SLGS NEWSLETTER

SRI LANKAN GEOTECHNICAL SOCIETY

A Member Society of the International Society for Soil Mechanics and Geotechnical Engineering (ISSMGE)

Established in 1986

"History says that the first use of geothermal energy occurred more than 10,000 years ago in North America by American Paleo-Indians. People used water from hot springs for cooking, bathing and cleaning. The first industrial use of geothermal energy began near Pisa, Italy in late 18th century. Steam coming from natural vents was used to extract boric acid from the hot pools that are now known as the Larderello fields".

Conserve Energy Future

Greener Energy from Deep Earth

Ashani Ranathunga | *BSc. Eng. Hons (Ruhuna), PhD (Monash)*

According to *Energy Information Administration (EIA)*, the current energy demand will increase by around 50% in another two decades time. Further, the major energy sources of the today's world such as coal and oil (mineable) will remain only for another 50 to 60 years, warranting us to search for new energy sources.

Considering the enormous impact on global warming by the fossil fuels; environmentalists, reserachers and many oraganizations are demanding for the use of sustainable and renewable greener energy sources. Geothermal energy is one such energy source which is a trending topic.

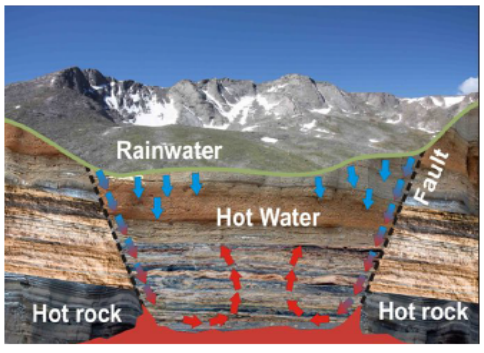
What is Geothermal Energy?

Geothermal energy is simply the utilization of heat generated from deep inside the earth. This heat is continuously generated in the Earth's core due to the slow decay of the radioactive particles. This thermal energy is comprised in the rock and fluids beneath Earth's crust. The footprints of geothermal energy run from the shallow ground to several miles below the surface, and sometimes even deeper to the extremely hot magma.

The most active geothermal resources are usually found along major tectonic plate boundaries where earthquakes and volcanoes are concentrated. One such most active geothermal areas in the world is called the "*Ring of Fire*". The Ring of Fire borders the Pacific Ocean and is bounded by Japan, the Philippines, the Aleutian Islands, North America, Central America, and South America (Source: *https://www.nationalgeographic.com*).

Geothermal reservoirs are formed when hot water or steam is trapped in cracks and pores under a layer of impermeable rock. The rainwater and melting snow feed these underground thermal aquifers.

Ring of Fire
(Source: *https://www.nationalgeographic.com*)



Geothermal Reservoirs
(Source: *http://www.geo-energy.org*)

Applications of Geothermal Energy

Direct Use of Hot Water from Hot Spring or Reservoir

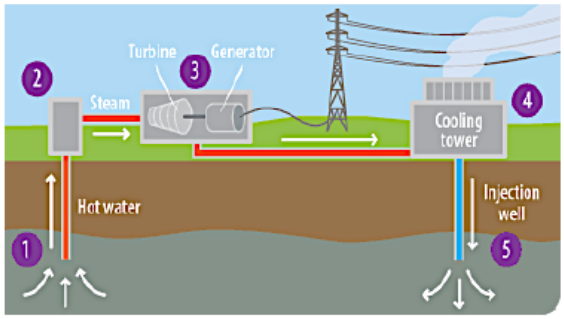
Some countries have been using geothermal reservoirs for their cooking and heating needs for millennia. For example, "The Maoris in New Zealand and Native Americans used water from hot springs for cooking and medicinal purposes for thousands of years. Ancient Greeks and Romans had geothermal heated spas. The people of Pompeii, living too close to Mount Vesuvius, tapped hot water from the earth to heat their buildings. Romans used geothermal waters for treating eye and skin disease. The Japanese have enjoyed geothermal spas for centuries." (Source: *Nersesian, R. L. (2016). Energy economics: markets, history and policy. Taylor and Francis, London, pp 334*).

