DEPARTMENT OF MINES AND ENERGY
SOUTH AUSTRALIA

REPT.BK.NO. 87/84

ARCHAEAN TO MIDDLE PROTEROZOIC MINERALIZATION OF THE GAWLER CRATON (INCLUDING THE STUART SHELF REGION) S.A.

GEOLOGICAL SURVEY

by

A.J. PARKER
REGIONAL GEOLOGY

JULY, 1987

DME.220/86

CONTENTS

LIST OF FIGURES

DEPARTMENT OF MINES AND ENERGY
SOUTH AUSTRALIA

Rept. Bk. No. 87/84
D.M.E. No. 220/86
Disk No. 55

ARCHAEAN TO MIDDLE PROTEROZOIC MINERALISATION OF THE GAWLER CRATON (INCLUDING THE STUART SHELF REGION) SOUTH AUSTRALIA

ABSTRACT

The scope for mineralization in the Gawler Craton ranges from Late Archaean iron and base-metal deposits to Middle Proterozoic copper-uranium-gold-silver and rare-earth elements. Archaean rocks are dominantly high-grade gneissic metasediments which are particularly magnetite rich. Early Proterozoic sequences form a fold belt along the eastern side of the craton and include metamorphosed calcareous, iron-rich and clastic sediments with potential for base metals in addition to the currently-mined iron-ore deposits. Deformed acid volcanics, similar in age and geochemistry to Mt Isa region volcanics, also occur within the eastern fold belt and host copper-gold mineralization. Middle Proterozoic sediments and acid volcanics are extensive in the central craton and host copper-uranium-gold-silver mineralization near the eastern margin of the craton and gold within the central/northwestern region.

INTRODUCTION

The geological evolution of the Gawler Craton spans a time interval from the Late Archaean to the present. Since the Middle Proterozoic, the craton has remained relatively stable with only thin, though often widespread, continental sediments being deposited during the Late Proterozoic, Cambrian, Permian, Mesozoic and Cainozoic. Only the Archaean to Middle Proterozoic period will be discussed in this paper.

Mineral production from the craton commenced in 1862 shortly after copper was discovered at Moonta and Kadina. The Moonta and Wallaroo mines were the richest mines in Australia and produced 336 000 tonnes of copper before closing in 1923. During the same period several small base-metal prospects were discovered and mined on Eyre Peninsula (Johns, 1961 & 1985) but none developed into substantial operating mines. Iron ore, though, has been an extremely important commodity being mined continuously at Iron Knob, Iron Monarch, Iron Prince, Iron Baron and Iron Queen since the turn of the century. Iron Duke, at the southern end of the Middleback Ranges, is soon to be commissioned. Gold has been mined semi-continuously at Tarcoola and Glenloth since about the same time (Daly et al., this volume) and will soon be mined at Olympic Dam.

The discovery of a huge deposit of copper + uranium + gold + silver + rare earth elements ore at Olympic Dam in 1974-75 prompted renewed exploration interest not only in the Middle Proterozoic of the Stuart Shelf region (n.b. the Stuart Shelf developed during the Late Proterozoic (Adelaidean) after formation of Olympic Dam ores) but also throughout the entire Gawler Craton.

More recently, the discovery of zinc + lead mineralization in Early Proterozoic metasediments at Menninnie Dam (Berg & Higgins, this volume) has further increased the mineral potential of the craton. However, the full potential of the Gawler Craton has yet to be realized.

REGIONAL GEOLOGY

The principal tectonic events leading to development of the Gawler Craton occurred during three major periods or megacycles (Fanning et al., in prep.):

1. 2700 - 2300 Ma: Late Archaean sedimentation and volcanism followed by Early Proterozoic plutonism and metamorphism (Sleafordian Orogeny);

2. 2000 - 1700 Ma: initial basin/platform sedimentation followed by widespread plutonism, metamorphism and deformation (Kimban Orogeny) with local volcanism and continued sedimentation through to ca. 1700 Ma;

3. 1650 - 1450 Ma: anorogenic acid magmatism including extensive felsic volcanism, high-level granite plutonism and local intracontinental clastic sedimentation.

Archaean to earliest Proterozoic

The oldest basement rocks of the Gawler Craton are the Mulgathing Complex (Daly et al., 1978; Daly, 1985) in the northwest and the Sleaford Complex (Webb & Thomson, 1977; Fanning et al., 1981) in the south (Fig. 1). The latter records isotopic ages ca. 2300 - 2650 Ma (Fanning et al., 1986) and clearly contains two principal components: an older supracrustal layered-gneiss sequence of Archaean ancestry (the Carnot Gneisses) which was metamorphosed and deformed during the Sleafordian Orogeny ca. 2450 - 2550 Ma, and an intrusive granitoid suite (the Dutton Suite) emplaced ca 2300 - 2350 Ma. Mulgathing Complex rocks are similar, with supracrustal iron-formation-bearing layered gneisses of Archaean ancestry (the Christie Gneisses) intruded by ca. 2300 - 2350 Ma granitoids (eg the Glenloth Granite). Both the Sleaford Complex and the Mulgathing Complex are granulite-facies gneiss complexes with analogies to the Western Gneiss Terrain of the Yilgarn Block (Daly, in prep.). There are no known greenstone belts in the Gawler Craton although thick basic (to rare ultra-basic) bodies in the Tarcoola-Glenloth region may represent the deeper root zones of former greenstones.

Early Proterozoic

In the Gawler Craton, there is little recorded sedimentary or tectonic activity from the period 2300 - 2000 Ma. On southern Eyre Peninsula, the Sleaford Complex is overlain by clastic sediments of the Hutchison Group which, since it overlies a ca. 1950 Ma granite gneiss on central Eyre Peninsula (Miltalie Gneiss) and is intruded by ca 1850 Ma granitoids (Parker et al., 1985), is interpreted to have been deposited ca. 1950-1850 Ma. The Hutchison Group consists of basal quartz clastics, the Warrow Quartzite with local quartz-pebble conglomerate and calc-silicate gneiss, overlain by carbonates, iron formation, amphibolite and pelitic to semi-pelitic schist of the Middleback Subgroup and Yadnarie Schist (Parker and Lemon, 1982). Highly-deformed rhyolites (Bosanquet Formation) may occur within the Yadnarie Schist near Darke Peak (Rankin & Flint, 1987).

The Hutchison Group has been intensely and multiply deformed and metamorphosed and the peak metamorphic grade of middle to upper amphibolite facies combined with the often very intense deformation has disrupted not only individual lithologies but also the entire sequence. Metamorphism/deformation (the Kimban Orogeny) occurred ca. 1850-1700 Ma as recorded by intrusion of numerous granitoids ranging from early, I-type, granodioritic bodies (the Donington Granitoid Suite, Mortimer et al., 1986) to late-orogenic adamellite plutons (Webb et al., 1986). Mylonites throughout eastern Eyre Peninsula and the northwestern craton formed late during the orogenic development and represent major crustal shear zones (Parker, 1980b, Rankin et al., 1987).

East of the Middleback Ranges, low metamorphic grade schists, amphibolite, and minor quartzite, the Broadview Schist, are associated with felsic volcanics and fine-grained gneisses, the Myola Volcanics. These have been subjected to at least part of the same orogenic cycle that affected the Hutchison Group but are stratigraphically younger as confirmed by a U-Pb zircon age of 1791±4 Ma (Fanning et al., in prep.). Of particular interest is the similarity, in both age and geochemistry, of the Myola Volcanics to the Argylla and Bottletree Formations in the Mt Isa Inlier (Wyborn et al., in press).

