Paper L 6

THE VALUE OF ERTS-1 IMAGERY IN RESOURCE INVENTORIZATION ON A NATIONAL SCALE IN SOUTH AFRICA

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ABSTRACT

It has been shown that ERTS imagery, particularly in the form of 1:500 000 scale false colour photolithographic prints, can contribute very significantly towards facilitating and accelerating (dramatically, in some cases) resource surveys and geologic mapping. Fire mapping on a national scale becomes a feasability; numerous new geologic features, particularly lineaments, have been discovered, land-use can be mapped efficiently on a regional scale and degraded areas identified.

The first detailed tectonic and geomorphological maps of the Republic of South Africa will be published in the near future mainly owing to the availability of ERTS images.

INTRODUCTION

This paper reports some of the results of ERTS participation proposal SR-9616 'To Assess the Value of Satellite Imagery in Resource Inventorization on a National Scale', Principal Investigator, O.G. Malan.

This project was managed by an ERTS Investigator's Committee, under the chairmanship of the Principal Investigator, which included representatives of the cooperating agencies; the Soil and Irrigation Research Institute and Botanical Research Institute, both of the Department of Agricultural Technical Services, the Geological Survey of the Department of Mines and the Department of Planning and the Environment as well as from organizations rendering support services.

The general approach in this study was an attempt to integrate ERTS results on a broad scale into current resource survey programmes, rather than to create an intensive new research project.

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The advantage of this approach was that it was possible to draw on the experience of a larger number individuals from a variety of agencies representing mainly 'end users' confronted with practical resource survey and management problems rather than purely academic issues. Also use could thus be made of existing organisational structures, facilities and field personnel.

A disadvantage was that, because of other priorities in current programmes of the agencies involved, progress sometimes was slower than expected and all objectives could not be achieved before the deadlines imposed by NASA. Furthermore, because the priorities of different agencies did not coincide geographically, a truly multidisciplinary investigation has not been achieved. Such an approach would most probably have yielded considerably more information than the sum of the separate investigations.

Besides the cooperating agencies, useful contributions were also received from individual scientists attached to universities and other research organizations.

COVERAGE

All 77 scene positions covering the Republic of South Africa were imaged, of which only 7 were not imaged at least once with less than 5 % cloud cover. Of these, 30 % cloud cover was the worst. The remaining scene positions were imaged cloud free up to seven times. With the exception of six RBV frames, all imagery was MSS.

Unfortunately these images were not evenly distributed temporally: No images were acquired over the Republic during the autumn-winter months April to July. This is to be regretted for three reasons:

1) No mid-winter images, with the lowest sun angles accentuating topographic features, were available.
2) The possibility of detecting urban air pollution, which is worst during winter mornings in the interior, could not be tested.
3) Experience with high level false colour aerial photography indicated that maximal discrimination between some vegetation types could be expected during autumn.

DATA HANDLING

Initially an organization was set up to produce and distribute 1:1000 000 scale black and white photographic prints produced from 70 mm positives. Although these were usually adequate for the identification of geologic structural features, it soon became apparent that for vegetation and land use purposes, this product was unsatisfactory.

Experiments were therefore undertaken to produce economically a large scale false colour product. The optimum product in terms of ease of production and handling, cost and information content was found to be 1:500 000 scale false colour photolithographic prints. Since the NDPF 70 mm positive transparencies were often unsharp, these were produced from 9 inch positive transparencies in the following manner:

In order to obtain a final scale as closely as possible to 1:500 000, a cartographic analysis was undertaken. This indicated that a cross track registration mark separation of on the average 397 mm (compared to 395 mm nominal) was required.

In one step the NDPF 9 inch positive was enlarged to a negative screen of this scale with 175 screen points per inch (giving 6.5 million screen points per colour compared with 7.5 million theoretical data points per band). Simultaneously the contrast was also increased by processing step 5 and step 14 of the grey scale, respectively, to 0 % and 100 % transmission (in the negative screen). Densitometry on a few selected scenes have indicated that very little information is lost by sacrificing the extreme ends of the grey scale in favour of increased contrast.

MSS bands, 4, 5 and 7 were then offset printed in a set of trichromatic colours, respectively yellow, magenta and cyan.

It is gratifying to note, as indicated by the example of the street pattern of Paulpietersburg situated at approximately 30° 50' E, 27° 25' S in scene 1047-07191 (Fig. 1), that the 'resolution' has apparently improved through the three additional generations (screen, plate, print) after the NDPF product.

