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The Geology Of Certain Igneous Intrusive Rocks In The Far East Rand, Transvaal, South Africa

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2015-01-12
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the/
area south of Marievale Mine, where the Main-Bird strata and the dyke have been removed by erosion.

According to Ellis (3), the fracture occupied by the intrusion was solely the result of internal tension due to subterranean subsidence. There are indications however that the course of the dyke was determined to some extent by pre-existing fractures or faults. This is suggested by its frequent changes of direction and also by the fact that the dyke, where it transgresses the Main Reef Leader, frequently dips inwards, towards the downthrown side. A tension fracture due to vertical stresses would have to dip outwards, towards the upthrown side. In the northern part/of the "Old Lady", in Springs and Daggafontein Mines, there is horizontal separation of the reef, on the dyke on the eastern side and overlapping on the western and southern sides. The rocks inside the dome have not only dropped vertically but have moved horizontally in a south-westerly direction, as would be expected if the sunken block were bounded partly by pre-existing fractures dipping in directions between west and south. Fig. 14 illustrates this point.

In Springs Mine, several major faults in the vicinity of the "Old Lady" and the New State Areas Intrusion are roughly parallel to the nearest portions of the "Old Lady" dyke and dip in the same direction as the dyke (Plate III). The inference is that these faults, and others which are now occupied by the dykes, existed before subsidence and intrusion took place, the

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the/
shape of the "Old Lady" being largely determined by these earlier faults.

The New State Areas Intrusion (Plate VI), as seen in the Upper Witwatersrand System, is a small replica of the "Old Lady" with a similar vertical displacement of the strata. The dyke phase nearly always dips south-westwards. There is horizontal separation of the reef on the dyke on the eastern side and a corresponding overlap on the western side. The sill phase occurs immediately below the Bird Amygdaloid. There can be little doubt that this intrusion is part of the "Old Lady" and joins it somewhere in the Lower Witwatersrand System.

(c) The Simple Dykes and Sills

Simple dykes and sills of quartz diabase are very numerous in the Witwatersrand strata and vary in thickness from a few inches to over 100 feet. Some of the narrower intrusions, too decomposed for identification, may be ilmenite diabase, but the majority are believed to be quartz diabase.

The dykes have no particular trend, but their direction of dip is mostly between west and south. They nearly always displace the strata vertically, either as normal or reversed faults, sometimes both in different parts of the same dyke. The three most important linear dykes which intrude the Main Reef Leader, and a thick basin-shaped intrusion of unknown extent in the west of Brakpan Mine, are shown in Plate III.

Sills have been seen in underground workings and in shafts and boreholes at various horizons up to the Elsburg Series.

/ They

series/.
They are not confined to any particular area and are much thinner than the upper sill phase of the "Old Lady". Generally they are completely decomposed.

Two examples are known underground of intersections between narrow decomposed dykes, believed to be quartz diabase, and normal and reversed faults devoid of igneous material. In both cases the dykes are younger than the faults and are not displaced by them. This shows that the strata were fractured and faulted before the quartz diabase dykes and sills were intruded. The dykes follow pre-existing planes of fracture or faulting and in most cases suffered a great deal of shearing through renewed movement on the fractures at a later period.

2. PETROLOGY

Quartz diabase is a tough, pale grey, fine-grained rock with a dull, non-lustrous appearance similar to ilmenite diabase. In thin dykes and sills and near the margins of thicker intrusions it is usually sheared and completely decomposed. When sheared it is difficult to distinguish in hand-specimen from shale.

Occasional specimens from the centres of thick intrusions show an ophitic texture in thin section (fig. 15). The essential minerals are plagioclase felspar (andesine-labradorite) and augite, with accessory iron ores and quartz, sometimes in the form of micropegmatite. The plagioclase is saussuritised and very cloudy; fresh patches are very rare. The augite is

/largely

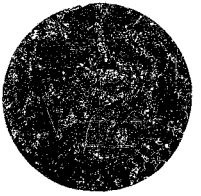


FIG. 15

Quartz Diabase from centre of "Old Lady" Dyke, East Daggafontein Mine. Ordinary light. Magnification X21.
Plagioclase, saussuritised (pale grey laths)
Remnants of long prismatic crystals of Augite, enclosing Plagioclase laths (darker grey, indistinct)
This specimen is unusually coarse and fresh. Ophitic texture is clearly visible.

