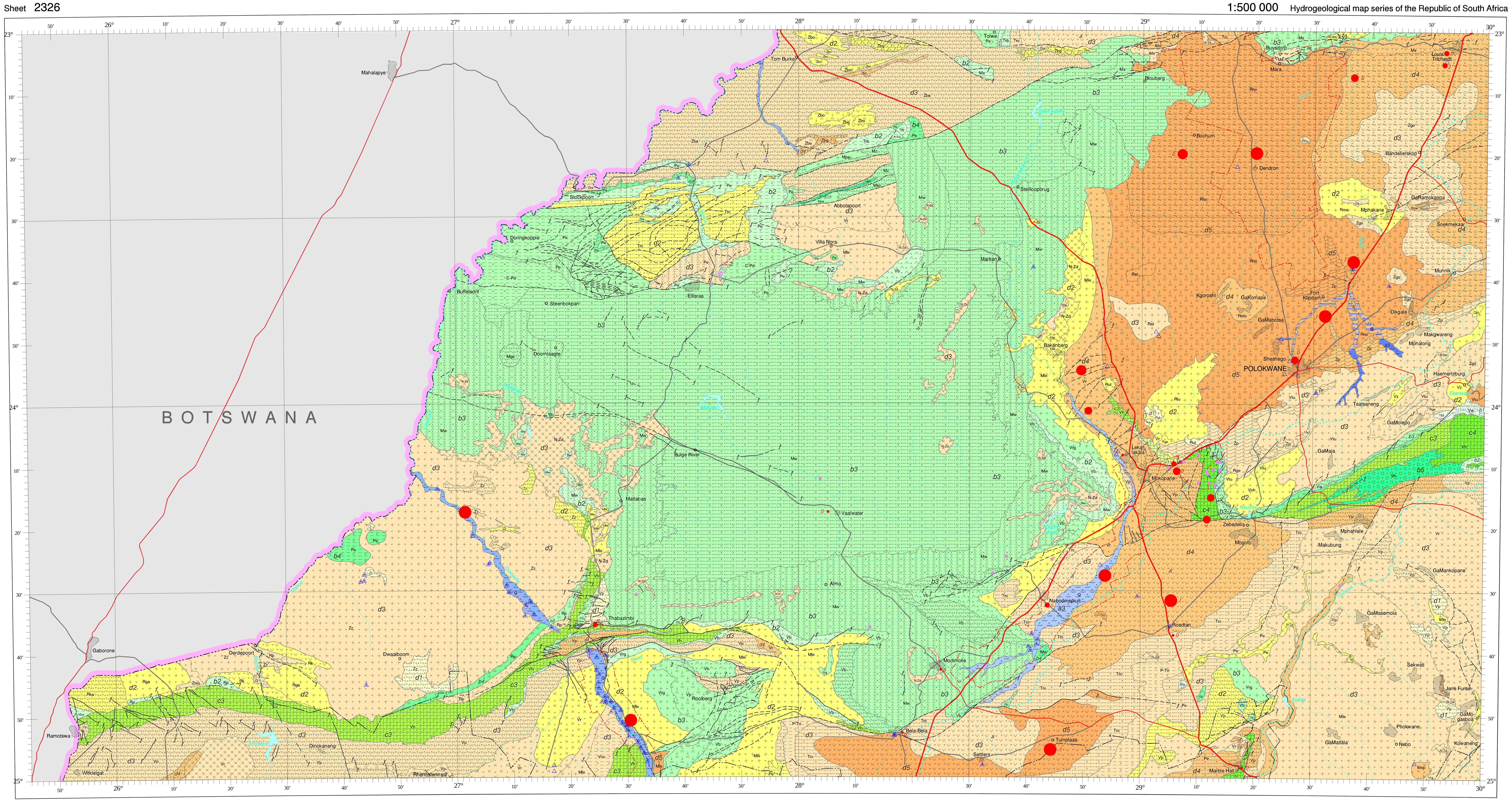


POLOKWANE

2003

DEPARTMENT: WATER AFFAIRS AND FORESTRY

10 0 10 20 30 40 km

Lambert´s conformal conic projection. Standard parallels 17 °30´ & 23°30´. Central meridian 28 °. Spheroid Clarke 1880.

Map Author - W.H. du Toit

GIS Specialist - A.J.I. du Toit

Cartographer - F. Jonck

Assisted by:
Mapping Management Team:
P.S. Meyer (Consultant), F. Jonck and E. Botes

This map was approved by the Director-General of the Department: Water Affairs and Forestry.

