Geophysical delineation and mineral potential of mafic-ultramafic intrusions in the Arunta Region

Tony Meixner, Dean Hoatson, Yanis Miezitis, Subhash Jaireth & Jon Claoué-Long

Andrew Young Hills
Three major studies

Dean Hoatson, Jon Claoué-Long & Shen-su Sun
- Geological setting, event chronology & mineral potential

Tony Meixner & Dean Hoatson
- Geophysical interpretation – total subcropping extent, depth of cover, orientation & internal structure

Yanis Miezitis, Subhash Jaireth & Dean Hoatson
- Mineral potential modelling

Acknowledgements:
- Colleagues at Northern Territory Geological Survey
- Various exploration companies in the Arunta Region
Distribution of major Arunta mafic-ultramafic intrusions
Andrew Young Hills

High level - fractionated intrusion
Compositionally layered
Undeformed
1635±9 Ma
Crustal contamination
Commingling of mafic-felsic magmas
Early history of S saturation

Andrew Young Hills intrusion
- Gabbronorite, gabbro, quartz
  - gabbro, tonalite, diorite
- Hornblende granite
Andrew Young Hills
Mount Chapple Metamorphics

Large composite mafic-intermediate-felsic granulite body
Central portion dominated by mafic granulite
Felsic unit: 1771 ±10/-6 Ma
Early history of S saturation
Mafic unit: 1774.0 ± 1.9 Ma
Mount Hay Granulite

Sub-horizontal elongate balloon-like body

Primary crystallisation age: 1803±5 Ma
Deformation event: 1700±17 Ma

Mount Hay Granulite intrusion

- **Gabbro**
- **Mafic granulite**
- **Mafic granulite, garnet gneiss**

Anburla Anorthosite

Anorthosite
Mount Hay Granulite

Crustal contamination
Commingling of mafic-felsic magmas
Early history of S saturation

Mount Hay Granulite intrusion
- **Gabbro**
- **Mafic granulite**
- **Mafic granulite, garnet gneiss**
- Anbula Anorthosite
- Anorthosite

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Attutra Metagabbro

Relatively homogeneous weekly recrystallised metagabbro

Preservation of original igneous textures

1786.4 ± 4.2 Ma

S undersaturated

PGE-bearing magnetite layers
Mordor Complex

Undeformed composite plug-like body

1133 ± 5 Ma

PGE-bearing sulphide mineralisation

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Summary of geophysical signatures

- Intrusions coincident with high gravity anomalies
- Intrusions generally have medium to high magnetic anomalies
- Magnetic signatures are dependant on metamorphic grade and post emplacement deformation history
  
  Low grade: readily differentiated from country rock primary igneous features
  - Andrew Young Hills (macroscopic layering)
  - Mordor Complex (composition differences)

  High grade: not so easy to differentiate from country rock variable magnetic signatures are the result of deformation processes
  - Exception: Mount Hay Granulite - high grade, exhibits macroscopic layering
Interpreted mafic-ultramafic intrusions

Subcropping intrusion
- High magnetic intensity
- Coherent linear anomalies
- High magnetic intensity
- Massive texture
- Deeply buried intrusion
- Diffuse magnetic anomaly

Fault
- Boundary confident
- Boundary less confident
- Magnetic trend

Andrew Young Hills

North

Liebig

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Interpreted mafic-ultramafic intrusions

Andrew Young Hills

50 km

Interpreted mafic-ultramafic intrusions
Interpreted mafic-ultramafic intrusions
Interpreted mafic-ultramafic intrusions
Interpreted mafic-ultramafic intrusions
## Relationships with crustal events

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Potential settings for mineralisation in Arunta intrusions

- Attutra Metagabbro
- Andrew Young Hills
- Mt Hay, Mt Chapple
Mineral potential modelling

Knowledge driven qualitative method applied to rank the mafic-ultramafic intrusions with their probability to host Ni-Cu-Co±PGE mineralisation

Three types of orthomagmatic deposits:
1. Basal segregations of Ni-Cu-Co±PGE sulphides in mafic-ultramafic intrusions (Voisey’s Bay type deposits)
2. Stratabound PGE-bearing sulphide layers in large layered mafic-ultramafic intrusions (Merensky Reef type deposits)
3. Stratabound PGE-bearing sulphide layers in alkaline-ultramafic intrusions (Alaskan type deposits)
Mineral potential modelling

Stratabound PGE bearing sulphide layers in alkaline-ultramafic intrusions (Alaskan type)

Basal segregations of Ni-Cu-Co ± PGE sulphides (Voisey Bay type)

Stratabound PGE bearing sulphide layers in mafic-ultramafic intrusions (Merenski Reef type)
Favourable mineralised environments

Basal Ni-Cu-Co ± PGE sulphides
- Ni bearing magmas
- Rapid S saturation by magma contamination with country rock
- Massive sulphides hosted by thin basal gabbroic rock
- Massive sulphides confined to
  - basal contact with feeder conduit
  - structural embayments
  - base of thickest sequences of cumulates

Geophysics (magnetics)
- Define intrusion geometry
- Determine younging direction
- Locate favourable mineralised environments

Geophysics (airborne and ground electromagnetics and induced polarisation)
- Delineate conductive sulphides

Basal contact
Highly prospective

Embayment?
Highly prospective

Feeder conduit?
Highly prospective
References

Journal papers


Geoscience Australia Records