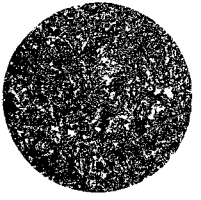


FIG. 16

Quartz Diabase from "Old Lady" Dyke, Daggafontein Mine.

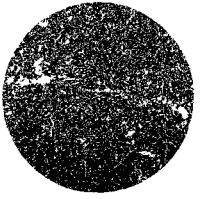


FIG. 17

Quartz Diabase from "Old Lady" Dyke, Springs Mine.

Ordinary light. Magnification X19.
No trace of primary texture.
Uralite (small pale bladed crystals)
Chlorite, Calcite, Leucoxene etc. (grey, indistinct)
Iron Ores (black)
Quartz (clear)
In fig. 17 a veinlet of quartz, epidote and calcite crosses centre of field.

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largely altered to uralit

Typical quartz diabase decomposed than the speci ophitic texture are still remain except possibly qu and occurs in thin bladed the rock a characteristic scope. Iron ores occur occurs in minute clear po Albite is sometimes consp showing characteristic li zoisite, calcite, rutile, present.

Frequently the rock (fig. 17). It consists iron ores, quartz, calcit of a primary texture. M epidote and calcite are f there are occasional reli however the rock is sheal destroyed.

Essential Mine

Plagioclase - phenocr 60% An or compl replace

is/

largely altered to uralite and chlorite.

Typical quartz diabase is finer in grain and much more decomposed than the specimen shown in fig. 15. Relics of ophitic texture are still visible but no primary minerals remain except possibly quartz. (fig. 16). Uralite is abundant and occurs in thin bladed crystals and long fine needles, giving the rock a characteristic "feathery" appearance under the microscope. Iron ores occur in small grains and specks. Quartz occurs in minute clear pools and occasionally as micropegmatite. Albite is sometimes conspicuous as small scattered crystals showing characteristic lamellar twinning. A little epidote, zoisite, calcite, rutile, pyrite and pyrrhotite are occasionally present.

Frequently the rock is in a very advanced state of alteration (fig. 17). It consists of a confused mass of uralite, chlorite, iron ores, quartz, calcite and other minerals, without any trace of a primary texture. Minute veinlets of chlorite, quartz, epidote and calcite are fairly common. Near intrusive contacts there are occasional relics of a porphyritic texture. Generally however the rock is sheared and all its primary features are destroyed.

Essential Minerals

Plagioclase - tabular crystals. Occasional larger phenocrysts. Approximate composition: 40% - 60% An (andesine-labradorite). Saussuritised or completely decomposed. Occasionally replaced by albite.

Augite - anhedral crystals enclosing plagioclase. Finely foliated. Colour: brown. Non-pleochroic. Birefringence about .025. Extinction angle, c-axis:z = about 40°. Variety: diallage. Nearly always altered to uralite and chlorite.

Uralite - secondary. Occasional pseudomorphs after augite. Long bladed crystals. Aggregates of fine needles. Pleochroism weak, x = y = colourless to pale green or yellow, z = green or bluish green. Birefringence .025 to .030. Extinction angle, c-axis:z = 150 - 180. Composition: actinolite. Patchely or completely altered to chlorite.

Accessories

Iron ores - magnetite and ilmenite. Scattered crystals, grains and specks. Leucoxene and occasional sphene after ilmenite.

Quartz - minute clear pools, interstitial micropegmatite, granular aggregates, veinlets. Probably of both primary and secondary origin.

Chlorite - secondary. Replaces augite and uralite. Common in cavities and veinlets. Massive, pale green to colourless, faintly pleochroic. Birefringence very low. Variety: penninite.

Albite - secondary. Small crystals, sometimes with indistinct outlines. Conspicuous lamellar twinning. Occasionally replaces primary plagioclase.

Epidote - secondary. Small scattered grains, aggregates, veinlets. Colourless to pale yellow-green. Occasionally accompanied by zoisite.

Calcite - secondary. Individual rhombs, granular aggregates, veinlets. Common in very altered and sheared rock.

Rutile - minute scattered needles, sometimes in radiating aggregates.

Pyrite, Pyrrhotite - occasional small disseminated crystals and grains.

The rock is an intensely metamorphosed quartz dolerite. Compared with ilmenite diabase, which is in many respects

/similar

respects/
similar, it is generally finer in grain, more uniform in composition and texture, and more altered. Ilmenite, leucoxene, epidote and chlorite are less conspicuous and quartz in the form of micropegmatite is more common.