On northern Yorke Peninsula, in the Moonta-Wallaroo district, the principal lithologies include a schist-gneiss-quartzite-amphibolite sequence, the Doora Schist (Parker, 1980), and felsic volcanics, the Moonta Porphyry (and the equivalent Wardang Volcanics: Bone, 1984; Fanning, 1985). There has been considerable debate over the relationship of schist to porphyry and of those units to units on Eyre Peninsula. However, because the Moonta Porphyry has been deformed and partially recrystallized it is considered to be related to the Doora Schist unit and also to either the Myola Volcanics or McGregor Volcanics of Eyre Peninsula (which display very similar recrystallized lithologies). This is in contrast with earlier correlations of Moonta Porphyry and Gawler Range Volcanics (Thomson, 1969). A ca. 1740 Ma zircon age for Moonta Porphyry rhyolite from Moonta (Fanning et al., in prep.) is similar to the inferred age of McGregor Volcanics although deformation of the Doora Schist is more complex.

McGregor Volcanics and the immediately-overlying, volcaniclastic Moonabie Formation crop out on northeastern Eyre Peninsula where they were weakly deformed during the waning stages of the Kimban Orogeny. The volcanics are bimodal, though rhyolites predominate, and the Moonabie Formation is a very massive to poorly-bedded grit/sandstone (Giles et al., 1980).

A widely-distributed but poorly-understood sequence of hematitic siltstones occurs in the subsurface of the southern Stuart Shelf region (Fig. 2) and was deposited during the latest Early Proterozoic. It is represented by the Wandearah Metasiltstone near Port Pirie (Parker, 1983), is deformed and recrystallized, and is believed to have been deposited prior to Gawler Range volcanism. Basic volcanics (Willamulka Volcanics) are interbedded with Wandearah Metasiltstone on northern Yorke Peninsula.

Other Early Proterozoic units on the Gawler Craton are of plutonic origin. They encompass a very broad spectrum of granitoids ranging in age from 1850 - 1600 Ma (Webb et al., 1986) and recording varying degrees of deformation and recrystallization (Parker et al., 1981). On southern Eyre Peninsula and southern Yorke Peninsula they are collectively known as the Lincoln Complex (which includes the Donnington Granitoid Suite).

Middle Proterozoic

The earliest Middle Proterozoic records a very significant change in tectonic character of the Gawler Craton. Unlike their predecessors, clastic sediments and felsic volcanics that formed during this period are not highly deformed but, rather, form a relatively flat blanket covering the northeastern quadrant of the craton. Voluminous felsic volcanics, the Gawler Range Volcanics (Fig. 1; Blissett, 1987; Branch, 1978), formed during a short interval of time ca. 1600 - 1590 Ma (Fanning et al., in prep.) and were accompanied by clastic, largely fluvial, sedimentation represented by the Tarcoola Formation in the northwest (Daly, 1985) and the Corunna Conglomerate in the southeast (Lemon, 1972).

Large anorogenic granite plutons accompanied volcanism or were intruded shortly thereafter ca. 1590-1580 Ma. They are collectively known as the Hiltaba Suite.

Also widespread in the Stuart Shelf region, but considerably younger than the Gawler Range Volcanics, is a thick, quartzose, sandstone sequence, the Pandurra Formation (Fig. 2). Its distribution infers deposition within a ca. 400 km long "trough" trending NW from Whyalla, and dating of local shales suggest an age ca. 1420-1400 Ma (Fanning et al., 1983).

TECTONIC FRAMEWORK

Regional distribution of rock units described above is significant when considering the tectonic evolution of the Gawler Craton. Archaean supracrustals are dominant in two regions, the Coulta and Christie Subdomains (Thomson, 1980; Fig. 3), occur sporadically in the Cleve and Wilgena Subdomains, and may also extend into the relatively unknown Nawa Subdomain. Structural fabrics of Archaean rocks within all subdomains, however, have been overprinted by Kimban Orogeny fabrics so that the original Archaean to earliest Proterozoic tectonic framework is not decipherable.

The Wilgena Subdomain contains local Early Proterozoic sediments and records a relatively strong Kimban Orogeny overprint with deformed Kimban granitoids being particularly common. However, the principal Early Proterozoic development of the Gawler Craton was concentrated within the Cleve Subdomain (Fig. 3), a major fold belt extending the length of eastern Eyre Peninsula and probably extending to the north beneath the Gawler Ranges and Stuart Shelf. Except for possible equivalents near Tarcoola and at Mount Woods, the Hutchison Group is confined to this belt and probably never extended much further west than its present exposures. Quartz-pebble conglomerates and basal clastics of the Warrow Quartzite occur in a north-northeasterly-trending linear belt through central Eyre Peninsula and likely represent fluvial or proximal sedimentary facies marginal to a shallow-marine platform or intracontinental basin deepening easterly (Parker & Lemon, 1982). Extensive carbonates occur in the central fold belt and represent marginal facies to the thick iron-formations that are best preserved in the extreme northeastern region. The Yadnarie Schist represents possible flysch sediments succeeding the sag-phase chemical/clastic sediments.

Multiphase deformation in the Cleve Subdomain has produced a sinuous fold belt that appears to wrap around an Archaean nucleus located to the west in central-western Eyre Peninsula. Deformation is most intense in the east of the fold belt and early generation folds appear to be rooted in high-grade gneissic cores of the eastern region and overturned to the west suggesting a westerly transport direction (Fig. 4). The main, gneissic, core zone which extends from Port Lincoln through the hills immediately west of Cowell to the Lake Gilles region, records the highest metamorphic grade, contains gneisses of relatively deeper crustal origin, and is bound by a number of major mylonite zones. It is the root zone of the fold belt and contains numerous elongate syn-orogenic granitoid plutons.

The Moonta Subdomain developed during deformation, but on the eastern flanks of the fold belt and is consequently sub-parallel to the Cleve Subdomain. However, the Moonta Subdomain represents a separate phase of development of the Gawler Craton. Whereas the Hutchison Group was largely of clastic origin, rock units of the Moonta Subdomain have a very significant volcanic component and may represent a volcanic arc or subduction complex accreted to the then eastern margin of the developing craton. Alternatively, like models for the Pine Creek Geosyncline and Mount Isa regions (Etheridge et al., 1984 and in press), the volcanic belt may represent a second cycle of intracontinental stretching and rifting on an underplated Archaean-Early Proterozoic crust (nb the Hutchison Group would represent the first cycle in this model).

On northernmost Yorke Peninsula lapping onto the Moonta Subdomain (Fig. 5) but extending north under the Stuart Shelf (Fig. 2), the Wandearah Metasiltstone represents either a further, maybe flyschoid, development of the Moonta Subdomain cycle or a third extensional or rifting phase. The associated basic Willamulka Volcanics might support the latter.

By contrast to earlier cycles, Middle Proterozoic tectonics involved only extension and thermal subsidence with no ensuing compressional or thrusting phases. Extensive, ca. 1600 Ma felsic volcanics from Nuyts through the Gawler Ranges, under the Stuart

Shelf and likely under the Adelaide Geosyncline to the Mount Painter and Curnamona regions, infer a major, ca. 200+ km wide, eastnortheast-trending zone striking at least 700 km across the Gawler Craton and older fold belts. Crustal extension, thermal subsidence and possibly underplating were all therefore approximately at right angles to equivalent features proposed for the Early Proterozoic. Furthermore, there seems little doubt that the bulk of the felsic volcanics was emplaced on or within a stable continent rather than a continental margin. However, the intersection, under the Stuart Shelf, of this Middle Proterozoic volcanic belt and the slightly older Moonta Subdomain is a region of considerable economic interest and, by contrast to the central Gawler Ranges Subdomain, may have been a zone of more intense Middle Proterozoic tectonic activity perhaps reflecting a cratonic margin.

