Ultramafic rocks of the Paleoproterozoic greenstone belt in the Guiana Shield of Suriname, and their mineral potential

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Abstract

The ultramafic rocks of the Marowijne Greenstone Belt in Suriname comprise intrusive dunite-gabbroic bodies, ultramafic lavas and volcaniclastic rocks. They were emplaced in the early stages of the Trans-Amazonian Orogeny(2.26-2.09 Ga). They present several economically interesting mineralisations including chromium, nickel, platinum, gold and diamonds. In Suriname diamonds are found since the 19th century; possible source rocks show similarities with the diamondiferous komatiitic volcaniclastic rocks in Dachine, French Guiana and in Akwatia in the Birimian greenstone belt of Ghana. This might point to a regionally extensive diamond belt in the Guiana Shield and its pre-drift counterpart in the West-African Craton.

Introduction

- The ultramafic rocks of Suriname are one of the least investigated, but economically most promising rocks in the Paleoproterozoic greenstone belt.
- It stretches over a distance of 1500 km along the whole northern coast of the Guiana Shield from Venezuela to the Amapá state in Brazil (Figure 1).

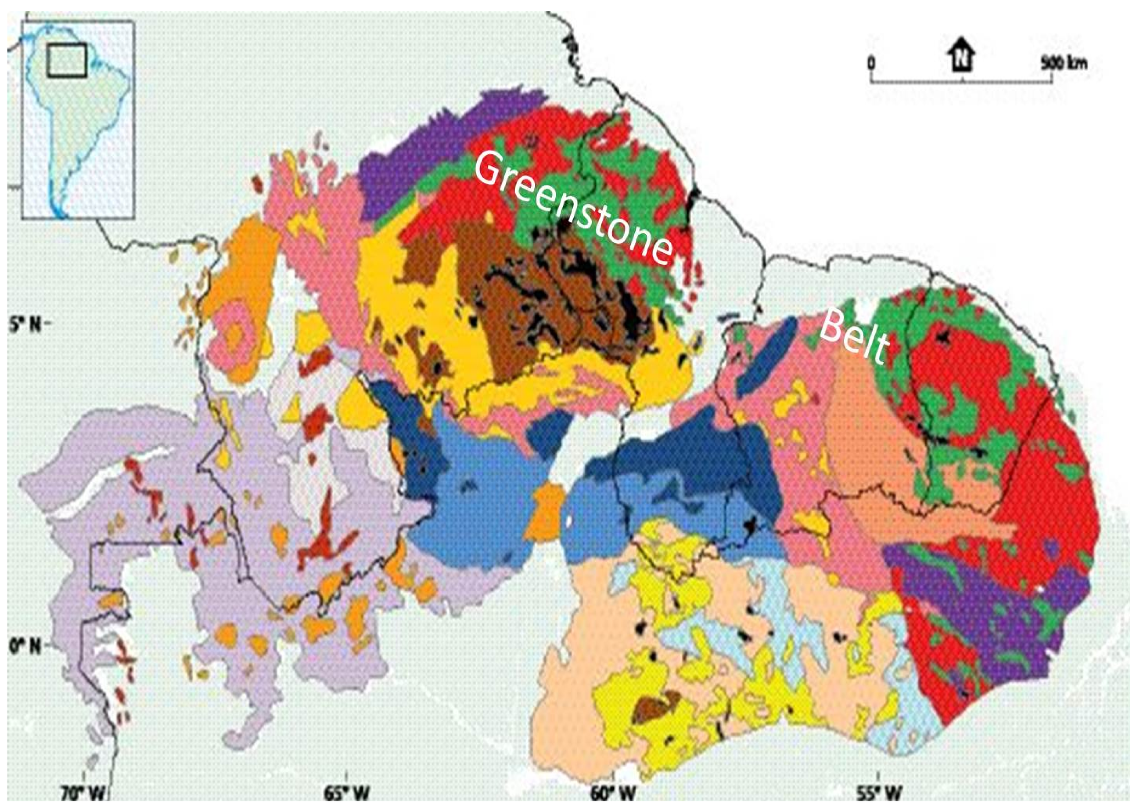

Figure 1: The Trans-Amazonian Greenstone Belt of the northern Guiana Shield (Daoust et al., 2011).

