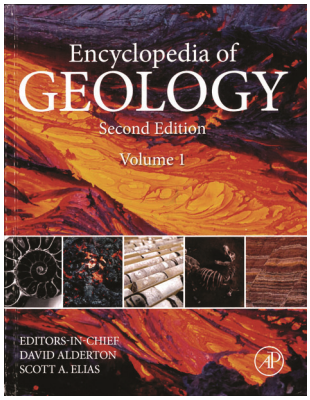
The two closing chapters make the reader want more. There is a mention of 'engineering temper' in the foreword of the book written by Prof. Abhay Karandikar. The book includes at least three anecdotes where engineering temper of the author is evident. What one learns in an engineering course of study ought to be the savior for an engineer. Soft skills, managerial abilities, personality traits, etc., are necessary but not sufficient to thrive in the long run. A person who can analyse things around, look at them from an engineering perspective, and constantly think about how to improve them is the one who is likely to climb towards the top of the wage pyramid. Such a person can also fatten the pyramid by bringing in new work. Cultivating the engineering temper would certainly help one build and sustain a career in engineering.

G. K. ANANTHASURESH

Department of Mechanical Engineering,
Indian Institute of Science,
Bengaluru 560 012, India
e-mail: suresh@iisc.ac.in



Encyclopedia of Geology, Second Edition, Vols 1 to 6. David Alderton and Scott A. Elias (Editors-in-Chief). Academic Press, an imprint of Elsevier, 125, London Wall, EC2Y 5AS, UK. 2021. 5622 pages. Price: US$ 2900.00.

Encyclopedias as compendiums that provide state of the knowledge either of one field of study or all the branches of knowledge have always found a respectable niche in libraries and educational institutes of the world. Encyclopedia as a cultural artefact has evolved over the ages and acquired a universal format as preserving medium of human knowledge. The first encyclopedia in history, with all its traditional attributes, is said to be Pliny's *Naturalis historia*. Prepared in the first century CE, and the first of its kind, this work is considered as an ambitious work that ranges from astronomy to geology and from art to zoology. This work reflecting the pre-renaissance understanding of the world and containing widely speculative and often packed with erroneous explanations, however, offers a peephole of the world as it was understood in the earliest part of the first millennium. Primarily an explorer-cum-science communicator, Pliny, the elder himself died while investigating the volcanic eruption that famously destroyed the ancient city of Pompeii in 79 CE. The post-renaissance cultural period in Europe along with the popularization of printing techniques witnessed a large transformation in the format of encyclopedias that also resulted in their wider diffusion. The 21st century saw the domination of digital and crowd-sourced versions, such as Wikipedia, as reference tools, partly replacing the traditional formats. The development of the electronic, multimedia encyclopedia also resulted in transforming the market and growth of readership. When I initially viewed the hefty tomes of *Encyclopedia of Geology*, the immediate question that came to my mind was how a new generation prospective user would approach such heavy print volumes, who is probably more at ease using digital platforms. And, as I started leafing through these volumes, the old-fashioned book lover in me, however, could not help liking its weight in my hands.

Encyclopedia of Geology, Second Edition, as indicated by its editors-in-chief, is an improvement over the first edition, reflecting the advances in geological sciences in the last 15 years, since the original publication. In contrast to the first edition that was primarily rocks-based, the editors-in-chief say that the second edition has expanded its coverage to include solid-Earth interactions with the atmosphere and hydrosphere. This broader perspective is necessitated by the realization that the geology has evolved into a multidisciplinary area of research, now coming under an all-encompassing umbrella-term 'Earth sciences', wherein increased application of chemistry, physics, mathematics, biology, and astronomy has become a norm. *Encyclopedia of Geology* in six volumes totalling 5622 pages presents state-of-the-art reviews on the key aspects of Earth and planetary research. The sections include: the solar system, tectonics and structural geology, geophysics, geochemistry, mineralogy, igneous geology, metamorphic geology, surface processes and sediments, history of life, regional geology, geological resources, palaeoclimates and applied geology. Mainly targeting the undergraduates and teachers as well as general readership, each of the 340 articles follows a standardized format that includes fundamental concepts and theory, followed by future directions. New areas of discussion cover mass extinctions, origins of life, prospects of life beyond Earth, plate tectonics and its influence on faunal provinces, new types of mineral and hydrocarbon deposits, methods of dating rocks, and surface processes. The techniques of remote sensing and other tools of investigations such as electron microprobe analysis and fluid inclusion, are discussed in detail. Commenting on each one of the articles in these volumes, as expansive as these are, is not a practical proposition. Naturally, a researcher is expected to go more carefully through the chapters that are of immediate interest to him. That is what I am doing in this commentary.

The first volume begins with an article on the history of geology most comprehensively written by the distinguished scholar and geologist, Celâl Şengör (Istanbul Technical University). Growth of geological knowledge from pre-history to classical Greco-Roman times and the awakenings during European renaissance, ending finally with the plate tectonic revolution receives a broad-brush treatment in this article. This article sets the stage for rest of the chapters – as if the acquired geological knowledge waiting for a cue to break open its seams to spread over the rest of the pages of encyclopedia. The succeeding chapters in the volume deal with the solar system and planetary geology, and of course meteorites – the geological time slice freebies delivered to us from the outer space, as it were a bonus for all our expensive nail-biting technological feats to understand the planetary geology. The chapter on 'Prospects for life beyond Earth' summarizes the new scientific clues on the possibilities for life in some of the planets and the moons (by Davila and Parenteau). The tragic destiny of Mars – where a life-supporting environment had existed in its early phase is particularly a gripping story. The authors say that 'it is a "tale of two planets", one that is barren inhospitable desert today and the other that

