Age Distribution of Lunar Impact-Melt Rocks in Apollo Drive-Tube 68001/2

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Introduction

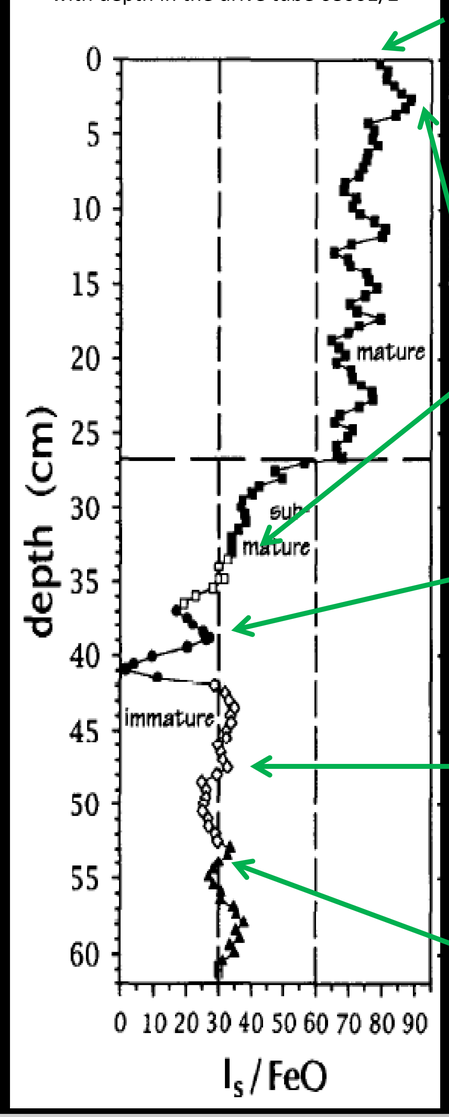
- Apollo 16 double-drive tube 68001/68002 provides impact and volcanic materials along a depth of ~60 cm in five compositional distinct units (Fig. 1 and 2) [1].
- 68001/2 offers the potential to study distinct populations of impact melts with depth to understand how "gardening" affects these samples.
- We will use unbiased major-element chemistry, mineralogy, and age to understand the impact history of the Apollo 16 landing site.
- The study demonstrates the techniques that landed missions require to identify lithologies of interest (e.g., impact melts).

Fig 1: Surface photo for double drive tube 68001/2 (NASA: AS16-108-17684).

Clast Groupings

- Six 0.5 g bulk soil samples from each of the five intervals in 68001/2, plus one near surface sample were sieved each into aliquots of size fraction of >250 µm, >106 µm, and fines. This produced 50-70 >250 µm particles from each interval.
- We have hand-polished >300 individual particles from the five distinct units in 68001/2 (sub-splits: 1079, 1080, 1105, 1106, 1107 and 1108) and grouped them based on textural similarities. The grains have been analysed using a PhenomX SEM to collect Back-scattered Electron images (BSE) and Energy-dispersive X-ray (EDS) spectrums.
- Fourteen different populations of impact melts and lithic samples have been found within the collection (see below).

Fig 2: Variation of I_s/FeO (maturity indices) with depth in the drive tube 68001/2



