Impact-melt Populations In Apollo Drive-Tubes

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Introduction

- Apollo Drive-tubes offer the potential to study distinct populations of impact melts at various depth in the regolith.
- Apollo 16 double-drive tube 68001/68002 (Fig 1a and 1b) provides impact and volcanic materials along a depth of ~60 cm in five compositional distinct units (Fig. 1c) [1].
- We will use major-, minor- and trace element chemistry, mineralogy, and Ar-Ar ages 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).

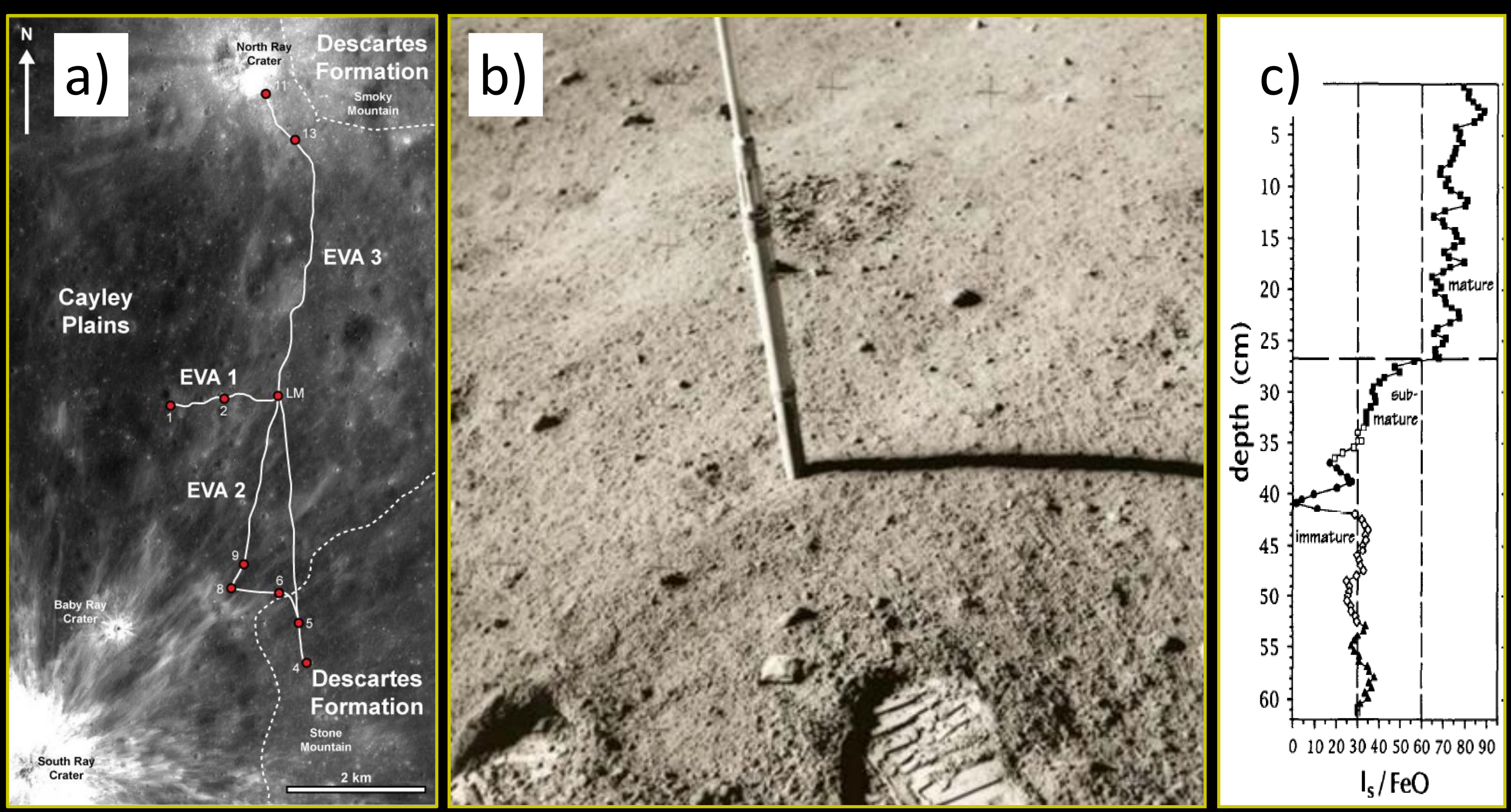


Fig 1: a) LROC NAC image (M106777343RE, M106777343LE) of the Apollo 16 landing site. 68001/2 was collect at station 8. b) Surface photo for double drive tube 68001/2 (NASA: AS16-108-17684). c) Variation of I_s/FeO (maturity indices) with depth in the drive tube 68001/2.

