Indicator Mineral Morphology

UBC Graduate Course – Diamond Exploration
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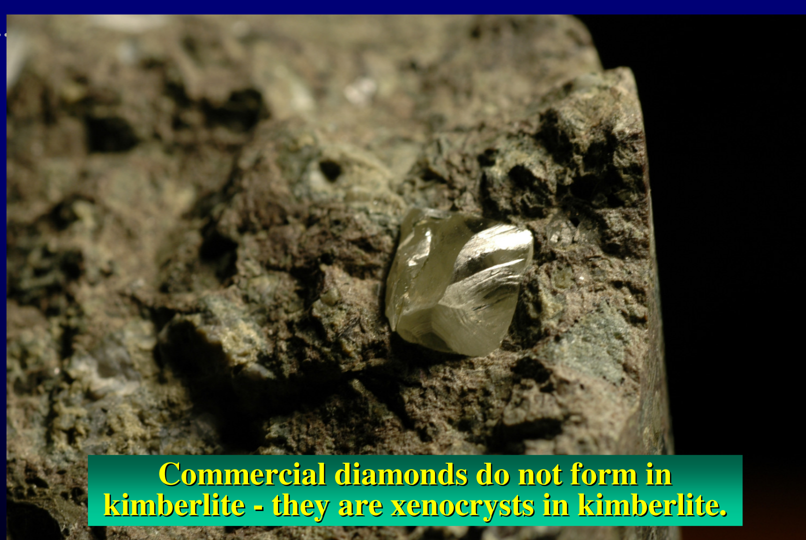
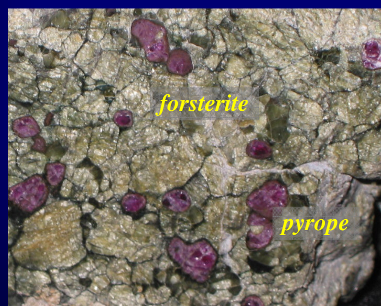
Diamond, Kimberlite, Indicators



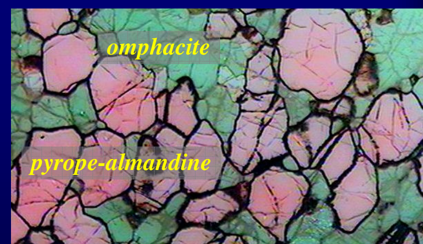
(Four-Carat Diamond, Renard 65, Quebec)

Diamond Parent Rocks

peridotite parent rock



eclogite parent rock



Most diamonds originate in mantle peridotite and eclogite - the parent rocks of diamond.

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The Four D's of Diamond Exploration

Disruption – the diamond parent rock is removed from its mantle stability field.

Disaggregation – the diamond parent rock (xenolith) is physically broken apart and attacked by fluids in the igneous host rock (kimberlite)

Dissemination – diamonds, parent rock minerals (indicators) and parent rock fragments (xenoliths) are physically mixed into the igneous host rock.

Dispersion – surviving indicator minerals are eroded from the igneous host by weathering, and by alluvial, fluvial, glacial, and/or marine processes.

