Crystallinity of Apollo 14 Zircon

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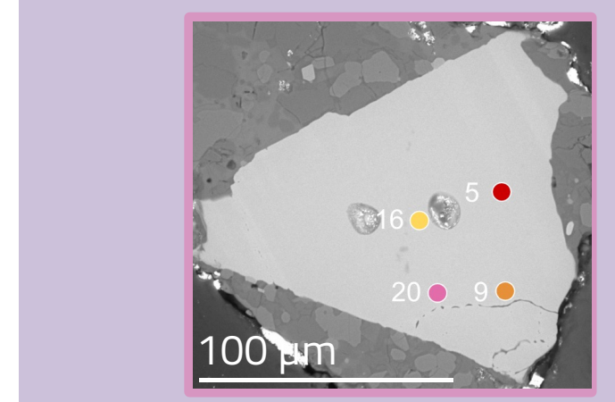
I. Introduction

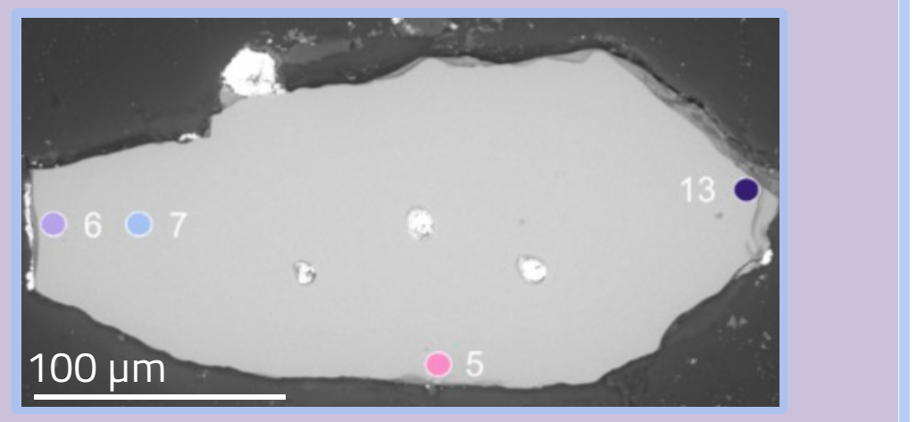
Zircon resists chemical and physical alteration, which permits its use in deciphering the compositional history of the crust of planetary bodies. We have 18 zircons from the lunar breccia 14311 and soil sample 14163, ^{207}Pb/^{206}Pb ages ranging from 4.30 to 3.93 Ga, which we are using to gain a better understanding of the water content of the lunar crust. We employed Raman analysis to investigate the crystallinity of our grains, as metamic or amorphous grains are unlikely to record primary "water" signatures. We then turned to CL to search for zoning and impact microstructures as well as EBSD to determine crystallographic orientation. To-date, no "water" in lunar zircon measurements have been conducted, and crystallinity of lunar zircon by Raman is also a relatively unexplored subject. Our work aims to expand the database of measurements of lunar zircon.

II. Raman analysis

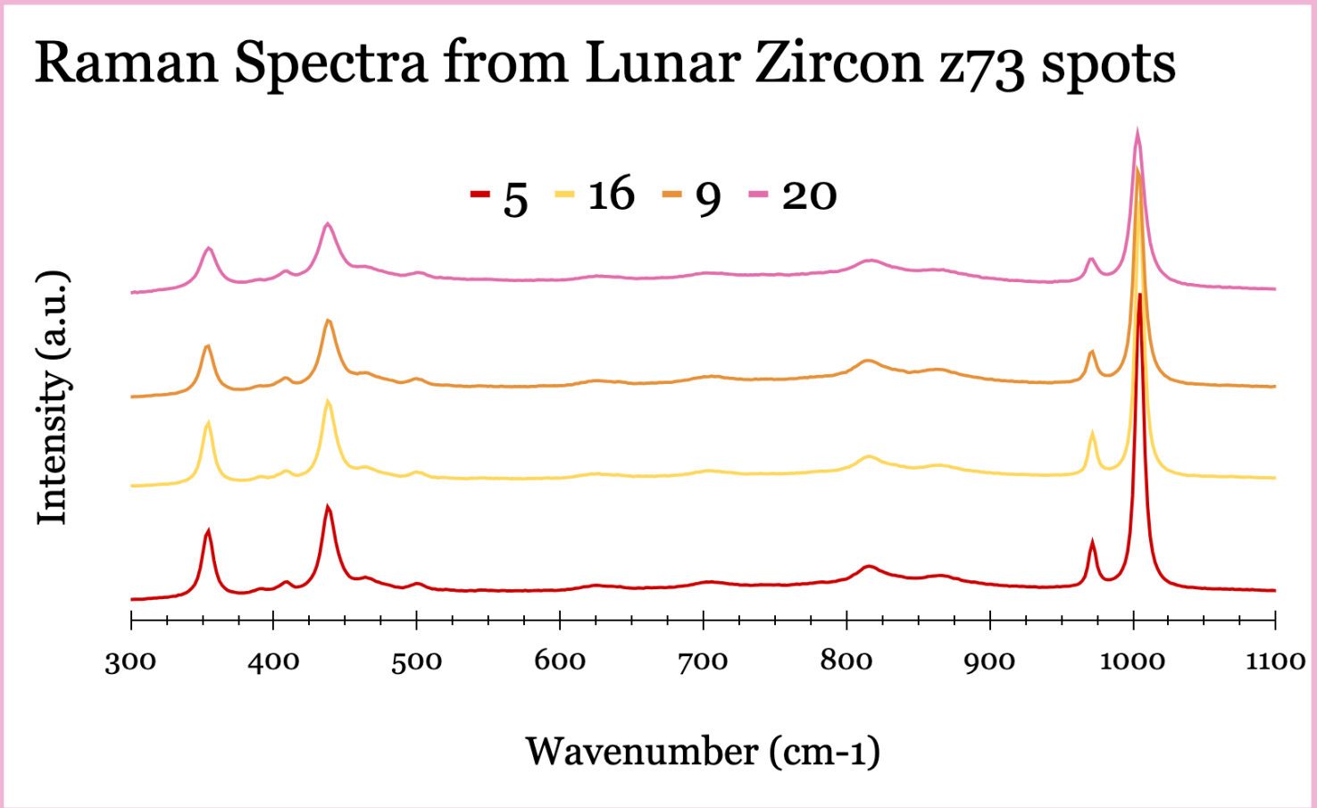
- Our 18 grains display a range of crystallinity. One of the most crystalline, z73, and one of the least, z65, are to the right.
- The four spectra to their right were chosen to represent the range of observed crystallinities.

