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Creationist Geology: Where do the 'Precambrian' Strata Fit?

DR ANDREW SNELLING

ABSTRACT

Creationists have long tended to argue that Precambrian strata represent pre-Flood rocks. They have consistently adopted the common (that is, until recently) evolutionary view that these strata are non-fossiliferous. This argument is no longer feasible because of the discoveries in recent years of numerous fossils (principally algae) and abundant organic matter (often as graphite) in Precambrian rocks around the world.

For creationists to be consistent the implications are clear: Precambrian sediments containing fossils and organic remains were probably also laid down during Noah's Flood. Creationist geologists need to avoid being bound by the evolutionists' geological column and associated terminology. It is necessary to start again using the presence of fossils or organic matter as a classification criterion in the task of rebuilding our understanding of geological history within the biblical framework.

THE GEOLOGICAL COLUMN/TIME-SCALE

Such concepts as the assumption of uniformity of natural processes and the long held idea of the supposed 'Great Chain of Being' were used by 19th century scientists to construct the geological time-scale and the geological column. Many of them postulated that over long periods of time (millions of years) the slow geological processes we observe today laid down the rocks of the Earth's crust in an ordered sequence which now corresponds to the evolutionists' view of the development of life by random natural processes. Thus the geological column and the geological time-scale are inseparably linked, the former being divided into rock strata corresponding to the time periods of the latter, based on the contained fossils.

That fossils are now the key to the maintenance of both the geological column and the geological time-scale cannot be disputed. Ager says,

> *'No palaeontologist worthy of the name would ever date his fossils by the strata in which they are found. It is almost the first thing I teach my first-year students. Ever since William Smith at the beginning of the 19th century, fossils have been and still are the best and most accurate method of dating and correlating the rocks in which they occur.'*[1]

However, the order in which the fossils continue to be placed in the geological column is determined, not just by their sequence of occurrence in the rock strata, but by the assumption that they represent the evolution of all life. This is clearly stated by O'Rourke:

> *'Evolution is more than a useful biologic concept; it is a natural law controlling the history of all phenomena . . . . These principles have been applied in* ***Feinstratigraphie****, which starts from a chronology of index fossils, abstracts time units from it, and imposes them on the rocks (Schindewolf, 1960, p. 7). Each taxon represents a definite time unit and so provides an accurate, even infallible date.'*[2]
>
> *'The chronology used by* ***Feinstratigraphie*** *is said to be deduced from the principle of evolution; "time units are derived from . . . the development of organisms . . ." (Schindewolf, 1960, p.18); "the evolution of the forms of life . . . provides . . . universally applicable time marks . . ." (Jeletsky, 1956, p. 682). Well, evolution by natural selection is so slow it cannot be clocked and extended back to quantify the fossil record. Nor can its rate be estimated from fossil morphology without reference to a pre-existing time scale. Before it could be used to mark off time units, it had to be calibrated by comparing it to the geologic column . . . Correlation is said to derive a guarantee from the irreversibility of evolution. Each fossil was*

a unique event; each taxon, an interval of time in a cumulative sequence.'[3]

'Here is the tacit assumption that the sequence of fossils is just given, inasmuch as it literally took place in the development of the Earth. On the other hand, our knowledge of the sequence was pieced together from many sections. The procession of life was never witnessed, it is inferred. The vertical sequence of fossils is thought to represent a process because the enclosing rocks are interpreted as a process.'[4]

CREATIONIST GEOLOGY

On the other hand, creationists interpret the majority of the fossiliferous sedimentary rocks of the Earth's crust as testimony to Noah's Flood, which occurred approximately 4,300 years ago (based on a literal addition of chronologies in Genesis). Creationists do this because they regard the Genesis record as implying there was no rain before Noah's Flood (Genesis 2:5), therefore no major erosion, and hence no significant sedimentation or fossilization.

However, the Flood was global and erosional, since its purpose was destruction. Therefore, the first major fossilization commenced at this time, so the majority of the fossils are regarded as organisms that were rapidly buried during this event, and subsequently fossilized. Creationists therefore regard the sedimentary strata, and all metamorphosed rock strata and igneous rocks according to their relationship to the sedimentary strata, as needing to be classified into those formed during the time of the Creation Week, pre-Flood, Flood, (early, middle and late), post-Flood and recent. Because they hold to completely different principles for explanation of most of the rock strata of the geological column, creationist geologists have to re-interpret the geological evidence. As Dillow says of the geological column:

'It should be obvious that if the earth is only 6,000 years old, then all the geological designations are meaningless within that framework, and it is deceptive to continue to use them. If, as many creationist geologists believe, the majority of the geological column represents flood sediments and post-flood geophysical activity, then the mammoth, the dinosaur, and human beings all existed simultaneously . . . some limited attempts have been made by creationist geologists to reclassify the entire geological column within this framework, but the task is immense.'[5]

What Dillow is also suggesting is that the evolutionists' geological column and their terminology should be completely scrapped, and then creationist geologists should start again.

However, having said that, Dillow, in his book **The Waters Above**, presents his 'Reclassification of geological strata along the lines of flood geology',[6] in which he lumps together as pre-Flood strata much of what historical evolutionary geology terms Precambrian, and only considers the Cambrian to Recent as Flood and post-Flood strata. In so doing Dillow has merely followed in the footsteps of other creationists, for example, Coffin.[7] It is my contention that those who do this have failed to study carefully the evidence for the Flood deposition of many Precambrian strata and have therefore unwittingly fallen into the trap of lumping together all the Precambrian strata into the Creation Week. The usual reason for doing this is that the evolutionists regard the Precambrian as so different, so devoid of life in comparison with other rocks, that creationists have simply borrowed their description.

PRECAMBRIAN STRATA AND NOAH'S FLOOD

I believe that to be consistent, we must completely start anew and assign all strata that show evidence of deposition in Noah's Flood to the Flood period within the creationists' geological time framework, irrespective of the stratum's evolutionary age or designation.

For example, because trilobites are believed by evolutionists to have 'appeared' at a certain point in the evolutionary progression of life, the point at which trilobites 'appear' as fossils in the geological column is labelled by evolutionists as the beginning of the Cambrian Period. Consequently, wherever these same trilobite fossils are found in rock strata, those strata are automatically assigned to the Cambrian, the beginning of which is now designated as being 570 million (evolutionary) years ago.

However, if the evolutionary assumption is ignored, why would these trilobite fossils still have to be assigned to the same time point in geological history? According to the Flood model, trilobites would not necessarily have been buried and fossilized at the same time everywhere around the globe. Surely it's possible, even likely, that as trilobites were being buried in the area which is now North America, other sediments devoid of fossils such as trilobites were being deposited in the area of Australia?

It is true that there are comparable patterns of sedimentation and fossil content of strata from continent to continent, but as Flood geologists we are not bound by the rigid evolutionary order and time-scale for strata or fossils. Consequently, some so-called Precambrian strata in Australia may have been deposited at the same time as so-called Cambrian strata in North America. Any similarities then in the patterns of sedimentation and fossil contents of strata between Australia and North America would be the result of other factors, such as the organisms (or lack thereof) in the sediment source areas, ecological zoning, differential mobility and/or the sorting action of the Flood waters.

So if evolutionary designations of all strata are not to be regarded as a rigid, globally-applicable time sequence, why should many so-called Precambrian strata not be also regarded as Flood strata? If so, what evidence in them would we look for? The answer is simple. They are also often fossiliferous, or they commonly contain abundant organic matter which is the remains of fossils.

PRECAMBRIAN FOSSILS

Whitcomb and Morris[8] suggested that the main criterion for recognition of Precambrian rocks is they be non-fossil-bearing. This criterion can no longer be maintained as there is now abundant evidence that rocks which evolutionist geologists classify as Precambrian do in fact contain a variety of fossils. In any case, this criterion cannot be rigidly applied since many so-called Cambrian-Recent strata are also non-fossil-bearing.

The most significant of these Precambrian fossils are microscopic algae and megascopic stromatolites, the latter being the layered structures formed as a result of the accretion of fine grains of sediment by matted colonies of micro-organisms, principally algae. That this is what stromatolites are has been verified by the study of 'living' stromatolites found thriving today in the shallow waters of Shark Bay near Carnarvon on the Western Australian coast,[9] in Spencer Gulf on the South Australian coast,[10] in shallow pools fed by springs in the Northern Great Sandy Desert of inland northern Western Australia,[11] and in Lake Clifton just to the south of Perth, Western Australia.[12] At these localities, and others overseas,[13] cyanobacteria (the photosynthesizing bacteria formerly known as blue-green algae) are today building cyanobacterial mats and stromatolites identical to those found in the fossil record, even as far back as about 3.5 billion (3.5×10^9) (evolutionary) years ago in Precambrian sediments. (In passing, it should be pointed out that evolutionists should be puzzled as to how these co-called 'primitive' micro-organisms have survived so long in the fossil record, unchanged, unevolving, and not prone to extinction.)

Fossil stromatolites have now been identified in rocks from all evolutionary time periods in the geological column, including the Precambrian. A recent significant 'find' of fossil stromatolites at a place called North Pole in the Pilbara area of Western Australia has received wide publicity.[14-17] Here stromatolites have been found in a chert-barite unit about 30m thick within a sequence of pillow basalts, minor intercalated sandstone, mudstones and evaporites. (It should be noted that pillow basalts are the result of underwater extrusion of lava, while chert, a rock composed of microscopic grains of silica, and barite, dominantly barium sulphate, are both regarded by evolutionists as water-deposited chemical sediments or 'evaporites', the latter term denoting their presumed precipitation via evaporation.) Various rocks in the area have been dated by radiometric methods to give an 'age' of about 3.5 billion (evolutionary) years for these stromatolites.[18,19] Two things about the fossils at this locality are clear — they are in water-deposited sediments associated with volcanics that were extruded under water, and their 'age' has been determined by radiometric dating within their broad geological setting.

THE AUSTRALIAN PRECAMBRIAN

Historically, the first known Australian Precambrian fossils were the '*organically preserved algal microfossils from the Ringwood evaporite deposit in the Gillen Member of the Bitter Springs Formation (Late Precambrian of Central Australia)*', 100km east of Alice Springs.[20,21]

Glaessner and Walter even in 1981 wrote:

> *'The rich and varied Precambrian fossil record of Australia is now being elaborated at an increasing rate. During the last 10 years the number of known microfossiliferous formations has increased from 1 to 16. Stromatolites are almost ubiquitous, microfossils and trace fossils are widespread, and new finds of fossil soft-bodied invertebrates are being made'.*[22]

They concluded:

> *'The Precambrian fossils of Australia are remarkably diverse, abundant and well preserved. It is unlikely that this continent is uniquely endowed with fossils, but what fossils exist are being rapidly discovered and described.'*[23]

And further:

> *'The micro-organisms and early animals did not live independently of each other or of their environment. Stromatolites are to be seen not only as potential biostratigraphic tools, but as the sedimentary record of microbial communities, the repository of otherwise unavailable physiological information on the constructing micro-organisms, and not least, a source of food and shelter (and perhaps oxygen) for the earliest metazoans'.*[24]

Figure 1 shows the geographical, geological and supposed time distribution of some of Australia's fossiliferous Precambrian strata. These strata span the whole of the so-called Proterozoic, from 2.35 billion to 570 million (evolutionary) years ago, and are found in nine different basins/strata sequences. Most of these fossiliferous strata, particularly those older than 800 million (evolutionary) years, only have stromatolites and algae in them.

