

Current Science Reports

What's Under the Deccan Traps *Deep scientific drilling in Koyna*

The Koyna region, in the western part of the Deccan Traps, had several earthquakes in the last 50 years. These earthquakes are believed to be induced by the Koyna–Warna reservoirs. To fully understand the seismicity in the region, we need data on the basement rocks below the Deccan Traps. But we do not have an adequate understanding of the basement under the Traps.

To investigate, researchers from the Borehole Geophysics Research Laboratory, Karad drilled nine vertical boreholes in the periphery of the seismic zone, between the Koyna dam and the Warna reservoir on both sides of the Western Ghats.

The team recently reported results from three cores from the Panchgani and Gothane sites on the eastern part and Nayari on the western part of the Western Ghats escarpment. The deepest drilling went down to more than three kilometres at the Gothane site, whereas the Nayari and Panchgani sites were drilled to more than 1200 and 1500 metres. It appears that the thickness of the Deccan Traps on the western side of the Western Ghats is less than on the eastern side.

The contact zone between the Deccan Traps and the basement is characterised by high iron oxides. The sediments commonly found under the Deccan Traps were absent in the Koyna region.

To understand the petrography of the basement rock, the team prepared representative thin sections and observed the depth-wise variations in petrographic properties under a polarising microscope. The core samples of the basement rocks showed signs of the severe stresses the craton had undergone. There were also signs of the melting and crystallisation of minerals.

The researchers measured major, trace and rare earth elements in representative samples. The results of these geochemical studies suggested the mixing of magma at several depths in the basement rocks. The sources of rare earth elements could be from the

earth's mantle or the base of the continental crust.

The results suggest that the Deccan Traps, remnants of volcanic lava flows about 65 million years ago, were laid over a part of the Dharwar craton, formed more than 2700 million years ago. The basement rocks in the Koyna region are typical of gneisses of the Dharwar craton exposed in peninsular India.

Researchers have long suspected that the basement of the Deccan Traps in this region is the Dharwar craton. The study provides data to confirm this. Researchers can now explore the role of basement rocks in seismicity in the region.

DOI: 10.1007/s12040-022-01888-z

Boosting Turmeric Yield *In north-eastern hill regions*



Image: Raghbir Khanna via Wikimedia Commons

Turmeric is an important crop in the hills of North-East India. The region produces several varieties of the rhizome. But turmeric is nutrient exhaustive. And, in the region, acidic soil, poor nutrient management, soil erosion, use of low-yielding varieties and poor irrigation result in low crop output. Poor returns on investment and efforts affect the already poor farmers.

To find a sustainable approach for maximum turmeric yield, researchers from eleven agricultural research institutes collaborated. For two years, they conducted a series of experiments in the fields of small-holder farmers in the Tamenglong district, Manipur.

After the early monsoon showers, the team planted rhizomes of a high-yielding variety, Megha Turmeric-1, adding plant biomass as mulch. The rhizomes were covered with banana stems to protect them from rain, to reduce soil erosion and to improve soil fertility.

The researchers applied nutrients in a site-specific manner. To neutralise soil acidity, they added lime to the soil. They also used farmyard manure, mineral fertilisers and biofertilisers, such as nitrogen-fixing and phosphate-solubilising bacteria.

After adding the various site-specific nutrient treatments, the researchers monitored the changes in soil properties. There was significant improvement in nitrogen, phosphorus and potassium. Other soil properties had not altered greatly. But biomass yield improved.

The team monitored crop growth and weeding was done periodically. Harvesting was done during the last week of December.

Statistical analysis of the data showed that the most important soil properties for turmeric rhizome yield are soil organic carbon, nitrogen and potassium.

'The best yield was with the use of lime, a mixture of farmyard manure, nitrogen-fixing bacteria and chemical fertilisers,' says Ingudam Bhupenchan-dra, ICAR-KVK, Tamenglong, Manipur.

The team then assessed profitability. They calculated the gross economic benefit by multiplying the yield per unit area with the price of the product. Under integrated crop management, net returns went up by 34%.

Agriculture extension departments can now take the package of practices for turmeric cultivation to other farmers in the North-East.

DOI: 10.1016/j.indcrop.2022.114745

Rice and Soil Quality *Under organic farming*

Rice is a major crop in the north-eastern part of India. However, rice cultivation under the acidic clay loam soils there, with modern input-intensive practices, reduces soil productivity and is not sustainable. What can we do to improve soil properties and make rice cultivation there more sustainable?

A team of researchers from ICAR institutes and state agricultural universities conducted a nine-year-long experiment to compare the different options suggested by research so far.