The intensity of metamorphism is an indication of the great age of the rock, which, since its emplacement, has suffered much deformation and shearing during recurring periods of earth-movement.

Contact metamorphism of shale by quartz diabase intrusions is generally masked by intense shearing at the contact, which has changed both shale and diabase into chloritic schist. At its contacts with quartzite or reef, the diabase only is sheared and the wall-rocks are darkened in colour, due to enrichment in fine chlorite. Near the "Old Lady" dyke the sediments are intruded by numerous quartz-carbonate veins. On the whole the contact metamorphic effects of the quartz diabase intrusions are small and local.

5. AGE

In Marievale Mine the "Old Lady" sill ends abruptly on the unconformity at the base of the Transvaal System (S). It is therefore older than the Transvaal beds. Dykes and sills of quartz diabase intrude strata of the lower Kimberley-Elsburg Series. They are therefore younger than most or all of the Upper Witwatersrand System. Between these limits is the Ventersdorp Period of vulcanicity.

/The

vulcanicity/.

The "Old Lady" was intruded either before or after, but not during, the extrusion of the Ventersdorp lavas, since the magma did not reach the surface (3). The magma solidified near the surface and not at great depth, since the diabase is similar, apart from the absence of amygdales , to the lavas of the Ventersdorp System and the Bird Series. The highest stratigraphic horizon reached by the "Old Lady" is the Kimberley Shale, not far bel.. the pre-Ventersdorp surface, but a considerable depth below the top of the Ventersdorp System. Quartz diabase dykes and sills intrude the lower Elsburg beds but are not known to penetrate the Ventersdorp lavas.

The above evidence points to the quartz diabase intrusions being older than the Ventersdorp lavas, their age being early Ventersdorp or late Witwatersrand.

/IX SUMMARY

IX SUMMARY

Below is a summary of the principal characteristics of the five groups of intrusive rocks described above.

1. THE DOLERITES

Type of Intrusion

Vertical dykes trending NW-SE to E-W.

Sills at or near present surface.

No vertical displacement of strata on dykes.

Petrological Features

Fresh dark holocrystalline rocks.

Texture ophitic to sub-ophitic.

Margins chilled, with porphyritic texture.

Essential minerals: plagioclase (labradorite-bytownite), augite (diopsidic).

Accessories: olivine (conspicuous in sills, rare in dykes), iron ores, biotite, quartz (in dykes, absent in sills).

Alteration

Very little. Plagioclase and augite generally fresh. Olivine serpentinised.

Age

Late Karroo.

2. THE SYENITES

Type of Intrusion

Sills in the Transvaal dolomite.

A few narrow inclined dykes in the Witwatersrand System.

Petrological Features

Holocrystalline rocks, dark or mottled (Green Syenite) and

/pale

and/
pale reddish (Red Syenite).

Texture hypidiomorphic-granular (granitoid).

Margins chilled, porphyritic.

Essential Minerals.

(a) Green Syenite: plagioclase (andesine, largely altered to albite), augite, uralite (after augite).

(b) Red Syenite: albite (90% of rock).

Accessories.

(a) Green Syenite: iron ores, quartz, biotite.

(b) Red Syenite: biotite, quartz (much micropegmatite), iron ores.

Alteration

(a) Green Syenite.

Moderate to intense. Andesine altered to albite, augite to uralite and chlorite. Secondary epidote, quartz and calcite.

(b) Red Syenite.

Moderate. Albite cloudy, biotite chloritised.

Age

Pre-Karroo. Bushveld or post-Waterberg.

3. THE ILMENITE DIABASE

Type of Intrusion

Irregular vertical dykes trending NE-SW.

Some sills and narrow inclined dykes.

Little vertical displacement of strata on dykes.

Petrological Features

Dull grey altered rock, fine to medium grained.

Texture ophitic (relics).

Margins chilled and decomposed, occasionally sheared.

Essential minerals: plagioclase (andesine-labradorite, decomposed), uralite (after augite).

Accessories: ilmenite, quartz?, various secondary minerals.

Alteration

Intense. Plagioclase replaced by chlorite and other minerals. Augite uralitised. Ilmenite leucoxenised. Secondary epidote, quartz, albite, calcite, talc.

Age

Pre-Transvaal, post-Ventersdorp.

4. THE NORITE-GRANOPHYRE

Type of Intrusion

Thick sills of norite overlain by granophyre, in the Kimberley Shale, Bird Quartzite and Jeppestown Series.

