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BUREAU OF MINERAL RESOURCES GEOLOGY AND GEOPHYSICS.

RECORDS.

1961/46

NOTES ON FIELD TRIPS, 1960

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During 1960 I visited the Carnarvon Basin with Dr. D. Trumpy, J. Guillemot and B. Tissot (of Institut Francais du Petrole) and R.A. McTavish (7th to 14th May), the Bowen Basin with B. Tissot, W.J. Perry, G. Tweedale, J.J. Veevers, R. Jensen, R. Paten and P. Bock (24th to 29th May), the Otway Basin with M. Guillemot, M. Tissot and Dr. Boutakoff (5th June), the Georgina Basin with K.G. Smith and R.R. Vine (14th June to 5th July), and Bowen Basin (with the Mt. Coolon and Clermont Parties) 26th September to 19th October.

The following notes record geological observations made on these field trips.

CARNARVON BASIN

Minilya 4-Mile Sheet

Minilya Syncline:

The contact between the Mesozoic and Permian on the right side of the Minilya River valley 550 yards south-east of Curdamuda Well (Condon, 1954a, p.103) was re-examined and confirmed as a steeply-dipping unconformity, not a fault as stated in Teichert (1940, p.19) and Condon (1954a, p.102). Glauconitic sandstone with a basal conglomerate of phosphatic calcareous siltstone, quartz and sandstone pebbles rests on a ferruginous surface of Permian shale. Both this surface and the overlying sandstone dip westward at about 25°. The Permian shale with abundant gypsum (probably an evaporite member) dips westward at 30° at the unconformity; farther east, beyond an anticline, the shale dips north-east under the Wandagee Formation: the shale is thus identified with the Quinnanie Shale although evaporites have not been reported in it elsewhere.

Structure: The Permian quartzwacke* beds between Curdamuda Well and Cundlego Crossing (Condon 1954b) are strongly jointed, the

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* Edwards (1950, p.146) proposed using Fischer's term quartzwacke for greywacke consisting dominantly of stable components (quartz, quartzite, chert, kaolin, zircon, rutile). The general term greywacke was proposed by Condon (1952) and qualified, as quartz greywacke (Condon 1954a). The more convenient and older term is now recommended.

joint system comprising two joint directions oblique to the strike, intersecting nearly at right angles with the intersection normal to the bedding. This normal compressional jointing indicates that these rocks have been subjected to tangential stress which may also have produced the folding and faulting of this area.

Cundlego Formation: The characteristic sedimentary structure of the sandy beds of the Cundlego Formation was not mentioned by Condon (1954a, p.72-75); it is finely laminated "festoon bedding", (Sutton & Watson 1960) also referred to as "Scour-and-fill" lamination.

K-52 Area

Callytharra Formation: The boundary between the Callytharra Formation and the Lyons Group was examined in the area south of the Middalya to Williambury road 2¼ miles east-south-east of K-52. A basal conglomerate marks the base of the Callytharra Formation: it consists of boulders, cobbles and pebbles derived from the Lyons Group but more rounded than similar material in situ in the Lyons. This bed rests on a truncated surface of the Thambrong Formation of the Lyons Group including varved siltstone/sandstone. This basal conglomerate was thought to be "the uppermost boulder bed" in the Lyons Group (Condon, 1954a, p.40).

Wooramel 4-mile Sheet

Winnemia Area, Gascoyne River:

The area between the Carnarvon to Gascoyne Junction road and the Gascoyne River, south of K39, was re-examined to determine the relationship of the Callytharra Formation and the Wooramel Group.

