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USE OF ERTS IMAGERY FOR NATURAL RESOURCES RESEARCH AND DEVELOPMENT IN LESOTHO.

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15. Abstract

This report covers the activities of the Lesotho ERTS-1 project. The major fields of interest were geology, in respect of minerals prospecting, and agriculture, in terms of assessing agricultural potential. Adverse weather conditions at the time of gathering of the images hampered the work in the agricultural field. The images were used to construct geological maps of Lesotho. Examination of these maps has led to the formulation of a working hypothesis about the location of kimberlite pipes in southern Africa, which could cut down the effort needed for productive prospecting.

*Note: Dr. Nixon left Lesotho before this report was written. See section I.3 page 5.

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PREFACE.

This report covers the major activities of the Lesotho ERTS-1 project. The project was designed to perform two functions: firstly to evaluate the ERTS imagery as a possible tool for the investigation of natural resources in Lesotho; and secondly to use the ERTS imagery, as far as possible, in the investigation of possible mineral resource sites and agricultural potential.

The activity included a critical analysis of the imagery in the following fields: geology, geomorphology, land use, crop production, range management, soils and soil conservation and hydrology. Work in the last five of the seven fields was hampered by the unusual weather conditions which prevailed at the time when the images were gathered.

The major significant result of the project was the formulation of a working hypothesis which may have application in exploration for diamonds.

In general, the project can be evaluated as a qualified success. The geological part of the project has resulted in the production of a geological map of the country. The agricultural part of the project was hampered by adverse weather conditions, as mentioned above, but sufficient experience of the imagery was gained to be able to state that imagery of this type would be invaluable in the assessment of the agricultural potential of the country.

I INTRODUCTION.

I.1 The Test Site.

The test site for the Lesotho ERTS-1 project was the whole of the Kingdom of Lesotho. Lesotho is a small, independent country completely surrounded by the Republic of South Africa. The area of the country is 30,344 square kilometres and can be divided into two distinct geographical regions. The larger of these two regions, comprising the eastern three quarters of the country, consists of mountain ranges rising to heights of over 3,300 metres. This area is not permanently inhabited, except for herdsmen, and is used mainly for the grazing of livestock. The western quarter of the country consists of lowlands lying at an altitude of 1,500 to 1,900 metres. This area supports about 75% of the total population of just over 1,000,000 and is the main agricultural region. The country depends on agriculture for 75% of its exports. The only known mineral resources are diamonds, which are found in certain mountain areas.

Lesotho is covered by four ERTS images, the areas being roughly defined on Map I. Each of these four image areas contains several distinct geographical features which are easily discernable on the ERTS images. The north-eastern area contains the following features:

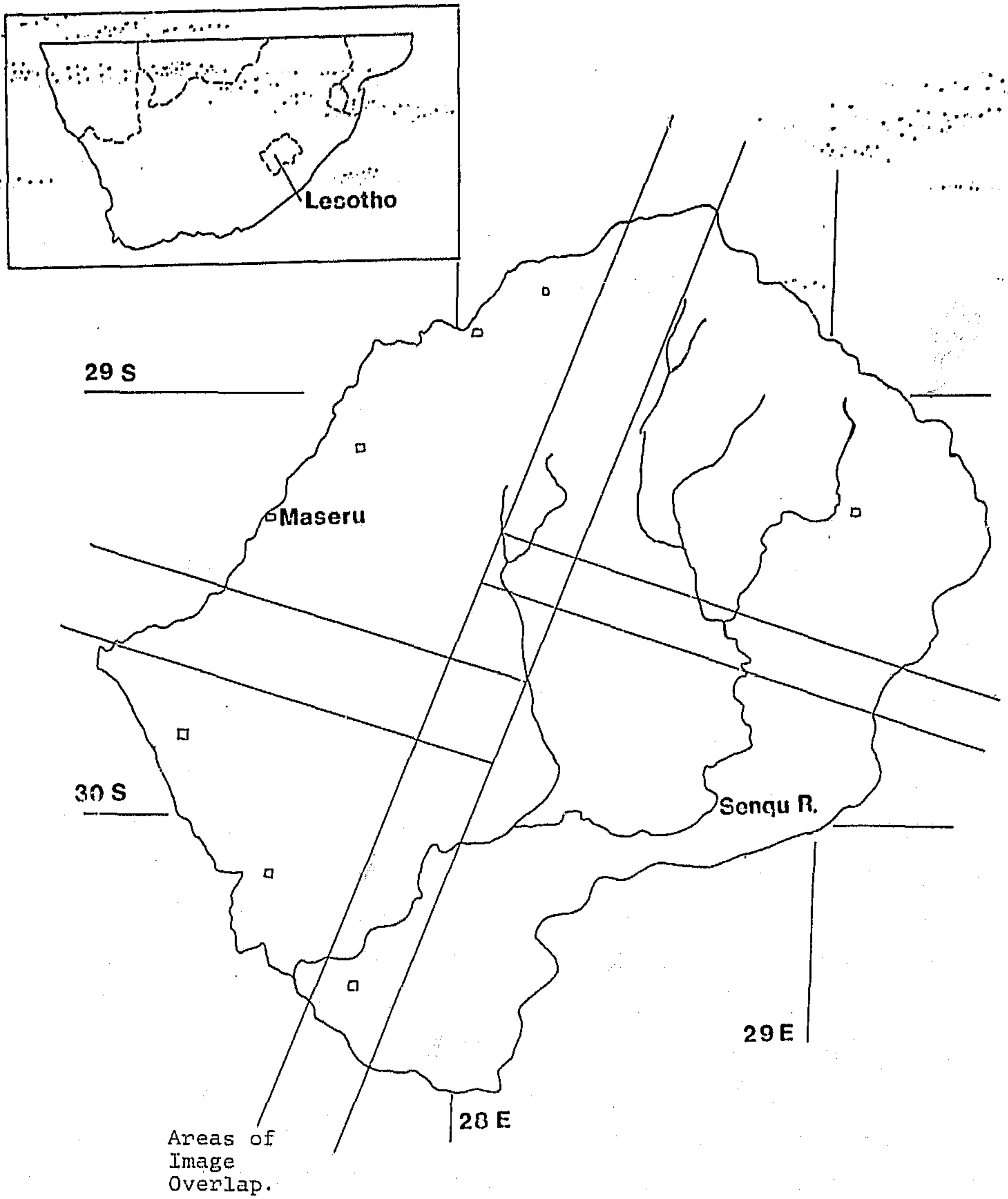
a) The border of the Republic of South Africa and Lesotho north of Butha-Buthe to the source of the Caledon River; the N.E. Drakensberg escarpment; and the S.E. Drakensberg escarpment south to Sani Pass.
b) The entire Malibamats'o catchment area and the entire Mokhotlong basin, with clear definition of the valleys and the mountain ranges.
c) Part of the western escarpment, foothills and lowlands north of Butha-Buthe.

The south-eastern area covers:

a) The border of the Republic of South Africa and Lesotho on the S.E. Drakensberg escarpment from Sani Pass to the southern corner of Lesotho; the S.W. border cutting across the mountains in the Quthing district, but not including the Quthing lowlands.
b) The Senqu River valley from the Qacha's Nek - Mokhotlong border, south to Mphaki, in the Quthing district, and the Senqunyane River valley north of Marakabei, both with associated mountain ranges.

In the north-west, the image covers:

a) The border of the Republic of South Africa and Lesotho on the N.W. of Lesotho, from the source of the Caledon River in the north to the Tsoaing tributary in the south.
b) The strip of lowlands and foothills associated with the N.W. border.
c) The N.W. range of the Maluti Mountains, showing



MAP I Approximate Image Coverage Map For Lesotho.

The areas on the eastern part of the country were scanned on day n, from north to south. Those on the western part on day n+1, again from north to south.

tributaries of the Caledon on the western side, and the upper Malibamats'o River and the sources of the Makhaleng, Senqunyane and Mantsonyane Rivers on the eastern side.

The fourth image area is of the south-western part of Lesotho and covers:

a) The border of the Republic of South Africa and Lesotho on the N.W. of Lesotho, from the Tsoaing tributary to the S.W. corner; and the S.W. border along almost its entire length.
b) The S.W. lowlands and foothills of Mafeteng and Mohale's Hoek districts.
c) The lower portion of the Senqu River Valley in Quthing, with the associated mountain ranges.

The four image areas listed above are in the order in which the images were gathered by ERTS-1.

I.2 The Images Received.