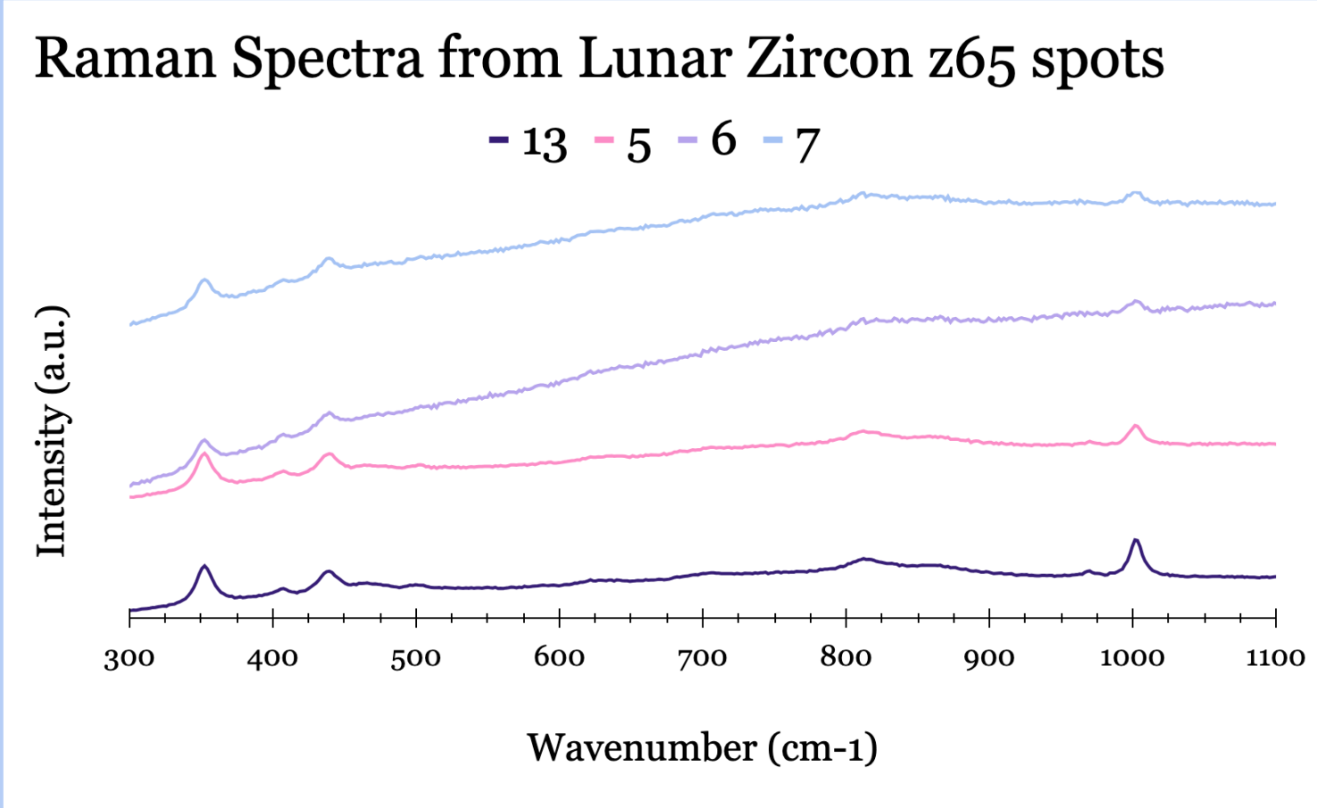


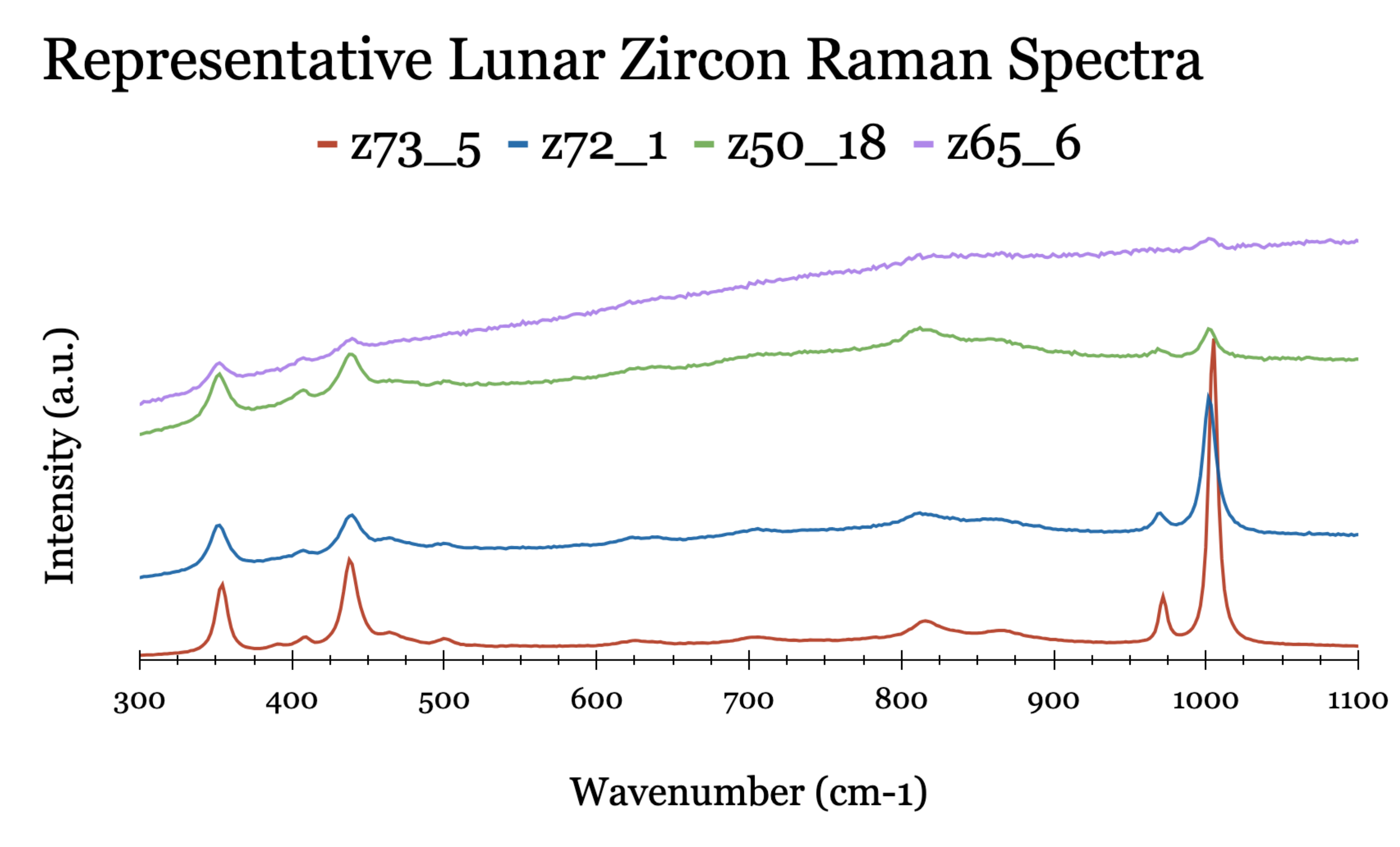
BSE image of z73



