A Study of the Southern Lunar Highlands:

The Identification and Measurement of a Peak 27 km South of Kinau P,

66 km West of the Terminator at Colongitude 335.9°

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ABSTRACT

The identification and analysis of a lunar mountain peak 66 ±3 km West of the terminator was performed from images obtained on 11 November 2010 from 2313 to 2321 UTC and a Colongitude of 335.9°. Through the use of various software tools available to the amateur astronomer, the height of the identified peak located at approximately 17.2° E and 62.7° S was calculated. The minimum value for the height of the peak is 2470 (+750, -100) meters above the floor of crater Kinau A.

1. INTRODUCTION

During the initial analysis of images of the Moon obtained on the evening of 11 November 2010, a series of images (88 frames) of the southern region were examined. These images were obtained between 23:13:33 UTC and 23:20:44 UTC with the mean time of 23:16:54 UTC. Using AVIStack 2.0 (Ref. 1), a stacked image was obtained. (Figure 1).

Figure 1. AVIStack Image of Lunar Southern Region 11 Nov 2010 2317 UTC.

The Lake of the Woods Observatory (MPC I24) is located in Locust Grove, VA, USA. The equipment used in this observation was an Astronomy Technologies AT8RC Ritchey-Chretien of 0.2-m aperture f/8 with a measured focal length of 1610mm. An ATIK 314e TEC CCD imager was used, this camera provides a FOV of 13.8' x 10.3' of arc (1391 x 1039 pixels). The plate scale was 0.6 arcsec / pixel. The seeing was fair at 6/10 and the transparency was very good at 5/6. Future imaging with this configuration will add a 2" 2x Barlow lens to increase the effective FL to approx. 3200mm and increase the plate scale to a value of 0.3 arcsec / pixel.

2. Analysis

As can be seen in Figure 1, there are several peaks lit west of the terminator, this paper will concentrate on the peak west of Mutus, a 190 km crater at 30° E, and 64° S. This image was resized and processed to bring out more details and loaded into the application Lunar Terminator Visualization Tool (LTVT) (Ref. 3). This excellent program allows you to use your images to texture map a spherical model of the Moon which positions the model (and the

image) to the correct orientation (Sub-Solar and Sub-Observer points) to allow the correct geometry to be calculated at any given date and time. Once the image is calibrated to the model, the program provides precise measurements of lunar longitude and latitude, and also solar altitude and azimuth at the local coordinates. The program also allows you to rotate the spherical model to where the point of interest (POI) is normal zenith point simulating an aerial photograph from directly above the POI. Figure 2 depicts the view from the Earth (Sub-Observer) and Figure 3 depicts the aerial photo view. This view is rendered as if one was directly above the feature looking straight down.

