



Council for Geoscience

**REPORT ON ECONOMICALLY-VIABLE
MINERAL RESOURCES IN THE CITY OF
CAPE TOWN'S ADMINISTRATIVE AREA**

by

D.I. COLE

Western Cape Regional Office

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ECONOMIC, ENVIRONMENTAL & SPATIAL PLANNING
Environmental Resource Management Department
Environmental Compliance Branch



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1. Introduction

This report is a result of a request by Arne Purves, City of Cape Town, for digital data on the economic and potentially economic mineral resource fields in the City of Cape Town's administrative area. This data was captured and placed on ARC-GIS. A total of eleven mineral commodities were identified, namely stone aggregate – granite, stone aggregate – Malmesbury slate, stone aggregate – Table Mountain sandstone, brick clay, plastic clay, building sand, silica sand, gravel (ferricrete), limestone, kaolin and phosphate. Their distribution was compiled as separate layers on ARC-GIS. This report describes each mineral commodity systematically in terms of the location, extent, economic viability and alternative sources outside the Cape Town area. The GIS data standards are given in Appendix 1.

2. Methods of Study

The distribution and areal extent of the resource fields of the eleven mineral commodities were captured from a variety of sources and drawn manually on stable transparent paper on a scale of 1:50 000. These fields were scanned and input onto ARC-GIS as shape files. Some of the fields, namely stone aggregate – granite, stone aggregate – Table Mountain sandstone, gravel (ferricrete) and limestone, were already delineated on published and unpublished 1:50 000-scale geological maps (Theron, 1984; Roberts, 2001) and could be quickly captured. Stone aggregate – Malmesbury slate was captured from the publication of De Villiers (1980) and a report by Hill et al. (1992). Brick clay was mainly captured from the latter report and plastic clay from the report of Cole et al. (2010) and unpublished map data from the 1:50 000 unpublished 3318DD Stellenbosch geological sheet (J. Viljoen, pers. comm., 2011). Building sand was mainly captured from the bulletin of Cole and Viljoen (2001), the distribution of working pits (Motsoenyane, 2010) and GoogleEarth images of exploited and unexploited sand dunes. Silica sand was captured from the bulletin of Hill and Theron (1981), the report of Hill et al. (1992) and data from boreholes. Kaolin was mainly captured from the handbook of Heckroodt (1992) and phosphate, which forms only one small resource field near Atlantis, from the publications of Du Toit (1927), Haughton (1933), Hill et al. (1992) and Roberts (2001). The resource fields were further constrained and verified by use of the Council for Geoscience's mineral database, SAMINDABA, which has the following information for each mineral site: 1) Locality details; 2) Deposit size and status of deposit; 3) Level of exploration; 4) Level of exploitation; 5) Host rocks and their stratigraphy; 6) Ore body size and description; 7) Level of sampling, geochemistry and grade of mineral commodity in ore and; 8) Data references. The comprehensive description of mineral deposits and resource fields on the 1:250 000-scale 3318 Cape Town sheet (Cole, 2003) was also utilised. Urban/industrial areas and the Cape Peninsula National Park were excluded from the study.

3. Resource Fields

Resource fields for stone aggregate – granite, stone aggregate – Malmesbury slate, stone aggregate – Table Mountain sandstone, brick clay, plastic clay, silica sand, gravel (ferricrete) and kaolin are shown in Figure 1 and fields for building sand, limestone and phosphate in Figure 2.

