# Volcanological reconstruction of mineralized sequences in the Minerie – Murrin Murrin area, Archaean Kurnalpi Terrane

by

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Many volcanic sequences, particularly those deposited in water, include intercalated facies that are not genetically related. The result is a complex facies architecture that is characterized by juxtaposition of products from vastly different source environments. Each facies retains distinctive characteristics that relate to formative volcanic processes and volcano type and setting, proximity of the volcanic source, and temporal relations (syn- versus post-eruptive). Volcanic facies analysis provides a powerful tool to resolve the origins of these problematic rocks. This approach, which is applied here, has provided new constraints on the volcanic facies architecture, environment of eruption and emplacement, and tectono-stratigraphic evolution of sequences in the Minerie to Murrin Murrin area of the Kurnalpi Terrane, Yilgarn Craton (Fig. 1).

Three conformable lithofacies associations, from stratigraphic lowest to highest respectively, can be identified on the basis of composition, constituent facies, and provenance.

## Association A: Post-eruptive volcanogenic sedimentary deposits and andesitic–dacitic lavas (Welcome Well Complex)

The Welcome Well Complex comprises volcanogenic sedimentary facies, intercalated with coherent andesite–dacite and associated autoclastic breccia facies. Massive and flow-banded andesite–dacite contains evenly distributed feldspar phenocrysts with groundmasses ranging from spherulitic to formerly glassy (perlitic). Flow interiors are coherent or cut by planar to curviplanar cooling contraction fractures, and grade out into marginal hyaloclastite facies formed during quenching by seawater.

The volcanogenic sedimentary facies comprises matrix- to clast-supported conglomerate, pebble–granule breccia, sandstone, and siltstone beds that are not related to contemporaneous eruptions and are characterized by polymictic clast assemblages, mixed provenance, abundant rounded texturally variable andesitic lithic clasts, and thin to thick sedimentation units. Diffuse bedding and grading within the conglomerate facies is defined by subtle variations in maximum and mean particle size, suggesting single depositional units are up to a few tens of metres thick. Amalgamated unit boundaries are common, implying sustained input of detritus from subaqueous density currents (principally grain flows and debris flows). Pebble-sandstone beds (3–4 m thick) comprise one or more high-concentration turbidite divisions. These may include: a lower division of planar and cross-laminated sandstone reflecting traction sedimentation ($S_1$); an interval of reversely graded traction-carpet deposits ($S_2$); with or without a grain-supported lithic and crystal-rich pebble–granule breccia and sandstone division, reflecting a declining sedimentation rate during accumulation from suspension ($S_3$).

Rounded to sub-angular clasts were reworked in above wave-base (fluvial, shoreline) environments prior to final deposition in flanking deeper water (below storm wave-base) environments. Blocky andesitic clasts have phenocryst populations and shapes that suggest some were sourced from the autoclastic carapace of intrabasinal lavas by sediment gravity flows that scoured the sea floor. Sedimentation accompanying degradation of an un-preserved medial emergent volcanic edifice was contemporaneous with subaqueous (below storm wave-base) eruption and reworking of proximal andesitic–dacitic lava facies.

## Association B: Komatiitic basalt and tholeiitic basalt facies (Minerie sequence)

Association B is dominated by tholeiitic basalt intercalated with subordinate spinifex- and cumulate-textured komatiitic basalt units and crystal-vitric-lithic sandstone facies. Lateral and vertical transitions between massive coherent basalt facies, pillow lava, and autoclastic facies are widespread. Flow interiors are commonly crystalline (doleritic), whereas flow tops are marked by intervals of formerly glassy basalt and thin (metre thick) autoclastic breccia facies, reflecting asymmetric cooling and crystalliz-

