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Defence ministry nod to ease Tata Steel's Subarnarekha port acquisition

By Jayajit Dash

The project proposed at Subarnarekha needs 1,215.43 acres of land for the port area

The Defence ministry is on the verge of granting conditional approval for development of the Subarnarekha port off the coast of north Odisha. The nod is expected to overcome a major hurdle for Tata Steel that has announced to acquire a majority stake in the port project. The steel maker has signed a definitive agreement with Chennai-based Creative Port Development Ltd (CPDPL) to pick up 51 per cent equity in the port project from the original promoters.

“The Defence ministry, particularly the Defence Research Development Organization (DRDO) had been opposing many minor port projects along the coast of north Odisha. The identified port sites were close to their missile testing facility near Chandipur. For the Subarnarekha port, the Indian Air Force had certain objections as their practice limit zone fell under the port limits. But, after discussions with the defence ministry officials, the row is almost settled and we are awaiting a formal approval”, said an Odisha government officer.

Defence secretary Sanjay Mitra had negotiated with the Odisha chief secretary Aditya Padhi to settle the issue. Padhi is understood to have suggested a formula where the operations of the Air Force and the port project can go hand in hand. Later, Padhi followed it up with a meeting in New Delhi to clinch the deal in favour of Odisha's port sector development.

CPDPL, promoted by two technical entrepreneurs, Ramani Ramaswamy and Ramaswamy Rangarajan, had entered into a concession agreement with the Odisha government in January 2008 to develop the Subarnarekha port as an all-weather deep-draft facility.

The port project proposed at Subarnarekha needs 1,215.43 acres of land for the port area and 1,565.93 acres for the rail corridor. Out of 1,215.43 acres of land needed for the port area, 158 acres constitute Gochar land, 193 acres Bhudan land, 138 acres of encroached land and the remaining 724 acres being free land.

The original cost of developing the port project was pegged at Rs 2,345 crore but an assessment by the state government shows that the revised cost could go up to Rs 4000 crore.

For Tata Steel, the port is expected to address its strategic needs in the future. Besides, its strategic location makes the port attractive to structurally enhance the competitive position of Tata Steel's India operations, especially its greenfield Kalinganagar project in Odisha. The steel maker, however, has stated previously that the acquisition and development is subject to certain conditions precedent, detailed technical assessments and financial closure.



Rare Israeli dogs to protect PM, VVIPs

Home and Defence ministries told to jointly source such sniffers

Collar sensors to detect suspicious movement

- *The dogs from Israel will have a collar sensor and they will secure the area from any suspicious material or individual and relay data to a mobile control unit*

- *This will help in cases when a VVIP wants to visit a place at a short notice and the Blue Book cannot be followed*
- *Sources say negotiations are underway to upgrade all the 3,000-4,000 dogs engaged by the Central paramilitary and defence forces to match the capability level of SPG canines*

With the elite security force SPG already acquiring a set of rare breed of dogs from Israel that are specially trained in sniffing explosives and are also capable of taking down armed suspects, the Prime Minister's Office (PMO) has directed the Ministries of Home and Defence to work out a common proposal for sourcing such sniffers, upgrading the training facilities and other technology.

The move is seen as a result of the growing strategic ties between India and Israel, where New Delhi appears to be proactive in not only learning and upgrading its security skills, but also intends to procure gadgets and weaponry.

The newly acquired dogs will help improve the ability of SPG, which is specially raised to protect the PM, ex-PMs and their families. Talks are also on between the two countries for sensor-based sanitisation of venues being visited by the VVIPs, who get the SPG security cover.

Sources said negotiations are also underway to upgrade all the 3,000-4,000 dogs engaged by the Central paramilitary and defence forces under a 10-year technology upgrade programme to match the capability level of SPG canines. The PMO has asked the ministries of Home and Defence to formulate a common proposal citing requirements of the dogs, upgrade of training infrastructure and other technology, they added.

