Metamorphism on Mars: A View from Eskolaite-bearing Chromite-magnetites in Northwest Africa (NWA) 7533

Yang Liu[1], Chi Ma[2], John Beckett[2], David Flannery[1], Abigail Allwood[1]

[1]Jet Propulsion Laboratory, California Institute of Technology, Pasadena, CA 91109, USA.
[2]Division of Geological and Planetary Sciences, California Institute of Technology, Pasadena, CA 91125, USA.

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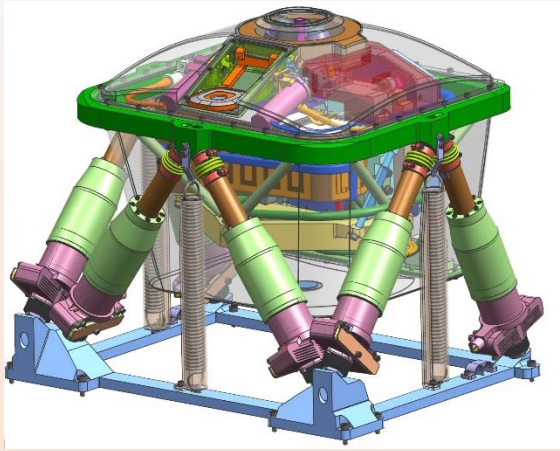
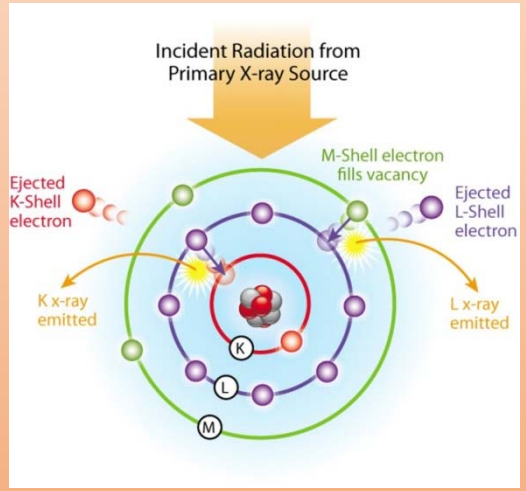
Jet Propulsion Laboratory
California Institute of Technology

PIXL: Planetary Instrument for X-ray Lithochemistry



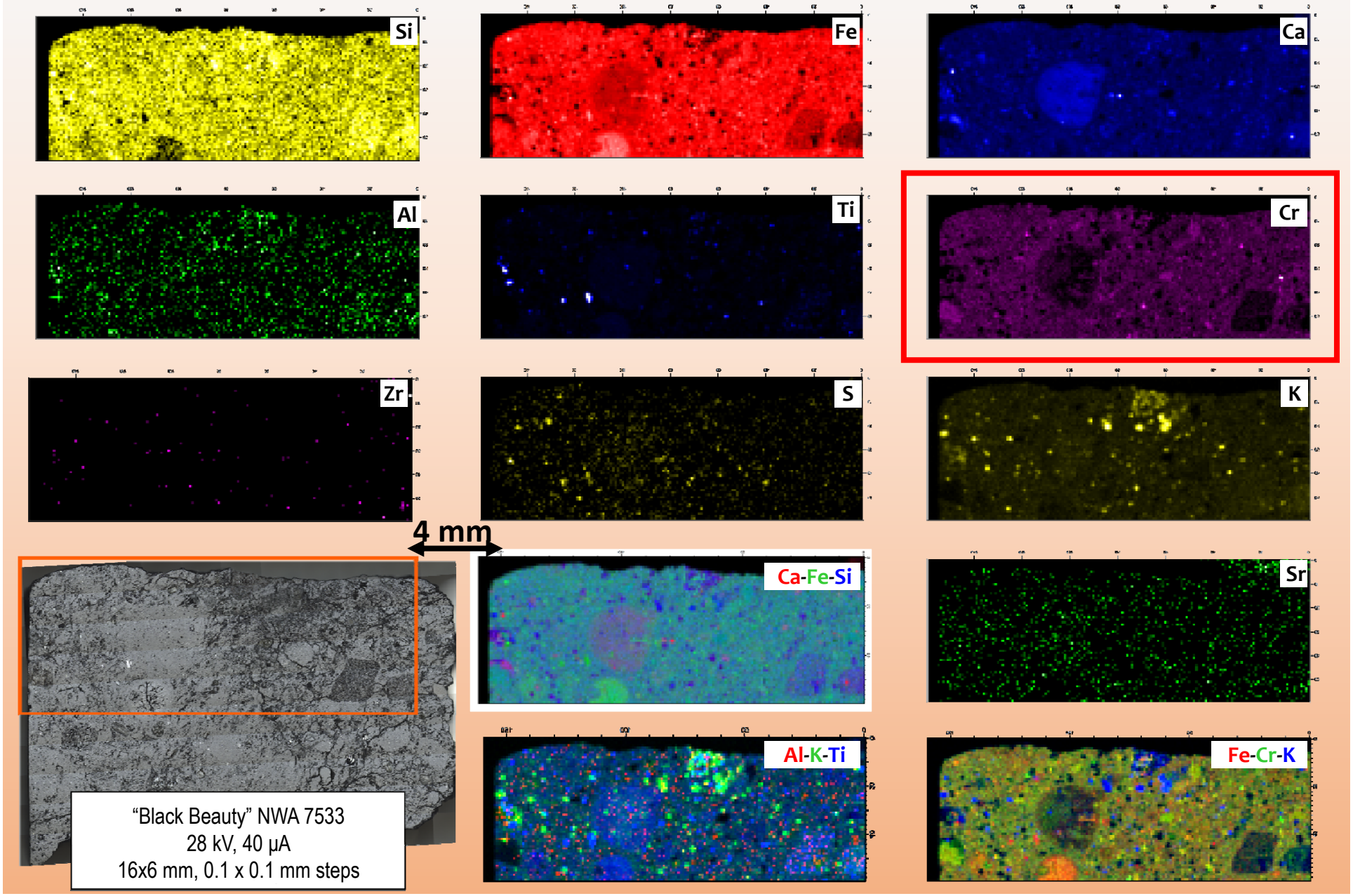
Micro X-ray fluorescence (XRF) spectrometer

