CAPE GEOSITES

HOUT BAY MANGANESE MINE

Early mining in the Cape Peninsula

Abandoned workings in manganese lode near Hout Bay. The bluish-grey and reddish-brown ore was exploited between 1909 and 1911.

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HOUT BAY MANGANESE MINE

THE CAPE GEOSITES SERIES

Hout Bay manganese mine (Figs. 1 and 2) 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 1990s. More recently, descriptive text for the plaques has been limited to English allowing for more information to be displayed.

Figure 1 : Location map for Hout Bay manganese mine. See geological map below for more detail and GPS co-ordinates.

INTRODUCTION

Manganese ore was mined on the slopes above Flora Bay on the eastern shore of Hout Bay between 1909 and 1911. (Fig. 2; Welsh, 1917). Adits (horizontal tunnels) were excavated in an east-southeast trending vein-like manganese deposit (manganese lode) up the lower northwestern slopes of Constantiaberg (Figs. 3 and 4). The topography is flatter over the eastern part of the lode, where the ore was also exploited from several shallow surface excavations (Figs. 5 and 6; Welsh, 1917). A total of seven adits were excavated and the lowermost adit (Fig. 4) can be reached via a gravel road and footpath, starting at a car park on Chapman's Peak Drive, some 300 metres south of the East Fort (Fig. 2).

An information plaque with English and Afrikaans text, which includes a map, geological cross-section and an interpreted view of the slopes of Constantiaberg (Rogers, 2018, p. 214), is located outside Mariner's Wharf at the northern end of Hout Bay harbour (Fig. 2).

A section on the initial discoveries of manganese near Hout Bay and the nature of the mining operations is first given, followed by the geology and genesis of the ore.

INITIAL DISCOVERIES AND MINING OPERATIONS

The first written account of the presence of manganese near Hout Bay is given in "The Cape Monthly Magazine", dated December 1873 (C.B.E., 1873), where a group of people was shown the deposit *in situ*, as well as loose blocks of manganese ore on the lower slopes of Constantiaberg, on 19 November 1873 (C.B.E., 1873; Spargo, 2010). Manganese became a more valuable metal in 1882, when Robert Hadfield discovered that an iron-manganese alloy increased the toughness of steel and was resistant to abrasion (Spargo, 2010). As a result, prospecting for manganese worldwide increased and in 1893, ore from the Hout Bay deposit was assayed by a Mr P. Lee of the South African College Laboratory, who found that it contained between 76 % and 83 % MnO_2 (Cape Argus, 1893). The manganese ore was situated on the farm "*An-de-Waterkant*", which was owned by Jacob Trautmann, a German immigrant, who founded Hout Bay's fishing industry (Schrire, 2010). In April 1892, Trautmann sold 22 morgen of land at R2 per morgen, but, following the rich assay results only months later, the land was then sold for R220 per morgen (Burman, 1969). However, events were to come full circle because, after the failure of the mine in 1912 (see below), Mr E. Trautmann, the grandson of the original owner, repurchased the property in 1943 (Burman, 1969; Schrire, 2010).

Following the assaying of ore in 1893, further development was minimal until 5th September, 1905, when the Cape Manganese Ore Company Ltd was registered in London, with the aim of acquiring, from Boxall and Associates, the mining rights over an area of 46 morgen in the Hout Bay Forest Reserve, via a purchase consideration of ₤61 060, payable in the form of ₤1 060 in cash and ₤60 000 in full-paid shares (Spargo, 2010). However, this company did not proceed with prospecting and mining, and another company, Hout Bay Manganese Ltd, had started mining by at least March 1909, although they were only registered in Cape Town in June 1909 (Spargo, 2010).