But this compilation in Figure 1 is not exhaustive. The Proterozoic/Archaean boundary is usually placed at 2.5 billion (evolutionary) years,[25] so the occurrence of the fossilized stromatolites and algae in 3.5 billion (evolutionary) year old rocks at North Pole indicates that such fossils are not only found in Proterozoic strata. There has been some debate about those fossils at North Pole,[26-28] but their validity is now generally recognized in both popular and textbook presentations on the supposed evolutionary history of life.[29-32] Yet the only other Archaean stromatolites found in Australia are in the 2.6 billion (evolutionary) year old Gindalbie Formation near Kanowna (near

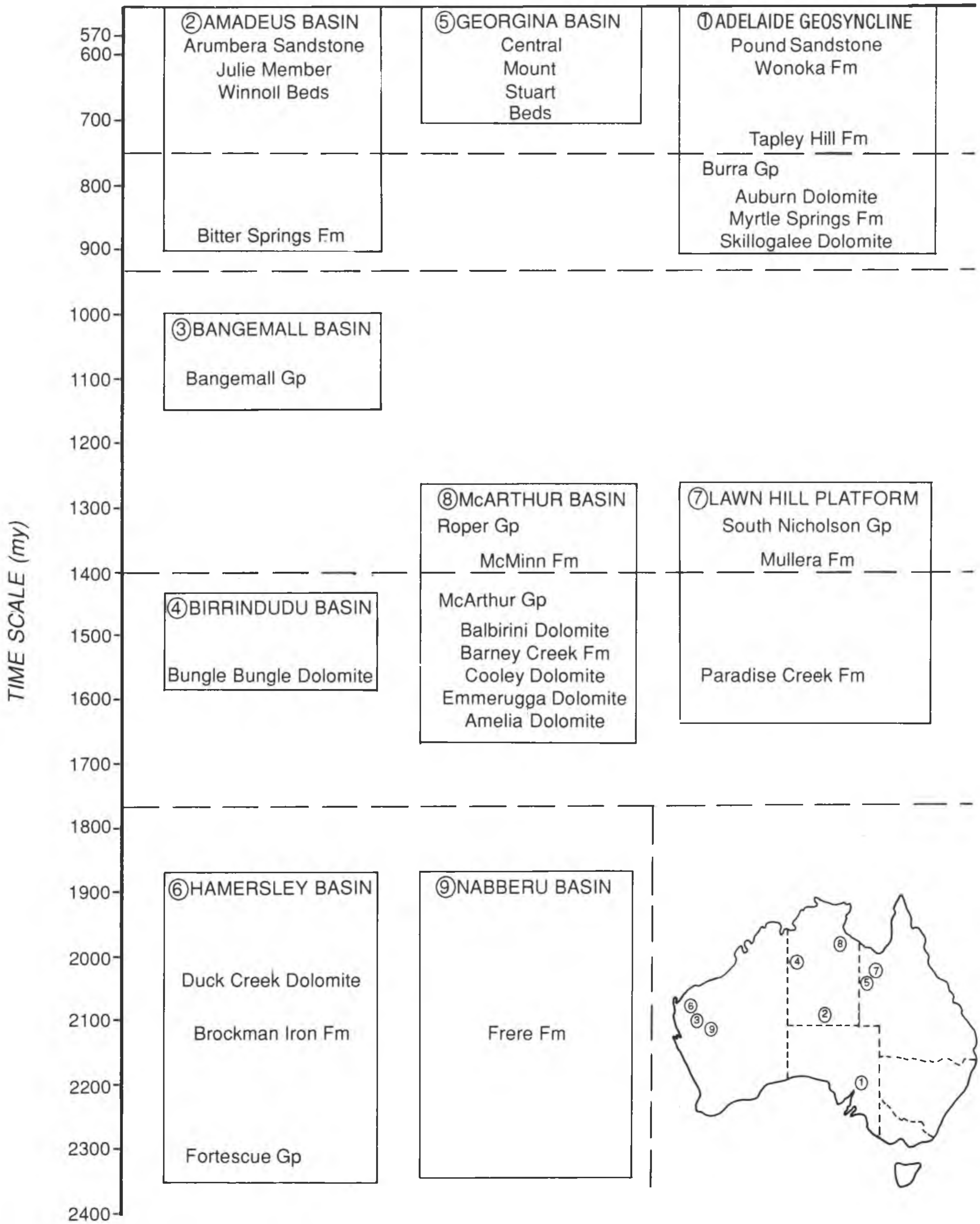

Figure 1. Location of Australian Precambrian sedimentary basins and the approximate evolutionary ages of the relevant fossiliferous formations (after Glaessner and Walter — reference 21).

Kalgoorlie) in the Yilgarn Block of Western Australia.[33]

However, stromatolites are far more prolific in Proterozoic strata sequences, particularly in Western Australia.[34] They are, for example, ubiquitous in the Duck Creek Dolomite of the Hamersley Basin (see Figure 1), a group of Early Proterozoic 2.0 billion (evolutionary) year old cycles of dolomite deposition with clearly identified stromatolites within them.[35] Not listed in Figure 1, are the occasional stromatolites found in a number of rock strata of similar 'age' in the Pine Creek Basin of the Northern Territory — the Celia and Coomalie Dolomites, and the Cahill and Koolpin Formations.[36-39]

Furthermore, the evolutionary 'age' of rock strata doesn't necessarily determine the content of bacteria or algae fossils, as evidenced by the fossil assemblage in the H. Y. C. Pyritic Shale Member of the Middle Proterozoic, 1.5 billion (evolutionary) year old, Barney Creek Formation of the McArthur Basin in the Northern Territory (see Figure 1).[40] Many of the bacteria and algae fossilized in this sequence of carbonaceous, dolomitic and pyritic shales (organic carbon content up to 4.8%) and interbedded dolomitic, vitric tuffs and sedimentary breccias are also found in the 2.1 billion (evolutionary) year old Frere Formation of the Nabberu Basin and the 870 million (evolutionary) year old Bitter Springs Formation of the Amadeus Basin (see Figure 1). Significant also is the association of these black cherty shales and their fossilized bacteria and algae with the copious fine-grained zinc and lead sulphides within the McArthur River (H.Y.C.) mineral deposit, the world's largest undeveloped Pb-Zn deposit, indicative of the probable role played by the bacteria and algae in the formation of the Pb-Zn sulphide mineralisation.

However, in the Late Proterozoic strata of the Adelaide Geosyncline and the Amadeus Basin (see Figure 1), from 650 to 570 million (evolutionary) years (the so-called Vendian in North America and Europe), the first metazoan fossils 'appear' in the rock record, called the Ediacara fauna after the type locality in the Flinders Ranges of South Australia.[41-44] So significant have these metazoan fossils (typically soft-bodied jellyfish, medusoids, worms and sea pens) become that the time period represented by these fossils in the rock record has by some been designated as the Ediacaran Period.[45,46]

From this compilation and brief discussion of the Australian Precambrian fossil record it can be seen that stromatolites virtually span the whole record from the middle Archaean right through the Proterozoic, from 3.5 billion to 570 million (evolutionary) years, while significant metazoans also occur 'late' in the record. However, it is not just the diversity, abundance and richness of the record (terms used by Glaessner and Walter) that is impressive, but the geographical extent and thickness of these Precambrian fossiliferous strata, and the other strata interbedded with them. Figure 2 shows the location and extent of Australia's exposed Precambrian 'basement' and sedimentary basins. More than two-thirds of the Australian landmass west of the Tasman Fold Belt is underlain by the Precambrian 'craton', and much of this is now covered by a series of little deformed or metamorphosed 'platform covers', ranging from late Archaean upwards.[47] Palaeozoic strata now cover portions of the Precambrian 'craton', but at least half of the latter is still exposed.

Furthermore, these Precambrian strata sequences are very thick. For example, the Hamersley Basin (including the Wyloo Group), now regarded as late Archaean to early Proterozoic and the oldest of these strata sequences (see Figure 2), has a cumulative thickness of rock strata (including basalts, tuffs and other volcanics and igneous intrusives) estimated at almost 21.5km (21,500m).[48,49] The strata of the middle Proterozoic Bangemall Basin lie with angular unconformity on the strata of the older Hamersley Basin, and in the western portion of the Bangemall Basin the total thickness of the sedimentary strata is about 13.7km (13,700m).[50] Thus the total cumulative thickness of the sequence of successive Precambrian rock strata represented in these two basins alone is approximately a staggering 35.2km (35,200m, 115,456 feet or 21.87 miles)! And some of these strata are fossiliferous.

Similarly, in northern Australia is the Pine Creek 'Block', Inlier, Geosyncline or Basin (depending on which terminology is used), which is unconformably overlain by the McArthur Basin (see Figure 2).[51] In the Pine Creek Basin there is a total thickness of early Proterozoic sedimentary strata of about 14km (14,000m), which are overlain by up to 1.2km (1,200m) of predominantly acid volcanics, and intruded by up to 0.5km (500m) of tholeiitic dolerites. Thus the total thickness of early Proterozoic strata in the Pine Creek Basin is about 15.7km (15,700m). In the unconformably overlying McArthur Basin there is a total thickness of middle Proterozoic sedimentary strata of at least 12km (12,000m). Some strata in both basins contain stromatolites and the total cumulative thickness of all the successive strata in these two basins is approximately 29.7km (29,700m, 97,416 feet or 18.45 miles).

THE PRECAMBRIAN WORLDWIDE

Is the Precambrian geological record of Australia, with its thick sequence of strata interspersed with fossiliferous rock units, unique? With respect to Precambrian stromatolites, Bertrand-Sarfati and Walter have reviewed occurrences worldwide.[52] They commented:

> *'Stromatolites are being used in Precambrian stratigraphy not only in the traditional areas of the U. S. S. R., Africa, Australia and India, but also, more recently, in Canada, the U. S. A., Mexico and especially China'.*[53]

