IMPACT MELT INCLUSIONS IN APOLLO 14 ZIRCONS: TARGET LITHOLOGY TRACERS?

Cynthia Tong[1], Carolyn Crow[1], Aaron Bell[1], Nigel Kelly[2], Desmond Moser[3], Timmons Erickson[4]

[1]University of Colorado Boulder [2]Bruker [3]University of Western Ontario [4]Johnson Space Center

BACKGROUND & OBJECTIVE

During impact bombardment, microstructural fractures within zircons can trap mineral melts produced by localized shock heating and record the compositions of nearby minerals at the time of impact [Davis, 2016; Hopkins & Mojzsis, 2015]. This project expands on qualitative analysis done by [Davis, 2016] and [Carolyn, 2019] to classify the compositions of Apollo 14 zircon melt inclusions and relate them to those of adjacent minerals to trace back the impact history of the Moon as recorded in these zircons.

We compared Sample 14311 elemental compositions between inclusions of ex situ zircons and minerals of bulk rock matrix. We performed Quantitative Electron Microprobe (EMP) Wavelength Dispersive Spectroscopy (WDS) on three thick samples, producing 232 mineral observations. We then performed Scanning Electron Microscope (SEM) Energy Dispersive Spectroscopy (EDS) mapping on 9 zircons with inclusions, of which 3 were selected for preliminary semi-quantitative analysis. Holistically similar WDS and EDS observations were graphed together on ternaries by elemental mol % for direct comparison.

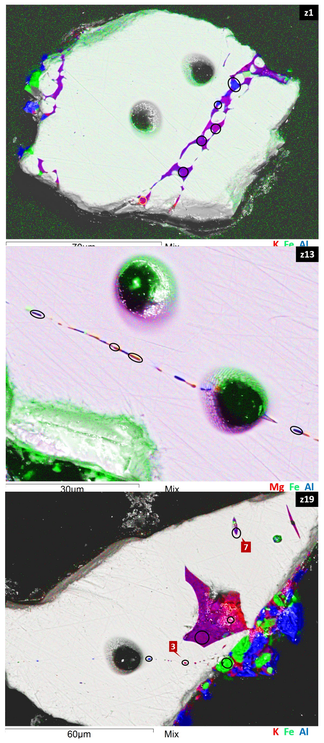

FIG 1: Melt inclusion EDS maps. Black circles indicate point analyses sites.

RESULTS I: FELDSPARS

Alkali feldspars are end-member K-spar and albite. Plagioclase varies from nearly pure anorthite to as much as An_{50} labradorite. This may represent different levels of bulk rock mixing as the zircons were emplaced or solidified within the breccia.

Inclusion data aligns well with mineral data, which supports that the melts indeed originated from feldspars in the surrounding bulk rock. Plagioclase-like inclusion compositions are narrow and align closely with nearly-pure anorthite mineral compositions, though they are generally more potassic.

Two unusual Ca-rich inclusion observations (4 & 7) were interpreted as glassy phases or a combination of multiple phases. This melt composition may be a unique product of shock heating and may suggest Ca preferentially enters melt during this melting process.

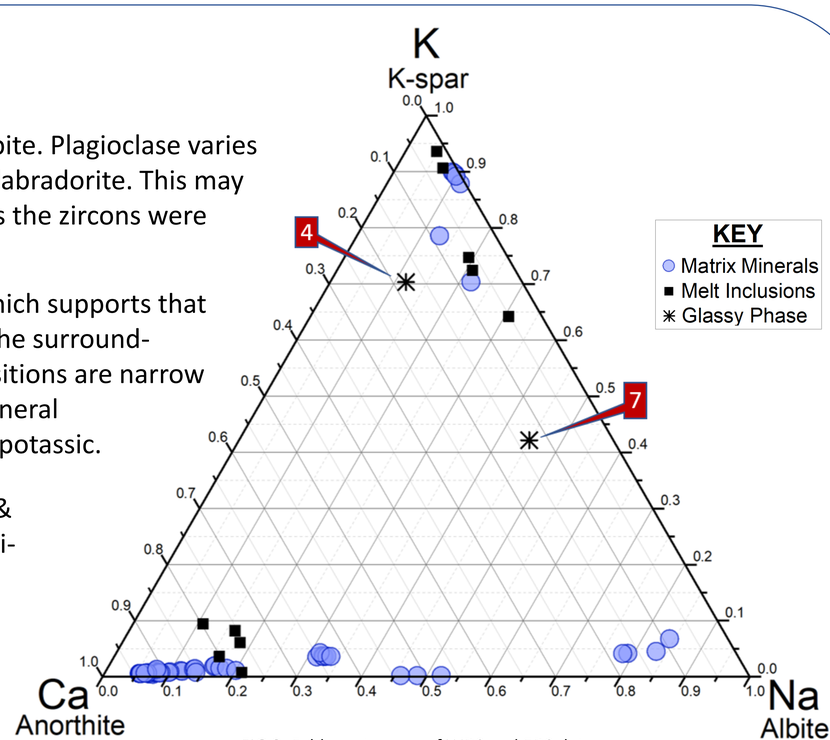

FIG 2: Feldspar ternary of WDS and EDS data

RESULTS 2: PYROXENES

Both orthopyroxenes (OPX) and clinopyroxenes (CPX) were present in the bulk rock. Both share narrow Fe-Mg variation, but the OPX have a wider range in Ca levels.

Melt inclusions are only OPX-like and are on average ~.1 mol % more Mg-rich. Wide Ca spread further supports that Ca may have the propensity to enter into and mix with melts produced through shock heating. Inclusion Mg levels do not strongly distinguish the parent rocks they originate from; however, they also do not isolate Mg-suite rocks as a possibility.

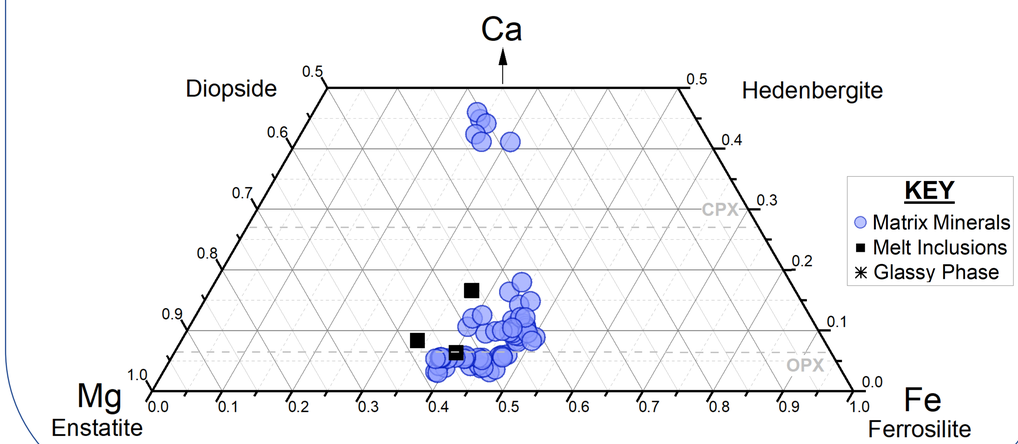

FIG 3: Pyroxene ternary of WDS and EDS data

CONCLUSION

- Melt inclusions represent compositions of minerals in surrounding bulk rock
- EDS analysis will be expanded to more ex situ zircons with inclusions; WDS analysis will be expanded to zircon-adjacent minerals and to another thick section
- Compositional results will be synthesized with zircon ages

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