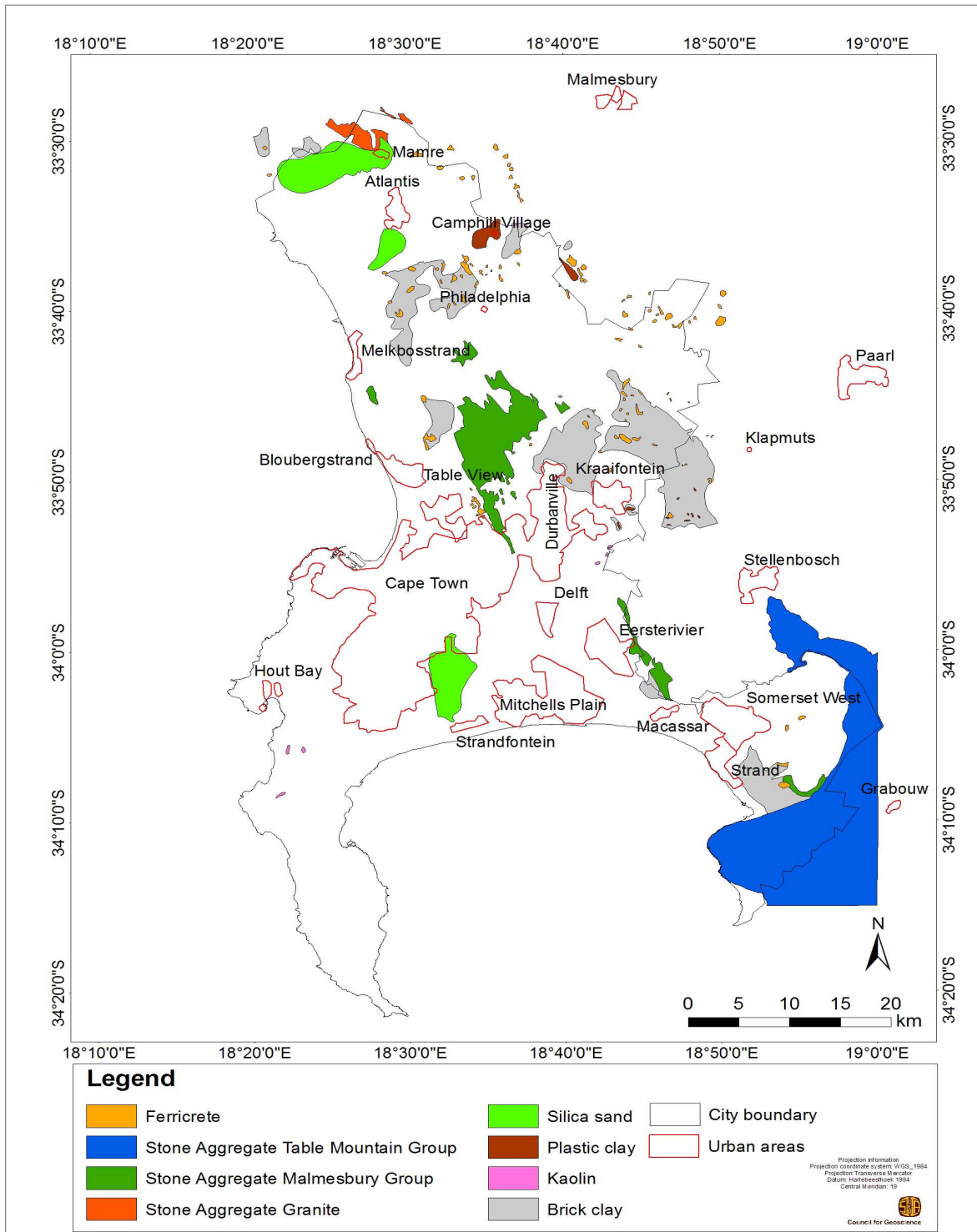


Figure 1: Resource fields for stone aggregate – granite, stone aggregate – Malmesbury slate, stone aggregate – Table Mountain sandstone, brick clay, plastic clay, silica sand, gravel (ferricrete) and kaolin in the Greater Cape Town area.