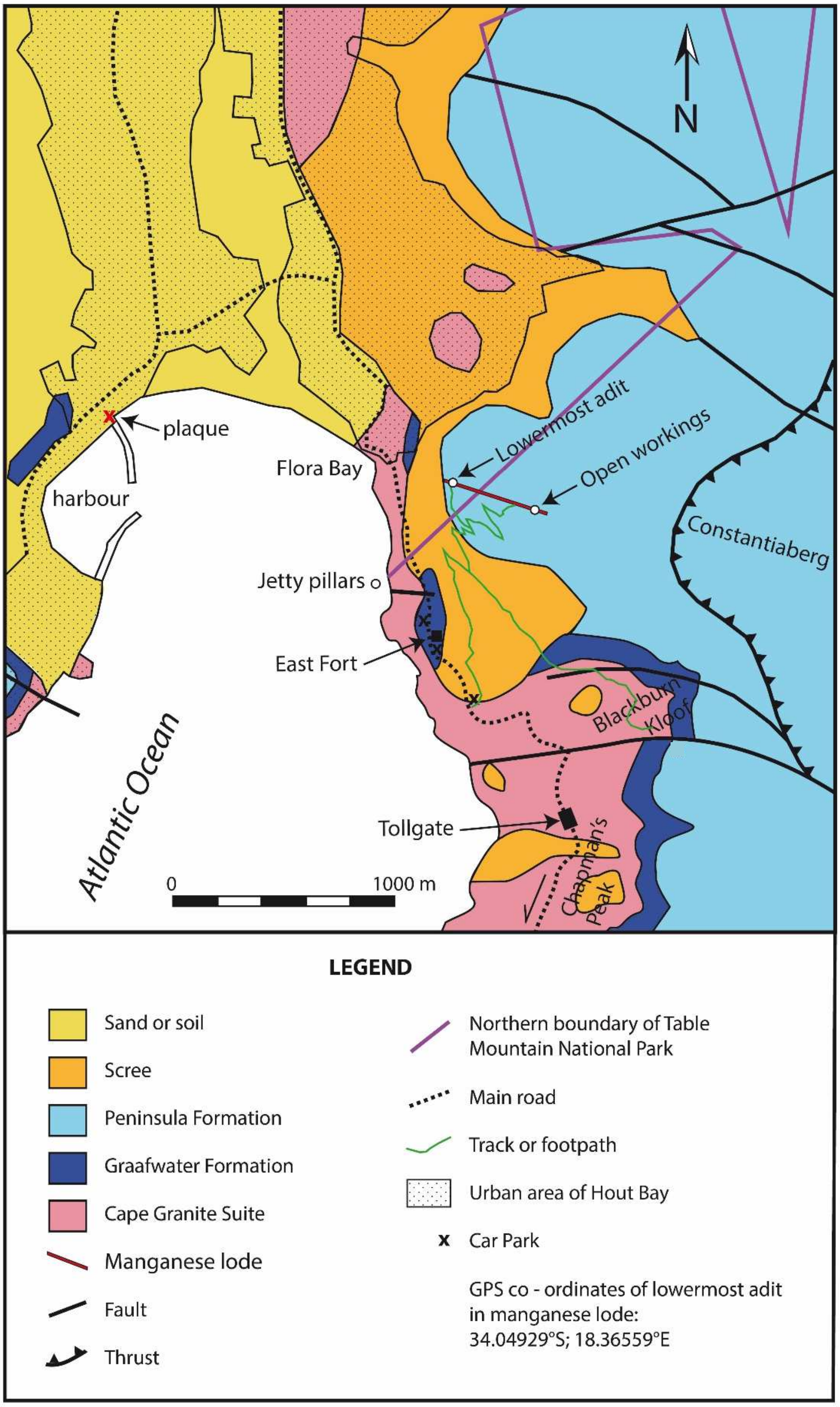

Figure 2 : Geological map showing the location of the Hout Bay manganese deposit and surrounding areas, access paths and roads and the Hout Bay urban area.

Figure 3 : Eastward view from Mariner's Wharf towards Constantiaberg, showing the location of the Hout Bay manganese lode, with white arrows marking the top and base. Black spots along the lode mark the entrance to adits.

Figure 4 : Miners in No. 1 adit, i.e. the lowermost adit (Fig. 5). Sourced from the Cape Argus Weekly, dated 26th January 1910. (for location see Fig. 2).

