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Delny-Mount Sainthill Fault System, eastern Arunta Block, Central Australia

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Introduction

The Delny-Mount Sainthill Fault System, a distinctive feature on satellite photographs, can be traced as a well-developed geological and geophysical feature extending some 130 km across the Arunta Block, central Australia. It has a slightly north-of-west trend, from 4 km south of Mount Thring (22°49′S, 136°02′E) to 5 km south of Delny Outstation (22°33′S, 134°49′S) (Figs 1, 2). The deformed nature of the rocks at Mount Sainthill was first noted by Smith and others (1960), who described a blastomylonite derived from nearby granite, and recorded the gradational contact between deformed and undeformed units. Shaw & Warren (1975) mapped the Delny section of the Fault System. The nature of the remainder of the Fault System and its continuity was recognised during rapid reconnaissance to provide data for interpretation of new coloured aerial photography in the 1976 field season.

Regional geology

The Arunta Block is considered to contain three major depositional units, each with probable stratigraphic significance, but recognised primarily by their distinctive lithologies (Shaw & Warren, 1975; Shaw & Stewart, 1976; Stewart & Warren, 1977, see Fig. 2). Division I consists principally of volcanogenic rocks and immature sediments, usually at the granulite grade of regional metamorphism. Division II (equated with the Warramunga Group in the Tennant Creek area) contains a larger proportion of derived sediments. Division III units (equivalent to Hatches Creek Group) contain mature quartzite and pelite. They overlie rocks of Division II unconformably.

In the region affected by the Delny-Mount Sainthill Fault System Division I is represented by the Kanandra Granulite, a unit of the Strangways Metamorphic Complex, cropping out mainly in a fault-bounded block extending eastward from south of Delny. It consists of garnetiferous felsic gneiss, with pods and thin layers of mafic granulite and lesser proportions of metasediments. South of the Fault System these granulites are intruded by small bosses of Mount Swan Granite (see below), but north of the Fault System they occur as rafts in the Mount Swan Granite (and possibly in the Dneiper Granite).

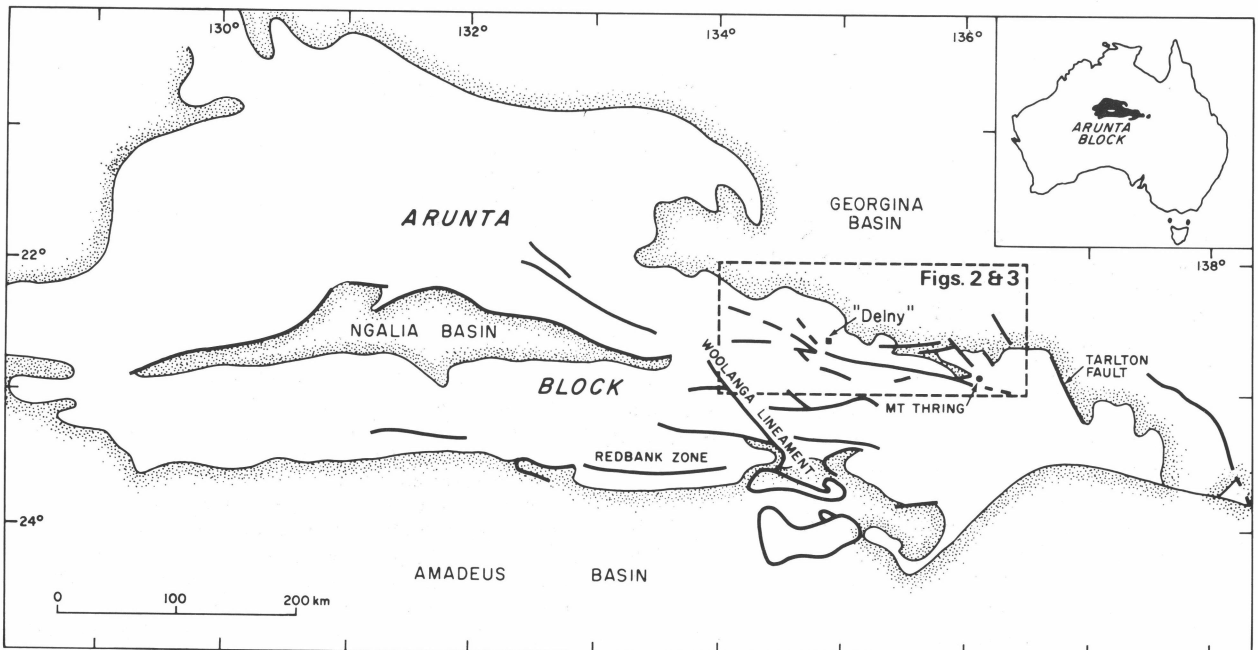

Figure 1. Major faults within the Arunta Block, central Australia.

