#2673

Zeeman Crater's Anomalous Massif

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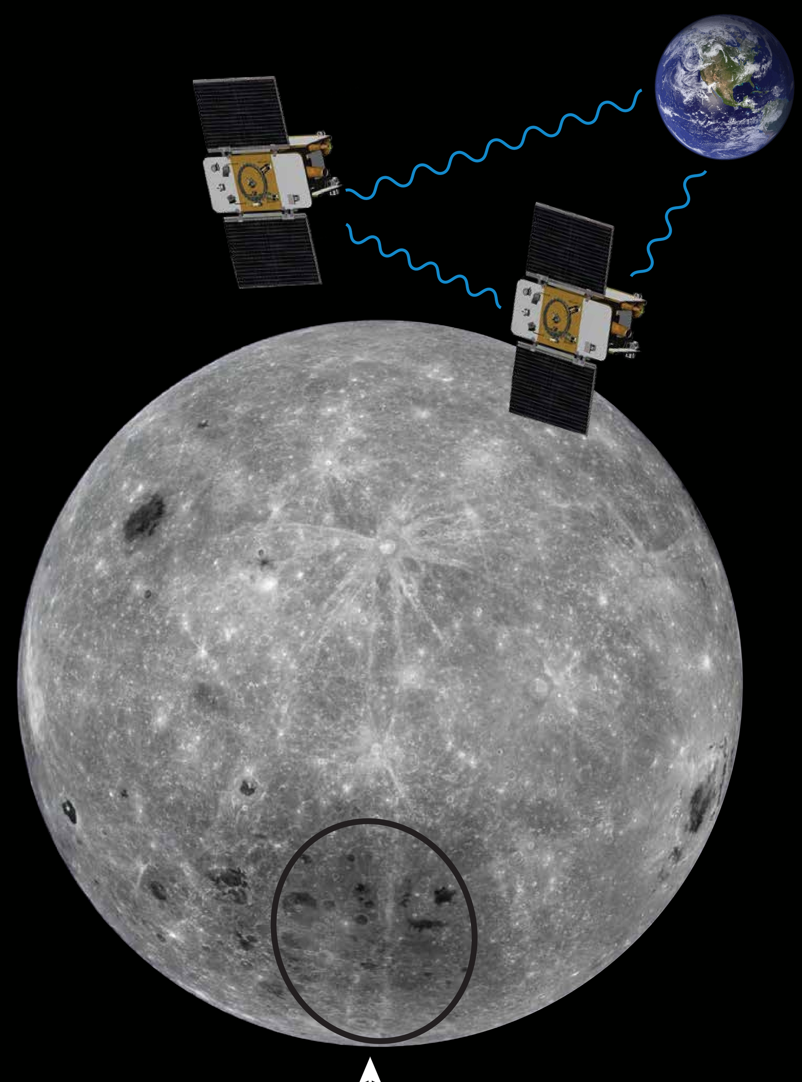
Methods

We applied Nettleton's method and GRAIL gravity data to calculate bulk density across 3 lunar craters. Integration over the l=200-700 spherical harmonic waveband yields effective porosity (ϕ_{eff}). Grain density was then inferred by dividing bulk density by a factor of (1-ϕ_{eff}).



GRAIL and LOLA data from the Planetary Data System (PDS).

Study Area

The South Pole-Aitken Basin (SPA) is a massive impact structure on the Moon. An impact this large would have easily excavated the mantle, but olivine has only been detected in Zeeman and Schrödinger crater[1,2]. This study investigates the origin of a nearly 8 km tall massif on the NW rim of Zeeman crater. Drygalski and Schrödinger, nearby craters, are also analyzed for context.