Formation of the present-day boundaries of the Gawler Craton was a diachronous event with northern and northwestern margins developing ca.1100 Ma during the Musgravian Orogeny, the eastern margin developing ca.800-490 Ma during formation of the Adelaide Geosyncline/Fold Belt, and the southern margin forming ca.100 Ma during breakup of the ancient Gondwana supercontinent.

MINERALIZATION

Christie and Coulta Subdomains

Archaean to earliest Proterozoic basement in both these regions is relatively poorly exposed and does not contain any major known mineral deposits. Magnetite-rich gneisses and Archaean banded iron formation have been drilled at Warramboo (near Kyancutta on Eyre Peninsula) and Mount Christie in the search for iron ore (Whitten, 1966; Daly et al., 1978). Iron formation in the Christie Gneiss contains up to 40% total iron at Mount Christie and up to 55% total iron in the form of magnetite near Ooldea (Parker, 1987). Hematite ores are unknown. Calc-silicates in the Christie Gneiss both near Mount Christie and near Kenella contain locally-anomalous base metals while weathered iron-rich mafics near Mount Christie and Lake Harris (Wilgena Subdomain) contain anomalous chrome and nickel. The poorly exposed Lake Harris mafic body which is 1200 m wide and at least 15 km in length is currently being prospected. Gold is being mined from the Glenloth Granite at Glenloth but elsewhere there has been very little exploration for gold or other base metals, in either weathered Archaean mafics, meta-morphosed acid volcanics or in banded iron formations. Minor sulphides have recently been intersected in Archaean magnetite+amphibole-rich gneisses/metasediments near Nundroo (Fig. 1).

Nawa Subdomain

This region is completely concealed and only known from a few isolated drill holes. Near Ooldea, granulite-facies quartz-sapphirine assemblages record high-P metamorphism in magnetite-rich gneisses similar to those in the Christie Gneiss. Basement is locally very shallow in the Ooldea region (<10m) and offers potential for mineralization in Late Archaean quartz-magnetite and garnetiferous gneisses.

Wilgena Subdomain

This subdomain contains a varied Archaean to Middle Proterozoic sequence. Anomalous mineralization in the Archaean is noted above but one of the principal economic targets within this region is gold in quartz veins and Hiltaba Suite granites near Tarcoola (Daly et al., this volume). The economic quartz veins cross-cut the Tarcoola Formation but are intimately associated with the Hiltaba Suite granites. Therefore they could potentially be found anywhere around Hiltaba Suite intrusions in a variety of host lithologies ranging from Archaean to Middle Proterozoic.

There is no record of significant base-metal mineralization in the Wilgena Subdomain except for within rare, anomalous, Archaean calc-silicates. Black, tuffaceous shales in the Tarcoola Formation are pyritic and offer potential for McArthur River-style, shale-hosted base metals particularly adjacent to volcanic vents or lineaments. Middle Proterozoic sub-volcanic breccias of Olympic Dam style occur at Bulgunnia (Daly, 1987) where they are associated with Gawler Range Volcanics and Tarcoola Formation. They offer potential for copper, uranium, silver and gold. Boulders and pebbles of fuchsite-bearing quartzite have been found in basal conglomerates of the Tarcoola Formation but their source is unknown.

Throughout much of the Tarcoola-Bulgunnia region, the Tarcoola Formation and Gawler Range Volcanics overlie banded iron formation (Wilgena Jaspilite) believed to be equivalent to the Middleback Subgroup of Eyre Peninsula. While this correlation cannot be confirmed, Wilgena Jaspilite is of distinctly lower metamorphic grade than the Archaean iron formations nearby and preserves finer sedimentary structures typical of Early Proterozoic jaspilites (Daly, 1980). It has been superficially examined as a source of iron ore (Whitten, 1966) but contains only 40% total iron. Early Proterozoic carbonates are not known from the Wilgena Subdomain and Early Proterozoic granitoids (Lincoln Complex equivalents) do not appear to be related to any known anomalous mineralization. Tin at South Lake was likely derived from Hiltaba Suite granites.

Cleve Subdomain

Middleback Subgroup iron ores of the Middleback Range (Miles, 1954; Yeates, this volume) are clearly the most important known mineral deposits in terms of mined ore and reserves. There are no known hematite orebodies in the Cleve Subdomain outside the Middleback Range, but magnetite and carbonate-rich iron formations occur throughout much of the eastern fold belt (Whitten, 1966).

In the Middleback Range, marbles and lower iron formations of the lower Middleback Subgroup define a former sedimentary-facies sequence which includes sulphide-facies iron formation (Parker & Lemon, 1982). The sulphides are pyrite and pyrrhotite reflecting the anomalous iron in the region, but to the west, apparently-equivalent carbonates and graphitic sulphide-bearing cherts contain significant base-metal sulphides (Berg & Higgins, this volume). Facies variations noted by Parker & Lemon (1982) suggest that the central/western zone of the Cleve Subdomain was originally a siliciclastic carbonate-dominated shelf which became progressively more iron rich in deeper-water facies to the east. This suggests that the central/western zone may be more favourable for carbonate-hosted base-metal sulphides. In addition to Menninnie Dam, anomalous base metals have been recorded in the Lincoln Uplands and the Cleve Hills where several small mines were worked in the 19th century (Johns, 1961).

Also in the Cleve Hills, significant copper and silver-lead mineralization has been recorded, and mined, from basal calc-silicates of the Warrow Quartzite. The Miltalie Mine (Parker et al., 1981) is the most important of these, although, on the same horizon, a small lode of silver assaying up to 208 kg/tonne fine silver was mined at Atkinson's Find (Johns, 1961). Uranium mineralization is also present in the Cleve Hills, associated with north-south faults intersecting carbonates and iron formation (eg Calcookara Mine, Ben Boy; Parker, in prep.). It may be significant that the Ben Boy prospect is located in Early Proterozoic basement close to a Middle Proterozoic unconformity. Uranium prospects also occur in Lincoln Complex granitoids near Port Lincoln (Johns, 1961).

Non-metallic mineralization is extensive throughout the Cleve Subdomain including marble, jade, talc and graphite. Graphite deposits at Mikkira near Port Lincoln are described elsewhere in this volume, but anomalous graphite also occurs at Carpa (Scott, 1977) and disseminated within cherts and gneisses associated with Middleback Subgroup carbonates and iron formations. Graphite also occurs in recently-activated shear zones sometimes associated with copper as at Murninnie Mine east of Moonabie.

Gold has not been a major economic target in the Cleve Subdomain although iron formations have been often sampled. Trace gold has been identified with banded iron formation at Mangalo Creek near Cleve but assays less than 0.3 ppb.

Except for uranium and local graphite in shear zones, Lincoln Complex granitoids are devoid of anomalous mineralization. Amphibolites near Tumby Bay have anomalous chrome and nickel (Flint, 1976) but elsewhere are barren. Dolerite dykes, too, are barren but the close association of zinc sulphides with a swarm of north-south ca. 1600 Ma dykes near Cleve raises the possibility that they may have played a role in the mineralizing process (-es). Anomalous manganese (up to 20%), zinc (up to 0.1%) and phosphorous (up to 0.1%) occur between two, weathered, NW-trending dykes in iron formation at Iron Monarch (northern Middleback Range) and may also be associated with dyke intrusion.

