The tragedy of being a geologist

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The geologists, who toil hard for finding minerals for scientific research and industrial development, sources of water for multifarious needs, make sustained efforts to make India self-sufficient in energy and help select appropriate sites for dams, power plants, alignments of roads and tunnels, suggesting ways of overcoming problems of stability and natural hazards, go ‘unwept, un-honoured and unsung’. Even the mainstream scientists have poor opinion of geologists as scientists and geology as a science. In the matters related to the wellness of the earth, the use of its bounties and assets, and the preservation of its environmental health, their opinions are not sought and their voices not heard by the powerful science councils, commissions and academies, and by the powers-that-be.

The domineering presence for decades of the sets of same persons with blinkers and biases in committees for awarding and rewarding individual endeavours is responsible for elbowing out or marginalization of those foot soldiers who work in the field for months on end – away from homes in harsh and often perilous terrains. Is it true that just because they have not spent or do not spend long hours in laboratories and tapped the internet data make them unworthy or recognition?

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TODAY the geologists of India are like what Balaram calls ‘largely unsung toilers’, likening them to what Rick O’Donnel describes as the Sherpas among ‘the faculty who do much teaching on a gruelling time-table and maintain interaction with students’ – the ones ‘who have helped to build the reputation of many climbers, famed for their conquests in the Himalayas’.

Is it not ironic that those who work on finding medicines for ailments, materials for electronic communication, transportation and information technology, and ways to live a life of luxury and comfort – are regarded star performers in science, whereas those who toil for finding minerals for scientific research and industrial development, sources of energy and water for our daily needs – go unwept, unhonoured and unsung?

I have many reasons to think that geologists are not just Sherpas, but are regarded as much less. When I reminisce the crucial happenings and the decisions taken by the powers-that-be in the governance of the country, in the scientific organizations of the government and the science academies, and recall the sometimes sarcastic remarks by a large number of mainstream scientists and engineers during my long innings as a fieldworker, I feel that most mainstream scientists have a poor opinion of geologists as scientists and of geology as a science.

Overlooking and belittling contributions

It is the geologists who find the hidden assets of the earth – minerals, oil and gas and groundwater. If our geologists were so unworthy as commonly assumed, then India would not have developed to the extent it has; and would not be boasting of having the world’s largest iron-ore deposits, of self-sufficiency in 35 minerals, including manganese, silica, selenium, ilmenite, zircon, coal, bauxite, chromite, mica, barytes, phosphates and graphite, and of being able to meet one-fourth of India’s need of petroleum oil and gas.

The geologists of the Geological Survey of India (GSI) have identified >300 geothermal fields waiting to be tapped for energy, discovered (among many minerals) coal deposits amounting to 213 billion tonnes in the Gondwana basins and about 254 billion tonnes in the Tertiary basins (down to the depth of 1500 m), and detected 820 billion cu.m of clean fuel gas (coal-bed methane) in just 16 places in central India.

Adopting an innovative approach and through sustained work over five decades, the earth scientists (specializing in structural geology, sedimentology, palaeontology, palynology, geochemistry and exploration geophysics) of the Oil and Natural Gas Corporation (ONGC) have succeeded in finding productive oil and gas fields, even in regions that were prior to 1947 dismissed as barren, as destitute of even conditions suitable for the formation and accumulation of petroleum hydrocarbons. There were more than 339 discoveries by the end of 2007 – 122 in the offshore and 217 in the onshore areas.
respectively – promising to provide 650 billion metric tonnes of oil and gas\textsuperscript{6}.

The hydrocarbon deposits of the Offshore Krishna–Godavari Basin (Andhra Pradesh) have provided India’s largest gas deposit (Figure 1). Here a single horizon, the Pulakollu–Pasarlapudi, has the potential of 3400 million metric tonnes of oil and gas, of which the established reserve is about 24 million metric tonnes\textsuperscript{7}. The Jaisalmer

Figure 1. Sediments in which petroleum oil and gas were formed and have accumulated to provide promising deposits in the Offshore Krishna–Godavari Basin.
Desert sand-covered Tertiary formations in the Jaisalmer Basin in NW Rajasthan which are reservoirs of oil and gas deposits.

