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COMMONWEALTH OF AUSTRALIA.

DEPARTMENT OF NATIONAL DEVELOPMENT.

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RECORDS.

1960/80

THE REGIONAL GEOLOGY OF THE DAVENPORT AND MURCHISON RANGES, NORTHERN TERRITORY.

by

K.G.Smith, J.R.Stewart & J.W.Smith.

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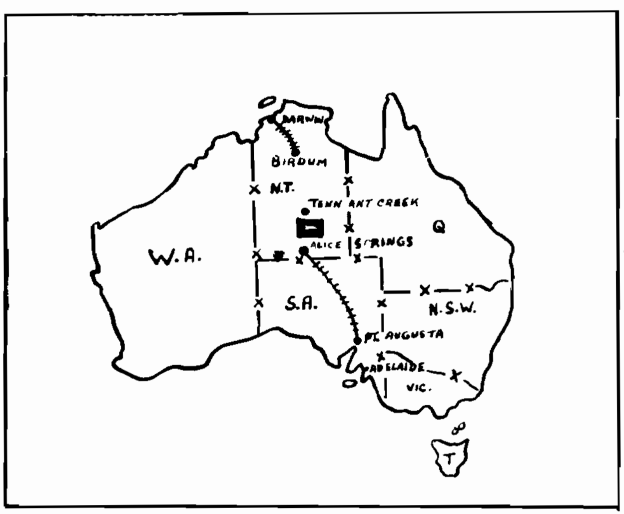
Fig 1.

Locality Map.



SUMMARY

This Report gives the results of field mapping done by a party from the Geological Branch of the Bureau of Mineral Resources, Geology and Geophysics in the area of the Davenport and Murchison Ranges, Northern Territory. This area is covered by part of each of the Barrow Creek, Bonney Well, Elkedra and Frew River 4-Mile Sheets. The whole of the area of the Davenport and Murchison Ranges was mapped in reconnaissance detail. The ranges consist mainly of Lower Proterozoic arenites of the Hatches Creek Group, which have been intruded by basic igneous rocks and by granite. In the north-eastern part of the area mapped the Hatches Creek Group rests unconformably on older Lower Proterozoic sediments of the Warramunga Group. The age of several masses of granite, determined by radioactivity methods, range between 1320 and 1440 million years. Fossiliferous Middle Cambrian sediments and ? Tertiary sediments rest unconformably on the Warramunga Group, on the Hatches Creek Group and on igneous rocks.

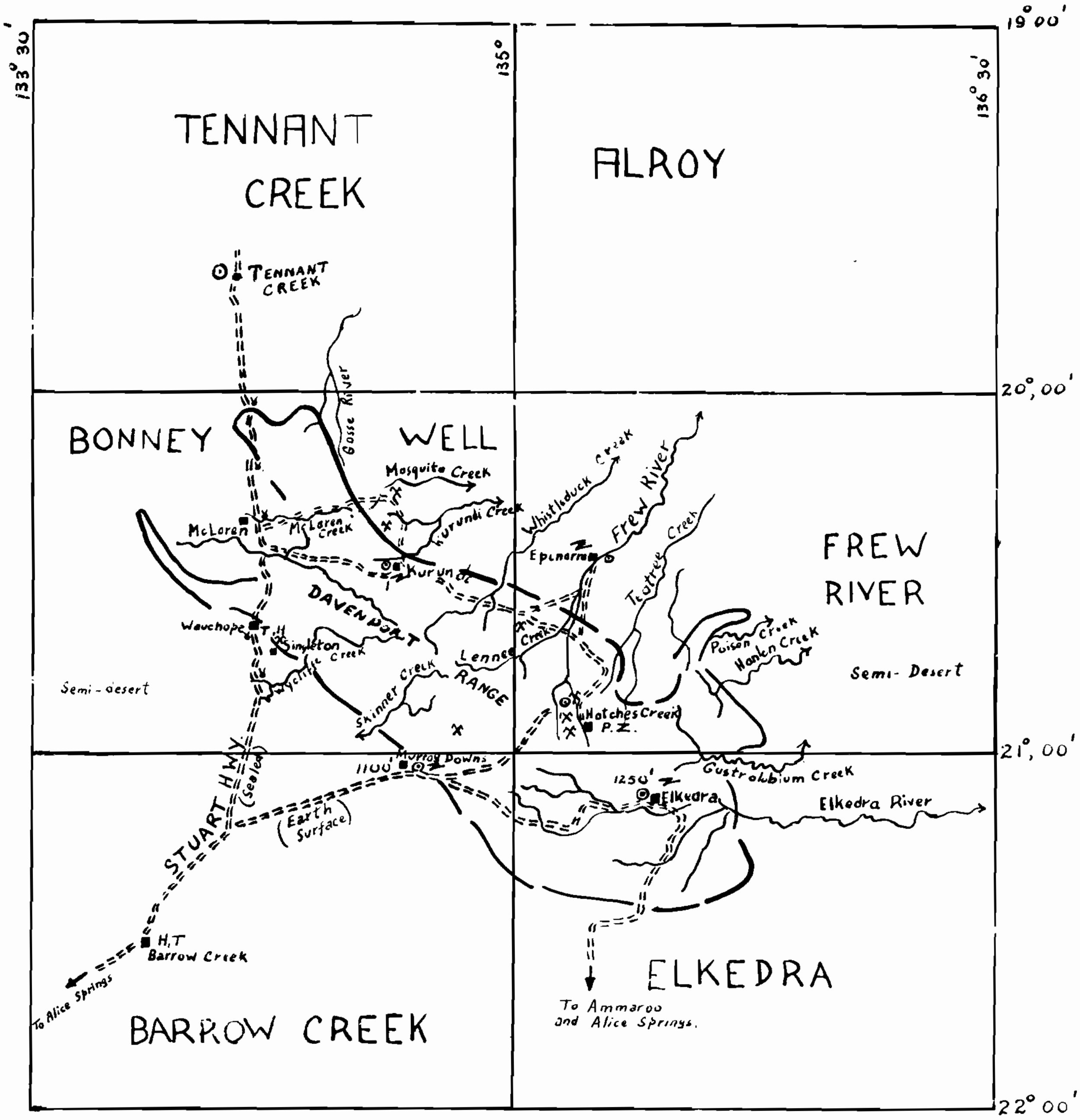
INTRODUCTION

<u>Location</u>: The Davenport and Murchison Ranges form roughly a diagonal to the rectangle bounded by the 134th. and 136th. meridians of longitude and the 20th. and 22nd. parallels of south latitude. The southern extremity of the Davenport Range is almost equidistant from the townships of Alice Springs and Tennant Creek; the northern extremity of the Murchison Range is about twenty-five miles south of Tennant Creek township.

<u>Development</u>: The area is divided into several large Pastoral Leases and Grazing Licences, and two Native Reservations. The Pastoral Leases and Grazing Licences are used for the raising of cattle for beef. One Native Reservation is uninhabited; the other, named Warrabri, is being actively developed.

Fig 2.

LOCALITY MAP, WITH REFERENCE TO AUSTRALIAN 4-MILE SERIES.



Scale:

Miles 32 16 0 32 64 Miles.

Reference

■	Homestead
H	Hotel
T	Telephone
P	Police Station.
Z	Transceiver
⊙	Aerodrome
//	Road
¥	Well, with windpump.
⚒	Mine
·1100'	Spot Height
⁄	Boundary of Area mapped, 1956.

Tungsten ores are mined on the Hatches Creek, Mosquito Creek and Wauchope mining fields.

The total white population is about one hundred and fifty. This figure fluctuates in accordance with the grade of tungsten ores and their market price.

Access: The bitumen-surfaced Stuart Highway, which links Darwin and Alice Springs, provides the main access to the area. The highway crosses the western portion of the Davenport Range near the small settlement of Wauchope, which is seventy-two miles south of Tennant Creek township. From a point forty-two miles south of Wauchope a formed, earth-surfaced road leads from the Stuart Highway to Murray Downs Station, Hatches Creek mining field, and thence to Kurinelli out-station and Kurundi. An extension of this road serves Epenarra station From Kurundi the road leads back to the Stuart Highway at Bonney Well, which is eighteen miles north of Wauchope.

At a point two miles north of Kurundi station a track leads to the Mosquito Creek tungsten and uranium workings and thence to the Stuart Highway at McLaren Well. Eight miles east of Murray Downs station a formed, earth-surfaced road leads to Elkedra station; from here a road of similar type leads south to Ammaroo station and ultimately to the Stuart Highway at a point fifty-nine miles north of Alice Springs. From each station, tracks lead to watering places and mustering yards for cattle. To the east of Hatches Creek mining field there are neither roads nor tracks in the Davenport Range.

Access from Queensland may be gained by earth-surfaced roads leading from Urandangie via several station homesteads to Ammaroo and Elkedra stations.

All of the earth-surfaced roads may become impassable for several days after heavy rain.

The nearest railhead is at Alice Springs. From its base at Port Augusta the Commonwealth Railways provide two passenger trains per week between the months of May and October, and one per week for the remainder of the year.

There are landing grounds suitable for light aircraft at Elkedra, Epenarra, Kurundi and Murray Downs stations, at Hatches Creek settlement and at Warrabri. There are sealed runways suitable for heavy aircraft at Alice Springs and at Tennant Creek.

Communications: Normal mail and telephone services are available at Wauchope on the Darwin-Alice Springs telegraph line, but there are no scheduled surface mail services to the remainder of the area.

From its base at Alice Springs, Connellan Airways operates a regular mail, passenger and freight service, one northbound and one southbound per week, to Elkedra, Epenarra, Kurundi and Murray Downs stations and to the Hatches Creek settlement. Both Tennant Creek and Alice Springs are ports of call on regular air services operated by Trans Australia Airlines, between Adelaide and Darwin. The same airline operates a regular service between Brisbane and Tennant Creek.

Elkedra, Epenarra, Kurundi and Murray Downs stations, Hatches Creek settlement and Warrabri Native Reservations are linked by radio telephone with the Alice Springs Base Station of the Royal Flying Doctor Service. This service provides prompt medical attention and transmits and receives telegrams.

The carriage of heavy goods is done by transport trucks of the semi-trailer type. Fleets of these vehicles ply between Alice Springs and the northern rail-head of Birdum, which is some three hundred miles south of Darwin. Ore from the Hatches Creek, Mosquito Creek and Wauchope mining fields is carried by road transport to the rail-head at Alice Springs.