The groundwater occurrence and groundwater quality maps were compiled by W.H. du Toit. The schematic cross-sections were compiled by P.S. Meyer and W.H. du Toit. The lithology was adapted by W.H. du Toit and P.S. Meyer from the 1:250 000 scale Ellisras 2326 (1993), Thabazimbi 2426 (1974), Pietersburg 2328 (1985) and Nylstroom 2428 (1978) maps, published by the Council of Geoscience. A.J.I. du Toit was responsible for the compilation of the borehole distribution map.
Precipitation and elevation data were obtained from the Computing Centre for Water Research, University of Natal, and compiled by H. Mullin. Information on roads, rivers, towns, international and provincial boundaries were obtained from the Chief Directorate: Surveys and Mapping, Department: Land Affairs, and edited by the Department: Water Affairs and Forestry. Permission from these respective institutions to make use of their information is gratefully acknowledged. Borehole data were obtained from the National Groundwater Data Base (NGDB) and from GPM Consultants.

Principal groundwater occurrence

Borehole yield class (median l/sec)(excl. dry boreholes)

Aquifer type	0.0 - 0.1	0.1 - 0.5	0.5 - 2.0	2.0 - 5.0	> 5.0
Intergranular	*	*	a3	a4	a5
Fractured	b1	b2	b3	b4	b5
Karst	c1	c2	c3	c4	*
Intergranular and fractured	d1	d2	d3	d4	d5

Two-layered: a5/d5 — Upper aquifer: Intergranular: > 5 l/s; Lower aquifer: Intergranular and fractured: > 5 l/s

Borehole yield class boundary

Note: Groundwater occurrence depicts the aquifer type(s) with the highest borehole yield, and does not always correlate with surface lithology.

Surface / Sub-surface lithology

(Unconsolidated sediments which are unsaturated, have been omitted from the map)

- Alluvium (clay, sand and gravel)
- Predominantly argillaceous rocks (shale, siltstone and mudstone)
- Predominantly arenaceous rocks (sandstone, feldspathic sandstone, arkose, shale, and grit)
- Argillaceous and arenaceous rocks (approximately equal proportions)
- Basic intrusive rocks (dolerite and diabase)
- Predominantly carbonate rocks (dolomite)
- Predominantly (banded) iron formation
- Predominantly rudaceous rocks (conglomerate and grit)
- Intermediate / basic / ultra basic intrusive rocks (gabbro, diorite, pyroxenite, norite, anorthosite, hornblendite and carbonatite)
- Acid / intermediate / alkaline intrusive rocks (various granitoids)
- Basic / intermediate extrusive rocks (basalt and andesitic lava)
- Acid / intermediate extrusive and intrusive rocks (rhyolite, andesite, tuff, volcanic breccia, felsite and quartz porphyry)
- Predominantly meta-argillaceous rocks (schist, amphibolite, metapelite and serpentinite)
- Predominantly meta-arenaceous rocks (quartzite and gneiss) and migmatite
- Predominantly meta-carbonate rocks (marble and calc-silicate rocks)
- Predominantly gneissoid rocks with xenoliths
- Various lithologies:
  Sedimentary rocks: Mko, Vp, Vw, Rp, Rka
  Metamorphic rocks: Mz, Mko, Mge, Zba, Zz
  Igneous rocks : Mge, Vw, Vb, Vp, Rp, Rka
- Lithological / stratigraphical boundary
- Inferred lithological / stratigraphical boundary
- Fault
- Inferred fault
- Dolerite and / or diabase intruded

Large scale groundwater abstraction

- >10 million m^3/a
- 5 - 10 million m^3/a
- 2 - 5 million m^3/a
- 1 - 2 million m^3/a
- 0.1 - 1 million m^3/a

- I Irrigation
- D Domestic
- Mining

- Spring (flow rate varying and inconsistent)
- Thermal spring (temperature in °C, flow rate varying)
- Artesian borehole
- Groundwater level recorder
- Groundwater level monitoring point
- Primary catchment boundary
- Subterranean Government Water Control Area
- Water course
- Primary perennial river
- Secondary perennial river
- Non-perennial river
- Dam
- City / town area
- Village
- Reference point
- National road
- Main road; Inset map: National road
- Inset map: Main road
- Additional secondary road (orientation purposes)
- Internatial boundary
- Provincial boundary
- * Not applicable to this map

