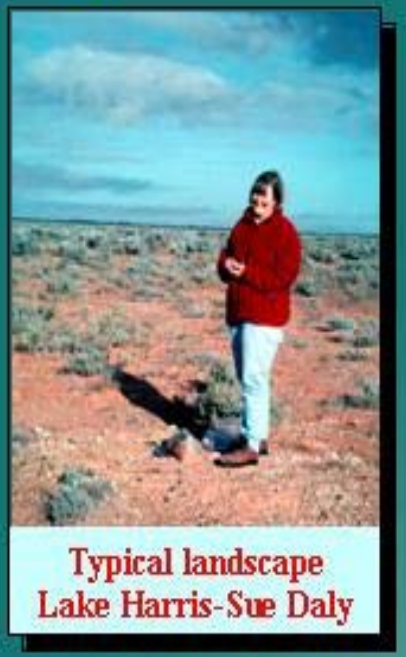
Preliminary assessment of the Ni-Cu-PGE potential of the Harris Greenstone Belt, Gawler Craton

Lake Harris Komatiite (*the* outcrop)

Dean Hoatson



Typical landscape Lake Harris-Sue Daly

Geoscience Australia
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Important contributions from:

MER (PIRSA): Marc Davies, Michael Schwarz, Sue Daly, Gary Ferris, Wen-long Zang (geology)

Other Specialists: Shen-su Sun (geochemistry), Morrie Duggan (mineralogy), Alan Purvis (petrography), Roland Maas (Sm-Nd isotopes), Mark Fanning (U-Pb geochronology)

