

# Cape Denison, the birthplace of Australian Antarctic expeditions

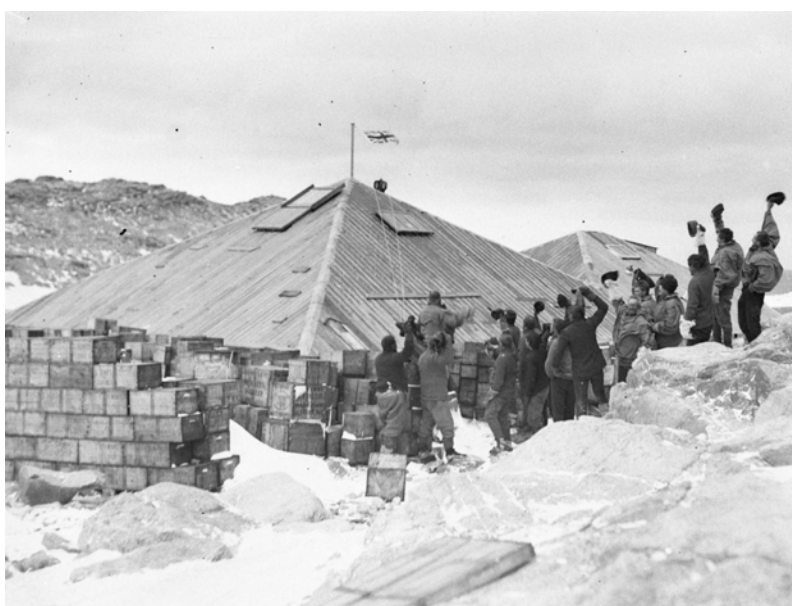
*New map and poster commemorates the Australasian Antarctic Expedition*



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This year marks the 100th anniversary of the Australasian Antarctic Expedition (AAE, 1911–1914) which was organised and led by the eminent geologist Dr (later Sir) Douglas Mawson. The objectives of the AAE were the exploration and scientific investigation of the then largely unknown coastline and hinterland in the vicinity of Adélie Land. This expedition marked the start of Australia's long engagement with Antarctica, a productive and active involvement that continues to this day.

The expedition departed Hobart on 2 December 1911 on the *Aurora*, under command of Captain John K Davis, and established a vital support base on Macquarie Island before continuing south to Antarctica and establishing the main base. Finding a suitable site for a base was difficult and Mawson finally located a small rocky ice-free cape, later named Cape Denison after Sir Hugh Denison, one of the major expedition supporters, located within Commonwealth Bay. The bay was named for the newly federated Australian Commonwealth and, according to Charles Laserson the expedition biologist, 'stretched in a great semicircle, bordered everywhere by high ice cliffs, with here and there a patch of black rock showing at the base'.



**Figure 1.** Members of the Australasian Antarctic Expedition (1911–14) celebrating the completion of the hut (Photograph by Frank Hurley).

Mawson decided that Cape Denison would be the location for the main expedition base (figure 1). During the initial landing at Cape Denison weather conditions were pleasant enough, with Mawson recording 'the day had been perfect'. However, the true character of Commonwealth Bay was soon to reveal itself with katabatic winds, that drain dense cold air from the polar plateau inland behind Commonwealth Bay, which are the most ferocious and persistent winds on the planet. Cecil Madigan, the AAE meteorologist, recorded a mean wind-speed of over 71 kilometres per hour over nearly two years of recording. Cape Denison is now acknowledged as the windiest place on Earth. Mawson's choice of title for his published account of the expedition, 'The Home of the Blizzard' was no idle appeal to poetic licence!

## Landforms of Cape Denison

Cape Denison is an ice-free rocky promontory covering less than one square kilometre which emerges from beneath the continental ice sheet (figure 2). The continental ice sheet rises steeply behind Cape Denison

reaching an altitude of '1000 ft in three miles and 1500 ft in 5 and a half miles' (Stillwell 1918). Cape Denison is described as a 'miniature mountain area' with four parallel broad-bottomed shallow valleys, with intervening rocky ridges, 'steep rock faces and sharp ledges'. Understandably, the main action responsible for the geomorphological features (or landforms) at Cape Denison is the erosive effects of glaciation, with abundant evidence of polished and striated rock surfaces, *roche moutonnée* (elongate whale-backs of bedrock, sculptured by the movement of ice flow) and abundant exotic glacial erratics (Stillwell 1918). 'Freeze-thaw' processes were also considered active erosive agents at Cape Denison during the summer months whereas the actions of wind and running water were considered comparatively minor geomorphologic agents (Stillwell 1918).