The Wooramel Group rests unconformably on the Callytharra Formation. Only the lower part of the Callytharra Formation is preserved, with a maximum thickness of 150 feet. The Moogooloo Sandstone equivalent, up to 400 feet thick, rests on the Callytharra and is overlain by a formation not recorded elsewhere in outcrop. This consists of fossiliferous calcarenite with thin beds of hard calcilutite and thin beds of fine-grained quartzwacke (Edwards 1950, p.146) in the lower part. It is 200 feet in this area and is overlain, apparently conformably, by sandstone of the Billidee Formation equivalent. The only other known occurrence of a calcarenite formation in this stratigraphic position is in Bore B.M.R. 8 (Mt. Madeline) where 65 feet of fossiliferous calcarenite was drilled between the One Gum Formation above and the Nunnery Sandstone below.

This formation is similar in lithology and fossils to parts of the Callytharra Formation and it seems likely that some isolated outcrops identified as Callytharra Formation may be this younger formation.

Carey Downs area

Cardilya Creek flows over the hard surface of the mottled zone of the lateritic profile between Rainbow Bore and the Carey Downs Homestead. The pisolitic ferruginous zone and lateritic soil (red sandy loam) are exposed in the banks, and continue into the sand-plain area where the longitudinal red sand dunes are formed by the winnowing and drifting of the sandy loam and the interdune areas are the exposed surface of the ferruginous or upper siliceous zone of the lateritic profile.

The lateritic material of the stream channel has been interpreted elsewhere as produced by Recent lateritization but in this area it is part of a continuous sheet of weathered rock, the stream dissection of which is at a very early stage.

BOWEN BASIN

The sediments of the "Lower Bowen Group" include black shale, black siliceous shale with laminae and beds of intermediate ashstone and tuff. Large and small scale slump structures (folds, breccia) are common. A deep-sea sedimentary environment in island-arc region is indicated.

The marine sediments of the "Middle Bowen Group" overlie the "Lower Bowen Group" probably unconformably. The relationship has not been observed directly but in places where the uppermost "Lower Bowen" sediments are absent a lowermost fossiliferous limestone of the "Middle Bowen" crops out.

The uppermost "Lower Bowen" sediments are overlain by fossiliferous quartzwacke and siltstone stratigraphically above the lowermost fossiliferous "Middle Bowen" limestone which is absent at this place (in Hazelwood Creek).

The mapping relationship may also be explained by a thrust fault; the overturning in the "Middle Bowen" and "Lower Bowen" sediments certainly suggests that this is possible.

The "Middle Bowen" sediments characteristically exhibit the structure produced by the action of sediment-burrowing and -eating invertebrates: a chaotic arrangement of fragments of sandy and carbonaceous sediment in which the original lamination is indicated only by lamination in some of the fragments. Intact burrows are recognizable in some of these beds but not in all. This important structure, which indicates abundant organic action during sedimentation but also indicates that much of the organic matter originally buried in the sediment was removed by scavengers, has not been named in English although it has been described (Dapples, 1938). Lombard (1956, p.370) includes it under the term "Stratification derangee". Thorslund and Westergard (1938, p.16) apply the Swedish name "Kraksten" (= crow stone) which they define as "a peculiar greenish grey spotted rock, made up of rapidly alternating, very thin layers or small lenses of argillaceous or pure sandstone and shale in which the originally pronounced stratification has been veiled or destroyed by burrowing animals".

As the feature is a sedimentary structure rather than a lithology a new structural term such as "phyrmatic" (from Gr., disorder) is required.

The "Middle Bowen" sediments of the north-eastern part of the Basin were deposited in moderately deep sea water (infra-neritic environment), whereas those of the western area were deposited in a shallow sea on a fairly stable shelf.