Chronostratigraphy

1	2	3	4	5	6
	PHANEROZOIC	Cenozoic	Quaternary	Q	Alluvium (Q)
1.8			Tertiary	T	
65		Mesozoic	Cretaceous	K	
142			Jurassic	J	Lebombo G. (Jl)
205			Triassic	Tr	Clarens F. (Trc); Bosbokpoort F. (Trb)
248		Palaeozoic	Permian	P	Solitude F. (P-Trs); Irrigasie F. (P-Tri); Ecca G. (Pe); Dwyka G. (C-Pd)
290			Carboniferous	C	
354			Devonian	D	
417			Silurian	S	
443			Ordovician	O	
495			Cambrian	Є	
545	PROTEROZOIC	Namibian		N	
900		Mokolian		M	Diabase (N-Zd); Spitskop C. (Msp); Glendower C. (Mge); Soutpansberg G. (Ms); Waterberg G. (Mw); Koedoesrand F. (Mko); Palala Granite (Mpa); Lebowa S. (Mle); Unnamed Mokolian rocks (Mz)
2050		Vaalian		V	Rustenburg S. (Vr); Rooiberg G. (Vb); Rashoop S. (Vrg); Pretoria G. (Vp); Crocodile River Fragment (Vco); Chuniespoort G. (Vh); Black Reef F (Vbl); Wolkberg G. (Vw); Meinhardskraal Granite(Vnh); Trufloop Granite (Vtu); Unnamed Vaalian rocks (Vz);
2650	ARCHAEOZOIC	Randian		R	Bothaville F. (R-Vbo) Moletsi Granite (Rmo); Hugomond Granite (Rhu); Matlala Granite (Rat); Matok Granite (Rma); Utrecht Granite (Rut); Lunsklip Granite (Rlu); Uitloop Granite (Rui); Geyser Granite (Rge); Gaborone Granite (Rga); Platberg G. (Rp); Kanye F. (Rka); Klipriviersberg G. (Rk); Hout River Gneiss (Rho)
3100		Swazian		Z	Modipe C. (Zmo); Messina S. (Zbm); Goudplaats Gneiss (Zgo); Mount Dowe G. (Zbo); Malala Drift G. (Zba); Gumbu G. (Zbg); Bandelierskop C. (Zga); Pietersburg G. (Zp); Unnamed Swazian Rocks (Zz)

1 = Million years before present (Council for Geoscience, 1997)
2 = Eonothem (Eon)
3 = Erathem (Era)
4 = System (Period)
5 = Symbol
6 = Complex (C), Suite (S), Group (G), Formation (F) (with symbol)

Schematic cross-sections to illustrate typical groundwater occurrence

Not to scale

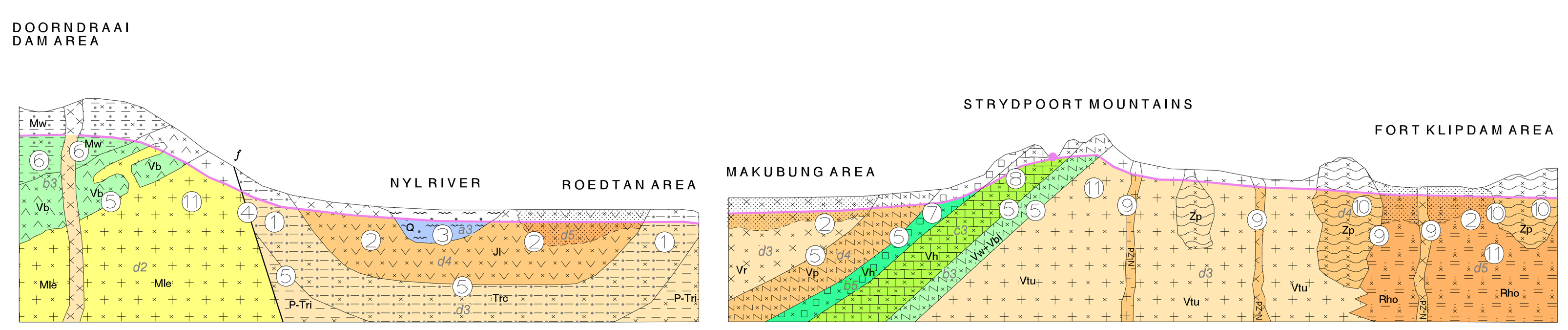
(1) The sandstone of the Clarens Formation (Trc) is characteristically massive and dense and is largely deprived of permeability and storativity. It thus offers only moderate groundwater yield, especially in the absence of dolerite intrusions, and a yield analysis revealed that about 70% of boreholes yield less than 3 l/s. Intergranular aquifer properties for this rock unit have been reported in some localities

(2) The groundwater potential of the fractured transitional zones between weathered and unweathered crystalline rocks is good. This is particularly true for the basalt of the Lebombo Group (Jl), the norite of the Rustenburg Suite (Vr) and the Hout River Gneiss (Rho). Deeper fracturing in solid crystalline rocks, often associated with faults and off-loading (and pegmatite bodies in the Hout River Gneiss), can also be targeted for groundwater development

