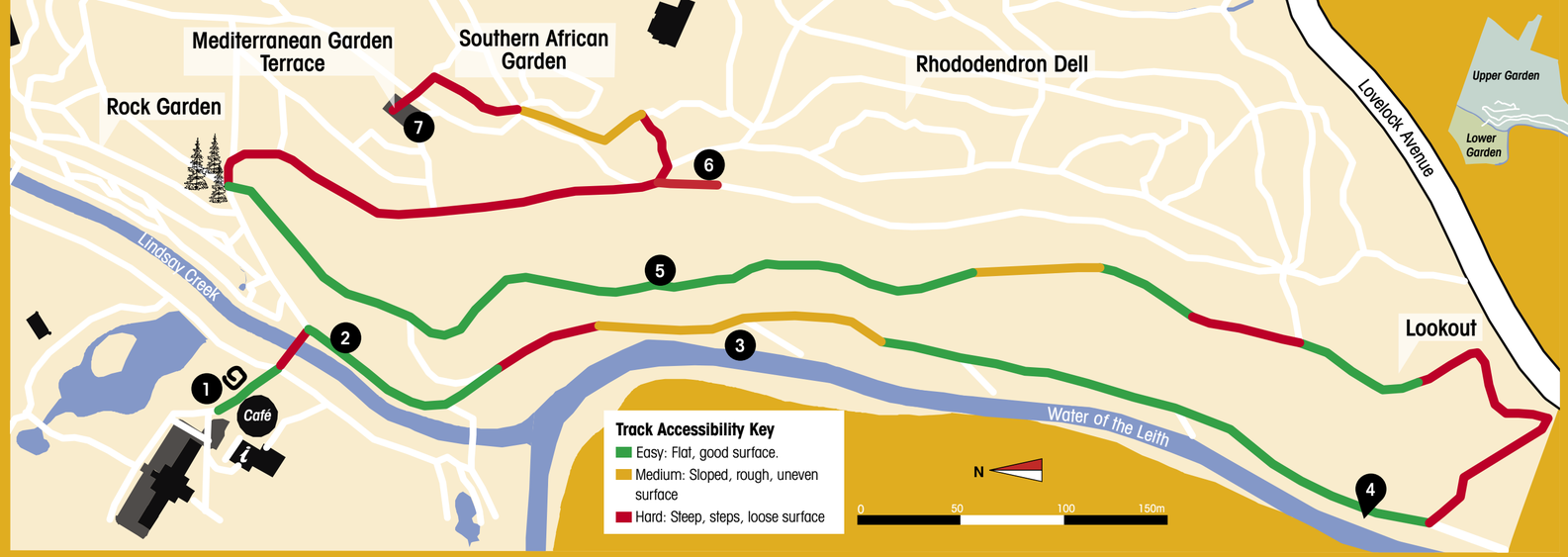
DUNEDIN BOTANIC GARDEN



Climb up the Dunedin Volcano

STOP 1 Old rock at heart of Dunedin Botanic Garden

Look past the worm sculpture to the base of the hill. One of the oldest parts of the volcano is just beneath the surface, now covered by the rock garden.

Hot, liquid basalt shot up from deep in the earth as part of the volcano's first eruptive phase around 16 million years ago. Basalt lava is free flowing and cools to form dark rocks and gently sloping hills.

More than 90% of the world's volcanic rocks are primitive basalt. The next stop looks at a more evolved, rare rock type.

Raw rock is future food for plants

When basalt escaped from the depths it brought to the surface exceptionally rich minerals which are essential to plant life.

After the basalt cooled and solidified, millions of years of weathering wore it down into a particularly fertile soil. Rich in magnesium and iron, it supported expansive forest, similar to what remains on Mount Cargill. A couple of trees from that original forest still survive in the Garden.

STOP 2 Time capsule of rare rock

Just across Lindsay Creek bridge, turn right. A cliff face has remnants of six-sided columns, created during the second eruptive phase, some 15 to 12 million years ago. Hot lava cooled then shrunk and cracked like mud. Today we can see fragments of broken columns.

This rare type of rock, trachybasalt, is a more "evolved" form of basalt than that under the rock garden. It took a long time to reach the surface.

This meant more time under the influence of underground pressure and temperature. Chemical changes also affected mineral content. As a result, trachybasalt became the raw ingredient for rich soil with particularly high levels of nickel, copper, zinc and other essential ingredients of life.

STOP 3 From sea floor to mountain top to river valley

Below us in the river are rocks made from remnants of other rocks. They come from the Silver Peaks, beyond the hills you can see in the far distance.

Well before the birth of Dunedin Volcano, some 250 million years ago, erosion left loose sediment on the sea floor. Over time, the sediment was buried, crushed and heated into a new rock, called schist, which was pushed up to form the hills.

Sand, silt and mud washed down the river during normal flow conditions, and larger stones and boulders tumbled down during floods. As they bumped against each other, rough edges were sandpapered and their shapes became more round and smooth.

Sedimentary rocks contain a lot of sand-sized grains, resulting in soils with good drainage and freely available nutrients.

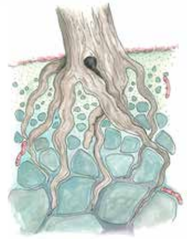
Fast moving environments host fast growing plants

Plant species growing in high-disturbance environments such as rivers can be quick growing, produce a lot of seed and complete their whole life cycle in just one year. This allows them to survive and thrive despite disruption.