Transgressive dyke phase displacing the Main-Bird strata vertically about 300 feet.

A few narrow dykes and sills.

Petrological Features

(a) Norite.

Dull greenish-grey rock, medium to coarse grained.

Texture hypidiomorphic to panidiomorphic.

Margins chilled.

Essential minerals: enstatite and diopside (altered to serpentine and uralite).

Accessories: plagioclase (bytownite-anorthite, decomposed), quartz (little micropegmatite).

(b) Granophyre.

Dull pale grey rock, medium to coarse grained.

Texture granitic.

Contact with shale gradational. Contact with quartzite sharper.

Essential minerals: orthoclase (decomposed), quartz (much micropegmatite), hornblende.

Accessories: ilmenite, chlorite.

Alteration

(a) Norite.

Intense. Pyroxenes altered to serpentine and uralite. Plagioclase decomposed.

(b) Granophyre.

Intense. Orthoclase sericitised, hornblende chloritised, ilmenite leucoxenised. Secondary calcite and occasional epidote.

Age

Late Ventersdorp.

5. THE QUARTZ DIABASE

Type of Intrusion

Thick sills in the Bird Series and Jeppestown Series, with transgressive dyke phase forming a closed ring and displacing the strata vertically about 250 feet (the "Old Lady").

Numerous thinner sills and inclined dykes with no particular trend, displacing the strata vertically.

Petrological Features

Dull grey altered rock, fine grained.

Texture ophitic (occasional relics).

Margins sheared and decomposed.

Essential minerals: plagioclase (andesine-labradorite, decomposed), uralite (after augite).

Accessories: iron ores, quartz (little micropegmatite), various secondary minerals.

Alteration

Extreme. Generally no primary texture. Plagioclase decomposed and seldom recognisable. ~~At~~ Augite uralitised. Secondary chlorite, quartz, epidote, zoisite, albite, calcite, leucoxene, rutile.

Age

Early Ventersdorp or Late Witwatersrand.

/X. ACKNOWLEDGEMENTS

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My thanks are due to Dr.J.A.Bancroft, Consulting Geologist, Anglo-American Corporation of South Africa Ltd., for permission to write this thesis.

I am indebted to other members, past and present, of the staff of the Anglo-American Geological Laboratory, Springs, for most of the underground geological mapping on which this work is based, and for the preparation of most of the thin sections I examined.

I thank Dr.B.B.Brock, Assistant Consulting Geologist, for his interest and criticisms, Mr.H.C.M.Whiteside and Mr.P.M. Strydom for many helpful suggestions in the course of the work, and Mr.C.S.Beugger for advice in drawing the plans and sections.

Springs, Transvaal.
30th November 1949.

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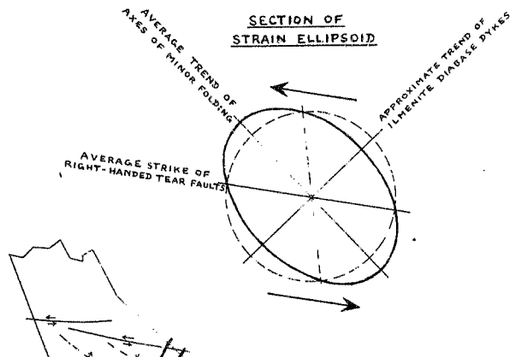
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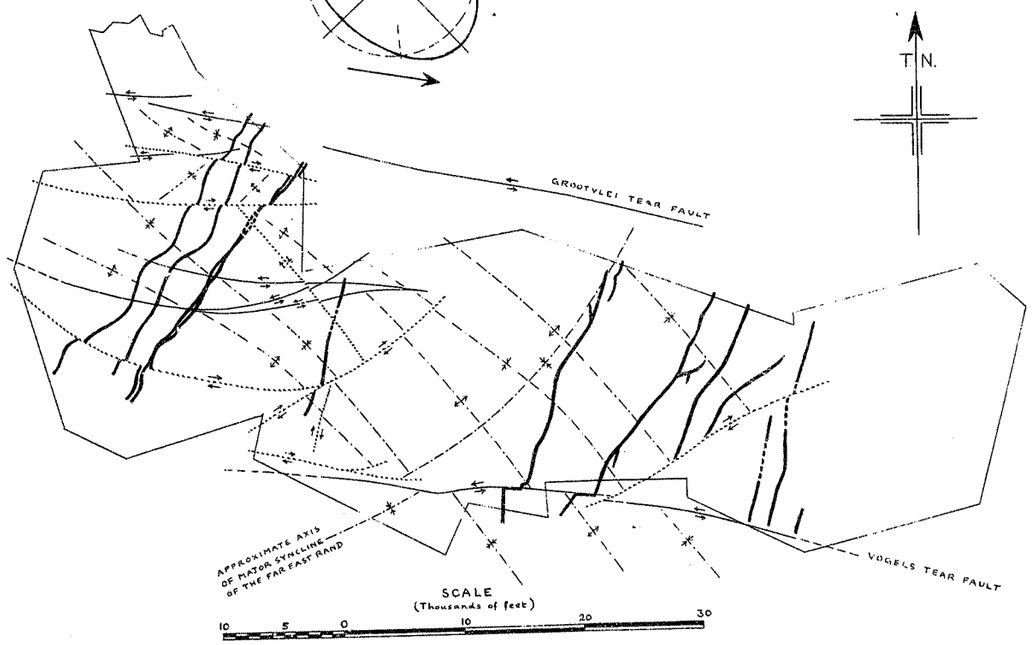
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PLATE VIII