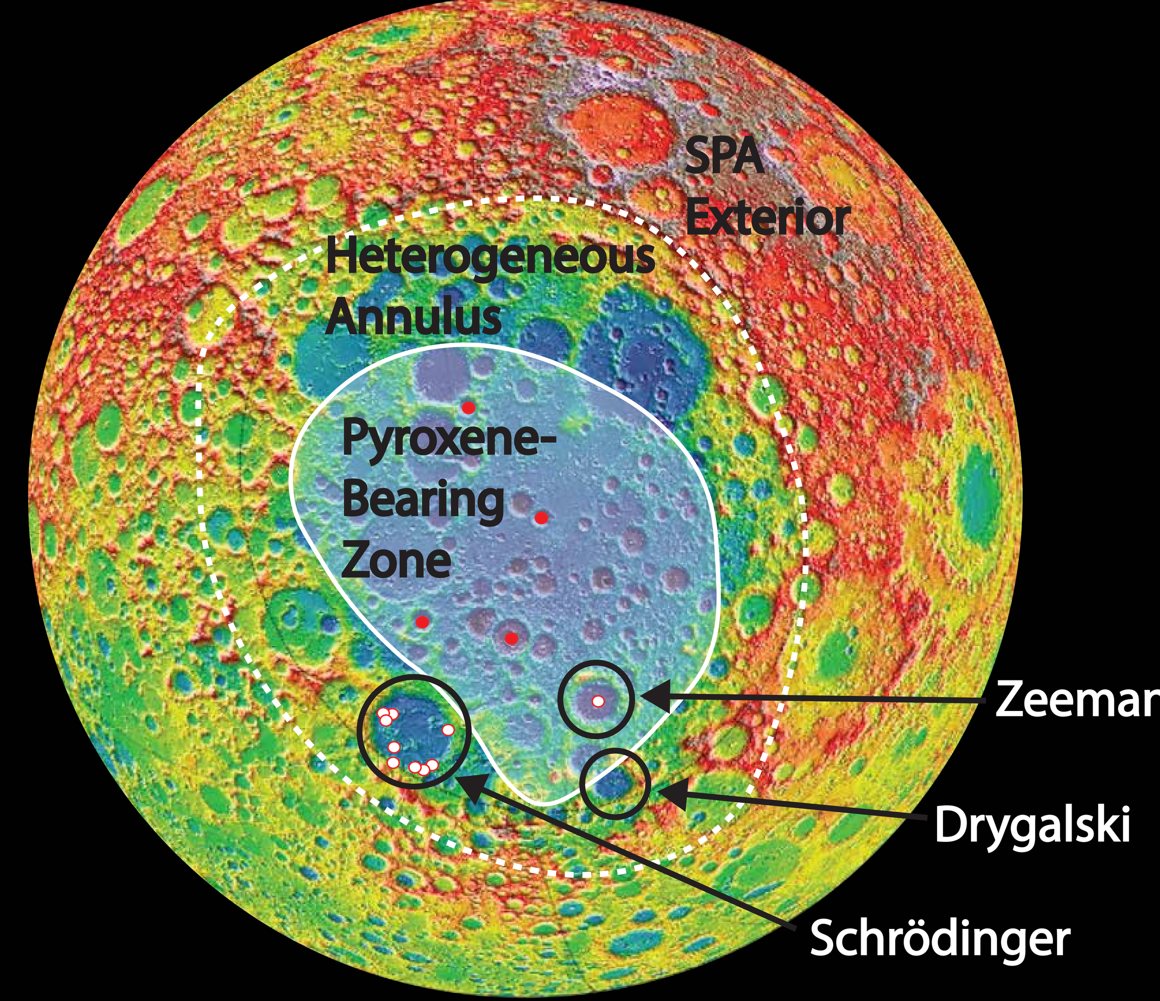


Figure modified from [1]Moriarty and Pieters (2018) and [2]Yamamoto et al. (2010).

Conclusions

The SPA likely formed by (1) melt sea differentiation[3] or (2) as surrounding, impact-melted crust flowed into the excavated basin[4]. Density results support the overlying noritic residuum of (1), but do not invalidate (2). Zeeman massif is not mantle-derived, but instead likely autochthonous, comprised of the same norite of the SPA floor. The massif may be crust ejected during a large impact which was lodged in the SPA floor, prior to the Zeeman impact.