The images received from NASA cover passes of the satellite between 9th September 1972 and April 1973. The images were typically received six to eight weeks after the satellite pass and full coverage of the country was first seen in Lesotho in January 1973. The first colour images were received in April 1973.

Most of the interpretation work was therefore carried out on the black and white images from the four MSS bands. The colour composites (type 'C') from passes of 15th October 1972 (orbit 1165) and 21st November 1972 (orbit 1681) have been used to construct an overall geological map of the country (see chapter on geological activities).

In general, the quality of the images was excellent, with cloud cover over Lesotho ranging from 0% to roughly 50% on the imagery received. The resolution was about 100 metres on the ground, which was sufficient for much of the geologigal and geomorphological work, but which was not good enough for the larger part of the planned agricultural project. A reliable resolution of the order of 30 - 40 metres seems to be required for much of the planned agricultural work.

I.3 Difficulties Encountered.

Several difficulties were encountered during the course of the work with the ERTS-1 images. Some of these were of local origin and would appear to be those common to many developing countries. Others arose through no fault of the local organisation.

One of the major problems, which became apparent fairly early in the course of the project, was the long delay between the gathering of an image by ERTS and the receipt of the processed imagery in Lesotho. As mentioned above, this was typically six to eight weeks. This delay rendered any attempts to use the ERTS data for short term range management decisions virtually useless. The delay in the receipt of colour composites was even worse, being about five to six months for the colour composites which have arrived.

A further problem connected with data receipt has been the non-availability of various images. As indicated earlier, and on Map I, Lesotho was covered by two satellite passes on successive days. Only once during the project did we receive images covering the whole country for one set of satellite passes. This has resulted in considerable difficulties in the interpretation of the data, as, in general, the images for a given part of the country were spaced 36 or more days apart, and the two halves of the country were imaged at different times during the growing period. It was thus virtually impossible to get a picture of the whole country at any given time.

The purely local problems are of two types: finance and personnel. Not counting time spent by the investigators and the capital cost of pre-existing equipment used during the project, the total expenditure has been of the order of R250.00 (US $375.00). This has obviously limited the amount of work which could have been undertaken. Negotiations with USAID for the financing of equipment and supplies unfortunately did not prove successful. A similar result was obtained from negotiations with UNDP for the financing of a full-time post for the interpretation of the Lesotho ERTS imagery.

The personnel problems arose because the majority of the investigators were expatriate staff on limited contracts. When their contracts expired and they left the country, there was, in general, no-one to take over the responsibilities in that particular area of the project. Particularly difficult in this respect was the loss of Dr. I.R. Lane, who originally handled most of the agricultural interpretation, and Dr. P.H. Nixon, the principal investigator.

II. INTERPRETATION TECHNIQUES.

Conventional aerial photographic interpretive techniques were used throughout the project. The images were examined at a scale of 1:1,000,000 and 1:250,000 using a Hilger and Watts light table and a Wild optical pantograph (Plan Variograph).

No advanced interpretive equipment, such as a multispectral viewer, has been available. Recourse has therefore been made to various photographic techniques to aid interpretation. Colour enhancement following density slicing on Agfacontour film has proved useful in differentiating certain soil and vegetation types. Second order slices have also been used to map certain features which have a characteristic spectral signature.

III. GEOLOGY AND GEOMORPHOLOGY.

III.1 Background.

The geology of Lesotho, which lies at the centre of the Karroo basin, is a simple stratification of shales and sandstones, belonging to the Beaufort and Stormberg series, forming the western lowland strip. These are overlain by a thick sequence of basaltic lava, the Drakensberg beds, also of Stormberg age (upper Triassic - lower Jurassic), forming the eastern highlands. The structure is essentially horizontal, although modified by the presence of numerous gentle basins and domes of up to 20 kilometres width and very shallow dip. Dolerite dykes and sills of late Karroo age, in part contemporaneous with the basalts, and kimberlite dykes and pipes of supposed Cretaceous age cut the sediments and lavas.

The only known commercially exploitable mineral resources of the country are diamonds, which, in 1970, made up 11% of export earnings. Exploration for petroleum has just begun. As Lesotho is extremely short of known natural mineral resources, it is of some urgency to identify the areas which are worth intensive ground-based study for the evaluation of potential resources, particularly diamonds.

