THE FRACTAL DIMENSION OF RIMA SHARP. Bo Li[1], Zongcheng Ling[1], Weijie Xu[1], Zhongchen Wu[1], Jiang Zhang[1],Jian Chen[1]. 1 Shandong Provincial Key Laboratory of Optical Astronomy and Solar-Terrestrial Environment; Institute of Space Sciences, Shandong University, Weihai 264209, China, (libralibo@sdu.edu.cn)

Introduction

The quantitative analysis of rivers and drainage networks in Earth and other planets has a long history. Particularly, after its fractal conception by Benoit Mandelbrot [1], many authors applied a fractal analysis to river network [2]. Rilles are obvious features on lunar surfaces which characterized by channels of varying depths and widths with parallel-striking, laterally continuous walls. The reasonable interpretations for the formation of SRs include formation by lava flow and erosion, either in subsurface lava tubes that subsequently collapsed or in surface lava channels [3-4]. However, there are not fractal studies concerning individual lunar rille channels, as most studies were focused on drainage patterns in Earth or Mars. In this paper, we studied the fractal dimension of lunar rille using the successive shift divider (SSD)method [5].

Method

The fractal dimension (FD) can be estimated by the ruler/divider technique where the perimeter of the rille channel is measured at many different length scales. A power-law fit to perimeter vs. length scale has an exponent of 1-DR, where DR is the ruler fractal dimension [6].

However, the result obtained using the ruler/divider technique is a single uniform fractal dimension for the rille channel observed. If a channel that traverses through different geological units with various heterogeneous rock types and topographic surfaces is arbitrarily divided into several segments, the fractal dimensions of the channel geometry should vary from region to region, namely in scale-dependent variations and location-dependent variations. In SSD method, a rille channel is discretized into m-1 segments (m nodes). At each of the two sides of a node denoted as Si, we pick up n nodes orderly, the 2n+1 nodes are belonged to the calculation segment of Si−n~Si+n. The fractal dimension of this segment is calculated by the ruler/divider method and marked as

the fractal dimension of node Qi (denoted as Di.). Then shift to the next node named Si+1, the fractal dimension of Qi+1, comes from the calculation segment of Si−n+1~Si+n+1 denoted as Di+1. The fractal dimensions Di (i=n, …, m-n) obtained by this method are discrete, so-called fractal dimension series of the rille channel.

Result and discussion

The longest observed SR, Rima Sharp, has an average length of 566 km and is located at 36.71°N and 313.61°E in northeastern Oceanus Procellarum near the western extent of exposed highland terrain associated with the rim of Imbrium. The channel of this long SR is observed to cut predominantly into five basalt units whose ages are from 1.33Ga to 1.67Ga (Fig. 1a and b). We use the SSD method with n=25 to calculate the FD of every point in the Rima Sharp and the result is shown in Fig.1c. We can see the FD is from 0.98 to 1.21 and various in different basaltic units. We also set the n=50 and 100 to derived FD using the same SSD method, the results are shown in Fig.2. We can see that: (1) with the incensement of node number, the changes and fluctuations of horizontal line are smaller; (2) the FD in derived from n=100 nodes are biggest than n=25, n=200 nodes; (3) the biggest FD are all located in basaltic unit I and II where highlands meet the maria; (4) in the basaltic unit II, there are both higher FD and lower FD values.