Climate: Long, hot summers and short, mild winters are usual. In summer, shade temperatures frequently exceed one hundred and ten degrees Fahrenheit. At this period of the year some of the miners cease work for several months. Field work is unpleasant under summer conditions and is best performed between the months of May and September.

The annual rainfall is normally about twelve inches; the heaviest falls normally occur between the months of November and March. However both rainfall and distribution is very unreliable. In 1956 there were heavy falls of rain in every month from April to October, inclusive.

The prevailing wind blows strongly from the south-east.

Vegetation: In areas of outcrop, spinifex, mulga and gidyea are common; gidyea grows most commonly in areas where acid volcanic rocks and porphyries crop out, but spinifex, which is absent from these areas, is abundant in all other places. There are many varieties of flowering shrubs.

Eucalypts line the courses of the larger streams. In semi-desert country on the eastern and western flanks of the ranges there are many varieties of acacia. In the eastern parts of the ranges the gastrolobium bush is common; it contains a poison which is fatal to cattle.

Topography: The Davenport and Murchison Ranges consist mainly of long, almost parallel, steep-sided, flat-topped ridges which are separated by wide, flat valleys. The height of the ridges is about 1650 feet above sea level. The tops of the ridges range from 200-350 feet above the floors of the valleys. The ridges are strike ridges; there are few gaps in them and therefore vehicle access, across the strike, is very difficult. Access along the strike is comparatively easy because vehicles can usually negotiate the floors of the valleys.

On the eastern and western flanks the ranges are bounded by plains about 900 feet above sea level on which low, parallel aand ridges trend north-west.

Several large streams drain from the ranges to the plains, where they "flood out"; no stream whose source is in the ranges reaches a river system which flows either to the sea or to an inland lake.

GEOLOGICAL INVESTIGATIONS

Previous Investigations: These took place in two phases. The period between 1895 and 1914 was one of exploration and prospecting, leading up to the first commercial mining in 1914. In the second period, between 1914 and 1956, investigations were confined to the mining fields and small areas adjacent to them.

In 1895, H.Y.L. Brown (Brown, 1895) made the first geological investigations; he examined some of the eastern part of the Davenport Range and commented upon probable auriferous country within the confines of the present-day Hatches Creek wolfram field.

In 1896 the same author (Brown, 1897) made another journey through some of the same country; he travelled from Barrow Creek to Hatches Creek and the abandoned Frew River station, then returned along Hatches Creek and proceeded south to Elkedra.

A.A. Davidson in 1898-99 (Davidson, 1905), led a prospecting expedition which was financed by the Central Australian Exploration Syndicate. Because of the undeveloped nature of the country at that time, the Central Australian Exploration Syndicate was interested only in the discovery of a large, rich orebody, preferably of gold. Davidson's party prospected most of the Davenport and Murchison Ranges but a long, conscientious search, conducted under conditions of considerable hardship, failed to discover any orebodies of the type which would interest the Syndicate. Nearly all of the small occurrences of copper, gold and lead now known in the area were discovered by Davidson and his party and D. Pedlar, a prospector in the party, found specimens of wolfram in the Hatches Creek area but the mineral was not identified.

In 1902, H.Y.L. Brown (Brown, 1903) again visited the Davenport and Murchison Ranges and from his geological observations concluded that there were large areas worth prospecting for gold. These areas were mainly on the northern and north-eastern flanks of the ranges; in these areas the sediments were very different from those in the ranges themselves.

W.R. Murray, in 1906 (Murray, 1907) led a prospecting party sponsored by the Department of Mines in South Australia and directed his efforts towards the discovery of payable alluvial gold but was unsuccessful.

In 1914 D. Pedlar's specimens were identified as wolfram; he obtained a Government grant of £50 and returned to the Hatches Creek area, where he soon pegged several leases. Within a short time several miners were working on the new field, which was inspected by T.G. Oliver in 1916 (Oliver, 1916).

In 1940, officers of the Aerial, Geological and Geophysical Survey of Northern Australia (A.G.G.S.N.A.) geologically mapped the mines at Hatches Creek and at Wauchope and the areas immediately surrounding them, a total of about 80 square miles. The same organisation carried out aerial photography over small areas near the Hatches Creek and Wauchope wolfram fields. (A.G.G.S.N.A. 1941)

In 1949 C.J. Sullivan re-examined the wolfram mines at Hatches Creek (Sullivan, 1951) and those of the Wauchope wolfram field, (Sullivan, 1952).

Tungsten ores were discovered at Mosquito Creek in 1951 and secondary uranium ores in 1955; these occurrences were inspected by officers of the Geological Section of the Bureau of Mineral Resources, Geology and Geophysics. (Joklik and Tonich, 1951; Bell, 1953; Lord, 1955)

P.S. Hossfeld (leader of the Northern Territory field parties of A.G.G.S.N.A. 1940-41, published the results of his geological observations in the Northern Territory in

1954; he made many references to the geology of the Davenport Range, and to that of the Hatches Creek area in particular.

Investigations in Adjoining Areas: Investigations in nearby areas, to the north of the Murchison Range, have some bearing on the stratigraphy of the Davenport Range - Murchison Range area. These investigations were made in the area of the Tennant Creek goldfield. Owen, (1942, unpublished) mapped an area of about 450 square miles on the goldfield; in 1948-50 a field party from the Geological Section of the Bureau of Mineral Resources, Geology and Geophysics mapped the regional geology of about 2500 square miles (Ivanac, 1954). The southern limit of this regional mapping was at about latitude 19°45'S, which is about 15' north of the northern limit of the area mapped during the 1956 survey of the Davenport and Murchison Ranges.

1956 Survey: A field party from the Geological Section of the Bureau of Mineral Resources, Geology and Geophysics mapped the whole of the Davenport and Murchison Ranges at a scale of four miles to one inch. The objects of the survey were to map the geology of the area as a whole and to prospect for metals, including uranium. The field work was done by K.G. Smith, J.R. Stewart, J.W. Smith, and G.R. Ryan. G.R. Ryan confined his work to the mapping of the regional geology of the Hatches Creek Wolfram Field and to the detailed mapping of the surface and underground workings of the mines; this work is the subject of a separate bulletin. The other geologists were responsible for the regional mapping of the whole area.

Concurrently with the regional survey, the Geophysical Section of the Bureau carried out airborne scintillograph and airborne magnetometer surveys of parts of the Davenport and Murchison Ranges in which one D.C.3 and two Auster aircraft were used. One Auster aircraft made close examinations of radioactive anomalies detected from the D.C. 3 aircraft; the other aircraft surveyed three small areas selected by the geological field party. (Livingstone, 1957); subsequently, radioactive anomalies detected from this aircraft were examined on the ground by officers of the Geophysical Section using car-borne scintillograph equipment (Langron, 1957).

The geological survey was made between the months of April and October 1956 and a total of eighteen man-months was spent in the field. An area of about eight thousand square miles, covering parts of the Barrow Creek, Bonney Well, Elkedra and Frew River four-mile sheets, was mapped. Aerial photographs taken by the Royal Australian Air Force provided a complete photographic cover of the area on a scale of 1:50,000. Some large-scale photographs, taken by A.G.G.S.N.A., were available for the area of the Hatches Creek Wolfram Field. Field data was plotted on aerial photographs and then transferred to semi-controlled mosaics of Barrow Creek, Bonney Well and Elkedra 4-mile sheets. Full map control was available for the Frew River four-mile sheet and the geology of that area was compiled on a slotted template assembly at photo scale which was then reduced photographically to four mile scale. The map on Plate 1 was produced by fitting together the three semi-controlled sheets and the controlled sheet of Frew River.

NOMENCLATURE

In this report the standard practice of the Bureau of Mineral Resources with respect to time divisions of the Precambrian is followed, i.e., two main time divisions, Archaean and Proterozoic with the Proterozoic divided into Lower Proterozoic and Upper Proterozoic.

This practice is not uniform in Australia although these divisions within the Precambrian are universally recognised. Some States follow it; others adopt the practice of

South Australia and Western Australia, place the two older divisions within the Archaean and restrict Proterozoic to the youngest division. Browne, editor of David (1950) used Lower, Middle and Upper Precambrian. Hossfeld (1954) used Archaeozoic and Proterozoic and divided the Proterozoic into Lower, Middle and Upper.

GEOLOGY

(a) Lower Proterozoic: The oldest rocks exposed are those of the Warramunga Group. This Group was named formally by Ivanaac (1954) in the Tennant Creek area; Owen (1942) had previously used the term "Warramunga Series" for the Precambrian sedimentary rocks of the Tennant Creek area.

The Warramunga Group crop out on the north-eastern and north-western flanks of the Davenport and Murchison Ranges. These rocks were mapped in reconnaissance detail only, the object being to establish the structural and stratigraphic relationships between them and the sedimentary sequence which crops out in the Davenport and Murchison Ranges.

The rocks of the Warramunga Group crop out in isolated pinnacles and mesas whose elevation is rarely more than 100 feet above the level of the surrounding plain. The sedimentary rock types are sandstone, greywacke, siltstone, shale and red and black banded chert. Some rhyolites were observed which appear to be conformable with the sediments.

The Warramunga Group has been strongly folded and faulted and has been intruded by basic rocks, by acid porphyry and by a microcline granite which is porphyritic in feldspar. In nearly all cases, metamorphism is restricted to thermal metamorphism at and near the contact with both granite and porphyry. The contact metamorphism is of a low order and is evidenced by narrow zones of silicification. In rare cases, mica-schists were observed.

In the area mapped, the discontinuity of outcrop prevented any determination of the regional structure of the Group. A range of strikes from 270 degrees to 040 degrees[ø] was recorded, with a maximum in a general west-north west direction.

The discontinuity of outcrop and the strong folding did not permit any reliable measurement or estimation of the thickness of the Warramunga Group.

The field relationships of the Warramunga Group are as follows:

(a) in the Tennant Creek area (after Ivanaac, 1954)

(1) the Warramunga Group has been intruded by granite.

(2) both the Warramunga Group and the granite which intrudes it are overlain unconformably by the Helen Springs Volcanics, which are considered to be of Lower Cambrian age.

(3) the fossiliferous Gum Ridge Formation, of lower Middle Cambrian age, lies unconformably on the Warramunga Group, on granite and on the Helen Springs Volcanics.