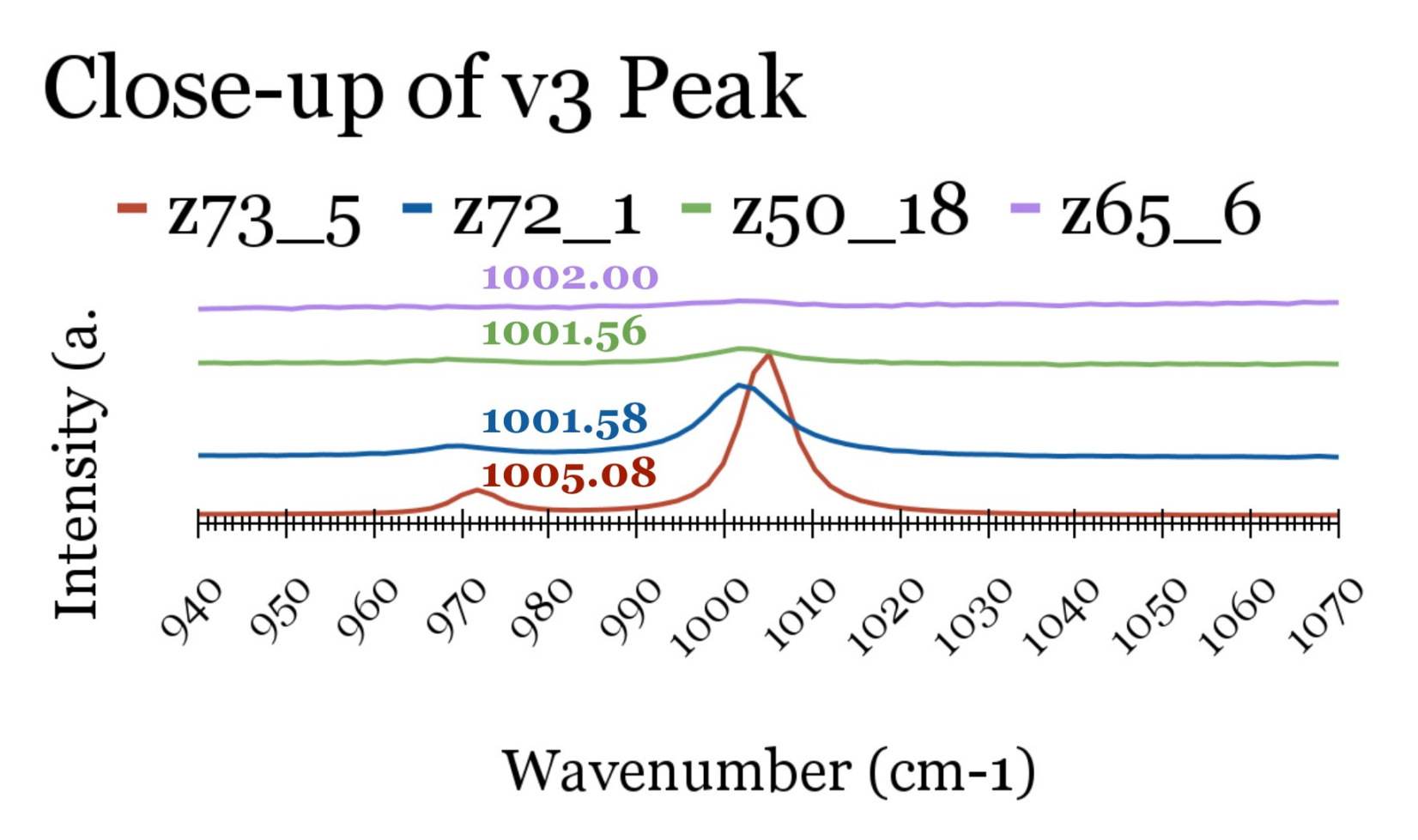
BSE image of z65

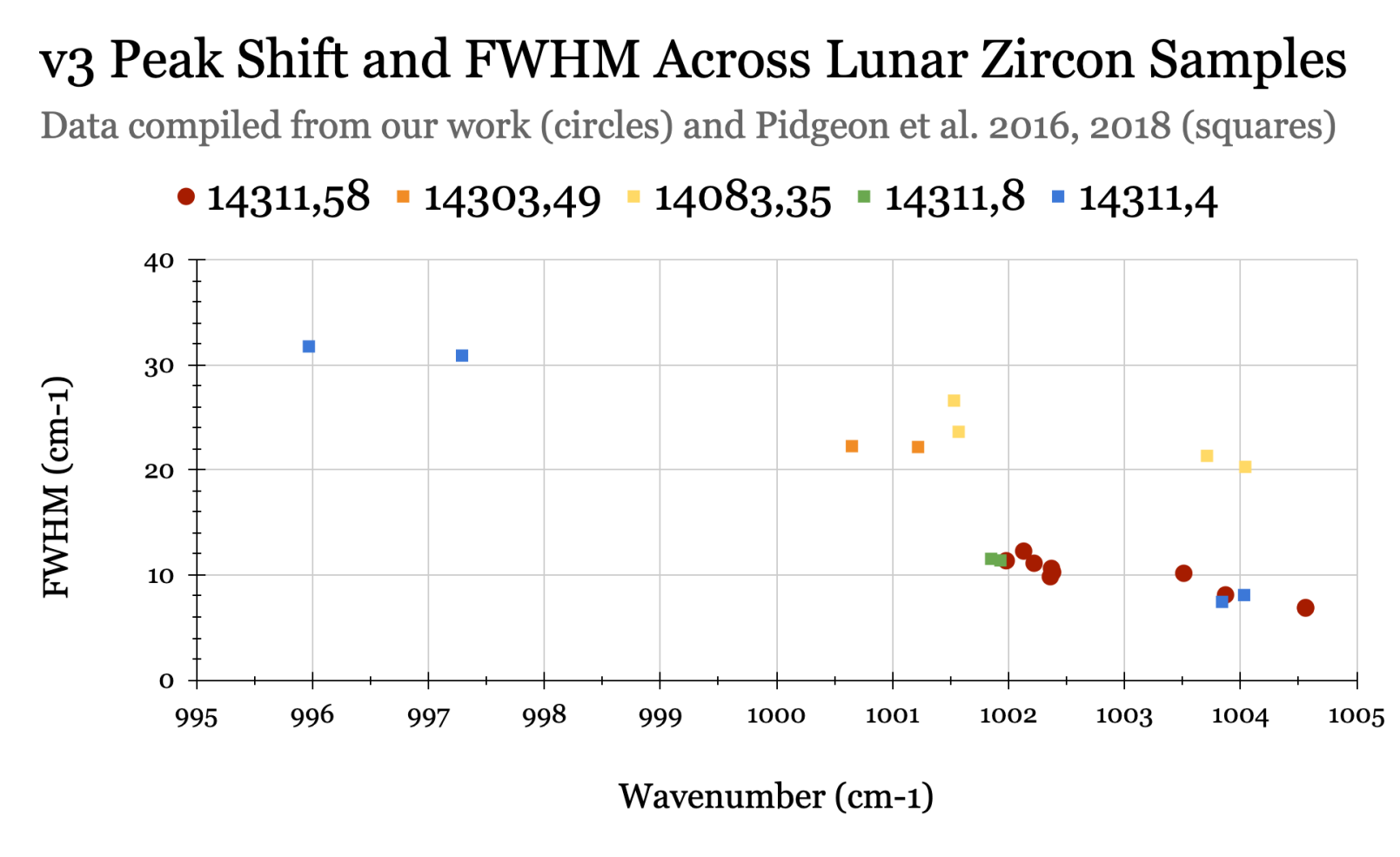






- Location of the v3 peak is used as a gauge for crystallinity. In pure, crystalline zircon, the peak occurs at 1008 cm^{-1}.



