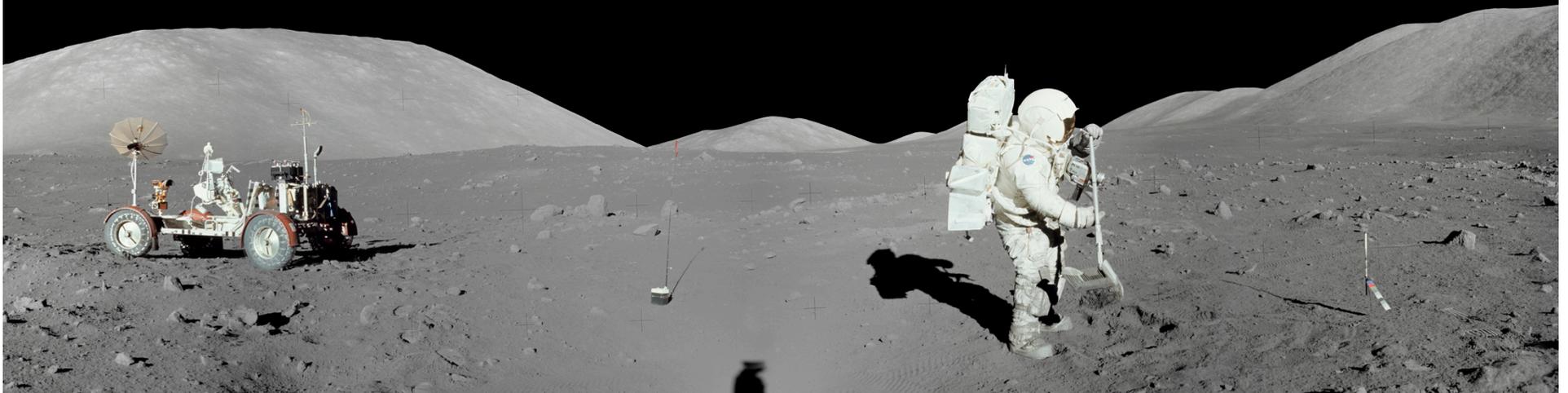


OLIVINE CUMULATE 71597

Patrick Donohue & Clive Neal
University of Notre Dame



OLIVINE CUMULATE 71597

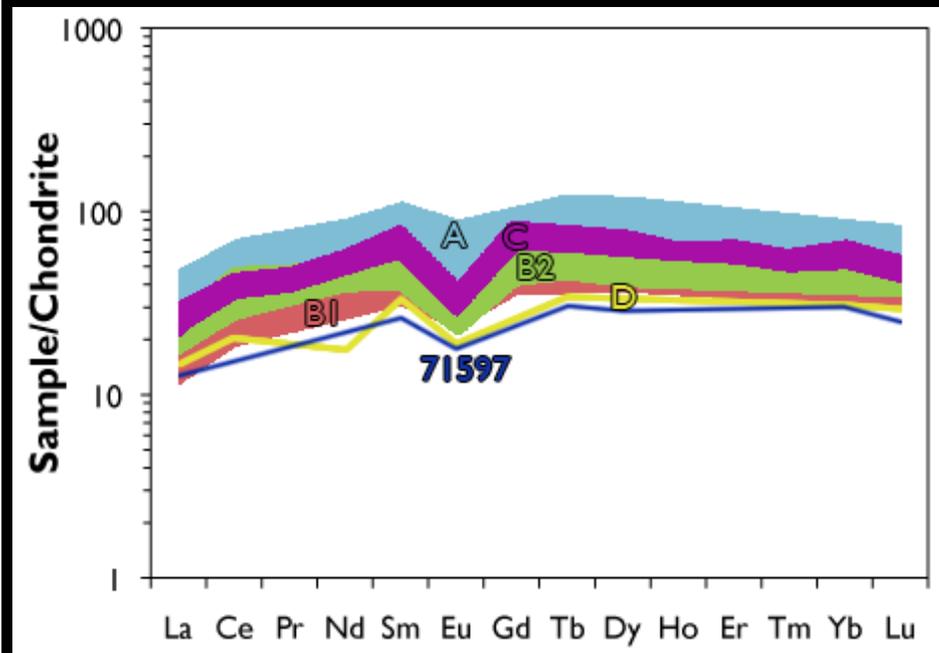
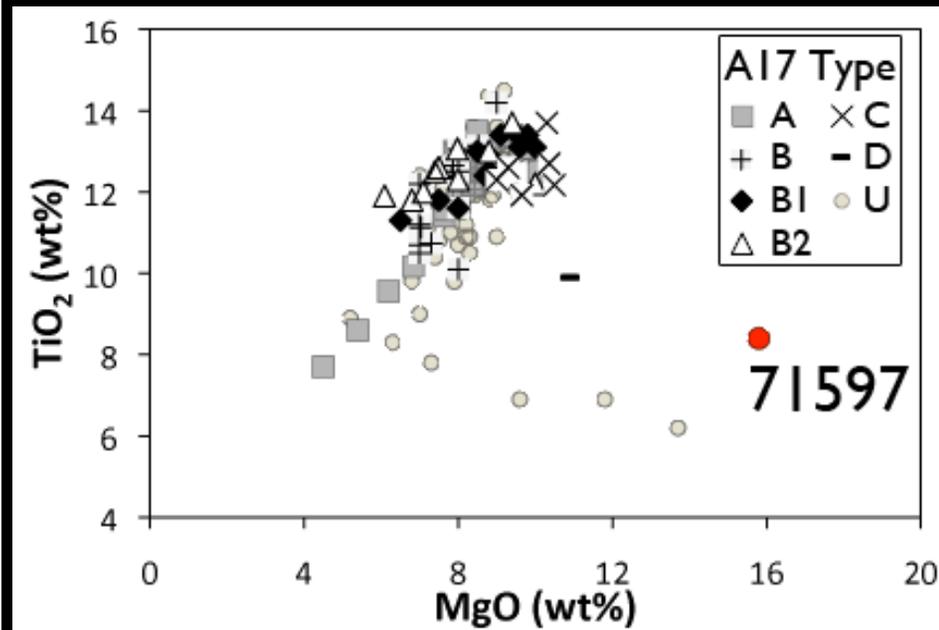


