PASCAS PARK

Underground Village
Down the Rabbit Hole

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Pascas Foundation is a not for profit organisation

PASCAS PARK UNDERGROUND VILLAGE – Down the Rabbit Hole:

Topics to be considered:

Day to day use of the underground facility could involve:

1. Community rooms and long term library facility.
2. Community communal kitchen, canteen and dining for 450 individuals.
3. Medium term storage of processed food, e.g. Life Pack.
4. Storage area for supplies and equipment.
5. School for up to 300 students.
6. Living quarters with 150 bedrooms.
7. Infirmary and medical treatment for up to 20 people.
8. Convenience store, spa, woodworking, metalworking, maintenance, meeting rooms, theatre, community centre, offices and management rooms.

Environmental issues to be understood and managed:

1. Air quality control. Oxygen level monitoring. Temperature control. Air flow management.
2. Temperature control. The room temperature maintenance to be within specific ranges.
3. Electrical energy supply. The facility to be off-grid and independent of any external supply. That is, initially to be solar and wind turbine, then in anticipation of severe external conditions to be totally underground supply. Stand-by diesel generation. Bicycle power generators?
4. Water supply. This to be accessible and managed from within the underground facility.
5. Moisture and water management, both fresh and waste, and control thereof.
6. Sewerage waste management. Onsite independent treatment plant.
7. Recycling of nutrient rich waste water for food production underground.
8. Artificial light for food growth and human health.
9. Waste management during extended confined stays within the underground facility.
10. Fire and smoke management and safety.
11. Emergency exiting.
12. Radon, a colourless and odourless gas, as well as other gases, management thereof – ventilation.
13. Volatile fuel (diesel) storage for power generation and others.
14. Exercise options for residents – gymnasium, confined sports, etc.
15. What is the maximum number of lodgers during an environmental crisis?
16. What are the numbers of people that could be accommodated and duration thereof?
17. How to manage psychological effects of extended stays by residents.
18. What equipment and facilities should be available within this confined space?
19. How deep underground does the facility have to be so residents are protected from anticipated external environmental issues that may need to be dealt with?
20. How to manage re-entry into the open during extremes of weather events and how to protect those who first exit the underground facility.
21. What communication options should be installed?
22. What will this all cost?

Humans could survive underground, but it would take a lot more than shovels

https://www.popsci.com/humans-survive-underground/

How to avoid becoming a full-blown mole person.

At the Whitney Museum of American Art, you can stand under a boxy old TV, mounted on the wall just above eyesight, and watch the pixelated clouds from Mario Kart slowly blow across the screen. Stripped of their context in the larger Nintendo game world, *Super Mario Clouds*, 2002, by multimedia artist Cory Arcangel, the artificial sky feels uncanny: just familiar enough the difference threatens to drive you insane.

While tracking the slow creep of Arcangel's creation, I wondered: If rising sea levels, air pollution, and temperatures one day push humanity underground, is this all we'll have to remember the sky?

Humans have lived underground for millions of years, but only in fits and starts. Our cave-painting ancestors left behind handprints and hunting scenes. In Tunisia, many people still live in what the *The Atlantic* calls "crater-like homes," with rooms built into the Earth, and a central circular patio open to the sky. And in the "dugout" village of Coober Pedy, Australia, locals pray in a subterranean cathedral and visitors sleep in sediment-streaked hotel rooms.

Underground development continues to this day. Many northern cities maintain underground tunnels, some so elaborate as to be christened "shadow cities," in order to cope with severe winters. In Beijing, a million people live in nuclear fallout shelters beneath the city's clogged urban arteries. Other dense urban spaces, like London and Mexico City, are also seeking to grow down, now that the limits of sprawl and high-rises become clear.

Still, even "cavemen" ventured outdoors. Living entirely underground would be unprecedented, to the point of being nearly unfathomable. But experts say with good design and a lot of psychological support, humans could make convincing—and surprisingly healthy—mole people.

Good thing, too, because the above world is looking increasingly inhospitable.

Eternal sunshine

The biggest difference between living *on* Earth and living *in* Earth is sunlight. UVA and UVB rays are essential for growing plants for food and stimulating the production of vitamin B in the human body. These golden rays also appear to have immune-regulating affects, aid in the treatment of psoriasis, and keep us happy. But "sunlight" doesn't necessarily have to come from the actual sun. LED lamps that offer UV wavelengths can crank out the rays our bodies—and our crops—crave.

Instead of sprawling, sun-drenched fields, underground farms will be more like metal boxes bathed in high-intensity lights and fed by nutrient-rich recycled water. Such systems already exist: Square Roots, an indoor farming company, grows vertical rows of leafy greens in compact shipping containers packed tight with red and blue LED bulbs. Using a method called hydroponics, farmers can circulate water infused with mineral nutrients through the network of life-sustaining shelves. While it operates out of a parking lot in Brooklyn, these systems are, for all intents and purposes, already underground, so long as there's electricity.

Securing a food supply isn't enough, however. Humans also need vitamin D to maintain bone health. The best-known source of vitamin D may be sunlight exposure (which encourages our bodies to produce vitamin D on its own), there are plenty of other ways to get your hands on the good stuff. In 2012, *Slate* reported on how a Russian cult survived underground, thanks in part to vitamin D-rich foods. So long as we can continue to farm animals in our earthen abodes, egg yolks, fish, milk, and cheese will keep us in the clear. If that doesn't work, vitamin D supplements and fortified foods like cereals and juice could do the trick.

Sunny dispositions might also be at risk. Seasonal Affective Disorder, better known by the apt acronym SADs, is already a wintertime scourge. As daylight becomes increasingly sparse each season, many already turn to "happy lamps," which provide artificial sunlight. Though some SADs sufferers may need antidepressants, therapy, or other forms of support, carefully-planned light therapy can reduce many of the most severe symptoms.

But things are liable to get a lot worse sub-surface. When isolated in caves without light, humans have been documented to sleep for as much as 48 hours at a stretch. Using artificial lights to regulate Circadian rhythms will be another essential component of any subsurface world.

A spotless mind

Going underground may be physically possible, but it's sure to be psychologically taxing. Lawrence Palinkas is a professor at the University of Southern California and an expert in extreme environments. Typically, he says, people are screened for traits that would allow them to thrive in a stint aboard the

International Space Station, or a sabbatical at a remote research outpost in the Antarctic. Characteristics like openness to new experiences, for example, are often deemed essential.