In two plots they used a biofertiliser consortium consisting of *Azospirillum* and phosphate-solubilizing bacteria at different levels per hectare. In another, they used compost. In yet another, both compost and the biofertiliser consortium. Compost enriched with the biofertiliser and rock phosphate at two different amounts were applied in two other plots. Azolla, an aquatic fern known to be beneficial in rice cultivation, was yet another application. As control, they had a plot with the recommended chemical fertilisers.

In May 2011, they sowed paddy seeds of the *Keteki Joha* cultivar in the instructional-cum-research farm at the Assam Agricultural University.

Compost and enriched compost were applied under puddled conditions in the first fortnight of June, before transplanting the seedlings in experimental plots. The roots of the rice seedlings were dipped in a solution containing *Azospirillum* and phosphate-solubilizing bacteria before transplanting in the test plots. All plots were given the same treatment of weeding and pest control. The crop was harvested in the last week of November for measurement and analysis.

The researchers monitored the soil quality at different depths and the quality of the grains in terms of nutrients.

After nine years, they compared the value of the different treatments. Improvement in soil biochemical properties was best where compost enriched with rock phosphate and the biofertiliser was applied at the rate of 5.0 tonnes per hectare.

Rice quality in terms of major and micronutrient content also turned out to be the best with the same treatment.

For sustainable rice cultivation, farmers in the north-east need to start experimenting with the suggestions of the researchers.

DOI: 10.1080/03650340.2022.2084084

Drug Repurposing

Antimalarial drug for cancer

In many cancers, pyruvate dehydrogenase, an enzyme in mitochondria, is inhibited by the addition of a phosphate group by another enzyme, pyruvate dehydrogenase kinase 3. This leads to changes in sugar metabolism, increa-

sed cell division and proliferation of capillaries, typical of cancers.

So, drugs targeting pyruvate dehydrogenase kinase 3 could perhaps be used to treat cancer.

Saleha Anwar from Jamia Millia Islamia, New Delhi collaborated with scientists from Saudi Arabia, the UAE and the US to explore the idea.

The team has been exploring approved drugs such as naringenin and hordenine to target kinases towards cancer therapy. Recently they tried artemisinin, extracted from the plant, *Artemisia annua*, used in the treatment of malaria.

The researchers downloaded the structure of pyruvate dehydrogenase kinase 3 from a protein data bank and the artemisinin molecule's structure from PubChem, a drug data bank.

They then simulated molecular docking between artemisinin and pyruvate dehydrogenase kinase 3. Artemisinin had strong binding affinity to the enzyme and the docked complex was stable.

The researchers validated their computational observations through *in-vitro* experiments using a fluorescence binding assay. They titrated the fluorescence emission spectra of the enzyme with various concentrations of artemisinin. There was a significant decrease in fluorescence intensity with increasing concentrations of artemisinin, signalling a strong binding affinity of the molecule in the *in-vitro* studies also.

'Getting approvals for a new drug may take 10–15 years and huge financial investments,' says Saleha Anwar. 'Our approach of repurposing existing drugs can overcome these limitations.'

Pyruvate dehydrogenase kinase 3 is present in gastric, colon and lung cancers and in acute myeloid leukaemia. Such cancers could be treated using artemisinin. However, rigorous clinical trials are required before artemisinin is prescribed for cancer.

DOI: 10.1016/j.molliq.2022.118928

Preterm Neonatal Deaths

Birth asphyxia underrated?

Respiratory distress syndrome, breathing difficulty during birth, is considered a leading cause of death among premature babies. However, birth asphyxia,

the inability of new-borns to take their first breath, exhibits the same manifestations. So, physicians may misdiagnose breathing difficulty cases as respiratory distress syndrome without considering the underlying pathology.

Shivaprasad S. Goudar and team from the J N Medical College, Belagavi recently examined the extent of such a tendency in India and Pakistan. They recruited women with premature babies from neonatal intensive care units in the two countries.

They also collected clinical information including the placental pathology of these women during their pregnancy and monitored the premature babies in the neonatal intensive care units.

If the babies died, physicians diagnosed the cause of death based on information available at the time of death.

A panel of experts then determined the cause of death based on the International Classification of Disease Version-10. The panel used information such as obstetrical history, placenta evaluation and foetal tissue.

The researchers compared the cause of death determined by the physicians with the findings by the experts.

The physicians determined that around 70% of the deaths were due to respiratory distress syndrome and only 3% due to birth asphyxia. In contrast, the experts found that only 27% of the deaths were due to respiratory distress syndrome and 34% to asphyxia.

In around 10% of the cases, physicians determined both conditions as cause of death while experts identified that 23% had both conditions as the cause of death.

The researchers then compared the cause of death in terms of the two countries.