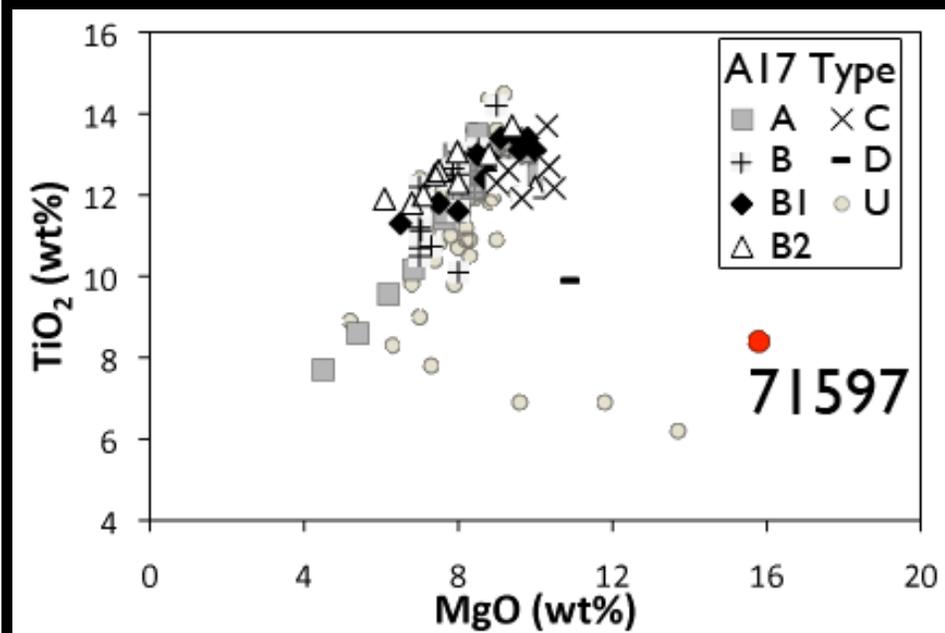
JSC S73-31803

Warner *et al.* (1977) PLSC 8th

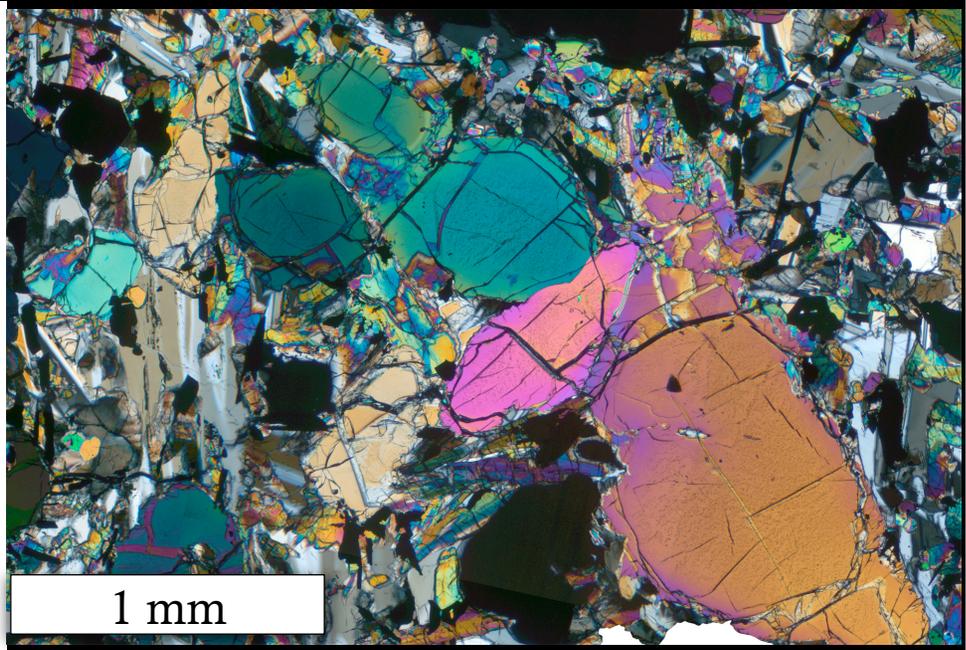
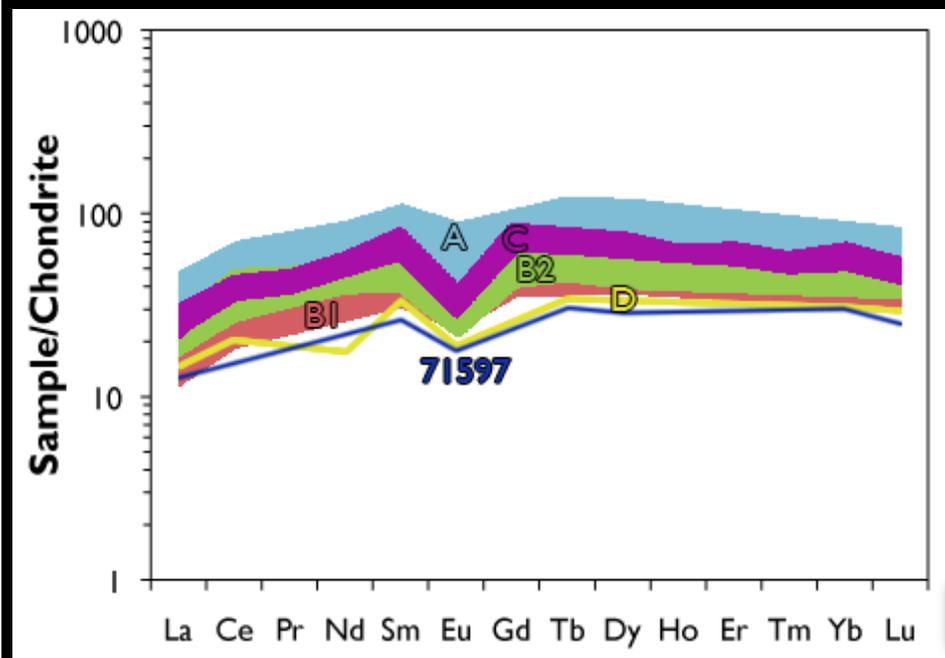
- Highest MgO (15.8 wt. %)
- Highest modal olivine abundance (19.3%)

- Whole-rock rare earth element (REE) abundance parallels high-Ti basalts





Olivine Forsterite
histogram



35 years later...

- No other high-Ti sample comes close to the extensive accumulation in 71597

Warner *et al.* (1979) PLPSC 10th

- likely from Type B/B1 flow

Neal *et al.* (1990) GCA v.54

- olivine Fo is too low for WR Mg#

- Whole-rock oxygen isotopes

Wiechert *et al.* (2002) Science v.294

35 years later...



Fig. 2. Transmitted light photomicrograph (X nicols) showing plagioclase-poikilitic texture of the rock. Most of field of view is occupied by a single plagioclase crystal which poikilitically encloses crystals of olivine (high relief), pyroxene, armalcolite (large opaque crystal at lower left) and ilmenite. Horizontal dimension equals 2.5 mm.

Warner et al. (1977)

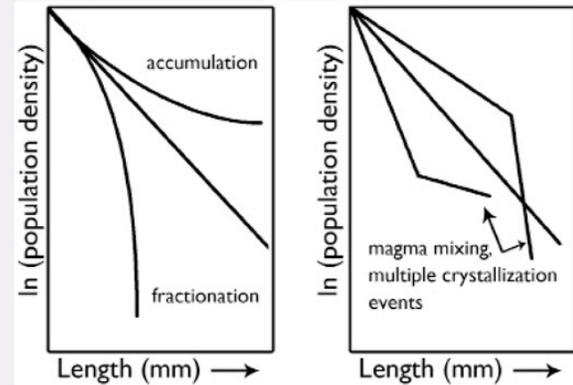
Research goals

- Mineral major and trace element geochemistry
 - Olivine
 - Ilmenite
 - Pyroxene
 - Plagioclase
 - Armalcolite
 - Melt inclusions
- Model crystallization history and parent composition
- Tie in 71597 with other high-Ti basalts
- Are any crystals xenocrysts, from multiple magma pulses, or from multiple sections in a flow?

METHODS

Crystal Size Distributions (CSDs)

- Estimate 3D crystal shape [8]
- Plot size vs population density
- Linear slope is function of growth rate & residence time [9]



Electron Probe Micro-Analysis

- Analyze representative crystals of ilmenite, olivine, plagioclase, pyroxene, armalcolite & mesostasis
- core and rim on larger crystals
- Cameca SX50 at University of Chicago, IL
- 1-10 μm spot size

Laser Ablation-ICP-MS

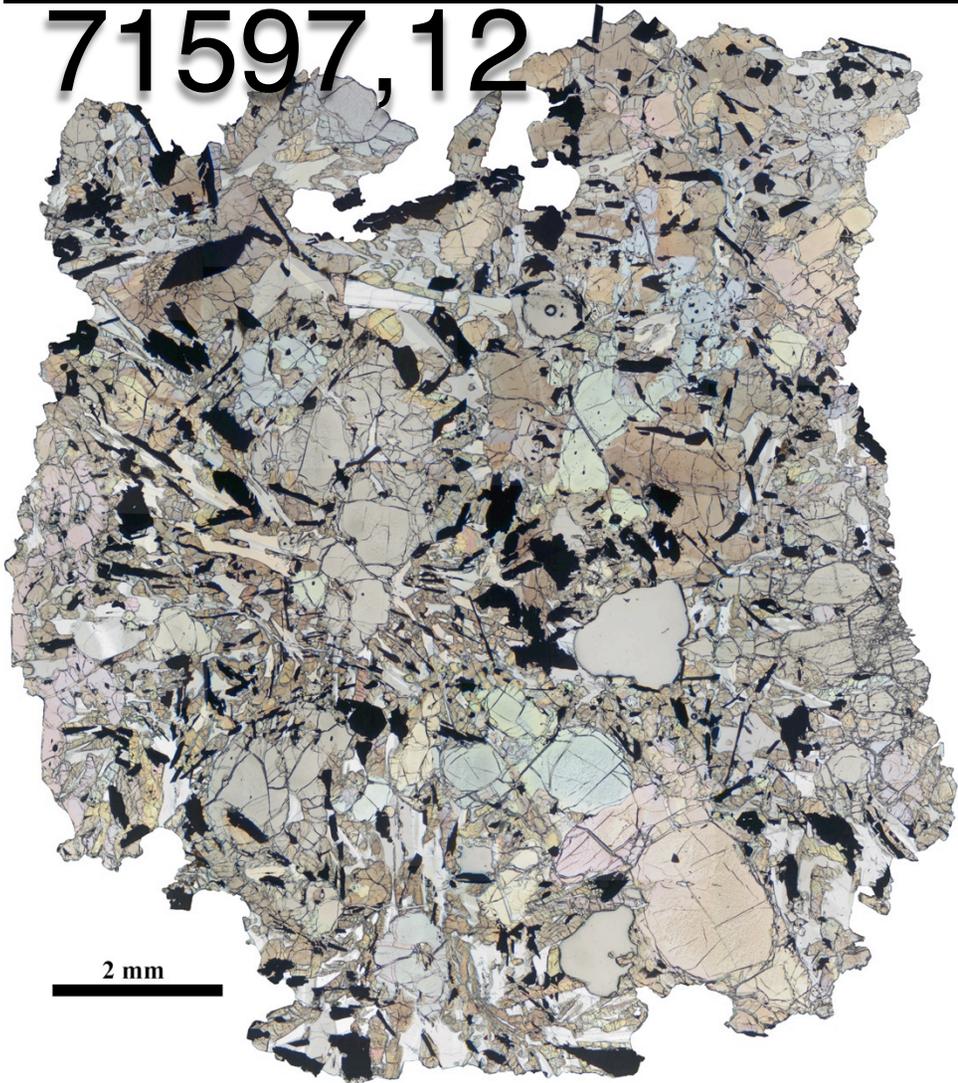
- *In-situ* trace element analyses for petrogenetic modeling
- Guided by EPMA analyses and petrography
- New Wave 213nm laser system on ThermoFinnigan Element2 ICP-MS, University of Notre Dame, IN
- 40-55 μm spot size for olivine & ilmenite; $\sim 75\mu\text{m}$ line rasters on pyroxene and plagioclase

