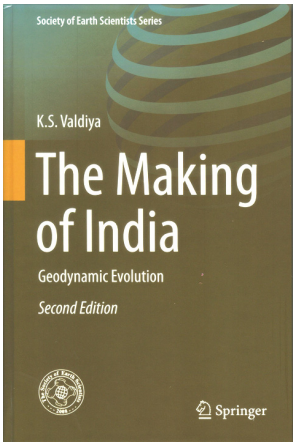

The Making of India: Geodynamic Evolution, 2nd edn. K. S. Valdiya. Springer International Publishing, Switzerland. 2016. xxxvi + 924 pages. Price: Not mentioned.

The Indian subcontinent is geologically a fascinating terrain preserving a record of 4 billion years of earth's history. It is a treasure house of diverse rocks, minerals and fossils. However, there are only a few books that cover the entire spectrum of geological records, particularly the modern advances. Of course, there are the classics by D. N. Wadia, M. S. Krishnan and E. H. Pascoe, but all of them belong to the pre-plate tectonic era. About a decade ago, R. Vaidyanadhan and M. Ramakrishnan brought out a two-volume work with a comprehensive coverage and written with a modern perspective. K. S. Valdiya's encyclopedic work belongs to this genre and is an invaluable addition to the geological literature on India. Valdiya took up the Herculean task of distilling a vast amount of information and presenting it in an easily digestible form, conveyed through lucid language. Geological, geomorphological, geochemical, geophysical, geodynamical, biological and resource aspects of each of the geological terranes are discussed in a logical sequence. Personally I welcome the emphasis on field aspects all through the book. This book would cater to the needs of a wide variety of readers from undergraduate students to teachers, research workers and professional earth scientists. The writing would kindle the interest of the reader and motivate him to go to the original and additional sources. For a book of this size (924 pages) with such a large amount of information, some omissions and errors may be expected. A few of these are mentioned below. However, these in no way detract from the worth of the book.

The book starts with a succinct description of the different physiographic divisions, which brings out all the significant topographic details of the Indian subcontinent. I am intrigued that Valdiya includes Shan-Karen plateau within India. Geologically it lies on the Burmese plate (a fragment of the Eurasian plate) and was not a part of the wandering Indian landmass after it broke off from the Gondwanaland.

The next chapter is an introduction to the different geological terranes in India and whets the reader's appetite for the details about them. Chapters 3 and 4 deal with the four principal cratons that make up the Indian shield. The book clearly brings out that all the cratons have extended histories and each has important cratonization events at 3.4–3.5, 3.0–3.1 and 2.5–2.6 Ga. A brief discussion on the temporal and geodynamic aspects of the amalgamation of the cratons and their relevance vis-à-vis the assembling of the ancient supercontinent Ur or Columbia would have been a valuable addition to the summaries presented.

Chapters 5 and 6 describe the Palaeoproterozoic and Mesoproterozoic mobile belts that skirt the cratons. The coverage is extensive, but some recent information, particularly on geochronology is not included. The North Delhi and South Delhi Fold Belts are mentioned, but the descriptions make some general statements about the Delhi Supergroup without specifying which of the two fold belts these refer to. The Central Indian Tectonic Zone (CITZ) is generally thought to play an important role in the stitching together of the northern Bundelkhand block and the southern Dharwar and Bastar cratons. The geodynamic importance of this belt in the assembling of the Indian shield and its role in the formation of the Vindhyan basin could have been discussed a bit more elaborately. Valdiya is in favour of linking up the Aravalli–Delhi fold belt and the Satpura mobile belt (CITZ), but there is no hard evidence in support and alternative interpretations are possible. The Neoarchaean Kotri–Dongargarh Volcanic Belt belongs to the southern block and has probably evolved in a rift setting; yet it is included as a Palaeoproterozoic mobile belt. There is a serious error, probably inadvertent, on p. 165 – the South Purulia Shear Zone does not mark the northern boundary of the Singhbhum Shear Zone, but of the North Singhbhum Mobile Belt. Chapter 6 on the Eastern Ghats Metamorphic Belt (EGMB) summarizes the recent work on the structural set-up, the lithotectonic subdivisions and the interesting metamorphic patterns. The Ongole Domain is, however, distinctly different from the part north of the Godavari Rift, and was accreted to the East Dharwar Craton much earlier than the final amalgamation of the main EGMB to the Bastar Craton in Pan-African time. Some have suggested that the earlier accretion is related to the assembling of Columbia. As Valdiya mentions, the Grenvillian orogeny affected the main EGMB, but Grenvillian dates are absent in the Ongole Domain. These complexities remain unaddressed in the book.

