

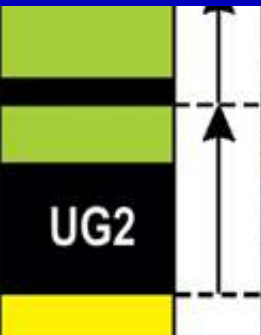
Hydrogen isotopes in phlogopite indicate crustal fluids in the UG2 layer, Bushveld Complex

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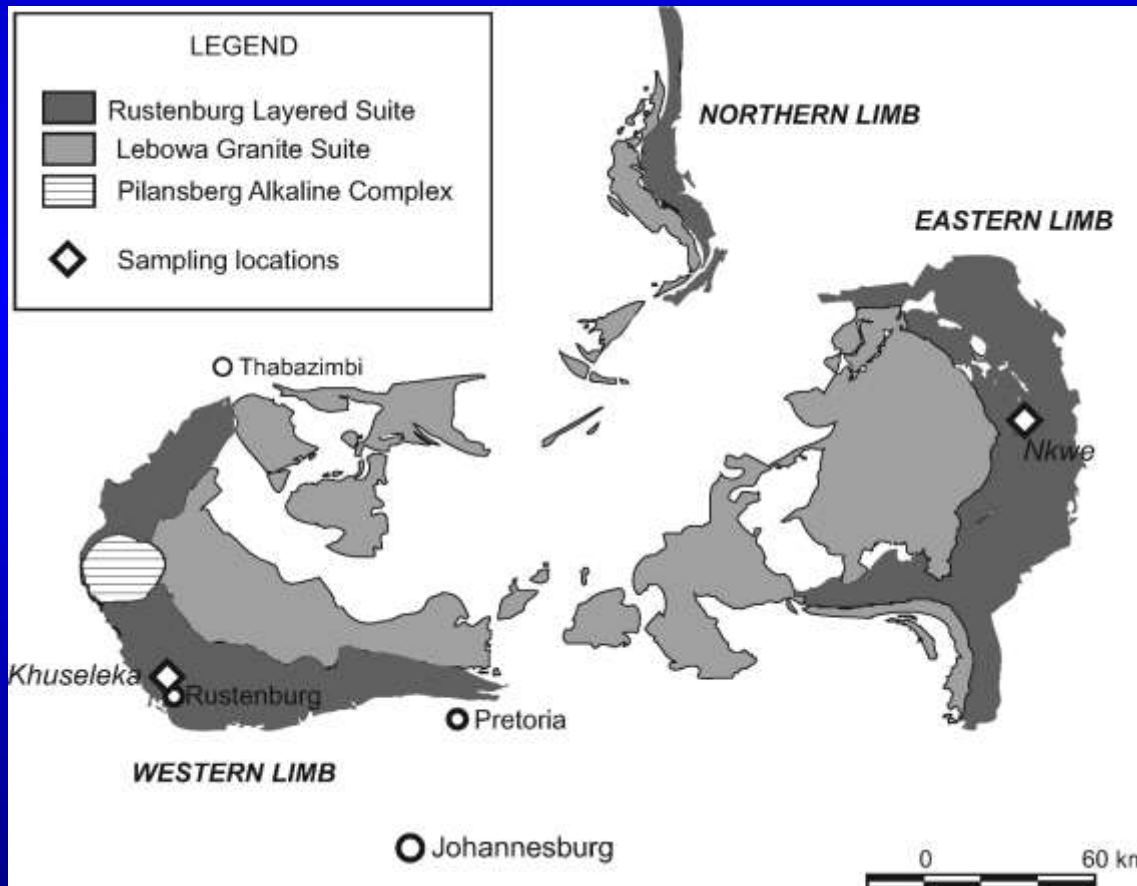
³*Museum für Naturkunde Berlin, Germany*



The Bushveld Complex: the world's largest igneous intrusion on Earth

Rustenburg Layered Suite (RSL)

- ultramafic-mafic
- main source for PGE, Cr and V
- crustal contamination (high initial Sr, Nd, Pb, Os)



Veksler et al., JP, 2018

STAVOREN GRANOPHYRE

Xenolith

Ferro-diorite

Ferro-gabbro-norite

Magnetite layers

Pyroxenite marker

Gabbro-norite

P.G. Marker

Bastard C.U. / Merzsky C.U.

