IGES, Dublin
Use of Indicator Minerals in Exploration

Indicator Minerals for Ni-Cu-PGE Exploration

Presented by Stu Averill
Overburden Drilling Management Limited
September 01, 2003

5-Cent Coins

Canadian Nickel

U.S. Nickel

Irish Euro

INIDICATOR MINERAL (AGI Glossary)

A mineral that suggests the presence of a mineral deposit

INDICATOR MINERAL (Stu Averill)

A mineral having certain physical and chemical properties that make it *useful* for identifying significant mineralization or alteration *at long range*

Properties of Ni-Cu-PGE Indicator Minerals

- coarse-grained (>0.25 mm)
- occur in few if any rocks other than fertile mafic/ultramafic intrusions or komatiites
- visually distinctive
- chemically resistant to weathering
- sufficiently heavy (S.G. >3.2) to be readily concentrated from large samples by gravity means
- amenable to further concentration by electromagnetic separation

Ni-Cu-PGE INDICATOR ELEMENTS

Special elements in an indicator mineral which are related directly to Ni-Cu-PGE mineralization or to the gravitational or alteration processes that concentrated the mineralization

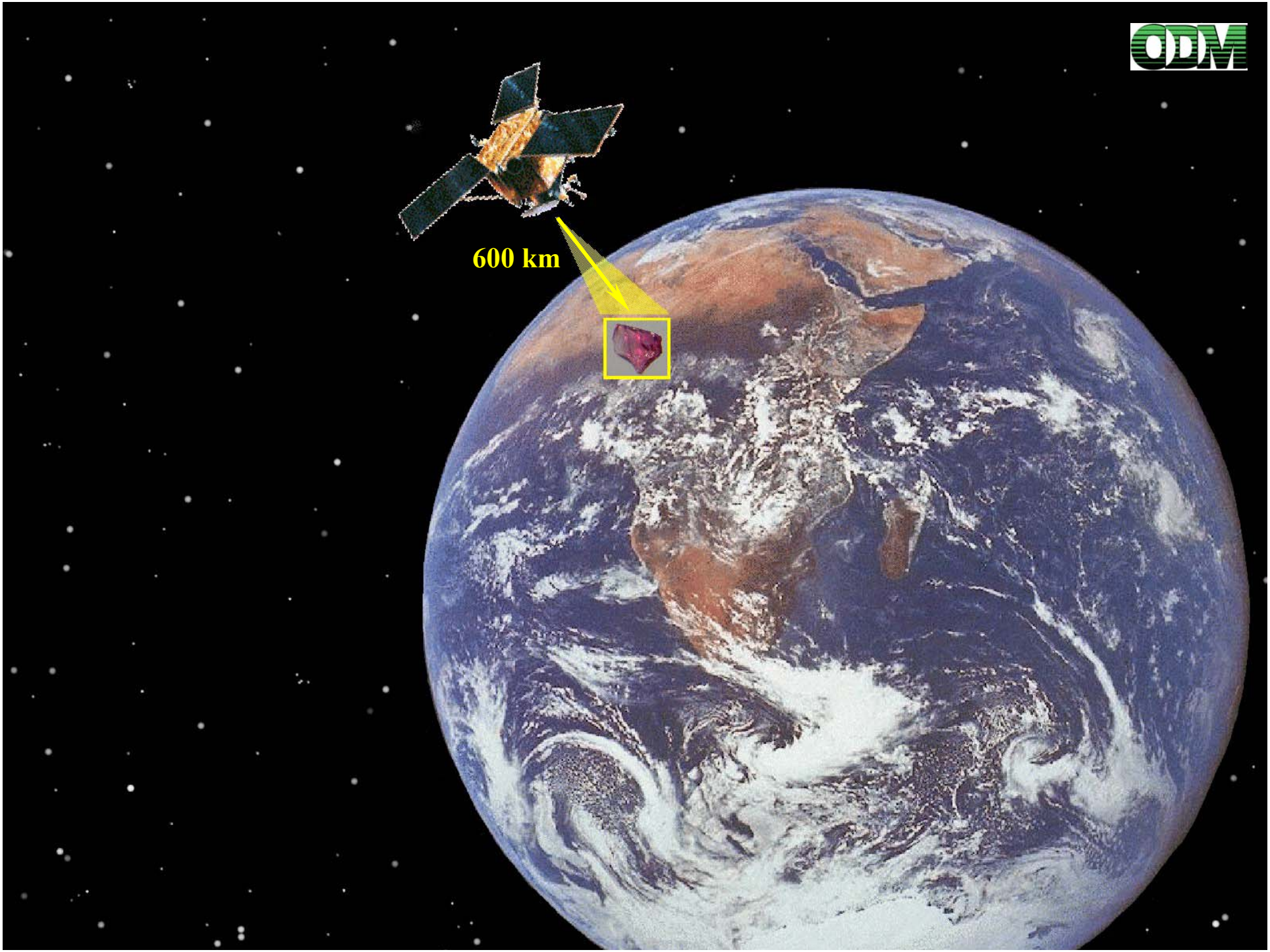
Principal Indicator Elements in Ni-Cu-PGE Indicator Minerals

