

Is there life on Europa?

Kevin P. Hand¹

BOOK REVIEWED-*Unmasking Europa: The Search for Life on Jupiter's Ocean Moon*

by Richard Greenberg

Praxis/Springer: 2008. 278 pp. £17.50/\$27.50

In the field of astrobiology, the discovery of life beyond Earth sits like a gem inside the nested Russian dolls of physics, geology, chemistry and, ultimately, biology. Efforts to understand the habitability of worlds within our Solar System began with physical and astronomical surveys, and have now moved on to the challenge of cracking open the geological secrets of key destinations such as Mars and the large, icy moons of Jupiter and Saturn.

Understanding the geological context for life is critical. Rock cycles, whether they are of silicates or ices, enable chemical cycles that can then be exploited by biological systems. Such cycles are central to life on Earth. On Mars, the demise of mantle convection may have led to the planet becoming cold and dry. Near the giant planets of the outer Solar System, and perhaps around massive extrasolar planets, rock cycles may be driven by the gravitational squeezing of icy moons due to tidal interactions. On icy moons such as Jupiter's Europa, the mixing of irradiated, oxidant-rich surface ice with a water ocean could maintain a chemically rich environment capable of sustaining life.

In *Unmasking Europa*, planetary scientist Richard Greenberg details in depth our geological understanding of the tidally tormented icy surface of Europa. Without pulling any punches, he also describes the equally tormented scientific debate that has led to the current canon. More than a decade after the Galileo spacecraft returned magnetic-field and gravity data that strengthened the case for a subsurface, liquid-water ocean on Europa, we still do not know whether that ocean lies beneath an ice shell just a few kilometres thick or a shell with a thickness of more than ten kilometres.



NASA/JPL-CALTECH

Europa's fractured icy surface could conceal life beneath.

From an astrobiology perspective, a thin shell could permit direct cycling of oxidant-rich ices with the ocean. A thick ice shell, however, would impede the cycling of surface material, possibly limiting the chemical energy available to any life below the surface. On this contentious debate over the ice thickness, Greenberg notes, "by itself, modelling of heat transport on Europa is too uncertain to definitively discriminate between thin conductive or thick convective ice". However, on the basis of a host of geological features observed in images from the Voyager and Galileo missions, many of which are reproduced in the book, Greenberg argues compellingly that only a thin shell is consistent with the observed ridges, cycloidal features and chaotic terrain of Europa, all of which can be explained through tidal dynamics.

Although Greenberg occasionally strikes an acerbic tone when describing scientific differences with those on what he calls the thick-ice bandwagon, his motivation seems noble. He fears that "the most brilliant young minds may leave science if they perceive it to reward something other than good research". He feels that the data point towards a thin ice shell but that political powers have marginalized this interpretation and those scientists who advocate it. When discussing his own work, Greenberg generously bestows much credit on his former students, postdocs and colleagues.

In *Unmasking Europa*, Greenberg succeeds in conveying a story, not of heroes and villains, but about the rise and fall of ideas and how some become accepted for reasons that perhaps go beyond empirical support. In Greenberg's earlier work, *Europa the Ocean Moon* (Springer, 2005), which is of similar scope but targeted to a research audience, the political storyline is not particularly appropriate. In his latest work, he delivers an accessible and well-laid-out popular-science treatment in which the political narrative is more pertinent, although obviously biased towards his own perspective. Greenberg uses humour to balance out the tone, as in his suggestion

that the reader should buy a second copy of the book just to cut out the images and do the geological reconstructions while reading the first copy.

Tides are the recurring theme of Greenberg's treatment — they "connect the orbits of Jupiter's moons to the geology of Europa, creating environments potentially suitable for life". Only one short chapter deals with the possibility of a biosphere; more detail on the known chemistry of Europa would have been welcomed. Nevertheless, his treatment of tidal dynamics is thorough.

Europa has not yet revealed a smoking gun, as have the icy plumes of Enceladus, to indicate that it is geologically active today. This has left the planetary geology community staring at the limited imagery of Europa, wondering what its surface features reveal about the interior. Centuries ago, geologists began adopting the uniformitarian mantra of 'the present being the key to the past'. In the ebb and flow of planetary science, with data streams punctuated by missions that are all too rare, we often find ourselves struggling to decipher the geological present, much less the past.

Unmasking Europa provides a comprehensive and engaging account of Europa's past and present, and sets the stage for the many questions that will be answered by future missions as we continue our search for life beyond Earth.