**GLOBAL SURVEY OF LUNAR WRINKLE RIDGE FORMATION TIMES** Z. Yue[1], G. Michael[2], K. Di[1], J. Liu[3]. [1]State Key Laboratory of Remote Sensing Science, Institute of Remote Sensing and Digital Earth Chinese Academy of Sciences, Beijing, China 100101. [2]Planetary Sciences and Remote Sensing, Institute of Geological Sciences, Freie Unversitaet Berlin, Malteser Strasse 74-100, Haus D, Berlin 12249, Germany. [3]Institute of Geochemistry Chinese Academy of Sciences, Guiyang, China 550002.

**Introduction:** Wrinkle ridges are a common feature of the lunar maria and an indicator of the post-formational deformation of the mare infill. It is difficult to constrain the timing of wrinkle ridge formation from crater counts because they have limited areal extent, and even over the area which can be mapped, it is difficult to determine whether superposed craters post-date the ridge formation or have merely been uplifted during the deformation. There are, however, parts of the wrinkle ridge structures where it is possible to make such a determination: namely, where the ridge shows a sufficiently steep boundary or scarp that we see whether it deforms an intersecting crater or the crater obliterates the relief of the ridge. Such boundaries consitute only a small component of the wrinkle ridge structures yet they are sufficiently numerous to enable us to obtain statistically significant crater counts over systems of structurally related wrinkle ridges.

We carried out a global mapping of mare wrinkle ridges, identifying appropriate boundaries for crater identification, and mapping superposed craters. Data were analysed using the buffered crater counting method [1].

**Method:** Image data for the study were drawn from the Lunaserv mapserver LROC NAC overlay [2] at 2048 pixels/degree, equivalent to about 15 m/pixel, to cover the area of the previously mapped ridges [3].

Portions of the ridge boundaries showing scarps or pronounced steep boundaries were mapped with polylines in a GIS system (Fig 1). Superposed craters were mapped using CraterTools to determine the crater [4]. We used a simplified buffering scheme compared to that described by [5], but with the same intent: to reference each crater to a buffer area around the polylines, representing the area where we would have been able to identify other superposing craters of the same diameter, if they were present. Each scarp-intersecting crater was examined and included only if judged to post-date the scarp formation.

**Results:** Eight aggregated ridge systems (Procellarum, Imbrium, Serenitatis, Crisium, Frigoris, Nubium, Fecunditatis, Humorum) yielded average ages in the range 3.1–3.5 Ga, corresponding to 0.1–0.65 Ga after emplacement of the oldest lavas observed at the surface in each mare [6-10]. Figure 2 shows the result for Mare Crisium, where the ridge systems were split into three spatial groupings to investigate potential timing differences.

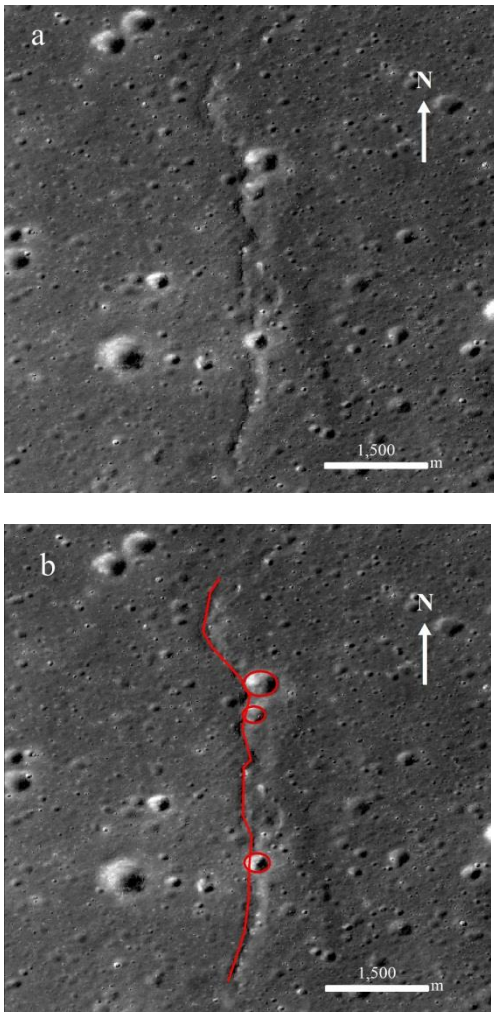


Figure 1. Examples of craters which (*a*,*b*) post-date (red circles, 19.1°W 42.6°N, Mare Imbrium) wrinkle ridge formation. Images from Lunaserv mapserver LROC NAC overlay [2].

