

### 3. STRATIGRAPHY

The study area contains rocks representing different stages in the tectonic evolution of the Kaapvaal Craton from late Archaean to present times. However, this study only considers a simplified stratigraphical subdivision (Table 3.1) for all the sequences except those of the Bushveld Complex, as is present in BOSGIS. The simplified stratigraphical divisions do not affect the purpose of the study, which is a regional structural analysis. In this chapter the subdivisions of BOSGIS are compared to that of the geological map of South Africa (Keyser, 1997). A brief description of the lithology of each subdivision is also given. For a detailed description and discussion of the stratigraphy and lithology of the Bushveld Complex and its surrounding areas, the reader is referred to S.A.C.S.(1980).

#### 3.1 Archaean Rocks

The 'Archaean Rocks' subdivision is a collective term for all the greenstone- type rocks, of Swazian age, occurring in the study area. These greenstone belts represent ancient volcano-sedimentary packages which underwent greenschist metamorphism. Three greenstone belts can be distinguished in the study area, namely the Pietersburg, Murchison and a portion of the Barberton greenstone belt. In this study no distinction is made between the various formations of the greenstone belts, and all the belts are represented as one undifferentiated unit. Table 3.2 provides an outline of the simplified stratigraphy used in the study versus the detailed lithological subdivisions according to Keyser (1997).



Table 3.1 Stratigraphic subdivisions considered during this study

Erathem	Supergroup	Group	Formation	Intrusives		
Cenozoic			Alluvium, sand, calcrete			
Mesozoic	KAROO			Karoo dolerites		
Palaeozoic						
Mogolian				Alkaline Intrusions, Pilaesberg etc.		
		WATERBERG		Diabase Intrusions?		
Vaalian				BUSHVELD COMPLEX	Micro granite, Hornfels, Leptite, Hybrid rocks	
					LEBOWA GRANITE SUITE (with pegmatite zones)	
					RASHOOP GRANOHYRE	
					RUSTENBURG LAYERED SUITE	Upper Zone (with magnetite bands)
						Main Zone (with pegmatite zones)
						Critical Zone
						Lower Zone
						Marginal Zone
						'Under Bushveld'
						Diabase Intrusions?
Randian	TRANSVAAL	PRETORIA	Loskop, Rust de Winter, Glentig			
			ROOIBERG			
			upper Pretoria			
			Magaliesberg			
			lower Pretoria			
			CHUNIESPOORT			
Randian			WOLKBERG/ Black Reef			
			GROBLERSDAL			
				Various Granites		
Swazian	Archaean rocks					



Table 3.2 Stratigraphic subdivisions of Swazian-age greenstone belts:

a) According to Keyser (1997)

Erathem	Sequences					
Swazian	Pietersburg	Giyani	Gravelotte	Rubbervale	Barberton	Moodies
				Mac Kop, Weigel & La France		Fig Tree
				Leydsdorp		
				Mulati		Onverwacht

b) This study

Swazian	Archaean Rocks
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### 3.2 Various Precambrian Granites

A large continuous stretch of Precambrian granitic rocks are exposed in the eastern portion of the study area. This area is characterized by individual massive granite plutons as well as intensely deformed gneissic and mylonitic zones. Different ages and modes of emplacement have been determined for the various granites, and compositional differences are well recorded (S.A.C.S., 1980, Keyser, 1997). Some granites pre-date the formation of greenstone belts, whereas some are intrusive into the greenstone belts. However, in this study all the granites are considered as an undifferentiated unit. In addition, 'Various Precambrian Granites' do not only include the granitic rocks of the eastern region, but also the rocks of the Makoppa dome, Johannesburg dome, and the Dennilton dome. Table 3.3 shows the compositional and age distinctions made by Keyser (1997) versus the simplified divisions of this study.