III.2 The Geological Interpretation of the Imagery.

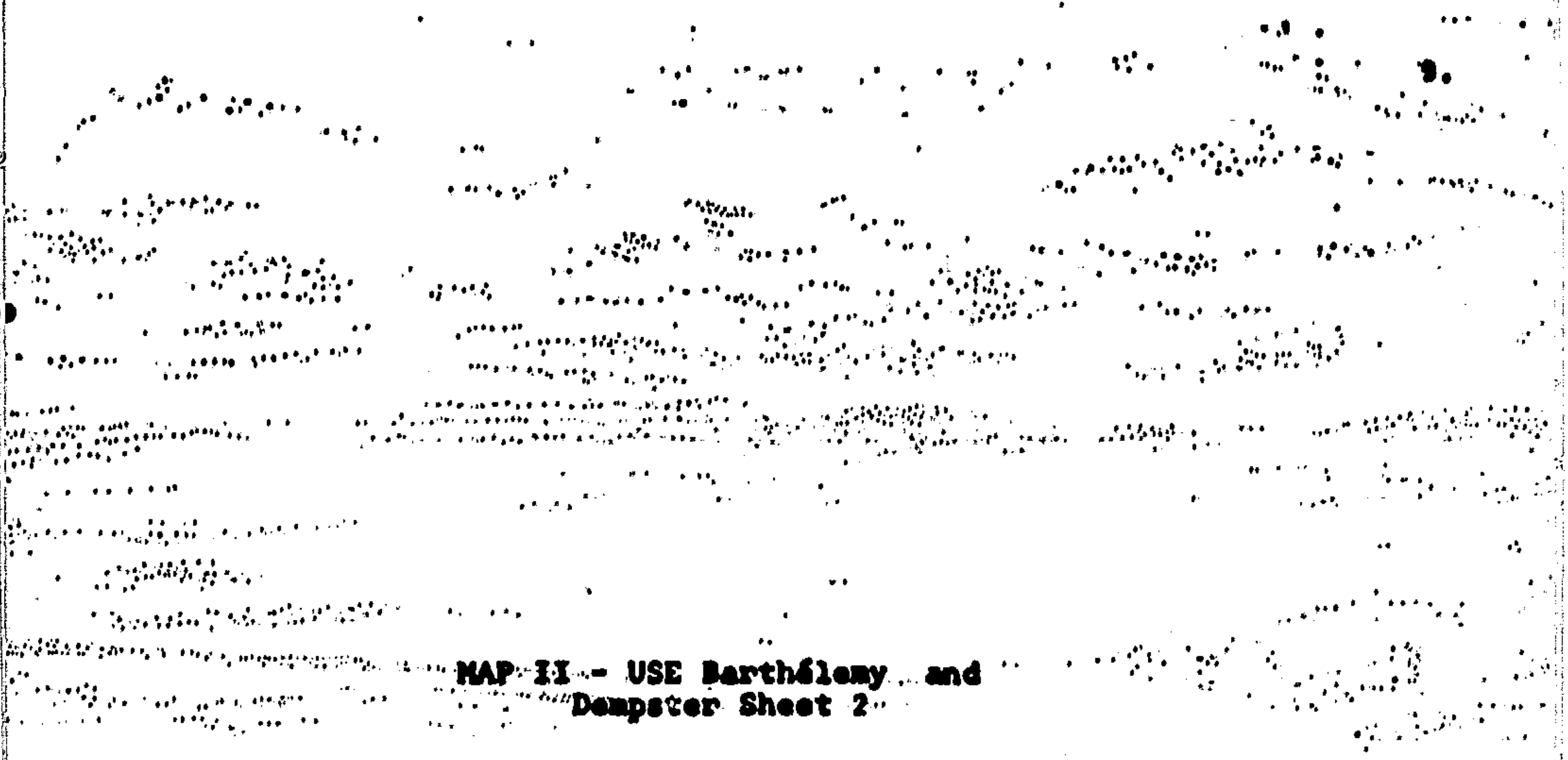
III.2.1 The Images and Interpretation Used.

