STORIES IN STONE

WEST COAST STORY: CAPE TOWN TO CAPE COLUMBINE

Duncan Miller

Parts of the text have been reworked from the following articles published previously:

Miller, D. 2007. A brief history of the Malmesbury Group and the intrusive Cape Granite Suite. *South African Lapidary Magazine* 39(3): 24–30.
Miller, D. 2008. Granite – signature rock of the Cape. *Village Life* 30: 42–47.
Miller, D. 2009. Cape Columbine – the westernmost exposure of the Cape granites. *South African Lapidary Magazine* 41(1): 5–8.

Amour Venter and Jo Wicht are thanked for their permission to use photographs taken on various field trips of the Cape Town Gem & Mineral Club.

Safety

Some locations can be dangerous because of opportunistic criminals. Preferrably travel in a group with at least two vehicles. When inspecting a road-cut, park well off the road, your vehicle clearly visible, with hazard lights switched on. Be aware of passing traffic, particularly if you step back towards the road to photograph a cutting. Keep children under control and out of the road.

Previous page: The Cape Columbine lighthouse, near Paternoster on the Vredenburg Peninsula

CAPE TOWN TO CAPE COLUMBINE

This route starts with a look at the intrusive contact between Cape granite and Malmesbury hornfels at Sea Point. A visit to a special outcrop of Malmesbury Group rocks at Bloubergstrand then takes you on a tour along the West Coast to various exposures of rocks of the Cape Granite Suite.

Anyone driving around the Cape Peninsula is familiar with granite, perhaps without even knowing it. It forms the rounded boulders exposed along the shoreline from Sea Point to Chapman's Peak on the western seaboard; and from Simon's Town, past Boulder's Beach with its comical penguins, to Miller's Point on the False Bay coast. Above these granites lie the horizontal beds of the yellowish Table Mountain sandstone, which is younger than the granite.

So, how did it get there? Geologists now know that when continents collide and ancient seas are squeezed between them, it gives rise to huge mountain chains, like the Himalayas or the Alps. In their roots partly molten rock intrudes the deeply buried and heated sediments, eventually cooling to form pods of granite. Such a mountain chain wrapped itself around what is now southern Africa, but it wore down through erosion very rapidly, and in a couple of million years was reduced to an undulating plain at sea-level. This plain, made up of an exposed patchwork of Malmesbury Group rocks and intervening humps of Cape granite, eventually was drowned by the sea. Sandy shoreline sediments were deposited, solidifying with progressively deeper burial, to form the Table Mountain sandstone. Subsequent uplift and erosion has stripped off most of the sandstone, leaving steep cliffs rising above the granite lower storey.

The granite of the Cape Peninsula is a typical granite, with coarse mineral grains which crystallised slowly out of the deeply buried molten mass as it cooled. If you look at it closely, the most conspicuous mineral is a feldspar, which forms blocky, light coloured crystals, sometimes up to the size of a matchbox.

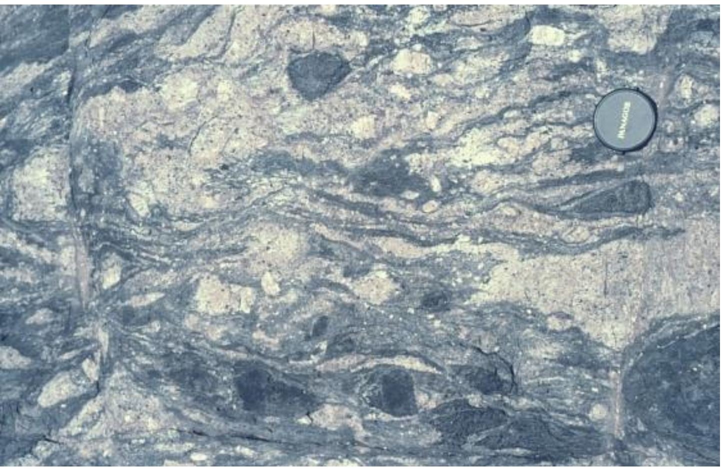
The Peninsula Granite cropping out along the shoreline south of Sea Point (photograph by Amour Venter)

In between these feldspars there are greyish, glassy-looking patches of quartz, as well as smaller amounts of black minerals, like mica and tourmaline. The Peninsula Granite is part of a widespread family of granitic exposures of similar age, stretching from George in the east to the Richtersveld in the west, with some patches exposed near Worcester and Robertson. Near Cape Town, the towns situated on or near granite include Stellenbosch, Paarl with its famous landmark Paarl Rock, Darling, and Langebaan.

