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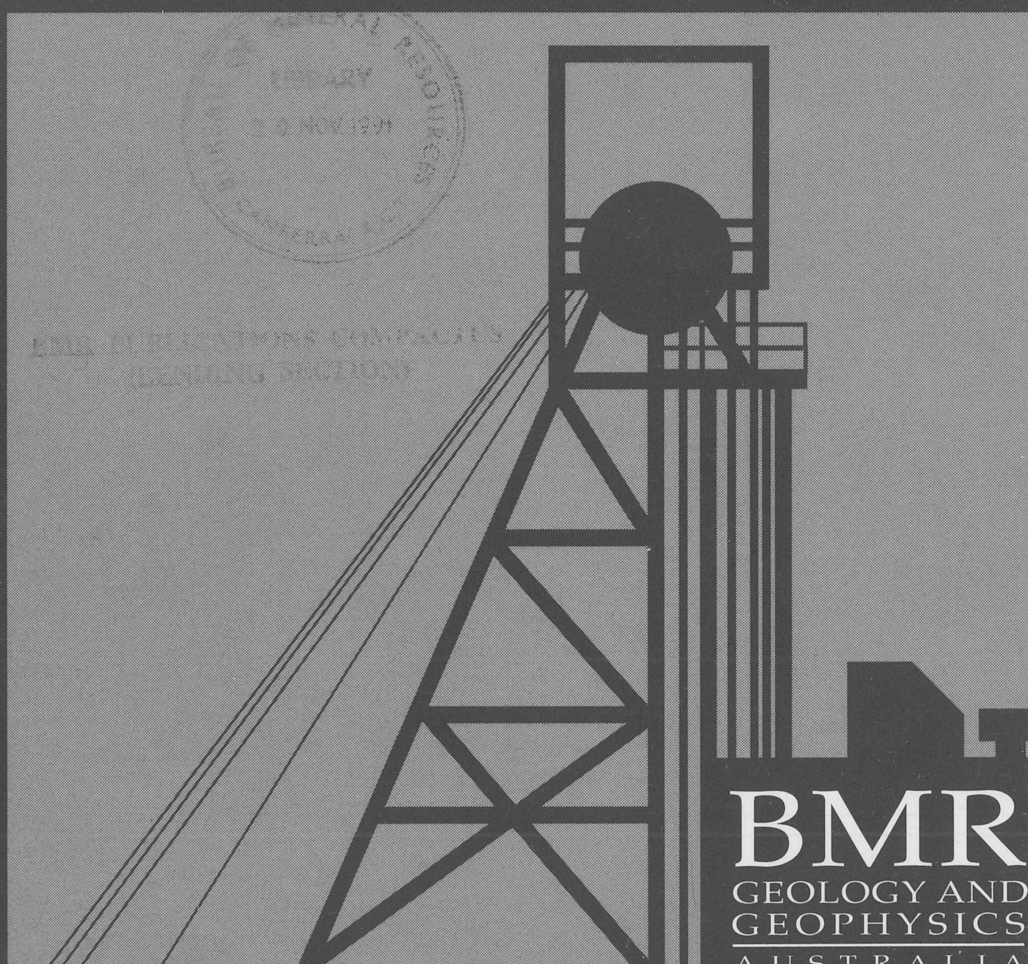
Notes on the Geology of the Blayney Area
Record 1991/66



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GEOLOGY AND
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AUSTRALIA

by
G.A.M. Henderson

MINERALS AND LAND USE PROGRAM
BUREAU OF MINERAL RESOURCES, GEOLOGY AND GEOPHYSICS

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Geoscience for Australia's future

DEPARTMENT OF PRIMARY INDUSTRIES AND ENERGY

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ABSTRACT

Geological mapping, new age determinations and re–examination of previous palaeontological and magnetic data have resulted in a provisional reinterpretation of the Ordovician volcanic stratigraphy in the Blayney district. The Angullong Tuff in the Blayney-Carcoar area has been divided into the Blayney Basalt, an entirely volcanic unit, and the Coombing Formation (new name), a unit of chert and sedimentary rocks with thin mafic sills. The Blayney Basalt occurs only to the east of a newly recognised major fault, that passes immediately to the west of Carcoar, and that in part forms the western boundary of the Carcoar Granite. A north-dipping sequence to the west of this fault contains the Mount Pleasant Basalt (formerly Mount Pleasant Andesite), overlain by a partly sedimentary unit tentatively correlated with the Coombing Formation, overlain in turn by a strongly magnetic volcanic unit now believed to correlate with the Walli Basalt farther to the west which is also strongly magnetic. Recently published age determinations on dykes intruding sedimentary rocks immediately above the Mount Pleasant Basalt at Junction Reefs indicate an early to middle Ordovician age. These sedimentary rocks are therefore considerably older than the late Ordovician Malongulli Formation with which they were previously correlated. The oldest rocks indicated by fossils are sedimentary rocks beneath the base of the main volcanic succession south of Panuara which are known to contain middle Darriwillian graptolites.

The Ordovician volcanic succession has been intruded by a large number of bodies ranging from moderate-sized granite plutons of Siluro-Devonian age to small bodies of intermediate and basic composition. Many of the latter are chemically and petrographically similar to the volcanics they intrude and hence are probably cogenetic. Age dating has recently confirmed an Ordovician age for the Prince of Wales Monzodiorite but earlier dating of intrusions of similar composition at Cadia give a Silurian or Devonian age.

The structure consists essentially of folded sequences with an overall plunge to the north, cut by several major north–south faults. The major fault at Carcoar marks a boundary between relatively broad open folds to the west and tight, complex folding to the east.

The Ordovician volcanics, sediments and related intrusives are host to deposits of gold, copper, iron and minor silver and barite in various associations, as well as one deposit containing cobalt, uranium, molybdenum, copper and nickel.

CONTENTS

ABSTRACT . . . . **iii**

INTRODUCTION **6**

GENERAL 6
PREVIOUS WORK 6
1989 MAPPING PROGRAM 7

STRATIGRAPHY **7**

GENERAL REVIEW 7
RECENT OBSERVATIONS 10
Abercrombie Beds 10
Mount Pleasant Basalt 11
Coombing Formation 11
Blayney Basalt 13
Wombiana Formation 14
Quigleys Hill Tuff 14
Walli Basalt 15
Granitic intrusives 15
Intermediate and basic intrusives 15

STRUCTURE **17**

GENERAL REVIEW 17
RECENT OBSERVATIONS 17
Folding 17
Faulting 18
Shear zones and foliation 18

CHEMISTRY OF THE IGNEOUS ROCKS **19**

MINERAL DEPOSITS **19**

ACKNOWLEDGEMENTS **21**

REFERENCES **22**

FIGURE **24**

1. Geological sketch map of Blayney area. 24

TABLES **25**

1. Chemistry of some volcanic rocks. 25
2. Chemistry of some intrusive rocks. 26

APPENDIX **27**

1. Tabulated rock sample data in rockchem database. 27

INTRODUCTION

General

As a result of an agreement between the Bureau of Mineral Resources (BMR) and the Geological Survey of New South Wales (GSNSW) under the National Geoscience Mapping Accord BMR undertook, as part of its Lachlan Fold Belt project, to map an area of approximately 2500 km^2 on the Molong High around Blayney in the Bathurst 1:250 000 Sheet area. This area is underlain by Ordovician mafic volcanics and associated sedimentary rocks and is bounded by Tertiary volcanics to the north and the Wyangala Batholith to the south. The eastern and western limits of the area were to be the Silurian and Devonian rocks of the Hill End and Cowra Troughs respectively. This work was designed to advance understanding of the detailed stratigraphy of the volcanics and their relationship to the very numerous small intermediate to basic intrusions of similar composition. The volcanics and associated sedimentary rocks are host to economic deposits of gold such as at Browns Creek and Junction Reefs, numerous small deposits of copper and iron, and minor deposits of other commodities. It was hoped that more detailed knowledge of the geology and geological history of the area would enhance prospects of discovery of new mineral deposits. This mapping was only partly complete when the agreement with GSNSW was reviewed. Rather than map only the Ordovician Volcanics BMR has now agreed to map the entire Blayney 1:100 000 Sheet area, although this includes only some of the Ordovician volcanics. The results of the BMR mapping will be incorporated by GSNSW in a 2nd edition of the Bathurst 1:250 000 geological Sheet. These notes give an outline of the geology of the Ordovician volcanics incorporating the recent incomplete mapping. Grid references in text are the Australian Map Grid in metres as shown in Figure 1.

