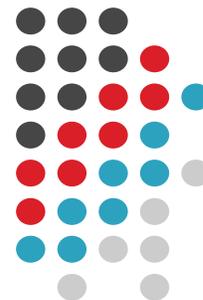




# ISEG NEWS

Bridging Communication Gap.....Dissipating Information



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## MESSAGE FROM SECRETARY

Dear Colleagues,  
I am pleased to announce that Journal of Engineering Geology which was launched in the year 1966 soon after the inception of the society in 1965 has completed 50 years. The President released Volume XL No. 2 of the journal which has served the engineering geology

in India for a very long time. In fact this is the only journal published in engineering geology from our country and has carved out a niche for itself. Now, it is proposed to organize a two day conference in October 2017 to mark the launch of electronic version of the journal. The first circular shall be issued in January.

The issue regarding permanent office of the society has been under discussion for quite some time. The same had been elaborately debated in the 2<sup>nd</sup> and 3<sup>rd</sup> council meetings. It has been decided to open bank account for this purpose at Faridabad or in NCR and locate premises.

.....Continued on Page 2



## EDITORIAL

Dear Members,  
"Oh! You did that? That's awesome" said by Anyone.

Appreciation is the best form of motivation. The Executive Council, especially the editorial team is deeply indebted to our members and well-wishers for recognizing our efforts in order to take things forward. Still many mile to go... we had promised to deliver and we will.

This year as Journal of Engineering Geology completes it's fifty glorious years, the ISEG is planning to celebrate its Golden Jubilee. This shall be our humble effort to commen-

date all past editors, authors, and distinguished reviewers who had contributed immensely for taking journal to greater height.

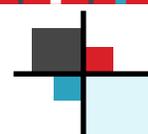
During the last Executive Council Meeting, President, ISEG had formly released the latest issue of Journal of Engineering Geology (Vol XL, No 2). This volume contains remaining papers of EGNM-2015. Hoping that this issue shall suffice the long standing demand of several authors and delegates of the above conference. Efforts are being made to bring out the journal in electronic form and I assure our members that this system

shall be very comprehensive but handy. It shall eliminate the regular complaints by some members of not receiving the hard copies by post. Meanwhile, in order to make our society more vibrant and communicative, we had also created ISEG groups on *Facebook* and *LinkedIn*. I hope the members shall enthusiastically join the above groups to connect with Council Members and other Life Members of the society. With your active participation and contribution we can develop them as a platform for sharing knowledge and

.....Continued on Page 2



**1966-2016**  
**JOURNAL OF ENGINEERING GEOLOGY**



## BIANNUAL HIGHLIGHTS

May 2016 to October 2016

The 2nd Executive Council Meeting of the ISEG was held on 2nd July, 2016 at the Expediting Office of SJVN Ltd., IRCON Building, Saket, New Delhi Under the Chairmanship of Shri R.N. Misra, President, ISEG and CMD, SJVN Ltd. The meeting was attended by members of ISEG Executive Council as well as council members of ISEG Delhi-NCR Chapter. Shri Imran Sayeed, Secretary welcomed the Executive Council members and conducted the proceedings. Several important issues including : proposed certification course for practicing Civil/Mining Engineers & Geologists, Geotechnical Orientation Program, list of pool of experts for taking up consultancy services on behalf of the society, publishing of ISEG Newsletter and Journal of Engineering Geology, permanent office building of ISEG and maintaining ISEG & JoEG websites were discussed. Several important decisions were taken w.r.t. above issues. Sh. Arindom Chakraborty, Joint Secretary, formally proposed the vote of thanks and expressed gratitude to all Council members for sparing their valuable time and participating in the meeting.

### MESSAGE FROM SECRETARY

(Continued From Page 1)

The task before all the senior members, council members as well as life members of the society is to mobilize collection of donations for this purpose. ***I hereby issue the first appeal to come forward and donate generously for the society.*** We will construct a prestigious and dear structure brick by brick. In fact the younger members of the council located a premises in Faridabad close to Delhi border at a very modest price. I also visited the area and was pleased to see the development. I know this, however, remains a cherished dream for many of us but let me tell you that a beginning has been made.

Our aim in the society has been primarily to develop engineering geology and geotechnics with related studies in environmental geology, soil and rock mechanics, water resources, mining and exploration geology. Accordingly the society encourages holding of lecture series, seminars and conferences to share experiences. To have minimal standards in engineering geology is it necessary to have a License for qualified personnel as seen in many other countries? I invite your suggestions in this regard. Please feel free to agree or disagree and should ISEG encourage and define modus

operandi for such certification.

For the council members who cannot attend the meetings in person it is strongly encouraged to participate through emails, telephone etc and also comment on the draft minutes of the meeting as and when they are circulated. We can function more vibrantly if we get feedback not only from Council but also from all members of the society.

Please be assured that under the leadership of our President and blessings from seniors as well as active participation from youngsters, the society shall scale greater heights.

With regards and thanks,



(Imran Sayeed)  
Secretary, ISEG

### EDITORIAL

(Continued From Page 1)

latest information for the development of the society and our fraternity as a whole.

