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RECORDS.

1962/87

SUBDIVISION AND CORRELATION OF THE MIDDLE BOWEN BEDS.

by

J.M.Dickins, E.J.Malone and A.R.Jensen,

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SUMMARY

Three subdivisions of the Middle Bowen Beds, designated units A, B, and C, are recognised in the north-eastern part of the Bowen Basin (or Synclinorium). The Collinsville Coal Measures are shown to be a formation in the Middle Bowen Beds, equivalent to most of unit B. The Collinsville Coal Measures and unit B are further divided into units B1, B2, and B3.

Each of the five units, A, B1, B2, B3, and C, contains a characteristic macrofossil assemblage. Locally, the units have distinctive lithological characteristics and are effectively rock units. In a regional sense, they are akin to stages.

Units A, B, and C can be recognized in A.F.O. (Associated Freney Oil Fields N.L.) Cooroorah No.1 and S.Q.D. (Shell (Queensland) Development Pty Ltd) Morella No.1. Units A and C are present in A.A.O. (Associated Australian Oilfields N.L.) No.7 Arcadia, but unit B appears to be very thin or absent. In the Springsure area, the boundary between the Cattle Creek Shale and the Aldebaran Sandstone appears to correspond to the boundary between units A and B, and the top of the Catherine Sandstone to the top of unit B. If this is correct, the Mantuan Productus Bed corresponds in stratigraphical position to the Big Strophalosia Zone (= clarkei bed).

The Bandanna Formation appears to contain both Middle Bowen Beds and Upper Bowen Coal Measures.

INTRODUCTION

The transgressive nature of the upper part of the Middle Bowen Beds was first recognized in the Clermont area (Veevers, Randal, Mollan and Paten, 1961) where it was mapped overlying Carboniferous and older rocks. Subsequently, this transgressive unit was identified during the 1961 season in the more complete Middle Bowen Beds sequence of the north-east Bowen Basin. At the same time, the equivalents of the Collinsville Coal Measures were recognized in this sequence, immediately below the transgressive upper unit and above a basal unit.

This has permitted a three-fold division of the Middle Bowen Beds of the Bowen, Mount Coolon and Mackay 1:250,000 Sheet areas. The subdivisions are based on stratigraphical and palaeontological information. They are referred to as units A, B, and C, A being the oldest. Locally, these units may have distinctive lithological characteristics and are effectively rock units. In a regional sense they are akin to stages. The distribution and recognition of these units is discussed in this report.

Units A, B, and C are thought to be related to major changes of environment affecting the whole Bowen Basin. Hence, they are considered to be of regional significance. We consider that the same three-fold division can be recognised in the Middle Bowen Beds in the south-western part of the basin. The relationship of units A, B, and C to the sequences in the three wells, A.F.O. Cooroorah No.1, A.A.O. No.7 Arcadia and S.Q.D. Morella No.1, and to the sequence cropping out in the Springsure and Emerald areas is discussed in this report.

We are grateful for discussion of various matters to B. Tissot, head of the French Petroleum Institute Mission in Australia, and to P.R. Evans, palynologist of the Bureau of Mineral Resources, who are working on problems associated with the Bowen Basin. We take, however, full responsibility for the conclusions. The Institut Francais du Petrole Mission has supplied 1:2,000 compilations of the electrical and lithological logs of Cooroorah No.1, A.A.O. No.7 Arcadia, and S.Q.D. Morella No.1 on which are based the logs used in Plate 2. We are also grateful to Mr D.M. Traves, Chief Geologist and to the management of Mines Administration Pty Ltd for permission to use the information on A.A.O. No.7 Arcadia, and to Mr C.E. Crapp, Senior Geologist and the Bowen Consolidated Coal Mines Ltd for allowing us to use their log of borehole N.S. 371.

The macrofossils are considered in a separate report by Dickins (/in Malone et al., 1962), and unless otherwise stated, all the references to the palaeontology are taken from his report.

NORTH-EAST BOWEN BASIN

Bowen, Mount Coolon, and Mackay 1:250,000 Sheet areas.

Full details of the geology of the Middle Bowen Beds in these areas are recorded in separate geological reports for each area, (Malone, Corbett & Jensen, 1961; Malone, Jensen, Gregory & Forbes, 1962; Jensen, Gregory & Forbes, 1962). Plate 1 shows the distribution and thickness of the Middle Bowen Beds and of units A, B, and C in the above three areas, as far south on the eastern flank of the basin as Mount Landsborough.

On Plate 1, sections 3 and 4 are measured; the others were computed using dip and strike information and plan widths measured on the airphotos where the locations of the top and bottom of the unit were known. The accuracy with which the fossil collections are located on the sections varies somewhat but in no case is the possible error critical.