(b) in the Davenport - Murchison Range area

(1) the Warramunga Group is overlain unconformably by the sedimentary sequence which constitutes most of the Davenport and Murchison Ranges. These sediments are unfossiliferous.

(2) outcrops of both the Warramunga Group and the sediments of the Davenport and Murchison Ranges have been intruded by granite; but the granite bodies may not be all of the same age.

(3) the Warramunga Group, the sediments of the Davenport and Murchison Ranges and some of the granites are conformably overlain by fossiliferous sediments of lower Middle Cambrian age.

ø Bearings in this report are referred to magnetic north.

The field evidence thus establishes a Precambrian age for the Warramunga Group. Earlier workers, e.g. Sullivan (1951), Noakes & Traves, (1954) and Hossfeld (1954), considered the Group to be of Lower Proterozoic age and they correlated it with the Brocks Creek Group of the Katherine-Darwin region. Walpole (pers.comm.) correlated the Warramunga Group with the Brocks Creek Group and on the basis of age determinations made on granite which intrudes the Brocks Creek Group, considered that both Groups are of lower Lower Proterozoic age.

During 1957, J.W Smith collected fresh samples of granite from various localities in the Davenport and Murchison Ranges and in the Tennant Creek area. The age of these samples was determined by P.M. Hurley, by the potassium-argon ratio method[ø]. The ages of three samples of granite which intrude the Warramunga Group are respectively 1630, 1510 and 1400 million years. Two of these, namely 1510 and 1400 million years fall into a group, whose average is 1450 million years, of granites which intrude the sediments of the Davenport and Murchison Ranges. The age 1630 million years is indicative of the youngest possible age of the Warramunga Group and accordingly the Group is considered to be of lower Lower Proterozoic age (Hurley et alia, 1959).

A thick, conformable sequence of dominantly arenaceous rocks, which constitutes most of the Davenport and Murchison Ranges, rests unconformably on the Warramunga Group and is regarded as ~~Upper Lower~~ upper Lower Proterozoic in age (Hurley et alia, 1959).

Part of this sequence was first named the Hatches Creek series by Hossfeld (1941): he divided it into three units, the "Top series", "Hatches Creek series" and the "Bottom series", with a suggested unconformity between the

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[ø]These ages have not been checked by other methods and should be accepted with reserve.

lower two units. Sullivan (1953) used the name Hatches Creek in the same sense but changed the classification to Group. In an unpublished paper in 1951, Sullivan referred to sedimentary rocks in the Wauchope wolfram field as the "Davenport Range Group"; Ivanac (1954) referred briefly to the "Davenport Range Group" but he did not define it. The regional mapping carried out in 1956 has shown that the sediments of the Hatches Creek and Wauchope wolfram fields belong to the one unit; the Davenport Range Group is therefore redundant.

Hossfeld (1954) extended the name "Hatches Creek" to cover both the original Hatches Creek series and the Top series in both the Davenport and Murchison Ranges; he accepted the classification of 'group' and designated the Hatches Creek area as the type area of the unit. However he regarded "Bottom series" as unconformably below the Hatches Creek Group. The present authors retain Hossfeld's Hatches Creek Group but extend it to cover the "Bottom series" because of evidence, referred to below, to indicate that the 'Bottom series' is a conformable part of the whole sequence.

The scope of the 1956 survey did not permit the examination of sections in sufficient detail to define and name formations but it was recognised that the sedimentary sequence consisted of several conformable formations which, if precisely defined, would constitute a group. With the concurrence of the Stratigraphy Nomenclature Sub-committee Territories Division, Geological Society of Australia, the writers retain the classification of Group, in accordance with past usage, although no definite formations within the unit have yet been named or defined.

The rocks of the Hatches Creek Group are mainly thin to medium-bedded, medium to coarse-grained, silty, silicified quartz sandstone. Quartz grains are usually sub-rounded; small-scale cross-bedding is common and ripple-marks are abundant; tension joints are well developed. The quartz sandstone is usually either pink, grey or blue-grey. These arenites, which include some beds and lenses of pebble conglomerate up to two hundred feet thick, crop out in long, sub-parallel ridges. In valleys between the ridges, shale, siltstone, soft greywacke, and extrusive volcanic rocks crop out. The shale, siltstone and greywacke are poorly exposed and complete sections of rocks of these lithologies are seldom seen The extrusive rocks include both acid and intermediate types; usually they can be traced over long distances, e.g. 40 miles, and they commonly maintain a fairly uniform thickness over such distances. The field relations of some of the basic igneous rocks is not clear, and the problem of whether they are extrusive rocks which are members of the Hatches Creek Group or whether they are sills which intrude that Group has not been resolved. These basic rocks are discussed in a later section of this Report.

About four miles south of the southern limits of the Hatches Creek wolfram field there are outcrops of rocks which Hossfeld (1954, loc.cit.) correlated with his Agicondi Series of Lower Proterozoic age. He considered that the Hatches Creek Group rested with an angular unconformity on these rocks, which he named the 'Bottom series'. They consisted of schistose and sheared igneous and sedimentary rocks. Mapping done during the 1956 survey showed:

(a) the sedimentary rocks of Hossfeld's 'Bottom series' are the oldest, excepting those of the Warramunga Group, exposed in the Davenport and Murchison Ranges. They crop out in small areas only and they have been very strongly sheared. The strong shearing has affected arenites of the Hatches Creek Group which crop out nearby and outside the area in question it has produced schistose rocks from original shale and siltstone which are definitely members of the Hatches Creek Group.

(b) the outcrops of igneous rocks in Hossfeld's 'Bottom series' are mainly quartz-feldspar porphyry which intrudes the Hatches Creek Group. There is one small area of granite and associated greisen which intrudes the quartz-feldspar porphyry.

(c) no evidence of an angular unconformity between the sediments of Hossfeld's 'Bottom series' and his Hatches Creek Group was found.

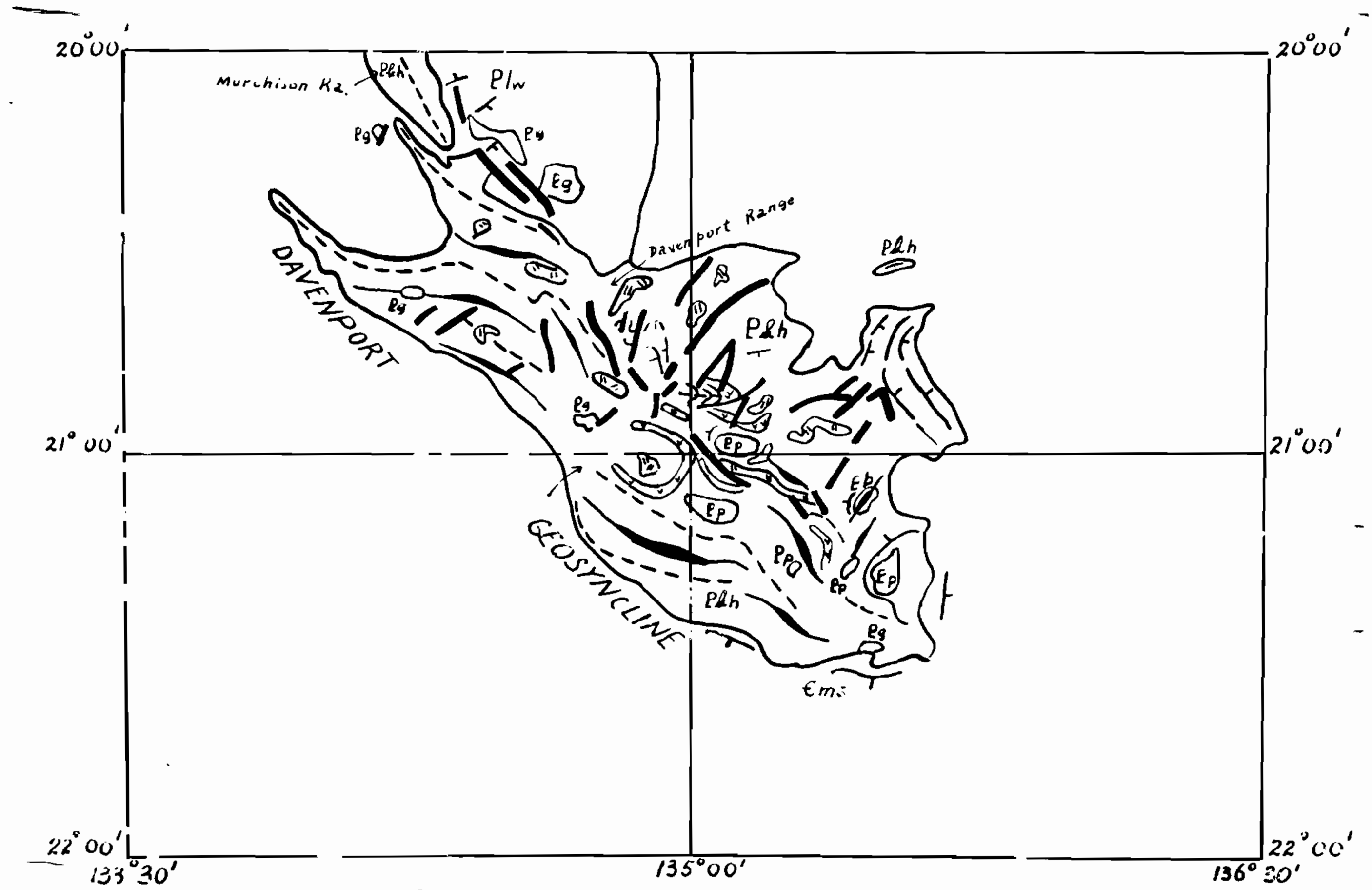
The igneous rocks of Hossfeld's 'Bottom series' undoubtedly intrude the Hatches Creek Group and therefore the only problem is that of the stratigraphic position of the sheared sedimentary rocks. In the absence of any angular unconformity, the present authors believe that they belong to the conformable sequence of the Hatches Creek Group and that the showing is probably only of local significance.

No sections were measured in the Hatches Creek Group during the 1956 survey but estimates of its thickness were made in two localities; these localities are shown by section lines a-a' and b-b' on Plate 1. Both estimates are based on large numbers of dip angles read on the ground and distances measured from air photographs. In section a-a' the estimate is 18,000 feet and in b-b' it is 25,000 feet. The estimate in a-a' is considered more reliable than the other because every significant change of dip was recorded on this section line.