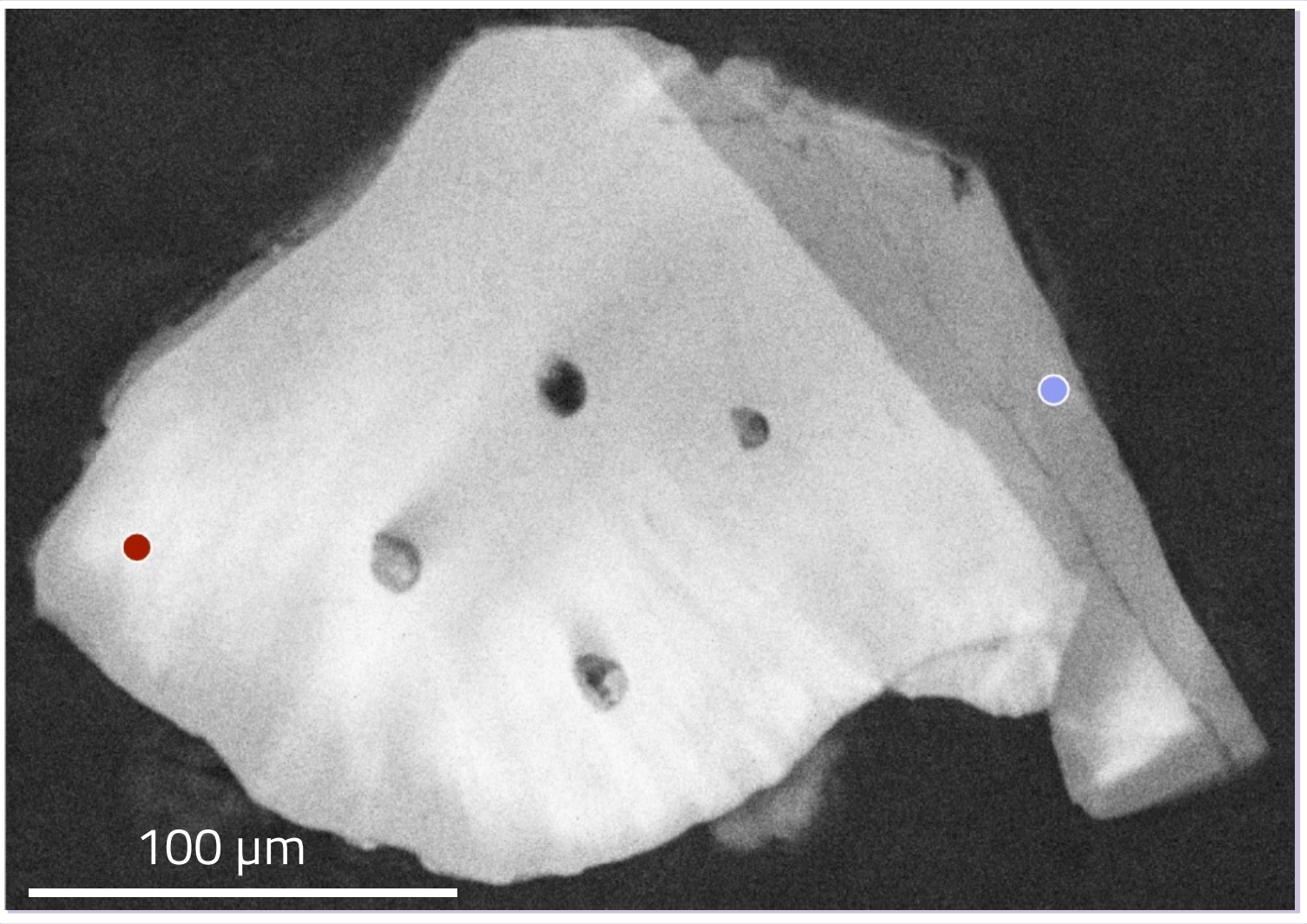


- Data from charts to left are compared to previously published lunar zircon data from Pidgeon et al. 2016, 2018.