We all know that our country is poised to construct some of the World's largest dams, deepest tunnels, highest and longest of the bridges and so on. Very soon Country's longest bridge shall be commissioned on the River Brahmaputra at Sadiya connecting Assam with Arunachal. As we move forward, it is our duty to look back to retrospect and eulogize the inheritance received from our ancestors. With this objective in mind and encouraged from the response for my post in the ISEG facebook group and further suggestions from Past Secretary, we are introducing a new series on the "Engineering Geological and Construction Material aspects of the Indian Monuments". This series shall give us an opportunity to cherish our heritage as we scale-up new heights in civil construction. It is a matter of great honour for us that senior members have volunteered to contribute on this subject for the forthcoming issues. The editorial team is certainly indebted for this stimulus inspiration from you all Sir's especially, President and Secretary, ISEG for incessant encouragement and support. We are starting the series with an article on Monuments of Delhi's Northern Ridge in this issue. It also carries an article about the life and contributions of James Hutton, famously known as

"Father of Modern Geology" under the biography series. My utmost gratitude to Shri M. Raju, D.G., GSI, who in spite of his busy schedule never forgets to send such inspiring compilations. The report by Shri Y. Deva, IAEG Vice President Asia on the activities of IAEG at IGC 2016 held in Cape Town, South Africa is also published. Our sincere thanks to Shri Deva for his comprehensive report. Various challenges faced for the development of hydropower in our country are highlighted in the last article of this issue.

I wholeheartedly welcome Shri Gopi Kannan L whose candidature has been approved by the Executive Council for the post of Joint Editor. I offer my sincere gratitude to the Executive Council for expanding the editorial team.

With these remarks, the present issue of ISEG is being presented. I sincerely hope our members will like it.

Kind regards and best wishes,



(Rahul Khanna)  
Editor, ISEG



## JOURNAL OF ENGINEERING GEOLOGY RELEASED BY PRESIDENT, ISEG



Shri R.N. Misra, President ISEG and CMD, SJVN Ltd. officially released the Journal of Engineering Geology, Volume XL, No.2 issue during the 3rd Executive Council Meeting of ISEG held on 17th December 2016 at the Expediting Office of SJVN Ltd., New Delhi. He congratulated the editorial team for this achievement and requested all the council members to contribute technical papers for the Journal so that the forth-coming issues can be published timely. Dr. V.K. Sharma, Vice President, ISEG and Dy. Director General (Retd.), GSI, Shri Imran Sayeed, Secretary, ISEG and General Manager (Geotech), NHPC, Shri. N. K. Mathur, Convener, ISEG Delhi-NCR and Ex-General Manager (Geotech), NHPC Ltd., Shri Pradeep Singh, Co-Convener, ISEG Delhi NCR and Director, GSI also graced the occasion.

## UNDERGROUND STRATEGIC PETROLEUM RESERVE OF INDIA : A STATUS REPORT

**Gopi Kannan L**

Joint Editor, ISEG  
Manager,  
Engineers India Ltd. (EIL), New Delhi



Photo 1. Underground unlined rock storage cavern facility at Vishakhapatnam



Photo 2. Pooja being performed before crude intake near the inlet pipeline of Vizag Cavern

To deal with contingencies arising out of supply disruption of crude oil, Govt. of India is creating Strategic Petroleum Reserves (SPR) entailing crude oil reserves of 5.33 MMT (39 Million Barrels). To implement and operate these SPRs a special purpose vehicle namely Indian Strategic Petroleum Reserves Ltd. (ISPRL) under ministry of Petroleum & Natural Gas was created. For execution of its SPR projects, ISPRL has engaged Engineers India Limited (EIL), a consultancy organization under the aegis of MoP & NG, as Project Management Consultant (PMC). **Under Phase I** storage program, three facilities have been created at Vishakhapatnam, Mangalore and Padur (Udupi), with storage capacity of 1.33 MMT, 1.5 MMT and 2.5 MMT respectively. The storage facilities entail storage of crude oil in Underground Unlined Rock Caverns. Rock excavations of all these storage caverns are successfully completed. The typical storage caverns dimensions are 20m width, 30m height with a length of about 700-950 m. The project in Vizag is excavated in the geological setting of Eastern Ghat mobile belt, which is characterized by Khondalites as the predominant litho unit, whereas Mangalore and Padur projects are seated in Peninsular Gneissic rock complex of Karnataka with mainly gneisses and intrusive granites along with few mafic intrusions

A historical milestone was achieved by the country, when crude was successfully taken in the underground rock caverns at Vishakhapatnam on 05<sup>th</sup> May 2015 and commissioned as the first crude cavern of the country. Recently Storage caverns at Mangalore were also commissioned on **12<sup>th</sup> October 2016**.

**Under Phase II** storage program, plans currently are afoot to create Strategic Petroleum Reserves at further two locations, namely Chandikhol in Odisha and Bikaner in Rajasthan which entails storage of crude oil in underground rock caverns and underground salt caverns respectively. Government of India is considering the proposal for establishment of Phase II storage program for a total storage capacity of 10.0 MMT of crude oil which includes 4.4 MMT storage capacities at Chandikhol and 5.6 MMT storage capacities at Bikaner. In this connection, Secretary, MoP & NG, Shri K.D. Tripathi, senior officials of Indian Strategic Petroleum Reserves Ltd & Engineers India Limited visited the proposed site near Chandikhol along with the revenue officials of the State Govt. of Odisha recently. Construction work in this site is expected to start by mid - 2017.

## MONUMENTS OF THE NORTHERN RIDGE AND ASOKAN PILLAR - THE FREIGHTED ROCK RELICS OF DELHI

**Rahul Khanna**

Editor, ISEG  
Manager, NHPC Ltd, Faridabad.

