Aqueous Evolution of Jupiter's Galilean Satellites

Jeffrey S. Kargel, U.S. Geological Survey, 2255 N. Gemini Dr., Flagstaff, AZ 86001, U.S.A., Email: jkargel@flagmail.wr.usgs.gov

Jupiter's four major satellites form an orderly system resembling a miniature Solar System. Marked differences in their composition and geology are explained by the input of energy at different developmental stages, including heating due to (a) adiabatic compression in the Jovian nebula, (b) accretion, (c) the Jovian flux of infrared radiation of energy released by Jupiter's gravitational contraction and differentiation, (d) tidal dissipation, and (e) electrical induction. The magnitude of these sources vary inversely with orbital distance, yielding volatile-poor assemblages near Jupiter and volatile-rich assemblages far from it, but the periods in which these processes operated differ. Recent discoveries regarding Io and Europa suggest a model whereby they were substantially more volatile rich at one time. Io once may have passed through an aqueous stage similar to today's Europa-where SO2 plumes vent into outer space today, they once may have vented into an ice-covered ocean.

Aqueous chemistry and evaporative processes now dominate Europa's continuing

geochemical evolution, but Io has dried out completely. Now Io's geochemical development is dominated by interactions among high-temperature silicate magmas, elemental sulfur, and sulfur dioxide.

However, telltale chemical clues to an aqueous past and the means by which it desiccated are given by the composition of material escaping Io and feeding the Io plasma torus. These substances seem to include salts and elemental sulfur that once may have settled onto a seafloor and crusted an icy surface. Other than differentiation, Ganymede and Callisto have evolved chemically relatively little.