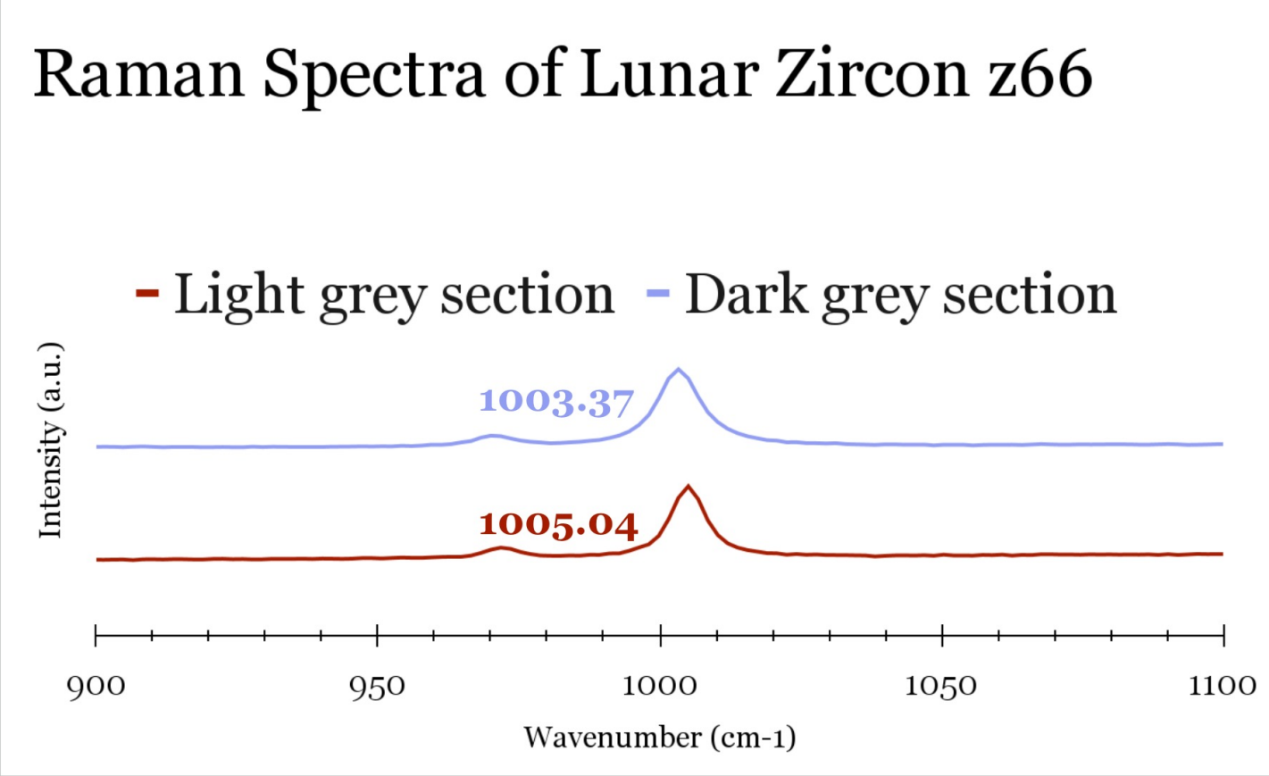
Methods: Raman analysis was performed at Syracuse University using a 532 nm laser operated at ~3 mW (10% laser output).