Mg, Cr, Al


ODM
SRB-99
22


Cr-pyrope

Canadian Ni-Cu-PGE Indicator Mineral Sites


ODM
600 km

Common Ni-Cu-PGE Indicators

Indicator Mineral	Chemical Composition	Indicator Elements
Stage 1: Gravitational (cumulus) settling of silicate & oxide mineral grains		
olivine	$(Mg,Fe)SiO_4$	Mg
orthopyroxene	$(Mg,Fe)_2Si_2O_6$	Mg
Cr-diopside	$Ca(MgCr)Si_2O_6$	Mg, Cr
chromite	$(Fe,Mg)(Cr,Al)_2O_4$	Cr, Mg, Al (±Zn)
Stage 2: Assimilation of felsic, pyritic country rocks		
hercynite	$FeAl_2O_4$	Al
corundum	Al_2O_3	Al, Cr, Ti
Cr-garnet	$Ca_3(Cr,Al,Fe)_2Si_3O_{12}$	Cr, Al
Stage 3: Combining of S with Fe + Ni-Cu-PGE to form a sulphide liquid		
chalcopyrite	$CuFeS_2$	Cu, S
cobaltite group	$(Co,Ni)AsS$	Co, Ni, As, S
loellingite group	$(Fe,Ni)As_2$	Ni,As
sperrylite	$PtAs_2$	Pt, As
PGE alloys	PGE	PGE

Stage 1: Gravitational (cumulus) settling of silicate & oxide mineral grains

- Indicates the passage of a sufficient volume of mafic/ultramafic magma to form a significant Ni-Cu-PGE deposit
- Produces useful Mg and Cr-bearing indicator minerals

