EVALUATION OF SPATIAL DISTRIBUTION OF CRATERS ON LUNAR SURFACE FOR DETECTION OF SECONDARY CRATERS. T. Kinoshita[1], C. Honda[1]. N. Hirata[1]. T. Morota[2]. H. Demura[1]. N. Asada[1]. [1]Department of Computer Science and Engineering, University of Aizu, Ikki-machi, Aizu-Wakamatsu City, Fukushima 965-8580, Japan. (email: s1160065@u-aizu.ac.jp). [2]Graduate School of Environmental Studies, Nagoya University Nagoya 464-8601, Japan.

Introduction: Estimates of the relative and absolute ages of geological units with crater counts are based on assumption that the cratering process is well described with a mathematical model of Poisson process. This means that each impact occurs purely randomly, anytime and anywhere, independently of previous impacts [1].

The secondary craters are small craters surrounding large primary craters, and they have irregular shapes and occurrence in chains and clusters, sometimes with distinctive herringbone patterns [2]. The secondary craters give a biased spatial distribution of craters. Researchers extract craters excluding a surface that contains secondary craters from lunar and planetary images based on his or her subjective views. As a result, recognized secondary crater's region might have been different each other. An algorithm which detects the secondary craters quantitatively is needed. The algorithm which detects non-random spatial distribution of craters from spatial distribution of craters has been researched [1] [3].

The purpose of this research is to develop an algorithm for evaluating spatial distribution of craters on lunar images. The algorithm applies to ideal spatial distribution of craters and real spatial distribution of detected craters, and evaluates whether a non-random portion in real-area by comparing a clustering parameter.

Method: The first step is to generate a suite of random populations of craters that possess the same number density as real data. We considered the possibility of crater's overlap and erasure by newly formed crater. Each crater was kept without overlapping. The size of simulated craters is determined randomly by following the Neukum production function [4]. So, the crater size-frequency distribution by our simulation reflects the isochron curves. Minimum size of craters of our simulation corresponds to the minimum size of craters derived from real data. We tried this Monte Carlo simulation 1000 times.

The second step is to apply the single-linkage (SLINK) hierarchical clustering algorithm [5] to each simulation data and real data, calculating a clustering parameter (k) during each step of the clustering process [3].

The algorithm compares the k values of the real data with those of the simulations of random spatial distribution of craters. If the k value of real data is under mean-3σ of simulations, we decided non-randomness spatial distribution of craters.

Result: We demonstrated for two regions on Mare Crisium. We evaluated craters more than 400 m diameter that detected from KAGUYA/TC. As a result of visual inspection, one region contains a lot of clustered secondary craters, and another region contains little clustered secondary craters.

Figure 1 shows a result of clustering analysis applied to a region that contains a lot of secondary craters. In the range of 38 to 313 of clustering level, craters that belong to these clustering levels are considered to be clustered secondary craters. The candidate secondary craters in the upper left of the image are evaluated to be clustered craters by our algorithm (Figure 2).

Figure 3 shows a result of clustering analysis applied to a region that contains little secondary craters. At almost clustering level, there is real data within the range of Mean ± 3σ. So, this means almost random spatial distribution of craters on the region. The almost craters of more than 400 m diameter on the region are evaluated the primary craters by our algorithm (Figure 4).

Summary: The clustered secondary craters could be evaluated non-random spatial distribution of craters quantitatively by our clustering analysis. We should remove quantitatively the region that contains secondary craters for crater chronology.

References:

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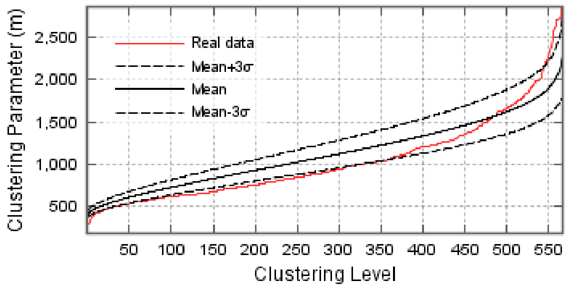

Figure 1: Clustering analysis applied to a region that contains a lot of secondary craters. Mean and σ of 1000 simulations are plotted. Clustering Parameter is distance of between clusters. Clustering Level is the number of steps during SLINK.

