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THE PRECAMBRIAN ROCKS OF TASMANIA, PART VII

NOTES ON THE PETROLOGY OF SOME ROCKS FROM THE PORT DAVEY-BATHURST HARBOUR AREA

By

A. SPRY[1] and W. E. BAKER[2]

(With two plates and two text figures.)

ABSTRACT

Petrological examination suggests that the rocks of the Port Davey-Bathurst Harbour area may be divided into two main groups: the regionally metamorphosed schists, quartzites, phyllites and amphibolites which are probably older Precambrian, and the essentially unmetamorphosed sediments which are probably younger Precambrian. The latter can be divided into three main types; subgreywacke sandstones and slates (Ila Bay, Bramble Cove and north eastern Bathurst Harbour), greywacke sandstones, slates and conglomerates (Joe Page Bay) and orthoconglomerates and quartzites (Mts. Rugby, Berry, &c.).

INTRODUCTION

The geology of the remote south-western corner of Tasmania is complex and observations by Twelvetrees (1906, 1908, 1909), Baker (1957), Stefanski (1957), and Taylor (1959) have left major problems of structure and stratigraphy unanswered. Jennings (1960) summarized the information available and made suggestions as to possible stratigraphic relations as a basis for further work. Investigation of Precambrian rocks in various parts of Tasmania (Spry 1962a, 1962b, 1963a, 1963b) has shown that a study of the structural petrology of these rocks is a useful guide to the stratigraphy although use of the degree of deformation and tectonic style to subdivide the rocks of an area is by no means infallible (Spry 1963a). The following notes are based on field work (W.E.B. and A.S.) and petrology (A.S.). This work is generally in agreement with that of Jennings (1960), but like it, is only intended to be an aid to detailed field investigations in the future.

Despite the fact that the stratigraphy and structure of this area is almost completely unknown, no less than thirty-five stratigraphic terms have been used in a formal sense (Stefanski 1957, Baker 1957, Taylor 1959). With the possible exception of Jennings' (1960) terms, few of the formal names are used according to the Australian Code of Stratigraphic Nomenclature and at present it is practically impossible to understand what some terms mean. Formations and groups have been named without reference to type areas, the same rock is given different names of different authors (or even by the same author), unconformities or conformable successions are postulated with no supporting evidence, and the same stratigraphic name is used by different authors to apply to different rocks.

No formal stratigraphic terms will be used in this paper and it seems that, until formal stratigraphic terms can be used in an accurate, understandable manner, the stratigraphic names for this area may have to be abandoned.

PRINCIPLES

The rocks are divided into a number of lithological assemblages using the amount of metamorphism and deformation as criteria following Spry (1962a) because the structural and stratigraphic relations are not yet clear from field studies. The low to medium-grade metamorphics strongly resemble rocks at Frenchmans Cap, the upper Mersey-Forth area and Ulverstone, and are assigned to the *Older Precambrian* (Spry 1962a). Moderately deformed but unmetamorphosed sediments resemble rocks between Zeehan and Corinna and along the North-West Coast (Spry 1957a, 1964) and may be *Younger Precambrian*. Slightly deformed conglomerates, greywackes &c. do not resemble Precambrian rocks elsewhere in Tasmania closely but are probably Younger Precambrian.

ROCKS OF OLDER PRECAMBRIAN TYPE

These rocks are distinguished by their metamorphism and deformation. They are divided into (1) a *Schist-Quartzite-Amphibolite Assemblage* containing regionally metamorphosed sediments and basic igneous rocks belonging to the quartz-albite-epidote-almandine subfacies of the Greenschist Facies and possibly the Almandine Amphibolite Facies (Turner and Verhoogen, 1960). (2) A *Quartzite-Phyllite Assemblage* containing low grade regionally metamorphosed sediments belonging to the quartz-albite-moscovite-chlorite subfacies of the Greenschist Facies.

Petrological examination shows that the metamorphism was accompanied by two periods of deformation and in the following descriptions, the criteria and terminology of Spry (1963a, 1963b) are used; S_0 is bedding, the first deformation F_1 produced a foliation S_1 and a lineation L_1; the second deformation produced S_2 and L_2 &c.

I. Schist-Quartzite-Amphibolite Assemblage.

Dark grey schists outcrop extensively on the wave-cut platform extending northwards from Kelly Basin beyond Bond Bay. The schists to the

(1) Department of Geology, University of Tasmania.
(2) Broken Hill University College.