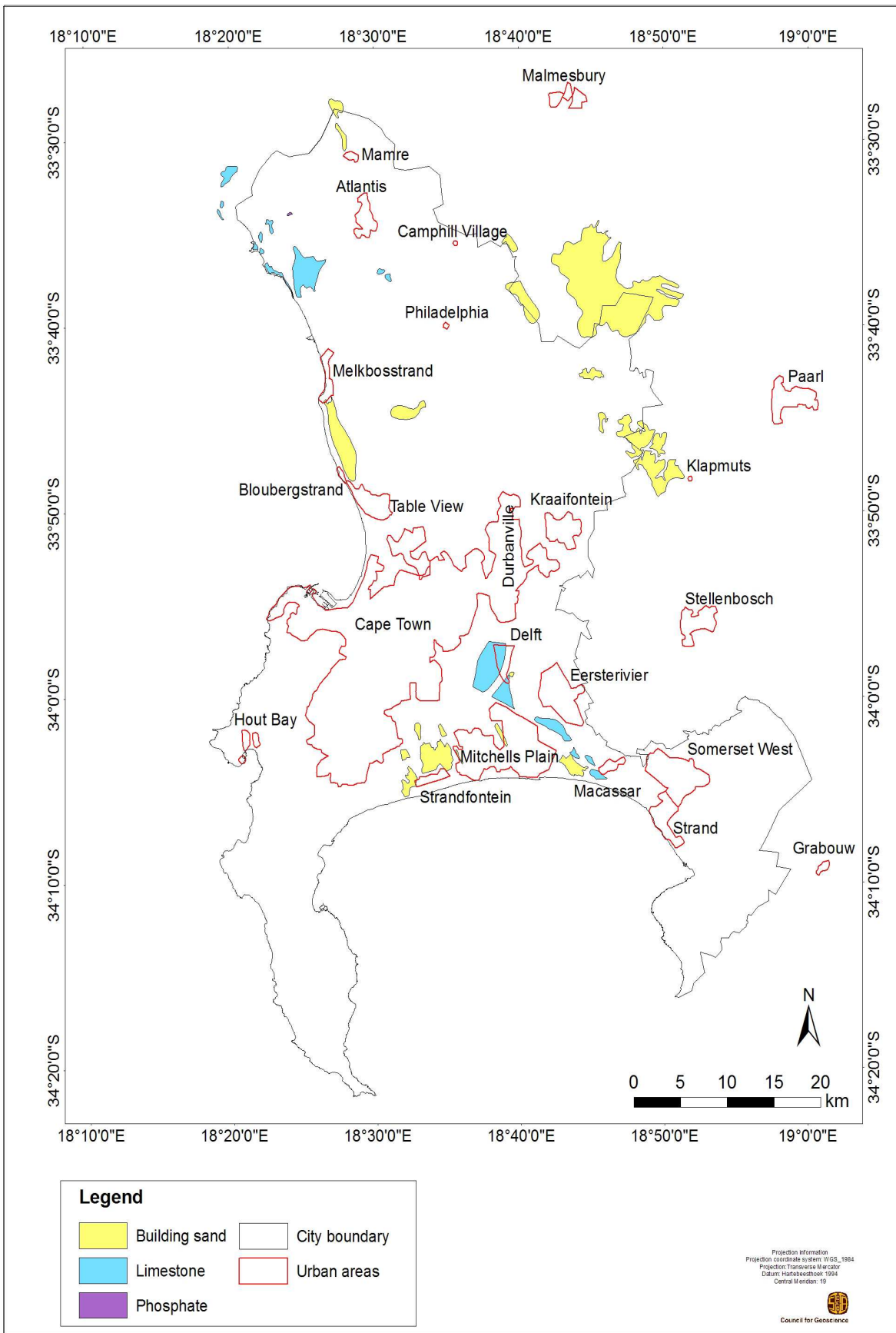


Figure 2: Resource fields for building sand, limestone and phosphate in the Greater Cape Town area.

3.1 Stone Aggregate – granite

Resource fields for stone aggregate from granite are confined to the Mamre region (Fig. 1). Here, coarse-grained, porphyritic granite forms three resource fields northwest, north and northeast of Mamre. It was formerly exploited from a quarry 3 km northwest of Mamre for concrete aggregate and road-construction material (Minerals Bureau, 1987). This granite forms part of the Late Precambrian Darling Batholith, which trends north beyond the City of Cape Town's administrative area (CCTAA) boundary. Other granites within this batholith contain large alkali feldspar phenocrysts, which are prone to disintegration and/or muscovite, both of which are deleterious for concrete aggregate (South African Bureau of Standards, 1994). Similar granites, as well as sheared granites occur elsewhere in the CCTAA near Klipheuwel, Kuils River and Somerset West (Theron et al., 1992; Cole, 2003) and are excluded as potential sources of stone aggregate. Sources of granite suitable for stone aggregate outside the CCTAA boundary are restricted to fine-grained equigranular granite located between 5 and 12 km north of Malmesbury, which is exploited at one site, Rheeboek Quarry (Cole, 2003; Motsoenyane, 2010).