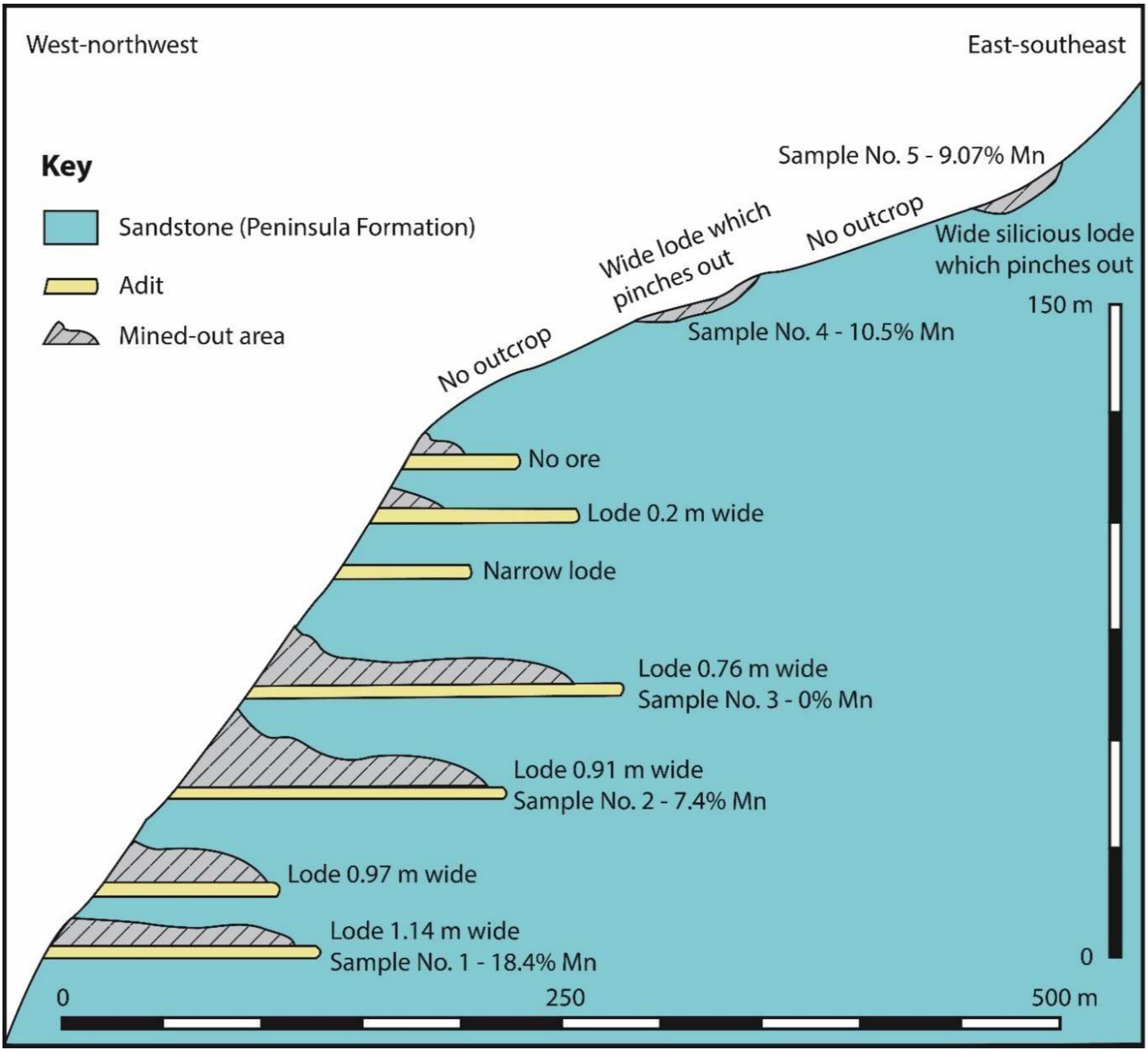

Figure 5 : Vertical section of the Hout Bay manganese mine, showing approximate positions of adits and shallow surface excavations on the lower slopes of Constantiaberg. Modified from Welsh (1917).