This product has received very favourable comment from all investigators both with respect to ease of interpretation and annotation. It can be highly recommended since it can be produced by a process which is commonly commercially available at a reasonable cost (locally approximately US $200 per scene per first 100 copies, rising US $7 per additional 100 copies).

It proved to be so popular with scientists from universities, exploration companies, governmental agencies etc., that total coverage of the Republic is currently being produced on a subscription basis.

An I^2S Mini-Addcol Additive Colour Viewer was also employed in some investigations and Computer Compatible Tapes were received, but too late to include any results in this paper.

RESULTS

Only some major results of the investigation will be highlighted. The complete Type III report, which will be released by NASA in due course, should be consulted for more details.

Soil Mapping--Identification of soil types was only possible where a close correlation exists between soil type, vegetation, terrain morphology, geology, climate or land use. Nevertheless ERTS imagery draws attention to differences within specific areas and in special cases allowed personnel to determine some of the known boundaries more accurately and faster.

Geomorphological Mapping--The possibilities of application of ERTS images in geomorphological mapping are very promising - particularly in arid regions. This data base, being ideally commensurate with the small scale mapping, eliminates the cost and drudgery associated with conventional sources of information. Geomorphological features such as mountains, ridges, river valleys and alluvium, footslopes, plateaux, canyons, alluvial, colluvial and aeolean deposits, etc. could be identified consistently.

The first detailed 1:1500 000 scale geomorphological map of the Republic of South Africa will be taken from its present second approximation to the final publication edition solely as a result of ERTS imagery. In Figure 2 a portion of this map is shown.

Agricultural Land Use and Planning--It is possible to distinguish cultivated land, natural grazing land and irrigation schemes. In special cases further subdivision is possible.

Areas where mismanagement has led to over exploitation of natural vegetation or the invasion of degraded vegetation types can be identified.

On the basis of ERTS images it is also possible to delineate homogeneous agricultural areas for the purpose of planning for optimal land utilization as shown in Figure 3 for the Springbok Flats and adjacent region.

Urban and Regional Land Use--Except when applied to very broad and large scale components of a metropolitan area, the scale of ERTS images is too small to yield significant results in urban land use.

For land use on a regional scale as shown, for example, by a comparison of Figures 4 and 5, ERTS images yield information which differs negligibly from that provided by conventional aerial photography. The time required for the analysis of a 1:500 000 false colour ERTS print of this area was minimal in comparison.

This means that ERTS images enables a rapid inventory of land use on a regional scale for the entire Republic - a task which, by conventional means, would have been well-nigh impossible.

Roads and railways can be located depending on the contrast with the surroundings. Roads are particularly visible during or soon after construction or when surfaced with light coloured materials such as calcrete: Railways can be located over long distances in some areas, probably owing to deliberate burning of grass along the tracks to prevent coal burning steam engines from igniting grazeland.

Water reservoirs and larger ponds can be identified as well as political boundaries such as those between the Republic and South West Africa, Lesotho and Swaziland.

Vegetation Mapping--Major vegetation types can be mapped, often with a high degree of accuracy, as established by ground control or by comparison with aerial photography, in spite of the fact that in most cases images were acquired during a season when differentiation was less than optimum. Maximal differentiation can be obtained for dense wooded forest and scrub as well as for sparse vegetation types.

These surveys, for example those illustrated in Figure 6 and 7, could be completed within a matter of weeks as opposed to periods of years by conventional means.

Failure to resolve some vegetation types such as open savanna from grassland or natural forest from exotic tree plantations and shrub might be due to the unfavourable time of imagery.

Fire Mapping--An unexpected result of great importance for management purposes has been the ease with which burnt area can be mapped. This applies to both grassland in the interior and shrub vegetation such as 'fynbos' (macchia) in the Western Cape (Figure 7).

In the case of grassland, which may be burnt annually, a preliminary survey in Natal has shown that the position, extent as well as time of burning to within less than 18 days can be determined with ease. In the case of 'fynbos!, which is burnt every few years, the age of the vegetation in burnt areas could be estimated up to 5 years and more.

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Thus by use of ERTS imagery the monitoring of veld fires on a national scale becomes a practicability for the first time.

Geology--The most significant contribution of ERTS imagery in South African geology to date has been the discovery of numerous previously unknown lineaments, such as indicated in Figure 8.

ERTS imagery has been so informative that it is already being used routinely in all current survey and small scale mapping and map revision programmes.

The compilation of the first detailed tectonic map of the Republic of South Africa has been initiated as a result of the availability of ERTS images.