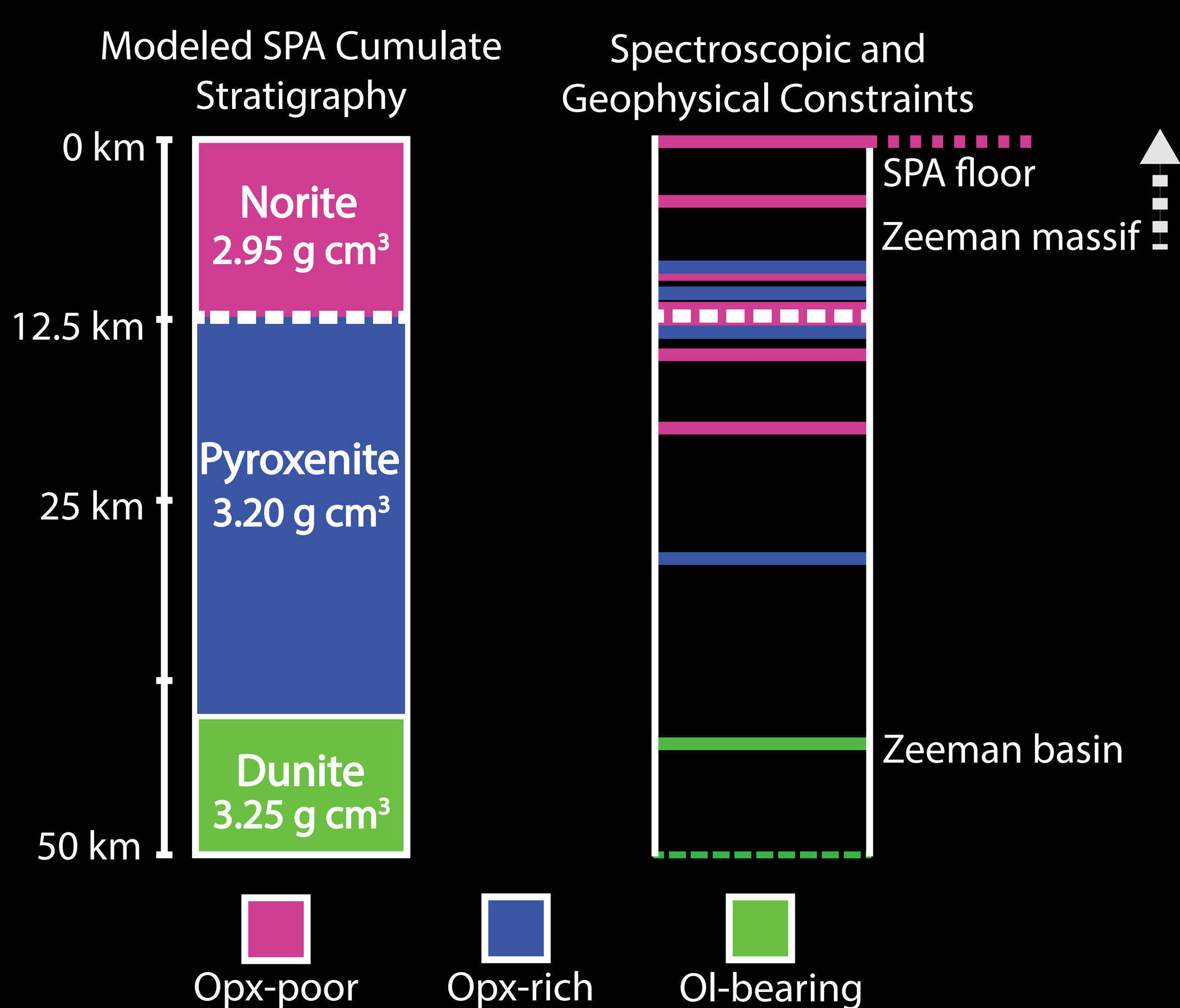
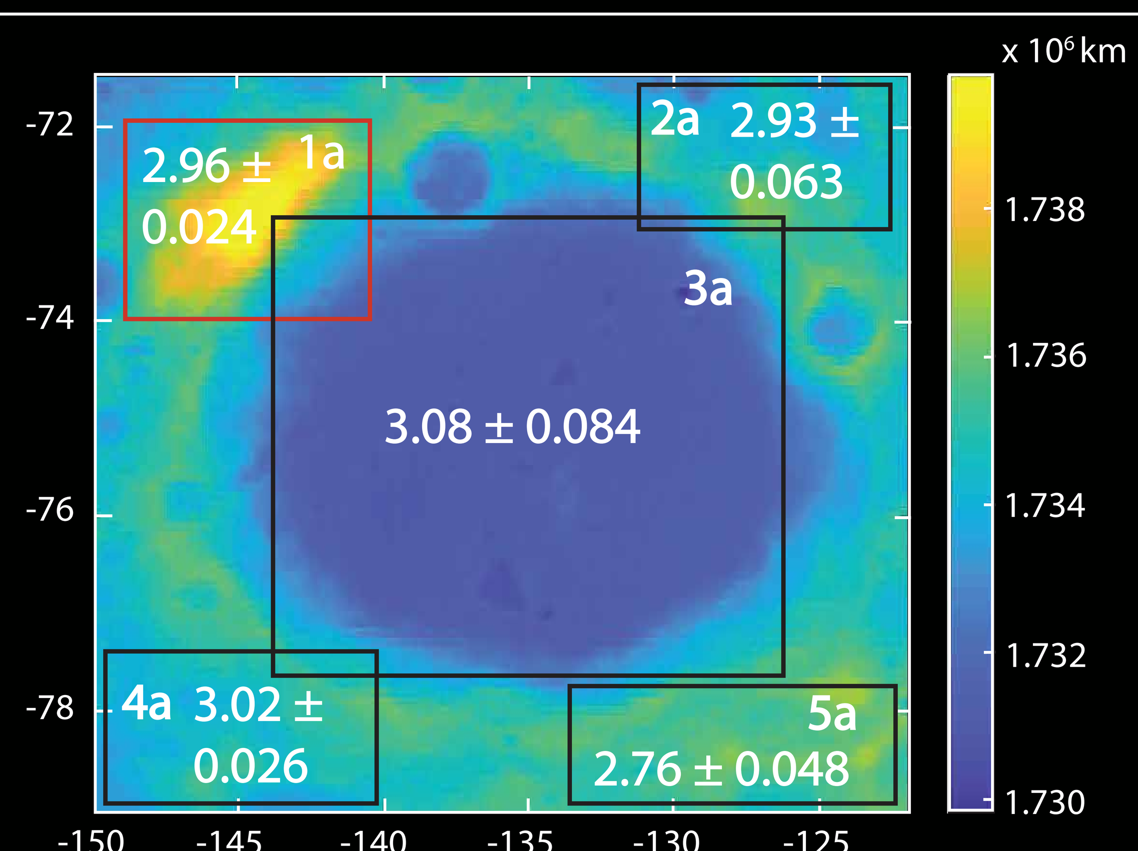