The interpretation was carried out by R. Barthélemy, who came to Lesotho in August 1973 as photogeologist for the Department of Mines and Geology. He commenced the study of the satellite imagery as apreliminary to the preparation of a photogeological map of Lesotho, using conventional aerial photography. It must be stressed that the annotation and initial interpretation of the Lesotho imagery was thus wholly objective, the interpreter having just arrived in Lesotho and professing no detailed knowledge of the geology of southern Africa. All lineaments, features and colour 'facies' were recorded before geological maps or reprints were consulted. In particular, the locations of known kimberlite pipes were added only after the satellite maps had already been drafted, and structural trends recognised.

Images of the 15th October 1972 (orbit 1165) were used for the eastern portion of the country and those of the 21st November 1972 (orbit 1681) for the west. Positive type 'C' colour transparencies at a scale of 1:1,000,000 were used, attention first being directed at areas of image overlap (roughly 25% of the total area) using a Hilger and Watts mirror stereoscope. The rest of the area was then interpreted non-stereoscopically.

III.2.2 Non-linear Features Seen. (See Map II)

The geographic extension of Lesotho, totally surrounded by the Republic of South Africa, was striking, due to



MAP II - USE Barthélemy and Dempster Sheet 2

differences in land usage on each side of the Caledon River in the west and the clarity of the Drakensberg scarp in the east. The sparseness of the vegetative cover in the lowlands accentuated the light beige colour of the soils on sandstones and shales and made their differentiation from the reddish-brown and greenish-brown basalts of the high plateau to the east much easier. In the north-east and east, the sandstone/basalt contact is often situated within, or at the base of, the cliff. As this contact was not emphasized by over-grazing, it was not so evident at the 1:1,000,000 scale, particularly where obscured by basaltic scree.

A green tint was observed on the less steep slopes of valleys within the basalts, and it is thought that this corresponds to brown coloured herbaceous vegetation, which was dormant at the time when the image was gathered. It is possible, however, that this tint is related to volcanic ashes which are sometimes present at the base of the basalt, but this remains to be confirmed in the field.

A yellowish-brown 'facies' of basalt was found only in the major valleys and could correspond to old alluvial flats on the basalt. In this situation, the differentiation between the lavas and sedimentary beds was not easy.

It was rarely possible to trace the lithological subdivisions in the sedimentary Karroo of the Lowlands. However, the greenish-brown colour of the dolerite intrusions made them easy to distinguish from the sediments, an example being the sills of the extreme western tip of Lesotho, near Wepener.

Many red dots were seen on the images. These correspond to vegetation which remained lush near springs and in marshes and peat bogs. These are known locally as 'sponges', and, in the mountain area are of more than hydrological interest in that some are known to coincide with depressions over kimberlite pipes.

After the map was completed, the exact positions of about 20 known kimberlite pipes in the north and south-west of the country were plotted from 1:40,000 aerial photographs. Only five of these could be picked out on the satellite imagery at a scale of 1:1,000,000; two of them (Mothae and Pipe 224) because they correspond with sponges, and three others (Liqhobong, Letseng and Kao) because they gave rise to a particular bluish colour which is characteristic of freshly dug kimberlite on false-colour infrared photography.

Other blue dots appeared on the satellite imagery. Some of these, which have been checked in the field, correspond to areas of greyish-brown basalt outcrops or denuded ground. In the lowlands, blue-turquoise dots correspond to muddy ponds and greenish-blue dots to dykes or sills of dolerite.

III.2.3 Structure and Lineaments (See Map III)

Structurally, dips are practically invisible at the 1:1,000,000 scale. The morphology seems to indicate a

MAP III - Use Barthélemy and
Dempster sheet 1

NNE-SSW anticlinal trend in the north of Lesotho, near the source of the Caledon River which approaches N-S towards the centre of the country. The detailed structure is more complicated, and small structures in the underlying sandstones generally do not extend into the upper basalts.

There may be a synclinal trend 10 to 20 kilometres east of the anticlinal trend, and a perianticlinal closure may exist another 20 kilometres further east. These trends are the same as possible low zones and high zones based on the study of the altitude of the sedimentary/basalt contact.

Lineaments (joints, often filled with dykes of dolerite, sometimes kimberlite, faults etc.) are clearly visible at a scale of 1:1,000,000 in both the sandstones and the basalts. Five or six principal directions can be distinguished.