The time-rock nature of units A, B, and C is shown by the fact that a distinct fauna is associated with each. These faunas were first recognized while studying the fossils collected during the 1960 season. Additional material collected during 1961 has increased the number of species on which the faunas are based and has permitted the subdivision of one fauna into three parts.

The faunas are :

Fauna IV, associated with unit C,
Fauna III, " " " B,
Fauna II, " " " A.

Fauna III has been divided into III a, III b and III c, each of which is associated with subdivisions B1, B2 and B3 of unit B. The subdivisions of unit B can be recognised on fossil content in some places and on lithology in Gebbie Creek and the Collinsville area. Fauna III c is represented by only two collections, M416 and M417, collected in the Mt. Landsborough area.

The palaeontological basis of the faunas is shown on Table 1. A noticable feature is the large number of new species introduced with each succeeding fauna. This is thought to be partly due to ecological control, reflecting the changes of environment from one unit to the next. However, the faunas reflect evolutionary changes, also, and thus the boundaries between faunas are time lines.

Collinsville - Gebbie Creek Area

The equivalence of the Collinsville Coal Measures with part of unit B of the Middle Bowen Beds is shown by comparing the log of the Bowen Consolidated Coal Mining Co. diamond drill hole N.S.371 with the Gebbie Creek measured section. Both these are shown on Plate 2. The base of unit C is clearly marked on both sections. In the drill hole, it is a pebble conglomerate band above the coal measures; in Gebbie Creek, it is marked by a scattering of pebbles and cobbles, followed by a pebble conglomerate band overlying a monotonous quartz greywacke and siltstone sequence. Fossil collection, B261e a rich Fauna IV collection helps to locate the base of unit C in Gebbie Creek.

The Glendoo Sandstone Member is a fossiliferous marine transgression forming a prominent marker in the Collinsville Coal Measures. As a distinct sandstone unit, it can be recognized only in the Collinsville area. It is included in sub-unit B2 which, in the Collinsville area, consists of the dominantly sandy sequence separating the upper and lower coal measure units.

The fossils contained in the Glendoo Sandstone Member belong to Fauna IIIb. Fossil collection B261 d from Gebbie Creek is small but identifiable as Fauna III b and equivalent to that contained in the Glendoo Sandstone Member. The dominantly sandy sequence in Gebbie Creek containing collection B261 d is regarded as sub-unit B2.

Sub-units B3 above and B1 below are coal measures without marine fossils in drill hole N.S.371; they are carbonaceous quartz greywacke and siltstone sequences in Gebbie Creek. Several thin coal seams were mapped in Gebbie Creek in unit B1 which also contained some marine fossils in the lower part.

The Collinsville Coal Measures are probably equivalent to most of unit B above the Wall Sandstone Member. This member was not recognised in the Collinsville Coal Measures, and may lense out to the north of Gebbie Creek.

Exmoor - Blenheim Area

The three units A, B and C are recognised on the eastern flank of the Bowen Basin, from south of Gebbie Creek :

to the Mt. Landsborough area. A composite lithological column is shown on Plate 2, to represent the section in the Blenheim area in the Mt. Coolon Sheet area where the total thickness of the unit can be estimated reasonably accurately. The composite section is based on sections measured during the 1960 field season. The measured sections were moved along strike and fitted into this section at their appropriate stratigraphical positions. The sections were migrated a maximum of 8 miles. The resulting lithological column should be a reasonable approximation as many of the beds in this area are laterally persistent over greater distances than 8 miles.

On this section the boundary between units A and B is placed about 200 feet below the base of the Wall Sandstone Member to include a fossiliferous quartz greywacke and siltstone sequence. Collections from this horizon (B261, MC420) belong to Fauna III a.

In section 8, collections MC657, MC1065 and MC1414 were made approximately 300 feet below the base of the Wall Sandstone Member. These collections belong to Fauna II. The presence of the two faunas in known positions relative to the Wall Sandstone Member locates the boundary between units A and B with reasonable accuracy.

The Wall Sandstone Member can be traced north from the Blenheim area to the Gebbie Creek area. The base of unit B in Gebbie Creek is placed about 200 feet below that member in an area of no outcrop, about 200 feet above outcrop of Lower Bowen Volcanics.

Unit A is not exposed in the Gebbie Creek section. There, unit B may directly overlie the Lower Bowen Volcanics as is the case in the Collinsville area. Unit A is well developed in the Exmoor section and is present in every section south of Exmoor. It is rather thin in the Blenheim area where the Middle Bowen Beds are attenuated.