Taking the case of minerals as a source of nuclear energy, geologists of the Atomic Minerals Directorate (AMD) have recently discovered (in addition to many findings in the past) one reserve that is ranked among the world’s top 20 reserves of medium-grade uranium – about 150,000 tonnes along 160 km in the Tummalapalle belt (Figure 5), about 4400 tonnes in a 5 km stretch in the Cuddapah Basin in Andhra Pradesh. Another find of higher-grade uranium ore was made at Domiasiat and Phlangdiloin in Meghalaya. Now, 4250 tonnes of ore containing uranium as high as 0.1% has been discovered at Gogi in Yadgir District, Karnataka.

There are several instances of the sustained efforts by geologists to make India self-sufficient in energy. Just because they do not spend long hours in laboratories does not make them unworthy of recognition. It may be emphasized that geologists work for months on end, away from the comforts of homes and laboratories, in harsh or even perilous terrains and under adverse climatic conditions with little or no items of daily need. But their finds are treated in the same vein as if unskilled labourers picked up valuables, which were already there. Little do
Figure 3. Locations of oil fields in front of the Patkai–Naga–Arakan mountain range in the Assam Basin. Oil has been found in the foothill belt of Arunachal Pradesh also.

Figure 4. a, The main petroleum fields in the Sabarmati–Cambay Basin. b, Oil and gas fields in the Offshore Bombay Basin.
the mainstream scientists know that many of (even) the short notes in earth science journals, including *Current Science*, have eventually led to major discoveries of minerals, oil and gas.

In the context of drying-up mountain springs, dwindling stream discharges and poisoned rivers, we are constrained to look for underground reserves of water. The geohydrologists of the Central and State Ground Water Boards have established that in a part of the Indogangetic Basin alone, there are large reserves of water – 52.52 million ha-m in the Ganga sub-basin, 53.73 million ha-m in the Brahmaputra sector and 5.98 million ha-m in the Barak sub-basin. In the basins of each of the major rivers of India, water is stored safely in aquifers. Furthermore, the myriad shear zones and fault zones in the rocky terrains of plateaus, hills and mountains have been
found to contain reserves of water, requiring periodic if not continual recharge. Even in the heart of the Thar Desert in NW Rajasthan, geologists have discovered multiple buried channels filled with sweet water. Despite continuous withdrawal through tube wells for intensive irrigation, there was no sign of decline (until about 1996) in the discharge of water coming from these buried channels. The replenishable groundwater reserves in the country used to be 45.3 million ha-m until about a decade ago.

Forgotten: role in taming rivers and building roads

Dams are constructed across rivers with the aim of storing water for irrigation and electricity generation. The construction of dams also involves making tunnels across mountain ranges. It used to be mandatory for dam builders to seek the advice and active involvement of engineering geologists, both at the feasibility-stage investigation (ranging from months to years) and the construction-stage investigation (5–10 years). The engineering geologists of Geological Survey of India (GSI) monitored the changes investigation (5–10 years). The engineering geologists of Geological Survey of India (GSI) monitored the changes in ground behaviour and its response to loads, structures, and tampering of the hillsides. This is why there were hardly any cases of dam failure or tunnel collapse in the last 60 years.

The wave of globalization – which is euphemistically called liberalization – swept away all mandatory requirements. Many of the Himalayan rivers have been literally sold to private players. In earthquake-prone Uttarakhand, for example, hundreds of big and medium-size dams have been proposed or are being built by private players in rivers riven with active faults and shear zones (with extremely weakened rocks). The experts from whom private players are required to obtain no objection certificates certainly cannot be on site to study the day-to-day work, which is what the GSI geologists used to do and continue to do in the projects they are involved with. In the case of government undertakings, their own geologists do the needful, but they have to work under the constraints of the wishes of their engineer bosses. I wonder what would happen to the dams built in this manner when the tremors rock the ground or when the mountain slopes collapse.