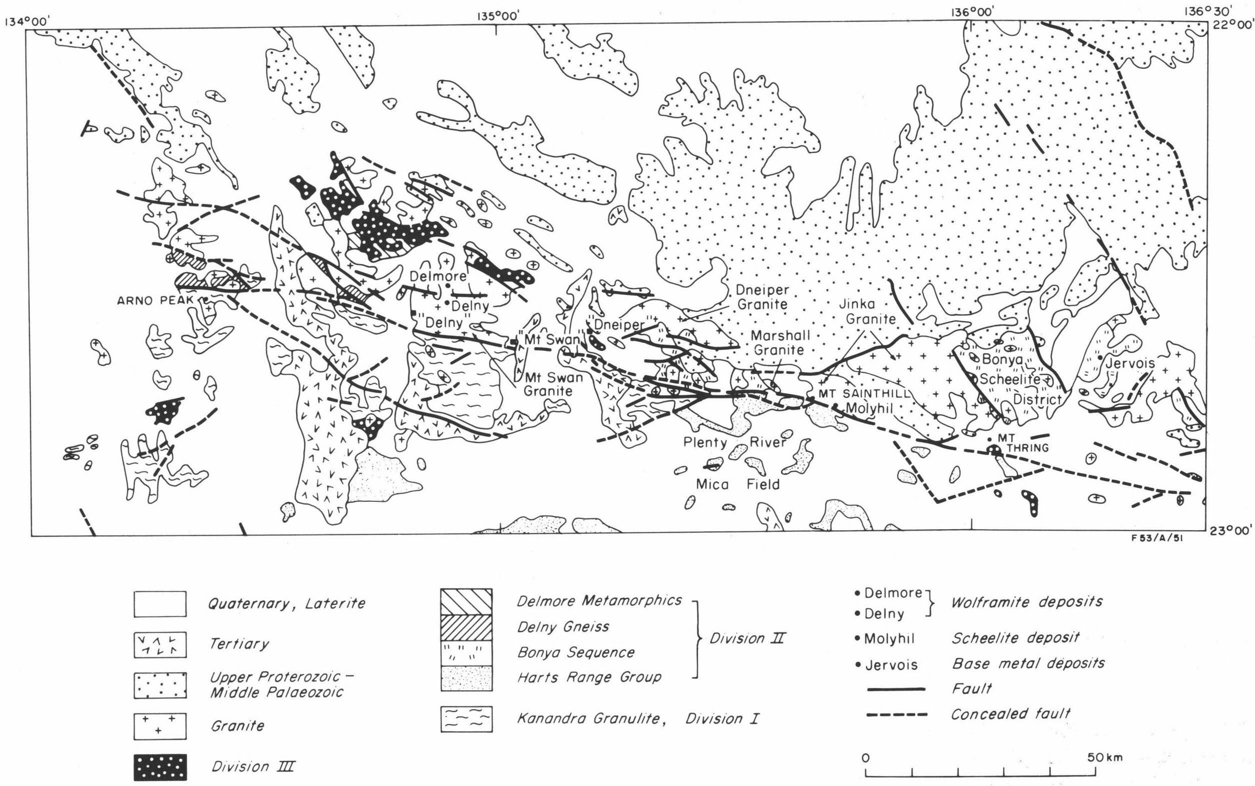

Figure 2. Regional geological setting of the Delny-Mount Sainthill Fault System.