Moonta Subdomain

Historically, the Moonta-Wallaroo mining district on Yorke Peninsula is one of the most important mining districts in South Australia and, with ca. 250 diamond drill holes (totalling >60,000 m) drilled since 1961, is still an area of active exploration. Output from Moonta-Wallaroo was 336 000 tonnes of copper and 1 682 kg of fine gold (some coming from purchased ore from Western Australia and Tasmania). Ore grades from combined Moonta-Wallaroo crude during the period 1904-1923, averaged 3.39-3.61% copper, 0.34 g/tonne fine gold and 0.56 g/tonne fine silver (Flint, 1983).

Geologically, the Moonta and Wallaroo districts are quite different though mineralized quartz veins are common to both (Jack, 1917; Dickinson, 1942). At Moonta, mineralization occurs within three main fracture or shear zones striking approximately north-south and dipping 40-65°W (Jack, 1917). The quartz-tourmaline lodes are developed in highly-strained Moonta Porphyry that has undergone considerable metasomatic/hydrothermal alteration.

The Wallaroo lodes (at Kadina), by contrast, occur within quartz-veined mica (-hornblende-feldspar) schists (Doora Schist) of metasedimentary origin. Wallaroo Main Lode, Stirling's Lode, Devon Lode and Morphett's Lode all trend east-southeast and are subvertical, the Main Lode dipping steeply south in the upper portion but north below 200m.

Primary mineralization at Moonta-Wallaroo is varied though dominantly bornite, chalcopyrite, chalcocite, pyrite, pyrrhotite, molybdenite, hematite and magnetite with traces of gold, silver, bismuth, uranium, base metals and fluorite. Sulphide mineralization at Moonta is zoned: bornite-chalcocite at top, pyrite at bottom. Gangue minerals are quartz, tourmaline, chlorite and K-feldspar.

3 km northeast of Moonta near the old Poona Mine, a significant gold-copper prospect has recently been discovered by drilling of a geophysical anomaly (Norgold Ltd prospectus, 1987). A resource of 125 000 to 145 000 tonnes at 7.8% Cu and -.2 g/tonne Au is indicated, the primary sulphides being pyrite-chalcopyrite in altered and sheared quartz-feldspar-chlorite

porphyry.

East of Kadina there is local copper mineralization in lower metamorphic grade metasediments of the Wandearah Metasiltstone. Lodes at New Cornwall Mine and Wandilta Mine trend northwest dipping steeply to the southwest (Jack, 1917) and were generally siliceous. Thick calcite bodies host ore in Wandilta Mine.

Outside the main Moonta-Wallaroo district, copper-molybdenum mineralization occurs north of Kadina associated with east-west fractures, and in the Port Pirie region, traces of copper occur within the Wandearah Metasiltstone (Parker, in prep.). In view of the similar ages of volcanics in the Moonta Subdomain to the Mt Isa province, there is potential throughout this subdomain for significant lead-zinc mineralization. Felsic volcanics of similar age also occur in the Peake and Denison Inlier on the northeast margin of the Gawler Craton (Fanning et al., in prep.) extending the potential length of the Moonta Subdomain along the entire eastern margin of the craton.

Nuyts, Gawler Ranges and Stuart Shelf Subdomains

Since the discovery of the Olympic Dam deposit (Roberts & Hudson, 1983), the northeastern end of the broad zone defined by these subdomains (Fig. 4) has been a focus for exploration activity. The major economic targets have been copper and uranium (and to a lesser extent gold, silver and rare-earth elements) and the principal areas of exploration have been coincident aeromagnetic and gravity anomalies northwest of thick Pandurra Formation (Fig. 2).

In addition to Olympic Dam, subeconomic mineralization occurs at Acropolis (copper sulphides, uranium, rare-earth elements, iron oxides; Paterson, 1986), Wirrda Well (copper, uranium, gold), Oak Dam (uranium, rare-earth elements, iron; Paterson and Muir, 1986) and in basement of the Mount Gunson region (copper; DDH's EC-21 and SAR 8, Knutson et al., 1983 Paterson et al., 1986). Acropolis is a felsic to intermediate volcanic pile faulted against diorite and gneissic granite to the east and intruded by alkali quartz syenite (Fig. 6). It shows general affinity to Olympic Dam with sulphide mineralization (66 m at 0.7% Cu in ACD-1) and uranium closely associated with large bodies/zones of hematite/magnetite alteration (e.g.

intersections averaging ca. 60% Fe over 200m; Paterson, 1986). However, in detail, the style of mineralization is different and the presence of large bodies of magnetite is unique. Granite breccia in the southeast of Acropolis prospect is weakly mineralized and likely of volcano-sedimentary origin.

Wirrda Well is a massive granite-breccia body several hundred metres across that may represent an explosive pipe or conduit within gneissic megacrystic granite. Again hematite and magnetite are pervasive. Chloritized (to weakly-hematized) intermediate felsic to mafic volcanics on the northern edge of Wirrda Well prospect appear to overlie the breccias suggesting that the main phase of hematitic alteration/veining may have preceeded or accompanied volcanism.

Oak Dam prospect, on the northeast side of the Arcoona geophysical zone, is developed beneath Pandurra Formation in hematitic breccias, conglomerates and siltstones with local graded units a few centimetres to over a metre thick. Some massive hematite breccia overlies decomposed felsic volcanics (by contrast to Wirrda Well) and iron content locally exceeds 50%.

In the Mount Gunson region, anomalous copper has been recorded in both altered intermediate to basic volcanics (EC-21) and in the underlying hematitic Wandearah Metasiltstone (SAR-8). The latter is locally brecciated and folded, and contains cherts and calcsilicates (Fig. 7) with local assays up to 15.2% Cu, 6.9% Zn, 75 g/tonne Ag and 1.82% Pb. The Wandearah Metasiltstone in SAR-8 in similar to folded and often locally brecciated metasiltstones from the Roopena, Port Pirie and Bute regions.

0·3m >1015m depth.

Elsewhere in the Nuyts, Gawler Ranges and Stuart Shelf Subdomains, very little metallic mineralization has been recorded. The lower units of the "older" Gawler Range Volcanics offer the greatest potential for mineralization being more variable in composition than the blanketing upper Yardea Dacite.

AJP:AM

A.J. PARKER

REFERENCES

Anderson, C.G., 1980. Magnetic and gravity interpretation of the Stuart Shelf. Aust. Soc. Expl. Geophsycs., Bull. 11: 115-120.

Berg, R. and Higgins, M., this volume. Menninnie Dam Pb-Zn prospect.

Blissett, A.H., 1987. Geological setting of the Gawler Range Volcanics. Geological Atlas Special Series, scale 1:500 000. S. Aust. Dept. Mines and Energy.

Bone, Y., 1984. The Wardang Volcanics, Wardang Island, Yorke Peninsula, S.A. Geol. Surv. S. Aust., Q. geol. Notes 89: 2-7.

Branch, C.D., 1978. Evolution of the Middle Proterozoic Chandabooka caldera, Gawler Range acid volcano-plutonic province, South Australia. Geol. Soc. Aust., J. 25: 199-216.

Daly, S.J., 1980. Wilgena Hill Jaspilite. In Barnes et al., Some Semiprecious and Ornamental Stones of South Australia. Geol. Surv. S. Aust., pp 83-91.

Daly, S.J., 1985. TARCOOLA map sheet, Geological Atlas of South Australia, 1:250 000 geological series. Geol. Surv. S. Aust..

Daly, S.J., 1987. Bulgunnia well-completion report. Geol. Surv. S. Aust. Rept. Bk. 87/ (unpubl.).

Daly, S.J., in prep.. The Mulgathing Complex. R. Soc. S. Aust., Trans.

Daly, S.J., Horn, C.M. and Fradd, W.P., this volume. Tarcoola Goldfield.