A collaborative GA-MER study

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HARRIS GREENSTONE DOMAIN

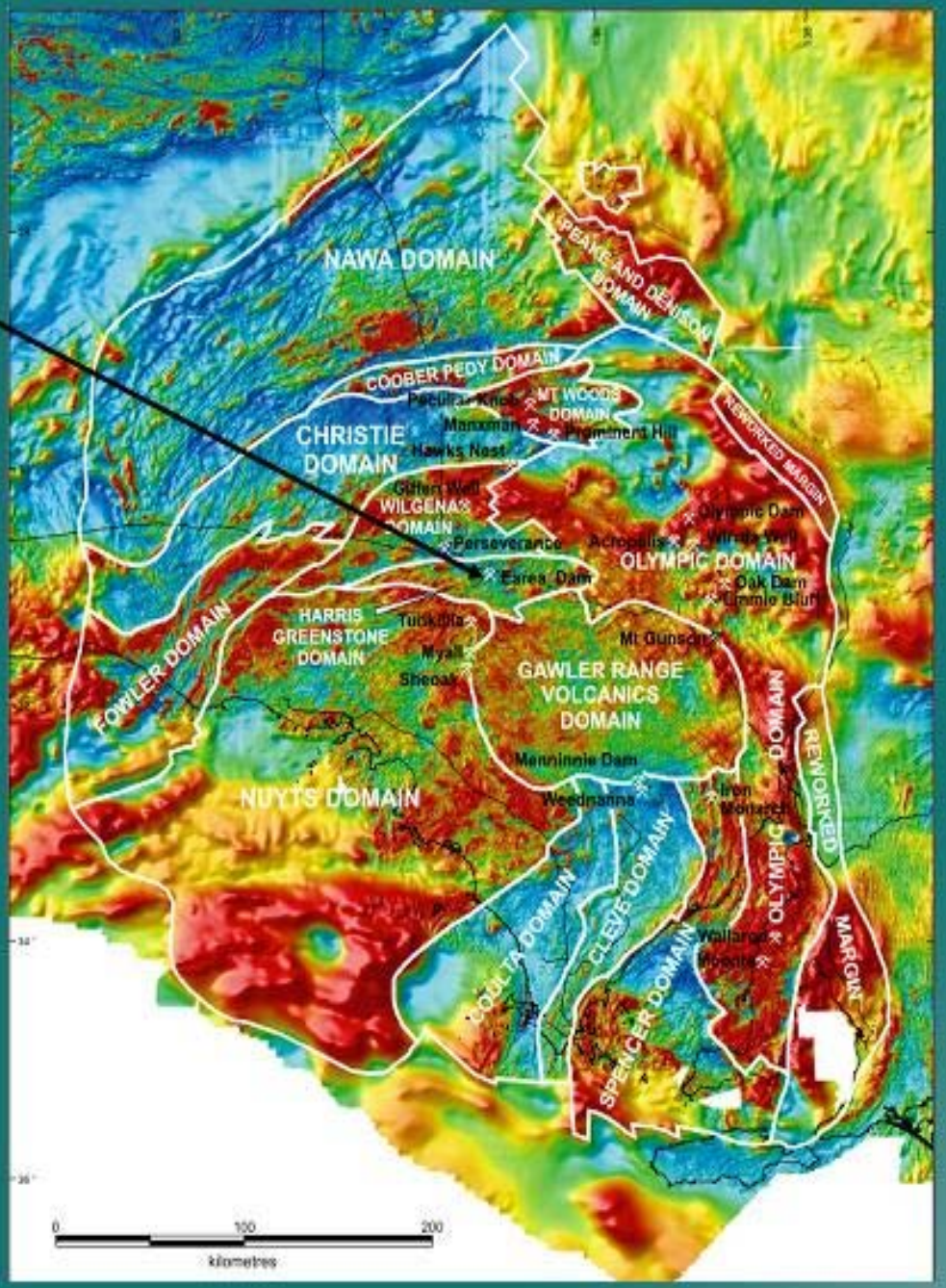

Image: TMI/Domains
Ferris et al 2002

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- *HGD*: small (~50 x 220 km) late Arch-Prot arcuate terrane:
  - ultramafic-mafic volcs (Lake Harris Komatiite-*LHK*)
  - aluminous metaseds (Christie Gneiss)
  - orthogneiss (Kenella Gneiss)
  - mafic intrusions (South Lake Gabbro)
  - granites (Glenloth Granite)
  - Prot gran/volcs/seds (Hiltaba, GRV, Tarcoola Fm)

- *LHK sequence*: high to low Mg (43-15% MgO) komatiite, komatiitic & tholeiitic basalts, minor BIF, metaseds, ?pyroclastics; steeply-dipping, 300+ km strike extent, middle amphibolite facies overprint (~2440 Ma)

