

decarbonizing world. The chapters cover sectoral and regional analysis, exergetic life-cycle assessment, exergy and industrial ecology, exergy and multi-objective optimization, and exergy in policy development and education. The sectors under consideration are residential, commercial, industrial and transportation – which form a large fraction of the energy-use sector. The regional comparisons are only between USA and Canada. The Indian researchers might want to take this up as a challenge and as a topic of study to develop similar results for the country. This aspect is important considering our commitments to the Paris Accord and is also in line with the National Mission on Enhanced Energy Efficiency. In the chapter on exergetic life-cycle assessments, it was a pleasant surprise to find aspects related to exergy as well as economic efficiencies and environmental impacts from substituting fossil fuels with renewable energy sources. As also the mention of hydrogen as a fuel, which has garnered significant attention in the past year with the establishment of the Hydrogen Mission. Interesting results on the possible benefits (for Canada) are presented. Given the increasing interest in the concept of circular economy, the chapter on industrial ecology provides the basis for examining the reuse and recycle of industrial waste streams. The chapter on exergy in policy development and education is motivated by the fact that the public is often confused when discussing energy and that people need to be aware of the basic concepts of exergy. The authors argue that similar to the concepts of the second law, entropy and enthalpy, exergy needs to be introduced to all technical personnel.

There is no doubt that exergy analysis is an important and necessary subject of study for anyone interested in energy systems, energy modelling, industrial processes and sustainable development. This book must be on the shelves of most libraries catering to the engineering and technology field. The practitioners might want to keep a copy of the same on their shelves as well.

JAI ASUNDI

Centre for Study of Science, Technology and Policy,
 No. 18 & 19, 10th Cross,
 Mayur Street, Papanna Layout,
 Nagashettyhalli (RMV II Stage),
 Bengaluru 560 094, India
 e-mail: asundi@cstep.in



Indian Placer Deposits. R. Dhana Raju (ed.). Cambridge Scholars Publishing, Lady Stephenson Library, Newcastle upon Tyne, NE6 2PA, UK. 2021. xxxv + 621 pages. Price: £95.99.

Amongst diverse types of mineral deposits, the 'placer deposits' have the following unique attributes. They (i) are economically important, mechanical, secondary, present or past accumulations/denudations of chemically resistant, stable, inert, hard, heavy minerals with specific gravity of >2.89 ; (ii) are separated from light minerals by weathering and erosion of diverse geologic source materials; (iii) are transported by moving water and/or air, based on natural gravity; (iv) are deposited for profit in an aquatic and aeolian regime; (v) have been mined since metals were first used by humans; (vi) are mostly of the Phanerozoic age (<542 million years (Ma)) and rarely of older ages (Palaeo-placers); (vii) are formed predominantly in the Cenozoic (<65 Ma), derived from the Mesozoic (<251 Ma) and older primary mineralizations, disseminations, regional background levels and lithified intermediate sources; (viii) occur worldwide at all elevations and at most latitudes, though majority is generally confined to the tropical and subtropical belts and, hence, economically important deposits occur in Australia, India, Brazil, Sri Lanka, Malaysia, Thailand, Myanmar, Vietnam, Mozambique, Sierra Leone, Madagascar, South Africa and Southeast USA; (ix) host many diverse precious, semi-precious, industrial and high-tech heavy minerals and metals, which include gold, platinum and other gemstones, magnetite, ilmenite, rutile, zircon, monazite, xenotime, chromite, cassiterite, columbite–tantalite, sillimanite, garnet, etc. (x) have yielded historically a significant part of the world's total supply of gold, platinum, tin and dia-

monds; (xi) are presently the source of most of the world's titanium; (xii) have a wide spectrum of mineralization, including precious, semi-precious, industrial, strategic and critical minerals required for the ornamental, conventional, high-tech and cutting-edge technologies-based industries; (xiii) are easy and less costly to mine, mostly by surface and open-pit mining, as they occur at very shallow depth either at the surface or near-surface; (xiv) have diverse controls, such as the source-rock geology, disintegration of minerals, resistance to weathering, transportation media, gradient, density difference, favourable locales, geomorphology, different environments of lacustrine, fluvial, beach, dune, marginal marine, marine and glacial waves and long-shore currents and (xv) have minerals and metals ranging widely in cost from a few hundred US dollars per tonne (e.g. ilmenite, sillimanite and garnet) to a few thousand US dollars per ounce (31.1 g of gold) and carat (200 mg of diamond).