But a motley crew could do alright, too, if they work together. Dedicated “change agents” with astronaut-like qualities might help to establish new cultural customs. Educators could disseminate the information and tools people need to thrive underground. “Over time, one could imagine that people would become adjusted to living underground and adopting new patterns of behaviour that would enable them to live comfortably with no adverse effects on health and well-being,” Palinkas says.

Design could play a role in our adaptation, too. Researchers in Antarctica, where greenery is sparse, quickly recognised the mood-boosting benefits provided by laboratory greenhouses. Similar spaces could pay dividends in our crusty new home. Other positive sights, sounds, and smells could migrate with us—and not just in digitised Super Mario form. A plan for an underground city in Singapore has expansive shafts pulling daylight down into the layered depths. Mock-ups for a Lowline park in New York show will "provide breathing space," according to the BBC, through "well-lit oases with palm trees and illusions of the sky."

Ultimately if technology and culture can support us in space, they can probably support us inside our own planet, too. Whether we need to do it, or can do it at scale, remains to be seen. Whatever happens, Palinkas says, “it’s certainly not just a matter of digging a big hole in the ground.”

BALDWIN O'BRYAN ARCHITECTS

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Mr Baldwin and Sean O'Bryan studied architecture together and, 30 years later, came together last year to form their Baldwin O'Bryan practice, which specialises in earth sheltered projects. "It's only a baby, but the baby is growing quickly," Mr Baldwin says.

While earth sheltered housing is not for everyone, he admits, it is often favoured by people wanting to live off the grid or living in areas of natural beauty. "It's primarily about merging the landscape of your site and area you're living in," Mr Baldwin says. "They don't necessarily want to destroy it with a whole bunch of ugly boxes."

The areas that earth sheltered houses are built in are often less accessible, adding to the expense, and can often be more susceptible to dangers such as cyclones and fires. While some earth sheltered houses are built using concrete as their main material, Baldwin O'Bryan uses a steel arch system, a time-effective method which reduces labour costs. Prefabricated, they can be bolted together quickly. In fact the walls and roof can be up within a day and a half, says Mr Baldwin, which is in sharp contrast to the two months it can take for the same to happen with an "off the shelf" volume builders home.

Mr Baldwin says the cost of a home through an average volume builder will be $1,000 per square metre; boutique builders will cost $1,500-$2,000; and a traditional, architect-designed home will cost anywhere between $1,500 and $3,000 per sq m (or more, depending on the finish). Baldwin O'Bryan's earth sheltered dwellings are about $1,500 per sq m.

Residents can save thousands annually on energy bills (see case study) and even more on north-facing sites if passive solar design is incorporated. But for those in bushfire areas, the greatest benefit they provide is safety. The only combustible materials are the owner's possessions, and the facades can be protected with clip-in fire shutters.

"This takes away the need to stay and protect," says Mr Baldwin, meaning people can "close up and know their house will still be there when they get back, so they can get out quicker."

Efficient Earth-Sheltered Homes

https://www.energy.gov/energysaver/types-homes/efficient-earth-sheltered-homes

Earth-sheltered housing can cost less to insure because they offer extra protection against extreme heatwaves, high winds, hailstorms, extended blizzard conditions and natural disasters such as bush fires, the devastating winds and rains from cyclones, tornados and hurricanes. However, the cost is significantly higher in construction.

Studies show that earth-sheltered houses are more cost-effective in climates that have significant temperature extremes and low humidity, such as the Rocky Mountains and northern Great Plains of USA. Earth temperatures vary much less than air temperatures in these areas, which means the earth can absorb extra heat from the house in hot weather or insulate the house to maintain warmth in cold weather.

Site-Specific Factors for Earth-Sheltered Home Design

Before deciding to design and build an earth-sheltered house, you'll need to consider your building site's climate, topography, soil, and groundwater level.

Climate

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Topography and Microclimate

The site's topography and microclimate determine how easily the building can be surrounded with earth. A modest slope requires more excavation than a steep one, and a flat site is the most demanding, needing extensive excavation. In the northern hemisphere, a south-facing slope in a region with moderate to long winters is ideal for an earth-sheltered building. South-facing windows can let in sunlight for direct heating, while the rest of the house is set back into the slope. (The reverse for southern hemisphere – north facing is preferred.) In regions with mild winters and hot summers, a north-facing slope might be ideal. Careful planning by a designer familiar with earth sheltering can take full advantage of the conditions on your particular site.

Soil

The type of soil at your site is another critical consideration. Granular soils such as sand and gravel are best for earth sheltering. These soils compact well for bearing the weight of the construction materials and are very permeable, allowing water to drain quickly. The poorest soils are cohesive, like clay, which may expand when wet and has poor permeability.

Professional soil tests can determine the load-bearing capability of soils at your site. Soil radon levels are another factor to consider, because high concentrations of radon can be hazardous. There are, however, methods for reducing radon build-up in both conventional and earth-sheltered dwellings.

Groundwater Level

The groundwater level at your building site is also important. Natural drainage away from the building is the best way to avoid water pressure against underground walls, but installed drainage systems can be used to draw water away from the structure.

Construction Materials and Considerations for Earth-Sheltered Homes

The construction materials for each earth-sheltered structure will vary depending on characteristics of the site and the type of design. Materials must, however, provide a good surface for waterproofing and insulation to withstand the pressure and moisture of the surrounding ground.

Concrete is the most common choice for constructing earth-sheltered buildings, because it strong, durable, and fire resistant. Concrete masonry units (also called concrete blocks) reinforced with steel bars placed in the core of the masonry can also be used, and generally cost less than cast-in-place concrete.

Wood can be used in earth-sheltered construction for both interior and light structural work. Steel can used for beams, bar joists, columns, and concrete reinforcement, but must be protected against corrosion if it is exposed to the elements or to groundwater. It is also expensive, so it must be used efficiently to be economical as a structural material.

Other Construction Considerations

Waterproofing

Waterproofing can be a challenge in earth-sheltered construction. Keep in mind these three ways to reduce the risk of water damage in your house: choose the site carefully, plan the drainage both at and below the surface of the house, and waterproof your house.

Waterproofing systems to consider include:

- Rubberized asphalt combines a small amount of synthetic rubber with asphalt and is coated with a polyethylene layer to form sheets. It can be applied directly to walls and roofs and has a long life expectancy.
- Plastic and vulcanized sheets are among the most common types of underground waterproofing. Plastic sheets include high-density polyethylene, chlorinated polyethylene, polyvinyl chloride, and chlorosulfonated polyethylene. Suitable vulcanised membranes or synthetic rubbers include isobutylene isoprene, ethylene propylene diene monomer, polychloroprene (neoprene), and polyisobutylene. For all these materials, the seams must be sealed properly to guard against leaks.
- Liquid polyurethanes are often used in places where it is awkward to apply a membrane, and are sometimes used as a coating over insulation on underground structures. Note that weather conditions must be dry and relatively warm during their application.
- Bentonite is a natural clay formed into panels that are nailed to walls or applied as a liquid spray. When the bentonite comes in contact with moisture, it expands and seals out moisture.

