Kimberley–Tanami–Arunta: geology and mineral systems

by

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Major mineral discoveries have been made in the Proterozoic rocks of the Kimberley, Tanami, and Arunta, and mines currently operating in WA include the world-class Argyle diamond mine, as well as the more recent Sally Malay nickel mine, and the Coyote gold mine. However, much of the area can be regarded as under-explored, either due to poor outcrop, rugged topography, or remoteness.

The Kimberley, Tanami, and Arunta form part of the North Australian Craton, which extends into Western Australia from the Northern Territory (NT). GSWA carried out second edition 1:250 000-scale remapping of the King Leopold Orogen in the Kimberley between 1986 and 1989. Together with the then BMR (later AGSO, and now Geoscience Australia) 1:100 000-scale mapping in the Halls Creek Orogen took place from 1990 to 1995 as part of the National Geoscience Mapping Accord. More recently, the Tanami and Arunta have been the focus of the joint GA–NTGS–GSWA* National Geoscience Accord North Australia Project, the results of which were presented at a meeting in Alice Springs in June 2006 (Lyons and Huston, 2006) and are summarized below. A major initiative of the project was the 2005 Tanami Seismic Collaborative Research Project, which acquired 719 km of deep seismic reflection data across the WA/NT border. GSWA is addressing the previously limited availability of pre-competitive geological data in the WA Tanami and Arunta, with the acquisition and interpretation of new aeromagnetic, radiometric, and gravity data, the database entry of legacy field observations, and the commencement of a 1:100 000-scale geological and regolith mapping program. The release of a Geological Exploration Package for the Arunta, and Geological Information Series Packages for the Tanami and Kimberley are planned.

Paleoproterozoic geology

Kimberley

The King Leopold and Halls Creek Orogens can be divided into three distinct terranes representing different tectonic settings interpreted to be part of a larger collisional orogen that sutured the Kimberley Craton with the rest of the North Australian Craton. The Hooper Complex and Western Zone of the Lamboo Complex formed as a marginal rift to the Kimberley Craton at c. 1872 Ma. The rift filled with turbiditic sedimentary rocks before being deformed and metamorphosed during the accretionary Hooper Orogeny (1865–1850 Ma). Intrusion of granitic and mafic–ultramafic rocks, and eruption of associated felsic volcanic rocks accompanied the orogeny. Mafic volcanic rocks and turbiditic sedimentary rocks in the Central Zone of the Lamboo Complex developed as an oceanic island arc at c. 1865 Ma. These were intruded by layered mafic–ultramafic rocks at c. 1855 Ma and by tonalite sheets at c. 1850 Ma. Peak metamorphism took place at c. 1845 Ma, coincident with the emplacement of further layered mafic–ultramafic intrusions and with the eruption of felsic and mafic volcanic rocks during rifting of the arc. The Eastern Zone of the Lamboo Complex contains a 1910–1880 Ma passive continental margin sequence that is transitional to an active margin setting at c. 1855–1845 Ma with the development of a foreland basin. During the 1835–1805 Ma Halls Creek Orogeny collision and suturing took place, and was accompanied by deformation, metamorphism and the intrusion of further granitic and mafic–ultramafic rocks in syn- and post-collisional settings. Syn- to post-collisional sedimentary basins include the c. 1835 Ma Speewah Basin overlying the Kimberley Craton, and the younger Moola Bulla and Red Rock Basins overlying the Lamboo Complex. The 1780 Ma Hart Dolerite is part of a large igneous province (LIP) intruded into the Speewah Basin and overlying Kimberley Basin.

Tanami

In the Granites–Tanami Orogen, Archean to early Paleoproterozoic basement underlies a c. 1864 Ma sequence of deep-water sedimentary rocks, turbiditic sedimentary rocks, and mafic volcanic rocks, which may have been deposited in an extensional, possibly back-arc setting related to the development of an arc in the Central Zone of the Halls Creek Orogen. Deformation during the early stages of the Tanami Orogeny (c. 1850 Ma) was followed by deposition of further sequences of deep-

* GA — Geoscience Australia; NTGS — Northern Territory Geological Survey

water sedimentary rocks and turbiditic metasedimentary rocks in a succession of foreland basins. The later stages of the Tanami Orogeny between 1835 and 1815 Ma may represent far-field effects of the Halls Creek Orogeny. Intrusion of two suites of granitic rocks accompanied the later stages of the Tanami Orogeny (1825–1810 Ma), and extension related to the eruption of a sequence of mafic volcanic rocks (1820–1790 Ma). The Pargee Sandstone (1758–1700 Ma) and the Birrindudu Basin (1735–1640 Ma) formed unconformably overlying sedimentary basins.

Arunta

The Arunta Orogen in WA is poorly known. In the NT the Arunta 'Region' is divided into the Aileron 'Province' in the north and the Warumpi 'Province' in the south, separated by the Redbank Thrust. These tectonic units appear to extend into WA. The Aileron Complex is dominated by turbiditic metasedimentary rocks probably deposited at c. 1835 Ma and is separated from the Granites–Tanami Orogen to the north by the extension of the Willowra Gravity Ridge. This is partly coincident with an aeromagnetic low, and may represent a fossil (≥1864 Ma) suture zone. The Warumpi Complex is interpreted as part of a terrane that was accreted to the southern margin of the North Australian Craton between 1690 and 1610 Ma during the Liebig Orogeny, prior to collision with the Mawson Craton at 1590–1570 Ma.

Mineral systems

The Kimberley, Tanami, and Arunta appear to be characterized by distinct mineral systems. The Kimberley is dominated by diamonds in kimberlite (Phillips Range) and lamproite (Argyle) diatremes, and by Cu–Ni–Cr–PGE–V–Co in layered mafic–ultramafic intrusions (Panton, Sally Malay), with potential for similar mineralization in mafic sills and associated volcanic rocks. There are also REE deposits associated with alkaline rocks (Brockman), Pb–Zn in volcanic-hosted massive sulfide (VHMS) deposits at Koongie Park, Sn–Ta–Nb in pegmatites (Mount Heartbreak), and orogenic lode Au (Ruby Queen). Mineralization in the Tanami is dominated by orogenic Au (Coyote and Kookaburra). The Aileron Complex of the Arunta Orogen has potential for the discovery of orogenic Au, iron-oxide Cu–Au–U (IOCG) and VHMS deposits, whereas the Warumpi Complex has potential for the discovery of major IOCG deposits associated with alteration around the Mount Webb Granite (Wyborn et al., 1998). The potential for unconformity-related U exists in all three areas, associated with overlying sedimentary basins (Killi Killi).

References

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