The deposition of unit B extends beyond the limits of unit A to the north and west. It was deposited in a shallower basin than was unit A. Deltaic or lagoonal conditions existed at times around the north-western margins of this basin, permitting the development of the coal measure equivalents of sub-units B1 and B3. Sub-unit B2 is a dominantly marine unit transgressive over the entire basin.

Extensive sandstone units, similar to the Wall Sandstone Member, are characteristic of unit B. On lithology alone, the base of the unit would be placed at the base of the Wall Sandstone Member, the lowest major sandstone unit. It is extended downwards to include the fine quartz greywacke and siltstone containing Fauna IIIa in sections 4 and 6. Similar lithologies are contained at higher levels in unit B.

The sub-units of unit B are tentatively recognised in the Blenheim area composite section. Poorly preserved fossils were noted in this part of the section during 1960. One collection, MC669, is tentatively correlated with the Glendoo Sandstone Fauna III b. Proposed detailed collectings during 1962

may prove the presence of the three sub-faunas. The three sub-units are not as clearly defined in this basinal area where unit B is entirely marine. They are best expressed in the northern and western marginal areas where the environment changes from deltaic to transgressive marine and back to deltaic.

Neither is the base of unit C so clearly marked in the Blenheim section. It is placed at the change from a dominantly sand size sequence to a dominantly siltstone sequence. Palaeontological data helps to locate the base of unit C. Collection MC802 (i) is a Fauna IV collection thought to be equivalent to the Big Strophalosia Zone. It is on strike with discontinuous outcrops of the Big Strophalosia Zone further north. The base of unit C is placed 480' below the MC802 (i) horizon. It is commonly about 400 feet below the Big Strophalosia Zone.

Homevale-Mt. Landsborough Area

The geology is structurally complicated in the Homevale to Carrinyah area where many fossil collections were made. Three collections, M21, M85 and M86, were made in the Mt. Landsborough area where the geology is less complicated and stratigraphical section 11 was computed. The positions of other fossil collections shown on section 11 are approximate.

The Fauna II collection M412 was made near Carrinyah Homestead, at a known stratigraphical height above the base of the Middle Bowen Beds. It is located on section 11 at this height above the base.

Collection M21, from the Landsborough section, is the Fauna III a found below the Wall Sandstone Member further north. Collections M413, M414 and M415 from the Homevale area, contain the same fauna and are placed at the same level as M21 on section 11. Collection M413 was made immediately below the lowest distinct sandstone unit in the sequence at Homevale. This sandstone occupies a position similar to that of the Wall Sandstone Member. Unit B in the Homevale to Landsborough area is somewhat different in lithology from the unit in the Bowen area. It is still characterised by sandstone units, though these are less well-developed than further north, and is generally more calcareous. The base of unit B is placed below collection M413. On section 11, it is placed about 200 feet below collection M21.

The boundary between units B and C lies between collections B417 and B418. B417 is a Fauna III c collection while the small B418 collection is recognisable as Fauna IV. A pebbly sandstone occurs at the base of unit C associated with the incoming of Fauna IV. No marked change of lithology from unit B to unit C was noted. However, unit C is much less exposed than unit B, which indicates a lithological change probably from the sandy sequence of unit B to a dominantly siltstone sequence.

Collections B417 and B418 were made in the Homevale area. Their stratigraphical height above collection B413 can be estimated and they are located on section 11 on this basis. Their location on section 11 may be inaccurate. These two collections are stratigraphically close together. They illustrate the rapidity of the change from Fauna III c to Fauna IV, characterised in most areas by the appearance of new species in Fauna IV. This change may represent a disconformity. However, an environmental change is considered a more likely explanation.

A.F.O. COOROORAH NO.1

The sequence in this well can be related to that cropping out both in the Clermont area and in the north-eastern part of the Bowen Basin. The three major subdivisions of the north-eastern part of the Bowen Basin, units A, B, and C are recognizable on lithological and electrical log characters. This well began high in the Middle Bowen Beds (Derrington, 1960). The top of unit B is at 1638 feet, the top of unit A is at 2640 feet and the bottom of unit A is at 3010 feet. On the basis of this correlation only a single calcareous zone is recognizable which could represent the Big Strophalosia Zone (=clarkei bed)*, that between 1175 and 1185 feet.

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* The relationship of the clarkei-bed and the Big Strophalosia Zone has been discussed elsewhere (Dickins, in Veevers et al., 1961).

This zone is associated with a high resistance zone on the electric log which extends down to about 1250 feet, 388 feet above the base of unit C, a distance comparable with that of the Big Strophalosia Zone above the base of this unit elsewhere (300 to 400 feet).