Sub-mm scale elemental analyses of geological materials



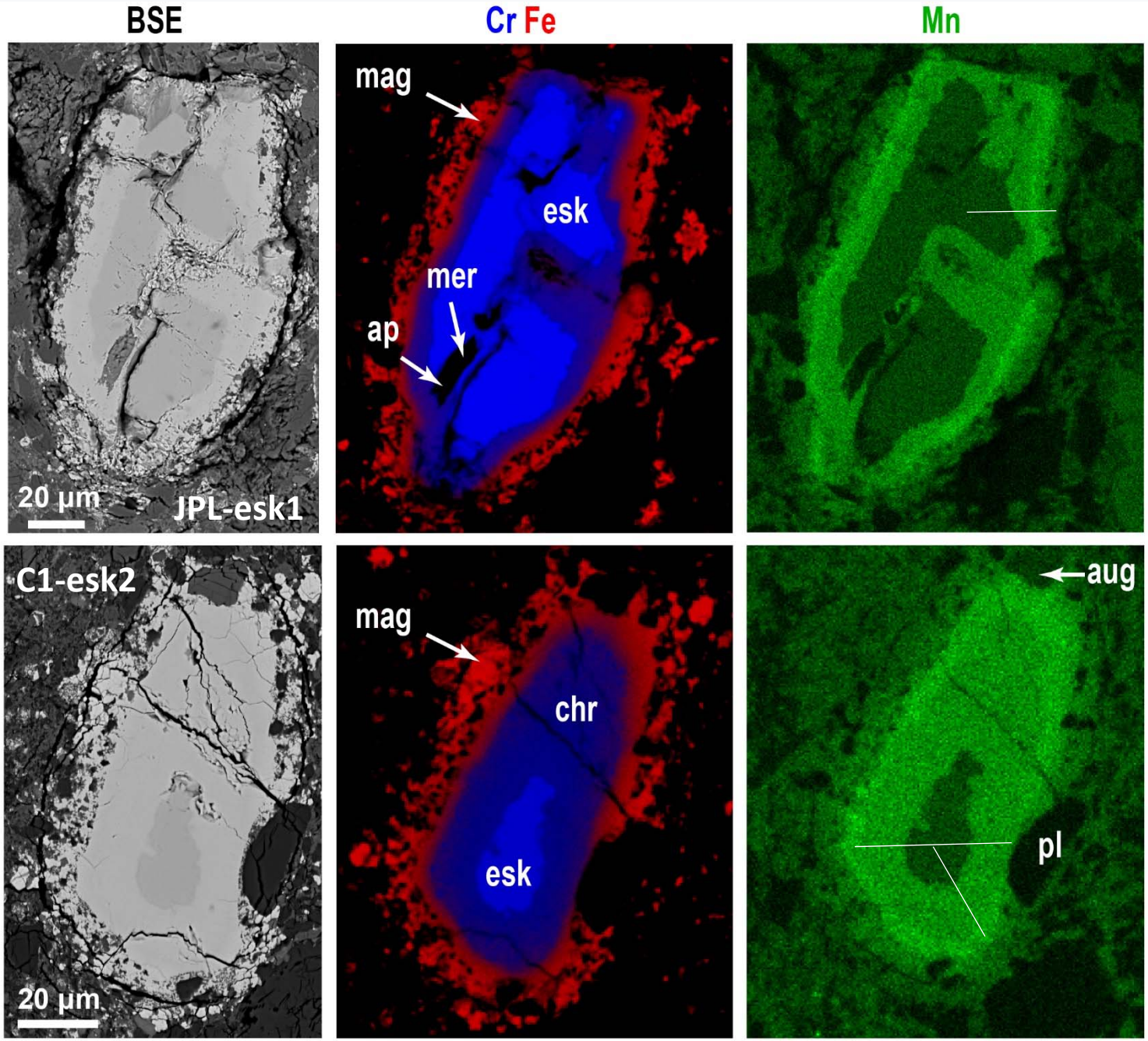
- ~100 micron beam diameter
- Raster scanning to survey spatial heterogeneity in sample chemistry
- Micro Context Camera and Structured Light Illuminators for **correlation of chemistry with individual grains**
- Major, minor, trace element detection
- Sensitivity to 10's ppm