was once Earth-like and could have supported life'. An accompanying photograph showing a water-borne cemented pebble bed section from the Gale crater region of Mars, taken by Curiosity Rover is a telltale proof for its Earth-like past – the section that has an uncanny similarity to what is retrieved from the Atacama Desert in Chile, shown in as an adjacent frame. The section on 'Geophysics' provides discussions on topics ranging from earthquake seismology, seismic tomography, seismic anisotropy, palaeoseismology, and exploration seismology, numerical and analog modelling among other geophysical topics. Freymueller and Elliot have prepared a succinct summary on the development in space geodesy techniques to constrain crustal deformation, an area of interest for earthquake seismologists. More improvements in precision in surface deformation monitoring are expected when measurements will reach the ideal error levels of ~1 mm for position and ~0.1 mm/year for velocity. Although a short discussion is given in this chapter, a more detailed treatment of Interferometric Synthetic Aperture Radar (InSAR for short) is needed because this technique is being increasingly used to detect and measure ground displacement over time. These techniques hold much promise in the prediction of many geological hazards. The article on earthquake seismology written by the Italian seismologists (Festa *et al*.) mostly focuses on the developments in observation systems and their bearings on understanding the characteristics of the preparatory phase of large earthquakes, and their importance in the domains of real-time-seismology (RTS) and the early warning systems. Recent advances in machine learning methods are revolutionizing the classical approach of earthquake detection and they help in identifying the microseismic events that are masked by the seismic noise – an important step in detailing the earthquake preparatory zone on micro-scale. The chapter on 'Paleoseismology, archeoseismology and paleotsunami studies' (by Meghraoui *et al*.) builds on selected examples from the North Anatolian fault, Dead Sea fault and Himalayan frontal fault along with tsunami geology studies from the Andaman Islands in the Indian Ocean. It is not clear what criteria the authors have used for the selection of case studies for their inclusion in the chapter. A highly cited paleoseismological method – the dating of the uplift events from the coral growth anomalies pursued with great success along the Sumatra coastline has not been included in this review (see also the chapter on geophysical hazards by Gordon Woo; p. 821 for some references to the studies related to previous earthquakes using corals). The cited works from the Himalayan frontal thrust, on the other hand, appeared skewed and this bias has resulted in ignoring some of the pioneering studies from that region. And one that is selected as an example of fault excavation study from the Himalayan frontal thrust cannot be considered as ideal as its interpretations have been critiqued.

The volumes 2, 3 and 4 contain reviews on igneous and metamorphic geology, Earth's surface processes, the geological time scale, evolution of life and major extinctions and explosions exemplified by the Proterozoic Ediacara and Cambrian Burgess shale bursts of new life forms along with syntheses of regional geology of Americas, Africa, Europe, Asia, Australia and Antarctica respectively. The 5th volume of the series focuses on the fundamentals of geochemistry, compositional models of the earth, geochemical applications, paleoclimates, and geological resources. The reviews by Scott A. Elias (History of green gas warming; CO_2) and Didier Paillard (Quaternary climates), respectively, discuss the major landmarks in the Earth's climate history. Relevant to our understanding of the present global warming phase induced by human activities, Scott Elias in his article notes that throughout the geologic time, the paleoclimatic record shows a strong relationship between temperature and the pCO_2 level. These insights help us understand the current climate crisis brought about by the phenomenal increase in pCO_2 in the Earth's atmosphere triggered by the anthropogenic activities. Considering the vital societal importance and as an extension of the chapters previously mentioned, the editors of the Encyclopedia could have allotted a separate chapter containing the summary of researches on anthropogenic global warming and a review of the assessment reports of Intergovernmental Panel on Climate Change (IPCC). A related article titled, 'The geological consequence of global climate change' (by Arendt *et al*.), however, appears in volume 6; pp. 510–522), under the theme 'Applied Geology and Society'. Totalling 26 articles, much of the print space in volume 5 is occupied by discussions on geological resources including the future frontiers in oceans and space. The first article in these series prepared by Gavin M. Mudd (RMIT University, Melbourne), underscores the concept of sustainability and ethics in the exploitation of finite natural resources and 'the need to shift our modern world to 100% renewable energy to address the climate change risks' – the sustainable developmental goal set forth by the United Nations. The final volume contains topics in geochronology, mapping techniques, engineering and hydrogeology. A section that stands out is 'Geology and Society' that discusses the themes including geomicrobiology, geological heritage, and Earth science teaching. The article on 'The origins, current state, and future of geological surveys and societies' by Edmund Nickless and John W. Hess is an informative narrative on history and future trends in the working of the agencies engaged in professional studies, outreach, and educational work. One of the oldest, the Geological Survey of India, established in 1851 by the British colonial government, does not find a place in this article, nor do the geological societies in India. How will the roles of surveys and societies change globally is a theme that may be of special interest to the professionals working in this field. For example, over the next several decades, the US Geological Survey, among other priorities, intends to deliver well-integrated observations, and predictions of the future state of natural systems, lead the nation in predicting changes in the landscape, thus providing high impact 21st century science in service to the society. The global challenges like the environmental changes, adaptation and community resilience form the background for all these initiatives of the new century.

Overall, the six volumes of *Encyclopedia of Geology*, *Second Edition*, with an option of electronic version, contain highly researched comprehensive reviews on various topics in Earth and planetary sciences. It is a fundamental resource for teachers and students of geology, as well as researchers and professionals who are seeking updates in geological studies – a fast growing dynamic field.

C. P. RAJENDRAN

National Institute of Advanced Studies,
Indian Institute of Science Campus,
Bengaluru 560 012, India
e-mail: cprajendran@gmail.com