Humidity

Humidity levels may increase in earth-sheltered houses during the summer, which can cause condensation on the interior walls. Installing insulation on the outside of the walls will prevent the walls from cooling down to earth temperature, but can also reduce the summer cooling effect of the walls. Careful planning by a designer familiar with earth-sheltered home design can keep humidity from becoming a problem.

Insulation

Although insulation in an underground building does not need to be as thick as that in a conventional house, it is necessary to make an earthen house comfortable. Insulation is usually placed on the exterior of the house after applying the waterproofing material, so the heat generated, collected, and absorbed within the earth-sheltered envelope is retained inside the building's interior. If insulating outside the wall, a protective layer of board should be added to keep the insulation from contacting the earth.

Air Exchange / Air Quality

Adequate ventilation must be carefully planned in an earth-sheltered house. Combustion appliances should be sealed combustion units that have a direct source of outside air for combustion and vent combustion gases directly to the outside. In addition, avoiding indoor pollutants such as formaldehyde from foam insulation, plywood and some fabrics can help keep indoor air healthy. An energy recovery ventilator, which exchanges heat in the outgoing exhaust air with incoming fresh air, minimises heat loss while ensuring good indoor air quality and is a useful addition to any energy-efficient home.

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Square Roots climate-controlled, indoor farms recreate ideal growing conditions from around the world—without pesticides or GMOs.

Square Roots is an urban indoor farming company growing local, real food while training the next gen eration of leaders in agriculture.

How to Build an Underground, Off-Grid, Virtually Indestructible Home

https://www.offthegridnews.com/grid-threats/the-surprising-facts-about-earth-sheltered-living/

As we travel downward it gets hotter and hotter, and this precludes digging all the way to the centre of the Earth and beyond. But the Earth's capacity to produce and hold heat can be of great benefit to human beings. If instead of trying to dig to China we instead go just a few feet down, we will discover temperatures that are always moderate even on the most frigid winter days – and also on the hottest summer days, since the Earth's temperature at a depth of a few feet does not fluctuate more than slightly over the course of an entire calendar year. The planet's natural warmth can be exploited as a source of energy (geothermal), but it can also be used to shelter living spaces and protect them from the elements all year round.

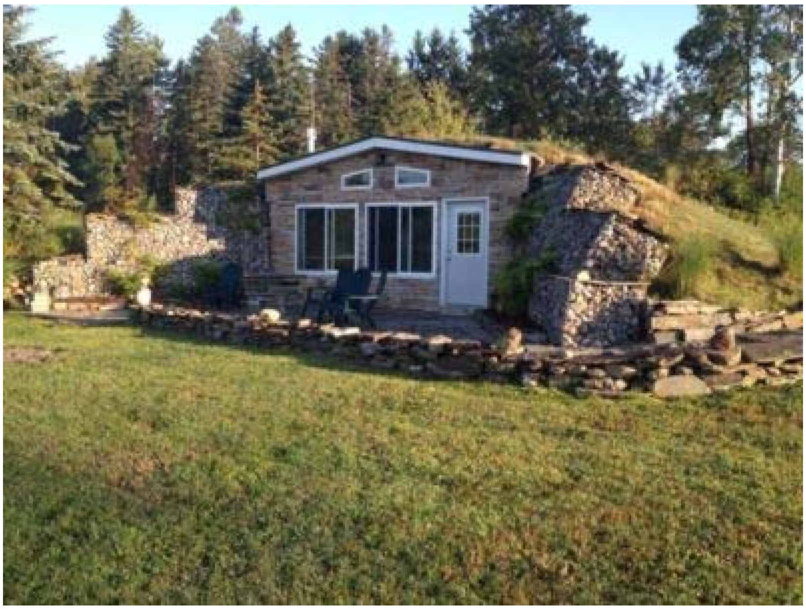
Yes, it is indeed possible to build homes that are partially or almost completely buried beneath the ground or the earth, and this type of residential construction has a lot to recommend it to those who are concerned with reducing costs and holding down their resource consumption, as well as protection from the extremist of weather and Earth events.

Earth-Sheltered Living Options: A Summary and Assessment

While earth-sheltered housing is not common, it has been around for a while. During the energy crisis of the 1970s, people became increasingly interested in finding ways to reduce their consumption of fossil fuel and energy-efficient forms of architectural design and construction began to draw a lot of attention. Underground living seemed to offer great promise, and many experiments were undertaken to explore potentially practical options for earth-sheltered homes that would be affordable and efficient.

These efforts met with mixed success, but the underground / earth-sheltered living movement never completely died out. In the years since the initial burst in interest introduced this unique and innovative style of building and living to the masses, much has been learned about what works and what doesn't, and as a result people who are interested in constructing earth-sheltered dwellings now have some legitimate options to choose from.

The key principle that gives earth-sheltered homes their utility and viability is thermal mass. This scientific measuring standard rates the ability of materials to absorb and retain heat, and it turns out that the ground beneath our feet has a higher thermal mass than just about any other substance. The earth's capacity to store heat and store a lot of it for a long period of time is quite impressive, and it is the ground's thermal mass properties that explain the consistently warm-to-moderate temperatures we find when we move just a few feet down below the surface.



While some earth-sheltered homes are built completely beneath ground level, many are constructed using a technique known as berming. Earth-bermed homes are built largely above ground, but piles of soil are then pushed up against the walls – all the way to the top – to form a protective cocoon of earth and vegetation that will separate the outer shell of the home from the open air. Roof covers of soil and vegetation may or may not be included with earth-bermed homes, but most seem to prefer them since they do increase a house's protection against atmospheric heat and cold.

There are three primary design styles for earth-sheltered homes: atrium, penetrational, and elevational. For those who would like to maximize their protection from the sun, the wind, the heat, and the cold, the atrium style is definitely the way to go. All of the rooms in such a residence are built completely beneath the surface of the earth, in a "town square" type of arrangement surrounding a central atrium space that functions as the home's entrance from above ground. Each of the rooms of the home will face the atrium on the north, south, east, or west, with spacious windows and possibly glass doors to allow the natural light to filter in from above. A short flight of stairs down into the atrium is all that is necessary to reach the bottom of the home's central space, as the underground rooms are generally placed no more than three feet beneath the earth's surface, given that subterranean temperatures are steady beyond this point.