PIXL Breadboard: NWA 7533



Eskolaite
- Irregular
- Uniform

Mantle to rim
- Cr ↓
- Fe ↑
- High Mn at boundary between mantle and rim



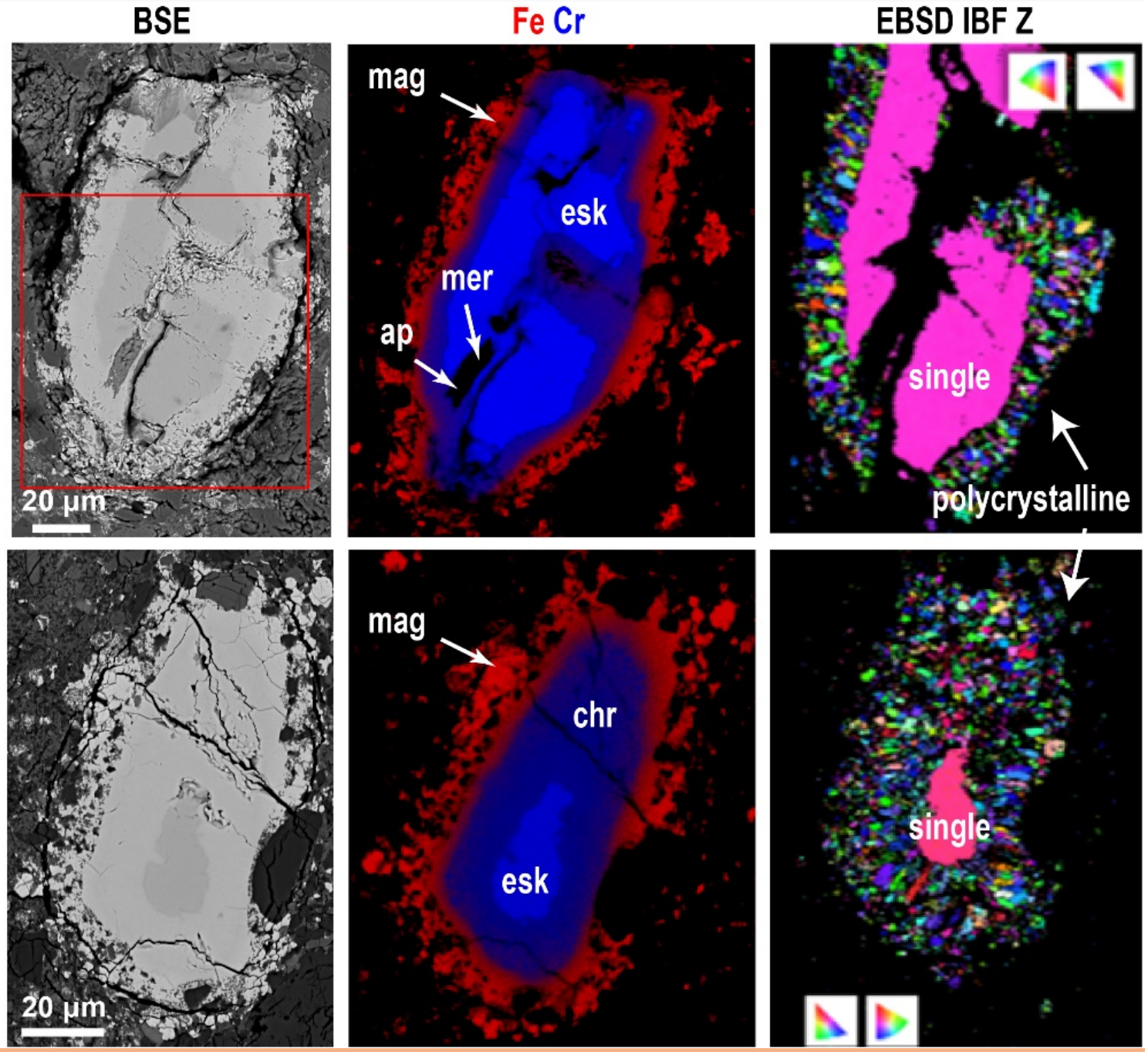
White lines are EMP traverses

Eskolaite

- Single crystal
- No strain (no deformation)

