Introduction: The surface of Ganymede displays several candidate regions of strike-slip tectonism, with shear failure presumably driven by a combination of global and local stress sources. As Ganymede orbits Jupiter every 171.6 hours, variations in gravitational tidal forces, due in part to the satellite’s eccentric orbit, (e = 0.013) act to deform the moon’s surface [1], with diurnal stresses on the order of a few kPa. Greater eccentricity in the past [2] could have resulted in greater diurnal stresses. Nonsynchronous rotation stresses (NSR) may arise if a tidally flexed satellite has an outer ice shell. We assume an NSR rate for Ganymede of \( \mu_f = 0.2 \) cases at all nine target regions. For example, Figure 1 illustrates the digitization of two major fault zones within the Nun Sulci, their corresponding strike-slip indicators (i.e., pronounced offset along the south branch, right-stepping en echelon structures along the north branch [9]), and modeled normal, shear, and Coulomb stresses for these structures, given their current fault orientation and prescribed \( \mu_f \).

In addition to assessing each fault zone’s ability to accommodate shear failure, we also compare each fault zone’s predicted sense of shear to the inferred shear directions from structural mapping efforts [10]. Using high-resolution Galileo solid-state imager (SSI) data, we have mapped in detail major strike-slip indicators (en echelon structures [11,12], strike-slip duplexes [13], strained craters [14], and offset of pre-existing structures) within all nine target regions. Multiple examples of strike-slip indicators, of both right and left-lateral shear, are documented in various combinations at each site, with ubiquitous examples of en echelon structures and at least one example of other indicators. We use rose diagrams and diagrammatic strain ellipses to examine trends and assess consistency between mapped structures, and we also infer main stages of tectonic deformation at each region. To perform a first-order comparison of mapped and modeled shear sense, we limit our analysis to mapped inferences of shear along major fault zone structures within each target region and compare these to the predicted shear sense for each modeled fault zone. We find compatible senses of shear among six of the nine regions; however, we note that these results are sensitive to both fault strike (affecting our models) and our inferred morphology of strike-slip indicators (from our mapping). Because confidence in shear sense is greatest for easily-identified strike-slip offsets (which also provide the strongest inference of brittle failure), we organize our results below into three groups: (1) fault zones with notable offset and compatible shear sense, (2) fault zones with other strike-slip indicators and compatible shear sense, and (3) fault zones with other strike-slip indicators but incompatible shear sense.

Fault zones with notable offset: Significant offset, as inferred in Galileo imagery, has been suggested at three of our target regions [9, 10]: Nun Sulci (50 km, left-lateral), Dardanus Sulcus (45 km, right-lateral), and Tiamat Sulcus (40 km, right-lateral). Likewise, modeled shear stresses along these offsets are in strong agreement with their respective inferred shear senses: the Nun Sulci (Figure 1) are dominated today by left-lateral shear stress, and Dardanus Sulcus and Tiamat Sulcus are dominated by right-lateral shear stress.

Summary of Results: Global tidal stress models limited to only present-day diurnal stresses do not permit Coulomb shear failure along any of the major fault zones of the nine regions investigated here. However, a combination of both diurnal and NSR stress mechanisms readily generate shear and normal stress magnitudes in all nine regions that could give rise to Coulomb shear failure today. For the assumed present-day fault geometry and location on the surface (i.e., measured planform geometry and assumed vertical dip) of the major fault zones of each region, these results suggest shear failure is possible down to depths of \(~1-2\ km\) for high friction (\( \mu_f = 0.6 \)) cases and \(~>2\ km\) for low friction (\( \mu_f = 0.2 \)) cases at all nine target regions.
ed. For example, a small backrotation of the modeled strike of Arbela, Anshar, and Uruk Sulcus by ~10-30° counterclockwise results in subtle but reversed sense of shear that is compatible with mapped shear indicators. It is also important to note that for each of these tectonically complex regions, the major fault zone structure adopted for our shear calculations may not have been formed by strike-slip tectonism, but instead by tensile stresses (as suggested by several en echelon features associated with several of these structures). Furthermore, when considering a ~50-90° backrotation of the tidal bulge corresponding to NSR stresses, models are able to predict a matching sense of shear.

**Conclusions:** We find that present-day diurnal and NSR tidal stressing mechanisms, in combination, are sufficient to induce shear failure along all of the inferred regions of strike-slip tectonism on Ganymede that we have studied. In addition, our models generally predict the same sense of shear as inferred from imagery and mapping efforts. Modeling that does not match the present-day inferred sense of shear may be consistent with a migrating ice shell as due to NSR, perhaps allowing for reorientation of modeled strike. Local conditions and pre-existing faults may affect sense of shear predictions. In future work, additional secular stress mechanisms, such as true polar wander, will also be considered as a possible alternative stress model.

**References:**


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