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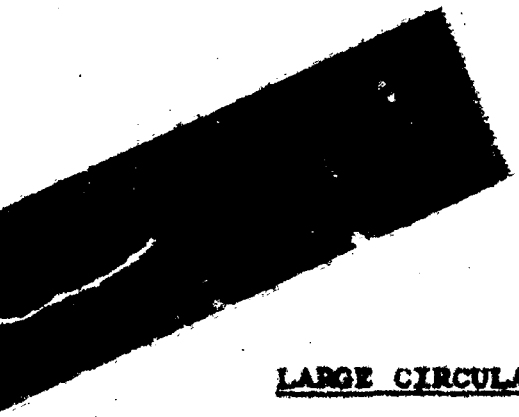

LARGE CIRCULAR STRUCTURES IN A SOUTH AUSTRALIAN PRECAMBRIAN VOLCANIC COMPLEX

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In 1961 the writer noted an arcuate pattern on the outcrop of the Gawler Range porphyry 50 miles west-south-west of Port Augusta, South Australia, showing up as a darker area on the mosaic of the Una one-mile sheet (Lat.32°35'S, Long.136°45'E). It was the only conspicuous structure noted in scanning 35 mosaics, none very clear.

The Gawler Range porphyry is a loose term given to a vast and poorly-known outcrop including the Gawler Ranges proper of northern Eyre Peninsula (which are a dissected plateau) but which extends, often under thin Quaternary cover, far to the north almost to the Trans-Australian Railway. The predominance of red-weathered felspar porphyry suggested an area of persistently similar rock-type, comparable rocks being known in scattered outcrops in the more poorly-exposed country for 100 miles north of the railway. The main outcrop covers over 12,000 square miles. Lack of known mineralisation within this main outcrop, which is not crossed by major routes, led to its being almost totally neglected since its discovery by South Australia's first Government Geologist H.Y.L. Brown in 1885.

The age of the Gawler Range porphyry was uncertain. It was compared by Leckhart Jack[1,2] with the richly copper-bearing felspar porphyry of Moonta in northern Yorke Peninsula lying about 100 miles to the south-east. This rock is nowhere exposed but undoubtedly intrudes Precambrian gneisses usually described as Archaean, though probably 'middle' Precambrian. Leckhart Jack suggested that the Gawler Range porphyry was an effusive equivalent of the Moonta porphyry, and later regarded

contiguous) conglomerates, as Mawson and Jack had recorded. The largest of the intrusions seen by Johns and Solomon was found to be a neck, with volcanic breccia as the main rock-type. Further, rocks almost indistinguishable from typical Woolton-type trachytes were found only 15 miles east of the main porphyry outcrop and recently the writer and H.W. Fander found similar rocks well within the main outcrop.

Stereoscopic examination of photographs of areas near the arc on the Uno sheet revealed eroded vents with diameters of about one mile. Numerous curved lineaments were detected, some concentric with the vents, among innumerable straight lineaments forming part of a superbly-displayed rectilinear joint pattern. This pattern is ascribed to torsional stress associated with block-faulting.

An assembly of 40 one inch to one mile mosaics, covering the whole of the main outcrop revealed very large circular structures. In the area south-west of the southern end of Lake Gairdner, and which forms the south-western part of the main outcrop, a valley with a constant width of about half a mile extends along a semicircle, having a diameter of about 35 miles. This is centred approximately on Yardea head station (i.e. sheep station). Diametric to this valley (which is obviously quite distinct from innumerable straight valleys of variable width, most of which are probably widened joints) a perfect graben extends from near Yardea for twenty miles eastward, with a regular width of about four miles. The graben meets the projection of the semicircle (for some widening-out of the valley occurs) on the south-westernmost inlet of Lake Gairdner, and this point appears itself to be the centre of a complex of elliptical shape, with a larger diameter of 12 miles.

Brief field examination of the large semicircular structure showed no major change in rock-type across the valley, which like most valleys in the Gawler Ranges is flat-bottomed

and entirely covered by alluvium, except at Pamey out-station, 17 miles south-west of Yardea, after which the feature has been named. At Pamey low hills between higher plateaux are formed of flow-banded porphyritic rhyolites much paler in colour than most of the porphyry, and showing extremely tortuous, swirling textures. They appear to be confined to a narrow zone about a quarter of a mile wide along the line of the semicircle. The rocks to north and south are distinctly different, and flow-banding is not common.

Structures radial to the Pamey Arc exist east of Pamey but with an exception noted below are confined, at least in obvious field expression, to an area not only outside the Arc, but south of a major east-north-easterly lineament which extends through the Gawler Ranges for 100 miles and is here almost tangential to the Arc. Along this lineament intense brecciation occurs, chemical alteration is common and rocks uncharacteristic of the surrounding areas outcrop. There is some evidence of an outer circle, concentric with the Pamey Arc, and forming the outer limit of occurrences of isolated hills of porphyry (several of which have shapes suggestive of eroded breached vents). The area within the Pamey Arc appears, as far as can be determined without distant oblique air views, to have a topographic expression which is saucer-like, though the scarps of the Yardea Graben are slightly back-tilted.

Another structure radial to the Pamey Arc (and parallel to the Yarloo Fault) is a body of granite which occupies a graben-like area near Hiltaba H.S. This has an outcrop which is rectangular, the longer dimension of 15 miles being aligned WNW. It is a vuggy fluorite-bearing granite quite distinct in type from others in northern Eyre Peninsula. As it intrudes the porphyry to the south of it, having a sharp vertical contact, it may be a large radial dyke.