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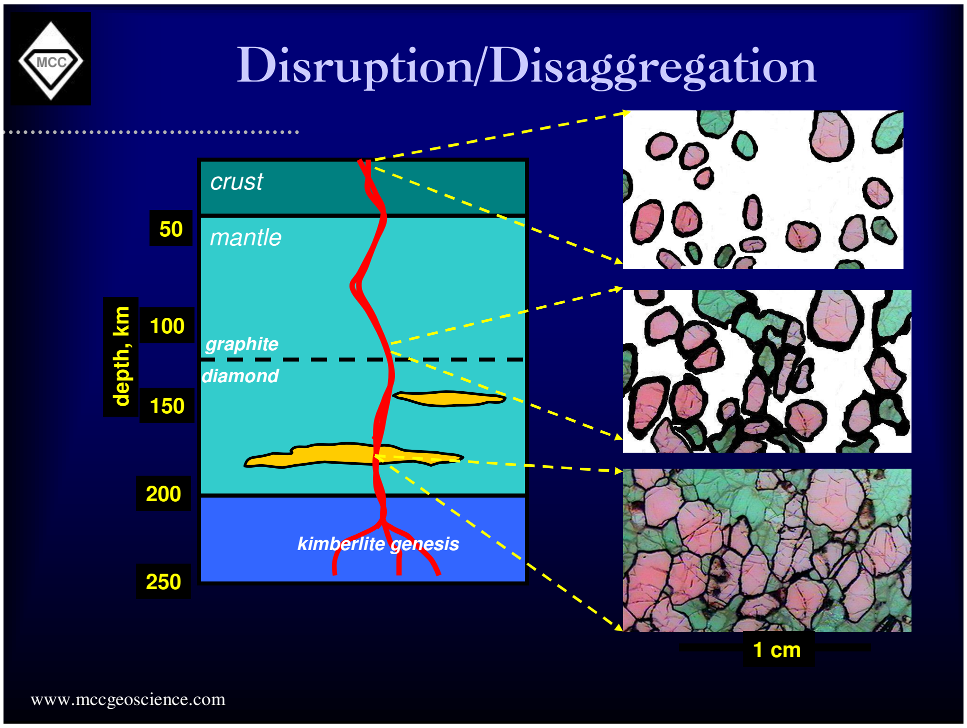
Disruption/Disaggregation
crust
mantle
graphite
diamond
kimberlite genesis
depth, km
50
100
150
200
250
1 cm
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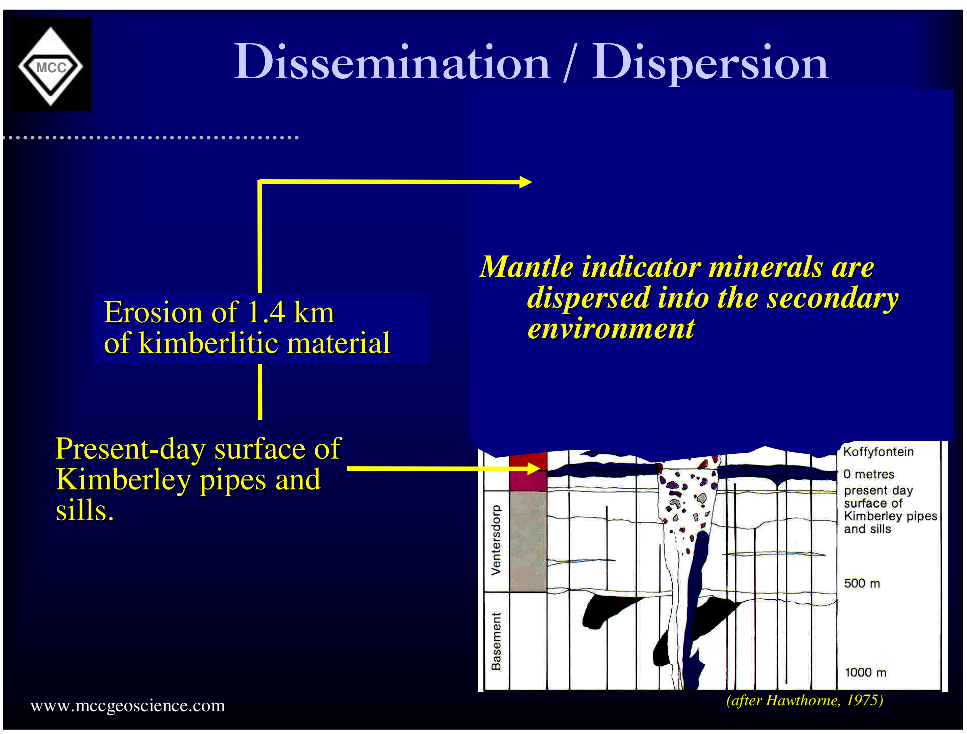
Dissemination / Dispersion
Erosion of 1.4 km
of kimberlitic material
Present-day surface of
Kimberley pipes and
sills.
Mantle indicator minerals are
dispersed into the secondary
environment
Koffyfontein
0 metres
present day
surface of
Kimberley pipes
and sills
500 m
1000 m
Ventersdorp
Basement
(after Hawthorne, 1975)
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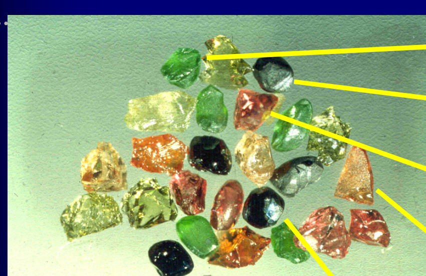
Sampling for Indicator Minerals