***"Delhi was a city of Djinnns. Though it had been burned by invaders, time and again, millennium after millennium, still the city was rebuilt; each time it rose like a phoenix from the fire. The reason for this was that the Djinnns loved Delhi so much they could never bear to see it empty or deserted".***

- Pir Sadr-ud-Din (Extract from William Dalrymple's City of Djinnns- A year in Delhi, 1993)

With a thought of starting the New Year uniquely, we chose to join a group of young historians who had volunteered for a Heritage Walk in the Northern Ridge area. Soaked in shimmering sunshine, the Sunday winter morning was the ideal setting for trekking few miles to explore the lesser known ruins and relics of this city in the company of enthusiastic storytellers who happened to be learned scholars as well. This region is one of the five fragmented zones of entire Ridge which is scattered in National Capital Territory of Delhi. Northern Ridge is northern most extension of Aravali hills, which extends from Gujarat through Rajasthan to Haryana and Delhi, before tapering out within the flood plains between Delhi University and Wazirabad on the western bank of River Yamuna.

Having an expanse of 87 hectares, the Northern Ridge is also known as green lungs of Delhi. It beholds within its undulatory terrain, several interspersed remnants of historical monuments which are testimonials of first War of Independence or the rebellion of 1857 as the British called it. Ascending on the Ridge just opposite the Vice Chancellor's office of Delhi University is one of the notable monuments called "Flagstaff tower" followed by Chauburja Mosque within the forest, Baouli and Pir Gayab in the Hindu Rao Hospital complex and the Mutiny Memorial located towards the southern edge. Even though most of these grand structures are in ruins, history unfolds itself as one traverses monuments after monuments, site after site with each of them narrating unique tales from the chapters of their history.

Flagstaff Tower which was constructed during 1828 out of the red sandstone was part of the British cantonment, used as Signal and Lookout tower by the army. It played an important role in 1857, when Delhi was captured by the rebellion sepoys rushing from Meerut. On one warm May morning, when the sepoys were on



Figure 2 Flagstaff Tower constructed out of red sandstone



Figure 1 Map showing expanse of Northern Ridge and location of important monuments

killing spree, looking for Europeans in the Cantonment, Civil Lines and the walled city of Delhi, the survivors started fleeing towards the Northern Ridge. This sturdy tower, with its canopied top rising above castellated parapets, located at the highest point on the ridge, seemed to be an ideal refuge. However, when the British women and children who had survived the ire of the sepoys gathered in this tower, they found the interior suffocatingly confined. Waiting for reinforcement that never came and once the news of escalating violence reached, then entire gathering left Flagstaff Tower and fled towards Karnal and Ambala on foot. A month later the Company army returned to capture Delhi, which was till then in control of the sepoys. They faced stiff resistance from the sepoys at the Flagstaff Tower. A fierce battle followed which led to the killing and wounding of a great number of soldiers. But finally, ridge had been recaptured by the British field force.

Trekking southwards on the ridge, at the intersection of the Chauburja Marg and Ridge Road, we came across the remains of Chauburja Mosque. This structure was built by Feroz Shah Tughlaq in the fourteen century A.D. entirely out of the rubble masonry which constitutes rough, unhewn building stone set in mortar, but not laid in regular courses. The rubble masonry walls formed the inner surface of the structure. It is a two storey structure which derives its name from the architectural feature meaning "four domes", which it once had. It was constructed by the sultan as part of his hunting ground. Some historians also believed that it was built as a mausoleum and later expanded and modified by the Mughals. Now only one out of four turret remains. This monument had played an important role during the rising of 1857 when it was used as a picket by the British during the fighting, which was one of the main reason for it being heavily attacked destroying three of its domes. Later it witnessed heavy fighting when they returned to recapture Delhi.



Figure 3 Chauburja Mosque made out of rubble masonry

Trekking further southwards on the ridge towards the Hindu Rao hospital compound, we came across two lesser known monuments built during the reign of Tughlaqs. One of them called Pir Gayab is so named after a Pir (saint) who vanished (Ghayab) while living inside this relic. The purpose of the construction of Pir Ghaib is still debatable with some believing that it served the purpose of hunting lodge of Firoz Shah, while others claiming that it might have served as an observatory for the sultan who had keen interest in astronomy. Just a few steps away from the Pir Ghaib is a Baoli, also constructed during the Tughlaq reign. Both the Pir Gaib and the Baoli are made from rubble masonry which was the typical mode of construction during the Tughlaq period. Presently, most of the above monuments have been under restoration by ASI.

Towards the southernmost end of the Ridge is located the Mutiny Memorial. It was built in memory of all those who had fought in the Delhi Field Force including British and native Indians, during the Indian Rebellion of 1857. However, in 1972 on the occasion of 25<sup>th</sup> Independence Day, Indian Government renamed it as "Fatehgarh" thus converting it as reminiscent of the Indian soldiers and declared it as protected monument. A new plaque was also erected which said that the "enemy" mentioned by the British were actually the freedom fighters and martyrs of India, who fought bravely against the repressive colonial rule in the First War of Indian Independence. In an attempt to commemorate the martyrs, their names were etched on slabs around the Memorial. It was built in the Gothic style in red sandstone, with four tiers rising from an octagonal base, it stands above a two tiered platform made from locally available hard quartzites. The lowest tier consists of seven faces containing memorial plaques and one face holding the stairs to the upper tiers. The 29.5m high tower has an ornamental façade with circular interiors. At the top fixed with a brick spire, stands a crucifix.