Middle Bowen Glacial Sediments

The glacial origin (Jack, 1879, p.7, Reid, 1924, p.462) of pebbles, cobbles and boulders in fossiliferous. Middle Bowen sediments has not been adequately established. In the Mt. Lebanon area north of the Clermont-Mackay Highway J.J. Veevers found siltstone and quartzwacke with marine fossils and scattered erratics, which I consider to be indubitably of glacial origin. The sediments apart from the erratics are normal marine sediments into which the erratics have been dropped from floating ice. The erratics range in size from coarse sand to large boulders. Lithologies include quartz, quartzite, granite, mica schist, phyllitic slate and limestone. A few of the quartzite pebbles are facetted and striated. Many of the fragments have a polished surface extending into re-entrants. Impact structure in the sediments is found under some boulders. The sediments are not turbidity current deposits and are thin bedded to laminated so that even if they were possibly turbidity current sediments the volume of individual layers is insufficient to have carried the cobbles and boulders. The mechanical weakness of some of the large mica schist and phyllite boulders demands that they were carried to the site of deposition. This, and the wide range of lithologies, precludes carriage by floating tree-roots and requires carriage by glacier ice (i.e. by icebergs) rather than by floe-ice (Lisitsin, A.P., 1958).

The small proportion of glacier-derived material in the sediment suggests that the glaciers reaching the sea were few and small valley glaciers. This contrasts with the sediments of the Sakmarian Lyons Group of the Carnarvon Basin, W.A. where formations 1,000 feet thick consist predominantly of glacier-derived sediment (rock-flour to boulders). Whereas the term marine tillite is not inappropriate for these sediments of the Lyons Group it certainly would be for those of the "Middle Bowen" which are marine siltstone and quartzwacke with glacial erratics.

The intermediate sills intruding the "Middle Bowen" in the north-eastern area are jointed with the same joint system as that affecting the sediments: in both, the bisectrices of the joints are about 10° off the dip and strike directions. I take this to indicate that the sediments and sills were subjected to the same major stresses, that they were folded together and subsequently tilted by a different stress. As the main folding was late Permian to early Triassic this implies that the intrusion was penecontemporaneous with the deposition of the sediments.

The "Upper Bowen" sediments are generally poorly exposed. The characteristic lithology in outcrop (although this may not be the dominant lithology) is an arenite with festoon bedding. This arenite, which has been called "lithic sandstone" by McElroy (1957), is polymict in composition with variable proportions of quartz, feldspar, fine-grained rock fragments (slate, schist, quartzite, chert), ferromagnesian minerals, mica, chlorite. The size sorting is moderately good; there is very little to practically no matrix. The grains are sub-angular to sub-rounded. The rock is similar in mineral composition to greywacke (in particular to quartz-mengwacke or mengwacke of Fischer, 1933), but lacks the essential silty matrix of the greywacke. It is similar in texture to sandstone but lacks the maturity of typical sandstone (i.e. its composition is too varied and includes much labile material, and the grains are not rounded enough). Fischer (1933) and Condon (1952) did not recognize this important class of arenites. McElroy (1957) called attention to it but did not recognize its significance.

In eastern Australia it appears to be characteristic of fresh-water sediments e.g. "Upper Bowen", Newcastle and Greta Coal Measures, Ipswich Coal Measures and Otway Group. It is associated in sequence with plant-bearing shale and/or siltstone.

It probably represents the sand-sized fraction of a turbidity current from which the fine-grained fraction has been removed, perhaps by dilution of the turbidity current by the enclosing fresh water to the point where the density of the mud-water suspension is insufficient to carry the larger (sand-sized) grains. Under such conditions the sand would settle with very little silt/clay but would suffer traction and erosion by the muddy water passing over. This suggests that this lithology may be restricted to fresh-water sediments, although a large fresh-water turbidity current entering the sea may, after dropping some of its load, be thus diluted to the density where the sand could settle out separately.

This is a distinctive lithology that probably constitutes an important proportion of fragmental rocks. As "wacke" (German "silt") is excluded and sandstone is preferably restricted to dominantly monomineralic arenites, a new name such as "mengarenite" (German mengen, to mix in reference to its composition) is required.

The stratigraphic level of the uppermost beds of the "Upper Bowen" cannot be determined precisely yet, although current palynological work may soon provide useful information.