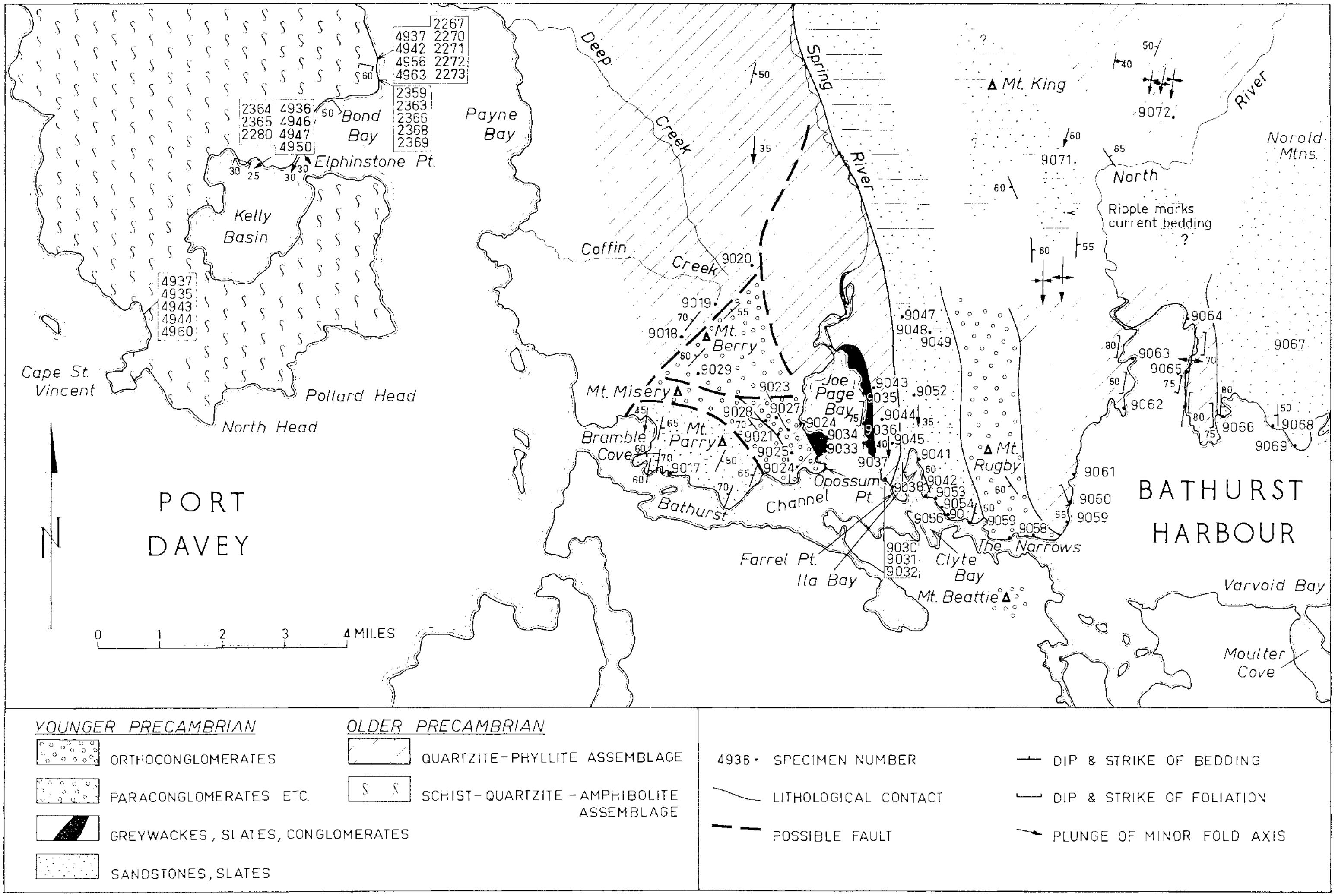

FIG. 1.—Geological sketch map of the northern side of the Port Davey-Bathurst Harbour Area.

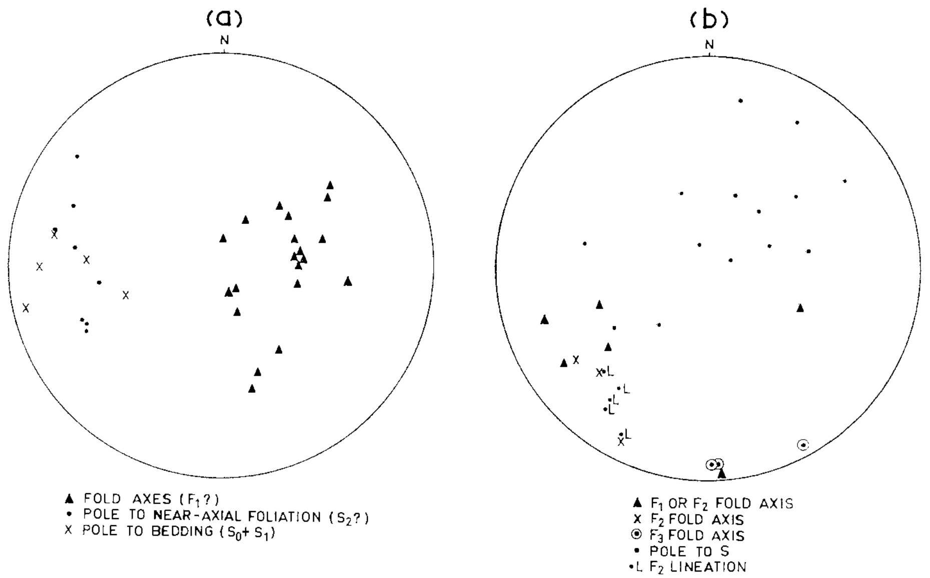

FIG. 2.—Structural data—
(*a*) Folds with discordant non-axial foliation, Davey-Crossing saddle.
(*b*) Fold axes, lineations and foliations in the Bond Bay area.

south are rich in garnet whereas those to the north contain abundant albite. Minor garnet-quartzites outcrop at Kelly Basin and amphibolite bodies occur 1 mile north of Bond Bay. The foliation strikes at between 100° and 160° and dips are moderate to the south and south east.

Small isoclinal folds of a colour banding (S_0?) occur within layers parallel to the main foliation (S_2) and plunge at about 40° towards 220° (Plate I., No. 1, fig. 2). These may be F_1 folds in which the axial surface cleavage (S_1) is paralled to, and masked by, S_2, but are more likely to be F_2 folds.

Lineation (ribs in quartzite, elongate envelopes to garnets) is not widespread but is strongly developed in places and is regarded as L_2. Measurements show that it plunges flatly towards about 220° (fig. 2).

Kink zones, crenulations, and folds up to ten or twenty feet across have a different tectonic style. They are essentially *parallel* folds and disturb S_0, S_1 and S_2; they have no axial-surface foliation and no mineral growth is associated with them (Plate I., 5 and 6). Both macroscopically and microscopically these folds have the characteristics of F_3 folds (Spry, 1963a, 1963b). These structures are strongly developed just east of Bond Bay where they are associated with faulting. A few rather open *similar* folds plunging flatly towards 145° near Kelly Basin probably belong to F_3.

Fine-grained schists (such as 4936*, 4946, 4947, 4950) consist of small (1 mm.) porphyroblasts of garnet in a foliated matrix of muscovite flakes (0.6 mm. long) with lesser biotite; albite occurs as lenticular crystals about 0.4 mm. long and in fine-grained lenticular aggregates. The garnet contains snowball structure (Plate II., No. 3) and is syntectonic but the internal surfaces (S) are discordant with S_e (the foliation in the surrounding matrix). Some albite contains simple helicitic structure discordant with S_e. The mica which outlines the foliation wraps around both garnet and albite which are thus older than the foliation (i.e. pretectonic). The S_i within albite and garnet are thus taken to be an old foliation S_1. The garnet is the same age as S_i and is syntectonic to F_1; the albite is younger than S_1 and is post-tectonic to F_1. The main foliation is thus S_2. Some albite is lenticular along S_2 and contains no S_i, this is probably syntectonic and of the same age as S_2. The muscovite and biotite which outline S_2 are interwoven and lenticular; these are taken to be both largely of similar age to S_2, and thus syntectonic to F_2; both micas occur in pressure shadows around garnet. Quartz forms elongate blobs along both S_1 and S_2 and is probably syntectonic to both F_1 and F_2.