The manganese orebody was found to trend west-northwest for about 500 metres and had an average width of 0.75 m (Fig. 2; Welsh, 1917). It cropped out along a steep slope closest to Hout Bay and levelled off towards Constantiaberg (Figs. 3 and 5). The ore was mined using seven adits between 20 and 84 m in length along the steeper slope and by open excavations on the shallower slope towards Constantiaberg (Figs. 2, 3 and 5; Welsh, 1917). The ore was stacked and sorted by eye and by hand, according to the amount of manganese it contained (Fig. 7). Richer ore has a sub-metallic bluish grey to black appearance, whereas material with a higher iron content has a dull reddish-brown colour. It consists of a complex microcrystalline mixture of many manganese and iron oxides, of which goethite ($FeO(OH)$), haematite

(Fe_2O_3), cryptomelane (KMn_8O_{16}) and manjiroite ($(Na,K)Mn_8O_{16}$) are the most abundant. The iron oxides possess a dull lustre and exhibit massive, laminated or fibrous (radial) textures. The manganese oxide minerals (collectively known as psilomelane) display characteristic botryoidal ("grape-like"), mammillary, stalactitic, as well as massive growth-forms.

Figure 6 : Dark-coloured manganese-lode approximately 1 m wide encased in very light grey, medium- to coarse-grained, quartzitic sandstone of the Peninsula Formation, near the eastern end of the lode above the open workings (see Fig. 2).

The manganese-enriched ore was then moved to a chute, erected on poles that extended from below the upper open workings to the shoreline southwest of the workings, over a distance of about 750 metres (Fig. 8; Spargo, 2010). The chute was constructed of wooden poles, 16 000 in number, with a steep slope of up to 45 degrees (Fig. 9). The chute was lined by corrugated iron sheets and there was at least one loading station someway down the chute to receive ore from the adits (Fig. 8; Spargo, 2010). The chute ended a short distance from the edge of the sea, where a stone and concrete jetty was constructed (Fig. 9). From the bottom of the chute, a short cocopan line transported the ore onto and along to the end of the jetty, where the ore was tipped into flat-bottomed lighters (Fig. 10). These then conveyed the ore to a ship anchored in deep water in Hout Bay and the ore was shipped to Europe for processing (Spargo, 2010). Since the chute terminated at about 100 m from the end of the jetty (Figs. 9 and 10), the rumour that ore emerging at high speed from the bottom of the chute went right through the bottom of the waiting lighter, sinking it, is untrue (Spargo, 2010). A persistent problem with the chute was that the ore tended to get stuck, which resulted in blockages along the chute.

Figure 7 : Sorted and stacked manganese ore probably located below the open workings (see Fig. 2). Sourced from the Cape Argus Weekly, dated 26th January 1910.

Figure 8 : Manganese chute high up on slopes above Hout Bay with a loading station in the foreground that probably received ore from the adits (see Figs. 3 and 5). Note the plume of disturbed water resulting from a large rip current off Flora Bay. Sourced from the Cape Argus Weekly, dated 26th January 1910.