Previous Work

The 1st edition of the Bathurst Sheet 1:250 000 Sheet (Packham, 1968) shows mainly the results of mapping carried out in the 1950s and early 1960s by staff and students of Sydney University Geology Department. Published papers dealing with the area of Ordovician volcanics west of Blayney extending to Panuara, Mandurama and Woodstock include those by Stevens (1952, 1954, 1955, 1957), Stevens & Packham, (1953) and Smith (1966). Unpublished work in the form of student theses was also drawn on, e.g. Fitzpatrick (1963), Offenberg (1963) and Shaw (1964). The geology of the area is summarised in Packham (1969). Since publication of the 1st edition of the Bathurst Sheet further regional and detailed studies have been carried out by Percival (1976), Berents (1977), Close (1978) and Webby & Packham (1982) and mineral deposit studies at Browns Creek (Taylor, 1983), Cadia (Welsh, 1975), Junction Reefs and other deposits. In recent years much exploration work has been done by mining companies who have produced detailed geological maps of small areas and made some attempts to show more general stratigraphic interpretations, in some instances indicating considerable modification to that shown in published maps. An unpublished 1:50 000 scale geological map of the Blayney area accompanies an internal report on mineralisation in the area by the Geological Survey of New South Wales (Bowman & others, 1977); it also includes some modifications to the previously published maps.

1989 Mapping Program

A total of about six weeks in one week periods was spent in the field between May and October 1989 mapping mainly in the immediate Blayney area. Samples of the volcanic and intrusive rocks were collected for petrography and chemical analysis. The limited amount of mapping done indicates that greater subdivision of the volcanic units in the eastern part of the area is possible than that shown previously. The mapping was insufficient to gain a complete understanding of the detailed stratigraphy and structure. However, the new data provide a basis for follow up work, which should clarify some of the stratigraphic and structural problems. It should also help to determine a chemical and petrographic basis for distinguishing between intrusive bodies which are Ordovician, and penecontemporaneous with the volcanics, and bodies that are possibly younger. The preliminary, revised geological interpretation based on the recent fieldwork is shown in Figure 1.

STRATIGRAPHY

General Review

The Ordovician succession in the west of the area has been divided into four main stratigraphic units which, until now, have formed the basis for interpreting the stratigraphic succession in the area as a whole. These units are, from the base, the Walli Basalt, the Cliefden Caves Limestone Group, the Malongulli Formation and the Angullong Tuff. The Walli Basalt is equivalent to the previous Walli Andesite, the change in name having recently been made to more closely reflect the dominant lithology (Wyborn, 1988). The Cliefden Caves Limestone Group (Webby & Packham, 1982) is the equivalent of the Cliefden Caves Limestone of Stevens (1952).

The succession in the west has been correlated with that in the east by Smith (1966). In the Junction Reefs area the lowermost volcanic formation, which Smith interpreted as correlating with the Walli Basalt, is named the Mount Pleasant Basalt (formerly Mount Pleasant Andesite). This formation overlies the sedimentary Abercrombie Beds and is overlain by another sedimentary formation until now interpreted as correlating with the Malongulli Formation. This upper sedimentary formation is, in turn, overlain by an upper volcanic sequence formerly all mapped as Angullong Tuff. The topmost part of the upper volcanic se quence consisting of bedded tuffs was named the Forest Reefs Beds by Offenberg (1963).

The western and eastern successions are separated west and northwest of Junction Reefs by an area of sedimentary rocks all mapped as Malongulli Formation by Smith (1966). This central, sedimentary sequence appears to be far thicker and more extensive than the other sequences mapped as Malongulli Formation in the type area and to the east, suggesting that a longer depositional period is represented here. Distinctive markers mapped by Smith within this thick sequence are three north-trending limestone conglomerate beds. The conglomerates cross the Belubula River at Flyers Creek and are reported to contain rock fragments of andesite, basalt, shale and siltstone as well as limestone.

The rocks mapped in the Bathurst 1:250 000 Sheet as Angullong Tuff in the east, around Blayney, have been later subdivided informally into the Blayney Andesite (now Blayney Basalt), Cowriga Limestone and Quigleys Hill Tuff (Bowman & others, 1977). Bowman and others (1977) also mapped a sedimentary unit at Blayney which they named the Wombiana Formation; they interpreted this unit as Silurian.

The Cowriga Limestone, consisting of shelf-carbonate rocks interbedded with thin tuffaceous mudstone (Taylor, 1983), occurs at Browns Creek and was interpreted by Bowman and others (1977) as a block downfaulted into older, surrounding Blayney Basalt. Taylor (1983) mapped it as forming the core of a north-plunging anticline and infers that it is near the base of the Blayney Basalt. Other limestone outcrops farther to the north along Cowriga and Limestone Creeks (Lishmund & others, 1986) may also belong to this formation.

The Blayney Basalt was first mapped as the Blayney Andesite by Booker (1939) in a large area to the east of Blayney. The unit was subsequently extended by Bowman and others (1977) to include similar rocks northwest of Blayney including those surrounding the Cowriga Limestone.

The Quigleys Hill Tuff and Wombiana Formation have been mapped along narrow, northwest-trending belts through the town of Blayney. The Quigleys Hill Tuff was interpreted by Bowman and others (1977) as forming the flanks of a syncline within the Blayney Basalt. The core of the supposed syncline was occupied by sedimentary rocks of the Wombiana Formation which was inferred to be a probable southeastern extension of a rift of Silurian rocks east of Orange. However this conclusion was speculative because of the intervening cover of Tertiary basalt. No other, more direct, evidence of a Silurian age for the sedimentary rocks was given at that time, but more recently Silurian fossils have been reported from an exposures of limestone at the BY Gold Mine (pers. comm., John Surman, BHP Gold Mines Ltd, 1990) within this unit.

The Ordovician age of the volcanic and sedimentary sequences in the western half of the area has been established from fossils, particularly graptolites. A varied fauna of corals, trilobites, brachiopods etc. in the Cliefden Caves Limestone Group is also of Ordovician age (Packham, 1969; Webby & Packham, 1982). The graptolites have been found in a number of places, mainly in rocks mapped, or previously mapped, as Malongulli Formation. The oldest assemblages occur in the central, thick sedimentary sequence at several closely spaced localities near Cadiangullong Creek around GR 827878 (Smith, 1966). These assemblages are interpreted as early to middle Darriwillian (Da1-Da3) in age.

Other graptolite localities are:

- Mandurama Ponds Creek east of Junction Reefs (GR 871768) (Stevens, 1957)
- two localities west of 'Millamolong', 12 km west-northwest of Mandurama (GR 787814 and GR 800808) (Smith, 1966)
- Belubula River north-northwest of 'Millamolong' (GR801835) (Stevens, 1954)
- several localities north of Panuara (GR 795950,GR 828949 and GR 829943) (Stevens, 1954); (GR 808968, GR 808974, GR 815985 and GR 817987) (Stevens & Packham,1957)
- 1.6 km north-northwest of Woodstock (GR 698662)(Stevens, 1951)
- several localities in the type area of the formationnear Malongulli trig. (GR 719800) (Sherrard, 1953; Moors, 1970; Percival, 1976; Jenkins, 1978).

Most of these other localities contain the graptolite *Hustedograptus (Glyptograptus) teretiusculus*, which is the zone graptolite of late Darriwillian (Da4) (Cas & Vandenberg, 1988). A somewhat younger age of late Eastonian (Ea3) to early Bolindian (Bo1) is interpreted by Webby and Packham (1982) for assemblages in the type area of the Malongulli Formation where it overlies the Cliefden Caves Limestone Group. However, *Hustedograptus teretiusculus* was recorded there also by Sherrard (1953). A probable Eastonian age is suggested by the graptolites recorded by Stevens (1951) north of Woodstock.

