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Gondwana rocks of the Allan Hills

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The Gondwana System exposed at Allan Hills, southern Victoria Land, consists of flat-lying rocks of continental provenance that range in age from Permian to Jurassic. Two units are recognized: a lower one, the Victoria Group, mainly fluvial clastics, and an upper, the Ferrar Group, of volcanic origin.

During the 1982–1983 field season, our investigation centered on the stratigraphy and paleontology of the Victoria Group, as it was deposited while the ancient Gondwanaland was still united. Correlation of Gondwana rocks of southerly continental masses is traditionally based largely on fossils of land plants, but remains of terrestrial animals offer finer resolution as new

occurrences are found. While we found no vertebrate fossils, we did succeed in collecting a comprehensive suite of plant fossils of very high quality. This material will enhance the current basis of biostratigraphic zonation and may also provide new details of gross morphology of the Gondwana flora of Antarctica.

The stratigraphy of Allan Hills was discussed by Ballance (1977), Borns and Hall (1969), and Gunn and Warren (1962). (See figure 1.) The outcrop is in the shape of a crescent, the horns pointing nearly due north to enclose the blue ice of the bay (approximate coordinates 76°62'S 159°40'E). The arch of the crescent has a tail-like projection which is directed to the southwest. Topography produces a repetition of beds, the oldest in the central valley region, south and southwest of the bay. Paleocurrent vectors indicate flow to the northwest over most areas. The age of the different formations is based on plant fossils of the *Glossopteris* flora, which indicate Permian age, and the *Dicroidium* flora of Triassic age (Townrow 1967). The following is the sequence of Gondwana rocks in the Allan Hills as currently understood.

1. *Feistmantel Formation (Permian)*. Unlike other Gondwana basins in Antarctica, the basal tillite bed (Metschel Formation) is absent here. The oldest mappable unit, recognized by Ballance (1977) is a 30-meter thick Feistmantel Formation. The dominant lithology is laminated shale and fine sandstone which are commonly in rhythmic alternation. The beds are parallel or micro-crosslaminated, with occasional large-scale cross-bedding. On weathered sandstone surfaces, dome-shaped, concentric structures from 0.5 to 2 meters across are common. They are usually brown in color and may represent algal mats. Leaf impressions of both *Glossopteris* and *Gangamopteris* are found in the shale. A thin conglomerate occurs at the base and contains faceted gra-

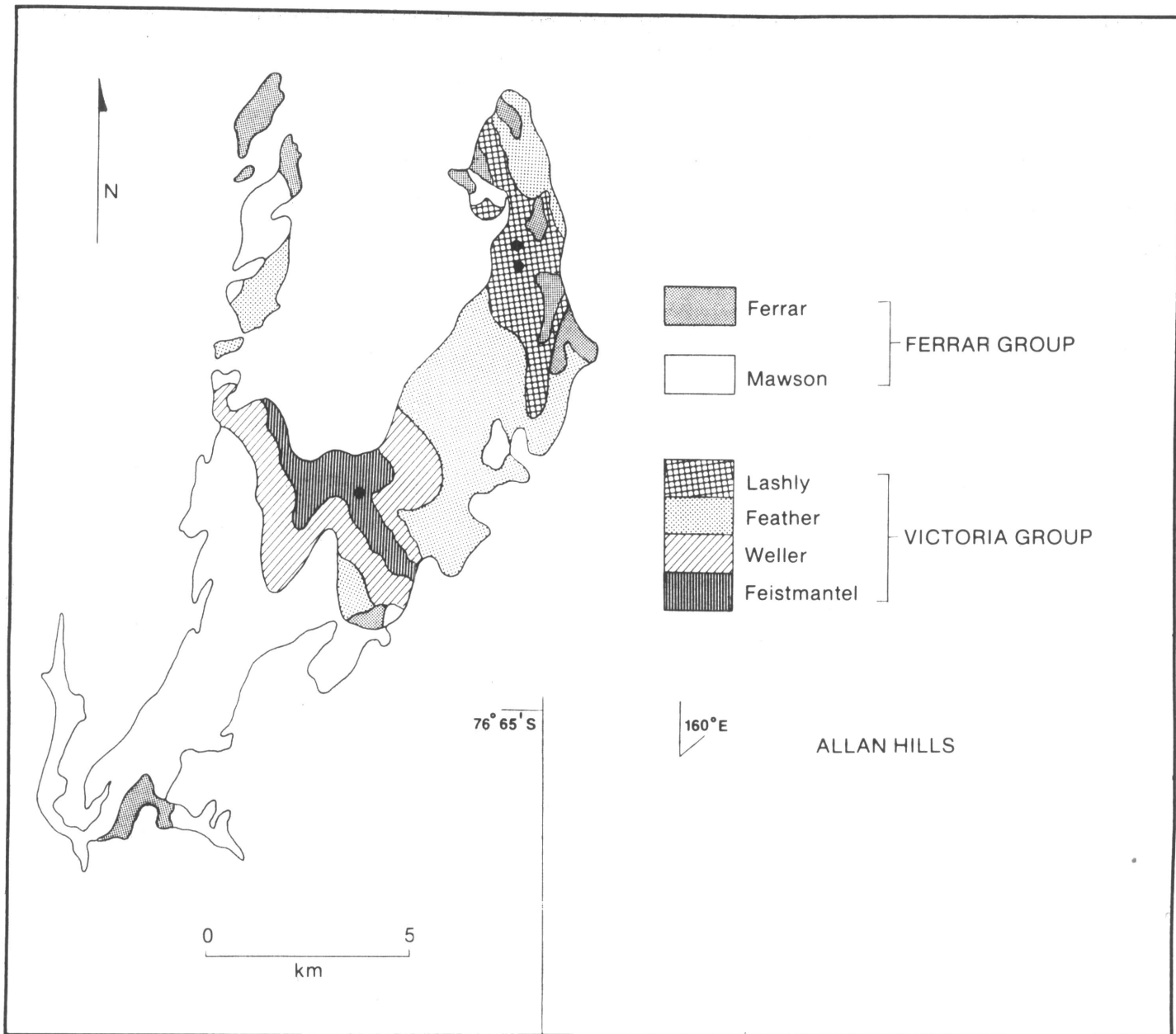


Figure 1. Geological map of Allan Hills (after Ballance 1977); Black circles indicate new fossil localities. ("km" denotes kilometer.)

nitic clasts which may suggest reworking from an underlying tillite.