The Harts Range Group (part of Division II) crops out in low hills rising above the Plenty River Plain to the south of the Fault System; it does not crop out north of the Fault System. The various units mapped by Joklik (1955) in the Harts Range can also be recognised in these hills, including garnet-biotite-quartz-oligoclase gneiss with minor mafic pods (Irindina Gneiss); calcareous gneiss and marble (Naringa Calcareous Member of the Irindina Gneiss and an unnamed unit); porphyroblastic felsic gneiss (Bruna Gneiss) and fine-grained leucocratic felsic gneiss (Enţia Gneiss). The metamorphic grade rises from upper amphibolite to granulite towards the Fault System; retrograde metamorphism is superimposed immediately adjacent to the Fault System.

Northwest of Delny, Shaw & Warren (1975) delineated two metamorphic units in Division II: the Delny Gneiss, mainly potash-rich pelites; and the Delmore Metamorphics, a suite of calc-silicate gneisses and semi-pelitic gneisses.

In the Bonya Scheelite District, northeast of Mount Thring, Central Pacific Minerals N.L. (Bowen, Hensridge, & Paine, 1972) have mapped a sequence of two-mica schist, metamorphosed intermediate volcanics, calc-silicate gneiss, marble, amphibolite and magnetite quartzite, informally referred to as the Bonya sequence. A similar but less well exposed sequence to the east contains the Jervois ore bodies (Robertson, 1959).

The region north of the Fault System between these two areas is not yet mapped, but reconnaissance traverses suggest that the Bonya sequence persists west, and correlates with the Delny Gneiss and Delmore Metamorphics.

The regional metamorphic grade north of the Fault System is generally lower amphibolite, but locally it shows conditions verging on upper amphibolite (Shaw & Warren, 1975; Dobos, 1975).

Both the Harts Range Group and the Bonya sequence are assigned to Division II, as they contain a large proportion of clastic sediments. However the pelites in them are completely different: the Irindina Gneiss contains a predominance of oligoclase relative to potassium feldspar, whereas the pelites of the Bonya sequence are rich in muscovite, which, at the upper amphibolite to granulite grade of the Irindina Gneiss, would give rise to orthoclase-sillimanite assemblages. In general the chemical characteristics of the Harts Range Group are better known than those of the Bonya sequence. However, points such as the occurrence of scapolite (which is characteristic of calcareous units of the Harts Range Group) north of the Fault System only as a contact metasomatic mineral indicate that in the Bonya rocks the two units are indeed different.

Rocks of Division III have been mapped 12 kms north of Delny Outstation, where a lower pelitic unit (Ledan Schist) and an upper quartzite (Utopia Quartzite) crop out. Similar rocks crop out north of the Fault System near Dneiper homestead (22°37′, 136°12′), immediately north of the Fault System at Mount Thring, and south of the Fault System, about 15 km southeast of Mount Thring. The metamorphic grade of these rocks is generally lower amphibolite, but reaches upper amphibolite southeast of Mount Thring.

Tectonically the Fault System is the northern limit of the Ambalindum Block of Shaw & Warren (1975) and, locally, the southern limit of the region of extensive granites (the northern Arunta zone of Stewart & Warren, 1977). Granite, making up about half the exposure north of the Fault System, ranges from gneissic and/or porphyritic to anisotropic. There are four named granites in the zone immediately north of the Fault System. From east to west these are the Jinka Granite, a coarse, even-grained, slightly gneissic granite; the Marshall Granite, a slightly gneissic leucogranite; the Dneiper Granite, a gneissic granite (probably a granite com-