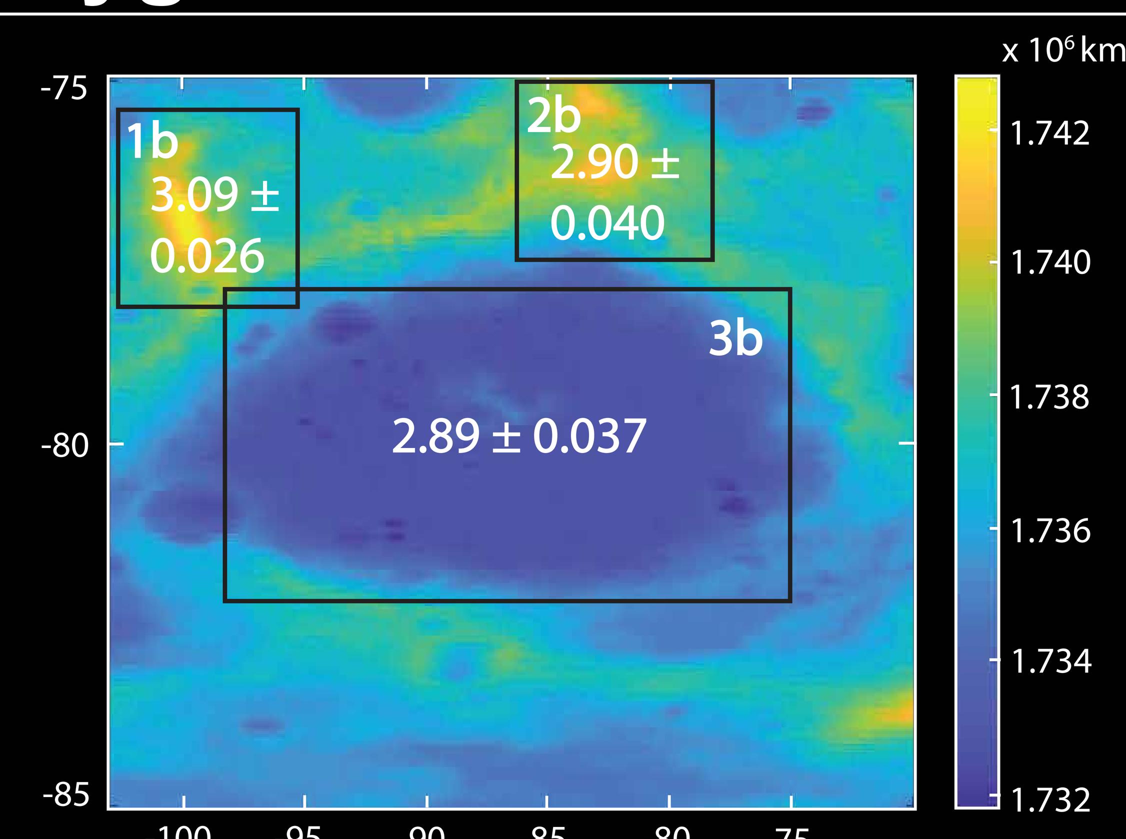
Figure modified from [3]Vaughan and Head (2014). [4]Johnson et al. (2017)