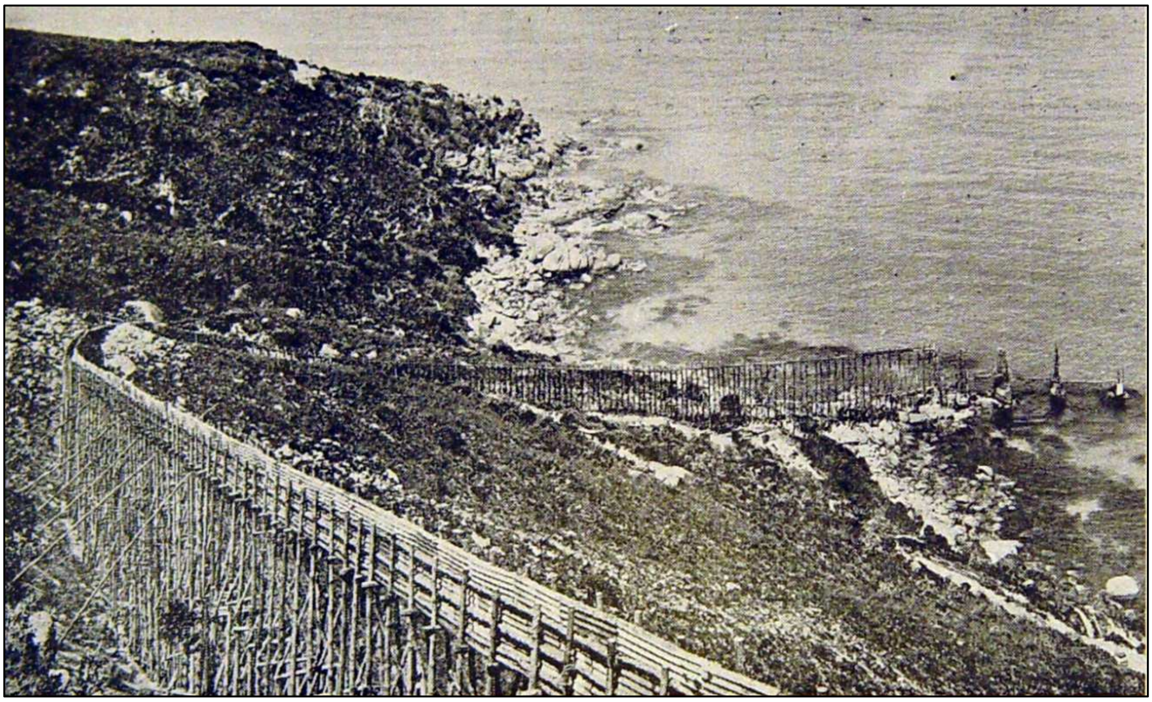

Figure 9 : Middle and lower sections of the manganese chute with the jetty at the base on the eastern coastline of Hout Bay (see Fig. 2). Sourced from the Cape Argus Weekly, dated 26th January 1910.

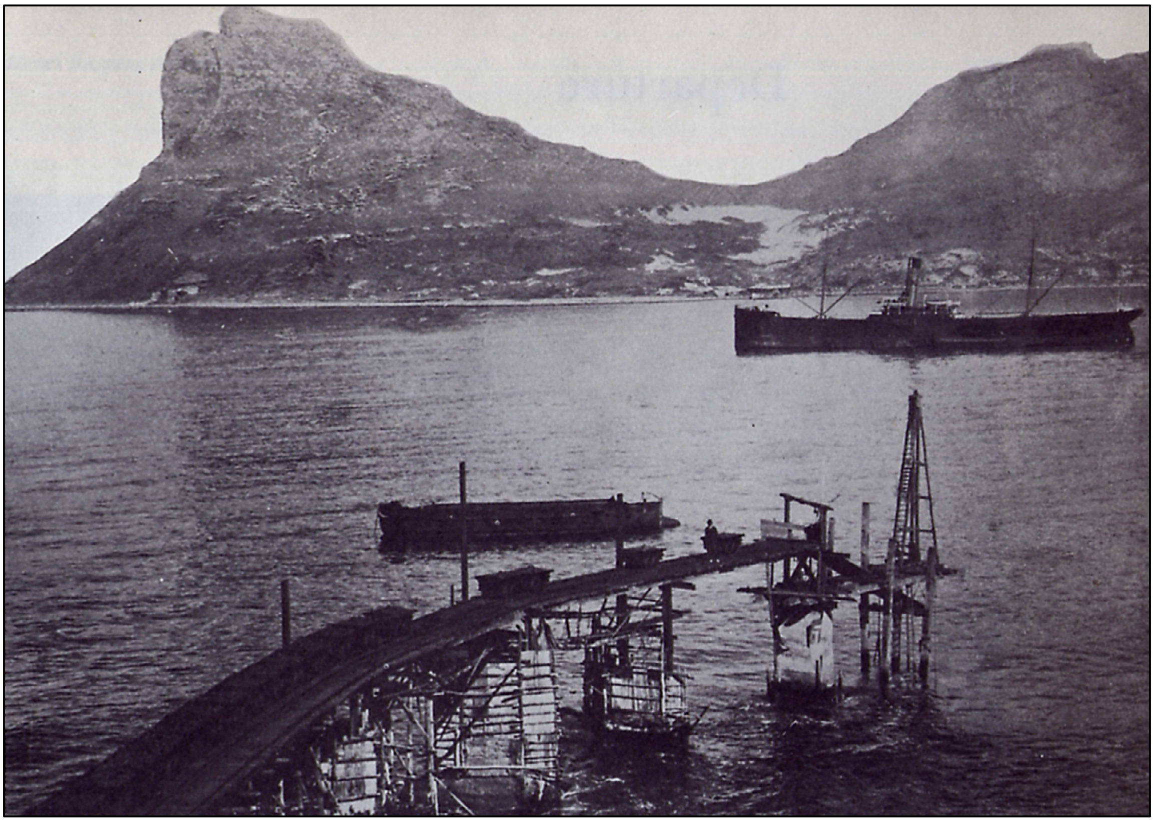

Figure 10 : The jetty with cocopans and a short chute at the end of the jetty, from which ore was tipped into a lighter. A lighter stands close by and a large steamer is anchored in deeper water. Sourced from the Western Cape Archives.