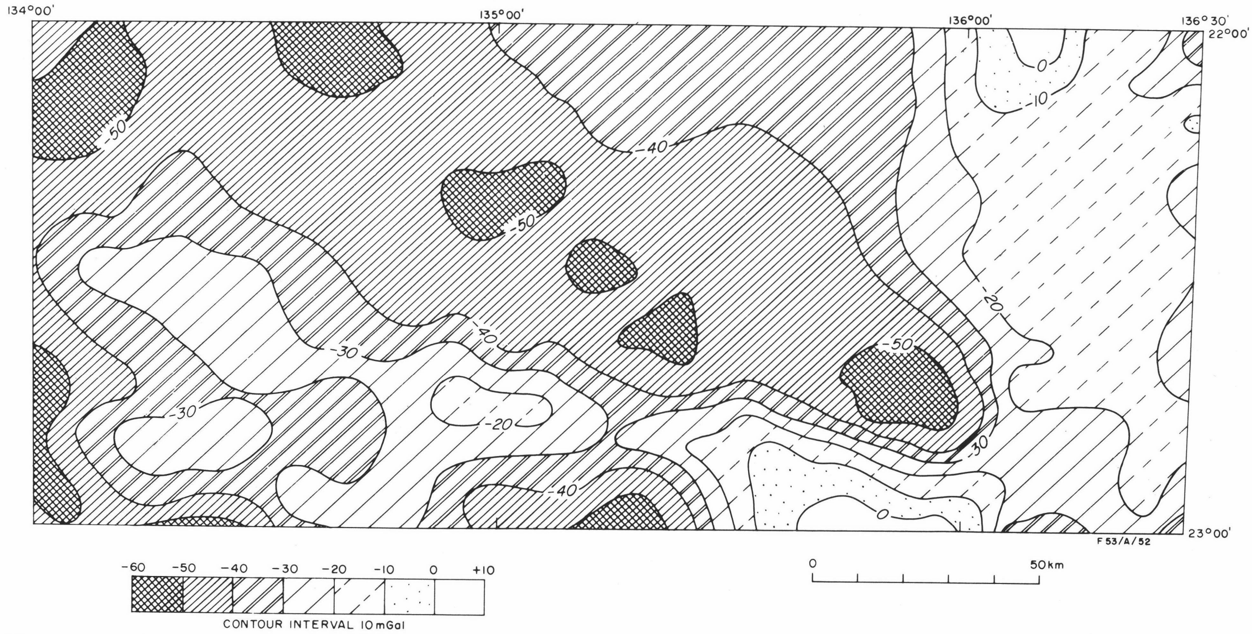

Figure 3. Distribution of Bouguer gravity anomalies in the vicinity of the Delny-Mount Sainthill Fault Zone (after the Gravity Map of Australia at 1:5 000 000).

plex); and the Mount Swan Granite, a porphyritic gneissic granite. In addition there are several other unnamed (and unmapped) granites in this zone. Outcrops of granite south of the Fault System take the form of small bosses intruding the Kanandra Granulite. In the west these are part of the Mount Swan Granite, but towards the eastern limits of the Kanandra Granulite the granites belong to the unnamed units (shown on the *extant* edition of the Huckitta 1:250 000 map as *Dneiper Granite*).

The Arunta Block north of the Fault System is overlain by platform sediments of late Proterozoic to Devonian age, including the Georgina Basin sequence.

In the late Mesozoic and early Tertiary this part of the Arunta Block was intensely and deeply weathered; in the middle to late Tertiary a number of small basins were filled by continental sediments.

Nature of the Fault System

The Fault System consists of a discontinuously exposed, anastomosing zone of deformed rocks, at some localities encompassing slivers of undeformed rocks. Zones of deformed rocks are commonly half a kilometre wide; at Mount Sainthill they exceed a kilometre in width. Generally the rocks within the deformed zones can be equated in composition with undeformed units away from the fault zone (cf. Smith and others, 1960), but there is a marked change in metamorphic facies from granulite or upper amphibolite to lower amphibolite and greenschist, and in fabric from granular to markedly layered and lineated. Segregation of quartz is not widespread, but where it has taken place the quartzose material has itself been deformed by later movements; the Delny section in particular contains mylonitic quartzite and refolded quartz veins. These features permit the tracing of the Fault System as a series of basement highs through an area of thin Tertiary sediments south of Mount Swan homestead. The rocks within the fault zones are less resistant to erosion, and tend to be less exposed than their undeformed counterparts; thus the Fault System generally occupies a topographic low. Towards Mount Thring the Fault System is very poorly exposed; south of Mount Thring (which contains mylonitic rocks but is not on the main Fault System) continuity with the Fault System is inferred from the juxtaposition in two adjacent monadnocks of units of Divisions II and III. A strong photolineament, traceable from the most easterly known outcrop of mylonitic rocks some 6 kms to the west, passes between the monadnocks. This photolineament continues through areas of sand cover for about 50 kms and is interpreted as a concealed fracture; but faults with a north-northwest trend parallel to the Tarlton Fault dominate this region.