Zeeman



Grain density for Zeeman's massif is consistent with norite. 3a has higher grain density, reflecting a greater abundance of ultramafic mineralogy. 5a yields grain density of pure anorthosite.

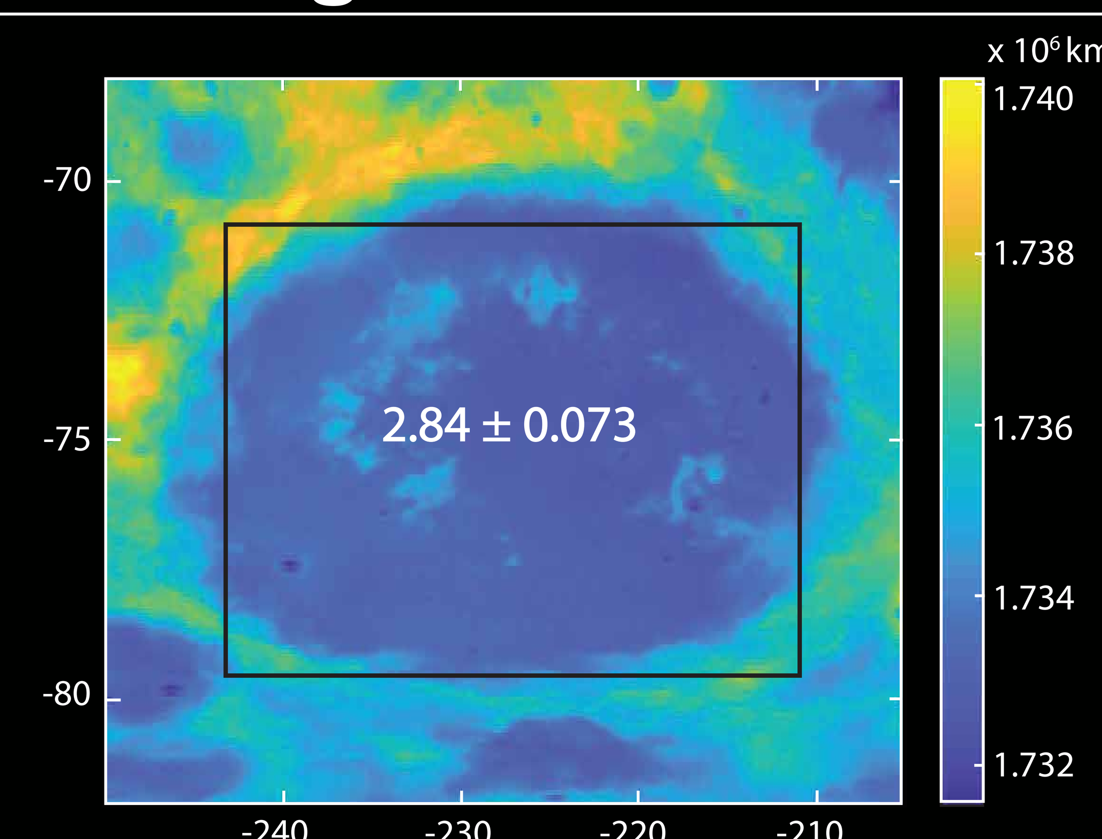
Drygalski



Grain density for Drygalski basin (3b) suggests a feldspathic composition, while 1b is more mafic. 2b is consistent with a noritic composition. These values challenge the previously assumed origin of 1-2b as remnant highland crust[5].

[5]Campbell and Campbell (2006)

Schrödinger



Schrödinger basin yields grain density lower than expected based on the presence of olivine. This crater is nearly twice the size of Zeeman or Drygalski[6], so the impact likely produced porosity greater than accounted for in the SPA average.

[6]Petro and Pieters (2005)