Cryolava Dome Formation on Europa
L. C. Quick et al. (2016b) Icarus, In Press

(a) 5 km (b) 5 km (c) 5 km (d) 25 km
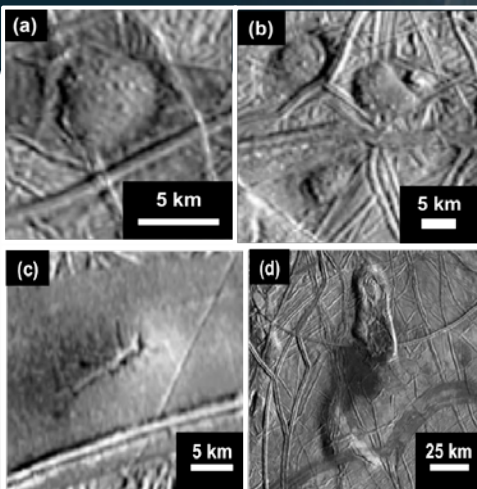
o A subset of domes on Europa's surface may have cryovolcanic origins (a-b). Unlike other domes that simply resemble "punched-up" versions of the surrounding terrain (c-d), the morphologies of these domes imply formation via the eruption and subsequent flow of icy lavas, or cryolavas, which are mixtures of water, ice, and salts. These dome-forming cryolavas may have originated in discrete fluid reservoirs in Europa's icy crust, or, at the ice shell/ocean interface

o Domes with possible cryovolcanic origins are circular to elliptical in shape and may be surrounded by dark moats (a-b). They are 3-10 km wide and 40-100 m tall, so are intermediate in size between volcanic domes on Earth and volcanic domes on Venus

o We have modeled (e-f) the formation of cryolava domes with dimensions similar to the domes in Fig. b, above, that are ~ 75-80 m tall and 5-6 km wide

o The cryolavas that may have formed these domes may have had *initial* viscosities between 10^3-10^6 Pa s. These viscosity values are consistent with flow properties similar to terrestrial basalt

o Our models have also been employed to explore volcanic dome formation on planet Venus (Quick et al., 2016a, JVGR), and cryolava dome formation on dwarf planet Ceres (Ruesch et al., 2016, Science)

(e)
- t = 2 days
- t = 27 days
- t = 3.6 months
- t = 1.5 years

Dome Height (km) vs Dome Width (km)

(f)
- t = 21 minutes
- t = 4.4 hours
- t = 17.5 hours
- t = 3.7 days

Dome Height (km) vs Dome Width (km)
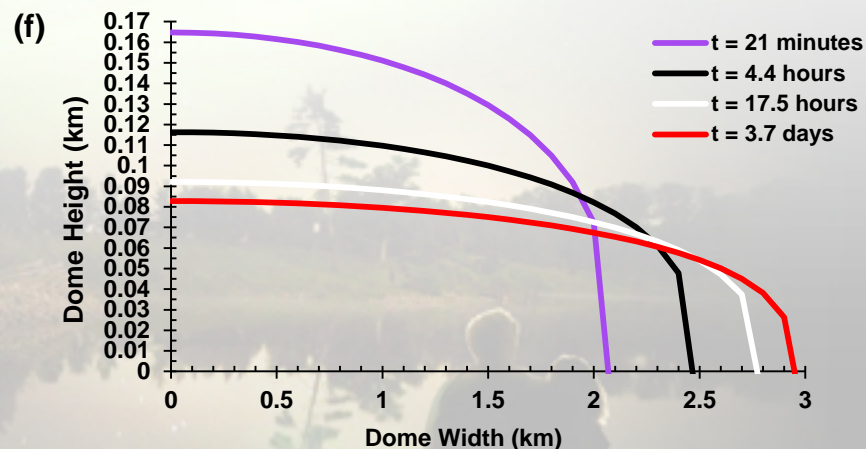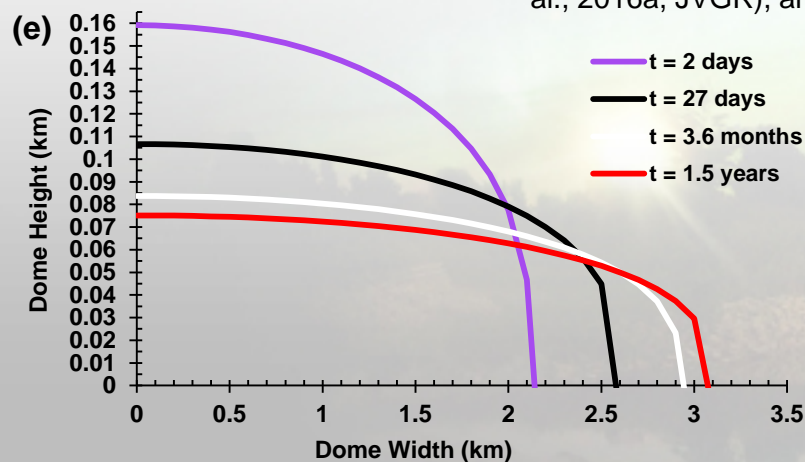
Axisymmetric Dome Profiles. (e) *High visocsity cryolava that cools slowly:* Here the bulk viscosity of the dome-forming cryolava is 10^9 Pa s. As the cryolava cools, its viscosity increases exponentially in 3.6 months' time, and it forms a domical shape after 1.5 years. **(f)** *Low viscosity cryolava that cools rapidly:* The bulk viscosity of the cryolava is 10^7 Pa s. Here cryolava viscosity increases exponentially in just over 17 hours, and it forms a domical shape in just under 4 days. These viscosity values are inclusive of a chilled crust which develops atop the cryolava flow. The presence of the crust makes the cryolava's final viscosity 3-4 orders of magnitude greater than its initial viscosity.