N86-23115

EVIDENCE FOR STRUCTURAL STACKING AND REPETITION IN THE GREENSTONES OF THE KALGOORLIE DISTRICT, WESTERN AUSTRALIA

J.E. Martyn, Esso Australia Ltd., Sydney

INTRODUCTION

Most previous stratigraphic interpretations of the southern part of the Norseman-Wiluna Greenstone Belt have proposed polycyclic sequences (e.g. Horwitz and Sofoulis[1]; McCall[2]; Williams[3]; Glikson[4]; Gemuts and Theron[5]). These invoked two and sometimes three successive suites of mafic and/or ultramafic volcanics and intrusives separated by felsic volcanics and immature clastic sediments, however no distinctive lithological differences were reported between successive mafic-ultramafic sequences. When interpretations of Williams et al.[6] and Hallberg[7], further to the north, are integrated, a total of four separate major mafic-ultramafic suites emerges for a large part of the Norseman-Wiluna Belt. Although the author does not intend to imply that all polycyclic stratigraphies are wrong in principle such a situation seems suspiciously over-complex and stimulates the need to look critically at the individual areas where stratigraphies have been erected. For the Kalgoorlie area in the south, some of the schemes have already provoked scepticism (Burke et al.[8]; Archibald et al.[9]) and a simpler model consisting of one cycle subject to structural repetition has been evolved by workers in the Geological Survey of Western Australia (Griffin et al.[10]) for part of this area. The latter authors drew attention to the 'carbon copy' similarity between the elements of some polycyclic stratigraphies. Much more regionally extensive integrated structural and stratigraphic data is still required to evaluate the relationship between structure and stratigraphy more fully, an objective substantially limited by poor outcrop and deep weathering, but with due effort, far from unattainable.

OUTLINE OF STUDY

Regional mapping by the author in an area of approximately 20,000 km^2 centred on Kalgoorlie revealed many problems and anomalies in several of the published stratigraphic schemes. However since insufficient critical stratigraphic and structural evidence had been given in support of the schemes it has not been easy to check the bases on which they were erected. The following lines of investigation have been pursued.

* Regional distribution and interelationships of lithologically similar sequences previously regarded as distinct, based on mapping, mineral exploration data, and geophysical interpretation. Emphasis has been on the mafic-ultramafic suites because they are the most easy to define and map.

* Critical evaluation of contacts and their associated structural features.

RESULTS

There are several instances where mafic-ultramafic suites previously proposed as younger (e.g. Coolgardie-Kurrawang area in Glikson[4]) join or merge with their 'older' counterparts when mapped over various distances. They range in size from splinter-like splays a few kilometres long diverging from a major mafic belt by up to a kilometre, to extensive sheets which are traceable for tens of kilometres as separate entities before joining with and becoming indistinguishable from their 'older' counterparts. Some successions are isolated in metasedimentary terrain, and never connect with their sequences of origin; however this situation is unusual. In areas where like elements of two proposed cycles are juxtaposed or interconnected (e.g. Widgiemooltha and Spargoville areas in map of Gemuts and Theron[5]) there seems to be no clear reason why they should have been regarded as separate.

The apparent stratigraphic thicknesses of many of the previously proposed younger mafic-ultramafic sequences is very variable. While they may be measurered in kilometres in some areas, in many localities the sequences are attenuated and deformed. They may be traced for tens of kilometres as apparently conformable packages of all or most of the major mafic and ultramafic lithologies, though individually these lithologies may occur as lenses or sheets hundreds or even only tens of metres in thickness. While such sequences have been interpreted in the past as volcanic intercalations in a eugeosynclinal sedimentary pile (McCall[2]; Glikson[4]), or the beginnings of new volcanic cycles, their degree of deformation and tendency to be smaller scale carbon copies of their 'older' counterparts is more consistent with structural repetition. In a number of instances they are overlain by felsic volcanic rocks suggesting cyclic development in a uniformly facing sequence. This is here regarded as evidence that repetition has been mainly by faulting and not by recumbent or isoclinal folding.