POSSIBLE STRAIN RELATIONSHIP BETWEEN THE ILMENITE DIABASE DYKES AND OTHER STRUCTURES

SCALE 1:100,000





REFERENCE

AXES OF FOLDING IN THE MAIN REEF LEADER

Synclinal — Anticlinal

TEAR FAULTS

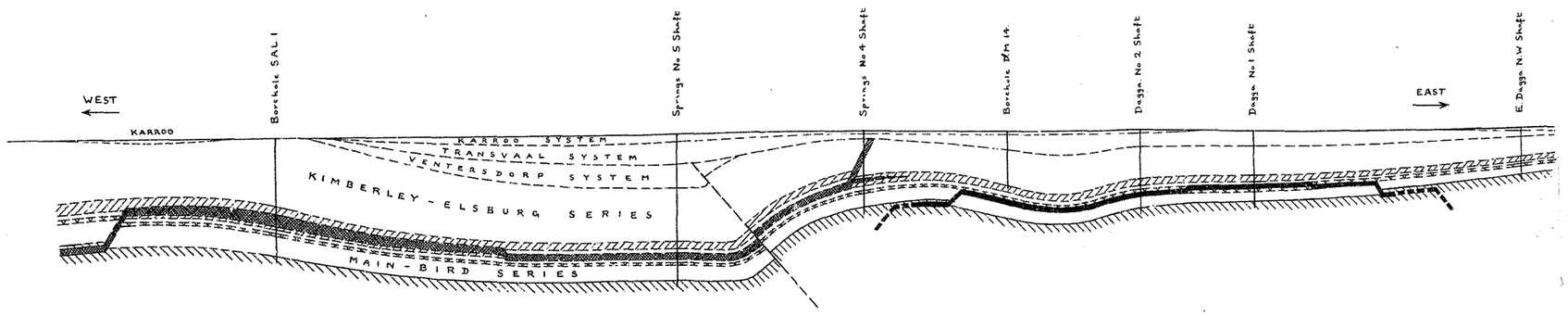
Right-handed — Left-handed

ILMENITE DIABASE DYKES

PLATE VII

SECTION OF NORITE-GRANOPHYRE AND "OLD LADY" INTRUSIONS

SCALE 1 : 50,000



SCALE
(Thousands of feet)