71597,13



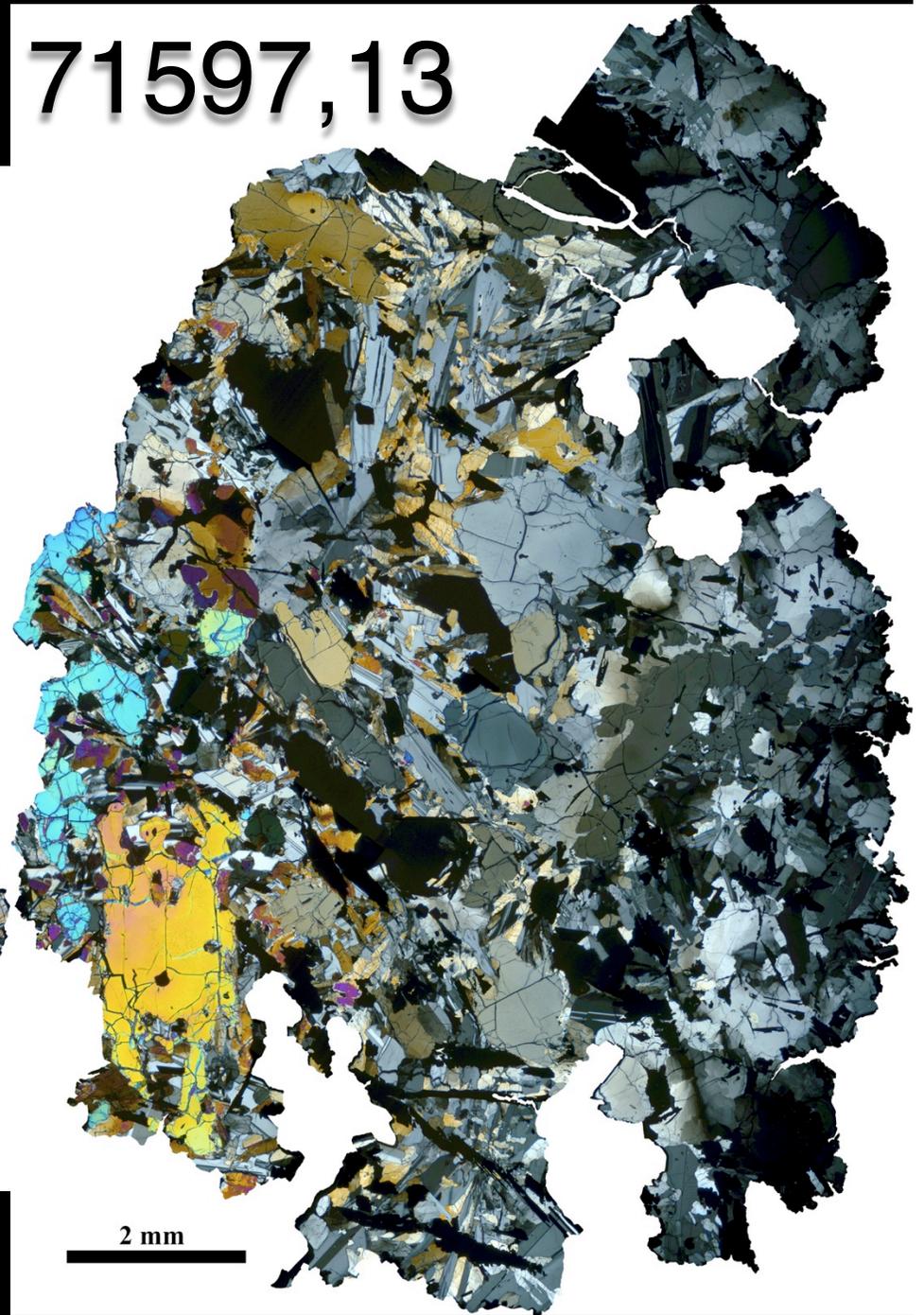
2 mm

71597,12



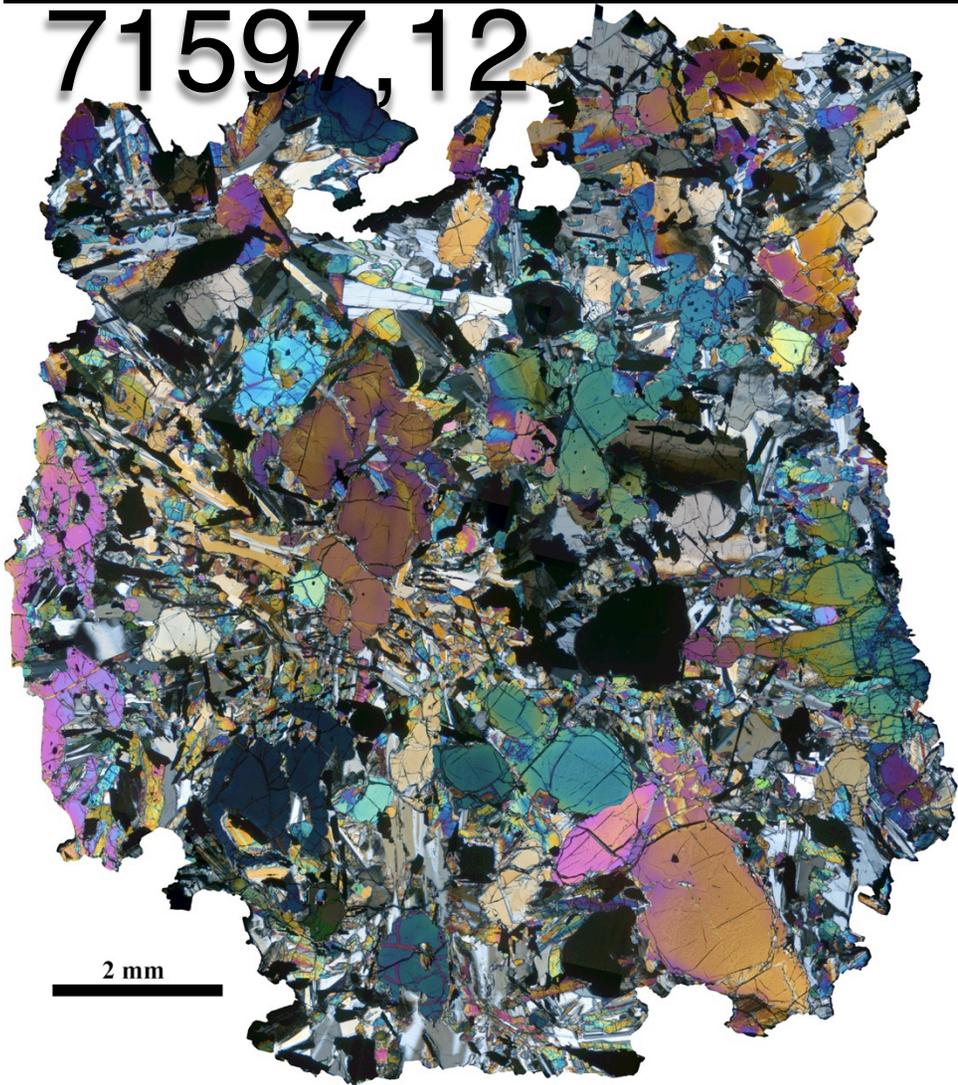
2 mm

71597,13



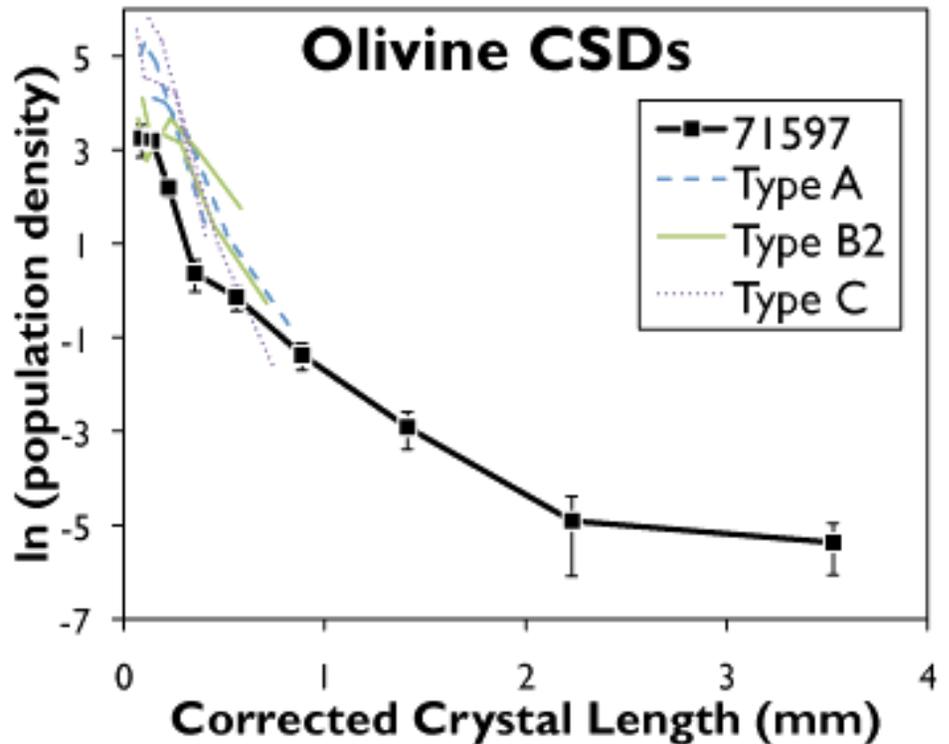
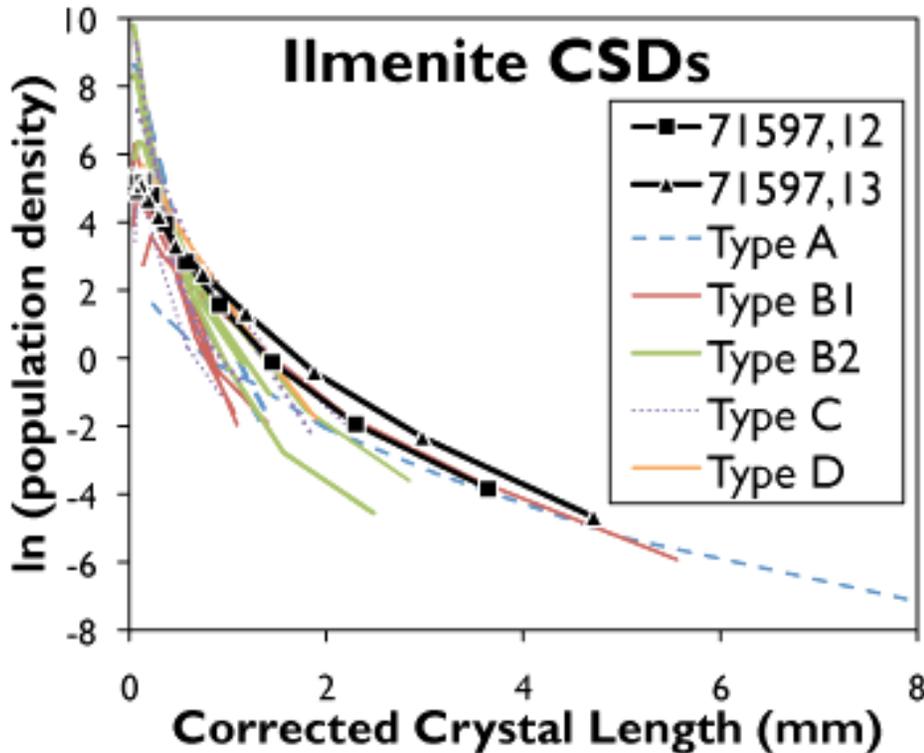