The Northern Ridge does not only bear the remnant monumental ruins of the Rebellion of 1857 but also grounds one of the two Asokan Pillars belonging to 250B.C. that were erected near the Hindu Rao Hospital. Originally erected in Meerut, it was shifted to Delhi almost fifteen centuries later here on the ridge. Feroz Shah who was a keen historian, architect and town builder, during one of his hunting campaigns, was captivated by the two spectacular monoliths – inscribed Asokan pillars erected at Topra near Ambala and the other near Meerut. He shifted the pillars



Figure 4 Mutiny Memorial or Fatehgarh made out of red sandstones with quadrangle two-tier base of hard quartzites

from their original locations and got them erected in Delhi; the former in his new capital and the latter on the ridge, near Pir-Ghaib, his hunting palace. The guiding historians narrated to us, how the Sultan elaborately planned safe uprooting of the rock pillar from its original location. Silk cotton known as "simal", was gathered in large quantities to surround the pillar before it was lowered horizontally to the ground. The covering was then removed, and replaced by reeds and rawhide to protect the pillar during transportation. He meticulously undertook the transportation of this several tonnes heavy monolith using a 42-wheeled cart that required 8,400 men to move it, 200 on each wheel was used to transport the stone to the river bank, where it was loaded onto a large barge. So much effort for a piece of rock is certainly appreciable. Nevertheless, the rock pillar was extraordinary as it had edicts by the Mauryan king Asoka engraved on it in "Prakrit", a colloquial language of that period using "Brahmi" script. At the time of re-installation of the obelisk in Delhi, in 1356, no one could understand the script. The popular belief at that time was that "these columns of stones had been the walking sticks of the accursed Bhim, a man of great stature and size". However, about five hundred years later, when the Brahmi script was deciphered by James Prinsep in 1837, the real motive of these rock columns was understood.

As seen now, the pillar is about 10m high and no more a monolith as it was damaged in an explosion during eighteenth century. The broken pieces were initially shifted to the Asiatic Society of Bengal, Calcutta and later brought back and re-erected. As we were discussing this herculean efforts of Feroz Shah, one of my fellow walker asked out of curiosity, "What is the stone used in building this pillar??" His curiosity matched mine as I was thinking the same. In fact, record says most of the surviving Asokan Pillars were either made of the spotted red and white sandstone from the region of Mathura, or buff-colored fine grained hard sandstone usually with small black spots quarried in the Chunar near Varanasi. Historians says that each of this pillars were cut, dressed and finely polished into circular columns and then carved with edicts, before being transported to various locations in the country for erection.



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- Membership Forms available at [www.isegindia.org](http://www.isegindia.org)

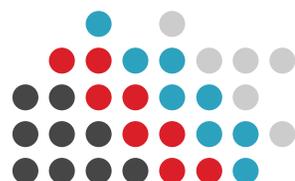


### IAEG Membership

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- Members with Bulletin : 29 Euros  
(Receive Newsletter also)
- Members without Bulletin : 4 Euros  
(Receive Newsletter only)
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**Note :**  
The dues may be paid in INR by demand draft in favor of "Indian Society of Engineering Geology", payable at Lucknow.



To commemorate

**FIFTY GOLDEN YEARS**

of its publication of

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**Indian Society of Engineering Geology**  
is organizing

An International Conference on

**"ENGINEERING GEOLOGICAL SOLUTIONS FOR SUSTAINABLE DEVELOPMENT"**

**Conference Date: 27-28 October 2017**

**Venue: New Delhi**

More details about the conference and its themes, exact venue, President's invitation, call for abstracts, key dates and other details will be issued in future circulars.

Participation from National and International fraternity in engineering geology, geological and geotechnical engineering, environmental geology and its related fields is solicited.

**FIRST CIRCULAR**

### MONUMENTS OF THE NORTHERN RIDGE AND ASOKAN PILLARS .....

Continued From Page 5

Imagining these rock pillars have undergone such a suave mobilization during third century B.C. and again in fourteen century A.D. enthralled our group. During the course of the walk, the above relics had become our reference point to the local history. Each monument of this place stood here in antiquity mesmerising us with the tales of past periods saying as if the song has ended, but the melody lingers on...

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Figure 5 The Asokan Pillar near Hindu Rao Hospital on the Northern Ridge

**Acknowledgement:**

Author is indebted to the team of Delhi Heritage Walk especially Ms. Harleen Kaur, Historian and Walk Leader for narration and reviewing the article.

Further reference from various sources including ASI publications, Records of GSI, Vol. 5-7, 1872, and other relevant literature available on the internet.

# IAEG AT CAPE TOWN IGC 2016

## Yogendra Deva

IAEG Vice President for Asia  
Head-Geology, ICCS Ltd., Bhilwara Group



IGC 2016 at Cape Town



IAEG Council meeting at Twelve Apostles Hotel, Camps Bay, Cape Town

Apparently, the whole global earth science community descended at Cape Town in August-September last. The occasion? It was the four-yearly prestigious International Geological Congress and the attendance was a whopping over five thousand! The Geological Survey of India, the hosts for the next IGC in 2020 at New Delhi made their presence felt with a strong contingent of over seventy scientists including IAEG India NG Past Secretary and Director General Mr. M. Raju along with immediate past Director Generals of the Survey Dr. Sudesh Wadhawan and Dr. Harbans Singh. It was festivity all over the town and if you happened to be in Cape Town at that time, you would keep bumping in to familiar faces wherever you went. I too had the pleasant opportunity of seeing many a few after years. The IAEG did well to grab the opportunity and hold its annual Executive and Council meetings, and the prestigious RWP prize presentations, on the sidelines of the big event. The IAEG President Prof Scott Burns mesmerized the audience with his grand presentation on the geology of wines!

The two day Executive body meeting, and the one-day Council meeting following it, were held at separate venues and deliberated upon the well designed agenda much of which was a carryover from the two-day interim Executive body meeting held earlier in May 2016 at Heathrow, London. The Executive body meeting had the attendance three short of the full house of twelve unlike the previous meetings at New Delhi and London that attracted 100% participation. The Council meeting had an impressive attendance of forty with a special invitee Björn Schouenborg representing the IUGS. Besides reports of the Executive body members and the representatives of the National Groups on their work summary and progress, discussions were held on new national groups, 2015 finance and forward-looking budget for 2016-18, the Bulletin, membership fee issues, IAEG strategy, TOC and Commissions,

IAEG-sponsored meetings, FedIGS meeting 2016, cooperation with sister societies, etc.

