

STRATIGRAPHIC SUBDIVISION OF THE TRANSVAAL DOLOMITE FROM ERTS IMAGERY

Jan Grootenboer, (*Spectral Africa (Pty) Ltd., P.O. Box 2, Randfontein, Rep. of South Africa*);
Ken Eriksson, John Truswell, (*Department of Geology, University of the Witwatersrand, Jan Smuts Avenue, Johannesburg, Rep. of South Africa*)

ABSTRACT

ERTS imagery has revealed the presence of broad stratigraphic subdivisions in the previously undifferentiated Transvaal Dolomite of the western Transvaal, Republic of South Africa.

While detailed field mapping in areas of good outcrop, as well as borehole logging has recently led to the recognition of a stratigraphy in the Transvaal Dolomite of the central Transvaal, poor outcrop in the western Transvaal has to date prevented this. The ERTS-imagery, however, clearly reveals the presence of six, and in the far west seven, distinct stratigraphic zones extending along strike for a distance of at least 200 km. Ground truth selected on the basis of ERTS imagery, identified these zones as corresponding to alternating units of dark-grey, chert-poor and light-grey relatively chert-rich carbonates. With an appreciation of the defined stratigraphy of the central Transvaal, the detailed geology mapped along the traverses was readily related to the zones evident on the imagery, extending the established stratigraphic subdivision of the carbonate sequence over an area of some 4000 sq. km.

The investigation clearly demonstrates the potential applications of ERTS-imagery in geological studies, even in a country where the geology is supposedly well known.

INTRODUCTION

ERTS Image No. 1158-07363 covers much of the western part of the Transvaal Province of South Africa. The area is of considerable geological interest as it includes the gold and uranium mines of the central and west Rand, the platinum and chrome mines of the Bushveld Complex, the Lichtenburg diamond fields, the Marico lead/zinc deposits, as well as numerous other mineral occurrences. Intense geological investigation has been in progress over the

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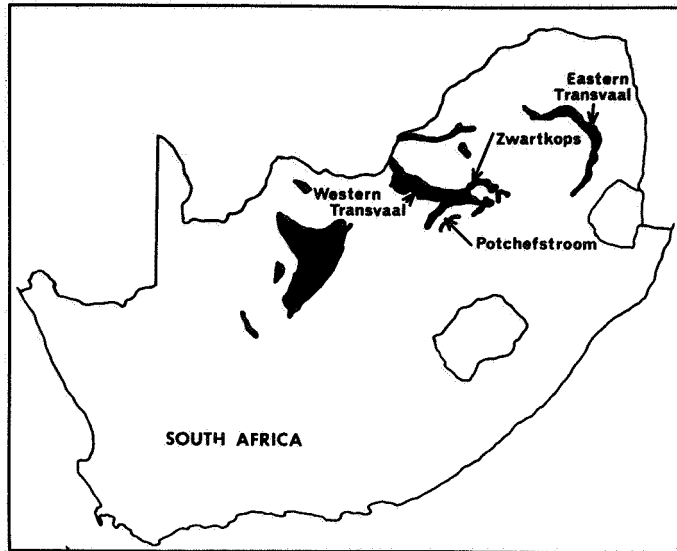


FIG. 1 : Distribution of the Transvaal Dolomite in South Africa.

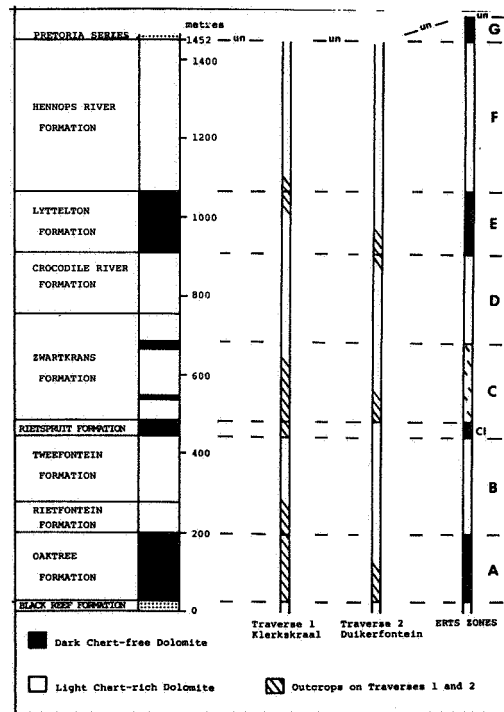


FIG. 2 : Stratigraphy of the Transvaal Dolomite from the Zwarkops area and relationship to outcrops along Ground Traverses and ERTS-zones.

