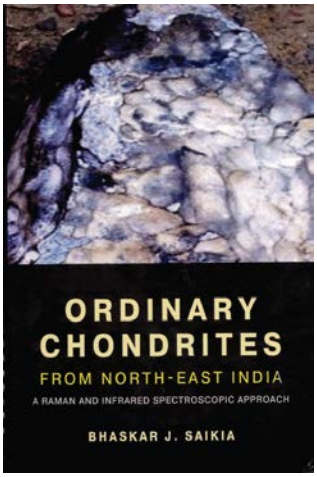


Ordinary Chondrites from North East India – A Raman and Infrared Spectroscopic Approach. Bhaskar J. Saikia. Cambridge Scholars Publishing, UK. 2020. 148 pages. Price: £ 58.90.

As all meteorites come from inside our solar system, they are the most important sources of information for improving our understanding of the origin and evolution of the solar system and various processes that occurred in the early solar system. Most of them are fragments of asteroids that broke apart long ago in the asteroid belt between Mars and Jupiter. The most interesting aspect of a meteorite might seem to be its sudden and quick fall to Earth with great speed. The fastest meteors travel at 71 kilometers (44 miles) per second. The faster and larger the meteorite, the brighter and longer it may glow, often in a blazing fireball. But scientists spend their careers studying meteorites because they contain a record of our solar system's history as early as 4.6 billion years. The study of meteorites has helped us understand the beginnings of our solar system, how planets and asteroids formed and how impacts of large meteorites have altered Earth's history and life on our planet. Some meteorites contain grains of dust ('stardust') that were produced by stars even before the formation of our Solar System. Studies of these pre-solar grains can increase our understanding of star formation and evolution.

Studies of meteorites are adding to our knowledge of the age and bulk chemical composition of the Solar System and the order in which different components in meteorites, their parent bodies, and the Solar System formed. Bombardment of the Earth by large meteorite impacts have shaped the face of our planet and also the Moon through time. Many scientists believe that a huge impact was even responsible for the formation of the Moon. Meteorites may have brought to the Earth the components necessary for life – organic compounds such as carboxylic acids, complex amino acids, aliphatic amines, acetic acid and formic acid can be transported great distances inside space rocks. Additionally, large meteorite impacts, like the one ~65 million years ago that led to the extinction of the dinosaurs can lead to major extinctions and influence the course of life on our planet. Recently scientists examined a section of this highly-shocked meteorite and found many high-pressure minerals like Bridgmanite. The mineral was named in 2014 in honour of Percy W. Bridgman, Nobel Laureate, who was awarded the 1946 Nobel Prize in Physics.

Late Devendra Lal, FRS initiated the study of meteorites in India, and it was further developed by Narendra Bhandari of the Physical Research Laboratory (PRL), who nurtured the Indian Planetary Research under the PLANEX program supported by ISRO and PRL. This encouraged meteorite research throughout the country.

The book under review on the ordinary chondrites by B. J. Saikia is one of the outcomes of this endeavour. This book is focused on the ordinary chondrites collected from North East India, viz. Dergaon, Mahadevpur, Kamargaon and Natun Balijan meteorites.

Ordinary chondrites (meteorites) are still referred to as H, L, and LL. These are classes that were established in the past based on bulk amounts of iron in metallic and mineral form in the rock. The H or high metal chondrites were given a range of around 12%–21% free metallic iron, and the L or low iron meteorites were given a lower range around of 5% to 10% iron metal. The LL group, when analysed were found to have very little free metallic iron and very low iron content in the minerals. The composition of specific minerals such as iron-rich fayalite $(Fe–Mg)_2SiO_4$ and Mg-rich forsterite $(Mg–Fe)_2SiO_4$ are determined precisely for numerous points on a test sample and then averaged. The equipment used today is often an electron microprobe, a method using a very fine – focused beam of electrons to bombard a sample for spot analyses. Electrons in the sample are knocked loose, and particles with characteristic wavelengths for the elements in the sample are produced and analysed simultaneously. Today, classifications of meteorites list numbers for values of iron in at least two different minerals and an accuracy of ± 0.02 mol% amount. These numeric values generally determine if a meteorite is an H, L or LL type chondrite. Mineral identification, the overall texture of the stone, the amount of recrystallization and, related to that, the state of preservation of the chondrules, if there are any, are a few of the features studied. New things like the evidence of shock, which can be seen as lines called planar deformation structures in the mineral crystals, are looked for. This last one, for example, gives good information about the strength of impacts the body suffered while out in space. Other characteristics can be studied as well under an optical microscope. Mentioned earlier were the shock features that can be seen under a microscope while examining a thin section of a meteorite. Shock metamorphic minerals are common in ordinary chondrites. Most of the minerals of the matrix or fragments of the host rock that occur in veins produced due to shock melting undergo phase transformations due to high temperatures and high pressures. It is designed to gauge the level of shock metamorphism displayed by the stone. A shock level of S1, therefore would be seen in a pristine meteorite that shows no shock features. S2 however, would show under the microscope some uneven darkening of olivine crystals as the specimen is examined in polarized light, and there might be cracking of mineral grains along paths other than the normal cleavage of the crystals. In meteorites that have seen even more shock metamorphism, there is melting of minerals and glass begins to appear. The metal becomes small blebs rather than grains. Finally, by the time S6 is reached, most of the minerals have melted and recrystallized, often into polymorphs which are minerals with the same composition, but a different crystal structure. Polymorphs can form under extraordinary shock and high pressures. Studying the shock-induced features of meteorites give science a look into the history of the chondrites.

