

## Evolution of the Lunar Crust [New Views of the Moon 2]

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### 1 Introduction **All**

#### 1.1 General Scope

Evolution of the lunar crust relates largely to the first 500 Ma of lunar history. It includes formation of a primary crust and several different types and phases of secondary crust as well as tertiary crust that involves reprocessing of primary and secondary.

The beginning of lunar crustal evolution is set by the character and evolution of the Magma Ocean that formed a mantle and distinctive anorthositic primary crust within ~200 Ma after formation of the Moon. An apparently less abundant, but pervasive, mafic-bearing secondary crust component (Mg-suite) formed nearly contemporaneously and is discussed here. The lunar crust continued to be shaped and evolved through the period of intense solar system heavy bombardment and as the primordial lunar mantle partially melts, sending magmas upward into the crust and resulting in mare basalt volcanism that peaked ~3.2-3.5 Ga.

Reference relation to other chapters...

### 2 Secondary and Tertiary Crust: Lunar Sample Foundation **Elardo assigns**

#### 2.1 Brief review of the chronology of the early lunar crust **[Elardo]**

#### 2.2 Mg-suite: Beyond the Apollo View **[Gross, Elardo]**

##### 2.2.1 *Evidence for KREEP-free Mg-suite lithologies?*

#### 2.3 New lithic clasts in brecciated lunar meteorites **[Gross, Treiman]**

##### 2.3.1 *Mg-spinel rich lithologies and experimental studies of their formation*

##### 2.3.2 *Meteorites from the ancient lunar crust - (e.g., Kalahari 009), other lithologies*

#### 2.4 Magnesian anorthosites and granulites **[Gross]**

#### 2.5 Felsic/silicic magmatism **[Jolliff]**

##### 2.5.1 *Models for the formation of silicic clasts*

#### 2.6 Mare Basalts **[Elardo]**

## Crustal Evolution Outline

2.6.1 *Geochemistry of meteoritic samples of  $\leq 3$  Ga mare basalts*

2.7 Stable isotope constraints on the origin of the crust [Magna, McCubbin]

2.7.1 *Non-traditional stable isotope constraints*

2.7.2 *Hydrogen isotopes - What are the reservoirs and processes controlling hydrogen isotope compositions and fractionations?*

2.8 Volatiles in the crust [McCubbin]

2.9 Observed alteration products and processes [Treiman, Elardo]

2.9.1 *What is the nature of alteration in reduced, water-poor environments?*

2.9.2 *How does alteration affect the pristinity of crustal lithologies and our interpretations based on them?*

### 3 Secondary and Tertiary Crust: Global Assessment Pieters assigns

3.1 [Feldspathic] Mg-rich lithologies and relation to Mg-suite [Pieters]

3.1.1 *Short review of Global Primary crust FAN/PAN [Donaldson Hanna]*

3.1.2 *Olivine-bearing troctolite lithologies [Ohtake]*

3.1.3 *OPX and Pigeonite dominated [Klima]*

3.1.4 *Mg-Spinel anorthosite [Pieters, Donaldson Hanna]*

3.2 Thorium [KREEP] distribution (brief review) [Greenhagen, Glotch]

3.3 Mare Volcanism

3.3.1 *Short Review [Klima, Greenhagen]*

3.3.2 *Pyroclastic deposits [Head, Pieters]*

3.3.3 *Young Ol-rich Hi-Ti basalts (Chan'E 3) [Pieters, etc]*

3.3.4 *Irregular mare patches - Compositions, ages, formation models [Head, Robinson]*

3.4 Non-mare volcanism (Si-rich, unsampled, etc.,....) [Glotch, Jolliff]

3.5 Constraints from SPA non-mare interior [Ohtake, Pieters]

3.6 Still hidden components [link to geophysics and geology...] [Dhingra]

3.7 Continued impacts and mixing: Breccias, a multiply recycled tertiary crust [Dhingra]

### 4 Integration and Issues

**Pieters and Elardo** assign/coordinate with other chapters

4.1 Global perspective vs limited samples

4.2 Evidence for Mg-suite as a global phenomenon?

## Crustal Evolution Outline

- 4.3 Likely Role of early Mantle Overturn
- 4.4 The missing upper mantle olivine?
- 4.5 Other Geophysical Drivers for early Crustal Evolution....
- 4.6 Probable/possible Role of Early Major Impacts (SPA,...)
- 4.7 Proposed stratigraphy within the crust and upper mantle
- 4.8 Comparison of mare basalt samples to the ages and inferred compositions of the mare basalt stratigraphy determined from cratering records
- 4.9 ETC....
- 4.10 Summary

## **5 Lessons learned over the last decade of lunar crustal analyses All**

Diversity, continual discoveries (and surprises), importance of expanding samples, importance of new technology (spacecraft and laboratory) to explore in greater detail....