Mantle to rim

- polycrystalline
- Radiating
- Random



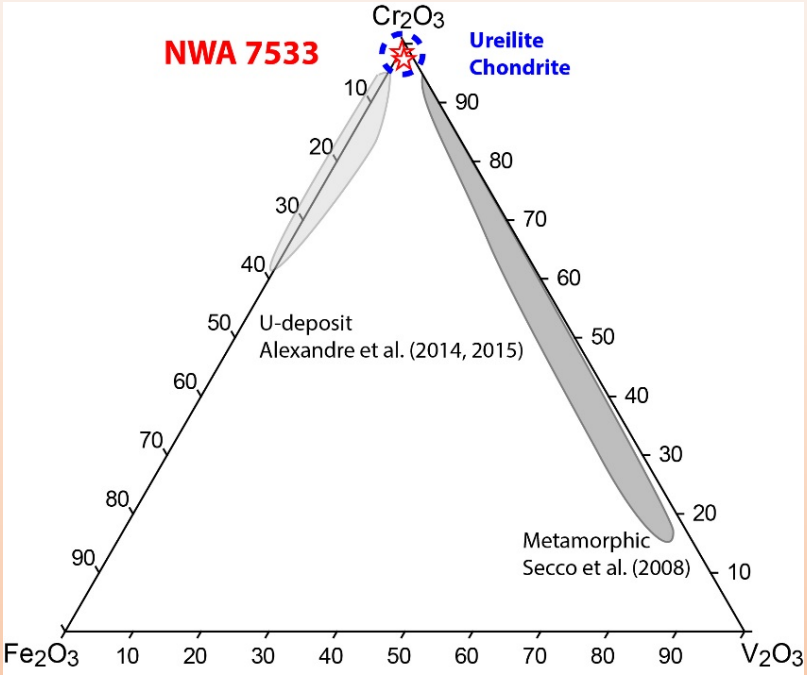
NWA 7533 Eskolaite Chemistry

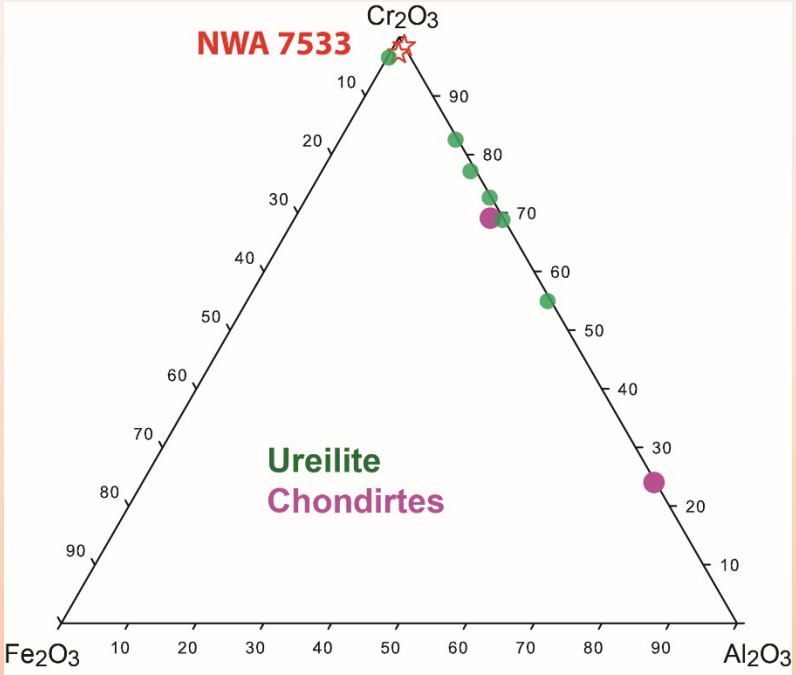
Wt%	Esk2 C1	Esk1 jpl	d.l.
n=	27	18	
MgO	b.d.	b.d.	0.02
TiO_2	0.08(1)	0.06(1)	0.01
MnO	0.36(1)	0.37(2)	0.02
Fe_2O_3	1.56(13)	1.34(11)	0.03
Cr_2O_3	97.4(2)	99.2(2)	0.02
Al_2O_3	0.02(2)	b.d.	0.02
SiO_2	0.02(2)	0.06(4)	0.02
V_2O_3	1.16(3)	0.28(2)	0.01
ZnO	b.d.	b.d.	0.05
CaO	0.03(1)	0.04(1)	0.01
Sum	100.7(1)	101.5(3)	

* Number in parenthesis is the 1σ of the average on the last unit

- Nearly pure eskolaite
- Differ in Cr_2O_3 and V_2O_3
- Fe_2O_3, V_2O_3, Al_2O_3 <1.6 wt%

