GEODETIC EXPLORATION OF TECTONICALLY ACTIVE AREAS ON THE MOON T. Marshall Eubanks[1], W. Paul Blase[1], C. J. Ahrens[2], [1]Space Initiatives Inc , Newport, Virginia 24128 USA, [2]Goddard Space Flght Center; tme@space-initiatives.com;

Introduction: The lunar surface is often assumed to be entirely static, except for tidal deformations and meteorite impacts; a recent study using Lunar Laser Ranging (LLR) constrains the relative motion of the Apollo 11 and 14 retroreflector arrays to be no more than 4 mm/yr over a 14-year period [1]. However, the seismometers left on the Moon by the Apollo astronauts as part of the Apollo Lunar Surface Experiments Package (ALSEP) arrays revealed relatively strong surface or near-surface lunar moonquakes [2], which must be associated with ground motions. Twenty-eight such events were detected in eight years of observation; the largest were energetic enough to present potential risks to astronauts in the vicinity of the seismic zone [3].

Active Thrust Faults on the Moon: Recent work has shown connections between surface moonquakes and geologically young thrust faults on the Moon, with 7 of the 28 ALSEP surface events being within 60 km of an apparently young lobate scarp [4]. These compressional faults seem to be mostly driven by stresses from the gradual isotropic compression (shrinkage) of the Moon [5]. The geologically youngest faults are also associated with fresh boulder fields, with large numbers of 1 to 10 meter boulders on top of or beside the fault ridges [6]. The rapid destruction of such boulder fields by meteorite impacts implies that this tectonic activity is likely still ongoing [7, 8].

In Situ Instrumentation of Tectonically Active Areas: Deployment of local geophysical networks directly in a tectonically active area would provide an entirely new view of lunar tectonics and lunar dynamics. These areas are a few km to a few tens of km in extent and could be instrumented in a single deployment with an array of ballistic penetrators [9].

Our analysis of the Gruithuisen Domes area indicates that there may be a tectonically active area there in a feature we call the “Gamma Pit,” about 10 km south of the base of the Gamma Dome (see Figure 1). We have analyzed the instrumentation of this pit in detail as a possible location for deployment of geodetic instrumentation, with a longitudinal distribution of fiducial points from the head of the Mare rille over to the highland peninsular scarp.

A array of Lunar Laser Ranging (LLR) Retroreflectors and COMPASS Very Long Baseline Interferometry (VLBI) radio beacons [10, 11], together with a 802.15.4-based local radio network providing point to point ranges [12], could be used to determine relative and global motions of the geodetic fiducial points at the centimeter level, and thus track any local co-seismic creep even in the absence of a large moonquake during the mission. The same deployment could install a seismological array to determine the sub-surface distribution of small moonquakes and creep events [13, 14]. Once the technology is fully developed these geodetic networks could be rapidly deployed areas displaying current activities, e.g., after the detection of moonquakes. Such missions would also be able to better constrain the seismic risk to astronauts of these active faults.

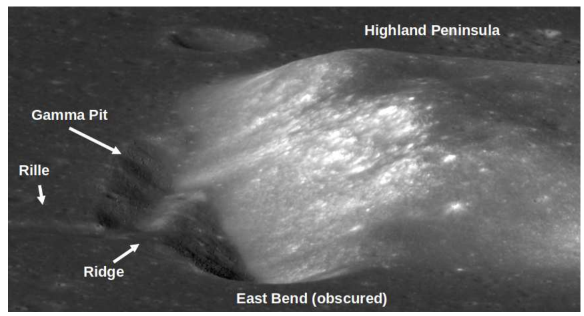

Figure 1: An oblique view facing West from LROC NAC image M1106087898LR showing the “Gamma Pit” located at the junction of Mare Imbrium and the Highland peninsula adjacent to Mons Gruithuisen Gamma [15]. The Mare side of the Pit slope has numerous boulders, indicating that the Pit may be tectonically active.

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