LOKI PATERA: THE BOTTOM OF A SEA STORY? G. J. Veeder, D. L. Matson, A. G. Davies, T. V. Johnson, and J. C. Castillo, Jet Propulsion Laboratory, California Institute of Technology, ms 183-501, 4800 Oak Grove Drive, Pasadena, CA 91109-8099 (Glenn.Veeder@jpl.nasa.gov).

Introduction: Loki Patera is the largest volcanic thermal source on Io [1-10]. Previously, we have considered Loki Patera as a magma 'sea' nearly 200 km in diameter, so-called as this is larger than any previously observed lava lake, and smaller than a magma 'ocean' [10-12]. The process by which a solid crust forms on the sea, thickens, and eventually founders has been previously described [6, 10-14]. We have modeled the variation in thermal output from Loki Patera and find the 'foundering crust' resurfacing model [13, 14] reproduces the observed variation in thermal emission [12, 15].

Titanic Sinking: Here we consider the fate of pieces of crust which founder and the relevant processes which may occur near or at the bottom. The crust grows thicker with age until parts of it become negatively buoyant and sink out of sight. As they descend the former cold topsides soak up their heat deficit from the immediate surroundings. This includes the process of 'bulking-up' [11, 12]. The rate of descent and the time scale for recovery to liquidus temperature constrain the manner in which material is recirculated back up to the surface. Next we discuss three possible pathways.

Three scenarios. 1) In the simplest case, Loki is actually decoupled from the deposition of the tidal energy within the rest of Io (*i.e*., Loki currently has no significant heat input). Either Loki is drawing down its original hot endowment or else it is coasting after being cut off at some time. The parts of the crust which do founder sink on a one-way trip and more or less intact pieces pile up on the bottom. This implies that Loki's magma sea is only a very big isolated puddle which is cooling monotonically and will completely solidify relatively rapidly on a geologic timescale.

2) In perhaps the most plausible case, Loki is heated by contact with a larger source region below it (*i.e*., Loki's magma sea is maintained by heat flowing through it all the way from the bottom up to the surface). Therefore, heat flow is directly linked with convection of descending solid blocks and rising liquid. The crust founders, sinks to the bottom, melts and recirculates up to the surface. This can be a relatively steady-state condition which might continue indefinitely. Over the long haul, all heat input at the bottom is balanced with all heat radiated from the top surface. The further implication is that the large Loki Patera could be a very old construct in spite of its young crust.

3) In another interesting case, Loki is heated directly from tidal energy deposited within itself (*i.e.*, Loki's magma sea is 'self-maintained'). This heating may result from uniform tidal dissipation throughout the entire volume of the magma sea; or else preferentially in or on the surfaces of the sinking slabs themselves which morph into viscous plumes. The crust founders in a similar fashion as in the previous cases; but thermal erosion melts blocks on their way down and they never make it all the way to the bottom. This implies that Loki has more active circulation near its upper surface, but little significant circulation at depth. Moreover, the 'bottom' of Loki is not well defined and remains irrelevant to first order.

Sea Story so far: The abyss of Loki is either the source of the energy sustaining its sea or else the final resting place of descending slabs. Currently, the depth of the magma sea is unknown.

Acknowledgements: This work was carried out at the Jet Propulsion Laboratory, California Institute of Technology, under contract to NASA. AGD, DLM and GJV are supported by grants from the PG&G program.

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