DEPARTMENT OF MINES
SOUTH AUSTRALIA

GEOLOGICAL SURVEY
REGIONAL GEOLOGY DIVISION

THE MINERAL POTENTIAL OF THE WILLYAMA COMPLEX, SOUTH AUSTRALIA

Text of a paper presented at an S.A.D.M. Symposium, "South Australia: The place to explore" on 8th December, 1977.

by

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ABSTRACT

Within the South Australian portion of the Willyama Complex, five zones may be distinguished, largely on tectonic and metamorphic grounds:
Zone 1: high grade gneisses and concordant amphibolites of the Mutooroo area. Cu mineralisation at the Mutooroo Mines is associated with these amphibolites and further exploration for similar deposits in this area is warranted.
Zone 2: medium to high grade gneisses and schists. Radium Hill occurs in this zone, and Cu occurs at Luxemburg associated with amphibolite and a major east-west aeromagnetic feature.
Zone 3: medium grade metasediments and granitic intrusives of the Olary-Weekeroo area. Mineralisation is associated with the albite-calc silicate-iron formation association. K-feldspar is mined commercially, barite is associated with the iron formation, apatite occurs sporadically and fluorite occurs disseminated in a granite gneiss. Albite pegmatites and albitite rocks with which they are associated are both potential sources for soda-feldspar.
Zone 4: the Kalabity area, characterised by major albitite horizons, and thick metapelite units. Mineralisation as for Zone 3.
Zone 5: a complex of partially uraniferous granitoids of the Mt. Victoria-Crocker Well area.

The overall structure of the Willyama Complex is determined by a complex system of curved, branching faults which have been active both before and subsequent to Adelaidean sedimentation. This pattern is repeated across the whole of the inlier in both States.

TEXT

Despite often intensive and repeated private company and government exploration, the South Australian portion of the Willyama Complex has traditionally received less attention than the New South Wales portion, which includes of course, the Broken Hill area.

I intend here to indicate areas in South Australia which have received little attention or deserve further work, by outlining the geology, structural setting and broad subdivisions of the Complex.

Initially I should emphasise the overall structural and stratigraphy unity of the Willyama Inlier, despite variations in metamorphic grade and lithofacies, and what is apparently the biggest stumbling block - a State Border! This stratigraphic unity is shown by the similarity of lithological associations of pelitic schists, calc-silicate rocks, iron formations, albite rocks and granite gneisses in both areas.

The South Australian part of the Willyama Complex is characterised by medium to high grade metamorphics, predominantly pleitic to psammopelitic schists and gneisses, granite gneisses, magnetite-bearing quartz-feldspar gneisses and migmatites. Distinctive marker units include graphitic schists, baritic iron formations, with albitic and siliceous variants thereof, and a variety of albite and calc-silicate rocks and breccias. In spite of intense multiphase deformation and metamorphism, bedding is still often preserved as a dominant layering and finely detailed sedimentary structures are often visible.

Five zones make up the Willyama Complex in South Australia, as numbered in Fig. 1. These are basically tectonic, as the stratigraphy transgresses them, passing from areas of high grade to low grade.

The first zone is the Mutooroo area, consisting of fairly high grade sillimanite-kyanite-garnet gneisses, aplites, granite gneisses and, most notably, concordant amphibolites similar to those of the Broken Hill area. Outcrop is generally very poor. Major vein-type copper mineralisation is recorded associated with the amphibolites at Mutooroo, with reserves of 9 million tonnes at 1.8%. I believe that, apart from some reconnaissance-style work and Department of Mines work in the Trinity Mine area, little has been done in this area to track down further mineralisation that may be associated with the amphibolites.

The junction of zones 1 and 2 is marked by a prominent aeromagnetic feature which could be the extension of the Mundi Mundi Fault.

Zone 2 consists of similar high grade kyanite gneisses, but lacking the conformable amphibolites.

Vein-type uranium mineralisation occurs at Radium Hill, and copper at Luxemberg. The copper is associated spatially with an amphibolite, and also with an east-west magnetic feature subparallel to the Thackaringa-Pinnacles Fault trend, a trend which is repeated throughout the South Australian Willyama Complex. Further exploration along these structures is warranted.

Iron formations occurring at the northern end of Zone 2 contain copper and gold and appear to be equivalent to the iron formations in lower grade areas to the north.

Zone 3 occupies the largest outcrop area of the region and contains what is generally regarded as the typical Willyama Complex of the Olary area: lower to mid-amphibolite grade (subsequently irregularly retrogressed) pelitic to psamitic metasediments, migmatite, layered calc-silicates, baritic iron formations and albite-calc-silicate breccias. Granitoids range from concordant tonalitic gneisses to intrusive porphyritic granites.

As explorationists in the area have been well aware, copper, cobalt and tungsten mineralisation is intimately associated with the calc-silicate/iron formation units and metallic mineral search is still most profitably directed towards these rocks and their stratigraphic equivalents.

The consideration of this stratigraphic relationship in combination with other factors mentioned earlier, such as the recognition of possible Thackaringa trends may yield useful directions of study in exploration work.

