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SOUTHERN RHODESIA GEOLOGICAL SURVEY

SHORT REPORT No. 36

Explanation of the Geological Map of the Country Around Salisbury

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INTRODUCTION

The map covers an area of approximately 477 square miles, extending westwards to include Lake McIlwaine and eastwards as far as the Sternblick Lime Works. The northern boundary corresponds in part to the southern margin of the map made by T. H. Wilson and published in Bulletin No. 33 (1937).

On account of the flatness of much of the ground natural exposures are not plentiful, but in recent years artificial exposures, mainly in brickfields and excavations for new buildings and sewage pipe lines, have supplied much information on the geology that could not otherwise have been obtained. Even so, it is likely that more artificial exposures will in the future reveal inaccuracies in the boundaries between the formations. However. it is felt that the time is overdue for the production of a map of the country around the capital city of the Federation.

PHYSICAL FEATURES

The country around Salisbury is gently undulating and lies at altitudes near 5,000 feet above sea level. To the west this subdued topography is broken by many steep-sided ridges, notably the Hunyani Poort range. These ridges, which include also the Warren Hills, Salisbury Kopje, the low Avondale ridge and

Emerald Hill, owe their existence to a formation that is relatively resistant to weathering and known as the Banded Ironstone. The highest ground is in the vicinity of Pomona and Borrowdale Estate and from here the land falls away rapidly eastwards as compared with the westward slope. This results in the development of more hilly country to the east, comprising the scenically attractive areas of Borrowdale Estate, Greystone Park, Helensvale and Umwindsidale.

The principal rivers draining the area are the Gwebi, Marimba and Makabusi flowing westward into the Hunyani River and the Umwindsi flowing eastward. The watershed between the Gwebi and Umwindsi valleys is in the neighbourhood of the Borrowdale Stores. The gradient of the Umwindsi River is much steeper that that of the westward-flowing streams, illustrated by the fact that the Gwebi River falls 400 feet in 23 miles whereas the Umwindsi does the same in 3 miles.

GEOLOGY

There is a variety of rock formations in and around Salisbury and the geological structure is complex. This is probably due to the fact that the city is situated near a wide V-bend in the strike of the formations, which here changes from N.-by-W. on the west side to NE. on the east side. There has consequently been much folding and compression of the rocks, accompanied by igneous intrusion. The stratification is everywhere steeply dipping.

The rocks are, for the most part, very ancient metamorphic types of Pre-Cambrian age, such as compose the gold belts of the territory. Gold has, in fact, been mined in the past close to the city on the west side, at the Golden Quarry and Lone Tree mines, and at the Xmas Gift mine in Avondale West. The three mines between them have produced about 10,000 ounces of gold.

In the western part of the area a small portion of the *Norton gold belt* is included, bounded on its east side by the prominent range of banded ironstone that has been cut through by the Hunyani River, thus providing the site of the Hunyani Poort dam. The rocks of this gold belt were almost certainly continuous with the Salisbury formations in the distant past.

These ancient rocks, which are sometimes known as the *Basement Schists*, are believed to owe their metamorphic condition to invasion in the depths by large volumes of molten magma which solidified to form what are now seen as the wide expanses of *granite* separating the gold belts. These have been exposed at the surface as a result of erosion operating for many hundreds of millions of years, during which period several thousands of feet of rock have been removed.

The following is a table of the geological formations represented, with symbols as shown on the map, in order of increasing age so far as known:—

	Symbol
Superficial deposits: soils, subsoils, ferricrete, alluvium	
Dolerite: dykes and sheets	D
Quartz: buck reefs and veins	Q
Porphyry	P
Granite, porphyritic granite	G, GP
Salisbury gabbro and allied rocks	H
Diorite	M
Greenstone Series: epidiorite, amphibolite	*E, B*
Banded ironstone	*i*
Crystalline limestone	*l*
Iron Mash Series	
Siliceous and felspathic schist, granulite and leptite	*g*
Metamorphosed felspathic grit	*a*
Felsite (volcanic lava)	*r*
Metagreywacke	*w*
Porphyroid	*P*
Conglomerate	*c*
Phyllite	*p*
Mica schist (biotite or muscovite)	*m*

A short description of these formations follows, starting with the oldest.