Daly, S.J., Webb, A.W. and Whitehead, S.G., 1978. Archaean to early Proterozoic banded iron formations in the Tarcoola region, South Australia. R. Soc. S. Aust., Trans. 102: 141-149.

Dickinson, S.B., 1942. The structural control of ore deposition in some South Australian copper fields. The Wallaroo-Moonta field. Geol. Surv. S. Aust., Bull. 20: 7-39.

Etheridge, M.A., Rutland, R.W.R. and Wyborn, L.A.I., in prep. Orogenesis and tectonic process in the Early to Middle Proterozoic of Northern Australia. Precambrian Res.

Etheridge, M.A., Wyborn, L.A.I., Rutland, R.W.R., Page, R.W., Blake, D.H. and Drummond, B.J., 1984. Workshop on Early to Middle Proterozoic of Northern Australia. Bur. Min. Resources, Aust., Record 1984/31 (unpubl.).

Fanning, C.M., 1985. Comments on Rb-Sr total rock measurements for Wardang Volcanics, Yorke Peninsula. Geol. Surv. S. Aust., Q. geol. Notes 93:1-6.

Fanning, C.M., Cooper, J.A., Oliver, R.L. and Ludwig, K.R., 1986. Rb-Sr and U-Pb geochronology of the Carnot Gneisses: Complex isotopic systematics for the Late Archaean to Early Proterozoic Sleaford Complex, southern Eyre Peninsula, South Australia. Geol. Soc. Aust., Abst. 15: 69-70.

Fanning, C.M., Flint, R.B., Parker, A.J., Ludwig, K.R. and Blissett, A.H., in prep. Proterozoic tectonic evolution of the Gawler Craton, South Australia. Precambrian Res.

Fanning, C.M, Flint, R.B. and Preiss, W.V., 1983. Geochronology of the Pandurra Formation. Geol. Surv. S. Aust., Q. geol. Notes 88: 11-16.

Fanning, C.M., Oliver, R.L. and Cooper, J.A., 1981. The Carnot Gneisses, southernmost Eyre Peninsula. Geol. Surv. S. Aust., Q. geol. Notes 80: 7-12.

Flint, D.J., 1976. Geological investigation of a nickel occurrence in basic to ultrabasic rocks west of Tumby Bay. Geol. Surv. S. Aust., Rept. Bk. 76/9 (unpubl.).

Flint, D.J., 1983. Moonta-Wallaroo mining field - production statistics 1860-1938. Geol. Surv. S. Aust., Rept. Bk. 83/11 (unpubl.) and Min. Resour. Rev., 155:76-77.

Giles, C.W., Goode, A.D.T. and Lemon, N.M., 1980. Middle Proterozoic volcanism and sedimentation in the Moonabie area. Geol. Soc. Aust., J. 27:53.

Jack, R.L., 1917. The geology of the Moonta and Wallaroo mining district. Geol. Surv. S. Aust., Bull. 6: 135 pp.

Johns, R.K., 1961. Geology and mineral resources of southern Eyre Peninsula. Geol. Surv. S. Aust., Bull. 37: 102 pp.

Johns, R.K., 1985. Mining and mineral resources. In Twidale, C.R., Tyler, M.J. and Davies, M., Natural History of Eyre Peninsula. R. Soc. S. Aust., Occ. Publ. 4: 47-55.

Knutson, J., Donnelly, T.H. and Tonkin, D.G., 1983. Geochemical constraints on the genesis of copper mineralization in the Mount Gunson area, South Australia, Econ. Geol., 78: 250-274.

Lemon, N.M., 1972. A sedimentological approach to the geology of the Corunna area, South Australia. Univ. Adel., B.Sc. (Hons) thesis (unpubl.).

Miles, K.R., 1954. The geology and iron ore resources of the Middleback Range area. Geol. Surv. S. Aust., Bull. 33.

Mortimer, G.E., Cooper, J.A. and Oliver, R.L., 1986. The geochronological and geochemical evolution of the Proterozoic Lincoln Complex, Eyre Peninsula, South Australia. Geol. Soc. Aust., Abst. 15: 140-141.

Parker, A.J., 1980a. Stratigraphic subdivision of the Hutchison Group on northeastern Eyre Peninsula. In Parker, A.J. (Ed.), Symposium on the Gawler Craton, 11 December 1979. Geol. Soc. Aust., J. 27: 48.

Parker, A.J., 1980b. The Kalinjala Mylonite Zone, eastern Eyre Peninsula. Geol. Surv. S. Aust., Q. Geol. Notes 76:6-11.

Parker, A.J., 1983. WHYALLA map sheet, Geological Atlas of South Australia, 1:250 000 geological series. Geol. Surv. S. Aust..

Parker, A.J., 1987. Ooldea 3 well-completion report and tectonic modelling. Geol. Surv. S. Aust., Rept. Bk. 87/ (unpubl.).

Parker, A.J., in prep.. WHYALLA, South Australia. Explanatory Notes, 1:250 000 geological series. Geol. Surv. S. Aust.

Parker, A.J., Fanning, C.M. and Flint, R.B., 1981. Archaean to Middle Proterozoic geology of the southern Gawler Craton, South Australia: Excursion Guide. Geol. Surv. S. Aust., Rept. Bk. 81/91 (unpubl.).

Parker, A.J., Fanning, C.M. and Flint, R.B., 1985. Geology. In: Twidale, C.R., Tyler, M.J. & Davies, M. (Eds), Natural History of Eyre Peninsula. R. Soc. S. Aust., Occas. Pub. 4:21-45.

Parker, A.J. and Lemon, N.M., 1982. Reconstruction of the Early Proterozoic stratigraphy of the Gawler Craton, South Australia. Geol. Soc. Aust., J. 29: 221-238.

Paterson, H.L., 1986. The Acropolis Prospect. In Paterson, H.L., Dalgarno, C.R., Esdale, D.J. and Tonkin, D., Basement Geology of the Stuart Shelf Region, South Australia. Geol. Soc. Aust., Exc. Guide, 8th Aust. Geol. Convention (unpubl.).

Paterson, H.L. and Muir, P.M., 1986. Exploration Licence 1316 (Part) - Stuart Shelf - relinquishment report. S. Aust. Dept. Mines and Energy, open file Env. 6562 (unpubl.).

Paterson, H.L., Dalgarno, C.R., Esdale, D.J. and Tonkin, D., 1986. Basement Geology of the Stuart Shelf Region, South Australia. Geol. Soc. Aust., Exc. Guide, 8th Aust. Geol. Convention (unpubl.).

Rankin, L.R., Martin, A.R. and Parker, A.J., 1987. Identification of a major crustal shear zone, northwest Gawler Craton, South Australia. Geol. Surv. S. Aust., Rept. Bk. 87/30 (unpubl.).

Rankin, L.R. and Flint, R.B., 1987. Broad View 1 DDH well-completion report. Geol. Surv. S. Aust., Rept. Bk. (unpubl.).

Roberts, D.E. and Hudson, G.R.T., 1983. The Olympic Dam copper-uranium-gold deposit, Roxby Downs, South Australia. Econ. Geol., 78: 799-822.

Scott, D.C., 1977. Carpa graphite deposit. Mineral Resour. Rev., S. Aust., 147:35-49.

Thomson, B.P., 1969. The Precambrian crystalline basement. In Parkin, L.W. (Ed.), Handbook of South Australian Geology. Geol. Surv. S. Aust., pp 21-48.

Thomson, B.P., 1980. Geological map of South Australia. Geological Atlas Special Series, 1:1 000 000 scale. S. Aust. Dept. Mines and Energy.

Webb, A.W. and Thomson, B.P., 1977. Archaean basement rocks in the Gawler Craton, South Australia. Search 8: 34-36.