3.2 Stone Aggregate – Malmesbury slate

This forms the major source of stone aggregate in the CCTAA. It comprises both hornfels, a dense hard rock that occurs within the zone of thermal metamorphism close to contacts with the intrusive granites of the Cape Granite Suite and, in the Tygerberg Hills, quartzitic argillaceous sandstone of the Late Precambrian Malmesbury Group. The largest resource field occurs in the Tygerberg Hills, with smaller fields at Blouberg, southwest of Philadelphia, east of Blackheath – Eerste River and southeast of Somerset West (Figure 1). It is currently being exploited from four quarries in the Tygerberg Hills, where quartzitic argillaceous sandstone is utilised, and one quarry at Eerste River, Peak Quarry (Motsoenyane, 2010), where hornfels is utilised. It is principally used for concrete aggregate and road construction. The inferred resources of hornfels and quartzitic argillaceous sandstone are enormous and probably total several billion tons (Hill et al., 1992; Cole, 2003).

3.3 Stone Aggregate – Table Mountain sandstone

Table Mountain sandstone was formerly exploited for concrete aggregate, railway ballast and road construction material at Glencairn Quarry between 1896 and 1978 (Theron, 1984), but this quarry now forms part of the Cape Peninsula National Park, which is out of bounds for mining. Within the CCTAA, Table Mountain sandstone is also present in the mountainous region northeast, east and southeast of Somerset West – Strand, where a resource field has been drawn (Fig. 1). It forms a good quality concrete aggregate, particularly the quartzitic sandstones of the Peninsula and Skurweberg Formations and is the main source of stone aggregate in the Bredasdorp, George and Knysna regions (Biggs and Du Cann, 1979; Roberts et al., 2008; Motsoenyane, 2010). It is currently being exploited from a shallow quarry named Palmiet, which is located on Portion 7 of the farm Elgin Forest 295 immediately east of the boundary of the CCTAA and between the N2 national road and the Peninsula Dam (Motsoenyane, 2010). Resources are huge, since the Table Mountain sandstone continues further east for another 20 km towards Bot River (Gresse and Theron, 1992).

3.4 Brick Clay

There are abundant resources of brick clay in the CCTAA (Cole, 2003). These mostly take the form of residual clay derived from weathering of the Malmesbury Group (Heckroodt 1980). It normally underlies flat or gently-inclined palaeo-erosion surfaces at elevations between 70 m and 200 m. These surfaces were subjected to long periods of weathering and are commonly capped by thin (< 2 m) ferricretes and silcrettes that represent prolonged pedogenic processes (Partridge and Maud 1987). Residual clay derived from the Malmesbury Group shale, slate and phyllite forms a suitable brick-making material, since it contains the essential minerals kaolinite, quartz and illite (Heckroodt 1991; Theron et al. 1992). Kaolinite has good sintering characteristics, while quartz acts as a stabiliser and illite produces plasticity (Van Strijp 1998). However, illite is generally a minor component in the Malmesbury Group residual clays (Heckroodt 1980, 1991) and in order to improve the plasticity, sedimentary plastic (ball) clay of Late Tertiary age is added (see section 3.5).