They went on to discuss the stromatolites of the

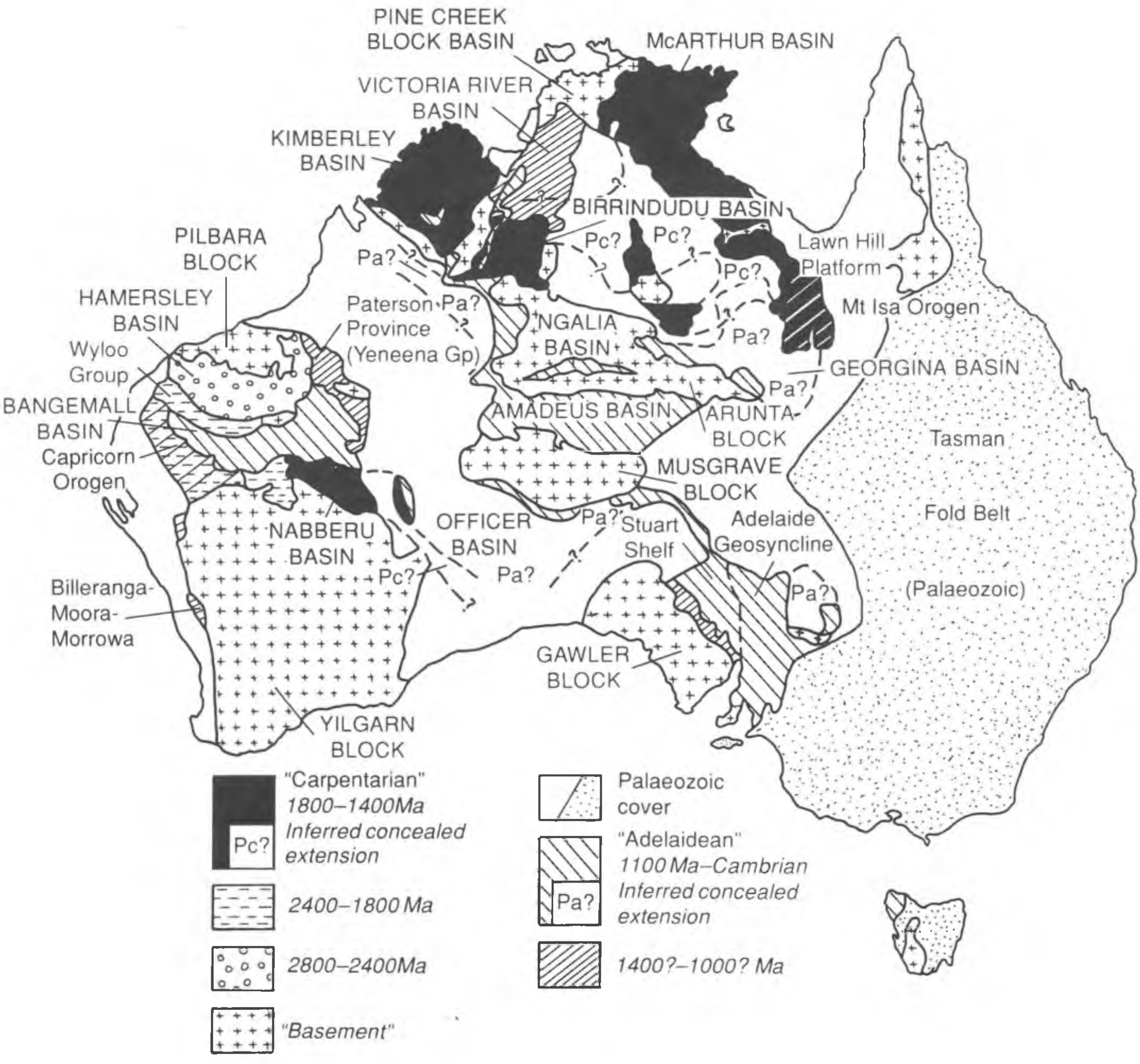

Figure 2. Location of the principal Precambrian platform-covering basins of Australia, designated according to their evolutionary ages (after Plumb — reference 47).

Proterozoic era throughout the world and state that

> '*none of the 53 forms* (of stromatolites) *now known from the Early Proterozoic are also reported from younger rocks*.'[54]

Elaborating on these Proterozoic stromatolites, they also summarize where they occur — in Siberia and the Ural Mountains of the U. S. S. R., southern India, the Himalayan region, China, the Sahara of North Africa, southern Morocco, the Congo, Zambia, Canada, the U. S. A., Greenland, northern Norway, Czechoslovakia, Finland, Mexico and Brazil.

However, as in Australia, the global fossil record of stromatolites begins in the Archaean, in rocks estimated at 3.3–3.5 billion (evolutionary) years old in South Africa and Zimbabwe.[55] Again, there has been some debate as to whether they are true stromatolites, but opinion now seems to favour their validity. The best known of these occurrences is in the Fig Tree Group of the Barberton Mountain Land of South Africa (see Figure 3), where several morphological types of stromatolites have been identified in finely laminated cherts overlying lava flows.[56,57] However, unlike the North Pole occurrence in

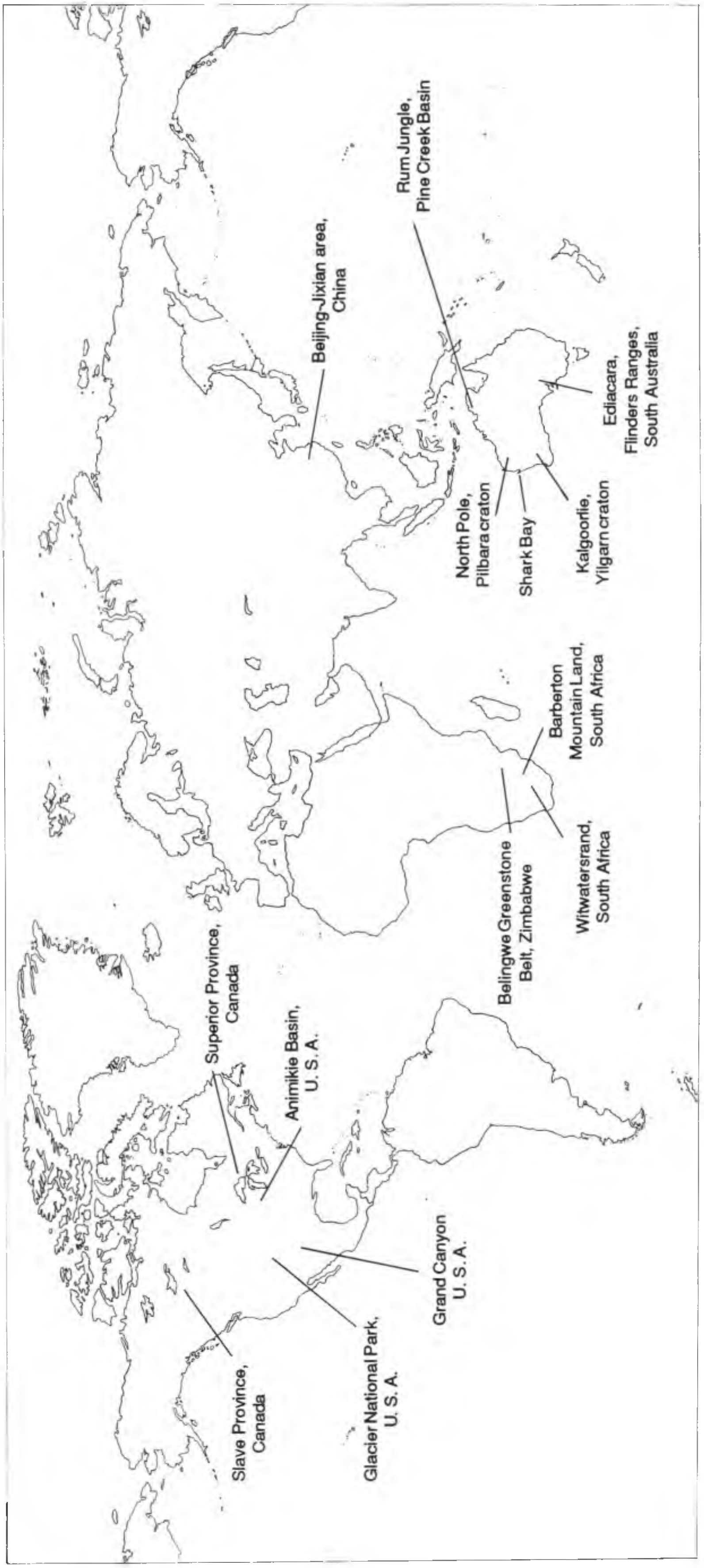

Figure 3. World map showing the location of various fossiliferous formations and places mentioned in the text.

Australia's Pilbara no evidence has been found of microfossils (that is, of the algae) in these rocks.

Similar doubts exist with the 3.5 billion (evolutionary) year old stromatolite structures in the Mushandike Formation of the Zimbabwean Archaean.[58,59] Although there is no clear evidence for algal filaments, all other criteria are met, so these are also now regarded as 'probable' stromatolites.

Still of Archaean 'age' are the 2.9–3.0 billion (evolutionary) year old 'probable' stromatolites in the Pongola Supergroup of northern Natal, South Africa.[60] Found in dolomite, in thin section they are very similar to modern 'blue-green algal' (cyanobacterial) mats.

In the late Archaean geological record, mostly around 2.7 billion (evolutionary) years ago, there are many examples of undisputed stromatolites. These include those in rocks from the Slave Province of north-western Canada[61] and from the Superior Province of southern Canada (see Figure 3),[62] as well as at least six examples from Zimbabwe, the best preserved and most notable being those in the Ngesi Group of the Belingwe Greenstone Belt (see Figure 3).[63,64] The stromatolites occur locally in the basal 100m thick Manjeri Formation, but are widespread and profuse in the limestones of the uppermost 2.5km thick Cheshire Formation, separated from the Manjeri Formation below by up to 6.5km of lavas and minor tuffs.[65] In outcrop, some 33 distinct stromatolitic beds have been recognized, which have been grouped together in what appear to be 22 cyclic units.[66] In thin section the finely defined lamination of the stromatolites and the algal textures are extremely well preserved, and there are layers rich in organic material, the Cheshire Formation stromatolites thus representing almost unaltered Archaean biogenic sediments.[67]

Perhaps the best known early Proterozoic fossil assemblage is that in the 2 billion (evolutionary) year old Gunflint Iron Formation of the Animikie Basin in North America (see Figure 3).[68-70] The Gunflint microbiota occurs in two ways — as columnar stromatolites in which there are two dominant microfossils (algal filaments and subspherical to ellipsoidal unicells), and as stratiform cherts rich in three other microfossils (as rosettes of fine filaments in clusters and as distinctive 'umbrella' shapes connected by 'stalks' to 'bulbs'). The classification of these microfossils is not yet certain, although they do probably represent cyanophytes ('blue-green algae') and filamentous bacteria very similar to some extant stromatolites and stromatolite microbiota today.

Walter and Heys have reviewed the literature on Precambrian stromatolites and tabulated the data on their occurrences and types.[71] They noted that in the early Early Proterozoic, 2.2–2.5 billion (evolutionary) years ago, the strata of five sedimentary basins worldwide contained six stromatolite taxa, but during the late Early Proterozoic, 1.65–2.2 billion (evolutionary) years ago, this had increased to 97 stromatolite taxa in the strata of 26 sedimentary basins. According to this evolutionary scenario the occurrences of stromatolites 'peaked' in terms of numbers of stromatolite taxa, with 182 in the strata of 37 sedimentary basins in the early Late Proterozoic (or Middle Riphean) 1.05–1.35 billion (evolutionary) years ago, but in terms of the number of basins when the strata of 41 sedimentary basins contained 180 stromatolite taxa in the middle Late Proterozoic (or Late Riphean) 675 million–1.05 billion (evolutionary) years ago. The subsequent 'decline', at a time when the 'Ediacara' metazoan fauna 'appeared', is interpreted as supposedly due to the first widespread grazing by such animals.

