CAPE GEOSITES

PAARL MOUNTAIN

Geology of a Cape landmark

Granite domes of Bretagne Rock (left) and Gordon's Rock (right) looking southwest.

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THE CAPE GEOSITES SERIES

Paarl Mountain is just one of the many geologically interesting sites in the Cape. This brochure forms part of an educational series that was compiled by the Geoheritage Subcommittee of the Western Cape Branch of the Geological Society of South Africa and is downloadable free of charge from the Branch website (https://www.gssawc.org.za). Bilingual descriptive plaques were placed at the sites during a programme sponsored by SANLAM in the 1990's.

Figure 1: Location map of Paarl Mountain. See Geological map below for more detail and GPS co-ordinates.

INTRODUCTION

Paarl Mountain received its name in 1657 when the Dutch settlers first entered the Berg River Valley and beheld the bare domes of granite, wet with dew, glistening in the morning sun. The crowning peaks at 600-700 metres elevation above sea-level are centrally situated in a granite intrusion, 60 km^2 in area, measuring 13 km north to south and 6.5 km in maximum width, west to east.

GEOLOGY

The rocks of the adjoining coastal plain and Berg River Valley belong to the Malmesbury Group, comprising metamorphosed siltstone and shale (phyllite) and impure quartzite of the Moorreesburg and Franschhoek Formations. The pile of sediments, perhaps some 6 km thick, was compressed into tight folds during mountain building (orogeny) and acquired a strong cleavage; consequently the rocks yield readily to weathering and erosion. Around the contact of the granite, however, heat of the intrusion baked the rocks into hard, resistant hornfels, which forms a ridge that rises to a height of 450 metres above sea level on the western side. This hornfels was exploited for stone aggregate at Windmill Quarry, which closed in 1979 and is located 5.5 km SSW of Windmeul (Cole, 2002, 2003).

The intrusive mass of the Paarl pluton is a good example of multiple injection of I-Type granites during Phase II (540 to 520 million years ago) of Cape Granite Suite emplacement (Scheepers and Schoch, 2006). The granites have not been precisely dated with only inaccurate whole rock $207^{Pb}/206^{Pb}$ ages of 548, 532, 525, 517 and 488 million years having been determined (Walraven et al., 1983, 1984). The igneous body as a whole, appears to be a steep-sided boss protruding upward from a much larger and deeper granite mass, exposed to the south as the Stellenbosch Batholith and in the north as the Malmesbury Batholith (Siegfried, 1999a). Along the eastern fringe is a rim of medium-grained granite, named the Laborie Granite (Siegfried, 1999b), about 1 km wide, that tends to stand out in relief above the other varieties.

The rock is light grey in colour and consists of pale pink to white feldspar, grey to colourless quartz and tiny flakes of black mica (biotite). It has been exploited as a source of building stone since 1892 and is known as "Paarl Grey" in the Stone Trade (Cole, 2002). It is presently exploited at one quarry, De Hoop (or Clift's Quarry) and is used for the production of cladding and kitchen tops.

Figure 2: De Hoop Quarry where blocks of medium-grained granite are extracted by means of feather-wedging – using chisels along a line of closely-spaced boreholes to prise open the block. The granite blocks are transported to the premises of J.A. Clift (Pty) Ltd in Paarl where they are cut and polished for cladding and kitchen tops.

Bluish grey, coarse-grained, porphyritic granite containing large single feldspar crystals, referred to as phenocrysts, builds the major part of the pluton and is well displayed in the large exposures of fresh rock. This granite is named the Bretagne Granite (Siegfried, 1999b). The large reddish potash-feldspar crystals are held in a matrix of white calcic plagioclase feldspar, quartz, biotite and tiny hornblende crystals (Siegfried et al., 1984).