The nearly N-S directions are the most represented (5^0-10^0 and especially 160^0-170^0). They are present practically all over Lesotho and surrounding South Africa. Sometimes, for example in the NW of Lesotho, these lineaments have a separation of only two kilometres. These directions, which many secondary streams follow, rarely appear in the form of large continuous lineaments suggesting large faults, but rather in the form of broken but ubiquitous lines, which could reflect pre-existing fracture directions in the basement, for example. Possible wrenching following this N-S direction was occaisionally noted, affecting lineaments of 110^0-130^0 direction. The N-S direction is itself cut once by the 80^0 trend.

In the structural map included in the explanation of the 1:1,000,000 map of South Africa (1970 edition), it can be seen that the 160^0-170^0 direction connects with a fault dated 2400 My, the continuation of which would cut the westernmost part of Lesotho near Wepener. There, lineaments of that strike link two locations of kimberlite pipes in Lesotho - one in the south (Lotoane) and a cluster of three pipes near Kolo, about 40 kilometres north. On or near the same strike is the Mynplaas pipe in South Africa and kimberlite occurences north of Welkom. In the north of the Republic of South Africa, the Kraaipan fold direction (3200-1100 My) shows the same strike near the 25^0 parallel. On the east coast, southwest of Durban, these nearly N-S directions are also fairly well represented.

The 80^0 direction is also well represented, but with lesser density, the distance between trends of this direction being not less than 4 kilometres, and generally greater. Major 80^0 trends traversing Lesotho seem to be at intervals of some tens of kilometres (often 40 km). This direction is thought by some authors to be that of the underlying basement. It is sometimes found near kimberlite pipes. It seems to be dislocated once by the 130^0 direction.

The 35^0-40^0 direction is also fairly well represented all over Lesotho and especially in South Africa east of Lesotho, where it coincides with the general orientation of the Drakensberg escarpment. In the west, it corresponds with the general orientation of the Caledon River near

Maseru and roughly with the escarpment separating lowlands and highlands, where one finds obvious fractures and a possible anticlinal axis in this direction. It seems to dislocate the 80° direction.

The 30° direction coincides in South Africa with the Witwatersrand fold (2400-2000 My and the Wonderkop fault in NE Transvaal. It is also parallel to the magnetic anomalies along the east coast ofshore from Durban (30°) to East London (40°).

The 110°-130° trend is obvious in the north of Lesotho where it is parallel to the escarpment forming the north-eastern border of the country. It is present all over the country and also in South Africa. This direction is known to be taken by almost all of the kimberlite dykes. Dolerites also follow it, but not to such an exclusive extent. In the south of Lesotho, this direction is sometimes associated with south facing scarps, suggesting faults downthrown to the south. At latitude 30° and longitude 28°20' a dolerite dyke having this 130° direction is seen to turn abruptly to follow the 100° direction. A known fault slightly to the south follows this 100° direction. A little further SW, the same direction change is seen in another dyke. This 100° trend is not well represented in Lesotho, and appears less in the north than in the south.

Other directions may be distinguished which are less well represented, for example the 50° trend which, in Lesotho, coincides with the Hellspoort fault. This fault has a downthrow of up to 300 metres and may link two kimberlite pipes - those of Lotoane and Ngopetsoeu. It is found again in the north where it may link two other pipes, Matsoku and Letseng, and also along some major streams.

III.2.4 The Location of Kimberlite Pipes.

Apart from the WNW-ESE direction of the kimberlite dykes, it does not seem at first sight as if the pipes are associated with another constant alignment, although, especially in the south of Lesotho, the 160°-170° direction is often present. In addition, clusters of pipes seem to have a tendency to be found on the flank of the possible syncline recognised in the satellite imagery. In the area covered by structural maps at 1:100,000 scale, 11 of the 15 known pipes occur within synclines, and three more at their edges, only one being situated on an anticline. On occaision, the 50° direction could have significance.

By a process of elimination, it appears that pipes of kimberlite are present only where the crossing of the three lineaments 50°,160°-170° and 100°-130° occurs. On the satellite map it is possible to see that four kimberlite occurences are localised at the four corners of a lozenge of about 50 km on a 50° strike and about 30 km on the 165° direction. Thses are Lotoane and Ngopets'oeu along the Hellspoort fault and northwards the cluster near Kolo and the blow 106/107 which can be linked to the first two by 160°-170° lineaments.