Israel has also helped in upgrading ITBP dog training centre to train 25 SPG dogs every four months. Thirty dogs have been inducted. The canines and technological gadgets for their upkeep and upgrade of the ITBP facility near Chandigarh has cost Rs 150 crore. Equipment has been procured to regularly test the saliva of canines to estimate their operational efficiency by analysing health parameters.



Sun, 13 Aug, 2017

India's tanks crash out of int'l contest

Snags Force T-90s Out Of 19-Nation Military Competition, China's In Final

The Indian Army has crashed out of a 19-nation military competition after its Russian-origin T-90S main-battle tanks broke down due to mechanical snags, even as the armoured fighting vehicles from Russia, China, Belarus and Kazakhstan raced ahead to the finals.

The Army swears by the T-90S "Bhishma" tanks, which are being licensed produced in India after the first 657 were imported for Rs 8,525 crore from Russia from 2001 onwards, though the DRDO accuses the force of cold-shouldering the indigenous Arjun tanks.

Sources said both the main and reserve T-90S tanks, shipped by India for the Tank Biathlon in the International Army Games at the Alabino ranges in Russia, developed "engine problems" after performing "exceedingly well" in the initial rounds of the competition.

"The fan belt snapped in the first tank. The reserve tank was then deployed for the race but its entire engine oil leaked just two kilometres before the end...it could not complete the race. It was sheer bad luck that led to the Indian team being disqualified," said an officer.

China, incidentally, has fielded its indigenous Type-96B tank in the competition, which includes firing on tanks on the move by machine guns and anti-tank projectiles at a two-km range while they negotiate rugged obstacles. Russia and Kazakhstan have deployed T-72B3 tanks, while Belarus has a modernised T-72 tank. The four are now competing for the top honours.

The T-90S tanks are the fulcrum of the Indian Army's "shock and awe" armoured battle plans. The force has 63 armoured regiments with around 800 T-90S, 124 Arjun and 2,400 older T-72 tanks as of now. After the first 657 T-90S tanks were imported, the Avadi heavy vehicles factory under the Ordnance Factory Board (OFB) is progressively "producing" 1,000 more tanks with Russian kits. In November last year, the defence ministry had approved the procurement of 464 T-90S tanks from the OFB for Rs 13,448 crore to add to the 536 ordered earlier.

The DRDO remains upset that the Army has not yet ordered upgraded Arjun MarkII tanks after inducting the first lot of 124 Mark-I variants, stressing the indigenous tanks did better than the T-90S tanks in comparative trials in 2010.

The Army, however, contends the 62-tonne Arjun, with its excessive weight and width, has poor operational mobility and flexibility. It has also launched a hunt for a "future-ready combat vehicle (FRCV)" to meet its requirements after 2027.



Sun, 13 Aug, 2017

India to add 7K MW nuclear power capacity

Mumbai: The Centre is looking at doubling the nuclear power generation capacity to about 14,000 MW, Union minister Piyush Goyal said today even as he ruled out its becoming the main source of energy for the country.

At present, India generates about 6,800 MW of nuclear energy.

"We have recently embarked on a plan to expand it by about 7,000 MW more and this will be through indigenously manufactured equipment. So, 10 units of 700 MW each we have proposed and we shall be investing in and we will start on that," the power and coal minister said at an event here.

The Union Cabinet in May had already approved the setting up of 10 indigenous Pressurised Heavy Water Reactors (PHWRs) for nuclear power generation.

"But, nuclear power will never ever become the main source of energy for India because it is very expensive. It has its own benefits. It is quite free of carbon, it does not pollute the environment and therefore, our government is encouraging it. We do need clean renewable sources of energy which is available 24 hours," Goyal said.

He said solar energy can only be generated during the day time and wind energy can be generated only during windy hours.

"Therefore, there is a need of a resource, which can be available 24 hours. Hydro is one such energy which we will promote and nuclear energy also we are promoting. But both these source are still quite expensive," he added.