Chapter 7 brings out the important feature that the northern part of the Southern Granulite Terrane is an Archaean granulite belt penetrated by younger plutons and the southern block is a granulite belt rejuvenated during Pan-African time. It also contains a brief description of the continuation of the South Indian granulite terrane to Sri Lanka. The tectonic relation between the Dharwar Craton and the juxtaposed Southern Granulite Terrane remains controversial.

Large Proterozoic intracratonic basins are distinctive features of the Indian shield and are described in chapters 8 and 9. These basins are important from the point of view of the mechanism of basin formation, Proterozoic supercontinent reconstruction and studying the evolution of the earth's atmosphere and primitive life forms. The structural architecture, sedimentary environment, broad climatic conditions, associated volcanic/intrusive activities and mineral assets are systematically described for the different basins. Among the older sequences the Cuddapah Basin, the Pranhita-Godavari Basin and the Kaladgi Basin are discussed. The eastern segment of the Cuddapah basin is the Nallamalai Fold Belt, which is thrust over by the EGMB/Nellore Schist Belt. The deformation in the Pakhal Group of the Pranhita–Godavari valley is probably coeval. Valdiya does not discuss the timing of this deformation, though it is important for modelling the supercontinent assembly. This is likely to have happened within the time-frame of 1.4–1.6 Ga and is probably related to the process of assembling Columbia. Geoch-

ronological data fix a time-frame of 1.0–1.5 Ga for the Chhattisgarh and Indravati basin development. There is little reason to put these two basins in the chapter on Neoproterozoic basin development. In the Vindhyan Supergroup the lowermost unit, the Semri Group, has broadly similar age (1.5–1.6 Ga) as the Cuddapah Supergroup. Valdiya discusses about life in the Semri times, but does not refer to the controversy about non-Ediacaran trace fossils or animal body fossils, and the implication of the findings vis-à-vis the early evolution of multicellular eukaryotes. The stratigraphy and sedimentation of the Upper Vindhyans are summarized incorporating the results of some of the recent studies. The Proterozoic basins are traditionally considered as intracratonic sag basins. In recent years models of continental rifting or foreland basin have been proposed. The issue is still unresolved.

The Proterozoics of the Lesser Himalayas are autochthonous to para-autochthonous sedimentary successions thrust over by sheets of metamorphic rocks with associated granitic rocks. An excellent synthesis of the structural architecture, stratigraphic sequence, metamorphism and magmatism is presented in chapter 10. Metamorphic rocks, of presumably Proterozoic age, occur in the Higher Himalayas also, the so-called Higher Himalayan crystallines. These are delimited by the Main Central Thrust at the base and Trans-Himalayan Detachment Fault at the top. Valdiya has emphasized that the Higher Himalayan Crystallines are distinctly different from the lower-grade Proterozoic metamorphics of the Lesser Himalayan nappes. Both Proterozoic and Cenozoic (Himalayan) tectono-thermal events are recorded in the Lesser Himalayan and Higher Himalayan metamorphic rocks. However, the regional geodynamic implications of the Proterozoic tectono-thermal events in the Himalayas are still to be worked out. Valdiya interprets the Lesser Himalayan rocks as representing a Proterozoic mobile belt along the northern margin of India, caught up in the Himalayan orogeny. The Proterozoic metamorphic complex of Myanmar was probably not a part of the Indian plate and was accreted to the latter during the Himalayan orogeny.

Chapter 11 discusses the Proterozoic–Cambrian transition in the Himalayan rocks. The lithostratigraphy, depositional environment, structure and life forms in different sectors in the Lesser Himalaya as well as in the Tethys domain are described in detail. Valdiya has also drawn attention to the evidence of Cambrian–Ordovician unconformity, volcanism and granite emplacement at about 500 Ma, to suggest that Pan-African tectonism not only affected South India but also the northern margin of the Indian subcontinent. This may be related to the subduction of the Proto-Tethys ocean floor below East Gondwana.

