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EDITORIAL

Popularizing geoscience in India

For the Indian youth today, geoscience is not among the most sought-after career choices. One reason for this is that the subject is not yet an integral part of the school curriculum. The lack of awareness about this field-based science in the high school usually leads to students opting for the traditional branches for higher studies. Several attempts have been made in the past by various organizations to set this anomaly right so that better quality students take up this branch, which would increase their employment opportunities, including those in schools and colleges. The Geological Survey of India (GSI) has recently taken an initiative to include geology in the syllabus at the secondary and higher secondary levels (www.gsi.gov.in). Beside this, the subject needs to be popularized among the general public through geoscience museums and geoparks of the country.

Geoscience museums and geoparks are ideal places for science popularization that entails dissemination of scientific knowledge, new findings and emerging ideas to the general public in a manner and language comprehensible to them. In general terms, a geoscience museum is an institution that houses, conserves and exhibits collections of rocks, minerals and fossils, whereas a geopark is an unified area with a geological heritage of national or international importance. While books, journals and magazines on geoscience do reach out to the society, geological museums and geoparks leave a greater and long-lasting impression on the general public at large, particularly on the children. In fact, geoparks are becoming favourable destinations for tourists these days, since they aim to apply innovative ideas and strategies, that not only improve the knowledge of tourists, but also promote cultural communication between tourists and the local inhabitants. Geotourism is a relatively new movement, where educated travellers go to distant places in order to improve their knowledge and awareness about the local natural resources, and traditions in acquiring and conserving them.

Museums and geoparks situated inside or in the close proximity of metropolitan cities are usually visited by a large number of people, provided they reach out to the visitors in a lucid manner through impressive and informative exhibits with multimedia and lecture series by experts. In the Indian context, most of these have curators to look after the existing collections, but lack active research staff and thus remain static in terms of educating

the public on contemporary, path-breaking scientific developments. Such a scenario needs to be changed and more researchers should be involved, which in turn would make such institutions more dynamic and innovative. Exhibits should be constantly upgraded with new findings and emerging ideas. On the other hand, it is really challenging to attract sizeable number of tourists time and again to museums and geoparks located in remote areas, even if they have famous fossil and rock archives. Besides good road connections to these places, availability of clean environment, drinking water, food, resting and recreational facilities is important. Some of these places may need considerable revamp in terms of the quality of their exhibits, including the kind of information they offer about their genesis, ages, scientific and societal relevance. Besides these, small souvenir shops selling replicas, geo-cards, printed geo-T-shirts, traditional art, local products, including geo-food, etc. would help attract tourists to such small museums and geoparks. In the times of internet revolution, networking of such government and private institutions with a common hub/platform for advertising at the district, state, national and even international levels will go a long way in developing the economy of a region. Local schools and universities should encourage their students to visit these places at least once a year. First and foremost, the local population needs to realize the importance of its own heritage and potential in building the economy of the region. Once local people take pride in their heritage, they will definitely contribute towards the preservation and further progress of the area, such as building roads, small hotels/restaurants, etc.

GSI has identified 26 geological sites as National Geological Monuments (https://www.gsi.gov.in/webcenter/portal/OCBIS/.../page_GEOTOURISM), in Rajasthan, Odisha, Karnataka, Andhra Pradesh/Telangana, Maharashtra, Gujarat, Chhattisgarh, Himachal Pradesh, Kerala and Tamil Nadu. The Indian National Trust for Art and Cultural Heritage has brought out a detailed monograph on the assessment of these geo-monument sites with their recommendations for future action (naturalheritage.intach.org/wp-content/uploads/2016/09/Geoheritage-Monograph.pdf). Small museums exist close to some of these geo-monuments. In order to make them attractive destinations for geotourists, the exhibits need to be theme-based with a story behind their discovery and significance. One excellent example is of stromatolites, the layered,

