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Mercury's radius change estimates revisited using high incidence angle MESSENGER data

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Estimates of Mercury's radius decrease obtained using the amount of strain recorded by tectonics on the planet range from 0.5 km to 2 km. These latter figures appear too low with respect to the radius contraction (up to 5-6 km) predicted by the most accredited studies based on thermo-mechanical evolution models. For this reason, it has been suggested that there may be hidden strain accommodated by features yet unseen on Mercury. Indeed, as it has been already cautioned by previous studies, the identification of tectonic features on Mercury might be largely biased by the lighting geometry of the used basemaps. This limitation might have affected the results of the extrapolations for estimating the radius change. In this study, we mapped tectonic features at the terminator thus using images acquired at high sun incidence angle (>50°) that represents the optimal condition for their observation. In fact, images with long shadows enhance the topography and texture of the surface and are ideal to detect tectonic structures. This favorable illumination conditions allowed us to infer reliable measurements of spatial distribution (i.e. frequency, orientation, and areal density) of tectonic features which can be used to estimate the average contractional strain and planetary radius decrease. We digitized tectonic structures within a region extending for an area of about 12 million sq. km (∼16% of planet's surface). More than 1300 tectonic lineaments were identified and interpreted to be compressional features (i.e. lobate scarps, wrinkle ridges, and high relief ridges) with a total length of more than 12300 km. Assuming that the extensional strain is negligible within the area, the average contractional strain calculated for the survey area is ∼0.21–0.28% (∼0.24% for θ=30°). This strain, extrapolated to the entire surface, corresponds to a contraction in radius of about 2.5–3.4 km (∼2.9 km for θ=30°). Interestingly, the values of contractional strain and radius decrease obtained in the present study are up to five times higher with respect to previous estimates. Our results are more compatible with recent studies suggesting that the Mercury's radius contraction could have been up to 5-6 km throughout its thermal evolution than previous results, supporting the idea that Mercury could have recorded more tectonism than that required to account for 1-2 km of radial contraction. These estimates should be confirmed by further observations over significant portions of the planet and at most favorable sun angle conditions using data from the MESSENGER orbital phase and the high resolution basemaps which will be provided by the next BepiColombo mission.