The weathered granite makes fertile soils, which in the past supported renosterveld, and now is prime agricultural land for growing wheat and increasingly for grape vines; although in some areas, like the Darling hills, the high potassium levels in the soils derived from the weathered feldspars in the granite can cause problems for wine farmers.

Getting up close to the Peninsula Granite (photograph by Jo Wicht)

At the well-known contact between intrusive granite and metamorphosed Malmesbury sediments at the southern end of the Sea Point promenade you can see coarse feldspar crystals, which are cream or grey coloured blocks, several centimetres in size. These are surrounded by a finer-grained material, made up mostly of quartz and smaller feldspar crystals. The dark, streaky looking patches in the granite are inclusions of Malmesbury slate, into which the molten granite originally intruded.



The migmatite, or mixed rock, at the Sea Point contact between lighter granite and darker metamorphosed Malmesbury sediments.

A loose boulder of migmatite at Sea Point, with granite at the bottom and bands of contaminated, formerly partially molten Malmesbury sedimentary rock above. Fluids expelled from the crystallising granite enabled large feldspar crystals to form in the metamorphosed sedimentary rock. (photograph by Jo Wicht)

These dark rocks originally formed the walls of the chamber holding the molten granite, called magma. As the magma forced its way into the surrounding rock, pieces of the wall rocks broke off. Some melted and dissolved in the granite magma but some were baked and included in the solidifying mass. These elongated inclusions of metamorphosed Malmesbury rocks tend to be orientated northwest-southeast in the granite.

This shows that while the deeply buried magma mass was solidifying it was subjected to direction pressure, which caused the elongated feldspar crystals and dark inclusions to line up as they have. We'll see this again later, in the Darling Granite.

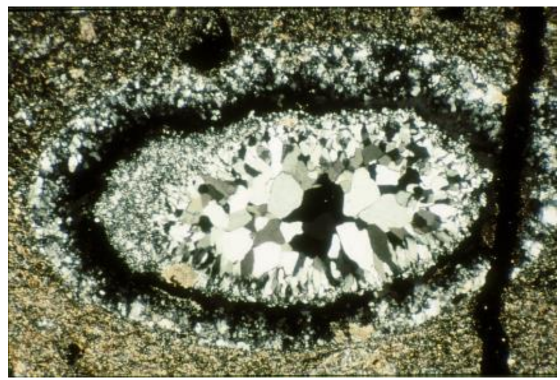
The Bloubergstrand Formation of the Malmesbury Group is exposed along the beach front and on the tombolo at the northern end of big Bay. The tombolo is accessible at low tide.

The tombolo at Big Bay, Bloubergstrand

The rocks here are the remains of an undersea volcano associated with Malmesbury Group sedimentary rocks. The molten lava had numerous gas bubbles that were distorted into typical almond-shapes as they rose in the flow. The fresh lava blocks tumbled down the sides of the erupting mound to form irregularly orientated jumbles, confusing the original lava flow directions. Eventually the empty gas bubbles filled with quartz and calcite, to form white amygdales embedded in the finer-grained, dark blue, altered lava rock.

Michael Schoeman pointing to the amygdaloidal lava on the Bloubergstrand volcanic outcrop

The almond-shaped amygdales, now filled with calcite and quartz, originally flowed upwards in the molten lava, like air bubbles in honey.