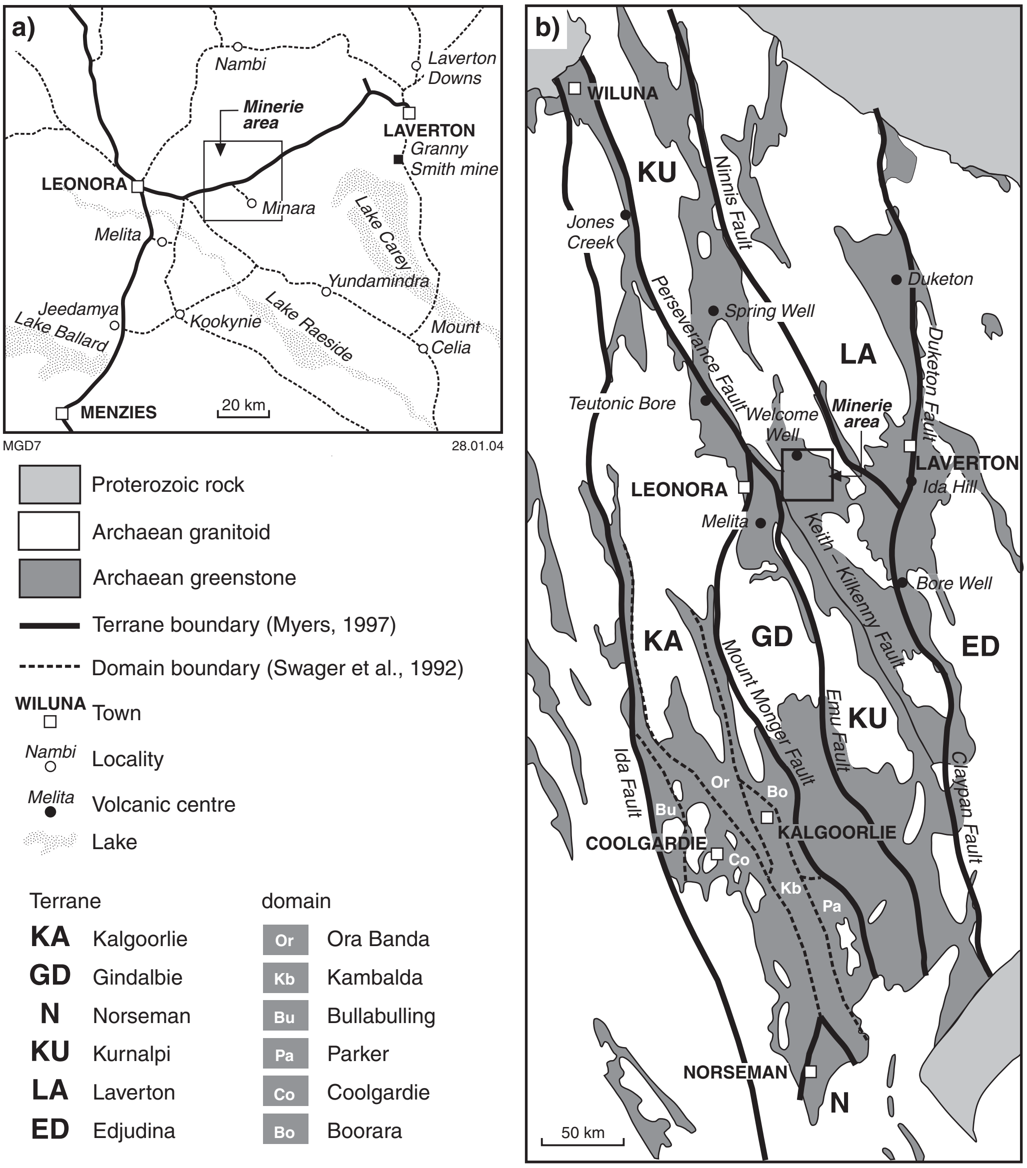


**Figure 1. a) Location of the Minerie – Murrin Murrin area. b) Simplified geological map showing the distribution of granitoid and greenstone in the Eastern Goldfields Province. Terrane boundaries, faults, and the principal domains are also shown. Modified after Myers (1997) and Brown et al. (2001)**

ation profiles. Autoclastic breccia facies are monomictic and comprise a complex arrangement of jigsaw-fit hyaloclastite, clast-rotated autoclastic breccia, pillow-fragment breccia, autobreccia, and pillow-lobe facies. Although typically massive, rare intervals display subtle variations in grainsize that may reflect limited syn-eruptive transport down flow fronts, possibly through rolling and tumbling. Extended breaks in mafic eruptive activity are marked by laterally continuous sandstone–siltstone beds, which are mainly felsic, post-eruptive turbiditity current deposits (Ta-c divisions) and suspension sedimentation deposits. The widespread occurrences of pillow lava, hyaloclastite, and turbidity current deposits suggest deposition in a relatively quiet, deep-submarine (below storm wave-base) depositional environment. Basaltic units are interpreted as the proximal–medial facies association of a subaqueous, non-explosive volcanic centre.

### Association C: Komatiite and felsic syn- to post-eruptive facies (Murrin Murrin ultramafic complex)

The prospective Murrin Murrin ultramafic complex includes juxtaposed and intercalated komatiite, komatiitic basalt, felsic vitric-crystal-pumice breccia–sandstone, and siltstone–sandstone facies. Komatiitic basalt facies are texturally variable and locally contain around 10% (visual estimate) amygdales. Where exposed, upper komatiite flow margins are coherent or marked by a thin (<10 cm thick), incipiently quench-fractured zone ($A_1$) that typically passes downward through a random spinifex-textured zone ($A_2$), into a zone of aligned (stringy-beef textured) pyroxene needles ($A_3$). Horizons rich in varioles and ocelli are subparallel to bedding in felsic volcaniclastic facies interleaved with the komatiitic basalt sheets, and both are locally truncated at discordant contacts with cumulate facies. Overall there is an interdigitation between komatiitic basalt and differentiates with orthocumulate to gabbroic textures that is interpreted to reflect both intrusive and extrusive (endogenous) modes of emplacement.

Lower contacts between komatiitic basalt flows and the volcaniclastic substrate vary from planar and broadly conformable to invasive, and locally comprise jigsaw-fit hyaloclastite and blocky peperite zones. Because peperite is diagnostic of synvolcanic interaction of magma with unconsolidated sediment, the age of komatiite volcanism can be constrained by the depositional age (2698 ± 5 Ma; Nelson, in prep.) of the intermixed dacitic volcaniclastic facies. The dacitic facies comprise 1–3 m thick, non-welded, normally graded pumice-crystal breccia beds, accretionary lapilli-rich beds, and planar- and cross-laminated vitric-crystal sandstone–siltstone units (low- and high-concentration turbidites, water-settled ash fall). The lithofacies character suggests syn- to post-eruptive sedimentation of pyroclasts from medial to distal volcanic centre(s) characterized by explosive (magmatic–phreatomagmatic) eruptions. Depositional environments were subaqueous (below storm wave-base) within the proximal facies association of a separate volcanic centre characterized by non-explosive ultramafic volcanism.

## References

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