The foliation S_2 has been crenulated with the incipient development of a fracture cleavage S_3 along which some biotite may possibly have grown. Chloritization of garnet is a very late process as the chlorite is randomly oriented.

The coarse-grained schists (such as 4935 and 4944) consist of albite porphyroblasts about 1 cm. across separated by irregular layers of contorted mica (about 1 mm. across). The albite is undulose and somewhat shattered, it contains helicitic structure with S_i discordant with S_e and the muscovite wraps around it. Albite is post-tectonic to an early phase but pre-tectonic to the main foliation which is thus S_2. It is so abundant in some

* Numbers refer to specimens in the collection of the Geology Department, University of Tasmania.

specimens (2363, 2368) that inter-tectonic metasomation is suggested (Gee, 1963; Spry 1963b, p. 117). The analysis in Table II shows 4% Na_2O. The garnets are very small (less than 0.1 mm.), are structureless and mostly contained within the albite although they also occur outside it. Many garnet crystals are fractured and in No. 4944 a lenticular aggregate of very thin grains apparently represents a granulitized large crystal. The garnet is of similar age to the albite but is a little older; it is post-tectonic to F_1 (i.e. later than S_1).

The main foliation S_2 is very irregular and contorted but the muscovite or biotite which outline it are younger than the folding of the foliation (i.e. are post-tectonic). This is indicated by the random disposition of the biotite within the foliation layers in 4944 and by the form of the muscovite in 4935. In this rock the mica flakes are not bent around the hinges of the crenulations as they would if they were present before the folds were formed. Instead individual flakes meet at the hinges indicating crystallization after the folds were formed.

The main differences between the fine- and the coarse-grained schists is that crystallization was largely syntectonic (to F_2) in the fine and post-tectonic in the coarse. The third phase of deformation affected the coarse rocks more strongly.

Chronology of crystallization and deformation of the garnet schists.

TABLE 1.

	F_1	F_2	F_3
	pre -syn- post tectonic	syn-post tectonic	syn-post tectonic
quartz			
muscovite			
biotite			
garnet			
albite			
S-formed	S_1	S_2	S_3
S-folded		S_1	S_1 S_2

Regionally metamorphosed basic igneous rocks occur within the garnet-mica schists. The simplest rocks consist of garnet, olive-green actinolite and albite with different amounts of biotite, chlorite and zoisite and accessory sphene, rutile and iron ore. The analysis (Table II) indicates that the rock was probably of olivine basalt type and is similar to amphibolites from the Raglan Range and the Lower Forth River.

An amphibolite mass about 200 yards across is exposed on the wave-cut platform about 1 mile northeast of Bond Bay. It lies among albite-rich schists which strike at 100° on the northern contact and 90° on the south with steep dips to the south. Both contacts are very disturbed and appear to be faulted. The amphibolite is weathered but it can be seen that the core is massive (2370, 2732) and that the material becomes schistose towards the margins (2274, 2273, 4956) with oblique mylonitized bands (2274) and thin light coloured zones which are very rich in feldspar (2369, 2374).

The transitions agree with the observations of Spry (1963b) in the Frenchmans Cap area. The massive centre is of coarse amphibolite containing large strained and bent pale amphibole crystals, broken andesine (Ab_{60}) and garnets belonging to F_1 but distorted by F_2 movements. These grade into schistose amphibolites in which all F_1 minerals except garnet relicts have been replaced by fine grained amphibole which is syntectonic (to F_2) and also ziosite and albite. Some varieties are very rich in albite (e.g. 2369, which has 1 cm. wide layers of fine-grained feldspar) which would appear to have been introduced (Plate I, No. 2). This albite is lenticular and at least part has been crystallized syntectonically (F_2) along the S_2 foliation. Introduction of albite could have taken place inter-tectonically between F_1 and F_2 and the richness in albite of some schists here suggests they may have been metasomatized also.

Specimens 4937 and 4942 contain large amphibole crystals up to 5 mm. across enclosing garnet. The large pale green actinolites in 4942 are undulose and fractured and were formed earlier than small amphibole, garnet and zoisite crystals. The small garnets are apparently older than the actinolite which is probably post-tectonic to F_1 and is followed by the quartz and albite. A little late chlorite has replaced garnet, and biotite has replaced actinolite.

No. 4956 consists of garnets up to 0.4 mm. across set in a fine parallel aggregate of olive-green actinolite crystals ranging from 0.02 to 0.2 mm. long. The actinolite wraps around the garnet which has been fragmeted and it also fills fractures in the garnet. The garnet is pre-tectonic with respect to the foliation delineated by the actinolite. Albite forms elongate, granular aggregates along the foliation; it is fresh, heals fractures in garnet and encloses actinolite. Apart from a few old undulose crystals the albite is post-tectonic.

Amphibole-biotite schists (e.g. No. 4963) are midway in composition between the pelitic schists and the amphibolites and are similar to a rock from the Raglan Range described by Gee (1963).

No. 4963 is composed of brown biotite flakes up to 4 mm. long with garnet (0.4 mm.), amphibole (0.6 mm.) and quartz (0.5 mm.). Biotite and actinolite are intergrown and apparently formed simultaneously; they form a foliation which appears to be parallel to the axial surface. In thin section the major foliation marked by muscovite wraps around albite porphyroblasts and cuts through the crests of folds of compositional layering. The albite contains helicitic structure in which S_i (dusty inclusions probably marking S_0) is contorted and is discordant with S_e. The albite is pretectonic to the main foliation but is of post-tectonic type and later than folded S_0. It seems likely, in view of the history of the rocks to the south, that the albite is inter-tectonic between F_1 and F_2 and that the major foliation is S_2. S_2 coincides with S_0 and S_1 except on the crests of folds.

The occurrence of a lime-bearing plagioclase, andesine Ab_{60}, in the amphibolite is important. Previously only albite with a low anorthite content (Ab_{92-95}) has been found in Tasmanian Precambrian metamorphic rocks and this is the reason why almandine and kyanite-bearing schists have been allocated to the Greenschist Facies rather than the Almandine Amphibolite Facies. Most of the schists have such low lime and high soda that a lime-bearing plagioclase might not occur even in high grade rocks but amphibolites in the Frenchmans Cap area contain albite also. Almost all of the albite in the schists belongs to the inter-tectonic period between F_1 and F_2 but it is possible that the Almandine Amphibolite Facies was reached during F_1 and that the Greenschist Facies minerals belong to the inter-tectonic period and to F_2. Tectonic inclusions of Eclogite and possibly Granulite Facies rocks in the Franklin Group on the Collingwood River might also be relicts of an early high grade episode.