Sample and Technique

- We received, six 0.5 g bulk soil samples from each of the five intervals in 68001/2, plus one near surface sample.
- We have hand-polished >300 individual particles (~1 mm) from the five distinct units (Fig 1c) and grouped them based on petrology, mineral chemistry and trace-elements.
- 68001/2 contains a wide variation of texturally diverse impact-melt particles including both clast-rich and clast-poor, crystalline and devitrified glass (Fig 2).
- Major and minor element chemistry of these impact-melts are compositionally very similar.
- The next step will be to determine the Ar-Ar ages of representative samples from each group and depth at NASA GSFC MNGRL.

Impact-melt Populations

- Trace element chemistry was used to sub-divide these impact-melts into 5 compositionally similar groups (Fig 3) :
- **Group 1** are similar to the Apollo 16 mafic impact-melts (Fig 3) and are thought to have formed from the younger KREEP-bearing material of the Cayley Plains (e.g., [9]).
- Group 2 show low Sm/Sc ratios, low incompatible trace-elements (ITEs) (Fig 3) and low Th content (Fig 4), compositionally similar to the majority of Apollo 16 impact-melts.
- Group 3 are characterized by their intermediate FeO and Th content (Fig 4). Group 3 is compositionally similar to the Apollo 16 regolith.
- Group 4 impact-melts have concentration of Sm exceeding 15 ppm (similar to Group 1 of [9], Fig 2). Group 4 shows the highest Sm/Sc ratios of the particles analyzed in this study and have the highest ITEs.
- Group 5 impact-melts have high FeO contents and are compositionally similar to mare basalts (Fig 4).

Fig 3: Sm verses Sc concentrations for impact-melts in Apollo 16 double drive-tube 68001/2. Fields represent impact-melt groups (1, 2, 3, and 4) from [9].

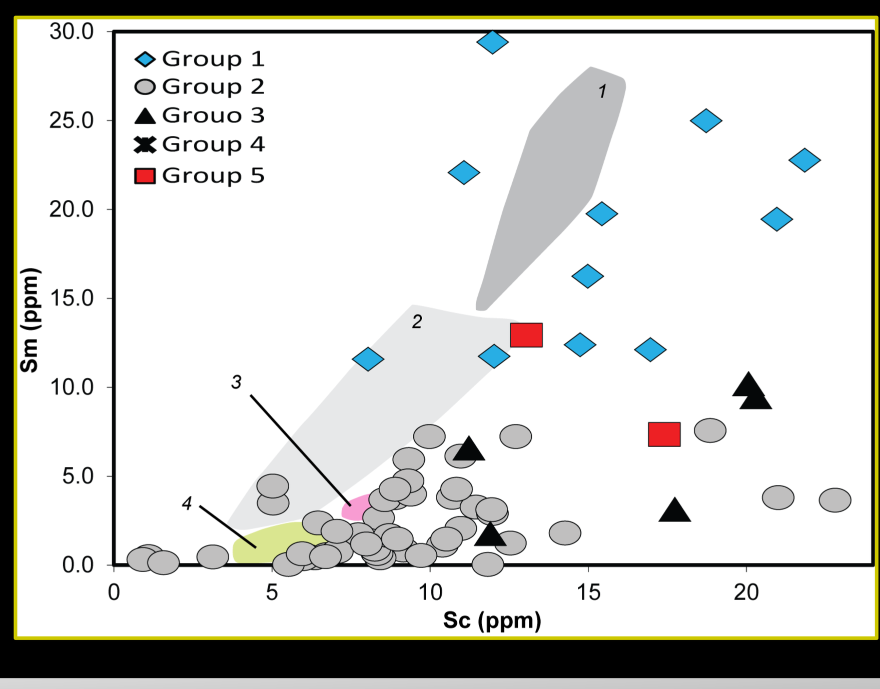
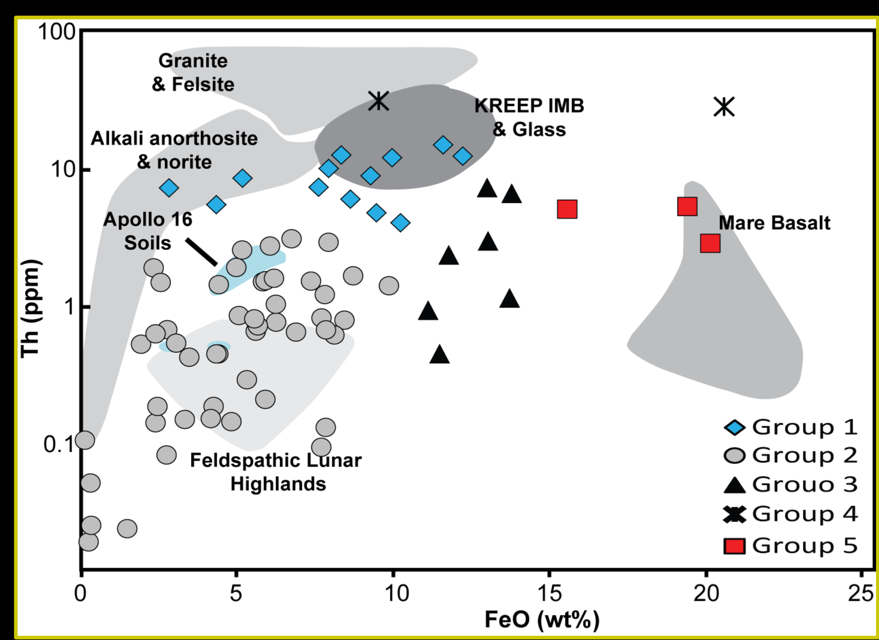