An older age for the central thick sequence of Malongulli Formation to the east is inferred by Webby (1976) who refers to it as 'Smith's Malongulli Formation'. It is certainly possible, given the latest interpretation of late Eastonian to early Bolindian for the type area of the Malongulli Formation (Webby & Packham, 1982), that this and all the sedimentary units in the north and east with *Hustedograptus teretiusculus* belong to a unit or units older than the Malongulli Formation. On the other hand, no sedimentary formations containing graptolites more directly comparable with those in the type area of the Malongulli Formation have been found at a higher level in the succession in the east.

An older age for Smith's Malongulli Formation in the east and north would raise the possibility that some of the volcanics there now mapped as Angullong Tuff are older than previously thought and correlate with the Walli Basalt. The Walli Basalt immediately beneath the Cliefden Caves Limestone Group gives a strong aeromagnetic signature which is possibly matched by the strong signature in what has previously been regarded as Angullong Tuff between Carcoar and Forest Reefs. A weak magnetic signature in the Mount Pleasant Basalt raises doubts about a direct correlation of this unit with the Walli Basalt as interpreted by Smith (1966).

Possible Mount Pleasant Basalt or volcanics of the same age crop out at Panuara. The volcanics there were mapped previously by Stevens (1954), Offenberg (1963) and Smith (1966) as Angullong Tuff. This seems unlikely, as the volcanics appear to dip beneath sedimentary rocks farther to the north containing late Darriwillian graptolites, and to directly overlie the central thick sedimentary sequence containing the early to middle Darriwillian graptolite fauna.

An indication of the age of the Angullong tuff in the type area is given by late Ordovician graptolites from two localities (GR 728870 and GR 755915) near the top of the formation north of Cliefden Caves (Stevens 1954). The first of these indicates a late Bolindian age according to Jenkins (1978). No graptolites have been found in rocks in the area east of the Wongalong Fault previously mapped as Angullong Tuff but now as signed to other formations.

The Angullong Tuff is unconformably overlain by Silurian sedimentary rocks in the northwestern part of the area. Jenkins (1978) has subdivided the Silurian succession west of Panuara into three groups made up of a number of formations. The three groups are, in ascending order, the Cadia, Waugoola and Panuara Groups. They are separated by appreciable time breaks or disconformities and range in age from early to late Silurian. These subdivisions presumably apply to the Silurian rocks between Cadia and Forest Reefs, but have yet to be identified there.

A small area of limestone containing Silurian fossils not shown on the map, about 6 km northeast of Woodstock, is reported by Close (1978). The position of this limestone in the sequence and the age of adjacent andesitic volcanics awaits clarification. The limestone and volcanics appear to occupy a fault-bounded wedge shown as unnamed andesitic volcanics in Figure 1.

Various intrusive bodies crop out in the area. Two medium-sized bodies, the Carcoar and Barry Granites, occur in the east and southeast of the area. The Carcoar Granite ranges from normal granite to quartz diorite, quartz monzonite and tonalite (Rayner, 1960). One of the more basic components, named the Long Hill Diorite by Bowman and others (1977), occurs on the northwest side. The Barry Granite ranges from massive, hornblende granite in the north to foliated, biotite granite in the south (Vallance, 1969).

The sedimentary and volcanic rocks in the south are in truded by plutons of the northern extremities of the Wyangala Batholith. The Wyangala Batholith is a composite body ranging from granite to quartz diorite and is commonly foliated.

The volcanic and sedimentary succession is also intruded by numerous small igneous bodies of mostly intermediate and basic composition which are most common in the Carcoar-Junction Reefs-Cadia area. Many of these bodies are shown in the Bathurst 1:250 000 Sheet (Packham, 1968), and others have since been mapped by students and mining exploration companies. These intrusives range in composition from syenite through monzonite and diorite to gabbro. Smith (1966) assigned names to several of the intrusives and described their mineralogy, including that of the largest in the area, the composite Prince of Wales Diorite (now Prince of Wales Monzodiorite). This unit has been interpreted as consisting of several smaller separate bodies ranging in composition from monzonite to diorite (Bowman & others, 1977).

The age of all the intrusives, including the granites, is shown as queried Middle Devonian in the Bathurst Sheet. Welsh (1975) describes the monzonite intrusions at Cadia and suggests either an Ordovician or middle Devonian age. Isotopic age determinations on the Cadia intrusions by Ambler & others (1977) give a Rb/Sr age of 4094 m.y., an age at about the Silurian-Devonian boundary. However, the described alteration of the rocks sampled indicates that the age determined may be the age of alteration and mineralisation rather than the primary age of the rocks. A late Silurian age determination for the Carcoar Granite is referred to by Perkins & others (1990).

Most of the intrusions are wholly within Ordovician rocks so that from field relationships alone they could be Ordovician or any younger age. Smith (1966), however, mapped one small body of augite-quartz microdiorite southwest of Panuara, which he named the Weemalla Diorite, as intruding Silurian rocks now assigned to the Panuara Group. The Panuara Group is the upper most Silurian unit and this intrusion therefore can be no older than latest Silurian. The Stokefield Metagabbro is reported as being intruded by the Carcoar Granite (Stevens, 1975), which places a younger limit on the age of the metagabbro.

Recent Ar/Ar isotopic age determinations (Perkins & others, 1990) indicate early Ordovician ages (479.2 ± 1.1 m.y. and 467.9 ± 1.1 m.y.) for diorite dykes in the Junction Reefs mine area, and a late Ordovician age (439.3 ± 1.0 m.y.) for the Prince of Wales Monzodiorite north of Junction Reefs. A Rb/Sr biotite-whole rock isochron age of (438.3± 2 m.y. was determined on a sample of Prince of Wales Monzodiorite from GR848802 in this study.

RECENT OBSERVATIONS

Abercrombie Beds

The sedimentary Abercrombie Beds crop out around Mandurama where they appear to form the oldest part of the succession. Good exposures are observable in road cuttings but natural exposures are uncommon. The unit in this area appears to consist mainly of siltstone and shale with some minor interbedded quartz sandstone and minor volcanics. Sandstone is more common in the lower parts of the sequence south of Lyndhurst. Dips are generally in a northerly direction and well-developed cleavage, mostly striking north-south, is commonly present. The Abercrombie Beds here are intruded at their base in the south by the Wyangala Batholith.

It is not clear whether sedimentary rocks in the Neville area, formerly mapped as part of the Abercrombie Beds, correlate with the Abercrombie Beds to the west or interfinger with younger volcanics. In an area of poor exposure chert and mudstone dipping and younging south and southeast are interbedded with volcanics younger than the Abercrombie Beds 2 km north of Neville, but other sedimentary rocks west of Neville seem, from the attitude of bedding, to underlie basal volcanic units farther to the west. Consequently the boundary of the Abercrombie Beds in this area as shown in Figure 1 is very approximate.

The thick sedimentary sequence straddling the Belubula River immediately east of the Narambon Fault, formerly mapped as Malongulli Formation, is now included in the Abercrombie Beds because of apparent continuity of the shaly sediments in this area with the Abercrombie Beds to the south. The correlation depends not only on the lithology but also on whether or not the overlying volcanics around Panuara belong to the Mount Pleasant Basalt. No fieldwork was done in this area north of the Mandurama-Canowindra road, and apparent continuity with the Abercrombie Beds to the south does not allow for possible faulting.

Mount Pleasant Basalt

The Mount Pleasant Basalt north of Mandurama consists of two north-dipping units of basalt, tuff and volcanigenic sandstone separated by mudstone that crops out extensively near the Belubula River around Golden Gully (GR 945765), 3km northeast of Mandurama. A previously mapped coarse-grained gabbro sill occurs between the lower volcanic unit and the mudstone unit which is interpreted as an interfingering of the Abercrombie Beds (Oab). The lower volcanic unit overlies sedimentary rocks of the Aber crombie Beds.

The volcanic units in the Mount Pleasant Basalt extend east to near Carcoar where they appear to turn abruptly to the south and then lens out north of the Mandurama-Neville road. However, a major north-south shear zone and fault along the western side of the Carcoar Granite extends south and probably truncates the Mount Pleasant Basalt west of Carcoar. Consequently, the previously inferred Mount Pleasant Basalt south of Carcoar (Bowman & others, 1977) may belong to another volcanic unit, possibly the Blayney Basalt as shown in Figure 1.

