Northwest Africa (NWA) 15468: A New Kind of Ordinary Chondrite with a Shocking History

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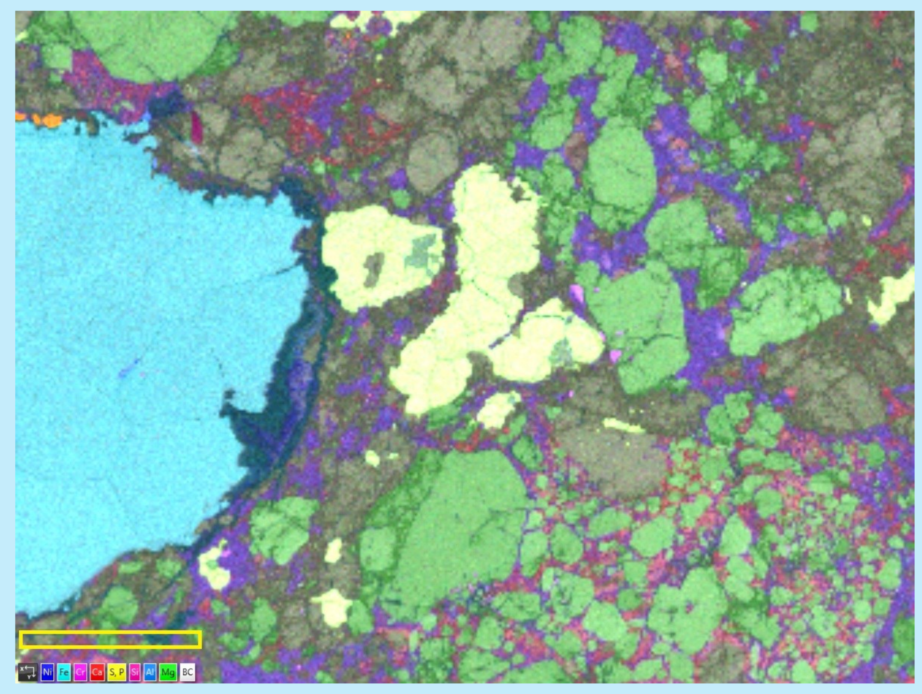
Mode based on BSE+element map with map area = 73.6 mm^2

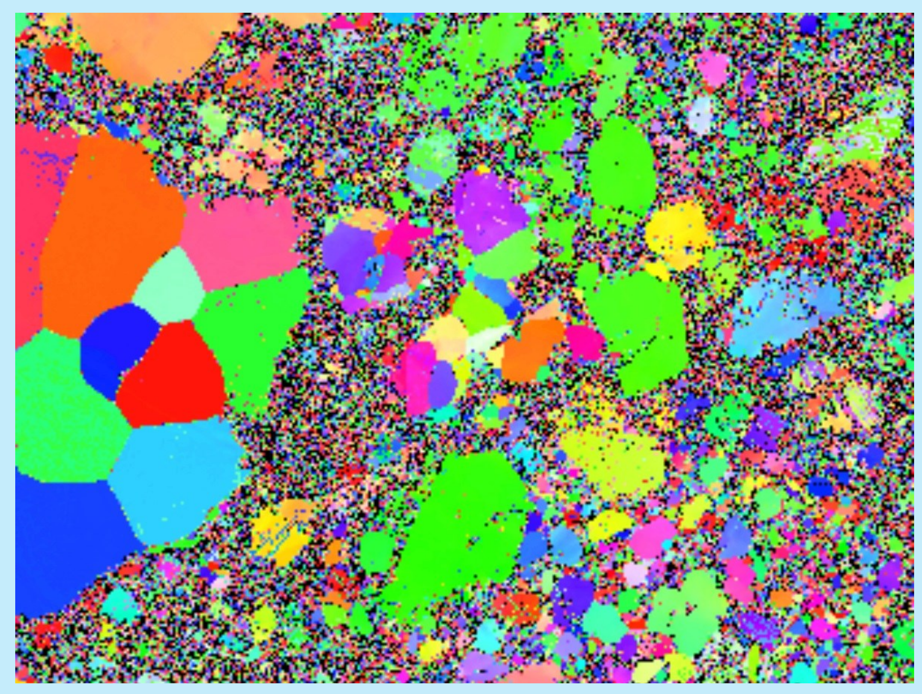
PHASE	AREA%	S.D.%		H vol%	L vol%	LL vol%
olivine	27.9	3		38	48	58
low-Ca pyroxene	38.9	3.2		28	24	16
high-Ca pyroxene	6.1	0.1		6	6	6
feldspar/glass	9.8	1.2		10	10	10
phosphate	0.5	0		<1	<1	<1
chromite	0.5	0.1		<1	<1	<1
Ni-poor metal	7.6	0.2				
Ni-rich metal	1.4	0.3				
metal, weathered	3	0.9				
troilite	4.5	0.1		5	5	5
total metal	12	1.3		10	<5	2