The Bulletin is in a strong position with the impact factor reaching 1.252, the highest ever, exceeding 1.0 for the first time. Thanks to the efforts of the regional Vice Presidents, while Nepal and Malaysia returned to the IAEG fold with impressive number of members, Nigeria was inducted as a new NG. Efforts are on to induct many more countries as NGs such as Algeria, Mozambique, Tanzania, Zambia, Pakistan, Philippines, UAE, Mexico. Paraguay, Peru, Uruguay, Tunisia, Egypt, Morocco and Norway. The IAEG Strategy – Vision, Mission and Objectives – got a big boost during the meetings and approval of the Council. This move is expected to rejuvenate the Association further.

The IAEG website [www.iaeg.info](http://www.iaeg.info) has undergone tremendous makeover and is a much stronger portal with a new Communication Strategy consisting of video lectures, web letter and messages on social network such as LinkedIn, and a specific database of presentations and lectures of IAEG members on different topics related to engineering geology involving more young people.

While the Council approved IAEG sponsorship of 3rd North American Symposium on Landslides at Roanoke, Virginia, USA in June 2017; SME Sustainability Symposium & Workshop at Denver, USA in February 2017; the Shaoxing International Forum on Rock Mechanics and Engineering Geology in October 2017 at Shaoxing, China; presentations were made on the forthcoming 11th IAEG Asian Regional Conference at Kathmandu, Nepal in November 2017 and the 13th IAEG International Congress at San Francisco, USA in September 2018.

Continued on Page 8



IAEG Executive body meeting at De Grendel vineyard and winery, Cape Town



IAEG Council group photograph, Cape Town



**IAEG AT CAPE TOWN IGC 2016**

Continued From Page 07



The IAEG moves on with new vigour and there would be lot more in near future.

The Asian region, on the other hand, can expect greater international interaction in some exciting technical programmes like onsite brainstorming focusing on crucial engineering geological and geotechnical issues. Join the IAEG and reap the benefits of strong database and networking!



The vibrant South Africa

*The more you know about the past, the better prepared you are for the future.*

- Theodore Roosevelt

**MAGNITUDE AND INTENSITY OF AN EARTHQUAKE**

**SHORT NOTE**

Waking up in the morning, the first thing we Indians love to do is to have a sip of piping hot tea and a brush with the morning news paper. Besides the mundane news clippings, once in a while the reader is attracted towards news articles where in there are statements as "Intensity 8.0 earthquake hits Dharchula" or "Magnitude 5.3 earthquake shook Pithoragarh". Any natural calamity which strikes the humanity comes as a reminder of the sheer power of the nature to overpower the mightiest of the human race. Such news subconsciously resurfaces the inbuilt fear of survival in human mind for any such calamity. Amidst this what is required is to scientifically understand our dynamic planet and get over the panic factor.

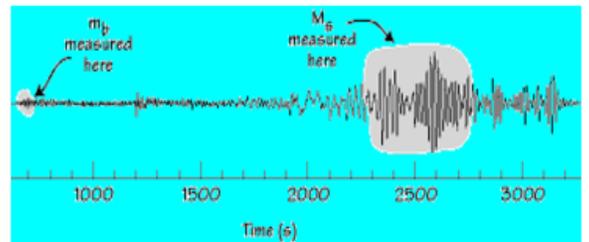
Often, it is misunderstood that the magnitude and intensity are one and the same measure of an earthquake event. However, ask any seismologist and he will tell you that Magnitude is a rating of the amount of energy release in a given earthquake. When two blocks of rock slide past each other during an earthquake, huge amount of energy is released in the form of seismic waves causing ground shaking, frictional heat on the fault surface, and gravitational potential energy. This magnum of energy is quantified by the term Magnitude. Magnitude of an event will remain same irrespective of its place of observation. This is an instrumentally measured quantity and it is properly expressed in numbers based on a logarithmic scale, the most popular been the Gutenberg and Richter scale.

On the other hand Intensity is the indexing of the damage caused to manmade structures due to an earthquake. The intensity scale consists of a series of certain key responses such as people awakening, movement of furniture, damage to chimneys, animal behaviour, pipelines damage and finally - total destruction. It is an arbitrary ranking based on human observation. A moderate magnitude earthquake can have a high or low intensity depending on the damage which in turn is dependent on quality of masonry structure.

Contributed By:- Ms. Pallavi Khanna, Dy. Manager, NHPC

**Discovery and innovation are the elixir of scientists. We thrive on discovery. We progress because of innovation.**

- Jack Oliver (1988), Bulletin of the Geological Society of America



a. Different magnitudes defined by Richter



b. Intensity map based on damage pattern



c. The 25<sup>th</sup> April 2016 Gorkha earthquake of magnitude 7.8 with Mercalli intensity of IX in Kathmandu resulted in total collapse of the ancient structure whereas the masonry engineered structure withstood the tremors hence highlighting the importance of quality of construction (Source: Internet Picture Gallery).