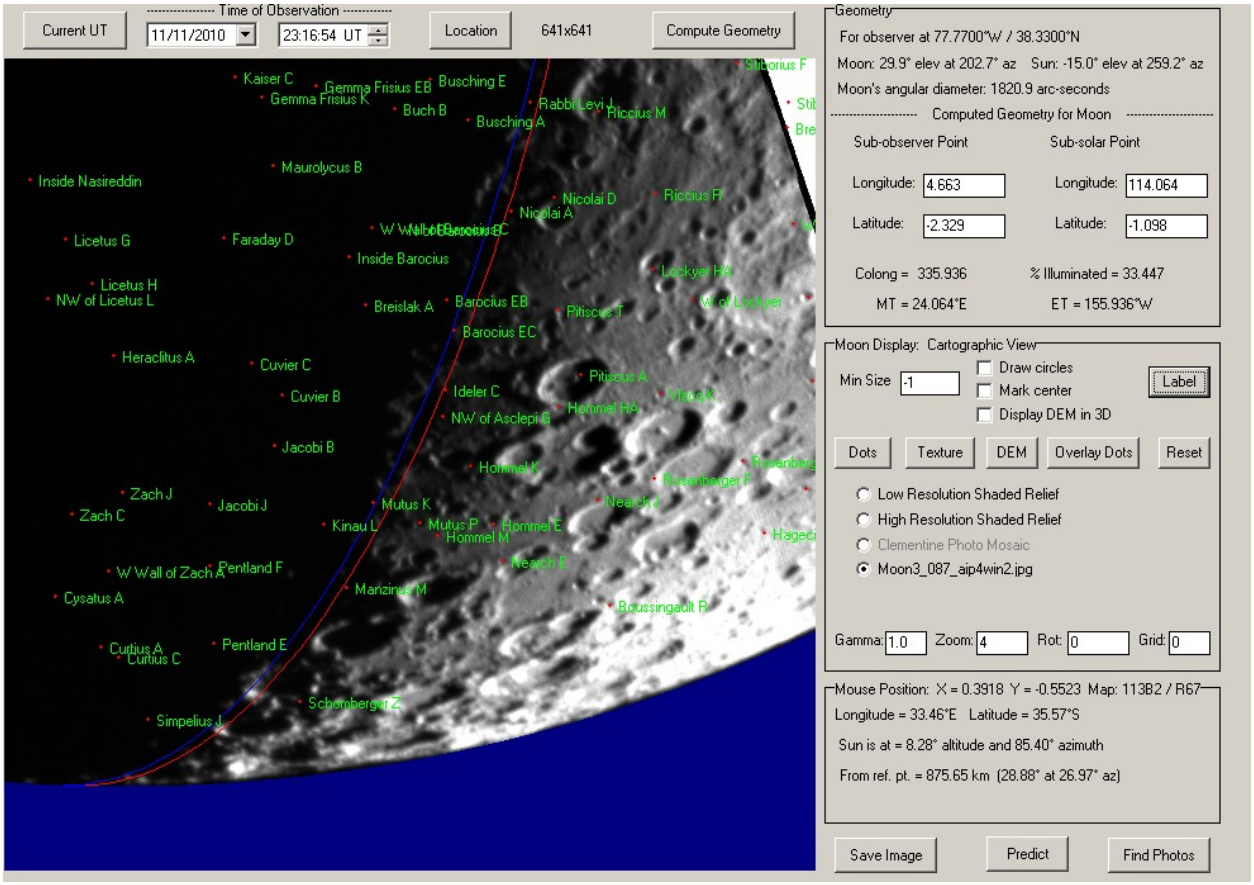

Figure 2.The Lunar Terminator Visualization Tool (LTVT) view of the image.

The screen depicted in Figure 3 was used to determine the location of the peak marked with the cyan + symbol to the west of Mutus. The terminator (±0.25°) is marked with the Red and Blue lines on the image.

