STORIES IN STONE

THE ROCKS OF YZERFONTEIN

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Originally published on the Cape Town Gem & Mineral Club's website http://ctminsoc.org.za/field-guides.php.

I thank Hayley Cawthra (Council for Geoscience) for positive comments on the draft text.

This description of the rocks of Yzerfontein draws heavily from these two recent publications:

Clemens, J. D., Buick, I. S., Frei, D., Lana, C. & Villaros, A. 2017. Post-orogenic shoshonitic magmas of the Yzerfontein pluton, South Africa: the 'smoking gun' of mantle melting and crustal growth during Cape granite genesis? *Contributions to Mineralogy and Petrology* 172: 72–96; 82–85. https://doi.org/10.1007/s00410-017-1390-9

Wilson, S. 2020. The petrogenesis of the intermediate to mafic rocks of the Yzerfontein Subsuite, and their relationship to-, and paragenesis of hydrothermal veining, Cape Granite Suite, Saldania Belt, South Africa. MSc dissertation, University of the Western Cape:1–210. https://etd.uwc.ac.za/xmlui/handle/11394/7398

Previous page: Very coarse crystals of white feldspar and dark pyroxene minerals in gabbro at Rooipan se Klippe (Gabbro Point), Yzerfontein

THE YZERFONTEIN PLUTON

Rocks of the Yzerfontein Pluton are exposed from Rooipan se Klippe in the north to Schaapen Eiland and Freddie se Klip south of Yzerfontein point.

These rocks are quite distinct in colour and composition from the more plentiful, lighter, grey Cape Granites exposed elsewhere along the coast of the southwestern Cape, although of similar age. The pluton consists of several phases of intrusive igneous rock, all of which cooled and solidified about 535 million years ago, at great depth in the crust of the Earth. They were exposed on the surface by subsequent erosion of many kilometres of rock originally above them.

The very dark rocks at Rooipan se Klippe, also known as Gabbro Point, consist mainly of gabbro – a medium- to coarse-grained igneous rock containing mostly light feldspar and dark pyroxene minerals. They are described in more detail below. At the southern end of the coastal outcrop, around Schaapen Eiland, the rocks tend to be considerably lighter in colour because they contain more feldspar and less of the dark iron and magnesium containing minerals. They too are described in more detail below.

A Google Earth image showing from north to south the locations of Rooipan se Klippe (Gabbro Point), Meeurots, Yzerfontein Point, and Schaapen Eiland.

The cliffs at Yzerfontein harbour consist of a dark, intrusive, igneous rock called monzonite, containing lighter feldspar with darker pyroxene and amphibole minerals. This medium-grained rock cooled from a melt at great depth in the crust of the Earth and was subsequently exposed by erosion of the many kilometres of rock above it. The construction to the left on the cliff face stabilises the remains of a Middle Stone Age shell midden. This shelter, under a former overhang in the white calcrete at the top, was occupied by humans about 115 000 years ago. The shelter itself probably was excavated by a former high sea-level around 120 000 years ago, and occupied shortly after the subsequent fall of the sea-level made it accessible.

The greenish-grey rocks along the shoreline between Yzerfontein main beach and the harbour are mainly varieties of medium-grained monzonite.

The dark, medium-grained rocks along the coast at Yzerfontein are quite distinct in appearance and composition from the familiar Cape Granite.

These are rocks containing more or less equal proportions of potassium feldspar and calcium-sodium feldspars, as well as the dark minerals pyroxenes and amphiboles, occasionally with minor amounts of quartz. This is a composition distinctly different from granite, which contains both more feldspar and much more quartz, with far fewer dark minerals.

In the cliffs at the harbour entrance you can see numerous rounded, fine-grained, dark inclusions in the monzonite. These have similar mineralogical and chemical compositions to the gabbros and monzonites themselves. They probably are fragments of chilled wall rock of earlier phases of the multi-phase intrusion.

The cliffs at Yzerfontein harbour are of monzonite, with numerous dark inclusions. These probably represent fragments of the chilled wall rock partially digested by the intrusive magma. The individual dark inclusions are roughly fist-sized, and mostly finer-grained than the surrounding rock.

The inclusions in the monzonite at the harbour do vary in their grain size. Some, like the one above, are finer-grained than the host rock. Some, like the one below, are coarser. This demonstrates the variability in this multi-phase intrusion.