Electricity Generation

The Earth's temperature at around 6400 km deep is same as the sun's surface, which is around 5500 °C. Scientists estimate that 42 million megawatts (MW) of power flow can be generated from the Earth's interior, primarily by conduction. Further, it is a proven technology that power generation by geothermal energy, has low to no emissions and has one of the smallest environmental footprints per unit output of any power supply option (Source: *http://renewableenergy.com*).

A workable geothermal system requires heat, water and permeability. The potential geothermal reservoirs for energy production are tested by drilling and testing temperatures and flow rates. Generally, the heat is transported up by fluid (water) circulation. This heated fluid is then used to turn a turbine of a generator to produce electricity. When the fluid is cooled down, it is returned to the geothermal reservoir to repeat the process. The first geothermal electric power plant was developed by Prince Piero Ginori Conti, at the Larderello, Italy dry steam field in 1904 and is still in operation today.

World's first Geothermal Electric Power Plant in Larderello, Italy
(Source: *http://renewableenergy.com*)



1. Hot water is pumped under high pressure.
2. The water converts into steam.
3. The steam spins a turbine and produces electricity.
4. The steam condenses back to water in a cooling tower.
5. The cooled water is pumped back into the reservoir.

Geothermal Power Generation
(Source: *https://www.epa.gov*)

Currently, United States leads the world in generating geothermal power. According to the *EIA*, geothermal power plants in the US produced 13.2 billion kilowatt-hours of electricity in 2017. As of 2017, 24 countries around the world such as Philippines, Indonesia, Mexico, Italy, Japan, New Zealand, and Iceland use geothermal power to generate electricity.

Geothermal Heat Pumps

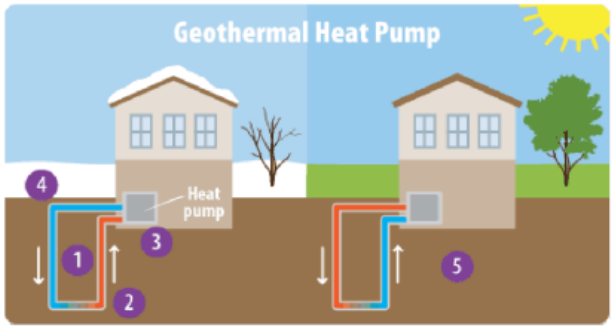
Geothermal heat pumps are used for cooling/heating buildings, and also for warming swimming pools. These systems transfer heat by pumping water or a refrigerant through pipes just below the Earth's surface, where the temperature is a constant 10 to 16 °C. During the winter, the water or refrigerant absorbs heat from the Earth, and pumps up this heat to the building above. In the summer, some heat pumps can run in reverse and help to cool buildings.

Klamath Falls, Oregon, USA has one of the largest district heating system to heat city buildings. The production well is out of the town and hot water is brought to the town by pipelines. Once the heat is used, the water is returned to the geothermal reservoir through an injection well. The city also heats some of its sidewalks during winter using geothermal energy by running hot water pipes under them (Source: *Geothermal Energy by Carrie Gleason, 2008*).

Advantages of Geothermal Energy

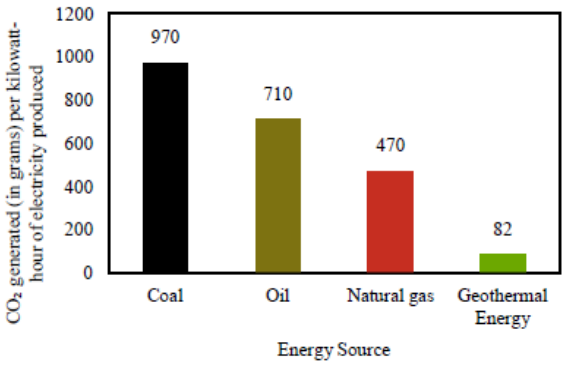
1. *A Sustainable Energy Source:* As the heat inside the earth's crust is long lasting, geothermal energy is considered as a sustainable energy source.

