Geochemical characteristics of the Alcurra Dolerite (Giles Event) and its extrusive equivalents in the Bentley Supergroup

by

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The c. 1067 Ma Alcurra Dolerite is geographically widespread throughout the Musgrave Province of Australia. This geochemically distinct suite was emplaced during the complex series of intrusive (Warakurna Supersuite) and extrusive (Bentley Supergroup) mafic to felsic magmatic episodes that form the c. 1085–1030 Ma Giles Event. The suite postdates the major mafic intrusive components of the Warakurna Supersuite (the c. 1078–1075 Ma layered mafic–ultramafic intrusions and c. 1075 Ma massive gabbros), which form the west-northwest spine (Fig. 1) of the west Musgrave Province.

The Alcurra suite is of particular importance because of its potential direct genetic links with mineralization — for example with contemporaneous and geochemically similar gabbros hosting orthomagmatic Cu–Ni–PGE mineralization at Nebo–Babel as well as Cu(–Ni–PGE–Au) mineralization at the Halleys Prospect. The Alcurra suite may also have links with ?orthomagmatic to hydrothermal Cu mineralization found at the Tollu Prospect and in dykes to the north of the Jameson Community. In view of these potential links, our ongoing investigation into the stratigraphy and geochemical relationships of the Warakurna Supersuite and Bentley Supergroup seeks to understand petrogenetic links between the Alcurra Dolerite and voluminous extrusive units of the Bentley Supergroup and to explain any petrogenetic differences using new geochronological and geochemical data.