2 mm

71597,12



2 mm

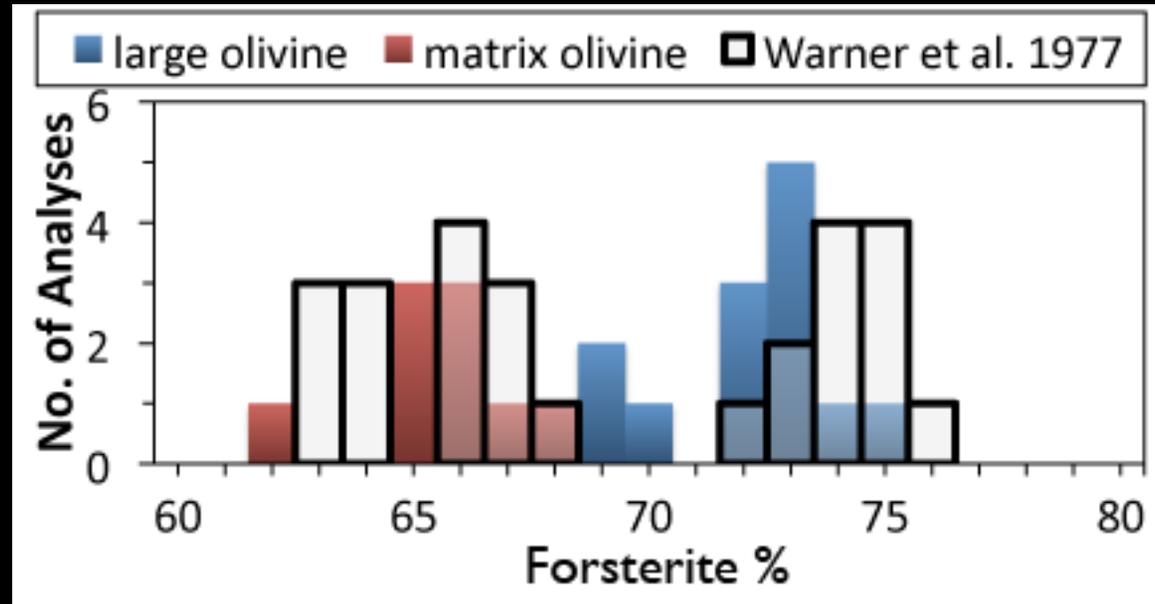
Crystal Size Distributions



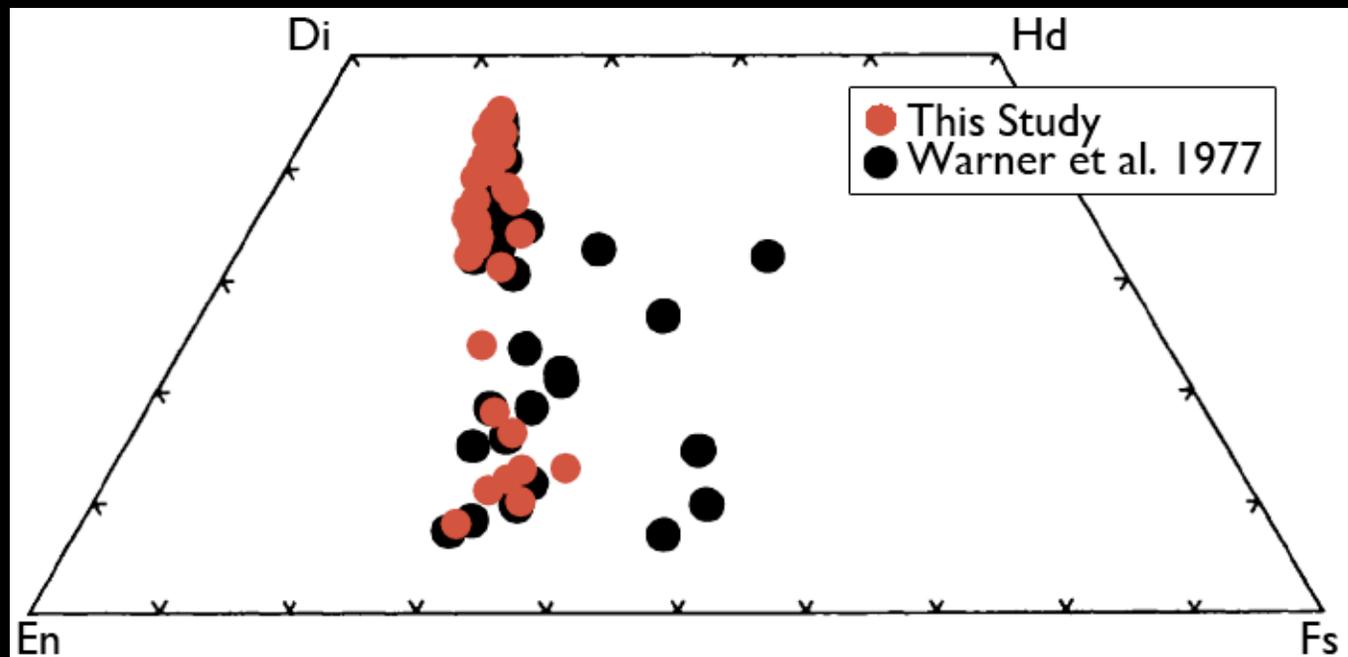
- ⊗ Curved ilmenite CSD
- ⊗ Typical of other high-Ti basalts