A total of twelve resource fields have been captured with the largest fields occurring between Stellenbosch and Klipheuwel and south and southeast of Atlantis (Fig. 1). Most of these fields are associated with residual clay of the Malmesbury Group, but east of Camphill Village, one field includes residual clay of the Cambrian Klipheuwel Group shales and south of Kraaifontein, another field includes sedimentary clay of the Miocene Elandsfontyn Formation (Fig. 1; Cole, 2003). The latter is currently being mined by Crammix (Pty) Ltd. Residual Malmesbury Group clay is presently being exploited for brick-making at five sites south of Atlantis, northeast of Bloubergstrand and northeast of Durbanville. Outside the CCTAA, the same clay is also extensive southwest of Malmesbury and south and west of Paarl and northwest of Stellenbosch, where it is exploited from five sites.

3.5 Plastic Clay

Plastic clays in the CCTAA are Tertiary in age and consist of transported, sedimentary clays rich in kaolinite, but with small amounts of quartz, mica, illite, montmorillonite and organic material, the last imparting good plastic properties (Heckroodt, 1980; McMillan, 1982). They resemble ball clays from Devon, England, but contain less mica, have higher TiO_2 and Fe_2O_3 contents and a lower K_2O content (McMillan 1982). They fire white to off-white in colour and have been used in the whiteware ceramic industry, but their major application is for use as a plasticiser and strengthener in the brickmaking industry. Here, in the CCTAA, small quantities are added to the predominant Malmesbury Group, residual brickmaking clay in order to improve the extrudibility of the brick clay. They form ten small fields between Kraaifontein and Klapmuts and two larger fields near Camphill Village (5.5 km²) and northeast of Philadelphia (0.75 km²). Varying proportions of clay have been exploited from these fields and the largest remaining resource is the field near Camphill Village (Fig. 1; Cole et al., 2010). It is currently being exploited from two sites northwest of Koelenhof and near Camphill Village (Motsoenyane, 2010). There are no known deposits outside the CCTAA, with the closest deposits being located near Heidelberg, Riversdale, Mossel Bay and Oudtshoorn.

3.6 Silica Sand

Silica sand is defined as unconsolidated sand containing greater than 85 per cent SiO₂ with 99 per cent by weight lying in the grain size range 0.1 – 0.5 mm (Lorenz and Gwosdz, 2003). It is used for glass manufacture and foundry sand. Three resource fields have been defined – Philippi Horticultural Area, a field south of Atlantis and a field north of Atlantis (Fig. 1). The Philippi Horticultural Area hosts the most important field, which was formerly protected for future mining by Proclamation Number 1760 of 1968 (Hill and Theron, 1981).

Silica sand has been exploited for glass manufacture in the Philippi area since 1925, but the initial workings from two pits located in the northern part of the area have long been abandoned (Hill and Theron, 1981; Cole, 2003). By 1958, almost 0.5 million tons of sand had been supplied to glass factories in South Africa (Hill and Theron, 1981). In 1956, Consol Glass started exploiting silica sand from a water-filled pit east of Hanover Park by means of dredge mining to a depth of 8 metres (Hill and Theron, 1981). This operation is still continuing, with dredging depths reaching down to 20 metres. A comprehensive study of the silica sands was completed by Hill and Theron (1981) based on data from numerous boreholes (Henzen, 1973), as well as deep boreholes drilled by the Geological Survey of South Africa between 1970 and 1973. They calculated an inferred resource of 405 million tons of high-grade sand with an average thickness of 15 metres. This resource lies between Lansdowne Road (M9) in the north, Strandfontein Road (M17) in the west, Weltevreden Road (M7) in the east and north of the northern boundary of Strandfontein in the south. The silica sands form the Springfontyn Formation and consist predominantly of clean, well sorted and rounded, fine- to medium- and medium-grained quartzose sand (Cole, 2011). Average SiO₂ concentrations in the Springfontyn Formation exceed 95 per cent (Cole, 2011). However, the Springfontyn Formation is only exposed at surface over the central and northern parts of the Philippi Horticultural Area and is covered by up to 10 metres of shelly sand of the Witzand Formation in the southern part of this area (Cole, 2011). Hill and Theron's (1981) resource calculation to a depth of 15 metres included sands of the overlying Witzand Formation in the southern part of the Philippi Horticultural Area and these have lower SiO₂ concentrations (76.5 – 97.2 per cent) and unacceptably high CaO concentrations (0.96 – 12.41 per cent). Cole (2011) recently re-assessed the data of Hill and Theron (1981) and delineated an area of 14 km² in the central and northwestern part of the Philippi Horticultural Area, where silica sands of the Springfontyn Formation are exposed at surface and where thicknesses exceed 15 metres, which is the normal maximum depth used for dredge mining. An inferred resource of 210 million cubic metres or 315 million tons of silica sand using a dry sand bulk density of 1.5 tons per cubic metre was calculated. It is important to preserve this deposit or at least a portion of it for future mining, as other silica mines in South Africa are restricted to quartzite deposits in Gauteng and Northwest Province and a quartz vein near Polokwane (Oosterhuis, 1998; Motsoenyane, 2010).