mound-like sedimentary structures formed by photosynthesizing microbes such as cyanobacteria. India has one of the best archives of stromatolites anywhere in the world, widely distributed in the country. The general public needs to be told in a simple way that we owe our existence to these almost 2.5 b.y.-old tiny microbes, since they brought about a major global atmospheric change by taking up atmospheric carbon dioxide and giving out the much needed oxygen for multicellular life to originate and grow. This 'great oxygenation event' is also responsible for iron deposits popularly known as 'banded iron formations', that account for over 60% of global iron reserves. Stromatolites can also help us understand the existence of extra-terrestrial life, including that on Mars. People would certainly like to own a small piece of polished stromatolite as a souvenir depicting the historical event that changed life on earth forever. Equally attractive would be a small piece of polished iron ore almost 2 b.y. old for the general public to own. Talking of multicellular life, the Vindhyan mountain range made up of sediments deposited in shallow seas almost a billion to half a billion years ago, spread across the central and northwestern part of the country, houses some of the most spectacular evidence of ancestors of jelly fish and worm-like early animals, which lacked any hard tissue. This was followed by a great revolution of organisms that acquired external shells. Some even went on to form internal skeleton-like organ that would become the backbone and ultimately lead to our own evolution. Again, we owe our existence to the extraordinary innovations that these early life forms underwent some 500 m.y. ago. And this story can be told in the context of the fossils and sediments that these early multicellular organisms are found in depicting, this grand diversity in the shallow ocean.

Another attractive destination for geo-tourists could be the eastern and southeastern parts of India that preserve coal and associated sediments, with famous Gondwana era plants and animals. Petrified wood forests across the country are other favourite places to visit. These ancient ecosystems become more meaningful if comparable modern ecosystems with herbarium are built alongside. Dinosaurs being so popular, tourists would love to know about the early sites from where the first dinosaurs were discovered in India, and how they were discovered. Who were the discoverers? How did the dinosaurs become extinct? Why is India known as one of the biggest hatcheries of dinosaurs? These questions, answered in the form of stories in the context of field exposures with embedded fossils wherever possible and Deccan Traps in the background, can be attractive for geotourists who would like to learn more about these geoparks by trekking and exploring the surrounding areas.

Kutch, Gujarat is perhaps one of the most spectacular places to study *in situ* fossils from Mesozoic and Cainozoic eras. Some of the path-breaking discoveries of fossils from this region include those of whales that walked, marine reptile *Ichthyosaurs* and Miocene mammals including apes. A detailed plan for developing a National

Geopark in Kutch has been proposed by Swarna *et al.* (2013). Gujarat also houses several lignite mines that have yielded amber (fossilised tree resin) with a diversity of early insects embedded in them as inclusions. In fact, some of the earliest Cainozoic mammals in the world, including those of early primates, representatives of our own lineage going back to almost 55 m.y. have been discovered from these lignite mines. Mining engineers and geologists can facilitate collection of such precious fossil remains in order to build small fossil museums.

The mighty Himalaya offers some of the best geological treasures which can be exploited for the promotion of geotourism and popularization of geoscience. At the foothills, the Saketi Fossil Park, Sirmaur, Himachal Pradesh, is unique as it showcases fossils that have been collected from the surrounding exposures of the Siwaliks. With its enormous treasure of vertebrate fossils and artefacts, this field museum has a huge potential for becoming a National Geopark or a Geological Field School station. However, this area needs a large-scale facelift in order to attract geotourists. First, *in situ* fossil sites close to this field museum need to be protected. Information regarding the displayed fossils needs to be updated in the context of new developments in palaeobiodiversity, ecological shifts and climate change. There are no permanent field schools in India where young palaeontologists/palaeoanthropologists can get field training from experts. So Saketi Fossil Park can become an ideal place for such a field school for the popularization of geoscience. Higher up in the Himalaya, Leh, Kargil and surrounding areas consist of breathtaking geological features. However, a geoscience museum that houses such a great geological heritage in this part of the Himalaya is absent.

India holds a great wealth of geological heritage that spans almost the last 4 billion years. Since it became a recognizable land mass, the subcontinent has been one of the most dynamic entities on the globe, shifting its position from the northern hemisphere some 1100 m.y. ago to the southern hemisphere around 500 m.y. ago, and then again to the northern hemisphere about 56 m.y. ago. Shortly thereafter, a massive collision of the subcontinent with Eurasia led eventually to the rise of the mighty Himalaya to the present 5 km amsl. During this entire journey, the subcontinent broke away and merged with various continents time and again, evidence of which lies in its preserved wealth of rocks, minerals and fossils. Existing museums and geoparks, and those that are coming up in India can take the lead in telling this incredible story of our country's journey in space and time, which in turn had and is still having a profound impact on the global climate change, origin and evolution of a variety of organisms, including that of our own ancestors.

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