- ⊗ Kinked olivine CSD
- ⊗ Distinct slope at larger sizes

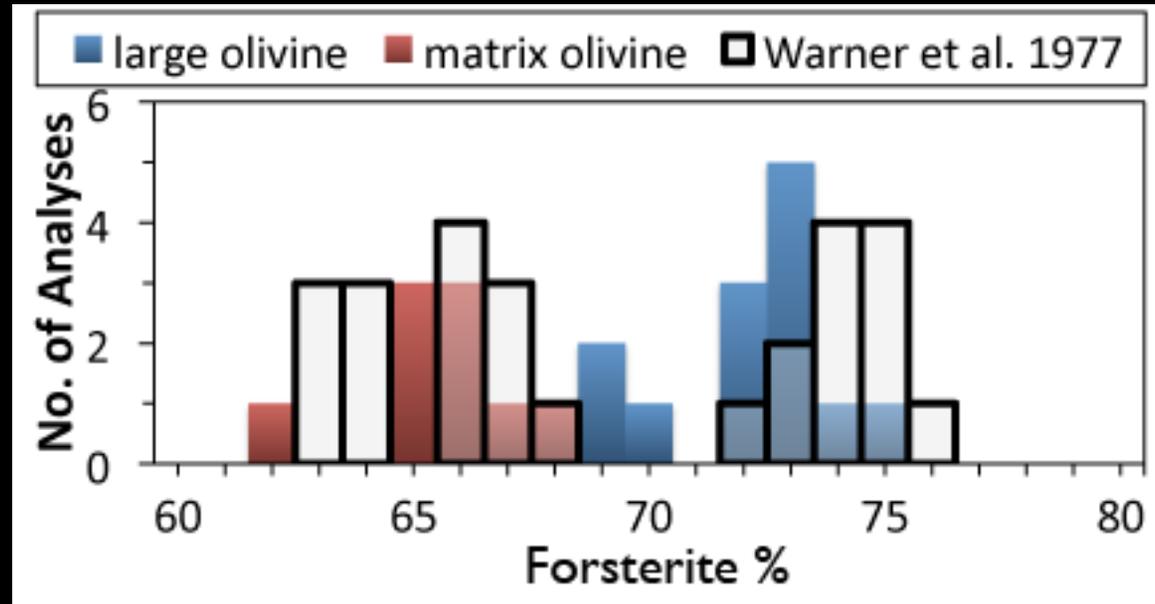
olivine



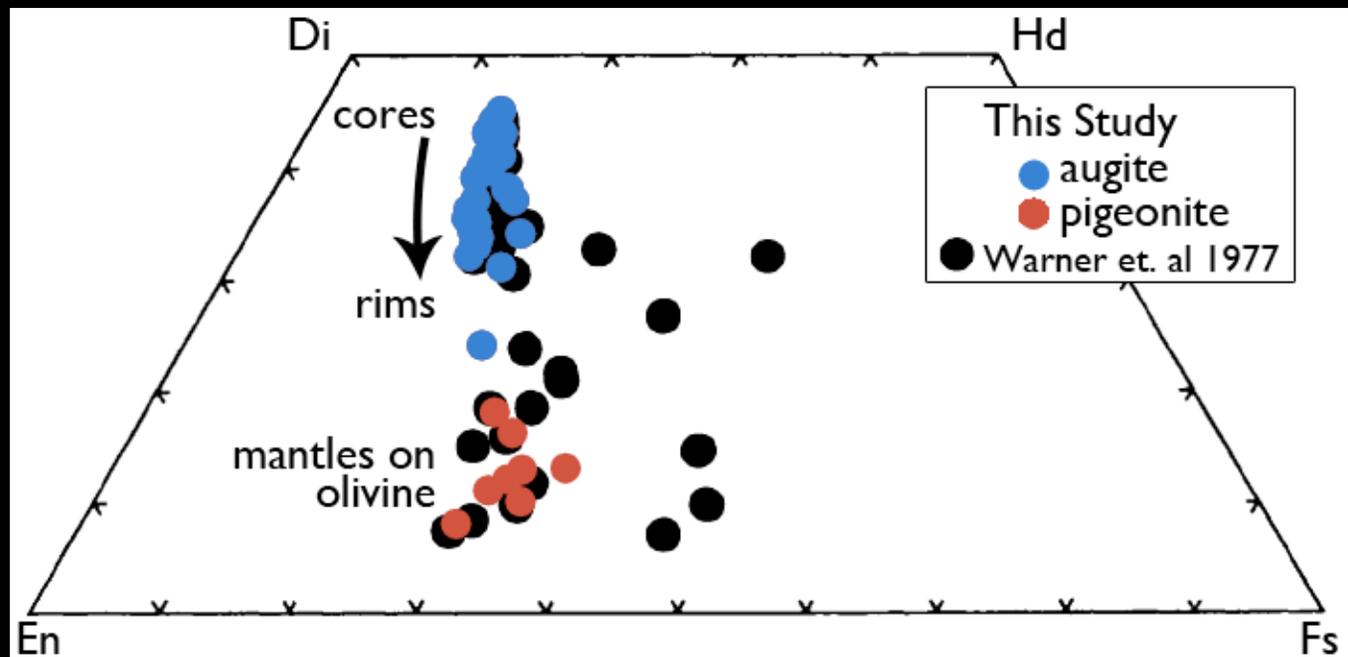
pyroxene



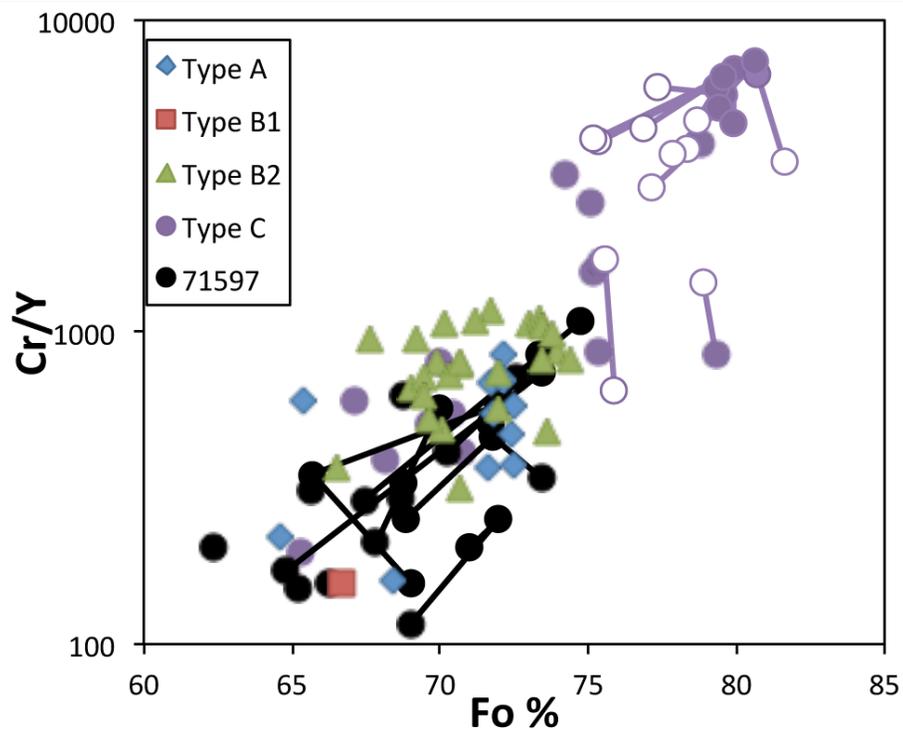
olivine



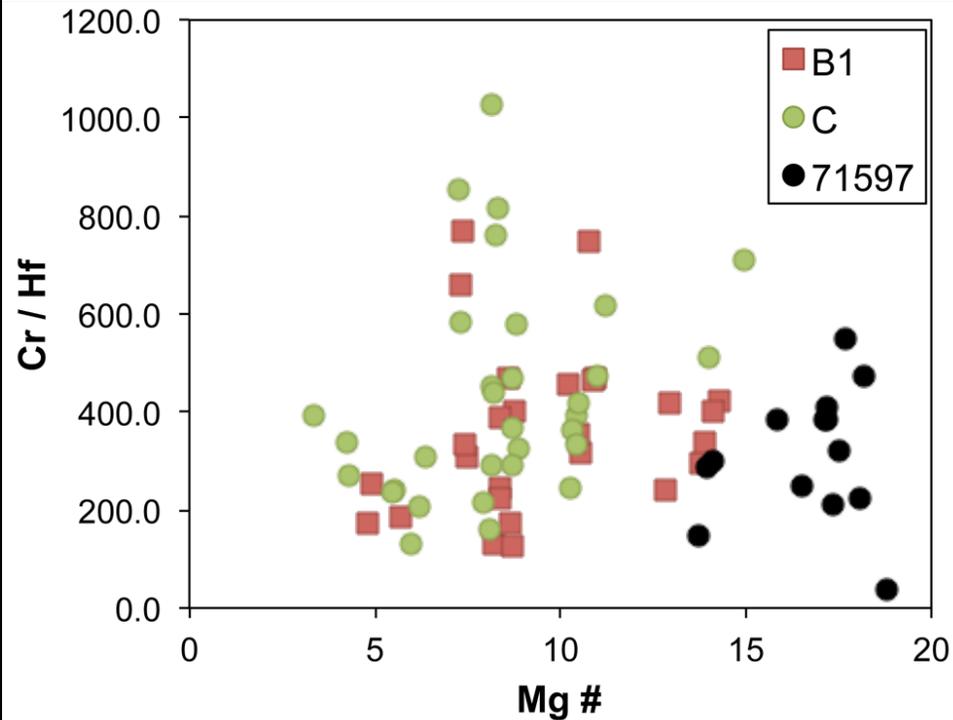