- *Temporal framework*: *LHK* cut by ~2500 Ma Glenloth Granite; ~2510 Ma felsic volcanics

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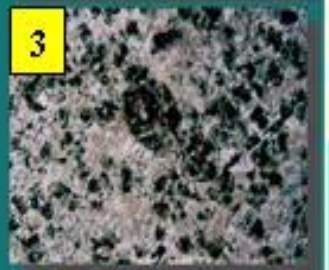
Pandurra Fm (>~1425) seds
Hiltaba Suite Granite (~1590): granite
Gawler Range Volcs (~1590): volcs
Muckanippie Anorth Suite (~?1630): anorth
Tarcoola Fm (~1650): seds
Symons Granite (~1690), St Peter Suite (~1630): granite
Wilgena Hill Jaspilite (>~1740): banded iron fm

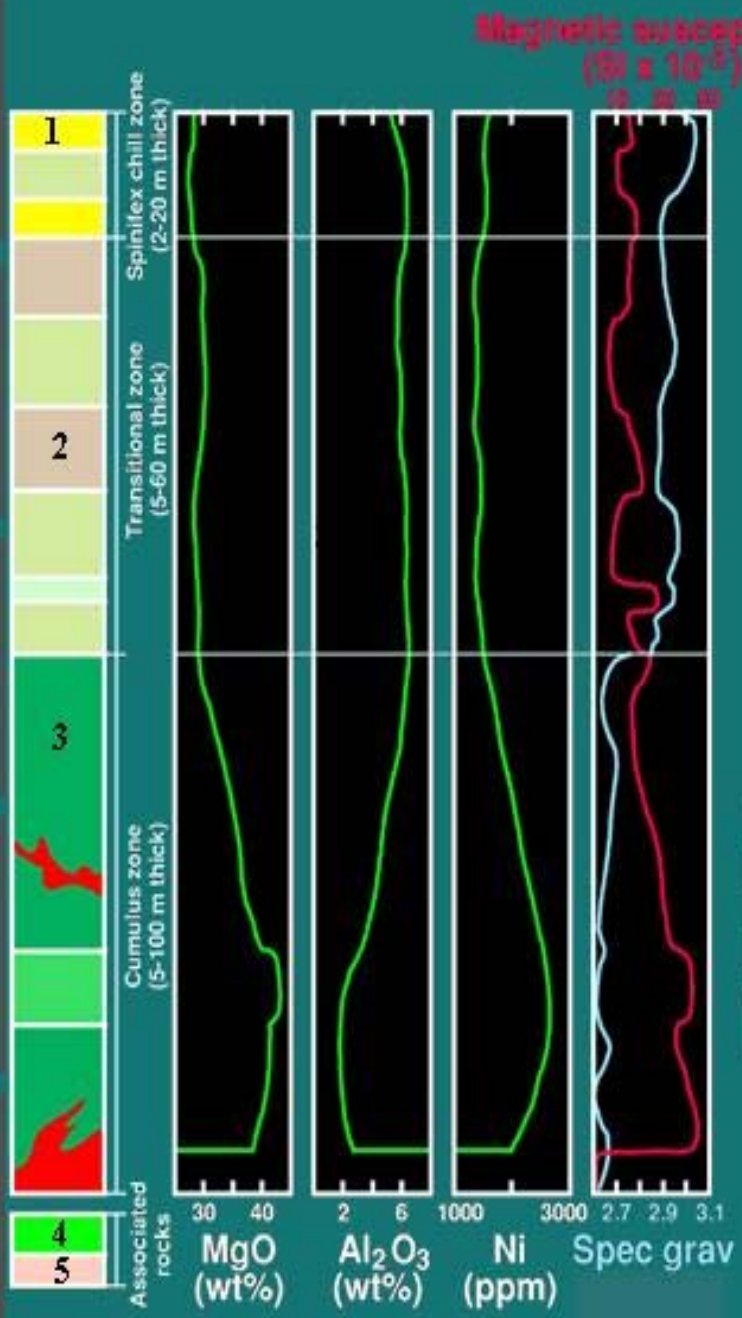
Glenloth Gran (~2500): gneissic gran
Harris Greenstone Seq. (>~2500): komatiite, basalt, felsic volcanics, banded iron formation, metasediments
Undiff Precamb basement: gran, orthogneiss, paragneiss

