SPINIFEX GEOCHEMISTRY LEADS TO DISCOVERY OF A NEW METALLOGENIC PROVINCE IN SOUTH WEST QUEENSLAND

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OUTLINE

- Results of GSQ sponsored spinifex geochemistry study in the Simpson Desert.
- Discovery of phoscorite-carbonatite intrusions.
- Geodynamic interpretation: a Devonian age plume track in the Australian plate.
- Greenfield exploration opportunities in this new metallogenic province.
- Applications in South Australia.
Primary or secondary elemental enrichments are useful vectors for mineralisation under cover.

Spinifex roots extend >80 m searching for water.

Roots are acidic, bacteria-rich environments that enable metals to become mobile.

Elemental anomalies (ppm to ppt) can be detected by ICPMS analysis of green fronds.

Spinifex preserves these elemental enrichment patterns.

REE patterns of buried lithologies are also preserved.
• Occurs in > 30% of the continent.
• A very common species in SA.
• Spinifex biogeochemistry is an excellent technique for exploration where regolith is sand covered.
• Elements concentrated in spinifex fronds include Au, Ag, PGEs, Cr, Ni, Cu, Pb, Zn, REEs, Sc and Nb

Distribution of spinifex from Reid and Hill (2013)
MINERAL SYSTEM CHARACTERISTICS OF ALKALINE INTRUSIONS > 3000 ANALYSES

- Pt, Pd, Re, Au, Cu, Sc, REE+Y, P, U & Th.
- Intrusions with similar chemistry to those drilled by AusQuest/GSQ ~ 100 km to the south east?
- Also identified epithermal terrane and accreted terrane signatures.
The Source of the Alkaline Signature

Alkaline plugs drilled by AusQuest-CDI in 2007
Searching for IOCGs

Most Igneous Rocks in this Field

[Map and diagram showing drill holes and mineral distribution]
Chondrite-normalised REE patterns of spinifex in the Tanami mimic the shape of the REE\textsubscript{(N)} pattern of the underlying syenite. Data courtesy of Ian Hodkinson (pers comm)

- Not reported in CSIRO’s spinifex studies.
- **Spinifex biogeochemistry a technique to map lithologies where the basement is obscured by surficial deposits.**
Lake Machattie phoscorite-carbonatite intrusion

- Mean Ni/Sc = 2.87
- Mean Cr/Ni = 1.93
Carbonatite – phoscorite complexes are pipe shaped intrusions 3-4 km in diameter.

Phoscorites contain variable amounts of carbonate (calcite, dolomite, ankerite), with olivine (forsterite), magnetite and apatite – only 28 occurrences cf. > 580 carbonatites.

Associated lithologies include dunite (olivinite) and pyroxenite as well as feldspathoid-bearing gabbro (ijolite), diorite, monzonite and syenite.

All associated with mineralisation e.g., Kola Peninsula and Brasil.
MAGNETIC ANOMALIES ULTRAMAFIC-MAFIC ALKALINE INTRUSIONS

AusQuest Samples

MULDH001

Cr/Ni = 1.55 ± 1.68

REE pattern and transition element ratio suggests a similar intrusion.
DIAMANTINA INTRUSIONS ARE REE ENRICHED

AusQuest Samples

LMDDH001

Compositions include carbonatites, pyroxenites, phoscorites and foid-bearing syenites
DIAMANTINA INTRUSIONS ARE REE ENRICHED

REE Profiles in Regolith over Diamantina Intrusions

Similar extreme levels of REE enrichment in weathering profile over Diamantina Suite Intrusions to that seen in JORC resourced Tanami carbothermal deposits.

Similar to REE variation in Kovdor phoscorite – carbonatite in the Kola Pen. Russia

Kovdor Data: Verhulst et al., (2000);
METALLOGENIC SIGNATURE OF ALKALINE INTRUSIONS

High Field Strength Elements

Phosphorus

REEY
Elevated Au, Pt & Pd

Primitive (lower) mantle Au = 1 ppb and Pt+Pd = 11 ppb.
Crustal Au = 1.8 ppb and Pt+Pd = 3.5 ppb.
ELEVATED SCANDIUM IN DIAMANTINA ALKALINE SUITE

Kovdor Averages
- Phoscorites: 41-67 ppm
- Carbonatites: 14-30 ppm

If plugs overlain by laterite, this might contain ore grades

Catalão 1
- Phoscorites: 25 ± 14 ppm
- Carbonatites: 20.5 ppm

Tapira
- Phoscorites: 38.8 ± 16 ppm
- Carbonatites: 14.1 ± 5.5 ppm

AusQuest Samples

LMD Cores Sc = 27.4 ± 9.6 ppm (n=206)
MUL Cores Sc = 27.3 ± 16.6 (n=89)
A MODEL FOR DIAMANTINA ALKALINE INTRUSIONS

- Early silicate alkaline magmas (dunites to syenites) intruded by carbonatite plug and dikes or cone sheets of carbonatite and ferrocarbonatite.
- Alteration envelope surrounding the carbonatite, dunites and other silicate magmas.
- Carbo- and fluoro-thermal fenite is enriched in REE and HFSE.
- These alteration zones are excellent exploration targets.

SUPER PLUMES AND PHOSCORITE-CARBONATITE MAGMATISM

- Diamantina phoscorite - carbonatite intrusions (386 Ma) & Merlin kimberlites (368 Ma) were intruded when “proto-Australia” over Pacific Super plume.

- Kola 376-382 Ma phoscorite-carbonatite intrusions emplaced when Baltic Shield above the African Super plume.

- Movement of Gondwana lithosphere over Pacific plume created a plume track.

PROSPECTIVITY INTERPRETATION OF THE MERLIN-DIAMANTINA-OWENDALE PLUME TRACK

- Length of track 2010 km
- Duration of track 76 Ma
- Silurian-Devonian
- Plate Velocity = 2.6 cm/y
- Hawaiian Plume plate velocity 9-10 cm/y
- Current drift of Australian plate 7 cm/y


The entire plume track is prospective for PGEs, REEYs, HFSEs, Sc, Au, Cr, Ni, P and diamonds

Toongi phonolite

Nolans Bore

Mt Weld

Copperhead

Philips Range

Killi Killi Hills

Norseman

Carrapatches

Narraburra

Yungul

Cummins Range

Mordor

Nolans

Olympic Dam

Toongi phonolite

Narraburra

Owendale/Fifield

Sc and PGE plugs 444±4 Ma (Geo. Sci Aust)

Owendale/Fifield on the same plume track as Diamantina-Merlin.

Merlin Kimberlites

368±4 Ma Zr. 367±4 Ma Rb-Sr (McInnes et al., 2009)

Diamantina Alkaline Suite

386±2 Ma (Carson et al., 2011)
OPPORTUNITIES USING SPINIFEX GEOCHEMISTRY IN SA & NT

Distribution of spinifex from Reid and Hill (2013)
A new Silurian-Devonian metallogenic province has been discovered in Australia using spinifex biogeochemistry. Targets include PGE, Sc, REE, HFSE, Cu, Au and possibly diamond. Intrusions are surrounded by REEY-rich fenite alteration zones and may be capped by metal-rich laterite. Province defines a previously unknown plume track produced when North Australian Craton traversed the Pacific Super plume. Plume track intrusions extend from NSW into SW Queensland and NW into the Northern Territory. The entire plume track is prospective. Spinifex biogeochemistry is a low cost and low impact technique with potential application for exploration in South Australia.