The potential benefit of ERTS to economic geology may be judged from the very lively interest of local mining and exploration companies in the 1:500 000 false colour prints.

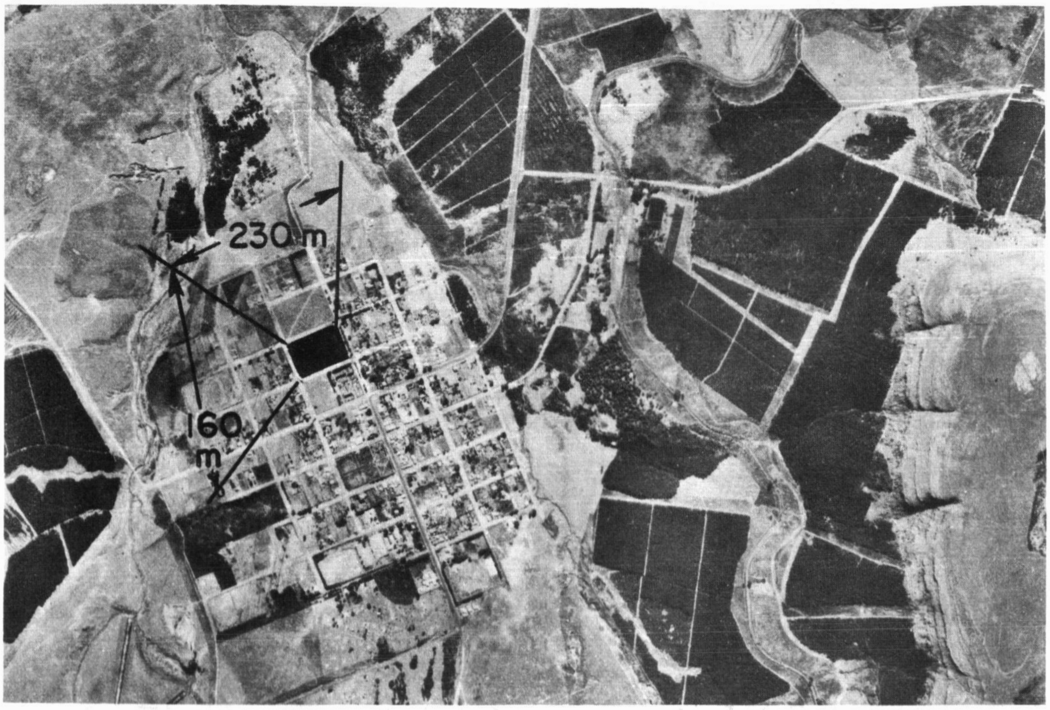
CONCLUSION

1. An ERTS image product, 1:500 000 scale false colour photolitho prints can easily be mass produced in consistent quality at a reasonable cost.

2. This product is easy to interpret with limited training and can be phased into current resource survey programmes without specialized equipment or major problems.

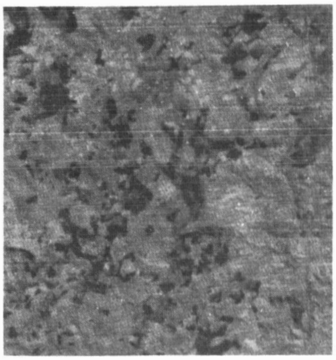
3. Being ideally commensurate with mapping scales at regional or national level, ERTS images can reduce the cost of and time required for national resource inventorization very significantly and make previously impossible types of survey a practicability.

4. Those government agencies most familiar with ERTS imagery in the Republic of South Africa, already routinely use them in their current survey programmes.