Although the Carborough Sandstone is generally structurally concordant with the "Upper Bowen" and the contact of the two is rarely exposed, the sudden change of lithology indicates a major tectonic event causing a complete change of sedimentary environment and in places there is a strong suggestion of unconformity between the two. To the north of the Redcliffe Tableland the "Upper Bowen" is folded in a tight south-plunging syncline with strikes on either limb diverging by only about 20°. These strikes trend towards the shallow syncline in the Carborough Sandstone, suggesting a strong angular unconformity.

Plutonic Intrusions

In the axial part of the Bowen Basin are a number of small intrusions of plutonic intermediate rocks. These intrude fossiliferous "Middle Bowen" and "Upper Bowen" rocks, and associated dykes intrude the Carborough Sandstone. The intrusions, therefore, are indicated to be Triassic or younger in age. The Permian sediments are generally strongly up-domed around the intrusion but the metamorphic effect is limit to induration: no obvious recrystallization was observed.

?Tertiary Basalt

The main evidence for the age of the basalt in the Bowen Basin is geomorphic: it rests on a mature erosion surface developed on Carboniferous, Permian and Triassic sediments and the surface of the basalt, where preserved, is strongly lateritized. The basalt has been deeply dissected.

The lateritic profile in Western Australia started to develop before the Eocene and continued after it. Palaeobotanical evidence and the virtual absence of terrigenous marine Neogene sediments suggest tectonic and climatic stability of the continent throughout the Tertiary. The change of climate to very unstable probably coincided with the beginning of the Pleistocene ice age of the Northern Hemisphere and tectonic movements probably intensified in the Quaternary (Beavis, 1960). Much of the strong dissection of Eastern Australia probably resulted from the climatic instability rather than from local or continent-wide tectonic events. The destruction of vegetative cover during arid periods, rather than increase of rainfall or of available relief, was probably the main cause of the erosion. The present period of dissection thus probably began about the start of the Pleistocene and this in turn gives the upper limit of the age of the basalt which therefore may be Jurassic to Pliocene.

Partly because of the dissection it is uncommon to find vents of the basaltic eruptions in this area. About 10 miles south-west of Clermont, on Douglas Creek, is the dissected remains of a volcanic cone. In what is probably the throat, columnar basalt with vertical columns forms a small outcrop only a few feet above the plain. At a distance of about 100 yards from the vent larger outcrops of basalt have flows dipping centrifugally away from the vent at 5 to 15°. These include columnar basalt with columns normal to the surface of flows, and flows of closely jointed basalt like that reported from explosion cones.

?Recent Puys

Rising above the present erosion surface mainly in the area east of Clermont are a number of isolated steep sided mountains composed of rhyolitic lava. R.G. Mollan reports that the basalt is upturned around these; Permian sedimentary rocks are strongly upturned in diapiric form around them. The outer few feet of the volcanic rock is a self-healed breccia and the form and structure of the mass suggest a similarity to the puys of Auvergne. In nearly all cases there is very little dissection. By reference to the geomorphology, these puys almost certainly are of Quaternary and probably of Recent age.

Relation of present basin structure to sedimentational structure.

The Bowen Basin is only part of the basin of sedimentation in which its sediments were deposited.

Its western margin is close to the margin of sedimentation: the "Middle Bowen" sediments were deposited in shallow water on an unstable shelf. "Lower Bowen" volcanics and deep-water sediments occupy the eastern margin, overlain unconformably by infra-neritic sediments. The "Upper Bowen" sediments were deposited in fresh-water ranging from shallow in the western part to fairly deep in the eastern. In the eastern part (east of Comet) the Upper Bowen sediments are tightly folded: the folding appears to have resulted from the tectonic compression of sedimentary (mainly slump) folds.

The main tectonic episode is epi-Permian and, within the "Basin", the main plutonic igneous event is post-Triassic. The present regional structural form had not been established in the Triassic: transport directions in the Carborough Sandstone are not related to present structure. This suggests that the Gogango geanticline was not developed until after the Triassic and probably was accompanied by the igneous intrusion. The overturning of the "Middle Bowen" sediments in the Blenheim Creek area may indicate that they were already strongly dipping before the intrusive-tectonic episode.

