EPSC Abstracts
Vol. 6, EPSC-DPS2011-1019-1, 2011
EPSC-DPS Joint Meeting 2011

Analysis of tectonics and cryovolcanism on Ganymede: possible observations with JGO-EJSM

R. Pozzobon (1), G. Cremonese (1), M.T. Capria (2), V. Da Deppo (3), M. Massironi (4)

(1) INAF – Istituto Nazionale di Astrofisica, Osservatorio Astronomico di Padova, Italy, (2) INAF-IASF, Roma, Italy, (3) IFN-CNR UOS Luxor, Padova, Italy, (4) Dept.Geosciences, Univeristy of Padova, Italy
.

Abstract
Voyager data revealed that the Jovian moon Ganymede, the biggest satellite in the solar system, consists of ancient heavily cratered dark terrain and younger resurfaced and tectonically deformed bright terrain (groove lanes and polygons). These terrains seem to have undergone an intense resurfacing and several models were developed. However both Voyager data and successively in 1996 Galileo SSI (Solid State Imager) images did not have a spatial resolution high enough to define the most likely resurfacing phenomena. In particular Galileo data coverage is not global (fig. 1) and there is a great heterogeneity in the spatial resolution going from more than 500 m/pixel in some areas to 100 m/pixel in a very few areas. The WAC (Wide Angle Camera), which should be on board the ESA mission JGO-EJSM, will provide a global coverage of Ganymede's surface with a constant spatial resolution of 150 m/pixel to perform in-depth geologic studies.

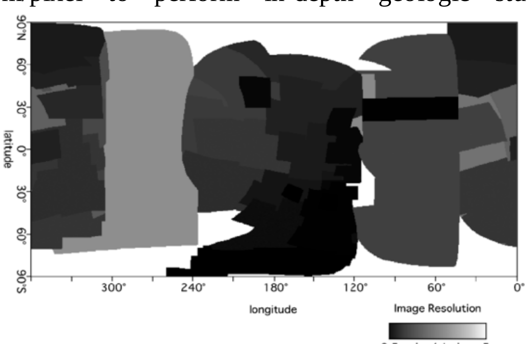

Fig. 1: Plot of the resolutions of image data across the surface of Ganymede (Patterson et al. 2010 [3]). Higher-resolution data: dark tones < 0.5 km/pixel, lower resolution data: light tones >5 km/pixel.

1. Introduction

Ganymede has two main types of surface which are discernible on the base of their different albedo, crater density and morphology. About one-third of its surface is covered by dark terrain, characterized by a relative low albedo and high density of craters. The other two thirds of the surface are represented by swaths and regions of bright terrain, which has higher albedo and much lower crater density. One of the most likely models proposed for the bright terrains resurfacing is the cryovolcanism (Pappalardo et al. 2004 [2]): water-ice magmas pushed to the surface to fill low lying areas. Several areas on Ganymede present a number of smooth swaths of bright material located on topographic lows, with some superimposition and overprint phenomena by other bright swaths. Some morphology was recognized with Galileo SSI images as possible sources and vents for cryovolcanism. Some scalloped depressions and crater bottoms present shapes commonly interpreted as icy domes, as in Melkart Crater (fig.2) or in the Galileo regio. Sippar Sulcus is another of the candidate regions to be formed by cryovolcanism (Schenk et al., 2001 [5], Head et al., 2002 [1]). It is clearly recognizable the rim of the source vent and the ice flow (fig. 3). It is important to notice that all these features are large scale morphologies. On the other hand many more volcanic features could potentially exist below the current limits of resolution of SSI (average resolution of 180 m/pixel).

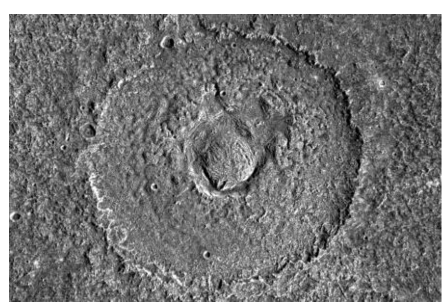

Fig. 2: Melkart crater: the central dome is a likely source for icy material (Galileo Image mosaic obtained with ISIS 3, 182 m/pixel resolution)

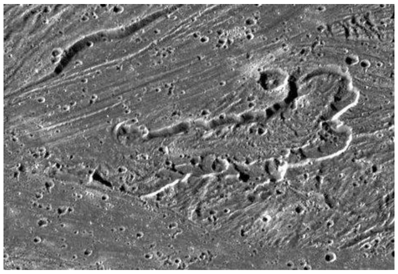

Fig. 3: Sippar Sulcus. It is clearly recognizable the possible ice source and the ice flow (Galileo Image 175 m/pixel).