pyroxene



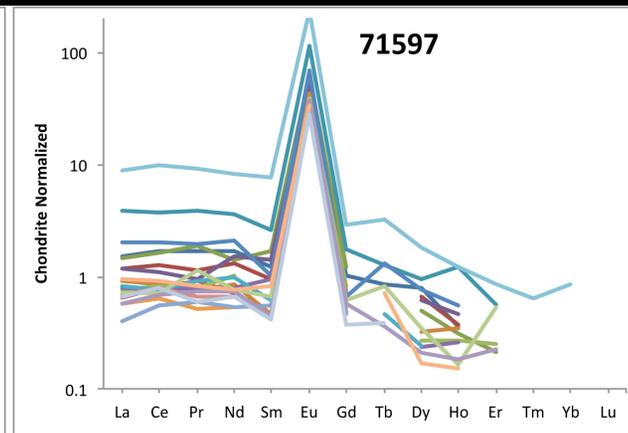
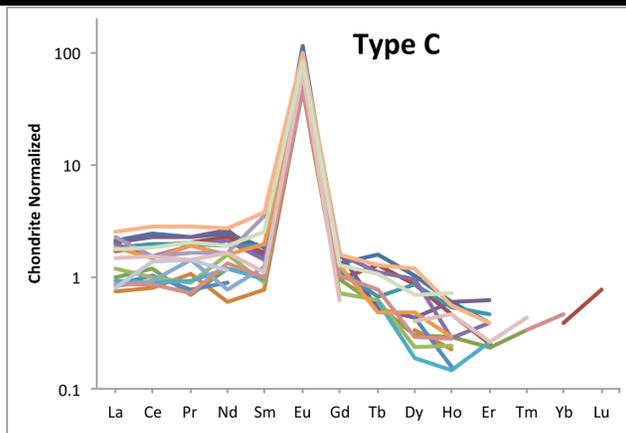
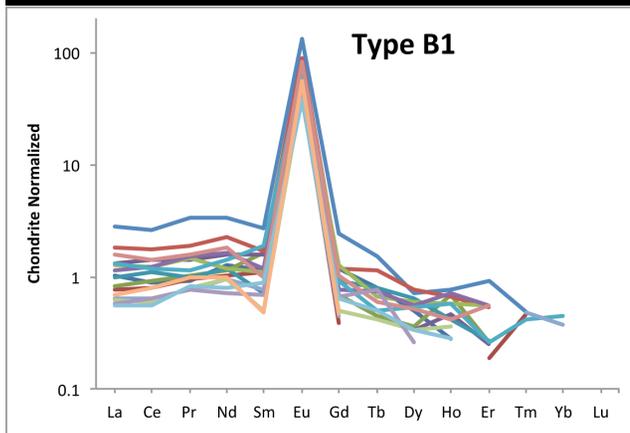
olivine



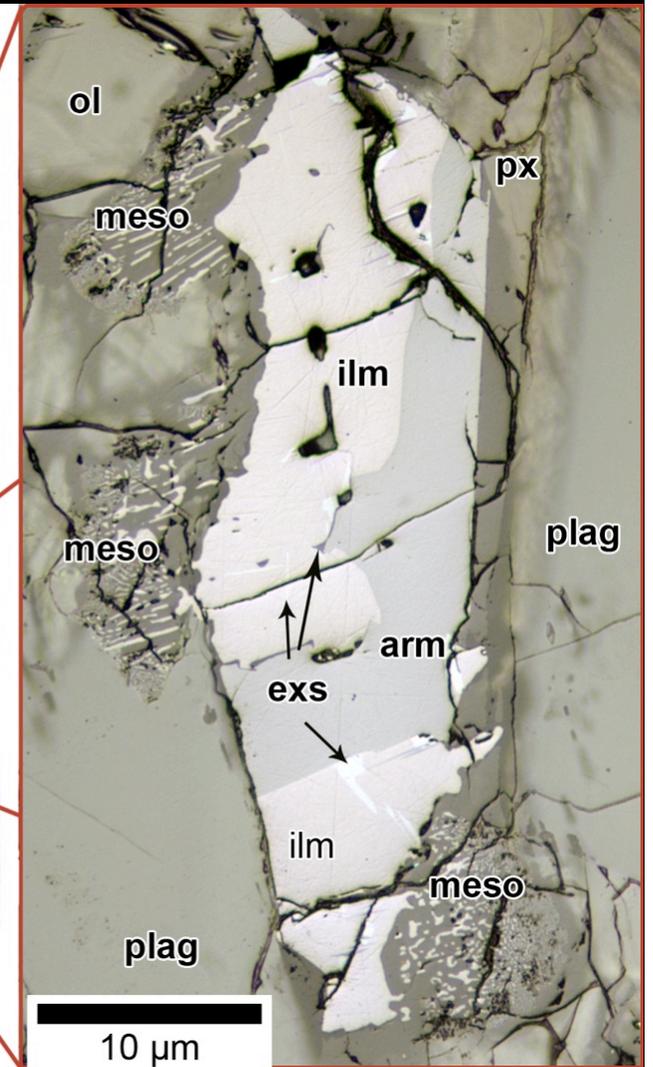
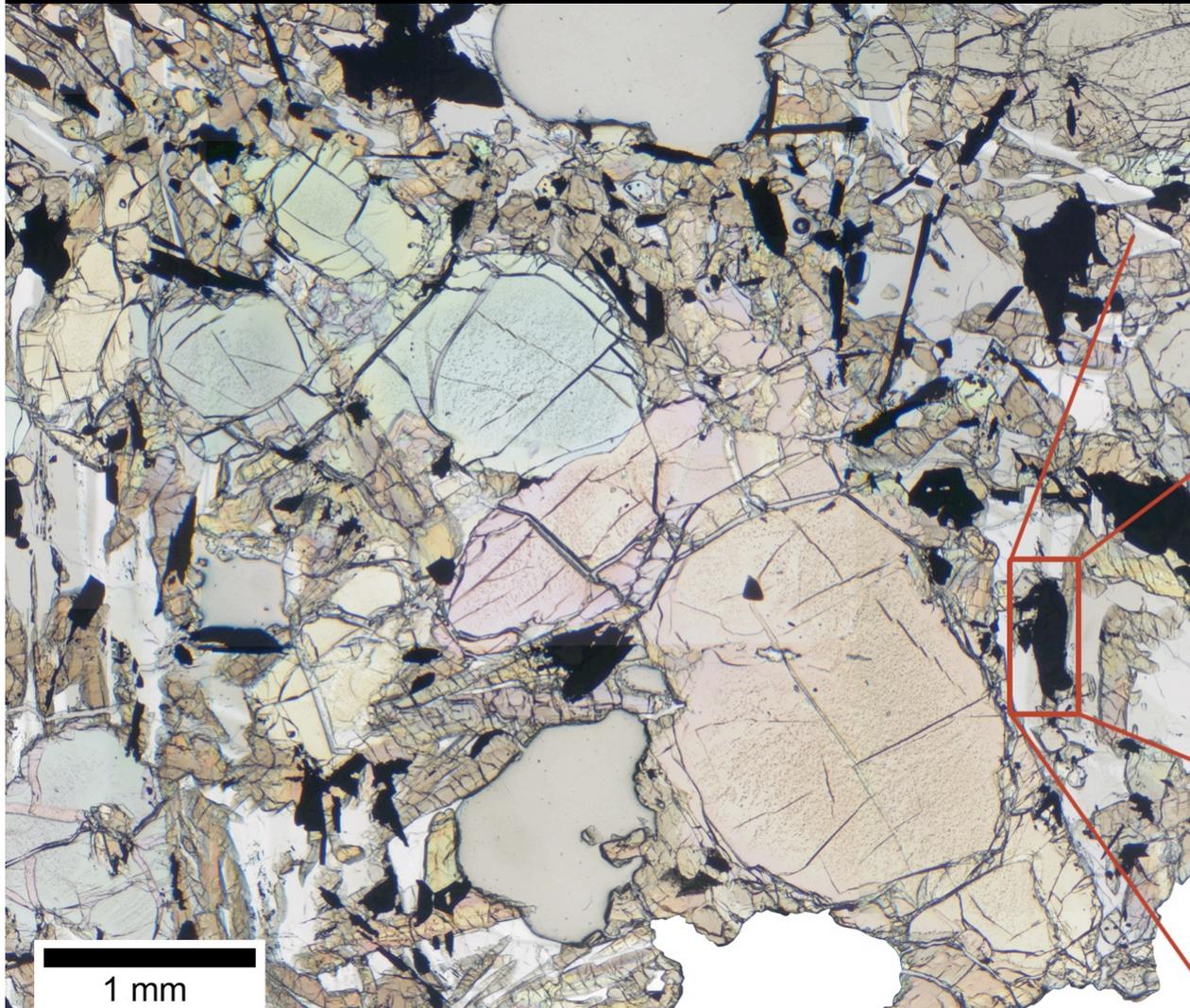
ilmenite