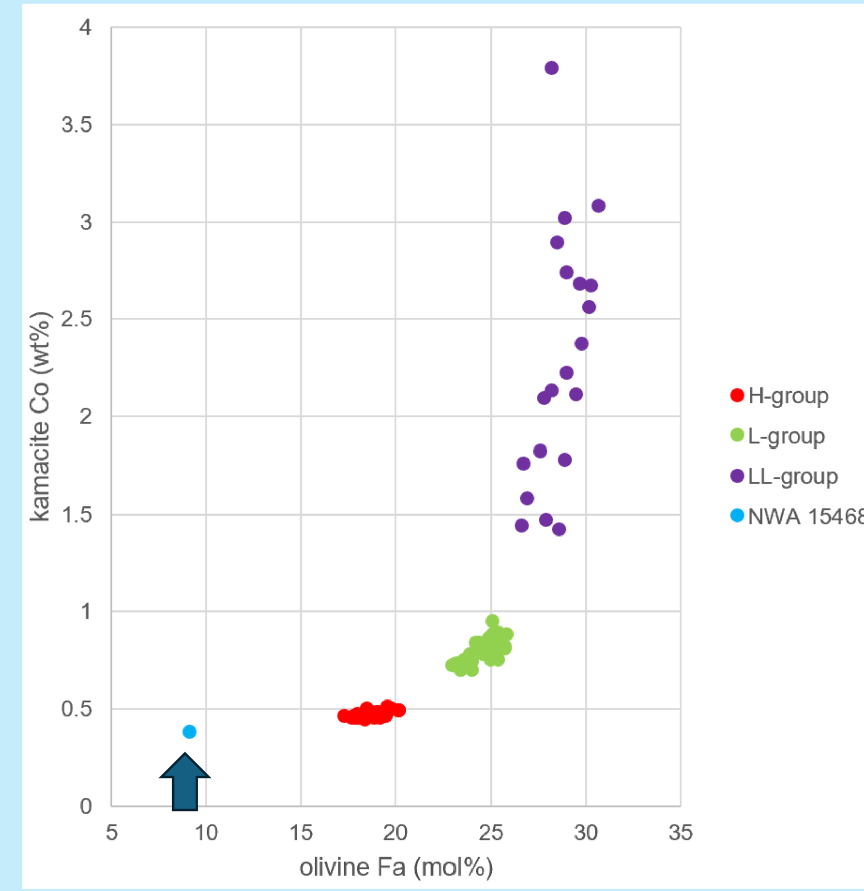
H, L, and LL-group data from [2]

Above right: Band contrast and element map image. Light blue is kamacite, yellow is troilite, green is olivine, low-Ca pyroxene is khaki, feldspathic material is purple and high-Ca pyroxene is salmon pink.