The sequence of unit C in Cooroorah then becomes comparable with that found in the Clermont area (Veevers, et al., 1961) shown on Plate 2. The coal beds between 140 and 132 feet occupy a position similar to those found in surface outcrops and the Crocker Formation is equivalent to the sandy beds with marine fossils found near the top of the Middle Bowen Beds. The Crocker Formation also occupies a similar position to the sandstones associated with the Martiniopsis bed in Parrot Creek of the Bowen area (Isbell, 1955, p.11). The thickness of unit C in the Cooroorah area is 1638 feet +, a thickness comparable with 1000 to 2000 feet estimated for the Clermont area.

A calcareous zone is found between 2089 and 2230 feet, i.e. in unit B, occupying a similar stratigraphical position to limestone beds in Morella No.1, and the Glendoo Member in the Collinsville Coal Measures. The top of this calcareous zone is close to "a refractor having an estimated velocity of 17,400 feet/second" at a depth of 2,000 feet recorded in a Bureau of Mineral Resources Seismic Survey in this area (unpublished file report by E.R. Smith). Smith considers this refractor correlates "with the refractor (velocity estimated 18,000 feet/second) recorded near Comet at a depth of 2,000 feet in previous surveys". He suggests the velocity indicates a limestone. The recognition of this zone may be useful in future seismic interpretation.

A.A.O. No.7 ARCADIA

As shown by Derrington (1957) in his unpublished report on this well, the Middle Bowen sequence differs considerably from that found in the Springsure area.

The base of unit C can be placed at the base of the breccia at 2250 feet although a slightly lower boundary at 2266 feet is possible. The boundary of this unit is based on a comparison of the well log with the surface sections. Unit B is absent or is represented by only a few feet at about 2266 feet. The predominantly siltstone sequence below this represents unit A. The base of unit A is tentatively placed at 2780 feet at the change in lithology and electric log. Whether the sandy unit below this represents the Staircase Sandstone, or belongs with the Undivided Freshwater Sediments of Webb (1956) (?= Orion Shale of Phillips, 1960) is not clear.

The interval 2266 to 2780 feet can be identified with unit A because of the macrofossils, especially Taeniothaerus and Ingelarella plana Campbell recorded by D. Hill (in Derrington, 1957). These fossils are characteristic of the Cattle Creek Formation in outcrop, and are referable to Fauna II. A marked change in the spores and microplankton also occurs at 2266 feet at the top of unit A (P.R. Evans, pers. comm.).

A zone with high resistivity electric log peaks occurs between 1900 and 2045 feet, 205 feet above the base of unit C. This zone, which is calcareous especially near the base, appears to represent the Big Strophalosia Zone (=clarkei bed) of Cooroorah No.1 and surface outcrops. From the occurrence of coal and changes in the electric log, the boundary between the Middle and Upper Bowen can be placed at about 640 feet. The sandy unit between 695 and 1025 feet would accordingly correspond at least partly to the Crocker Formation and to the sandy higher part of the Middle Bowen Beds in the Clermont and Parrot Creek areas. An indication is seen here, on which further information is available from Morella No.1, that the Bandanna Formation includes both Middle Bowen Beds and Upper Bowen/Coal Measures. The boundary between the Middle Bowen Beds and the Upper Bowen Coal Measures could alternatively be placed lower down at 1480 feet but the sequence in Cooroorah No.1 and in the Clermont area suggests this is less likely.

The absence or thin development of unit B indicates relief during or immediately after this time, and the thickness of unit A (Cattle Creek Formation), which is comparable with that found elsewhere, shows this relief was formed, at least partly, later than unit A time. If the identification of the Big Strophalosia Zone is correct, the thin interval between this and the base of unit C suggests the relief persisted into the beginning of unit C time.

S.Q.D. MORELLA No. 1

The Middle Bowen Beds of Morella No.1 are closely comparable to those in Cooroorah No.1. The boundary between the Middle Bowen Beds and the Upper Bowen Coal Measures on lithology and electric log can be placed at either 1327 or 1407 feet. The Bandanna Formation of Webb (1956), based on the unpublished work of Wade (1952), is therefore made up of both Middle Bowen Beds and Upper Bowen Coal Measures. The base of unit C is placed at 2702 feet, at the base of a distinct conglomeratic band. This is slightly lower than the main electric log change at 2550 feet: the basal sandier part of unit C appears to correspond closely in lithology to unit B and this is reflected in the electric log. Two calcareous zones are found in unit C, either of which may represent the Big Strophalosia Zone (=clarkei bed). The higher zone between 2140 and 2200 feet is 502 feet above the base of unit C and the lower between 2360 and 2405 feet is 297 feet above the base.