Norite

Chromite layers

Orthopyroxenite

Harzburgite

UPPER ZONE

MAIN ZONE

TRANSITIONAL ZONE

CRITICAL ZONE

LOWER ZONE

DIFFERENTIATION STAGE

INTEGRATION STAGE

0.704 0.705 0.706 0.707 0.708 0.709

Initial $^{87}\text{Sr}/^{86}\text{Sr}$ Ratio

Ferro-diorite

Ferro-gabbro-norite

Gabbro-norite

Anorthosite

Norite

Orthopyroxenite

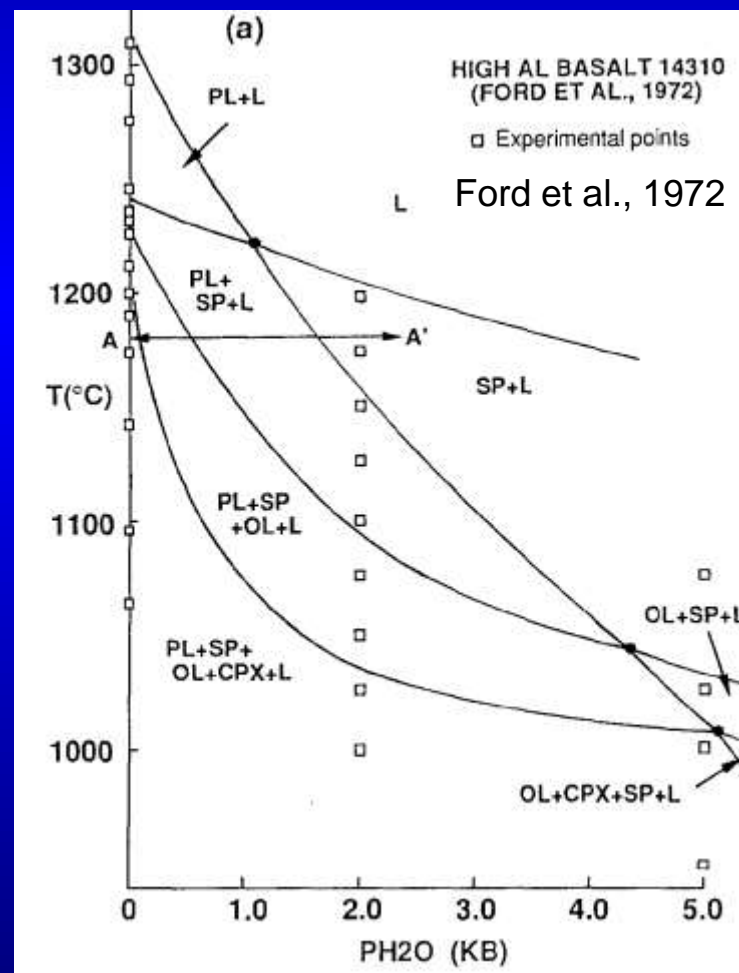
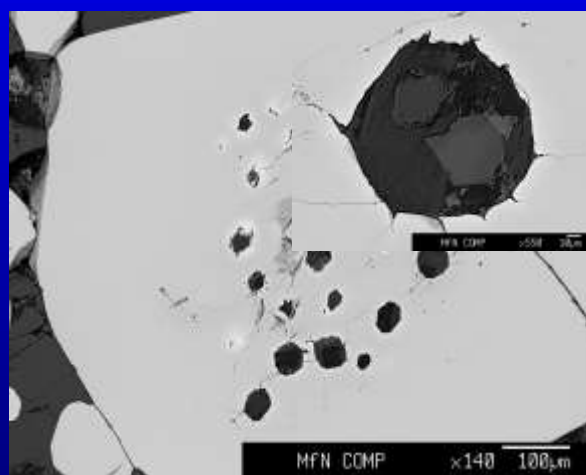
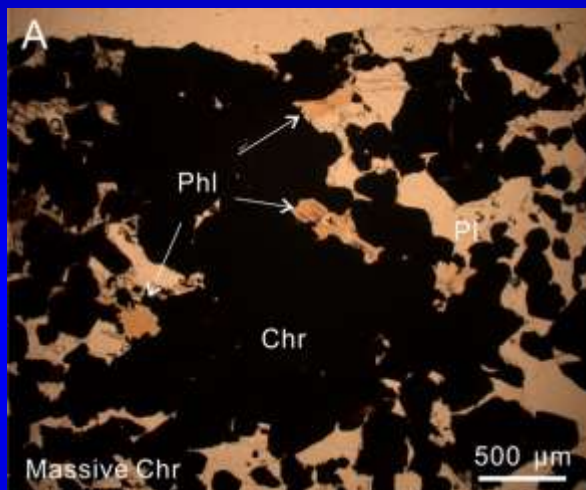
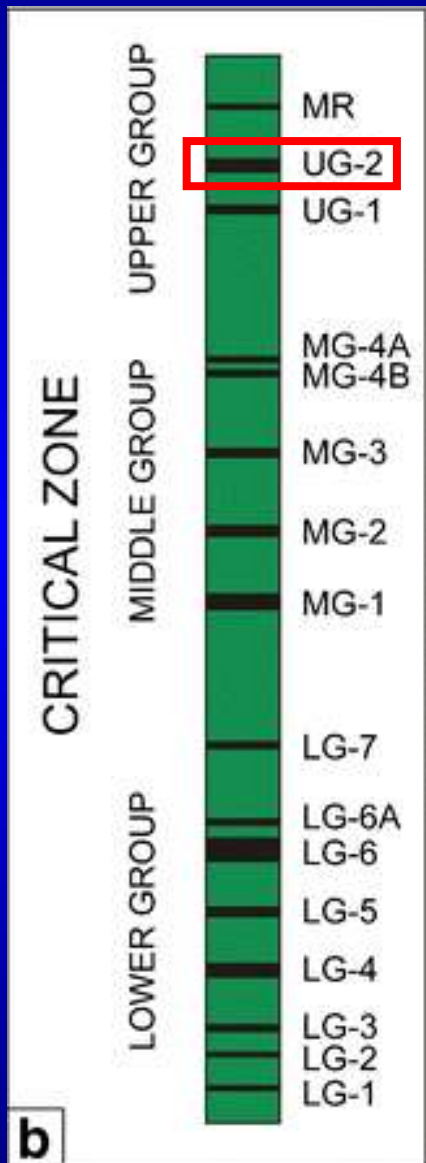
Harzburgite