Numerous other smaller circular or part-circular structures exist, much of the southern boundary of the main outcrop being formed by their intersection; some are faults which have moved in Quaternary time. Evidence for other circular or part-circular structures as large as or larger than the Fanny Arc is accumulating. On a recent field visit during which circular patterns south of Lake Everard were checked it was clear that these are concentric with the southern shores of that lake, which has an extraordinary shape. Moreover, this area, too has a saucer-like topography. In so far as the westernmost limbs of the lake are also concentric, it seems almost certain that in that area ring structures of at least 55 miles in diameter exist. The relationship of these to sympathetically-curved lineaments to the east between Lake Everard and Lake Gairdner is as yet obscure, but structures of 70 miles in diameter may exist. If certain lineaments noticed in the bed of Lake Gairdner are related, this figure would have to be increased to 100 miles.

Similar arcs entirely control the west shores of Lake Harris further north (it should be realised that on most topographic maps these lakes are all inaccurately delineated) and with radial lineaments form sector-like bays. Others include andesite dykes in the adjacent Glenloth goldfield, the bedrock outcrops of which appear to form part of an annulus. Large arcs, chords and radials have been noted in the Tarcoola district, where andesite dykes known to be gold-bearing are radial intrusions into sediments which are apparently downfaulted within an annulus. The writer recently recorded copper minerals at Tarcoola in fine grained variants of Gawler Range type volcanic rocks.

Numerous long straight lineaments occur in addition to that previously mentioned. Most are north-westerly, west-north-westerly, or east-north-easterly in direction. The most obvious is the Macumaree Fault, which extends for over 80 miles

west-north-westward from the west shore of Lake Gairdner. Dickinson[10] noted a break at Meeniree between the Gawler Ranges proper (to the south) and the northern outcrop. He was puzzled by the existence of good stockwater supplies at Meeniree in an area of salt lakes. This is explained by the accumulation in the fault-angle depression of waters flowing down the dip-slope of the ranges to the south, which receive about 12 inches of rainfall per annum.

About 400 rock specimens have so far been collected. These are being examined by H. W. Fander, who has already (pers. comm.) noted many welded tuffs and much devitrified glass. Radioactive age determinations by the strontium-rubidium method are in progress, by Dr. W. Compston, at the Australian National University.

The deeper implications of the large circular structures and their associated straight lineaments are still under study, particularly as the vast outcrop has so far not even been thoroughly reconnoitred. One obvious comparison is with lunar structures. Jeffreys[11] states that the terrestrial structures most like lunar 'craters' are the ring-dykes first noted by Clough, Maufe and Bailey in the Tertiary volcanic complexes of the Scottish Highlands. Jeffreys noted that the largest known ring-dykes were very much smaller in diameter than the average lunar crater, but did not regard this as important. While it has not yet been possible to obtain a three-dimensional picture of the large circular structures in the Gawler Ranges Volcanic Complex, the writer is strongly inclined to regard the Paney Arc as having been at one time the edge of a cauldron subsidence. It is realized that the retention of original topography (as is suggested by the saucer-like topography) in rocks of such age is very unlikely but it seems possible that a rejuvenation of the major structural controls may have assisted the development of what can perhaps be described as 'palimpsest topography'.

It is of interest that the centre of the Paney Arc lies on the projection of a line joining the epicentres of

South Australia's largest earthquakes, viz. 1902 September 19 Wareeka, Yorke Peninsula and 1897 May 10, 1948 April 8 Beachport and that the centre is about as far from Wareeka as Wareeka is from Beachport. This line is also parallel to the edge of the continental shelf off Eyre Peninsula.

The economic implications are also of interest. The Tarcoola and Glenloth goldfields undoubtedly owe their mineralisation to the volcanics. The association with copper is significant. Magmatic copper occurs in the Woolteana rocks, and gold is known. (The widespread copper mineralisation of the associated Adelaide System sediments has long been regarded by the writer as sedimentary-exhalative in type). 'Porphyry copper' is therefore thought to be a likely prospect in at least the north-west of the Complex. It may also be significant that the only tin localities in South Australia are at and near Glenloth in that same area. Minor gold occurrences within the Complex are now known, as well as a fluorite-bearing granite in a large graben thirty miles north-west of Yardea. Most interesting of all however is the possible connection with the exceedingly rich haematite bodies of the Middleback Ranges, all of which lie in a narrow north-south belt regarded by the writer as a major structural lineament parallel to one of the most fundamental in Australia, the Torrens lineament separating the West Australian shield from the Adelaide geosyncline. The richest of these bodies is Iron Monarch, and it is the nearest to the porphyry outcrop. Miles[6] and his co-workers believed the Gawler Range porphyry to be much younger than the ore-bodies and therefore to have played no part as a magmatic source. The question should be reconsidered. It may be very significant that a large aeromagnetic anomaly lies under the northern end of Lake Gilles, due west of Iron Monarch, and at a point central to the arc first noted; that the rocks of the Complex are invariably rich in haematite; and that 'Gawler Range porphyry' was recorded <u>under</u> the Iron Monarch orebody at about 650 feet

below surface in one drillhole. It is also curious that a line passing through the Paney Are centre, and through several other centres, and parallel to the Meemaree fault also passes through the Iron Monarch orebody.

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