The base of unit B is at 3868 feet at the marked change in electric log. In Morella No.1, unit B is calcareous and has marine fossils throughout, except slightly above the base, where coal is recorded. The occurrence of marine fossils below this sandy unit with coal, at the base of unit B, is similar in position to Fauna IIIa beneath the Wall Sandstone Member in the north-eastern part of the Bowen Basin. The middle part of the unit is particularly calcareous and limestone is recorded, occupying a similar position to the calcareous zone of unit B in Cooroorah No.1.

The presence of unit A is confirmed by the productid Strophalosia praovalis Maxwell identified by D. Hill (in Webb, 1956, p. 2335).

SERECOLD ANTICLINE - REID'S DOME AND EMERALD 1:250,000 SHEET AREAS, SURFACE OUTCROP.

The generalized section shown in Plate 2 is based on Hill (1957), and Phillips (1960), with some modifications based on Pallister and Mackay (1942). On the basis of lithological and faunal correlations the boundary between units A and B can be placed with some assurance at the boundary between the Cattle Creek Shale and the Aldebaran Sandstone of the Serecold Anticline. Whether the Staircase Sandstone and the Stanleigh Shale (Phillips, 1960) should be placed in unit A is not clear. The position of the Dilly Beds and the boundary between units B and C also presents difficulties. Faunal, lithological and bore information indicates the boundary between units B and C is not below the base of the Ingelara Shale and not above the base of the Mantuan Productus Bed. Reeves (1947, p.1349, fig.3) and unpublished work by Shell (Pallister and Mackay, 1942, p.4) indicates that a shaly unit of 300 feet or somewhat more intervenes between the top of the Catherine Sandstone and the Mantuan Productus Bed. Therefore, the boundary between the Catherine Sandstone and the overlying shaly unit is close to that between units B and C and may correspond. If this is correct the Mantuan Productus Bed

will become equivalent to the Big Strophalosia Zone (=clarkei bed) and the Ingelara Shale to the calcareous zone in the middle part of unit B in Morella and Cooroorah wells. This explanation seems to apply also to the Peawaddy Creek and Mount Serocold sections of Reid (1930, p.153). In addition, it would fit the field evidence from the Emerald Sheet area onto which the clarkei-bed has been traced and where it is found at a stratigraphical position at which the Mantuan Productus Bed might be expected (Veevers, Mollan, Olgers and Kirkegaard, 1962).

If the Big Strophalosia Zone (=clarkei bed) is correctly recognized in Morella No.1 and Arcadia A.A.O. No.7, the sandstone regarded by Webb (1956, based on the unpublished work of Wade, 1952) as the Catherine Sandstone in Morella No.1 and Arcadia Oil Search Limited (O.S.L.) No.3 is a higher sandstone than the Catherine Sandstone of outcrop. This sandstone (in Morella No.1 and Arcadia O.S.L. No.3) could be the Catherine Sandstone only if all the Big Strophalosia Zone (=clarkei bed) were equivalent to the whole or part of the Ingelara Shale, an assumption which is untenable.

By analogy with Cooroorah No.1, and Morella No.1 the lower part of the Bandanna Formation of Hill (1957) appears to belong to the Middle Bowen Beds and the upper part to the Upper Bowen Coal Measures.

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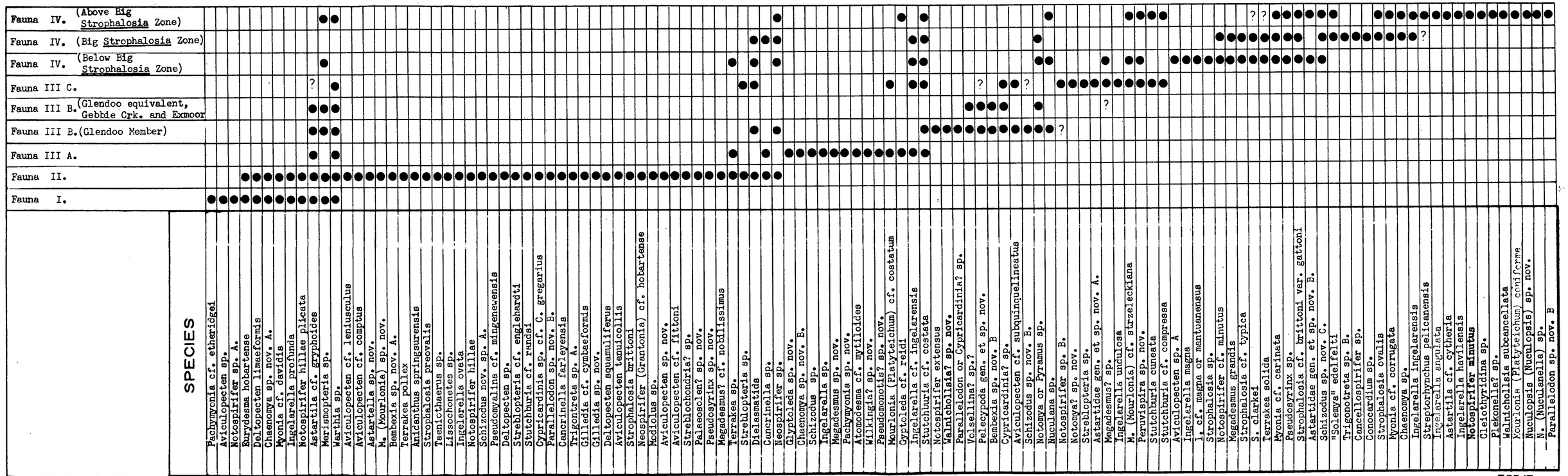
Table 1