Furthermore, road builders – including the Border Road Organization of the Government of India – do not seek the opinions of engineering geologists when laying roads and controlling landslides. Nor do they place on public domain the plans, layout and alignment of the projects undertaken. These roads criss-cross fault lines and shear zones, and quite often cut through the cone-shaped or fan-shaped masses of debris of old landslides and rock falls. The excavations for roads and the rumbling of heavy vehicles render these debris cones and fans very unstable, resulting in recurrent road failures with landslides – an endemic phenomenon in the Himalaya and the Western Ghats.

In the management of floods, geologists who know the difference between the river channel and the floodway (the natural passage of the river) and the nature and location of erosion are ignored.

Giving space to earth scientists

It is my humble submission that geologists should find space for consultation in matters related to the wellness of the earth, use of its bounties and assets, and preservation of its environmental integrity. In the Science Advisory Council to the Prime Minister – the nation’s most powerful body of scientists, which envisions and plans all aspects of scientific and technological development – there is no representation of earth scientists. The Council would be able to do much more, and effectively, if it were to have a member who could advise on matters such as: (i) the exploration, evaluation, mining and export-import of one-crop, non-renewable and fast-depleting minerals – even such strategic ones as petroleum, natural gas, coal, uranium, iron, aluminium, selenium, ilmenite, quartz and graphite; (ii) the tapping of hydrothermal energy; (iii) the search and appraisal of groundwater reserves, and (iv) the advisability of building high dams, networks of roads, bridges and energy complexes in seismotectonically active and ecologically sensitive belts or areas.

The Commission that guides, supervises and monitors the functioning of the Ministry of Earth Sciences (MoES) would be in a far better position to tackle problems related to natural hazards and environmental distress if it were to induct members: (i) having expertise on the dynamics and mechanisms of various earth processes, (ii) who are well-equipped to read and interpret signs of travails, tumults and trauma of the earth, and evaluate the hazard potential of geodynamic hotspots, (iii) who know about, and strive for unearthing the treasures (including water) hidden underground, (iv) who have knowledge of the capability of the land – to support various land uses and to bear the loads of engineering structures built for development, and (v) who have expertise on the natural (not man-made) pollution of groundwater, which causes debilitating diseases.

Magnificent irony

The irony is that this Commission of the MoES has not found it expedient even to seek opinions from such learned bodies as Geological Society of India, Indian Geophysical Union, Association of Petroleum Geologists, Society of Geoscientists and Technologists and Palaeontological Society of India. Seeking collective expert views of a large number of geologists and geophysists in-
volved in research and exploration, is particularly needed before embarking on such ambitious and excessively costly ventures as deep drilling in the stable continental region (e.g. Koyan valley in the Deccan Plateau) and in the mobile oceanic floor (e.g. Laxmi Basin), to know the composition of the rock, structure and state of stress in the crust. A large investment is needed to build a strong network to monitor earthquake occurrences in the geodynamic hotspots in the Himalaya, recurrently ravaged by natural hazards.

Geological Survey of India, the premier earth sciences organization of the country, is sternly guided by an officer of the Indian Administrative Service (IAS) in the Ministry of Mines: For many years, it was headed by non-geologists – once even by a specialist in instrumentation! The bureaucratic philosophy that is followed has nearly crippled this organization. The earthquake division (now placed under the MoES) de facto continues to be a subsidiary/subordinate unit of the India Meteorological Department. The head of the meteorologists has the say in the collection of seismic data. I strongly believe that it is time to establish and strengthen an independent National Institute of Seismology headed by an eminent and active earthquake specialist.

Another national institute established ‘to undertake, aid, promote, guide, and coordinate research in the geology of the Himalayas’ and ‘to carry out research towards the development of new concepts and models, concerning earth structures and processes operating in the Himalayas’ (DST letter No. 2(2)8/-ST, dated 19 November 1985) has been functioning for the last five years under the strict control (chairmanship) of the Secretary to Government of India, at present a pre-eminent inorganic chemist specializing in leather technology; and the Director is a marine palaeontologist specializing in summer monsoon!

The Chairman of an Institute of Himalayan environment and development has been, since its inception, an IAS officer. The Governing Body of this institute never thought of or felt the need for inducing environmental geologists in its scientific staff, who could take up problems of geodynamic processes such as the instability of mountain slopes and erosion of the productive soil that supports forests, horticulture and agriculture, the tampering of the ground for road construction and reckless exploitation of minerals.

