Assessment of spectral properties of Apollo 12 landing site

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1 Preamble
- Location/timelines
- Objectives
- Cross-section

2 Chandrayaan-1 M³
- Craters location map
- Craters hyperspectral signal

3 Methods and results
- FeO Mapping
- Zhang et al. corrected
- Object-based classification
- Relative Age Mapping
- Manual seek and compare
- Manual seek: 12063,79NT

4 Conclusions
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Conclusions
Location/timelines

- 3.2S 336.62E
- Surveyor: 19 April 1967
- Apollo 12: 19 November 1969
- Chan-1: 2 October, 2008
- Chan-1: 312 days
- (LROC NAC image here)

Fortezzo and Hare (2013) classify Apollo 12 landing site in an Erastothenian system with an age ranging from 1.1 to 3.2 Ga.
Objectives

- Initially designed to complement Alexander [2015]*
- Different scale and point of view from remote sensing
- Keeping the scale at the landing site level
- Using the Moon Multispectral Mapper (M³) @150m/pixel

- Hyperspectral signatures from lunar samples
- Hyperspectral response curves from M³
- Can we say something from those about the A12 landing site?

Cross-section

Apollo 12 Landing site mineralogical cross-section [Snape et al., 2013]
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Crater location map ($M^3$ band 19, reflectance @ 950nm)
A12 Craters hyperspectral signal
A12 Craters hyperspectral signal Zoom
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FeO equation

- Derived from Clementine work and type of equation
- Performs well regionally
- Zhang and Bowles [2013]*
- Made a GRASS GIS v7 Add-on: i.feotio2
- FeO and TiO$_2$ equations for Clementine and Chan1-M$^3$

$$\theta_{Fe}[wt\%] = -\arctan \left[ \frac{R_{950}}{R_{750}} - 1.26 \right] \left( \frac{R_{750} - 0.01}{R_{750}} \right)$$ (1)

Zhang et al [2013] FeO[wt%]
Object-based classification

- Classification based on both spectral and region growth statistics
- Removed M\(^3\) band 1 & 2 as empty
- Configured to simplify large regions instead of small units
- Trying to exploit the reflectance gap in craters signal
- Momsen and Metz [2012]*
- GRASS GIS: i.segment

A12 Craters hyperspectral signal gap
Object-based classification
Manual seek and compare

- Compare each Relab signal from Apollo 12 to $M^3$
- Removed $M^3$ band 1 & 2 as empty
- Closest found are half glass half rock (12063,79NT)
- $M^3$ signal too linear
Manual seek: 12063,79NT (Relab cls309)
Manual seek: 12063,79NT compare Staid et al. [2011] Mare Basalt
Manual seek: 12063,79NT compare Relab cls309 (detrended)
Finding: CPX

Graph from Pieters et al. [2014]
Finding: CPX

- **Pre-copernican**
  Augite/pigeonite leaning towards Hedenbergite (CaFeSi$_2$O$_6$)

- **Copernican**
  Augite/pigeonite leaning towards Endiopside/Diopside (CaMgSi$_2$O$_6$)

- Layer within 5000m in Copernicus crater (Pieters et al., 1985)*

- Aging going out of the ray, increase FeO[wt%]

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This study

- Found some Copernican and pre-Copernican CPX
- with FeO differences

Future

- 2018: Imaging IR Spectrometer on Chandrayaan-2 (600-2500nm)
- Will enhance this work, and add mineralogical identification power
- I would like to be involved, to continue bridging Lunar samples to RS data
Thank You