Webb, A.W., Thomson, B.P., Blissett, A.H., Daly, S.J., Flint, R.B. and Parker, A.J., 1986. Geochronology of the Gawler Craton, South Australia. Aust. J. Earth Sci. 33: 119-143.

Whitten, G.F., 1966. Suggested correlation of iron ore deposits within South Australia. Geol. Surv. S. Aust., Q. geol. Notes 18: 7-11.

Wyborn, L.A.I., Page, R.W. and Parker, A.J., in press. Geochemical and geochronological signatures in Australian Proterozoic igneous rocks.

Yeates, this volume. Middleback Range iron ore deposits.

John Parker.
14/8/87

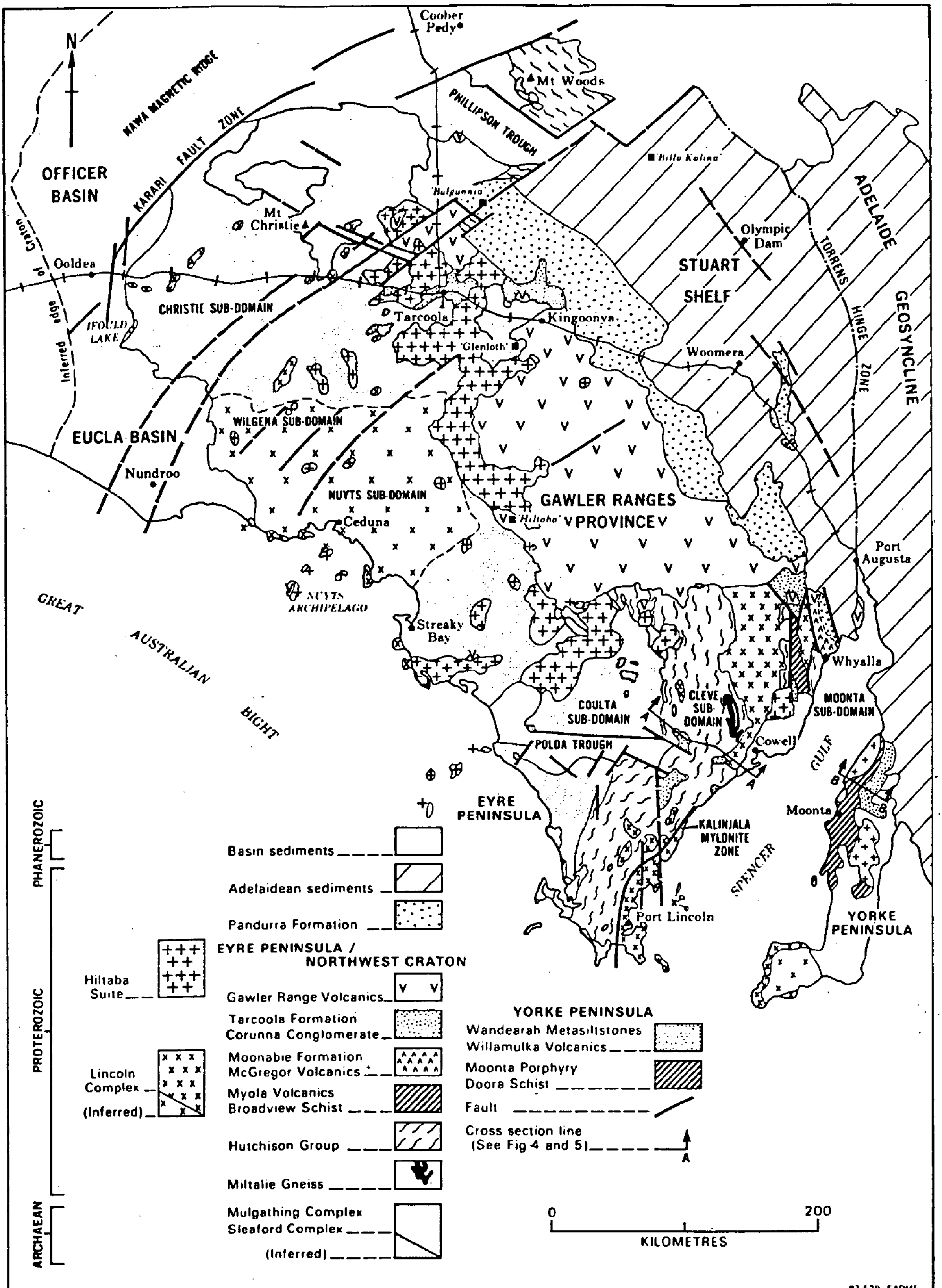

Figure 1. Geological map of the Gawler Craton.

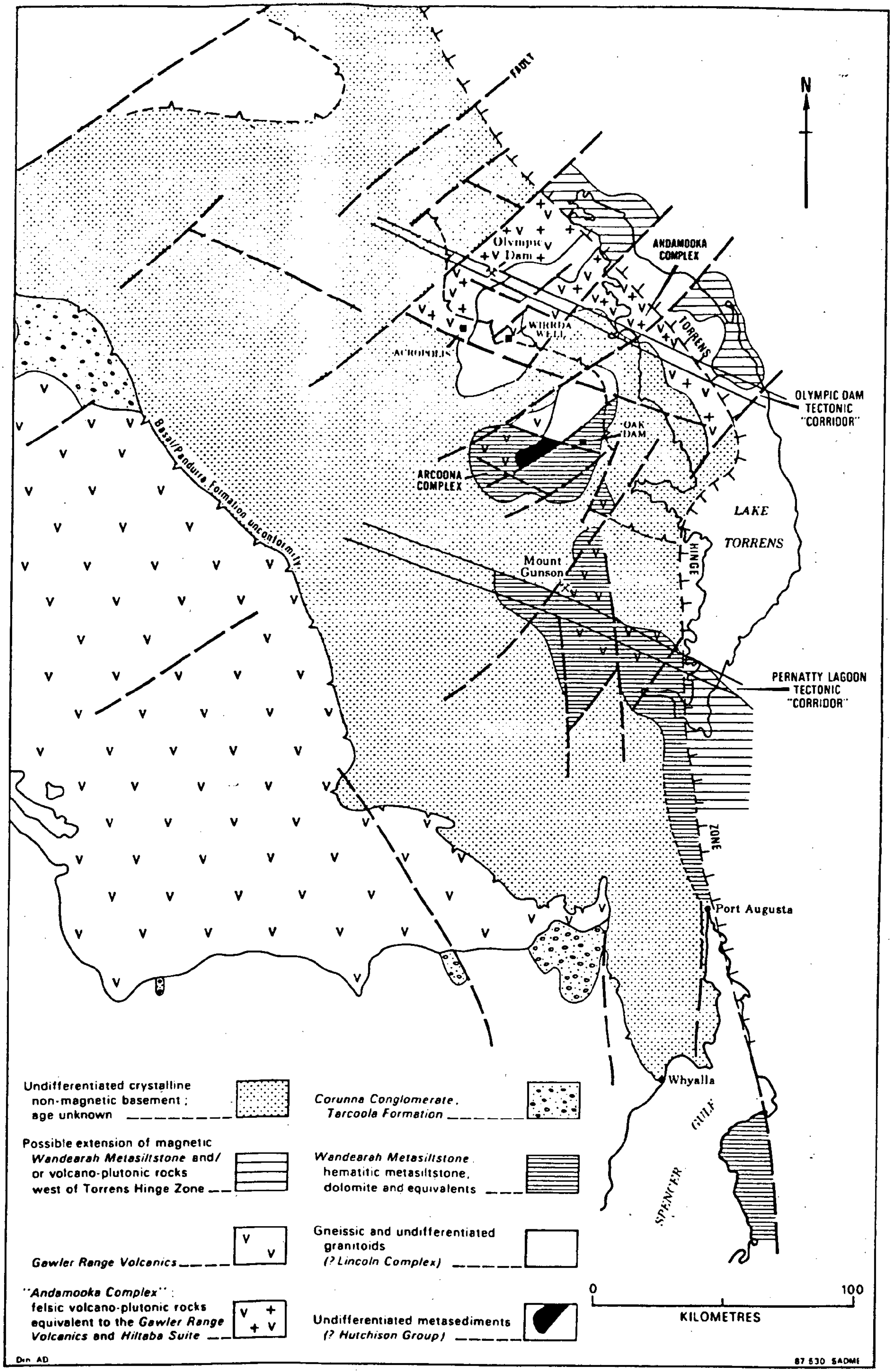

Figure 2. Interpreted subsurface pre-Adelaidean geology of the Stuart Shelf (in part after Paterson and Muir (1986) and Anderson (1980)).