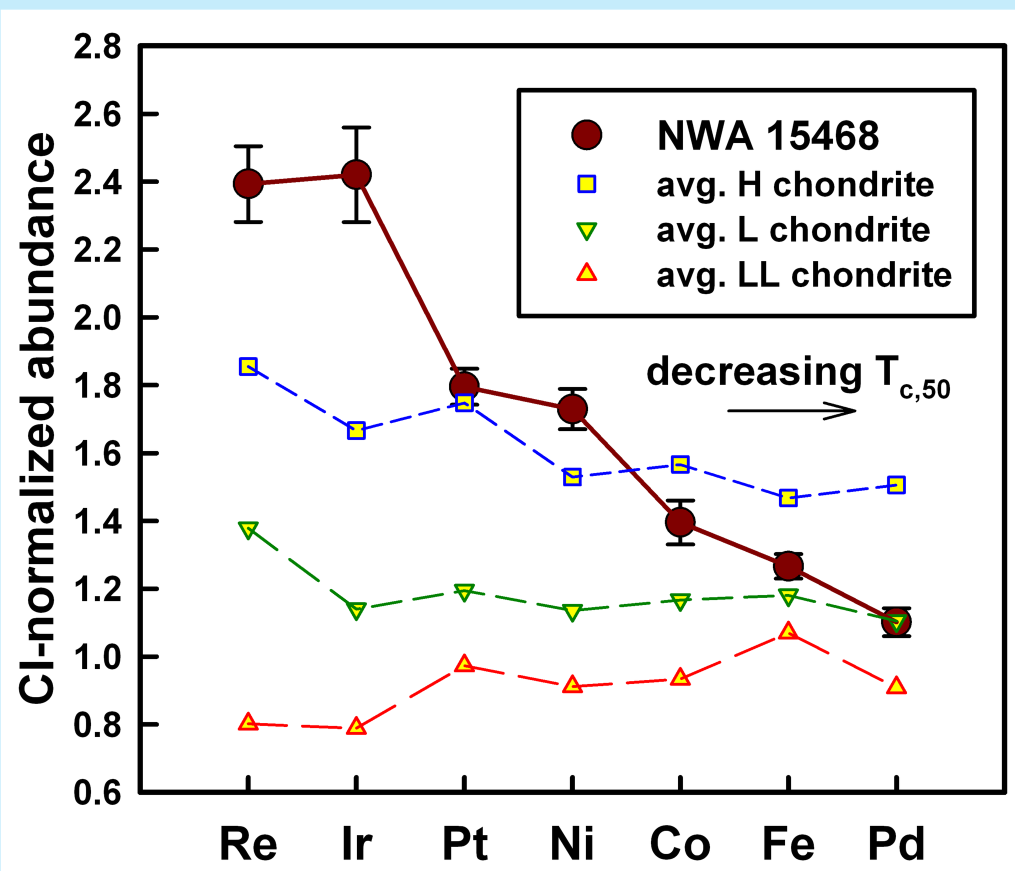


Below right: IPF X image showing that kamacite and troilite are polycrystalline.





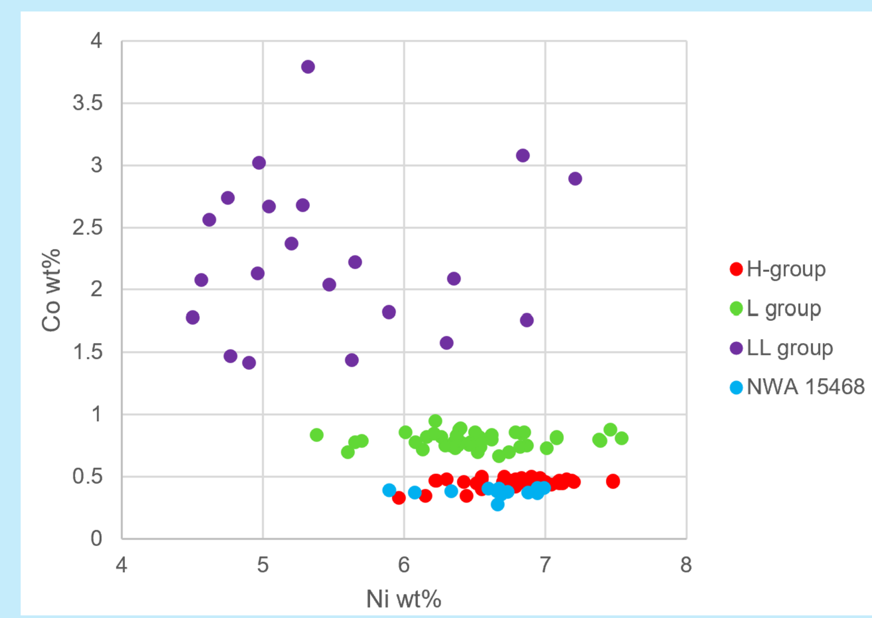
Above: Olivine Fa vs. kamacite Co for H, L, and LL chondrites (data from [1]). The mean for NWA 15468 (see arrow) plots on an extension of the OC trend.