Kruger, 1994

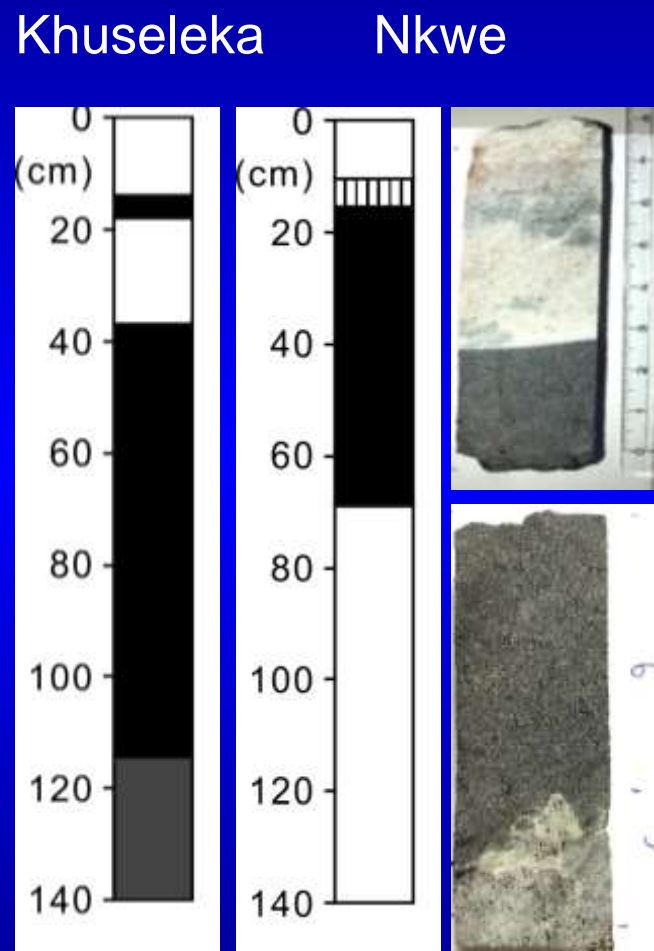
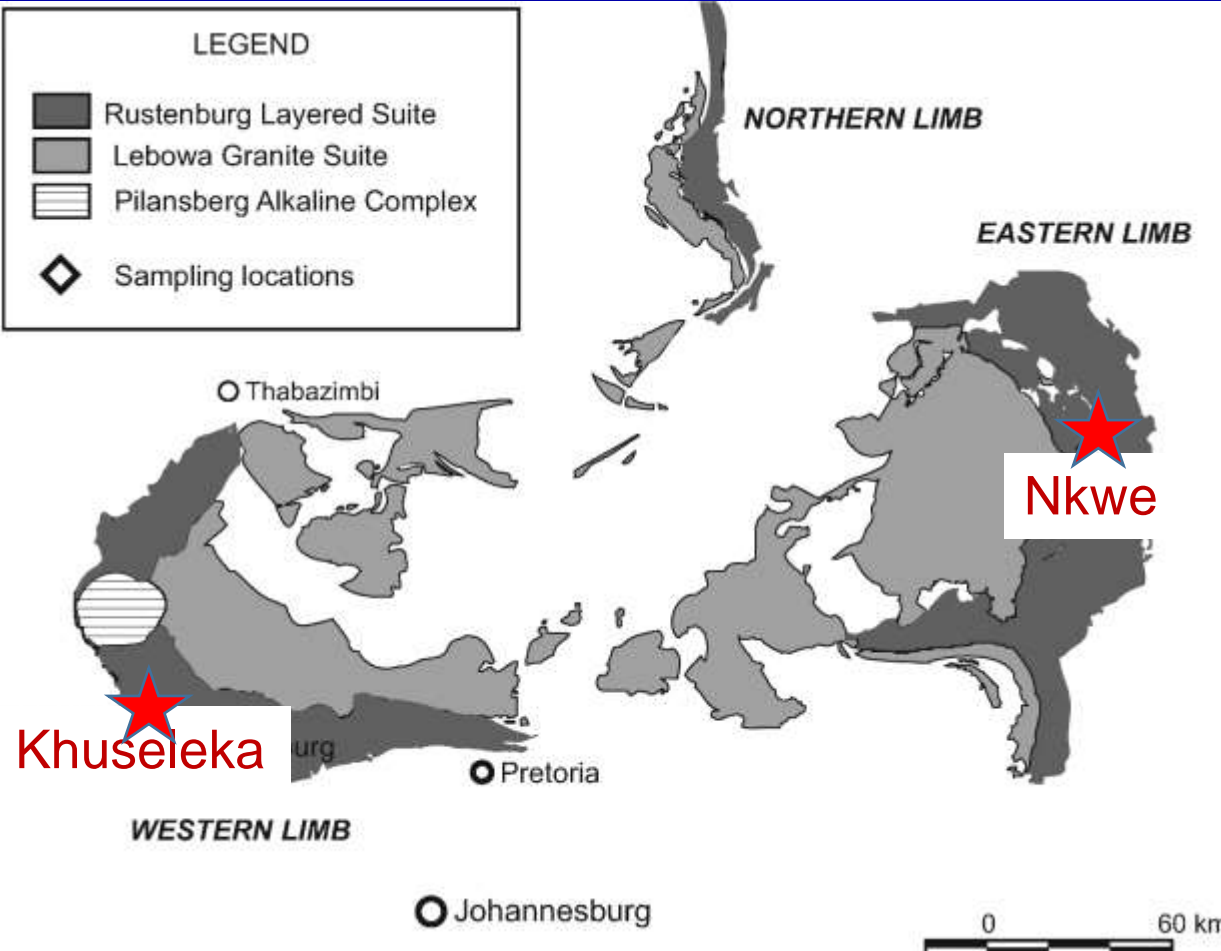
The Upper Group 2 (UG2) chromitite: the world's largest PGE ore bodies

Water probably play important roles!!! Internal or external?