Eskolaite in terrestrial rocks and other meteorites

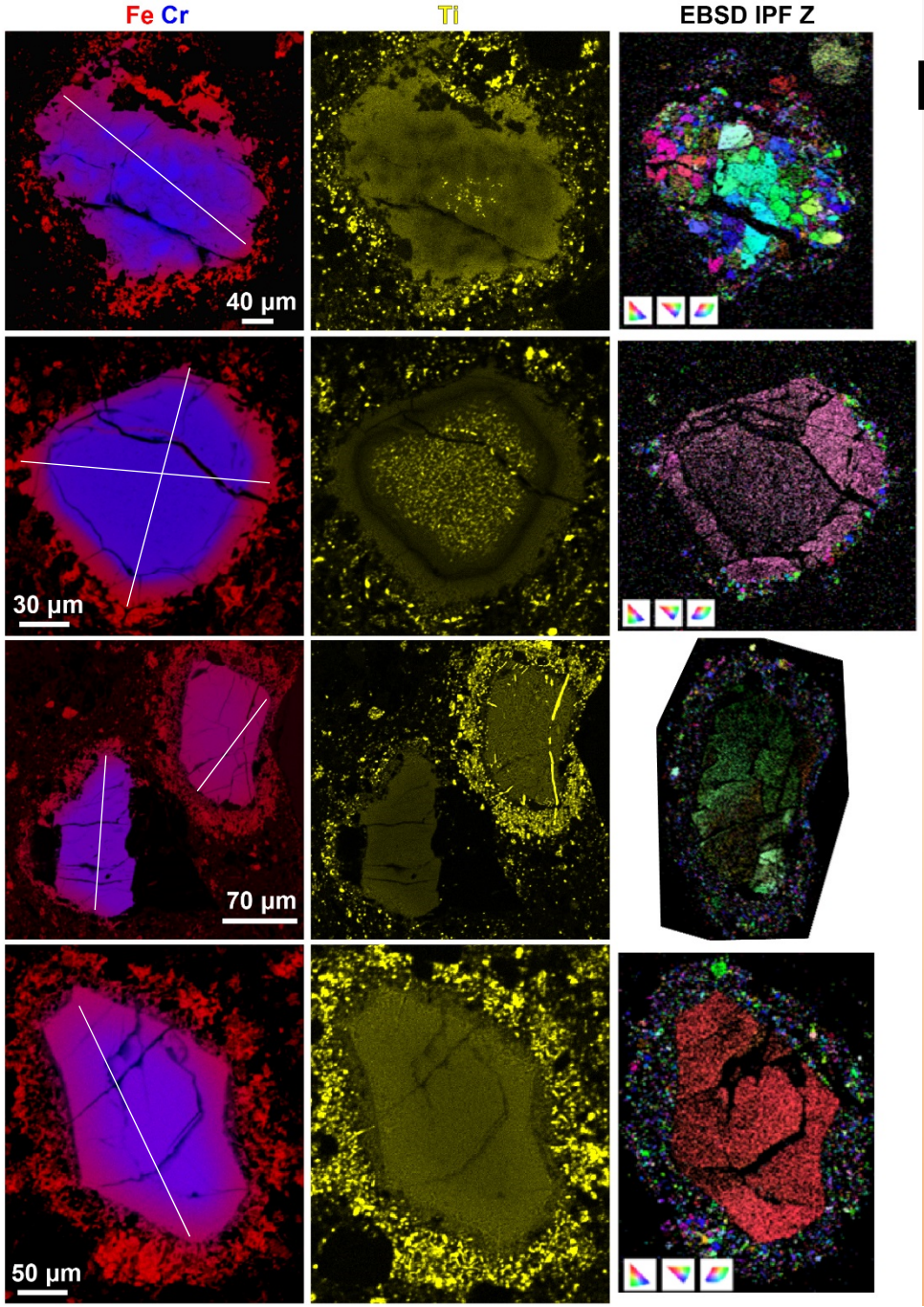




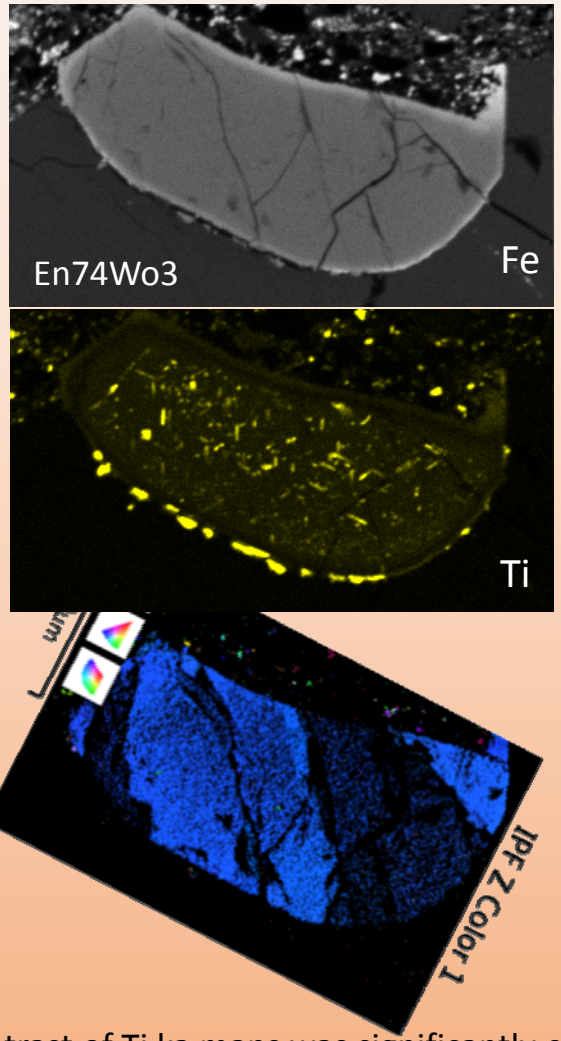
- Terrestrial occurrences contain either high V_2O_3 or Fe_2O_3
- Chondritic occurrences contain higher Fe_2O_3
- Ureilite occurrences contain higher Al_2O_3