SPECIES DISTRIBUTION CHART

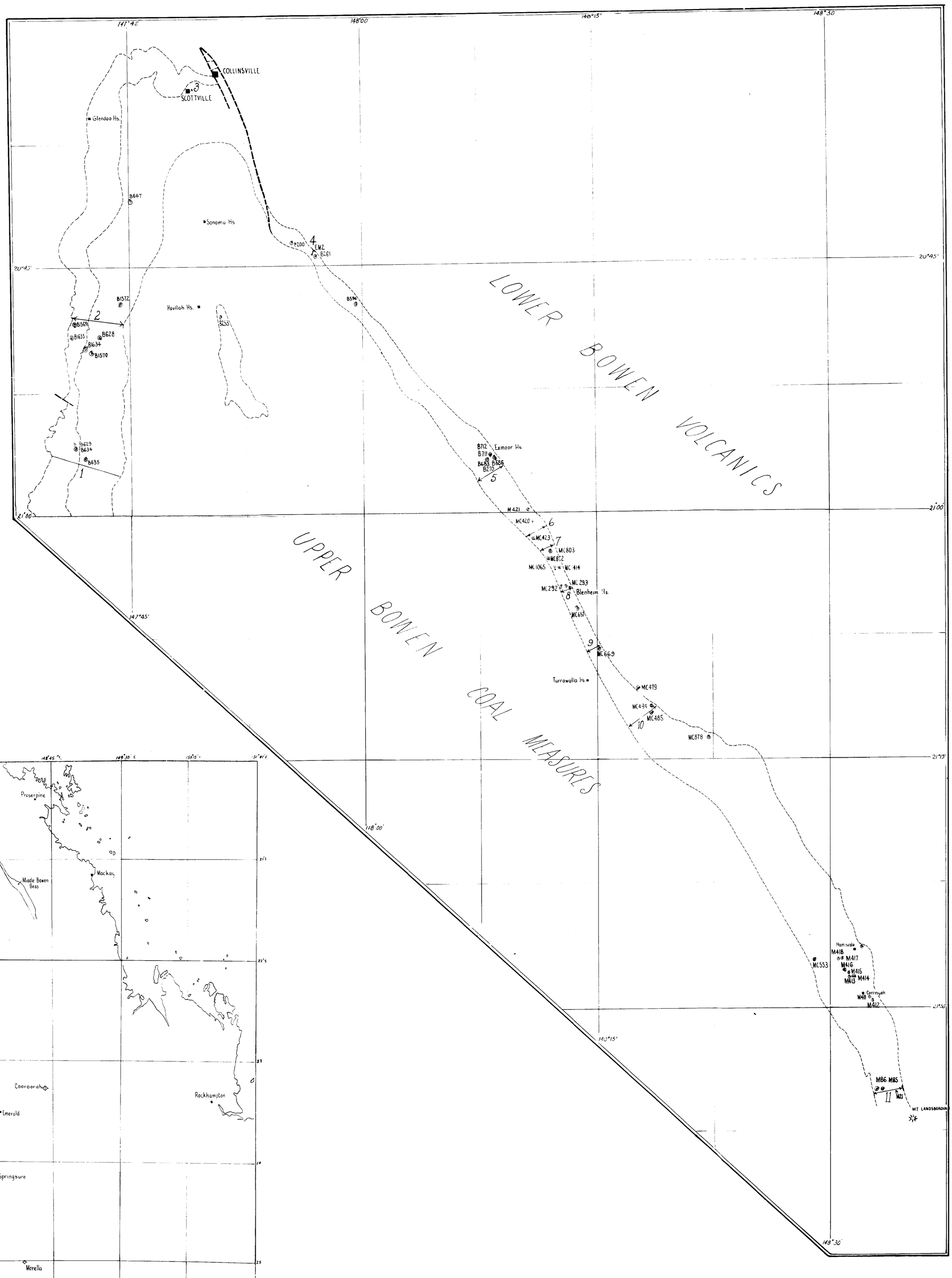
BOWEN MT COOLON AND MACKAY SHEET AREAS



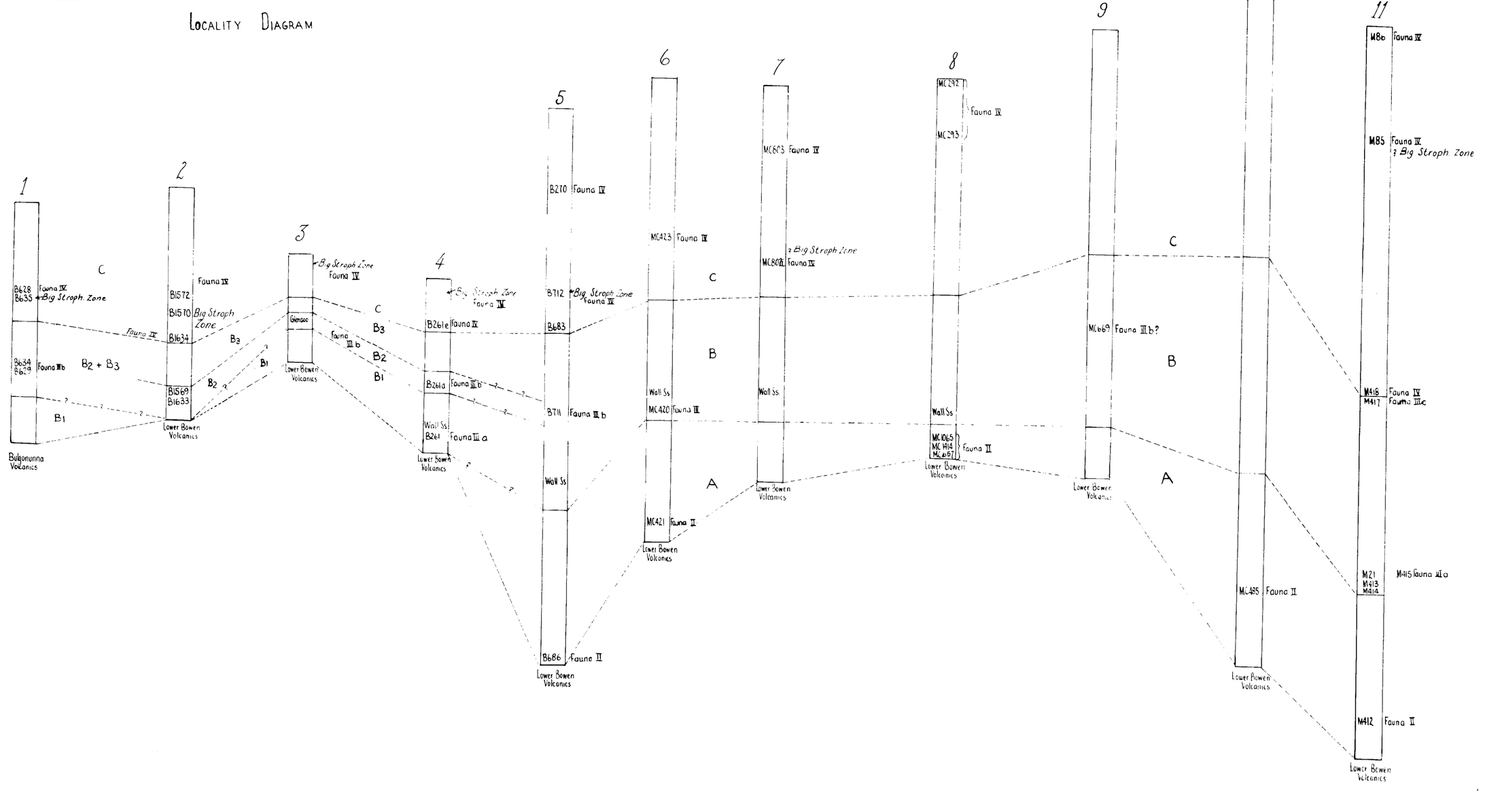
NORTH-EAST BOWEN BASIN

Outcrop Area of Middle Bowen Beds

Showing location of fossil collections and of stratigraphic sections



LOCALITY DIAGRAM



CORRELATION OF STRATIGRAPHIC SECTIONS IN THE MIDDLE BOWEN BEDS

Scale 1" = 1,000'