The ridge system in Tranquilitatis which, notably, is not concentric to the basin as for the neighbouring mascon basins Serenitatis and Crisium, yields a formation time of 2.4 Ga, that is 1.4 Ga after its oldest surface lavas [6].

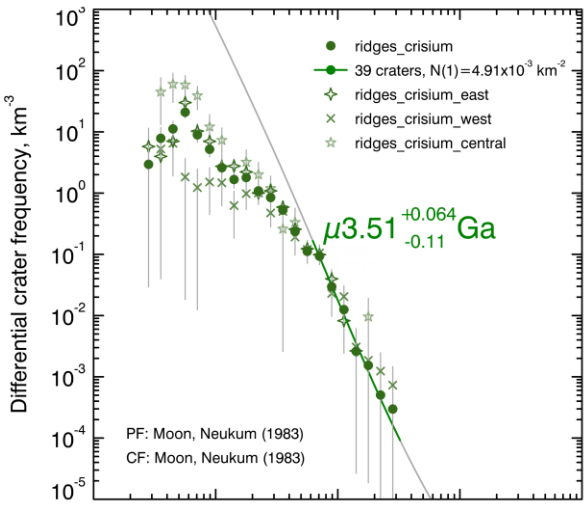


Figure 2. Sample average model age of wrinkle ridge systems for Mare Crisium (grouped into east, west, central, all-basin systems). Colours correcspond to mapped systems in Fig. 3. μ is a function representing the uncertainty of calibration of the chronology model [11]

**Conclusion:** We made a global survey of the ages of lunar maria wrinkle ridge systems using the buffered crater counting method. We find that, excepting Tranquilitatis, the ridge systems formed 0.1–0.65 Ga after emplacement of the oldest observable lavas in each mare, but not generally synchronously with one another. This is consistent with the source of stress being local to the maria basins. For those maria where we were not able to measure ages because of insufficient crater statistics, there is nevertheless no indication that the general picture is different.

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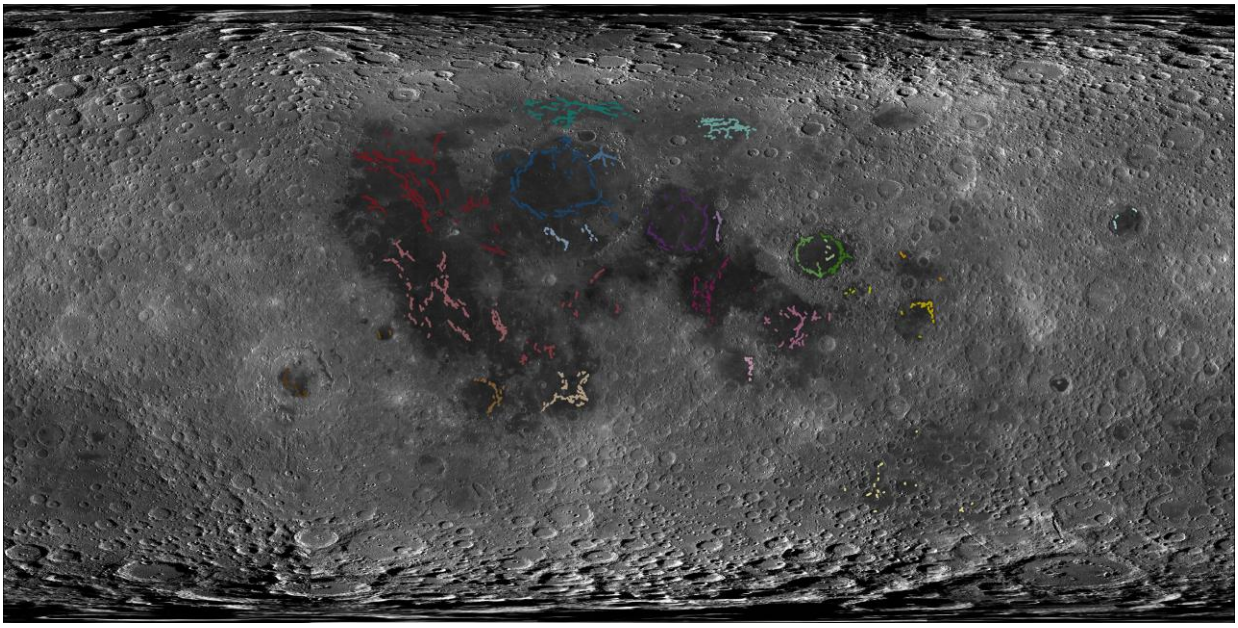

Figure 3. Globally mapped wrinkle ridges over LROC WAC mosaic. Separately aggregated systems of ridges marked with distinct colours