Goyal further said: "We are dependent on foreign sources for Uranium. As you are aware, China is blocking our entry into the NSG (Nuclear Suppliers Group), so we have some challenges. But, we are confident we will make progress."

In a veiled reference to Donald Trump's rejection of the Paris climate change agreement, Goyal said India does not agree with the US President's views on the issue.

"There is an effort and an attempt by some senior leaders of very large countries to belittle the issue of climate change and try and say that it is not really a problem for the world. But, we in India don't believe so.

"For all of us Indians, we have always respected nature.

We have always believed that the environment is an integral part of human existence," he added.

Game theoretic solution to Doklam

The only mutually beneficial course of action in Doklam is for India and China to pull their troops back

By Vineet Gupta

It has been two months and both sides have refused to budge. The Chinese insist on a unilateral Indian troop withdrawal while the Indians want a mutual troop withdrawal. As the war clouds over Doklam refuse to recede, let us try and understand the standoff from the point of view of Game Theory.

Game theory is a branch of mathematics that analyses how decisions are made in conflict situations. The decision makers are the “players” in a “game”. Each player chooses from a set of strategies available to him. The choice of strategies by the players results in an outcome. Each outcome is associated with a payoff (expected utility) for the player. Players are assumed to be rational in that they would prefer a higher payoff to a lower one. And each player assumes that other players are rational in the same sense.

To construct a game theory model of the Doklam standoff, let us assume that the two players, China and India, have to choose between three strategies: Withdraw, stay or escalate. The “stay” strategy means to maintain current troop levels and the “escalate” strategy means to increase troop levels. There is a cost to each player if he chooses to Stay and a higher cost of mobilising troops if he chooses to escalate. Since escalation is only limited to increasing troop levels it does not automatically result in war.

Each player can then be reasonably assumed to have the following order of preferences for the outcomes:

Withdraw when the other stays (total defeat), withdraw when the other escalates (defeat), stay when the other escalates (partial defeat), both escalate, both stay, both withdraw, escalate when the other stays (partial victory), escalate when the other player withdraws (victory), and stay when the other withdraws (total victory).

We can assign payoffs 0,1, 2, 3, 4, 5, 6, 7, 8 for the above outcomes respectively, where the numerical values of the payoffs have no meaning except to represent the ranking of the preference.

We construct a payoff matrix whose rows represent the choices for India (row player) and the columns the choices for China (column player). The nine cells of the matrix then represent the nine possible outcomes. The payoffs are written in each cell as an ordered pair of numbers. The first number in the pair is the payoff for India and the second number is the payoff for China (Fig 1).

It is clear from the payoff matrix that a player is always better off choosing to stay rather than withdraw, irrespective of the other player’s choice, i.e. the strategy to stay dominates the strategy to withdraw. Hence we can remove the strategy to withdraw from both players’ choice of strategies.

This reduces the game to the following payoff matrix (Fig 2):

This is the classic game of prisoner’s dilemma. The dominant strategy in this game is to escalate. This leads to the only equilibrium in the game, which is (escalate, escalate). Note that the both India and China are better off if they end up at the (withdraw, withdraw) outcome, which is the Pareto Optimal outcome. The only way this outcome is possible if both sides decide to cooperate.

Will the (escalate, escalate) outcome lead to war? Consider the situation where the two players do not cooperate. This leads to the outcome where both sides have mobilised troops and are at a standoff. The standard game used to describe a conflict situation in which two players appear to be heading for a clash is the game of chicken.

In this game, two drivers race their cars towards each other. Each player has the choice of swerving or not swerving. The player who “chickens out” and swerves first gets a lower payoff than the player who holds his nerve and does not swerve. If neither player swerves then the cars collide and result in the lowest payoff for

both players. After escalation, Indian and Chinese soldiers standing eyeball to eyeball, waiting for the other to blink, can be modelled as a game of chicken. The choices of strategy are to stay or attack (Fig 3). The stay strategy means to stay in the escalated position of the last game. Each player has the following order of preferences for the four possible outcomes: Both players attack (War); one stays and the other attacks (Defeat); both stay; one attacks and the other stays (Victory).