An intriguing occurrence of Precambrian megafossils is that near Jixian 100km east of Beijing in northern China (see Figure 3).[72] In a sandy dolomite containing flat-pebble conglomerate layers and a shaley siltstone, estimated at 1.7–1.9 billion (evolutionary) years 'old', small megascopic carbonaceous compressions have been found. These are the 'earliest' known specimens of two genera long regarded as probable eukaryotic fossil algae — carbonaceous ribbons, sometimes curvilinear and possibly twisted, of the genus *Tyrasotaenia*, and isolated thin black discs on bedding planes, with circular to ovate outline, of the genus *Chuaria*. In the same area of northern China, at 11 places and 17 localities, but in late Proterozoic silty shales 800 million–1.05 billion (evolutionary) years 'old', similar *Chuaria* and related macroalgal fossils are found at two stratigraphical levels, filling in the range of the genus *Chuaria*.[73]

Right throughout this continuous stratigraphic sequence from early through to late Proterozoic in northern China stromatolites are also found.[74] So prolific and so easily identified are these stromatolites that they have been used to correlate Proterozoic strata right across northern China and into southwest China.[75] For example, in the Beijing area the middle Proterozoic Wumishan Formation consists of 2229 metres of cherty dolomites that contain ubiquitous stromatolites accompanied by algal microfossils of two types — vesicle-like coccoids, often as small colonies, and some filamentous forms in organic laminae, that probably built the stromatolite mats, and solitary spheroidal coccoids and bar- or stalk-like forms, distributed randomly in organic-poor zones, that were probably planktonic algae.[76] In the Beijing area these Proterozoic strata total over 4500 metres, but in southwest China the Proterozoic sequence thickens considerably to more than 25,000 metres (25km), with stromatolites preserved throughout that thickness.[77]

Stromatolites are also found in Proterozoic strata sequences in the U. S. A. For example, both domal and columnar stromatolites are prolific in the Middle Proterozoic Altyn Formation, the oldest stratigraphic unit exposed in Glacier National Park, Montana (see Figure 3).[78] The basal member of the formation is believed to contain at least 17 cycles with an average cycle thickness of 4.2 metres in which stratiform stromatolites with some domal forms occur repeatedly buried by dolomitic sandstones, interpreted as transported under storm conditions. These sequences were studied in detail and it was suggested that some aspects of these cycles are very similar to sequences formed in Shark Bay, Western Australia, today. Microfossils of filamentous blue-green algae found in the Altyn Formation also bear similarities with modern day counterparts.

Also in the U. S. A. is the type location for the genus *Chuaria*, which is found in the Late Proterozoic Chuar Group in the Grand Canyon of northern Arizona (see Figure 3) and in the Uinta Mountain Group of northern Utah.[79] In the Grand Canyon particularly *Chuaria* is found at three stratigraphic levels within the Chuar Group, which also has stromatolites in it at three or more stratigraphic levels. This fossil assemblage of microorganisms is regarded as taxonomically varied, and is interpretered as consisting of open-water, cosmopolitan eukaryotic plankton. The same assemblage is known to occur in similar Late Proterozoic rock sequences in the Southern Urals of the USSR, northern and southern Scandinavia, east and north-west Greenland, and a number of other places.

Even the so-called 'Ediacara' fossil assemblage in South Australia has been found in other parts of the world — in north-west Spain,[80] in north Carolina (U. S. A.)[81] and in north-western Canada.[82] Jenkins[83] has also compared the stratigraphy of the western Flinders Ranges of South Australia with their contained Ediacara fossil assemblage with comparable assemblages occurring in similar successions in Namibia (southern Africa), in the northern Soviet Union and Siberia, in the Yangtze Gorges of China, in south-eastern Newfoundland (Canada), and southern Britain.

This brief survey of the world-wide occurrence of Precambrian fossils in thick sequences of sedimentary strata should dispel all doubts about fossil occurrences in Precambrian strata, making it no longer feasible or possible for creationists to argue that Precambrian rocks are non-fossiliferous. Certainly, fossils in Precambrian rocks are not ubiquitous and are often hard to find unless one knows what to look for, but the fossils are there nonetheless. Relative to the Phanerozoic, the Precambrian fossil record is indeed sparse, occurring in just a few strata within thick sequences, but such can also be true in Phanerozoic sedimentary sequences.

No, there are sufficient fossils now known in Precambrian strata for creationists to stop referring to Precambrian rocks as non-fossiliferous. This then implies that many of these Precambrian sedimentary strata may also have been deposited during Noah's Flood. But before the implications of this proposition are discussed further, it needs to be pointed out that there is a reason why we don't see more fossils in Precambrian rocks. In many instances, the fossils have been there, but all that remains now is organic matter in the rocks.

PRECAMBRIAN ORGANIC MATTER

The main reason why more fossils are not found in so-called Precambrian rocks is that many of these rocks have been altered, particularly by burial and tectonic pressures, but also by temperature (that is, they have been metamorphosed), and so the contained fossils have been destroyed. However, these same rocks often contain graphite and related forms of carbon. Whereas most Cambrian-Recent graphite deposits occur in readily identifiable metamorphosed coal-bearing sedimentary rocks, Precambrian graphite deposits are commonly found in medium to high-grade regionally metamorphosed schists and gneisses 'of controversial origin'.

Mancuso and Seavoy[84] claim that there is now *'good geologic and chemical evidence that the graphite found in all grades of Precambrian metamorphic rocks have the same source'* and *'that source is organic carbon'*. They go on to show that *'sufficient organic carbon of high concentration and purity is available in Precambrian sediments as coal or anthraxolite* (a name suggested for black, combustible, coal-like solid material found in Precambrian rocks that resembles anthracite coal but occurs in cross-cutting veins and fissures) *to account for the graphite deposits which occur in Precambrian schists and gneisses.'* To back up this claim they mention occurrences of coal and anthraxolite reported and described in the Precambrian rocks of Michigan, Ontario, the Northwest Territories and Northern Minnesota.

In Australia no similar occurrences of Precambrian 'coal' appear to have been reported so far. However, a very abundant rock type amongst Australian Precambrian strata is black (carbonaceous or graphitic) shales and graphitic schists (their metamorphic equivalents). For example, in the Kalgoorlie area the 3,000 m thick Black Flag Beds include units of black shales up to, and greater than, 100 m thick and tens of kilometres in strike length.[85] In the Pine Creek Basin, south and east of Darwin, several thick units of black shales and carbonaceous schists can be correlated across the basin over a distance of about 200km.[86] Furthermore, these rock types are often associated, to a greater or lesser degree, with Precambrian ore deposits — for example, at Broken Hill, Mt Isa, Kambalda, McArthur River, Koongarra, Jabiluka.

Saxby[87] lists five basic mechanisms by which organic matter can become part of a sediment: direct supply of organisms, absorption of dissolved organic molecules, precipitation, detrital supply, and hydrocarbon migration. With increasing temperature and depth of burial this organic material undergoes changes analogous to coalification or to the maturation of oil shales and petroleum source rocks. Figure 4 shows diagrammatically how the chemical compositions of coal macerals (that is, organic materials) are progressively altered during metamorphism. Saxby analysed the insoluble organic matter isolated from a variety of Australian and overseas ores

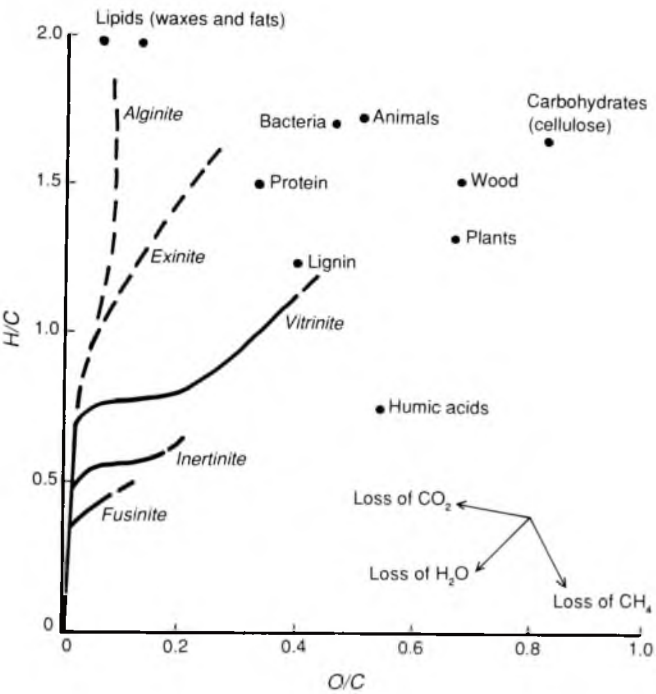

***Figure 4.** Atomic hydrogen/carbon versus oxygen/carbon diagram showing average values for precursors of sedimentary organic matter and lines of increasing diagenesis and metamorphism for coal macerals (constituents) (after Saxby — reference 87).*

and ore-related black shales, and these results are plotted in Figure 5. He concluded that since these ores were Precambrian, then bacterial and algal remains must constitute the main biological precursor to the organic material remaining in the analysed samples. The graphite now present in the ores and shales has been produced by 'post-depositional metamorphism and weathering'.

In his study, Saxby also analysed, for comparison, the organic matter in present-day Red Sea sediments and his result is also plotted in Figure 5. There it falls between the exinite and vitrinite lines, which when compared with Figure 4 puts the Red Sea organic matter close to lignin, which with cellulose is the major component of the organic material making up wood and plant cells. Even though these Red Sea metalliferous sediments are widely regarded by geologists as a modern-day analogue of the formation of metal deposits such as those at McArthur River, Mt Isa and Broken Hill, Saxby still maintains that the organic matter with these Precambrian metal deposits was originally algal and bacterial remains, unlike the organic matter in the present-day Red Sea metalliferous sediments. For comparison, a rock that contains organic matter that definitely was originally algal remains is the Julia Creek oil shale from the Cretaceous Toolebuc Limestone, also plotted on Figure 5. Since the pathways for the maturation (diagenesis/metamorphism) of these two original organic materials (that is, algal matter and lignin) converge with increasing maturation, at the levels of maturation reached by the organic matter in these Precambrian metalliferous ores it is not possible simply by looking at the analytical results as plotted on Figure 5 to determine which type of organic matter, as depicted on Figure 4, was the precursor organic matter. Unless there was other evidence it would appear to be equally valid to conclude that the organic matter in these Precambrian metalliferous ores had been lignin from plant remains as in the present-day Red Sea metalliferous sediments, the analogue for the formation of these metalliferous ores.

However, others have tried similar analytical techniques on present-day and recent algal mats, peats and oil shales, and compared them with numerous older rock strata consisting of sediments of undisputed algal origin. Philp[88] found some similarities between the fossilized algal matter in the Fig Tree Group strata of South Africa and present-day algal mats, the builders of stromatolites. The organic matter in Onverwacht Group strata, also from South Africa, and Kalgoorlie (Western Australia) shales gave more enigmatic results which he concluded probably reflect differences in the thermal history experienced by the organic matter in these rocks during and after their formation. Nevertheless, his review of the literature confirms the identification of organic compounds that could only have come from algae, bacteria or fungi, in a number of studies of organic matter in Precambrian rocks. Similarly, McKirdy *et al.*[89] analysed a wide range of organic matter containing shales, cherts, limestones, dolomites and phosphorites and were able to characterise the organic compounds in the fossilized stromatolites in their Precambrian samples, even where the organic matter would now normally be described as graphite. Thus these studies have shown a clear link between organic matter in Precambrian rocks and present-day algae and bacteria, including that in stromatolites similar to those found fossilized in the same Precambrian rocks.

