INSIGHTS INTO EUROPA'S SHALLOW WATER MOBILITY FROM THRACE AND THERA MACULA. B. E. Schmidt[1], D. D. Blankenship[1], G. W. Patterson[2] , P. M. Schenk[3] [1]Institute for Geophysics, U T Austin (britneys@ig.utexas.edu), [2]APL, [3]LPI.

Introduction: Recent work has shown that the formation of large liquid water melt lenses in Europa's shallow subsurface can explain diverse observations of chaos terrain morphology and potential distribution. In a relatively small region of Europa's surface, two striking chaos terrains exist that exhibit intriguing similarities and differences. Thrace and Thera Macula may well represent two snapshots of chaos formation while also providing constraints on how heterogeneity on Europa influences the final morphology of chaos terrain. Here, we compare these two features to constrain how shallow water moves and evolves on Europa.

Lens-collapse: In [1], analysis of the geomorphology of Conamara Chaos and Thera Macula, was used to infer and test a four-stage lens-collapse chaos formation model: 1) Thermal plumes of warm, pure ice ascend through the shell (e.g. Pappalardo and Barr 2004) melting the impure brittle ice above, producing a lake of briny water and surface down draw due to volume reduction. 2) Surface deflection and driving force from the plume below hydraulically seals the water in place. 3) Extension of the brittle ice lid generates fractures from below, allowing brines to enter and fluidize the ice matrix. 4) As the lens and now brash matrix refreeze, thermal expansion creates domes and raises the chaos feature above the background terrain.

Thera Macula: Thera Macula is likely forming above a melt lense that is liquid at present time [1], thus Galileo data in a sense capture chaos formation in a state of suspended animation. Here [Fig 1A] we see evidence for matrix formation to the South (SC), and to the North (NS), ice shelf rupture above a down-drawn surface. There is also evidence from swelling ridges intersecting Thera Macula for percolation of water out of the lense as the result of hydraulic gradients emplaced as the feature evolved [1, Fig 1A (a)].

Thrace Macula: Thrace Macula has been suggested to have formed as a result of extrusive cryovolcanic processes [e.g. 2,3]. However, there are morphological indications that this is not the case, particularly similarities with Thera Macula and in the light of the lens-collapse model. Not only is liquid water cryovolcanism thermodynamically improbable, Thrace Macula does not possess lobate features associated with high-viscosity flows. Rather, there is evidence for swelling and modification of preexisting structures by brine infiltration, injection and refreeze. Thrace Macula's domed appearance, mottled texture, and irregular margins support such a conclusion. Its topography (overall raised with respect to the background terrain) is an indication that the feature is older than Thera Macula.

Percolation. This inflow will be controlled by hydraulic gradients as well as the material properties of the ice. Such gradients can evolve as the surface undergoes diurnal forcing from tides, but also may migrate outward from the lense as a result of material freeze out within it, causing the water to flow into hydraulic lows. Discontinuities in material properties, such as between brittle and ductile or porous and solid ice may create pathways for such flow of water. Evidence for percolation and flow into low lying regions appears at the margins of Thrace Macula [Fig 1B (b)], where ice thickness gradients can drive water outward.

Modification. Like Thera Macula, ridges intersecting the feature are swollen but preserved; no matrial flow has entered the depressions and valleys between these ridges as might be expected from an extrusive flow [Fig 1B, inset c]. Hints of the preexisting terrain exist—preserved fractures and absence of ice blocks in this portion of the feature indicate slow modification of the ice by brine inflow and freeze out. The change in thickness between the modified and unmodified ice along these ridges is consistent with ~30% increase in volume post-infiltration, consistent with estimates [1].

Implications: Comparison of Thera and Thrace Macula shows evidence for shallow water mobility within Europa's crust and places constraints on the timescales and direction of water flow, as well as the material properties of the ice. Mobile brine has been previously suggested [4,5], but on the basis of a poor analog environment, sea ice [e.g. 4], and without a specific mechanism to create mobility. Sea ice is an a annual phenomena resulting from rapid freeze of water in high thermal gradients, creating thin platy ice and trapping impurities, and evolves according to extreme thermal and chemical heterogeneity. We will present more plausible analog processes for Europa's thick ice shell, brine infiltration in ice shelves or subglacial flow [e.g. 1 and refs. within], governed instead by material properties of the ice, surface topography, and hydraulics. Such an analog is consistent with terrain modification and observed topographic controlfor both Thrace and Thera Macula.