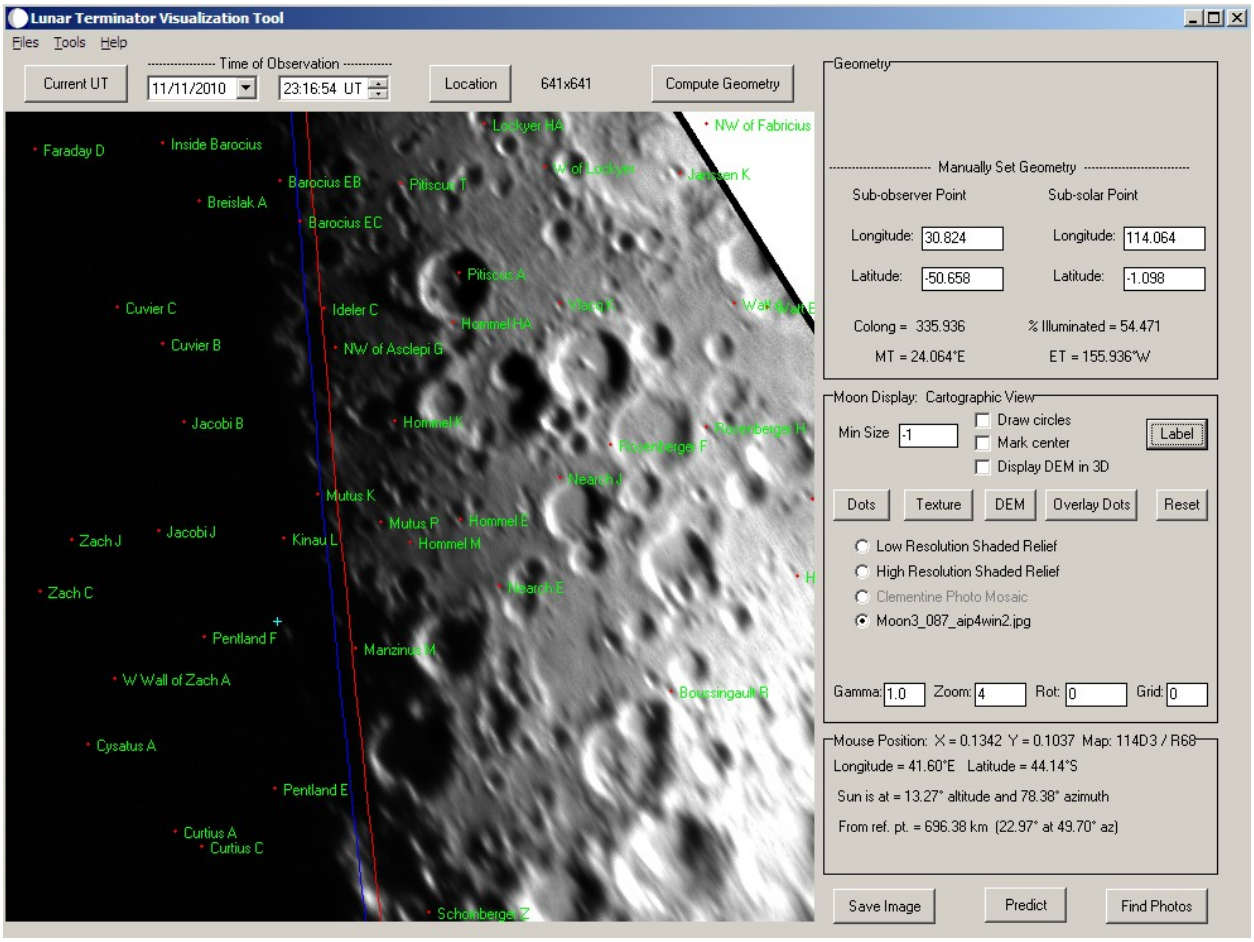

Figure 3. LTVT Aerial View of Lunar Image. Peak is marked with a cyan + symbol at lower left.

Once the coordinates of the face of the identified peak was measured, 17.2° E, and 62.7° S in this case, a close look at the list of LAC Charts (Ref. 4) determined that LAC-127 Hommel was the correct one. As shown in Figure 4, a close look at the chart shows a large mountain with a crater on top (un-identified on the chart) with the face of the mountain located at 17.0° E, and 62.0° S. On the chart this mountain was measured to be approximately 68 km west of the terminator at Colongitude 335.9° using LTVT. It is noteworthy that the LAC-127 Hommel chart depicts the mountain as a little further north and slightly west of the measured position. The Terminator is depicted on the chart in Figure 4 (Red and Blue lines, ±0.25°) and the Mean

Terminator was calculated as 360.0° - 335.9° = 24.1° E Longitude.