- locally abundant hydrous minerals, melt inclusions rich in volatile
- addition of H₂O to melts causing the melts only saturated in Chr



Tracing water origins by the hydrogen isotopes in phlogopite

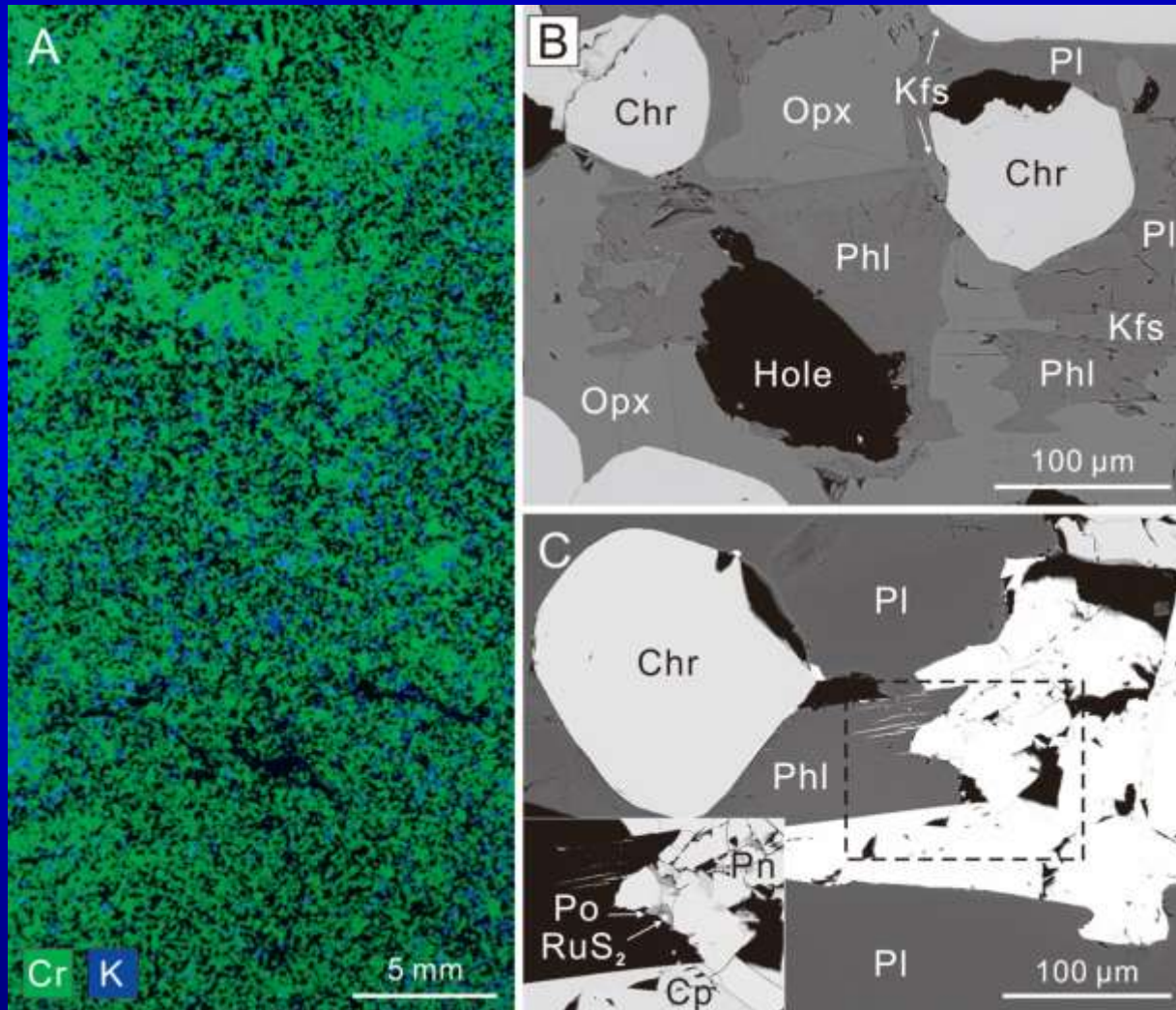