We can assign payoffs of 0, 1, 2 and 3 respectively for the four outcomes. Again, the numerical values of the payoffs have no meaning except to represent the ranking of the preference. As in the last game we construct a payoff matrix whose cells represent the four outcomes.

So what is the likely outcome of the standoff according to this model? It can be easily verified that there is no dominant strategy in this game. Hence there is no dominant strategy equilibrium. Consider the situation from the viewpoint of any one particular player. If this player is convinced the other player is going to stay, then he is likely to attack rather than stay. So the (stay, stay) outcome is not a stable outcome.

Similarly, if the player is convinced that the other side going to attack, then he would prefer to stay rather than risk a war. So the (attack, attack) outcome is also unstable. Since both players want to do the opposite of what the other player is doing, the only stable outcomes are where one player withdraws and the other escalates. These two outcomes, which are underlined in the matrix, are the only equilibria in this game. These equilibria are called the Nash equilibria, after the mathematician John Nash.

In an actual game of chicken, if one player rips out his steering wheel in view of the other driver it visibly forecloses his choice to swerve. And hence the other player is forced to swerve. China is trying to convince India and the rest of the world that that they do not have the option to swerve. Their position is that India has transgressed on their national sovereignty and they will have no choice but to resort to an attack.

Many analysts, convinced by the Chinese rhetoric, assume that the Chinese will ultimately resort to an attack. Hence, India will be better off withdrawing immediately. India on the other hand has called for a mutual withdrawal. To achieve this it needs to convince China that it has ripped out its steering wheel and will not swerve. When both players are convinced that the other will attack, the game will collapse to the (stay, stay) outcome. This means that the conflict ends at the original prisoner's dilemma game.

Then the two countries must cooperate to reach the mutually beneficial outcome of mutual withdrawal instead of needlessly expending resources in a futile standoff.



Sun, 13 Aug, 2017

Three Warfares: China's ace weapon

By Indrani Bagchi

Beijing Knows Best about Mind Games

China could be playing out a 'Three Warfares' strategy against India to wear it down through use of media, psychological and legal "warfare" in the Doklam crisis, feel Indian strategists involved in the current situation near the Sikkim-Tibet Bhutan trijunction.

Indian observers feel that China has now fully operationalised the concept, where the threat of military force is evident but leveraged through a more complex strategy. The provenance of the concept is not fully established, but sources said that China's Central Military Commission (CMC) approved the guiding concepts in 2003 for "information operations" for the People's Liberation Army (PLA). China might be employing the "Three Warfares" (san zhong zhanfa) concept to wrest Doklam. The concept was reinforced in 2010. Aimed at influencing public opinion and using legal arguments that are all a part of psy-ops, Three Warfares has been a critical component of China's approach in the South China Sea and beyond. It is now being applied in the Indian context where China has sought to turn its unilateral violation of status quo at Doklam into victimhood.

China has been adept at producing maps and quoting historical precedents to build a legal argument and its media offensive has seen it regularly threaten Indian forces with eviction. The moves to establish territorial and regional suzerainty, however, have often been seen as revisionist orientation in Chinese power.

In 2016, the concept was at work after the UNCLOS tribunal ruled against China dismissing its claims in the South China Sea. Though Philippines achieved a major international victory against a more powerful neighbour, China, with its application of the Three Warfares, success fully co-opted its president, Rodrigo Duterte, after he assumed office in 2016. Beijing also successfully played on his animosity to former US President Obama. A year later, China has emerged victorious, nobody mentions the UNCLOS ruling, and Philippines has submitted to Beijing.

According to a government analysis, on Doklam, China has looked to influence domestic and international opinion, even if it means trampling on Bhutan's claims and ripping up the 2012 agreement on tri-junctions. China's stateowned media, foreign ministry, defence ministry and even foreign minister Wang Yi have let loose a barrage of statements to dissuade India from its actions at the site. With every Indian media outlet amplifying the Chinese message, the idea is to use Indians to pressure their own government and make them back off.