2. *Renewable Energy Source:* The water used for the heat extraction is reused to pick up the heat again and again and hence is known as a renewable energy source.



1. Water or a refrigerant move through a loop of pipes.
2. When the weather is cold, the water heats up as it travels through loop that's buried underground.
3. The warmed water or refrigerant transfers heat into the building.
4. The water cools down after its heat is transferred.
5. On a hot day, the system can run in reverse.

Geothermal Heat Pumps
(Source: *https://www.epa.gov*)



CO_2 emission due to electricity production from different energy sources
(Source: *US Department of Energy*)

3. *Lower Carbon Emission:* According to US Department of Energy, coal, oil and natural gas release 970, 710 and 470 grams of carbon dioxide to generate kilowatt-Hour (kWh) of energy, respectively. Instead, geothermal energy releases only 82 grams of carbon dioxide per kWh.

4. *A Longer Life Span:* Geothermal power plants have longer life spans. For example, world first geothermal power plant at Larderello, Italy has been running for more than 100 years (since 1908). Further, the world's largest geothermal power plant, Geysers in California is running for more than 50 years (since 1960).

5. *Smaller Foot Print of Geothermal Power Plant:* According to the *US Department of Energy*, a geothermal power plant uses from 4047 to 32375 square meters per megawatt of electricity produced. However, nuclear power plants use 20235 to 40470 square meters per megawatt and coal power plants use 76890 square meters.

6. *A cleaner energy source:* Geothermal power is considered safer as it does not require combustion to produce heat hence, no risk of combustible gases being released in to the atmosphere.

7. *Other Economic Advantages:* A 2007 report said that United States added 5,635 Megawatt of geothermal electricity to the main grid which eventually added 30,000 full time jobs for construction and operation of the power plants (Source: *US Department of Energy, 2007*).

Disadvantages of Geothermal Energy

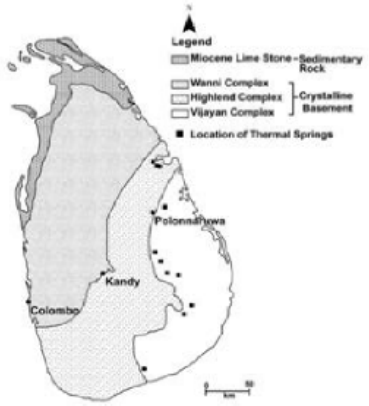
1. *Limited Accessibility:* In the case of geothermal power plants, it works best for areas where the geothermal resources are abundant with already fractured earth crust, such as in California, Iceland and Italy. The next challenge is transferring the heat to the power plants, or to homes and buildings by digging well and transfer networks like piping, cement casings etc.

2. *Higher Capital Cost:* The upfront cost associated with drilling wells and construction of the geothermal power plants is relatively higher than fossil-fuel based system. There are risks and technical challenge as well when it comes to drilling into hot rocks and sandy areas and hence, the geothermal projects can be very expensive.
However, the operational cost for geothermal energy is much cheaper. In the United states to heat up a 280-square meter house, it will cost about $60 per month using a geothermal heat pump which is much less than using conventional energy (Source: *Geothermal Energy by Alan Wachtel, 2010*).

3. *Environmental Impacts:* Geothermal power plant can cause the land around them to sink or fracture as water and heat get extracted from the reservoir. Therefore, scientists prefer natural cracks or faults before digging a new hole for extracting geothermal energy.
Also, water from geothermal reservoirs, contains some chemicals that are toxic to human health like arsenic, mercury, selenium and corrosive salt. Therefore, there's a possibility of the contamination of nearby wells, reservoir or surface water bodies.

Potential for Geothermal Energy usage in Sri Lanka

Geothermal Energy has been established as thermal springs in low enthalpy (35 to 61 ^{0}C) along a narrow belt in Sri Lanka, which runs approximately parallel to the Highland complex and Vijayan complex lithological boundary (Source: *Kumara, S. M. P. G. S. (2014), Potential for Direct Utilization of Geothermal Energy in Sri Lanka. Sciscitator, 1, 33-35*). These springs are not being used for any economic purpose while some have been used for recreational purposes. According to a study done by Kumara (2014) on the direct application of Sri Lankan Geothermal resources, following applications were identified.