Non-metallic mineralisation is also important in this zone: at present only potash feldspar is profitably obtained - from large discordant microcline pegmatites. However, concordant albite pegmatites appear to be associated with major albitite horizons in the sequence and both may be significant sources of soda-feldspar.

Barite occurs commonly with the iron formation, and fluorite in vein form has been mined on a small scale. In addition, up to 1% disseminated fluorite was recently noted in one of the concordant tonalitic or granodioritic gneisses.

The non-metallic potential of the complex will be discussed further by another speaker at this seminar.

Zone 4 is distinct from Zone 3 both on the basis of lithofacies and the degree of metamorphism and penetrative deformation. The layered calc-silicate units of Zone 3 are essentially replaced by thick laminated albitite horizons which contain minor calc-silicate minerals. The iron formation horizon, which can be traced throughout the Willyama Complex, is here often represented by an albite-magnetite-pyrite rock. Chiastolite, andalusite, chloritoid and fibrolite schists are also well developed.

Copper, cobalt, tungsten and zinc mineralisation, again, is related to the albitite-calc-silicate-iron formation part of the stratigraphy, such as at Mt. Howden.

Zone 5 is characterised by large, complex, multiply intruded granites adamellites and alaskites, with minor remnant biotite gneisses and migmatites. Portions of the granite suite carry disseminated davidite. Clearly these should be further investigated for low grade uranium deposits. Cainozoic and Mesozoic sediments in the Frome Embayment immediately to the north should be also further examined for Honeymoon-type deposits.

The overall structure of the Willyama Complex is depicted in Fig. 2, - the South Australian portion is broken up into a number of fault blocks by a complex branching system of shears which appear to have operated both before and subsequent to Adelaidean sedimentation. Block-tilting related to these shears has resulted in the present day disposition of Adelaidean rocks and Willyama Complex. It is clear that this pattern exists across the Complex in both States.