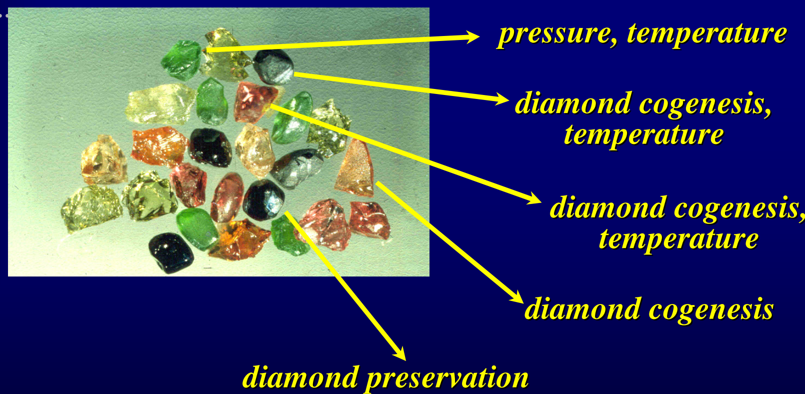
Indicator mineral sampling accounted for over 80% of kimberlite discoveries from 1872 – 1981

Mantle Indicator Minerals (KIMs)



unique appearance, high specific gravity, limited magnetic susceptibility, ubiquitous in the mantle

Mantle Indicator Minerals (KIMs)



indicator minerals allow for prioritization of exploration samples and igneous host rocks

Indicator Mineral Morphology

Assessment of the shape and surface features of indicators that are developed in the **primary** and **secondary** environments –

primary environment – the mantle parent rock and the igneous host rock;

secondary environment – the near surface (marine) and surface of the earth; weathering – physical and chemical transport – alluvial, fluvial, glacial, and marine.

– with the goal of establishing proximity to source.

Garnet Terminology (Western)

Primary Environment

Kelyphitic rim – a mix of hydrous silicate and oxide minerals formed as a reaction product between the igneous host and the parent rock mineral.

Sub-kelyphitic surface – ‘orange peel’ texture on garnet developed beneath the kelyphite.

Reaction surface – dendritic texture on garnet along planes in the garnet.

Sculpturing – dissolution along crystallographic planes that produce systematic pyramidal features.

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Garnet Terminology (Western)

Secondary Environment

Weathering – (chemical) etching of the garnet surface.
(physical) fracture due to stress release.

Transport – frosting, pitting, abrasion, conchoidal breaks.

Both primary surfaces and secondary surfaces are modified in the secondary environment.

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Supco Database to 1984

- physical search of libraries (no GeoRef)
- gleaned from 181 public & private sources
- 124 kimberlites, 15 countries
- entered all mineral analyses to 1984:
  - 4,002 garnets
  - 976 chrome diopsides
  - 949 chromites
  - 1,691 picroilmenites
  - 326 other mineral analyses
- also 3,519 minerals from 'non-kimberlite'

Supco Database to 1984

A total of

11,463 analyses collected,

all data entered by hand.

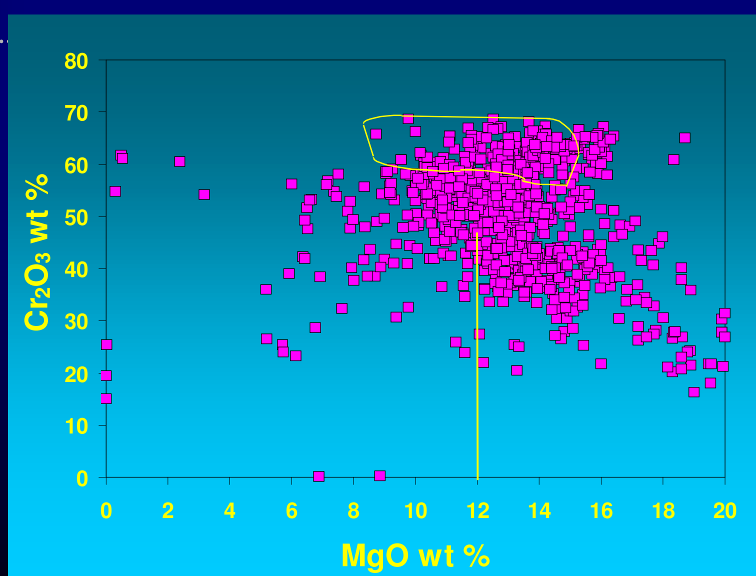
Linked reference, kimberlite, mineralogy, occurrence, association

