Koedoe 29: 39-44 (1986)

A Summary of the Precambrian Granitoid Rocks of the Kruger National Park

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Barton, J.M. (Jr.), J.W. Bristow and F.J. Venter. 1986. A summary of the Precambrian granitoid rocks of the Kruger National Park. — *Koedoe* 29: 39-44. Pretoria. ISSN 0075-6458.

Precambrian granitoid rocks underlie approximately 60 percent of the Kruger National Park. They occur primarily in the western portion of the park and comprise a wide variety of rock including granites, granodiorites, tonalites, trondhjemites and syenites spanning more than 1 500 Ma from the Archaean to the Proterozoic. Remnants of old greenstone belts are also found.

Key words: Archaean, Proterozoic, granite, gneiss, tonalite, igneous, metamorphic, carbonatite, greenstone, geochronology.

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• *Introduction*

Various types of Precambrian granitoid rocks underlie approximately 60 percent of the surface of the Kruger National Park (KNP) (Map; Inside back cover, this volume). Such rocks provide a basement on which were deposited the approximately 1 800 Ma old Soutpansberg Group and 300 Ma to 170 Ma old Karoo sedimentary and Lebombo volcanic rocks located to the north of the Soutpansberg and along the eastern edge of the park. The granitoid rocks form the northern portion of the Kaapvaal Craton, the continental nucleus of southern Africa. They have been mapped regionally by workers of the Geological Survey of South Africa but are essentially unstudied insofar as detail is concerned. This situation is in part due to the generally poor exposure that these rocks provide.

Only a few published sources deal with the granitoid rocks of the KNP and these sources concentrate on rocks exposed outside of the park. Du Toit (1954) described the granitoid rocks of southern Africa in general terms. Hanekom, Van Staden, Smit & Pike (1965) discussed the geology of the 2 050 Ma old Phalaborwa Complex, syenite intrusions of which occur within the park. Visser & Verwoerd (1960), Robb (1977, 1978) and Vorster (1979) discussed the geology of the granitoid rocks adjacent to and extending into the park in the south and southwest, and in the northwest respectively. At present, the granitoid rocks to the west of the park and north of the Olifants River are a subject of study by workers in the Geology Department of the Rand Afrikaans University. As a result of their investigations, a far greater understanding of the geological significance of these rocks is emerging. This paper presents a brief review of the little that is known about the granitoid rocks within the park as well as a certain element of speculation as to what may exist there based on the rocks occurring to the west.

Thoughts of their origin are briefly presented. It is hoped that more will be learned about these rocks in the not too distant future.

The Granitoid Rocks

Five types of granitoid rocks are known to exist within the KNP and a sixth type may exist there (Table 1). Of these types, four are of Archaean age (greater than about 2 600 Ma old) and the remainder are of Proterozoic age (between about 2 600 Ma and 600 Ma old). Karoo age granitoid rocks, *viz.* granophyres, occur in the Lebombo Mountains along the eastern margin of the park and these are described elsewhere in this issue (Bristow & Venter 1986).

1. Tonalitic and Trondhjemitic Gneisses

Areally, tonalitic and trondhjemitic gneisses are the most significant granitoid rocks in the KNP, being exposed in the south-eastern and west-central portions (see Map). These gneisses are generally light grey in colour and may be massive, banded or migmatitic. They are composed primarily of quartz and oligoclase with minor amounts of biotite and hornblende. Vorster (1979) named the gneisses occurring around and north of the Letaba River, the Klein Letaba Gneiss. More recently, the Geological Survey of South Africa has included the Klein Letaba Gneiss as part of the Goudplaas Gneiss on the 1984 1:1 000 000 geological map of South Africa. To the west of the park, at any rate, rocks grouped within the Goudplaas Gneiss were emplaced prior to about 3 500 Ma ago. Within the tonalitic and trondhjemitic gneisses are numerous xenoliths of greenstone belt rocks, remnants of the Murchison and Sutherland Greenstone Belts to the west. As far as can be deduced, these greenstone remnants are the oldest rocks exposed within the park.

2. The Nelspruit Granite-migmatite Complex

The Nelspruit granite-migmatite complex forms a large batholith that underlies most of the southern half of the Kruger National Park. It comprises several phases including granite, granodiorite and migmatite and is intruded by younger tonalitic and granodioritic plutons (Robb 1977, 1978). The batholith intrudes the tonalitic and trondhjemitic gneisses, indicating that the

UNIT	COMPOSITION	AGE
Phalaborwa Complex	syenite	± 2 050 Ma
Muscovite-bearing Pegmatites	granite	± 2 200 Ma
Granodiorite Plutons	granodiorite, granite and trondhjemite	2 650 ± 50 Ma
Granodiorite Plutons	granodiorite, granite, trond-hjemite and migmatite	2 800 ± 50 Ma
Nelspruit Granite-Migmatite Complex	granodiorite, granite and migmatite	± 3 200 Ma
Tonalitic and Trondhjemitic Gneisses	tonalite and trondhjemite	± 3 500 Ma

Ma = 10^6 years

older rocks were metamorphosed by that time. Unpublished isotopic data of Dr. E.S. Barton of the Bernard Price Institute of Geophysical Research at the University of the Witwatersrand, Johannesburg, indicate that the Nelspruit granite-migmatite complex was emplaced about 3 200 Ma ago and that at least one intrusive tonalitic pluton, the Cunning Moor pluton, was emplaced about 2 800 Ma ago. This age places a minimum limit on the timing of the main fabric forming event in the tonalitic and trondhjemitic gneisses. Furthermore, these data show that the migmatitic, granitic and granodioritic phases of the batholith share a common low initial $^{87}Sr/^{86}Sr$ ratio (hereafter referred to as Ro) of about 0.701, strongly suggesting that they are genetically related.

