Subsurface Engineering — More than Rocket Science!

The three pioneers of rocket science — Tsiolkovsky (1857-1936; Russia,), Goddard (1882-1945; US) and Oberth (1894-1989; Germany), were each attracted to the challenge of space travel by the book *From Earth to the Moon* (French; *de la Terre à la Lune*) 1865, by science fiction writer Jules Verne.[1]

In 1969, just eight years after President John F. Kennedy announced the US plan to travel to the Moon, Apollo 11 took two days to travel the 384,400 km (238,900 miles) from Earth to the Moon — and returned safely. Today, Voyager 1, which has reached the outer layers of our solar system, is relaying information to Earth from over 10 billion miles away.

One year before *From Earth to the Moon,* Verne had published another book *Journey to the Center of the Earth* (1864) (French; *Voyage au centre de la Terre).*

The distance to the center of the Earth is ~ 6,400 km (~ 4,000 miles). To date, the deepest penetration into the Earth is 12 km (7.5 miles): the Kola Deep Borehole, Russia. It took 24 years (1970-94) to drill, before efforts to go deeper were abandoned. The rock temperature at the bottom of the hole was 180°C (356°F).

The deepest mine, at 3.9 km,[2] has been accomplished after a slow progression from surface excavations over millennia.

Gravitational rock stress and rock temperature increase, on average, 25 MPa/km and 10°C/km depth.[3]

Tectonic stresses — predominantly horizontal — are often assumed to increase on the order of 8-10 MPa/km. Local departures from these averages may be substantial.[4]

"Going up" has transformed life on planet Earth.
It is time to look now at the Challenges — and Potential — of "Going down." [5]

"The human race truly understands less about the ground beneath its very feet than it does about the cosmos that abound. It's humbling to realize just how much mystery still exists right here on our little blue world." [6]

[1] http://www.rocketmime.com/space/history.html
[2] https://en.wikipedia.org/wiki/List_of_deepest_mines
[3] https://en.wikipedia.org/wiki/Geothermal_ gradient
[4] See e.g. http://geothermal.inel.gov/publications/future_of_geothermal_energy.pdf, Figure 1.5, p.1-14.
[5] "*While string theorists and cosmologists struggle to understand the dark matter in outer space, industrial physicists are tackling problems related to another kind of dark matter found in inner space."* Dr. Brian Clark, NAE, Schlumberger Fellow.
[6] http://www.iflscience.com/environment/deepest-hole-world