Chapter 12 deals with the Palaeozoic Tethyan sequence. The discussion on progression of Palaeozoic life would interest the general readers and students alike. Palaeozoic Era terminates with a marked stratigraphic hiatus at the top of the Permian; there was pronounced volcanism not just in India, but also in Oman and Tibet. Valdiya attributes this to Hercynian orogeny. However, the effect of Hercynian orogeny is pronounced only in Laurasia and West Gondwana. For East Gondwana, alternative tectonic models have been put forward. It has been proposed that rifting along the northern margin of East Gondwana led to the formation of the Neo-Tethys ocean and splitting of the Lhasa block from India; this rifting was associated with mafic volcanism as seen in Oman, Pir Panjal, Tibet and several other places. Some studies have suggested that the Lhasa terrane might have split-off from Australia, rather than from India.

Chapter 13 incorporates a thorough discussion of all aspects of the sediments of the Gondwana Supergroup which were deposited in fault-controlled basins. There is a comprehensive discussion on basin formation, sedimentation patterns, climatic conditions, plant life and animal communities.

Cretaceous volcanism is discussed in chapter 14. The Deccan Traps, the Rajmahal Volcanics, the volcanics of the St Mary's islands, as well as the alkaline rocks and carbonatites of Ambadongar and Mundwara are described in considerable detail. The tremendous outpouring of continental flood basalts is concluded to be plume-related. Critically discussing the evidence, Valdiya concludes that the Deccan volcanism was not a short-duration event as considered by some workers. Affinity of the Deccan fauna with the contemporary fauna of Central Asia, Mongolia and China has led him to suggest that the Indian land mass had already touched Asia. The K–T mass extinction is stated to be not a catastrophic event but a gradual phenomenon, and is ascribed to the environmental stresses engendered by the Deccan volcanism. Valdiya does not discuss about the possible role of a giant extraterrestrial impact, though there is strong evidence that such an impact did happen at K–T boundary.

The crustal extension associated with Late Mesozoic rifting in the Gondwanaland gave rise to sedimentary basins, both along the eastern and western continental margins. These basins have received considerable attention in recent years because of their hydrocarbon resources. They also throw light on the rift tectonics affecting the Indian shield during the Late Mesozoic. The Mesozoic sediments of the pericratonic basins are dealt with in chapter 15. The Mesozoic Tethyan sediments along the northern margin are described in chapter 16. The cycles of marine transgression and regression are discussed and tentatively correlated with the different stages in the northward motion of the Indian plate. The author has highlighted changes in the nature and pattern of sedimentation in response to global tectonics and climate change.

Collision of India and Asia with all the resultant effects – formation of volcanic arcs and back-arc basins, changes in sedimentation pattern, successive locales of ophiolite obduction, emplacement of large thrust sheets, detachment faults, southward migration of thrust fronts, metamorphism, anatexis and granite emplacement, formation of foreland basin – are described in great detail in chapters 17–19. The thrust architecture is clearly depicted through many geological maps and cross-sections. Valdiya lucidly describes how with the progress of collision the environment has changed from marine to terrestrial, which is reflected in the sedimentary sequence. The control of tectonics on the biotic and climatic changes is also discussed. The unusual feature of inverted metamorphism is discussed, though some recent developments in Himalayan geodynamic theories, e.g. channel flow, are not mentioned.

Coastal and offshore Tertiary basins are important from the point of view of our hydrocarbon resources. Exploration activities have generated a lot of new information on these basins, which is summarized in chapter 20. The sediments are said to be of dual facies – changing from Palaeogene marine to Neogene

deltaic and fluviatile, signifying gradual retreat of the sea towards the end of Oligocene. Rift tectonics is discussed, but an important omission is a reference to the Eocene Hinge Zone in the Bengal Basin.

The Andamans represent a zone of active subduction and back-arc spreading. A comprehensive summary of the lithostratigraphy, structural architecture and geodynamic scenario is presented in chapter 21. Logically this chapter should come immediately after chapter 19, because the Andaman subduction and Himalayan subduction are two facets of the same plate motion.

The Indo-Gangetic Plain is the cradle of ancient Indian civilization. It represents a foredeep basin formed about 1.5 million years ago. The sediment fill, subsurface structure, physiographic development, changes in drainage course, delta development, tectonism and climate changes are described in chapters 22 and 23. The Quaternary geology of the shield and the coastal belts are also covered. There is an interesting discussion on civilization shifts in the Harappan and Vedic times in relation to drainage and climate change. From the paucity of human fossils in the Indian Quaternaries, Valdiya rightly raises the following question: Did humans evolve outside the Indian subcontinent and enter as an evolved species of *Homo sapiens*? The discovery of *Homo erectus* and an archaic form of *Homo sapiens* from the Narmada valley is significant in this respect. Rigorous study of the Quaternary cover is somewhat neglected in India. It is to be appreciated that Valdiya has elucidated (chapter 24) the history of the Quaternary uplift (1–6 mm/yr) in the Himalaya as recorded in the geomorphology, drainage changes, river ponding and active faulting. The tectonism was accompanied by climate change and the two together played an important role in controlling human settlements, a prolific record of which is preserved in the Himalaya and western India. The course and history of human migration to India, which would be of interest to the general readers is briefly dealt with. Chapter 25 contains an excellent discussion on active faulting and seismicity not only in the Himalaya but also in the stable continental region. The importance of GPS studies and regular monitoring is stressed.