OBSERVATIONS ON CONTACTS

Many previous stratigraphies (e.g. Williams[3]; Gemuts and Theron[5]; Glikson[4]) have been erected in areas where fragmentary facing evidence suggests thick uniformly facing sequences. The potential for strike dislocations has generally been overlooked despite heterogeneous shear deformation. There has been an absence of critical treatment of major formational contacts to establish whether they are normal or tectonised. This is understandable in some instances since such contacts are rarely well exposed, however diligent search by the author has revealed many key outcrops. The vast majority of these provide compelling evidence that all is not well with the published polycyclic stratigraphies. Examination of contacts, especially basal ones, and the contact areas of the previously proposed younger mafic-ultramafic suites, commonly reveals strong peneconcordant shearing, recrystallised mylonitic or other cataclastic rocks, or in one instance (the Kalpini formation which is the highest mafic-ultramafic suite of Williams[3]), an overturned but undeformed contact with clear facing evidence the reverse of that previously proposed. Mapping the relationship between the contact zones and primary layering often reveals subtle discordances not readily explained by unconformity.

MODEL

Many proposed structural repetitions or fault slices are linear, others are arcuate and folded around major upright structures. Linear belts are often controlled by throughgoing transcurrent deformation zones with pronounced sub-horizontal lineations. Arcuate systems however were conceivably generated by earlier processes such as thrusting or gravitational gliding predating upright folding. Although transcurrent shearing is a feasible mechanism for repetition for at least some of the more linear belts, it is possible that even many of these began life as early thrust sheets and became stretched and aligned by later transcurrent deformation. Early thrusts, recumbent folds and layer-parallel shear fabrics have been documented in several localities in the Norseman-Wiluna Belt where prevailing strikes deviate from the NNW regional grain, or where tight upright folding is subdued or absent (e.g. Chapman[11]; Gresham and Loftus-Hills[12]; Archibald[13]; Platt et al.[14]; Martyn and Johnson[15]; Spray[16]). In one instance (Chapman[11]) a narrow mafic-ultramafic belt in sediments has clearly been generated by an overthrust. Almost certainly the recognition of this structural style in east-west trending or gently domed areas is a consequence of preservation. It is undoubtedly present also in NNW trending linear domains but is overprinted and hard to recognise. It is emphasised that thrust repetition does not explain all of the previously proposed younger cycles in the district. Some are a consequence of misinterpretation, by placing too great a significance on isolated stratigraphic facing observations, or from attempts to correlate across major upright faults. Broad regional observations by the author suggest that thrust repetition may be much more strongly developed in the Kalgoorlie district than elsewhere in the Norseman-Wiluna Belt though this conclusion is tentative.

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Thrusting does not appear to have occurred on a scale comparable with many Phanerozoic convergent plate boundaries. There is no evidence of juxtaposition of strongly contrasting domains, or of high pressure metamorphism. There is also a lack of pronounced east-west assymetry across the Norseman-Wiluna Belt as a whole. The tectonics can be viewed more in terms of a rearrangement of familiar elements of the local stratigraphy, a situation more consistent with a closed or intracratonic setting, rather than an open plate margin. This accords with models such as those of Groves[17]. As such, intrabasinal gravity gliding resulting from early uplift heralding later vertical tectonic events is the most favoured model by the author. This is consistent with the sedimentation style which is dominated by turbidites and includes debri flow deposits. Olistostromes have also been reported (Taylor, in Gee and Groves [18]). In some respects the scheme resembles that proposed by De Wit[19] for the Barberton Greenstone Belt. Felsic volcanism was intimately associated with sedimentation, and it is possible that concomitant granitic intrusion into a dense sheet of mafic-ultramafic volcanics may have triggered the instability that first led to the sedimentation and later to gravity gliding tectonics. Subsequent folding and faulting of the tectonically stacked sequence would have created the illusion of a polycyclic sequence which has suffered only upright folding and shearing. The upright tectonic events have generated their own set of interpretive problems. Peneplenation, and Tertiary lateritic weathering ultimately obscured much of the important evidence.

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