It is more than obvious that mainstream environmentalists too (largely botanists) do not want to involve geologists. I wonder how mainstream scientists would react if the Central Government were to make IAS officers as chiefs (director-generals/secretaries) of the Council of Scientific and Industrial Research, Indian Council of Medical Research, Indian Council of Agricultural Research and Department of Biotechnology, and allow them to be part of the overarching framework of the rigid Indian bureaucracy.

**Tyranny of small decisions**

We all talk – eloquently and quite often vociferously – of bringing young blood into our systems. If one looks at the compositions of the powerful earth sciences committees constituted by various government scientific organizations – for evaluating project proposals, selecting talents for awards (such as the Shanti Swarup Bhatnagar Prize for Science and Technology, and the National Geoscience Award), and of the three National Science Academies for electing their fellows – the hypocrisy becomes patent. In the relevant committees for earth and planetary sciences, there are persons or their chosen few who have been members or chairpersons for over two to three decades! If the decision makers in the committees do not find their favourite names in the short list, they reject all others as worthless. This has happened even at the topmost level, even after lower-level committees recommended names of deserving nominees. The domineering presence of the same set of persons, with blinkers, in all committees year after year carries clear implication that the-powers-that-be think that there are no worthy earth scientists left among the younger generation, who are competent enough to hand down best judgement. In such a scenario, all those who have experience, expertise, dedication, and daring for reaching new horizons have been elbowed out or marginalized.

**Lack of a National Mineral Policy**

Before globalization, active autonomous government undertakings such as the National Mineral Development Corporation, National Coal Development Corporation and Indian Copper Corporation Ltd played an important role in providing resources. Even though slow in their work, they strictly adhered to the national – and quite rational – mineral policy and followed all the rules of scientifically appropriate mining and protecting the environment. In order to prolong the lives of reserves they blended, if necessary, sub-grade ores with high-grade ones; to preserve the protective cover of soils they avoided dumping sub-grade ores with tailings and wastes on forested slopes, agricultural fields or streambeds.

Now the whole nation knows what is happening after these undertakings were virtually closed down or are wholly marginalized. There is unchecked plunder of the earth’s precious finite resources, shameless loot of the nation’s wealth, and denial of benefits for the people displaced and adversely affected by mining. For every tonne of iron produced, nearly 5.5 tonnes of ore has to be excavated – 4.5 tonnes being unrequired material (tailings)\(^1\). Imagine the cost of transportation of these ores (largely tailings and wastes) over long distances through roads and rail-lines, requiring consumption of huge quantities of diesel. Also think of the pressure on roads. Why not
produce the metal at or close to the mines and sell or export the finished material? Think of the large number of people, often tribals, getting jobs and their means of subsistence if this were done.

In the matter of giving leases to private players, the powers-that-be do not feel the need to seek the views of those geologists who toiled hard to search, survey, discover, explore, assess the extent, quality and potential of the earth’s assets. When ONGC has been doing excellent work for decades in the Sabarmati–Cambay and Offshore Bombay basins, and has the requisite capability and competence of mining oil and gas in more than two dozen countries all over the world, one fails to understand the logic of handing over producing fields (such as Panna–Mukta and Tapti in Rajasthan, and the Offshore Krishna–Godavari Basin) on the platter to private players and multinational corporate companies without single-penny compensation to ONGC (which discovered them at an enormous cost), on the pretext of inviting foreign players with money.

This is quite contrary to the worldwide trend of increasing resource nationalization of strategic minerals like petroleum. Even smaller countries in Africa are setting strict terms to outsiders, and are promoting larger and more active roles for national companies. Here in India, we are not only doling out precious assets to outsiders, but also providing (to private players) all the classified information that earth scientists have gathered through their painstaking work for over four decades, without even seeking their viewpoints. The private players quite often hire, on fabulous terms of contracts, experts from government organizations who have retired or are persuaded to take premature retirement. Those who know too much reveal to the private players all the data that our government keeps under wraps to Indian academics and researchers – this discrimination is in the face of the so-called liberalization and open-door policy!