Veksler et al., JP, 2018



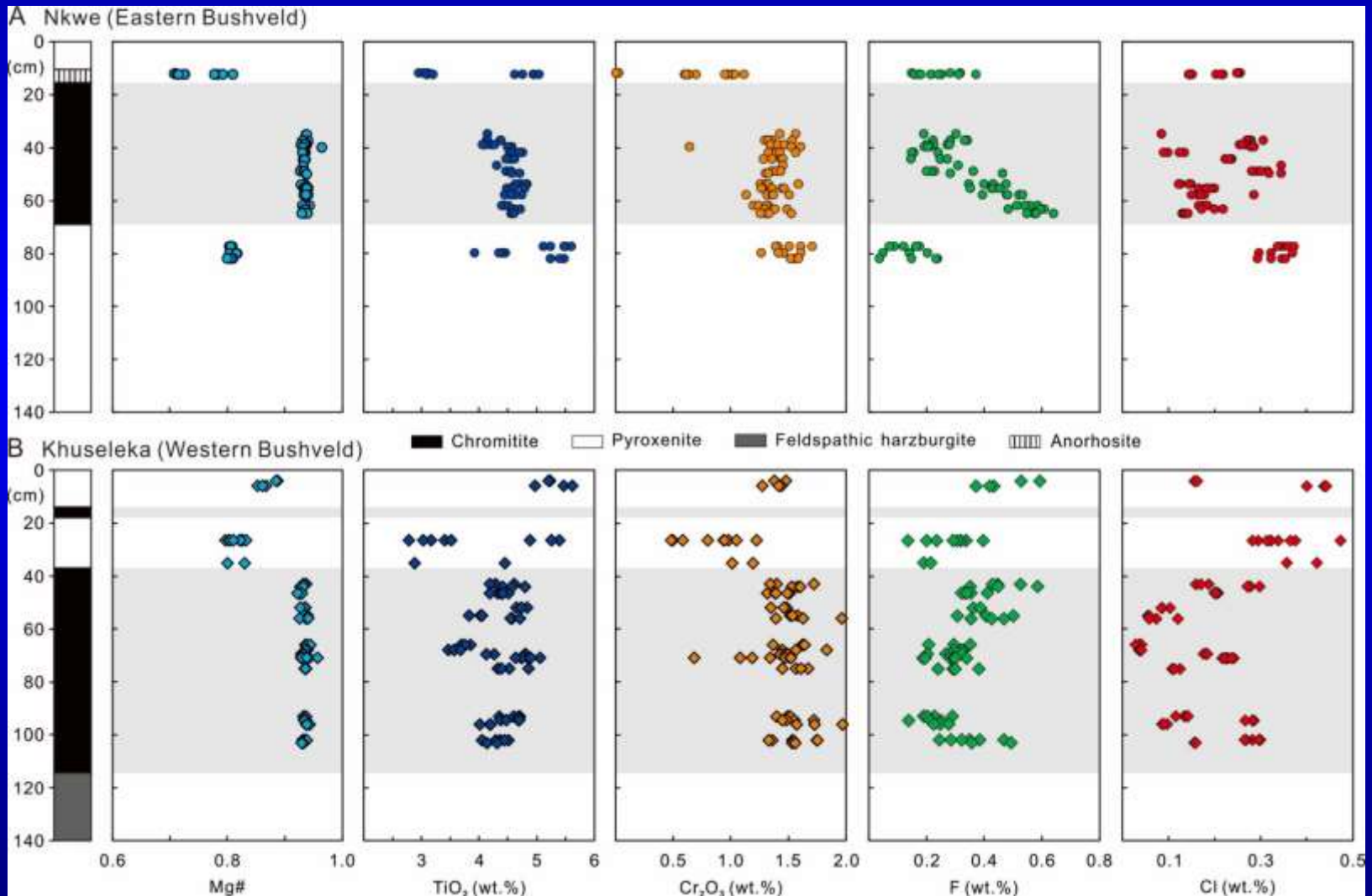
The phlogopite in the UG2 chromitite

- micro-XRF element maps: 1-3 vol.% phlogopite in the chromitite
- Opx replaced by Phl; Phl coexisting with late magmatic phases