The Mount Pleasant Basalt north of Mandurama contains indistinct ?dykes of hornblende diorite of similar texture to that of the basalt. The ?dykes can be readily detected, however, by their high magnetic susceptibility in contrast to the low susceptibility of the basalt itself.

Coombing Formation

An extensive folded sequence of chert with interfingering basalt sills, and minor black shale occurs to the east and south east of Carcoar. The sequence, which appears from limited structural data to form a south-southwest-trending synclinorium with its axis through the summit of Mount Macquarie, was previously mapped as undifferentiated Angullong Tuff. A typical part of this sequence, containing several sills and volcanigenic sandstone interbedded with the chert, is well exposed in a deep road cutting immediately east of Carcoar Dam (GR 023776). The unit is also well-exposed in a gorge along Coombing Creek, 5 km south of Carcoar. The unit is provisionally named the Coombing Formation.

Rocks mapped by Smith (1966) and Fitzpatrick (1963) as Angullong Tuff between Carcoar and Junction Reefs could belong to the Coombing Formation, judging by the presence of fine-grained rocks resembling chert interbedded with the volcanics in this area. However, a high magnetic anomaly in the northern part of this area contrasts with a low anomaly in the type area, and seems to suggest that this part, at least, is not Coombing Formation.

Probable Coombing Formation also occurs east of Barry, particularly on Dummy Hill (GR 156751) where massive chert similar to that on Mount Macquarie crops out. Interbedded shale, chert and volcanics 5 km north of Neville are also regarded as probable Coombing Formation.

A distinctive andesite with large black prisms of horn blende crops out about 1km north of Dummy Hill. The andesite is similar in hand specimen to hornblende andesite immediately north of the Belubula River near the top of the sedimentary sequence at Junction Reefs. It is also similar to another hornblende andesite in the overlying volcanics to the northeast at GR 894850. Apart from these hornblende andesites the sills in the Coombing Formation are pyroxene basalts similar to those in the Blayney Basalt (see below).

Most of the Coombing Formation crops out south of the Carcoar Granite and southwest of a fault between Barry and Moorilda. However, two small areas of possible Coombing Formation occur near Blayney. One is on top of a hill 3 km south-southwest of Blayney (GR 079839) where banded cherty siltstone interbedded with coarse and medium-grained volcanics and some coarse cobble conglomerate crops out. The conglomerate contains clasts of porphyritic, greenish basalt resembling some of that in the Blayney Basalt. The siltstone and volcanics appear to overlie the surrounding Blayney Basalt. The other area is along the Guyong road about 4 km north-northeast of Blayney where a fine-grained cherty rock is exposed.

The southern limit of the Coombing Formation in the Neville area is uncertain. Some of the sedimentary rocks around Neville, as discussed above, probably belong to the Abercrombie Beds.

The sedimentary rocks overlying the Mount Pleasant Basalt in the Junction Reefs area, now included in the Coombing Formation, are almost certainly older than the Malongulli Formation because of the early Ordovician age, referred to above, of the diorite dykes that intrude them. These sedimentary rocks appear to represent the basal part of the Coombing Formation in this area. Smith (1966) recognised three dominant lithologies along Mandurama Ponds Creek:

- Cherty shales and siltstones
- Labile arenites
- Andesites

He noted that the cherty shales and siltstones were the most common, with arenites mainly at the base of the sequence. He recorded a total thickness of 1650 m. The sedimentary rocks appear to thin rapidly to the east or else are partly cut out by faulting or a local unconformity. Small outcrops of chert around GR 923797 are the only major sedimentary rocks due north of Mandurama apart from one or two thin chert interbeds in the volcanics on the ridge immediately to the north. The whole sedimentary formation there appears to be no more than 200-300 m thick assuming the area of chert or no outcrop is all underlain by sedimentary rocks.

A thin sedimentary unit southeast of Carcoar, immediately east of the Stokefield Metagabbro, that includes tuffaceous siltstone at a new excavation near the old Carcoar mine site and black shale 2 km to the south, could be the same sedimentary unit as the basal Coombing Formation west of Carcoar. The connection is obscured, however, by the Stokefield Metagabbro and Carcoar Granite, and by the probable fault on the western side of these intrusions.

Blayney Basalt

The Blayney Basalt is exposed in many places around Blayney. It is not clear whether this unit underlies or interfingers with the Coombing Formation. A thick volcanic unit along a ridge east of the Blayney-Neville road about 6 km north of Neville represents part of the southern extremity of the Blayney Basalt. This unit may be a reappearance, on the eastern flank of the synclinorium through Mount Macquarie, of the basalt unit near the base of the Coombing Formation south of Carcoar. The Blayney Basalt is probably overlain by part of the Coombing Formation 5 km north of Neville, on the western side of the Barry Granite, judging by the southeast facing of bedding in the Coombing Formation dipping to the southeast. The Blayney Basalt is widespread between Blayney and Newbridge, and extends northwest from Blayney as far as Millthorpe beyond which it is covered by Tertiary basalt.

The Blayney Basalt south and southeast of Blayney is a pale or dark grey, altered rock with either distinct or indistinct clinopyroxene. The formation in this area cannot readily be subdivided. However, northwest of Blayney it can be separated into three distinctive subunits.

The first and most extensive subunit is a greenish agglomeratic basalt lava containing large black pyroxene phenocrysts. This rock forms numerous outcrops on the hills between the Blayney-Millthorpe and the Blayney-Browns Creek roads.

The second subunit is a massive, greenish, medium-grained, very crystal-rich basalt or tuff that extends along a ridge southeast from Millthorpe, east of the Blayney-Millthorpe road, and along strike to the southeast in railway and road cuttings 2 km southwest of Blayney. It also occurs in two other small areas. One is surrounding a limestone outcrop (?Cowriga Limestone) along Limestone Creek, 5 km south of Millthorpe, and the other is 5 km north of Blayney along the Grahamstown road (GR 079915).

The third subunit is a dark grey to purplish basalt (or possibly trachyandesite from chemical composition) with much calcite alteration and veining. The unit crops out along a belt immediately west of Blayney and also along the Blayney-Grahams town road (GR 077903).

The relationships between the three subunits cannot be seen in outcrop but can be inferred to some extent indirectly. If the limestone along Limestone Creek correlates with the Cowriga Limestone at Browns Creek, as inferred, it could also form the core of an anticline as at Browns Creek. Hence the massive medium-grained basalt that immediately surrounds the limestone would be the next overlying unit and the fragmental basalt with the large black pyroxenes would be the topmost unit.

The purple basalt is exposed in weathered contact with the medium-grained basalt in a railway cutting 2 km southwest of Blayney but the superposition is not clear. Textural differences between the two basalts at this exposure indicate that the purple basalt is not merely an altered variety of the medium-grained basalt. Purplish inclusions resembling the lithology of the purple basalt are found in the medium-grained basalt on the ridge southeast of Millthorpe. The inclusions suggest that the medium-grained basalt is younger than the purple basalt.

Wombiana Formation

The Wombiana Formation, consisting of shale and phyllite with limestone interbeds, underlies the town of Blayney and adjacent areas. It is not well-exposed in general, and no contacts indicating its relationship with surrounding units were found. Two interpretations are possible for its stratigraphic position. One is that the formation is indeed Silurian and unconformable on the Ordovician volcanics as interpreted by Bowman and others (1977). This seems to be suggested by the easterly dip away from the nearby volcanics of limestone and phyllite in a small quarry on the western side of the sedimentary belt 2 km northwest of Blayney (GR 073886). An easterly dip of the stratiform orebody at the old Blayney copper mine to the south (GR 078886) is reported by Bowman and others which suggests that formations there also dip to the east. On the other hand, a drillhole at the old mine (Clift, 1969) is reported to have passed from a volcanic rock into shale, suggesting that the volcanic rocks are overlying the sediments. The directions of dip and facing in the drillhole are not known.