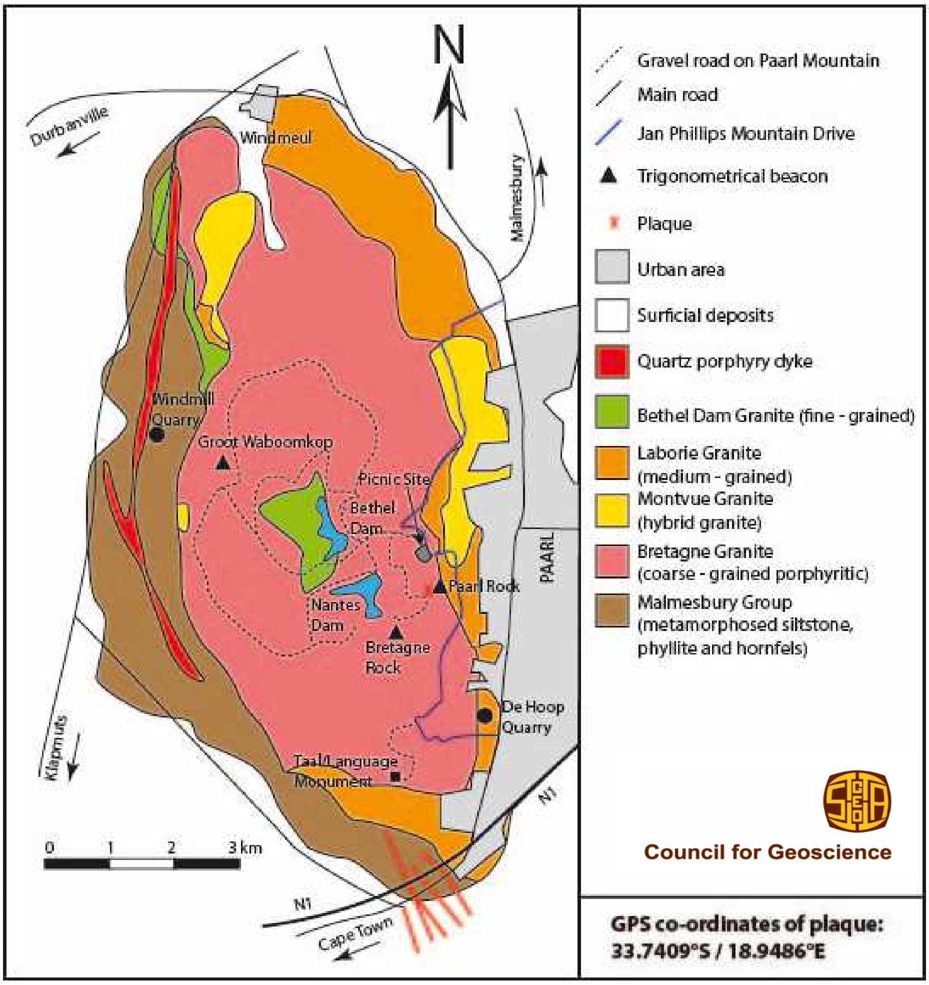

Figure 3: Geological Map of Paarl Mountain.

Small bodies of fine-grained granite, named the Bethel Dam Granite (Siegfried, 1999b), appear in the centre as well as in the northwest sector of the pluton. The rock forms small domical outcrops with smooth surfaces and is richer in quartz and biotite than the other granite types. In the peripheral zone of the pluton there are three occurrences of a "hybrid granite", the Montvue Granite, which is distinguished from the porphyritic granite by its higher biotite content and pink feldspar crystals rimmed by white feldspar (Siegfried et al., 1984). Several late quartz porphyry dykes, with visible crystals of quartz and feldspar in a very fine-grained groundmass, crop out in the hornfels contact zone to the south and west.

The coarse porphyritic granite contains dark inclusions (xenoliths) representing pieces of recrystallized country rock plucked from the walls of the pluton during intrusion. Irregular veins of fine-grained aplite and coarse-grained pegmatite containing clear to milky quartz are found in places.

Figure 4: Younger aplite (fine-grained granite) dyke intruding older porphyritic granite on summit of Bretagne Rock with the Drakenstein Mountains in the background looking eastwards.

INTRUSION HISTORY

The intrusion history is inferred from contact relationships and mineralogical evidence. The granite magma possibly formed by melting of crustal rocks at a depth of about 30-40 km. This melt then moved upward and formed a granitic magma reservoir, possibly about 14 km below the surface. Different magma fractions at about 700 °C were then derived from this source in stages to a depth of about 8 km (see diagrams):

Stage 1: Intrusion of coarse porphyritic granite (Bretagne Granite) by displacement of the wallrocks; heat changed the country rocks to hornfels, which is particularly extensive on the western side of the granite.