Above left: Modal mineralogy of NWA 15468 compared to OC. Olivine, low-Ca pyroxene, and total metal continue trends seen in OC.

Left: Bulk chemical data show that NWA 15468 resembles an OC. The siderophile elements show a strong volatility trend, far more pronounced than for average OCs, providing evidence for higher-temperature processing of NWA 15468.

Right: Individual analyses of NWA 15468 kamacite compared to OC means [1].

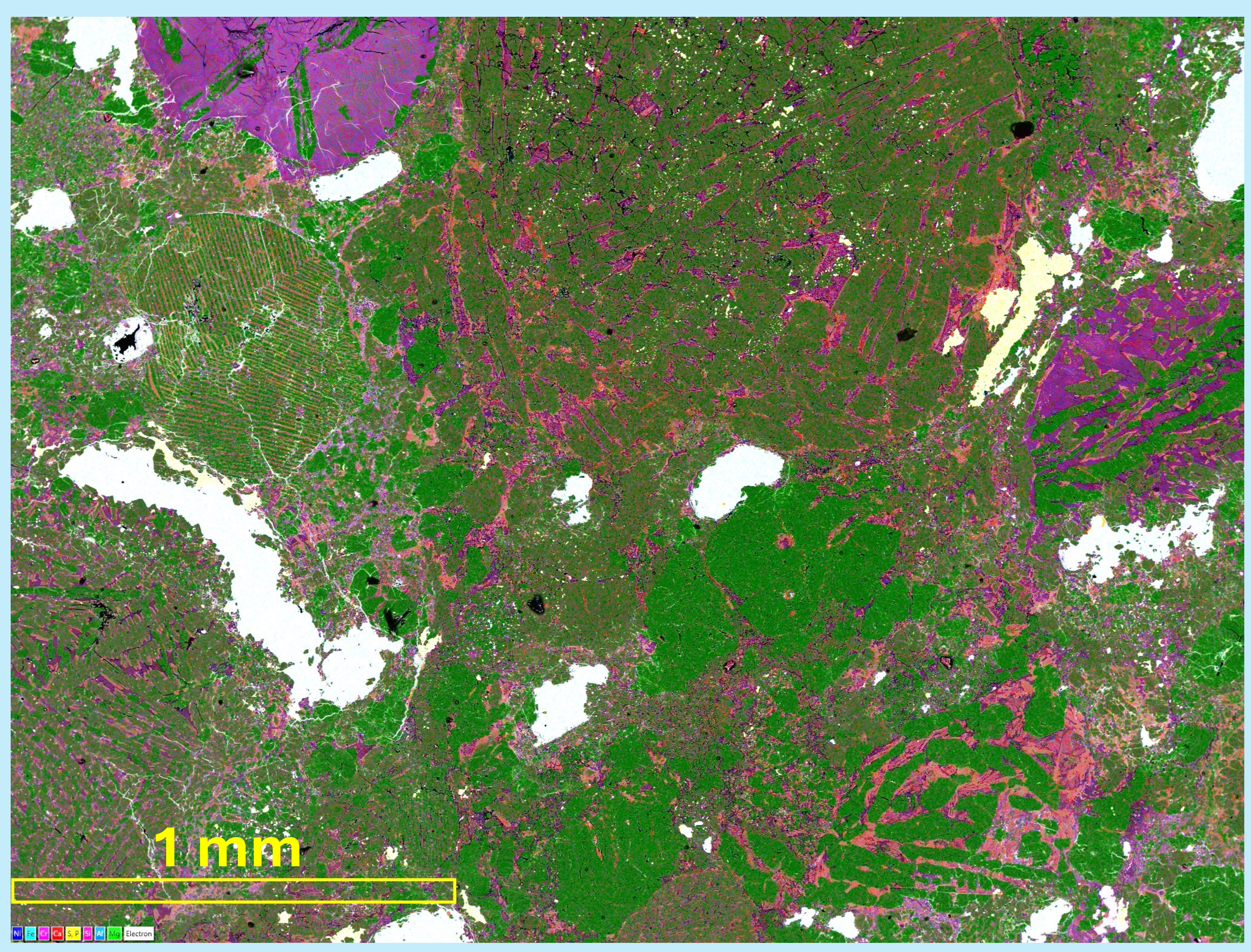


Right: EDS + BSE map showing 6 readily discernable partial chondrules.

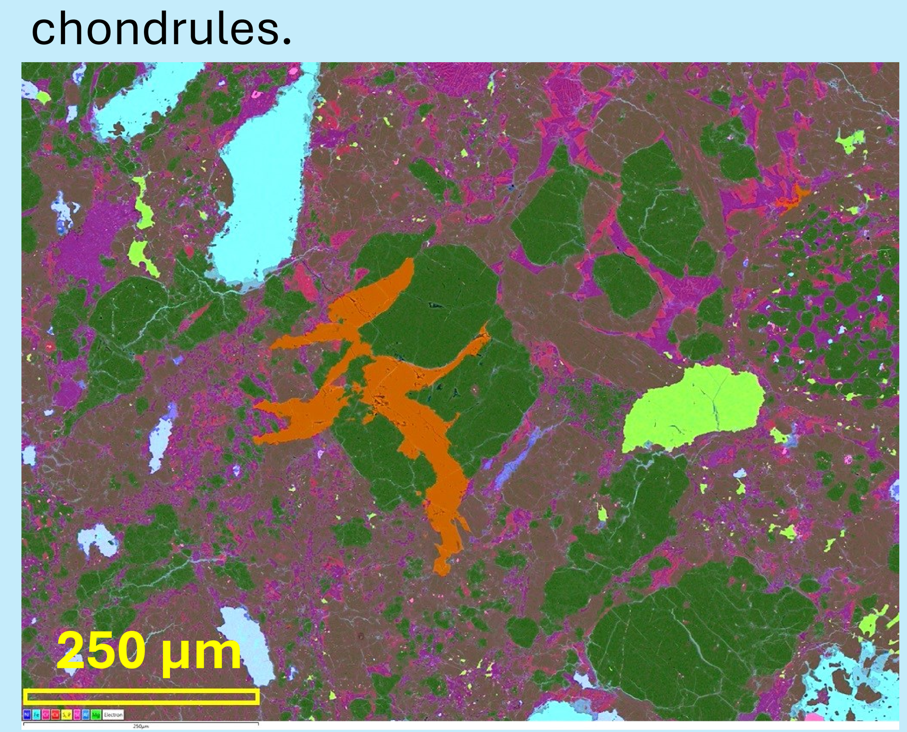
- Olivine = brighter green
- Lo-Ca pyroxene = duller green/brown
- High-Ca pyroxene = salmon/red
- Feldspathic glass or grains = purple
- Troilite = yellow
- Metal = white

Below right: EDS + BSE map of area with less discernable chondrules. Colors same as above with