In Pakistan, a more significant proportion of deaths is due to birth asphyxia.

In both countries, neonatal deaths due to birth asphyxia are largely misdiagnosed as respiratory distress syndrome. Along with breathing difficulty, clinical information such as obstetrical history, examination of the placenta and foetal tissue can help accurately distinguish respiratory distress syndrome from birth asphyxia.

Better obstetrical and neonatal management can prevent neonatal deaths

due to birth asphyxia. Birth asphyxia can be managed effectively if identified early. So, diagnosing the exact cause of death is crucial in preventing neonatal death.

DOI: 10.1111/1471-0528.17220

Targeting SARS-CoV-2 Replication *Silencing the right genes*

To develop vaccines and treatments for COVID-19, researchers are primarily targeting the spike protein. But Sriniwas Patnaik and team from the Kalinga Institute of Industrial Technology, Bhubaneswar is taking a different approach.

It is now known that the genes coded after the open reading frame 8 of SARS-CoV-2 play a major role in the survival and reproduction of the virus inside human cells. The team started investigating the possibilities of attacking the virus on that front.

Soon they realised that, even if the *orf8* gene is mutated or even deleted, as in the case of some variants, viral replication is not affected. So they looked into the other open reading frames. The open reading frame 7a, located next to *orf8*, had functional similarities with genes located at *orf8*. Moreover, the sequence in the region was conserved.

The team decided to compare the *orf8* and *orf7a* genes. They downloaded the sequences of the two genes in eleven variants from an online database. Multiple sequence alignments using the programme, Clustal Omega, confirmed sequence similarity between *orf8* and *orf7a* regions.

The next milestone was to silence both the genes. MicroRNA can regulate the expression of specific genes by duplexing with complementary sequences, forming a gene silencing complex. The researchers screened mature human microRNA from a microRNA target prediction database using *orf8* sequences.

The team shortlisted 18 microRNAs based on sequence complementarity. They used molecular docking tools, HNADock and PatchDock, to dock the shortlisted microRNAs with the SARS-CoV-2 sequences. Fifteen of the human microRNAs that bind to the *orf8* gene could also bind strongly with the *orf7a* sequence.

'Targeting the *orf7a* gene, a conserved alternative reserve of the *orf8* gene, can severely hamper the viral life cycle,' says Vaggu Goud, Kalinga Institute of Industrial Technology, Bhubaneswar.

Scientists working to develop a therapy for SARS-CoV-2 need to validate the microRNAs shortlisted by *in silico* methods, using wet lab-based experiments.

DOI: 10.1016/j.compbio.2022.105436

Haemoglobin in Badagas, Nilgiris *Harappan origins?*

In 1952, the prevalence of sickle cell anaemia was eight per cent among the Badagas, an endogamous indigenous tribal community of the Nilgiri district, Tamil Nadu. The data was not updated in the last 70 years.

To investigate the present situation, researchers from the Government Arts College, Udhamandalam and the Providence College for Women, Coonoor screened the Badaga population for the haemoglobin variants. Among the volunteers, they found eight cases with haemoglobin S and D-Punjab. This was surprising because there have been no reports on the presence of the haemoglobin D-Punjab variant in a native South Indian population.

The severity of sickle cell anaemia increases when both variants are present together. But, since the age distribution of those with both mutants varied from 8 to 60 years, there may be other factors at play.

The investigators observed an association of the haemoglobin D variant with the distal promoter, the BP1U motif, a small DNA segment where DNA regulating proteins bind and promote the expression of the beta globulin gene. Similarly, the haemoglobin S variant was associated with a group of genes inherited together – the Arab-Indian haplotype. When the Arab-Indian haplotype is present along with the haemoglobin S variant, it reduces the expression of haemoglobin S and induces the haemoglobin F variant. This reduces the severity of the disease and people live longer.

Earlier studies have suggested that the haemoglobin D variant and the Arab-Indian haplotype originated in

the Indus valley region while haemoglobin S with high levels of haemoglobin F originated in and is distributed throughout India. Based on this, the scientists suggest that the Badagas might have migrated from the Indus valley site or the present northwestern region to settle in the Nilgiris.

DOI: 10.1007/s12041-021-01348-5

Efficient Solar Drying *With louvered fins*

The thermal efficiency of solar air heaters is not as good as that of solar water heaters because air has lower heat transfer and thermal capacity than water. The type of surface that absorbs heat significantly influences the absorption of solar radiation. Absorbing plates with higher surface area for heat transfer and heat flow can improve thermal efficiency.

Louvered fins, additional metals placed at the base of absorbing plates at desired angles, can act as extended secondary surfaces to enhance the heat transfer surface area. Louvered fins have superior thermal efficiency. So, they are used in automotive and heating applications and in air conditioners. Could we use the same principle to improve solar drying?