a) Aerial Photograph, 1:27 000

b) Negative print
Band 5
ca 1:150 000



c) False colour
Bands 4, 5 & 7
1:500 000

FIG. 1 Aerial and ERTS photography
of Paulpietersburg

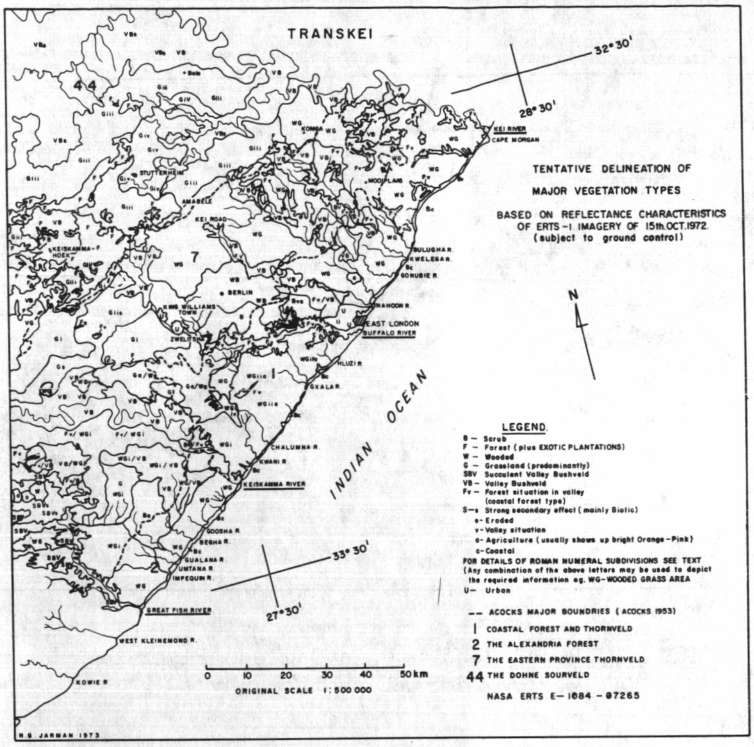


FIG. 6 Vegetation map of Eastern Cape based on E 1084-07265
1:500 000 false colour lithoprint

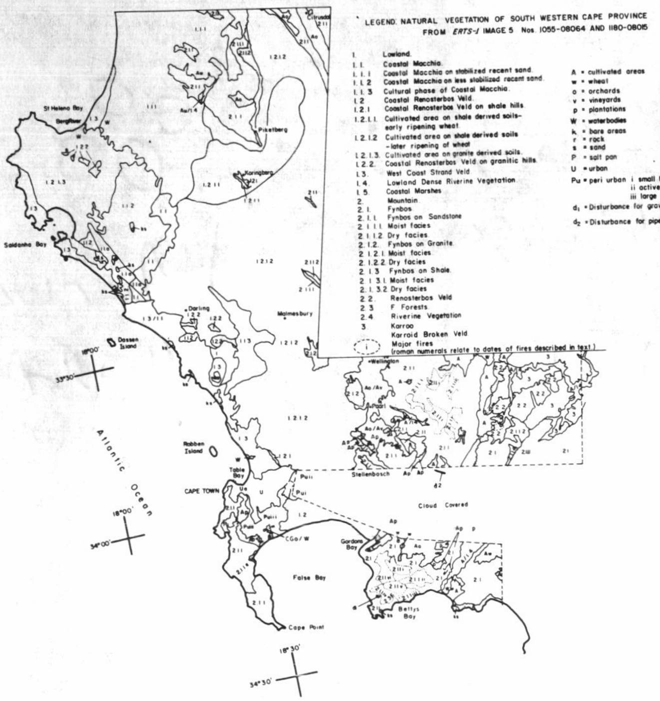


FIG. 7 Vegetation map of Southwestern Cape based on E 1055-08064
and E1180-08015 1:500 000 false colour lithoprints