A southwesterly dip of about 55 in bedded tuff (Quigleys Hill Tuff?) near the supposed position of the contact of the sediments and volcanics along strike to the southeast of the copper mine is exposed in a road cutting at the entrance to the Blayney water treatment plant (GR 093842). This dip suggests that the sediments underlie the volcanics. If the sediments do, in fact, underlie the volcanics it is possible that the limestone in the Wombiana Formation immediately west of Blayney at GR 073886 correlates with the Cowriga Limestone.

Another possibility which may explain the seemingly contradictory evidence for the relationship of the Wombiana Formation with the volcanics to the west, is that the boundary is partly or wholly faulted. It is also not out of the question that both Ordovician and Silurian sedimentary rocks occur within the area mapped as Wombiana Formation. The Silurian fossils reported from the Wombiana Formation indicate that at least some of it is Silurian.

Quigleys Hill Tuff

Apart from the bedded tuff dipping 55E referred to above no other exposures fitting the description of the Quigleys Hill Tuff were observed, even in areas where it is shown by Bowman and others (1977). The tuff therefore seems likely to be less extensive than thought and is not shown in Figure 1. Further investigations around Quigleys Hill, which is 6 km south of Blayney (GR 100813), are needed to clarify the relationship of the tuff with other units. Preliminary mapping indicates that Blayney Basalt forms the crest of Quigleys Hill and occurs between any tuff previously mapped in the vicinity of the old Quigleys Hill mine, reported as being on the western slope of the hill, and shale of the Wombiana Formation along the Blayney-Barry road on the eastern side of the hill. Sandstone and slate are reported from the old Quigleys Hill mine itself whose exact position is uncertain according to Stevens (1972). It is possible, for example, that the tuff and the reported sandstone and slate are an outlier of Coombing Formation similar to that mapped as forming the core of a syncline on top of another hill (GR 079839) 3 km southwest of Blayney (see Coombing Formation above).

Walli Basalt

Coarse, agglomeratic Walli Basalt was observed in outcrop along the Mandurama-Canowindra road about 15 km west of Mandurama but no detailed mapping was done in the area of outcrop of this formation.

An area of volcanics immediately west of the Carcoar Granite formerly mapped as Angullong Tuff and including the Forest Reefs Beds of Offenberg (1963) is now tentatively regarded as Walli Basalt. The principal reason for this is the strong magnetic response in the area, which appears to be matched by the strong magnetic response of the Walli Basalt in its type area. No obvious lithological similarity is known at this stage. Further field work and petrographic studies are needed to establish the correlation on a firmer basis. The Walli Basalt was previously correlated with the Mount Pleasant Basalt (Smith, 1966), but the weak magnetic response of the Mount Pleasant Basalt throws doubt on this interpretation.

Granitic Intrusives

The granitic intrusives crop out extensively in some places, but in many large areas of low relief granite bedrock can be inferred only from the soil characteristics in erosion gullies and excavations. Additional granite exposures have been created in recent roadcuts and in some places contacts with surrounding rocks have been exposed which indicate minor modifications to locations of granite boundaries. For example, contacts of the Carcoar Granite along its southern margin with the Coombing Formation are exposed in cuttings near Carcoar dam. A contact is also exposed in a cutting along the Mid-western Highway 2 km southwest of Blayney.

Booker (1939) shows a small area of granite about 2 km northwest of Blayney separated from the main body of the Carcoar Granite. The granite is a white, slightly greenish leucogranite, and is exposed in a quarry (GR 877895) immediately east of the Grahamstown road.

The position of a small inlier of the Wyangala Batholith east of Gallymont appears to have been misplaced about 2 km to the northwest on the 1:250 000 scale geological map. Photo-interpretation suggests that some of the boundary of the main mass of the Wyangala Batholith farther to the east has also been misplaced in a similar direction.

Medium-grained, grey granite, marginal to the main mass of the Barry Granite, crops out on the western side of this intrusion at GR 062693 north of Neville. The colour and texture in hand specimen resemble some of the intermediate intrusives within the volcanic formations to the north and northwest, but the rock is too rich in quartz to be a diorite or monzonite.

Intermediate and Basic Intrusives

A variety of intermediate and basic intrusives, ranging from dykes in road cuttings to more extensive outcropping bodies, were sampled. Some of them crop out poorly, so that their real extent is uncertain. The intrusives sampled include syenite, monzonite, diorite and gabbro. Some of these rocks are porphyritic, others even-grained. Colours range from grey to pinkish and greenish, and the rocks may be pale or dark depending on the proportion of feldspar minerals they contain. The dominant minerals in most of these rocks are plagioclase and clinopyroxene, with K-feldspar in various proportions in the monzonites and syenites. Minor minerals in some rocks include quartz and olivine. A few are rich in primary hornblende, but most amphibole is secondary actinolite after clinopyroxene.

Some rocks are foliated. For example, the Stokefield Metagabbro in a roadcut at Carcoar (GR 983780) is a dark, porphyritic rock with large white plagioclase phenocrysts aligned in a foliation dipping 45° to the southeast.

The intrusives that were sampled or observed can be grouped into several different types according to hand specimen and thin section characteristics as outlined below. Some of the intrusives are too small to be shown in Figure 1.

Coarse, pinkish syenite or monzonite

These rocks have been observed in four places in the central and northern parts of the area. A pink syenite forms part of an intrusion 2 km north of Panuara. Outcrops occur along a line striking west-northwest over a distance of at least 1 km, which suggests that the syenite has a dyke-like form. Pinkish monzonite and syenite crop out in several places at the southern edge of the Tertiary basalt 12 km west of Blayney. The limited amount of outcrop there makes it difficult to determine whether one large, or several separate intrusions, are present. Monzonite in this area at GR 970898 is porphyritic whereas syenite at GR 956898 is even-grained. Other rocks that fall into this group are the Errowan Syenite of Smith (1966), 14 km northwest of Carcoar, and another monzonite or syenite 4 km west-northwest of Carcoar.

Coarse, grey to greenish monzonite or diorite

Greenish monzonite occurs in places each side of the syenite 2 km north of Panuara. A small intrusion of diorite was mapped along a road 9 km northwest of Carcoar (GR 916856). Two monzonite intrusions were confirmed in an area where they had been mapped by Berents (1977) around 10 km south of Blayney. Berents mapped the two intrusions as associated with more extensive diorite, but in at least one place the outcrops mapped as diorite seem to be a dark, porphyritic basalt.

Gabbro

Three gabbro intrusions were observed in separate areas. Gabbro at Golden Gully, 3 km northeast of Mandurama, is probably the eastern end of a body that has been previously mapped as concordant with the surrounding formations. It is a very coarse, porphyritic, altered, greenish-grey rock consisting of both clinopyroxene and plagioclase phenocrysts in a groundmass of mainly plagioclase. A second gabbro crops out along a road 9 km northwest of Carcoar (GR 918850). This rock is also porphyritic with phenocrysts of plagioclase up to 10mm in diameter and intermediate-sized phenocrysts of clinopyroxene. The third gabbro is the Stokefield Metagabbro at Carcoar which is a dark grey rock containing large, milky-white plagioclase phenocrysts.

Clinopyroxene - mica diorite

Two related diorites, one coarse and the other medium-grained, crop out beside each other 2 km northeast of Junction Reefs at the eastern end of the Prince of Wales Monzodiorite. The medium-grained diorite forms the main part of the outcrop. It consists dominantly of plagioclase (An_{60}), lesser clinopyroxene and minor chloritised biotite. The coarse-grained variety was noted only on the southern margin. Its mineralogy is similar except that the biotite is fresh and it also contains minor olivine that is partly altered but which contains fresh cores.

Coarse mica diorite

Intrusions in two areas differ from the others so far referred to in that the mafic mineral is exclusively biotite, or an altered mica, rather than clinopyroxene. A medium to coarse greenish-grey diorite crops out in two places 2-3 km southeast of Blayney on a ridge east of the Blayney-Barry road. The rock is even-grained and consists of plagioclase and chlorite with very minor quartz. The other intrusive is a pale grey, porphyritic quartz diorite that crops out in a small area 5 km south of Carcoar (GR 982737).

Miscellaneous diorites

Several other diorites were observed in various places. Mostly they are pale or mid-grey, medium-grained and in places little different in hand specimen appearance from some of the basalts, although in thin section their holocrystalline character is clearly evident. One of these diorites forms a 2 m-wide, vertical dyke intruding the Coombing Formation in the deep road cutting immediately east of Carcoar dam. Another crops out 8 km south of Carcoar immediately north of the Mandurama-Neville road (GR 980708). A third occurs 2 km north-northeast of Barry (GR 112763).