Because its open outdoor space and adjacent rooms and entrances are all below ground, the atrium style delivers the most privacy and the greatest amount of protection from the vagaries of nature (high winds, thunder storms, cyclones, tornadoes, hurricanes, wildfires, etc.). However, because it is literally a hole in the ground, the atrium can easily fill with snow in a blizzard or rainwater in a tempest, which can cause flooding and drainage problems if some kind of system for diverting rain or melting snow has not been installed. Because the living areas are entirely beneath ground level, the rays of the sun are not able to enter at a low enough angle to provide ample amounts of natural light, and because the central outdoor space opens directly to the empty sky, the views enjoyed from inside the home are only as good as the effort that has gone into creating an attractive atrium space.

The elevational style, strictly speaking, is neither underground nor bermed, but is more of a combination of both. Elevational homes are built directly into hillsides or mountainsides, looking almost as if they have been inserted into the mouth of a cave, to enough depth to completely cover the side and back walls of the home. The front of the house is left open to the air, usually facing the south (northern hemisphere) in order to harvest the natural heat and light provided by the daily sun. Roof covers are normally added to such a home to complement the berm-like sheltering effect of the hillside, and houses constructed in the elevational style have shallow rectangular shapes that feature bedrooms and living spaces arranged linearly in the foreground so the sun can provide heat and light to all the important rooms of the house. Elevational homes are the least expensive type of earth-sheltered structure to construct, and with their hillside locations they frequently offer grand panoramic views of surrounding natural vistas.

Penetrational homes are built above ground, but are designed to fully exploit the protective abilities of the earth. Each wall of a home constructed in the penetrational style is completely bermed, with only the spaces over doors and windows left open to facilitate easy entrance, good cross-ventilation, and the effective harvesting of natural light. Roof covers are the perfect finishing touches for such a home, which is so well protected from the elements that it might as well be completely under the ground, even though the entrance of light and air remains unobstructed. Variations on the penetrational approach are certainly possible; for example, the southern side could be left open as it is in an elevational home, while the rest of the house (save for the windows and the back door of course) would be fully bermed.

Problems and Issues

Inside the protective shell of the earth, temperatures generally remain between forty-five and sixty-five degrees Fahrenheit (7°C - 18°C) all year round, and it is this moderate range that allows underground homes to remain comfortable in all seasons. Because the surrounding temperatures are so mild, heating and cooling costs can be reduced from 50% to 70% in an earth-sheltered residence.

However, this will require the use of insulation, since unprotected walls will eventually reach thermal equilibrium with the surrounding earth unless steps are taken to ensure that heat produced or collected inside the home is not leached away through the walls. The value of the earth as a climate modifier does not come from its insulating properties, which are minimal, but rather from its capacity to soak up and hold warmth, allowing it to maintain a moderate temperature level and dramatically reduce the need for artificial heat or air conditioning in an earth-sheltered home. But thermal equilibrium must be avoided, since the temperature of the earth at a few feet below the surface is just a bit too cool for comfort. So insulation will need to be used on the outside of the walls in an underground or bermed home to make sure that livable temperatures can be maintained inside with less reliance on secondary heating sources – or no reliance on them at all in the summer time. To keep the insulation from touching the earth, a protective layer of board will have to be added, and the wood used must be thick and strong enough to withstand the pressure of the earth pressing against it without warping or breaking.

While insulation is important, before it can be added the outside areas of an underground or earth-bermed structure must be fully waterproofed. Thin sheets of plastic, rubber, or artificial rubber specially designed for home protection will need to be applied to the walls and the roof to make an earth-sheltered residence watertight, since the earth can easily pass on moisture to anything with which it comes in contact. With the insulation placed on top of the waterproofing, things are even better protected, and a special type of drainage or filtration mat will need to be placed over the insulation on the roof in order to make sure that any moisture that comes from above can be easily channelled away. Underneath the poured concrete foundation of an earth-sheltered home, a layer of sand at least four inches deep (for the purposes of drainage) should be put in place, so that water cannot work its way into the home from below. A living roof made of soil and vegetation can provide even more protection from the elements, as much of the rain that falls from above or washes over the top of the home will be absorbed by the roots of the roof's plant life before it can seep in deeper and cause trouble.

Choice of location for an earth-sheltered home will go a long way toward eliminating any potential moisture problems. Areas where run-off from rain or melting snow could be a factor should be avoided, as should locations that have low spots where water might collect. Most importantly, it is essential to always build above the water table, otherwise even the best waterproofing schemes will be tasked to the breaking point, and it may prove all but impossible to keep moisture from leaking through into the home.

The weight and pressure of the earth will obviously put an enormous strain on the walls and roof of an earth-sheltered home, which is why concrete makes an excellent choice for a building material. While poured concrete can work just fine for the foundation and the floor, concrete blocks stacked and coated with a thin layer of fibre-reinforced surface-bonding cement are the proper selection for the walls of an earth-sheltered home, which must bear up under lateral pressures that can be quite significant. Heavy timbers should be used to construct the roof, which must be able to handle the combined load of the earth above it and the snow that falls in winter.

Even though underground or earth-sheltered living is highly efficient, because it is unconventional and has some special requirements the costs of a home constructed in this style will generally run from 10 to 30 percent higher than the average aboveground structure. Ultimately, the return on investment provided by lower fuel costs will more than negate the extra upfront costs, but for some, the higher initial expenditures could be a deal breaker. Studies have shown that over the long haul, earth-sheltered building is most economical for those living in climates that have significant temperature extremes and low humidity, such as the Rocky Mountains and the northern Great Plains. Elevational homes are the cheapest to build, but they tend to pay for themselves quickly only in those locations where relatively long and cold winters are the norm.