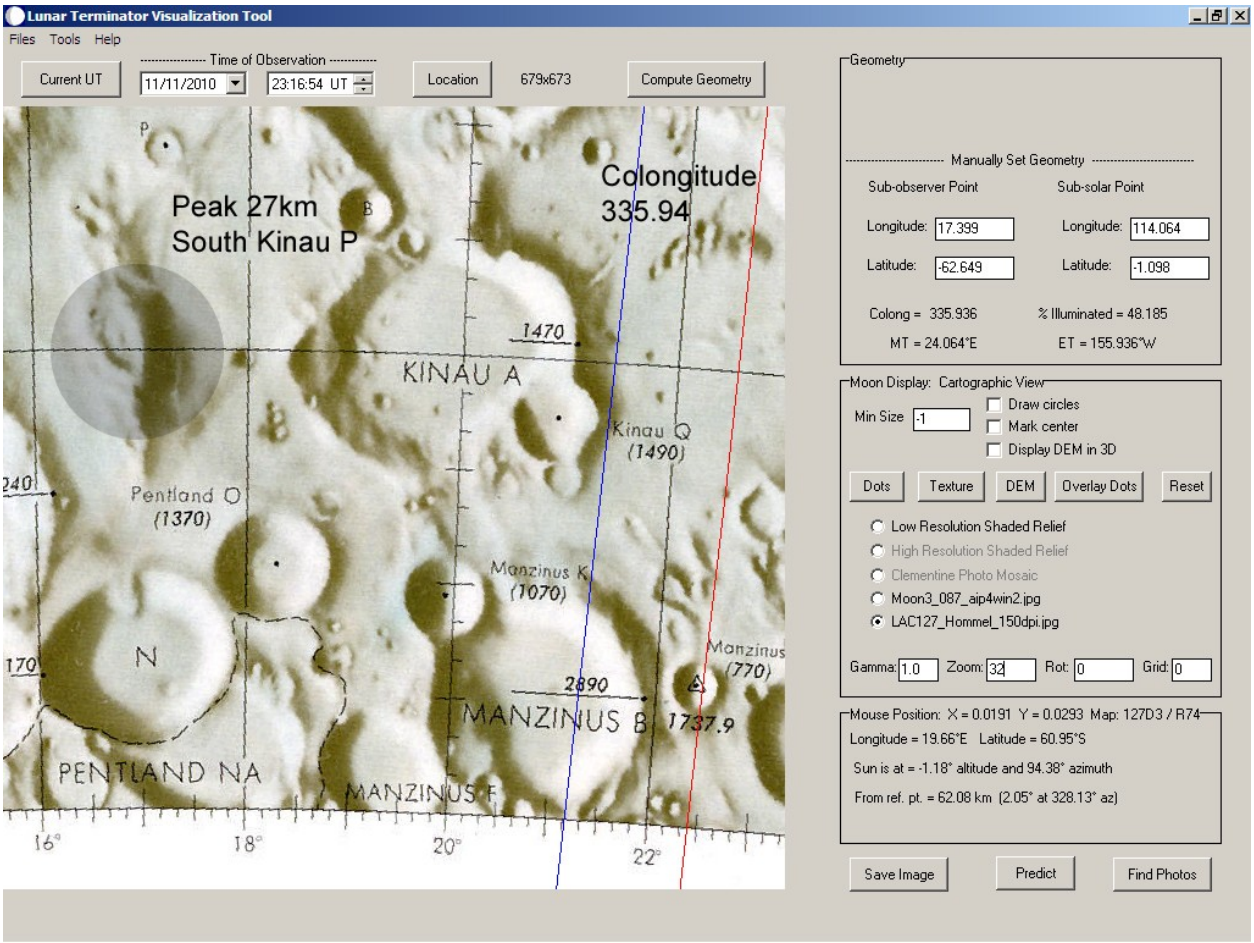

Figure 4.Mountain Peak identified on LAC-127 Hommel, 27 km south of Kinau P, and 68 km west of the Terminator.

Unfortunately the LAC chart does not depict the height of the peak, located approximately 27 km South of Kinau P as show in Figure 4. The LTVT program allows one to select a measurement mode to select a reference point at the end of the shadow, and then it projects a line to the Sub-Solar point in order to select a measurement point at the point of the lit up peak to determine the height of the peak. This would not work in this case since the peaks shadow was immersed in the depths of darkness with the rest of the local terrain west of the peak. A new method of measuring the height of peaks west of the Terminator would need to be developed. The method used is based on the fact that for a sphere, the Sun's shadow height is tangent to the sphere at the Colongitude. So any peak that shows west of the Terminator would be at least as high as the shadow line tangent to the sphere (Figure 5). This is because the most accurate point to measure the shadow distance is where the sunlight first hits the mountain at the lowest possible elevation. The additional height of the mountain in sunlight could be 500 m to 750 m. Additionally, the crater Kinau A is directly east of the peak in question. The rim of this crater on the eastern side is depicted as being 1470 m above the mean diameter of the Moon. The Terminator falls right on the eastern rim (as you can see if you look closely at Figure 3), so that would add another 1470 m to the value measured in LTVT, which will be determined shortly. So the method to measure the peak is to mark the reference at the Terminator and then measure the height difference at the tip of the peak. The result of these 2 measurements, the minimum height of the peak, and the distance from the Terminator is shown in Figure 6.