STRUCTURE

General Review

The structure in most of the central and western parts of the area is characterised by a general northerly dip of strata and plunge of minor folds, and by several major north-striking faults. Two of these faults are the Narambon and Wongalong Faults, both named by Smith (1966). The full extent of the Narambon Fault is uncertain, but, considering its reported prominence where it is exposed immediately north of the Belubula River, it is likely to extend farther north and south than previously shown. Stevens (1954) mapped the Narambon Fault immediately north of the Belubula River and another fault at 'Ashleigh', 5 km northwest of Panuara, that forms a local eastern limit of Silurian rocks. It is possible that these are parts of the same fault. The sense of movement (west block down) is the same in both cases and they are more or less along strike from one another. A southern extension of the Narambon Fault may join up with a fault that forms the eastern limit of the Cliefden Caves Limestone Group.

The structure in the east from previous maps is less clear. A northwest strike of units is evident through the town of Blayney where Bowman and others (1977) have interpreted the Wombiana Formation as occupying a syncline. The axis of this structure appears to be parallel to the Copperhannia Thrust which forms the eastern boundary of the Molong Rise. Bowman and others (1977) also show a queried, sinuous boundary between Abercrombie Beds and overlying Angullong Tuff southeast of Carcoar suggesting north-plunging folds in this area.

A northeast-striking fault truncating the Barry Granite is shown by Berents (1977). The northern half of the Barry Granite appears to be offset to the northeast.

RECENT OBSERVATIONS

Folding

Folding of the rocks in the Blayney-Carcoar area appears to be complex. A major north-south shear zone and inferred fault 1-2 km west of Carcoar appears to form a structural discontinuity between moderately to gently north-dipping rocks to the west and more intensely folded rocks to the east. Steep west-dipping, but probably east-facing, black shale 4 km south of Carcoar indicates the folds there may have axial planes overturned to the east. Farther to the east and northeast, at Carcoar dam and Mt Macquarie, the axes of folding swing around to the northeast. A syncline with a steep to vertical northwestern limb and a gently dipping southeastern limb is exposed in the road cutting immediately east of Carcoar dam. Folding is not evident on the ground on the summit of Mt Macquarie but the elliptical distribution of outcrops as seen on air photos indicates a fold, interpreted as a syncline striking northeast.

Folding in the immediate vicinity of Blayney is inferred to have northwest-striking axes from the few outcrops showing dips and the general northwest trend of rock units. However no folds are exposed. Overturned bedding is possible on the north western outskirts of Blayney (GR 073886) where interbedded limestone and phyllite show steeply dipping, almost coincident bedding and cleavage. The Wombiana Formation through Blayney could form either an anticline or a syncline, but its boundaries may also be partly or wholly faulted.

Faulting

Direct evidence for three major faults was seen in the field. One of these faults occurs immediately west of Mandurama and is shown in the 1:250 000 geological Sheet but the other two have not been previously mapped.

The fault west of Mandurama is exposed as a quartz reef beside the road 5 km northwest of Mandurama. The fault has previously been shown as ending due west of Mandurama, but another quartz reef west of Gallymont along strike to the south may represent a southern continuation of the fault. Displacement of the Mount Pleasant Basalt indicates west block down.

The other two faults are southeast of Blayney. Both consist of large quartz reefs with associated crushed and decomposed rock and both are exposed in road cuttings. One of these faults, at GR 146772, appears to form a boundary between Blayney Basalt and Coombing Formation along part of its length. Two 5 m-wide quartz reefs strike northwest and dip 60° southwest. The continuation of the fault towards Blayney is uncertain as the quartz reefs on the surface die out in an area of no outcrop. The reefs probably represent a normal fault with downthrow of Coombing Formation on the southwest side. The other fault is exposed at GR 190799. One 13m-wide quartz reef strikes west-northwest with a near-vertical dip. The sense of displacement is not indicated as Blayney Basalt occurs on both sides of it. The two faults may have formed as tension gashes associated with the sharp bend in the nearby Copperhannia Thrust.

Shear Zones and Foliation

A major meridional shear zone is known to extend along the western side of the Carcoar Granite and is probably associated with a major fault. The shear zone is evident in intensely foliated basalt exposed in a roadcut at GR 968779 and in an outcrop along the same road immediately south of the Belubula River. Farther to the north in the Browns Creek area several shear zones cut the Blayney Basalt. One of them is exposed along the Blayney-Browns Creek road at GR 011888. The strike of the shear zones going north from Browns Creek swings from northeast to slightly west of north. They all dip to the east at moderate to steep angles.

Foliation striking north-south is evident in some of Blayney Basalt along the Moorilda-Newbridge road from 1-2 km northeast of Moorilda. The foliation possibly indicates faulting west of, and parallel to, the Copperhania Thrust.

CHEMISTRY OF THE IGNEOUS ROCKS

Twelve rock samples, six from volcanic rocks and six from intermediate to basic intrusives, were analysed for major and selected trace element chemistry as shown in Tables 1 and 2. Of the six volcanic samples, four (89840023, 90840001, 90840003 and 90840004) are pyroxene basalts from the Blayney Basalt and two (89840034 and 90840006) are hornblende andesites from the Coombing Formation. Other analyses, including samples from the Blayney Basalt, Mount Pleasant Basalt, Walli Basalt, Coombing Formation and several intrusives, recently collected by D. Wyborn, are also taken into account in the following comments.

The analyses of the volcanics indicate a division into (1) a more basic group containing high CaO and low K_2O, and (2) a less basic group containing moderate CaO and high K_2O. The former group is common within the Blayney Basalt, whereas the latter group is represented in all formations. The former group generally corresponds with basalts containing large clinopyroxene phenocrysts and an overall dominance of clinopyroxene over plagioclase, whereas in the latter group plagioclase is in equal abundance or dominant over clinopyroxene. The purple basalt that forms part of the Blayney Basalt immediately west and northwest of Blayney is represented by analysis 90840001. This rock shows low CaO and high K_2O and is perhaps a trachyandesite rather than a basalt.

The intrusives listed include a syenite (89840007), two monzonites (89840006 and 89840022), a diorite (90840005), a leucodiorite (90840002) and a gabbro (89840030). The intrusives appear more felsic in hand specimen and thin section than the volcanics. However, the chemical compositions are consistent with an origin comagmatic with that of the volcanics. The lack of dark minerals in the leucodiorite is reflected in the low FeO, Fe_2O_3 and MgO contents. The SiO_2 content of the syenite appears to be somewhat low for a normal syenite and it is relatively rich in mafic minerals including clinopyroxene and altered biotite.

MINERAL DEPOSITS

The locations of mineral deposits in the area are shown in the Bathurst metallogenic map (Stevens, 1972) and their occurrence is discussed in notes to accompany the map (Stevens, 1975). Stevens divides the deposits into groups or districts. The deposits in the Blayney area belong to several of these districts, as listed below with their respective commodities in approximate order of importance.

- Forest Reefs-Junction Reefs District (Au, Cu, Ag)
- Browns Creek Deposits (Au, Fe, Cu)
- Cadia District (Fe, Cu, Au, Ag)
- Carcoar District (Cu, Fe, Mo, Co, U, Ni, As)
- Blayney District (Cu, Fe, Au)
- Gallymont District (south of Mandurama) (Au, Cu, Ag)
- Walli-Woodstock District (Cu, Au, Ag, Fe, Barite)

The most important deposits in terms of size are at Junction Reefs (Wilson, 1965), Browns Creek (Taylor, 1983) and Cadia (Welsh, 1975) and old gold mines have been reopened in recent years at the first two of these localities. Gold and copper have been the most important commodities in the past and much exploration has occurred in recent years. Although many exploration licences have been taken up and subsequently abandoned, as shown in the exploration reports submitted to the Geological Survey of New South Wales, promising indications in a few places have maintained interest in the area. Some of the known deposits worked in the past have also been investigated at various times by the Geological Survey of New South Wales.