(Ages shown in Ma)

30 km

(From 1VD TMI, Grav, DDHs: Hoatson et al 2002)





Lake Harris Komatiite

- *Komatiite with random platy spinifex*
- *?Flow top breccia*
- *Aphyric komatiite*
- *Komatiite with no relict texture*
- *Olivine adcumulate*
- *Olivine ortho- and mesocumulate*

Associated rocks

- *Felsic rocks (quartz diorite, dacite, chert)*
- *Banded iron formation, metasediments*
- *Pillowed metabasalt*

Images: GA-MER

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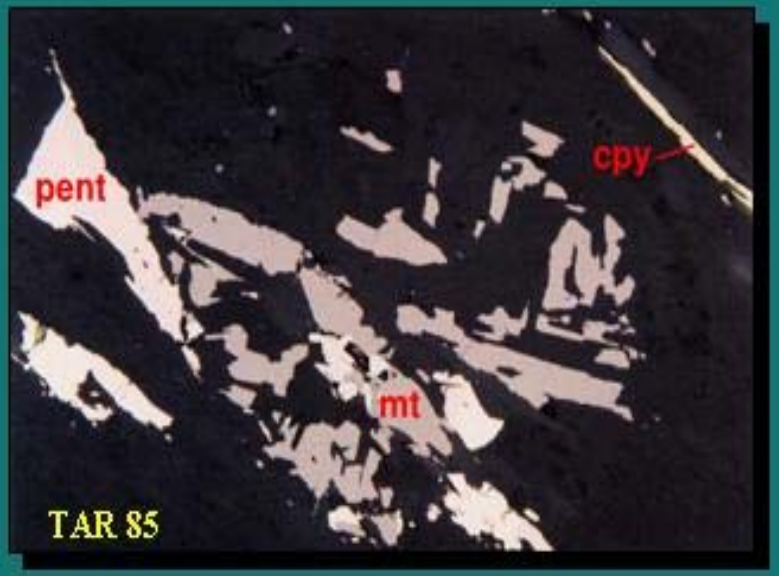
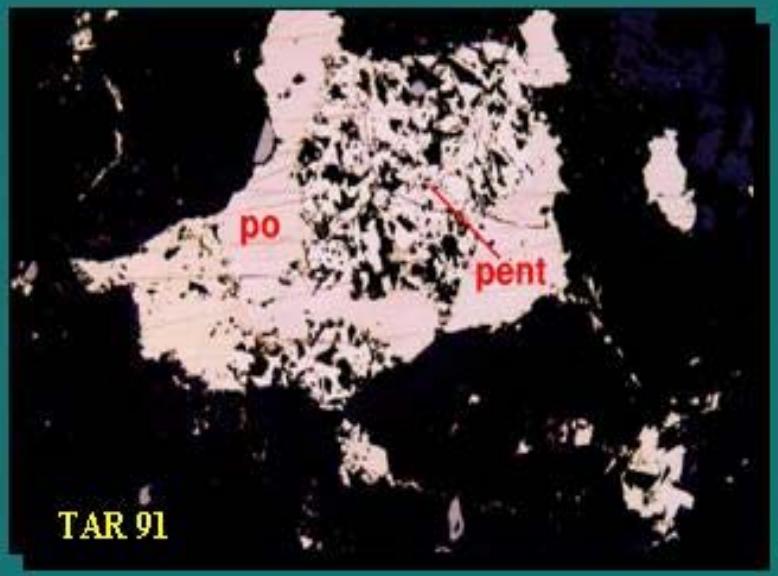
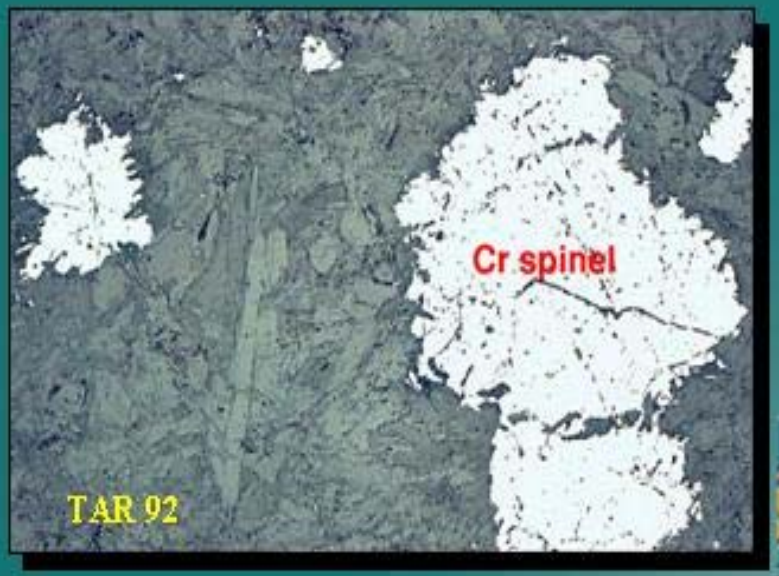
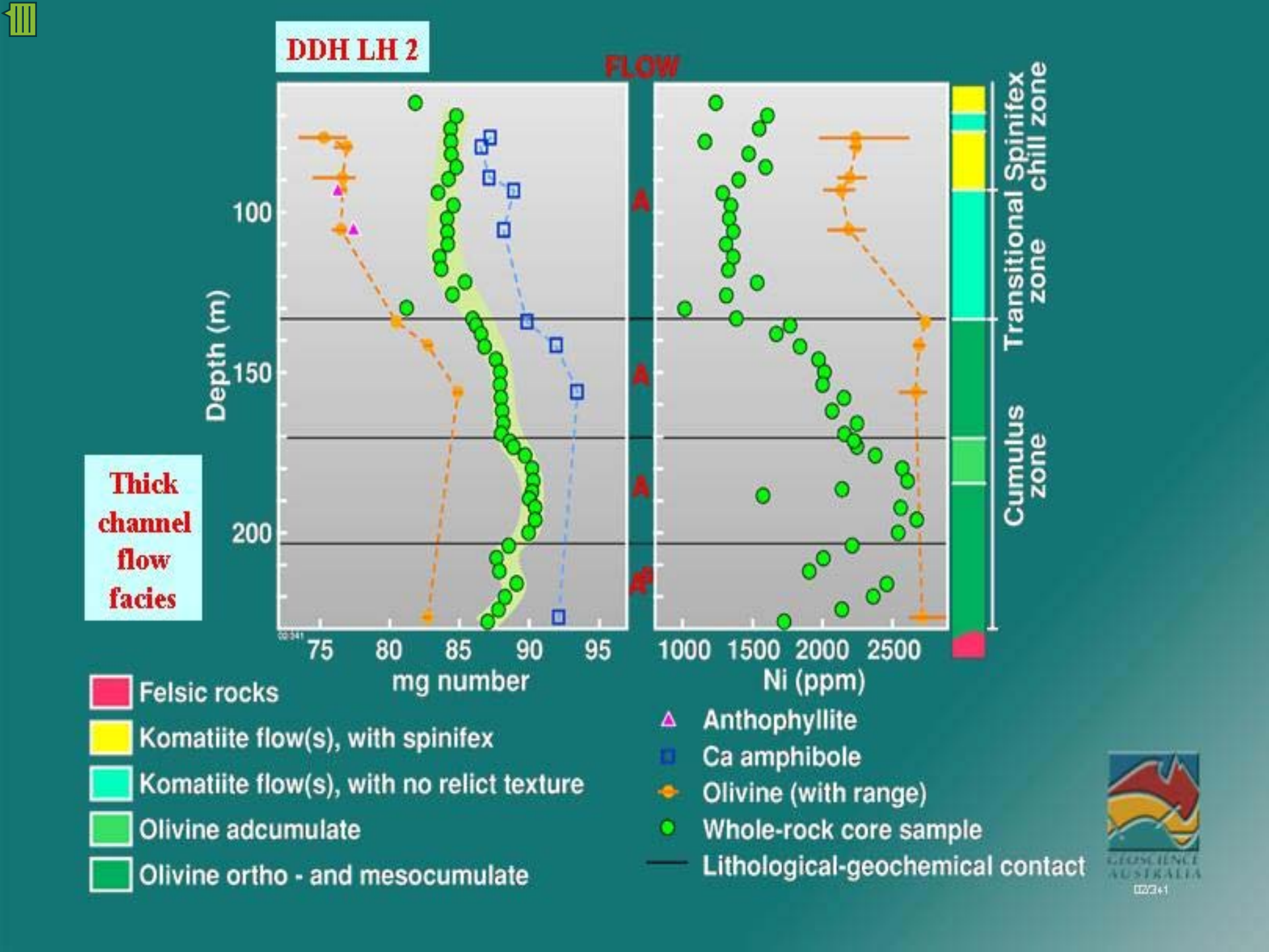
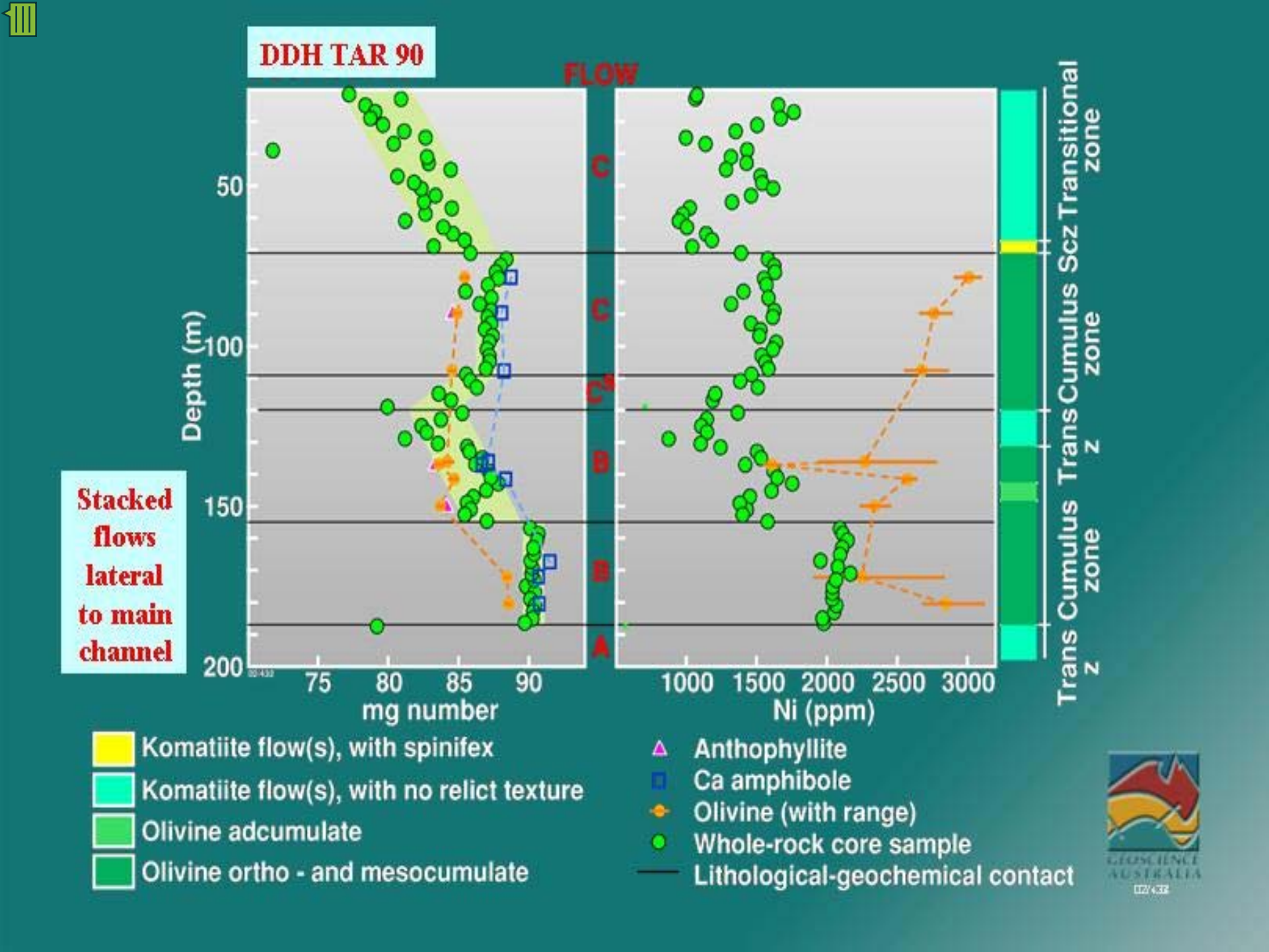