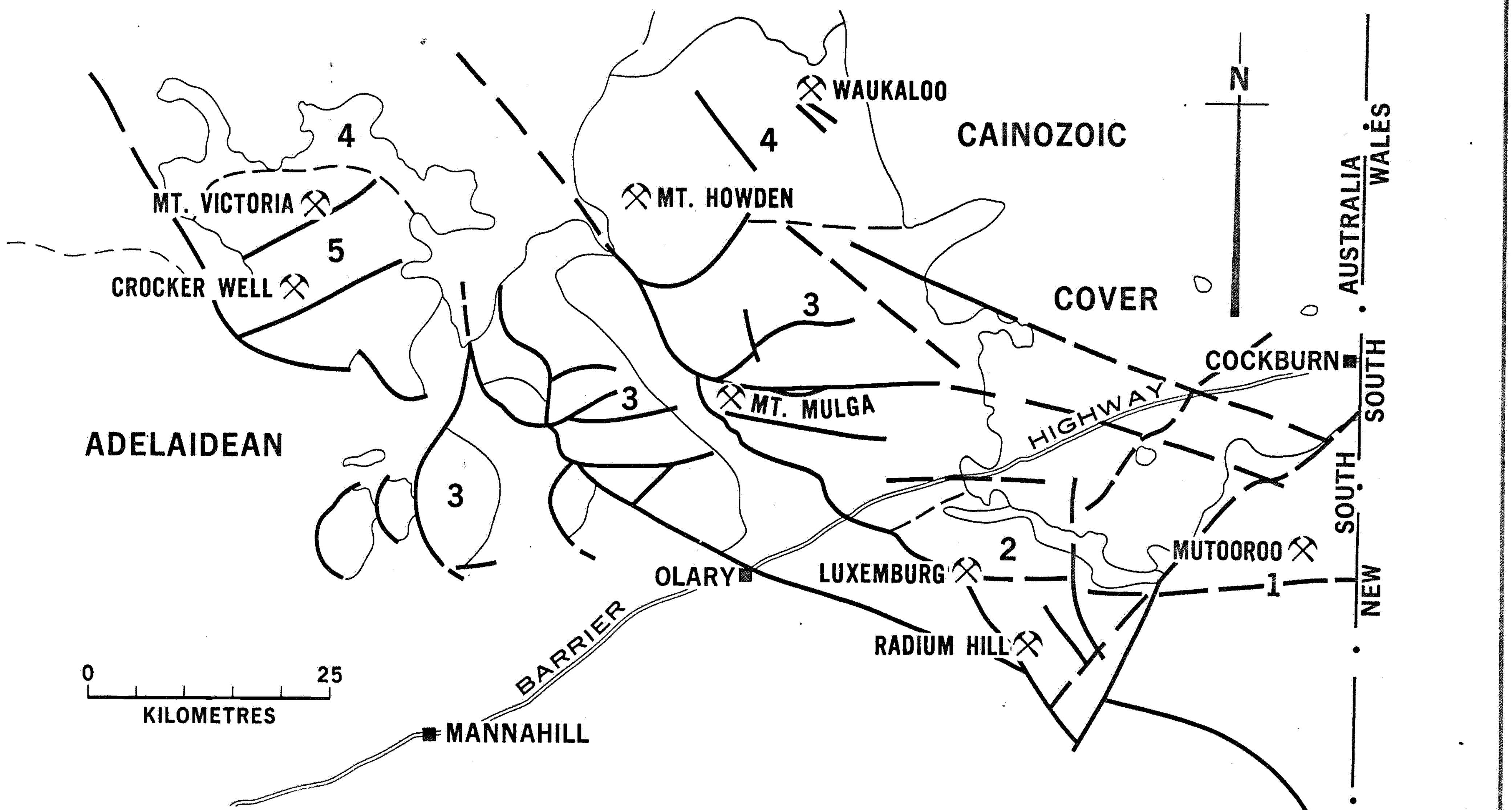

FIG 1

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BASIC SUBDIVISIONS OF WILLYAMA COMPLEX IN SOUTH AUSTRALIA

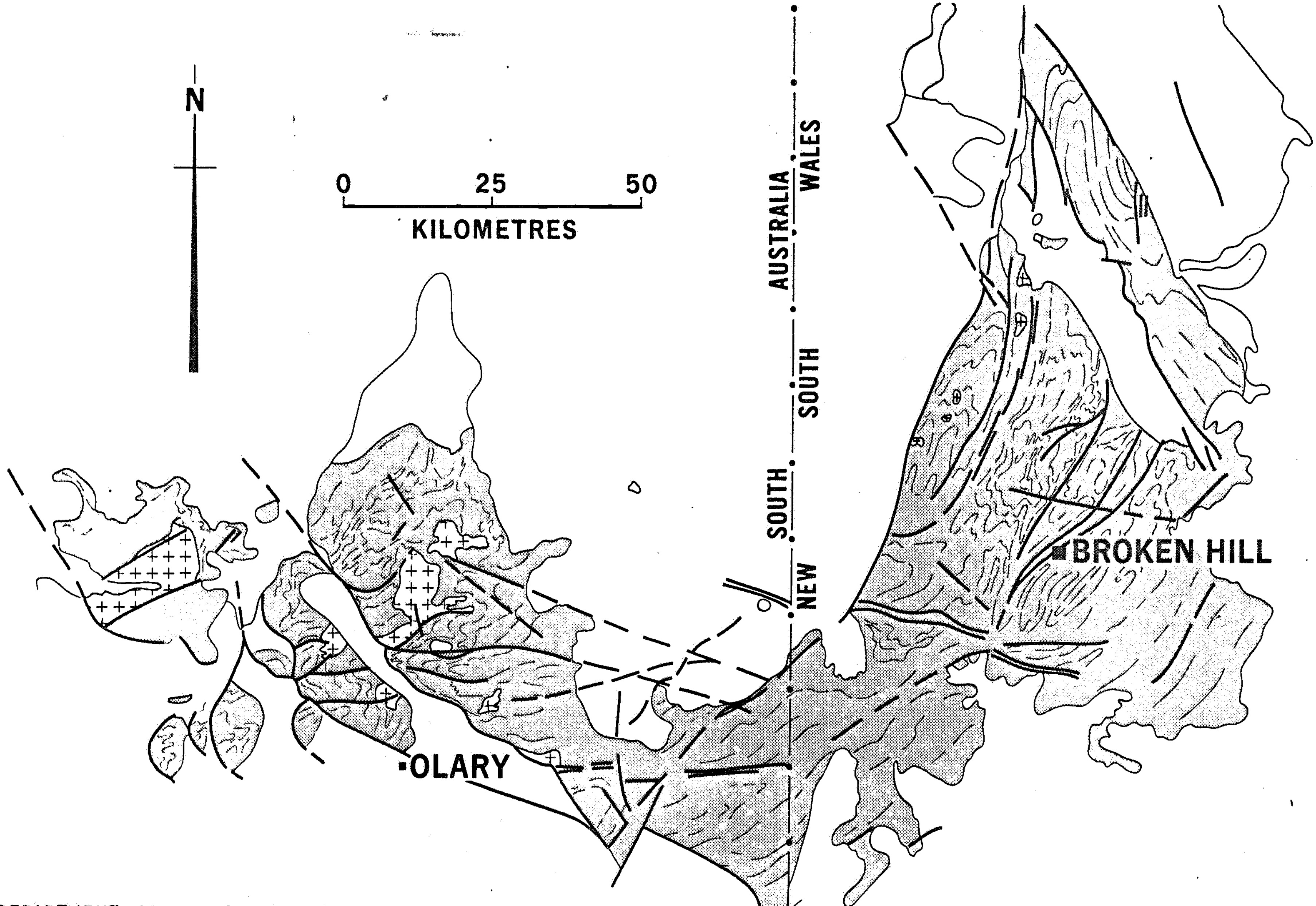

FIG 2.

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REGIONAL TRENDS AND DISTRIBUTION OF THE WILLYAMA COMPLEX IN S.A. AND N.S.W.