Closely related is the psychological warfare -calling the Indian foreign minister a "liar" to saying the "countdown (to war) had begun"; assertions that China would rescind its decision on Sikkim or "free" Sikkim from Indian oppression; or that it could interfere in J&K. All this is intended to "undermine India's ability to conduct combat operations through psychological means aimed at deterring, shocking and demoralising enemy military personnel." Suddenly, pictures of 1962 are being flashed through Chinese media. Some commentaries even claimed such was the anger among its citizens, that 1962 veterans are ready to send their children to fight India.

The Indian non-response has proved deflating for China. India's China experts have led the way and even the opposition has refused to react. That has shaped Indian public opinion somewhat.

In 2016, the three warfare operations exerted a strong "psychological frightening force" on everyone connected with the South China Sea issue -justifying China's rejection of it as a defence of "international justice". So China the rule-breaker suddenly became China the rule defender.

THE ASIAN AGE

Sun, 13 Aug, 2017

Japan deploys missile defence over N. Korea threat to Guam

Tokyo, Aug. 12: Japan deployed its Patriot missile defence system on Saturday after North Korea threatened to fire ballistic missiles over the country towards the US Pacific territory of Guam, local officials and reports said.

Regional tensions are mounting as Washington and Pyongyang ratchet up their war of words, with President Donald Trump warning Pyongyang would "truly regret" any hostile

action against the US.

Japan has in the past vowed to shoot down North's missiles or rockets that may hit its territory.

The defence ministry deployed the Patriot Advanced Capability-3 (PAC-3) system in Shimane, Hiroshima and Kochi in western Japan, which North Korea had warned could be along its missiles' flight path, public broadcaster NHK and Kyodo News said.

It also deployed the anti-missile system in neighbouring Ehime, while the Asahi Shimbun said one maritime Self-Defence Force Aegis destroyer was stationed in the Sea of Japan (East Sea) to shoot down airborne missiles.

Television footage showed military vehicles carrying launchers and other equipment for the surface-to-air system entering a Japanese base in Kochi before dawn. — AFP

Kim could test-fire a sub missile

NORTH Korea could be preparing to carry out a submarine missile test in defiance of President Trump's attempts to bring the rogue nation to heel.

Satellite images taken on Monday show activity at a test site which mirrors preparations ahead of the country's last test of their Pukguksong-1 submarine-launched ballistic missile in August last year.

The images were released after President Trump said American weapons are "locked and loaded" in case Kim Jong-un makes any more "overt threats" toward the US.

Joseph Bermudez, a specialist in North Korean defence and intelligence affairs, posted photographs on the authoritative 38 North blog of the US-Korea Institute at Johns Hopkins University.

"Recent commercial satellite

imagery reveals several developments suggesting that North may be accelerating development of the sea-based leg of its nuclear forces," he said.

Activity on a SINPO-class experimental ballistic missile submarine at the Mayang-do navy shipyard and submarine base, he said, suggests

Satellite images point at preparation at a test site

"that the North may be preparing for a new series of at sea test launches, has undertaken modifications or upgrades to the submarine's launch systems, or is developing a more advanced version of Pukguksong-1".

The Pukguksong-1 is an SLBM that was first successfully test-launched on August 24, 2016. That missile flew

500 km towards Japan, which leader Kim Jong-Un said at the time put the US mainland within striking range from a Pacific-based submarine. Bermudez said the preparations at the submarine in recent weeks match those ahead of previous tests.

Trump has not made it clear exactly what would constitute an "overt threat" to the US, or whether a fresh missile test would be grounds for military intervention.