THE IRON MASK SERIES

This formation takes its name from the Iron Mask Range in the Mazoe District, the high ridge through which the Mazoe River has cut a deep poort about 20 miles north of Salisbury, where the Mazoe Dam was built by the B.S.A. Company. From this range the formation outcrops southwards without a break to Salisbury, whence it strikes away eastwards through the Enterprise district.

The most characteristic rocks are pale grey, very fine-grained granulitic and sugary textured types composed mainly of quartz and felspar with varying quantities of such dark minerals as hornblende, biotite, diopside and epidote. Many of them have a crude banding which often suggests the flow banding of a lava. This is well seen, for instance, at Monavale Township, Colne Valley, and occasionally on Helensvale Estate. It is likely that both sedimentary and volcanic rocks are represented, the former being predominant. To the latter the term *felsite* is usually applicable. Where a sedimentary origin is fairly definite the rock may be called *granulite*, but in many cases the name *leptite* is a convenient one. This refers to a siliceous and felspathic fine-grained rock of doubtful origin.

Rocks of these types may be seen outcropping as large boulders in Newlands, Highlands, Colne Valley, Greystone Park and Helensvale townships. In the eastern part of Mabelreign Township there is a coarse-grained variety that at a first glance could be taken for a granite. However, the microscope reveals a clearly detrital structure and the rock is a *metamorphosed felspathic grit*, occasionally verging towards *conglomerate*. A good example of a conglomerate is exposed on the north side of Sherwood Drive, near the Ellis Robins School.

Quartzite is rare, but a massive, slightly micaceous quartzite was recently exposed in sewage trenches in Harari Township. This is so pure that in the powdered form it would probably make a good scouring powder or glass sand. Some of it could be described as a ganister.

On the main road to Gatooma, on Fontainbleau farm, a curious mottled rock is exposed as big boulders. This is essentially a quartzite but it has been veined and impregnated by epidote, a lime-bearing silicate. This mineral also partly replaces many of the granulites and felsites, e.g. in Rolf Valley Township, where the paler parts of the rock are due to it.

In certain places, especially near granite contacts, the metamorphism attains very high grades in these siliceous rocks, with development of the aluminium silicates sillimanite and andalusite, e.g. on Gleneagles and Chikurubi Estates and several localities in the Enterprise district. On Crowborough farm garnets can be seen in an exposure at a stream on the old Gatooma road, and a striking garnetiferous rock with cordierite is seen at a drift on the road to the Windsor mine, on Kintyre farm, about 2¼ miles N.-by-E. of the Hunyani Poort dam.

Besides these pale siliceous and felspathic rocks there is a wide expanse of dark metamorphosed sediments to which the name *metagreywacke* (shortened form of metamorphosed greywacke) is applied. These are well exposed on Greencroft Estate, Mabelreign Township and on the high ground on the north side of Haig Park Township. Westwards they extend as far as Mount Hampden Junction. They commonly form massive outcrops and small "dwalas" and are usually composed of varying proportions of hornblende, biotite and felspar, often with calcite, quartz, epidote or actinolite. In many places the felspar has grown into relatively large crystals (metacrysts) which appear as conspicuous white spots in the dark rock. Such rocks are called *porphyroids*, to distinguish them from igneous porphyries and can be seen on the sides of the Lomagundi Road in the northwest corner of Avondale West Township, near the Mazoe (Mt. Hampden) Road in the western part of Marlborough Township, and elsewhere. When decomposed the metagreywackes afford very fair brick clays, e.g. at the Empire Brickworks.

The best brick clays, however, are supplied by the *phyllites* and *pelitic schists* which form a major proportion of the Iron

Mask Series in this area. These are metamorphosed mudstones and, on account of their softness, scarcely ever exposed except in stream beds. They underlie wide areas near Mount Hampden Junction where many brickfields are in active operation, and much of the lower ground around and within Salisbury, and vary a good deal in character, some being fine-grained biotite schists, some ferruginous, some graphitic. They also include some silvery white mica schists, e.g. on the Ardbennie Road, in Harari Township. Thin beds of quartzite are occasionally interbedded with the ferruginous types. Phyllites also form much of the flatter ground between Lake McIlwaine and the Muzururu River.