- Ultramafic rocks are the host rocks of nickel, chromium, platinum, gold and diamond mineralisations in the Guiana Shield.
- According to Bosma et al., 1984 all ultramafic and mafic bodies in Suriname were classified together as De Goeje Gabbro.
- These rocks were considered to belong to a single magmatic event around 1870 Ma (Priem et al., 1971).
- Recent zircon datings from French Guiana (± 2147 Ma; Tampok gabbro, Pb–zircon evaporation; Delor et al., 2003a), showed that the ultramafics in the greenstone belt are at least 100 million years older than those found in western and central Suriname (dated at 1985 Ma, Kroonenberg et al., 2016).
- The ultramafic bodies in the Surinamese part, the Marowijne greenstone belt, have been renamed as the Bemau Ultramafitite.
- Those in western and central Suriname Lucie Gabbro (Kroonenberg et al., 2016).
- The two sets ultramaic bodies also differ in lithologies, talc schists, chlorite schists, tremolite and serpentinites are common accompanying rock types in the greenstone belt, but absent in the Lucie Gabbro of western Suriname.

Problem Statement

The nature of the emplacement of the lavas and volcaniclastics are still not understood, wheter they are extruded in a submarine environment, as suggested by the nature of the volcaniclastics. Whetrer the ultramafic lavas and vulkaniclastic rocks are from the same magmatic pulse as the cumulates, or else the cumulates injected into older ultramafic lavas.

Purpose

- The purpose of this study is to investigate the petrogenesis, emplacement and tectonic setting of ultramafic rocks in the greenstone belt.
- To evaluate their importance for mineralisation, in order to elucidate whether the source rock of the Suriname diamonds is comparable to the diamond bearing rock units occurring in Dachine and Akwatia.

Ultramafics in the Marowijne greenstone belt

The ultramafic rocks in the Marowijne Greenstone belt (Figure 2), can be grouped into three (3) main occurrences:

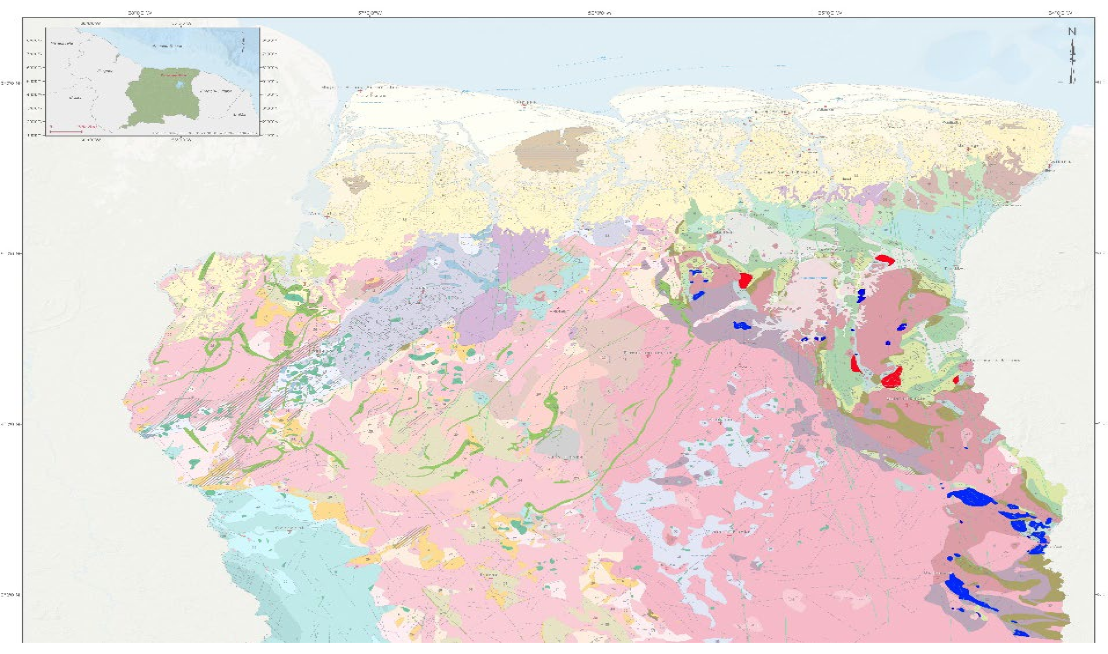

Figure 2: Occurrences of ultramafic rocks in red and metagabbros in blue (modified form geological map of Suriname, the national geological survey GMD).