The Hatches Creek Group has been intruded by basic igneous rocks, by quartz-feldspar porpyhry and other acid and intermediate igneous rocks and by granite. The basic intrusive rocks and the quartz-feldspar porpyhry occur over a large area. Outcrops of acid and intermediate intrusive rocks generally occupy small crescentic-shaped areas in the noses of folds in the area west of the Hatches Creek settlement, and small outcrops of granite are found in

Fig. 3

TECTONIC MAP
of
The Davenport and Murchison Ranges, Northern Territory.



Scale:

Miles 32 16 0 32 64 Miles

Reference

Synclinal Axis

Anticlinal Axis

Fault

Trend lines, with dip of beds.

Igneous Rocks

Pg — Proterozoic Granite

Pp — Proterozoic Porphyry

" " — Basic Volcanic Rocks

v v v — Acid Volcanic Rocks.

Cambrian: €ms — Sandover Beds.

unconformity.

Pre-Cambrian: Plh — Hatches Creek Group.

unconformity

Plw — Warramunga Group.

several localities. In all cases the granite intrudes sediments which are stratigraphically low in the Hatches Creek Group. The average of samples from four separate granite bodies, determined by the potassium-argon ratio method, is 1450 million years. (Hurley et alia, loc.cit.).

In most areas of the Davenport and Murchison Ranges, metamorphism of the Hatches Creek Group is of a low order; commonly only surface silicification is apparent. In the southern part of the Hatches Creek wolfram field, however, and for about five miles south of the field's south-eastern boundary, dynamic metamorphism has converted sandstone to dense quartzite and shale has been changed to slate and mica schist. In the central and northern parts of the Hatches Creek wolfram field and in several other areas, the intrusion of basic rocks has caused, locally, severe metasomatism of the Hatches Creek Group; in thin section, albite, oligoclase, epidote, sphene, apatite and chlorite are present.

On both the Wauchope and the Hatches Creek wolfram fields, hornfels is a common rock type; on the Wauchope field the formation of hornfels is due to contact metamorphism by the intrusion of granite. But on the Hatches Creek field, evidence from thin sections indicates that rocks which are now biotite-sericite-quartz hornfels may have been formed by metasomatic processes.

Structure of the Hatches Creek Group

The Group has been strongly folded into numerous basins and domes and into synclines and anticlines. Fig.3 shows the trends of major folds and faults. The domes and basins are roughly oval in shape with long axes ranging from 10 to 20 miles in length. The longest synclinal structure is about 65 miles long and there are several other synclines, and some anticlines, which are about 40 miles in length.

The dips are steep in most of the structures of the Davenport Range; in the long synclines, dips range from

60 degrees to vertical and in some places the beds are overturned by as much as 10 degrees. The dips in the domes and basins commonly range from 50 to 80 degrees but some of these structures have much flatter dips. In most of the area the fold axes trend roughly north-west. Many of these fold axes have a short sigmoidal section.

In general, the major faults strike in one or two directions - north-east or north-west. There are many trends, particularly in minor faults, which lie between these two dominant directions. Strike faulting, trending roughly north west, is common.

There have been at least two periods of faulting; on air photographs of the area several instances of the displacement of major faults, over considerable horizontal distances, by younger faults, are clearly visible. Evidence of two periods of faulting has been obtained also on the Hatches Creek and Wauchope wolfram fields. On both of these fields some of the ore occurs in quartz reefs which fill fractures produced by faulting; small displacement of some of the reefs is a common feature. The horizontal displacement on some of the major faults is of the order of miles but their vertical displacement is unknown.

Igneous Rocks

All of the igneous rocks are of Lower Proterozoic age. The granites are the youngest of the intrusive igneous rocks and the average age of the granite bodies samples is 1450 million years (Hurley et alia, 1959). In very few places can the relationships between the various types of igneous intrusive rocks be observed; the reasons for believing that the granite is the youngest of these are as follows:-

(a) porphyry is found commonly in the core of domal structures; similar intrusives of acid or intermediate composition occupy areas in the noses of folds. These intrusives were probably emplaced during the folding of the Hatches Creek Group and all types are considered to be roughly of the same age.

(b) In one locality granite intrudes feldspar porphyry and on the Hatches Creek wolfram field quartz veins carrying wolfram cut basic intrusive rocks. The wolfram is attributed to granite although the nearest outcropping granite is about six miles to the south. The outcrops of granite occur at random in the Davenport-Murchison Range area and they bear no relationship to fold structures, either on a local or on a regional scale.

(c) the basic intrusive rocks generally occur in random locations and, with one possible exception, do not bear any relationship to fold structures. They are considered to be the oldest of the intrusive rocks.

Thin sections of several igneous rocks from the Davenport-Murchison Range area have been studied by K.R. Walker; the descriptions appear in Appendix ~~I~~, and show the range in type of igneous rocks. Both extrusive and intrusive rocks are represented, for example specimen DR-38 is clearly an extrusive rock on field evidence.

The origin of one type of basic rock is in doubt; this rock crops out intermittently over a large area of the Davenport Range, and occupies the same stratigraphic position wherever it occurs. Good outcrops of this basic rock occur in the valley immediately east of Coulter's Waterhole which is situated on the main road to Alice Springs about 20 miles west-south-west of Hatches Creek settlement. At this locality the unit is estimated to be 2,000 feet thick; and towards the north-western extremity of its outcrop, near the Devil's Marbles, the thickness is about 800 feet. In some places it encloses a thin bed of silicified quartz sandstone, which is about 15 feet thick and can be traced over a distance of several miles in each case. There is no field evidence that it has a cross-cutting relationship to the arenites of the Hatches Creek Group and the authors consider that it is probably an extrusive rock rather than a sill.

Most of the granite bodies mapped in the field are two-mica, microcline granite, but some modifications of field descriptions are given in the descriptions by K.R. Walker, e.g., he describes sample Nos. DR 40 and DR 47 as adamellite. The granite in the Mosquito Creek area differs from the other granitic bodies in that it is porphyritic and contains numerous xenoliths of (?) basic rock.

All of the granites exhibit evidence of stress after consolidation; shearing movements have caused the brecciation of feldspar crystals, the bending of biotite flakes, and undulose extinction of quartz grains. Ivanac (1954) reported similar mineral deformation in the granite of the Tennant Creek area.

The following ages were determined by the potassium-argon method on one sample of granite from each of four separate granite bodies which intrude the Hatches Creek Group (Hurley et alia, 1959).

Locality	Age
(a) Devil's Marbles (6 miles north of Wauchope)	1540 million years
(b) Skinner Pound area	1320 " "
(c) 6 miles south of Hatches Creek Police Station	1480 " "
(d) 4 miles south-west of Supplejack Bore, Elkedra Station.	1430 " "

The average age of these granites is in agreement with that of others, obtained from widely-separated parts of

Central Australia, e.g., Barrow Creek, and the Jervois Ranges and Mt. Swan in the Huckitta 4-Mile Sheet (F53/11); granites from these localities were dated by the same method the results recorded in the publication (Hurley et alia, loc.cit.)

Further determination by total rock quoted above, and Rb/Sr methods are necessary to ascertain what the K/A ages represent. It is possible the K/A ages date the last orogeny in the area - the Davenport folding movement - and do not date the granite intrusion

(b) ?Upper Proterozoic: In several localities in the Davenport Range the Hatches Creek Group is overlain, with angular unconformity, by a formation which consists of boulder conglomerate, silty sandstone and siltstone. These sediments crop out as sheet deposits in valleys and also on isolated mesas whose topographic level is commonly below that of the ridges of the Hatches Creek Group.

The thickness of the formation does not exceed 150 feet and is commonly less than 100 feet. The dip of the beds is less than 15 degrees in most places but some dips of 40 degrees have been recorded. The boulders are well-rounded and consist of silicified sandstone which is similar, in the hand specimen, to that of the Hatches Creek Group; measurements of the long axis of boulders range from 9 to 15 inches. The matrix of the boulder conglomerate is usually lateritised, and in a few areas the matrix has been completely removed, to leave large numbers of loose boulders strewn on the surface. In rare instances where this matrix has not been strongly lateritised it resembles that of a tillite; it contains feldspar fragments, and angular fragments of quartz up to 4 mm long. No striations or faceting were observed on the boulders in these outcrops.

The sandstone beds of the formation are coarse-grained and cross-bedded, with a silty matrix and the quartz grains are commonly well-rounded. Polygonal mud cracks are common (on fallen blocks) and ripple-marks are numerous. The sandstone contains some bands of pebble conglomerate.

No fossils have been found in the formation and there is no evidence that it has been intruded by igneous rocks. Lithologically the formation is very similar to the Rising Sun Conglomerate which has been named and described by Ivanac (1954, p.24); but there is an essential difference in that the Rising Sun Conglomerate has been intruded by feldspar porphyry (Ivanac, 1954).

It is possible that the formation is of lower Middle Cambrian age as beds of this age crop out around the margins of the Davenport Range; they will be discussed in a later section, but it might be noted here that the Cambrian sediments have not been folded and that, although they commonly contain a basal conglomerate, there are numerous dissimilarities between these conglomerates and those of the beds under discussion.

Another possibility is that the beds are of fluvio-glacial origin but there is no definite evidence to support this. In Central Australia, glacial deposits of Upper Proterozoic age have been reported from the Tobermory and Huckitta areas (Noakes, 1956) and from Ellery's Creek in the Western MacDonnell Ranges (Pritchard & Quinlan, pers. comm.) The sequence in the Davenport Range may perhaps record this Upper Proterozoic glaciation.

The authors believe that the available evidence favours an Upper Proterozoic age for the sequence which crops out in the Davenport Range but no correlation with known Upper Proterozoic rocks elsewhere is made.

(c) Cambrian. Cambrian sediments crop out on the north-eastern, eastern, south-eastern and southern fringes of the Davenport

Range and also on the plains north and north-east of the range. Whilst the party was in the field, wet gas was encountered in a bore on Ammaroo station. The bore was drilled into Cambrian sediments which are higher stratigraphically than the beds exposed on the southern fringe of the Davenport Range.

During the 1956 survey, Cambrian sediments were mapped in reconnaissance detail only. Fossils were collected from numerous localities and they were later examined by A.A. Opik and Joyce Gilbert-Tomlinson of the Bureau of Mineral Resources.