Researchers from NIT, Jharkhand and the Chhattisgarh Swami Vivekanand Technical University set out to find out.

They fabricated louvered fins on the absorber plate at varying distances to determine the optimum spacing. Comparing the performance of the models with that of conventional solar air heaters, they found that fins with 2-centimetre spacing had the best thermal performance.

The solar air heater showed a higher temperature rise than seen in other fin spacing or conventional solar air heaters – around sixty degrees Celsius.

'The closely placed fins increase the heat transfer area,' says Subhash Chand, NIT, Jharkhand.

The movement of air in contact with the absorbing plate influences thermal efficiency. So the researchers varied mass flow rates, monitoring them with an orifice meter connected to a digital manometer.

The outlet temperature was found to reduce at higher mass flow rate and this led to a decrease in thermal efficiency. But, even then, the researchers could achieve more than 100% improvement in thermal efficiency.

Upgrading conventional solar heaters to louvered finned solar heaters can help achieve faster drying of agricultural and marine produce, say the researchers.

However, a cost-benefit analysis has to be done to assess feasibility before adopting the design for the agricultural and fisheries sectors.

DOI: 10.1016/j.solener.2022.04.046

Green Fluorescent Proteins Modified to detect metal ions

Copper is a harmful contaminant which needs to be detected and removed during wastewater treatment. The red fluorescent protein has inherent metal-binding properties, but low biosensing efficiency. The green light-emitting fluorescent protein is used as a sensor to monitor various biological processes, but has no affinity towards metals.

Can we combine the properties of these proteins to improve metal detecting biosensors, wondered Sisila Valappil and her colleagues from the Central Leather Research Institute, Chennai.

E. coli bacteria are an easily cultured source of green fluorescent proteins. Incorporating non-natural amino acids into the proteins can shift the fluorescent emission wavelength.

So the team genetically introduced a synthetic amino acid, 3-aminotyrosine, into green fluorescent proteins in *E. coli*.

With the introduction of the amino acid, the emission spectra of the green fluorescent protein shifted to a longer wavelength range. It red-shifted.

This modified fluorescent protein had twice the adsorption capacity and a greater binding affinity towards copper ions. This, the researchers attribute to

the electron-donating nature of the amino group. The amino group also changes the fluorescent properties of proteins, favourable for easily detecting metal ions.

'Red-shifted green fluorescent proteins can be used as sensors and for removing copper ions from wastewater,' says N. Ayyadurai, Central Leather Research Institute, Chennai.

The water purifier industry can explore the scope of these fluorescent sensors to improve treatment processes.

DOI: 10.1002/jctb.7130

Information Retrieval Based on query expansion

Simple queries can retrieve large amounts of information from search engines. But since users are often not trained in information retrieval, the query terms used may be inadequate or inappropriate. To reduce the vocabulary mismatch, search engines today use a thesaurus to expand query terms. But, even then, a lot of relevant information available on the web is not retrieved and, often, we see irrelevant results.

Instead of using only the thesaurus, why not use the ever growing knowledge on the web to expand the queries, wondered a team of researchers from VIT, Vellore, NIT, Patna and BIT, Mesra.

Using search engines such as Google, Bing and DuckDuckGo, they mined for relevant terms to expand queries. The researchers assigned higher weightage to words that appear frequently in the query and lower scores were given to terms such as "is" and "was" that were not significant for the search. Using such frequency and inverse frequency scores, query terms could be expanded automatically.

Many terms can have similar meanings. The researchers used *k*-nearest

neighbour to find terms close to the query term and based on the cosine of the trajectory of meanings in vector space, they expanded the query terms. Using the new terms, they applied the technique iteratively to expand the number of terms further.

They derived their final query expansion terms using correlation scores. Computing term-to-term correlation for each expansion word, they compared it with the original query. Query terms with the highest score were used as candidates for query expansion.

The researchers tested their strategy for query expansion using a large number of actual user queries. They used the dataset from the Forum for Information Retrieval and Evaluation for testing. Their model had a mean average precision of 25%, more than other existing models.

'Our web knowledge-based query expansion solution can effectively address vocabulary mismatch problems,' says Hiteshwar Kumar Azad, VIT.

'We tested the technique on different search engines using pseudo-relevant documents.

Our technique provides more relevant expansion terms,' says Akshay Deepak, NIT, Patna.

This method can be applied to any search engine available on the web to access relevant documents and web pages quickly. The major advantage is that topic searches can now be done with a minimum number of words.

DOI: j.patrec.2022.04.013

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ACKNOWLEDGEMENT: NCPOR, Goa for access to scientific databases.

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