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Why are the Geoid and the Areoid so similar?

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Spinning planets can be expected to assume a hydrostatic figure but Mars and the Earth are puzzling, not just because their figures depart from that norm, but because they depart in such similar ways. Earth's figure is composed of a part generated by subducted slabs in the mantle and a larger part, the Residual Geoid (RG). The RG highs match two antipodal bodies on the CMB (Large Low Shear wave Velocity Provinces, here called TUZO and JASON). In the past 15 years those two bodies have been shown to be dense (2% to 3% iron-enriched) and to have been stable with respect to the spin axis for the past 0.55 Ga. They lie on the equator meeting the requirement that the equator rotates to overlie anomalous masses if those are associated with geoid highs. Applying the new understanding of the RG to the Areoid (AR) calls for an interpretation of that very similar figure as also related to two antipodal equatorial dense masses on the CMB. Steeper gradients around the AR high over the western postulated mass on the Martian CMB and matching the areal extent of Tharsis volcanic rocks are attributable to an additional contribution to AR elevation from that surface igneous body.

Another striking similarity exists between the two planets. On the Earth, Large Igneous Provinces have been highly concentrated at the times of their eruption vertically above their plume sources in Plume Generation Zones (PGZs) at edges of Tuzo and Jason on the CMB. On Mars, great volcanoes including Olympus Mons, Alba Mons and the Elysium volcanic province are similarly concentrated vertically above the edges on the CMB of the two postulated Areoid dominating masses. This indicates that the Areoid and the two postulated Areoid dominating masses (ADMs) at the CMB have been stable at least since Tharsis erupted. We suggest that the formation of all three structures are linked to a major catastrophic episode generated by the Borealis crater-forming impact event. A recognized difficulty with the idea of a link to a Borealis impact related catastrophic event is that no such event has been discerned in Martian impact crater chronology or in the volcanic history of Mars.

On Earth the idea that Tuzo and Jason could have formed either slowly or rapidly under the present geodynamic regime contrasts with the idea, by analogy with the idea that the masses dominating the Areoid formed in a catastrophe, that Tuzo and Jason also formed in a catastrophe. On the Earth that catastrophic event is considered to have been the moon-forming event $\sim$ 50 My to 140 My into solid Earth history.