PHOTOMETRY AS A TOOL FOR IDENTIFYING AND CHARACTERIZING OCEANS BELOW. B. J. Buratti1, 1Jet Propulsion Laboratory, California Institute of Technology; Pasadena, CA 91109 Bonnie.Buratti@jpl.nasa.gov

Introduction: The identification of evaporate deposits and other chemical clues are well-known tools for probing oceans and pockets of liquid below planetary surfaces. For example, brines on Ganymede provided evidence for its subsurface ocean [1], and chemical clues in Occator Crater [2,3] pointed to its status as an ocean world.

Less understood and appreciated is the tool of photometry to identify ocean worlds and areas of possible venting to the surface. The unusual photometric properties of Europa [4] provided one of the early lines of evidence for a subsurface ocean harboring bacterial life [5]. Modeling of physical parameters through photometric modeling has identified plume or possible venting deposits on Io and Europa [6,7]. The main physical parameters that identify photometric anomalies are albedo, surface texture, roughness, and particle size.

Albedo: One of the first indications of activity on Enceladus was its nearly unit geometric albedo [8]. Furthermore, all terrains on its surface seemed to be the same albedo, even though they ranged in age from billions of years old to relatively recent. It was as if a coating of the surface had occurred. (Failure of the scan platform on Voyager 2 precluded the acquisition of images of the plume of Enceladus in a look-back sequence.)

Figure. This long forgotten Voyager 2 image of Enceladus taken in 1981 held early clues to its status as an ocean world.

Large solar phase angles: One widely used tool for detecting plumes or jets on planetary surfaces is to seek forward scattering from very large solar phase angles (>150°). A dedicated study to obtain these images during the Cassini mission, especially toward the end, failed to detect any plume or jets on Mimas, Dione, or Tethys [9, 10].

Surface Texture: Fluffy tenuous surfaces can indicate cryovolcanic fallout [6,7], while smooth surfaces can indicate the flow of slurries across a planetary surface. Key to this analysis are observations at very small solar phase angles. This requirement illustrates the need to capture a complete excursion in solar phase angle to characterize a planetary surface, and later, to choose a safe location for landing or sample return.

Roughness: Macroscopic roughness, which includes features ranging from clumps of particles to craters and mountains – anything in the geometric optics limit - can indicate infilling, slumping due to a subsolidus layer, or other unusual phenomena not even envisioned.

Practical Photometric Modeling: Any planetary mission, be it flyby or orbiter, needs a photometric model for describing how the surface scatters radiation. Any deviation from a baseline model in any of the physical parameters described above provides clues to venting, plume deposition, or other unusual phenomena, such as the red streaks on Tethys, or its blue pearls, both still poorly understood features [11].


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