Locations of thermal hot springs in Sri Lanka
(Source: *Kumara, 2014*)

1. *Steaming and drying of agricultural products:* As stated above, the geothermal sources in Sri Lanka have been located in Trincomale, Polonnaruwa, Monaragala and Hambanthota districts. These areas are agricultural regions of cultivating Cucurbitaceous family crops (Rice, maize, soya, etc.). For these production industries, thermal energy is needed for steaming and drying which can be supplied using the geothermal energy systems.

2. *Sugar Processing:* In the first production of raw sugar and the refinement of it requires considerable amount of steam in cane sugar industry. The geothermal heat energy can be used for evaporation in multiple effect evaporators.

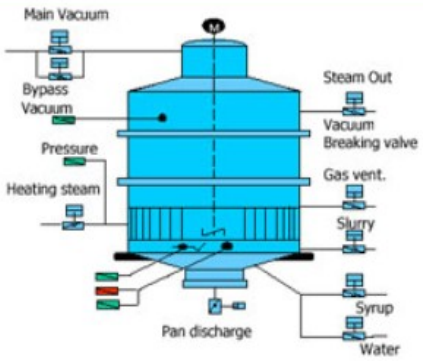
3. *Pulp Processing:* The Kraft and the sulphite process are two principal methods for processing essentially pure cellulose pulps out of wood where, substantial amounts of steam is required in the general process and drying operation.

4. *Timber seasoning:* Geothermal energy can be used for veneer fabrication, and a number of other seasoning operations of timber beneficially (Source: *Burrows W. (1970). Geothermal Energy Resources for Heating and Associated Applications in Rotorua and Surrounding Areas. U.N. Symposium on Geothermal Energy. Pisa, Italy*).

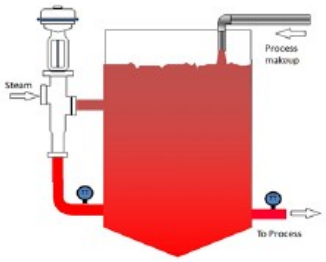
5. *Cold Storage:* Cold storage of fresh vegetables, fruits, meat and beverages can be achieved by the use of absorption chillers which utilize hot water as energy source.

6. *Recreational and health applications:* The existing hot springs and warm mineral springs can be developed according to the modern requirements such as geothermally heated swimming pools, mineral baths, mud baths, steam baths with some additional infrastructures such as hotels and recreational facilities can attract tourists improving the economy of the locals.

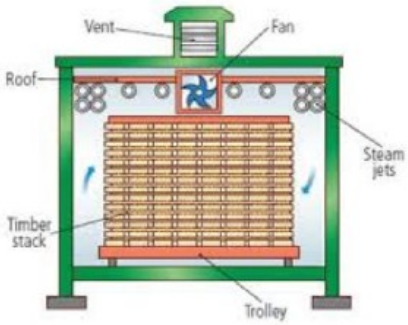
Geothermal Baths
(Source: *https://www.fontana.is and http://www.traveller.com.au*)



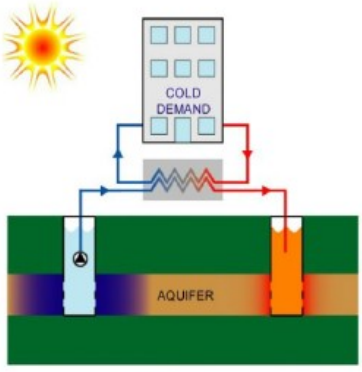
Sugar processing
(Source: *https://www.plantautomation.com*)



Pulp processing
(Source: *http://www.pulpheater.com*)



Timber seasoning
(Source: *http://www.wellons.com*)



Cold Storage
(Source: *http://sp.sonicsampdrill.com*)

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Geo forum conducted by Dr. Ashok Peiris

Geo forum for the month of February 2018 was conducted by Dr. Ashok Peiris, Principal Geotechnical Engineer GHD Pty Ltd, Australia on 15th February 2018 at the IESL Meeting Room 1.