Distribution of the Schist-Quartzite-Amphibolite Assemblage.

Descriptions by Stefanski (1957 pp. 101-106) indicate that similar rocks (garnet and albite-mica schists, quartzites and amphibolites) occur at Cox Bight and Red Point. They appear to extend northwards past Ray River and Umbrose Creek to Moulters Inlet and Fulton Bay on Bathurst Harbour. Stefanski also reported similar rocks at Wilson Bight and Ketchem Bay. It has not been possible to confirm the presence of the cordierite, andalusite and chiastolite reported by Everard (in Stefanski, 1957, p. 105) and examination of specimens at the Mines Department suggests that albite has been mistaken for these minerals.

TABLE II.

	(1)	(2)	(3)
SiO_2	43.16	44.78	73.1
Al_2O_3	16.12	13.44	13.6
Fe_2O_3	2.89	2.41	0.80
FeO	14.86	16.22	3.3
MgO	5.89	7.01	1.05
CaO	10.22	9.12	0.66
Na_2O	1.63	1.65	4.0
K_2O	0.32	0.47	1.18
H_2O +	2.68	1.58	1.40
H_2O —	0.18	0.07	0.39
TiO_2	2.00	2.81	n.d.
MnO	0.24	0.36	
P_2O_5	0.12	0.04	
	100.31	100.32	99.47

(1) Amphibolite, (4956) Bond Bay, Port Davey, *Anal. Tas. Mines Dept.*

(2) Amphibolite, Raglan Range (Spry 1962a). *Anal. Tas. Mines Dept.*

(3) Albite Schist, 2368, Bond Bay. *Anal. R. L. Bruce and L. W. Castenelli, A.M.D.L.*

II. *Quartzite-Phyllite Assemblage.*

Strongly deformed but low grade meta-sediments outcrop extensively just north of Farrell Point on the south-eastern side of Joe Page Bay (Long Bay of Jennings 1960 &c.) extending in a narrow belt for at least five miles north along the Spring River, and also extensively around the north-western side of Bathurst Harbour and to the north beyond the North River. This assemblage includes Baker's (1957) "Bathurst Shales" "Lindsay Quartzite" and "North Quartzite". It probably also includes Taylor's (1959), "North River Schist" and possible the "Solly River Quartzite" and "Old River Schist".

The rocks around the north-western section of Bathurst Harbour are glossy black phyllites and schists which have pronounced foliation and are tightly folded. Small chevron and conjugate folds belonging to F_3 have folded a foliation and an old lineation and produced a fracture cleavage S_3 along which there is no mineral growth. Small (down to microscopic size) isoclinal folds may belong to F_2 and the major foliation is probably S_2. S_1 is visible under the mricroscope as folded remnants between layers of S_2; S_0 may be represented as helicitic structures within albite. The dark meta-pelites consist of quartz and muscovite with minor chlorite, albite and graphite. Abundant tiny pits may represent weathered out chloritized garnet. The rocks resemble the Dove Schist of the Upper Mersey River. The simplest type (e.g. 9063) consists of finely grained quartz and muscovite both of which are elongate parallel to a pronounced foliation (S_2). Crenulations produce a fracture cleavage S_3.

More-common are varieties such as 9059, 9061, 9062 and 9065 which are dominated by a strong foliation along which there are layers richer in quartz or in muscovite and lines of opaque material, much of which is graphite. Contorted fold crests and disrupted limbs of old folds lie between the layers of the major foliation and contorted lines of tiny opaque grains or slightly curved bleds of quartz are enclosed helicitically in lenticular albite crystals. The coarse lithological layering visible macroscopically, together with the lines of graphite particles (Plate II, No. 5) probably represent bedding (S_0(which has been disrupted and is now parallel to the main foliation S_2. Remnants of S_1 still remain between the layers of S_2 and helicitically in some albite. The S_i of the helicitic structure (S_0 and S_1) in the albite is discordant with S_2. Lenses and sheaves of chlorite grow athwart S_2 and are post-tectonic to S_2; from the shapes of the aggregates, it would appear that chlorite has replaced biotite and garnet belonging to F_1.

These rocks are phyllonites and probably were formed by retrograde metamorphism from garnet or muscovite-biotite schists. The higher grade minerals garnet and biotite from F_1 were replaced by chlorite during F_2. Albite was inter-tectonic between F_1 and F_2. these rocks from Bathurst Harbour may really belong to the schist-quartzite assemblage but garnet has not yet been found.

Quartzite (e.g. 9072, the "North Quartzite" of Baker, 1957) occurs along the North River, 3 miles north of North Inlet. Massive and crenulated schistose quartzites are folded and show several lineations. No. 9072 (Plate I, No. 4) is a white, somewhat platy quartzite. An F_1 fold of bedding (S_0) and a bedding plane foliation (S_1) are crossed obliquely by a foliation (S_2) which is visible microscopically and the S_2-S_1 and S_2-S_0 intersections give a lineation L_2 which is oblique to the fold axis. Petrofabric analysis shows a strong preferred orientation of quartz with a girdle normal to L_2. In thin section the rock is a fine-grained quartzite with about 5% of muscovite as tiny flakes aligned crudely along S_2. The quartz is undulose and irregularly shaped with a slight tendency towards elongation along S_1.

The rocks ("Lindsay Quartzite" of Baker 1957) in the narrow belt extending north from Farrell Point (east of Joe Page Bay) along the Spring River, are somewhat similar. The quartzites (e.g. 9044) are tightly folded lustrous, foliated and lineated. No. 9044 is a fine-grained quartzite containing folds of about 8" wage length, with a foliation along the bedding and another parellel to the axial surface of the folds. The intersection of these foliations gives a lineation parallel to the fold axes. The folds are neither *similar nor parallel* as the thickness of the layers varies when measured either orthogonally to the bedding or parallel to the axial surface.

In thin-section the rock is finely crystalline and is composed of interlocking quartz grains with blurred margins, strongly elongate parallel to the axial surface and the axis of the fold. Sparse micas occur in bands (S_0) and outline a foliation (S_1) parallel to the bedding. A petrofabric diagram shows a strong preferred orientation of quartz in a broken girdle normal to the lineation. The pattern is similar to that of the quartzite (9072) from the North River.