Amid the heightened tensions, other countries in the region began preparing for the possibility of war as Japan deployed missile defenses on Saturday. Patriot missile defenses were pictured being set up in Kochi prefecture after the North threatened to fire its newly developed Hwasong-12 and 14 missiles over the country in order to strike at the US military base in Guam. *Daily Mail*

Business Standard

ISRO lines up 21 rockets, to launch 70 satellites in 5 years

By Alnoor Peermohamed

India is emerging as a hub for development of satellites as well as a launchpad for small satellites

India's space agency 'Indian Space Research Organisation' (ISRO) has lined up over 21 rocket launches, including the second test flight of its heaviest rocket the Geosynchronous satellite launch vehicle (GSLV) MK-III, which will be carried out over a period of the next three-four years.

The outlay is part of the Rs 8,658.74 crore sanctioned by the government for Isro to build and launch about 31 rockets, including 15 PSLVs, 13 GSLV's and three GSLV MK-III. So far the space agency has successfully built and launched 10 vehicles under the agreement.

"Isro's launch vehicles are being used for launching national satellites towards meeting the earth observation, communication, navigation and scientific needs of the country. The excess capacity has been used to launch satellites of other countries," said Jitendra Singh, Minister of State at the Prime Minister's office early this week. The Space Commission, which runs Isro, is under the direct oversight of the Prime Minister. The plan to launch the next 21 rockets comes at a time when India is looking at putting over 70 satellites in space over the next five years.

Isro has also said that 2017 will be the last year India will utilise foreign launch vehicles to hurl its satellites into space, suggesting that its in-house capabilities have been tested and proven enough to carry out such missions. India currently uses the Ariane 5 rocket, of Arianespace, the European Space Agency to launch its heavier communication satellites into space.

With GSLV-MK-III, the heavier rocket that can hurl four-tonne communication satellites into space, it can have the capability locally.

Jitendra Singh reiterated that Isro is making efforts to increase industry participation in building these launch vehicles as the need to step up its launch capabilities goes up, adding that no help from any foreign country is being sought in augmenting its capacity.

Isro has already engaged in forming a consortium with industry partners by 2020 to build and launch the Pslv, its workhorse rocket.

This would also allow it to focus on building capabilities in heavier rockets that are powered by a semi-cryogenic engine and the reusable launch vehicle that has potential to hurl cargo into space at low costs. At the same time, it has already begun outsourcing the manufacturing of its navigation satellite - Navic to a private consortium and looks to build capability in a satellite in the industry.

India is emerging as a hub for development of satellites as well as a launch pad for small satellites globally.



Sun, 13 Aug, 2017

IIT Guwahati develops silk patch to repair damaged heart tissue

By R. Prasad

The 3D patch has high cell density, a foremost requirement for heart tissue

Scientists at the Indian Institute of Technology (IIT) Guwahati have fabricated a 3D cardiac tissue patch using silk protein membranes seeded with heart muscle cells. The patch can potentially be used for regenerating damaged heart tissue.

“The 3D patch that we fabricated can be implanted at the site of damage to help the heart regain normal function. It can also be used for sealing holes in the heart,” says Biman Mandal from the Department of Biosciences and Bioengineering, IIT Guwahati, who led the research.

Cardiac tissue gets permanently damaged when oxygen supply is reduced or cut off during a heart attack. The damaged portion gets scarred and does not contract and relax, which over time leads to a change in the shape of the heart and reduced pumping capacity.

While currently available grafts fail to mimic the structure and the function of the native heart tissue as well as maintain high cell numbers, the patch developed by the IIT Guwahati researchers scores over these on many counts. The results were published in the *Journal of Materials Chemistry B*.

The team led by Prof. Mandal tested both mulberry (*Bombyx mori*) and non-mulberry (*Antheraea assama*) silk to fabricate the membrane. Silk proteins extracted from raw silk were used for fabricating the membrane by using a mould. The nano-groove structure on the mould was transferred to the silk membrane and this helped guide the heart muscle to grow in a linear fashion and parallel to each other thus mimicking the heart tissue structure. “We focused on developing a silk-based tissue engineered membrane which will allow the cardiac cells to grow while maintaining the structural anisotropy,” says Prof. Mandal.