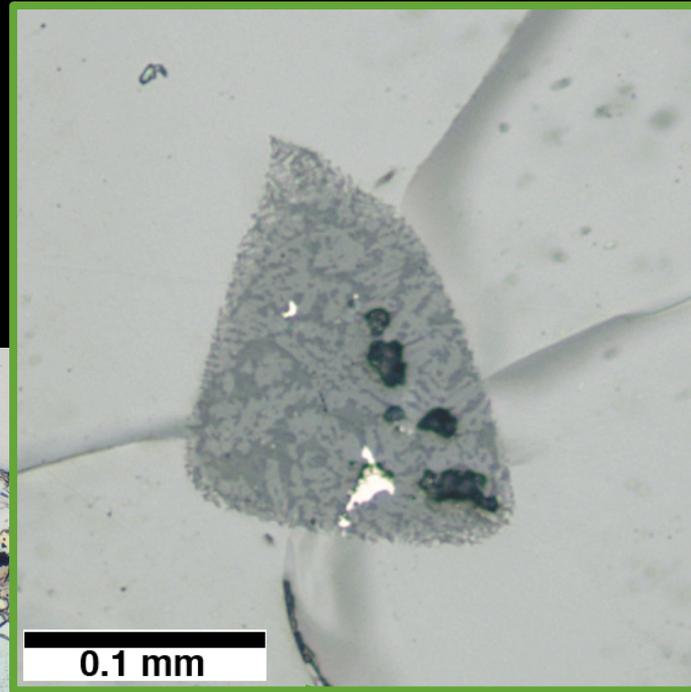
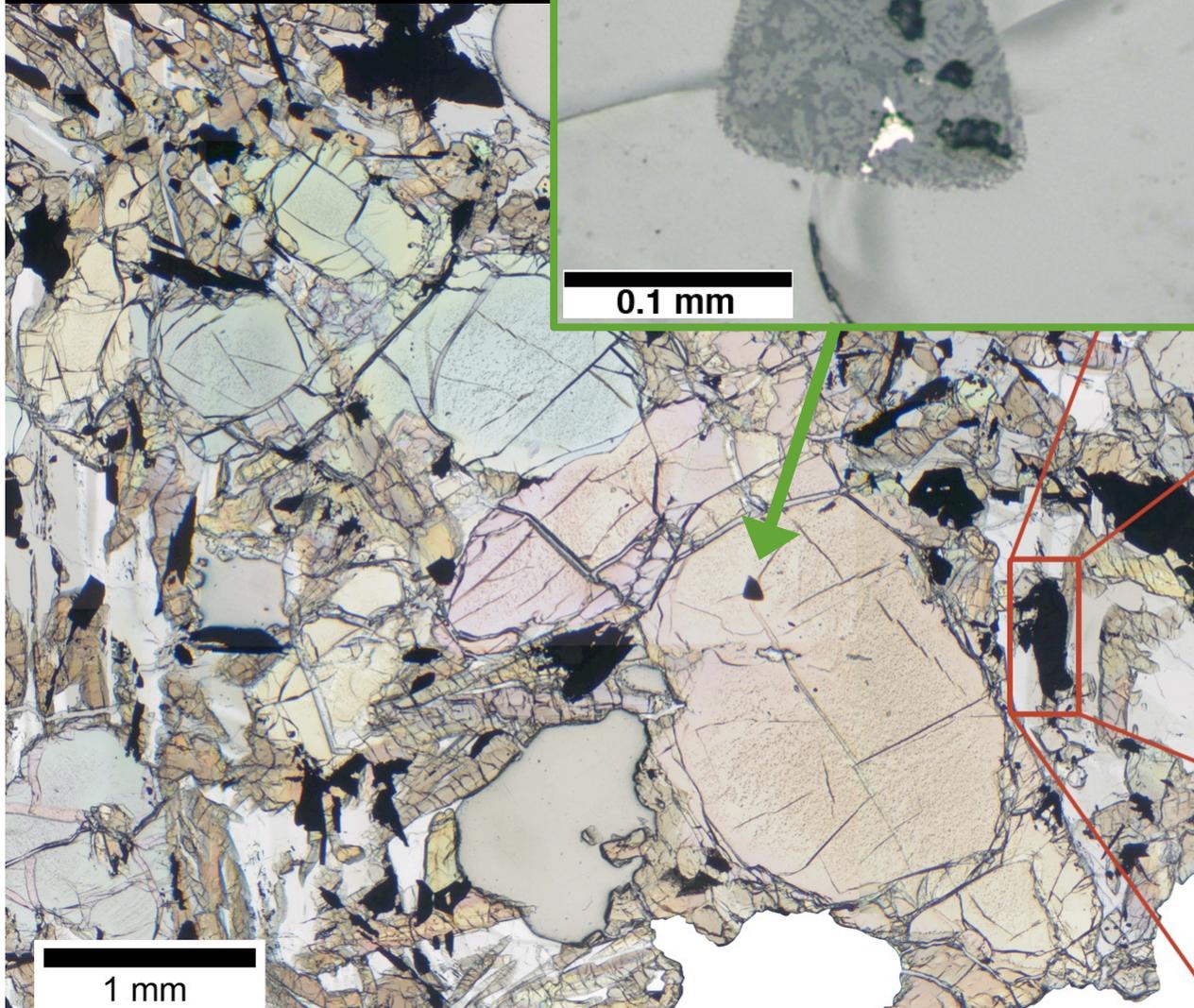
plagioclase