1) **The Bemau ultramafic complex in the Saramacca area (Figure 3a).**

- consists of cumulate dunite-wehrlite-clinopyroxenites and gabbroic plutonic rocks, probably Alaskan-type intrusives (Veenstra, 1983; Teuling, 2018)
- as well as ultramafic talc-chlorite schists, which might represent ultramafic lavas and volcaniclastic rocks based on the presence of vesicular and sedimentary structures (Figure 3b & c).

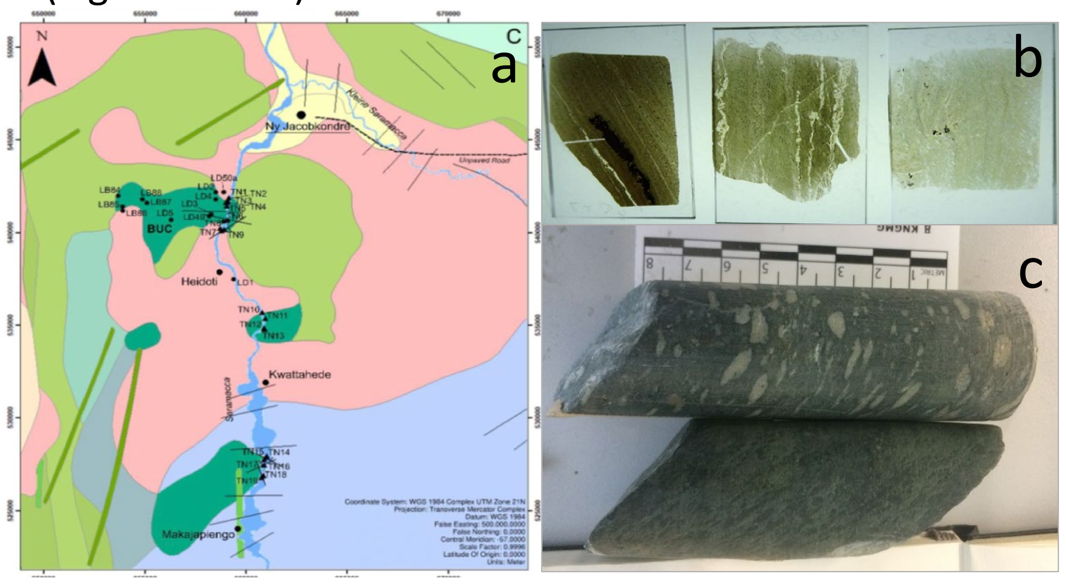

Figure 3: (a) The Bemau ultramafic complex modified from the geological map of Suriname (the national geological survey GMD), (b) Ultramafic volcaniclastic chlorite schists with sedimentary structures in thin sections of RGM cores (c) and vesicular textures in GMD chromite-bearing -chlorite-talc schists.

- An unusual corundum-chrome spinel rock is thought to represent a metasomatically desilicified cumulate (Teuling, 2018). The primary rocks in drill cores contain up to 0.5% Ni and 1,3% Cr, the overburden up to 0,25% Ni.
- The corundum-chrome spinel rocks contain up to 0,7% Ni and 6,5% Cr (Bosma et al., 1973; Veenstra, 1983).

2) **Residual chromite deposits associated with peridotites and talc schists**

- In a tributary of the Saramacca River (Upper Toekoemoetoe Creek): found in a weathering zone on top of a ± 2 km long ultramafic body, intercalated between biotite-hornblende gneisses (Bisschops, 1969).
- Similar small chromite bodies are found in an area west of the Upper Saramacca River (Den Hengst, 1975).
- Cr-bearing ultramafic intrusive rocks (≥ 1.0% Cr) have been recovered from the Piqué Hill, east of the Brokopondo storage lake (Bosma et al., 1973).