## Geology of Cape Denison

In addition to Mawson, Frank Stillwell was a qualified geologist and made major contributions to the geology of the Commonwealth Bay region (*The metamorphic rocks of Adélie Land*). Publications from the AAE on the geology, geomorphology, and other physical sciences appeared in a series of scientific reports published between 1918 and 1940. Geological studies did not resume at Cape Denison until Oliver et al (1983), Stüwe & Oliver (1989) and Sheraton (1989). French geologists (such as Heurtebize 1952; Bellair 1961a,b; Bellair and Delbos 1962) initially conducted investigations to the west in Adélie Land in the vicinity of the French Base Dumont D'Urville (Cape Jules, Port Martin and Point-Géologie) but recent French studies have examined outcrops both east and west of Cape Denison (Ménot et al 2007).



**Figure 2.** Cape Denison, facing northwest, overlooking Mawson's Hut from the 'Proclamation Plaque' site.

Ice-free bedrock along the George V Land coastline is limited to small rocky capes, islands and nunataks, and geological investigations focused on studies of material from moraine fields. Moraines are 'rubble piles' of rocks transported and concentrated as a result of glacial movement and may be transported many kilometres from their source region. The AAE also described the first meteorite found in the Antarctic (Bayly and Stillwell 1923) which was found in December 1912 on the ice plateau, 'about 20 miles from Cape Denison...'

The bedrock geology of Cape Denison, as well as other locations along the Adélie Land and George V Coast, was described by Stillwell (1918). The geology of Cape Denison is relatively simple and can be divided into two dominant rock-types in order of abundance, the Cape Denison Orthogneiss, and amphibolitised mafic dykes (the Cape Denison Amphibolite) which are described below.

## Cape Denison rock types

The most abundant rock type at Cape Denison is the Cape Denison Orthogneiss, described by Stillwell (1918) as coarse-grained grey quartz-feldspar layered granitic gneiss. Stüwe and Oliver (1989) further described the Cape Denison Orthogneiss as a variably foliated, partially migmatized felsic orthogneiss, that is, metamorphosed granite



(see figure 3). The Cape Denison Orthogneiss has been intruded by a number of now-amphibolitized mafic dykes (see also Sheraton et al 1989). Oliver et al (1983) noted, on geochemical grounds, that the Cape Denison Orthogneiss had ‘S-type’ characteristics, suggesting derivation from the melting of a predominantly sedimentary source rock. The Cape Denison Orthogneiss constitutes all of Cape Denison, the nearby offshore Mackellar Islands, and crops out around Point Alden and Port Martin about 50 to 70 kilometres to the west.

The other major rock type found at Cape Denison is amphibolitized mafic dykes (Stillwell 1918). These mafic dykes are between about 0.1 metre to 2 metres wide, dark green/grey in colour and generally planar in outcrop. The dykes are sub-parallel to the regional foliation, and are strongly foliated. Sheraton et al (1989) concluded, on the basis of geochemistry, that at least three distinct generations of mafic dykes are present but were recrystallised and deformed during the regional amphibolite-facies metamorphism.



**Figure 3.** The Cape Denison Orthogneiss, one of the two dominant rock types found at Cape Denison.

## Geochronology at Cape Denison

The first age determination of the Cape Denison Orthogneiss was conducted by Oliver et al (1983), who, reported the emplacement age of the Cape Denison Orthogneiss at  $2366 \pm 33$  million years ago (Ma). Recent uranium-lead (U-Pb) zircon geochronology analysis has been conducted at Geoscience Australia’s Sensitive High Resolution Ion Microprobe (SHRIMP2e) facility. The SHRIMP uses the natural radioactive decay of uranium to lead as a quantitative measure of

time. A cluster of accepted analyses, all from oscillatory zoned domains, return a median  $^{207}\text{Pb}/^{206}\text{Pb}$  age of  $2445 \pm 6.1/-5.2$  Ma (95% confidence level) which is interpreted as a conservative estimate of emplacement age for the Cape Denison Orthogneiss. The youngest six analyses from dark recrystallised metamorphic rims return a median  $^{207}\text{Pb}/^{206}\text{Pb}$  age of  $2419 \pm 11/-20$  Ma, broadly correlating with the Sleaford Orogeny (about 2480 to 2420 Ma) reported in the Gawler Craton in South Australia (Kositcin et al 2010).