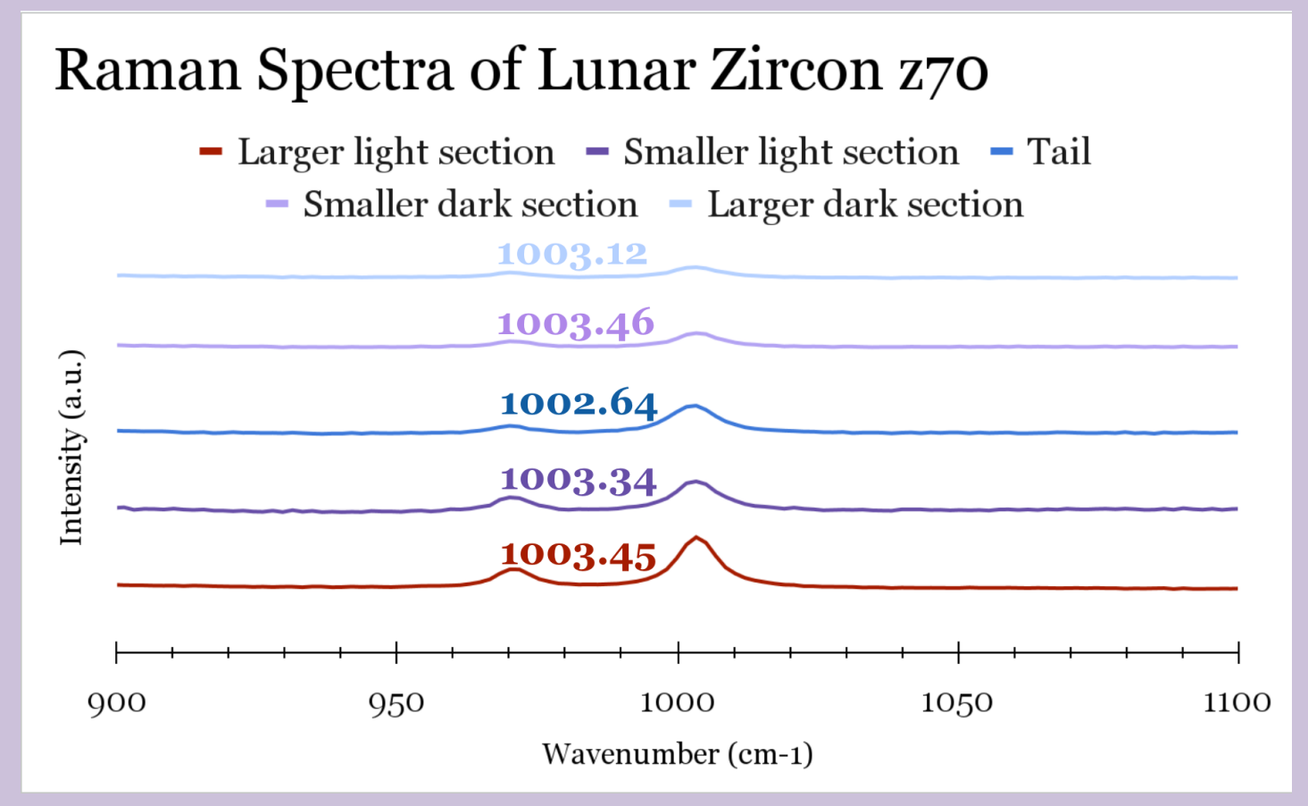
III. CL analysis

- 6 of 18 grains show clear contrast in CL imaging; the rest do not. Of those that do, not all show a correlation between CL image grey-scale color and Raman v3 peak shift.