Manganese grades are relatively low (5 – 30% manganese), and only about 5 000 tons of ferromanganese ore were extracted, before operations ceased in 1911. It is estimated that up to 2 000 tons still remain in stockpiles and that the original deposit contained approximately 20 000 tons of ore (Welsh, 1917). The mine closed, due to constant repairs to the chute and a high phosphorous (0.5 to 1.3 % P_2O_5) content (Welsh, 1917; Marchant et al., 1978), which made it unsuitable for most metallurgical purposes (Spargo, 2010). High P-values lead to problems with the plasticity, toughness, and weldability of steel (Tu et al., 2019), and a maximum figure of 0.35 % P_2O_5 in manganese ore has been given by Nijhawan (1957) for use in steel manufacture. In 1929, an attempt was made to reopen the mine, but due to the discovery of large, higher-grade manganese deposits in the Postmasburg region of the Northern Cape some three years earlier in 1926, this attempt failed (Spargo, 2010).

At the mine, horizontal timber supports and rusted corrugated iron in the adits represent the remains of platforms used by the miners (Fig. 11). Several stockpiles of ore are present near the mine workings (Fig. 12) and two concrete pillars, standing in the sea below the road, are the only remains of the jetty (Fig. 13).

GEOLOGY

The orebody occupies a vertical west-northwest trending fracture-zone in sandstones and minor siltstones of the Peninsula Formation of the Table Mountain Group (Figs. 2, 3 and 6; Welsh, 1917). The fracture-zone is associated with a normal fault, several of which displace rocks of the Table Mountain Group in the region of Hout Bay and have west-west-northwest- and northwest-orientations (Fig. 2; Geological Survey, 1984; Theron, 1984). Manganese staining and low-grade, manganese enrichment are also present in many of these faults (De Villiers, 1960; Theron, 1984; MacGregor, 2013).

The oldest rocks in the region of the Hout Bay manganese deposit are granites of the Cape Granite Suite, which are exposed along the shoreline and on the lower slopes of Constantiaberg in the vicinity of the road to Chapman's Peak (Fig. 2; Geological Survey, 1984; Theron, 1984). The granites are light grey, coarse-grained and porphyritic with phenocrysts (large crystals) of white feldspar up to 60 mm in length (Theron, 1984). The granites are about 540 million years old (Armstrong et al., 1998) and are non-conformably overlain by a 550 m thick sequence of flat-lying sedimentary rocks of the Table Mountain Group consisting of a lower Graafwater Formation and an upper Peninsula Formation (Fig. 2; Theron, 1984; Compton, 2004; Rogers, 2018). A nonconformity is defined as the plane of juncture between sedimentary rocks and underlying, older, metamorphic or igneous rocks, e.g. granite, when the sedimentary rocks lie above and were deposited on the pre-existing and eroded metamorphic or igneous rock (Wikipedia, 2013). The sedimentary rocks of the Graafwater and Peninsula formations, were deposited between about 490 and 455 million years ago, following uplift and exhumation (unburying) of about 8 km of rock comprising mostly Malmesbury Group shale and siltstone that had been intruded by the granite (Cocks and Fortey, 1986; Armstrong et al., 1998; Kisters et al., 2002; Frimmel et al., 2013).

Figure 11 : Lowermost adit showing horizontal timber supports and rusted corrugated iron. A picture of the actual mining in this adit in January 1910 is shown in Fig. 4. (for location see Fig. 2).

Figure 12 : Stockpiles of ore below the open workings at the eastern end of the lode (see Fig. 2). Professor Peter Spargo is at the front of the group with his hiking staff.

