SECOND VALLEY COASTAL CLIFFS

The cliffs behind the Second Valley jetty and isthmus display intensely folded rocks in which the interplay of dark grey and pale cream-coloured beds creates a superb exposure, justifiably recognised as a State Heritage place (Fig. 1; see description at <https://maps.sa.gov.au/heritagesearch/HeritageItem.aspx?p_heritageno=13214>).

Fig. 1. Folds at Second Valley.

Two formations are represented. The dark grey shale is assigned to the Tapley Hill Formation. This formation comprises laminated carbonaceous, partly calcareous siltstone and minor sandstone interpreted to have been deposited in relatively deep marine water, below the influence of wave action. It is one of the most widespread units in the Adelaide Superbasin, extending northward through the Mount Lofty and Flinders ranges and potentially as far as the SA-NT border, and attaining a maximum thickness of 2400 m (Fig. 2). This same formation is well exposed in road cuttings at the northern (Darlington) end of the Southern Expressway.

The pale cream-coloured rock is part of the Brighton Limestone. While its original relationship to the Tapley Hill Formation is not apparent at Second Valley, the Brighton Limestone elsewhere overlies the Tapley Hill Formation. Where fully developed, the Brighton Limestone includes sediments deposited in shallower marine waters, commencing with high-energy, subtidal to intertidal ooid shoals (typically found today in shallow tropical seas such as around Florida and the Bahamas) and stromatolites (as for example in Shark Bay, WA today), passing upward into supratidal dolostone. It is a much thinner formation (30 m thickness), deposited along the western margin of the Adelaide Superbasin (Fig. 2).