1.1 Cryovolcanism

There are major difficulties in understanding how cryovolcanic resurfacing can form. Liquid water is denser than ice and thus it tends to remain below the satellite's surface. The mechanism that cause melting and volcanism on Earth are not possible with icy materials (pressure release melting and adiabatic ascent of the material). A proposed mechanism involves the squeeze of water + ice deep reservoirs, that overcome the neutral buoyancy and reach the surface. The possible sources are rounded morphologies similar to vents (common in Galileo region (Prockter et al., 1998 [4]), some also with evidence of flow as in Sippar Sulcus fig. 3) and icy domes at the bottom of some big craters (Melkart in fig. 2, Ea). Unfortunately the current image resolution does not allow to perform detailed studies on the morphologies that are the most likely sources of cryovolcanism. WAC imagery combined with morphological data and DTMs will give us the possibility to locate the best candidate regions and to model the cryovolcanic resurfacing mechanisms with a Finite Element Method (FEM).

2. Improvements with the WAC

Increasing the spatial resolution of the WAC at 150 m per pixel at 500 km will provide a global mapping one order of magnitude better than the Galileo mission and will decrease the difference with the High Resolution Camera pixel scale. The capabilities of the WAC resolution in terms of geological detailed studies were tested downscaling high resolution HRSC (High Resolution Stereo Camera, 12 m/pixel) images of Mars surface showing volcanic forms at 150 m/pixel (fig. 4). Indeed, some volcanic features similar to those expected to be found on Ganymede have been located on Mars, such as vents, calderas and lava flows and they still remain recognizable even at a small scale.

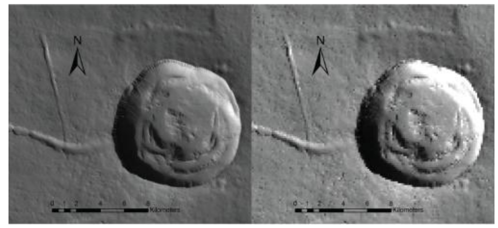

Fig. 4: HRSC image (left) of a caldera-like feature on Mars and the same image seen at WAC resolution (right). The main features are clearly recognizable.

6. Summary and Conclusions

The global image coverage on Ganymede needs to be improved, the Galileo coverage leaves some regions still unexplored and the variable resolution does not allow to perform detailed geological studies in some areas of great interest. The global coverage at 150 m/pixel of the WAC mounted on JGO-ESJM will provide a global imagery at a sufficiently high resolution to identify other previously unseen cryovolcanic vents and flows and to perform structural analyses on tectonic features. In addition the image resolution combined with morphological data and DTMs allows to model cryovolcanic processes in a realistic way using a FEM (finite element method) in order to understand the possible mechanisms of water and ice flows on Ganymede's surface.

References

[1] Head J., Pappalardo R., Collins G., Belton M.J. S., Giese B., Wagner R., Breneman H., Spaun N.; Nixon B., Neukum G., Moore J., 2002. Evidence for Europa-like tectonic resurfacing styles on Ganymede. Geophys. Res. Lett., 29 (24), DOI 10.1029/2002GL015961.

[2] Pappalardo R.T., Collins G.C., Head J.W., Helfenstein P., McCord T.B., Moore J.M., Prockter L.M., Schenk P.M., Spencer J.R., 2004. *Geology of Ganymede*. In: Jupiter. The planet, satellites and magnetosphere. Edited by Fran Bagenal, Timothy E. Dowling, William B. McKinnon.Cambridge University Press, p. 363 – 396.

[3] Patterson G.W., Collins G.C., Head J.W.; Pappalardo R.T., Prockter L.M., Lucchitta B.K., Kay J.P., 2010. *Global geological mapping of Ganymede*. Icarus, 207(2), 845-867.

[4] Prockter L.M., Head J.W., Pappalardo R.T., Senske D.A., Neukum G., Wagner R., Wolf U., Oberst J., Giese B., Moore J.M., Chapman, Clark R.; Helfenstein P., Greeley R., Breneman H. H., Belton M. J. S., 1998. Dark Terrain on Ganymede: Geological Mapping and Interpretation of Galileo Regio at High Resolution. Icarus, 135, 317-344.

[5] Schenk P.M., McKinnon W. B., Gwynn D., Moore J.M., 2001. Flooding of Ganymede's bright terrains by low-viscosity water-ice lavas. Nature, 410, 57-60.