2. *Weller Formation (Permian)*. The Weller consists of conglomerate, arkosic sandstone, shale, and coal, in fining-upwards cycles. The formation is about 50–80 meters thick and is easily recognizable from its coal-bearing horizons. There are at least 10 coal seams encountered in a measured section, the thickest one about 3 meters. Near the tops, some coal seams are roughly lenticular, elongate "pods" of fine clastic material that suggest mud or ash flows. They are very dark black from disseminated carbon and contain bits of charcoal. Because they weather white, they are reminiscent of the "White Band" of the South African Dwyka Series. Petrified logs and stumps are common in the sandstone. The stumps are frequently shot through with zones of charcoal, and the logs are almost univer-

sally encrusted with charcoal, as though they collectively represent the remains of a forest fire.

An extensive plant-fossil-assemblages sample was collected from the green and gray shale immediately below the second level of coal from the bottom of the Weller. The flora includes *Glossopteris*, often associated with stems and fructifications, and ginkgoales and equisetaleans are also present (figure 2, blocks a, b, and c) *Glossopteris* leaves are considered to have been deciduous because of the widespread abundance as "autumnal banks" (Plumstead 1952).

3. *Feather Formation (Triassic)*. The Feather consists of a massive, 300-meter-thick, pebbly conglomerate interbedded with sandstone, succeeded by a light green siltstone. Large-scale stratifications are common. It is devoid of coal and fossils, and its Triassic age is tentative.

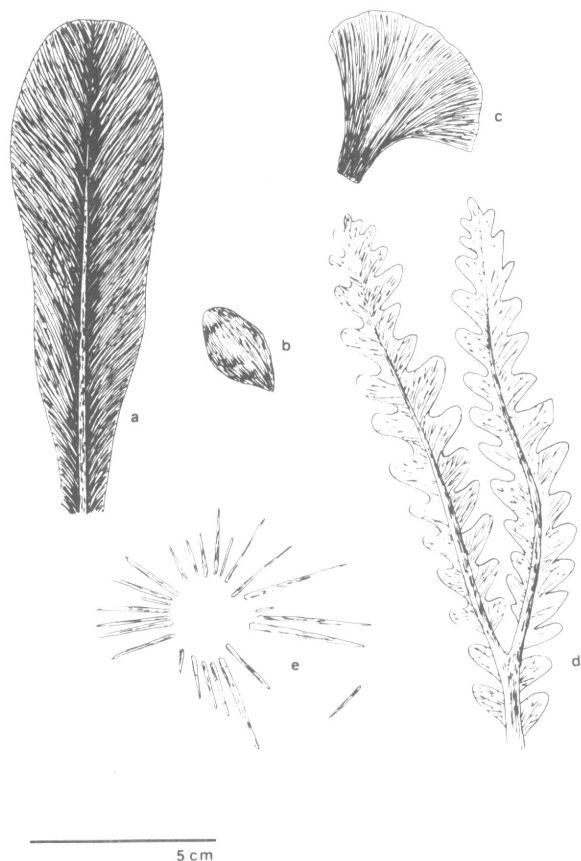


Figure 2. Plant fossils from Allan Hills. (a) *Glossopteris*; (b) seed of *Glossopteris*; (c) ginkgoaleaf; (d) *Dicroidium*; (e) equisetalean. a–c: from Permian Weller Formation. d–e: from Triassic Lashly Formation. ("cm" denotes centimeter.)

4. *Lashly Formation (Triassic)*. This 60–120-meter-thick unit consists of a cyclic sequence of sandstone, siltstone, carbonaceous shale, and coal. Petrified logs are very abundant, usually encrusted with charcoal as in the Weller. Unlike the Weller, however, petrified stumps in a position of growth were not observed in the Lashly. A rich flora of *Dicroidium* and related pteridosperms, equisetaleans, and several unidentified taxa, associated with possible arthropods and unionids, were found in a gray shale (figure 2, blocks d and e). Beautiful equisetaleans were also recovered from a white siltstone horizon. A local concentration of sulfide minerals (mainly pyrite and chal-

copyrite) associated with wood fossils indicates a strong reducing environment.

5. *Mawson Formation (Lower Jurassic)*. The Triassic strata are overlain disconformably by the Mawson Formation which consists of diamictite, originally thought to be a tillite (Gunn and Warren 1962) but now interpreted as a laharic deposit of basaltic composition (Borns and Hall 1969). Sedimentary interbeds in the adjacent Carapace Nunatak have yielded diverse biota of crustaceans, insects and plants; radiometric ages of the volcanic indicate Lower Jurassic (185 million years) age (Ball et al. 1979).

6. *Ferrar Formation (Upper Jurassic)*. The Victoria Group is intruded by sills and dikes of Ferrar dolerite. Grapes, Reid, and McPherson (1974) discussed the mechanism of emplacement of the tholeiitic sills and dikes in this area. The shallow intrusion of dolerite sills into the porous and permeable Permo-Triassic rocks resulted from volcanic mud flows and explosion breccias.

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