# JAMES HUTTON

FATHER OF MODERN GEOLOGY

**BIOGRAPHY**

**James Hutton** (14 June, 1726 - 26 March, 1797) was a Scottish geologist, physician, chemical manufacturer, naturalist, and experimental agriculturalist. Hutton devised one of geology's fundamental principles – uniformitarianism – which says that the same natural processes we see operating today are the ones that have always operated, and that these everyday natural processes have shaped our world. It explains features of the earth's crust by means of natural processes over geologic time. Hutton's work established geology as a proper science, and thus he is often referred to as the "Father of Modern Geology". Through observation and carefully reasoned geological arguments, Hutton came to believe that the Earth was perpetually being formed; he recognized that the history of the Earth could be determined by understanding how processes such as erosion and sedimentation work in the present day.

Hutton was born in Edinburgh as one of five children of William Hutton, a merchant who was Edinburgh City Treasurer and his wife, Sarah Balfour. His father died when James was only three. He was educated at the High School of Edinburgh, where he was particularly interested in mathematics and chemistry. At the age of 14, he attended the University of Edinburgh as a "student of humanity". He was apprenticed to the lawyer George Chalmers when he was 17, but took more interest in chemical experiments than legal work. At the age of 18, he became a physician's assistant, and attended lectures in medicine at the University of Edinburgh. After three years he went to the University of Paris to continue his studies, took the degree of Doctor of Medicine at Leiden University in 1749 with a thesis on blood circulation.

After his degree Hutton returned to London, then in mid-1750 went back to Edinburgh and resumed chemical experiments with close friend, James Davie. Their work on production of sal ammoniac from soot led to their partnership in a profitable chemical works, manufacturing the crystalline salt which was used for dyeing, metalworking and as smelling salts.

Hutton inherited from his father a lowland farm which had been in the family since 1713, and a hill farm. In the early 1750s he introduced farming practices from other parts of Britain and experimenting with plant and animal husbandry. He recorded his ideas and innovations in an unpublished treatise on *The Elements of Agriculture*. This developed his interest in meteorology and geology. He wrote that he had "become very fond of studying the surface of the earth, and was looking with anxious curiosity into every pit or ditch or bed of a river that fell in his way". Hutton noticed that "a vast proportion of present rocks are composed of materials afforded by the destruction of bodies, animal, vegetable and mineral, of more ancient formation".

Hutton was one of the most influential participants in the Scottish Enlightenment, and fell in with numerous first-class minds in the sciences including John Playfair, philosopher David Hume and economist Adam Smith. Hutton held no position in Edinburgh University and communicated his scientific findings through the Royal Society of Edinburgh. He was particularly friendly with Joseph Black, and the two of them together with Adam Smith founded the *Oyster Club* for weekly meetings. Between 1767 and 1774 Hutton had close involvement with the construction of the Forth and Clyde canal, making full use of his geological knowledge. In 1777, he published a pamphlet on *Considerations on the Nature, Quality and Distinctions of Coal and*



**James Hutton**

(14 June 1726 – 26 March 1797)

## THE HUTTON MEMORIAL GARDEN



James Hutton Memorial Garden was constructed in 1997 on the occasion of the bicentenary of his death at St. John's hill at the site of the house where he lived till his death in 1797 at the city of Edinburgh in Scotland. This garden incorporates stones from localities that were important in the development of his geological theories. It has a bronze plaque mounted on a single block of Clashach stone, a Triassic dune-bedded sandstone from a coastal quarry north of Elgin presently being used in major buildings, an outstanding example being the National Museum of Scotland. On the cut face of the stone beneath the plaque, inscribed the famous final sentence of Hutton's 1788 paper: '...we find no vestige of a beginning, no prospect of an end'.

The stone bearing the bronze plaque was surrounded by other large boulders intended to illustrate two of the main themes of Hutton's remarkable geological work. Two boulders showing granitic veins illustrate Hutton's work on the origin of granite. The other three boulders were of conglomerate, carried by ice and water illustrates Hutton's understanding of the cyclicity of geological processes.

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*Culm* which successfully helped to obtain relief from excise duty on carrying small coal. From 1791 Hutton suffered extreme pain from stones in the bladder and gave up field work to concentrate on finishing his books. A painful and dangerous operation failed to resolve his illness and he died in Edinburgh.

Hutton had a variety of ideas to explain rock formations he saw around him, but according to Playfair he "was in no haste to publish his theory; for he was one of those who are much more delighted with the contemplation of truth, than with the praise of having discovered it". After some 25 years of work, his *Theory of the Earth; or an Investigation of the Laws observable in the Composition, Dissolution, and Restoration of Land upon the Globe* was read to meetings of the Royal Society of Edinburgh in two parts, the first by his friend Joseph Blackon 7 March 1785, and the second by himself on 4 April 1785. Hutton subsequently read an abstract of his dissertation *Concerning the System of the Earth, its Duration and Stability* to Society meeting on 4 July 1785. In it, he outlined his theory as follows;

The solid parts of the present land appear in general, to have been composed of the productions of the sea, and of other materials similar to those now found upon the shores. Hence we find reason to conclude: 1st, that the land on which we rest is not simple and original, but that it is a composition, and had been formed by the operation of second causes. 2nd, that before the present land was made, there had subsisted a world composed of sea and land, in which were tides and currents, with such operations at the bottom of the sea as now take place. And, lastly, that while the present land was forming at the bottom of the ocean, the former land maintained plants and animals; at least the sea was then inhabited by animals, in a similar manner as it is at present. Hence we are led to conclude, that the greater part of our land, if not the whole had been produced by operations natural to this globe; but that in order to make this land a permanent body, resisting the operations of the waters, two things had been required; First, the consolidation of masses formed by collections of loose or incoherent materials; Secondly, the elevation of those consolidated masses from the bottom of the sea, the place where they were collected, to the stations in which they now remain above the level of the ocean.

