In the Lachlan Fold Belt in NSW the remarkable contrast in geologic processes between the Ordovician and the Silurian has been an outstanding feature for the tectonic model. Initially, the Lachlan Fold Belt in the Ordovician conforms to an oceanic island arc complex. However, in the Silurian the tectonic model is based on the subcropping areas of volcanics. Dashed outlines indicate probable Ordovician and Silurian history of the Lachlan Fold Belt in NSW. The suggested tectonic model outlines below also may explain why the area is a gold province and possibly also a potentially economic platinum province.

**Suggested tectonic model**

At some time before the Ordovician the Lachlan Fold Belt consisted of a continent and possibly rather thin continental crust. Isotopic evidence from Silurian-type greenstones in the crust indicates that it was formed in the Late Proterozoic to Cambrian. Underlying it was a subcontinental lithosphere depleted in basaltic components. Much of the primordial mantle sulphur (250 ppm) would have been removed during this depletion because sulphur is highly soluble in basaltic liquids (1000 ppm), so any sulphur left in the lithosphere (< about 50 ppm) would be in the form of sulphides enriched in Au and PGEs. This is even more apparent if the later Ordovician and Silurian tectonism were to volcanic and high-level sills in the Ordovician silicic rocks (Fig. 20) hints at some other process possibly operating.

In the Ordovician the continental crust has been in deep oceanic environment, suggesting downwarping of the lithospheric mantle, and certain conditions in the mantle must have triggered melting of the lithosphere to produce the shoshonites. A possible mechanism involves the delamination of a cold, dense subcontinental lithosphere (Molnar & Gray 1979: Geology, 7, 58-62) whose negative buoyancy, as a result of cooling, overcame the positive buoyancy of the overlying thin continental crust. As the subcontinental lithosphere foundered it partially melted. Magmas from this melt were trapped beneath the Wagga Metamorphic Belt. Asthenospheric mantle was able to replace it. Initial subduction of hot asthenospheric mantle to replace it. Initial subduction of hot asthenospheric mantle to replace it. Initial subduction of hot asthenospheric mantle to replace it. Initial subduction of hot asthenospheric mantle to replace it. Initial subduction of hot asthenospheric mantle to replace it. Initial subduction of hot asthenospheric mantle to replace it. Initial subduction of hot asthenospheric mantle to replace it.

**Mineralisation**

The Ordovician shoshonites resemble chemically volcanics on Lihir Island and Fiji (Fig. 20b) which also host major gold deposits. Clearly, then, such rocks are important hosts for gold mineralisation. As already suggested, the Ordovician shoshonites were derived from a lithosphere previously depleted in sulphur (< about 50 ppm) but with very high Au and PGE abundances (1 ppb Au, 5 ppb Pd, and 8 ppb Pt), so those sulphides present contained elevated abundances of Au and PGEs.

**Silurian tectonism**

The founding of subcontinental lithosphere in the Ordovician would have led to the upward flow of hot asthenospheric mantle to replace it. Initial breakage of the lithosphere probably took place beneath the Wagga Metamorphic Belt. Asthenospheric mantle at a temperature of 1200-1300°C.

**Ordovician volcanism, gold mineralisation, and an integrated tectonic model for the Ordovician and Silurian history of the Lachlan Fold Belt in NSW**

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**Fig. 19.** Distribution of Ordovician volcanics of the Lachlan Fold Belt in NSW and associated gold deposits. Dashed outlines indicate probable subcropping areas of volcanics based mainly on aeromagnetics.**

**Fig. 20.** Comparative element content: (a) Ordovician volcanics of the Lachlan Fold Belt, NSW, and (b) modern shoshonites. The primordial mantle noble gas values are from Wood & others (1979: Contributions to Mineralogy & Petrology, 70, 319-339).**

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**New Guinea**

Lihir Island

Fiji

Western USA

Mount Hagen, New Guinea

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**Australia**

Nine Mile Volcanics

Angulonung Tuff

Goonumba Volcanics (NSW Geol Surv)

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**Gold deposit**

Platinum-rich intrusive complex

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The Ordovician volcanics of the Lachlan Fold Belt, NSW, and (b) modern shoshonites. The primordial mantle noble gas values are from Wood & others (1979: Contributions to Mineralogy & Petrology, 70, 319-339).**

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Growth of the Lachlan Orogen by eastwards accretion

The Lachlan Orogen is often considered a single entity, because all the outcropping rocks have a northerly trend, and the oldest outcropping rocks over the width of the orogen have a range of only Cambrian to Ordovician. This model has always had the difficulty that the orogen is too wide (1000 km) to have been formed in a single episode. Moreover, because the model is based on geological information only, it suffers from the additional problem that more than half the area is covered by post-orogenic sediments.