Micaceous quartzites (e.g. 9043, 9045) occur in this belt also.

Massive white quartzites (9020), foliated and lineated quartzites (9019), and light grey, glossy crenulated phyllites (9018) extend from the north-western slopes of Mt. Berry to Coffin Creek ("Berry", "Western" and "Coffin" Quartzites of Baker, 1957). These show many of the characters of the older Precambrian rocks but are not as strongly deformed as the rocks described above. in thin section, the phyllite No. 9018 is strongly foliated and consists of alternate layers rich in muscovite or elongate quartz. Remnants of an old foliation are visible as discordant trails of muscovite across the quartz lenses. Some quartzites (e.g. 9019) are white, foliated and lineated. In thin section the quartz, which is undulose with deformation lamellae, forms slightly elongate but irregularly shaped crystals with blurred margins. Twisted muscovite flakes outline the foliation.

Rocks of Younger Precambrian Type.

Quartzites, conglomerates, slates and phyllites, which have been folded tightly in places but which are not regionally metamorphosed, are abundant in the Bathurst Harbour region. These rocks are much less deformed than those included in the older Precambrian assemblages in that bedding is clearly visible. A single cleavage is present in most rocks and a second (fracture) cleavage develops in places. These sediments resemble younger Precambrian rocks of the Zeehan-Smithton-Burnie area (Spry, 1964) but have a different and simpler tectonic syle than the older Precambrian metamorphics. The conglomerates contain abundant pebbles of foliated and lineated quartzite, phyllite and schist which are identical with the older Precambrian rocks of the district so that a major tectonic and metamorphic episode (presumably the Frenchman Orogeny) separated the two groups. An actual surface of angular unconformity has not been observed.

Three main lithological assemblages are recognized: I. *Quartzites and slates.* These include the sediments to the north-east of Bathurst Harbour ("Old River Quartzite and Meta-Pelite" of Baker, 1957: "Upper Member of the Moulter Cove Formation" of Taylor 1959); the narrow strip extending north from Ila Bay along the eastern side of the Spring River ("Ila Bay Quartzite and Conglomerate" of Baker, 1957), and the sediments between Bramble Cove and Mt. Parry ("Bramble Quartzite and Meta-Pelite" of Baker, 1957). II. *Ortho-conglomerates and quartzites.* Thick white quartz-conglomerates occur at Mt. Rugby, Mt. Mackenzie, Mt. Berry, Mt. Misery, Mt. Beattie ("Mackenzie Conglomerate", "Rugby Conglomerate" and "O'Possum Conglomerate" of Baker, 1957). The relations of these conglomerates to each other and to other rocks in the area are not clear but it is tentatively assumed that they are equivalent to each other and belong to the younger Precambrian assemblage. III. *Greywackes and paraconglomerates.* Dark-coloured, poorly sorted sediments with abundant sedimentary structures occurring at Joe Page Bay ("Long Bay Shale" of Baker, 1957) may be younger Precambrian.

I. *Quartzites and Slates.*

Quartzites and slates outcrop along the northern shoreline of Bathurst Channel between Bramble Cove and Mt. Berry. They strike at about 25°, dip steeply (60°-70°) to east and west, and have been folded about axes plunging at up to 45° towards about 190°. On the eastern shore of Bramble Cove, slates become contorted in the core of a small anticline and there are segregations of quartz (Nos. 9010, 9012, 9013).

The quartzites range from deformed and recrystallized varieties such as 9017 which consists microscopically of a mosaic of inter-locking undulose quartz and 9016 with mortar texture to impure varieties such as 9015 with about 10% of feldspar (microcline) and 10% of sericite outlining a foliation.

Most of the pelites are recrystallized quartzose siltstones. In 9014, quartz comprises about 40% of the rock as irregular and lenticular crystals about 0.1 mm. long in a foliated matrix of fine sericite. A few flakes of clastic muscovite about 0.3 mm. across are present, together with accessory tourmaline, tiny rutile needles and rounded grains of zircon. Mica-rich varieties such as 9022 are light coloured, glossy phyllite with a strong foliation and several irregular lineations produced by fine crenulations. Macroscopically these rocks resemble the glossy slates of the Oonah Quartzite and Slate near Zeehan but some thin sections show the tiny quartz grains to be strongly elongate parallel to the fine muscovite giving a texture somewhat similar to some of the simpler varieties of Whyte Schist. Specimen No. 9010 from the core of the anticline at Bramble Cove is tightly contorted and in thin section looks like a fine-grained contorted mica schist. No. 9013 contains a little fresh, light brown biotite.

The rocks outcropping along the north-eastern shoreline of Bathurst Harbour and across the plain to the north ("Old River Quartzite and Metapelite" of Baker, 1957) resemble those at Bramble Cove. Quartzite is the dominant rock-type; the purer varieties are white but some weathered examples are brown and ferruginous. They are thinly bedded with a bedding-plane cleavage. Quartzites (9068 and 9069) are similar to the feldspathic quartzite (9015) from Bramble Cove but contain a little more feldspar (about 20% of albite and microcline).

The phyllites are light-coloured with a cleavage oblique to the bedding. In thin-section, specimens such as 9070 are composed mainly of closely packed sericite flakes forming a strong foliation with about 10% of quartz as lenticular crystals or aggregate along the foliation. Jennings (1960, p. 183) observed ripple marks, cross-bedding and mud-cracks in quartzites at the mouth of the Old River. These features extend for at least a mile south along the eastern shore of the harbour. Ripple marks and cross-bedding were also observed east of the North River and on the northwest slopes of Mt. Berry.

The sediments forming a narrow belt from Ila Bay north along the eastern side of the Spring River ("Ila Bay Quartzite and Conglomerate" of Baker 1957, "Younger Precambrian" of Jennings 1960, p. 183) differ somewhat from the rocks at Bramble Cove and the Old River. Quartzites, which are the dominant rock type, are white to grey and commonly flecked with tiny fragments of black shale or have abundant clastic muscovite flakes along the bedding. They have a distinct cleavage oblique to the bedding and some contain isoclinal folds (No. 9053).