The graphitic phyllites are sometimes full of little white needles of chiastolite (aluminium silicate), such as can be seen near the Causeway Post Office. They are often associated with banded ironstone quartzite, so much so that Mr. H. B. Maufe, the first Director of the Geological Survey, found it difficult to separate them and showed them in one colour on his map of the Enterprise schist belt. It now seems more convenient to show all phyllites and pelitic schists in one colour regardless of their association or otherwise with banded ironstone. Rather characteristic, too, are certain "knotted" schists, well exposed in brickfields along the Makabusi River south of the city, which are due to the formation of metacrysts of andalusite during metamorphism. These may be seen also in the Chiripagura stream, north of the Henry Chapman Golf Course, and to the east of Nazareth House, on both sides of the Enterprise road.

Much of the very large area underlain by these phyllites was formerly thought to be composed of volcanic greenstones and it is only the numerous brickfields opened up and boreholes sunk that have revealed the true state of affairs. Furthermore, the fact that the granulites and leptites tend to form conspicuous outcrops has caused an exaggerated idea of their extent. As the map and cross section show, they form a quite subordinate proportion of the formation as compared with the phyllites.

Banded ironstone is in many places interbedded with the phyllites and can be seen in quarries and excavations, notably in the cutting for the road through Salisbury Kopje. The rock is essentially a banded quartzite, the banding being due to layers alternately richer and poorer in iron oxide. The layers are often intensely contorted and the rock passes laterally into graphitic slate or phyllite. No true slates are known in the area, the nearest approach being on the ridge on the west side of Sherwood Drive, south of Meyrick Park Township, where large quantities of material have been removed for road construction and other purposes. On account of the way it breaks readily into flat slabs the banded ironstone is much used for building rough walls in gardens or as crazy paving stones.

As was mentioned in the section on Physical Features, banded ironstone forms the cores of the conspicuous hill ranges to the

west of Salisbury and some of them are very persistent on the strike. Where rivers cut through them there is likely to be a suitable dam site, and both the Hunyani Poort Dam and the Mazoe Dam have been built on this formation.

The banded ironstones are not confined to the Iron Mask series, but occur also in the Greenstone Series and other formations in all the gold belts of Southern Rhodesia.

This last remark applies also to the *Crystalline Limestone* which, however, is quite rare in comparison with the Banded Ironstone. In the area of the map this formation occurs near the eastern margin and the rock has been quarried at intervals for many years at the Sternblick Lime Works. An extensive drilling campaign during the past few years has proved the existence in this vicinity of a tonnage large enough to warrant the erection of a cement works near the Arcturus road. Furthermore, this drilling has revealed large bodies of crystalline limestone of which there is no indication at the surface, suggesting that many such bodies may well exist in other parts of the territory, awaiting discovery.

The only other known occurrence in the Salisbury area is a body that was struck in a well in the northern part of Greendale Township, about 800 yards NW. of the Greendale trigonometrical station. Here again there is no sign of the rock on the surface. It appears to be just about on the same stratigraphic horizon as the Sternblick limestone. No limestone has yet been discovered in the Norton gold belt.

THE GREENSTONE SERIES

This series is so named because the chief constituent mineral of the fresh rocks is either hornblende or chlorite, both being green minerals, but in ordinary outcrops the rocks mostly appear black, and on a fresh fracture dark blue, and they give rise by decomposition to deep red clay soils. The finer-grained members fall mainly under the name of *epidiorite,* which is derived by metamorphism from basaltic lava. The series is essentially of volcanic origin, having originated as widespread lava flows. But it also includes medium- to coarse-grained rocks that probably represent intrusive bodies of basic magma. These are named *amphibolites* and *doleritic greenstone* or *meta-dolerite* according to the proportion of felspar and to texture.

This formation, in many degrees of coarseness, is well exposed on Rhodesville and Greendale Townships, but also underlies wide areas north and north-east of Salisbury, e.g. on Pomona Estate. Typical basaltic epidiorites, sometimes showing pillow structure, occur here, and in many places both here and at Rhodesville a pale green veining by epidote is rather characteristic.

Massive, coarse-grained amphibolite is seen near the Government Forest Nursery at Highlands, on the new Enterprise road 6½ miles from the city centre, in north Greendale and in Mandara Township. The shapes of these supposed intrusive bodies appear to be irregular and do not suggest parallel-sided sheets or dykes.