The distal hinge of the original basin of sedimentation probably is in the coastal area near Mackay. I have not examined this area and published descriptions are insufficient to determine lithologies in terms of sedimentary environment and palaeogeography.

Effect of Igneous and Tectonic History on Oil Prospects

An area with such a lengthy and varied igneous history could easily be dismissed as having no oil prospects. This is not necessarily so.

There is no evidence of a general rise of temperature and/or pressure such as would destroy all organic material: the coal seams of the Upper Bowen are not of very high rank and even where they are intruded there has been little alteration of the coal seam except within a few feet of the dyke. The Collinsville coal seams (base of "Middle Bowen") show stronger effects but these are still local although sills may completely destroy a thin seam. Shales are indurated only very close to the Permian sills and for a greater but regionally small distance from the ?Mesozoic plutonic intrusions. No basaltic dykes have been seen intruding the Permian sediments and the metamorphic effect of the Quaternary puys is very small.

The small rise of temperature associated with the intrusion of the Permian sills is likely to have helped primary migration by reducing viscosity without causing any destruction of hydrocarbons.

In the "Middle Bowen" migration was probably westward across the full width of the present basin and northward up the regional basin plunge. The intercalated sands would provide good channels for primary migration. Traps would be provided by the depositional anticlines of the western shelf area and by permeability barriers particularly in the paralic region south of Collinsville. Neither of these regions has been disturbed by tectonic or igneous activity since.

In the epi-Permian the central part of the basin (eastward of a line, from west of the Redcliffe Tableland to Comet, which is the western hinge of the sedimentary basin) was strongly compressed and folds, tight in some places, open in others, developed. Some of these may have developed from minor sedimentary folds.

The major regional structure - the Bowen Syncline and the Gogango Geanticline - developed at some time after the Triassic, accompanied by plutonic intrusion in the geanticline and in small forceful intrusions that domed up the Triassic and Permian sediments. These would have adverse affects on oil only if they happened to intrude an established oil pool. The heat of intrusion may have had the effect of producing some gas (methane hydrogen, carbon monoxide and carbon dioxide) from the coal of the Upper Bowen and this would collect in the intrusion domes. Those that have not been breached by erosion are likely to contain dry gas.

The basalt and rhyolite volcanic activity in the shelf area probably had little metamorphic effect on oil pools.

In the exploration of this basin, it will be essential to determine the age of the anticlines because only those that were in existence during sedimentation have much prospect of containing petroleum. These appear mainly to be confined to the western shelf area.

Cooroorah Bore

The Cooroorah Bore was drilled by Associated-Freney with Commonwealth subsidy (Derrington, 1960) at the culmination of an anticline expressed at the surface in "Upper" and "Middle Bowen" sediments and confirmed as continuing to great depth by Bureau seismic reflection survey. It was thought that this anticline was located on a platform that existed during sedimentation. No fossils were found in the bore and only fixed carbon remained of any original organic matter. Slump structures in cores indicate that the area was not topographically high in the Permian but rather was part of the basin slope. The sediments are of infra-neritic rather than shallow-water type. The structure is post depositional. The bore was abandoned after passing through strongly indurated sediments, andesite and intermediate and acidic intrusive igneous rocks. These probably are Permian sills, penecontemporaneous with the "Middle Bowen" sediments, rather than "Lower Bowen" volcanics, sediments and intrusives or younger intrusives. The sedimentary structures observed in the cores establish the palaeogeographic setting of the area and suggest that the anticline was developed too late to trap any migrating Permian oil.

OTWAY BASIN

Only the area between Torquay and Port Campbell was visited.