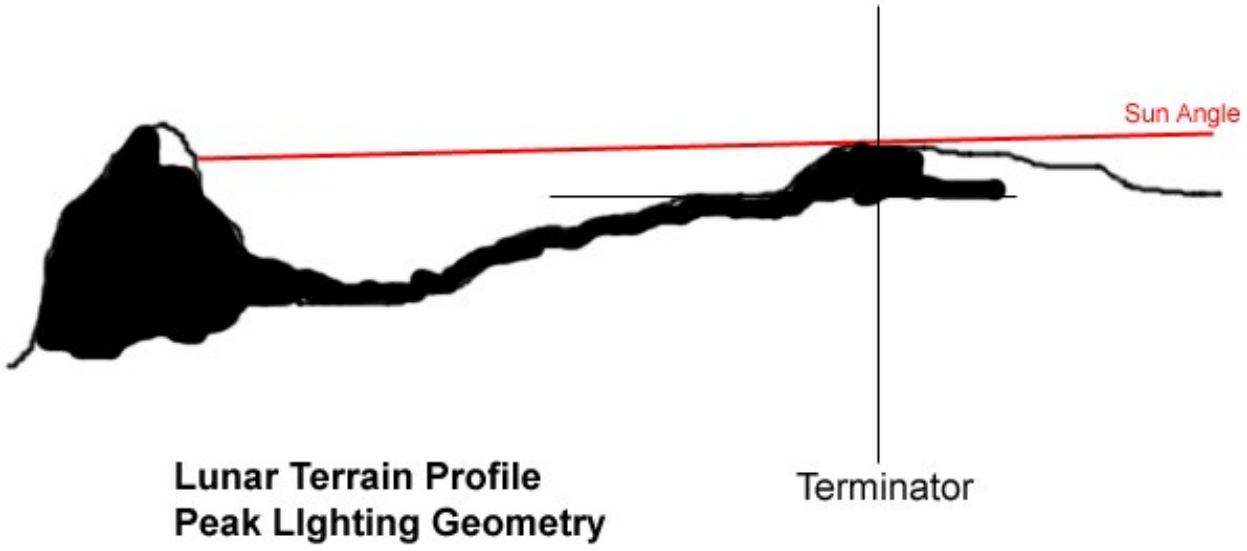

Figure 5. Geometry of Lunar Terrain Profile.