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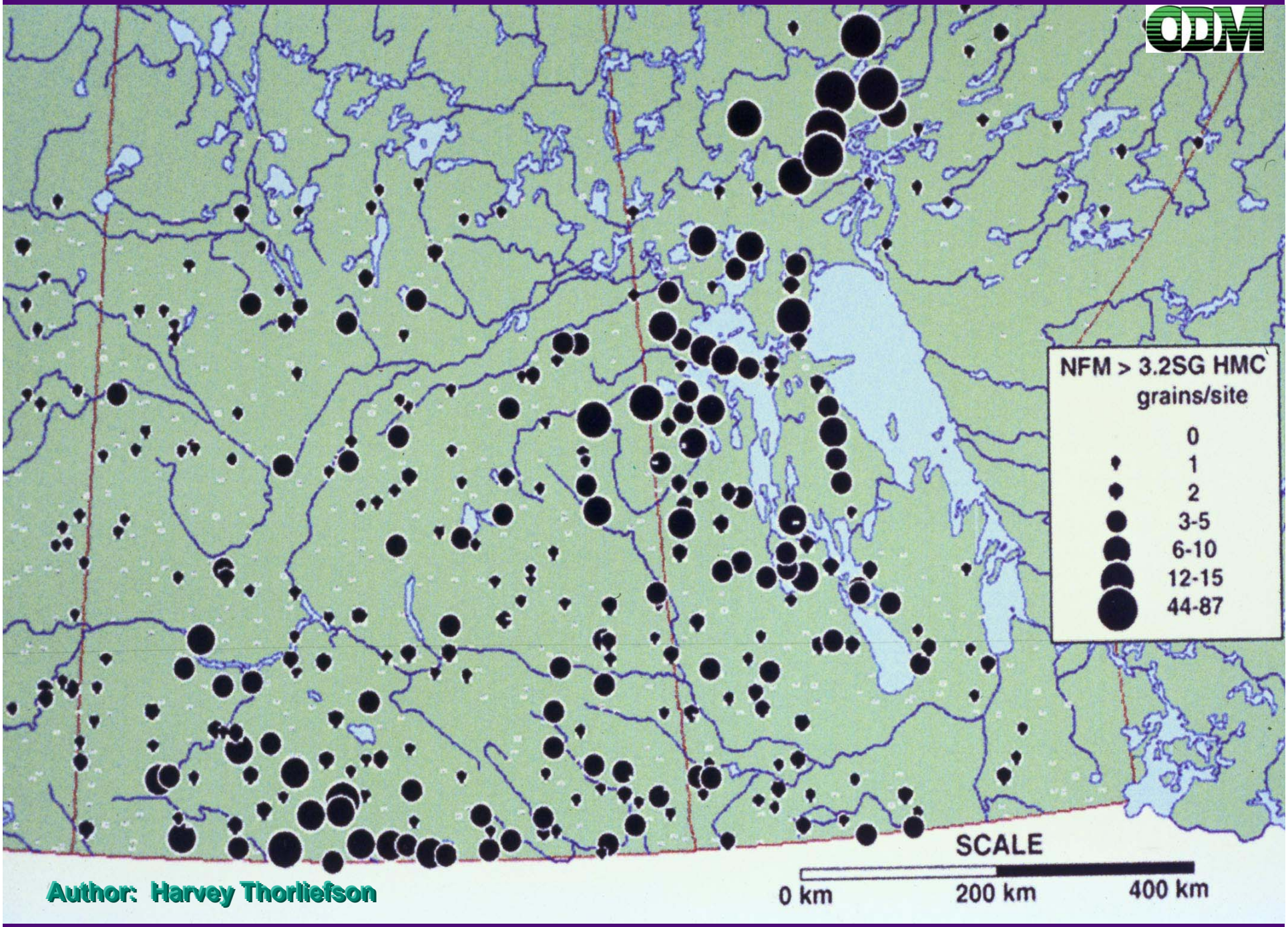
ODM
Cr-diopside

Canadian Ni-Cu-PGE Indicator Mineral Sites


ODM
NFM > 3.2SG HMC
grains/site
0
1
2
3-5
6-10
12-15
44-87
SCALE
0 km
200 km
400 km
Author: Harvey Thorliefson

Canadian Ni-Cu-PGE Indicator Mineral Sites


Chromite

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PGE alloys	PGE	PGE

Stage 2: Assimilation of felsic, pyritic country rocks

- Adds sulphur essential for separation of Ni-Cu-PGE from olivine and pyroxene
- Produces hybrid Mg-Al rocks (norite, troctolite, contact breccias)
- Produces useful hybrid Fe-Al and Cr-Al indicator minerals