Geochemistry of the Alcurra Dolerite

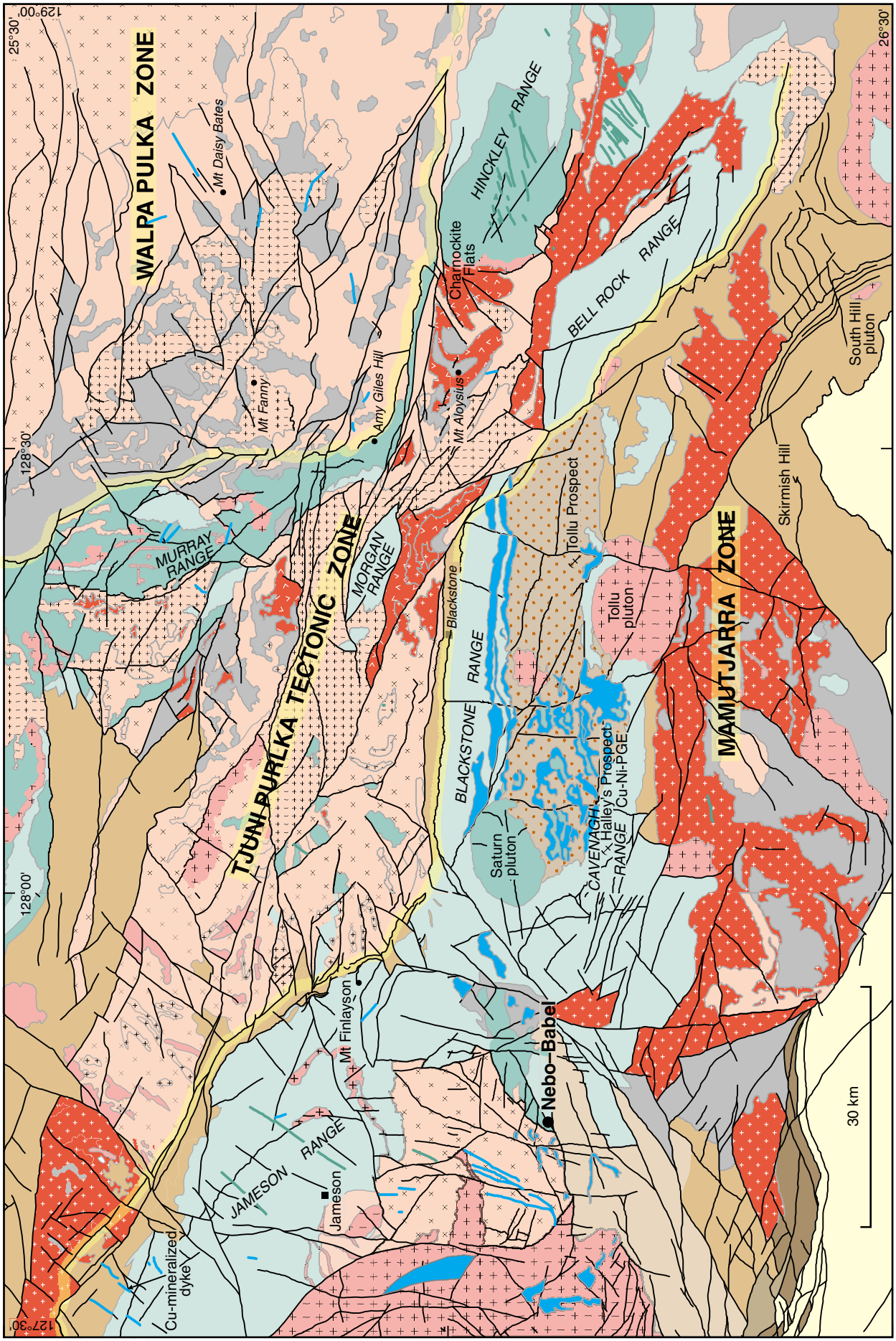
The Alcurra Dolerite is an evolved, strongly Fe-enriched and incompatible trace element-rich suite of tholeiitic to mildly alkalic intrusions that extends across all lithotectonic zones of the west Musgrave Province (Fig. 1). These rocks are geochemically distinct from other mafic intrusive rocks of the Giles Event and from rocks of other dyke suites in the region (e.g. the Kullal Dyke Suite; Fig. 2). Major- and trace-element trends suggest that the evolution of the suite is mainly controlled by fractionation of olivine and plagioclase, with later magnetite fractionation. Bulk compositions (SiO_2 ~47.5 wt% and MgO ~6 wt%) are consistent with crystallization at high T, and low P, f_{H2O} and f_{O2}. Minimum La/Nb (~1.5) and La/Sm (~2.6) ratios (Fig. 3) are regionally constant and reflect incorporation of an enriched (ultimately crustal) component into the melt that was compositionally homogeneous. Neodymium isotopic data indicate that this enriched component was ancient (>1600 Ma) and likely either reflects a compositionally homogeneous lower crustal contaminant or a previously enriched mantle source. Divergences from these minimum La/Nb and La/Sm ratios likely reflect upper crustal contamination (see arrows in Fig. 3) and, interestingly, are most pronounced in areas where the Alcurra Dolerite is known to be mineralized.

Comparisons with the Bentley Supergroup

The Bentley Supergroup is composed mainly of voluminous bimodal mafic and felsic volcanic rocks. The oldest component — found in the Blackstone region — is the c. 1078 Ma Kunmarnara Group, and includes the amygdaloidal basaltic lavas of the Mummawarrawarra Basalt. This basalt is a very distinct geochemical group (Fig. 3) that can be correlated, over several 100 km, with the Mount Harris Basalt in the Northern Territory (Close et al., 2003). Evidence for significant contamination by a discrete crustal component clearly distinguishes it from the younger Alcurra Dolerite.

The Tollu Group is composed of the felsic lavas of the c. 1072 Ma Smoke Hill Volcanics and these are overlain by the basic to intermediate lavas of the Hogarth Formation. Deposition of the Hogarth Formation possibly overlapped with emplacement of the Alcurra Dolerite, and the two groups show strong compositional similarities.