The coarser varieties (9048, 9052) are poorly sorted with large quartz grains (0.3 mm.) set in a fine-grained (0.5 mm.) quartz-sericite matrix. Bedding is outlined by parallel clastic muscovite flakes and the oblique cleavage by tiny sericites. These rocks grade into coarse siliceous siltstones (9053, quartz 0.05 to 0.02 mm.) with up to 40% sericite.

The pelites (9041, 9054) are siliceous siltstones containing about 55% quartz (.01-.02 mm.), 40% fine parallel sericite giving a foliation and about 5% clastic muscovite. Accessories are tourmaline, rutile and zircon.

The rock underlying the saddle between the Spring and Crossings Rivers is a slaty siltstone (No. 2357). It is buff coloured with a strong cleavage. Original bedding strikes at about 340° and dips east at 40°, and the strongest foliation (S_2) strikes at about 160° and dips east at about 50°.

A thin section shows that the rock is finely grained and consists of quartz and fine muscovite. Bedding which consists of compositional layering has been deformed and dismembered. Parallel to bedding is a foliation shown by parallel mica flakes. This foliation (S_1) has been crenulated and a strong, closely spaced, fracture cleavage S_2, has developed along the appressed limbs of the asymmetrical contortions.

White quartz-conglomerates and pebbly quartzites are interbedded with the quartzites at Ila Bay, particularly on the eastern side of the belt. These contain subangular to subrounded fragments of metamorphic quartzite (with a strong foliation &c.), fine-grained mica-scist, phyllite, undulose quartz, muscovite flakes, tourmaline grains and also fragments of fine-grained quartzite and phyllite similar to the adjacent rocks with which the conglomerates are apparently interbedded. The sediments have not been recrystallized and show little evidence of deformation. The matrix of the granules and pebbles is coarse to fine sand-size rock- and mineral-fragments.

In general, the rocks at Ila Bay are similar to sediments thought to be of younger Precambrian age in north-western Tasmania e.g., the Oonah and Burnie Quartzite and Slate. The presence of conglomerates is important as it suggests a close relationship between the Ila Bay sediments and the thick conglomerates at Mt. Rugby &c. Jennings (1960, p. 183) observed pebbles in these sediments at the Spring River and suggested that the presence of worm casts indicated a possible correlation with the Rocky Cape Group.

II. *Orthoconglomerate—quartzite Assemblage.*

Massive white quartzose conglomerates containing fragments of the older Precambrian metamorphic rocks cap many of the higher mountains in the area. Conglomerate extends from the peak of Mt. Rugby south to the shoreline at the Narrows and apparently further to Mt. Beattie. The formation strikes at 170° and dips west at 75° and is presumed to overlie the schists of Bathurst Harbour unconformably. The actual contact is not exposed and the attitudes of the rocks above and below the contact are similar.

The conglomerates contain pebbles and boulders up to six inches in diameter. Breccias and pebbly sandstones are common. The sedimens are sheared and smashed in places but contain a single indistinct foliation. The elongate, ellipsoidal form of some pebbles is probably an original feature and not due to deformation of the conglomerate.

Thin sections (9057, 9058) show that the rocks are moderately well-sorted, contain angular to subrounded fragments and have no cement and very little matrix. The rock-fragments include metaquartzite, mica-schist, phyllite and slate, most of which are identical with the metamorphic rocks of the older Precambrian in the vicinity, with some pelitic fragments rather similar to members of the younger Precambrian *quartzite-slate assemblage.* In general there is no matrix or cement and the particles are held together by phyllite and slate fragments moulded around and between the quartzite particles, but a thin sericite layer cements some fragments.

Similar conglomerate extends from Mts. Berry, Misery and Mackenzie south to Bathurst Channel. Pebbles range up to eight inches in diameter and are mostly pelitic rocks in the lower part of the formation and quartzites in the upper part.

The age of these unfossiliferous conglomerates is not known. Stefanski (1957, p. 94) remarked on their similarity to the Ordovician Owen Conglomerate and Jennings (1960, p. 180) suggested that they might be Cambrian. The conglomerates are not unlike the Owen but are much more siliceous and are better sorted than the conglomerates of the Cambrian Dundas Group. They are not unlike Precambrian conglomerates in the Donaldson Group (Spry 1964) and as conglomerates occur within the quartzites and slates at Ila Bay, it is suggested that the conglomerate at Mts. Rugby, Berry, Mackenzie, Misery and Beattie is younger Precambrian in age.

Conglomerates, sandstones and slates which outcrop on the eastern slopes of Mt. Mackenzie down to Opossum Point ("Opossum Conglomerate" of Baker 1957) are intermediate in character between the orthoconglomerates described above, and the paraconglomerates and associated sedimens described above, and the paraconglomerates and associated sediments described later from Joe Page Bay.

Quartzose conglomerates (9024, 9028) in the upper part of the formation are similar to those of Mt. Rugby &c. except that the metamorphic rock fragments are held together by a recognizable sand-silt matrix (sericite and quartz) which constitutes about 30% of the rock. Grey paraconglomerates (9023, 9025) are rich in dark-coloured (carbonaceous) slate fragments and have an abundant matrix. The matrix is cleaner in 9023 and many of the larger fragments are rounded to well-rounded. Grey quartzites (9029) are somewhat similar to those at Ila Bay and the north-eastern part of Bathurst Harbour. They consist dominantly of sand-grade, angular quartz fragments with a few particles of mica-schist, slate and meta-quartzite in a weakly foliated sericitic matrix (10%). Interbedded grey sandstones and siltstones (9027) contain a single cleavage oblique to well developed bedding.

III. *Paraconglomerate—greywacke Assemblage.*

Dark coloured conglomerates, greywackes, slates and shales occur around the coastline of Joe Page Bay ("Long Bay Shale") of Baker 1957 and Jennings 1960).

The sediments at Joe Page Bay are dark greywacke sandstones and shales or slates displaying graded bedding, slump structures, flame casts &c., with a few lenses of dark conglomerate. The rocks dip steeply, some being overturned, have a cleavage oblique to the bedding and have been folded. The authors cannot agree with the statement of Jennings (1960, p. 181) that "the rocks have suffered little more deformation than our Permian sequences". The name Long Bay *Shale* was a misnomer as the pelites are not shales but slates and in any case, pelites are not overwhelmingly dominant.

The most common rocks are well cleaved, poorly sorted siltstones and fine-grained sandstones containing abundant labile rock fragments and minerals. Carbonaceous material gives many of the rocks a dark colour.