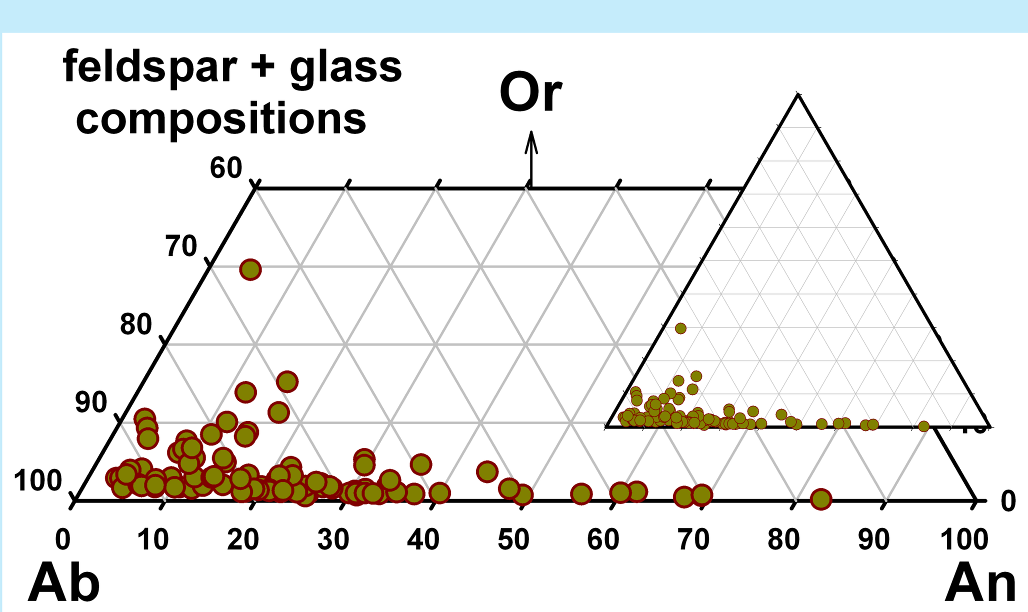
- Orange = chlorapatite
- Pink = chromite