The uranium ore at the Carcoar Co-U-Mo-Cu-Ni deposit (GR 995775) is mentioned in a general discussion of uranium deposits in New South Wales (Rayner, 1960), and the deposit as a whole has been investigated in several geophysical and geochemical surveys by BMR in the 1950s (Daly & others, 1951; Matheson, 1952; Daly, 1955; Horvath & Royston, 1957). Renewed interest in this deposit has been shown recently owing to the presence of rare earth elements. A new exploratory pit has been opened up and the immediate area mapped in detail (Windh, 1988).

Stevens (1975) attempted to classify all the deposits in the Bathurst 1:250 000 Sheet area in terms of origin, host rock or association with nearby rock bodies. Those of his classifications which apply to the deposits in the Blayney area fall into two groups. The first group includes deposits related to felsic plutonic bodies and the second group deposits related to the Ordovician volcanism. The classification is as follows, with some deposits of doubtful origin or association listed more than once.

1. Deposits in felsic plutonic bodies or near their contacts and related to the plutonic bodies

TYPE	EXAMPLES
Magnetite Cu	Copper deposit in skarn near Blayney; perhaps Cadia, Little Cadia and Carcoar iron deposit.
Au with Cu, Fe	Browns Creek deposit
Au in quartz veins	Gallymont deposits
Co-U-Mo-Cu-Ni association	Carcoar

2. Deposits in Ordovician andesitic to basaltic rocks

TYPE	EXAMPLES
Disseminated Cu-Au or Au-Cu commonly associated with small acid to intermediate intrusive and/or extrusive phases. Includes porphyry copper type.	Much of Forest Reefs-Junction Reefs district; mineralised intrusive at Cadia
Cu deposits with minor Au and Ag, mainly fault or fracture controlled.	Walli-Woodstock district; Coombing and Summers copper mines (Carcoar district)
Massive, stratiform magnetite deposits± important minor Cu, Au values.	Cadia and Little Cadia deposits; Carcoar iron deposit
Disseminated native copper	Walli-Woodstock district
Stratiform or stratabound gold, disseminated in largely tuffaceous andesitic rocks.	Junction Reefs deposits
Barite veins with traces of copper	Cliefden Springs deposits (Walli-Woodstock district)

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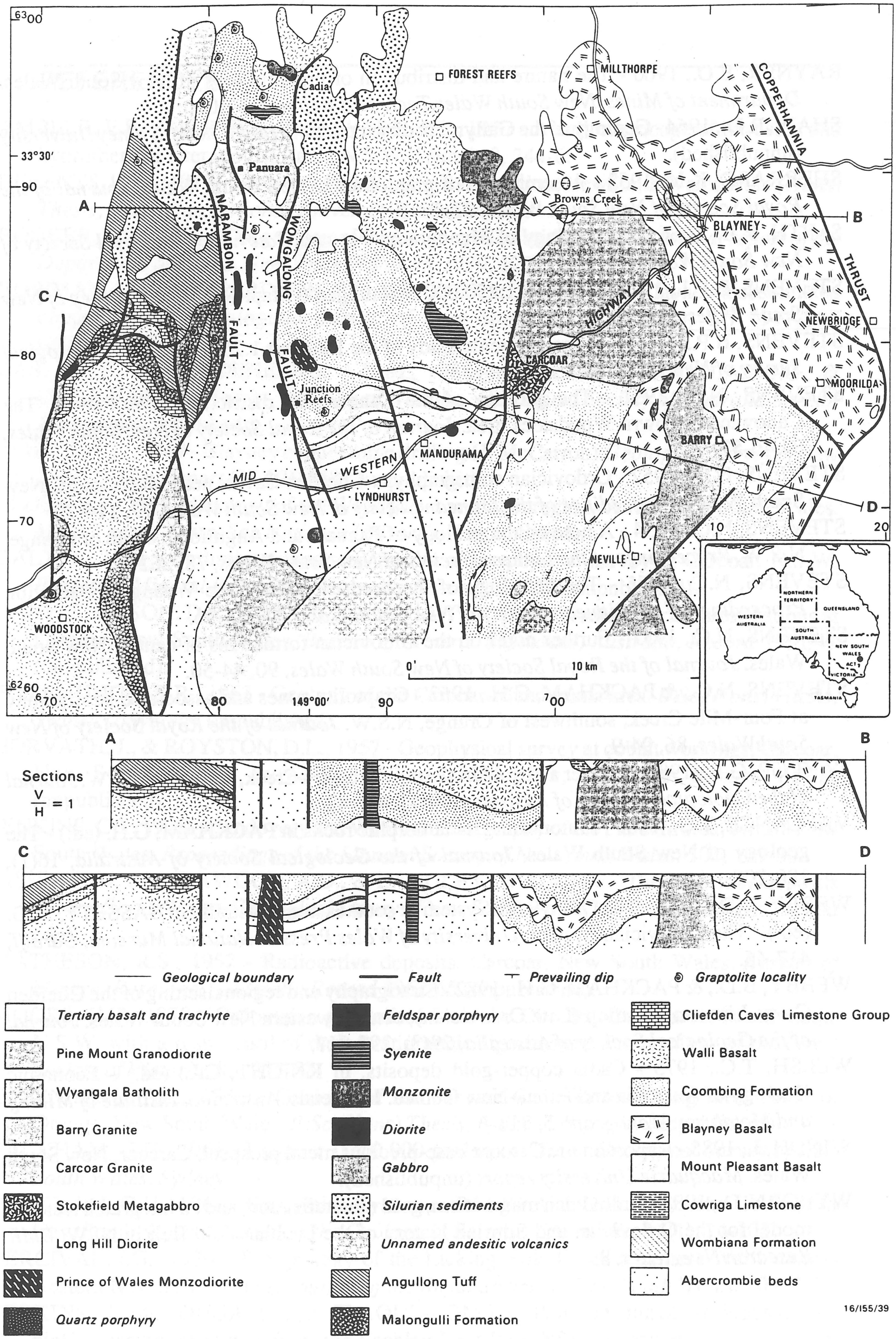

Fig. 1. Preliminary geological sketch map of the Blayney area.

Table 1. Chemistry of some volcanic rocks

Reg. No.	89840023	89840034	90840001	90840003	90840004	90840006
Grid Ref.	031900	894850	064889	060762	130723	152760
SiO_2	49.62	55.07	50.28	49.94	48.78	49.27
TiO_2	0.60	0.46	0.59	0.74	0.63	0.48
Al_2O_3	13.66	18.85	13.90	16.23	13.72	17.00
Fe_2O_3	2.57	4.38	6.75	1.81	2.70	2.59
FeO	6.98	2.70	4.04	10.19	7.57	7.30
MnO	0.14	0.16	0.19	0.24	0.18	0.17
MgO	9.11	2.36	8.12	4.07	7.15	5.99
CaO	9.56	5.86	5.46	10.63	12.44	9.66
Na_2O	2.27	3.72	3.52	2.91	1.72	2.83
K_2O	1.61	3.61	3.12	1.07	1.66	0.99
P_2O_5	0.24	0.33	0.36	0.30	0.27	0.29
S	0.00	0.00	0.00	0.00	0.01	0.00
LOI	3.40	2.16	3.62	1.65	2.87	2.94
Total	97.76	99.66	99.95	99.78	99.70	99.51
Ni	119	5	78	32	49	51
Cu	80	91	12	64	130	99
Zn	92	77	87	104	86	81
Hf	3	1	1	3	2	1
Ta	5	1	2	3	1	3
Li	12	13	10	6	6	7
Sn	<1	<1	<1	<1	<1	2
Nb	4	6	3	9	4	4
Zr	56	64	37	69	32	27
Mo	<1	<1	<1	<1	1	1
Ag	4	3	3	3	4	4
Mn	1315	1418	1807	2234	1746	1653
V	262	126	261	321	318	298
Cr	506	9	320	98	225	165
Ba	1134	1272	925	407	723	462
La	11	14	11	10	12	7
Ce	15	24	23	20	7	8
Nd	9	11	9	11	7	5
Pr	<1	2	2	4	2	4
Cs	<1	<1	<1	2	2	3
Sc	34	14	32	44	0	38
Be	3	3	2	2	2	2
Th	1	1	1	<1	1	<1
Rb	27	69	34	14	24	18
Pb	4	6	5	2	6	10
Y	8	17	16	22	25	12
Sr	473	859	266	565	482	589
U	0.5	1.0	0.5	<0.5	0.5	<0.5
Se	1	<1	<1	1	<1	1
Ga	14	17	15	18	15	16
As	3.5	3.5	9.0	35.0	8.0	3.5
W	54	169	86	182	182	169
Bi	<1	<1	1	<1	<1	2
Ge	1.0	0.5	2.5	1.5	1.0	1.5

Table 2. Chemistry of some intrusive rocks.