The Graafwater Formation is approximately 65 m thick and crops out above the granite in the lower slopes of Constantiaberg (Fig. 2; Geological Survey, 1984; Theron, 1984). It consists of interbedded beige-coloured, fine-grained sandstone, siltstone and reddish-brown-coloured mudstone and lies below a scree-covered slope some 70 m below the lowermost adit of the manganese mine (Fig. 2). The overlying Peninsula Formation is about 485 m thick and is exposed on the slopes and summit of Constantiaberg (Fig. 2; Geological Survey, 1984). The upper contact with the Pakhuis Formation is not present, being confined to a small area on the summit of Table Mountain (Theron, 1984; Rogers, 2018). The Peninsula Formation consists of a uniform light grey and very light grey, medium- to coarse-grained, quartzitic sandstone that contains isolated, well-rounded, white, quartz pebbles up to 70 mm in diameter (Fig. 6; Theron, 1984).

The Graafwater and Peninsula Formations formed from sediments deposited on a vast coastal plain located on a flat, undulating granite platform between a highland area to the north and a sea to the south (Turner, 1990; Compton, 2004). Rivers draining the highlands flowed southwards towards a sea in southwest Gondwana. On reaching the coastal plain, these rivers deposited alternating layers of sand, silt and mud of the Graafwater Formation. The coastline progressively built seawards towards the southwest and on the landward side, the coastal plain passed into a much more extensive alluvial plain, drained by wide, shallow, river channels (braided rivers), in which were deposited mainly sand and some gravel that formed the Peninsula Formation (Turner, 1990; Compton, 2004). Sedimentation continued in a predominantly marine environment, at least until 280 million years ago, but these younger formations have been removed by subsequent erosion, following uplift associated with the Cape Orogeny (Mountain-Building Episode) between 280 and 220 million years ago (Johnson et al., 2006).

The opening of the South Atlantic, associated with fragmentation of the supercontinent Gondwana, which began about 150 million years ago, resulted in the formation of steep normal faults in the region of Hout Bay (Fig. 2), which were later the sites of manganese mineralisation. The faults show varying levels of rock displacement and intersect both the sedimentary rocks of the Graafwater and Peninsula Formations, as well as the underlying granite of the Cape Granite Suite (Fig. 2; Geological Survey, 1984; Theron, 1984). A thrust fault is present on the western flank of Constantiaberg (Fig. 2; Geological Survey, 1984; Theron, 1984).

Geologically, the remaining elements in the Hout Bay region comprise scree, sand or soil. Scree deposits of probable Pliocene to Pleistocene age (< 5 million years) cover the lower slopes of Constantiaberg (Fig. 2; Geological Survey, 1984; Theron, 1984). The scree consists of angular blocks of sandstone with interstitial gravel and sand, several metres in thickness (Theron, 1984). It covers the extreme western portion of the manganese lode and encasing Peninsula Formation (Fig. 2). Light grey, windblown, fine- to coarse-grained, sand containing abundant shell fragments and quartz, is present in the central and western parts of Hout Bay, resting on granite and Table Mountain Group sandstone (Fig. 2; Geological Survey, 1984). The sand was deflated from the beach sands of Hout Bay by prevailing winds from the southeast during the dry summer months. Brackish calcareous soil and alluvium occur along the Disa River in Hout Bay, over a maximum width of 400 m (Geological Survey, 1984).

GENESIS OF THE MANGANESE ORE

Manganese mineralisation is confined to major fault-zones, which occur predominantly in sandstone of the Peninsula Formation. For example, Cole et al. (2015) listed 18 manganese deposits within the Peninsula Formation, but only 2 within the younger, now eroded, Nardouw Subgroup of the Table Mountain Group in the Western Cape Province.

At the Hout Bay deposit, manganese mineralisation extends only a few metres beneath the surface with Welsh (1917) reporting a maximum width of 18 m in the open workings on the eastern part of the lode (Fig. 2) pinching out rapidly to 1.5 m at a depth of 3 m. This pattern occurs over the entire length of the lode with the width decreasing to about 1 m at a depth of 6 m. Other deposits in the Table Mountain Group of the Western Cape have a similar morphology, with the maximum depth of pinch-out being 30 m (Welsh, 1917). De Villiers (1960) classified the manganese deposits into three groups: 1) high-grade gash-vein fillings of psilomelane, strictly limited in extent and depth; 2) medium- to low-grade impregnations in breccias of fracture zones; and 3) shallow, low-grade impregnations (dark brown to black staining) of sandstones over comparatively wide areas. Only the first group, which includes Hout Bay, is of economic importance. Manganese lodes in the Cape Peninsula do not favour any particular stratigraphic level in the Peninsula Formation. The lodes, which are thickest at the surface and peter out at moderate depths, maintain this pattern regardless of the topography, indicating that mineralisation was controlled by the present topography (Marchant et al., 1978).