The emplacement age of the dykes has proven more problematic. Sheraton et al (1989) concluded that the mafic dykes correlate with similar mafic dykes identified in the Gawler Craton in South Australia (Kositcin et al 2010) and the likely minimum age of dyke emplacement was suggested at around 1600 Ma based on a possible relationship with dykes exposed at the Port Lincoln area in South Australia. However, a conclusive estimate of the emplacement age of the mafic dykes of Cape Denison has been elusive. Zircons from the Cape Denison Amphibolite yielded only three zircons. However, all three grains preserve oscillatory zoning and have elevated thorium/uranium (Th/U) values, characteristic of zircons crystallised from a mafic silicate melt. Seven analyses on these zircons returned a weighted mean  $^{207}\text{Pb}/^{206}\text{Pb}$  age of  $1809 \pm 10$  Ma (95% confidence level), which

was interpreted as the emplacement age of the mafic dyke protolith.

Other geochronological studies (for example, Rb-Sr (rubidium to strontium) analysis of micas; Arriens 1975, Bellair 1961a,b) suggest that amphibolite-facies metamorphism affecting the Cape Denison region occurred around 1500 to 1700 Ma. The timing of retrograde amphibolite-facies metamorphism along George V Land coast to the east and west of Commonwealth Bay is somewhat better estimated to have occurred at around 1710 Ma. This correlates with a similar aged metamorphic event (Kimban Orogeny, 1740 to 1690 Ma) in the Gawler Craton in South Australia (Oliver & Fanning 2002, Ménot et al 2007) which is outlined below.

## Cape Denison in Gondwana

Current reconstructions of the supercontinent Gondwana place the coast of South Australia adjacent to the coastline of Adélie Land and George V Land prior to rifting and the dismemberment of Gondwana. One of the most conclusive lines of evidence which confidently links rocks in the Commonwealth Bay region with exposed rocks in South Australia is the correlation of the 'Cape Hunter Phyllite' with similar phyllitic rocks on the Eyre Peninsula.

The Cape Hunter Phyllite, west of Cape Denison, was described by Stillwell (1918). The rock is a low-grade fine-grained phyllite, unlike

other high-grade metamorphic rocks in the region. Based on lithological chemical and isotopic constraints, Oliver and Fanning (1997) correlated the Cape Hunter Phyllite with phyllites exposed at Coffin Bay on the west coast of the Eyre Peninsula in South Australia. This study, as well as later more comprehensive studies (Fanning et al 1995, Oliver & Fanning 2002), and the geochronology results determined at Geoscience Australia, clearly place the Cape Denison region directly opposite the Gawler Craton in South Australia (Kositcin 2010). These studies led to the concept of a contiguous continental block termed the 'Mawson Block' after Sir Douglas Mawson (Fanning et al 1995, Oliver and Fanning 1997 2002). The Mawson Block includes the Gawler Craton and the rocks of the Commonwealth Bay region and formed part of the amalgamated supercontinent of Gondwana. The full extent of the Mawson Block is currently difficult to assess as the Antarctic component is largely covered by continental ice sheet, but geophysical evidence (Finn et al 2006) strongly suggests the Mawson Block extends well into the interior of the present day continent of Antarctica. While breakup of the supercontinent Gondwana commenced in the Jurassic Period (around 185 Ma), Antarctica began to rift from Australia much later, some 85 to 80 Ma in the late Cretaceous Period, a dynamic tectonic process that continues to this day (figure 4).



**Figure 4.** The separation of Australia from Antarctica, which began about 85 to 80 million years ago, was the last major geological event in the breakup of the supercontinent of Gondwana.

## Conclusions

The AAE (1911–1914) represented the first Australian managed and led expedition to the Antarctic and represents one of the last bold endeavours of what has become known as the ‘Heroic Era’ of Antarctic exploration. The expedition raised the profile of the Antarctic within the Australian consciousness, highlighted the geopolitical importance of the Antarctic and formed a basis for future scientific research in the Antarctic. The expedition provided a solid foundation for ongoing interest and involvement and led directly to Mawson claiming, during subsequent expeditions, the Australian Antarctic Territory, an area of almost 6 million square kilometres, for the Australian Commonwealth.

## Cape Denison Historic Site poster

As part of the celebrations marking 100 years of Australian expeditions in the Antarctic, Geoscience Australia, in partnership with the Australian Antarctic Division, has released a new special edition geologically-themed poster of Cape Denison. The commemorative poster presents a summary of Mawson’s Australasian Antarctic Expedition, a brief description of the geological features of the area, as well as new data on the geochronology of Cape Denison.

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