West of Delny, the system may continue beneath Tertiary cover to link up with a major fault north of Arno Peak—perhaps adding another 60 km to its length.

Dips on the deformed rocks are steep (85°-65°S near Mount Sainthill, 80°N in parts of the Delny section), and lineations plunge steeply. This suggests at least that the later movements on the fault have had a major vertical component. At the Delny end of the Fault System the distribution of Mount Swan Granite and Kanadra Granulite suggests that a deeper level of the intrusive contact is exposed north of the Fault System, and hence that the cumulative effect of movement on the Fault System has been north-side-up, without any significant transcurrent component. The curvilinear nature of the fault traces is also at variance with transcurrent movements.

Geophysical expression

The Fault System forms a distinctive feature on regional aeromagnetic maps, mainly because of the contrast in magnetic characteristics of juxtaposed units. To the south, granulites of Division I give a magnetically disturbed but high response, whereas the Harts Range Group is magnetically quiet and low, with local contrast over calc-silicate horizons. North of the Fault System the Delny Gneiss and Delmore Metamorphics produce magnetically disturbed areas, whereas the granites, particularly the Jinka Granite, give magnetic lows.

There is a marked gravity gradient across the Fault System (Fig. 3). To the north extensive granites correspond with Bouguer anomaly lows. Higher values south of the Fault System correspond to granulites of Division I and granulites in the Harts Range Group close to the Fault System.

The aeromagnetic and the regional gravity maps suggest that the Fault System ceases to be a major feature east of Mount Thring.

Age of the Fault System

There is no direct evidence for the age of the Fault System. The youngest units deformed within the system are granites with ages in excess of 1700 m.y. (L. P. Black, BMR, pers. comm.). The Redbank Zone, a wide belt of highly deformed rocks forming a major west-trending lineament near the south-central margin of the Arunta Block was initiated at about 1620 m.y. (Marjoribanks & Black, 1974). This is only one of the major structures within the Arunta Block to have been successfully dated so far. It trends more nearly east-west than does the Delny-Mount Sainthill Fault System, but the two are similar—both are wide, intensely deformed, and markedly retrogressed structures post-dating the major regional metamorphism. The Delny-Mount Sainthill Fault System does not cut the late Proterozoic-Middle Palaeozoic units, and is overlain by Tertiary sediments.

Economic implications

The Fault System separates the Harts Range Group from an extensive area of granites; it also separates a northern area more prospective for tungsten from the presently derelict Plenty River Mica Field in the Harts Range Group. The Bonya Scheelite District contains a number of metasomatic deposits of scheelite in calc-silicate skarns, introduced by pegmatites and granite (Bowen and others, 1971), and the Molyhil deposit (scheelite and molybdenite), about 6 km east-northeast of Mount Sainthill, is in roof pendants of calc-silicate skarn in the Jinka Granite. The Delny and Delmore wolframite deposits north of the western end of the Fault System are in roof pendants of meta-pelite and amphibolite in the Mount Swan Granite. Only a few traces of scheelite (at about 23°03′S, 135°05′E) have so far been found south of the Fault System.

The most important metallotect controlling the distribution of the fluorite and barite veins cutting the Jinka Granite north and northeast of Mount Sainthill was considered by Jensen (1971) to be proximity to the unconformity with the overlying late Proterozoic sediments. All known deposits are less than a kilometre from the present position of the unconformity, and at least some are demonstrably younger than the basal sediments of overlying units. Van Alstine (1976) has advanced a theory that fluorite deposits are clustered along major structures: it should be noted that the fluorite deposits are close to the north side of the Fault System.

The spatial relationship of the Mud Tank Carbonatite and the late Proterozoic Mordor Igneous Complex to the Woolanga Lineament (Fig. 1), a deep fracture in the south-central Arunta Block, has been noted by Langworthy & Black (in prep.). If the Delny-Mount Sainthill Fault System persists as a near vertical structure deep into the crust it may also serve as a conduit for similar intrusions. Presently the only indications of deep-source intrusions are three (separate) short references to high copper-chrome values or to small ultrabasic intrusions in the district (Hosking, 1972; Cooney, 1973; Geological Survey of the Northern Territory, 1976).

Acknowledgement

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