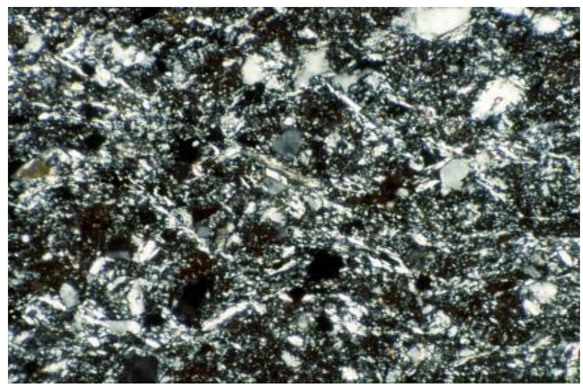


A petrographic thin section through a single amygdale 30 mm long shows its later filling with quartz grains

A bit further south, along the rocky beachfront there are more exposures of this amygdaloidal lava, as well as reddish sub-aqueous tuff. This is a fine-grained rock consisting of volcanic ash deposited under water. Volcanic ash is composed of very fine mineral grains, really a sort of volcanic grit. If it is hot enough when it settles on the sea floor the individual grains can weld together to form a hard, structureless rock.

This volcanic rock was erupted on the floor of the Adamastor Ocean before it closed and its sediments were intruded and metamorphosed by rocks of the Cape Granite Suite during the Saldanian Orogeny. Recently, the tiny zircon crystals erupted in the Bloubergstrand lava were dated by uranium-lead isotope dating, and shown to be 554,5 ± 5,4 million years old (Kisters, Agenbach & Frei 2015). This date is identical to that of the earliest Cape Granites, implying that both volcanism and sedimentation were taking place in a closing marine basin, with these sub-marine rocks being plastered onto the growing margin of Gondwana as the former Adamastor Ocean closed.

The contact between the lighter, fine-grained, welded tuff and the darker sedimentary rocks on which it was deposited, at Bloubergstrand



Seen in a petrographic thin section under the microscope the tuff consists of very fine mineral grains. Width of field of view is 0,5 mm.

The Darling Granite pluton has a width of about 15 kilometres and a length of 55 kilometres, and is itself stretched and elongated in the northwest-southeast orientation. It is one of a number of similar granite bodies exposed in the Western Cape. Other well-known examples are the granites on the Cape Peninsula, Paarl Mountain, and the granites around Langebaan and Saldanha. The rock in between these granite plutons is mostly buried under sand and soil, but consists of intensely folded and baked Malmesbury Group rocks. These started out as sediments deposited on the floor of an ancient sea. This sea closed up, with collision of the continental masses on each side. This collision buried, squeezed, and baked the former ocean floor sediments. Molten material intruding from below this pile of baked and deformed sediments eventually cooled and solidified at depth. Subsequently, several cycles of erosion exposed the granites we see today.

As you near the Darling hills on the R27, you can see a poorly-sited and conspicuous quarry on the right-hand side of the road. This was opened to provide the strong granite needed for the aggregate used in the concrete for the containment building of the nearby Koeberg nuclear power station. The rocks exposed on the hilltop at !Khwa ttu San Cultural Centre, some 40 kilometres north of Cape Town on the R27 near Yzerfontein also are granites belonging to the Darling pluton.

This is a mass of rock which originally solidified at depth, and which forms part of the Cape Granite Suite of rocks. Granite is a coarse-grained igneous rock, which cooled and solidified from a molten mass deep within the Earth's crust. Geologists estimate that the Darling Granite formed about 545 million years ago, at a depth of 7 to 10 kilometres below the surface. What we see now has been exposed by erosion.

The Darling Granite exposed at !Khwa ttu (photograph by Amour Venter)

The Darling Granite can be visited easily at !Khwa ttu. Here it has the usual constituents of granite, but has been squeezed by geological forces while it was still soft. The matchbox-shaped feldspar crystals have been forced to line up, with their lengths roughly north-south, as have the elongated inclusions of partly digested Malmesbury slates.

A xenolith, a fragment of dark Malmesbury slate, embedded in the Darling Granite at !Khwa ttu (photograph by Amour Venter)

The whole mass of the Darling Granite has been stretched north-south. The cause of this is the Colenso fault, which runs from Saldanha to Stellenbosch, past the landward side of the Darling granite. Geologists think this fault must have been active when the Darling Granite was intruded into the surrounding Malmesbury rocks 540 million years ago. It may well have been active on several occasions since, and some geologists think it may still pose a potentially hazardous line of weakness in the crust of the Earth, cutting right across the Western Cape.