(3) Groundwater can be developed from saturated unconsolidated alluvium that occurs along rivers like the Crocodile, Nyl, Magalakwena, Sand and Lephalala, provided the clay component of the alluvium is negligible. Alluvial thicknesses of up to 20 m occur and yields in excess of 10 l/s are not uncommon

(4) Fractured fault zones, especially if related to tensional stresses, are potentially rich targets for groundwater development

(5) Contacts between different rock lithologies, and bedding planes within sedimentary rock units often yield groundwater. The contact zone between the basaltic lava of the Lebombo Group (Jl) and the sandstone of the underlying Clarens Formation (Trc) is particularly high-yielding



(6) In the sediments of the Waterberg Group (Mw) groundwater occurs in joints, bedding planes and particularly at the numerous diabase intrusive contact zones. The groundwater potential of the sediments is generally low, as about 87% of boreholes yield less than 3 l/s. However, this view may alter as results of recent exploration revealed that yields of up to 20 l/s can be obtained in sedimentary rocks in the Vaalwater and Alma areas. These high yields are seemingly not related to intrusions

(7) Well-developed joints and fractures occur in the competent (banded) iron formation of the Penge Formation (Chuniespoort Group (Vh)), particularly in the Strydpoort Mountains where borehole yields in excess of 5 l/s are common. However, the yield potential of this unit elsewhere in the map area appears less favourable

(8) The yield potential of the carbonate rocks of the Malmani Subgroup (Chuniespoort Group (Vh)) is moderate to high, and 36% of boreholes in this rock unit yield more than 3 l/s. Groundwater occurs in fractures, joints, solution cavities and in diabase intrusive contact zones. Numerous springs occur in this unit. The groundwater potential of the carbonate rocks in primary form is generally poor

(9) The pre-Vaalian age granite-gneiss rock units in the map area have been intensively intruded by largely northeast-striking diabase dykes. Fractured contact zones associated with these intrusions can be utilised for groundwater development. Recent investigations have revealed that zones between 10 to 100 m from these dyke contacts in the Hout River Gneiss (Rho) are much more productive and yields in excess of 30 l/s are common

(10) Swazian age xenoliths in the Hout River Gneiss (Rho) and Goudplaats Gneiss (Zgo), north east of the section area, are often jointed and fractured and have successfully been targeted for groundwater development. The contact zones of these inclusions with the surrounding rocks are also likely propitious drilling sites

(11) The rocks of the Hout River Gneis (Rho), and to a somewhat lesser extent the Goudplaats Gneiss (Zgo), units (northeast of the section line) seem to be prone to weathering and jointing, thus resulting in generally high groundwater potential. The presence of numerous pegmatites, which appear at different levels to relatively great depths, seem to contribute substantially to the high groundwater potential of these units. The granitic rocks of the Turfloop (Vtu) and Lebowa (Mle) units are, however, less prone to weathering and jointing, and also lack the occurrence of pegmatitic bodies and their groundwater potential is noticeably lower

Weathering
Groundwater level

Note: For additional information concerning groundwater occurrence refer to accompanying brochure.

This general hydrogeological map is part of the 1:500 000 Hydrogeological map series of the Republic of South Africa.

This map is not to be used for the purpose of local borehole siting. Simplified lithology may be considered as guidelines only. Further geological information can be obtained from the Council for Geoscience. The map series is produced with Arc/Info software.