XRF Data for 68001/2

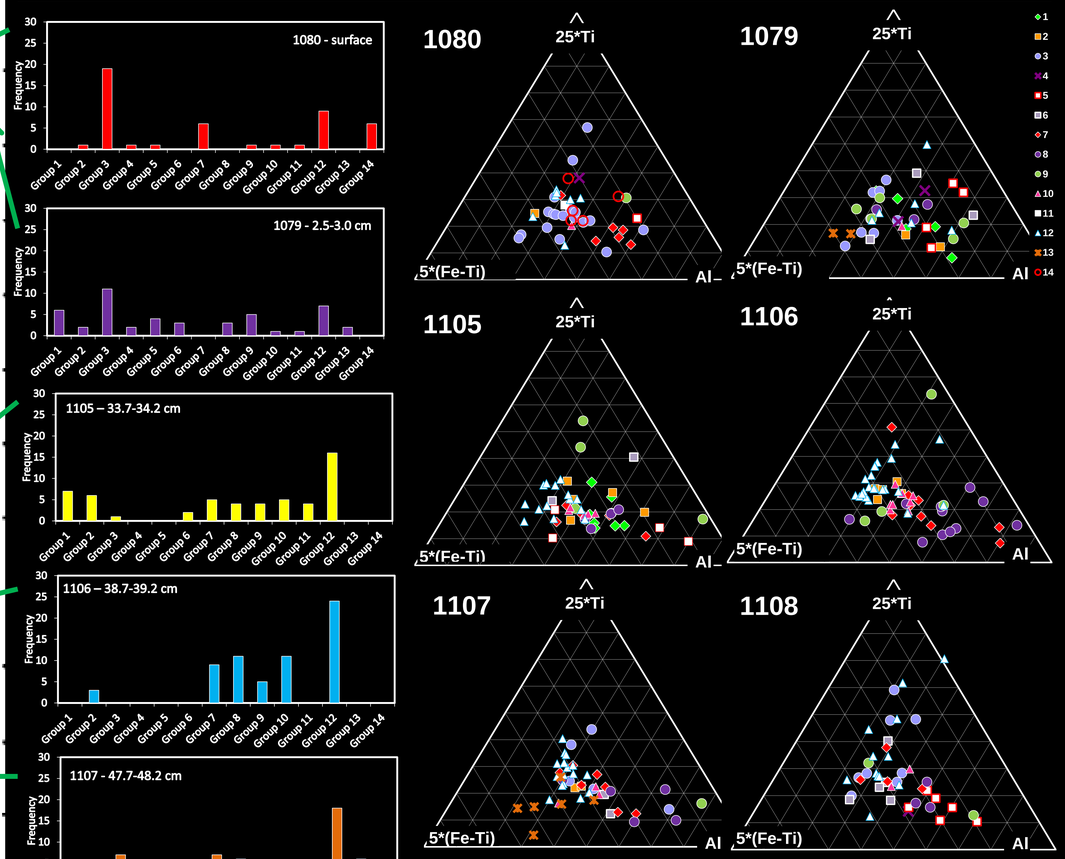


Fig 4 (above): Ternary diagrams showing XRF analyses for each sub-split of 68001/2. Diagrams show individual groupings based of texture.

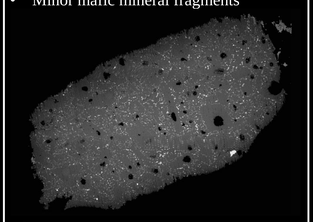
Fig 3 (Left): Histogram for the frequency of particles in each group from the six different intervals in 68001/2.

Future Work

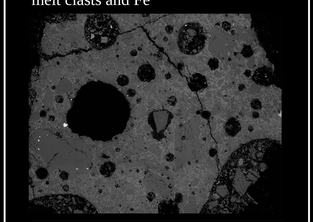
- Fully Characterize the 14 groups using SEM and EMPA techniques.
- Ar-Ar dating of representative samples at NASA GSFC MNGRL.

Groups

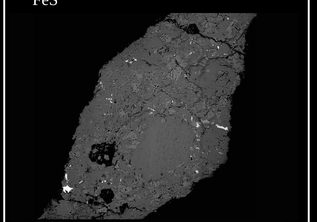
Group 1 (68002,1079_1A)
- Clast-rich impact melt breccias (IMB) dominated by clasts of plagioclase.
- Granulitic mafic melt material surrounds grain boundaries
- Inclusions of metal (e.g., Fe and Cr)
- Minor mafic mineral fragments



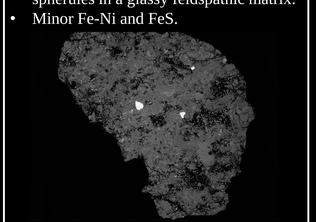
Group 2 (68001,1106_1A)
- Clastic-feldspathic IMBs with a series of different sized anhedral to subhedral anorthosite chadacryst enclosed in a vitrophyric mafic melt matrix.
- Minor mafic mineral fragments, impact melt clasts and Fe



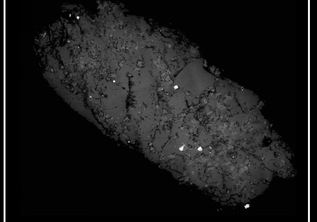
Group 3 (68002,1079_4A)
- IMBs with a subophitic texture.
- Anhedral plagioclase with mafic melt material - Mg#>75 ([Mg/(Mg+Fe)] × 100)
- Metal grains include ilmenite, Fe-Ni and FeS



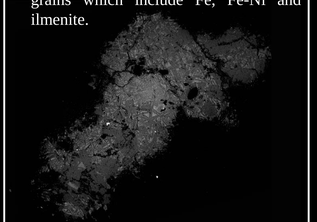
Group 4 (68001,1080_12A)
- Regolith Breccias (grouped based on rock classification not similarity to each other).
- Variety of lithic clasts, mineral fragments, impact melt and rare glass spherules in a glassy feldspathic matrix.
- Minor Fe-Ni and FeS.