Post-1984

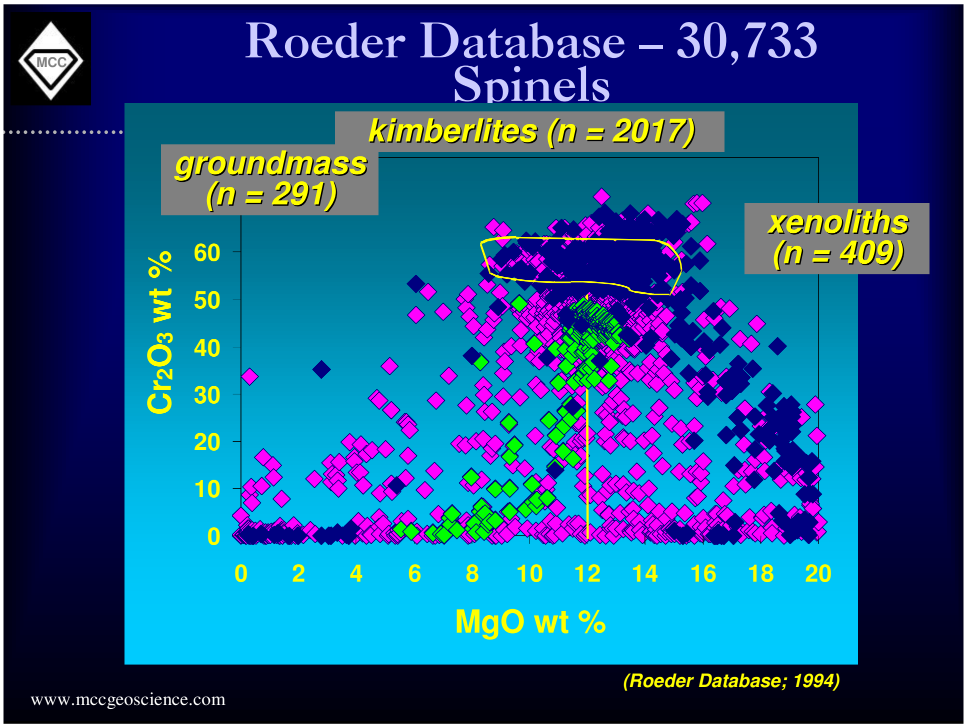
Mobil Oil buys out Superior Oil, dismantles the Superior Minerals Division.

Data etc., were 'discarded'