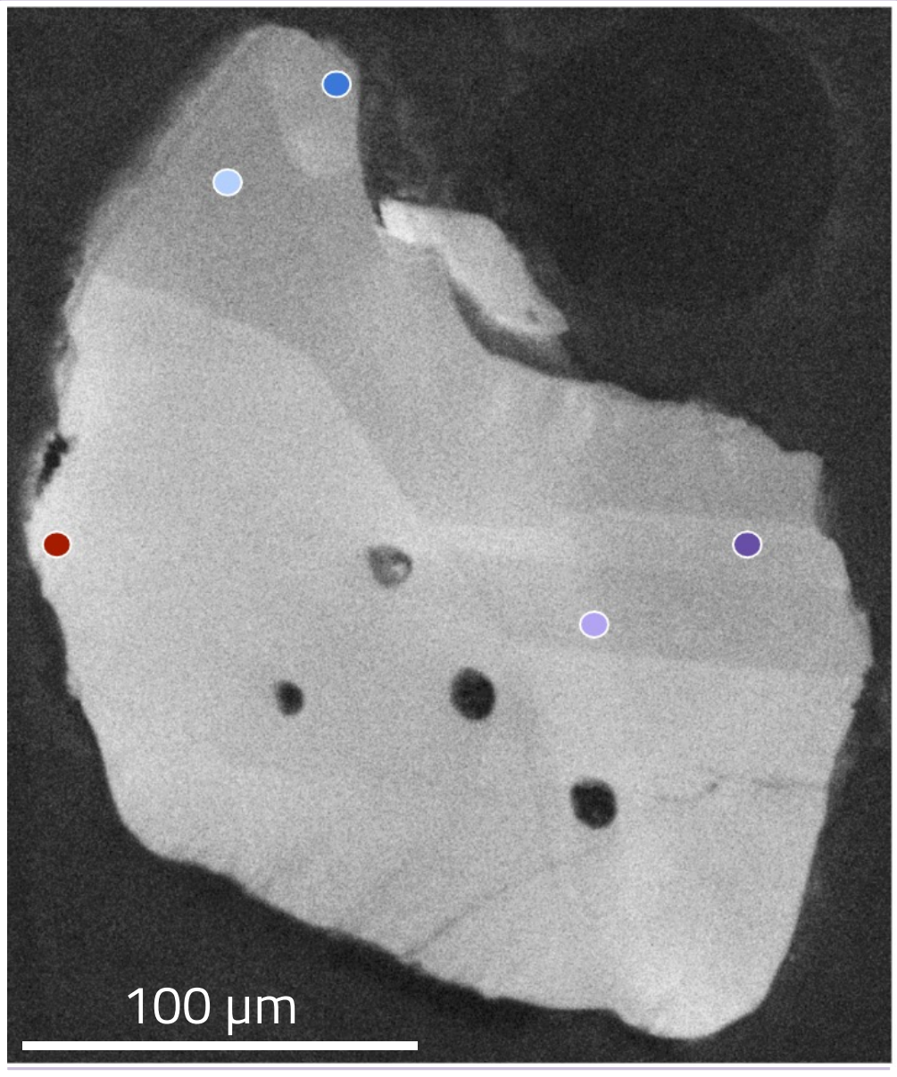


CL image of z66





z66 shows a difference in v3 peak location between sections, z70 does not

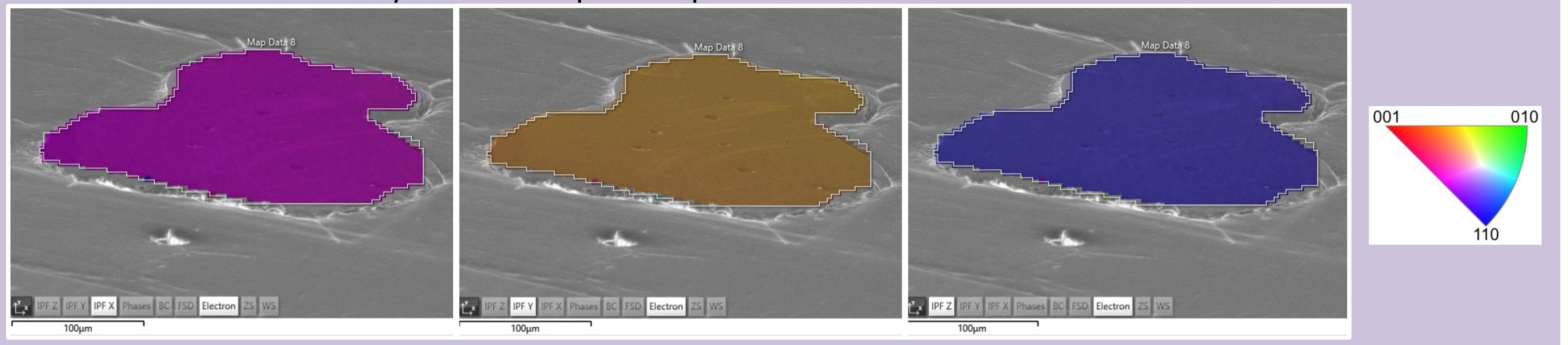


CL image of z70

Methods: Panchromatic CL imaging was performed at Syracuse University.

IV. EBSD

- 7 of the 18 grains were analyzed with step sizes varying from ¼ µm to 3 µm. No microstructures were found.
- z50 (below) was analyzed at a 3 µm step size.



Inverse Pole Figure (IPF) images X, Y, Z from left to right. IPF key to the right.

Methods: EBSD was performed at RPI using a Zeiss 1540 EsB Crossbeam FIB/SEM with a 70° tilt and 20 kV accelerating voltage.

V. Moving forward

We will finish EBSD analysis for all of the grains with a uniform step size. Along with revealing any potential impact-related microstructures, the analysis will assess the crystallographic orientation of each grain. This is crucial to the next step of our project - analysis by FTIR in search of structurally bound OH. Absoroption features in FTIR are a function of crystallographic orientation, therefore, quantifying the "water" associated with the crystal structure will require knowledge of individual grain orientation.

References and acknowledgements

Pidgeon, R. T., Merle, R. E., Grange, M. L., Nemchin, A. A., & Whitehouse, M. J. (2016). Annealing of radiation damage in zircons from Apollo 14 impact breccia 14311: Implications for the thermal history of the breccia. *Meteoritics & Science*, *51*(1), 155–166. https://doi.org/10.1111/maps.12572

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