The Mesozoic sediments at Eastern View were found to be "mengarenites" rather than arkose (Edwards & Baker, 1943*). They contain small lenticular fragments of coaly matter and siltstone pellets. The coastal section as far as Apollo Bay consists of similar lithology with minor siltstone beds. There are many small anticlines and synclines but the coast generally follows the regional strike and very little thickness is exposed. To the west of Cape Otway, on the highway between Lavers Hill and Peterborough, the Mesozoic sediments are interbedded quartz sandstone and shale/siltstone. This sequence may be a lateral variation of the "mengarenite" sequence but seems more likely to be a younger sequence, on the western plunge of the generally anticlinal Otway Range.

GEORGINA BASIN

Tobermory Sheet

In the Tarlton Downs area the Cambro-Ordovician dolomite is affected by deep Tertiary weathering that has produced a granular texture in the residual rock. This is so unlike the original dolomite that it may be regarded as a separate formation. In some places sedimentary textures and structures (intraformational breccia, oolites) common in the fresh dolomite may be recognized in the weathered rock.

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* Edwards and Baker (1943) give a good description (based on 300 thin sections of rocks from the Otway Range, Gippsland Hills and Western Victoria) of the size sorting, mineralogy, and chemical composition of these sedimentary rocks. They are certainly not arkose: the particle source is not dominantly granitic but mixed granitic, sedimentary and intermediate volcanic.

Huckitta Sheet

In the north-eastern part of Huckitta 4-mile sheet, between the Lucy Creek and the north edge of the sheet area, an anticline is developed in dolomite and fossiliferous sandstone.

In this area residual buttes of deeply-weathered dolomite rest on the fresh rock.

Elkedra Sheet

The Sandover Beds (Öpik, 1956, 42) were examined in several places along the Sandover River road. Nowhere was fresh rock seen in outcrop: the outcropping rock is everywhere strongly weathered by deep Tertiary weathering. The rock is weathered (leached) silty dololutite, dololutite and dolarenite commonly richly fossiliferous. The equivalent fresh rock may be seen in bore cuttings. The silty dololutite weathers to a fine-grained siliceous rock. Where undissected, the surface of this rock is covered by pisolitic laterite.

Similar weathered lithology is seen in the Middle Cambrian west of Soudan, west of Thorntonia, at Quita Creek and elsewhere, and in the Ordovician Swift Formation (Casey et al. 1960, p.48).

Sandover River Sheet

In a large part of the area of the sheet south of the Sandover River, bedded dolomite crops out. It mainly has very gentle dips but total structural relief is of the order of a thousand feet. The sequence is not only dolomite: interbedded with the hard beds of dolomite are friable dololutite, shale and fine-grained sandstone. These are continuous in sequence with fossiliferous Ordovician sediments on Glenormiston sheet (Casey et al 1959; Condon, 1958, p.10) and with Cambrian sediments on Tobermory Sheet (Smith and Vine, 1960). No fossils have been found in this area.

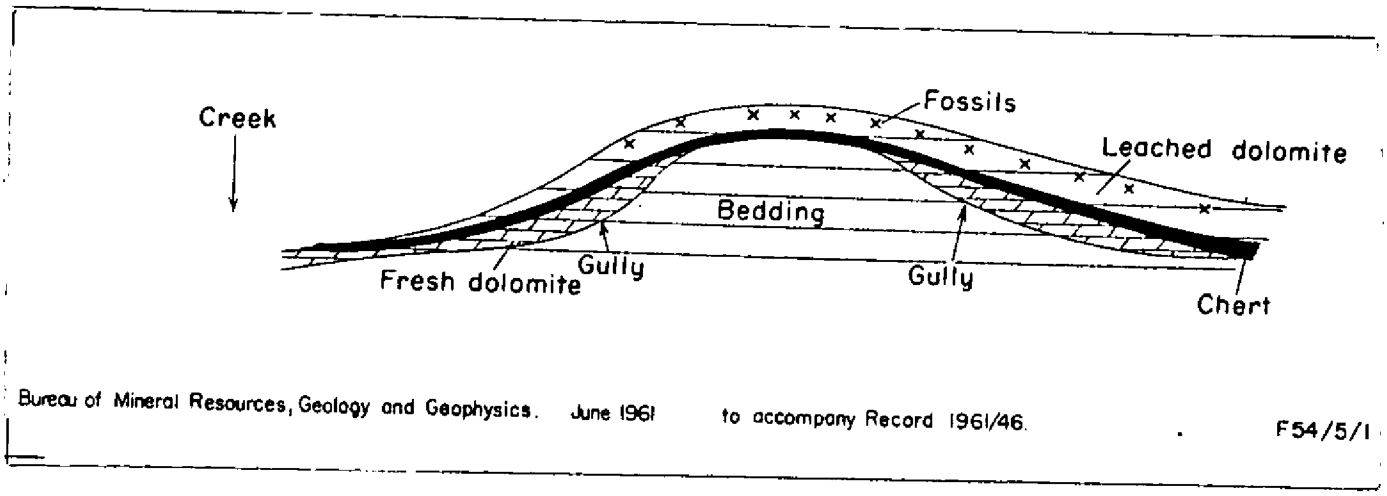
Residual gravels of pebbles and cobbles of a wide range of lithology were found in the area north of Bathurst.

