TITAN AS AN ICY MOON: EVIDENCE FOR CRYOVOLCANISM AND TECTONICS FROM CASSINI/VIMS. Jason W. Barnes, *NASA Ames Research Center, M/S 244-30, Moffett Field, CA 94034-1000, USA, (Jason.W.Barnes@nasa.gov)*, Robert H. Brown, *LPL*, Laurence Soderblom, *USGS/Flagstaff*, Christophe Sotin, Stephane Le Mouélic, Sebastien Rodriguez, Lucille LeCorre, *Université Nantes*, Bonnie J. Buratti, Karly M. Pitman, *JPL*, Roger N. Clark, *USGS/Denver*, Ralf Jaumann, *DLR*, Paul Hayne, *SSI*.

Abstract:

Like the other large icy moons, Titan is predicted on theoretical grounds to posess a liquid water mantle beneath its icy crust [1]. There is as yet no more definitive empirical evidence for this subsurface ocean, unlike for Europa [2, 3], Ganymede [4], Callisto [3], and Enceladus [5]. Titan's extended atmosphere limits *Cassini* passes to be at least 1000 kilometers above the surface, reducing the sensitivity of gravitational and magnetic experiments to subsurface conditions.

The atmosphere inhibits surface imaging as well, by atmospheric absorption, haze scattering, and the closest-approach-altitude limitation. The best imaging resolution of Titan obtained to date was 400 meters/pixel by VIMS during the T20 (2006 October 20) flyby, and that only in a small footprint. Typical global resolutions are more like 10-20 km/pixel. The resolution discrepancy between available data covering Titan and that covering its sister water-mantle moons makes intercomparison challenging. Geological processes driven by Titan's atmosphere and hydrosphere (methanosphere) like aeolean burial and exhumation as well as fluvial erosion and deposition dominate on Titan, and hence conceal possible similarities between Titan and other icy moons.

Nevertheless, in this talk we identify a set of Titanian features present in the Visual and Infrared Mapping Spectrometer (VIMS) dataset that may share similar origins to those seen on other icy moons. The processes that drive these features are likely extrusive and/or tectonic.

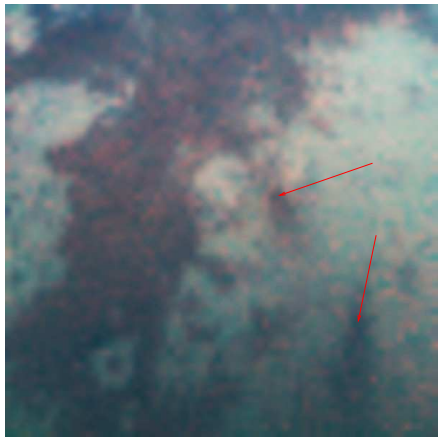

Figure 1: Omacatl (top) and Elpis (bottom) Maculae on Titan as seen from VIMS during T5 (2005 April 16).

Possible cryovolcanic features have been identified on several other icy moons, including Europa [6], Ganymede [7], Triton, Miranda, and Ariel [8]. We will discuss Titan's cryovolcanic candidates Tortola Facula [9], Tui Regio [10], and the possible flow feature seen by both VIMS and RADAR in northern Fensal [11, 12], comparing them to those on other icy moons.

Though other explanations remain viable (I prefer an impact origin myself – JWB), Titan's Omacatl and Elpis Maculae may represent plume-deposits downwind of a surface source [13] (Figure 1), reminiscent of those on Triton [14] though they would likely be heated from below, and not from above as on Triton [15].

Large-scale tectonic fractures cover the surface of Europa (e.g., [16]). VIMS T20 observations revealed what is possibly a linear mountain range on Titan, identified based on topographic shading (Figure 2. Though the processes that drive mountain formation on Titan have not yet been established, the T20 mountains may result from teconism similar to that seen on other icy moons. Titan also sports several sets of dark regions with polygonal boundaries that are preferentially oriented in the ordinal directions. The virgae seem only to exist between 20 and 30 degrees of the equator in both the northern and southern hemispheres. Though we really don't know what they are or what made them, we are investigating possible tectonic processes. As a complete speculation, the confinement of these features within a narrow latitudinal zone may be the result of a changing tidal stress field like that seen on Europa [17], but operating on a much slower timescale.

References

[1] Tobie G., Lunine J.I., and Sotin C. (2006) *Nature, 440* 61–64.

[2] Carr M.H., Belton M.J.S., Chapman C.R., Davies M.E., et al. (1998) *Nature, 391* 363–+.