Table 3.3 Stratigraphic subdivisions of Precambrian Granites

a) According to Keyser (1997)

Erathem	Intrusive rocks		
Randian	Unnamed biotite granite		
	Mashishimale Suite	Granites: Maranda Moletsi Mpageni Palmietfontein Shirindi Smitskraal Turfloof Utrecht	Granites: Baderoukwe
	Granites: Hugomond Jerome Matlala Matok Mosita Meinhardskraal		Pompey
			Willie
			Lekkersmaak
			Lunsklip
			Uitloop
			Unnamed Ultrabasic rocks
		Sailsbury Kop Granite	Cunning Moor Tonalite
		Rooiwater Complex	
Swazian	Houtrivier Gneiss	Unnamed potassic granite and gneiss	Modipe Complex
	Vaalfontein Gneiss	Nelspruit Suite	Makhutswi Gneiss
	Halfway House Granite		Unnamed trondhjemitic and tonalitic gneiss
		Goudplaats Gneiss	Kaap Valley Tonalite

b) This study

<b>Randian</b>	Various Granites
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### 3.3 Transvaal Supergroup

A complete succession of the Transvaal Supergroup is present in the study area. The Transvaal rocks generally act as the floor and roof of the Bushveld Complex. Furthermore, isolated occurrences of Transvaal rocks, known as Transvaal Inliers, are found within the Bushveld Complex (Hartzer, 1987). The Transvaal Supergroup can broadly be subdivided, from base to top, into the Wolkberg, Chuniespoort, Pretoria, and lastly the Rooiberg Group. Detailed studies done on the Transvaal Sequence have established well defined lithological subdivisions (S.A.C.S. 1980). The proto-basinal rocks of the Wolkberg Group are characterized by rift-related volcanics and immature sediments (Eriksson and Reczko, 1995). Widespread Transvaal deposition commenced with the Black Reef formation consisting of a basal dolomitic unit and upper banded iron formations (S.A.C.S., 1980). The Pretoria Group unconformably overlies the Chuniespoort Group and is characterized by alternating sandstones and mudrocks, with interlayered volcanic units (Eriksson and Reczko, 1995). Finally, the Rooiberg Group consisting of felsic lavas occur at the top of the sequence. Table 3.4 provides the detailed subdivisions of the Transvaal Supergroup as depicted by the geological map of South Africa (Keyser, 1997) versus the generalized subdivisions used in this study.

### 3.4 The Bushveld Complex

Extensive work has been done in the past on the stratigraphic subdivisions and lithology of the Bushveld Complex, and the reader is referred to S.A.C.S. (1980) for a detailed description. The major subdivisions, from bottom to top, include the Rustenburg Layered Suite, Rashoop Granophyre Suite and the Lebowa Granite Suite. The Rustenburg Layered suite can further be subdivided into five zones namely, from base to top, the Marginal Zone, Lower Zone, Critical Zone, Main Zone, and Upper Zone. The Marginal Zone consists of fine-grained plagioclase-orthopyroxene cumulates (Vermaak, 1976; Teigler 1990; Eales et al., 1993) and the Lower Zone is characterized by orthopyroxenites and harzburgites (Von Grunewaldt and Harmer, 1993). The Critical Zone contains the economically important Merensky reef and UG1 and UG2 layers, and is marked by a lower feldspathic pyroxenite, followed by norite and anorthosite (Visser, 1998, Von Grunewaldt & Harmer, 1993). The Main Zone marks the presence of gabbronorite and anorthosite, with the absence of chromite and olivine. Lastly, the Upper Zone is characterized by numerous magnetite layers (Visser, 1998). The Rashoop Granophyre suite consists primarily of granophyre, granophyric granite, granophyre porphyry and pseudogranophyre (Visser, 1998). The thick Lebowa Granite Suite consists mostly of coarse to medium grained granites. The BOSGIS data base reflect most of these stratigraphical subdivisions of the Bushveld Complex (Table 3.5).



Table 3.4 Stratigraphical subdivisions of the Transvaal Supergroup.

## a) According to Keyser (1997)

Erathem	Supergroup	Group	Formation
Vaalian	TRANSVAAL	ROOIBERG	Loskop, Rust de Winter, Glentig
			Selons River
			Schrikklouf
			Kwaggasnek
			Damwal
			Dullstroom
			Rinkhalskop
			Smelterskop
		PRETORIA	Houtenbek
			Salie Sloot
			Leeuwpoot
			Steenkampsberg
			Cyferfontein/Riffontein
			Nederhorst
			Kwarriehoek
			Lakenvalei
			Vermont
			Rayton
			Magaliesberg
			Silverton
			Daspoort
			Strubenkop
			Dwaalheuwel
			Hekpoort & Boshhoek
			Timeball Hill & Rooihoogte
		CHUNIESPOORT	Duitschland
			Penge
			Malmani
	Black Reef		
Randian		WOLKBERG/ BUFFELSFONTEIN/Bloempoot/ Wachteenbeetje	