These could not have been river transported to this area which is 100 miles from the nearest similar metamorphic and igneous rocks. They are almost certainly remnants of the Permian tillite and equivalent of the Tarlton Formation.

Urandangi Sheet

The Ardmore area (Öpik, 1956, p.13) was visited to compare the sequence with that in the Huckitta-Tobermory area.

The basal sedimentary formation, (Riversdale Formation - Öpik, 1959, p.9) resting unconformably on Precambrian metamorphic rocks, is brownish red pebbly greywacke, dolomitic in part. This grades up into dolomite the weathered part of which display abundant fossils. The chert in this area is clearly a replacement of the dolomite at the base of the weathering profile: identical sedimentary structures (breccia, micro-slump-folding, type of bedding and lamination) can be found in the fresh dolomite and the chert.



Diagrammatic section, Ardmore Outlier north of Split Creek

The red greywacke is similar in lithology and stratigraphic position to the Mt. Baldwin Formation (Smith et al, 1960).

The dolomite cropping out in the ridge 10 miles east of Urandangi (Carter & Noakes 1958) dips westward at about 3 degrees. The Ordovician fossils found in this area almost certainly are in sequence in this dolomite and not unconformable on it. The dolomite is weathered to the granular residual material and the cherty replacement rock.

The Austral Downs Limestone (Noakes & Traves 1954, p.40) along the Georgina River north of Urandangi in places rests on fresh dolomite and in others on the deeply weathered dolomite. This suggests that the limestone was deposited after dissection and stripping of the weathered mantle i.e. in the Pleistocene (see above p.14). The more general relationship (where the limestone rests on the weathered rock) has suggested a Tertiary age for this unit.

Avon Downs Sheet

Four miles north of Lake Nash homestead, bedded dolomite is folded into a domal anticline about 10 miles east-west and 5 miles north-south. This area is about midway between the metamorphic basement of the Mt. Isa-Cloncurry area and the Precambrian sedimentary sequence of the Davenport Ranges. Middle Cambrian sediments dip off both of these basements so the Ordovician fossils reported from this central area are likely to be in sequence and the Lake Nash Anticline may be closed in the Ordovician.

Ranken Sheet

The Wonara Beds (Öpik, 1956, p.40) 10 to 30 miles west of Soudan on the Barkly Highway are similar in lithology to the Sandover Beds - leached dololutite and chert replacing dolomite. The sink-holes 9½ miles west of Soudan suggest that limestone underlies the dolomite since the dolomite is not soluble enough to allow cave development. Detrital laterite pisolites form a deposit up to 20 feet thick exposed in the walls of the sink holes. Fresh dolomite is not exposed.