Seeding the silk

Heart cell lines and cells taken from the heart tissue were used for seeding the silk membrane. The presence of certain cell-binding protein sequences (RGD motifs) and greater surface roughness of the non-mulberry silk, which is endemic to north-east India (locally called muga silk), facilitated better anchorage and cell binding. “The cells grew and proliferated, filling the membrane 7-10 days after it was seeded,” he says.

As heart tissue continuously contracts and relaxes, the engineered tissue should have good elasticity. “The muga silk exhibited good elasticity and mechanical strength comparable to native heart tissue as we used only 2% silk proteins to make the membrane,” says Shreya Mehrotra, Department of Biosciences and Bioengineering and first author of the paper. “When tested on mice, we found the muga silk was immunologically compatible and hence not rejected by the immune system,” she adds.

Making a 3D patch

The single membranes with proliferating cells were then stacked one over the other to form a 3D patch. “In 5-6 days, the cells present on top of the membrane bound to the membrane above it leading to the layers sticking to each other,” Prof. Mandal says.

“Stacking the membranes to form a 3D patch overcomes the drawbacks of current scaffolds used for cardiac tissue engineering in terms of creating a high cell dense anisotropic patch, a foremost requirement for this tissue,” he stresses.

The silk in the patch supports the cells till the newly formed cardiac tissue integrates with the native heart tissue and degrades once the integration takes place. “This method is better than the conventional direct delivery of cardiac cells to repair the damaged portion of the heart as the cells get washed out from the injected site,” says Ms. Mehrotra.

The team will carry out animal studies in collaboration with AIIMS.



Sun, 13 Aug, 2017

Himalayas losing rare fossils to souvenir hunters

By Sharath S. Srivatsa

Coral reefs from Triassic period are among items on sale

Fossils dating back a couple of hundred million years, in remote villages of Lahaul and Spiti valley of Himachal Pradesh, are being mined and sold as cheap tourist souvenirs, destroying key links in the ancient geological history of the Indian subcontinent.

These fossils can be bought for as low as Rs. 50 from local shops and eateries where they are displayed. Of several shapes and sizes, the common fossils on sale are coral reef of the Triassic period, between 250 million and 199 million years old, and ammonoids of Triassic-Jurassic period, between 199 million and 145 million years ago.

The geological remnants, described as part of a marine sequence, can be found in the hills near Lalung, Mud, Komic, Hikkim and Langza villages in the Lahaul and Spiti district in Spiti valley about 200 km from Shimla.

What is more, two of the three places where giant scorpion trace fossils along with trilobite traces were found in Parahio valley have been destroyed during construction of a road to Pin valley. The giant scorpion traces are unique and found only in Antarctica, Australia and Spiti Valley.

During construction of a canal, Middle Norian Coral reef in Ratangnala, a tributary of Spiti river was mined to provide building materials. The excavated earth has covered what is left of the reef.

Another geologically significant feature belonging to the era when continents first stabilised, a Paleoproterozoic paleosol in the Sutlej valley, was exposed during the construction of Hindustan-Tibet Road in Himachal Pradesh. Walls have been constructed on either side and nothing can be observed now.

Rising tourism has contributed to the erosion in Spiti valley, which paleontologists say is the “museum of Indian Geology”. Many tourists are aware of the availability of fossils here and offer to buy them in large numbers, spurring locals, including children, to identify and pick fossils at various sites. The fossils have hit the internet, with the Spiti valley souvenirs featuring on travel sites and blogs, and some tour operators offering to take customers directly to the sites to acquire fossils between May and October.

“Fossils have been in high demand, especially in the last two years as the number of tourists has increased. Everyone coming to Kaza is aware of fossils on sale. We try to create awareness, but often fail,” says Tanya Roy, who runs Wanderer’s Nest, a homestay at Kaza. She is the founder of Earthroute, which works to protect indigenous culture and promotes sustainability.