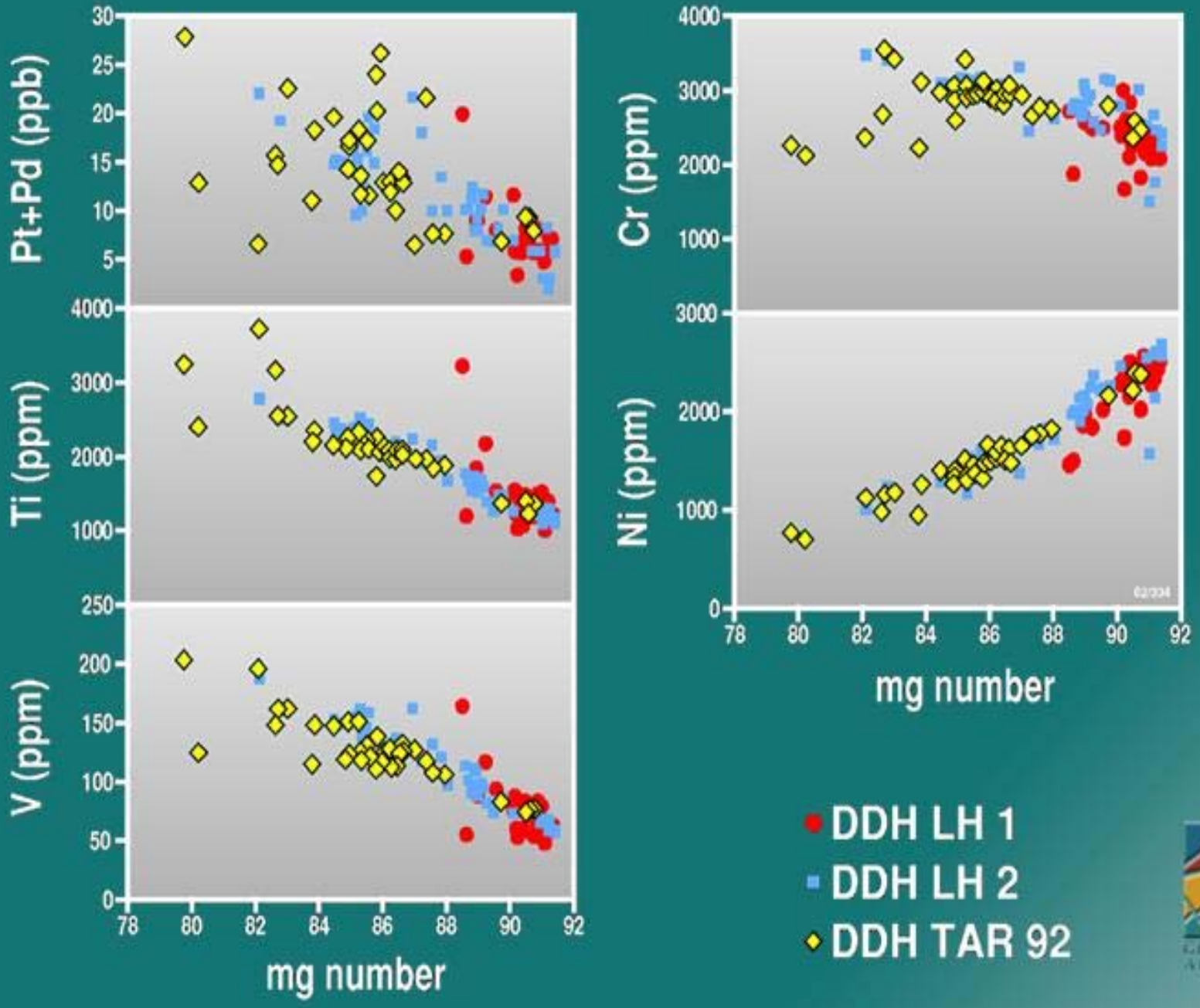


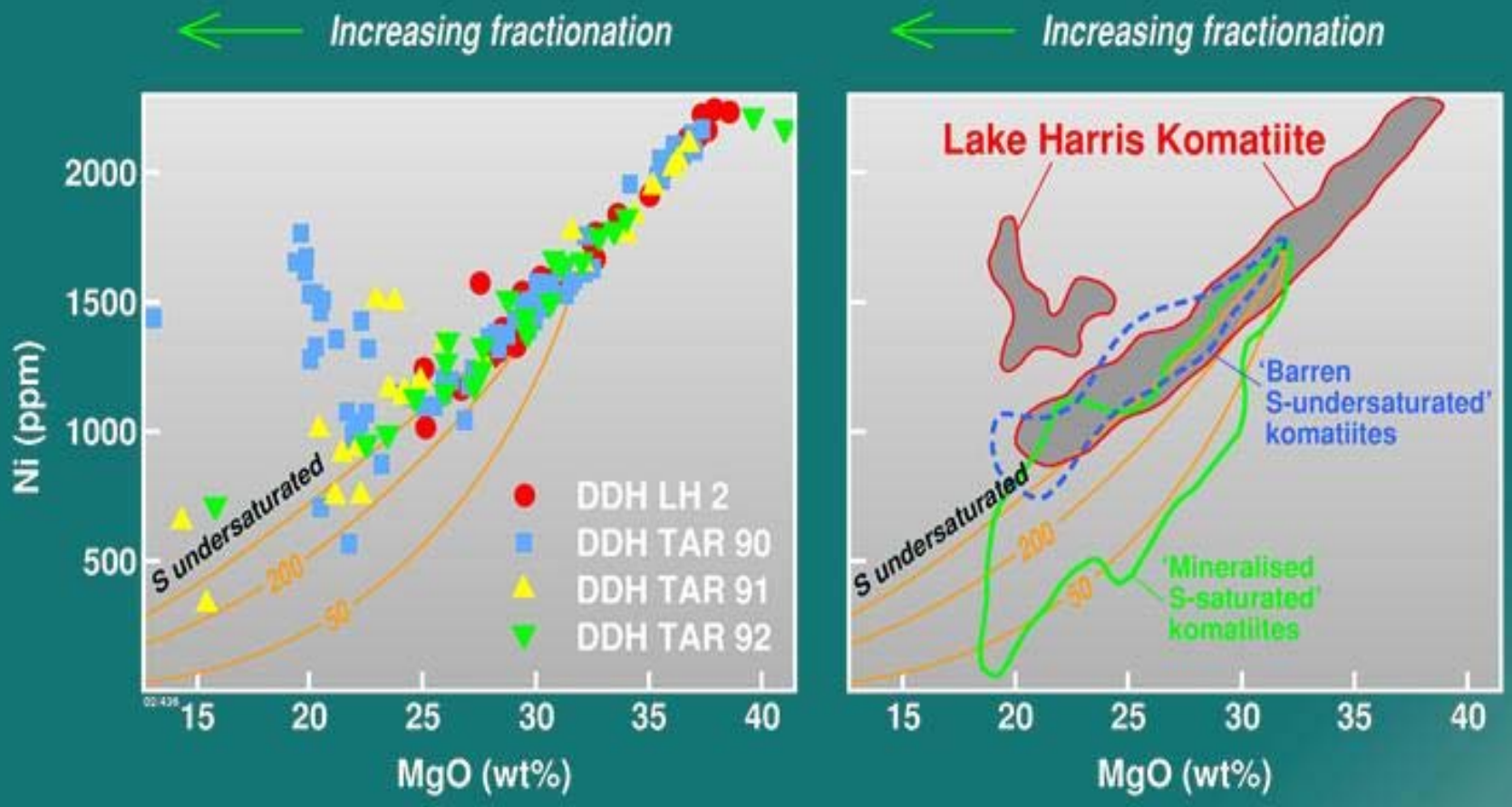


Reflected Light Images: Purvis & Duggan 2002

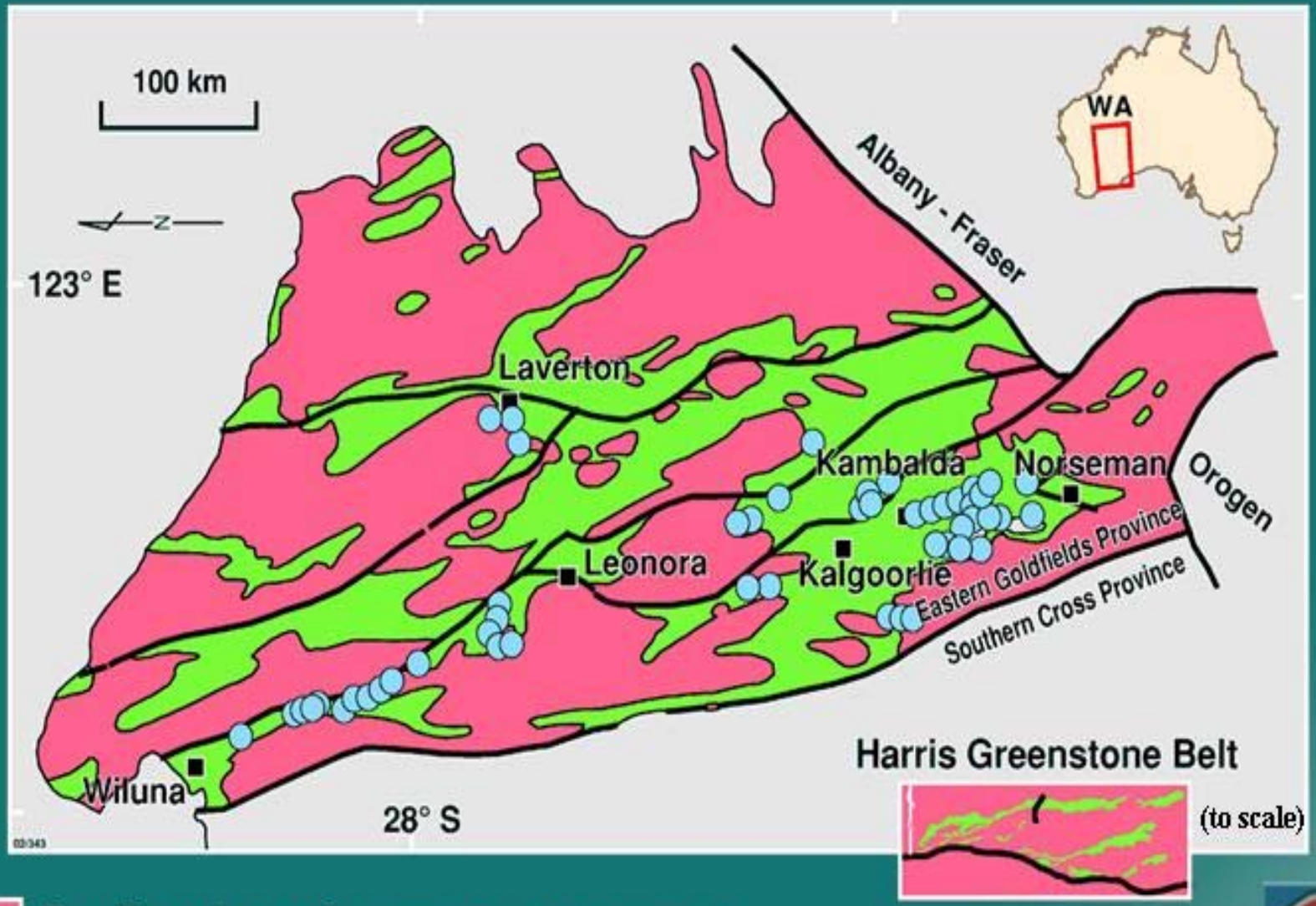

DDH LH 2
FLOW
Depth (m)
100
150
200
A
A
A
AP
75
80
85
90
95
mg number
1000
1500
2000
2500
Ni (ppm)
Transitional Spinifex zone
chill zone
Cumulus zone
Thick channel flow facies
Felsic rocks
Komatiite flow(s), with spinifex
Komatiite flow(s), with no relict texture
Olivine adcumulate
Olivine ortho - and mesocumulate
Anthophyllite
Ca amphibole
Olivine (with range)
Whole-rock core sample
Lithological-geochemical contact


DDH TAR 90
FLOW
C
C
C
B
B
A
Depth (m)
50
100
150
200
75
80
85
90
mg number
1000
1500
2000
2500
3000
Ni (ppm)
Trans Cumulus Scz Transitional zone
Trans Cumulus Trans Cumulus zone
Trans Cumulus zone
Stacked flows lateral to main channel
Komatiite flow(s), with spinifex
Komatiite flow(s), with no relict texture
Olivine adcumulate
Olivine ortho - and mesocumulate
Anthophyllite
Ca amphibole
Olivine (with range)
Whole-rock core sample
Lithological-geochemical contact