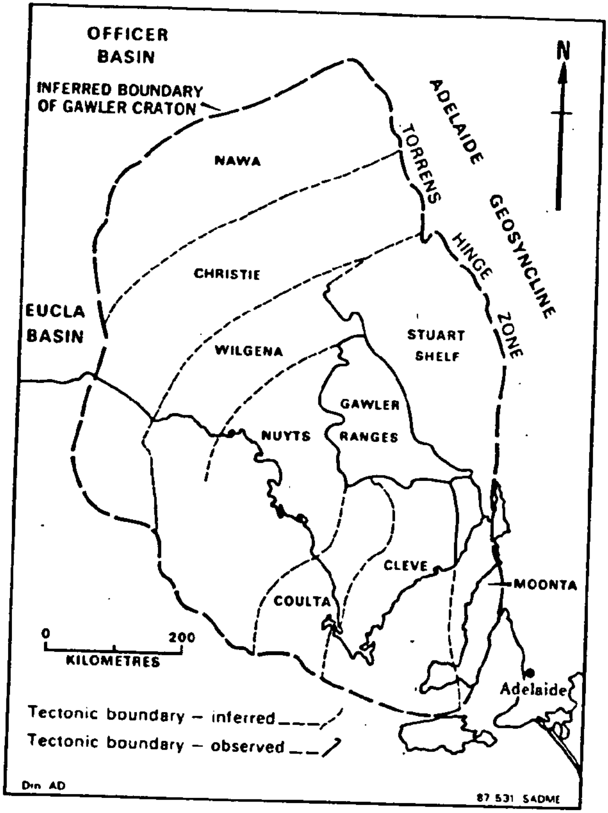

Figure 3. Tectonic subdomains of the Gawler Craton.

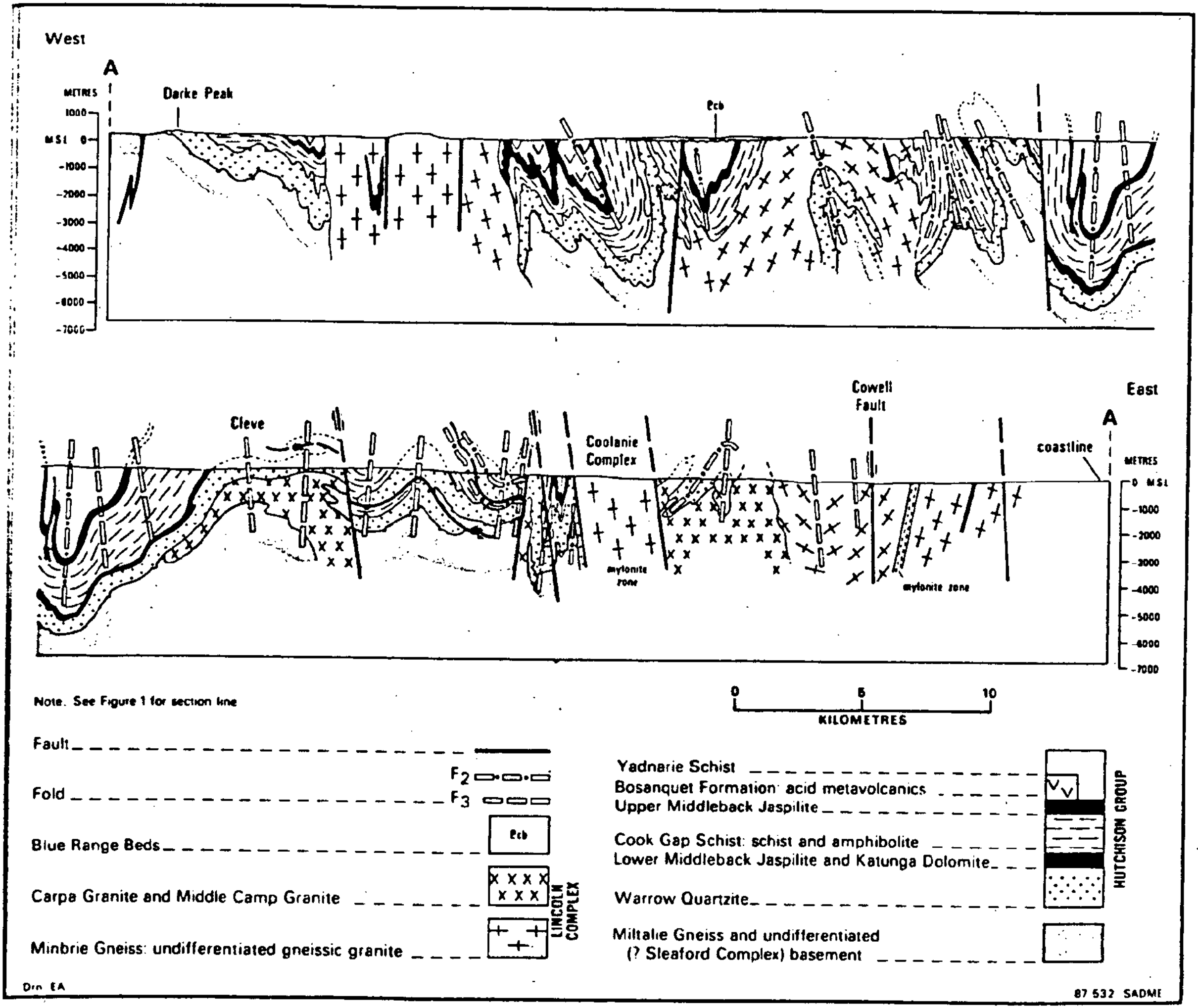

Figure 4. Composite cross-section from Darke Peak to near Cowell across central Eyre Peninsula. Compiled from Parker (1983) and Flint *et al.* (in prep).