The first record of Cambrian sediments in the area was provided by A.A. Davidson who, in the course of his prospecting expedition of 1898-99, collected fossils from a locality "forty-five miles south-east from Elkedra station". (This refers to the old Elkedra homestead.) From the specimens collected by Davidson, Etheridge (1902) described Pagetia significans(Eth) and Peronopsis ~~E~~elkedraensis.

In the area mapped, Cambrian sediments crop out in isolated mesas and in small plateaux. The sediments rest, with an angular unconformity, on rocks of the Hatches Creek Group and on igneous rocks which intrude that Group. The Cambrian sequence may be divided into two conformable units:

(a) a basal unit of conglomerate and sandstone;

(b) a unit of shale, chert and limestone.

No measurements of total thickness were made but it is estimated that this would not exceed 250 feet.

Opik (1956) proposed the informal name 'Sandover Beds' for a sequence of lower Middle Cambrian sediments which crop out immediately north of the Sandover River, about 25 miles south of the southern margin of the Davenport Range. The Sandover Beds are a continuation of the Cambrian sediments on the southern margin of the Davenport Range; because the mapping in 1956 was of a reconnaissance nature only, formation names will not be given to units (a) and (b) outlined above; the name 'Sandover Beds' is extended to include these units.

In unit (a) no fossils were found. The basal conglomerate differs from that of the ?Upper Proterozoic sediments in that cobbles and boulders of the Cambrian sequence are angular and are composed of all rock types on which the sequence rests in that vicinity. In some places large angular blocks of the underlying rock types are incorporated in the Cambrian sequence. A representative section of unit (a) was measured in a mesa 7 miles north of Supplejack Bore on Elkedra Station. Here the sequence, in descending order, consists of:

Top of mesa;

7	feet	coarse-grained, cross-bedded, brown quartz sandstone with angular pebbles of quartz;
10	"	brown, medium-grained, silty quartz sandstone with some thin pebble bands;
1	"	pebble conglomerate;
1	"	brown, coarse-grained, laminated quartz sandstone;
2	"	cobble conglomerate;
3	"	brown, coarse-grained, thin-bedded quartz sandstone;
1	"	pebble conglomerate;
2	"	brown, medium-grained, cross-laminated, silty quartz sandstone;
10	"	boulder conglomerate; the boulders are angular and consist of quartz, quartz sandstone and acid volcanic rocks. The size of the boulders ranges to 9 inches.
37	feet	

The section unconformably overlies acid volcanic rocks of Lower Proterozoic age.

Unit (b) carries an abundant and well-preserved fauna which includes trilobites, brachiopods and hyolithids.

The fauna clearly indicate a lower Middle Cambrian age (Opik & Gilbert-Tomlinson, pers.comm.).

Opik (pers.comm.) considers that the fossiliferous Cambrian outcrops on the eastern and north-eastern fringes of the Davenport Range are a correlate, and probably a former extension of, the Gum Ridge Formation (Ivanac, 1954). In accordance with this opinion two sequences of lower Middle Cambrian sediments are shown on Plate 1; - the Gum Ridge Formation and the younger Sandover Beds. In the author's opinion, there are no lithological differences, in the area mapped, between the Gum Ridge Formation and the Sandover Beds, but slightly older trilobites have been found in the northern area.

In the area mapped there are no signs of tectonic disturbance in either the Gum Ridge Formation or the Sandover Beds. Opik (1956,p.35) has recorded weak fault movements in the Sandover Beds at a locality a few miles south of the area under discussion.

(d) ? Tertiary: A porous, pebbly limestone which is believed to be of Tertiary age crops out in several isolated localities in the area mapped. The most extensive area of outcrop is near the north-western end of the Davenport Range. In addition there are small outcrops near Kurundi Station homestead, east of Macrob Bore on Elkedra Station and in the Hatches Creek area. Evidence from water bores indicates that similar rocks underlie sand and alluvium in the Warrabri area, and similar rock was encountered in a well at Murray Downs Station homestead.

The rocks commonly crop out poorly; they are white or grey in colour and on air photographs they show a pattern of scattered, white dots. Numerous flint nodules occur in the sediments. The thickness of the sequence is unknown; about 40 feet is exposed in the area on the north-western end of the Davenport Range and a thickness of 50 feet has been reported in the well at Murray Downs homestead.

No fossils have been found in the sequence. Noakes & Traves (1954) considered that sediments of similar lithology in the Tennant Creek area and on the Barkly Tableland were of Tertiary age and the sequence in the Davenport Range area is also believed to be of this age.

ECONOMIC GEOLOGY

The most important ores produced from the area are those of tungsten. Small deposits of copper, lead and gold have been worked by prospectors, and there is one uranium prospect.

(a) Tungsten

Ores of tungsten have been mined on the Hatches Creek, Wauchope and Mosquito Creek fields and one small deposit has been worked in a quartz vein in granite about 2 miles south of Supplejack Bore on Elkedra Station. Another small prospect occurs near Epenarra Station homestead.

The Hatches Creek field is the largest of the three mining fields. The main ore produced is wolfram but scheelite has been found in some prospects; bismuth and copper occur in the ore in several mines. The Hatches Creek wolfram field was mapped in detail in 1956 and the results published (Ryan 1960).

The Wauchope wolfram field ranks second to the Hatches Creek field in production. Sullivan (1952) reported on the geology and production of this field; a brief inspection was made by the authors in 1956. Wolfram is mined from narrow quartz veins whose dips are generally low. The quartz veins are commonly concordant in both dip and strike, with the beds of the Hatches Creek Group in which they occur. The wolfram mines are located on the southern limb of a large anticline which pitches in an easterly direction. The nearest outcropping granite is a small body about 2½ miles north of the wolfram field (A.G.G.S.N.A., 1941); in the mines there are beds of hornfels produced by contact metamorphism of the Hatches Creek Group by granite intrusives.

The Mosquito Creek Wolfram field was discovered in 1951; brief inspections were made by Joklik & Tomich (1951,) and by Bell (1953). Some small, rich pockets of wolfram and scheelite have been mined. The ore occurs in narrow quartz veins which occupy shears in granite. Some scheelite has been obtained from the soil adjacent to several of the quartz veins. There was very little mining activity on this field in 1956 and at present (1960) there is none.

(b) Uranium.

In 1955, secondary uranium minerals were discovered about 7 miles south-west of the wolfram workings, at Mosquito Creek; the uranium deposit was inspected by J.H. Lord (1955). The prospect is located in a shear in rocks of the Warramunga Group; the surface extent is small but during 1956 the lessee sank two shafts to test the depth of the prospect.

The regional geological party selected three areas for testing by airborne scintillograph and several radioactive anomalies were detected from the aircraft (Livingstone, 1956); the results were released to the public upon completion of the airborne survey. Some of the anomalies were inspected by the regional geological party and by a car-borne survey from the Geophysical Branch of the Bureau. No worthwhile deposits of radioactive minerals were discovered during these ground inspections, and similar reports were made by prospectors who had examined some of the other anomalies.

STRATIGRAPHIC TABLE - DAVENPORT RANGE AREA

AGE	GROUP	LITHOLOGY	TOPOGRAPHY	IGNEOUS ACTIVITY FOSSILS, ETC.	REMARKS
Quaternary		Sand, alluvium			
Tertiary		Limestone	Low		Good supplies of underground water
	UNCONFORMITY				
Middle Cambrian	Un-named Group	Quartz sandstone, conglomerates. Shales, limestones, cherts.	Mesas and low rounded hills	Brachiopods, Trilobites, Hyolithids.	
	UNCONFORMITY				
? Upper Proterozoic	UNCONFORMITY	Conglomerate, sandstone	Low outcrops in valleys, low mesas	Granites	Ore deposits.
					End of orogeny.
				Quartz-felspar porphyry and acid intrusives. Basic stocks and intrusions.	Folding in progress.
					Orogeny begins
				Basic Sill?	
Lower Proterozoic	Hatches Creek Group	Thin-bedded, cross-bedded, ripple-marked, medium and coarse grained, sub-angular quartzite and sandstone, shale, greywacke, pebble conglomerate, siltstone, interbedded acid volcanics.	Long parallel ridges separated by flat valleys.		Deposited in Davenport Geosyncline.
				Basic Flow ?	
	UNCONFORMITY				
Lower Proterozoic	Warramunga Group	Quartz sandstone, greywacke, shale, siltstone	Low pinnacles, Low mesas.		

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PETROGRAPHIC DESCRIPTION OF ROCKS FROM THE DAVENPORT RANGE

by K.R. WALKER

DR26 - Hand Specimen:

The rock is red-brown, and has a massive igneous appearance and a sub-conchoidal fracture. It is porphyritic; phenocrysts of pink feldspar and quartz are evenly distributed in the aphanitic groundmass. In a fresh surface minute mica flakes fleck the groundmass. The weathered surface is iron-stained and forms a yellow-brown crust on the rock.

Thin Section:

In thin section the rock can be seen to be porphyritic, glomerophorphyritic and granophyric. Phenocrysts of plagioclase and quartz are set in a delicate feathery granophyric base. The quartz phenocrysts are generally corroded and measure up to 1.5 mm., and those of plagioclase are sub-idiomorphic or idiomorphic and measure up to 2 mm; they are in optical continuity with their corresponding component in the surrounding intergrowth; one of the plagioclase crystals is strongly corroded. The feldspar of the intergrowth is light brown; needles or rays of quartz which form feathery intergrowth with it are up to 0.3 mm.long. Numerous spherulites are in the granophyric groundmass and these measure up to 0.5 mm. diameter. Throughout are small opaque iron mineral grains and flecks of white mica. Rare small zircon and apatite grains occur throughout.

The plagioclase in the phenocrysts is oligoclase and is twinned mostly according to the albite law. Phenocrysts are fairly fresh, though flecked with sericite. The feldspar in the base has a light brown clouding.

The rock is a granophyric quartz-oligoclase porphyry.

DR34. Hand Specimen:

The rock is a dark grey, massive basic igneous rock. It is medium-grained and consists mainly of dark green hornblende and cream plagioclase. Fine pyrite grains occur throughout.