1984 – 949 Chromites



(Supco Database)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Roeder Database – 30,733 Spinels
kimberlites (n = 2017)
groundmass (n = 291)
xenoliths (n = 409)
Cr_2O_3 wt %
0
10
20
30
40
50
60
0 2 4 6 8 10 12 14 16 18 20
MgO wt %
(Roeder Database; 1994)
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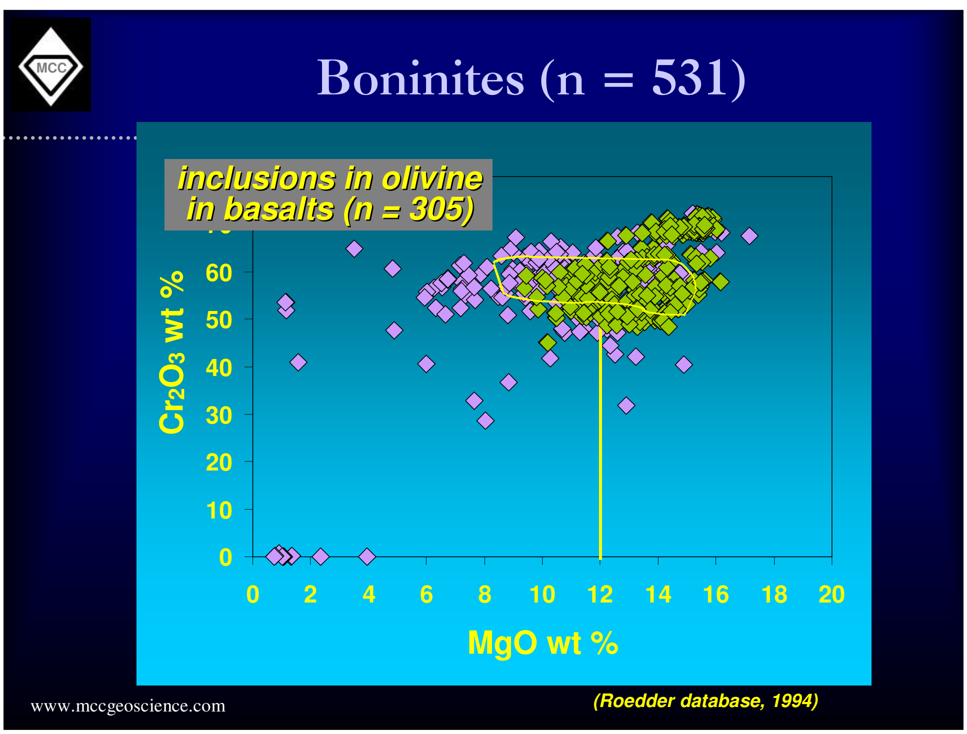
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Boninites (n = 531)
inclusions in olivine in basalts (n = 305)
Cr_2O_3 wt %
0
10
20
30
40
50
60
0 2 4 6 8 10 12 14 16 18 20
MgO wt %
(Roedder database, 1994)
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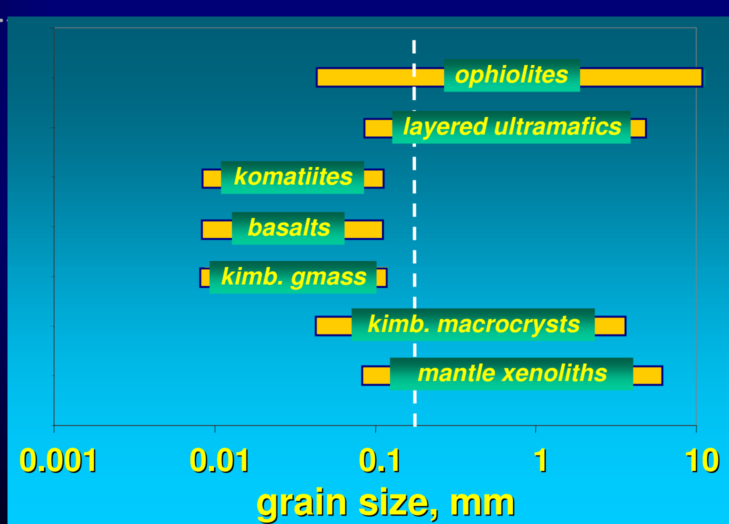
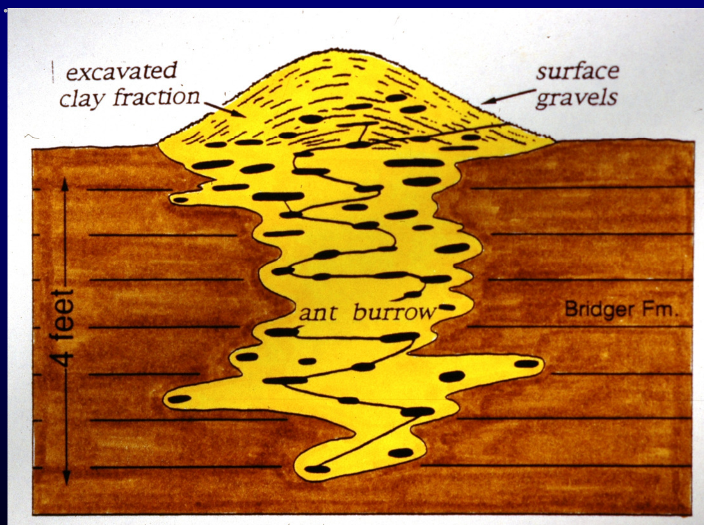
Screen Size Divisions

DIN-4188 (mm)	ENDECOTT (Mesh)	BS-410 (Mesh)	ASTM-E11 (Mesh)	TYLER (Mesh)	Mesh Size (microns) (µm)	CFM	KCC	AMC
0.100	none	none	none	none	100			
0.106	140	150	140	150	106		|←	
0.150	100	100	100	100	150			
0.180	80	85	80	80	180	|←	→|	
0.212	70	72	70	65	212			
0.250	60	60	60	60	250	→|←	|←	
0.300	50	52	50	48	300			
0.425	40	36	40	35	425			|←
0.500	35	30	35	32	500	→|←	→|←	→|←
0.600	30	25	30	28	600			
0.850	20	18	20	20	850	→|		→|←
1.0	18	16	18	16	1000		→|	→|
1.180	16	14	16	14	1180			

Spinel Size Range in Rocks



Pogonomyrmex Occidentalis



Summary Points

- Know the regional geologic history of the AOI, including changes in stream direction, capture etc.
- Sample the dominant clastic lithologies for indicators, and identify contributions from paleo-deposits
- Use associated non-kimberlitic minerals as indicators of transport when possible
- Document primary morphology on the indicators
- Document the morphology of known kimberlites and lamproites in the region
- Check non-geologic literature for human effects on mineral dispersion, e.g. ancient farming or modern road-building
- Characterize the sedimentary nature of paleo-sediments in the area
- Use regional garnets as monitors of sedimentological conditions
- Systematically classify each anomalous grain or grain population, paying attention to size and other characteristics