The Lachlan Orogen has been mapped over its full extent using gravity and magnetic anomalies. These give three independent data sets: (1) gravity (10--50 km) magnetic anomalies indicating the boundaries between bodies of different density at mid upper-crustal level; (2) short-wavelength (1--10 km) magnetic anomalies, indicating along-strike magnetic trends at the top of the Lachlan Orogen rocks (basement); and (3) intermediate-wavelength (10--50 km) magnetic anomalies indicating the extent of belts of anomalous apparent susceptibility near the top of the basement.

Figure 21 shows (in black) magnetic trends, and (in blue) areas inferred to be separate terranes on the basis of geology and the three geophysical data sets. The relative ages of cratonisation of the terranes have been inferred from the direction of the trends within: a younger terrane has trends parallel to its margin with an older one, whereas an older terrane has trends oblique to a younger one. The deformation of the younger terrane produces, in the older one, a band about 100 km wide along the margin, with trends parallel to the margin. The subdivisions in Figure 21 are labelled in the order of their inferred cratonisation age. Terrane A is Proterozoic crust to the west. Its eastern margin at mid upper-crustal level is taken to be at an elongate gravity gradient that is low to the east. Terrane B is part of the Thompson Orogen. C may in part be the next-oldest terrane; C1 has trends that are generally not parallel to the adjacent margin, consistent with an allochthonous origin and cratonisation before accretion. D has trends parallel to the margins of both A and C1, so it is likely to have been cratonised later; it may consist of several separate, elongate terranes (D1, D2, D3). Terrane E has trends that cut those of B and C and have an indeterminable relationship with those of D. It may be an area of intracratonic deformation separating the Lachlan and Thompson orogens. Terrane F is younger than B, C, D, and possibly E. Its western margin is in part the Gilmore Suture. Terrane G truncates the gravity trends at the southern end of the orogen at an angle of about 40°. Its eastern margin is the boundary between the igneous and sedimentary granites (the S/I line). Terrane H is the New England Orogen of Silurian to Carboniferous accretion, with fore-arc deposits on older crust in G1.

The geophysical data appear to confirm the separation between the Thompson and Lachlan orogens, and the reality of the S/I line and Gilmore boundaries. The geophysical data are consistent with the accretion being by either gradual formation of new crust in place, or the docking of pre-existing allochthonous terranes.

Two geological associations in places characterise the boundaries between the terranes. First, some of the boundary rocks are ultramafic-mafic flows or intrusions. Secondly, the major terrane boundaries (C2/D1, C/F, and F/G) are the abrupt change from the Precambrian to the Paleozoic rocks over the width of the orogen. At boundary F/G, the metamorphism is in the older terrane, so it is likely that area D1 was cratonised before accretion of area C2.

This model describes the formation of the Lachlan Orogen by successive sequences, each involving accretion, folding, and cratonisation. It should be consistent with the rocks and structures in the upper part of the crust. Lower parts of the crust may be older or younger. For example, there is good chemical and isotopic evidence for Precambrian material under area F and the western margin of area G.

For further information contact Dr Peter Wellman at BMR (Division of Petrology & Geochernistry).

AMEC's Working Party on Gemstone Processing

Since the 1960s at least, studies have been made of the Australian gemstone industry in an endeavour to establish what proportion of Australian gemstones is processed locally and what proportion is exported unprocessed. In December 1987 the first formal meeting of the AMEC (Australian Minerals & Energy Council) 'Working Party on Gemstone Processing' was held at the South Australian Department of Mines & Energy, Adelaide. The Working Party is made up of representatives from State Mines Departments, jewellers' associations, gem cutters, gemstone miners' associations, and BMR.

The objectives of the Working Party are:

1. to establish the proportion of gemstones processed in Australia compared with that exported unprocessed overseas.