Thin section:

The rock in thin section can be seen to be blastophitic, and to consist almost entirely of plagioclase and uralitized pyroxene. Subordinate amounts of hornblende, biotite, quartz and opaque iron mineral are present. The feldspar laths measure from 1 to 3 mm.long and the ferromagnesian mineral grains range between 1 and 4 mm. across; both occur in roughly equal amounts.

The plagioclase crystals are idiomorphic and lath-shaped, or tabular. Both simple and complex twins are common and measurements on two crystals with albite-Carlsbad twins indicate compositions of $Ab_{32}\ An_{68}$, and $Ab_{34}\ An_{66}$. Many crystals are zoned and undulose extinction is also prevalent. Alteration, mostly of adjacent ferromagnesian minerals, resulted in the development of uralitic amphibole along feldspar cleavages.

The ferromagnesian grains are mostly cores of pyroxene within uralitic amphibole - or are original pyroxene rimmed with amphibole. However, alteration to amphibole has also occurred along cleavages. These grains are subidiomorphic or xenomorphic, as are those of hornblende that occur in small numbers when alteration has been slightly more extensive. In the original pyroxene, and in the partly uralitized grains, relict schiller structures can be seen. The small inclusions forming this structure appear to be altered to amphibole.

Of the minor constituents, opaque iron mineral is the most abundant, and grains measure from 0.5 to 2 mm. Biotite flakes are also evenly distributed throughout and they measure from 0.2 to 1 mm. Quartz forms irregular interstitial grains.

The rock is an <u>autometamorphosed dolerite</u> or it is a <u>dolerite</u> that has undergone very low grade metamorphism. This alternative is supported by the undulose extinction and slight granulation of wavy feldspar grains, and also by the development of amphibole in their cleavages and cracks. However, feldspar alteration involves no more than slight flecking with sericite; feldspar has probably changed little from its primary composition.

DR40. Hand Specimen:

The rock is fine-grained and granitic; it is coloured pink by the feldspar. Sparse phenocrysts of feldspar measure up to 10 mm. Feldspar, quartz, biotite and muscovite can be identified in hand specimen. Quartz is translucent grey, and the micaceous minerals are widespread, forming, in places, clots.

Thin section:

In thin section the rock can be seen to be allotriomorphic granular. It consists mostly of microcline, plagioclase, quartz, biotite and muscovite. The accessory minerals are apatite and an epidote mineral. There is a wide range in grainsize from less than 1 mm. up to 3 mm; generally, the microcline grains are larger than those of quartz, and the muscovite flakes are considerably larger than those of biotite.

Quartz mostly forms irregular interstitial grains that measure from 0.5 to 2 mm; it shows strong undulose extinction and partial granulation.

The plagioclase is the most abundant feldspar; most grains are xenomorphic and turbid brown; they contain indistinct albite twin lamellae which may be flexed and show strain. A direct determination of the composition of the plagioclase is not possible, but as its R.I. is slightly greater than that of Canada balsam, it is probably oligoclase.

Microcline is slightly perthitic and forms xenomorphic grains that show fairly coarse grid iron twinning, and only slight alteration.

Flakes of biotite average about 0.5 mm. in size, and are pleochroic from dark greenish brown to buff. Much of the biotite is strung out as if occupying fractures. Pleochroic haloes are common and granular epidote occurs in close association with groups of biotite flakes. The muscovite almost everywhere shows signs of distortion.

A micrometric analyses by point counter of the thin section shows that it is composed of 31.9% quartz, 29.5% plagioclase, 27.1% microcline perthite, 6.9% muscovite, 4.7% biotite.

The rock is an adamellite, but it has certain affinities with an alkali granite in its abundance of muscovite.

DR.41. Hand Specimen:

The rock is a mauve-brown, massive acid rock that breaks with a conchoidal fracture. Small feldspar phenocrysts can be recognised in the aphanitic groundmass. The weathered surface is pitted and iron-stained.

Thin Section:

In thin section it can be seen that sub-idiomorphic feldspar phenocrysts are evenly distributed in an incipiently recrystallized base of quartz and feldspar. Small bundles of biotite flakes, which measure up to 0.2 mm. across, are evenly distributed throughout the base. The phenocrysts range in size from 0.5 to 2.5 mm. The groundmass is silicified and contains irregular quartz grains that average 0.15 mm. across. Aggregates of quartz form patches up to 1 mm. across and these are probably recrystallized quartz phenocrysts. The feldspar phenocrysts are albite, as their R.I. is below that of Canada balsam; they are twinned according to the albite law.

Accessory minerals are chlorite, hornblende, apatite, zircon, sphene and opaque iron mineral. The opaque iron mineral is fairly widely distributed throughout in this section.

The rock is a silicified albite porphyry; accurate naming, however, is made difficult by the fineness of the groundmass and thus by the lack of identification of minerals. There is a paucity of dark minerals.

DR.42. Hand Specimen:

The rock is dark grey. It is massive and breaks with a conchoidal fracture to expose flesh-coloured feldspar phenocrysts (up to 2 mm.) in a dark aphanitic groundmass. The weathered surface of the rock is buff-green and spotted with slightly weathered feldspar crystals.

Thin Section:

In thin section the texture is seen to be porphyritic; most phenocrysts are plagioclase. Plagioclase crystals also form glomeroporphyritic patches. In one case a group of xenomorphic plagioclase grains forms a rounded mosaic, and may therefore have been a rock fragment caught up in the magma. The groundmass is finely crystalline and consists mainly of quartz and possibly some plagioclase. It comprises quartz with abundant sericite and some biotite, and the average grainsize of the irregular quartz grains is 0.15 mm. Biotite, however, also forms bundles of criss-cross flakes which may pseudomorph original ferromagnesian minerals or is strung out in trains forming an irregular network. Accessory minerals are calcite, opaque iron mineral, chlorite, sphene, apatite and zircon.

Most phenocrysts are idiomorphic and measure up to 3 mm. The plagioclase has a positive 2V and an R.I. slightly greater than that of Canada balsam, which indicates its composition is albite-oligoclase. It shows variable sericitization. The phenocrysts form 20% of the thin section and biotite 10%. The remainder is groundmass.

The rock is a silicified dacite.

DR43. Hand Specimen:

The rock is an acid volcanic. The weathered surface is flesh pink and spotted with feldspar phenocrysts. The rock breaks with a sub-conchoidal fracture and exposes a red-brown surface showing feldspar phenocrysts in an aphanitic groundmass. A few quartz phenocrysts can be recognised. The feldspar phenocrysts measure up to 3 mm.

Thin section:

The thin section of the rock is porphyritic; most phenocrysts are plagioclase and the remainder are quartz. Those of plagioclase measure up to 2.5 mm. and those of quartz up to 1 mm. across. The phenocrysts are set in a finely crystalline groundmass which appears somewhat feathery, as much of the intergrown quartz and alkali-feldspar forms narrow and branched grains. Although the thin section is holocrystalline, resolution of crystal margins is difficult, even under high power. Fine white mica flakes are scattered throughout the groundmass.

The plagioclase is albite-oligoclase; it is more or less evenly flecked with minute flakes of sericite.

Quartz phenocrysts are corroded, have pseudo-inclusions, and show undulose extinction.

Accessory minerals are zircon, opaque iron mineral, biotite, and sericite. The opaque iron mineral is widespread.

Estimate of mineral percentages can only be roughly made. Plagioclase phenocrysts form 10% and those of quartz 5% and of biotite 3%. The groundmass forms 10% and quartz and feldspar each 35% of the rock. The accessory minerals account for the last 2%.

The rock is a metadacite whose alteration is low-grade regional.

DR44. Hand Specimen:

The rock is an acid volcanic which has a rust-stained and flesh-coloured weathered surface that contains weathered feldspar phenocrysts. It breaks with a conchoidal fracture and exposes a dark brown surface containing numerous pink feldspar phenocrysts that measure up to 4 mm. across. They occur in an aphanitic groundmass with evenly distributed small biotite flakes.

Thin Section: The thin section shows that the rock is porphyritic. The phenocrysts are idiomorphic oligoclase crystals that measure up to 3 mm. Biotite phenocrysts are widespread and smaller; they form single flakes or are grouped together in bundles. The groundmass consists of finely crystalline quartz and feldspar, and contains numerous small biotite and chlorite flakes. The intergrowth of quartz and feldspar grains tend to be feathery. However, complete resolution of all grains in the groundmass is difficult. Accessory minerals are zircon, sphene, epidote, hornblende, calcite and apatite. Opaque iron mineral is widely distributed throughout; some grains measure up to 0.5 mm., but most are much smaller.

Most biotite flakes are pleochroic from light golden-brown to dark green-brown. Alteration to chlorite along the cleavages is common. The chlorite also forms individual flakes that are strongly pleochroic from pale to rich lettuce-green.

The rock is a metadacite which has undergone low-grade regional metamorphism.

DR47. Hand Specimen:

The rock is granitic and consists of pink feldspar, translucent quartz and muscovite; biotite can be recognised also. It is partly weathered and inclined to disintegrate into grains of its component minerals. The rock is medium-grained; grains average about 5 mm.

Thin Section: The thin section shows that the rock is allotriomorphic granular and that it consists mainly of quartz, plagioclase, microcline-perthite, muscovite and biotite. Many of the grains are fractured and partly granulated; the grainsize ranges from 1 to 5 mm. Secondary minerals are sericite and chlorite.

Quartz grains measure up to 5 mm; they are fractured and show undulose extinctions. Moreover, partial granulation has resulted in some of them being traversed by feathery fractures.

The feldspar is mostly microcline-perthite and perthitic microcline; grains range up to 5 mm. They show typical grid-iron twinning and well-developed cleavage. Many irregular cracks traverse them, and these in some cases are occupied by biotite. The plagioclase is oligoclase; it generally contains numerous albite twin lamellae. These are bent in many grains.

Muscovite flakes measure up to 5 mm. but many are smaller. As they are strongly cleaved it can be seen that they are flexed. Biotite has grown along some cleavages; some of it is altered to chlorite; opaque iron mineral is associated with it in some places. Both biotite and chlorite contain numerous small pleochroic haloes. The biotite is pleochroic from pale brown to green-brown.

The thin section consists of 35% quartz, 30% microcline-perthite, 25% plagioclase, 7% muscovite and 3% biotite. This is a visual estimate only.

The rock is adamellite.