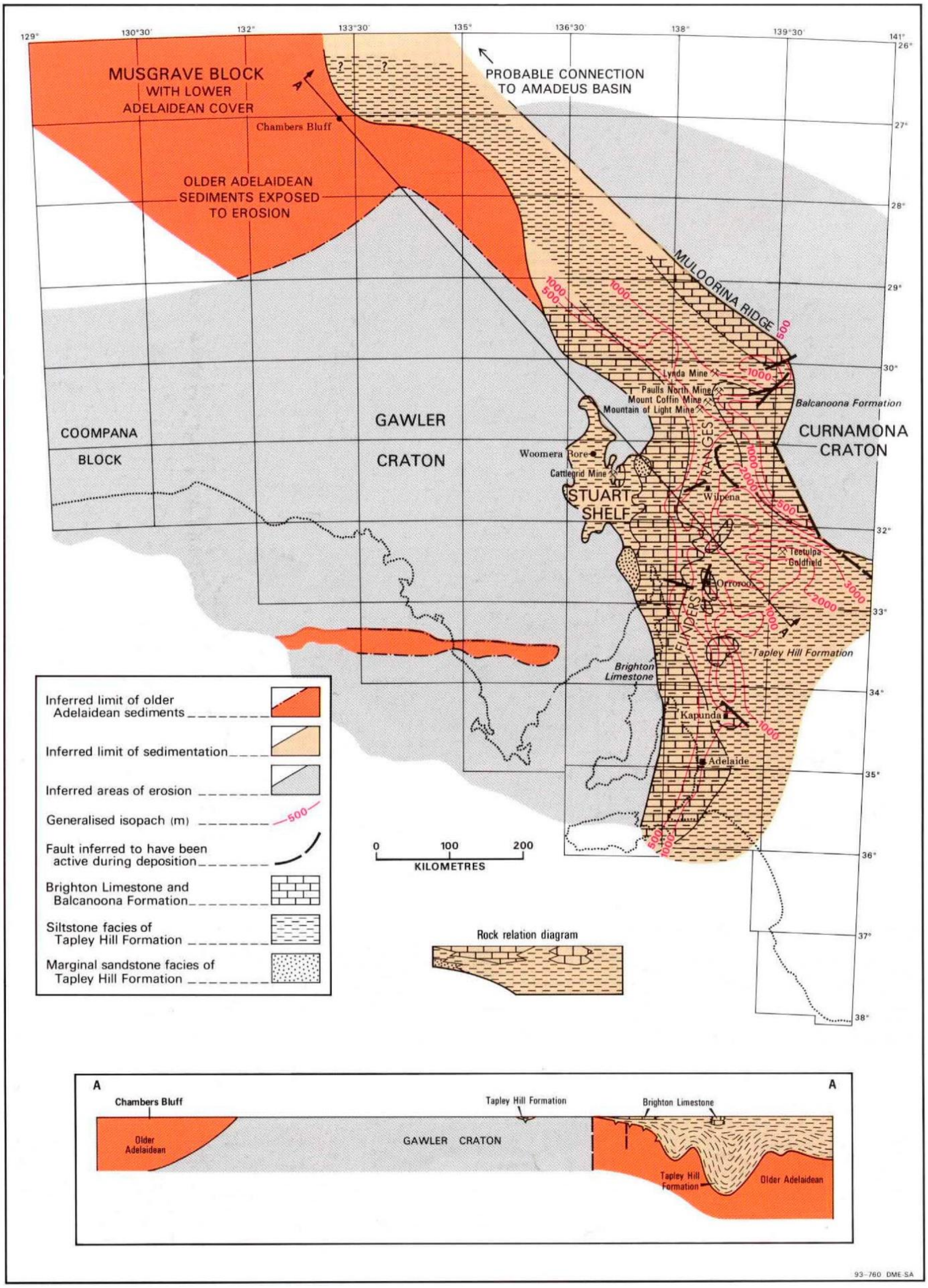

Fig. 2. Map showing extent of interglacial Cryogenian formations in SA (Preiss & others 1993).

These two formations were deposited during the Cryogenian period, between 720–635 mya [million years ago]. This period is so named because it is bracketed at its beginning and end by major global glaciations, respectively named Sturtian and Marinoan (or Elatina) (Fig. 3). However, the two formations exposed at Second Valley were deposited during more temperate times, immediately following the Sturtian glaciation. (These names refer to Sturt Gorge and the nearby suburb of Marino in southern Adelaide, where glacial deposits were first recognised by Walter Howchin, a lecturer at the University of Adelaide, and TW Edgeworth David, a professor of geology at the University of Sydney. These two eminences collaborated in the study of these glacial deposits during the 1890s. As some of the earliest recognised glacial deposits of this age, the names have come to be adopted worldwide.)