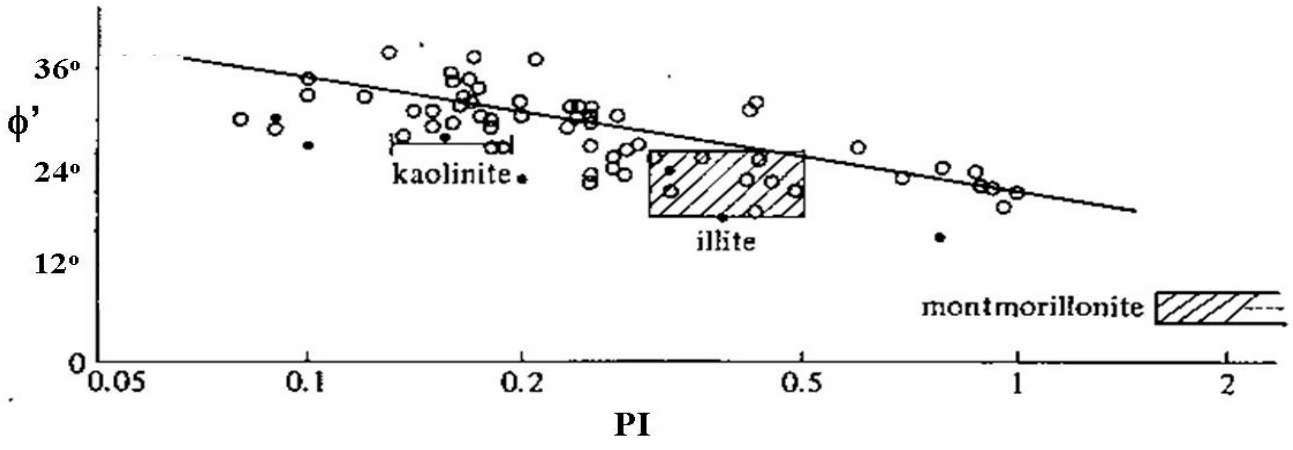
The title of the geo forum was "Rail Embankment Design over Landfill". The lecture covered characterization of landfill material for establishing design parameters and design of rail embankment over landfill towards limiting total and differential post construction settlement within allowable limits. The lecture also includes the details on selection of ground treatment/improvement techniques considering cost, environmental factors while focusing on operation and maintenance requirements in optimizing the design.

