Introduction: Are the presence or absence, and compositions, of mare basalts flows in lunar impact basins influenced by the presence or absence of mascons? In the decade after the Apollo missions, detailed studies addressed questions of mare basalt interactions with mascons [1]. Modern datasets, geographic information systems, and hydrocode modeling allow examination of these interactions in ways that were not previously possible.

Mascons: Roughly circular gravity highs, reflecting basin-forming impacts followed by mantle uplift and - in some cases - mare infilling, are known as mascons [2]. Hydrocode modeling indicates that mascon formation is dependent on impact parameters, as well as crustal thickness and temperature [3].

Many basins are adjacent, and lava from one basin has often flowed into another basin. The present study is restricted to the nearside basins that exist in isolation [4], to avoid this cross-contamination.

Seven isolated >300 km diameter mascon basins (Balmer-Kapteyn, Crisium, Humboldtianum, Mutus-Viacq, Orientale, Schiller-Zucchius, Smythii) are compared to two nearside basins that are not underlain by mascons (Pingre-Hausen, Werner-Airy) [4].

Data Sets: LROC QuickMap [5] produces images of the lunar surface from WAC mosaics (Figs. 1a, 2a), that can be aligned with orbit-derived geophysical and geochemical parameters.

Gravity. The GRAIL mission [2] provided high-resolution maps of the Bouguer gravity fields (Figs. 1b, 2b), as well as crustal thickness models derived from these data (Figs. 1c, 2c).

TiO$_2$ Abundances. One of the most diagnostic oxides in lunar lavas is TiO$_2$ [6]. Abundance can be derived from WAC 321/415 nm band ratios [7] (Figs. 1d, 2d).

Samples. Luna 24 returned a 170 g drill core sample from the south-east quadrant of Mare Crisium [8].

Ages: The mascon basins range in age from Pre-Nectarian (>3.92 Ga; Balmer-Kapteyn, Mutus-Viacq, Schiller-Zucchius, Smythii) to Nectarian (3.92 - 3.85 Ga; Crisium, Humboldtianum) to Lower Imbrian (3.85 - 3.80 Ga; Orientale) [4]. The two non-mascon basins, Pingre-Hausen and Werner-Airy, are Pre-Nectarian [4].
A fragment of the Luna 24 core in Mare Crisium has a Sm-Nd age of 3.3 +/- 0.4 Ga [8]. The oldest exposed mare lava in the Humboldtianum basin has a crater count age of 3.7 Ga [9]. Other flows in the basin are as young as 3.4 Ga. Across the nearside, each of the oldest dated flows is at least 100 My older than the basin in which it occurs [4,9].

**Mantle Uplift and Deep Fracturing:** Hydrocode and GRAIL crustal thickness models [2] both support the preserved uplift of the underlying mantle by tens of km, as well as deep circumferential fractures, in mascon basins such as Crisium (Fig. 1c). These features are not apparent in models of the non-mascon basins Pingre-Hausen and Werner-Airy (Fig. 2c).

**Presence or Absence of Mare Flows:** Crisium is totally filled by mare flows (Fig. 1d), while Humboldtianum, Orientale, Schiller-Zucchiis, and Smythii are partially filled. Balmer-Kapteyn, Pingre-Hausen, Mutus-Viacq, and Werner-Airy (Fig. 1d) show no evidence of exposed mare lavas.

**Compositions of Mare Flows:** The average TiO$_2$ abundances (wt.%) of mare lava in three mascon basins from this study are: Crisium (2.6), Orientale (2.5), and Smythii (2.7) [7]. Fragments of the Luna 24 core have TiO$_2$ abundances of ~ 1.0 wt. % [8].

**Conclusions:** During much of the Pre-Nectarian epoch the lunar crust and upper mantle were too warm to preserve the mantle uplift and circumferential fractures that characterize mascons. As the crust and mantle cooled, these features were generally preserved [3,4]. Hundreds of My later, residual thermal energy and heat from radioactive decay raised temperatures deep below the surface to the melting point of mantle material. Much of the initial melting resulted in low-TiO$_2$ magma [6] that reached the surface preferentially along fracture pathways preserved in mascon basins. **Thus, the presence or absence, and compositions, of mare basalt flows in lunar impact basins are influenced by the presence or absence of mascons.**