Esk-free Chr-Mag grains

NWA 7533

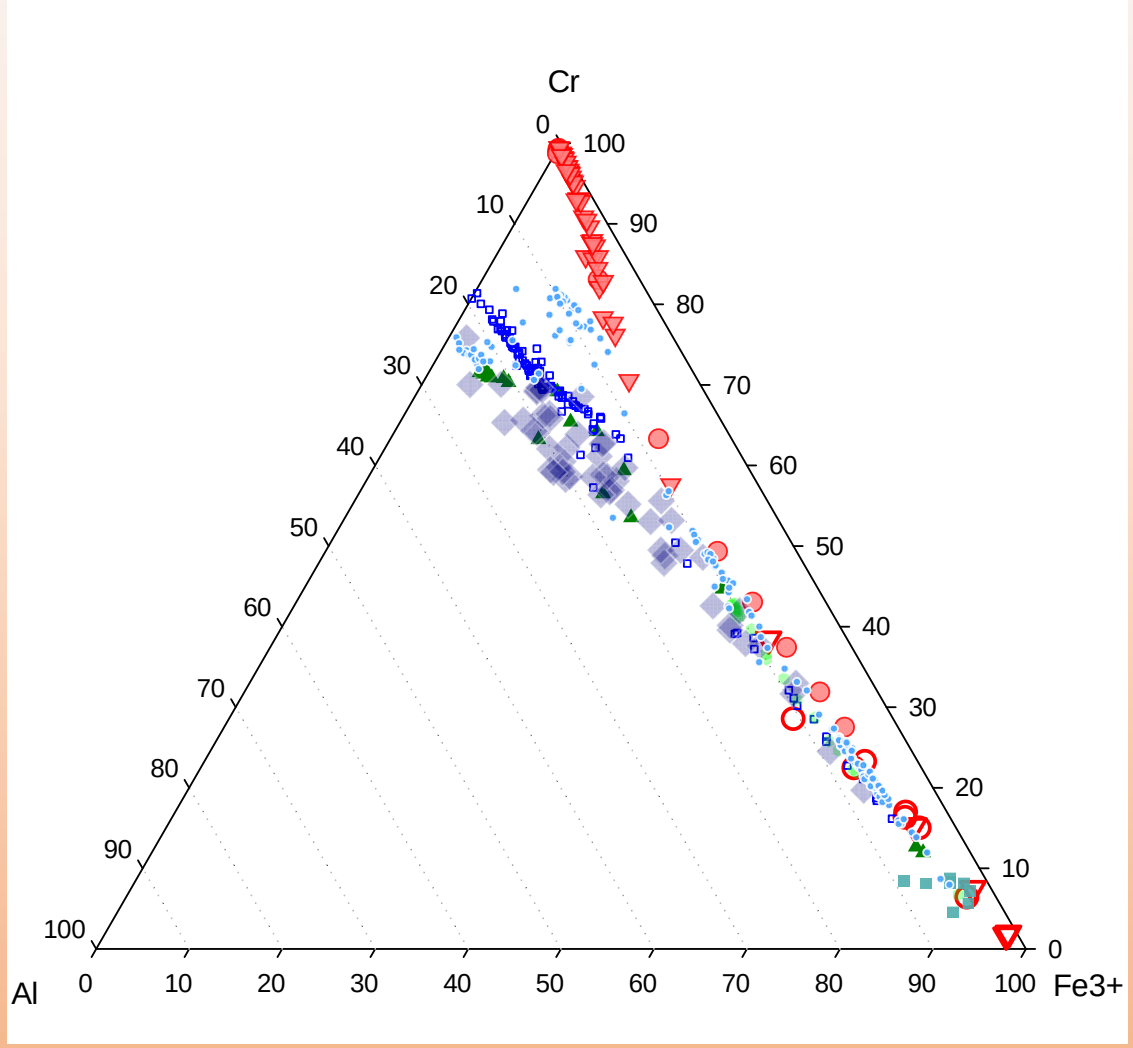


7533C1 Site 8: chr in px

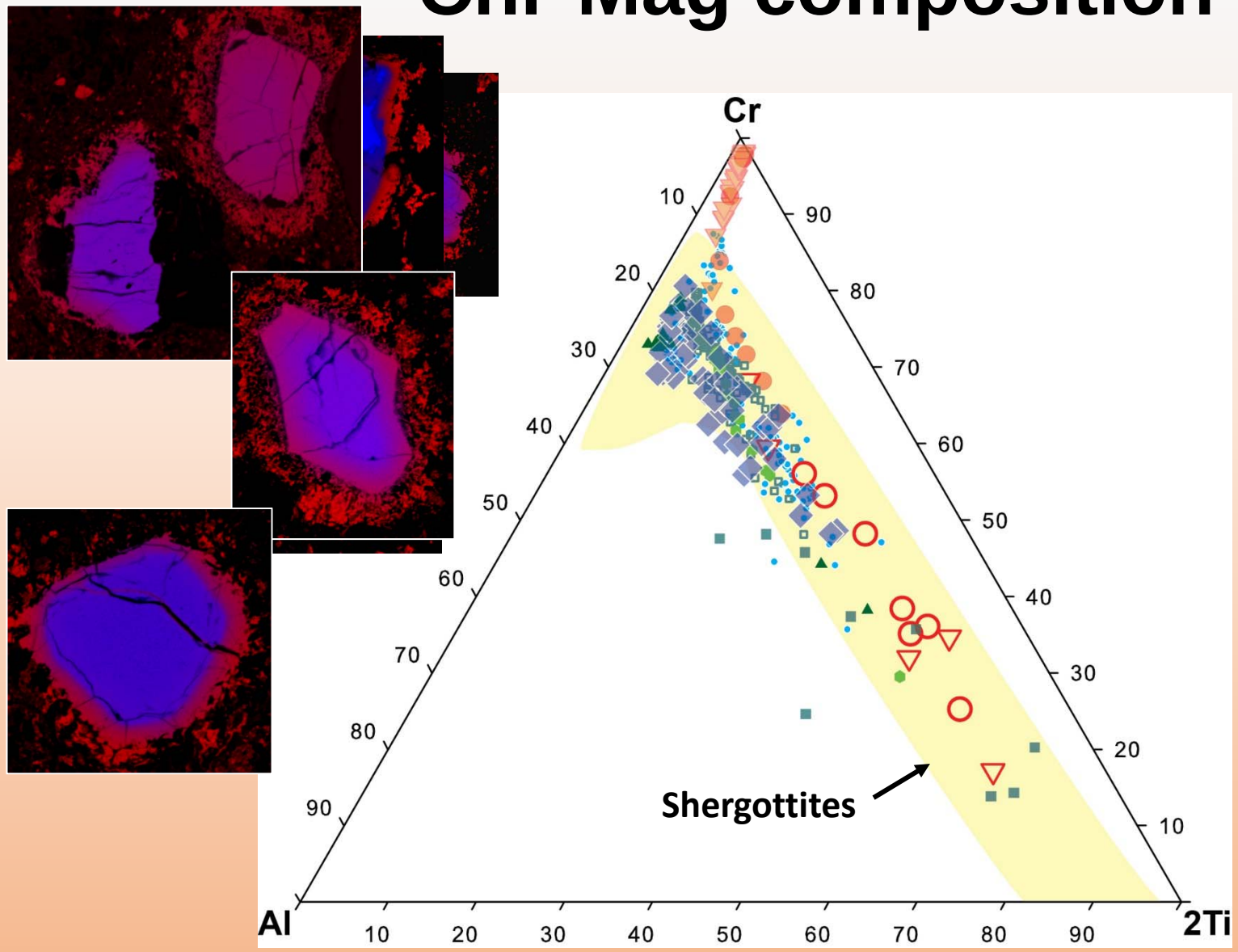


The contrast of Ti ka maps was significantly enhanced to show the Ti inclusions

Chr-Mag composition



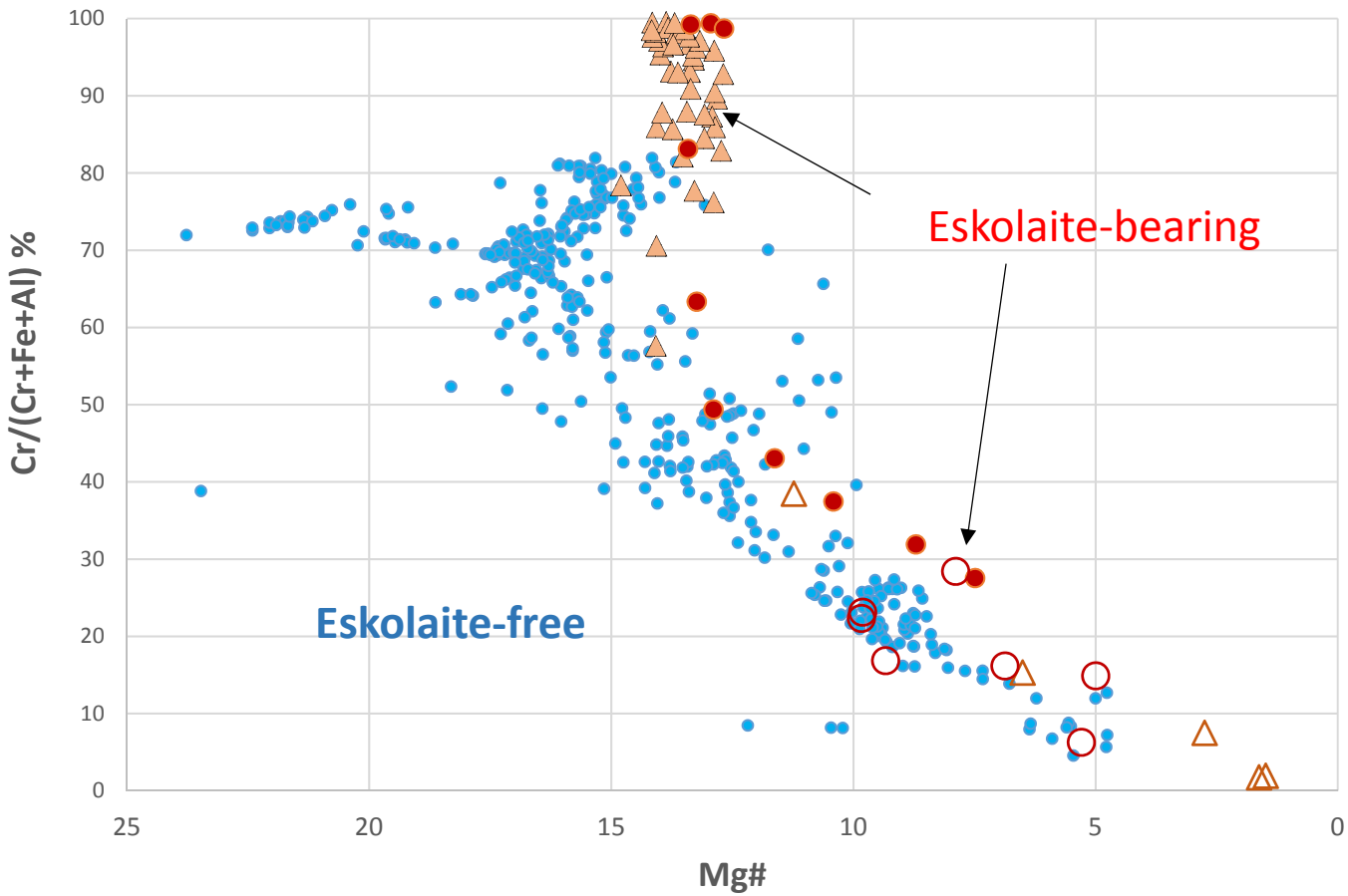
Chr-Mag composition



C1_site 8: chromite in pyroxene

Others include 6 more grains