10 5 0 10 20

REFERENCE

WITWATERSRAND SYSTEM

- Kimberley Shale
- Bird Amygdaloid
- Jeppestown Series

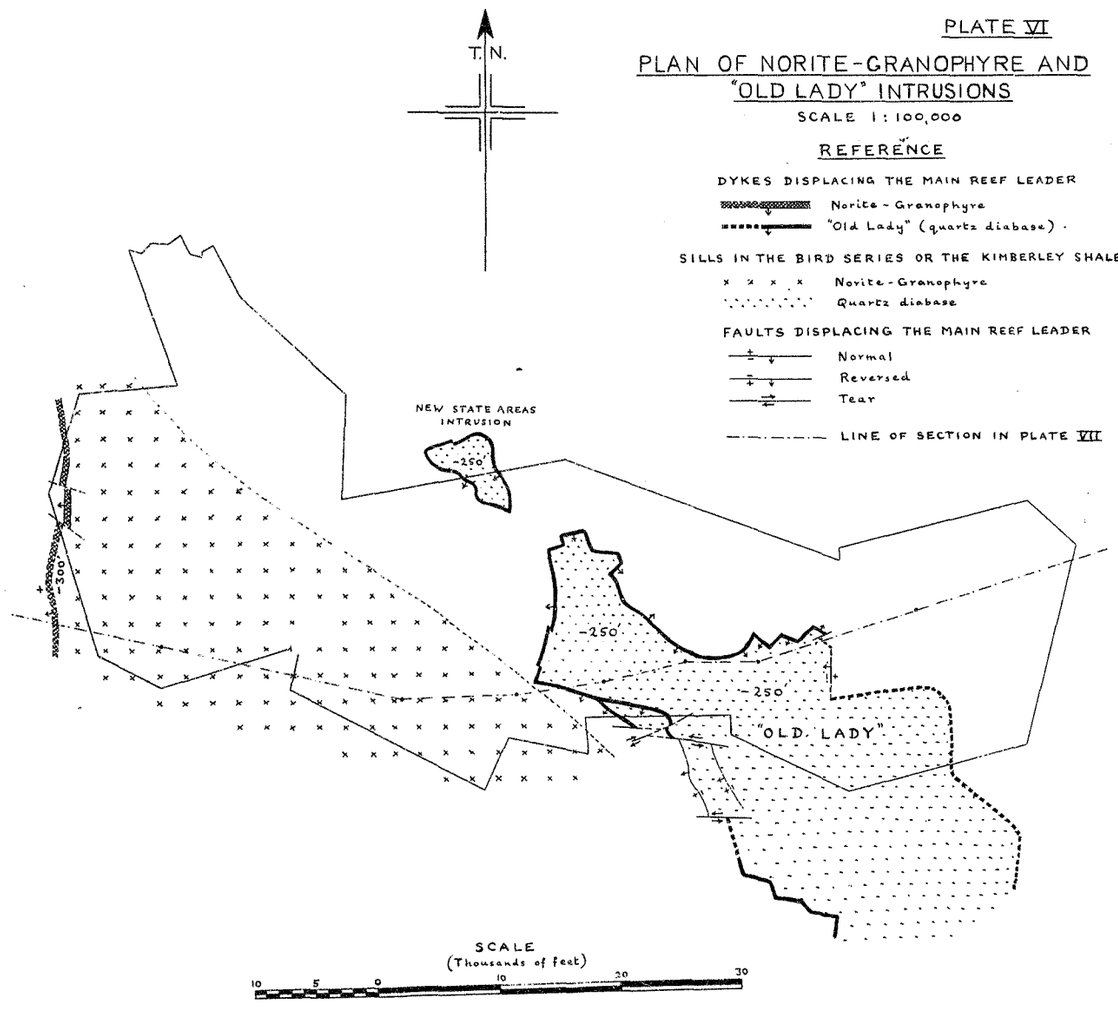
INTRUSIVES

- Norite-Granophyre
- Quartz Diabase

PLATE VI

PLAN OF NORITE-GRANOPHYRE AND "OLD LADY" INTRUSIONS

SCALE 1:100,000



REFERENCE

DYKES DISPLACING THE MAIN REEF LEADER

- Norite - Granophyre
- "Old Lady" (quartz diabase).