## b) This study

Erathem	Supergroup	Group	Formation
Vaalian	TRANSVAAL		Loskop, Rust de Winter, Glentig
		ROOIBERG	
		PRETORIA	upper Pretoria Magaliesberg lower Pretoria
		CHUNIESPOORT	
Randian		WOLKBERG/ Black Reef	
		GROBLERSDAL	



Table 3.5 The stratigraphical subdivisions of the Bushveld Complex.

a) According to Keyser (1997)

<b>Vaalian</b>	<b>BUSHVELD COMPLEX</b>	<b>LEBOWA GRANITE SUITE</b>		
		<b>RUSTENBURG LAYERED SUITE</b>	<b>Upper Zone</b>	Roossenekal Subsuite, Bierkraal Magnetite Gabbro, Molendraai Magnetite Gabbro (Magnetite)
			<b>Main Zone</b>	Dsjate Subsuite, Pyramid Gabbro-Norite & Grasvally, Norite-Anorthosite (Plat Reef)
			<b>Critical Zone</b>	Dwars River Subsuite, Schilpadnest Subsuite (chromite) (Merensky Reef)
			<b>Lower Zone</b>	Croydon Subsuite & Shelter Norite, Vlakkfontein Subsuite & Kolobeng Norite, Zoetveld Subsuite (chromitite)
<b>RASHOOP GRANOPHYRE SUITE/ Unnamed granodiorite</b>				

b) This study

<b>Vaalian</b>	<b>BUSHVELD COMPLEX</b>	<b>LEBOWA GRANITE SUITE</b> (with pegmatite zones)	
		<b>RASHOOP GRANOPHYRE SUITE/ 'Under Bushveld'</b>	
		<b>RUSTENBURG LAYERED SUITE</b>	<b>Upper Zone</b> (with magnetite bands)
			<b>Main Zone</b> (with pegmatite zones)
			<b>Critical Zone</b>
			<b>Lower Zone</b>
<b>Marginal Zone</b>			



### 3.5 Diabase Intrusions

It is well known (Cawthorn et al., 1981) that the diabase intrusions occurring in the Bushveld Complex and surrounding areas are of distinctly different ages and compositions. They vary from pre-, syn-, and post-Bushveld in age to post-Waterberg in age. On the 1:000 000 geological map of South Africa (Keyser, 1997), diabase intrusions occurring in and around the Bushveld Complex are indicated to be pre/post or syn-Bushveld in age whereas the diabase intrusions occurring in the Waterberg Group are believed to be post-Waterberg in age. Since the BOSGIS database makes no distinction between the various ages, all the diabase intrusions are regarded to be of the same age.

### 3.6 The Waterberg Group

Two major Waterberg basins occur in the study area, the Middelburg-Cullinan basin in the south and the main Waterberg basin in the northwestern part of the study area. Good stratigraphic correlation exists between various formations of these two basins. The Waterberg Group can broadly be divided into a lower, middle and upper sequence and consists of brownish-red sandstone, conglomerate, grit, tuff, lava and yellowish to white sandstone (Snyman, 1996). However, in the study area, the Waterberg Group is represented as an undifferentiated sequence. Table 3.6 shows the subdivisions as present on the published geological map (Keyser, 1997), versus the undifferentiated sequence of the study area.

Table 3.6 Stratigraphical subdivisions of the Waterberg Group

a) According to Keyser (19997)

Erathem	Group	Sub-Group	Formation
Mokolian	WATERBERG	Kransberg	Vaalwater
			Cleremont
			Sandriversberg & Mogalakwena
		Matlabas	Aasvoëlkop & Makgabeng
			Skilppadkop & Setlaole
		Nylstroom	Alma
			Swaershoek
		Blouberg	

b) This study

Erathem	Mokolian	WATERBERG GROUP
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Alkaline and carbonatite complexes are distributed throughout the study area. They include the Pienaarsrivier, Pilanesberg, Spitskop, Kruidfontein, Nooitgedacht, Tweerivier, and Ystervark (previously Goudini) Complexes. All these complexes are of late Mokolian in age and are considered to have an emplacement age between 1430 and 1200 Ma (Visser, 1998). In this study, however, no distinction is being made between the various complexes and they are merely treated as 'Alkaline Intrusions'. Figure 3.1 shows the locations of the individual complexes in the study area.