Figure 13 : Two concrete pillars, standing in the sea below the Chapman's Peak Drive, about 350 m northwest of East Fort (see Fig. 2). These pillars represent the only remaining part of the jetty that was used for the shipment of manganese ore (see Fig. 10).

De Villiers (1960) suggested that the manganese in the lodes was derived from their host, the Peninsula Formation sandstones, since small quantities of manganese are disseminated in the sandstones (6 to 4115 ppm (Marchant et al., 1978, Table II)). De Villiers (1960) stated that meteoric (rain) water descending into the sandstone and subsidiary siltstone would become impregnated by manganese and iron oxide gels, probably in the form of flocculant suspensions. These were subsequently drawn to the surface by capillary action, especially along passages afforded by shear zones and gash openings associated with the fault. On close approach to the surface, they were concentrated by evaporation of the solutions, which led to the precipitation of gels as colloform masses along the sides of open fissures or as impregnations in brecciated sandstone. This material was then oxidised further and hardened into stalactitic psilomelane and crustified limonite (goethite). The tenor (average metal content) of the final ore would depend on the proportions of manganese to iron present in the migrating solutions.

Marchant et al. (1978) investigated this genesis in more detail, focussing on the Hout Bay deposit. They sampled sandstones of the Peninsula and Graafwater Formations for manganese and other elements characteristic of the manganese lodes, namely iron and phosphorous. The Peninsula Formation contained between 0.0006 and 0.4115 %

Mn, 0.33 and 3.27 % Fe_2O_3 and up to 0.16 % P_2O_5, all of which occur in major concentrations in the vein deposit, i.e. mean values of 47.49 % MnO_2, 17.51 % Fe_2O_3 and 1.29 % P_2O_5. Furthermore, it was found that the ore contains no known concentrations of any elements, which are rare in the sandstone. Marchant et al. (1978) also assayed between 0.3078 and 7.0 % Mn, 1.14 and 20.9 % Fe_2O_3 and 0.06 and 1.05 % P_2O_5 in sandstone and siltstone of the Graafwater Formation, suggesting that these rocks could also have been a source of manganese in the Hout Bay lode. Four soil traverses were completed over a distance of 500 m, moving north of the lode, and the results of manganese analyses showed a low dispersion of manganese away from the lode. The lack of a well-developed pedogeochemical anomaly, caused by a large subsurface ore body, supports the hypothesis that the manganese lode formed near the present land surface, as a result of precipitation in shallow open fissures, by evaporation of groundwater solutions (Marchant et al., 1978). This process was originally referred to as "lateral secretion" (Phillips and Louis, 1896).

The age of the manganese deposits is unknown, but in order to accumulate a considerable quantity of manganese in the lode (20 000 tons of ore, according to Welsh (1917)), by means of lateral secretion from the surrounding sandstone, a period of several million years would be required. It is possible that the manganese ore persisted at the land surface, while erosion of the sandstones proceeded during the later Tertiary about 15 million years ago (Compton, 2004), with the manganese concentrations being continually regenerated as the element was leached from rock near the descending surface. The precipitation of manganese was enhanced by the presence of pre-existing surfaces of manganese and iron oxides, i.e. by an autocatalytic effect. Thus, it would have been possible for the manganese deposit to survive at the land surface, as it was lowered by erosion.

Several dolerite dykes occupy west- west-northwest- and northwest-trending fractures in the Chapman's Peak area (Fig. 2; Geological Survey, 1984), one of which yielded a radiometric potassium-argon (K-Ar) date of 131 ± 5 million years (Reid et al., 1991). As in the case of the formation of the faults, the intrusion of the dolerite dykes was directly related to the fragmentation of the supercontinent Gondwana, which began about 150 million years ago. The relationship, if any, between the inception of manganese mineralisation and the emplacement of these Early Cretaceous dolerite dykes, is unknown.

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CONTACT

Western Cape Branch of the Geological Society of South Africa:

https://www.gssawc.org.za

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