The influx of a large number of private players without a regulatory authority to oversee their methods would inevitably prove disastrous to the integrity of the natural environment. A mineral deposit may be large, or even very large, but it is not – and cannot be – inexhaustible. Moreover, we would need all our mineral assets during times of emergency when no other country would come to our help. The nation seems to follow an economic system that believes that it is cheaper to destroy or deplete the assets of the earth than to preserve them, regenerate them. This generation must think of the needs and the survival of the generations that would follow. The nation must see that what nature has given us must not be overused, misused or sold out to foreign buyers, however acute the need may be. What will the nation do with a booming economy and a large foreign exchange reserve when the face of the country is ravaged and defiled?

There is an imperative and urgent need to have a Mineral Regulatory Authority with overarching powers to:

(i) regulate, or control the exploitation of minerals – ensuring scientific methods of mining, proper utilization of low-grade ores, beneficiation of ores, minimal waste, and no harm to the environment; (ii) control and monitor export of resources, and (iii) promote or facilitate formulation and periodic review of the National Mineral Policy involving even non-government earth science organizations, societies and associations to elicit the collective views of earth science experts.

Constraints in publications

Geologists are made the target of criticism primarily for not coming up with papers in high-impact journals, and not taking up subjects of research that excite physicists and chemists. I wonder if the critics know that it takes at least two to three years to carry out intensive field work in addition to laboratory studies to write just one paper. Making measurements, collecting data (even from underground) and then mapping precisely, often in harsh terrains under unfavourable climatic and social conditions, takes time. Writing a paper is not as simple as generating data through push-button gadgets and drawing conclusions about phenomena that happened millions of years ago in the unfathomable deep interior or as easy as downloading a mass of data from the internet and making attractive models that are appealing to foreign peers.

There is another problem. Academic researchers do not have easy access to the Survey of India topographic maps, as large parts of the country have been put in the ‘restricted’ category; this restriction is under the pretext of security! On the other hand, the Google images and topographical maps purchasable in US, UK and Russia have better resolution, are easily available on the internet and can also be bought abroad. Why cannot high-resolution maps be made available to Indian researchers? If someone somehow gets hold of maps of the requisite scale, he cannot reproduce them in his papers as he would be inviting the wrath of the law of the land (jail). All he can do, and does, is to reproduce a tracing – shorn of all the details of landforms that are so crucial to prove his points. Besides, satellite images of the requisite scale are too costly for ordinary workers. It is no wonder, then, that it is very difficult to publish in international journals.

Geologists in government organizations such as GSI, ONGC, AMD, Mineral Exploration Corporation Ltd, National Mineral Development Corporation Ltd, and Central Ground Water Board are required to get written permission from the top to publish their papers, of course shorn of classified information. It takes two to ten years to get this mandatory permission! The result is that the hard work and findings of the humble foot soldiers in earth sciences remains buried in the archives! It is no wonder that geologists go down – unhonoured and unsung.
Summing up

There cannot be greater injury to a man than to disparage the heritage of his experience and rob him of the credit that he deserves. After 50 years of hard work as a geologist I will go to my funeral pyre with the feeling: that those of us who sincerely seek, search, strive and struggle have no place in the scheme of things in India today; that no heart bleeds for the plight of Mother Earth; that connections do. Our first Prime Minister, Jawaharlal Nehru, had the great vision of making India’s top geologist, D. N. Wadia his Geological Advisor (and National Professor) and bestowed on him the same respect and authority as he gave Homi J. Bhabha, Vikram A. Sarabhai and S. S. Bhatnagar. It was at the initiative of D. N. Wadia that ONGC, AMD, NGRI and NIO came into existence. Time has changed drastically since those golden days.

In the end I will quote what one of the greatest leaders of India Sardar Vallabhbhai Patel said in a different context: ‘It will be a folly to ignore realities. Facts take their revenge if they are not faced squarely and well.’

18. Uranium minerals of high grade at Gogi in Yadgiri district in Karnataka, Deccan Herald, 15 July 2011.

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