SILLS IN THE BIRD SERIES OR THE KIMBERLEY SHALE

- Norite - Granophyre
- Quartz diabase

FAULTS DISPLACING THE MAIN REEF LEADER

- Normal
- Reversed
- Tear

LINE OF SECTION IN PLATE VII

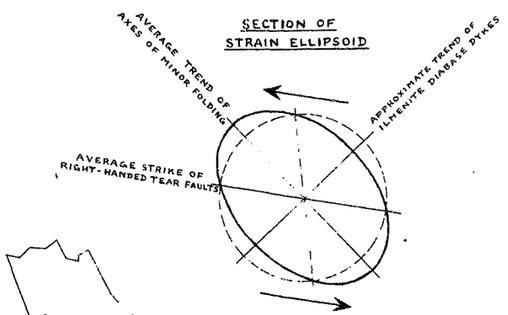
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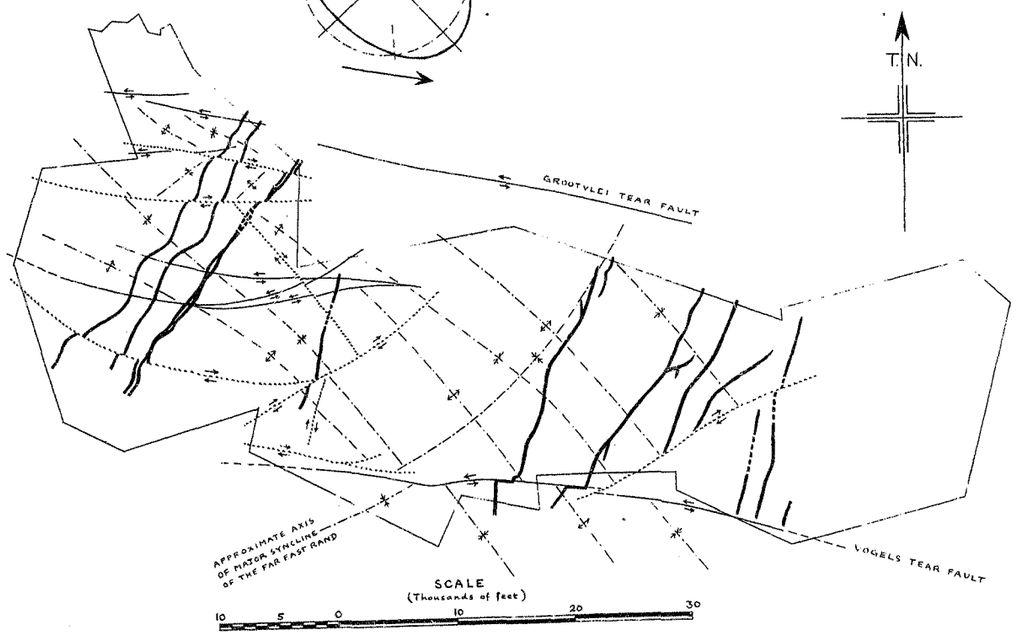
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PLATE VIII

POSSIBLE STRAIN RELATIONSHIP BETWEEN THE ILMENITE DIAPASE DYKES AND OTHER STRUCTURES

SCALE 1:100,000





REFERENCE

AXES OF FOLDING IN THE MAIN REEF LEADER

Synclinal — Anticlinal

TEAR FAULTS

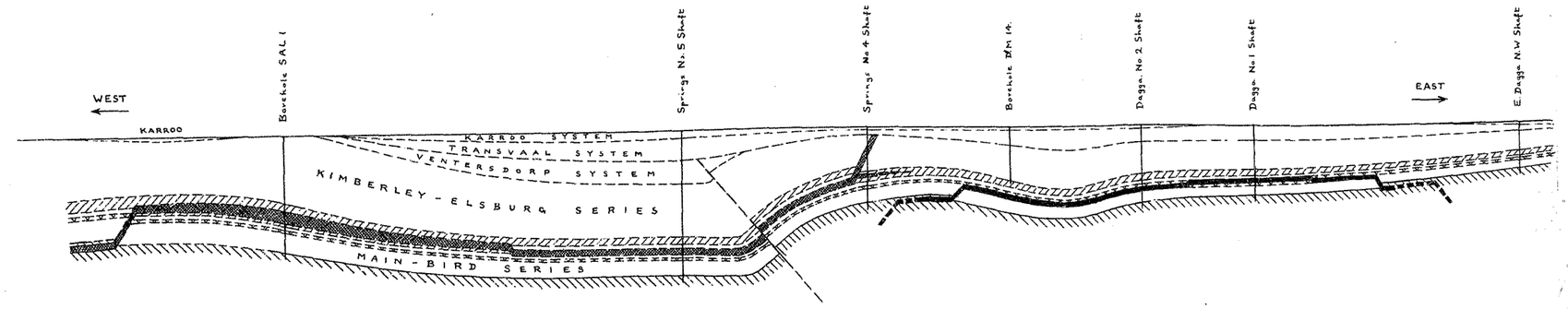
Right-handed — Left-handed

ILMENITE DIABASE DYKES

PLATE VII

SECTION OF NORITE-GRANOPHYRE AND "OLD LADY" INTRUSIONS

SCALE 1 : 50,000



SCALE
(Thousands of feet)