last 90 odd years following the discovery of gold in 1886, and the area has been repeatedly mapped both by mining companies and the Geological Survey.

The image includes an area of some 4 000 sq. km. underlain by the Transvaal Dolomite. Over most of this region the northerly dipping Dolomite is characterised by extremely poor outcrop, generally being covered by residual soil. It is only near the eastern extremity of the image, south of the Hartbeespoort Dam that better outcrop occurs. Until recently it was considered that the Dolomite was relatively uniform in nature and as a result no subdivision of this unit was recognised, even on geological maps published as late as 1967. However, logging of borehole cores in the Potchefstroom area (Eriksson, 1972), and field mapping in the eastern Transvaal (Button, 1973) and at Zwartkops south of the Hartbeespoort Dam (Eriksson and Truswell, in press) (fig. 1) has now revealed the existence of a stratigraphy.

Broad zones of contrasting colour tone within the area underlain by the Transvaal Dolomite are clearly evident on the ERTS image. The conformable nature of these zones which extend over a strike length of some 200 km. strongly suggest that the colour tones reflect broad stratigraphic units. This was confirmed by ground traverses which identified these zones as reflecting alternating major zones of dark-grey chert-poor and light-grey chert-rich dolomite which could be directly related to the broad stratigraphic zones mapped at Zwartkops.

THE STRATIGRAPHY OF THE TRANSVAAL DOLOMITE

The Lower Proterozoic, essentially non-clastic Transvaal Dolomite was previously mapped as a single unit between the clastic Black Reef and Pretoria Series (fig. 2). Detailed examination of borehole cores from the Potchefstroom area resulted in a stratigraphic subdivision of the Transvaal Dolomite based largely on the presence or absence of chert and the colour of the dolomite (fig. 1), (Eriksson, 1972). In a general sense 3 dark chert-poor zones, the middle of which is the thinnest, and 3 light chert-rich zones were recognized. Button (in press) extended this stratigraphy in a regional study in the eastern Transvaal (fig. 1) an area of good outcrop where, however, the thin middle dark chert-poor zone of the Potchefstroom area was not traced. He noted the appearance of an additional dark chert-poor mixed dolomite-limestone zone stratigraphically above those developed in the Potchefstroom area. The succession developed in the eastern Transvaal can be shown to extend around the northern flank of the Transvaal basin into the extreme western Transvaal. Moving eastwards into the area under consideration this uppermost chert-poor zone is truncated by an erosional unconformity (un, fig. 2).

In the Zwartkops area north-west of Johannesburg, where exposures are good, a detailed stratigraphy has now been established in the Transvaal Dolomite (Eriksson and Truswell, in press) through detailed field mapping. In the broadest sense eight formations of alternating chert-rich and chert-poor dolomite can be recognized (fig. 4) but a considerable amount of detailed lithological information has also now become available. The chert-poor zones are the basal Oaktree Formation, the thin Rietspruit Formation and the Lyttelton Formation. In addition there are thin chert-poor zones in the Zwartkrans Formation above the Rietspruit Formation (fig. 2).

ERTS IMAGE 1158-07363

The distribution of the Transvaal Dolomite is evident on a colour composite of Bands 4, 5 and 7 of image 1158-07363 (fig. 3). The Dolomite is characterized by a greenish colour tone and occurs as a zone trending across the centre of the image, and again in a less distinct arc in the Potchefstroom area to the southeast.