This book has 11 chapters, followed by an eight-page subject index. In chapter 1, Dhana Raju presents an overview of the placers of gold, platinum, diamond and other gemstones; tin, rare metals, rare earths and heavy mineral sand (HMS) deposits, encompassing the historical–economic aspects of placers, their provenance rocks, exploration, mining and post-mining operations. In chapter 2, Sangurmth deals with the primary supergene lateritic and placer gold occurrences, prospects and 42 micro-mines opened up by the ancient/modern artisanal miners over an area of ~ 1200 km² in the Wayanad–Nilambur sector, Kerala, within the granulitic terrain of southwest India. These have been known for over two centuries and are the earliest ones explored for gold in India. In chapter 3, Satyanarayana *et al.* present an account of India's inland diamond placer and primary deposits/occurrences, their source/host-rocks, geology, geomorphology, distribution, exploration, mining and processing at Majhgawan, the country's only plant for diamonds, and resources, besides India's pre-eminent position in the world from the pre-historic times for diamonds and their trading as also some world-famous diamonds, such as the *Koh-i-Noor*. Ramesh Babu presents in chapter 4 a detailed account of the eluvial, deluvial, colluvial and alluvial rare metal (RM: Nb–Ta, Be, Li and Cs) placer deposits, associated with the primary mineralized source rocks – zoned rare metal and rare earth (RMRE) granite

BOOK REVIEWS

pegmatites and their replacement zones – in three major pegmatite belts, viz. (i) the Bastar–Malkangiri Pegmatite Belt (BMPB) in Chhattisgarh, (ii) the Jharsuguda district in North Odisha, and (iii) the Holenarsipur and Nagamangala schist belts in Karnataka, together with their geology, exploration, RM- and Sn-mineralogy (columbite–tantalite, beryl, spodumene, lepidolite and amblygonite, and cassiterite), mineral chemistry, resources and mineral processing for the upgradation, concentration and recovery of RM minerals in the field-based mobile recovery plants. In chapter 5, Ramesh Babu gives an account of HREE and LREE riverine, small placer deposits in the form of xenotime and monazite, derived from the intrusive granites and pegmatites in the Chhotanagpur Granite Gneiss Complex region in parts of Chhattisgarh and Jharkhand, along with their geology, exploration, mineralogy, chemistry of RE-minerals and their concentrates, evaluation and mineral processing for recovery, concentration and up-gradation of the RE-minerals. In chapter 6, Palanivel *et al.* present some of the advanced methods of geo-informatics used to probe lithology, structure, geomorphology and location of the placer HMS deposits, taking as a case-study the placer deposits of Kerala. In chapter 7, Chandrasekaran *et al.* present data on the beach placer heavy mineral deposits of Kerala, in terms of their geology, geomorphology, structure, evolution, areal extent, exploration, evaluation, mineralogy, grade, grain size, chemical characters, resources, mining, production, value-addition, and lake-bed and offshore resources. In chapter 8, Chandrasekaran and Murugan document the shoreline, fluvial and inland red sand placer HMS deposits (Teris) in Tamil Nadu,

covering the aspects of geomorphology, geology, exploration, evaluation of the beach and dune HMS deposits, Teri sand deposits and fluvial HMS occurrences, their mining, HM resources, mineralogy and mineral chemistry of ilmenite, mineral beneficiation, production and value-added products. In chapter 9, Ravi discusses the shoreline HMS deposits in Andhra Pradesh, covering aspects of the geology, influence of hinterland geology and geomorphology on the HM-grade, exploration, evaluation, resources, reserves, sedimentological parameters, mineralogy and mineral chemistry of HMs, offshore HMS occurrences, downstream industry with value-addition, economic prognosis, environmental concerns and refilling–recycling–reclamation–reuse (R-4) of the mined areas. In chapter 10, Ravi deals with the shoreline and inland HMS deposits/potential occurrences in Odisha, covering the aspects of regional geology, provenance rocks, geomorphology, structure, tectonics, exploration and resource evaluation of HMs in the major deposits and potential occurrences, together with salient aspects of the mineralogy, textures, sedimentology, EMP-based mineral chemistry of HMs and a brief account on the offshore HM resources and the environmental constraints in the study area. In chapter 11, Dhana Raju documents the mineral processing of HM deposits with many flowsheets for separation, concentration, purification and extraction of both the individual placer HMs and their contained valuable metals, together with different processes to obtain their value-added products, e.g. high-cost, enriched Ti-products such as synthetic rutile/anatase and Ti-slag from raw ilmenite sand; rare earth (RE) products from the major placer RE miner-

als of monazite and xenotime, together with a list of important uses of the placer minerals and their valuable metals in both conventional and high-tech industries as well as in other fields, such as jewellery, medicine, defence and green energy. Though all the figures in the book are in black and white, a centrespread of 16 coloured figures like geological maps is given in between the chapters 1 and 2. The book was dedicated to the late Dr G. Prabhakar Rao and late Dr K. M. V. Jayaram, two pioneer geoscientists of the Atomic Minerals Directorate for Exploration and Research (AMD), Department of Atomic Energy, Government of India, who contributed immensely to knowledge on the placer mineral sand deposits and placer RMRE deposits of India respectively.

I have found the chapters on inland diamonds (chapter 3), rare metal pegmatites (4) and coastal placers of Kerala (7), Andhra Pradesh (9) and Odisha (10) to be the most comprehensive and useful. Chapters 1 (overview) and 11 (mineral processing and value-addition of placer deposits) are well written. Chapter 6 lacks depth and the readers should refer to other comprehensive books as well. I strongly recommend this scholarly and well-printed book to the geoscientific faculty, research and post-graduate students in the universities and professionals in the geo-research organizations and industries. Librarians of the geoscience departments and central libraries of institutions should procure a copy of this excellent book.

BASANT K. SAHU

*Department of Earth Sciences,
Indian Institute of Technology Bombay,
Mumbai 400 076, India
e-mail: bksahu@iitb.ac.in*