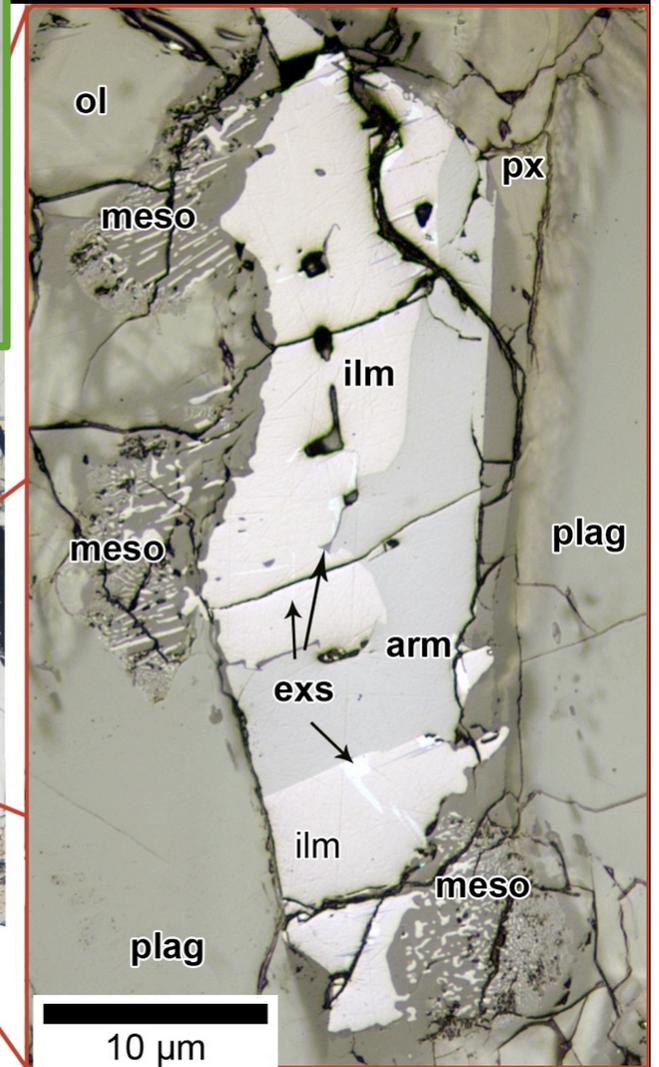
“Melt inclusions of high-Ti olivine cumulate 71597”



Melt inclusions:
Trapped liquid

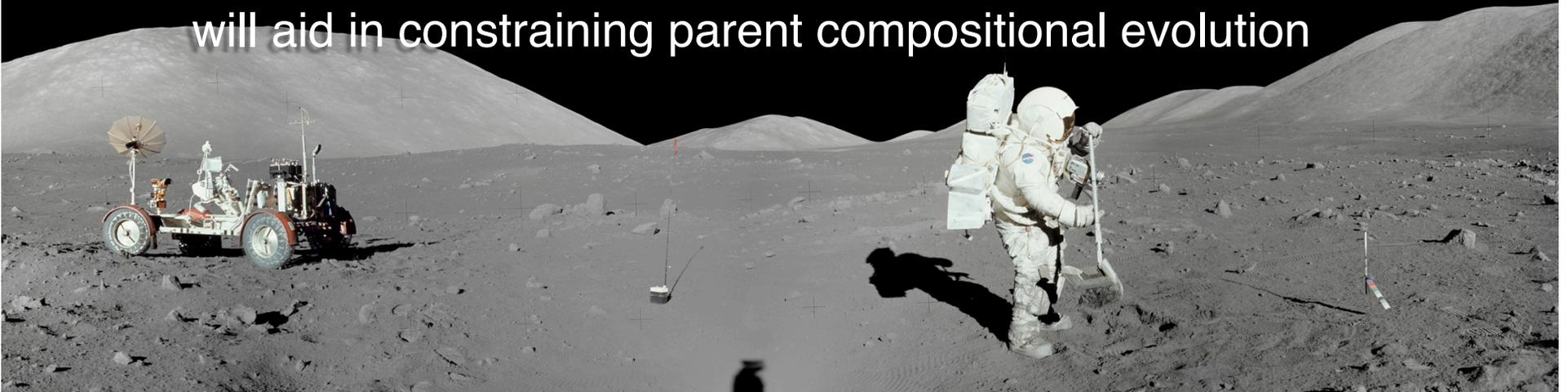


Mesostasis:
“dregs” of liquid

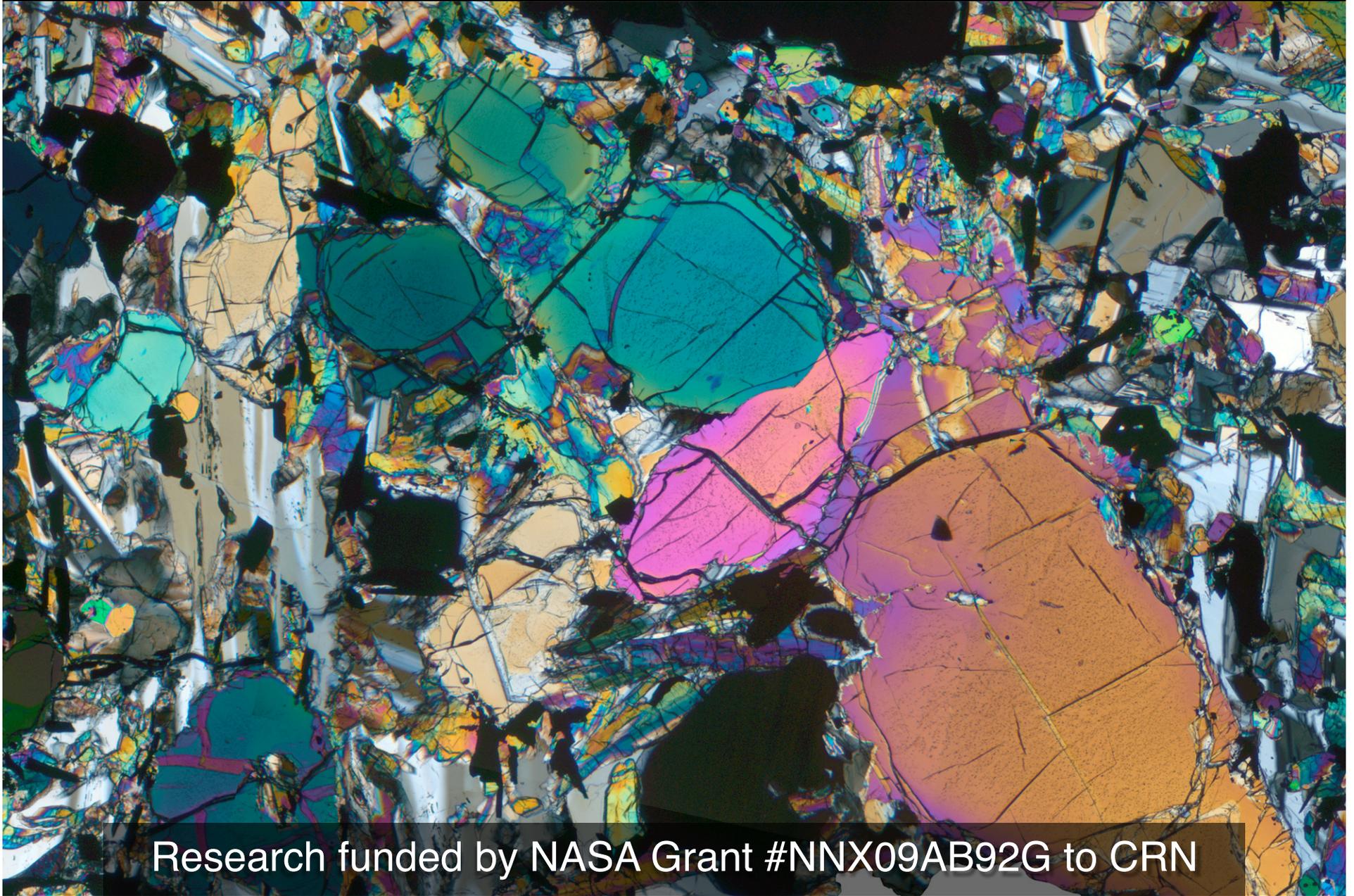


Big picture

- Large, resorbed olivines present at time of eruption
- Calculated residence times from CSDs upwards of 10 years for coarse olivine, with matrix olivine and ilmenite crystallizing over 1-2 years
- If 71597 crystallized from a Type B1 flow, 11 of 12 of which are coarse-grained, the flow may have been thick enough ($>10\text{m}$) to form cumulate zone
- Melt inclusions and mesostasis trace element analyses will aid in constraining parent compositional evolution



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and Ian Steele (University of Chicago, EPMA)



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