Where good outcrop conditions prevail, as at the eastern extremity of the image, the Dolomite is characterized by a relatively dark uniform colour tone in which tonal variations are difficult to distinguish. Over the remainder of the western Transvaal, however, distinct zones of varying colour tone can be recognized within the Dolomite. Four zones of dark colour tone are recognizable, although the uppermost of these is developed only in the western extremity of the image. These dark zones are separated by three wider zones of light green colour tone. The various zones will be referred to in alphabetical order from the base upwards as indicated in figs. 2 and 4.

The conformable nature of the zones strongly suggests that they represent major stratigraphic subdivisions within the Dolomite which are continuous over a distance of at least 200 km. The termination of the uppermost dark unit is related to a major erosional unconformity at the top of the Dolomite.

GROUND TRUTH

Ground truth was gathered over a period of three days and involved traverses by car along roads over the area underlain by the Dolomite. The first two days were devoted exclusively to locating areas where sufficient outcrop was available for



FIG. 3 : Portion of ERTS Image 1158-07363 with limits of Transvaal Dolomite outlined.

further study. Over large areas outcrops are virtually absent rendering accurate identification and correlation with the established stratigraphy impossible. Traverses covered and the outcrops encountered along them are indicated in fig. 4. Only the Klerkskraal traverse contained any significant outcrop, and this was confined mainly to the lower half of the succession. This and scattered outcrops on the Duikerfontein traverse were investigated on the third day.

The Klerkskraal Traverse: Fair outcrop was encountered near the base of the Dolomite on this traverse, permitting recognition of the Oaktree Formation of dark chert-free dolomite, coinciding with Zone A (fig. 2) of dark colour tone on the image.