The Bentley Supergroup is best exposed in the Mount Eveline – Warburton Range area where its oldest outcrop component is the Pussy Cat Group. This group includes the amygdaloidal basaltic lavas of the Glyde Formation, some of which might be as young as c. 1065 Ma, although the rhyolitic 1071 ± 5 Ma Kathleen Ignimbrite (GSWA sample 195723) also forms a component of the group. Although basalts of the Glyde Formation show evidence of significant upper crustal contamination (Fig. 3), their least-contaminated rocks are compositionally very similar to the Alcurra Dolerite.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MORGAN RANGE
BLACKSTONE RANGE
HINCKLEY RANGE
BELL ROCK RANGE
JAMESON RANGE
CAVENAGH RANGE
Mt Daisy Bates
Mt Fanny
Amy Giles Hill
Mt Aloysius
Charnockite Flats
Blackstone
Tollu Prospect
Tollu pluton
Saturn pluton
Halley's Prospect Cu-Ni-PGE
Skirmish Hill
South Hill pluton
Mt Finlayson
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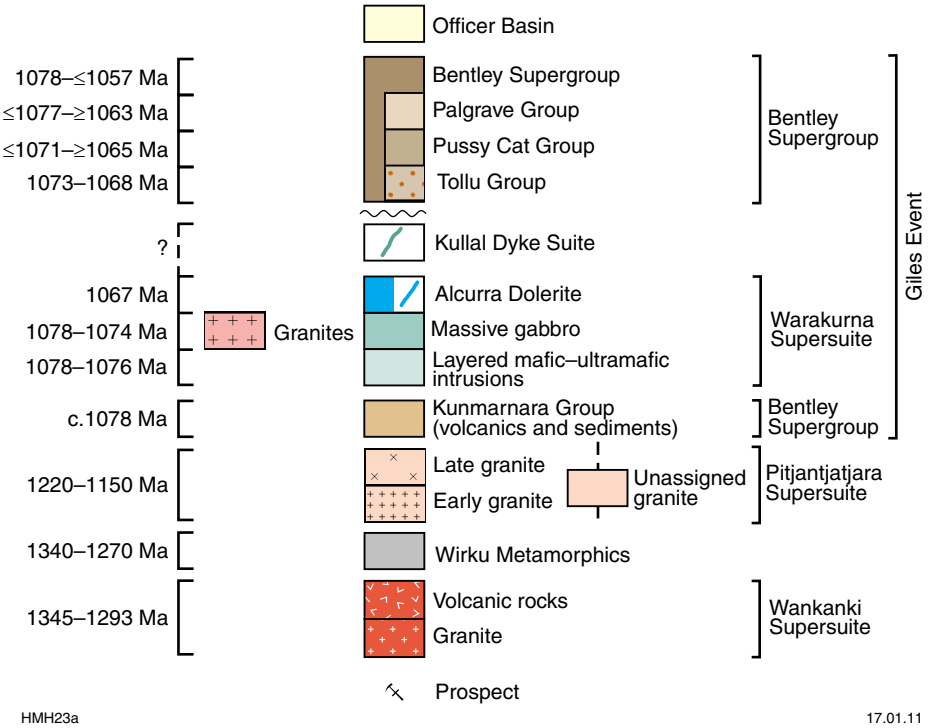

Figure 1. Solid geology interpretation of the eastern portion of the west Musgrave Province showing the distribution of major Alcurra Dolerite intrusions, extending through the Jameson, Blackstone and Bell Rock Ranges

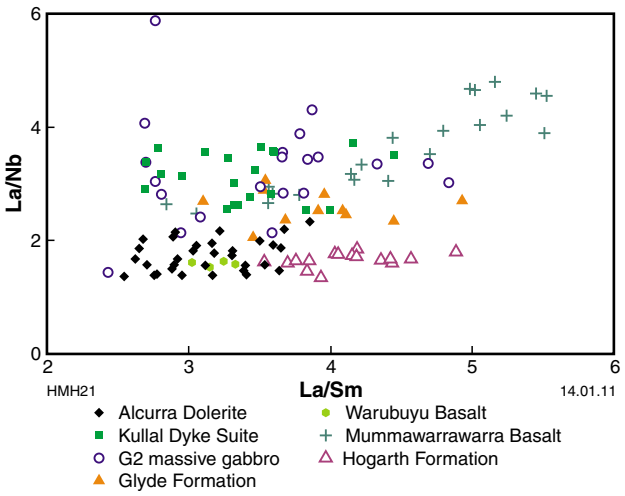

Figure 2. La/Nb vs La/Sm showing the Alcurra Dolerite, massive gabbro (Warakurna Supersuite), Kullal Dyke Suite, Mummawarrawarra Basalt, Glyde and Hogarth Formations, and Warubuyu Basalt

