Comparison of the depth of lunar crater calculated from the shadow length of the crater depending on altitude of the sun at different time.

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The present study aimed to examine and compare the depth of the lunar crater calculated from the length of the shadow on the lunar crater which changes depend on the altitude of the sun at different time of the night. A telescope (Orion 10") and a cell phone (Asus: A600CG) were used to take images of two craters; Goclenius (depth 1.5 km) and Macrobius (depth 3.9 km), every hour from 21:46 – 04:46 on the night of 10th of November 2014 (ICT).The pixel lengths of the shadow on the crater were measured by ImageJ program. The pixel lengths were then converted to kilometers by using the rule-of-three in arithmetic. The shadow was compared to the width of the control crater in the same image, in which the actual width is already known. Due to the fact that the apparent shadow length we observed could be shorter than the real shadow due to the observation angle to the normal of the crater, we have to multiply the length that we originally converted to km by $\frac{1}{\cos(\text{latitude})\times\cos(\text{longitude})}$ (latitude and longitude are coordinates of the lunar crater).The altitude of the sun on the crater (α) was then calculated by using the following equation: **cos(CS) = cos(PC)cos(PS)+sin(PC)sin(PS)cos(CPS)**

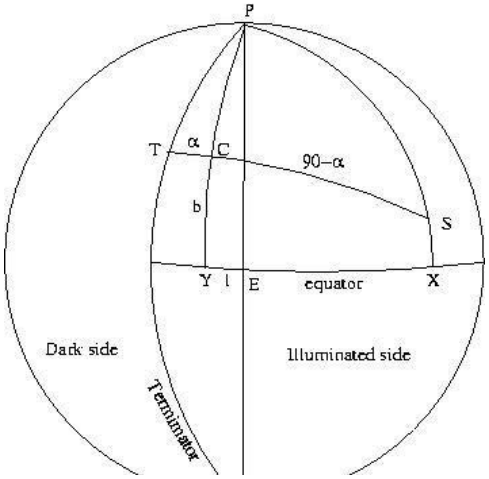
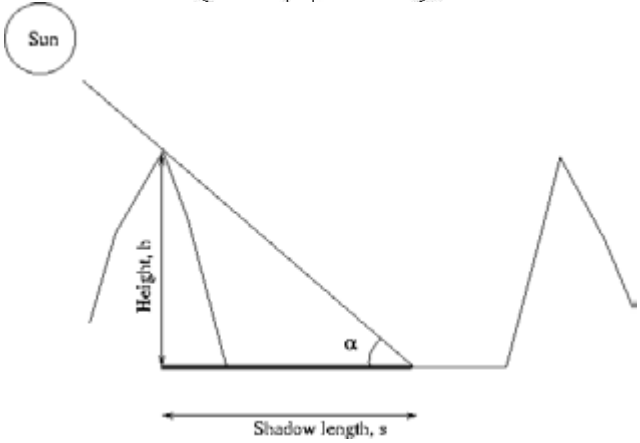


Figure 1. The diagram illustrates the part of the moon used to calculate the altitude of the sun on the crater. C is the crater, E is the sub-earth point, P is the lunar pole, S is the sub-solar point and T is the terminator which divides the illuminated part from the dark part on the moon.



The relationship $\tan\alpha = \frac{\text{Height}}{\text{Shadow length}}$ was used to calculate the depth of the lunar crater.

Figure 2. The diagram shows the altitude of the sun on the crater's relationship with the shadow length and the depth of the lunar crater.

Results revealed that the calculation of the depth of the Goclenius crater (depth, 1.5 km) at 03:46am, with the altitude of the sun of 1.93˚, has the highest error at 18.13% and the errors of calculation weren't directly variation with the time so the errors are caused by the measurement of the shadow's length using pixel units by utilization ImageJ program. While The calculation of the Macrobius crater (depth, 3.9 km) at 04:46am, with the altitude of the sun of 0.85˚, has the highest error at 74.74% and the errors were increasing directly variation with the time since 01.46 am till 04.46 am. Where the altitude of the moon were between 65°-72° during the observation at 01.46-04.46 am so the errors weren't caused by variation of atmosphere which make the images be twist but the cause of high error is, in comparing to the Goclenius crater, the Macrobius crater was positioned closer to the terminator and therefore had a very small altitude of the sun. When the time passed, the altitude of the sun became smaller. Since the altitude of the sun was very small, the length of the shadow casted by the crater's rim was elongated and might surpass the width of the crater. However, we could only observe the shadow length within the width of the crater which appears to be shorter from reality, thus the depth of the crater calculated by the apparent shadow's length also be shallower.

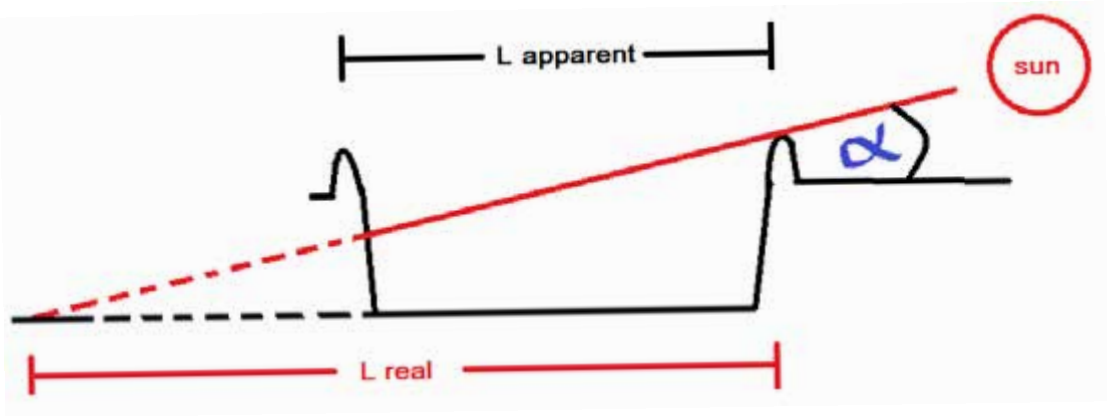


Figure 3. The diagram shows the model of the altitude of the sun, the apparent shadow length and the real shadow length on Macrobius crater.

Reference

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