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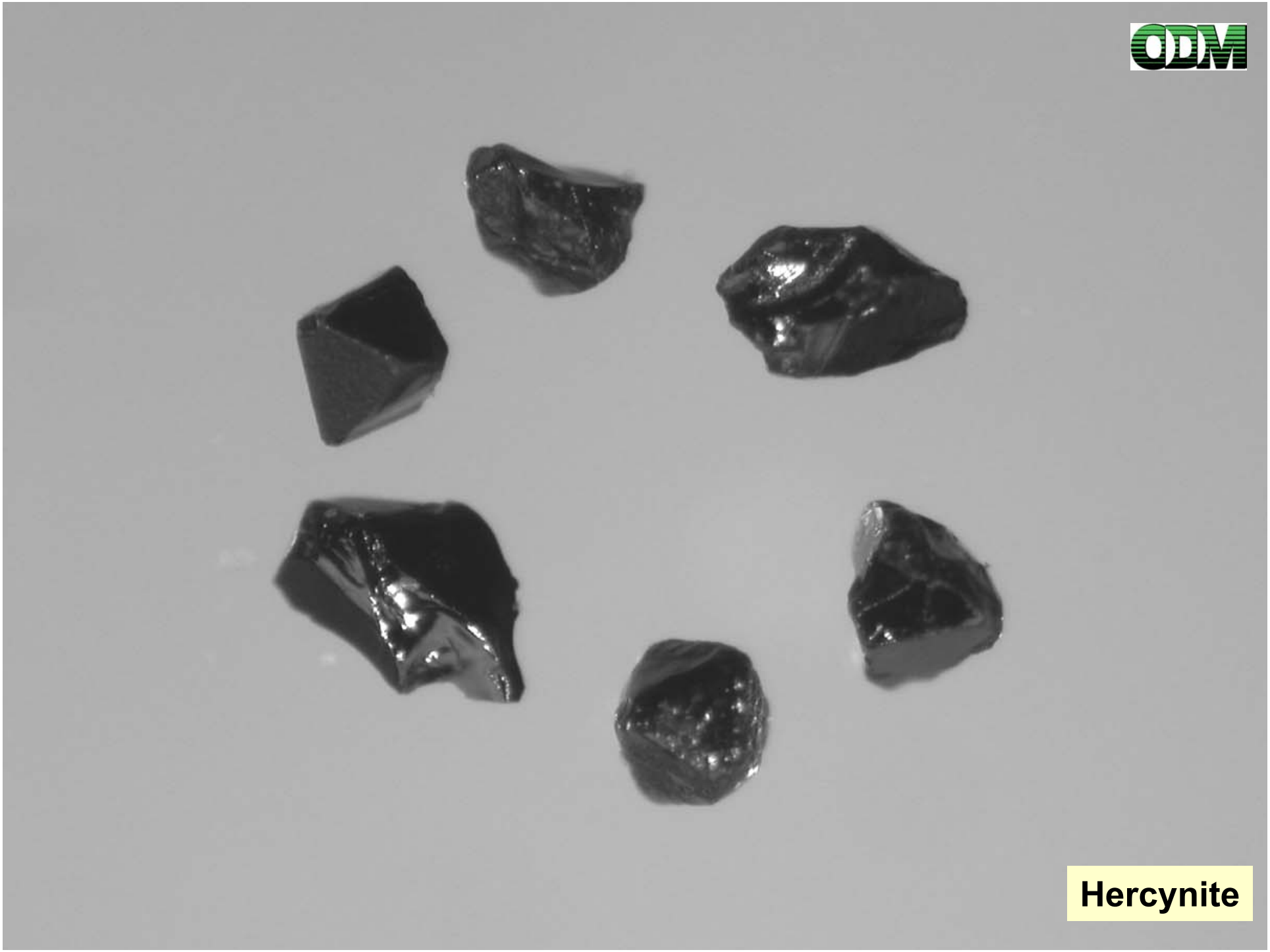
Hercynite