DR51. Hand Specimen:

The rock is massive and appears to be basic igneous. It is so fine-grained that individual minerals cannot be readily identified. Facets of ferromagnesian minerals and feldspar can be recognised with difficulty. The rock has an iron-stained weathered surface.

Thin Section: The thin section has an intergranular texture and contains glomeroporphyritic patches of feldspar laths. It consists mainly of plagioclase, uralitic amphibole, epidote, and chlorite. Accessory minerals are opaque iron mineral, sphene, quartz and prehnite. Most plagioclase laths measure about 0.5 mm. long, but laths in the glomeroporphyritic patches, and also some individual laths, measure up to 1 mm. Most interbedded uralitic amphibole grains are less than 0.2 mm. across; a few pseudomorphs, however, measure up to 1 mm. long.

The plagioclase is oligoclase - andesine laths are idiomorphic or sub-idiomorphic. Much of the twinning preserved is according to the albite law. Alteration is to epidote; most laths contain small grains of this mineral and show undulose extinction.

The coloured minerals are uralitic amphibole, epidote and chlorite. These occur interstitially, but, as mentioned, epidote is included within many plagioclase laths.

The uralitic amphibole tends to be fibrous, pale, and only slightly pleochroic. Uralitization of the original ferromagnesium minerals has resulted in the formation of some quartz as a by-product.

The rock is a fine-grained basalt or dolerite which has undergone low grade regional metamorphism. It is probably best called a <u>metabasalt</u>. The original feldspar would have been more basic; lime has gone to make up, with some of the magnesia from original ferromagnesian minerals, epidote and chlorite. Much of the opaque iron mineral has been converted to sphene. Reconstitution, however, was insufficient to result in stress causing a lineation of mineral grains; but stress is evidenced in the feldspar laths by their undulose extinction, fracturing, and bent twin lamellae.

<u>DR52. Hand Specimen:</u>

The rock is fine-grained and of basaltic appearance. It is massive, and breaks with a sub-conchoidal fracture to expose a medium grey surface. Its weathered surface is iron-stained.

<u>Thin Section</u>: The thin section consists essentially of altered feldspar laths and interstitial epidote, uralitic amphibole and chlorite. Original pyroxene forms cores within uralitic amphibole. There are a number of penninite-filled cavities with idiomorphic inclusions of epidote. The laths range up to 2 mm. long and most interstitial grains rarely exceed 1 mm. across and have indefinite grain margins. Accessory minerals are opaque iron mineral, sphene, calcite, apatite, and quartz.

Most of the feldspar laths are pitted with small epidote and chlorite inclusions. Much of the twinning has become indefinite; the R.I. of the feldspar indicates that it is probably acid oligoclase.

Most of the original ferromagnesian minerals have been altered to uralite; chlorite is another product of alteration and, with epidote, also forms the cavity fillings.

Opaque iron mineral grains average about 0.2 mm. across and are evenly distributed throughout; skeletal grains suggest it is ilmenite.

The rock is a slightly metamorphosed or an auto-metamorphosed <u>dolerite</u>.

<u>DR107. Hand Specimen:</u>

The rock is a buff-grey siltstone. Its weathered surface is dark rusty-brown. The fracture of the rock is partly controlled by the poor cleavage. The rock is too fine-grained for individual minerals to be identified.

<u>Thin Section:</u> The thin section is finely micaceous and has a poor schistosity. The lineation of mica flakes may parallel original bedding planes; numerous quartz and feldspar grains are evenly distributed throughout. These measure up to 0.1 mm. whereas the mica flakes are much smaller. Feldspar is an important component; grid iron twinning indicates that some opaque iron mineral grains are widespread; these include some magnetite idioblasts (0.1 mm. diameter). Accessory minerals are green tourmaline, apatite, hornblende, leucoxene and epidote.

The thin section is cut by a siliceous vein 0.1 mm. wide.

The rock is siltstone.

<u>DR131. Hand Specimen:</u>

The rock is massive and has a rusty-brown weathered surface in which cream weathered plagioclase crystals that measure up to 8 mm. across can be seen. The rock has an irregular fracture and its fresh surface is green-grey. Within the grey fine groundmass, cream plagioclase phenocrysts and green epidote grains can be identified.

Thin Section: The thin section is that of a porphyritic basic igneous rock with numerous amygdules. The plagioclase phenocrysts are idiomorphic and measure up to 3 mm. across; they are set in a groundmass of feldspar microlites and of fine actinolitic needles. Glomeroporphyritic patches of feldspar also occur. The amygdules dominate the texture and consist of epidote with or without quartz or chlorite; they have layered structures, and measure up to 5 mm. in diameter. That is, some have a core of chlorite bordered by a shell of epidote. Fine opaque iron mineral grains are scattered throughout the base. Accessory minerals are calcite and biotite. Calcite occurs in amygdules and in feldspar.

The plagioclase is oligoclase, and that in phenocrysts contains albite lamellae, as well as complex twin sub-individuals. Crystals have a light brown clouding.

The rock is a porphyritic and amygdaloidal oligoclase basalt; whose alterations is deuteric or extremely low grade regional.

DR133. Hand Specimen:

The rock breaks with an uneven fracture and exposes a medium green-grey surface. It is a fine-grained basic rock that contains cream plagioclase phenocrysts randomly distributed throughout; feldspar and amphibole can be identified in hand specimen. Its weathered surface is rusty-brown and contains protruding weathered cream feldspar phenocrysts.

Thin Section: The thin section is ophitic and consists mainly of plagioclase, pyroxene, and abundant secondary chlorite, sericite, epidote and sphene. Accessory minerals are quartz and opaque iron mineral (probably magnetite and ilmenite). Quartz occurs mainly in the mesostasis where it is commonly intergrown with alkali-feldspar. Most of the plagioclase forms laths, but feldspathic patches now extensively saussuritized, were probably also plagioclase phenocrysts. Sericite and epidote are abundant in these patches. Grainsize averages about 1 mm.

Sericitization of plagioclase makes the determination of its composition difficult. A few relict grains indicate a composition of about Ab_{55} An_{45}.

The pyroxene is an augite with a moderate positive 2V. Some of it is altered to uralitic amphibole and chlorite.

This rock is a dolerite that is essentially auto-metamorphosed, but which may have suffered slight dislocation metamorphism. This is indicated by fractures and slight granulation of some grains; such a condition possibly also resulted in some uralitization and sericitization.

DR138. Hand Specimen:

The rock is red-brown and igneous, and is somewhat iron-stained; feldspar phenocrysts are weathered and flesh-coloured. A freshly broken surface shows that quartz and the feldspar phenocrysts are set in an aphanitic groundmass; phenocrysts of quartz are smaller than those of feldspar that measure up to 4 mm. across. Also in the groundmass are numerous small (0.5 mm. diameter) red spots, closely spaced, which are that part of the groundmass impregnated with finely divided hematite.

Thin Section:

The thin section contains plagioclase phenocrysts in a partly granophyric groundmass; these measure up to 2 mm. The red spots, some of which are nearly opaque red, can be seen to be brown-stained oligoclase spherules; some of them are partly silicified. The spherules measure up to 0.5 mm. in diameter. Some of the spherules are completely siliceous, but these are not iron-stained, and are readily identified by their uniaxial figure. The various spherules are abundant and randomly distributed.

The groundmass contains numerous clear xenomorphic quartz grains and albite laths; some of these laths penetrate, or are included in, the spherules. Lesser constituents are chlorite, sphene, and opaque iron mineral; flecks of chlorite are concentrated around grain margins. Sericite flecks the surface of the plagioclase, and some of the phenocrysts contain numerous quartz inclusions as a result of their silicification.

The rock is a feldspar porphyry that has certain granophyric affinities in that its groundmass contains late stage crystallization products, spherulitic-plagioclase and quartz, and patches of crush quartz-feldspar intergrowth. However, it has been extensively silicified.

DAVENPORT RANGES - NAMES AND MINERAL CONTENT OF ROCKS AS REQUESTED

DR33. Uralitized and Saussuritized gabbro pegmatite: The thin section mainly consists of saussuritized plagioclase, uralitized pyroxene quartz, and opaque iron mineral. Ilmenite in the pre-existing opaque iron mineral is altered to sphene, leaving grains with relict magnetite blades. Epidote is an abundant component of the saussurite. Grains are even and average about 4 mm.

DR38. Granophyric rhyolite porphyry or granophyric porphyritic rhyolite:

The thin section is essentially a micrographic intergrowth of quartz and potash feldspar in which a few quartz and plagioclase phenocrysts, and numerous concentrations of fine-grained chlorite, occur. The intergrowth is delicate and commonly feathery, and is out by numerous fractures. Opaque iron mineral grains are sparsely distributed throughout. The phenocrysts measure up to 1 mm. diameter.

DR49. Quartz-feldspar porphyry or dacite:

Most phenocrysts are plagioclase; a few are quartz and opaque iron mineral. Some of the opaque iron mineral, however, is partly converted to sphene. The groundmass is extremely fine-grained and consists mainly of alkali-feldspar and quartz. Accessory minerals are apatite, zircon and chlorite; finely divided opaque iron mineral dusts the thin section in places. Most phenocrysts measure from 0.5 to 2 mm.

DR65. Adamellite:

It contains microcline, quartz, sodic plagioclase, muscovite, apatite, and opaque iron mineral. The mineral grains are partially granulated, and those of plagioclase are sericitized and turbid; undulose extinction is common. The muscovite flakes are well-cleaved and flexed. Grainsize is variable; most grains measure from 0.5 to 4 mm. across.

DR66. Sericitized quartz-albite porphyry:

Most phenocrysts are microcline; a few are quartz and albite. These are set in a groundmass of quartz, sericite, accessory biotite, and rare apatite. The rock has been partially granulated. Opaque iron mineral grains are widespread. Phenocrysts measure up to 1 mm. across, and quartz grains in the groundmass average 0.1 mm.

DR106. Granodiorite porphyry:

It contains phenocrysts and glomeroporphyritic patches of plagioclase in a crystalline groundmass that is partly granophyric. The plagioclase is oligoclase. Most of the groundmass is quartz and alkali-feldspar; small amounts of chlorite, opaque iron mineral, and leucoxene, as well as accessory apatite, are present. Partial granulation is indicated by fractured grains with undulose extinctions and by numerous cracks outlined by iron staining and mica concentrations. Most phenocrysts measure from 0.5 to 4 mm.