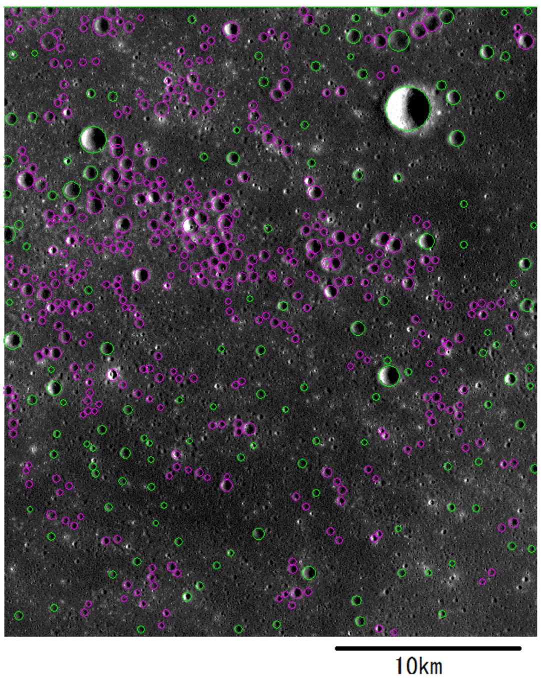

Figure 2: Visualized image of clustering analysis containing a lot of secondary craters. The area of image is a part of Mare Crisium (TC_MOR_02_N18E057N15 E060SC, spatial resolution: 10 m $pixel^{-1}$). Magenta circles are spatially non-random with clustering parameter k < mean - 3σ, green circles are spatially random with mean - 3σ < k < mean + 3σ.

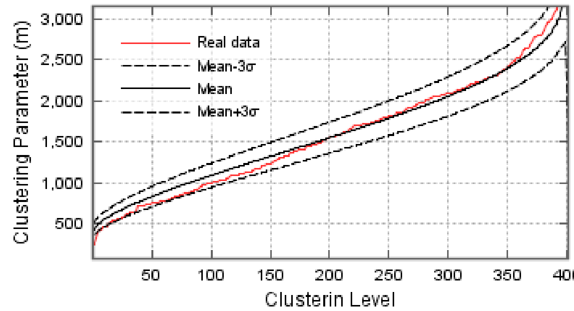

Figure 3: Clustering analysis applied to a region that contains little secondary craters. Mean and σ of 1000 simulations are plotted. Clustering Parameter is distance of between clusters. Clustering Level is the number of steps during SLINK.

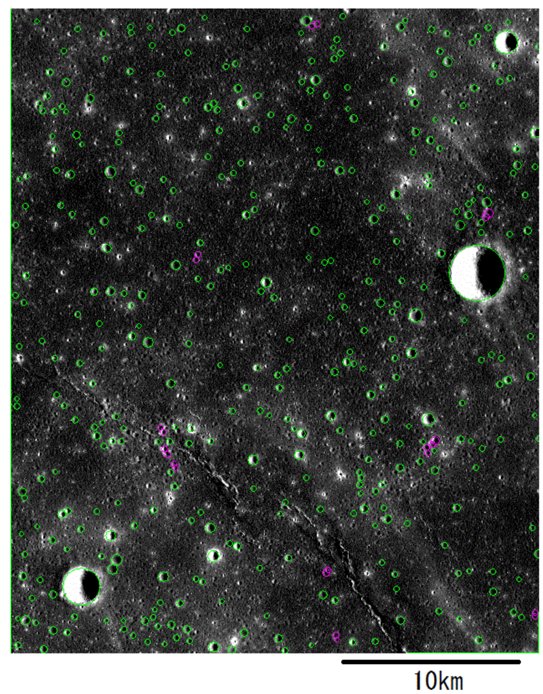

Figure 4: Visualized image of clustering analysis containing little secondary craters. The area of image is a part of Mare Crisium (TC_MOR_02_N18E060N15E063SC, 10 m $pixel^{-1}$). Magenta circles are spatially non-random with clustering parameter k < mean - 3σ, green circles are spatially random with mean - 3σ < k < mean + 3σ.