From the R27–Yzerfontein intersection to Darling you could take a detour. The Darling hills are underlain by the multi-component Darling pluton. One of its youngest components, the Klipberg Granite, is exposed in the prominent hill to your left shortly before you reach Darling town itself. It is a relatively fine-grained granite, producing rock-strewn slopes, very different from the more deeply weathered soils that cover most of the fertile hilly terrain.

The coastal town of Yzerfontein has several rocky exposures along the shoreline, none of which consist of granite, although they are part of the Cape Granite Suite. The northern-most one, at the northern end of Yzerfontein beach is gabbro, a coarse-grained igneous rock containing no quartz, and hence not a granite.

A group of members of the Cape Town Gem & Mineral Club visit the outcrop of gabbro at the northern end of Yzerfontein beach. The rock here is a coarse-grained igneous rock consisting of dark green magnesium- and iron-rich minerals and light-coloured feldspar. (photograph by Amour Venter)

A boulder of gabbro at Yzerfontein beach with magmatic layering, formerly horizontal layers with varying concentrations of lighter-coloured feldspar and darker-coloured pyroxene and amphibole minerals. (photograph by Amour Venter)

The gabbro displays clear banding, with darker and lighter bands alternating on a ten centimetre scale. The lighter bands contain a greater proportion of feldspar compared to the darker ones. This is ‘magmatic banding’, formed by crystals of different density settling out of molten rock in a magma chamber at different rates, under the influence of gravity.

At the southern end of the Yzerfontein main beach, and most of the way around the coastal outcrop towards the south, there is a different rock type – diorite. This is finer-grained and contains less of the dark green minerals than gabbro. In places, like in the artificial cliffs at the harbour, there are gabbro xenoliths in the diorite, showing that the diorite solidified later.

Further south still, at Schaapen Island, the diorite is intruded by a dyke of light-coloured rock called syenite, which is crammed with darker xenolithic inclusions of gabbro and diorite. These obviously solidified before their incorporation in the intrusive syenite.

Intrusive syenite containing xenolithic fragments of dark gabbro and diorite, on Schaapen Island, Yzerfontein

There are also numerous veins containing red jasper and yellow pyrite crystals cutting the diorite on Schaapeneiland. (photograph by Amour Venter)

Plan your visit for low tide when you can walk dry shod to the ‘island’. (photograph by Amour Venter)

The origin of these dark ‘mafic’ rocks at Yzerfontein is somewhat obscure, but there are smaller outcrops of similar rocks scattered throughout the Tygerberg Terrane. They are part of the intrusive phase of the Saldanian Orogeny, when Malmesbury Group sediments were deeply buried and magma formed by partial melting intruded the rocks at higher levels. These darker, denser rocks could be the residues after separation of the lighter components that formed granites, possibly also intermingling with them to some extent to form the hybrid granodiorite rocks of intermediate composition. A recent interpretation is that they may be the ‘smoking gun’ of deeply sourced magma from the Earth’s mantle, that provided the necessary heat source for the production of the large volumes of Cape granite during the Saldanian Orogeny (Clemens et al. 2017).

In the last road cutting south of the turnoff to Langebaan, the R27 crosses granitic rocks directly affected by the Colenso Fault zone. This is one of the numerous NW-SE trending faults that follow the ‘grain’ of the southwestern Cape. Here the associations between a wide variety of granitic rocks is complicated by a series of faults and joints. The rock ranges from coarse-grained granite to fine-grained aplite, in which it is difficult to make out the individual grains by eye.

The granite rocks in the road cutting on the R27 immediately south of the Langebaan turnoff, show a dramatic variation in texture and grain size over short distances. This may be due to the proximity of the Colenso Fault. (photograph by Amour Venter)

At Langebaan itself the Olifantskop granite quarry is hollowed out of the hill northeast of the town. This granite was used for building the breakwater and harbour of Saldanha.

