Current Science Reports

Extra-peninsular Gondwana Rocks

Arunachal Pradesh, Himalaya

Mousumi Gogoi, from Dibrugarh University, has been travelling through the rough terrain of Tawang, Nagaland, Sikkim, Manipur, Mizoram and Assam, trying to understand the geology of those mountainous regions.

Ranjan K. Sarmah and Tapos K. Goswami, Mousumi's mentors, advised her to focus on the well exposed Gondwana sandstones in the West Kameng region of Arunachal Pradesh.

The Gondwana formations are usually associated with coal deposits in India. But the environmental and climatic conditions that existed during the sedimentation of these Gondwana rocks are not fully understood.

So Mousumi, assisted by Bashan N. Mahanta, Hiruj Saikia and Bhaskar Oza from the Geological Survey of India started their field trip along the zig-zag winding National Highway 13, in the Pinjoli–Sessa road section of the West Kameng District in Arunachal Pradesh.

Image: Mousumi Gogoi

While descending the mountains towards the Kameng River and the Main Boundary Thrust that formed the mountains, they realised one important factor about the Gondwana rocks in the region. The Gondwana rocks were sandwiched between low to medium grade crystalline rocks of the Bomdilla group, formed some 2500 to 1600 million years ago on the northern side, and the Siwalik group formed 23 to 2.6 million years ago in the south.

The researchers collected samples along the way and, back at the lab, prepared thin sections of the sandstone samples to characterize them using polarizing microscopes and X-ray fluorescence.

The sandstones were poorly sorted quartz and rich in feldspar containing silicates of aluminum. The abundance of rare earth elements and thorium indicated a silica rich igneous source for the formation of the Gondwana rocks. Light rare earth elements were more than heavy rare earth elements and did not contain europium, which suggested granites as source rocks.

Geochemical analysis suggested that the Gondwana rocks would have formed after the Archean eon, 2500 million years or so ago. According to the researchers, humid conditions were prevailing during the deposition of the Gondwana sediments.

The variations in the clay minerals in the sediments reflect climatic changes. The sediment samples they collected seemed to be derived from cratonic sources with a significant contribution from metamorphic rocks. There was evidence of some minor recycling of sedimentary rocks also.

X-ray diffraction of the finer sediments showed a dominance of clay mineral assemblages, indicating an alkaline environment during sedimentation.

The research team also studied the weathering and erosional conditions of the source. The source terrain was intensely to moderately chemically weathered.

The inferred palaeoclimatic condition was favourable for coal formation. Research organizations can use this study to investigate coal deposits in the Himalaya region under similar geological conditions.

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Predicting Ozone

Iodine emissions from ocean

Iodine, emitted from the ocean, reduces ozone in the lower atmosphere and, thus, improves air quality. But, at present, models that predict India's air quality do not consider iodine emissions because of a lack of data.

So Anoop Mahajan and team from IITM, Pune measured active iodine compounds over the Indian Ocean on board the research vessels, *R. V. Agulhas* and *Sagar Kanya*, during the International Indian Ocean Expedition in 2015 and the Indian Southern Ocean expeditions of 2014, 2016 and 2018.

They found elevated emissions of iodine compounds. The emission, especially of more reactive inorganic iodine, was different from globally estimated iodine emissions.

The team then collaborated with researchers from BHU and Spain to investigate the impact of these iodine emissions over India.

They used their data in the Weather Research and Forecasting coupled with Chemistry model to simulate conditions with no iodine emission, only organic iodine compounds and with emission of both organic and inorganic iodine.

The team validated the impact of iodine on the model's simulated air quality results with data collected during the expeditions. The results showed the critical role of iodine in the accurate prediction of ozone, oxides of nitrogen and hydrogen.

Models that do not include iodine chemistry overpredict ozone pollution. And when using the global ocean emission estimates, the model overpredicts the effect of iodine and will show lower than observed ozone pollution over India.

'Tropospheric ozone reacts with iodine compounds on the ocean surface and produces reactive iodine compounds in the gas phase. These reactive species, such as hypoiodous acid and molecular iodine, significantly impact air quality,' explains Anoop Mahajan.

'The emissions from the ocean also affect air quality estimates over the Indian subcontinent,' adds Swaleha Inamdar, his colleague.

Iodine emissions can change concentrations of ozone, nitrogen and hydrogen oxides by 15–50%. With the inclusion of regional data and seasonal variations of iodine over ocean and land, the models improve and reflect reality better.