Stage 2: Injection of a wedge of medium-grained granite (Laborie Granite) into the contact between the coarse porphyritic granite and the Malmesbury Group and formation of hybrid granite (Montvue Granite) through reaction of magma with wallrock.

Stage 3: Injection of fine-grained granite (Bethel Dam Granite) in separate conduits through the porphyritic granite. Finally, quartz porphyry dykes were intruded along fractures and quickly chilled. According to more accurate U-Pb SHRIMP radiometric age determinations on similar I-Type granites in the Robertson Pluton, which yielded a date of 536 ± 5 million years (Da Silva et al., 2000), it was concluded that the Paarl Pluton was emplaced during the period between 540 and 520 million years ago, i.e. Early Cambrian (Scheepers and Schoch, 2006).

SUBSEQUENT GEOLOGICAL EVENTS

Stage 4: After intrusion, the granite and surrounding Malmesbury Group country rocks were uplifted and eroded to form a mountainland. Continuous erosion reduced the landscape over some 30 million years to sea-level. This land surface then subsided, allowing the deposition of several thousand metres of sediments of the Cape Supergroup and thereafter of the Karoo Supergroup. During the Permian-Triassic Cape Orogeny between about 280 and 220 million years ago, these sedimentary rocks were folded, uplifted, fractured and carved into ridges and valleys.

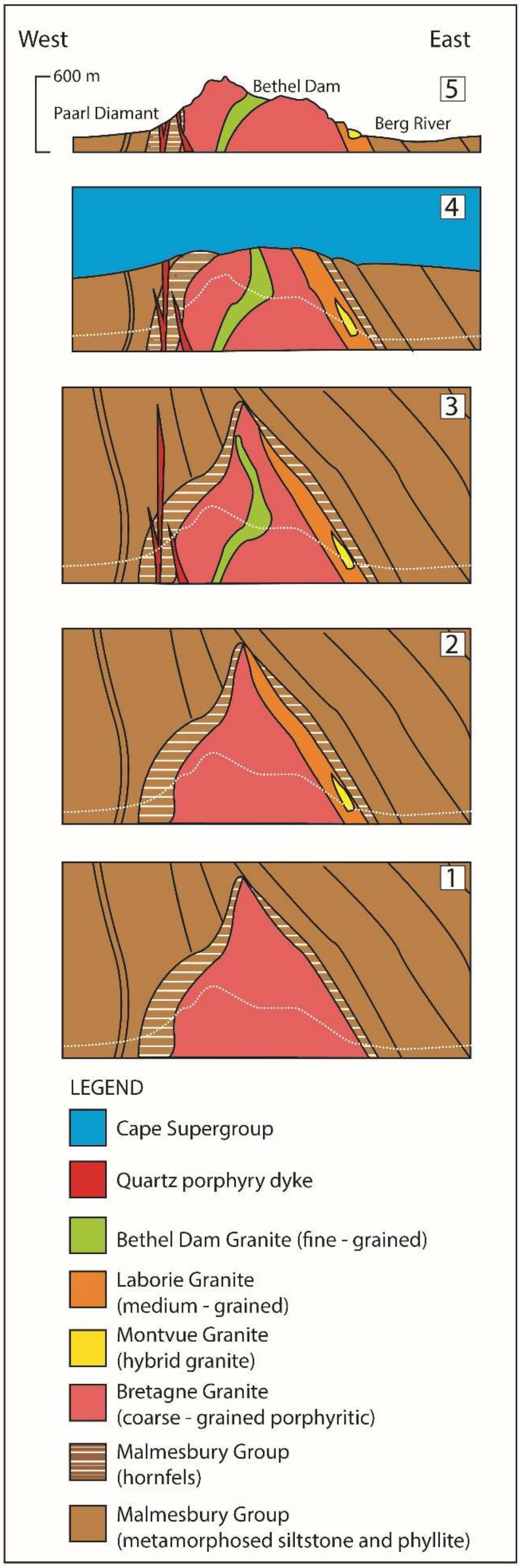

Figure 5: Intrusion and erosional history of Paarl Mountain granite.

Stage 5: The sandstones and shales of the Cape Supergroup that once extended across and beyond the present coastal plain were eroded away except for remnants such as the Cape Peninsula, Simonsberg and Kasteelberg. Loose sandstone boulders on the slope south of Jan Phillips Mountain Drive suggest that the Table Mountain Group sandstone cap on Paarl Mountain was eroded away in comparatively recent geological time.