B. J. Saikia has pioneered the meticulous application of spectroscopic techniques in analysing the mineralogy of meteorites. Raman and infrared spectroscopy provides information about the structure and composition of minerals and has been increasingly applied in planetary sciences in recent years. The conventional powder–X-ray diffraction technique is powerful but cannot be used for micron-sized samples or ultra-high-pressure glassy samples. In this context, vibrational spectroscopic techniques are ineluctable tools for characterizing micron-sized samples. In chapters 3 and 4, the

author discusses the mineral characterizations by Raman and Fourier transform infrared techniques. Raman spectrum has been used to determine the correlation between the peak position and the element content of characteristic peaks in the olivine and pyroxene spectra as an alternative method to determine the composition of olivine and pyroxene in ordinary chondrites. The data were used to evaluate their classification into the chemical groups of ordinary chondrites. Chapter 5 discusses the presence of organic traces in the NE ordinary chondrites. It is well established that the carbonaceous extracts of Murchison and other carbonaceous chondrites contain organic compounds like amino acids. But the presence of organic matter in ordinary chondrites has been reported only recently.

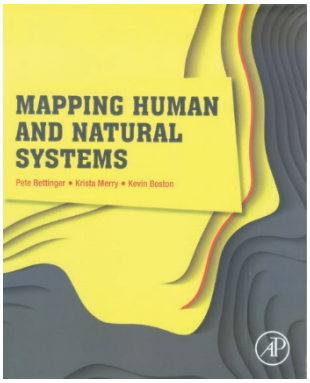
Overall, this book is well written and concise, with a particular focus on the usefulness of vibrational spectroscopic methods in meteorite research with sufficient references to the recent literature pertaining to meteorite research. The appendix provides a comprehensive list of all meteorites observed in India.

I recommend this book to all students, academic researchers and university teachers interested in learning about the usefulness of spectroscopic techniques (often used by Experimental Physics and Chemistry communities) in studying Earth and planetary materials.

I am grateful to National Institute of Advanced Studies, Indian Institute of Science Campus, Bengaluru, and Indian National Science Academy, New Delhi for the support.

G. PARTHASARATHY

School of Natural Sciences and Engineering, National Institute of Advanced Studies, Indian Institute of Science Campus, Bengaluru 560 012, India
e-mail: partha@nias.res.in



Mapping Human and Natural Systems. Pete Bettinger, Krista Merry and Kevin Boston. Academic Press, an imprint of Elsevier, 125 London Wall, London EC2Y 5AS, United Kingdom. 2020. xiv + 341 pages. Price: US$ 99.95.

Three distinguished forestry researchers have come together to bring out this excellent book as a practical guide to modern cartographers and map users in general. Two of them are experts in forestry and one in geography, an essential combination to publish a book of this kind, which does not require a review but an introduction for the benefit of map developers and users in the digital age. This pool of expertise has produced a book useful for students and researchers in environmental science, forestry, ecology, wildlife and natural resource management.

Pete Bettinger, in addition to his expertise in forestry, is acknowledged for his skills in geographic information systems (GIS) analyses of resources and resource conditions, time and cost of forest operations and assessment of geographical positioning systems' (GPS) accuracy in a forested environment. He teaches forest planning, forest measurement, and aerial photogrammetry and conducts research in applied forest management with particular emphasis on harvest scheduling, precision forestry and geospatial technologies. Krista Merry is a geographer who researches applied forest management, emphasising remote sensing, geospatial technologies, landscape planning and precision forestry. She has skills in using GIS, satellite imagery and aerial photography. Kevin Boston specialises in forest engineering, applied forest management, landscape planning and geospatial technologies. These authors have nurtured a fascination for drawing maps since childhood. As adults, they have mastered the fundamentals of digital mapping and produced a book that provides the users with a ready reference to learn about map creation and interpretation and to help them better interact with and construct maps. It is no exaggeration to say that this book fills the long-felt need for a single source on the fundamentals of mapping in the digital age. It is indeed a compulsory read to understand the principles and methods of map development in the modern world.

The book has been divided into nine chapters, intended to cover an array of topics connected to mapping in a logical manner that 'allows general thoughts regarding maps and mapping processes'. The novelty of this book is that each chapter's content is intermixed with reflections, diversions, inspection and translation 'to encourage curiosity, and help develop creativity and critical thinking skills'. Reflections are meant to encourage 'readers to think deeper about the mapping ideas'. Diversions are meant to divert the reader from the book and 'ask the reader to put the book aside and solve a problem'. The readers will be asked to obtain and organize the necessary data and develop a map that communicates a certain message. Inspection encourages the user or reader to 'analyse the map and determine the relative quality of the map with respect to the chapter topics within which each inspection is introduced'. Translation refers 'to the potential message that the map developers have been attempting to communicate the use of works…'. According to the authors, these aspects are likely to 'engage readers in the process of spatial thinking… and to improve readers' ability to communicate and receive messages through maps, and to ensure that they are better positioned to understand the purpose of maps and mapping procedures.

Chapter 1 opens with a series of axiomatic statements about map(s). It includes four sections: (a) maps as models, (b) maps as memories, (c) maps as inspiration and (d) maps as products. Each section is intermixed with reflection, diversion, inspection and translation. These are common to all the chapters to serve the intended purpose. The authors observe that 'People now naturally access cartographic information on digital devices, and while the traditional role of a map as depository of source of information still remains, its role has shifted in many respects to a tool of interaction with map user.'

Chapter 2 provides a historical account of multitude of types of maps through the ages. Two broad sections deal with this theme. The traditional types of maps