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Damodar Valley
Surface water quality

The Damodar valley has the richest coal reserves in India. But coalfields are also a threat to surface water bodies.

Recently, researchers from CSIR-CIMFR and IIT Dhanbad collaborated to analyse factors influencing surface water quality in the East Bokaro coalfield, Damodar valley.

They collected water samples from ponds, reservoirs and rivers during the pre-monsoon, monsoon and post-monsoon seasons.

Chemical analysis showed that the samples had calcium–magnesium–bicarbonate and calcium–magnesium–sulphate, along with mixed types. The major ions in surface water come from rock weathering. Dilution in total dissolved solids, potassium, fluoride, magnesium and chloride during the monsoon, highlighted seasonal variations.

The high concentrations of nitrates, fluorides and total dissolved and undissolved solids make some samples unsuitable for drinking. High magnesium concentrations render water hard, making it difficult for soap to lather.

'But, of course, we can safely use the water for irrigation,' says Mukesh K. Mahato, CSIR-CIMFR, Dhanbad.

The findings are useful for people in East Bokaro to make informed decisions on the use of surface water in the region.

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Trace Metals in Backwaters
Barrier prevents dilution

The Thanneermukkom saltwater barrier was constructed across the Vembanad Lake to prevent tidal action and the intrusion of saltwater into the Kuttanad low-lands in Kerala. The barrier divided the lake into brackish water from the sea and fresh water from rivers. This protected paddy cultivation in the lowlands from salt water. However, the barrier has caused unforeseen ecological problems in the backwaters.

Arunpandi Nagarathinam and team from the CSIR-National Institute of Oceanography, Kochi recently estimated the trace metals in the backwaters, using water hyacinth, an aquatic weed known to accumulate heavy metals.

The group collected plant samples from four locations upstream of the Kochi backwaters. When the barrier was closed, the group observed a high accumulation of trace metals, except iron, in water hyacinth roots and stems. Iron was present in excess during the monsoon.

While rivers bring iron, metals like cadmium, nickel and lead come from industrial and domestic waste dumped in the Kochi backwaters.

'Restricting the saltwater flow has disrupted the harmony of the sea with the Kochi backwaters,' says Jyothibabu Retnamma, CSIR-NIO, Kochi.

The invasion by water hyacinth tolerant to the trace metals may be because of the barrier, compounded by pollution from the city's rapid industrialization.

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Bacteria Remediate Arsenic
Klebsiella pneumoniae

Arsenic is toxic to most living creatures. However, some bacteria are arsenic resistant. They change the oxidation state of arsenic to a less harmful form. But which are the best bacteria for this purpose?

Researchers from the Indira Gandhi Krishi Viswavidyalaya (IGKV), Raipur recently identified some arsenic-resistant bacteria in industrial and mining sites at Chhattisgarh. Chhattisgarh is among the seven worst arsenic-contaminated states in India.

The researchers collected soil and water samples from diverse arsenic-contaminated sites and isolated 108 bacteria. They cultured the bacteria in arsenic-containing media.

'Only 24 bacteria could survive in arsenic media,' says Prahlad Kumar, IGKV.

'The best was a *Klebsiella pneumoniae* strain. It could live at 600 millimolar arsenic concentrations,' adds S. B. Gupta, his colleague.

Using atomic absorption spectroscopy, the researchers examined the arsenic detoxification.

'*Klebsiella pneumoniae* could remediate about 40 per cent arsenic,' says Biplab Dash, IGKV.

Remediating arsenic-contaminated sites using such bacteria would significantly reduce health complications among people living in arsenic-contaminated areas.

But *Klebsiella pneumoniae* is known to be a pathogen. The team sequenced the DNA of these arsenic-resistant bacteria and identified two genes involved in detoxification.

'Now that we know the genes involved, we could engineer harmless bacteria for efficient arsenic remediation,' says Ravindra Soni, IGKV.

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Ganga Ecosystem
Humans degrade

The heavily industrialized Kanpur region dumps waste metals and other toxic material into the Ganga. Deepa Jaiswal and Jitendra Pandey, BHU wanted to understand how this affects the river's ecosystem.

From 2016 to 2019, they have been collecting river water between Kannauj and Varanasi from May to June, when water flow is low and pollutants are abundant.

They assessed the samples for water quality indicators – dissolved oxygen, biological oxygen and chemical oxygen demands – which influence the survival of aerobic organisms.

