosphere associated with active volcanism along the global mid-ocean ridge network, and fossil plants as indicators of the global carbon cycles of the past.

Each article in the volume is an informative bibliography. I found the following pieces of information fascinating: Earthquakes may be viewed as instabilities in the nonlinear lithospheric system. Planetary orbits may be traced now over billions of years using computers. Numerous objects outside the orbit of Neptune may belong to the solar system. Subducting lithospheric slabs may penetrate the lower mantle.

Another significant impression from the review articles is that statistical and probabilistic concepts are more indispensable for the earth and planetary sciences now, than ever before. While the post-graduate earth science curricula at Indian universities require a rudimentary knowledge of these topics, there is an urgent need to increase the emphasis.

I wrote in *Resonance* in May 1999, that in time the theory of plate tectonics too will pass. Although my intent there was pedagogic, I was pleased to read in Keilis-Borok's article that 'earthquake prediction problem (is) closely related to a current frontier of the solid earth sciences: emergence of a fundamental concept that would succeed plate tectonics'.

Perusal of this volume has widened my horizons and given me pleasure. If only other motivated earth and planetary scientists in India could refer easily to the present, the previous and the future volumes of the series!

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