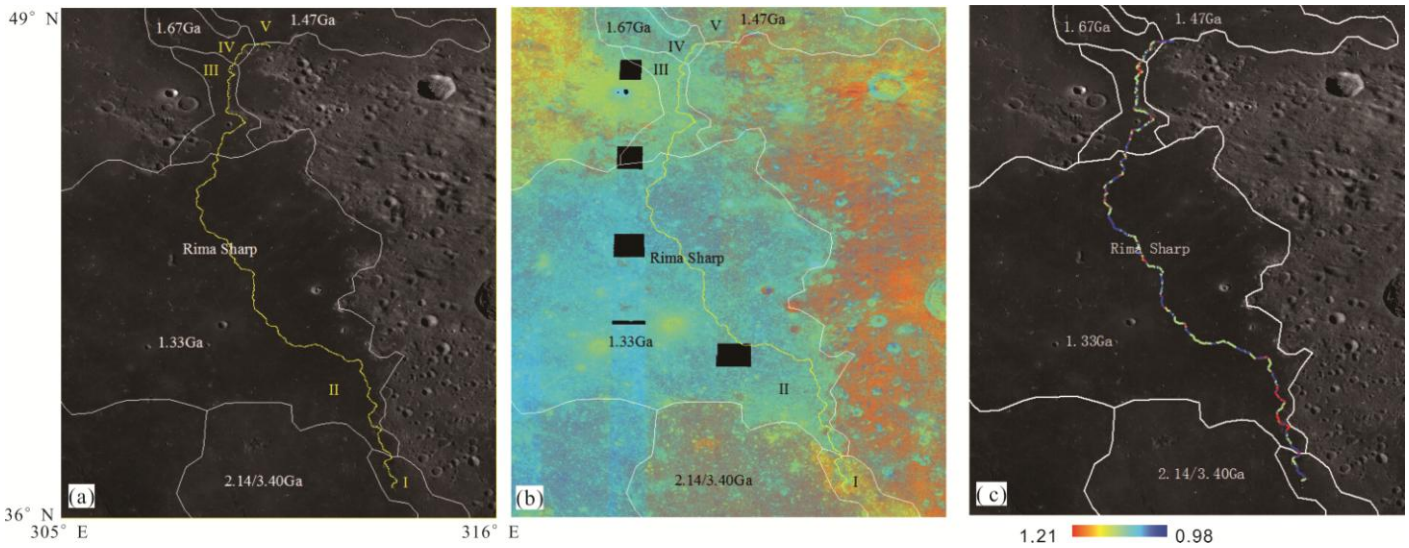

Fig.1 The basalts units and Rima Sharp are shown in the WAC mosaic image (a), and with Clementine UVVIS color map (b).

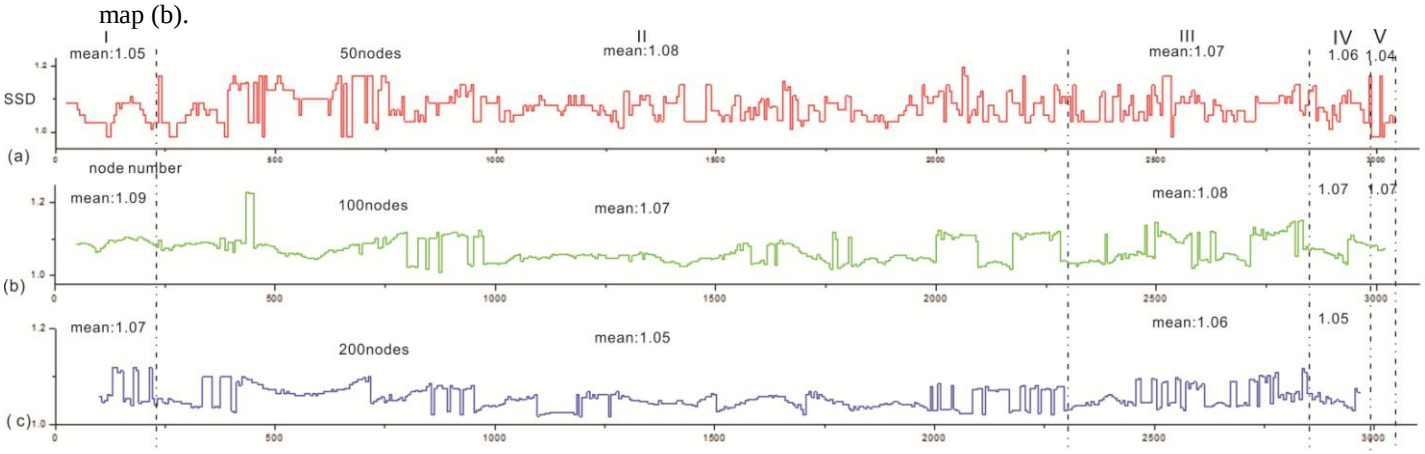

Fig2 The horizontal step lines of Rima sharp with three segments. (a) *n*=25, (b) *n*=50 and (c) *n*=100. I, II, III, IV and V are the five basaltic units the rilles incised into.

Acknowledgements: This work was supported by the National Natural Science Foundation of China (41373068, U1231103), the national science and technology infrastructure work projects (2015FY210500), the Natural Science Foundation of Shandong Province (ZR2015DQ001, JQ201511), Young Scholars Program of Shandong University, Weihai (2015WHWLJH14) and the Fundamental Research Funds for the Central Universities (2015ZQXM014).

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