The researchers observed that the tannery industries located in Kanpur can be the main cause of increasing oxygen demand in the middle stretch of the river as they continuously add oxygen demanding wastewater to the river. This depleted dissolved oxygen levels in the Ganga.

The depletion of oxygen increases the demand for biological and chemical oxygen and reduces redox potential in sediments. This results in the release of heavy metals and phosphorus from sediments in the river's midstream and downstream regions. Agricultural runoff further enriches nutrient availability. Both these factors promote the growth of harmful algae on the river surface, preventing sunlight from penetrating into water.

'This threatens underwater organisms,' says Deepa Jaiswal.

Moreover, microorganisms that clean river water were drastically reduced. The researchers claim that the absence of oxygen results in the death of aerobic organisms in the river. Eventually, water quality degrades and a foul smell develops. This affects the food chain and is a threat to fish and dolphins.

'However, metals, chemical oxygen and biological oxygen demand gradually decreased downstream,' says Jitendra Pandey.

The researchers compared Ganga water quality during the COVID-19 lockdown and recorded an improvement. This suggests that human intervention contributes to degrade the Ganga ecosystem.

'If the authorities do not act to prevent river pollution, the effects on the river ecosystem can become irreversible, and eventually affect humans through the food chain,' cautions Jitendra Pandey.

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Increasing Apricot Shelf Life

Using waste

Coating fruits with chitosan can increase shelf life. If chitosan is loaded with antioxidants, it increases shelf life further. Pomegranate peel is rich in antioxidants. Why not try pomegranate peel extract and chitosan for increasing apricot shelf life?

Amir Gull and colleagues, Sher-e-Kashmir University of Agricultural Science and Technology, Srinagar prepared a nanoemulsion of chitosan and glacial acetic acid.

One per cent emulsion had higher droplet size, electric charge and lower viscosity.

'The high electric charge around the droplets and low viscosity make them electrochemically stable,' says Nusrat Bhatt, SKUAST, Kashmir.

The researchers mixed the chitosan nanoemulsion with pomegranate peel extract. And they coated freshly harvested apricots with one per cent chitosan, and chitosan with various concentrations of the peel extract. The treated fruits were then stored at 4°C for 30 days along with control apricots.

The researchers examined the treated fruits for any visible infections and weighed them every five days.

After a month, fruits coated with a 1% emulsion of chitosan had lower weight loss and 35% decay.

'The coating reduces fungal attacks and prevents moisture from escaping. This reduces weight loss,' explains Nusrat Bhatt, SKUAST-K.

However, total soluble solids and organic content in the fruit reduced. Apricots treated with chitosan and peel extract, on the other hand, were firmer with better colour even at the end of storage.

'Applying chitosan and fruit peel extract suppressed enzymes which degrade cells, and reduced respiration. This delays apricot ripening,' explains Sajad Mohd Wani, SKUAST-K.

Coated apricots had higher antioxidant activity and lower ascorbic acid and carotenoid content.

'This is due to the delayed oxidation of phenolic compounds by free radicals and chelating metals,' says Shaiq Ahmad Ganai, University of Kashmir.

The team also found fewer bacterial, yeast and mould infections in the apricots. Trained experts rated the treated apricots above five on the nine point hedonic scale.

Coating fruits with chitosan, from chitin waste discarded by shrimp and prawn processing industries, and pomegranate peel, fruit waste, is an economic method to increase the shelf life of delicate fruits.

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Filariasis Vector

Plant extracts to manage

Filariasis, an infectious tropical disease, is transmitted by *Culex quinquefasciatus*. Trying to control the vector population using chemical insecticides leads to insecticide resistance among insect pests. Moreover, chemical residues accumulate and harm the environment.

To find safer alternatives, A. Jebanesan and team, Annamalai University investigated mosquito larvicidal chemicals in five plants. The plants are traditionally used in the region to manage pests. Literature seemed to lend credence to the practice.

The researchers used various concentrations of the plants' leaf, peel and seed extracts on third instar mosquito larvae. After one day, mortality rates were recorded.

'Treating with wood apple extracts produced the highest mortality. Trifoliate orange came second,' says P. Senthamarai Selvan, ICAR-National Bureau of Agricultural Insect Resources, Bengaluru.

Image: Aditya Madhav

The team selected an unused cement tank and a mini pool for field trials.

'At a concentration of 100 milligrams per litre, extracts from both plants killed 90 per cent of the larvae,' says A. Jebanesan, Annamalai University.

'The combined larvicidal effects of wood apple and trifoliate orange phytochemicals can be impressive,' exclaims P. Senthamarai Selvan, ICAR-National Bureau of Agricultural Insect Resources.