References: [1] Schmidt, B. E. et al. (2011) *Nature 479* 502-505. [2] L. Wilson et al., (1997) *JGR, 102, 9263.* [3] Miyamoto, H., et al. (2005) *Icarus 177 413–424* [4] Head, J.W., R. Pappalardo, (1999) JGR, 104, 27143. [5] Kortz, B.E. et al,(2000) *LPSC XXXI 2052.*

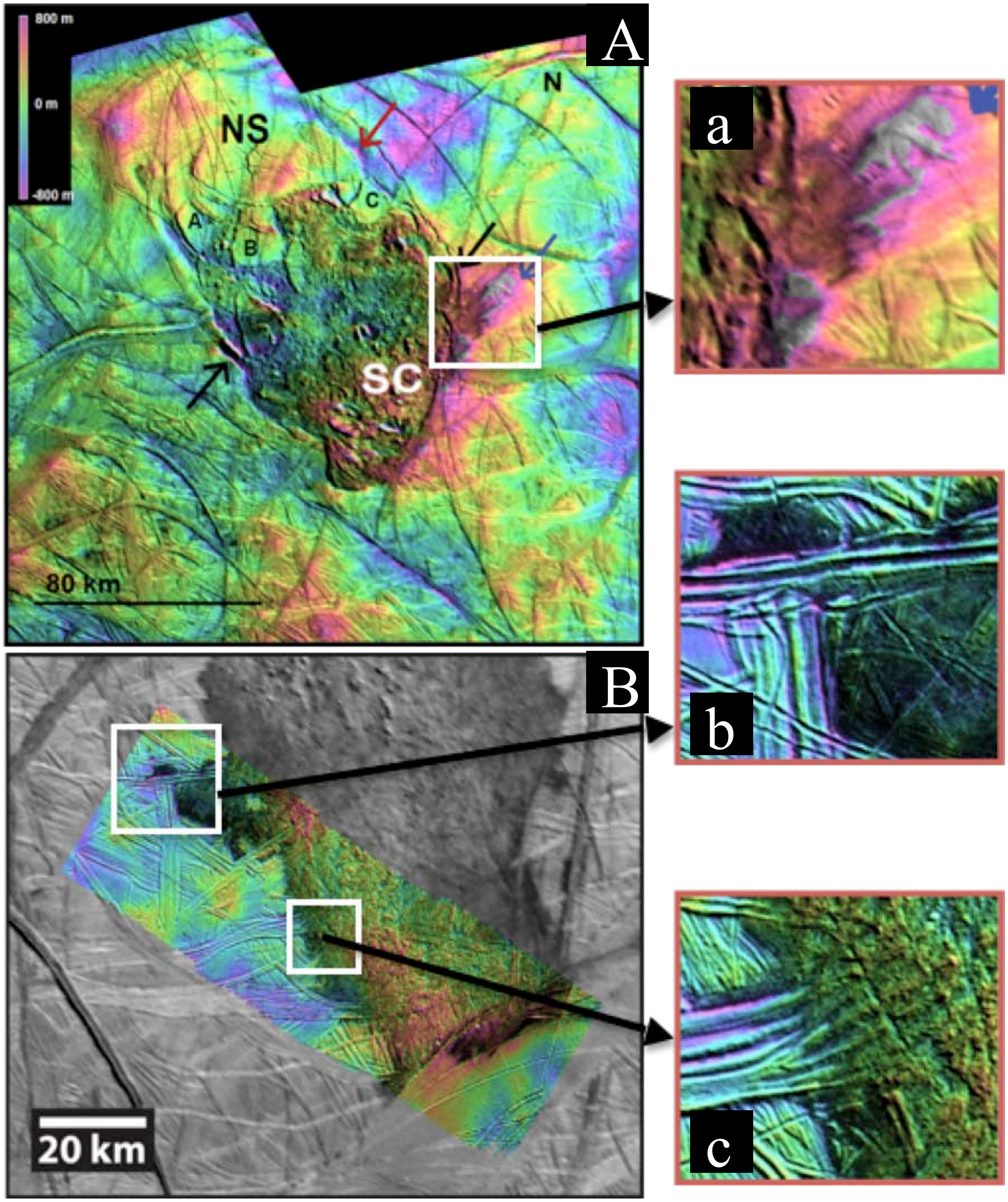

Figure 1: Thera Macula (A, reproduced Figure 2 from [1]) and Thrace Macula (B) are two features in the same region of Europa. Thrace Macula has previously been assumed to represent effusive cryovolcanic flows. However, in the context of the lens-collapse model, it is possible to reinterpret the feature instead in terms of brine infiltration and refreeze. In particular, comparing the swollen bands entering Thera Macula (a) and Thrace Macula (c) shows that the features are similar, and both can be explained by modification of preexisting structures [e.g. 5], likely by brine infiltration, freeze and thermal expansion, consistent with an absence of lobate structures. Percolation of water into hydraulic and topographic lows, controlled by topographic boudaries causes smooth embayment in (b), indicating brines may be percolating into this region.