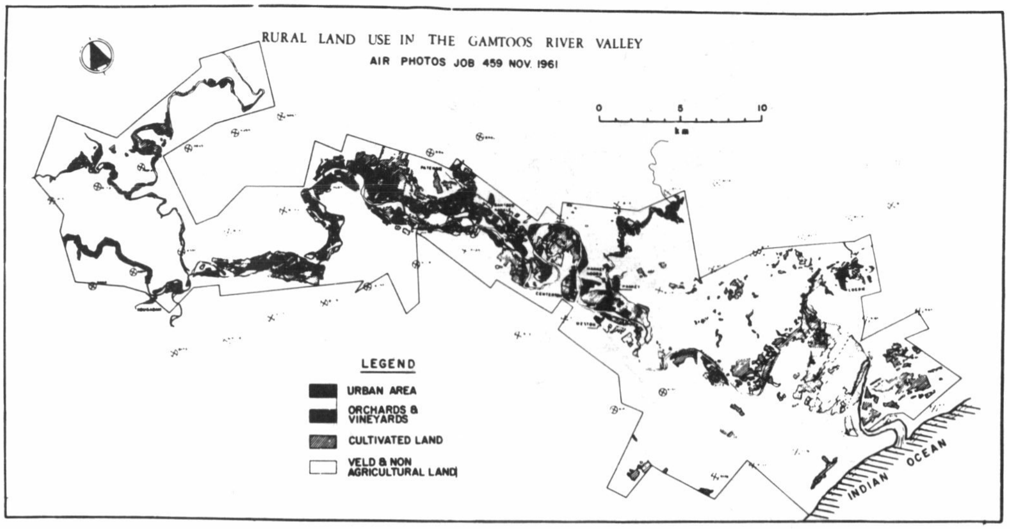


FIG. 4 Rural land use in Gamtoos River Valley from aerial photography

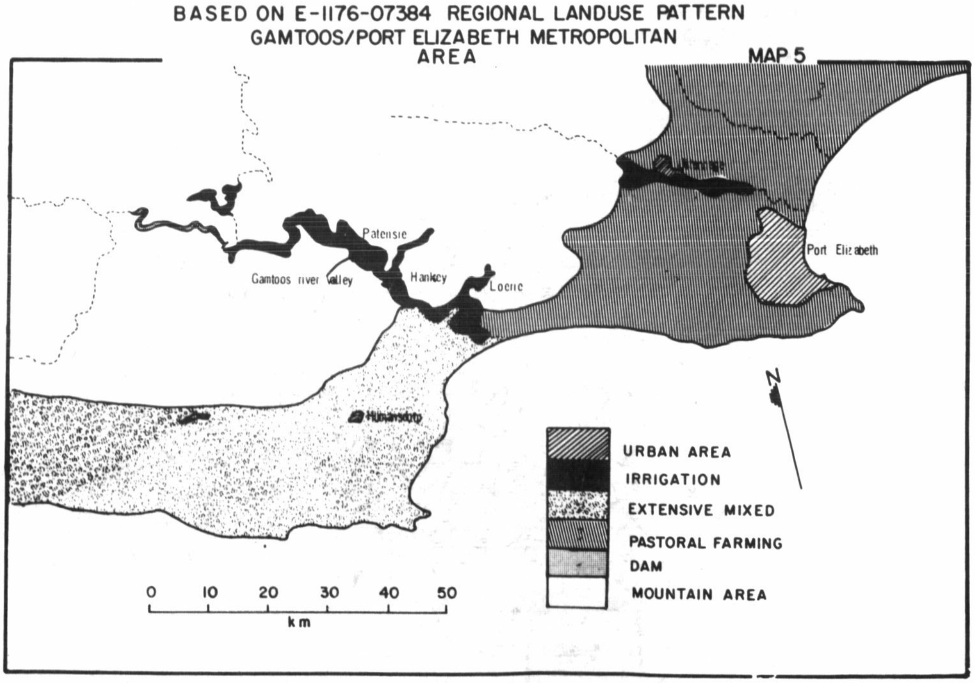


FIG. 5 Regional land use in Gamtoos River Valley based on E-1176-07384 1:500 000 false colour lithoprint

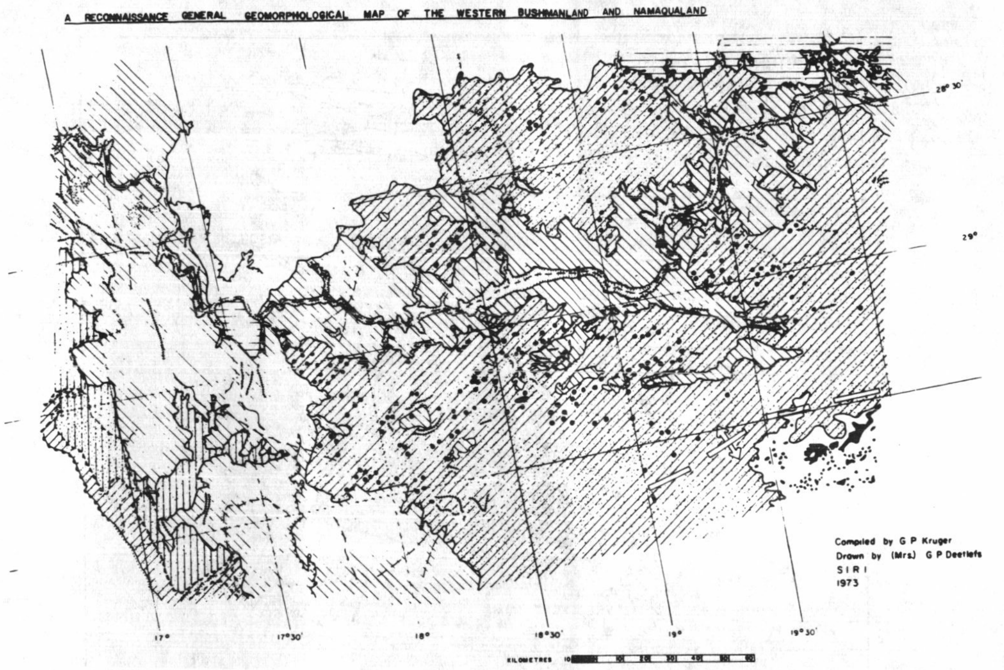


FIG. 2 Reconnaissance general geomorphological map of western Bushmanland and Namaqualand