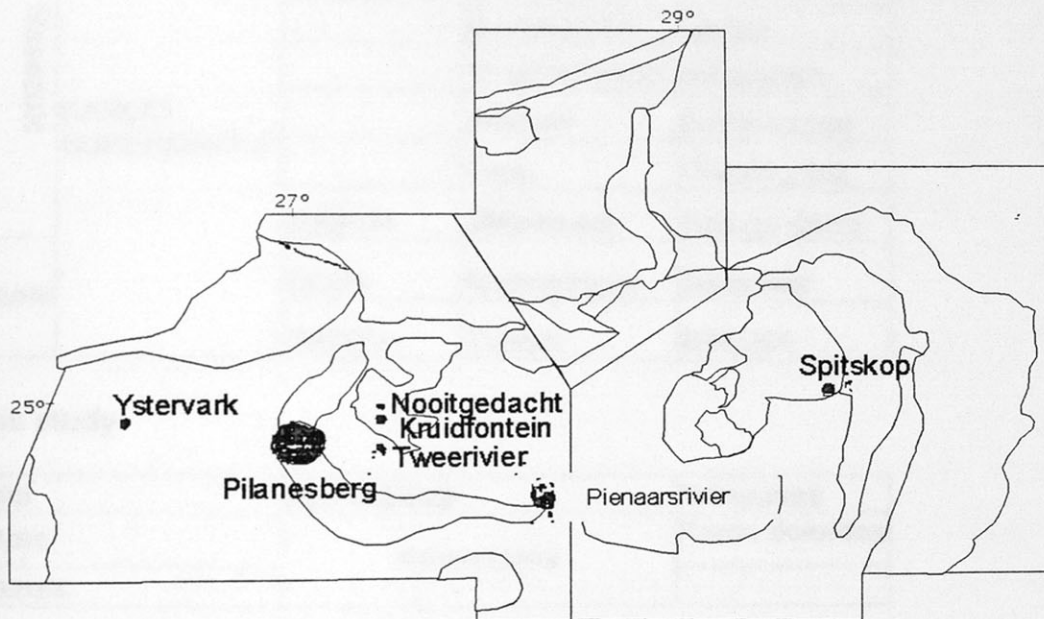


Figure 3.1 The distribution of alkaline complexes in the study area.

### 3.8 Karoo Supergroup

The Karoo Supergroup is broadly characterized by glacial deposits, deltaic successions, aeolian deposits and flood basalts. Rocks of the Karoo Supergroup occur in several regions in the study area and the stratigraphy vary within these respective regions (Keyser, 1997). In the center of the study area, just north of Pretoria, the Karoo rocks underlie an area known as the Springbok Flats. In this area the Karoo rocks occur in a basin with an east-north-easterly axis which represents one of the smaller preserved basins of the main Karoo basin. In addition, some patches of Karoo rocks are found to the south of the Springbok Flats, mainly in the Witbank-Middelburg region. The second region includes scattered occurrences of Karoo rocks in the north of the study area, along the Palala shear zone. These rocks do not correlate with the Karoo rocks found in the Springbok Flats and Middelburg-Witbank area. Lastly, in the North West Province minor outcrops of Karoo rocks occur which again do not correlate with the Karoo rocks occurring in some of the other regions. This study considers the Karoo rock as an



undifferentiated sequence, irrespective of the region in which these rocks occur. However, dolerites which intruded during Karoo times (Keyser, 1997) are presented as a separate unit. Table 3.7 shows the classification of the Karoo Sequence according to the various regions versus undifferentiated Karoo rocks found in the study area.

Table 3.7 The stratigraphical subdivision of the Karoo Supergroup

a) According to Keyser (1997)

Erathem	Supergroup	Springbok Flats area	Northern Province	Northwestern Province
Mesozoic	KAROO SUPERGROUP	Letaba	Letaba	
		Clarens	Clarens	
			Bosbokpoort	Lisbon
			Klopperfontein	Greenwich
			Solitude	Eendragtpan
			Fripp	Grootegeeluk
			Irrigasie	Mikambeni
Paleozoic		ECCA	Madzaringwe	Swartrant
		DWYKA	Tshidzi	DWYKA

b) This study

Erathem	Supergroup	Intrusives
Mesozoic	Karoo rocks	Karoo dolerites
Palaeozoic		