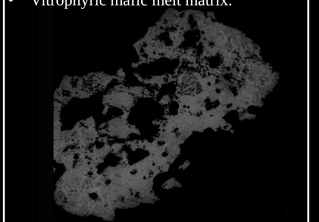
Group 5 (68001,1108_3A)
- Granulites
- Some larger (200 µm) plagioclase xenocrysts and small (<100 µm) mafic mineral fragments
- Fe-metal and Fe-Ni inclusions.



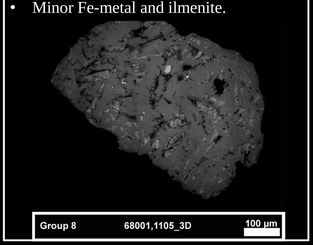
Group 6 (68002,1079_2b)
- Clast-bearing hypocrystalline impact melts.
- Interstitial tabular plagioclase enclosing mafic glass melt pockets.
- Subhedral plagioclase clasts and metal grains which include Fe, Fe-Ni and ilmenite.



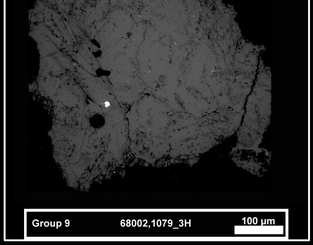
Group 7 (68002,1079_2J)
- Clastic IMBs with plagioclase clasts.
- Plagioclase clasts have rounded grained boundaries likely from the thermal erosion in the melt.
- Rare fragments of pyroxene
- Vitrophyric mafic melt matrix.



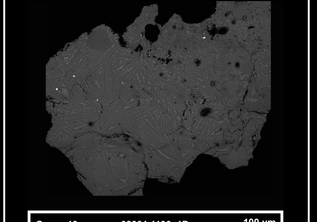
Group 8 (68001,1105_3D)
- Clast-poor crystalline impact melts.
- Subophitic texture
- Tabular plagioclase with interstitial mafic melts.
- Mafic melts show a sharp shard-like texture.
- Minor Fe-metal and ilmenite.



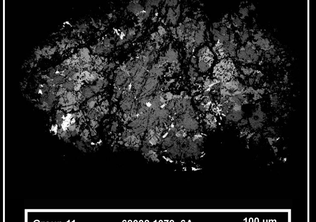
Group 9 (68002,1079_3H)
- Cataclastic anorthosites
- Minor mafic and accessory minerals (e.g., FeS and Fe-Ni).



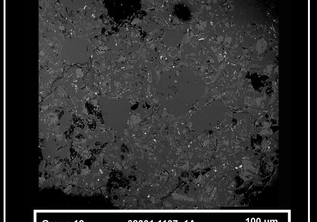
Group 10 (68001,1106_1D)
- Devitrified hypocrystalline clast-free impact melts.
- Spinifex-like texture.
- Micro-laths of plagioclase crystals enclosing interstitial mafic phase.
- Minor Fe-Ni metal.



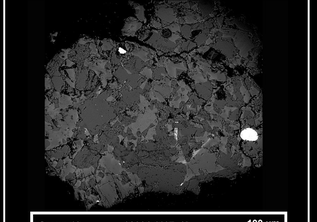
Group 11 (68002,1079_6A)
- Fragmental breccias dominated by basaltic material.
- Mineral fragments include plagioclase, pyroxene, olivine and ilmenite.



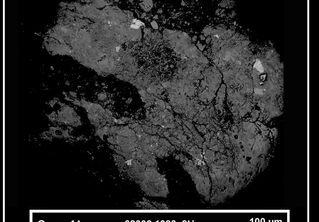
Group 12 (68001,1107_1A)
- Feldspathic IMBs with a subophitic texture.
- Similar to Group 3 but without the mafic mineral fragments.



Group 13 (68001,1107_3I)
- Intergranular impact melts
- Anhedral plagioclase enclose zoned Mg-rich mafic melts.
- Minor Fe-Ni and Fe-metal are present as spherules and irregular grains.



Group 14 (68002,1080_8H)
- IMBs consisting of multiple impact melt textures situated in a shock-welded glassy matrix.



References: [1] Korotev *et al.* (1997) *Geochim Cosmochim Acta* 61, 2989-3002.

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