Silica sand in the resource field south of Atlantis (Fig. 1) consists of fine- to medium-grained, rounded and well-sorted quartzose sand of the Springfontyn Formation, which averages 5 metres in thickness (Roberts, 2001). It thickens northward and is overlaid by up to 28 metres of shelly sand of the Witzand Formation (Rogers, 1980). However, these sands form the Atlantis aquifer where mining is prohibited (Cole, 2003). In the resource field south of Atlantis, silica concentrations are unknown, but the sand has been mined at one site since 1982 on the farm Brakke Fontyn 32 for foundry sand (Cole, 2003). Silica sand in the resource field north of

Atlantis (Fig. 1) also consists of fine- to medium-grained, rounded and well-sorted quartzose sand of the Springfontyn Formation, but is relatively thin (< 10 metres) and lies on the northern side of the Atlantis aquifer (Rogers, 1980; Roberts, 2001). Silica concentrations are unknown.

Outside the boundary of the CCTAA, the only known silica sand deposit is on the farm Elandsfontyn 349, 14 km west of Hopefield. It is 11 metres thick, but is covered by sandy overburden 15 metres thick (Cole, 2003). The silica sand is relatively high in grade with three samples yielding 95.14, 96.84 and 98.57 per cent SiO₂ (Horn and Cole, 1993).

3.7 Gravel (Ferricrete)

A variety of rocks and sediments can be used to produce gravel for fill and road or pavement construction in the CCTAA, such as Malmesbury Group shales, scree material and colluvium, but this would result in much of the open land outside the urban areas becoming a single resource field. Ferricrete is the most valuable of these rock types as a source of gravel (Hill et al., 1992) and it is utilised as subgrade for asphalt and concrete pavements or roads and as gravel wearing course on unsealed roads (Netterberg, 1998). It formed as a result of pedogenesis accompanied by a fluctuating water table (Roberts, 2001). It takes the form of nodules and/or exotic clasts cemented by ferruginous material with the principal minerals being goethite, limonite and hematite (Roberts, 2001). It does not exceed 2 metres in thickness and normally occurs on flat or gently-inclined palaeo-erosion surfaces at elevations between 70 m and 200 m. These surfaces were subjected to long periods of weathering and thick residual clays commonly underlie the ferricrete (section 3.4; Partridge and Maud 1987).

Ferricrete forms numerous small exposures or resource fields, rarely larger than 2 km² in areal extent. These are concentrated east of Strand, north, east and south of Kraaifontein, west of the Tygerberg Hills and in the region between Klapmuts, Philadelphia and Mamre (Fig. 1). Many of these deposits have already been partly exploited. Similar deposits occur outside the boundary of the CCTAA towards Klapmuts, Paarl and Malmesbury, but the tonnage of inferred resources is limited.

3.8 Kaolin

Kaolin was previously an important mineral commodity in the CCTAA and was exploited for ceramic manufacture, paper filling, paint filling, pesticides, medicines, cosmetics and pharmaceuticals (Cole, 2003). Its principal use was for paper filling, since the quality was insufficient for paper coating (Heckroodt, 1992), but with the advent of cheaper ground calcium carbonate as a replacement, kaolin has lost its importance and the last working mine west of Noordhoek closed in 2007. However, it can still be regarded as a potentially-economic commodity, since it is the source material for ceramics.