If a skew grid of the above dimensions is constructed, about twenty kimberlite occurences are in or near the crossing of the two directions 50° and 165° whose bisectrice is about 110°. These occurences are in both Lesotho and South Africa (including Kimberly and Premier mines linked by the 50° direction). If the above occurences are not a coincidence, the grid can be used to select the relatively rare sites where it is likely that kimberlite pipes could be found. This would facilitate the search for diamonds in Lesotho.

III.3 The Geomorphological Interpretation of the Imagery.

Preliminary analysis of black and white images at a scale of 1:1,000,000 has indicated that valuable geomorphological information is readily available. The general 'overview' provided by the images is easier to interpret in terms of the major geomorphological units than is aerial photography at a larger scale. The recurrent land form patterns are easily distinguished, as are the relationships between the lowlands, foothills and mountain chains. Similarly, the drainage basins and catchment areas of the various rivers are well defined.

It is possible to delimit, for example, various erosion surfaces, forms of fluvial accumulation such as flood plains and accumulation terraces as well as valleys of different cross-sections and allineation. Land forms resultant from different slope processes are distinguishable such as plateaus, scarps, scree slopes and pediments. Using these data, it is possible to deduce relationships between evolutionary developments and structure, for example, the occurence of dykes and their relationship to the development of drainage patterns.

Some forms of accelerated erosion can be observed on the imagery e.g. gullies and sheetwash surfaces. These are of particular interest to Lesotho which has problems of soil erosion of massive proportions. Work is, as yet, incomplete on the relationship between forms of soil erosion and the various geomorphological units.

IV. AGRICULTURE.

IV.1 Background.

Agriculture is of prime importance in the development of Lesotho. The country can be divided into two major agroecological zones which correspond to the two major geographical divisions of the country. The lowland region contains most of the cultivable land, estimated at 40,483 hectares (1,000,000 acres). The mountain regions are used for communal grazing of cattle, sheep and goats, which are moved seasonally from the lowlands to the mountains in early summer. The higher mountains have an alpine environment which restricts their use to sheep grazing.

The agriculture of Lesotho is greatly hampered by a rainfall pattern which is erratic in terms of both time and space. Similarly, the poor communications due to the mountainous terrain hamper the collection of data relevant to agricultural development. Unfortunately, ERTS-1 gathered images during a period of severe drought. The drought, which was one of the worst for many years, resulted in very little germination of the crops. As a result, the ERTS-1 images were of limited value for agricultural purposes.

The differences in agricultural practices between relatively developed and under-developed countries (Republic of South Africa and Lesotho, respectively) made the political boundaries of the country strikingly evident. In South Africa, the fields are much larger than those in Lesotho, and are more often irrigated. This resulted in the images showing clear areas of growth on the South African side of the border whereas in Lesotho the soil was mainly bare.

The few results which were obtained from the early imagery are summarised in the sections below.

IV.2 Land Use.

The major soil and rock types occuring in the country could easily be distinguished, mainly due to the sparseness of the vegetation cover. As these define the major ecological zones, the data obtained will be of use in future surveys.

Due to the small field size typical of under-developed countries, individual fields are not distinguishable in the imagery. The situation is alleviated somewhat by the practice of planting fields in blocks, each block containing the same crop. At the time when the images were gathered, there had been very little planting or germination of the crops over most of the country. As a result, it was virtually impossible to delineate the cropland areas for the purposes of a land use register. This problem was particularly difficult in the mountain areas whereit was not even possible to identify which valleys had been used for crop production rather than grazing purposes.

IV.3 Crop Production.

As pointed out above, individual fields are not resolvable on the ERTS imagery in Lesotho. When the images were gathered, there had been little planting or germination of the crops. However, in certain regions, blocks of unharvested winter wheat were identifiable, for example in the Roma valley. Similarly, irrigated areas in Butha-Buthe and at T'sakhalo stood out clearly against the general background of little or no plant growth in the lowlands. Unfortunately, no useful images were received after the rains finally began at the beginning of February 1972, so that the identification of the late crop areas was not possible.

IV.4 Range Management.

Definate patterns of image density showed on all of the ERTS bands during the dormant period over the mountain region. These patterns are related to soil type and depth, altitude and rainfall distribution and may highlight areas of different vegetational composition. Images gathered after a fall of rain in the mountain region in early October show a great increase in plant vigour. This response was differential with respect to altitude zones and provided evidence that the effect of length of growing season was easily discernable on the imagery. Areas of grassland where burning off had taken place were easily identifiable, and, in the regions where there was a slight rainfall, the recovery of the vegetational cover could be followed.