Chapter 26 deals with a topic that is not usually covered in Indian geology textbooks – the ocean floor topography, geology and geodynamics of the Indian Ocean, Arabian Sea and Bay of Bengal. Coastal sediments as well as the Bengal Fan and Indus Fan are also described. Valdiya's effort is laudable because the oceans are not only the locales of potential future mineral and energy resources, but are also important from the global geodynamics point of view.

Chapter 27 is the grand finale, a resume of the preceding chapters; it outlines the evolution of the Indian subcontinent from 3.5 Ga to Recent.

Two topics that are included in the discussion of each geological terrane, (a) an outline of the evolution of life through time traced through the description of life forms in each time-slot, and (b) the mineral assets, would be of interest to all readers. The book is profusely illustrated by well-drafted maps and sections, which have added to the value of the book; however, editorial lapses have led to a few mismatches between caption and illustration. The references are exhaustive and would be useful for researchers, but some recent works have not been quoted and there are a few important omissions, e.g. the seminal paper on Charnockite Formation by Janardhan *et al.* (*Contrib. Mineral. Petrol.*, 1982, **79**, 130–149), the Rajasthan crustal evolution paper by Kaur *et al*. (*Precambrian Res*., 2011, **187**, 155–164), the North Singhbhum Mobile belt paper by Mahato *et al*. (*Precambrian Res*., 2008, **162**, 102–107), the zircon dating work by Ghosh *et al*. in the Southern Granulite Terrane (*Tectonics*, 2004, **23**, TC3006), and the review of Himalayan tectonics by Yin (*Earth Sci. Rev.*, 2004, **76**, 1–131). A frustrating experience for me was the absence of an Index, which makes it extremely difficult to navigate through the book, or to locate a particular topic.

Overall, this is an excellent book on Indian geology in all its aspects, and would be extremely valuable to students and researchers. The publishers may consider bringing out a cheaper paperback version, so that it becomes more accessible to students and young researchers for whom this book is meant.

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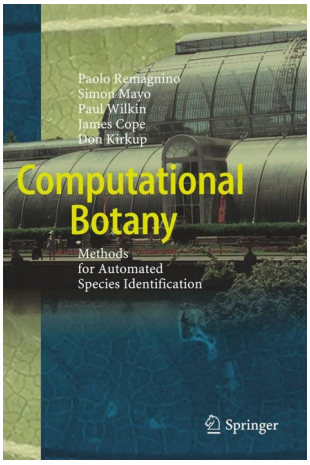

Computational Botany: Methods for Automated Species Identification. P. Remagnino, S. J. Mayo, P. Wilkin, J. Cope and D. Kirkup. Springer-Verlag, Heidelberger Platz 3, 14197 Berlin, Germany. 2017. viii + 114 pages. Price: 112,14 € (Hardcover). ISBN 978-3-662-53743-5.

Technological development is revolutionizing the world. There are certain aspects of plant science that have got new impetus through the advent of computers, digital photography, image analysis and many other tools. For instance, L-systems based plant modelling[1], plant genomics, image analysing for anatomists, etc. are some of the outcomes of this. Identification of plants has always been an important and fascinating area for botanists. However, there is a decline in the prominence given to taxonomists, which has subsequently reduced the number of taxonomical experts across the globe[2]. Even though biotechnological tools provide accurate identification of plant species, these procedures are tedious, laborious and costly. Therefore, morphological-based plant identification is usually adopted.

The progress in digital photography and image analysing techniques has made automated plant identification possible. The first author of this book Paolo Remagnino is not a botanist by profession; he is a professor at the School of Computing and Information Systems, Kingston University, London. Similarly, the second author is also from a computer science background. The other authors are botanists from the Royal Botanic Gardens, Kew. So, this book is a laudable outcome of an interdisciplinary research collaboration. There are many