From rock to soil

Rock is worn down by wind, rain and freeze-thaw cracking. Penetration by plants' roots also contributes to the process, as is happening on the bank above you.

Soil microbes, bacteria, insects and earthworms slowly break down and mix the rocks, clays and plant material into soil.



STOP 4 Rare rock type

Directly on the opposite side of the river is a stiffened lava flow at the base of the tree.

It is a particularly rare type of rock, phonolite. Worldwide, it is less than 1% of exposed volcanic rock, and in the Garden it exists only in this far corner.

Like the rock at stop 2, it is also part of the volcano's second eruptive phase. But the phonolite was underground for even longer and is the most evolved rock type in the Garden. All this processing means it contains a special chemical cocktail of minerals for making soil – silica, sodium and potassium. These are all either beneficial or essential for plant life.

When phonolite erupts as lava it is very sticky and doesn't spread very far, so tends to form domes. Many of the peaks around Dunedin are actually domes of phonolite.

Rocks affect soil chemistry

The mineral composition of a rock affects the chemistry of the soil formed from that rock and its "acidity" or "alkalinity".

Over time water leaches through rock and soil, carrying nutrients away, leaving the soil acidic (like a lemon). Soils that formed from certain rocks have a greater ability to resist this acidification than others. Under certain rare conditions of rock type, climate and location, some soils can become alkaline (like soap), the opposite of acidic.

Plants do best in soil which is neither highly acidic nor highly alkaline because both extremes limit nutrient availability. Somewhere in between is good.

Nevertheless, different plant species are adapted to soils of different acidity and alkalinity. For example, the native kowhai, *Sophora longicarinata*, grows on alkaline limestone whereas rimu (*Dacrydium cupressinum*) will tolerate acidic soils.

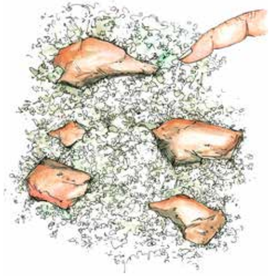
STOP 5 New rock created between eruptions

Eruptions can be separated in time by thousands to millions of years.

This slightly odd looking rock marks a dormant period after the eruptions below us. While the volcano slept, old lava flows were scraped away by weathering, then pressed and squashed to form this new sedimentary rock. You can still see dark fragments of the original volcanic rock.

An ancient river might have helped erode the original rock. It may have had a completely different source to the Water of Leith below us and even flowed in a completely different direction. Things were so different that the Water of Leith probably didn't even exist then.

Despite being only metres thick, this sedimentary rock represents a huge time period between eruptions, perhaps lasting millions of years.



Quick home for plants

Because sedimentary rock consists of layers, it breaks down quickly. Compared with volcanic rocks, it forms soil quickly. This offers an early home for plant life when a new ecosystem is forming.

STOP 6 The top of the volcano

We are now walking through the youngest exposed lava flow in the Botanic Garden, part of the third and final eruptive phase of the Dunedin Volcano. Above us, the slope of the hill becomes nearly flat, the top of the youngest lava flow.

The rocks here may be as young as 10 million years old. Once again this basalt has cooled and cracked in a hexagonal pattern to form columns.

Volcano a great base for a botanic garden

Native plants have grown up adapting to basalt's nutrient-rich soils. Supplemented by wind-blown dust, Dunedin's volcanic soils also make a great underlay for a botanic garden.

As well as the volcano's contribution, gardeners constantly supplement the raw soils with top layers to create ideal growing conditions.

STOP 7 Dunedin Volcano formed Dunedin

You have just walked through millions of years of geological time, from some of the oldest eruptions of the Dunedin Volcano to one of the most recent.

Weathering and water eroded the volcanic rocks; time and pressure rebuilt them. The end result is different soil types with their own particular qualities, each contributing to the Garden being such a great place for plants.

Flagstaff, the high hill in the distance, is also made of volcanic rocks and is part of the same volcano. All of Dunedin is. There are quite a few things about the volcano we don't yet know but we do know its role in forming such rich soils for plants.

Manaaki Whenua Landcare Research

Climb up the Dunedin Volcano

Dunedin Botanic Garden is planted on a long extinct, ancient volcano of rare rocks. They show us a graphic picture of the violent changes that happened here over millions of years.

This one hour walk will lead you through layers of time, starting at the base of the hill with rocks that erupted first, then finishing at the top with the most recent. Some sections are steep; others are flat. This is the best spot in the city to see three phases of the volcano so clearly.

You will see the planet's different types of rock and learn about the forces that built them. You'll also see how volcanoes create fertile soil essential to plant life.

Dunedin Volcano is extinct

There were at least two main vents to the Dunedin Volcano, one near Port Chalmers and the other at Hooper's Inlet. Elsewhere around the city were many more, small volcanic centres; the nearest to the botanic garden was at the quarry site near Logan Park.

Dunedin Volcano has not erupted for millions of years and is not expected to anytime soon.

Volcanoes create different types of rock

Magma (melted rock) wells up from deep within the Earth. After cooling, some rocks remain as is but others are crushed or heated to form something completely new, called metamorphic rock.

A further type, sedimentary rock, is formed from the erosion of existing rocks. Loose sediment is squeezed together underground, resulting in rocks with visible layers that can sometimes even be pulled apart.

How did magma get there in the first place?

Scientists think the planet began as a disc of material from the solar system. The disc had a magma ocean containing elements, the tiny building blocks of chemicals.

The disc's spinning pulled the heavy elements into the middle. The lighter material was flung to the outside and as it cooled, started to form the planet's crust.