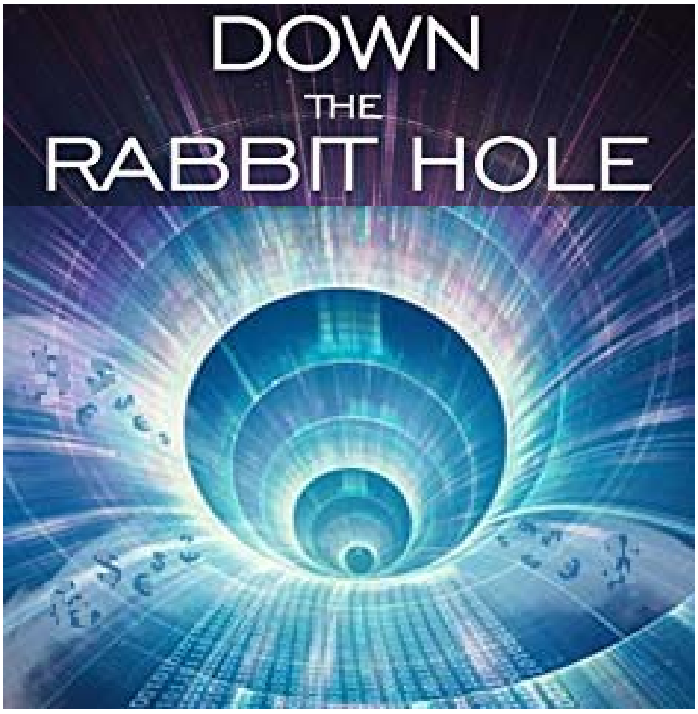
One hidden problem that potential underground home owners must be aware of is the possible presence of radon, a colourless and odourless gas produced in the ground by uranium decay that can be life-threatening if it collects in sufficient concentrations. While it is not impossible to build an earth-sheltered structure in areas with elevated radon levels, steps will have to be taken to guarantee that all radon can be collected and vented from the home, which adds another layer of expense onto a project that already can cost a pretty penny.

The Undeniable Advantages of Earth-Sheltered Living

To those hearing of it for the first time, underground living might sound more like exotic fantasy than practical reality, something we would put in the same category as flying cars or cities built beneath the surface of the sea. It all seems so impractical and fanciful somehow. But earth-sheltered living, far from being the stuff of science fiction, is actually a practical and cost-efficient option in many circumstances, as long as careful thought and effort are put into the design, site selection, and construction stages of the projects. A number of details must be taken care of to make sure an earth-sheltered home will be warm enough, sturdy enough, and dry enough to be liveable and stand the test of time, and this precludes cutting corners or taking shortcuts that might compromise performance.

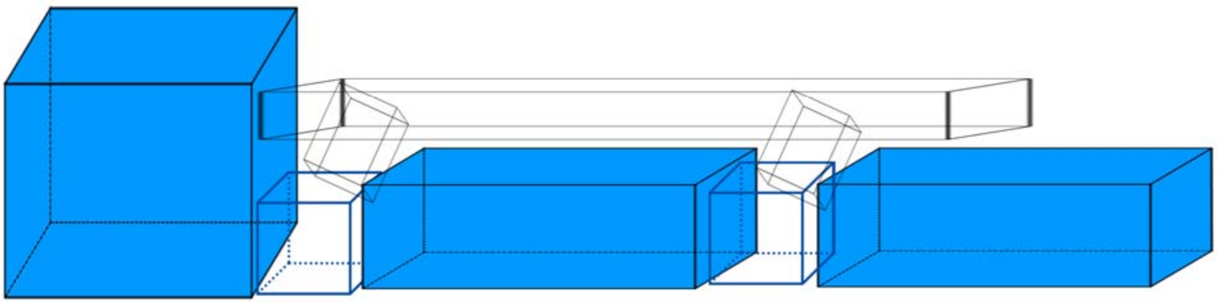
But once an earth-sheltered home is finished, what you will have on your hands is something very special indeed. Because it is protected from the elements, it will require little maintenance and can outlast a conventional home by decades. Because it is constructed to take advantage of the temperature-moderating effects of the earth's immense thermal mass, it will stay warm in the winter and cool in the summer without demanding significant inputs from energy-consuming auxiliary heating and cooling systems. And because it is so incredibly well-sheltered by the warm embrace of the surrounding earth, an earth-sheltered home will be largely impervious to the ravages of natural disasters such as cyclones, tornadoes, hurricanes, earthquakes, and bush fires, not to mention the predations of human intruders with bad intentions.

So while it may be a surprise to discover for some, earth-sheltered living is an exciting option that all who are willing to think outside the box in their search for a more efficient way of living should investigate fully before they proceed with their plans to construct their brand new homes.

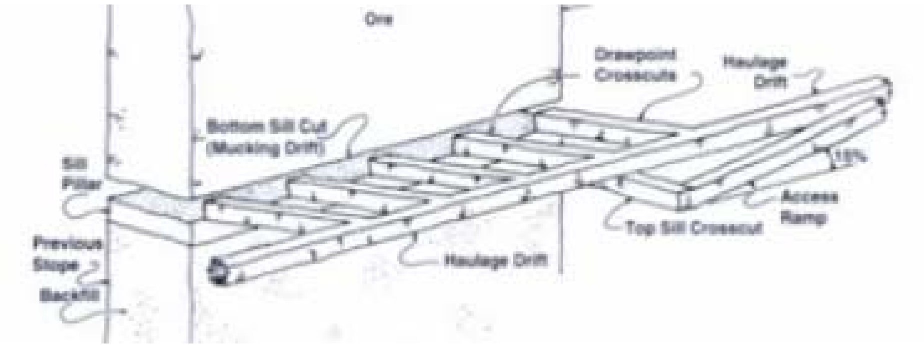


Storage School Accommodation

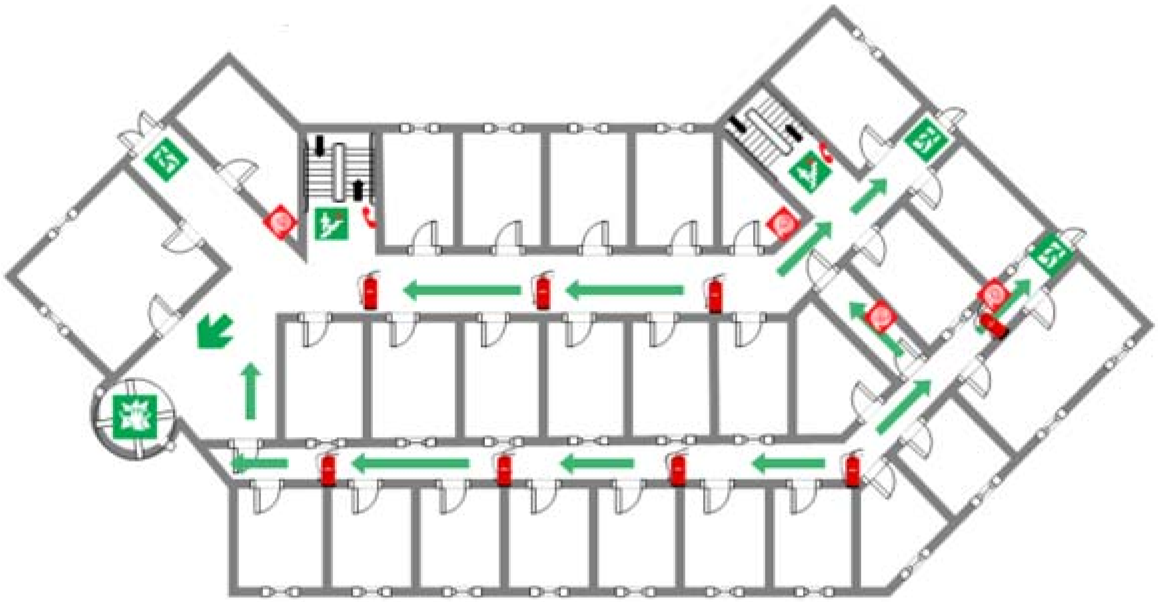
Heavy equipment entry tunnels between each unit with crossover tunnel to facilitate later extensions as well as providing emergency services and exit.