Since there appears to be copious quantities of organic matter, derived from algae and bacteria primarily in stromatolites, in numerous strata within thick Precambrian sedimentary sequences, the maturation of that organic matter could potentially have also produced liquid and gaseous hydrocarbons (oil and natural gas). Such has been found in Australia. While drilling a stratigraphic hole in the Proterozoic McArthur Basin in the Northern Territory in 1979, an oily liquid and several types of bitumen were found in the silicified porous carbonate-rich Looking Glass Formation.[90] Subsequent study suggested that these residues were from oil generated from the organic matter in shales and stromatolites in dolomites, either in the Looking Glass Formation itself or lower in the 1.6 billion (evolutionary) year 'old' McArthur Group. The drilling of further holes and continuing investigations of potential source rocks in the area eventually led to success in 1985 — the discovery of the world's oldest live oil.[91]

Continued research has led to the discovery of five po-

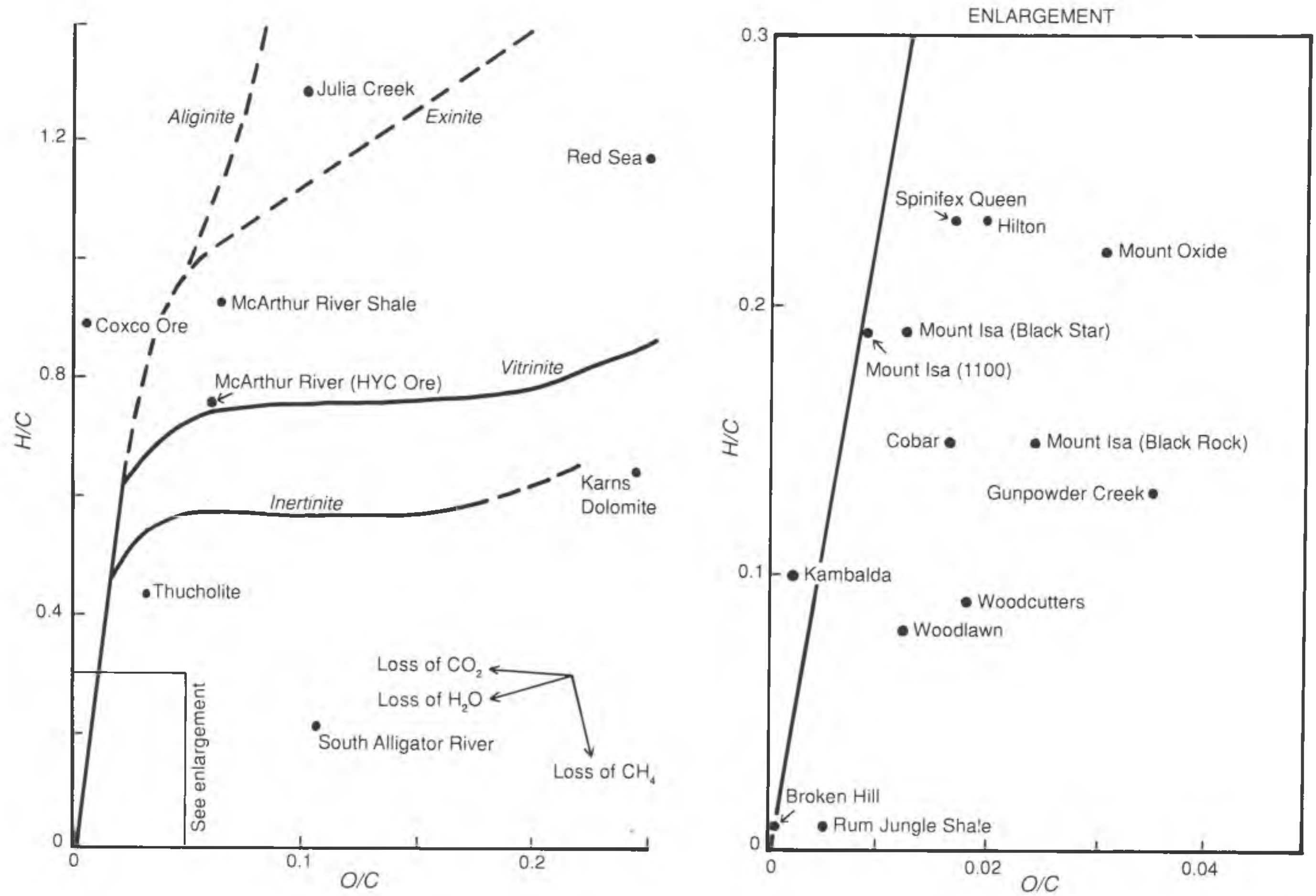

Figure 5. Atomic hydrogen/carbon versus oxygen/carbon diagram showing plotted on it organic matter isolated from metalliferous ores and associated rocks (after Saxby — reference 87). Apart from the Red Sea sediments and Thucholite (Witwatersrand, South Africa), all the ores and rocks are from Australian locations.

tential source rocks in the McArthur Basin, particularly the Barney Creek Formation of the McArthur Group and the Velkerri Formation of the overlying Roper Group, which compare favourably in thickness and potential with demonstrated petroleum source rocks in the Phanerozoic.[92,93] The former contains up to 7% total organic carbon which consists of algal remains, some of which is partially degraded, while the latter contains up to 6.5% organic carbon and the organic matter is primarily partially degraded algal material. The researchers concluded that maturation levels in McArthur Group sediments vary from marginally mature to overmature, and that hydrocarbon generation occurred prior to the deposition of the younger Proterozoic sediments of the Roper Group. In contrast, the source rocks in the Roper Group are marginally mature to mature, and considerations of burial history suggest that hydrocarbon generation in the Roper Group may have occurred during its deposition, although a later Early Palaeozoic timing cannot be excluded. Confirmation of the validity of this research has come with the news that a commercial company successfully drilled for oil and gas in the area late in 1990. Following a minor flow of good-quality oil and gas, a drill stem test over an interval of 64.6 metres recovered 16 million cubic feet per day of gas, 2 metres of oil and 448 metres of oil-and-gas-cut formation water.[94]

Two other examples are relevant to emphasising that the organic matter in Precambrian rocks is the metamorphosed remains of fossilized algae and bacteria. In the Rum Jungle area of the Pine Creek Basin of the Northern Territory (Australia) (see Figure 3) are uranium and associated base and precious metal deposits. Organic matter in the host rocks of the Whites Formation and Coomalie Dolomite is now predominantly graphite, consistent with the metamorphic history of these rocks. The total organic carbon content averages 3.9%, although in some samples it reaches 10.44%.[95] Black filamentous and spherical bacterial and cyanobacterial (blue-green algal) microfossils typical of Early Proterozoic microbiota world-wide were recovered from this graphitic organic carbon in these host rocks. Furthermore, mineral grains in some of the host rocks were found to be coated with graphitized organic matter, presumed to have resulted from thermal degradation of a petroleum phase that existed prior to metamorphism of these rocks. Hydrocarbons were also found to still be present in fluid inclusions within carbonates of these two host rock units, and preliminary analysis of this oil suggests that it migrated in after metamorphism (because it escaped graphitisation). Thus we see again that sophisticated modern research techniques can tell us a lot about the graphite commonly found in Precambrian strata, and the bulk of it is derived from organic matter that was once algal and bacterial material.

For many years debate has raged over the origin of the carbonaceous material which occurs in the gold-bearing reefs of the 2.3–2.7 billion (evolutionary) year 'old' Witwatersrand Group of South Africa (see Figure 3). This carbonaceous matter, akin to graphite, was called thucholite, because it is also radioactive due to its contained thorium and uranium (Th, U, C, H, O-Lite). Although this carbonaceous material was early recognised as being of organic origin, it was not until the mid 1970's that the technology was developed to show authoritatively that the Witwatersrand 'carbon' is in fact the fossilized remains of Precambrian plants.

In a series of papers, Hallbauer and his associates[96-98] reviewed this controversy and the evidence, then proceeded to show conclusively that an examination of the external appearance and internal structure of the carbon shows that it is the relatively undamaged remnants of a Precambrian mass vegetation of comparatively large plants that were preserved *in situ* (as evidenced by the consistent upright columnar form of these fossilized remains even over large distances). In reconstructing the original organism a carpet-like colony of upright columnar individuals can be envisaged, each about 0.3–0.5 mm in diameter and up to 7 mm in length, with a membranous outer covering and irregularly arranged fibres within. The upright position of these columnar particles after diagenesis points to a tough, leathery plant texture that appears to rule out structures normally encountered in algae. Each of the columns appears to be a complex plant or part of a colony of plants. A second type of carbon, consisting of small spherical particles with a diameter of 0.2–1 mm, the so-called 'fly-speck carbon', was concluded to be the vegetative diaspores of the columnar plants, while a third type of carbon, which is an apparently amorphous form, upon closer examination gives the impression of organic debris which has been washed into its present position. The fact that gold and other materials were apparently extracted from the environment by the organisms and deposited inter-space and intra-cellularly points to fungal activity, while chemical evidence appears to favour a photosynthesising plant. These considerations have led to the postulation of a symbiotic association between photosynthetic algae and non-photosynthetic filamentous organisms that were probably fungi, similar to lichen today.

More recent studies such as that by Ebert *et al.*[99] have confirmed and refined these conclusions. These Witwatersrand carbon seams contain carbonised black organic tissues which are composed of filaments and balls that are typical of microfossil morphologies from Early Proterozoic rocks in Southern Africa and other parts of the world. The characterization of the material only confirms that these seams are best described as semi-anthracite coals produced by the burial of microbial mats.

IMPLICATIONS AND DISCUSSION

The preceding review, although lengthy, is still only a sample of the data now available on fossils and organic matter in Precambrian strata around the world. Nevertheless, the evidence presented for numerous fossils and abundant organic matter in these Precambrian rocks should be sufficient to convince creationist geologists that they need to rethink where they place these sediments in the creation-Flood model for earth history. What I am contending here is that these sediments should be considered to have been laid down during the Flood year, along with most of the so-called Cambrian to Recent strata. What I am also suggesting is that continued placement of these Precambrian sedimentary strata and thick strata sequences into the period from the middle of Creation Week until the Flood is no longer tenable.

A common response to these assertions would be that since the fossils and organic matter in these Precambrian rocks are all of plant origin, being primarily algae and bacteria, then it is perfectly reasonable to place these fossils into the pre-Flood period, and more particularly, into Day 3 of the Creation Week. The events of Day 3 have always been a prime candidate for creationist geologists to account for significant geological activity prior to the Flood, but we need to be clear as to what the biblical record says occurred on that day.

Genesis 1:9–10 tells us that God commanded the dry land to appear from under the waters that were then covering the globe. On the basis of the earth's obedience to that command, it is clear that great, violent earth movements must have occurred to push up above the waters whatever rocks already existed on the surface of the globe under those waters. At the same time some rocks may have formed out of those waters, as well as new molten material pushing upwards into, and assisting, the uplifting continental blocks. As the land of this super-continent was being pushed up and breaking the surface of the globe-encircling waters, significant erosion would have occurred due to the moving waters now beginning to drain off this emerging land surface. As these sediment-laden waters slowed after running off the emerging land surface, their load of sediments would have been deposited as rapidly-formed sedimentary strata. Thus on the basis of these two verses of Scripture we can postulate significant geological activity, encompassing the intrusion of molten material into the early-formed rocks, the extrusion of volcanic lavas (initially underwater), deformation of rocks and accompanying metamorphism due to the heat and pressures, and sedimentation producing sedimentary rocks.