Geo technical Toolbox

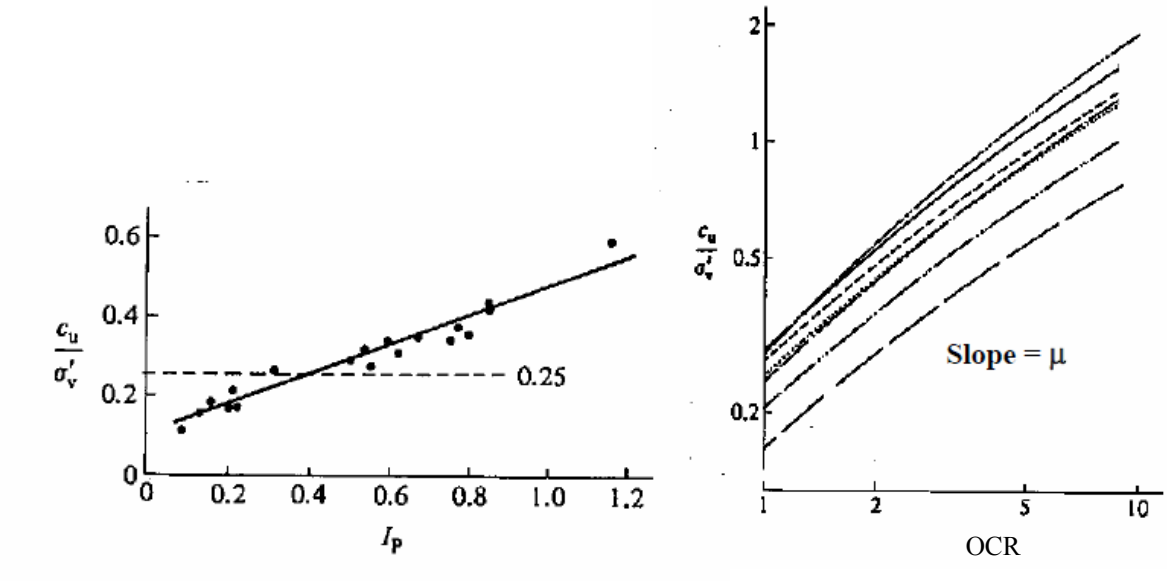
SOME RULES OF THUMB FOR SOIL PROPERTIES

Based on an article by ,
Prof. John Atkinson. (Senior Principal, Coffey Geotechnics and Professor of Soil Mechanics, City University, London)

There are a number of rules of thumb relating simple test results to soil properties. Few such rules are depicted below.



A rule of thumb to relate φ/ to plasticity index. (Wood, 1991)



(a) Normally consolidated soils (b) Overconsolidated soils

Relationship between undrained shear strength, plasticity index and OCR. (Wood, 1991)

Forthcoming Conferences

- The 7th International Conference on Unsaturated Soils (UNSAT2018), August 3-5, 2018 , The Hong Kong University of Science and Technology (HKUST), Hong Kong, http://www.unsat2018.org.
- 11th International Conference on Geosynthetics, 16th September 2018, Seoul, South Korea, http://www.11icg-seoul.org/
- International Symposium on Energy Geotechnics, 25-09-2018, Switzerland, Lausanne, http://seg2018.epfl.ch/
- 7 ICEGE 2019 - International Conference on Earthquake Geotechnical Engineering, 16th-20th June 2019, Rome, Italy, Email: agi@associazionegeotecnica.it.

SLGS and ISSMGE Membership Fees

SLGS members are kindly requested to pay the membership arrears at your earliest. A notice indicating due fees is attached.

Please inform any changes in the contact details.

Membership Admission Fee	Rs. 200/=
Annual Membership Fee	Rs. 700/=
ISSMGE Fee	Rs. 1500/=

Forthcoming Events of SLGS

Call for papers for SLGS Journal

SLGS wishes to call for full papers for its Annual Journal. Number of pages per paper is limited to 12. All the papers will be subjected to double blind review by two referees. Selected papers will be published in the SLGS Journal (hard copy version) and will be made available online through the SLGS website. Please send your papers to the following email address.
Editor Journal: nadeejpriyankara@yahoo.com

The SLGS Newsletter comes to you in volumes of four fascicles issued in February, May, August and November in each year. If you prefer to receive the newsletter by email, please send your email address to the editor, newsletter

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Note: The views expressed by authors are not necessarily the views of SLGS.

International conference in Geotechnical Engineering (ICGE 2020)

Following the very successful ICGE-Colombo-2015, Sri Lankan Geotechnical Society (SLGS) is planning to organize another International Conference in Geotechnical Engineering, ICGE-Colombo-2020 on August 10-11, 2020 in Colombo.

A local organizing committee and an international advisory committee is formed incorporating members from organizations involved in the field of geotechnical engineering in Sri Lanka and overseas.

We hope to have several keynote lectures in the mornings and two or three parallel Technical sessions in the afternoons. A poster session will also be held. Several keynote speakers would be identified to cover areas of greater interest. An exhibition would be held in parallel with the conference. Several site visits will be held after the conference.

Possible themes tentatively identified as;

- Geological and Geotechnical Modelling
- Ground Improvement
- Landslides and Slope Stability
- Ground Subsidence
- Foundations
- Analytical and Numerical Modelling
- Site Investigations
- Problematic Soils (Expansive Soils, Organic Soils)
- Design for Earthquakes
- Environmental Geotechnics
- Geotechnical Instrumentation and monitoring
- Case Histories
- Rock Engineering, Tunnelling
- Deep Earth Energy

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