3. 2 800 Ma old Granitic, Tonalitic and Trondhjemitic Gneisses

A suite of approximately 2 800 Ma old grey granitoid rocks including the Cunning Moore pluton have been recognized to the west of the KNP but as yet not within the park. These rocks vary in composition from muscovite-bearing granite through granodiorite to tonalite. They cross-cut earlier fabrics in the old tonalitic and trondhjemitic gneisses and the Nelspruit granite-migmatite complex and contain xenoliths of the surrounding lithologies, indicating that they are intrusive rocks. North of the Letaba River, they are gneisses and migmatites demonstrating that they have suffered a metamorphic event which did not affect the rocks further to the south.

4. 2 650 Ma old Granodiorite Plutons

2 650 Ma old plutons are found throughout the northern portion of the Kaapvaal Craton and many surround and intrude the Murchison, Pietersburg and Sutherland Greenstone Belts. These plutons are largely undeformed and composed of many textural phases. Most are granodioritic and granitic in composition but some are trondhjemites. All plutons share a common low Ro ratio of about 0.702, indicating a common source. Within the KNP, these plutons occur north of the Letaba River where they form conspicuous koppies. The Baderoukwe and Shabarumbe plutons crop out north of the Letaba River and the Shamariri Pluton crops out along the Shingwedzi River.

5. Muscovite-bearing Pegmatites

Coarse-grained muscovite-bearing pegmatites are exposed south of the Letaba River and south-east of Phalaborwa. These pegmatites are part of an east-west trending pegmatite belt passing through the town of Mica. West of the park, muscovite, feldspar and other minerals are mined from these rocks. Preliminary geochronological data suggest that these pegmatites were emplaced about 2 200 Ma ago, prior to the emplacement of the Phalaborwa Complex.

6. Syentitic Plugs of the Phalaborwa Complex

The 2 050 Ma old carbonatite complex at Phalaborwa is surrounded by a series of syenite plugs and dykes, many to the east occurring within the Kruger National Park (Hanekom *et al.* 1965). These plugs are texturally very heterogeneous. Some are massive grey to pink syenite while others are composed of syenite breccia. The reconstructed smelting site at Masorini occurs on one of the these plugs. These rocks are discussed in detail by Frick (1986) in this volume.

Discussion

The compositions and textures developed in granitoid rocks reveal a great deal about the tectonic history of these rocks. The granitoid rocks exposed within the KNP formed, and in some cases were deformed, under many different geological conditions and during many specific geological events. The tonalitic and trondhjemitic rocks exposed north of the Letaba River were intruded and were metamorphosed into gneisses prior to about 3 200 Ma ago. Subsequently, they were deformed during a major period of tectonic activity associated with the deformation of the Limpopo Belt and the greenstone belts immediately to the south (Barton 1983). This deformation resulted in another recrystallization of these rocks and changes in their bulk chemical composition. South of the Letaba River, however, these rocks and those of the Nelspruit granite-migmatite complex escaped deformation during the Limpopo event and display primarily their earliest emplacement and deformational histories. The 2 650 Ma plutonic rocks, the muscovite-bearing pegmatite and the Phalaborwa syenite plutons are undeformed and largely unaltered, displaying their emplacement geometries.

Tonalitic and trondhjemitic rocks may be formed by partial melting of a wide spectrum of rock composition but are commonly formed by partial melting of amphibolitic lithologies similar to those found in greenstone belts. In modern environments, such granitoid rocks form by partial melting of subducted oceanic crust. There is a growing body of evidence to suggest that greenstone belts contain elements of obducted oceanic crust. Obduction usually takes place in compressive regimes associated with subduction zones, the latter being sites of tonalite and trondhjemite formation.

Granodioritic and granitic rocks such as those exposed in the Nelspruit granite-migmatite complex and the 2 800 Ma and 2 650 Ma old plutons can not as easily be derived by simple partial melting of amphibolite. They are more easily derived by partial melting of more refined rocks such as tonalites and trondhjemites or from sedimentary rocks derived from such rocks. The low Ro ratios of these rocks indicate a lower-crustal, granulitic source.

Numerous I-type granitoid plutons were emplaced into the northern portion of the Kaapvaal Craton approximately 2 650 Ma ago (Barton & Van Reenen 1983). They share a remarkably similar Ro ratio of about 0.702, indicating that they had a common source, probably granulitic lower crust. These plutons were emplaced along east-northeast trends, parallel to a number of shear zones in the area. It is felt, therefore, that there is a genetic link between genesis of these plutons and movements along the shear zones. Movements along these shear zones were responsible for thickening of the continental crust within the Limpopo Belt.

The east-west trending zone of pegmatite that is found within the KNP formed along a zone of high fluid activity. This zone, almost assuredly must have been associated with a shear zone.

The Phalaborwa Complex was emplaced approximately 2 050 Ma ago, coevally with the emplacement of the Bushveld Complex to the west.

Acknowledgements

The authors, JMB and JWB appreciate the support of the staff of the Kruger National Park afforded them. Financial support from the Council for Scientific and Industrial Research and the Bernard Price Institute for Geophysics (University of the Witwatersrand) is also acknowledged.

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