The rounded outcrops of massive granite developed by spalling off of curved rock slabs along partings more or less parallel to the surface. These partings probably originated as the rock expanded owing to pressure relief with the removal by erosion of overlying material. The wide spacing (one kilometre or more) of vertical master joints accounts for the large size of the domes. Oval hollows in the bare surfaces probably formed through attack by acidic groundwater seeping in from soil pockets. Paarl Mountain owes its preservation to the greater resistance of granite to erosion, as compared to the surrounding Malmesbury Group rocks.

Figure 6: Plinth and plaque of the Geological Society of South Africa, located southwest of Paarl Rock and north of Bretagne Rock as seen in the background.

Figure 7: Exfoliation of curved slabs of porphyritic granite on north flank of Bretagne Rock.

Figure 8: Corestone of granite near Paarl Rock view site, west of Berg River Valley.

CONTACT

Western Cape Branch of the Geological Society of SA:
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ADDITIONAL READING

- Compton, J.S., 2004. The Rocks and Mountains of Cape Town. Juta and Company Ltd, 112pp.
- Johnson, M.R., Anhaeusser, C.R. and Thomas, R.J. (Editors), 2006. The Geology of South Africa. Geological Society of South Africa, Johannesburg / Council for Geoscience, Pretoria, 691pp.
- McCarthy, T. and Rubidge, B., 2005. The Story of Earth and Life: A Southern African Perspective on a 4.6-Billion-Year Journey. Struik Publishers, 333pp.
- Norman, N. and Whitfield, G., 2006. Geological Journeys: A Traveller's Guide to South Africa's Rocks and Landforms. Struik Publishers, Cape Town, 320pp.
- Rogers, J., 2018. Geological Adventures in the Fairest Cape: Unlocking the Secrets of its Scenery. Popular Geoscience Series, Council for Geoscience, 7, 320pp.

REFERENCES

- Cole, D.I., 2002. The building stones of Cape Town: a geological walking tour. Popular Geoscience Series, Council for Geoscience, 3, 132pp.
- Cole, D.I., 2003. The metallogeny of the Cape Town area. Explanation of Metallogenic Map Sheet 3318 (scale 1:250 000). Publication of the Council for Geoscience, Pretoria, 80pp.
- Da Silva, L.C., Gresse, P.G., Scheepers, R., McNaughton, N.J., Haartmann, L.A. and Fletcher, I., 2000. U-Pb SHRIMP and Sm-Nd age constraints on the timing and sources of the Pan-African Cape Granite Suite, South Africa. Journal of African Earth Sciences, 30, 795-815.
- Geological Survey, 1990. Geological Map of Sheet 3318 of Cape Town (scale 1:250 000). Compiler: J.N. Theron. Publication of Council for Geoscience, Government Printer, Pretoria.
- Scheepers, R. and Schoch, A.E., 2006. The Cape Granite Suite. In: Johnson, M.R., Anhaeusser, C.R. and Thomas, R.J. (Editors). The Geology of South Africa. Geological Society of South Africa, Johannesburg / Council for Geoscience, Pretoria, 421-432.
- Siegfried, H.P., 1999a. Malmesbury Batholith Units. Catalogue of South African Lithostratigraphic Units (M.R, Johnson, Editor), 6 (6-17 – 6-20).
- Siegfried, H.P., 1999b. Paarl Pluton Units. Catalogue of South African Lithostratigraphic Units (M.R, Johnson, Editor), 6 (6-25 – 6-27).
- Siegfried, H.P., de Bruin, D. and Boshoff, A., 1984. The geology and geochemistry of the Paarl Granite Pluton, Cape Granite Suite, South-Western Cape. Bulletin of the Geological Survey of South Africa, 75, 44pp.
- Walraven, F., Burger, A.J. and Allsopp, H.L., 1983. Summary of age determinations carried out during the period April 1981 to March 1982. Annals, Geological Survey of South Africa, 17, 87-93.
- Walraven, F., Burger, A.J., Allsopp, H.L., Retief, E.A. and Swanepoel, D.J. de V., 1984. Summary of age determinations carried out during the period April 1982 to March 1983. Annals, Geological Survey of South Africa, 18, 69-73.