3) **The De Goeje mountains ultramafics (Figure 4)**

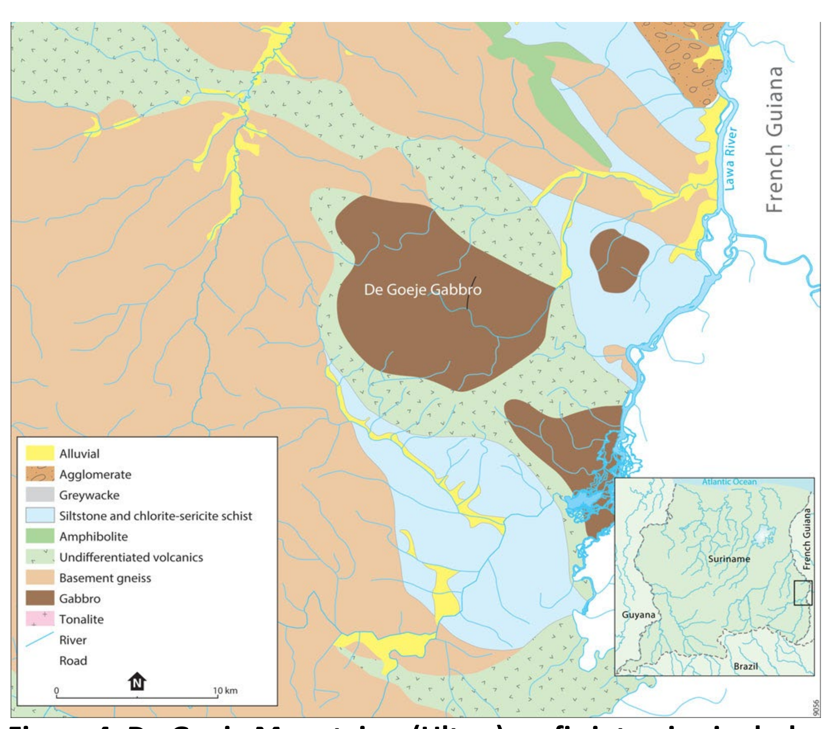

Figure 4: De Goeje Mountains, (Ultra-) mafic intrusive in dark brown (Kioe-A-Sen et al., 2016).

- consist of intrusive metagabbronorite and meta-ultramafitite (pyroxene-bearing granite-granodiorite to peridotite-dunite).
- Smaller amounts of serpentines and talc rocks, with hornblende, biotite or phlogopite and dusty plagioclase.
- Opaque minerals found are apatite and spinel, the latter especially in olivine bearing rocks (Bosma et al., 1983; Bosma et al., 1984; Kroonenberg et al., 2016).
- Apart from placer gold, alluvial platinum has been recovered, as small rounded grains (≥ 0.5 g/t), but still not encountered in the primary rock (Bosma and Groenweg, 1973).
- In French Guiana across the Marowijne River, alluvial platinum has been recovered as well in a similar setting (BRGM, 1980).

Diamond-bearing ultramafic rocks

- **In Suriname** diamonds are found since 1880, mainly in the Rosebel- Sabanapasi area derived alluvium from the Rosebel conglomerates (Kooten, 1954).
- Schönberger, (1974) washed many samples of Rosebel conglomerates, and concluded the the source to be ultramafic rocks.
- Recent research resulted in the discovery of ultramafic volcaniclastic rocks in GMD drill cores (Figure 3c).
- Volcaniclastic-ultramafic rocks (Figure 3b) (chlorite-carbonate and phlogopite-talc–carbonate schists), are found in drill cores from Rosebel Gold Mines, (Ramlal, 2018).
- These rocks show high contents of chromium (>1000 ppm Cr) and nickel (>600 ppm Ni).
- RGM chemical database indicate these rocks are widespread in the whole area, suggesting a larger distribution.
- Findings of diamonds are also reported in the NE part of the Nassau Mountains area, near the Conglomerate and the Paramacca Creek (Headley, 1913).

Diamond occurrence in the neighbouring countries

- The main sources of gem-grade diamonds are ultrapotassic kimberlites or lamproites (Janse and Sheahan, 1995).
- In Venezuela, diamond bearing kimberlites have been found in the Guaniamo region (Kaminsky et al., 2004).
- Other important diamond occurrences in Venezuela are alluvial deposits, mainly associated with Roraima Formation.
- Similar diamond deposits are found in Guyana, Roraima.
- All rivers and streams that flow along or across Roraima group contain diamonds (Swiecki, 2011).
- However, in French Guiana recent research revealed an unusual diamond deposit in the Paleoproterozoic Inini Greenstone belt at Dachine (Figure 5).