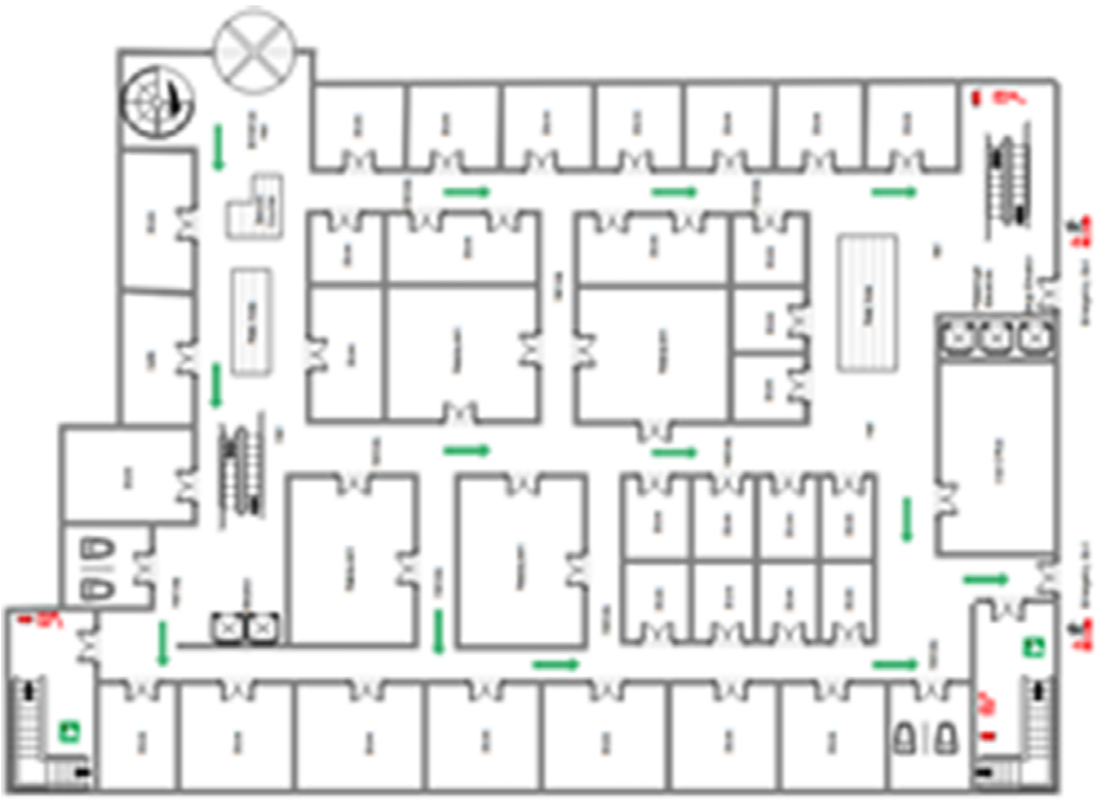


Three major entrances, one for each of storage, schooling and accommodation. One extra as emergency exiting as well as entry for further extensions should they be required.