Published by:
Department: Water Affairs and Forestry

First Edition 2003
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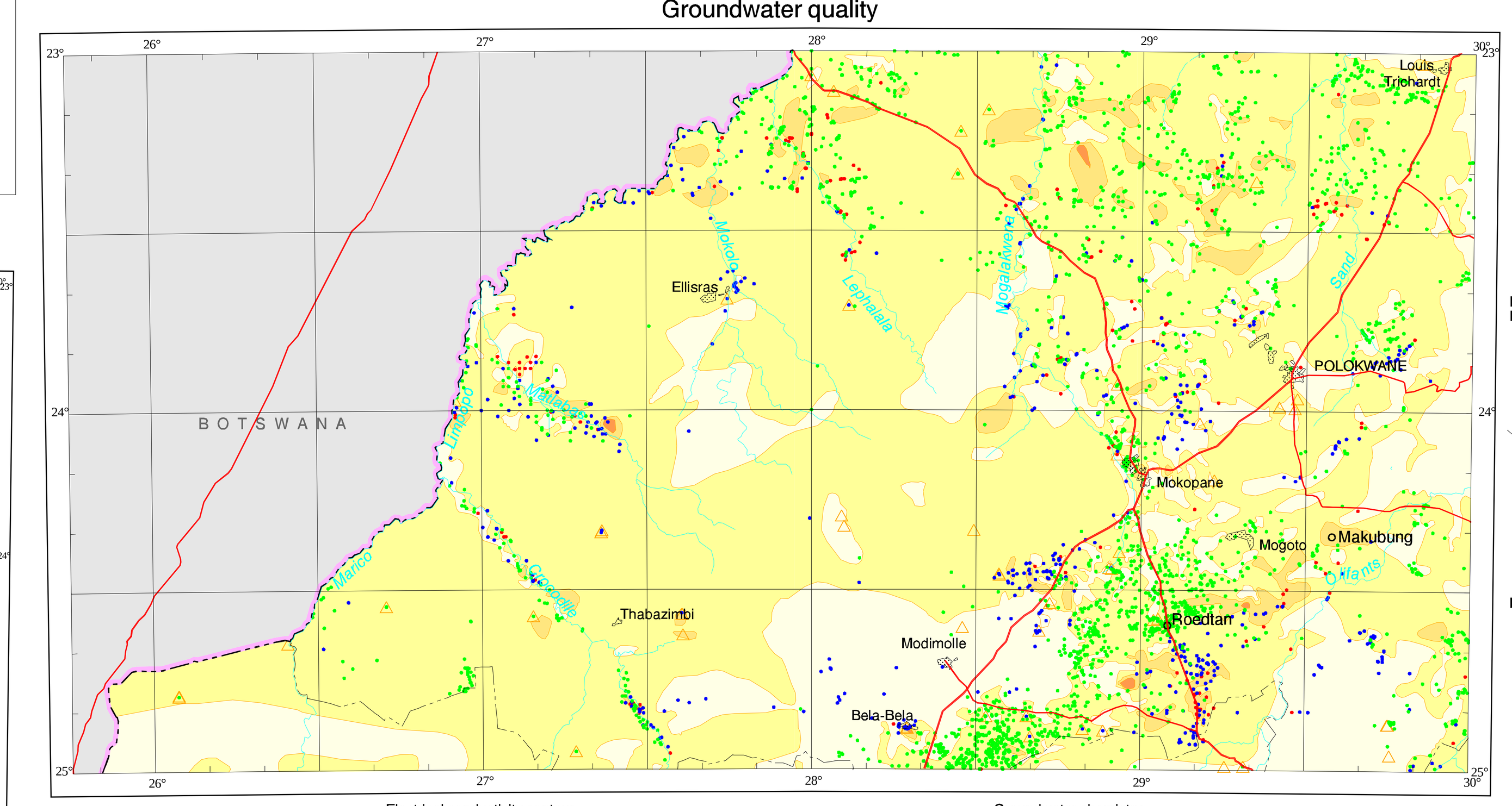
Digital data, copies of this map and accompanying brochure are obtainable from:

Department: Water Affairs and Forestry
Private Bag X313
Pretoria
0001

Web site:
http://www-dwaf.gov.za
/geohydrology/index.htm

Printed by:
Associated Printing
Cape Town

Groundwater quality



- 0 - 70 mS/m
- 70 - 300 mS/m
- 300 - 1000 mS/m
- > 1000 mS/m
- Electrical conductivity contour
- Groundwater quality monitoring point