The Cape Granite Suite rocks, including the Yzerfontein Pluton, are thought to have originated in a mountain-building episode due to the closure of the former Adamastor Ocean. This lay between what is now South America and Southern Africa. It closed over a period of several tens of millions of years, with the ocean floor plunging into the Earth’s mantle.

This culminated in partial melting of the former ocean floor sediments to form molten masses of granitic composition. These were graviationally bouyant and rose up through the crust, intruding into the surrounding rocks, where most of them solidified slowly to form large granite bodies.

Some molten masses actually emerged on the surface to form volcanoes. The rocks of the northern end of the Langebaan Peninsula, visible from Yzerfontein on a clear day, are actually the remains of such a volcanic eruption some 519 million years ago.

The Yzerfontein Mafic Subsuite, with the same age as the Cape Granite Suite, is thought to have been part of the same geological events that accompanied the closure of the former Adamastor Ocean.

At first sight the dark rocks on the Postberg at the northern end of the Langebaan Peninsula may look similar to those at Yzerfontein, but actually they are lava erupted on the surface about 519 million years ago.

But the very different composition of the Yzerfontein gabbros and monzonites compared to the Cape granites presents a bit of a geological puzzle. Currently, the best explanation is that there may have been a tear in the ocean floor slab that was plunging into the Earth's mantle. This allowed hot mantle material to become directly involved in producing the voluminous granitic melts. The Yzerfontein Pluton appears to be made up largely of this mantle material, with very little admixture of a molten phase carrying zircon crystals derived from partial melting of older sediments on the former Adamastor Ocean floor.

ROOIPAN SE KLIPPE (GABBRO POINT)

The dark rocks at Rooipan se Klippe, or Gabbro Point, at the northern end of Yzerfontein main beach, are mainly medium-grained to coarse-grained gabbro, as is Meeurots in the distance out in the bay.

Rooipan se Klippe, called Gabbro Point by geologists, and Meeurots, the rocky island in the bay, are the only substantial outcrop of gabbro in the southwestern Cape. It is related in age and geological setting to the far more numerous outcrops of light grey Cape Granite. The granite has a very different mineralogical composition, with more feldspar and plentiful quartz, which is absent from the gabbro.

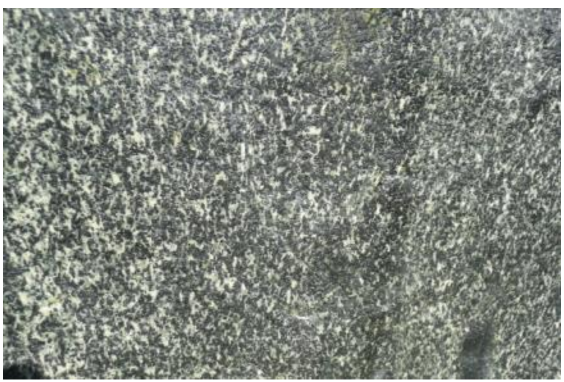
The dark rocks here are the northernmost outcrop of the so-called Yzerfontein Pluton. They are also intrusive rocks, which solidified deep in the crust of the Earth about 535 million years ago, and were exposed on the surface by subsequent erosion. Gabbro is a medium- to coarse-grained igneous rock consisting mainly of lighter coloured feldspar and darker pyroxene that crystallised from a melt. In these boulders the proportions of feldspar and pyroxene vary.

In some examples, particularly toward the northern end of this outcrop, there are chunks of coarser gabbro enclosed by finer rock of similar composition. This demonstrates that it was a multi-phase intrusion, with later melts incorporating earlier solidified material. There is also a more general variation in the composition of the gabbro. Some parts of the outcrop contain more feldspar and so are lighter in colour than others.

Coarse-grained gabbro at Rooipan se Klippe, with white feldspar crystals up to 5 mm long.

On a finer scale, some boulders show a compositional banding, with alternating layers of more plentiful dark pyroxene crystals grading into lighter layers with more plentiful, lighter feldspar crystals. The banding is fairly regular, with individual bands about 10 centimetres thick. The banding dips nearly vertically but presumably originally was horizontal. This variation in composition is called magmatic layering and its origin in igneous rocks is still something of a geological puzzle.

A boulder on Gabbro Point showing very clear banding, of alternating layers richer in lighter feldspar or darker pyroxene minerals. This layering probably was originally horizontal. The bedrock at Gabbro Point seems to have been tilted also vertical. A close-up photograph below shows the distinct difference in concentration of dark and light minerals in successive bands.