Canadian Ni-Cu-PGE Indicator Mineral Sites

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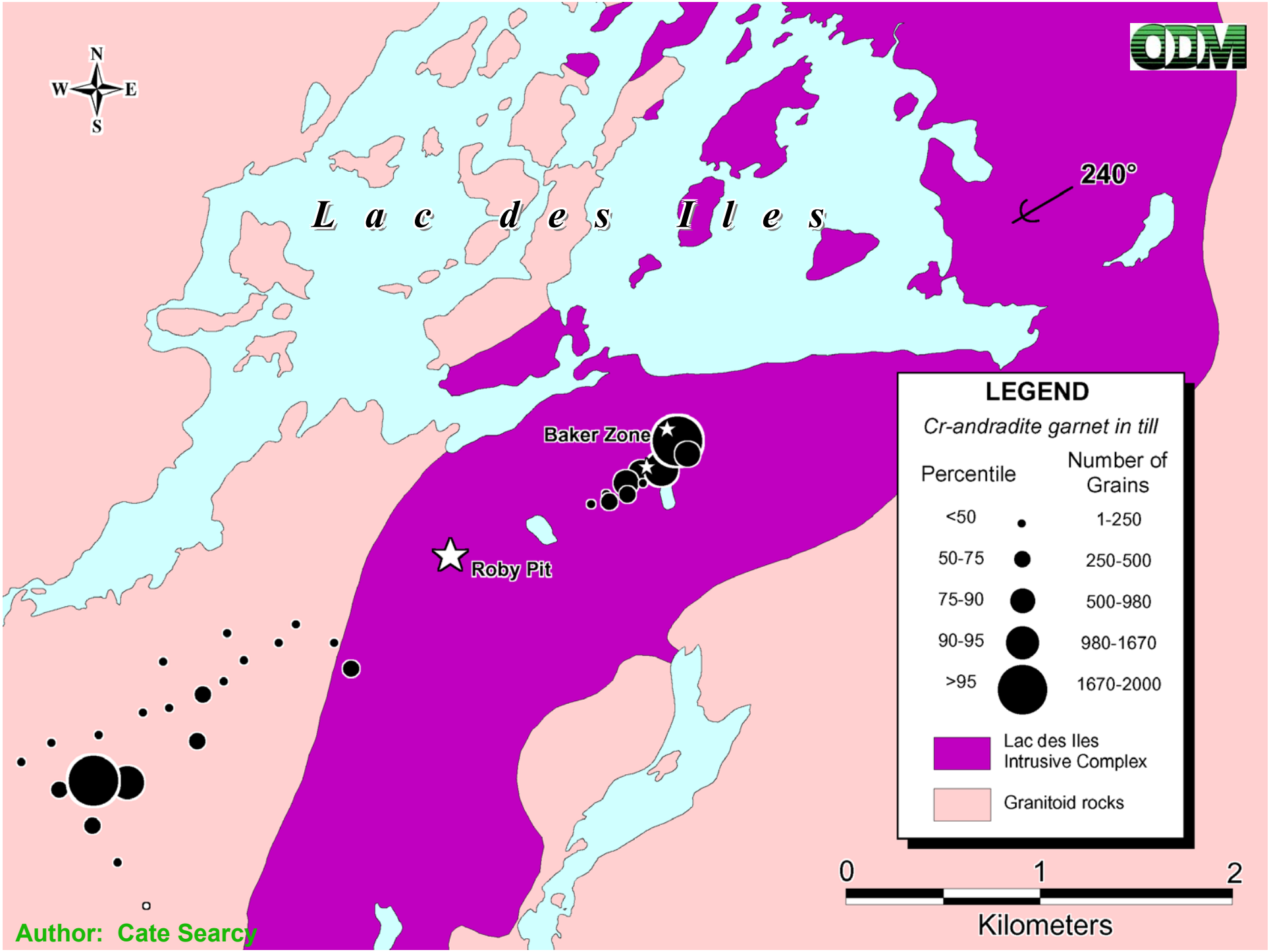
N
W
E
S
ODM
Lac des Iles
240°
Baker Zone
Roby Pit
LEGEND
Cr-andradite garnet in till
Percentile
Number of Grains
<50
1-250
50-75
250-500
75-90
500-980
90-95
980-1670
>95
1670-2000
Lac des Iles Intrusive Complex
Granitoid rocks
0
1
2
Kilometers
Author: Cate Searcy


Cr-andradite


Chromite

Stage 3: Sulphur combines with Fe and Ni-Cu-PGE to form a heavy sulphide liquid

- Causes the Ni-Cu-PGE to settle to the bottom of the magma to form mineable massive sulphides
- Produces useful indicator minerals

