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Amount of Erosional Exhumation on Titan Inferred from Drainage Network Morphology

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River networks on Titan, Earth, and Mars provide the only known examples of non-volcanic fluvial activity in our solar system. The drainage networks on Titan are apparently the result of a methane cycle similar to Earth's water cycle. The scarcity of impact craters and uneven distribution of fluvial dissection on Titan suggest that the surface of the satellite may be relatively young. Cryovolcanism, tectonic deformation, deposition of organic aerosols and erosional exhumation all provide plausible mechanisms for resurfacing, but determining which process has been dominant is a key question for deciphering Titan's geologic history. River networks are one of the most visible indicators of the extent of methane-driven modification of Titan's surface. We present a method to use river network morphology to identify networks that have produced little exhumation due to erosional dissection of an initial surface. We validate this method by applying it to a numerical landscape evolution model, and test the method by applying it to river networks on Earth with different exhumation histories. Analysis of drainage networks on Kaua'i provides an additional test case for which we can reconstruct the initial surface, and therefore the amount of erosion. We mapped fluvial networks in all Synthetic Aperture Radar swaths obtained by Cassini prior to summer 2010. Application of our method to the largest and most completely-imaged drainage networks indicates that Titan's fluvial networks have produced only minor erosional modification of the surface. This implies either a recent resurfacing event or long-term fluvial incision rates that are slow relative to the rate of resurfacing.