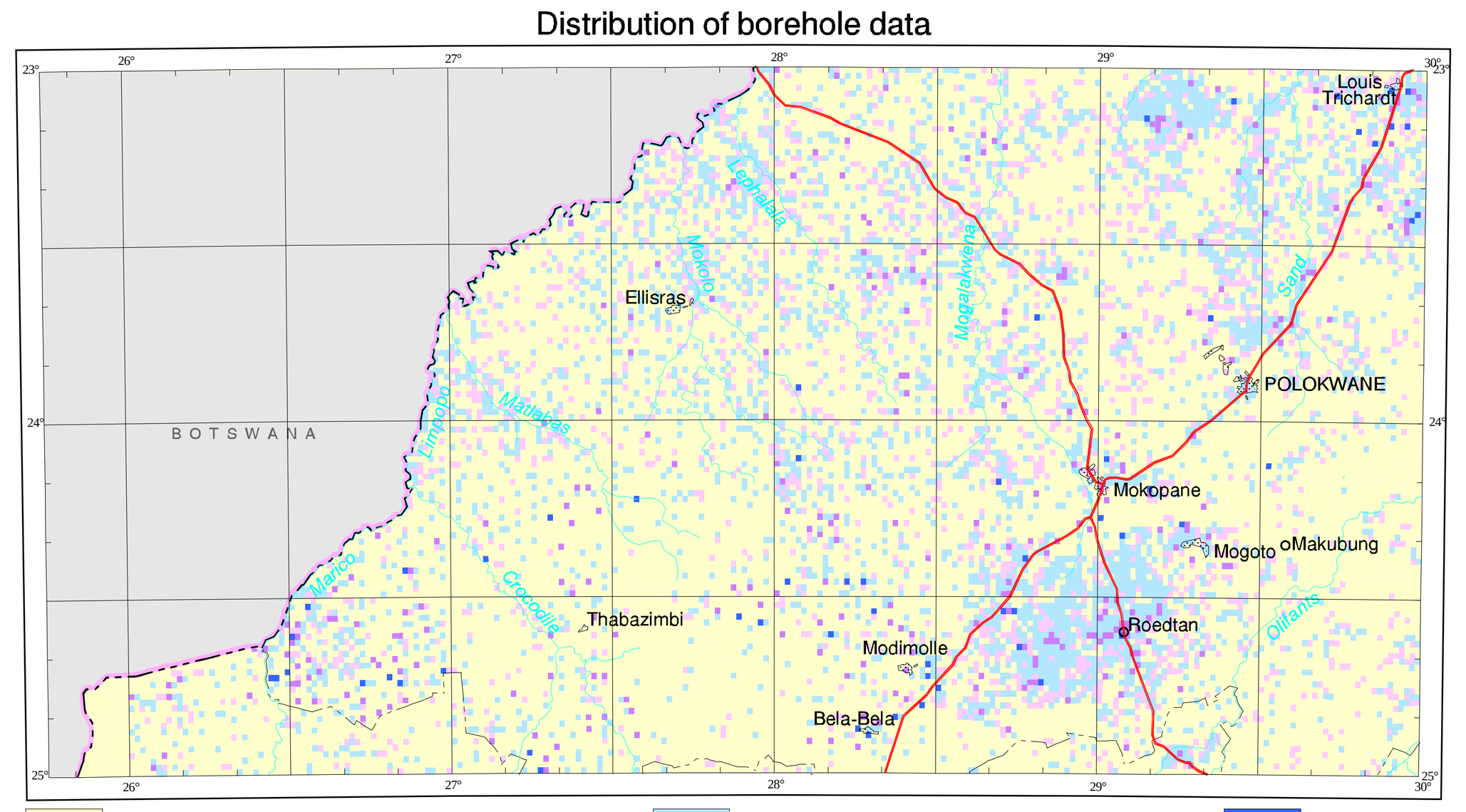
Groundwater chemistry

- Nitrate > 10mg/l
- Fluoride > 1.5mg/l
- Nitrate > 10mg/l & Fluoride > 1.5mg/l

Note:
Nitrate and fluoride concentrations are shown only where the maximum allowable limits are exceeded and data are available. There may be other localities where concentrations of fluoride and nitrate exceed the above limits. Unfortunately no groundwater analyses are available to prove or disprove this.
For additional information concerning groundwater chemistry refer to accompanying brochure.