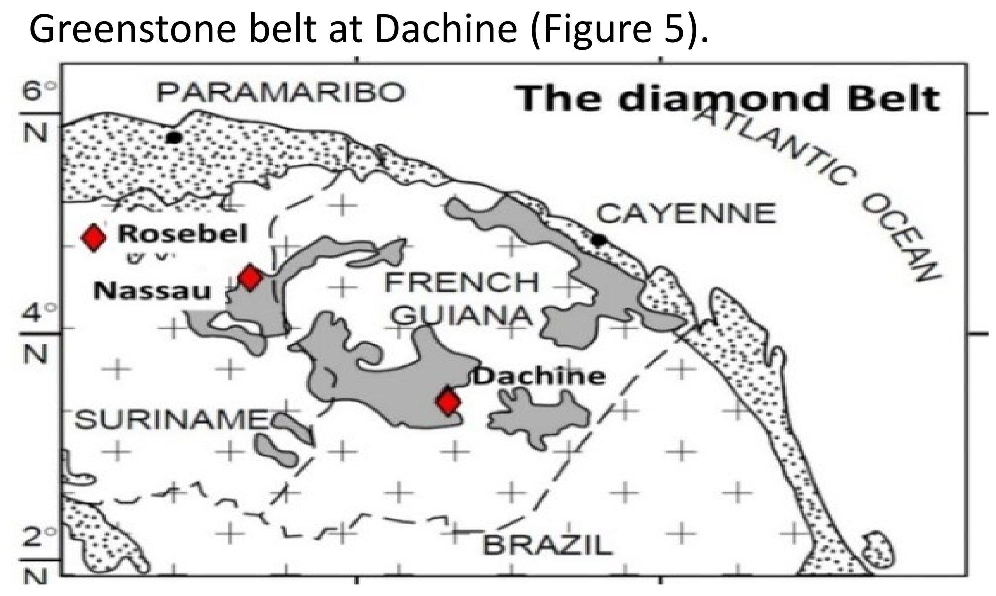

Figure 5: possible regional diamond belt,mmodified from Capdivela et al., 1999.

- The host rock is a ultramafic volcaniclastic body (chlorite-carbonate-talc schists and phlogopite-talc schist) with komatiitic geochemical affinities (Capdevila, et al., 1999).
- A similar type of diamond deposit is found in Akwatia, Ghana, within the Early Proterozoic Birimian Belt.
- The diamonds are associated with syn-eruptive volcaniclastic metaturbidites, with composition resembling komatiites (Canales, 2005), the host rock is actinolite-tremolite schist.

Conclusions

- Ultramafic rocks in Suriname are an integral part of the Trans-Amazonian Orogen, their role in the magmatic history of this event still has to be elucidated.
- The age and stratigraphic relations of the ultramafic rocks should be investigated, age dating is required to elucidate the position of these rocks in the magmatic deformational and metamorphic events in the Greenstone belt.
- The processes that gave rise to the nickel, chromium, platinum and gold mineralisations have to be sorted out.
- The source rocks of the diamonds in Suriname have not yet been found, there is a possibility that the ultramafic rocks represent a regional event of diamondiferous komatiitic volcanism in the eastern Guiana Shield, further research is ongoing to test this hypothesis.