Hutton's most important contribution to science was his theory of the earth, first announced in 1785. Hutton had then been actively interested in geology for fully thirty years. Interest in various branches of the earth sciences was then widespread, but recognition of geology as an individual science had scarcely begun. Crystalline rocks such as granite and gneiss, usually found in the core of mountain ranges, were regarded as primeval in age, and the sediments, often fossiliferous, on the flanks of the mountains and in low ground were assumed to be flood deposits. This classification carried no implication that any rocks were older than the five or six thousand years allowed for in biblical chronology. By about the middle of the eighteenth century, however, one or two authors had suggested that geological time might be longer than this chronology allowed. The effects of erosion, long recognized, formed a subject for debate over whether denudation would ultimately render the earth uninhabitable, or whether it would be compensated by the elevation of new lands on which life would continue. Broadly speaking, the position was that many geological observations had been made and recorded in the literature; but previous attempts to synthesize these observations into a general "theory of the earth" were unscientific and had not proved acceptable. The issue had been confused and progress retarded by a literal belief in the biblical account of creation and the universal flood.

The variety of subjects that Hutton studied intensively, and his general way of life, indicate that he was a man interested in knowledge for its own sake, without thought of personal advancement, and his works show an overriding intent to fit all the subjects he discussed into the framework of his philosophy.

#### Free style compilation by:

**M. Raju**

Director General  
Geological Survey of India, Kolkata



**If you work without love, you are working like a slave. When you work with love, you work like an emperor. Your work is your joy, your work is your dance.**

**-Osho**

ISEG ON  
SOCIAL  
MEDIA



Indian Society of Engineering Geology (ISEG) is dedicated to the cause of Engineering Geology and Geotechnical Engineering in the country. Understanding the importance of the social media in the modern times and with an aim to broaden the outreach of the Society among its Life Members and well wishers, very recently open groups have been formed on the various social media platforms such as Facebook and LinkedIn. These forums may be utilized by the Executive Council as well as the Life members to share knowledge, propagate useful information and interact more effectively. All members are requested to join these groups and make society more vibrant and dynamic.

For ISEG on face book follow the link: <https://www.facebook.com/groups/1632745770360379>. For ISEG on LinkedIn, follow the link: <https://www.linkedin.com/groups/10329213>

#### NATIONAL GEOSCIENCE AWARDS-2016

Following team members of Engineers India Limited have been selected for the prestigious **National Geoscience Award 2016** by the **Ministry of Mines**, for their contribution in the field of **Applied Geology (Engineering Geology)**.

1. **Dr. Atul Nanda**
2. **Dr. Ranjit Rath**
3. **Saikat Pal**
4. **Gopi Kannan**

The Award will be presented in an Award ceremony to be held in New Delhi.

## CHALLENGES FOR HYDROPOWER DEVELOPMENT IN INDIA

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Secretary, ISEG



**Arindom Chakraborty**  
Manager (Geo), NHPC Ltd.,  
Jnt. Secretary, ISEG



### Introduction

Sustainable Electric Power is an essential requirement for the growth of any developing nation like India. Renewable sources of power which includes hydro are the best form of green power. Keeping in view the high rate of depletion of fossil fuels owing to continuous extraction, need of tapping the renewable sources for future use has not only been strongly felt but will be the backbone of future generations.

At the end of 2016, the total installed power capacity in India stood at 310005.28 MW out of which hydropower accounted for merely 14 % ( $\pm 43139.45$  MW). The percentage of hydropower has come down from 45% in 1970 to about 14% in 2016 which is believed to be not sufficient to have a balanced grid for operation. It may be appreciated that according to experts, the ideal hydro thermal mix is 40:60. On the other hand, out of overall hydropower potential of 1,48,700 MW only 29% has been harnessed so far.

Indian rivers carry more than two third of their annual flow during the monsoon months. This huge amount of water can be stored by creating large storage dams for power generation, flood moderation, navigation, irrigation and other purposes. Hydropower can provide inexpensive energy and control flood and regulate release of water during drought. Moreover, life of dams and reservoirs are also long which is more than other forms of renewable sources.

To meet the country's energy demand at a faster pace, development of large hydropower projects is an essential requirement. Therefore, there is a need to increase dependence on hydro power particularly for the peaking requirements for the development and prosperity of the nation.

### Advantages of Hydropower

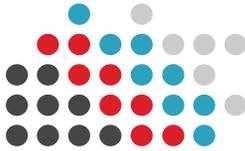
- Relatively longer and useful plant life.
- Helps in the fighting Climate change & Sustainability issues, help in bringing down carbon emission & carbon footprint.
- Environment friendly & Non Polluting – Unlike Nuclear and Thermal Power Plants, Hydro Power Plants hardly discharge any form of solid, liquid or gaseous wastes into the eco- system.
- Run- of -River (ROR) projects can be developed with minimal environmental impact. On the other hand storage schemes provide much needed water security which is essential for survival of all flora and fauna including human beings. Formation of reservoirs may change the ecosystems but in many aspects their creation is beneficial to the environment. For example in dry areas there will be a rise in water table in the neighborhood thereby benefiting all forms of life. In fact after commissioning of projects in ten years more greenery is seen in project areas due to availability of water. Areas around reservoirs can be easily developed into biodiversity parks. Both terrestrial and aquatic life can be developed. The Nagarjunasagar-Srisaileum Tiger reserve around Nagarjunasagar dam is a great example of co-existence of large dams and wild life. In fact it is the largest tiger reserve in India and in spite of law and order problems the number of tigers has increased from 40 in 1983 to 110 in 2016.