50 40 30 20 10 0 50 100 150 200 km
1:1 500 000

Distribution of borehole data

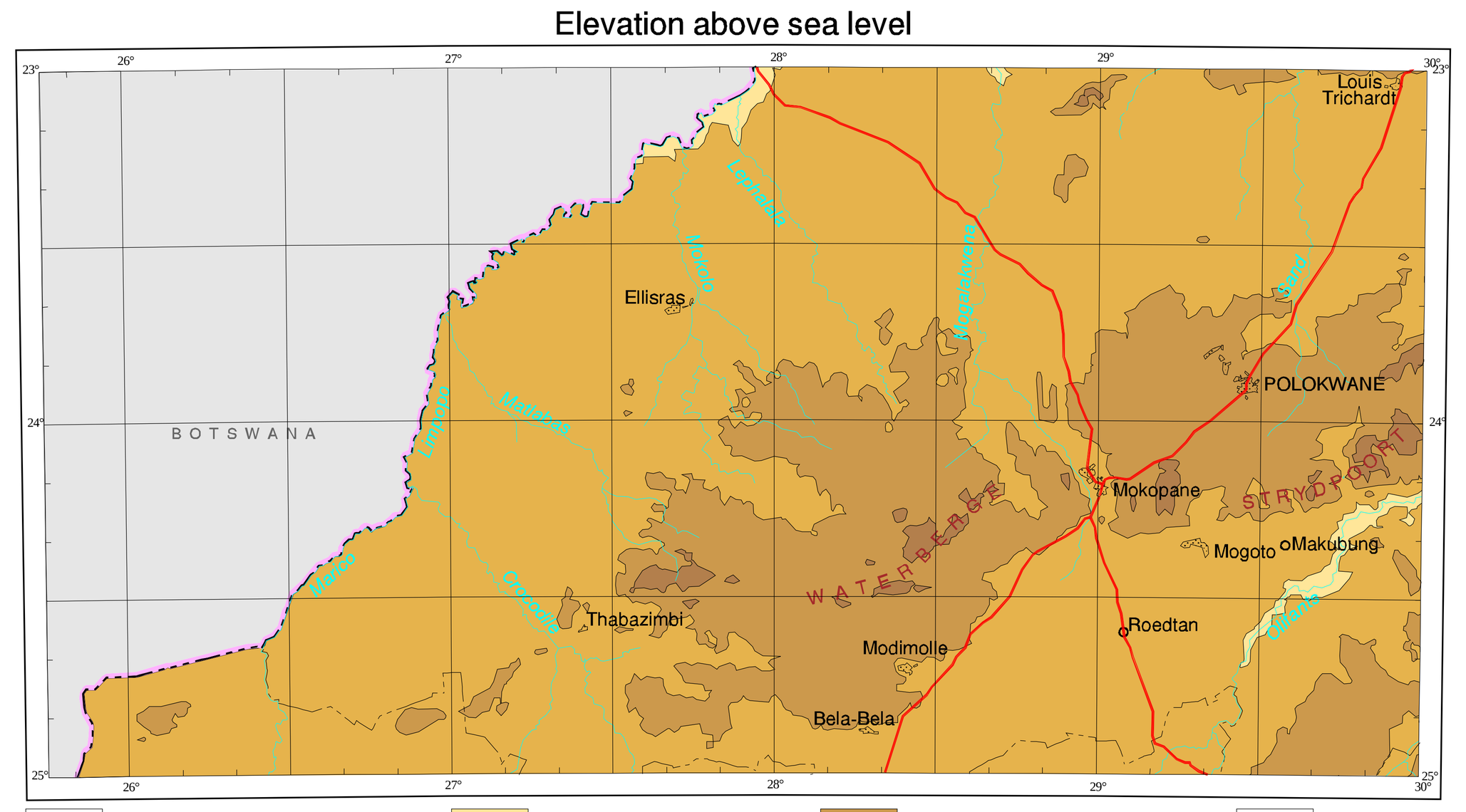


- No borehole information
- 1 Borehole
- 2 - 10 Boreholes
- 11 - 20 Boreholes
- > 20 Boreholes