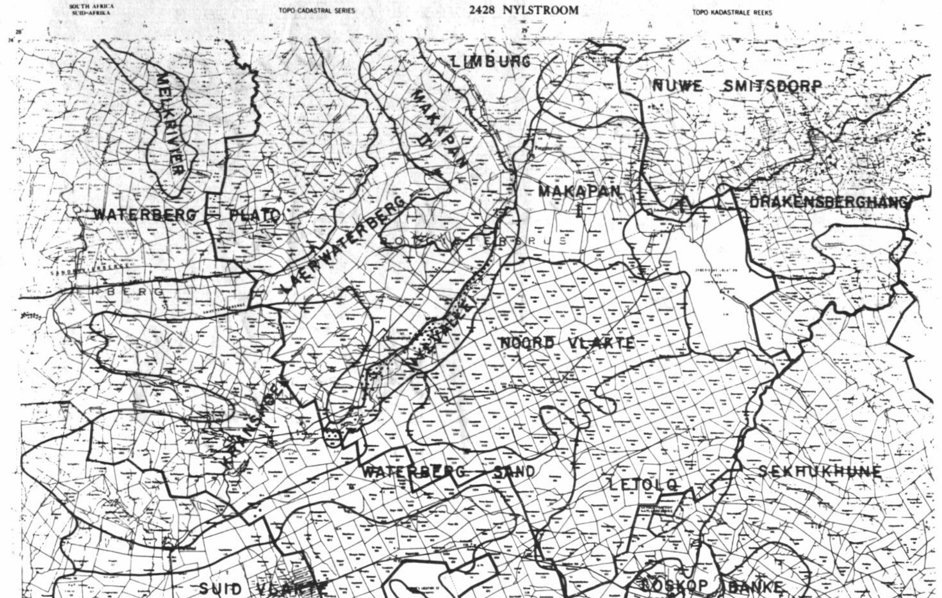


FIG. 3 Broad agricultural regions based on E 1049-07295 superimposed on topocadastral map

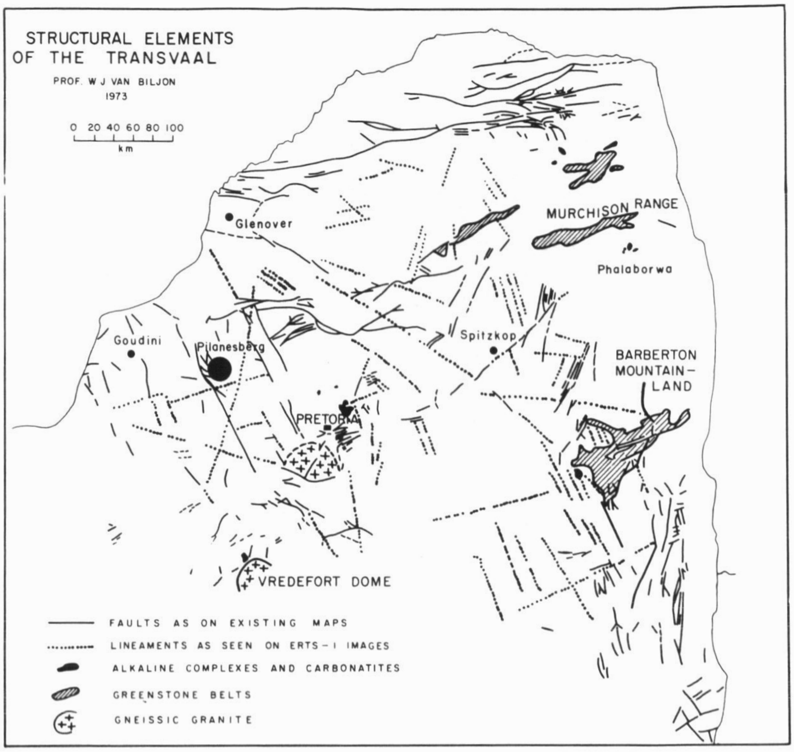


FIG. 8 Structural elements of the Transvaal, known and new features discovered on ERTS mosaic