In the CCTAA, all the kaolin deposits are a result of residual weathering of coarse-grained, porphyritic granite of the Cape Granite Suite. Three resource fields are present in the Noordhoek – Fishhoek Valley with measured mineral resources of 0.9, 1.3 and 2.95 million tons (Cole, 2003). A small deposit is present at Oakhurst near Hout Bay and it is mined on a very small scale for the production of ceramics. In the Brackenfell-Kuils River area, four deposits or resource fields are present (Heckroodt, 1992). The two larger deposits have measured mineral resources of

1.1 and 1.3 million tons and were formerly exploited for ceramic manufacture (Cole, 2003).

Outside the boundary of the CCTAA, four deposits or resource fields occur between Somerset West and Stellenbosch, the largest of which at Stellenbosch Airdrome, has a measured mineral resource of 11.6 million tons (Cole, 2003).

3.9 Building Sand

Building sand is concentrated in the Philippi Horticultural Area, the region west of Macassar and the region south of Malmesbury, which is largely outside the CCTAA (Fig. 2). Deposits further away are generally unviable because 80 km is the maximum distance that building sand can be economically transported (Cole and Viljoen, 2001). Philippi is the traditional sand-mining area of Cape Town, but remaining resources are confined to the southern part of the Philippi Horticultural Area (Cole, 2011). The sand occurs in north-northwest-trending hairpin parabolic dunes of the Holocene Witzand Formation. It is fine- to coarse-grained and contains comminuted shell fragments (Cole and Viljoen, 2001). It is only suitable for mortar sand and remaining resources are probably in the order of 10 million tons. In the Philippi Horticultural Area, the dune sands overlie high-grade silica sand of the Springfontyn Formation (section 3.6; Cole, 2011). Grading analysis indicated that these high-grade silica sands could be used for mortar or plaster sand, as well as glass manufacture, but any exploitation would have to use dredge mining (Cole and Viljoen, 2001).

In the region west of Macassar (Fig. 2), very fine- to coarse-grained quartzose sand with comminuted shell fragments forms northwest-trending hairpin parabolic dunes. Dunes north of the central ridge line are being exploited for mortar sand. Remaining resources are probably in the order of 30 million tons (Cole and Viljoen, 2001). In the region south of Malmesbury, four resource fields are present with only one within the CCTAA (Fig. 2). The sand consists of very fine- to gritty, unsorted sand with an average thickness of 0.85 metres (Cole and Viljoen, 2001). It commonly overlies ferricrete resting on residual clay of the Malmesbury Group and represents hillwash deposits derived from granite of the Paardeberg batholith. It is used for concrete, plaster and mortar sand (Cole and Viljoen, 2001). The remaining inferred resource is probably in the order of 20 million tons.

Other resource fields of building sand occur in north-northwest-trending hairpin parabolic dunes between Bloubergstrand and Melkbosstrand, which are suitable for mortar sand and have an inferred resource of about 5 million tons (Cole and Viljoen, 2001), aeolian sand of the Springfontyn Formation east of Melkbosstrand, hillwash sand north of Mamre and hillwash sand near Klappmuts (Fig. 2; Cole and Viljoen, 2001). Minor hairpin parabolic dunes occur west of Khayelitsha and southeast of Delft (Fig. 2). A significant resource was sterilised when hairpin parabolic dunes were flattened during the development of Khayelitsha. There are no large building sand resource fields outside the CCTAA and within the CCTAA, the building sand resources will probably be depleted within 20 years. The most suitable replacement is probably crushed sand from Table Mountain sandstone, since transporting unconsolidated fluvial and aeolian sand from Namaqualand would be prohibitively expensive (Cole and Viljoen, 2001).