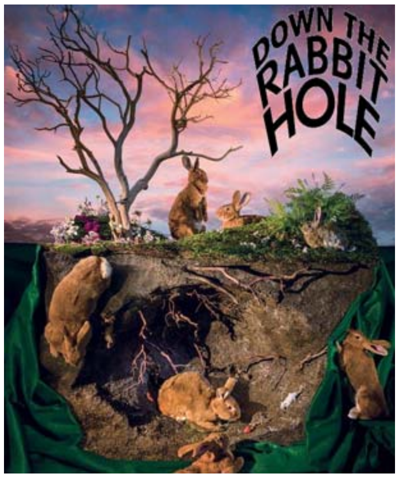


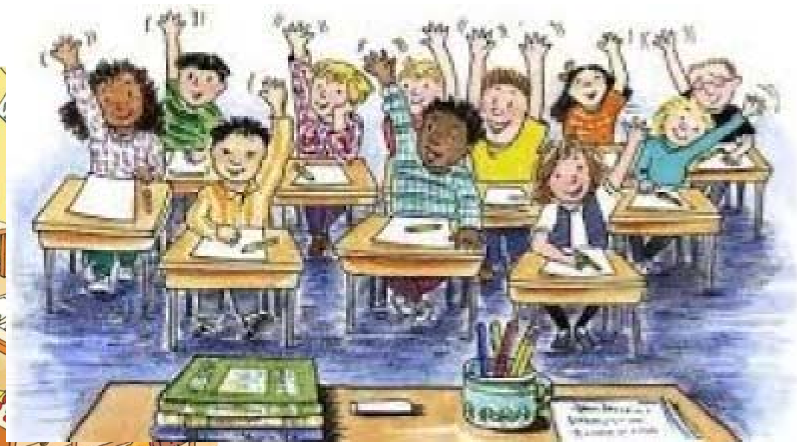
12 Unit Per Floor






BALCONY
KITCHEN
LOBBY
BEDROOM
BATH
STAIRCASE
CORRIDOR
LIFT

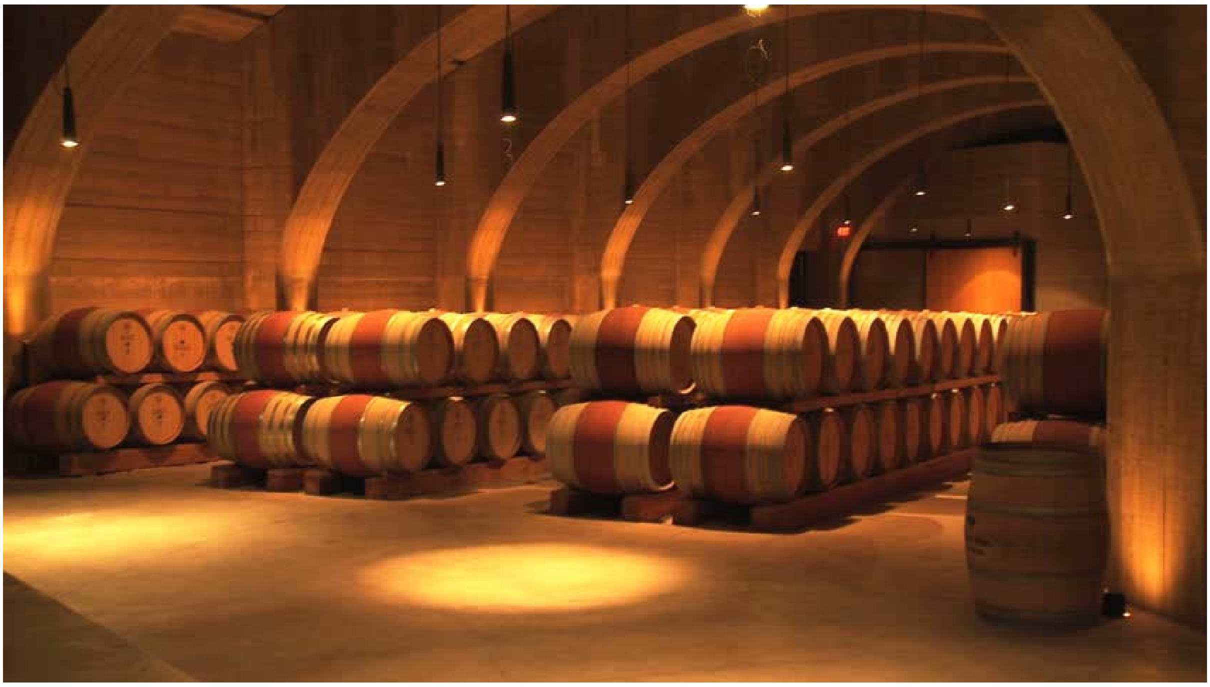

DOWN THE RABBIT HOLE

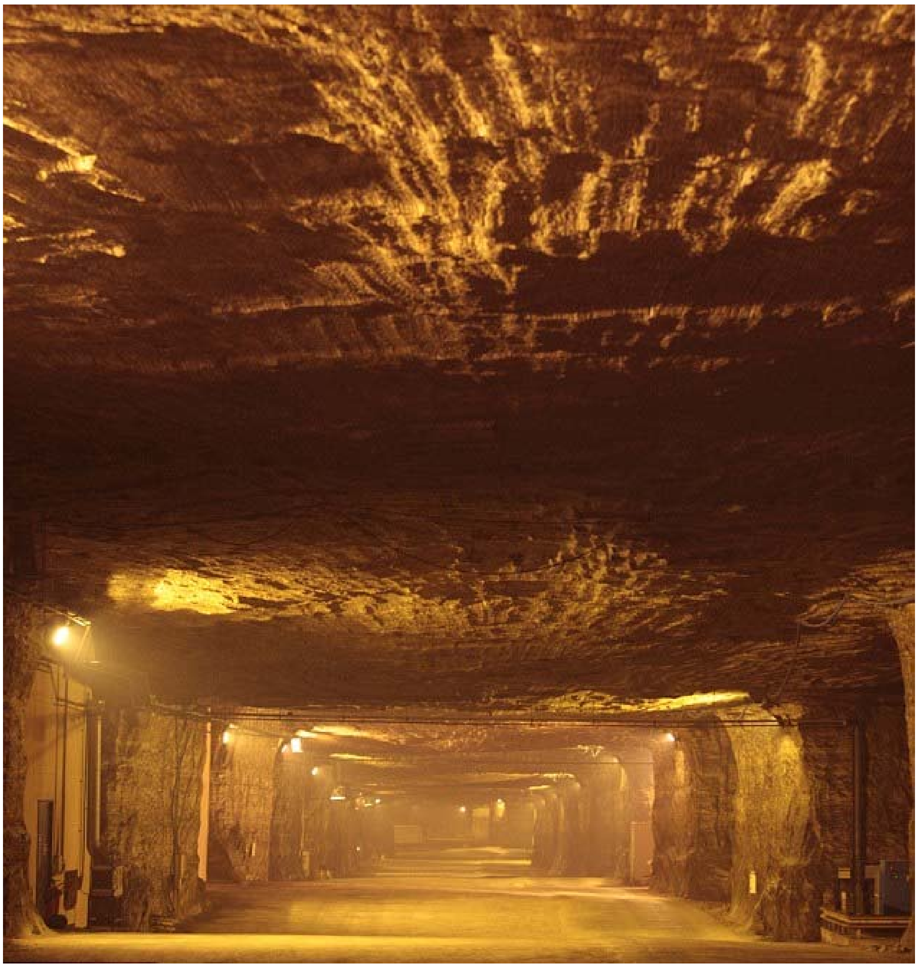



x+y=xy

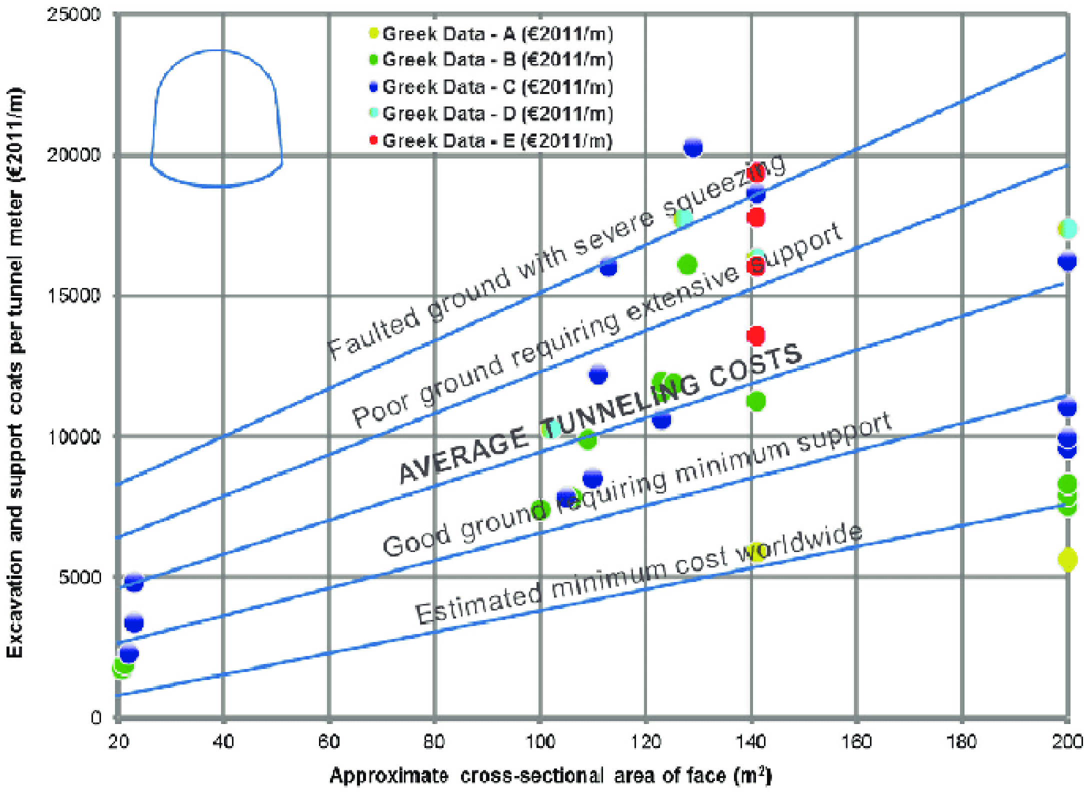

Motel Rooms, Budget & Dorm Accommodation


Motel Rooms, Budget & Dorm Accommodation






SANDVIK
DD422iE


Greek Data - A (€2011/m)
Greek Data - B (€2011/m)
Greek Data - C (€2011/m)
Greek Data - D (€2011/m)
Greek Data - E (€2011/m)
Faulted ground with severe squeezing
Poor ground requiring extensive support
AVERAGE TUNNELING COSTS
Good ground requiring minimum support
Estimated minimum cost worldwide
Excavation and support costs per tunnel meter (€2011/m)
Approximate cross-sectional area of face (m²)
25000
20000
15000
10000
5000
0
20
40
60
80
100
120
140
160
180
200

Tunnelling differs from the construction of other infrastructure in a plethora of ways. The main issues that distinguish tunnels from other infrastructure arise from the risk involved with excavation through unknown ground conditions and the numerous individual cost drivers that contribute to the overall cost. These cost drivers include, but are not limited to the following direct and indirect factors, all of which must be accounted for in our analysis.

• Geology • Excavation Type • Materials / Plant • End-Use • Length

• Face Area • Depth • Lining Type • Locality • Labour Cost

• Health and Safety Regulations • Market Competition • Client Knowledge

• Government and Public Support • Contract Type • Cost of Bidding

Consider AU$500 m^3 for excavation costs. Then follows normal finishes.

Magnesium Concrete – Mysliwiecz geopolymer / Canadian concrete – Gladstone – durable 1,000 years (Portland calcium lasts 70 years). Magnesium oxide to carbonate.

Steve Rhind – his company that is involved in the tunnelling is Kingsfeld Excavation & Haulage Contractors, *Kingsfeld* Pty Ltd. 100 Nuwarra Rd Moorebank NSW 2170. Company Representatives. *Steve Rhind*, Managing Director – 0418 264 003

Scenic Rim's Natural History

The Scenic Rim, south-east Queensland, Australia, is a naturally beautiful region and it's these natural attractions that draw thousands of visitors each year.

The Scenic Rim is home to six National Parks. In December 1994 parts of the Main Range, Lamington, Springbrook and Mt Barney National Parks were included in the Central Eastern Rainforest Reserves Australian World Heritage Listed Area.

Volcanic history