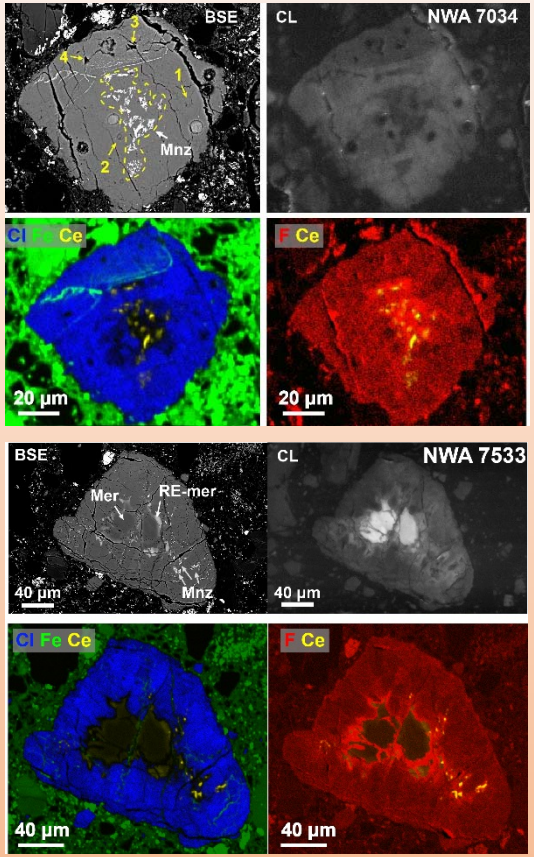
Chr-Mag composition

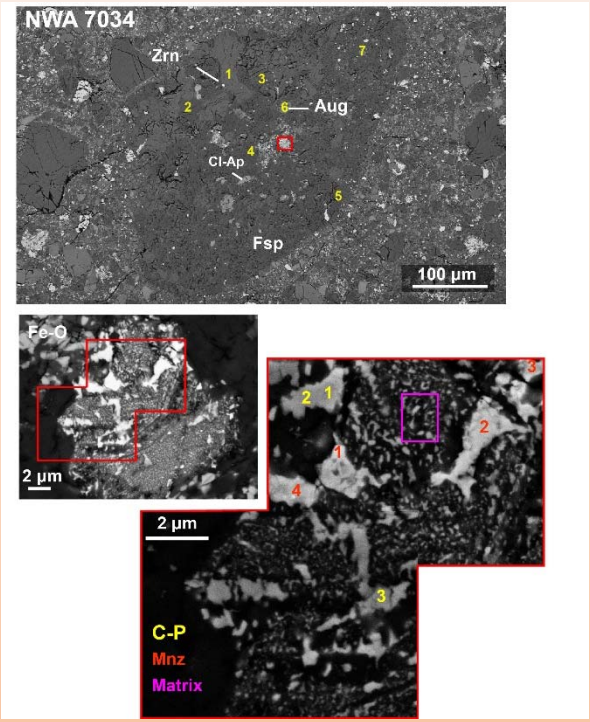


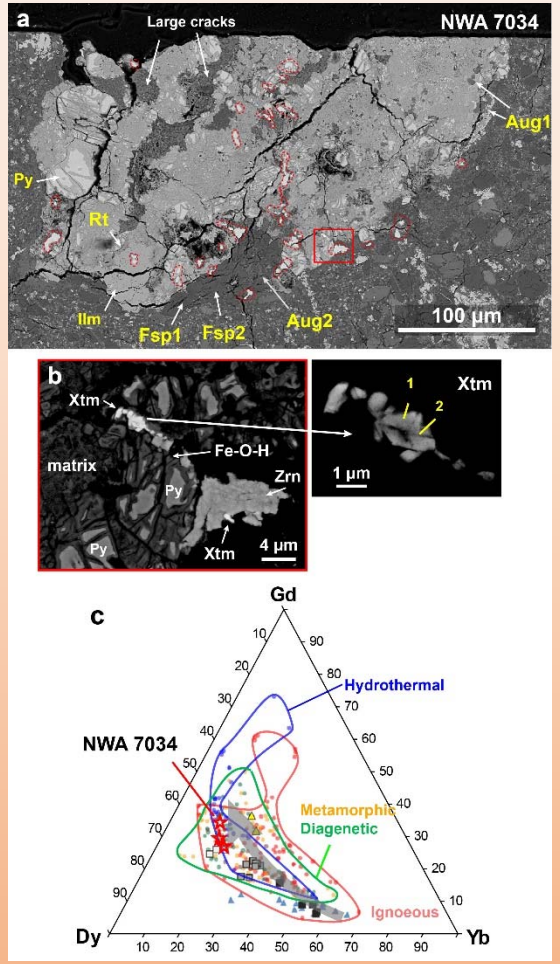
Possible Formation Mechanism

- Eskolaite is usually secondary
  - ❑Hydrothermal/Metamorphic origin
- Polycyrstalline chromite with nearly pure endmember composition
  - ❑2nd Hydrothermal/Metamorphic event
- Outer rim of magnetite, silicate, ilmenite, apatite
  - ❑3rd Hydrothermal/Metamorphic event

Other evidence of fluid-crust interactions in NWA 7034/7533







Summary

- Unusual occurrence of eskolaite-chromite-magnetite in NWA 7533
- Multiple lines of evidence suggest hydrothermal/metamorphic events in martian crust
- These features may be derived from different source regions