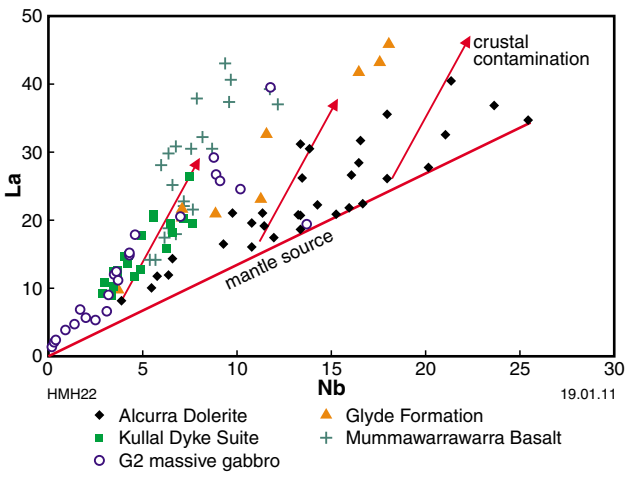

Figure 3. La vs Nb showing regionally constant minimum La/Nb and the effect of upper crustal contamination on all magma batches

The c. 1064 Ma Palgrave Group consists of a generally south-striking sequence that dips and youngs to the west. The succession is folded on a large scale and consists of felsic volcanic and pyroclastic rocks with minor lenses of mafic volcanic rocks. Regionally extensive, formerly vitric, units show remarkable geochemical homogeneity. Geochemically similar rhyolite forms a major component of the Scamp Volcanics and a new age of 1064 ± 5 Ma from the Scamp Volcanics (GSWA sample 195678) potentially links them with the Palgrave Group. Mafic lenses within the lower Palgrave Group and dolerite intrusions within the Scamp Volcanics are both geochemically very similar to the Alcurra Dolerite.

The Cassidy Group consists of a sequence of alternating and variably amygdaloidal mafic lavas and flow-banded rhyolitic lavas, such as the 1065 ± 5 Ma Wururu Rhyolite (GSWA sample 174690) and the 1057 ± 6 Ma Thomas Rhyolite (GSWA sample 174691). Several microgranite intrusions in the Mount Eveline area are geochemically similar to the Wururu Rhyolite and are most likely their synvolcanic equivalents. Basalts such as the Warubuyu Basalt show strong compositional similarities with the Alcurra Dolerite. The Thomas Rhyolite shows geochemical similarities with evolved rocks of the Hogarth Formation and with 1055 ± 10 Ma quartz diorite intrusions (GSWA sample 187054), which were emplaced into the Palgrave Group, and all of these show trace-element similarities with the Alcurra Dolerite.

The geochemical composition of the Alcurra Dolerite differs from most other mafic intrusive units of the Warakurna Supersuite (Figs 2, 3). However, several volcanic units of the Bentley Supergroup show remarkable compositional similarities and were most likely derived from the same source. Although the uncertainties on geochronological constraints allow the possibility that dolerite intrusions in the Scamp area, the Warubuyu Basalt, and quartz diorite intrusions into the Palgrave Group, are the same age as the Alcurra Dolerite, they are more likely to be younger intrusions derived from the same mantle source. Furthermore, the geochemical trends discussed show that basalts of the Glyde Formation and mafic lenses in the lower Palgrave Group could be genetically linked to the Alcurra Dolerite (suite).

References

Close, DF, Edgoose, CJ and Scrimgeour, IR 2003, Hull and Bloods Range, Northern Territory: Northern Territory Geological Survey, 1:100 000 Geological Map Series Explanatory Notes.

Traka Resources Limited 2008, Quarterly Activity Report December 2008, viewed January 2011, <http://www.trakaresources.com.au/quaterly.asp>.