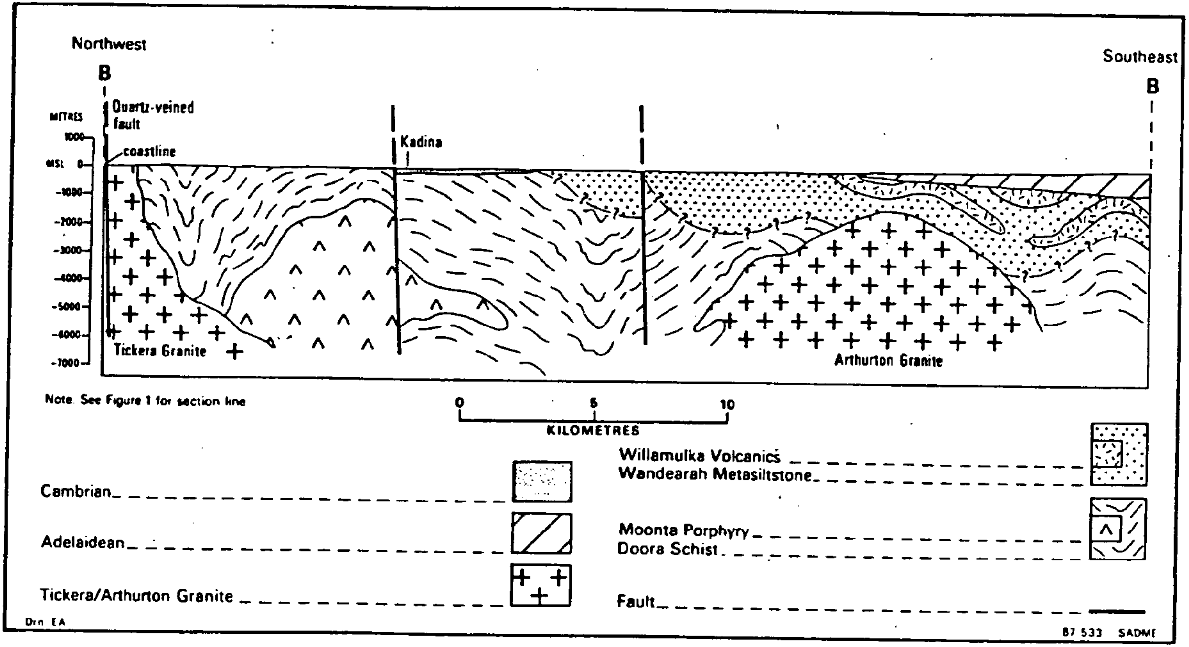

Figure 5. Schematic cross-section, showing inferred rock relationships, across Northern Yorke Peninsula.

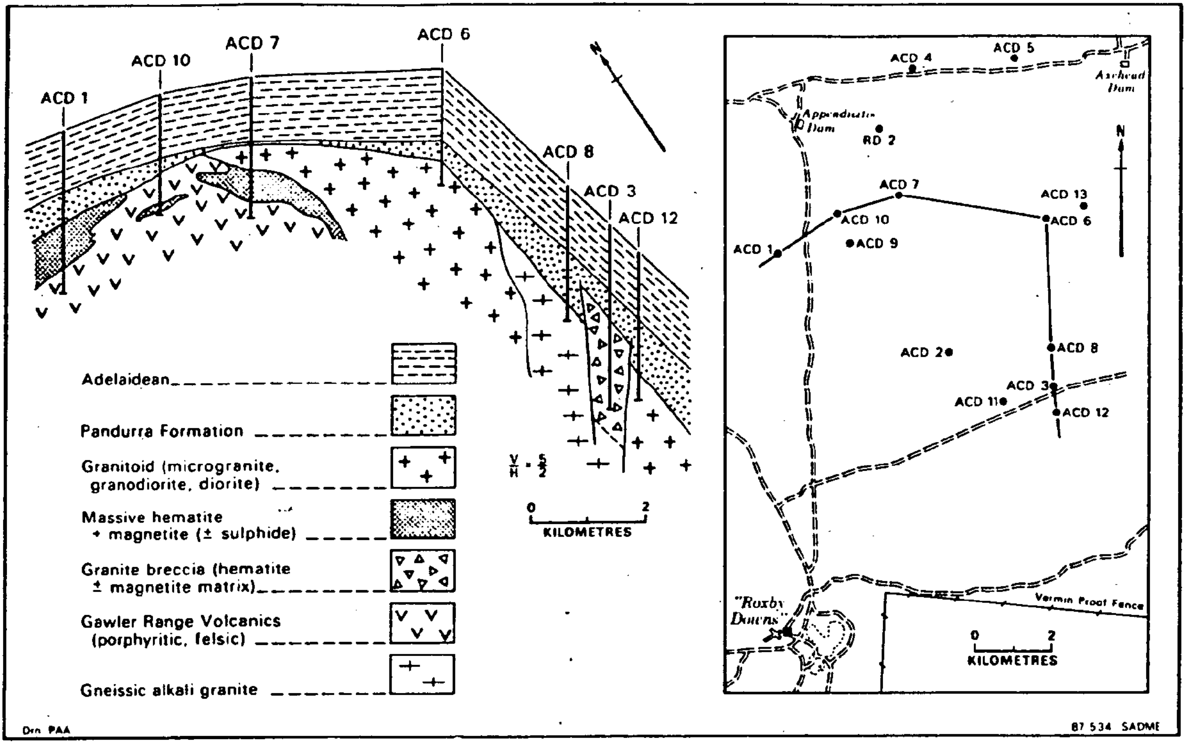

Figure 6. Geological fence diagram through the Acroplis Prospect constructed from data in Paterson (1986). The line of section is shown in the inset.

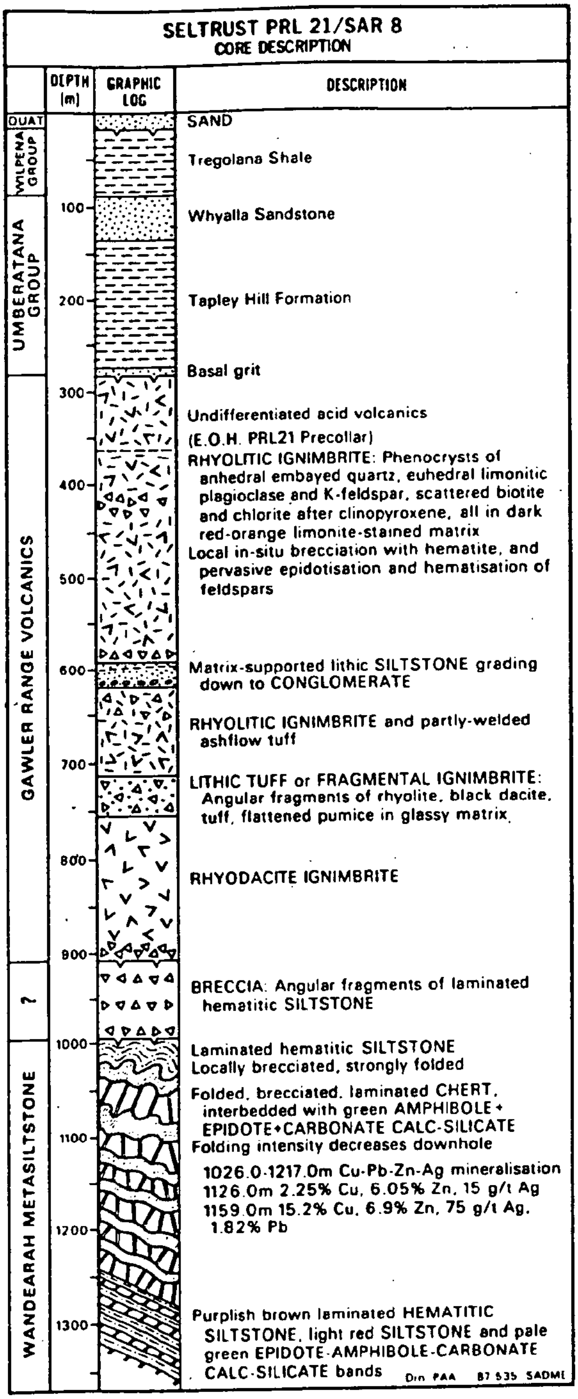

Figure 7. Summary geological log of Seltrust PRL 21/SAR 8 diamond drillhole (simplified from Paterson, 1986).