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TITLE: How Are the Jets, Heat and Tidal Stresses across the South Polar Terrain of Enceladus Related?

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ABSTRACT BODY: The jetting activity observed across the south polar terrain (SPT) of Enceladus and monitored by the Cassini imaging investigation (ISS) over the last 8 years, has previously been shown [1,2] to be roughly spatially coincident with the excess thermal radiation emitted by the `tiger stripe' fractures crossing the SPT [3,4]. It is also roughly coincident with those localized regions on the fractures undergoing greatest tidal shear stress [2]. The relationship, however, among all three phenomena…shearing, anomalous thermal emission, and jetting…is unclear. Do the shear stresses, and possible associated frictional heating along the sub-surface walls of the fractures, melt the ice there to form liquid water which, in turn, supplies the jets? Or do tidal stresses simply create a deeply rooted system of cracks extending 10s of kilometers to the putative regional sea below, thereby providing the vertical pathways for sea-derived liquid droplets and water vapor, and the latent heat they carry, to reach the surface?

To address these questions, we completed our survey of the SPT as imaged at high resolution (< 1.3 km/pixel) by Cassini ISS beginning in 2005 and extending through the very last Enceladus flyby in May 2012. Ninety-seven (97) jets have been identified either on the main trunks or branches of the 4 fractures. A handful of these jets are obviously time-variable, appearing `on' at times and `off' at others. We have used the methodology of Nimmo et al. (2007) [5] to compute the time-varying tidal stresses – magnitudes, phases and orientations, both shear and tensional – within the ice shell and across the fractures, and compared these to the strength, spatial distribution, and time-variability of the jetting activity.

From this work, we investigate the relationships among all these phenomena. We examine the correlations between stress magnitudes (shear and normal) and the magnitude of the jetting activity, as well as search for synchronicity between the phasing of the observed variable jets and that of the eruption states (on/off) predicted by the tidal stress model of jet variability presented by Hurford et al. (2007) [6]. We consider also the likelihood that cracks can propagate vertically upwards through the bulk of the ice shell, and remain open

long enough to deliver vapor and liquid to the surface.

Finally, we show that recent observations by the Cassini VIMS experiment of individual hot spots in the vicinity of the south pole on Baghdad fracture (7) are likely coincident with, and the thermal signature of, individual jets seen in ISS images.

We will discuss the implications of all these results, as well as others (such as the salinity of the jet particles [8]), for the genesis of the heat and jets observed across the SPT.

1 Spitale, J.N. and Porco, C.C. (2007), Nature 449, 695; 2. Porco, C.C. et al. (2011), AGU Abst P13F-02; http://adsabs.harvard.edu/abs/2011AGUFM.P13F..02P ; 3. Porco, C.C. et al. (2006), Science 311, 1393; 4. Spencer, J.R. et al. (2006), Science 311, 1401; 5. Nimmo, F., et al. (2007) Nature 447, 289-291; 6. Hurford, T. et al. (2007). Nature 447, 292-294; 7. Blackburn, D.G., et al. (2012), LPSC Abst; http://adsabs.harvard.edu/abs/2012LPI....43.1532B; 8. Postberg, F., et al., (2011), Nature 474, 620-622.

KEYWORDS: [6280] PLANETARY SCIENCES: SOLAR SYSTEM OBJECTS / Saturnian satellites, [5480] PLANETARY SCIENCES: SOLID SURFACE PLANETS / Volcanism, [5462] PLANETARY SCIENCES: SOLID SURFACE PLANETS / Polar regions.

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