However, these sedimentary rocks so produced would definitely have to be non-fossiliferous, since plant life had not yet grown. We are told in Genesis 1:11–12 that the plant life grew on the dry land late on Day 3, clearly after all the geological activity which had built that dry land. The record states that it was **dry** land on which the plants grew, implying that most of the geological activity, particularly the violent activity, had ceased by this time. Furthermore, since this dry land was now to be populated with animals and the sea filled with fish, any further violent geological activity would have potentially buried and fossilized animals and fish, etc. So the geological upheavals of this Day 3 of the Creation Week must have been confined primarily to the earlier part of that day.

This then leaves the possibility that these plant remains, which after all only begin to appear in the geological record in the so-called Late Archaean and Early Proterozoic, belong to the period from the end of Day 3 of Creation Week up until the time of the Flood. Some may object at this point that because these prolific Precambrian fossils and organic matter described above are all of plant, algae, and bacterial origin, then the sentence of death at the Fall is thus made irrelevant, because plants were thus already being eaten and 'dying' in the Garden of Eden before the Fall. However, the plants were specifically given to be food for the animals and man, and the absence of death described as part of the idyllic conditions of Eden has to do with the lack of the shedding of blood due to violence, decay and thus death in that sense. Consequently, there is no theological problem if plants were being buried and fossilized by sedimentation in the Creation Week and pre-Flood era. The observation that because stromatolites, the most abundant structural form of fossilized algae and bacteria in Precambrian strata, are today found in shallow waters, either shallow marine waters or shallow brackish lakes where sedimentation is relatively slow and quiet, then these Precambrian stromatolite-bearing strata must represent these shallow marine environments of the pre-Flood era. Added to this, the multi-celled Ediacara fauna and related organisms are then also all believed to represent shallow marine forms of life in the pre-Flood seas.

The pattern of rock types in the Precambrian certainly appears to fit this interpretation. In the so-called Archaean we now see large bodies of granite surrounded by belts of volcanic rocks that were extruded as lavas under the ocean, and these volcanic rocks are interbedded with sediments. However, when we come to the Late Archaean and Proterozoic strata we see very thick sequences of sedimentary rock containing these plant fossil remains, and although this does fit the model already built from the Scriptural record, the thicknesses of these strata sequences, I believe, preclude their deposition in the pre-Flood era. There isn't enough time, for instance, between the end of Day 3 of Creation Week and the beginning of the Flood to account for these thick strata sequences, considering that conditions in the pre-Flood world would appear to have been, from the Scriptural record, rather tranquil and peaceful. There is nothing in the Scriptural record to suggest sudden violent changes geologically as a result of the Fall and the curse. There would have been immediate biological changes, but the behaviour of the pre-Flood people towards Noah's warnings suggest that violent weather and catastrophic geological events had not been their lot hithertofore. With the possibility that there may not even have been rain at this time (Genesis 2:5–6), nor violent volcanic eruptions and the like, then there would not have been the geological activity necessary to deposit such thick sequences of strata in such a short space of time.

On the other hand, however, is the 'problem' of these supposedly shallow water algal-built stromatolites, now fossilized in the strata, which today are seemingly built and fossilized only ever so slowly. Nevertheless, it has yet to be demonstrated that these stromatolite structures, and the organisms (algae and bacteria) that build them, may not also have survived in deeper marine conditions, particularly under the influence of submarine volcanism and associated chemical precipitation. Such is the geological setting of the stromatolites found at North Pole in Western Australia, where they are in, and associated with, chemically precipitated rocks such as chert and barite, and are interbedded with volcanic rocks (pillow basalt lavas). So if we didn't observe the algae building stromatolites today in the shallow waters of Shark Bay, then these stromatolites at North Pole may have been interpreted as representing deeper marine conditions with accompanying volcanism. Of course, there is still the possibility that some of these micro-organisms and stromatolite structures may have been uprooted from their shallow water environments and transported with the sediments that now enclose them into deeper marine settings. But such conditions would certainly not have prevailed in the pre-Flood era and would again suggest that these Precambrian strata are potentially Flood-deposited sediments. Furthermore, the fact that these strata sequences are not only thick, but can be correlated trans-regionally, such as in Northern Australia, argues for trans-regional and even continent-wide processes, and such would be of a catastrophic nature, including volcanic outpourings, consistent with the Flood.

A further implication of the above model is that since fossils of micro-organisms and organic matter in shales and schists, for example, are associated with mineral deposits such as the McArthur River, Mt Isa and Broken Hill lead-zinc-silver, the Rum Jungle uranium and Witwatersrand gold orebodies, then these ores must also be either Flood-deposited, or have formed either late in the Flood or soon after, depending on whether the ore minerals were deposited with the enclosing sediments or emplaced after earlier independent deposition of the enclos-

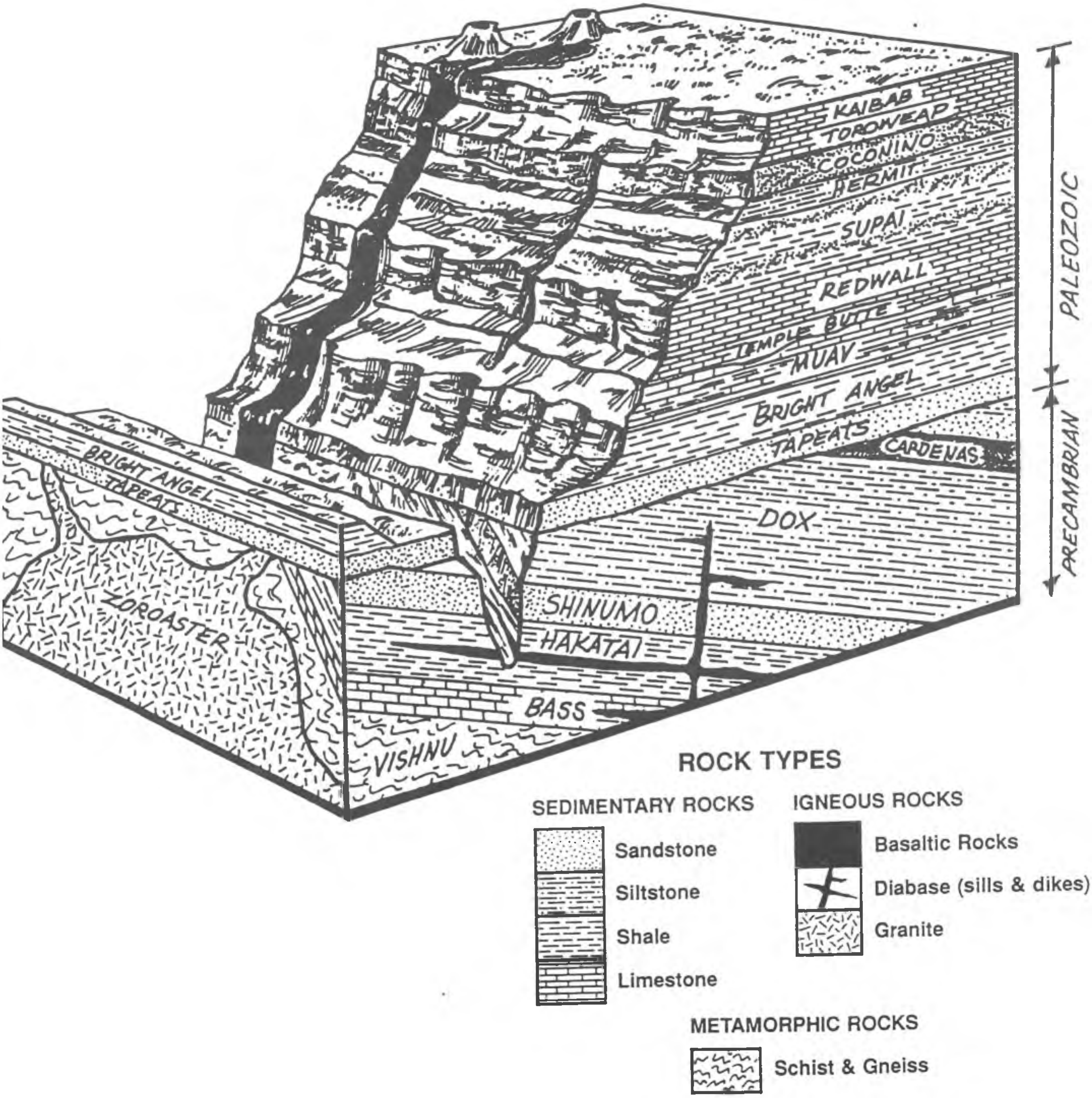

Figure 6. Generalised geological block diagram showing most of the strata of the Grand Canyon, Arizona, U. S. A., and the topographic form of the north rim (after Austin — reference 102).

ing sediments. The evidence for this association between organic matter and ore-forming processes has already been discussed above and is extensively treated in the scientific literature, for example, Saxby.[100] In the context of the creation-Flood model, I have already presented elsewhere the abundant evidence that supports the conclusion, for instance, that the Mt Isa lead-zinc-silver ore-bodies were deposited with the enclosing sediments during the Flood.[101] In that example micro-organisms were also fossilized in the host sediments, and the ore metals were supplied by seafloor volcanic fluids at a rate which is conceivably consistent with both the time framework for the Flood and the rates for such volcanic emissions known today.

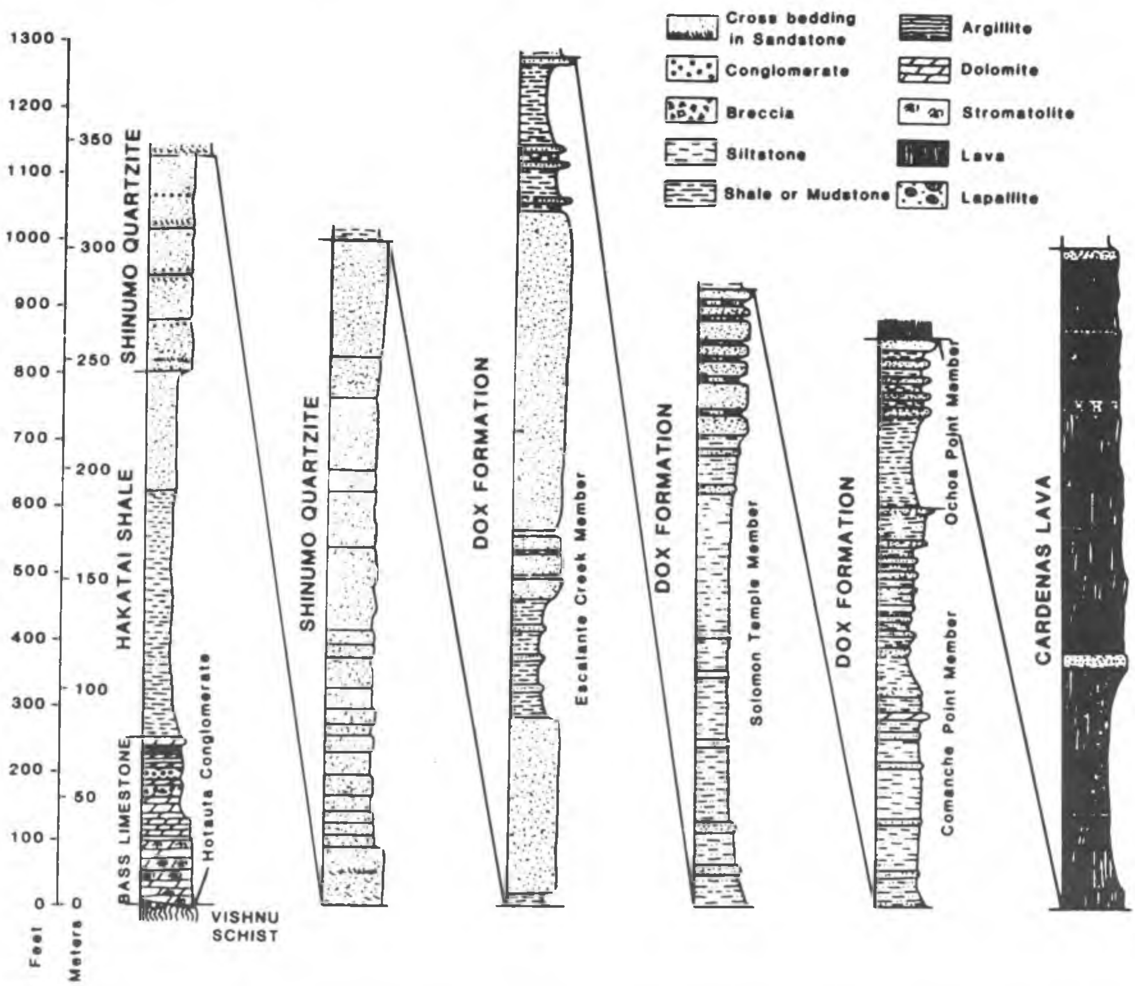

Figure 7. Columnar section of Middle Proterozoic Unkar Group strata, Grand Canyon Supergroup, showing the strata thicknesses and lithologies (after Hendricks and Stevenson — reference 116).