Pt+Pd (ppb)
Ti (ppm)
V (ppm)
Cr (ppm)
Ni (ppm)
mg number
mg number
DDH LH 1
DDH LH 2
DDH TAR 92



Overseas komatiite data: Naldrett 1989


100 km
N
123° E
WA
Albany - Fraser
Laverton
Kambalda
Norseman
Orogen
Leonora
Kalgoorlie
Eastern Goldfields Province
Southern Cross Province
Wiluna
28° S
Harris Greenstone Belt
(to scale)
Granitic rocks, gneiss
Greenstone
Fault or lineament
Major Ni-Cu sulphide deposit

	Lake Harris	Eastern Goldfields
AGE	>2500 Ma	2700 Ma
EXTENT	300+ km	10-1000's km
MET GRADE	Amphibolite	Greenschist
PRIMITIVE KOM	43% MgO	45% MgO
PRIMITIVE OL	Fo_{89}	Fo_{94}
TEXTURES		

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Exploration Considerations: Positives

- Extensive magmatic systems → 100's of km with variety of komatiites (43-15% MgO)
- Preserved volcanic facies: thick (160 m) channel and composite thin (5-40 m) flows
- Dominantly fertile S-undersaturated magmatic systems with low S (100-600 ppm S) and high Pd+Pt (5-30 ppb)
- Similar broad setting, rock types & primitive compositions to greenstones in EGP/SCP

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Exploration Considerations: Negatives

- Poor outcrop and extensive cover (20-80 m)
- High proportion of younger granitic rocks; S-bearing country rock sediments rare and thin? → need S-saturation mechanism
- ?Passive ponding environments rather than turbulent channel systems that assimilate S-bearing country rocks
- Amphibolite facies overprint & sheared contacts

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3-D Perspective: Kambalda Dome

Red: Ore shoots

White: S-bearing sediments

Blue: Contact sediments

Yellow: Lunnon Basalt (footwall)

Image: Fractal Graphics & WMC Ltd
Data: 4000 DDHs & 70 mine sections

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Future Studies?: Ni-Cu-PGE Potential

- Identification of S-bearing sediments cut by komatiite flows (DDH-TMI-gravity modelling); need to identify S-saturation mechanism
- S-evolution studies (high versus low Pd/S)
- Isotope (Re/Os) studies → crustal contamination
- Robust regional geochronological framework
- Characterisation of volcanic architecture