In thin section, greywacke sandstones such as 9035, 9036 and 9037 consist of closely packed, elongate and angular fragments of mica schist, phyllite, slate, metamorphic quartzite and quartz. The matrix is difficult to recognize but irregular wisps and sheaves of parallel authigenic sericite and chlorite occur between the fragments. Fresh albite constitutes not more than 5% of the rocks.

Finely grained dark conglomerates such as 9022 consist of well rounded rock fragments in a dark, carbonaceous and weakly fissile silt matrix. Conglomerates such as 9033 are light coloured and consist of sub-rounded quartzite fragments in an abundant, cleaved, quartz-sericite matrix.

STRATIGRAPHY

The main conclusion which can be drawn from this petrographic study is that the rocks can be divided into two main types, each of which has equivalents elsewhere in Tasmania.

The metamorphic rocks of Bond Bay, North Inlet, and Cox Bight have a complex structural history and are identical with rocks considered to be older Precambrian elsewhere in Tasmania.

The remainder of the rocks are assigned tentativley to the younger Precambrian. The sediments at Bramble Cove, at Ila Bay and in the north east of Bathurst Harbour are similar to the Oonah (or Burnie) Quartzite and Slate. The greywacke assemblage at Joe Page Bay might be equivalent to the Cowrie Siltstone and the Interview Slate. The thick conglomerates and quartzites at Mt. Berry &c., could be equivalent to the Donaldson Group.

The sediments at Joe Page Bay differ markedly in lithology from those elsewhere in the area with the possible exception of some rocks from Clyte Bay and Varvoid Bay, described by Stefanski (1957, pp. 91, 92). Their degree of deformation is compatible with that of rocks considered to be of probable younger Precambrian age. The sedimentary structures indicate affinities with the greywackes even though they are deficient in matrix and labile minerals. They appear to grade upwards into the subreywacke assemblages at Opossum Point and thence into the orthoquartzite conglomerates of Mt. Rugby.

Stefanski (1957, p. 92) suggested a glacial origin for the rocks at Clyte Bay but no striated pebbles have been found and the sediments are regarded as " turbidites ".

The sediments do not closely resemble the Dundas Group. Sedimentary structures are developed more strongly than in the Dundas Group, and cherts are not present. Perhaps most important is the lack of volcanics either as lavas or as particles in the conglomerates and sandstones. Fragments of fine-grained volcanic rocks and chert are typical of Dundas Group sediments everywhere but appear to be absent in the Joe Page Bay sediments.

The following stratigraphic succession is tentatively suggested along with possible correlations which should be taken to indicate lithological similarities rather than necessarily time equivalents.

TABLE III.

Age	Rock Type	Locality	Similar Rocks
Younger Precambrian	Orthoconglomerate	Mt. Rugby, Beattie, Berry, Misery, Mackenzie, Opossum Pt.	Donaldson Group
	Greywackes, slates and paraconglomerates	Joe Page Bay	Cowrie Siltstone
	Subgreywacke sandstones and slates	Ila Bay, Bramble Cove, north-eastern Bathurst Harbour	Oonah Quartzite and Slate
Older Precambrian	Quartzite and phyllite	North River, Farrel Pt., Coffin Creek, (North-western Bathurst Harbour?)	Mary Group
	Schist, quartzite and amphibolite	Kelly Basin, Bond Bay, Red Pt.	Franklin Group

STRUCTURE

The area is dominated by roughly north-south strikes and westerly dips. It seems likely that the same rocks (e.g. conglomerates at Mt. Rugby and Mt. Berry) appear in several places dipping in the same direction but in view of the doubtful stratigraphy it is not possible to outline the major structure. Structural highs outlined by the older rocks trend in a northerly direction through Kelly Basin and from Bathurst Harbour to Cox Bight. The work of Taylor (1959, pp. 39-42) suggests another belt of older Precambrian rocks through the Spero Range. The older rocks are separated by strike-faulted synclinal belts of younger Precambrian sediments.

An unconformity between metamorphosed and unmetamorphosed sediments is indicated by the presence of pebbles of metamorphic rocks in unmetamorphosed conglomerates and by a marked discordance in grade of metamorphism and degree of deformation between the two major groups. It is not known whether there is more than one unconformity in the district. Some previous workers (Stefanski 1957 and Taylor 1959) have postulated conformity or lack of conformity between various units without advancing any evidence in support. It has been shown (Spry 1957b, 1962a) that unconformities within the Precambrian are very difficult to recognize and the numerous postulated unconformities in the south-west of Tasmania must be viewed with suspicion until their validity is supported by careful and detailed work.

The correlations made by Taylor and Stefanski must also be viewed with suspicion. It is reasonable to point out similarities in lithology which a worker notes between the rocks in this area and those he has examined elsewhere but correlations such as those of Stefanski (1957, pp. 98-100) and Taylor (1959, p. 41) are more likely to mislead future workers than help them.

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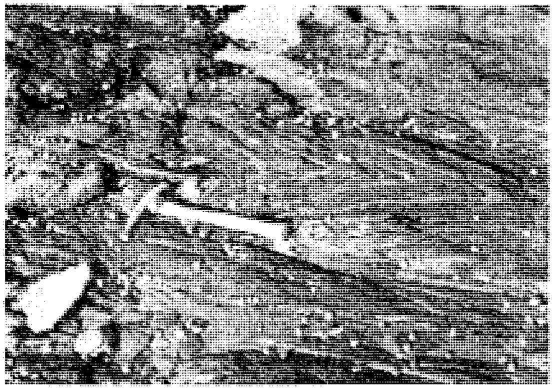

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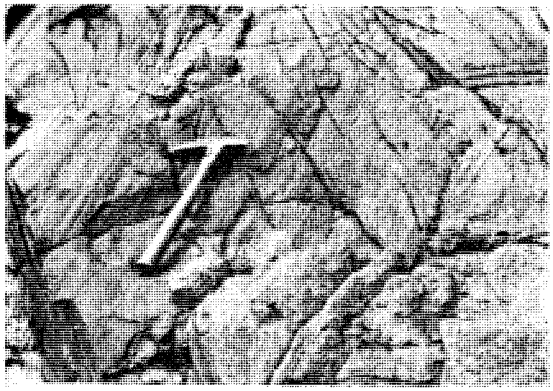