This discussion leads us back to Dillow's original conclusion that the evolutionists' geological column and their terminology must be completely reassessed and creationist geologists start again from basics. Before this can be done we must decide the criteria for reclassifying rocks and ores as either Creation Week, pre-Flood, Flood (early, middle or late) or post-Flood. What I am contending here is that fossils, whether they be microscopic or macroscopic, plant or animal, and their fossil counterpart, organic matter, along with its metamorphosed equivalents (graphite and related carbon forms), are the primary evidence which should distinguish Flood rocks from pre-Flood rocks, regardless of the evolutionary 'age'. Another factor will be the strata sequences themselves — the rock types and patterns of occurrence locally, regionally, continent-wide and from continent to continent. Other criteria will be necessary to distinguish the various stages of the Flood or any post-Flood localized catastrophes.

Ultimately, we have the enormous task before us to re-examine area by area, the geology and ore deposits of Australia, the U. S. A. and the world; to reclassify the rocks and ores; and then to rebuild our understanding of geological history within the biblical framework. Much work is already being done in understanding the evidences for the Flood in various local areas around the world, but as yet we haven't reached consensus on all the criteria for identifying the various geological components we observe in the rock record today that fit the biblical framework. The most pressing need, I believe, has been in this area of Precambrian geology, and so this has been the focus of this study. However, having presented and discussed the criteria for dividing the Precambrian rocks into Creation Week, pre-Flood and Flood, it is important that these be applied to a significant geographical area that could in the future be utilised as a type area.

A CASE STUDY — GRAND CANYON (USA)

There are a number of good reasons why this geographical area should be chosen as a good practical case study. First, the area is well known because of its spectacular scenery and extensive exposure of strata, so it is of interest to geologists world-wide. Second, exposed in the Grand Canyon and surrounding areas is one of the most extensive strata sequences anywhere in the world,

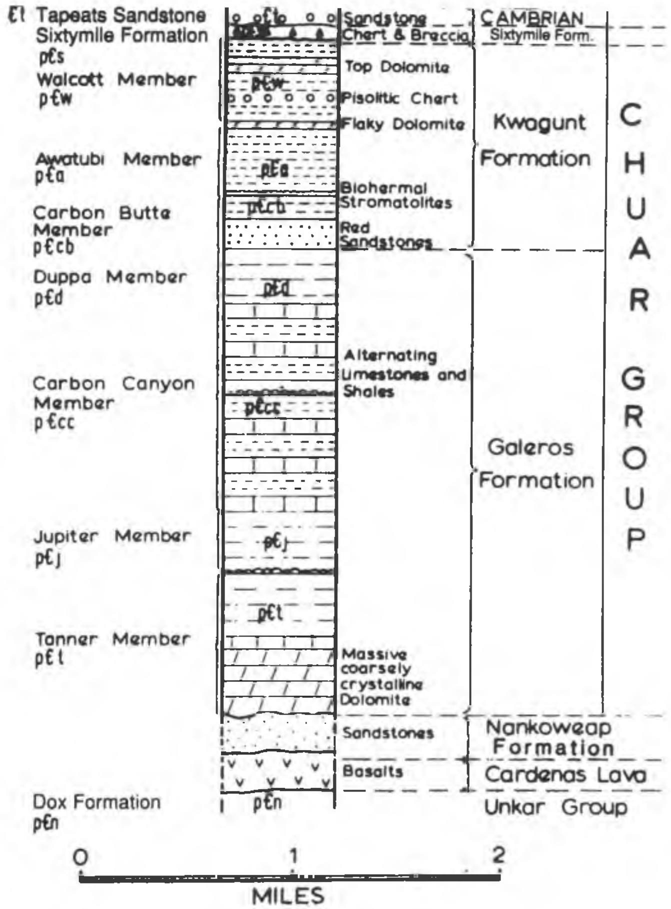

Figure 8. Stratigraphic column of the Upper Proterozoic Nankoweap Formation, Chuar Group and Sixtymile Formation, Grand Canyon Supergroup, showing the strata thicknesses and lithologies (after Ford — reference 117).

which spans much of the geological record, including the Precambrian. This makes it an ideal location for establishing the criteria for the creation-Flood model and applying them to the strata. And third, a creationist interpretation of the Grand Canyon strata using the creation-Flood model has already been attempted.[102] This enables comparison of the practical applicability of the criteria presented in this paper against both the extensively exposed rock strata in the Grand Canyon and a current creationist interpretation.

Figure 6 is a generalised block diagram of the rock strata that are exposed in the Grand Canyon and their relationship to one another. Figures 7 and 8 carefully depict the details of the Precambrian strata exposed at the bottom of the Grand Canyon along the Colorado River. At the base of the sequence is the Vishnu Complex and the Zoroaster Plutonic Complex and related rocks, which are estimated to be at least 1.65–1.7 billion (evolutionary) years old.[103] Unconformably overlying these basement complexes are sedimentary and volcanic strata that make up the Grand Canyon Supergroup, while unconformably overlying them are the horizontal Palaeozoic sedimentary strata of the outer canyon walls.

In his creationist view of Grand Canyon strata, Austin has assigned the Vishnu Schist, Zoroaster Granite and related rocks of the crystalline basement complexes to the early Creation Week, primarily to Day 1 and the initial creation of the earth, although he suggests that the instrusives of the Zoroaster Plutonic Complex were emplaced during the earth movements early on Day 3. He then proposes that a little later on Day 3 these rocks were exposed and eroded due to the uplift that caused the dry land to appear, and subsequently on this bevelled surface the sedimentary and volcanic strata of the Grand Canyon Supergroup were deposited in the time interval from Day 3 through the pre-Flood era until the initiation of the Flood. The horizontal Palaeozoic sedimentary strata are then interpreted as early Flood strata.

There are a number of reasons why this creationist interpretation needs to be modified in accordance with the criteria discussed in this paper. First, it needs to be recognised that the Vishnu Schist consists of a sequence of sandstones, shales, impure carbonate sediments and basic volcanic rocks that have been metamorphosed and deformed, possibly by two major and one minor metamorphic-deformational events.[104] It has been suggested that these rocks originated as sediments and volcanic lavas laid down on the seafloor probably between 2.0 and 1.8 billion (evolutionary) years ago and that the Elves Chasm and Trinity Gneisses formed the seafloor or basement upon which the Vishnu sediments were deposited.[105] The estimated total thickness of these sediments and volcanics that now make up the Vishnu Complex is greater than 40,000 feet (12,200 metres). These sediments and the crystalline rocks on which they were deposited were then deformed and metamorphosed in two stages, the later period of regional metamorphism and deformation being the more severe. These two periods of metamorphism have been estimated from scant isotopic data as having occurred between 1.72 and 1.71 billion (evolutionary) years ago and between 1.68 and 1.65 billion (evolutionary) years ago respectively.[106] It was because of this second main metamorphic/deformational event that the plutons, dikes and sills of the Zoroaster Complex were intruded into the Vishnu Complex at that time and subsequently.[107,108]

It is this inbuilt earlier geological history for these basement rocks that places doubt upon their identification as early Creation Week rocks. Given also the enormous thickness of precursor sedimentary strata for the Vishnu Complex metamorphic rocks, at the very least these could be tentatively placed as being sedimentary strata from the Day 3 uplift during Creation Week. This does not necessarily place the igneous precursors of the Elves Chasm and Trinity Gneisses into the category of Day 1 rocks. The restricted exposures of these rocks do not allow us to decipher whether there were even earlier rocks into which these plutons were intruded, and how these plutons might compare with the so-called Archaean plutons that form the hearts of the continental nuclei of Australia (the Yilgarn and Pilbara cratons)[109,110] and South Africa (the Kaapvaal craton),[111,112] for instance, which may in part be remnants of what were Day 1 rocks, in and around which are sequences of interbedded sediments and volcanics, the latter being extruded underwater. We need to keep in mind that should Day 1 rocks have survived, they will not now have their original character, having been altered by multiple cycles of metamorphism and deformation in the various events since their creation. So because we can't make these comparisons with the even older geology from other continents, it is hard to be emphatic as to whether these schists, gneisses and granites are only Day 3 of Creation Week, or how much of them are a record of Day 1.

However, it is over the Grand Canyon Supergroup strata that there is a bigger divergence of opinion. The Grand Canyon Supergroup has been divided into the Unkar Group (see Figure 7), the Nankoweap Formation, the Chuar Group (see Figure 8), and at the top of the sequence the Sixtymile Formation. Austin regards the Unkar Group sediments and lava flows as representing the deposits of Day 3 of Creation Week and residual sedimentation which prevailed after Day 3, and postulates that the area represents pre-Flood ocean floor on which the Nankoweap Formation and Chuar Group strata were also deposited in the 1650–1700 years between creation and the Flood.[113]

To justify this interpretation, Austin points to the lack of undisputed fossil remains in the Unkar Group, while the presence of stromatolites and *Chuaria* in the Chuar Group he sees as the evidence that they are shallow marine sediments which were thus deposited on the pre-Flood ocean floor. Furthermore, he identifies the Sixtymile Formation, which is composed of reddish beds of sandstone with minor amounts of chert that are interstratified with a breccia of angular fragments of the reddish sandstone and blocks of shale and limestone from the underlying formation, as the beginnings of the breaking up of the fountains of the great deep at the beginning of the Flood. On top of the Sixtymile Formation is of course what is known as 'The Great Unconformity', the erosion surface regarded by many creationist geologists as **the** feature formed by the upheaval and massive erosion at the onset of the Flood. Austin says that this is the most prominent unconformity in the Grand Canyon and that it probably exists through a major portion of the North American continent, and perhaps on other continents, thus attesting to its importance as evidence of a major geological upheaval. He adds that the depth of erosion at this unconformity adds to this picture of the onset of Noah's Flood, because in the western and central Grand Canyon the overlying horizontal Palaeozoic strata sit directly on the schists, gneisses and granites of the Vishnu and Zoroaster basement complexes, the Grand Canyon Supergroup strata having been presumably eroded away.

