

Archaean

3600 to 2500 million years ago



The geological history of Australia began early in the Archaean era, around 3500 m.y. ago, with the formation of rocks that now underlie much of the Pilbara region of Western Australia. Little is known of the origin and extent of these very old rocks, which are today severely folded and compressed. However, the sequence of events during the remainder of the Archaean, which lasted for over 1000 m.y., is better known.

The earliest rocks of the Pilbara consisted of silts, sands, iron-rich sediments and chert overlain and intruded by basic volcanic rocks. Between 3450 and 3000 m.y. ago they were folded, severely metamorphosed and uplifted to form mountain ranges interspersed with scattered volcanoes.

Over the next 300 m.y. troughs developed which first filled with volcanic material, then with iron-rich sediments and lastly with sandy and silty sediments interbedded with basic lava flows. Between 2700 and 2600 m.y. ago uplift associated with granite intrusions again occurred.

The formation of the Yilgarn Block to the south began sometime prior to 3100 m.y. ago with the deposition of sandy and silty sediments and some basic volcanics. This sedimentary sequence was subsequently uplifted, metamorphosed and partially melted to form a belt of high grade metamorphic rocks now lying along the west and possibly the north of this block. The history of the rest of the Yilgarn Block is less clear; the rock sequences closely resemble those of the Pilbara Block but they began forming much later, around 2700 m.y. ago.

To the east, in South Australia, the Gawler Block is younger still, having begun to form about 2600 m.y. ago just before the end of the Archaean. Sandy, silty and iron-rich sediments and basic volcanics were laid down but later uplifted, deformed and metamorphosed during the Early Proterozoic.

Little is known about the climate during the formation of these Archaean rocks. Nevertheless, life on earth had already begun and some of the oldest known fossils in the world—primitive life forms such as blue-green algae and bacteria—



have been found in Archaean rocks in Western Australia.

As a result of compression over thousands of millions of years Archaean rocks are characterized by a 'platy' mineral structure. In Australia 'greenstone' is a particularly characteristic Archaean rock, resulting from much-altered basic lava flows. This very resistant rock today forms ridges above the generally flatter and lower terrain of other Archaean rocks.

Economically exploitable deposits of gold, iron, nickel, copper and zinc occur in the Archaean rocks of Western Australia; iron, gold and copper also occur in rocks of this age in South Australia. Bauxite, resulting from the much more recent weathering of Archaean rocks, is abundant in the Darling Range near Perth.

The first crustal rocks formed about 4000 million years ago in the Archaean Era; some of these now form part of Australia. The first primitive life—bacteria and algae—evolved in the oceans around 3500 million years ago and fossil traces of the earliest life forms so far discovered (stromatolites) have been found in north-western Australia. Major nickel and gold mineralisation in Western Australia dates back to the Archaean.

Proterozoic

2500 to 570 million years ago



(far left) **Modern stromatolites along the shores of Hamelin Pool (W.A.)** These provide an understanding of fossil stromatolites, including some found near North Pole (W.A.), which formed an algal reef 3500 m.y. ago. A slice of this ancient reef displaying a stromatolite dome structure is shown below.

(left) **The Kombolgie Sandstone, Arnhem Land (N.T.)** About 1700 m.y. old, this thick and flat-lying Middle Proterozoic sandstone is strongly jointed and covers a wide area. It overlies Early Proterozoic rocks which host significant uranium deposits.

At the beginning of the Proterozoic the Australian landmass consisted of three or four isolated crustal blocks. By the end of the era, almost 2000 m.y. later, these blocks had coalesced to form almost all of the west and centre and significant parts of eastern Australia.

In the north deposition of iron-rich sediments and volcanics which had begun at the end of the Archaean in the Pine Creek Inlier (and probably also in the Litchfield Inlier) continued. During the Early Proterozoic these sediments were uplifted, metamorphosed and intruded with granite.

Further south, between the Pilbara and Yilgarn Blocks, large volumes of basalt poured into the Hamersley Basin, where it was deposited in association with river silts and sands between 2400 and 2000 m.y. ago. Depressed by the continually increasing weight of deposits this area was inundated by the sea and marine sedimentation commenced. Shallow water sediments—mainly sands and some silts and limestones as well as more basalt—were followed by deeper water sediments of silts and muds, mostly iron-rich. Sedimentation ended between 1800 and 1700 m.y. ago when the whole region was uplifted, folded and metamorphosed. Similar events occurred in the Napperu Basin on the northern edge of the Yilgarn Block.

Thus the pattern was set and during the remainder of the Proterozoic more crustal blocks developed, both as adjacent additions to older Archaean or Early Proterozoic ones and then as new ones. The developmental process for each was essentially similar: marine sedimentation, usually with some associated volcanicity, followed by uplift, folding, metamorphism and granitic intrusion. The pattern of crustal development spread generally eastward to form, by the end of the Proterozoic, crustal blocks in what are today northern Queensland, western New South Wales and Tasmania. By this time, some 600 m.y. ago, a major portion of the crustal platform which now forms Australia was already in existence and the skeleton of the remainder had developed.

Because of a much larger geographical extent of sedimentation and a larger and more diverse fossil record, more is known about climates in the Proterozoic than in the Archaean. Evidence suggests that world climates were mostly mild and equable. However, glacial episodes occurred at the beginning and the end of the Proterozoic. During the later episode glaciers developed about 750 m.y. ago on highlands bordering the Adelaide Fold Belt, causing the deposition of glaciomarine sediments—morainic rock debris dropped from icebergs—and boulder clay (now compressed into tillite). Glacial sediments of similar age also occur in Proterozoic rocks ranging from the Broken Hill area to northern and north-western Australia.

Over the long Proterozoic Era life forms evolved from simple microscopic algae and bacterial organisms to a diverse range of much larger marine creatures including jellyfish and worms. Most significantly, the first creatures with hard body parts, for example sea shells (brachiopods), and animals with hard external skeletons (arthropods) such as crustaceans began evolving at the end of the Proterozoic. As a consequence fossil records from this time onward are more complete, increasing considerably our knowledge and understanding of subsequent geological events and environments.

Proterozoic rocks are of immense economic importance to Australia since they contain most of our largest metalliferous mineral deposits. Major mining centres and areas such as Broken Hill (lead, zinc and silver), Mount Isa (copper, lead and zinc), the Pilbara and the Middleback Ranges (iron), Tennant Creek (gold and copper) and the Alligator Rivers area (uranium) all exploit the mineral wealth of Proterozoic rocks.

So by the end of the Proterozoic, 570 m.y. ago, a major portion of Australia's crustal platform and a significant proportion of its mineral resources were in existence.

The 2000 million years spanning the Proterozoic—the era of 'formative life'—saw the evolution of the first multicellular organisms though life was still confined to the oceans. Much of the Australian continent was consolidated through mountain building and sedimentary deposition. Major metallic mineralisation included the Hamersley iron province, the base metal deposits at Broken Hill and Mount Isa, and the uranium deposits of the Alligator Rivers area.