3.10 Limestone

Limestone in the CCTAA is confined to the Quaternary Langebaan Formation. It comprises quartz-bearing limestone, calcareous sandstone and subordinate pedogenic calcrete (Theron et al., 1992). The original sediment, including comminuted shells, was deflated from beaches and deposited in northwest-trending aeolian dunes on the Cape Flats and north-trending dunes north of Cape Town (Rogers, 1980). The sediments were later calcified due to groundwater dissolution of calcium carbonate from the abundant shell fragments and its precipitation as secondary calcite in the pore space, leading to the formation of slightly to moderately cemented aeolianite (Rogers 1980; Roberts 2001). Several resource fields are present on the western coastal plain north of Melkbosstrand and on the Cape Flats between Macassar and Delft (Fig. 2). The CaCO₃ grades are low, ranging from 43 to 57 per cent (Martini, 1987). This means that its applications were restricted to building lime (Cole, 2003). The pedogenic calcretes have been utilised for base course, subbase and subgrade for asphalt and concrete pavements or roads and as gravel wearing course on unsealed roads (Netterberg, 1998). These were previously worked from shallow quarries north of Melkbosstrand and south of Delft (Cole, 2003). None of the limestones are exploited at present and higher quality limestone is exploited for cement at Riebeeck West and Piketberg and for agricultural lime at Bredasdorp.

3.11 Phosphate

Phosphate in the CCTAA is confined to a single deposit on farm number 982, 7 km west of Atlantis (Fig. 2). It consists of quartzose sand containing phosphatised shell fragments in a matrix of cryptocrystalline francolite and formed in a shallow marine environment some five million years ago (Birch, 1977). It has an indicated resource of 50 000 tons of ore grading between 17 and 22 per cent P₂O₅ (African Minerals Corporation, 1964). The average thickness is 1.5 metres and there is an overburden of sand of the Springfontyn Formation between 3 and 4.5 metres thick. The deposit has not been developed and its principal application is for agricultural fertilizer. Several larger phosphate deposits are present further north on the western coastal plain between Langebaan and Doring Bay.

4. Conclusion

The City of Cape Town's administrative area contains eleven economic and potentially-economic mineral commodities. Resource fields were drawn for each commodity and then captured on ARC-GIS. The economic mineral commodities currently being exploited are stone aggregate – Malmesbury slate, stone aggregate – Table Mountain sandstone, brick clay, plastic clay, building sand, silica sand and gravel (ferricrete). Resources are abundant, with the exception of building sand and gravel (ferricrete), which will probably be depleted within 20 years. Stone aggregate – granite, limestone and kaolin were previously exploited and have a potential for renewed exploitation should market conditions improve. Phosphate is confined to a single relatively small deposit, which has a potential to be developed should market conditions for agricultural fertilizer improve.

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APPENDIX 1
GIS Data Standards

GIS DATA STANDARDS

Metadata standard:

Standard name: FGDC Content Standards for Digital Geospatial Metadata

Standard version: FGDC-STD-001-1998

Time convention used in this document: local time

Metadata profiles defining additional information

- ESRI Metadata Profile: <http://www.esri.com/metadata/esriprof80.html>

Description information

* Abstract

The project aimed at identifying natural resource areas for City of Cape Town. This would therefore assist the City to monitor mined natural resources and therefore provide necessary measure in areas that need to be conserved and protected from mining activities.

* Purpose

The purpose of this study was to identify and map existing natural resources within the City of Cape Town Municipality boundary.

* Status of the data

Complete

Data update frequency: None planned

* Publication information

Who created the data: Council for Geoscience

Contact person: Mr L. Ngcofe or Ms P. Mthembu

Tel: 021 943 6700

Physical Address: 3 Oos Street, Bellville, 7530

Spatial information

Map Projection Name: Transverse Mercator

Scale Factor at Central Meridian: 1.000000

Longitude of Central Meridian: 19.000000

Latitude of Projection Origin: 0.000000

False Easting: 0.000000

False Northing: 0.000000

Planar Coordinate Information

Planar Distance Units: meters

Coordinate Encoding Method: coordinate pair

Coordinate Representation

Abscissa Resolution: 0.000000

Ordinate Resolution: 0.000000

Geodetic Model

Horizontal Datum Name: D_Hartebeesthoek_1994

Ellipsoid Name: WGS_1984

Semi-major Axis: 6378137.000000

Denominator of Flattening Ratio: 298.257224