The Olifantskop granite quarry at Langebaan, showing the curved jointing typical of large granite bodies, eventually producing rounded domes like those of Paarl mountain. (photograph by Amour Venter)

Across the lagoon, the rocky tip of Langebaan Peninsula has harboured a geological secret for over a hundred years. It was only about twenty years ago that geologists from the University of Stellenbosch discovered that these rocks are in fact the remains of a volcano, and not granite that cooled at depth at all.

The volcanic rocks of Postberg, seen across the lagoon from Langebaan

An eroded pinnacle of Postberg ignimbrite, a rock that looks superficially like granite but in fact erupted on the surface as a lava

Several of these molten masses managed to reach the surface. They erupted in a sequence of explosive, high-temperature lava flows, so hot that the volcanic dust, small quartz and feldspar crystals, and shards of volcanic glass were welded together to form the rock geologists call ‘tuff’. The crystal inclusions made these rocks look superficially like granite, but when studied closely using paper-thin slices under the microscope, their volcanic origin was revealed. These volcanic rocks are the subject of ongoing research that has identified the ‘granite’ rocks on the northern side of Saldanha Bay to be volcanic too.

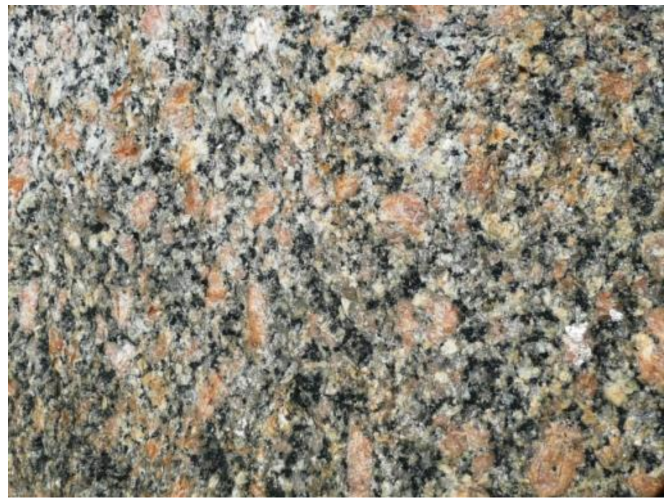
The granular appearance and insets of other rocks make the Postberg ignimbrite look like a granite, when in fact it is a welded tuff.

Outcrops of the Postberg ignimbrite are easily accessible by car at Tsaarsbank in the West Coast National Park.

Cape Columbine juts into the icy Atlantic ocean, just south of the picturesque and rapidly expanding village of Paternoster on the West Coast. It is justifiably famous for its vernacular architecture, abundant crayfish, unpredictable weather, and its lighthouse. This is a solidly handsome building, and was the last manned lighthouse built on the South African coast. It was inaugurated on 1 October 1936 and still operates, although it has been automated. A visit allows you get to grips with the granitic rocks cropping out on the shoreline at Paternoster and at Cape Columbine itself.

Outcrop of Vredenburg Granite on the beach at Paternoster. The rounded weathering is typical of a fairly homogeneous granite.

The older of the two granitic rocks is the Vredenburg Granite also referred to as the Vredenburg quartz monzonite in some older publications. It is a rock with both potassium feldspar and plagioclase feldspar and a high quartz content of 30–40% (Bailie et al. 2020). It forms the major outcrop of granite on the Vredenburg Peninsula, and weathers into massive blocks, creating castellated tops to the hills.



The Vredenburg Granite is a coarse-grained granite, with conspicuous pink potassium feldspar crystals, in a fairly coarse matrix of other feldspar, quartz and mica.

One of these, Kasteelberg just outside the village of Paternoster, is an important archaeological site with a long history of human habitation, including the remains of Khoikhoi encampments. These pre-colonial herders had both cattle and sheep, which they grazed on a seasonal round in the Swartland and coastal strandveld. They would congregate at Kasteelberg to harvest seals at the coast, and render their fat in earthenware pots.

The granite slabs at Kasteelberg contain numerous elongated grooves made by these itinerant herders, perhaps to grind grass seeds to make porridge.