Bureau of Mineral Resources, Geology & Geophysics, April 1962

To accompany Record No 1962/

GENERALIZED SECTION

SEROCOLD ANTICLINE - REID'S DOME

S.Q.D. MORELLA No.1

A.A.O. No.7 ARCADIA

COMPOSITE SECTION

PEAK DOWNS - GRASS TREE TANK AREAS

CLERMONT 1:250,000 AREA

A.F.O. COOROORAH No.1

COMPOSITE SECTION

BLENHEIM AREA

Mt. COOLON 1:250,000 AREA

CORRELATION OF MIDDLE BOWEN BEDS

SCALE 1:2000

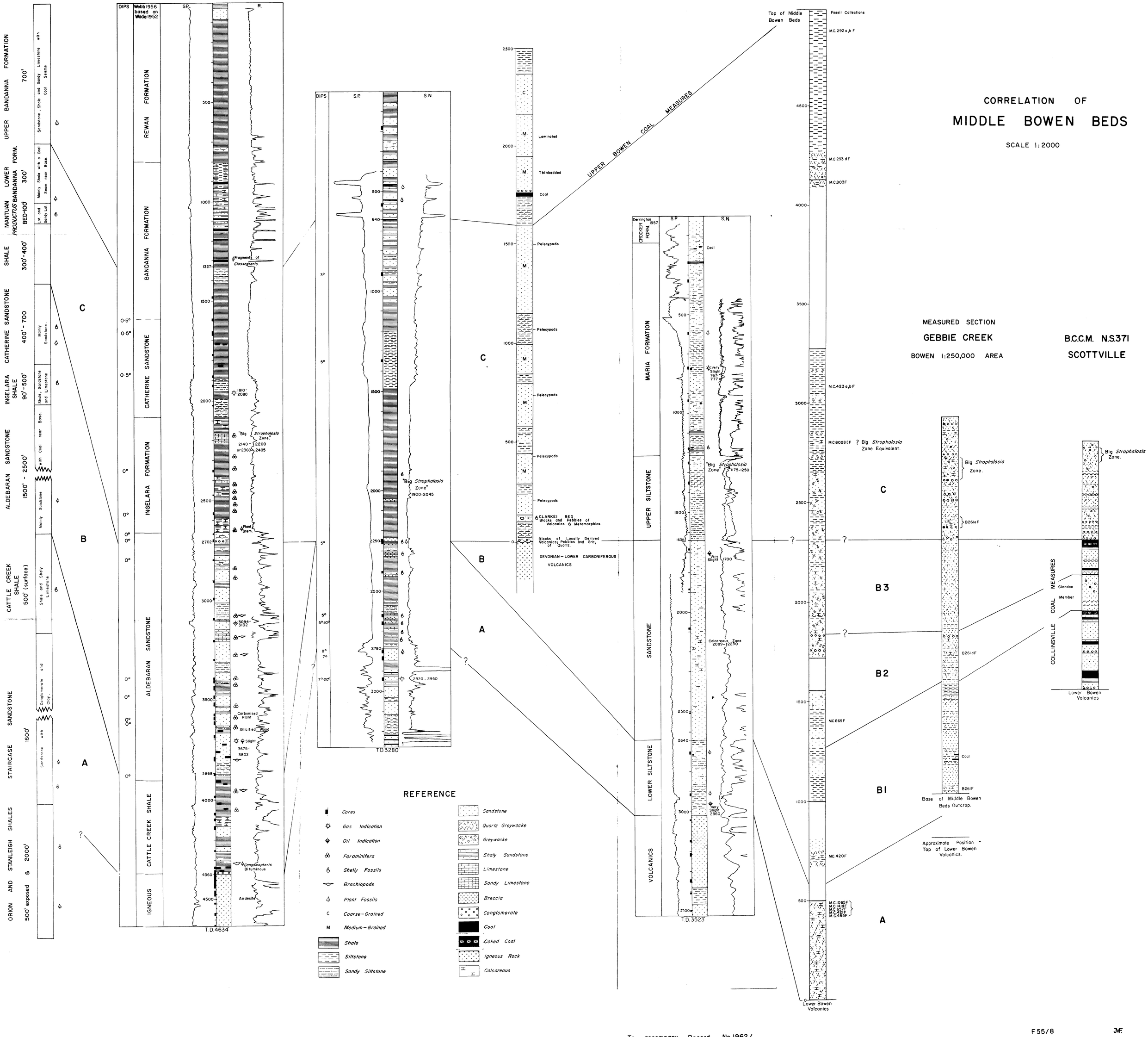
MEASURED SECTION

GEBBIE CREEK

BOWEN 1:250,000 AREA

B.C.C.M. N.S.371

SCOTTVILLE



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