India has about 40% of global filarial infections. Half the population is under risk of infection. Pouring extracts from wood apple or trifoliate orange into water bodies could control the mosquito menace.

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Dexamethasone for COVID-19

Inferring molecular mechanisms

Recently, a large randomized study showed that dexamethasone reduced mortality in patients requiring respiratory assistance during COVID-19 treatment. The synthetic hormone provides relief by down-regulating the production of pro-inflammatory molecules such as interleukins and provides relief. But it also has a suppressive effect on the immune system.

So, Abhay Sharma, CSIR-Institute of Genomics and Integrative Biology, New Delhi investigated how the

molecular mechanisms of dexamethasone therapy impact the immune system.

From databases, he accessed transcriptomic datasets of post-mortem lung tissue from COVID-19 patients. He then compared the data of altered gene expression with those of uninfected healthy individuals of the same age. He also took differential gene expression data of immune cells of COVID-19 patients to compare with those of healthy individuals. To understand the response to the steroid, he also examined gene expression in dexamethasone-treated human lung cell lines.

The findings suggest that dexamethasone activates the transcription of anti-inflammatory genes and suppresses the transcription of pro-inflammatory genes. This reduces lung inflammation in COVID-19 patients.

He found nine differentially expressed genes, including some that favour dexamethasone over other anti-inflammatory drugs for the symptomatic treatment of COVID-19.

However, besides suppressing inflammation, the steroid hormone impacts other immune activities and should be used with caution.

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Indoor Air Quality

Airborne microbe concentration

With outdoor pollution and poor air quality, how does indoor air-quality fare in Delhi? Researchers now have an answer and it does not smell good.

Researchers from the Satyawati College, Delhi, measured airborne microbial concentrations indoors.

They collected indoor air samples every month from April 2019 to March 2020 at four residential locations in North Delhi. They also documented meteorological data to identify seasonal variations in bacteria and fungi indoors. They found a higher concentration of airborne microbes than WHO permitted levels.

In the samples, the researchers identified abundant *Staphylococcus* and *Micrococcus*, bacterial strains known to cause pneumonia and other infections. Among fungal strains, *Cladosporium*, *Aspergillus* and *Penicillium* were the most prevalent. They cause allergic reactions and respiratory problems.

Overall, the bacterial microbes were bigger than the fungal spores. Smaller fungal spores can reach the lower lungs and bronchi and cause serious respiratory issues.

The bacteria and fungi indoors were highest in June and August. The lowest concentrations were recorded in December and January.

'There were high concentrations of microbes in June and August, when the humidity was also high,' says Rajeev Singh, Satyawati College.

'In December and January, the concentrations reduced along with temperature,' says Pradeep Kumar, his colleague.

Human activity and outdoor weather affect indoor microbial concentrations. Identifying the major sources of indoor microbes will help take preventive steps against infections.

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Tackling Climate Change

The poor need to be resilient

Climate does not differentiate between socio-economic classes. Yet the poor are more vulnerable to climate change as they lack resources to tackle the problems. How do the poor figure in climate resilience trajectories, in adaptation and mitigation strategies?

Rajiv Pandey from the Indian Council of Forestry Research and Education, Uttarakhand was part of a team of scientists from around the world who came together to answer the question.

The team defined climate resilient trajectories as development pathways to be undertaken, along with strategies to curb climate change and mitigate its impact. The pathways should be sustainable yet flexible to adapt to climate-related changes.

Poor populations, amounting to about 4.2 billion, depend mainly on agriculture and natural resources for livelihood. But climate change-related extreme events like floods and droughts affect agricultural yield.

Besides these, the degradation of ecosystems and biodiversity loss also impact sustenance. A rise in global temperatures by up to 1.5°C does not impact biodiversity much. This provides more flexibility in terms of solutions – if the poor in a population do not increase.

But, if the rise crosses 1.5°C, loss in biodiversity becomes significant and poverty will start increasing. Then policy makers might have to make tough decisions to keep living sustainable, say the researchers.

The poor will then need to be supported by ensuring food, energy and water security along with climate resilient infrastructure and economic security. So, if development supports the poor in these areas and mitigation steps consider the impact on this class, the efforts can be fruitful for all sectors.

'If we proceed thus, we can tackle climate change equitably,' says Rajiv Pandey.

Policy makers and stakeholders need to ensure that the policies fit all – rich or poor – so that we, as a society, adapt to the changing climate.

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