References

- Bisschops, J.H. 1969. The Roraima Formation in Surinam. 7th Guiana Geological Conference. Verhandelingen Nederlands Geologisch Mijnbouwkundig Genootschap 27, 109–118.
- Bosma, W., A.G. Ho Len Fat, and C.C. Welter. 1973. Minerals and mining in Suriname. Mededelingen Geologisch Mijnbouwkundige Dienst van Suriname 22: 71-101.
- Bosma, W., and W. Groeneweg. 1973. Review of the stratigraphy of Suriname. Mededelingen Geologisch Mijnbouwkundige Dienst Suriname 22: 17–41.
- Bosma, W., S. B. Kroonenberg, K. Maas, and E. W. F. De Roever. 1983. Igneous and metamorphic complexes of the Guiana shield in Suriname. Geologie en Mijnbouw 62 241–254. .
- Bosma, W., S.B. Kroonenberg, R. van Lissa, K. Maas, and E.W.F. de Roever. 1984. Explanation to the Geological map of Suriname Mededelingen Geologisch Mijnbouwkundige Dienst van Suriname 27, 31–82.
- BRGM. 1980. Inventaire minier du Département de la Guyane. Bilan et perspectives au 31.12.1979. BRGM Direction Cayenne, 127 pp.
- Caen-Vachette, M. 1988. The West African craton and the Guiana Shield: a single craton from the Lower Proterozoic Paleomagnetism. Journal of African Earth Sciences 7: 479-488.
- Canales, D.G. 2005. The Akwatia diamond field, Ghana, West Africa: source rock. MSc thesis Department of earth and Environmental Science, New Mexico Institute of Mining and Technology, 145 pp.
- Capdevila, R., N. Arndt, J. Letendre, and J. F. Sauvage. 1999. Diamonds in volcaniclastic komatiite from French Guiana. Nature London 399, 456-458.
- Delor, C., D. Lahondere, E. Egal , J.M. Lafon, A. Cocherie., C. Guerrot, and V. de Avelar. 2003a. Transamazonian crustal growth and reworking as revealed by the1:500,000-scale geological map of French Guiana. Géologie de la France. 2-3-4, 5–57.
- Den Hengst, P. 1975. The Upper Saramacca chromite. Mededelingen Geologisch Mijnbouwkundige Dienst Suriname 23, 244–249.
- Gruau, G., H. Martin, B. Leveque, R. Capdevila, and A. Marot. 1985. Rb-Sr and Sm-Nd geochronology of lower Proterozoic granite-greenstone terrains in French Guiana. South America: Precambrian Research 30, 63-80.
- Headley, D.E. . 1913. Diamonds in Dutch Guiana. The Engineering and Mining Journal 94 no. 18, p. 888.
- Janse, A.J.A., and A.P. Sheahan. 1995. Catalogue of world wide diamond and kimberlite occurences: a selective and annotative approach. Journal of Geochemical Exploration 53, 73-111.
- Kaminsky, F.V., S.M. Sablukov, L.I. Sablu, and D.M. DeR. Channer. 2004. Neoproterozoic 'anomalous' kimberlites of Guaniamo, Venezuela: Mica kimberlites of 'isotopic transitional' type. Lithos 761 565-590.
- Kioe-A-Sen, N.M., M.J. Van Bergen, T.E. Wong, and S.B. Kroonenberg. 2016. Gold deposits of Suriname: geological context, production and economic significance. Netherlands Journal of Geoscience; Geologie en Mijnbouw 95 4: 1-17.
- Kroonenberg, S.B., E.W.F. de Roever, L.M. Fraga, N.J. Reis, T. Faraco, J.M. Lafon, U. Cordani , and T.H. Wong. 2016. Paleoproterozoic evolution of the Guiana Shield in Suriname: A revised model. Netherlands Journal of Geoscience 95, 491-522.
- Priem, H.N.A., N.A.I.M. Boelrijk, E.H. Hebeda, E.A.T. Verdurmen, and R.H. Verschure. 1971. Isotopic ages of the Trans-Amazonian felsic magmatism and the Nickerie Episode in the Precambrian basement of Surinam, South America. Geological Society of America Bulletin 82, 1667–1680.
- Ramlal, S. 2018. An investigation of the Brincks intrusion and its relationship to the surrounding gold deposits, Brokopondo, Suriname, South America. MSc thesis Anton de Kom University of Suriname, 142 pp
- Schönberger, H., and E.W.F. de Roever. 1974. Possible origin of the diamonds in the Guiana Shield. Geology, 1974, 2 (10) 474-475
- Swiecki, R. 2011. *http://www.minelinks.com.* March. Accessed October 23, 2018. http://www.minelinks.com/alluvial/diamondGeology42.html.
- Teuling, F.S.R. 2018. Petrogenesis of the Bemau Ultramafic Complex, Guiana Shield, Surinam. MSc thesis Department of Earth Sciences, Utrecht University, 144 pp.
- van Kooten, C. 1954. Eerste onderzoek op diamant: Rosebel-Sabanpassie. Geologisch Mijnbouwkundige Dienst van Suriname Mededeling 11, 63 pp..
- Veenstra, E. 1983. Petrology and Geochemistry of Sheet Ston Broeke, Sheet 30, Suriname. Geologisch Mijnbouwkundige Dienst Suriname, Mededeling 26, 138 pp.

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