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DEPARTMENT OF MINES

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REGIONAL CONTROL OF METAL DISTRIBUTION IN SEDIMENTS OF THE UPPER PROTEROZOIC-LOWER CAMBRIAN OF SOUTH AUSTRALIA

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The Adelaide System (Upper Proterozoic of South Australia) has been described by numerous South Australian authors. Mawson and Sprigg (1950) have formally defined the units. Campana and Wilson (1955) and Horwitz (1960) have given some accounts of this sequence in the Eclogae Geologicae Helvetiae.

This system has been subdivided from base to top into the Torrensian Series, the Sturtian Series and the Marinoan Series. Locally, the Willouran Series occurs below the Torrensian. These units rest on the Archaean crystalline basement and this contact is sometimes referred to as the "Grand Unconformity". The Marinoan Series is overlain by sediments which are identified as Lower Cambrian (Daly, 1956).

Campana and Wilson (op. cit.) have aligned columnar sections, all projected on a north-south plane. The author followed this initial step by mounting on boards all recorded sections and additional sections measured in the field for this purpose, in order to give a three-dimensional picture of the basin of sedimentation. Four mountings on boards have been assembled, one for the Torrensian-Willouran Series, one for the Sturtian and lower part of the Marinoan Series (glacial beds Campana and Wilson, op. cit.), one for the upper part of the Marinoan Series (post-glacial beds of Horwitz, op. cit) and one for the Lower Cambrian. These models have revealed some interesting and unexpected basin patterns as well as sedimentary mineralisation controls.

The area studied is that of the Mount Lofty, Olary and Flinders Ranges regions, extending from north to south for approximately 600 km. and east-west for 250 km. at its widest portion.

The picture evolving so far is one of highs and lows resulting from the intersection (or interferences) of two sets of geanticlines. Thus the pattern emerging is one of localised thin and thick sections separated by sections of medium thickness. As examples, the post glacial beds, up to and including the Pound Quartzite of Mawson (1938), are ~~1000m.~~ 800m thick near the Oraparinna Mines (Mawson 1939), 3000m. thick near the Nuccaleena Mine and 7000m. thick ~~two miles~~ 70 km. south-east of ~~Leigh Creek~~ Copley. This pattern which was not predictable from conventional concepts appears to fit in best with patterns formed by experimental interference type shear deformation as developed by O'Driscoll (1961, a, b).

The stratigraphic studies to date show that within the Marinoan Series all recorded barytes and copper occurrences have three controls in common.

(1) They occur in beds, here referred to as favourable beds, that have their source area in the Gawler Ranges region. This is based on their various colours as well as the distribution and size of clastics. The Gawler Ranges are composed of a variety of rocks, amongst which are great developments of porphyries.

(2) They are controlled by a geochemical environment. Barytes occurs in purple beds and copper appears at the passage from purple to green pyritic beds.

(3) They occur in relatively thin sections of the Marinoan Series, i.e. on geanticlines and the domes formed at their intersections.

The following points are of interest:-

(a) In the Marinoan Series the boundaries of sediments from different source areas do not conform exactly with the change due to geochemical conditions at time of deposition, nor with the isopach lines.

(b) Copper occurs where the three required conditions are fulfilled sometimes in veins infilling joints or faults, as coatings in cleavage or bedding planes, concentrated along dolomite bands or disseminated throughout the sediment. Barytes occurs mainly in veins.

(c) So far, there is no evidence of geographic migration, on a regional scale, of the geanticlines during Marinoan times whilst the other two requirements do vary their geographic distribution with time and, thus, the conditions are not always directly superposed in the strata. The evidence suggest that the geanticlines are not coincident for the Torrensian, the Sturtian and the Marinoan Series.

(d) Pyrite occurs in favourable beds where they are green. It is abundant where the beds are thinnest and rare where the beds are thick.

(e) There is virtually no metamorphism in the Adelaide System where these observations have been made.

(f) In the upper part of the Marinoan Series (post glacial beds) no disconformities have been noted. It has been possible to trace units across the broad basin of sedimentation from the source area, in the west, to occurrences far in the east, the north-east and the south. The ABC Range Quartzite of Mawson (1939b), for example, shows all the stages of lateral facies variations, from a coarse felspathic quartzite near its source in the Gawler Ranges region to siltstones with rare sandy members in the Mackara region, 100 km. to the east, and the Umberatana region, over 200 km. in the north. This gradual facies variation ~~does not~~ appears to be ~~affected by~~ independant of the absolute thickness variations (i.e. the domes and basins of the intersecting geanticline ridges). There was, thus, an interesting combined effect between sedimentation, broad subsidence of the mega-basin (to use the terminology of O'Driscoll op. cit.) and the differential subsidence on the smaller basins and domes caused by the intersection of the two geanticline systems.
This is not the case for the lower beds of the Adelaide System where similar dome-basin patterns are recognisable and where three disconformities and unconformities have been recognized in the Adelaide region in beds below the Sturtian Series. These occur in the margins of one such basin. In this case, source areas, geochemical conditions at times of deposition, grain size in the clastic members and absolute thickness variations are more closely related to the shape of this basin.

In the Lower Cambrian plot, a small basin is well defined. It is centred ~~90~~ 70 km. south-east of Leigh Creek in the Northern Flinders Ranges.

The thickness of the lower Cambrian in these areas varies from 1000 m. to a maximum of 8000m. (included in the last value, is the upper part of the Lower Cambrian that was obtained by projection). Within the limits of scale and present information, this maximum Cambrian thickness is centred on a zone of maximum thicknesses in the Marinoan Series. It is notable in the district that all copper and lead occurrences which are recorded in Cambrian rocks occur where these are less than 2300m. thick. Thus, the 2300m isopach line which can now be plotted with a fair degree of accuracy in the region appears as a circle, ~~30~~ 50 km. in diameter. This delineates an area within which there is no recorded sign of mineralisation. Outside this circle, in areas where the Lower Cambrian is thinner, copper and lead mineralisation is well known to occur. This distribution does not appear to be related to post sedimentary folding which affects as well as exposes equally well the rocks both within and outside the ring defined by the 2300 m. isopach line in the Lower Cambrian.

Thus for the Lower Cambrian of this region, two of the three prescribed conditions for mineralisation are recognized: Favourable beds and zones of thin sedimentation.

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