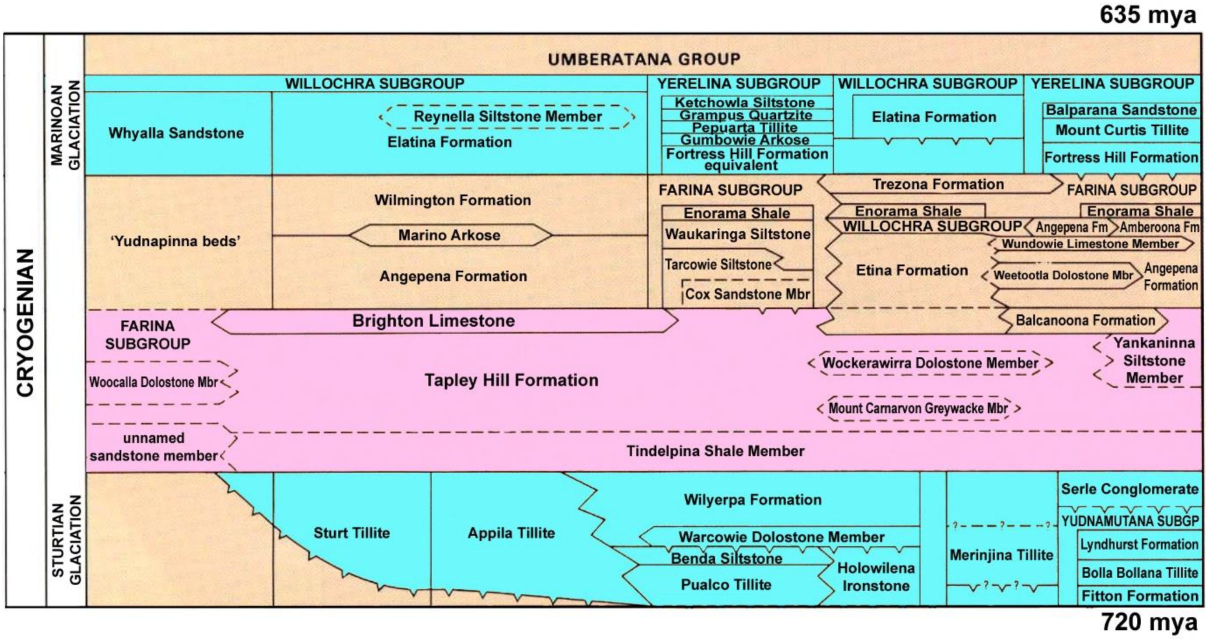

Fig. 3. Stratigraphic chart of Cryogenian formations in the Adelaide Superbasin. Blue = glacial deposits. Pink = formations exposed in Second Valley cliffs. Subgp = Subgroup; Fm = Formation; Mbr = Member. Adapted from Preiss & others (1993).

Global context

During the Cryogenian, Australia was attached to Antarctica on the south, India on the west, and a variety of southeastern and eastern Asian fragments on the north, forming a supercontinent at that time. Australia itself was in the low latitudes of the northern hemisphere. Much of eastern Australia did not exist, except perhaps as isolated island chains.

Life at that time was largely limited to single-celled microbial forms such as bacteria, algae and acritarchs (spores). During the two global glaciations, there is evidence that glaciation at sea level extended from the poles to the equator: Snowball Earth (or as some researchers prefer, given that there is local evidence of open ocean, Slushball Earth). However, between the glaciations, climates were relatively temperate.

Delamerian Orogeny

The Cryogenian deposits at Second Valley represent only a small portion of the entire Adelaide Superbasin rock succession. Altogether, deposition commenced around 840 mya with the opening of an extensional north-south crustal rift, and did not definitively terminate until around 500 mya when the superbasin was possibly laterally compressed by the convergence of adjacent continental blocks. This latter event is termed the Delamerian Orogeny (after the village of Delamere on Fleurieu Peninsula).

The Delamerian Orogeny affected the Adelaide Superbasin rock succession from Kangaroo Island at least as far north as the Peake and Denison ranges in northern SA, with the greatest impact toward the southern end of this tract. In the south (including Fleurieu Peninsula), rocks were strongly deformed to generate folds, faults and shear zones, moderately metamorphosed, and intruded by granites (such as those at Victor Harbor). These orogenic effects also extended into western NSW and Victoria, and beyond, into Antarctica. The orogeny is interpreted to have uplifted a substantial mountain range, the Delamerides, along the former Adelaide Superbasin.