Fig 4: FeO verses Th content for impact-melts particles in 68001/2. Fields for different lithologies are taken from [10].



Apollo Next Generation Sample Analysis

- The same techniques will be applied to unopened and unstudied Apollo double drive tube 73001/2 as part of the ANGSA consortium.

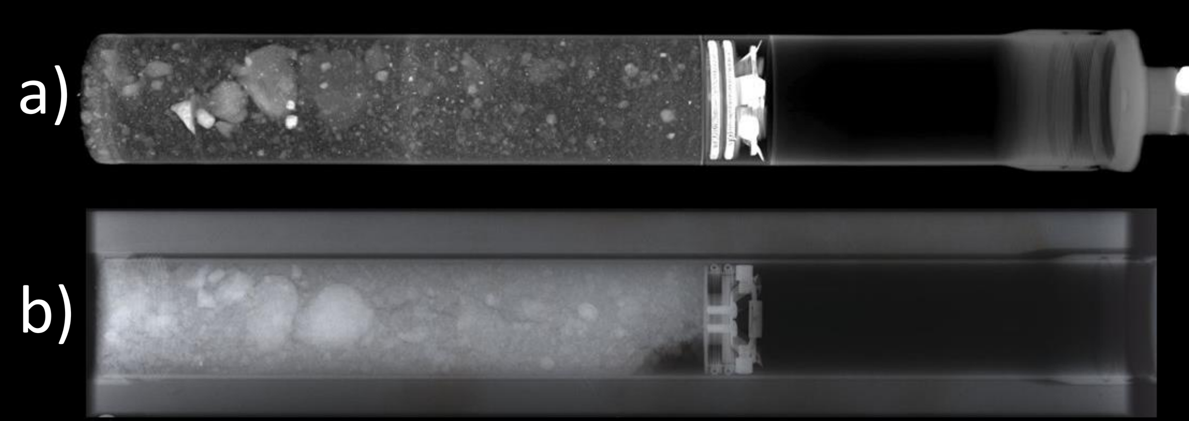
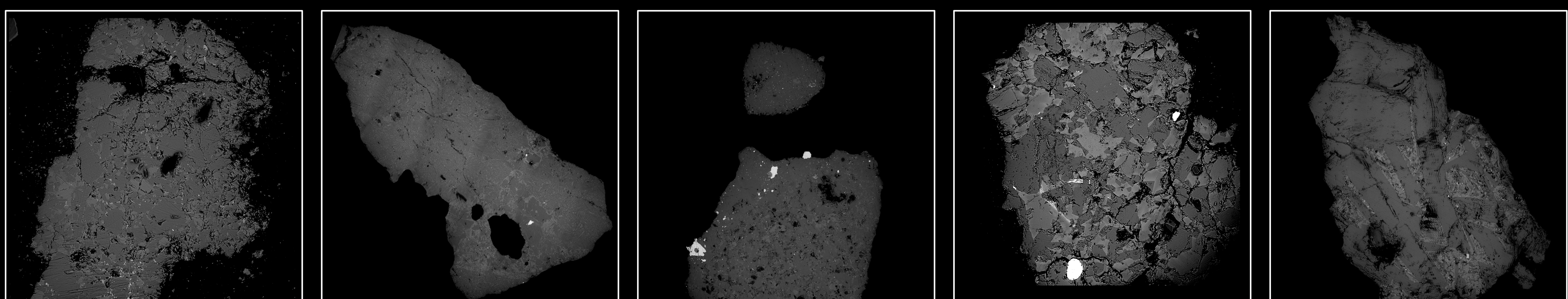


Fig 5: a) Apollo 73002 X-Ray Computed Microtomography scan taken in 2019 (Credit: DaveEdey and Romy Hanna (UT Austin). b) X-Ray scan of 73002 taken in 1974 (Credit: NASA)



Group 1: 68001,1080 _11e | **Group 2: 68001,1105 _3c** | **Group 3: 68001,1105 _1b** | **Group 4: 68001,1107 _3i** | **Group 5: 68001,1105 _3a**

Fig 2: Representative textures from the compositionally distinct groups in 68001/2. Fourteen different textural types were found across the groups.

Apollo 16: North Ray Crater - AS16-116-18594 – AS16-116-18613

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