It's not until you investigate how the Scenic Rim came to be that you realise how significant this dense cluster of mountains is. The Scenic Rim Mountains and the Mt Warning area in northern NSW are known as the Green Cauldron and were once a volcanic hotspot, which over the years has grown into a lush landscape featuring six National Parks.

Scenic Rim geologist, Dr John Jackson, says the Scenic Rim was formed over a three million year period, more than 26 million years ago.

"As the heat intensified, volcanic activity erupted and the mountains formed from magmas and lavas that intruded from the hotspot," Dr Jackson explains.

Mt Warning and Focal Point Mountains are known volcanoes and John says there were most probably others, but proving it is difficult.

"Australia was travelling north over a hotspot, then it changed direction and slowed down and that is the real reason for the Scenic Rim. The change in direction and the slower speed allowed for the build up of the dense mountain range. To give you an idea of the speeds, when Peak Crossing to the Glass House Mountains was formed we were travelling about 70km/million years. That speed slowed to 26km/million years when the Scenic Rim was created and you get the effect of the mountains that are all stacked up together".

"By the time we reached Mt Warning, Australia speeds up again and the mountains are more dispersed."

Natural Flora and Fauna

This early volcanic activity reveals itself in the region's rich flora and fauna. The temperate climate and rich basalt soils have proven fertile grounds for rainforests to prosper.

"It all comes down to the chemistry of the rocks and the soil which leads to different vegetation and different birds and animals which feed on the different seeds," says Dr Jackson.

"All of this comes from the rocks, that's where it all begins."

The Scenic Rim region is a treasure trove of unique plants, animals and distinctive vegetation types. The mountains preserve living links to Australia's ancient past, while one of Australia's two species of lyrebird inhabits the region's rainforest and wet eucalypt forests. The stories, rituals and traditions of the indigenous inhabitants are woven around the natural environment and highlight their connection to a living landscape.

Basalt, solid weighs 3.011 gram per cubic centimetre or 3,011 **kilogram** per cubic metre, i.e. **density** of **basalt**, solid is equal to 3,011 **kg**/m³.

Rock	Density		
Andesite	2.5–2.8	Limestone	2.3–2.7
Basalt	2.8–3.0	Marble	2.4–2.7
Coal	1.1–1.4	Mica schist	2.5–2.9
Diabase	2.6–3.0	Peridotite	3.1–3.4
Diorite	2.8–3.0	Quartzite	2.6–2.8
Dolomite	2.8–2.9	Rhyolite	2.4–2.6
Gabbro	2.7–3.3	Rock salt	2.5–2.6
Gneiss	2.6–2.9	Sandstone	2.2–2.8
Granite	2.6–2.7	Shale	2.4–2.8
Gypsum	2.3–2.8	Slate	2.7–2.8