THE UNIVERSITY OF ADELAIDE

A GEOCHEMICAL AND ISOTOPIC STUDY OF MAFIC AND INTERMEDIATE ROCKS IN THE OLARY PROVINCE, SOUTH AUSTRALIA - MAGMA SERIES DISCRIMINATION AND GEOCHRONOLOGICAL FRAMEWORK.

by HSR FREEMAN

November, 1995
A GEOCHEMICAL AND ISOTOPIC STUDY OF MAFIC AND INTERMEDIATE ROCKS IN THE OLARY PROVINCE, SOUTH AUSTRALIA-MAGMA SERIES DISCRIMINATION AND GEOCHRONOLOGICAL FRAMEWORK.

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November 1995

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Abstract

Sampling and analysis of the mafic and intermediate igneous rocks from the Olary Block in South Australia has revealed eight geochemically distinct rock types. The Outalpa Amphibolite is characterised by low concentrations of Fe(total), Ti, P, LREE and HFSE relative to the Cathedral Rock samples of Pierini (1994). The Antro and Poodla granitoids have intermediate compositions and exhibit remarkable geochemical similarity except for alkali abundances. Three types of apparently later greenschist facies dolerites can be distinguished by geochemical means. The HPT (high phosphorous & titanium) dolerites have higher concentrations of LREE and HFSE than the LPT (low phosphorous & titanium) dolerites. The Rainy Day dolerite has low phosphorous and high titanium concentrations, and has HFSE and LREE concentrations intermediate between the HPT and LPT dolerites.

The Maldorky Lamprophyre that crops out south of the Olary township has lamproitic affinities, and is geochemically similar to the post-Delamerian Ordovician lamprophyres near Truro and Anabama Hill.

ɛNd(T) values are generally higher for the Outalpa amphibolite, LPT dolerites and Rainy Day dolerites, indicating derivation from a more depleted source or greater crustal interaction. The Poodla Granitoid has significantly lower ɛNd(T) than the Antro Granitoid: this is consistent with petrographic and geochemical evidence that suggests a greater level of crustal contamination of the former.

A Pb/Pb zircon date for the Antro Granitoid was obtained using the evaporation ('Kober') method. A magmatic age of 1679±13Ma is comparable to SHRIMP ages from the Broken Hill Block (e.g. Page and Laing, 1992). Significantly, this age may constrain the intrusion of the Outalpa Amphibolite to post ~1700Ma and pre- ~1680Ma.
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**Map I:** THE GEOLOGY OF THE AREA WEST OF AMEROO HILL, OLARY BLOCK (1:5000).

**Map II:** THE GEOLOGY OF THE AREA 2km NE OF ANTRO WOOLSHED, OLARY BLOCK 'Rainy Day' (1:2500).

**Map III:** THE GEOLOGY OF THE AREA 5km EAST OF ANTRO WOOLSHED, OLARY BLOCK (1:2500).
### Abbreviations

<table>
<thead>
<tr>
<th>Abbreviation</th>
<th>Description</th>
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<tbody>
<tr>
<td>B.E.</td>
<td>Bulk Earth</td>
</tr>
<tr>
<td>bt</td>
<td>biotite</td>
</tr>
<tr>
<td>CFB</td>
<td>continental flood basalt</td>
</tr>
<tr>
<td>CHUR</td>
<td>chondritic uniform reservoir</td>
</tr>
<tr>
<td>cpx</td>
<td>clinopyroxene</td>
</tr>
<tr>
<td>DM</td>
<td>depleted mantle</td>
</tr>
<tr>
<td>EMI</td>
<td>enriched mantle type I</td>
</tr>
<tr>
<td>EMII</td>
<td>enriched mantle type II</td>
</tr>
<tr>
<td>$\epsilon$Nd(T)</td>
<td>epsilon neodymium value at time, T</td>
</tr>
<tr>
<td>E-type MORB</td>
<td>enriched mid ocean ridge basalt</td>
</tr>
<tr>
<td>feld</td>
<td>feldspar</td>
</tr>
<tr>
<td>Ga</td>
<td>Giga-anna (billions of years before present)</td>
</tr>
<tr>
<td>HFSE</td>
<td>high field strength element</td>
</tr>
<tr>
<td>HPT</td>
<td>Olary Block high phosphorous &amp; titanium dolerite</td>
</tr>
<tr>
<td>HREE</td>
<td>heavy rare earth element</td>
</tr>
<tr>
<td>LIL</td>
<td>large ion lithophile (element)</td>
</tr>
<tr>
<td>LOI</td>
<td>Loss on ignition</td>
</tr>
<tr>
<td>LPT</td>
<td>Olary Block low phosphorous &amp; titanium dolerite</td>
</tr>
<tr>
<td>LREE</td>
<td>light rare earth element</td>
</tr>
<tr>
<td>Ma</td>
<td>Mega-anna (millions of years before present)</td>
</tr>
<tr>
<td>Mg#</td>
<td>magnesium number ($=\frac{Mg^{2+}}{Mg^{2+}+Fe^{2+}}$)</td>
</tr>
<tr>
<td>MORB</td>
<td>mid-ocean ridge basalt</td>
</tr>
<tr>
<td>mu</td>
<td>muscovite</td>
</tr>
<tr>
<td>OIB</td>
<td>ocean island basalt</td>
</tr>
<tr>
<td>OIT</td>
<td>ocean island tholeiite</td>
</tr>
<tr>
<td>plag</td>
<td>plagioclase</td>
</tr>
<tr>
<td>P.M.</td>
<td>primordial mantle</td>
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<tr>
<td>P-T-t</td>
<td>pressure-temperature-time</td>
</tr>
<tr>
<td>qtz</td>
<td>quartz</td>
</tr>
<tr>
<td>REE</td>
<td>rare earth element</td>
</tr>
<tr>
<td>TDM</td>
<td>depleted mantle model age</td>
</tr>
<tr>
<td>tour</td>
<td>tourmaline</td>
</tr>
<tr>
<td>XRF</td>
<td>X-ray fluorescence</td>
</tr>
<tr>
<td>zir</td>
<td>zircon</td>
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</table>
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