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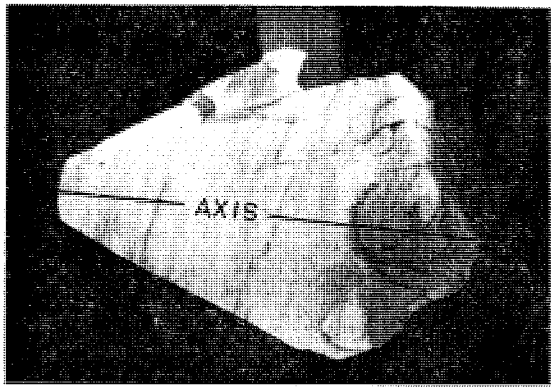

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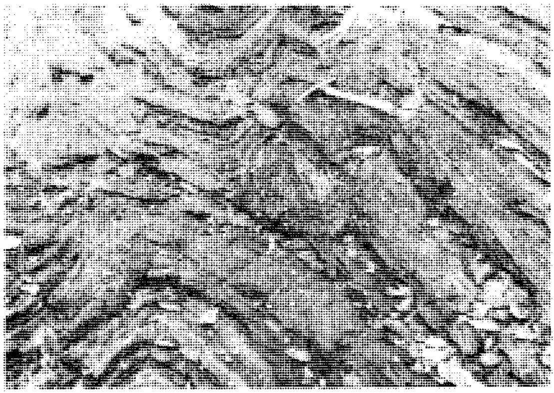

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PLATE I.—

No. 1.—Isoclinal (F_2?) folds in mica schist, Kelly Basin.

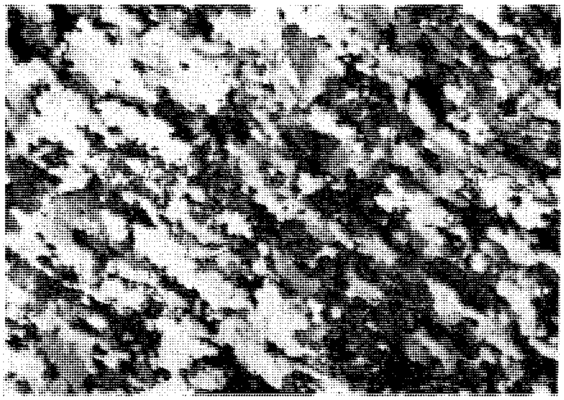
No. 2.—Amphibolite with patches of albite, Bond Bay.

No. 3.—Lineation (L_2) in garnet-mica schist, Bond Bay.

No. 4.—Fold in quartzite with lineation oblique to fold axis. Specimen No. 9072 from the North River is 3 inches long.

No. 5.—Kink-bands (F_3) in mica schist, Bond Bay.

No. 6.—Folds (F_3) in mica schist, Bond Bay.



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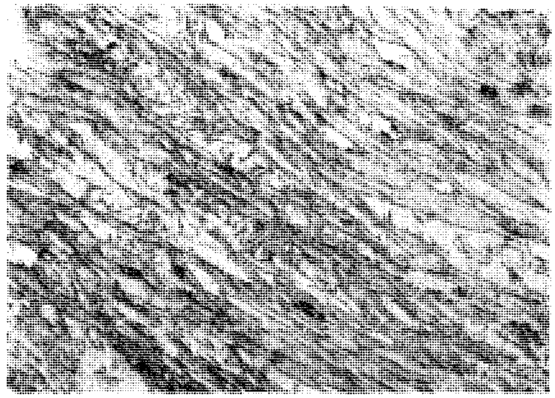

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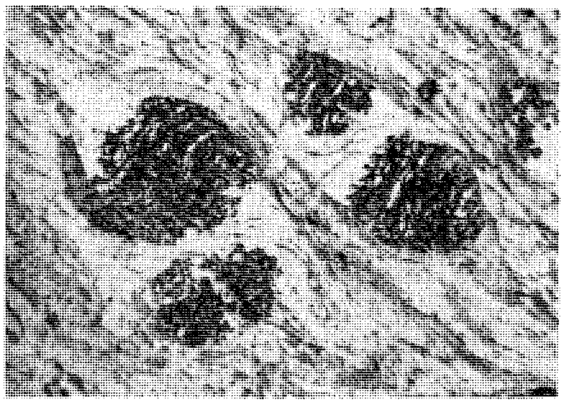

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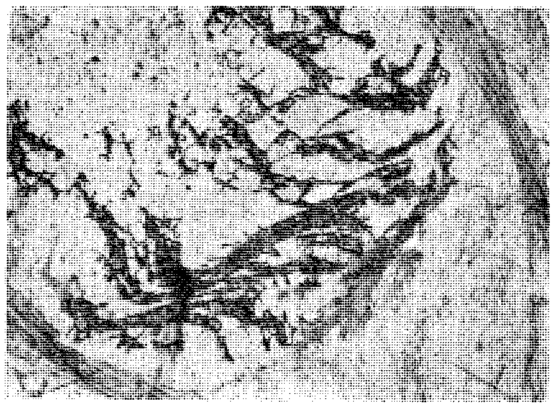

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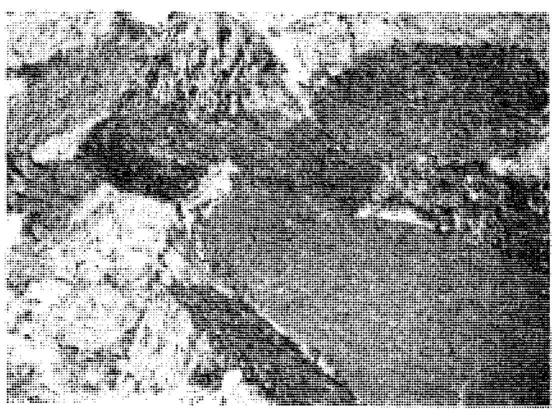

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PLATE II.—

No. 1.—Quartzite, No. 9044. Older Precambrian, Farrel Point.

No. 2.—Phyllite No. 9018. Older Precambrian, Bathurst Harbour. The main foliation is S_2 with relicts of folded S_1, between the layers.

No. 3.—Snowball garnets in mica schist, No. 4946, Coast West of Kelly Basin.

No. 4.—Skeletal garnet in schist No. 4965. Coast west of Kelly Basin.

No. 5.—Albite crystals enclosed by S_2 and including S_0 as Si. Specimen No. 9062, phyllite, Bathurst Harbour.

No. 6.—Paraconglomerate, Joe Page Bay.