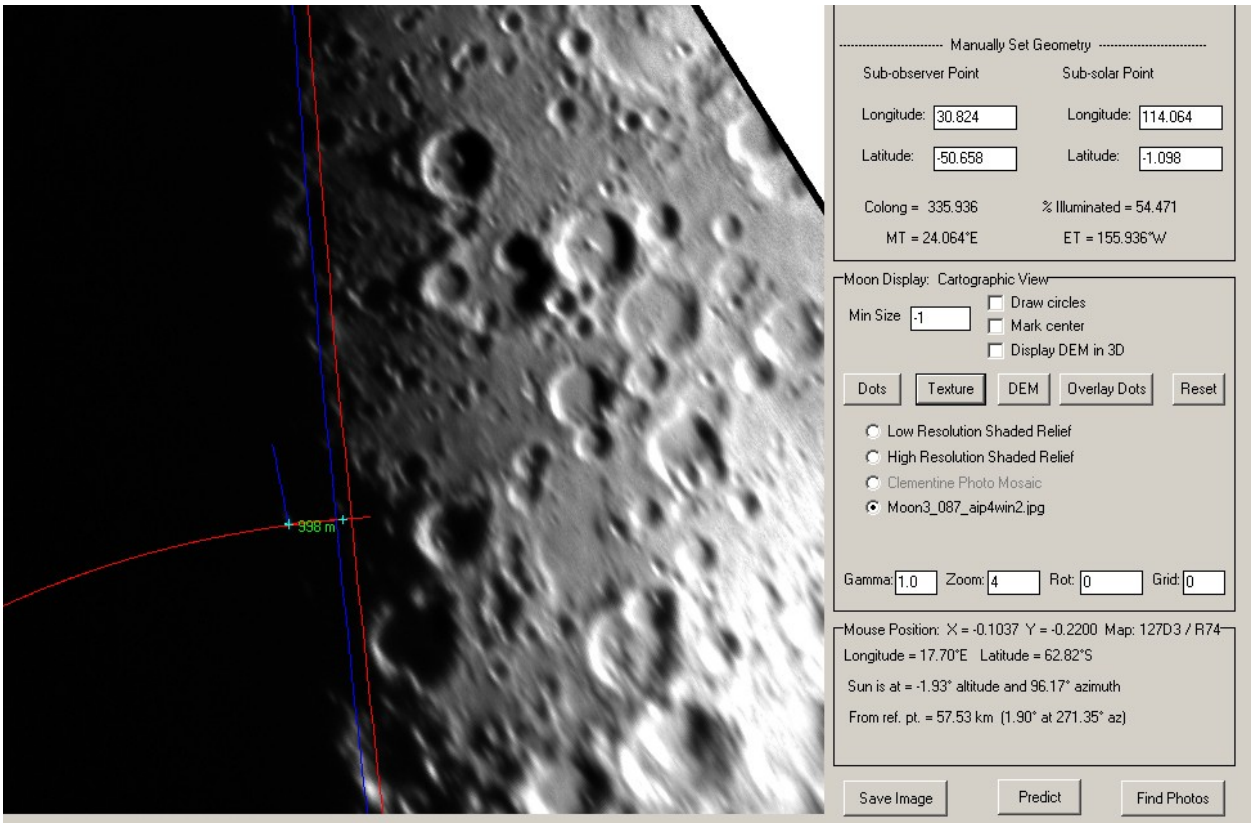

Figure 6. The LTVT Measured Distance from the Terminator and height of the peak.

Using the Digital Elevation Model (DEM) in LTVT (LRO/LOLA Lunar Reconnaissance Orbiter Data) a measurement of the height between the floor of Kinau A and the measured location of the peak resulted in an elevation of 3100 m (Kinau A floor 1735.8 km, Mountain Peak 1738.9 km), this is very much in accordance with the measured value of 2468 m +750 m / -100 m (Figure 7). The location of the peak was also measured to be at 17.2° E, and 62.7° S. on the DEM.