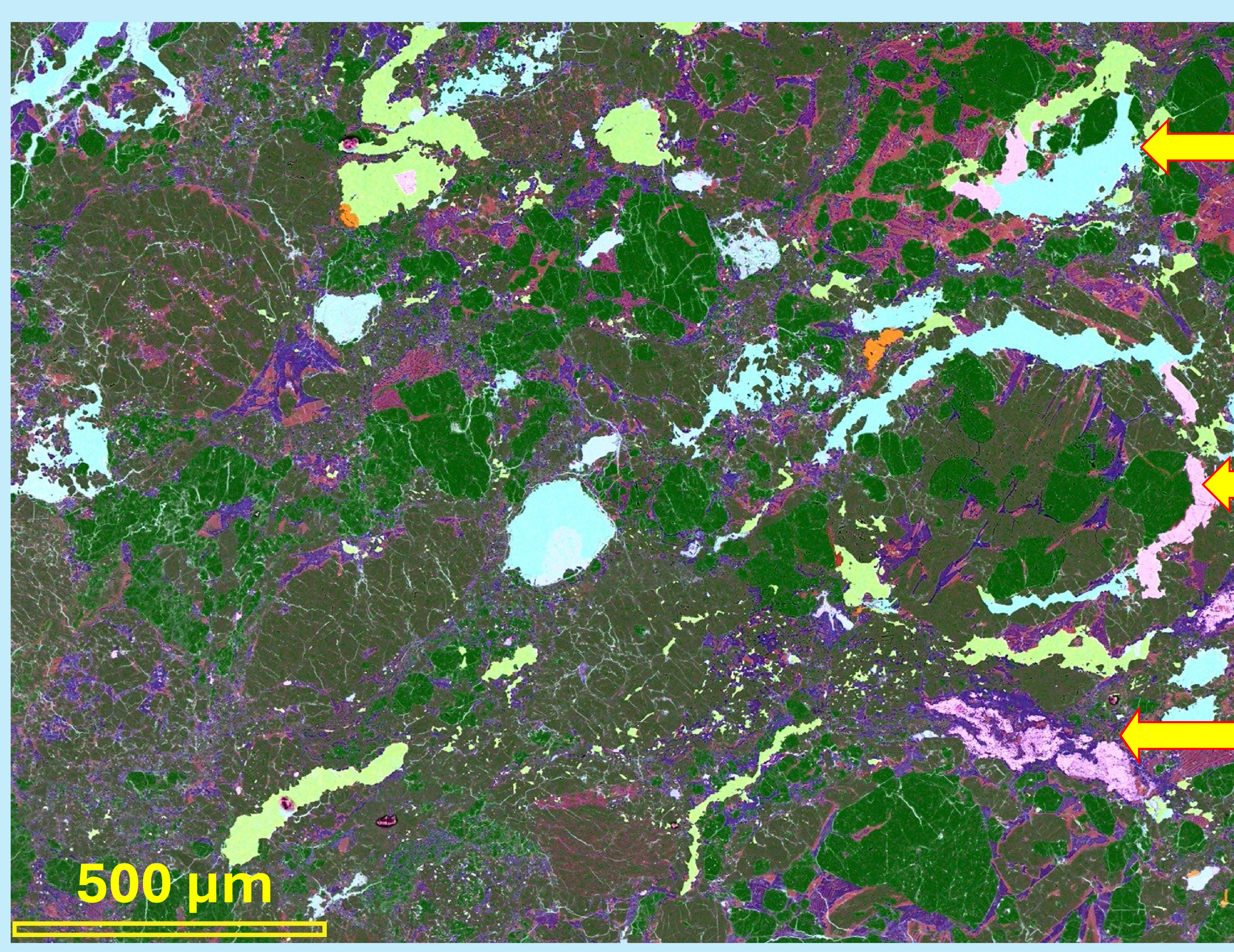


Below: Chlorapatite (orange) cuts across an olivine grain (green). Many grains or veins are roughly aligned in two approximately perpendicular directions. While veins often border clasts or chondrules, they also frequently cut across grains or chondrules.



Below: Feldspathic material is mainly glass, both chondrule mesostasis and matrix, although some crystalline feldspar is present. Feldspathic material is highly variable in composition indicating little annealing or metamorphism following formation.





Aggregate composed of metal (white), troilite (yellow), chromite (pink), enclosing olivine (green) and high-Ca pyroxene (salmon) from an adjacent poorly defined chondrule.

Metal, chromite, troilite vein cutting across olivine and low-Ca pyroxene (khaki) inside a chondrule.

Feldspathic-chromite assemblage or FCA (aka chromite-plagioclase assemblage [5]). Numerous FCAs occur in this meteorite.

EBSD data suggests that the meteorite was strongly shocked, with olivine $GOS_{d>50}$ (grain-scale-average misorientations with an area equivalent to a circular grain > 50 µm diameter) = 4.14±1.96, which indicates a weighted shock stage (WSS) ~ 4 [3, 4], comparable to a conventional shock stage of S4 [6]. EBSD data provides evidence for shock at high temperatures, with model deformation temperature (T_{deform}) = 958±88 ºC [3].

References: [1] Rubin (1990) *Geochimica et Cosmochimica Acta* 54:1217-1232. [2] Hutchison (2004) Meteorites. A Petrologic, Chemical and Isotopic Synthesis. Cambridge University Press. [3] Ruzicka A. M. et al. (2024) *Geochimica et Cosmochimica Acta* 378:1-35. [4] Jamsja N. and Ruzicka A. (2010) *Meteoritics & Planetary Science* 45;828-849. [5] Rubin (2003) *Geochimica et Cosmochimica Acta* 67:2695-2709. [6] Stoffler et al. (1991) *Geochimica et Cosmochimica Acta* 55:3845-3867.