10 5 0 10 20

REFERENCE

WITWATERSRAND SYSTEM

- Kimberley Shale
- Bird Amygdaloid
- Jeppestown Serie

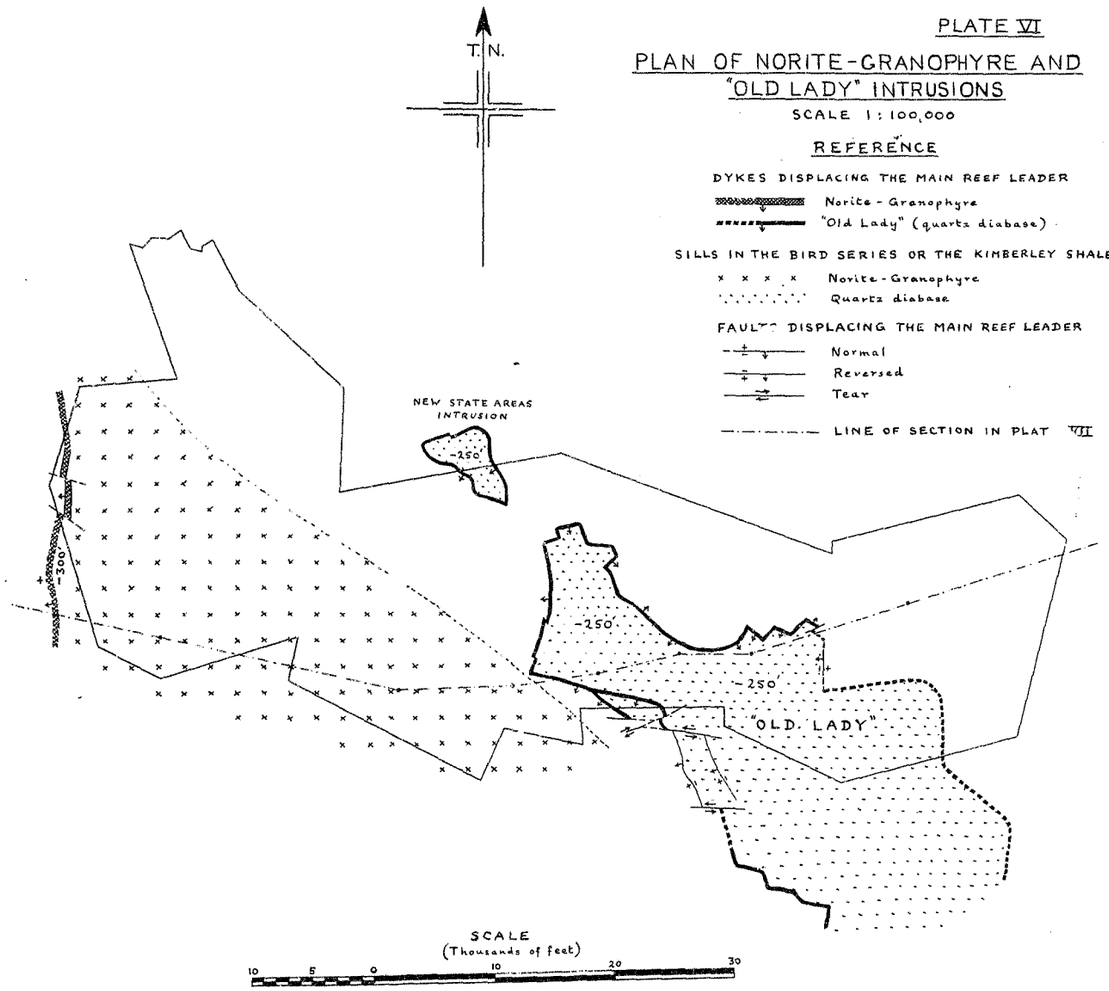
INTRUSIVES

- Norite-Granophyre
- Quartz Diabase

PLATE VI

PLAN OF NORITE-GRANOPHYRE AND "OLD LADY" INTRUSIONS

SCALE 1: 100,000



REFERENCE

DYKES DISPLACING THE MAIN REEF LEADER

- Norite - Granophyre
- "Old Lady" (quartz diabase)

SILLS IN THE BIRD SERIES OR THE KIMBERLEY SHALE

- Norite - Granophyre
- Quartz diabase

FAULTS DISPLACING THE MAIN REEF LEADER

- Normal
- Reversed
- Tear

LINE OF SECTION IN PLAT VII

Author Brandt R T
Name of thesis The Geology Of Certain Igneous Intrusive Rocks In The Far East Rand, Transvaal, South Africa.

PUBLISHER:
University of the Witwatersrand, Johannesburg
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