The Ranken Limestone (Öpik, 1956, p.41) appears to rest on the "Wonara Beds" that crop out west of Soudan and to grade up into the dolomite on the east side of the Ranken River: the whole sequence dips eastward at about 1 to 2 degrees. The Upper Middle Cambrian fossils found near Coolibah Bore (Öpik, 1956, p.41) are probably in sequence with rather than unconformable on, the dolomite. No evidence of a distinctive lithology with unconformable relationship to the dolomite could be found. The weathered surface rock is residual from the dolomite.

Along the Barkly Highway between Soudan and Camooweal the dolomite and quartz sandstone, occurring mainly as "float" in the black soil was found to have many distinctive textures and structures that suggest that mapping of lithological units in this "no-outcrop" area may be possible. No indubitable fossils were found but much of the dolomite and sandstone has the appearance of fossiliferous rock.

Residuals of the Tertiary deep-weathered profile remain on the Barkly plain but much of the surface is a shallow immature calcareous clay developed on fresh carbonate rock. The method of erosion of the weathered mantle from the very flat surface is not readily explained. Much of the material may have been removed in solution rather than suspension. The residuals at Barry's Caves (24 miles west of Soudan) show the typical hard mottled zone and softer, granular pallid zone of the deep weathering profile, equivalent to the lateritic profile.

Camooweal Sheet

The stratigraphic and structural relationships between the Camooweal Dolomite (Öpik, 1956, p.12) and the Middle Cambrian formations of the Morstone area were examined.

In Argus Creek, the Age Creek Formation consists of dolarenite, oolitic dolomite, calcarenite and sandy dolomite. Brown chert nodules are developed on the surface of some beds. This sequence dips south-south-west at a low angle (3° to 5°) the higher dips (of 15 to 25° east) previously recorded here (draft compilation, Camooweal 4-mile sheet, 1960) were found to be the dips of very large foresets. Sets of cross-bedded strata up to 50 feet thick were seen. The calcarenite in this area occurs as foreset lenses within these thick sets. This large-scale cross-bedding and the clean lithology suggest long-shore currents on a stable shelf.

In Argus Creek south of Marion Bore the Age Creek sequence continues without lithological or structural change to the western limit of outcrop. It must be inferred that in this area either the Camooweal Dolomite is not present or that it is identical, there, with the Middle Cambrian Age Creek Formation.

East of Morstone the Age Creek Formation grades laterally into the Mail Change Limestone. Thus there is apparently a lateral change in lithology from limestone in the east to dolomite in the west, along the regional strike.

The "Split Rock Sandstone" (Öpik, 1956, p.19) as mapped in the 1960 draft Camooweal 4-mile sheet has no validity as a formation. Many areas mapped as this unit near the Camooweal-Thorntonia road were examined. All of these are the weathered profile developed in the carbonate rocks: quartz sandstone is included in only a few places; generally the rock is the skeletal residual rock resulting from the leaching of carbonates. Its "wide stratigraphical range" results from its derivation from formations ranging from V-Creek Limestone to Age Creek Formation. In most respects this development is similar to the "Steamboat Sandstone" (Öpik, 1956, p.20) of the Quita Creek area (Condon, 1958, p.11).

The Pollands Water Hole Shale, in its type locality, is typical deeply weathered radiolarite similar to the Aptian Windalia Radiolarite (Condon 1954a, p.109) of the Carnarvon Basin, W.A. Much of the area mapped (draft compilation, Camooweal Sheet, 1960) as Pollands Waterhole Shale is the deeply weathered surface of the Cambrian carbonates that produce a skeletal residual rock superficially resembling the weathered radiolarite.

Pisolitic laterite about 3 to 4 feet thick rests directly on fresh limestone (Mail Change Limestone) six miles southward from Old Morestone. This laterite is in place (not detrital) but has no mottled or pallid zone between it and the fresh rock. It perhaps indicates that the limestone in this area is very pure so that the only residuum after mature weathering is iron hydroxide.

Why isn't it detrital then?

Then how do you get the 'Split Rock SSt.' + other skeletal rocks by weathering it?

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