SALISBURY GABBRO AND ALLIED ROCKS

This body of rather coarse, basic rock forms a mass measuring about 6½ miles long by a mile and a half wide, elongated SW.-NE. and underlying the north-western half of Salisbury city. It weathers into large boulders which can be seen in abundance, e.g. at the Botanical Gardens on Hartmann Hill and in Alexandra Park Township, and also in Belvedere Township. Its shape in depth is quite unknown, but since it has been encountered in a borehole at Aspindale Park, a couple of miles to the south-west of its south-western end as shown on the map (which is only an assumed position on account of absence of exposures), it perhaps has the form of an elongated stock or lopolith, widening downwards, as is shown on the cross section.

Its composition is variable and, particularly in northern Belvedere and western Milton Park, the rock is far from homogeneous. Essentially it is an augite-plagioclase rock, but the augite is frequently replaced by hornblende and uralite. Hypersthene is common in places and occasionally replaces augite to an extent that warrants the name *norite* for the rock. This has been noted, for instance, near the Isolation Hospital in Prince's Road. In other parts olivine appears, e.g. near Government House and in south Belvedere, and the rock becomes an olivine gabbro.

When the sewerage trenches were being dug for Belvedere and Milton Park Townships a remarkable variety of rocks was exposed. Near Lawrie Road in Milton Park peculiar ultrabasic types occur, and in north Belvedere the rock is much contaminated by xenoliths (foreign inclusions), comprising amongst other types fragments of white leptite such as forms the greater part of Monavale hill to the north. It is also penetrated by white veins composed of albite and epidote. The included fragments are in places so numerous as to produce what might be called an intrusion breccia or *agmatite*. Similar xenoliths occur near Milton Avenue on its east side.

The presence of the white veins, as well as the widespread amphibolization, suggests that the gabbro is older than the granite, not younger as was at one time supposed.

In a few places, e.g. near St. George's School and on the Belvedere landing ground, the felspar becomes abnormally abundant at the expense of pyroxene and the rock approaches the composition of an *anorthosite*.

In spite of careful scrutiny of many specimens and outcrops of the gabbro no sign of mineralization has yet been observed in it.

A large mass of similar rock is exposed on the new township of Eland Park, which adjoins Helensvale on the north-west. Immediately to the south, on Quinnington and Greystone Park, is a wide expanse of dolerite and the contact between the two is difficult to determine with precision. It is presumed that the dolerite forms a flat sheet overlying the gabbro. The latter becomes distinctly paler and more felspathic when traced north-eastward, i.e. down the valley, and grades into a *diorite*. In places, as in north Belvedere and elsewhere, it is full of fine-grained xenoliths.

GRANITE

Granite country extends far and wide to the south and south-east of Salisbury. It is a massive, coarse-grained rock composed essentially of quartz, felspar (both potash and soda-lime varieties) and biotite (brown mica). It is normally crossed by both vertical and horizontal joints and it is these joints that are responsible for the great boulders, often of bizarre shapes, that are scattered over the countryside, sometimes piled on top of one another. Rain water penetrates down and along the joints causing decomposition and wearing away of the rocks and consequent rounding of the enclosed granite.

Many quarries have been opened up in the granite for the production of crushed stone of various grades, french drain blocks, etc. In places the rock is cut by dykes of *pegmatite*, and in the quarries of Graniteside, immediately south of the city, these have been found to contain crystals of beryl. The pegmatite here is a very coarse quartz-felspar rock.

Around the headwaters of the Gwebi River the Pomona stone quarries have exposed a *porphyritic granite*, with felspar phenocrysts three to four inches long. This granite mass is roughly oval in shape and measures about $2\frac{1}{2}$ by $1\frac{1}{2}$ miles, penetrating epidiorite. It is presumably an offshoot or "cupola" rising from the main mass of granite that is believed to underlie the whole area in depth. Another, much smaller, "cupola" occurs on Homefield farm.

PORPHYRY

The term porphyry implies a rock with porphyritic texture, i.e. relatively large crystals (phenocrysts) of a particular mineral, or more than one, embedded in a fine-grained groundmass. Where white phenocrysts lie in a dark groundmass there is often a resemblance to the markings of a guinea-fowl, so that many people refer to such rocks as "guinea-fowl rock" or "guinea-fowl porphyry".