However, the unconformity between the Grand Canyon Supergroup and the underlying metamorphosed Vishnu and Zoroaster basement complexes has been called 'The Greatest Unconformity', because it probably represents a greater scale of upheaval than 'The Great Unconformity' between the Grand Canyon Supergroup and the horizontal Palaeozoic strata above.[114] We need to also get into perspective the thicknesses of the strata involved. The Unkar Group strata are 1775 metres (5,822 feet) thick (see Figure 7), the Nankoweap Formation 113 metres (370 feet) thick, the Chuar Group 2,013 metres (6,610 feet) thick, and the Sixtymile Formation 60 metres (200 feet) thick (see Figure 8), making a grand total thickness for the Grand Canyon Supergroup of 3,961 metres (13,002 feet).[115-117] This should be compared to the estimated thickness of more than 12,200 metres (40,000 feet) of Vishnu precursor sediments and volcanics deposited on the igneous precursors to the Elves Chasm and Trinity Gneisses. Consequently, where the horizontal Palaeozoic strata sit unconformably directly on the Vishnu Schist and Elves Chasm Gneiss, for instance, then the erosion at that unconformity potentially accounts not only for the erosion of the Grand Canyon Supergroup, but for much of the Vishnu Schist precursor sediments as well. While it is not clear whether all this erosion took place at the time of the formation of 'The Great Unconformity', since the thickness of precursor Vishnu sediments and volcanics is very much greater than the thickness of the Grand Canyon Supergroup, it could be argued instead that erosion of the Vishnu at 'The Greatest Unconformity' was greater. To be sure the breccias in the Sixtymile Formation and the boulders at 'The Great Unconformity' at the base of the horizontal Palaeozoic strata are spectacular evidence of catastrophic processes. However, there is a discontinuous conglomerate unit called the Hotauta Conglomerate Member at the base of the Bass Limestone just above 'The Greatest Unconformity', and this conglomerate consists of rounded, gravel-sized clasts of chert, granite, quartz, plagioclase crystals, and micropegmatites in a quartz sand matrix, all material eroded from the underlying Vishnu and Zoroaster basement complexes.[118]

Of course, this erosion at 'The Greatest Unconformity' has been interpreted by Austin as due to the Day 3 land uplift, which was followed immediately by the deposition of the Unkar Group sediments, beginning prior to creation of the plants on dry land. However, this is contradicted by the presence of biscuit-form and biohermal stromatolite beds within the Bass Limestone immediately overlying 'The Greatest Unconformity',[119,120] an example of which is on display in the Grand Canyon Natural History Association's Yavapai Point Museum at the South Rim. Austin dismisses these by referring to them as only possible and therefore uncertain, but he also dismisses the reports of pine pollen in the overlying Hakatai Shale[121-123] as doubtful. Moreover, organic carbon is reported in the Solomon Temple Member, and thin layers of stromatolitic dolomite are found in the Comanche Point Member, both of the Dox Formation.[124,125] These evidences of plant life fossilized in these strata, if verified, can only mean that these strata were deposited **after** the creation of plants at the **end** of Day 3, and not during the land uplift in the early part of Day 3 before the plants were created, as suggested by Austin.

Furthermore, even if we agreed that the Nankoweap Formation, Chuar Group and Sixtymile Formation strata were deposited on the ocean floor in the pre-Flood era between the end of the Creation Week and the beginning of the Flood, this would still represent deposition of over 2,100 metres (7,000 feet) in about 1650 years, necessitating an average depositional rate of about 1.27 metres (or 4.24 feet) per year throughout that period. That doesn't seem that large a rate of deposition, but these figures need to be seen in perspective. Using figures from Nevins,[126] the best estimate of the average sediment thickness over the entire ocean floor today would be about 2,950 feet (899 metres). At today's rate of sediment input into the oceans, that thickness of sediments would take a matter of 30 million years to be deposited on the ocean floor. Then by simple division of 2,950 feet (899 metres) by 30 million years we arrive at an average rate of deposition across the ocean floor of a mere 0.0001 foot (or 0.00003 metres) per year! So the 1.27 metres (4.24 feet) per year average rate of deposition for these Grand Canyon Supergroup sediments in the pre-Flood era is over four orders of magnitude greater than current average rates of deposition on the ocean floor.

Added to this, today's climatic conditions are far more extreme and harsh than what we understand of climatic conditions in the pre-Flood era from the Scriptural record. Lest it be argued that the area of oceans in the pre-Flood era may have been half of today's area or less, to accumulate the same quantity of sediments as on today's ocean floor in half the area would only double the average rate of sedimentation, still four orders of magnitude short of this supposed deposition rate in the pre-Flood era. Moreover, during the pre-Flood era we also understand that the land was far more lushly vegetated than the present land surface, as attested to by today's enormous volumes of coal, most of which is the fossilized remains of the plants that grew in the pre-Flood era. With the land lushly vegetated, and climatic conditions very agreeable, including the possibility of no rain, then it is possible to strongly argue that the rate of sedimentation would have been even less than today's average rate. Therefore, on these figures alone it is difficult to conceive that these Grand Canyon Supergroup sediments were deposited in the pre-Flood era.

However, it is entirely conceivable that these Grand Canyon Supergroup rocks were deposited during the catastrophism of the Flood. We have already seen that there are some fossils in the Unkar Group, and by comparison the Chuar Group is quite rich in fossils, particularly easily recognised beds of stromatolites and abundant microfossils, including *Chuaria*.[127,128] We also need to get the thicknesses of strata in perspective again. Quite rightly, much has been written by creationists of the evidence for catastrophic Flood deposition of the prominent horizontal Palaeozoic strata in the canyon walls, but it needs to be kept in mind that these strata only total a thickness of 1,220 metres (4,000 feet),[129] which is a considerably smaller thickness than the thickness of the Chuar Group strata that Austin maintains were deposited in the pre-Flood era. Of course, Austin only regards these Palaeozoic strata as early Flood, since above these Palaeozoic strata is a further considerable thickness of sedimentary strata that clearly are Flood-deposited.

In the Colorado Plateau to the north of the Grand Canyon, and progressively exposed in the so-called 'Grand Staircase' of southern Utah, are approximately 9,070 metres (29,750 feet) of Mesozoic sedimentary strata [130] which would be regarded by most creationists as also being deposited during the Flood. At the top of that sequence is an unconformity upon which have been deposited sediments (the Claron Formation) that have been interpreted as lake deposits. These Austin (and I) would regard as post-Flood, being some of the sediments that probably accumulated in his so-called Grand Lake, the waters of which accumulated behind the natural 'dam wall' of the Kaibab Upwarp until breaching caused a catastrophic drainage of the lake and erosion of the Grand Canyon, all in the immediate post-Flood period.[131]

So to add 3,961 metres (13,002 feet) of Grand Canyon Supergroup strata to the Palaeozoic and Mesozoic strata which total about 10,290 metres (33,750 feet), to then be the combined thickness of probable Flood strata in this part of North America, does not place any additional strain on our conceptual models for the catastrophism during the Flood. Indeed, Austin has already pointed to evidence of rapid deposition and tectonics in plastically deformed strata within the Shinumo Quartzite of the Unkar Group,[132] which is consistent with these strata also being deposited during the Flood.

CONCLUSIONS

We can see how application of the recognition of fossiliferous material in Precambrian strata adds to our criteria for recognising which rocks were probably deposited during the Flood. In the case study in the Grand Canyon, while application of this criterion potentially pushes the beginning of the Flood down lower into the strata sequence, it doesn't radically change the prevailing creationist interpretation.

Furthermore, it helps creationist geologists to better account for the thick Precambrian sequences of sedimentary strata, which in other parts of the world, as we have seen, are far thicker — for example, 35,200 metres or 115,456 feet in the Hamersley and Bangemall Basins of Western Australia compared to the 3,961 metres or 13,002 feet of the Grand Canyon Supergroup, although for a fairer comparison we should probably add to that the 12,200 metres or 40,000 feet of precursor Vishnu sediments and volcanics. While some creationists have attributed much to the geological upheavals of Day 3 of the Creation Week, inclusion of these enormous thicknesses of Precambrian strata in that event makes it of far greater catastrophic significance than the Flood. While this may be allowable given the global nature of the Day 3 event also, the presence of these abundant fossils and organic matter, even though they are of plant origin, in these thick Precambrian strata sequences rules out their deposition during the early part of Day 3, when the plants were not created until the latter part of that same day. Moreover, even if some catastrophic erosion and deposition continued on into the latter part of Day 3 and beyond, the fossilized stromatolite structures still cannot be accounted for in that time slot, simply because it would have taken much more than a day or two for the microscopic mat-building bacteria/algae once created to build those large stromatolites.

As we have also seen, it is also totally untenable to shift this thick strata sequences 'problem' into the Creation Week to pre-Flood era, since the depositional rates required to accumulate such thicknesses are totally inconceivable within the climatic and geological regime of that era, even when compared with today's depositional rate and climatic/geological conditions. Furthermore, pointing to the stromatolite fossils in these thick strata sequences as evidence of deposition on the floor of a shallow pre-Flood ocean only exacerbates this depositional rate problem, since modern depositional environments that include stromatolites record rates of deposition that are even slower than the current average rate, which we saw was four orders or magnitude less than the depositional rate required for Austin's pre-Flood deposition of strata in the Grand Canyon sequence.

Consequently, I would argue that it is far easier to conceive of most, if not all, of these Precambrian strata sequences, particularly from the Late Archaean and Early Proterozoic onwards, as being deposited during the Flood. While this adds, in some areas, considerably to the thickness of strata to be accounted for by the Flood, it allows creationist geologists to still account for other Archaean sedimentary strata, plus large areas of associated terrains of metamorphosed sediments, and assign them to Day 3 of Creation Week and earlier. After all, if the Flood was that devastating a catastrophe, it is probable that very little of the pre-Flood crustal landmass survived, let alone it being in a form (state) which would allow us to recognise its early Creation Week characteristics, having suffered from the upheavals of Day 3 which obviously included metamorphism, deformation and intrusion of magmatic materials.

It is hoped that this review of the Precambrian strata, and the numerous fossils and abundant organic matter contained therein, plus its application to a well known area that is potentially a type location for the development of a coherent and universally applicable creation-Flood model for earth history, will assist creationists worldwide in their endeavour to unravel and explain the geological evidence that has for so long been the stronghold of our evolutionary opponents. The topic of where the Precambrian strata fit into the creation-Flood model has largely been ignored since I first wrote on this topic over eight years ago,[133] so it is hoped that this present paper will stimulate the much-needed discussion that will ultimately lead to a consensus in the creationist understanding of the geological evidence.

We still have an enormous task ahead of us, but the purpose of this will not just be theoretical or theological. A better interpretation of the rock strata should produce a better tool for the discovery and usage of metal and other economic mineral deposits, and more efficient ways for man to exercise his dominion over this earth.

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Dr Andrew Snelling is a geologist with a B.Sc.(Hons) from The University of New South Wales and a Ph.D. from The University of Sydney. He has worked in the mining industry and is still a consultant geologist, but now also works full-time with the Creation Science Foundation where he contributes to **Creation Ex Nihilo** magazine and edits the **Creation Ex Nihilo Technical Journal**. He resides in Brisbane, Australia.