DR109. Porphyritic and amygdaloidal acid lava:

The thin section contains idiomorphic phenocrysts of oligoclase, and amygdules of quartz and fine mica, in a finely granophyric base. A few aggregates of strained quartz grains have opaque iron mineral bordering the grains. Some of the base is replaced by silica. Small spherules (0.2 mm. diameter) occur throughout; many are coloured red-brown. Muscovite flakes fleck, and small opaque iron mineral grains dust, the thin section. Finely divided hematite causes rusty-brown colouration in places. Most phenocrysts measure from 1 to 2 mm., and the amygdules mostly range from 0.5 to 1 mm. in diameter.

<u>DR110</u>. <u>Quartz-feldspar porphyry or metadacite</u>:

Most phenocrysts are of altered oligoclase, but some are corroded quartz. The groundmass is feldspathic and siliceous (partly silicified in that silica and sericite possibly replace some original feldspar); some granophyric patches are present. Chlorite and biotite are concentrated into patches which are numerous and evenly distributed. Many of the silicified patches appear to be spherules of quartz. Opaque iron mineral is scattered throughout. Accessory minerals ~~and~~ are apatite and sphene. Phenocrysts measure up to 3 mm., but many were about 1 mm. across. Alteration is low grade regional.

<u>DR123</u>. <u>The rock is probably best called a rhyolite</u>:

However, the composition of the feldspar phenocrysts cannot be determined because of sericitization. The other phenocrysts are quartz. The groundmass is extremely fine-grained and consists of quartz, alkali, feldspar, and sericite. Small grains of opaque iron mineral occur throughout. Zircon is accessory. Phenocrysts measure up to 1 mm. across.

<u>DR125</u>. <u>Dacite</u>:

Phenocrysts are plagioclase and corroded quartz; criss-cross patches of biotite probably replace original ferromagnesian minerals. Most phenocrysts are oligoclase. Minor mineral constituents are calcite, chlorite, sericite, apatite, zircon, sphene, and opaque iron mineral. The groundmass is very fine-grained, crystalline, and fairly siliceous; it contains quartz, alkali-feldspar and numerous small sericite flakes. A poor flow-structure is discernible, especially around the many idiomorphic plagioclase phenocrysts. Phenocrysts measure up to 3 mm. across. The rock has undergone low grade metamorphism.

DR129. Spherulitic granite porphyry:

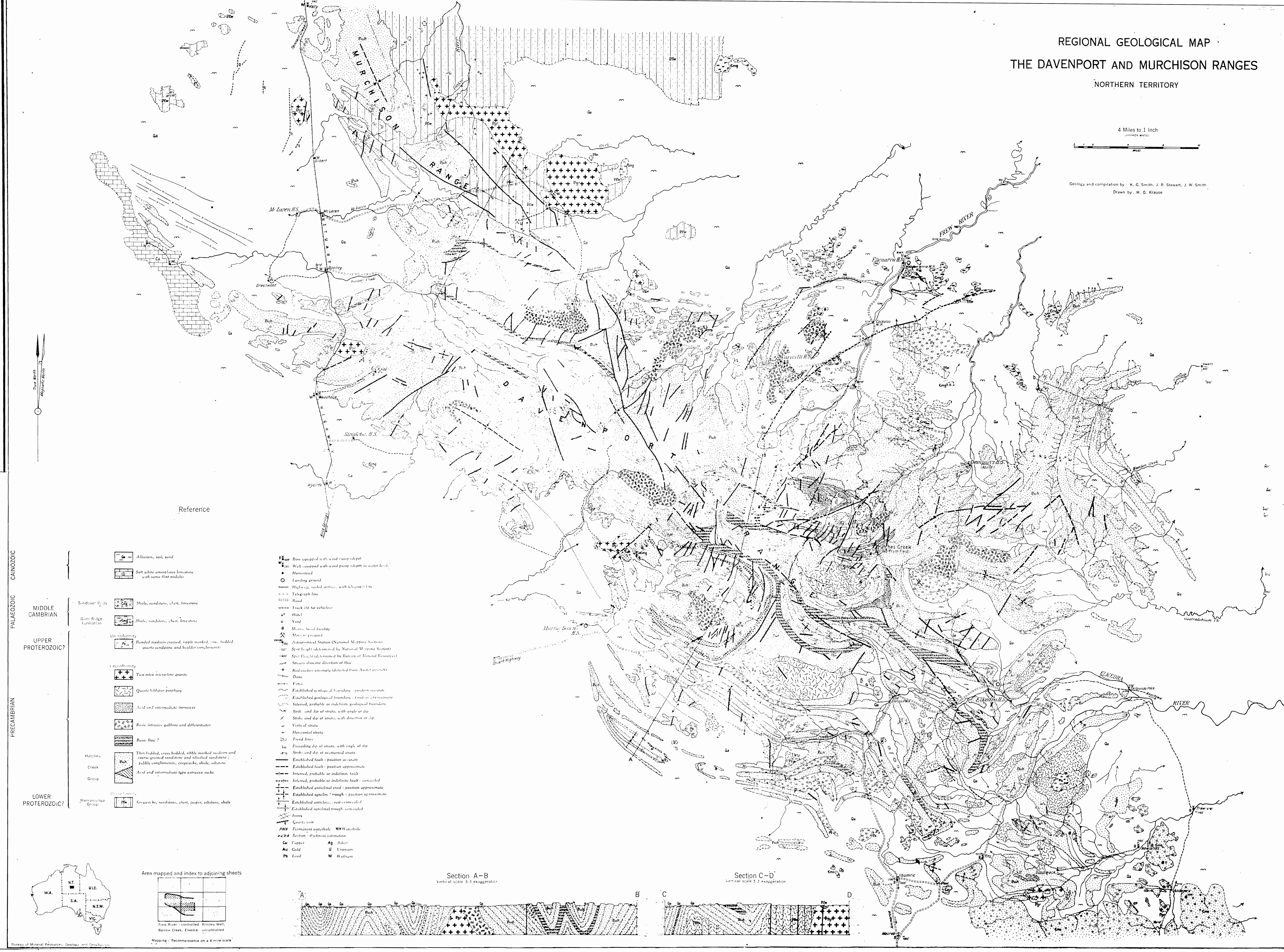
Nearly all the phenocrysts are albite; the remainder are quartz, which are much smaller than those of plagioclase. The groundmass contains numerous spherules of orthoclase, subordinate quartz, and minor quantities of albite. Opaque iron mineral grains are fairly numerous, and iron-staining is not uncommon. Accessory minerals are leucoxene, chlorite, sphene, and apatite. Plagioclase phenocrysts measure up to 1 mm.; whereas the quartz phenocrysts are only about half this size.

DR139. Aplitic granite:

The thin section consists of xenomorphic microcline, quartz, and sodic plagioclase grains. The plagioclase is partly altered to sericite and clay, whereas the microcline is absolutely fresh. Both muscovite and biotite are present; some of the biotite is altered to chlorite; accessory minerals are zircon, apatite, sphene, and opaque iron mineral. Secondary minerals are calcite, epidote, sericite and chlorite. The texture is granular or saccharoidal: grainsize averages about 0.2 mm.; some grains measure up to 0.5 mm.

DR141. Fine-grained basic igneous rock - probably metabasalt:

Most of it consists of small feathery needles of actinolite amphibole in a reconstituted feldspathic (andesine, about An_{40}) groundmass; opaque iron mineral grains are evenly distributed throughout. Accessory minerals are chlorite, sphene, biotite, and apatite. The rock is fine-grained, and averages 0.2 mm.


REGIONAL GEOLOGICAL MAP
THE DAVENPORT AND MURCHISON RANGES
NORTHERN TERRITORY
4 Miles to 1 Inch
Geology and compilation by : K. G. Smith, J. R. Stewart, J. W. Smith
Drawn by : W. G. Krause
MURCHISON RANGE
DAVENPORT RANGE
FREW RIVER
ELKEDRA RIVER
Reference
CAINOZOIC
Alluvium, soil, sand
Soft white amorphous limestone with some flint nodules
PALAEOZOIC
MIDDLE CAMBRIAN
Sandover Beds
Shale, sandstone, chert, limestone
Gum Ridge Formation
Shale, sandstone, chert, limestone
UPPER PROTEROZOIC?
Unconformity
Banded medium-grained, ripple marked, cross bedded quartz-sandstone and boulder conglomerate
PRECAMBRIAN
Unconformity
Two-mica microcline granite
Quartz-feldspar porphyry
Acid and intermediate intrusives
Basic intrusive gabbros and differentiates
Basic flow ?
Hatches Creek Group
Thin-bedded, cross bedded, ribble-marked medium and coarse-grained sandstone and silicified sandstone ; pebble conglomerate, greywacke, shale, siltstone
Acid and intermediate type extrusive rocks
LOWER PROTEROZOIC?
Unconformity
Warramunga Group
Greywacke, sandstone, chert, jasper, siltstone, shale
Bore equipped with wind pump (depth)
Well equipped with wind pump (depth to water level)
Homestead
Landing ground
Highway, sealed surface, with telegraph line
Telegraph line
Road
Track (fit for vehicles)
Hotel
Yard
Marine fossil locality
Mine or prospect
Astronomical Station (National Mapping Section)
Spot height (determined by National Mapping Section)
Spot Height (determined by Bureau of Mineral Resources)
Stream showing direction of flow
Radioactive anomaly (detected from Auster aircraft)
Dune
Fence
Established geological boundary - position accurate
Established geological boundary - position approximate
Inferred, probable or indefinite geological boundary
Strike and dip of strata, with angle of dip
Strike and dip of strata, with direction of dip
Vertical strata
Horizontal strata
Trend lines
Prevailing dip of strata, with angle of dip
Strike and dip of overturned strata
Established fault - position accurate
Established fault - position approximate
Inferred, probable or indefinite fault
Inferred, probable or indefinite fault - concealed
Established anticlinal crest - position approximate
Established synclinal trough - position approximate
Established anticlinal crest - concealed
Established synclinal trough - concealed
Joints
Quartz vein
PWH Permanent waterhole
WH Waterhole
Section - thickness estimation
Cu Copper
Au Gold
Pb Lead
Ag Silver
U Uranium
W Wolfram
Area mapped and index to adjoining sheets
Mapping : Reconnaissance on a 4-mile scale
Section A—B
Section C—D
Bureau of Mineral Resources, Geology and Geophysics