[3] Khurana K.K., Kivelson M.G., Stevenson D.J., Schubert G., et al. (1998) *Nature, 395* 777–+.

[4] Anderson J.D., Lau E.L., Sjogren W.L., Schubert G., et al. (1997) *Nature, 387* 264–266.

[5] Brown R.H., Clark R.N., Buratti B.J., Cruikshank D.P., et al. (2006) *Science, 311* 1425–1428.

[6] Figueredo P.H., Chuang F.C., Kirk R.L., and Greeley R. (2000) in Lunar and Planetary Institute Conference Abstracts, vol. 31 of *Lunar and Planetary Institute Conference Abstracts*, 1026–+.

[7] Head J.W., Pappalardo R.T., Kay J., Collins G., et al. (1998) in Lunar and Planetary Institute Conference Abstracts, vol. 29 of *Lunar and Planetary Institute Conference Abstracts*, 1666–+.

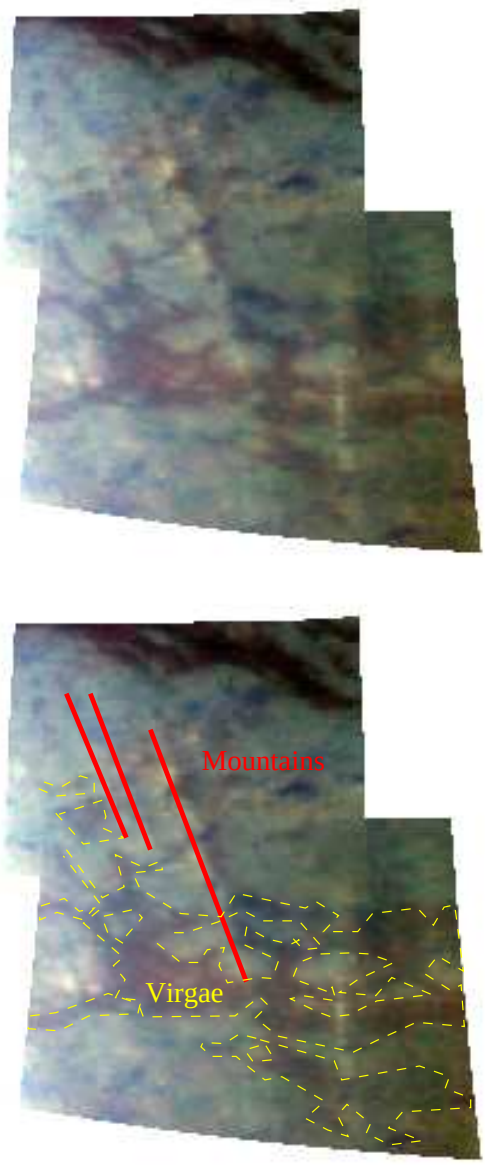

Figure 2: Mountains and the possibly tectonic Virgae on Titan, as seen by the Visual and Infrared Mapping Spectrometer onboard Cassini during the T20 flyby on 2006 October 20.

[8] Kargel J.S. (1995) *Earth Moon and Planets, 67* 101–113.

[9] Sotin C., Jaumann R., Buratti B.J., Brown R.H., et al. (2005) *Nature, 435* 786–789.

[10] Barnes J.W., Brown R.H., Radebaugh J., Buratti B.J., et al. (2006) *Geophys. Res. Lett., 33* 16,204–+.

[11] Le Corre L., Le Mouélic S., Sotin C., Rodriguez S., et al. (2007) in Lunar and Planetary Institute Conference Abstracts, vol. 38 of *Lunar and Planetary Institute Conference Abstracts*, 1828–+.

[12] Lopes R.M.C., Mitchell K.L., Stofan E.R., Lunine J.I., et al. (2007) *Icarus, 186* 395–412.

[13] Hayne P., Combe J., and McCord T.B. (2006) *AGU Fall Meeting Abstracts* A166+.

[14] Soderblom L.A., Becker T.L., Kieffer S.W., Brown R.H., et al. (1990) *Science, 250* 410–415.

[15] Brown R.H., Johnson T.V., Kirk R.L., and Soderblom L.A. (1990) *Science, 250* 431–435.

[16] Pappalardo R.T. and Sullivan R.J. (1996) *Icarus, 123* 557–567.

[17] Hurford T.A., Sarid A.R., and Greenberg R. (2007) *Icarus, 186* 218–233.