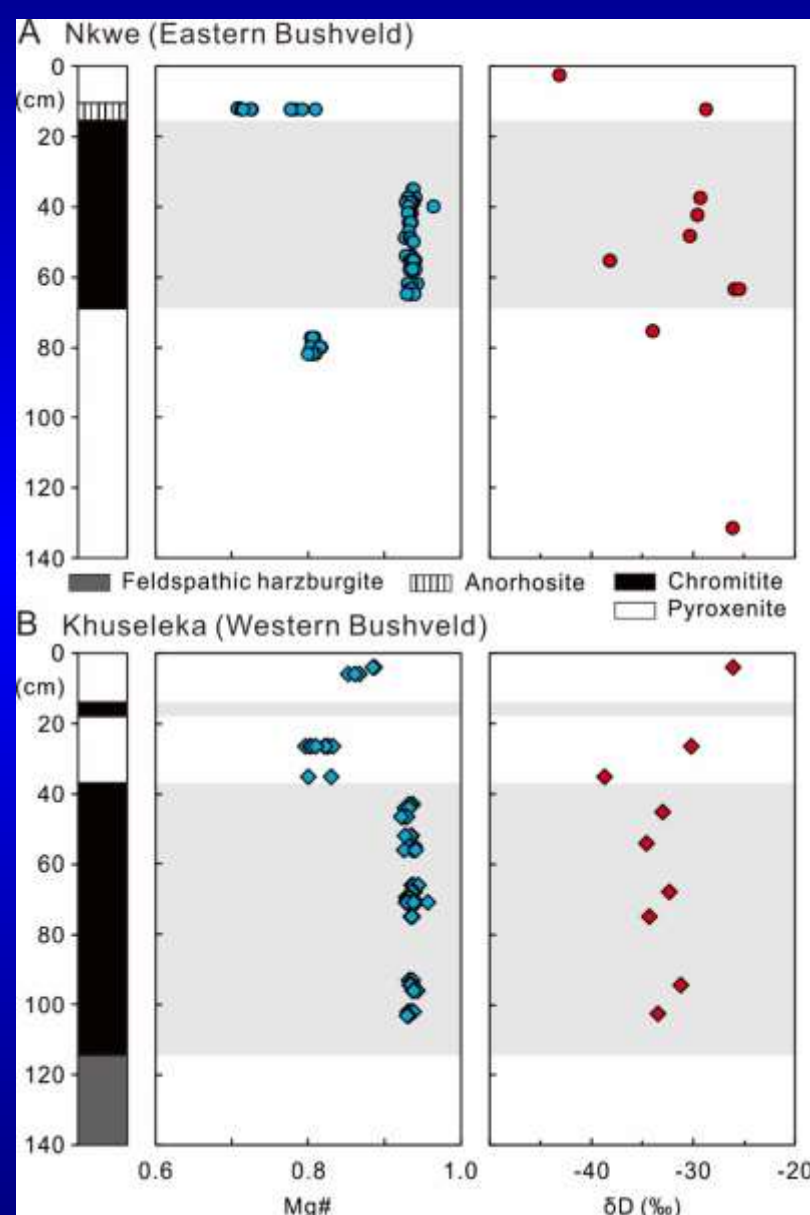


Composition of phlogopite in the UG2 chromitite and adjacent rocks

- relatively constant through the UG2 but within a wide range in the adjacent rocks
- rich in halogens (up to 0.47 wt.% Cl and 0.64 wt.% F)



Hydrogen isotopes in phlogopite indicate crustal fluids in the UG2 layer



- Nkwe
chromitite: -38.2 to -25.5‰
silicate rocks: -43.1 to -26.1‰
- Khuseleka
chromitite: -34.6 to -31.3‰
silicate rocks: -38.7 to -26.1‰
- mantle: -80 ± 10 ‰ (Kyser and O'Neil, 1984)
- Candidates for crustal endmembers in the Transvaal Supergroup (sandstone and shale)
porewater: -5 ± 7 ‰ (Clayton et al., 1966)
dehydration of clay minerals: -15‰
local meteoric water: -20‰
- Calculation suggests significant amounts of crustal fluids incorporated in the UG2 magmas