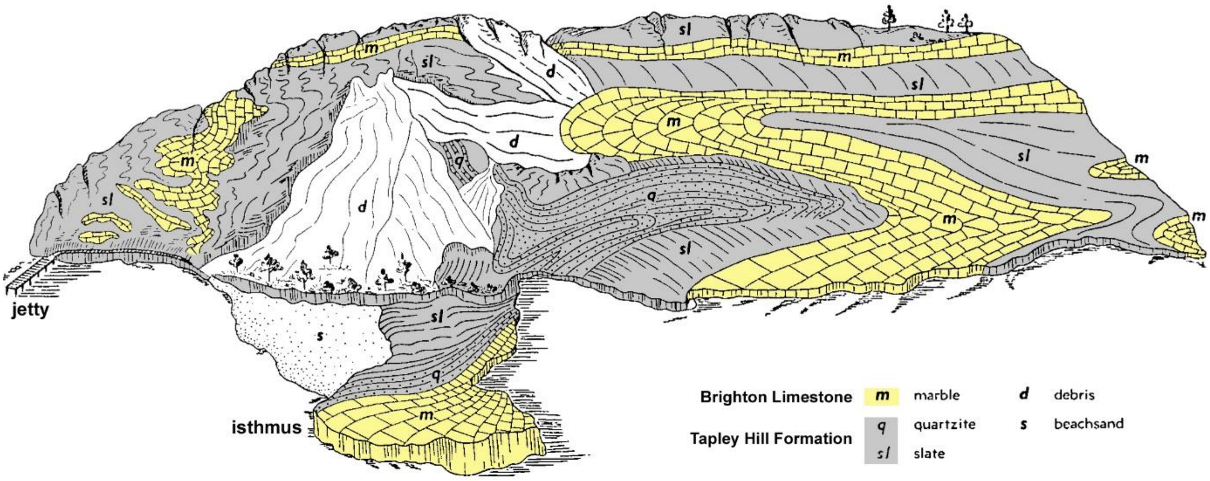

Fig. 4. View to southeast showing face of Second Valley coastal cliffs. Adapted from Campana & others (1953).

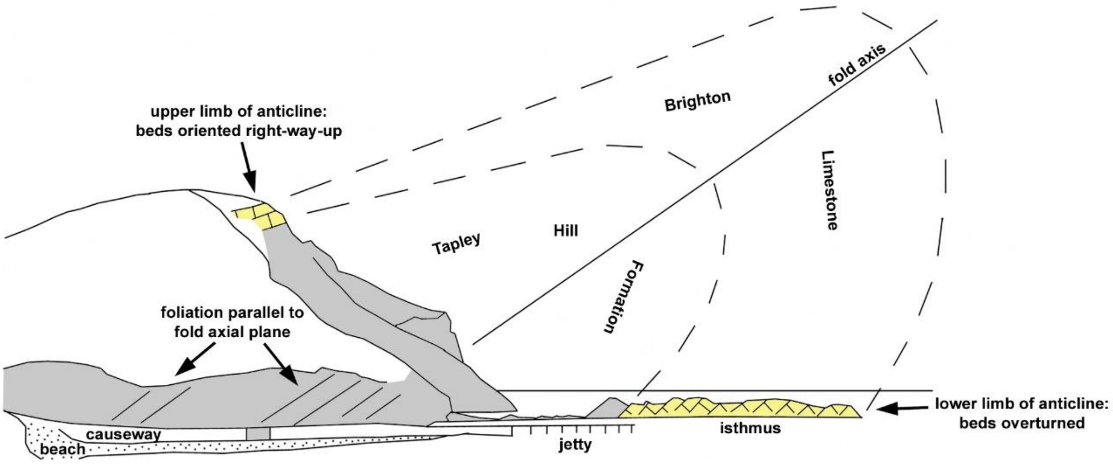

Fig. 5. View to southwest showing grossly simplified sketch profile reconstruction of megafold (near-recumbent anticline) in Second Valley coastal cliffs between the jetty and the isthmus. Legend as for Fig. 4.

The intensely folded rocks seen in the Second Valley coastal cliffs owe their existence to the Delamerian Orogeny. The major structure in the area is a megafold: a near-recumbent (ie with near-horizontal axis) anticline that tracks the coast from the Hobart Memorial to Second Valley and beyond to Rapid Bay. In the Second Valley cliffs, the fold axis is indicated by the dominant foliation dipping landward (to the southeast) at about 30°. Consequently, grey-brown marble (metamorphosed limestone) of the Brighton Limestone near the clifftop is oriented right-way-up as it is on the upper limb of the anticline, whereas on the isthmus below, this formation is overturned as it is on the lower limb of the anticline (Figs 4–5). The folded strata between these surfaces are intensely intermixed; these folds are stretched in the direction of the foliation (Fig. 1). Altogether, these cliffs represent the deep core of the Delameride mountain chain, since largely eroded. (The present Mount Lofty and Flinders ranges are due to much later uplift; the ranges we know are relative latecomers).

Numerous faults are superimposed on the folds and associated foliation. These are consistently reverse faults, indicative of convergence due to lateral compression during the Delamerian Orogeny (Fig. 6).

Fig. 6. Reverse drag fault in cliff face behind Second Valley beach. Arrows indicate sense of movement, consistent with dragged beds below fault (centre). Width of field about 3 m.

The delightful beach and cliffs we enjoy today are the products of a history extending back over 700 million years.

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