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Chalcopyrite

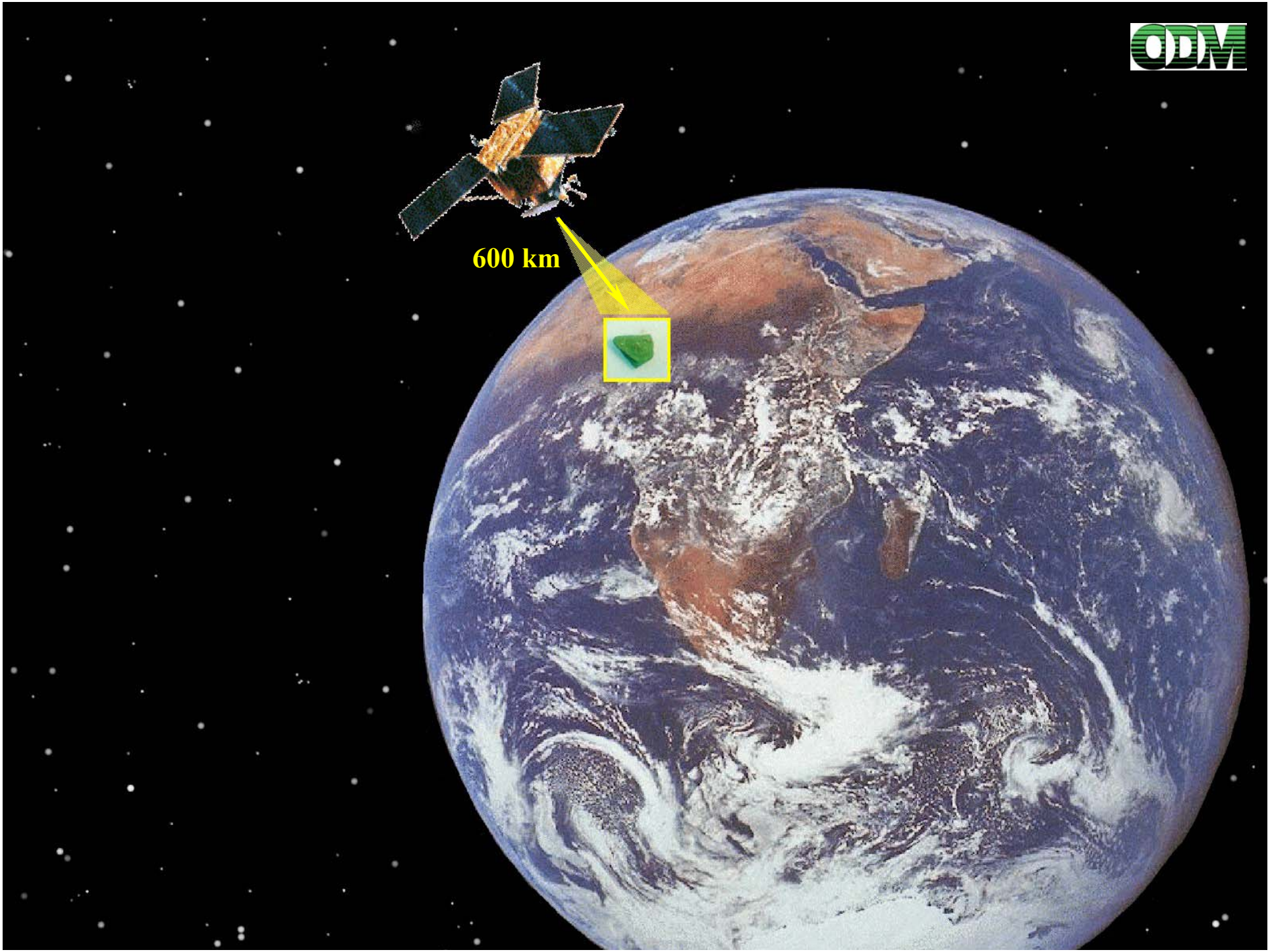

ODM
SRB-99
22

CONCLUSIONS

Ni-Cu-PGE Indicator Mineralogy is Cost-Effective and Practical

- **It is hypersensitive.** Very few samples are required – as few as one per 400 km^2 for cumulus minerals and one per 4 km^2 for hybrid alteration minerals

- **It is very diagnostic.** Mineral grains from the three stages of Ni-Cu-PGE metallogenesis are mapped separately, giving an exceptionally clear view of both the overall fertility of the mafic/ultramafic target and the locations of any mineralized "hot spots"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