Borehole data points per 1 minute grid

1:2 000 000

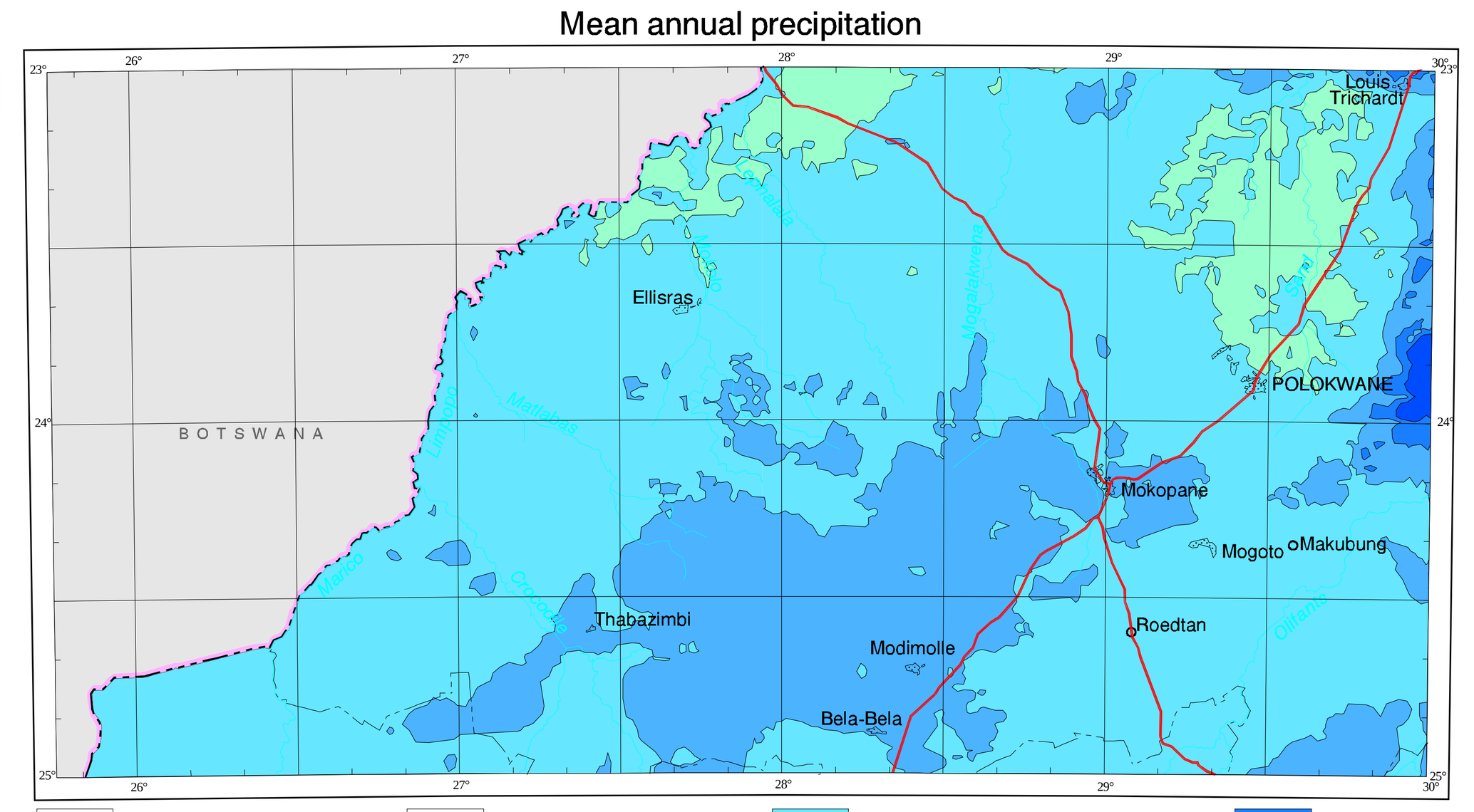
Elevation above sea level



- sea level - 200 m
- 200 - 400 m
- 400 - 800 m
- 800 - 1200 m
- 1200 - 1600 m
- 1600 - 2000 m
- 2000 - 2500 m
- > 2500 m

1:2 000 000

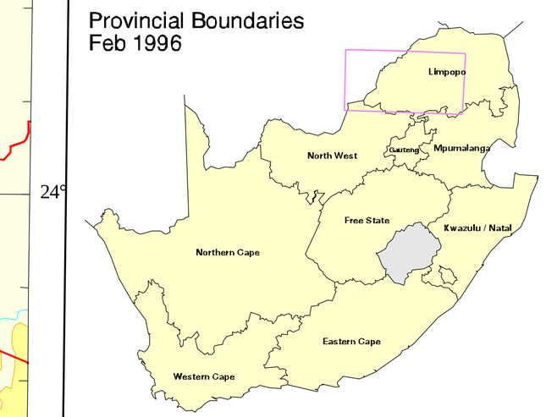
Mean annual precipitation

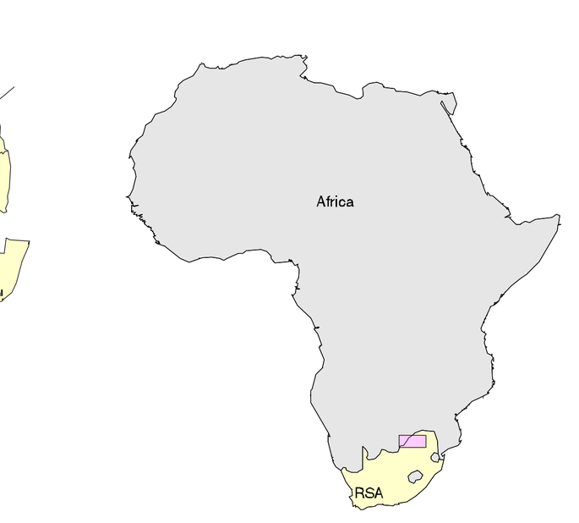


- 0 - 100 mm
- 100 - 200 mm
- 200 - 300 mm
- 300 - 400 mm
- 400 - 600 mm
- 600 - 800 mm
- 800 - 1000 mm
- > 1000 mm

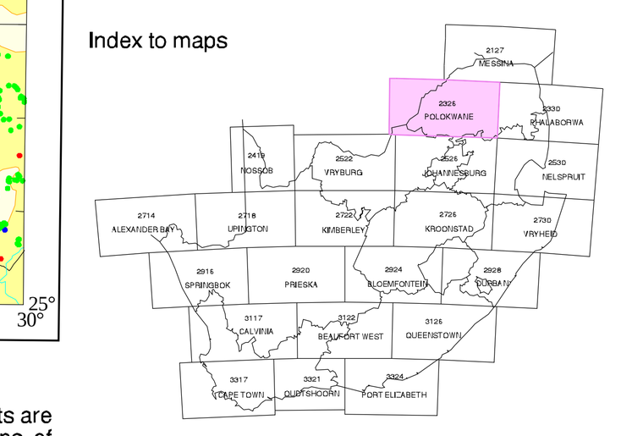
1:2 000 000

Provincial Boundaries
Feb 1996





Index to maps



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