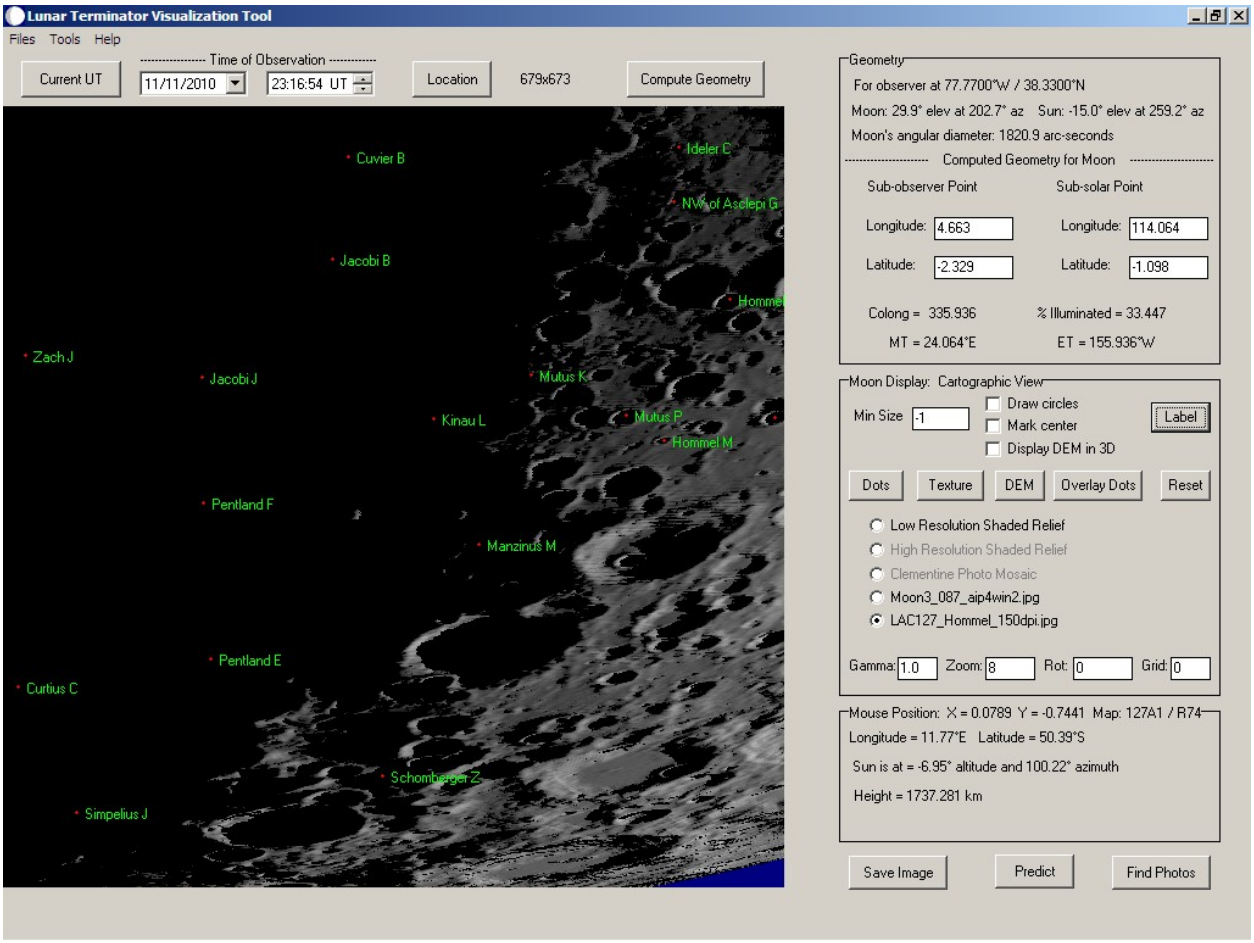

Figure 7.The DEM (LRO/LOLA) depiction of the Mountain Peak at the time of observation (center of image).

3. Conclusion

The results of the analysis has shown that the height of the identified peak at measured location 17.2° E, and 62.7 ° S to be at a minimum 2468 meters +750 m / -100 m above the floor of Kinau A. This was verified using the DEM in LTVT. The uncertainty in the height measurement is greatest to the + side due to the method utilized and could be as much as 750 m. The minimum height could be lower by up to 100 meters (-100 m) depending on how one places ones cursor and also on the resolution of the images obtained. Additionally, the distance from the Terminator at Colongitude 335.9° is shown to be approximately 63 km. The distance from the terminator has an uncertainty of approximately 3.0 km, based on the resolution of the image plus any effect the foreshortening has on the measurement. Finally, to properly measure

this peak, one should take images during the first appearance of the peak to determine the proper Colongitude of the Terminator and to properly account for the distance to the peak from the Terminator. Only in that way will you get the true peak height value.

Using LTVT allows one to measure the Selenographic data on images, but the further South one goes, the more uncertain one is as to the location of certain features depicted on Earth-based images of the Lunar surface. In the case presented in this paper, it is feasible to measure features as far south as 62° S Latitude on the lunar surface and identify features on the dark side of the Moon.

4. References

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