Internal usability and surface observability of lunar lava tubes

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Abstract. Lunar lava tubes are potentially ideal sites for exploration and habitation[1], shielded from surface hazards and providing unique scientific opportunities. Current observations indicate that such tubes exist[2345] but cannot reveal their internal characteristics. Modeling elastic deformation around a lunar lava tube constrains its internal stability and how surface topography and cracking can be used to characterize tube geometry. Modeled tubes show extensive internal roof and floor failure, leaving only small regions of uninterrupted easily usable floor near the tube edges (Fig. 1). Including curving floors instead of flat ones decreases tensile floor stress. Decreasing the tube height-to-width ratio increases tensile floor stress and promotes failure. The tubes also produce patterns of tensile cracking on the surface; the distances from the tubes to these cracks depend linearly on tube width. These cracks could be used to determine tube dimensions from the surface. The south end of Rima Mairan shows linear cracks connecting depressions that may be evidence of a partially collapsed tube approximately 200 m wide. Other locations show possible linear cracking around sinuous rilles, but never as clearly as near Rima Mairan. The failure that caused Rima Mairan's two depressions may have also led to wider and more visible surface cracks. Cracks in other locations may have been covered or eroded by regolith accumulation processes, or may be too small to see with existing satellite imagery.

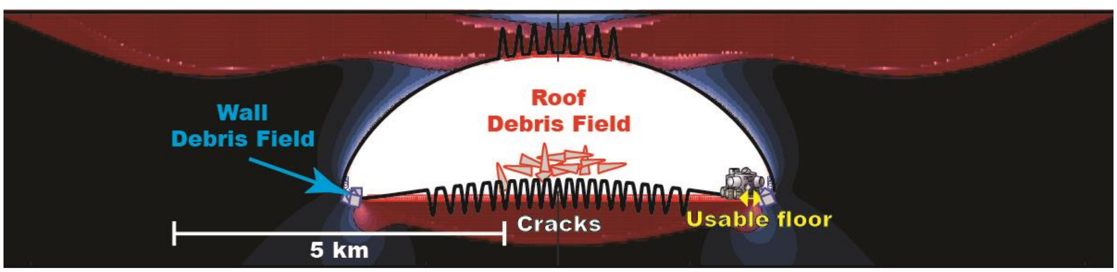

Figure 1: Stress field (red shading denotes tension) around a modeled lunar lava tube, and resulting failure. Floor tensile cracks, roof debris from tensile failure (red), and wall debris from compressive failure (blue) result in relatively little usable floor (yellow).

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