Down at the coast, the Vredenburg Granite crops out around Paternoster and as far south as Cape Columbine itself. Just south of Paternoster it forms big boulders, some of them like giant monoliths tossed into the sea. These rounded boulders are the result of sustained weathering, first by ground water percolating down joint cracks in the massive granite, and eventually through ‘onion skin’ weathering as successive layers exfoliate, taking off the sharp corners first and rounding the boulders in place. They are far too large to have been tumbled round in the sea.

All the granitic rocks in the Western Cape are thought to have intruded during and shortly after a continental collision, which took place over half a billion years ago, part of the assembly of the former Gondwana supercontinent. The Vredenburg Granite dates to about 560–540 million years, and is related in time to the Paarl and Robertson granite intrusions. It is relatively undeformed, although cut by some aplite (fine-grained granite) veins and narrow shear zones. What xenoliths there are, appear to be pieces of other igneous rocks, quite unlike the metamorphosed Malmesbury sedimentary rocks which form the conspicuous black xenoliths in the well-known Peninsula Granite and the Darling Granite.

Shortly after its emplacement the Vredenburg Granite was intruded by small bodies of mafic (dark) rock, which are exposed in a small bay on the northern side of Cape Columbine. These rocks contain feldspar and quartz crystals in a very dark, fine grained matrix, and may be related in origin to the similar mafic intrusive rocks exposed on the coast further south at Yzerfontein.

Aplite dyke of fine-grained granite, running through a boulder of Vredenburg Granite, and a xenolith of igneous rock (below)

The dark rocks on the right in the photograph above are an igneous intrusion into the lighter Vredenburg Granite, just south of Paternoster

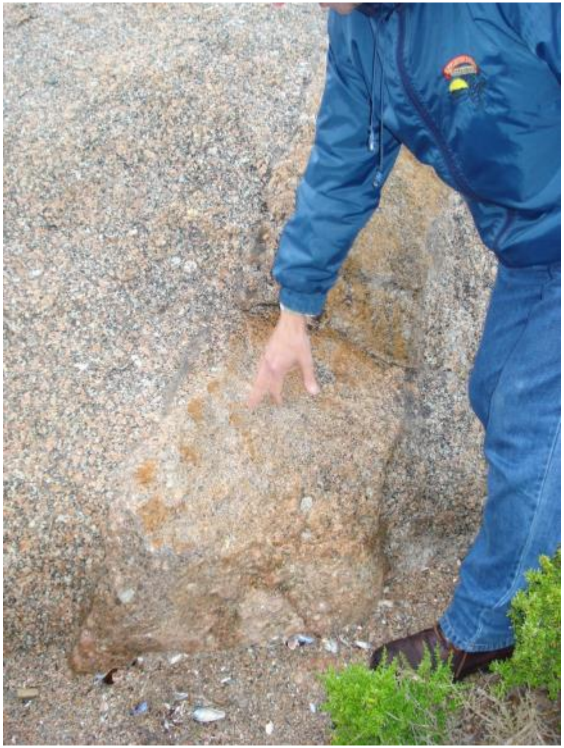
The next magmatic event was the intrusion of the Cape Columbine Granite, which is exposed from Cape Columbine itself, just west of the lighthouse, southwards for a few kilometres, until it disappears under the sand of Northwest Bay.

Cape Columbine itself, viewed from the lighthouse

The next rocky outcrop to the south is the Trekoskraal Granite, older than both the Vredenburg Granite and the Cape Columbine Granite. This is explained partly by the presence of the Colenso Fault zone, which runs NW-SE all the way from Northwest Bay to Stellenbosch.