- Much lower O&M cost as compared to Thermal Power Plants.
- Helps in meeting the peak power demand in the country, enhancing power system stability.
- Improved Plant Load Factor of Thermal units- Grid stability and Peak Load Management by spontaneous starting, stopping and load variation ability. Hydropower provides high level of service to power system (reliability, flexibility and efficiency).
- Remote area development- Improves infrastructure of interior areas and local population gets manifold advantages including better economy, job opportunities, education, healthcare facilities, connectivity & communication facilities.
- Multipurpose Hydro power projects- Help in flood moderation, irrigation, navigation and drinking water requirement.
- Catchment of river basins is treated by the hydro project developers even though there is no impact on catchment except reservoir area. This helps in curtailing massive soil erosion & checking landslides in mountainous regions.

### Challenges Involved in Hydropower Projects

Despite several benefits, hydropower development in the Country has taken a backseat in the last few years owing to various challenges/constraints. The major challenges being faced by hydropower industry are listed below;

- Hydro Power Projects are site specific. Every single site has unique topographical, geological and geomorphological set up. Hence, inception, planning, design, execution etc. are altogether different.
- Hydropower projects are located in far flung areas having very limited infrastructure connectivity and communication facilities which put lot of hindrance in transportation of man and machines during execution.
- Scarcity of Reputed Contractors/Skilled technicians/workers- Very few reputed contractors are available in the hydropower sector in India. In case of tunneling, even though more than 400 km hydropower tunneling has been accomplished till date in India, process of execution has not advanced much in last fifty years. Moreover, due to uncertainty and lack of publicity of good works in hydropower sector and extreme locations, major construction agencies often refrain themselves from venturing into hydropower sector.
- Security concerns – Vast hydro potential of the country is available in the areas affected by insurgency and militant problems. The law and order problem in such areas lead to delay in execution of the project as well as cost over runs.
- Local inhibitions & lack of awareness – Often, Hydro Power Projects also suffer from the regional and local expectations. Project developers frequently encounter many types of demands from the locals of these areas over and above the standard compensations. Sometimes, these demands are also motivated by vested interests by taking the advantage of lack of awareness in the local public about benefits of hydropower and misinformation leads to strikes and agitations.
- Water being a state subject many clearances and agreements are required at state level also.
- Hydrological Aspects– Hydropower projects depend basically on availability of water and topography (head). While the assess-



## ISEG NEWS

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ment of available head is relatively easy and is done by surveys, availability of water and seasonal variations is a challenging task. Hydrologists depend heavily on long term meteorology data records and discharge measurements. Non-availability of reliable data is a constraint in some cases.

- Geological Aspects - The construction time of a hydropower project is greatly influenced by the geology of the area. It is, therefore, essential that state-of-the-art investigation and construction techniques are adopted to minimize geological risks as well as the overall gestation period of the projects. Inaccessibility of the terrain, high superincumbent cover, lack of proper time and budget for investigation etc may result in inaccuracies in development of precise geological model. Sometimes, even after carrying out extensive investigation using new techniques, an element of geological uncertainty remains especially for sub-surface structures which can be addressed by carrying out ahead of face investigations during construction. For this purpose, proper time and provision for investigation and testing even during construction is necessary. However, unnecessary usage of geological reasons to cover-up other deficiencies needs to



be strongly discouraged.

- Rehabilitation and resettlement – Rehabilitation and resettlement is also a critical issue for hydropower projects particularly for large storage dams which involve huge submergence.
- Storage versus ROR Schemes – There is a lot of discussion going on towards development of Hydro Projects as storage or run of the river (ROR). Both the types of schemes have benefits as described above. Nowadays, after awareness of water security in the Country, focus has been shifted towards development of storage dams also.
- Hydropower projects involve investment of huge debt capitals, which is a big challenge for the developers.
- With the present power scenario and major policy initiatives to boost renewable sector (mainly solar and wind), it is becoming difficult to sell hydropower. There is reluctance on the part of distribution utilities to enter into long term Power Purchase Agreements (PPAs).
- Provision of providing 12% free power as loyalty to the State Government affects the financial viability of the project severely. Often the State Governments demand for upfront money before allotment of the projects with a condition to adjust the same from the cost of free power. Moreover water cess payable to State Government for O&M projects is also a burden on the developers.

### Revival of Hydropower Sector – some propositions

- Widespread Public awareness program to be organized to promote power generation, environmental, socio-economic, communication, flood control, irrigation, navigation, tourism and other benefits associated with hydropower.
- Incentive schemes like Govt. subsidy, tax holiday, mandatory long term PPA's with State DISCOMs, Hydropower Obligation scheme (HBO) for all the State Governments etc. to be introduced for making the hydropower projects lucrative ventures.
- Site specific design based on comprehensive investigation program followed by well documented contract clearly mentioning the anticipated risk and their remedial measures are to be followed judiciously.
- Single widow clearance system to be introduced to reduce the high gestation period of hydropower projects.
- Selection of experienced contractor well equipped with trained manpower and machineries is also important. Risk sharing between developer and contractor in case of unprecedented events may be finalized beforehand to avoid any delay during construction.
- Use of modern technology in construction.
- Infrastructure development such as roads and bridges are beneficial for the local area. Advantages of local area development are completely ignored and it is hydro which takes the cost burden of roads and bridges which are otherwise used by all concerned. Awareness about this and also cost sharing formula or subsidies by the government are required.

### The Bottom Line

Hydropower projects should not only be viewed on the basis of huge capital investments or high gestation period rather may be considered as a part of national building activity like development of road and rail network, flood moderation etc. rather than only for power development.

**The future rewards those who press on. I don't have time to feel sorry for myself. I don't have time to complain. I'm going to press on.**

**- Barack Obama**