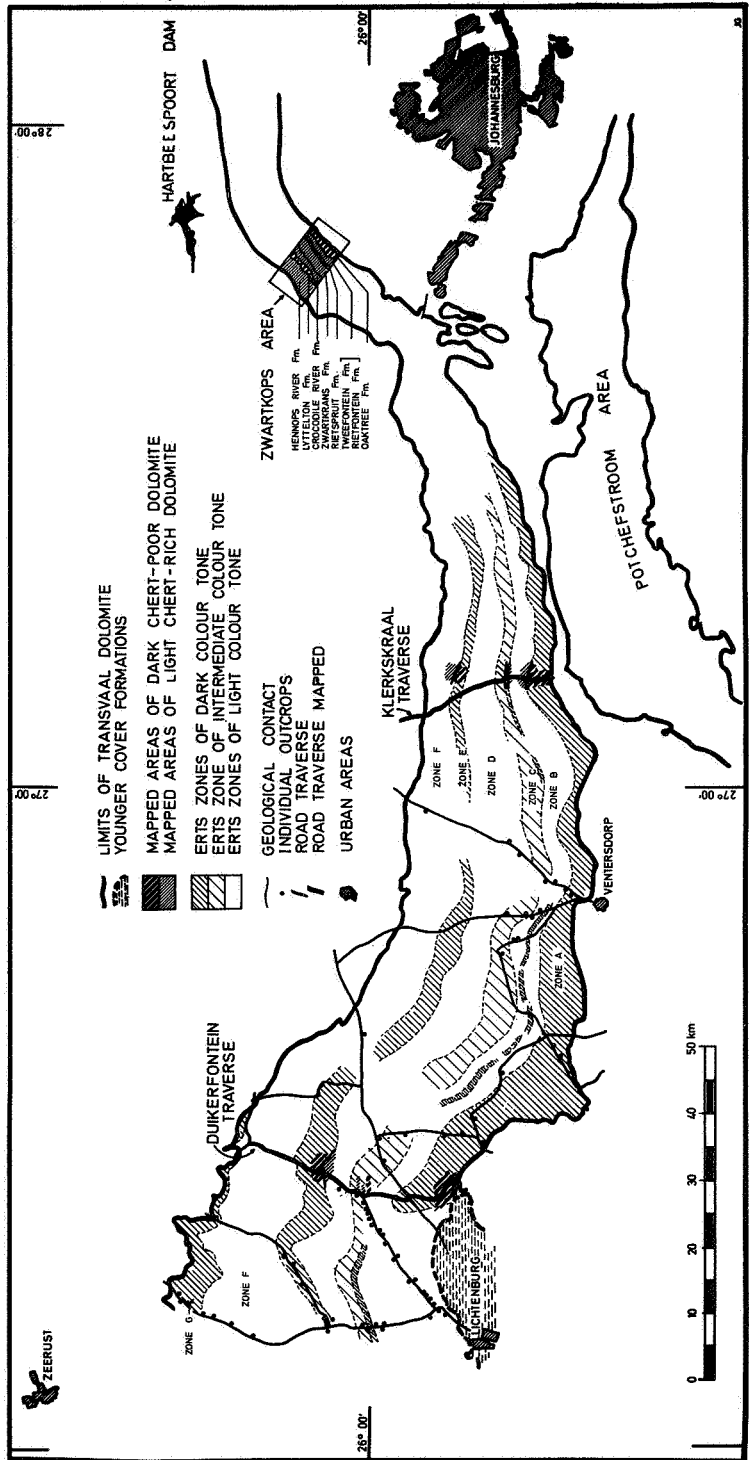


FIG. 4 : Extension of the stratigraphy of the Transvaal Dolomite from the Zwartkops area into the western Transvaal based on ERTS.

The contact between the Oaktree Formation and the overlying chert-rich, light-grey Rietfontein Formation was accurately located in the field and coincides with the change in tone on the ERTS image (Zones A-B). Outcrop conditions deteriorated from this point northwards, but the dark dolomite of the Rietspruit Formation (Zone C-1, fig. 2) characterized by linked columnar stromatolites, was located in the field and could be correlated with the thin unit of very dark colour tone (fig. 4). At the base of Zone C this unit was overlain by alternating thin bands of dark chert-poor dolomite and lighter chert-rich dolomite which probably represents most of Zone C. Towards the north this material graded into uniform light-coloured chert-rich dolomite referred to as the upper Zwartkrans and Crocodile River Formations (Zone D, fig. 2). Farmlands obscured the remainder of the succession but in an area slightly to the east the contact between the chert-poor Lyttelton Formation and Hennops River Formation was located and found to coincide approximately with the contact between Zones E and F (fig. 2) on the image.

The Duikerfontein Traverse: In the south of this traverse isolated outcrops of dark chert-free dolomite were found near the base of the Dolomite. Some occurrences of chert-rich dolomite were noted in this area, still well within Zone A, but these probably represent thin units of local chert development. Further north along the traverse thick soil covers the remainder of Zone A and all of Zone B. A thin unit of dark dolomite, strongly resembling that overlying the Rietspruit Formation on the Klerkskraal traverse, was found within Zone C on the image. Outcrops are virtually absent along the remainder of the traverse, the area being covered by thick soil, but the contact between the Lyttelton and underlying Crocodile River Formations could be accurately located and coincided with that between Zones D and E on the image (fig. 4).

SUMMARY

1. ERTS imagery has revealed the presence of broad stratigraphic units in the Dolomites of the western Transvaal.
2. Despite a long history of geological activity, no stratigraphic subdivision of the Dolomite had previously been recognized in the western Transvaal. This was largely the result of poor exposure and the uniform nature of the Dolomite.

3. The stratigraphic units revealed on the imagery can be correlated with the generalized stratigraphy of a better exposed area.
4. Four zones of dark colour tone are distinguished on the image and correspond to dark chert-free dolomite. One of these units is very thin (50 m). The uppermost Zone (G) is truncated by an unconformity.
5. Three zones of lighter tone correspond to light-coloured chert-rich dolomite.
6. These seven zones are best seen in those areas of the western Transvaal that are characterised by poor outcrop and low dips. In contrast the zones become indistinct in areas of better exposure or steeper dip.
7. The investigation has demonstrated the usefulness of ERTS imagery as a rapid mapping technique in the extension of a known Transvaal Dolomite stratigraphy into an area of poor outcrop.

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