## WRIT IN STONE: DO YOU KNOW INDIA'S GEOHERITAGE SITES OF JHAMARKOTRA AND ZAWAR?

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There are many shelves of retorts, some complete, some half-broken, around Zawar, hinting at its rich legacy of smelting zinc – both of the past and the present. | Photo Credit: Devayani Khare

With 40 locations on the UNESCO World Heritage List, India's cultural sites – some of them of archaeological significance – are globally recognised even as plans to conserve them are underway. Most of these sites celebrate human history, yet what of the *landscapes* against which these chapters have played out? What of India's <u>geodiversity and geoheritage</u>?

Landscapes across the Indian subcontinent bear signatures of many geological events, from the evolution of life to the cycles of mass extinction preserved in the fossil records. These events include meteorite impacts, volcanic eruptions that laid down the Deccan Traps, the collision of continents that birthed the Himalaya, Lakshadweep's coral atolls, the birth of rivers and how they shaped fertile river valleys, massive deltas, and the world's largest mangrove forests.

The resulting landscapes shaped the rise and fall of civilisations and empires; they influence the organisation of wealth and political power in modern societies. This is why our geodiversity and geoheritage are worth remembering, and preserving.

Geodiversity is the variety of rocks, fossils, minerals, and natural processes that shape our landscapes while geoheritage refers to sites that offer insights into the evolution of the earth and can be used for research, reference, and awareness. The Geological Survey of India has recognised a number of geoheritage sites around the country, but there are more that deserve the recognition yet haven't.

To draw the attention of local governments, industries, and the public to potential sites, the Society of Earth Scientists (SES), a group of independent researchers bridging the gap between earth science and society, anchored a national programme for International Geodiversity Day in October 2022, followed by three field workshops to look for potential sites across India.

The first workshop was about dinosaur fossils in Bagh, Madhya Pradesh, and the second one in the Kachchh region of Gujarat focused on Jurassic life and tectonic features, and highlighted

what each state has to offer for tourism, science, and education.

For the third workshop, earlier this March, a group of field geologists, geology professors, archaeologists, and mining industry representatives gathered to scout a fossil park at Jhamarkotra and the metallurgical remains at Zawar, around 20 km southeast of Udaipur, Rajasthan.

A short, dusty climb from the Jhameshwar Mahadev pond, with no wall, fence or signboard, lies a stromatolite fossil park: it hosts stromatolites dating back 1.8 billion years, exhibiting a variety of textures and sizes.

A stromatolite is a layered sedimentary rock created by microorganisms. As such, stromatolite fossils preserve records of cyanobacteria, commonly known as blue-green algae – the earliest life on the planet. These organisms developed the ability to photosynthesise and make their own food. By doing so, they pumped large quantities of oxygen into the atmosphere of primaeval earth, allowing most other life to evolve and flourish.

Stromatolites are sometimes called 'crocodile-skin rock' due to their unusual textures. In this case, the texture was the result of the carbonate matrix eroding away more easily than the phosphate-rich minerals. | Photo Credit: Devayani Khare

Cyanobacteria live in shallow waters; their quest for sunlight, for photosynthesis, caused them to trap sediments and deposit them as lens-like layers. The resulting stromatolites allowed their colonies to expand and flourish – almost like microbial reefs.

Jhamarkotra's fossils are phosphate-rich because the trapped sediments were mainly phosphate minerals. These fossils are part of the reason why the region is a thriving mining hub today: the phosphate is mined for use as agricultural fertilisers. But as mining operations in the region have expanded, the industry has presented a double-edged sword: it can identify and preserve the fossils or it can damage or destroy these records of our geological past.

For now, local bodies have cemented these specimens together, in the hopes of preserving them for scientific value and posterity. With only the villagers and thorny acacias as custodians, a lot of work will be needed to raise awareness and preserve these stromatolites.

Another interesting geoheritage site lies some 40 km south of Udaipur: Zawar, the world's oldest known zinc-smelting site. It is of archaeological and metallurgic importance.

The landscape around Zawar bears numerous traces of zinc mining and smelting operations in ancient times, including open stopes, trenches, chambers, galleries, shafts, and open-pit mines. The discovery here of earthen retorts – brinjal-shaped, long-necked vessels – is particularly significant: their presence here suggests Zawar had a unique zinc-smelting legacy.

Before the advent of high pressure technology, extracting zinc was a considerable challenge. Zinc has low boiling and melting points, so heating it forms a vapour, which readily oxidises in contact with the atmosphere. However, the people of Zawar extracted zinc using a distillation process that required the use of a retort and an external condenser.

This is why, of all metal extraction techniques, the one employed to obtain zinc represents the height of metallurgical prowess. Zawar's zinc-smelting operations date back 2,000 years. In 1988, the American Society of Metals acknowledged it to be the earliest zinc-smelting site in the archaeological record. Written records also trace the use of zinc in ancient medicine and in mediaeval weapons of war. The people in the region also traded it with their counterparts in

China and Japan.

So the big question today is: Can we preserve Jhamarkotra and Zawar as geoheritage sites?

Apart from its World Heritage list, UNESCO also has criteria for 'Global Geoparks': sites with geological heritage of international value. Both Jhamarkotra and Zawar may qualify if they meet a few other conditions as well.

To this end, in the coming weeks, participants from the three SES field workshops. plus geologists, the national tourism board, and industry representatives will attempt to draft a roadmap to have these locations accredited as geoheritage sites. The roadmap will outline the geological, cultural, and natural components to be included in each geopark, identify relevant stakeholders, and chalk a management plan.

The SES also hopes to raise awareness about India's rich geoheritage via digital and offline campaigns.

When we take pride in our country's rich and varied heritage, let us also include landscapes that tell of its rich and varied geological history.

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