On Mount Pleasant and Avondale Townships there occur three small masses of rock of granitic aspect penetrating older formations. The largest of these is that on which the University College stands, at Mount Pleasant. It weathers into large boulders and is characterized by little black patches composed mainly of hornblende, scattered sparsely and indiscriminately through the rock. These are assumed to be basic segregations, such as commonly occur in granitic rocks. It differs from a normal granite in that it has a distinct porphyritic texture, phenocrysts of white felspar (oligoclase) up to about 3.5 mm. long being embedded in a fine-grained quartz-microcline groundmass. Hornblende is also an important constituent, in spongy crystals up to about 0.8 mm. long. There are no quartz phenocrysts; all the quartz is in the groundmass and forms not more than perhaps 15 per cent of the rock. Strictly speaking, then, the rock should be called a *granodiorite-porphyry*.

Another occurrence is a lenticular mass in the eastern part of Avondale, elongated SW.-NE. Here the porphyritic texture is not so evident in a hand specimen and there is a distinct foliation. The third occurrence is just south of the Lomagundi Road and east of West Road, Avondale, but little is known of this, due to lack of exposures.

Further west along the Lomagundi Road, near the boundary between Avondale West and Greencroft Estate, there are abundant outcrops of "guinea-fowl" rock which at a casual glance is indistinguishable from the University College rock. However, close examination with lens and microscope reveals important differences and these, together with the field relationships, render it likely that the rock is a felspathized metagreywacke, i.e. porphyroid, and not an intrusive porphyry.

Six miles west of Salisbury, on Tynwald farm, there is another large mass of "guinea-fowl" porphyry which has been quarried for some years. This resembles the rock at the University College, but the felspar phenocrysts are mostly larger and there is a somewhat higher content of hornblende. The most suitable name in this case is *quartz diorite-porphyry*. It makes good concrete aggregate and road metal.

As in the case of the Salisbury gabbro, there is no evidence of the attitude of the margins of this mass, and the outward dips shown on the cross section are purely hypothetical.

QUARTZ

Under this heading fall what are known as "buck-reefs" of white quartz which usually fill large fractures in the earth's crust. Only one has been noted near Salisbury and that occurs in the township of Hillside, where a low ridge trending N.-S. stands between the railway line and the Makabusi River and is com-

posed mainly of quartz. There is a broad zone of fracturing here, for the granite in the river bed shows a series of parallel quartz-filled fissures for some distance east of the main buck-reef.

The zone continues south of the river into Hatfield Township. On the western edge of Queensdale Township a large quarry has been excavated on the east side of the quartz. This quarry exposes phyllite, which seems to form a long lenticular mass that probably controlled the development of the fracturing. A second lenticular mass of phyllite occurs further south again, just west of Hatfield School, but no quartz is apparent there.

DOLERITE

Dolerite is a rock with a mineral composition similar to that of a gabbro, i.e. it consists of the two minerals pyroxene and plagioclase (lime-soda felspar) in roughly equal proportions, with small quantities of other minerals such as ilmenite, quartz, olivine or apatite. It differs from a gabbro in its texture and in being normally finer-grained. The dolerites around Salisbury are commonly quartz-bearing and they form masses of highly irregular shape in plan. This is due to the fact that they have the form of undulating "sheets" with flat or only gentle dips.

Wide expanses of dolerite occur to the north of Lake McIlwaine; in the western part of Marlborough Township and on Bluff Hill farm; in north Avondale and Mount Pleasant; and on Borrowdale Estate and Colne Valley. It weathers into rounded boulders, in general rather smaller than those of the gabbro, due to its less coarse grain size, and yields a deep red soil similar to that of gabbro and epidiorite. All these three rock types, in fact, are similar in chemical composition. It is a high iron content that produces the red colour of the soils.

A common feature of dolerite boulders is "spheroidal weathering", shown by the flaking off of layers like those of an onion. This is rarely seen in the case of gabbro and epidiorite.

The age of these intrusions is not known apart from the fact that they are younger than all the other principal formations in the area, which they cut across at high angles. The small ovoid or circular patches of dolerite that appear on the map are mostly relict masses or "outliers" resting cake-like upon the older formations. The outlines of these masses as shown on the map are in most cases conjectural, on account of the flatness of the terrain, and future boreholes and excavations are likely to reveal inaccuracies.

The rock also forms vertical or steeply dipping "dykes", like the so-called "Hatfield dyke", the existence of which was proved only by boring for water, since it very rarely forms surface outcrops. This rock is an olivine-bearing type, containing also a little quartz and potash felspar.