The differences in image density correlated well with existing maps of approximate carrying capacity. Growth in and near the sponge areas was especially striking, but, due to the drought in the early summer, the changes in range vegetation were not typical.

IV.5 Soils and Soil Conservation.

Because of the exceptionally dry nature of the season in which the images were gathered, variations in the density of the images in black and white and colour in the composites appear to be largely related to underlying soil and exposed rock colour. An extreme example of the soil differentiation possible was the way in which the dark alluvial soils along the rivers in the lowlands show clearly against the surrounding duplex soils.

Gulley erosion systems were visible radiating out from sandstone slopes into the surrounding duplex soil zones. Sheet erosion was apparent in the mountains, especially in overgrazed areas. As no imagery was available after heavy rainfall, it was not possible to identify areas of mass slippage and which erosion areas were still active.

IV.6 Hydrology.

Although hydrology was not one of the areas picked out in the proposal for ERTS-1, several important hydrological features were apparent in the imagery. As mentioned above, the mountain catchment areas were excellently delineated. Sponges in the mountains and other areas of surface water were revealed, as well as river flow. This could have been of prime importance in relation to rainfall, if the data had been available. In the western catchments, tributaries could be seen flowing from the mountains, but drying up before reaching the Caledon River. This was found to be related, as expected, to the degree of silting up of the particular river and the amount of soil erosion in its upper reaches. It was hoped that this feature of the ERTS imagery would be of use in identifying areas where water would be available for stock during the drought, but the delay between the gathering of the images and the receipt of the data in Lesotho precluded this.

V. PAPERS PRESENTED.

During the course of the project, one paper was presented which was based on the Lesotho ERTS-1 project. This was a report on the then current status of the project by A. A. Jackson and P. H. Nixon, and was presented at the ERTS symposium of the 16th COSPAR meeting in Konstanz.

It is intended that much of the data on the geological interpretation of the imagery set out in Chapter III will be presented in a paper by R. Barthélemy and A. Dempster at a symposium devoted to ERTS-1 results in southern Africa, to be held at Grahamstown, S. Africa, in July 1974.

VI. CONCLUSIONS.

VI.1 General.

The major general conclusion which can be drawn from the LesothoERTS-1 project is that it was a qualified success. Circumstances prevented the attainment of all of the objectives set out in the original proposal, but, much valuable information was gained in all fields. The availability of advanced interpretive equipment would have made the project easier as lesstime would have had to have been spent on tedious manual methods of interpretation. This is particularly important in a situation where the amount of experienced manpower is strictly limited. Delays in the receipt of the data limited its usefulness in certain fields.

The experience with ERTS-1 has indicated that participation in the ERTS-B project could have considerable benefits to Lesotho, particularly in the agricultural field where ERTS-1 was not as successful as might have been the case. This limited success in agriculture was due to the unusual weather conditions which prevailed during the gathering of the images.

VI.2 Geology.

As far as the geological aspects of the project were concerned, the project was a success. The following important conclusions can be drawn from the examination of the imagery:

1) It is possible to trace the lithological boundaries between sedimentary rocks and basaltic rocks, both extrusive and intrusive.

2) It has been possible to localise sponges in the mountain areas, some of which may conceal undiscovered diamond pipes.

3) Among the more important benefits derived from this project has been the localisation of possible main structural axes within the framework of lineaments present. Study of the localisation of known kimberlites on maps derived from the satellite imagery has led to the formulation of a working hypothesis which may have application in exploration for diamonds. (Localisation of individual pipes near the flanks of synclines, and of lines of pipes along the flanks of Precambrian 'lows' of 50^0 and 165^0 trends.)

VI.3 Agriculture.

Due to the unfortunate drought which occured during the period when the images were gathered by ERTS-1, the usefulness of the data was limited. However, the experience with the ERTS-1 data indicates that the objectives which were laid down in the original proposal (and which have been included in the proposal for ERTS-B) are attainable with the imagery. Less delay between image gathering and receipt of data would have made the images extremely useful for directing stock movements to areas where feed and water were available. Higher resolution would have been helpful in certain areas.