Reg. No.	89840006	89840007	89840022	89840030	90840002	90840005
Grid Ref.	829935	830937	970898	919850	942757	112763
SiO_2	54.46	49.97	55.90	51.72	60.77	51.01
TiO_2	0.64	0.59	0.53	0.52	0.37	0.43
Al_2O_3	18.96	17.02	15.90	14.13	18.83	18.02
Fe_2O_3	2.28	4.56	3.44	2.85	0.52	3.11
FeO	3.85	4.88	3.82	5.50	0.98	4.41
MnO	0.12	0.16	0.14	0.12	0.04	0.16
MgO	2.08	3.60	3.88	8.06	1.97	3.88
CaO	6.19	7.27	6.55	8.43	8.86	9.30
Na_2O	4.85	3.07	3.55	2.80	4.99	3.41
K_2O	3.00	4.26	4.00	2.73	0.36	2.77
P_2O_5	0.52	0.95	0.35	0.42	0.30	0.42
S	0.00	0.00	0.00	0.02	0.00	0.01
LOI	3.08	3.29	1.70	2.62	1.82	2.81
Total	100.03	99.62	99.76	99.92	99.81	99.74
Ni	13	11	20	111	5	17
Cu	293	403	162	180	0	72
Zn	80	89	66	53	13	73
Hf			4	1	2	1
Ta			<1	<1	2	1
Li			14	23	4	8
Sn	<2	2	<1	<1	<1	<1
Nb	4	3	6	4	7	6
Zr	88	40	88	61	63	46
Mo	<1	1	<1	1	<1	1
Ag			3	4	3	3
Mn	1076	1470	1295	1103	360	1460
V	182	361	192	220	154	262
Cr	12	5	64	434	2	5
Ba	514	933	1134	622	199	1019
La	16	14	18	23	11	16
Ce	30	21	47	39	20	37
Nd	17	8	20	15	7	15
Pr			7	5	3	3
Cs			4	3	2	1
Sc	12	16	20	24	16	29
Be			4	3	3	3
Th	<2	<2	5	4	3	3
Rb	47	74	78	45	3	31
Pb	8	12	12	7	3	7
Y	17	15	20	14	17	15
Sr	784	1321	1029	855	1010	1164
U	1.0	<0.5	2.0	2.0	1.5	1.5
Se			<1	1	1	<1
Ga	19	16	17	15	19	18
As	3.0	2.0	6.5	14.0	2.5	4.0
W			297	144	378	245
Bi			1	1	<1	<1
Ge			1.5	2.0	3.0	1.5

APPENDIX

Tabulated rock sample data in rockchem database

sampno	origno	mapno	airphoto	lithology	stratunit	gridref
89840001	115	8731	OR4S/63/2	Chert	Coombing Formation	111912
89840002	115	8731	OR1S/123/1	Syenite		992140
89840003	115	8731	OR1S/123/2	Syenite		009138
89840004	115	8731	OR1S/123/3	Syenite		010140
89840005	115	8631	M7/64/5	Granophyre (C)		681019
89840006	115	8631	M8/90/1	Monzonite (C)		829935
89840007	115	8631	M8/90/10	Syenite (C)		830937
89840008	115	8631	M8/90/11	Qtz Syenite		841929
89840009	115	8730	BL2N/57/4A	Diorite		023776
89840010	115	8730	BL2N/57/4B	Basalt (meta.)	Coombing Formation	024776
89840011	115	8730	BL2N/57/6	Basalt (meta.)	Coombing Formation	032782
89840012	115	8730	BL2N/61/1A	Gabbro	Pr. of Wales Monzodiorite	857792
89840013	115	8730	BL2N/61/1B	Diorite	Pr. of Wales Monzodiorite	857792
89840014	115	8630	BL2N/61/2	Hb Andesite	Coombing Formation	852789
89840015	115	8730	BL3N/70/12	Basalt	Blayney Basalt?	980741
89840016	115	8730	BL3N/72/5	Chert	Coombing Formation	016738
89840017	115	8730	BL3N/72/8	Basalt	Coombing Formation	008747
89840018	115	8731	OR4S/61/2	Basaltic ?tuff	Blayney Basalt	028961
89840019	115	8731	OR4S/61/5	Basalt	Blayney Basalt	043918
89840020	115	8731	OR4S/59/10	Basaltic ?tuff	Blayney Basalt	022919
89840021	115	8730	BL1N/134/7	Syenite		956898
89840022	115	8730	BL1N/134/9	Monzonite (C)		970898
89840023	115	8730	BL1N/136/5	Basalt (C)	Blayney Basalt	031900
89840024	115	8730	BL1N/136/8	Basalt	Blayney Basalt	076862
89840025	115	8730	BL1N/136/9	Basalt	Blayney Basalt	069846
89840026	115	8730	BL1N/136/17	Basalt	Blayney Basalt	071879
89840027	115	8730	BL1N/138/8	Basaltic ?tuff	Blayney Basalt	112843
89840028	115	8730	BL1N/138/10	Mica diorite		108845
89840029	115	8730	BL1N/132/8	Diorite		917851
89840030	115	8730	BL1N/132/9	Gabbro (C)		919850
89840031	115	8730	BL1N/132/11	Hb Andesite	Coombing Formation	899856
89840032	115	8730	BL1N/140/2	Basalt	Blayney Basalt	173869
89840033	115	8730	BL2N/61/10	Basaltic tuff	Coombing Formation	890847
89840034	115	8730	BL2N/61/11	Hb Andesite (C)	Coombing Formation	894850
89840035	115	8730	BL3N/72/4	Basaltic ?tuff	Blayney Basalt	045740
89840036	115	8730	BL3N/74/1	Basalt	Blayney Basalt	113759
89840037	115	8730	BL2N/53/8	Basalt	Blayney Basalt	158802

sampno	origno	mapno	airphoto	lithology	stratunit	gridref
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90840001	115	8730	BL1N/136/3	Basalt (C)	Blayney Basalt	064889
90840002	115	8730	BL3N/70/27	Leucodiorite (C)		942757
90840003	115	8730	BL3N/74/10	Basalt (C)	Blayney Basalt	060762
90840004	115	8730	BL3N/74/11	Basaltic ?tuff (C)	Blayney Basalt	130723
90840005	115	8730	BL3N/74/15	Diorite (C)		112763
90840006	115	8730	BL3N/76/27	Hb Andesite (C)	Coombing Formation	152760
90840007	115	8730	BL1N/136/6	Leucogranodiorite		077895
90840008	115	8730	BL2N/55/5	Monzonite		077778
90840009	115	8730	BL2N/55/25	Basalt	Blayney Basalt	121797
90840010	115	8730	BL2N/57/4E	Diorite		023776
90840011	115	8730	BL2N/59/8	Basaltic tuff	Coombing formation	927802
90840012	115	8730	BL3N/68/7	Basaltic tuff	Mount Pleasant Basalt	889743
90840013	115	8730	BL3N/70/26	Basaltic tuff	Mount Pleasant Basalt	938760
90840014	115	8730	BL3N/70/31	Gabbro		943764
90840015	115	8730	BL3N/70/34	Hb diorite		942777
90840016	115	8730	BL3N/70/43	Diorite		979708
90840017	115	8730	BL3N/72/47	Quartz-mica diorite		982736
90840018	115	8730	BL3N/74/5	Monzonite		067762
90840019	115	8730	BL4N/119/3	Diorite		015673
90840020	115	8730	BL4N/119/10	Granodiorite		062693

Note: List includes all samples with thin sections. Those with a C after the lithology were also chemically analysed.