The different proportions of lighter and darker minerals in individual bands affect the rate of weathering. Consequently, some boulders have a grooved appearance where slightly less resistant bands have been worn away more rapidly.

In places the dark gabbro is cut through by much lighter seams of more coarsely crystallised rock. Where the boulders have split along these seams you can see clearly the blocky, white, feldspar crystals and the angular, nearly black, pyroxenes.

At Gabbro Point there are several boulders that have cracked along a very coarse-grained layer of light feldspar with dark pyroxene crystals. These are even more distinct in the close-up photograph below, with feldspar crystals up to 10 mm long.

There are also patches of brown staining from the weathering of iron sulphide inclusions, and some veins and patches of the bright green mineral epidote. Epidote is an alteration product, due to late stage hydrothermal activity in which hot fluids penetrated cracks in the solidified rock. These fluids leached various chemical components from the surrounding rocks, particularly calcium and iron, to form epidote. Epidote also partially replaces some of the original mineral grains in places, resulting in a very handsome, mottled green rock.

A hydrothermal vein cutting through the rocks at Rooipan se Klippe. This is typical of a large number of such veins cutting all the rocks of the Yzerfontein Pluton. In this example, the rock has been stained yellow and brown by oxidation of the iron pyrite in the vein.

SCHAAPEN EILAND

Schaapen Eiland is nearly the southern-most outcrop of the Yzerfontein Pluton. It can only be accessed at low tide. Its rocks include some of the youngest phases of intrusion within the pluton.

Schaapen Eiland and the rocks immediately south, including Freddie se Klip, are the southernmost outcrops of the so-called Yzerfontein Pluton. This includes all the dark rocks exposed along the coast from here to Rooipan se Klippe to the north, and also the rocks on Vlaekop, the hill behind the town, as well as Meeurots, the rocky island in the bay. All these rocks cooled and solidified from a molten state about 535 million years ago, deep in the crust of the Earth. They were exposed by the subsequent erosion of many kilometres of rock formerly overlying them.

The greenish-grey rocks of Schaapen Eiland are mostly monzonite. This consists of light-coloured feldspar and darker pyroxene and amphibole minerals. Southwest of the apex of the island there is a band of much lighter, pink to reddish rock, crowded with darker angular and rounded lumps. The pink rock is a fine-grained, feldspar-rich rock called syenite. The inclusions in it are fragments of gabbro and monzonite from the main body of the pluton. They must have crystallised well before the intrusion and solidification of the syenite carrying them. This is further evidence of the multi-phase nature of the Yzerfontein intrusive rocks.

This pink rock on Schaapen Eiland is an intrusive dyke. The matrix is mainly medium-grained feldspar, making it a rock called syenite. It contains numerous angular and rounded inclusions of coarser-grained, dark rocks. These are chunks of gabbro and monzonite ripped up from earlier phases of intrusion of the Yzerfontein Pluton.

Hydrothermal alteration by hot fluids travelling through the Yzerfontein rocks has modified them. The largest hydrothermal vein runs NW-SE between the car park and Schaapen Eiland. You have to cross it at low tide to explore the island itself.

One of the most obvious alteration products is epidote, a bright green mineral. This has replaced some of the original calcium-rich minerals in the rock itself, but also forms the green veins and crusts on many of the blocks of rock. Epidote isn't the only mineral found here in veins. Schaapen Eiland is crossed by numerous hydrothermal veins, containing various amounts of quartz, tourmaline, epidote, red jasper, and pyrite. This yellow iron sulphide mineral, sometimes called fool's gold, is visible in the cores of many of the veins. (Please don't damage the rocks by trying to take samples.)

Looking from the car park toward Schaapen Eiland you can see there is an active tidal channel. It has eroded one of the largest of the many NW/SE-orientated hydrothermal veins and minor faults cutting the outcrops of the Yzerfontein Pluton. You can only cross this channel dry-shod at low tide, so you need to time your visit to Schaapen Eiland accordingly.

FURTHER READING

Clemens, J. D., Buick, I. S., Frei, D., Lana, C. & Villaros, A. 2017. Post-orogenic shoshonitic magmas of the Yzerfontein pluton, South Africa: the 'smoking gun' of mantle melting and crustal growth during Cape granite genesis? *Contributions to Mineralogy and Petrology* 172: 72–96; 82–85. https://doi.org/10.1007/s00410-017-1390-9

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