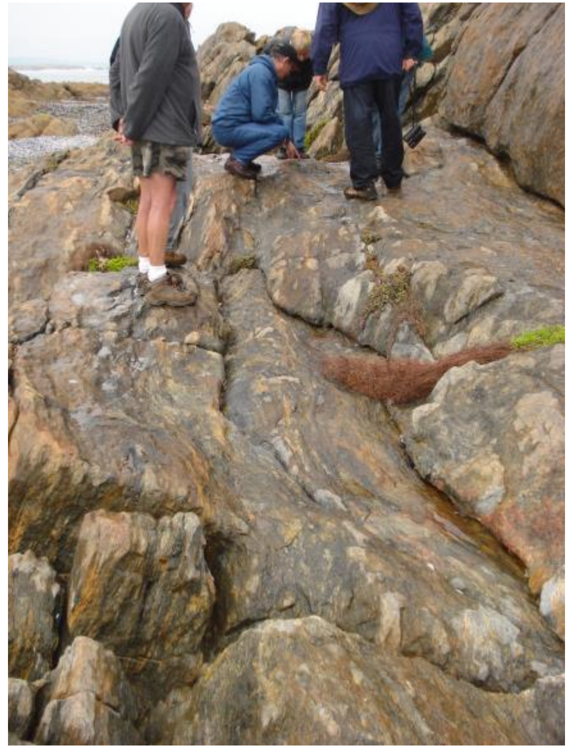
The Colenso Fault is an important feature of the geology of the Western Cape and may be a major crustal suture line. There is evidence that it was active from the time of the first intrusion of the Cape granites. The early Darling Granite, which lies right up against the fault and dates to about 550 million years ago, is sheared and stretched parallel to it in a NW-SE direction, with indications that the fault then allowed slip to the left. The younger Trekoskraal granite, cropping out just south of the fault at Northwest Bay, has signs that by about 540 million years ago the fault slip had changed direction to the right, presumably because of a change in the direction of maximum pressure in the ongoing continental collision. The Cape Columbine Granite, dating from about 520 million years ago, was also affected by right-hand slip on the Colenso Fault, which obviously was active for tens of millions of years.

The Cape Columbine Granite is finer grained than most of the Vredenburg Granite, but looks superficially similar. Closer inspection shows that it is littered with large granitic xenoliths, principally angular chunks of Vredenburg Granite, into which it is intrusive. The Cape Columbine Granite contains very dramatic shear zones, mostly trending north-northwest, more or less parallel to the Colenso Fault lying just to the south.



A large granite xenolith of Vredenburg Granite in the Cape Columbine granite (photograph by Jo Wicht)

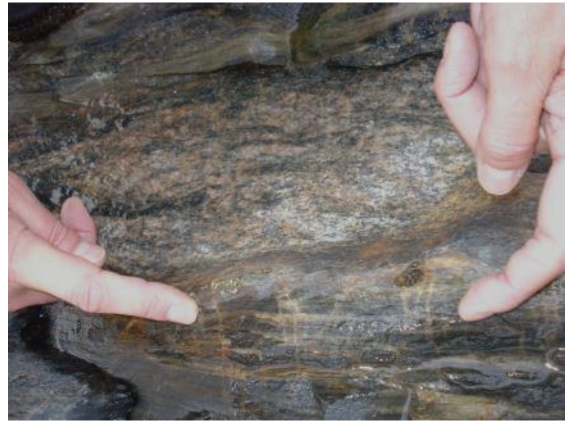
These shear zones are typically very dark, fine grained, and usually not very wide, up to about 10 centimetres. Nevertheless, there is at least one very dramatic example up to 25 metres wide and over 1,5 kilometres long.



Highly deformed shear zone in the Cape Columbine Granite (photograph by Jo Wicht)

This looks nothing like a granite, but more like a highly metamorphosed sedimentary rock. In fact it is a ‘cataclasite’ or zone of completely crushed granite, or mylonite, in which the quartz has been largely recrystallised.

Another view of the dramatic shear zone in the Cape Columbine Granite. This line of intense deformation of the granite is visible from space as the dark NW-SE diagonal line in the Google Earth photograph below.



Within the shear zone, individual crystals and granite xenoliths have been stretched to many times their original lengths. (photograph by Jo Wicht)

These zones formed presumably in response to regional collisional pressures causing right hand slip on the Colenso Fault and also the localised shearing in the Cape Columbine Granite. This cataclasite is exposed in the rocks just below Cape Columbine lighthouse itself and is a spectacular geological feature. It is well worth the visit to this windswept promontory.

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