GLOBAL IDENTIFICATION AND SPATIAL DISTRIBUTION OF LUNAR FAULTS. T. Lu, S. Chen, K. Zhu, and M. Sun, College of Geo-exploration Science and Technology, Jilin University, Changchun 130026, China (lutq2014@126.com, chensb@jlu.edu.cn).

Introduction: Geological structures described as faults are found on the Moon. Faults caused by endogenetic forces on the Moon are important geologic features because they provide records critical for understanding the temporal and spatial changes in stress states. They also provide information on formation mechanisms, which in turn have implication for lunar internal evolution.

Further inferences about the source of global stress depend on detailed tectonic mapping. Several global maps have been made of tectonic structures on the Moon based on Lunar Reconnaissance Orbiter data: lobate scarps [1], wrinkle ridges [2], and grabens [3]. These structures formed in the last ~3.5 Ga of the Moon, and can only constrain the stress states of the late Moon. Lunar faults usually formed in the early history of the Moon [4], and can be used to constrain on the sources of stress of the early Moon. However, there has never been an elaborate mapping on the global distribution of large-scale faults (hereinafter referred to as faults) of the whole Moon until now.

Global mapping: The global Bouguer gravity gradient data [5] of the Moon was used in this study. Lunar fault expressions can be distinguished based on their elongated linear anomalies characterized by negative gradients stand out clearly above the background variability. The identify results are classified into probable (black line) and possible (grey line) faults according to the obvious degree of linear anomalies in the map.

Spatial distribution and orientations: The global survey of faults in this study from the gravity gradients resulted in the identification of 50 probable faults with a combined length of 9381 km and 176 possible faults with a combined length of 27756 km for a total length of 37137 km (Figure 1).

The faults of NW-SE and NE-SW are the obvious preferred orientations on a global scale, and then the N-S, the last is the E-W. The preferred orientation of faults at different latitudes in the northern hemisphere has obvious interesting characteristics. The preferred orientations of different latitudes are different, which are N-S of the low latitudes (Figure 2a), NW-SE and NE-SW of the middle latitudes (Figure 2b) and E-W of the high latitudes (Figure 2c), respectively. Compared with the northern hemisphere, the preferred orientations of faults at different latitudes in the southern hemisphere of the Moon has similar characteristics, namely, NW-SE and NE-SW of the middle latitudes (Figure 2e) and E-W of the high latitudes (Figure 2f). However, the difference is that the preferred orientation of the low latitudes in the southern hemisphere of the Moon is the same as the middle latitudes, which is the NW-SE and NE-SW (Figure 2d).

Probable formation mechanism: The formation time of lunar faults was determined earlier than ~3.85 Ga by crosscutting relationship with the impact crater. The Moon was mainly subjected to two global stresses in the first billion years, thermal expansion and tidal stresses.

Global expansion will result in isotropic horizontal stresses [1], which will form the structure without preferred orientations, and this can explain part of the reasons for fault formation in Figure 6. However, obviously, this does not account for the identified result with the preferred orientations shown in Figure 6. Hence, it cannot simply be that the theory of global thermal expansion can explain the origin of all lunar faults, and the cause of the preferred orientation of the faults should been attributed to other stresses.

Tidal stress may have been a source of global stress in the early history of the Moon [1]. At least two effects resulted from tidal stress to the early Moon, tidal despinning and orbital recession. Both despinning and orbital recession cause the shape of the Moon changes, which has led to stresses in their (presumably) solid outer crusts, and thus, to global systems of faults if the stresses were sufficiently large. Although stresses must have locally deviated from the global pattern, and accompanied by the heterogeneities in the strength of the lithosphere on the Moon, a fracture network compatible with the global stress pattern might still statistically exist [6], which is consistent with the result that the faults have preferred orientations at different latitudes in this study.

It is unreasonable to advocate that lunar faults are caused by any sole source of global stresses. Purely global expansion stress or tidal stress are difficult to explain the formation mechanism of lunar faults, which is best explained by the combined action of two stresses.

Outlook: The next step is to further process the gravity data (Euler deconvolution) to judge the properties of the faults. This can better constraints the source of stress that caused the faults.

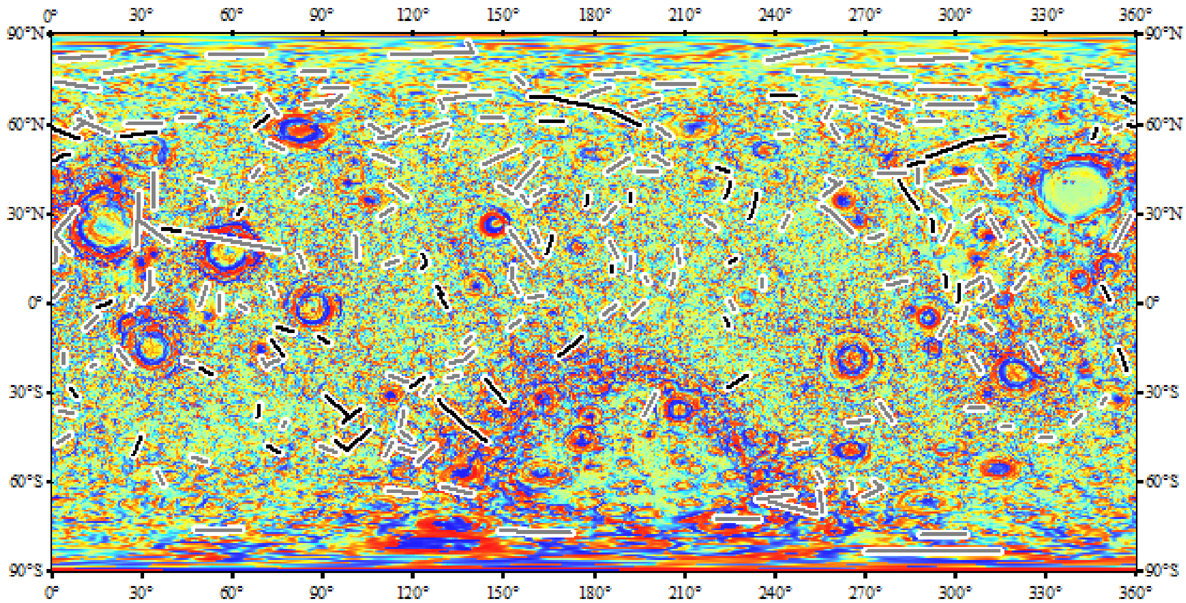

Figure 1. Global distribution of the identified lunar faults. Base map: Horizontal Bouguer gradient.

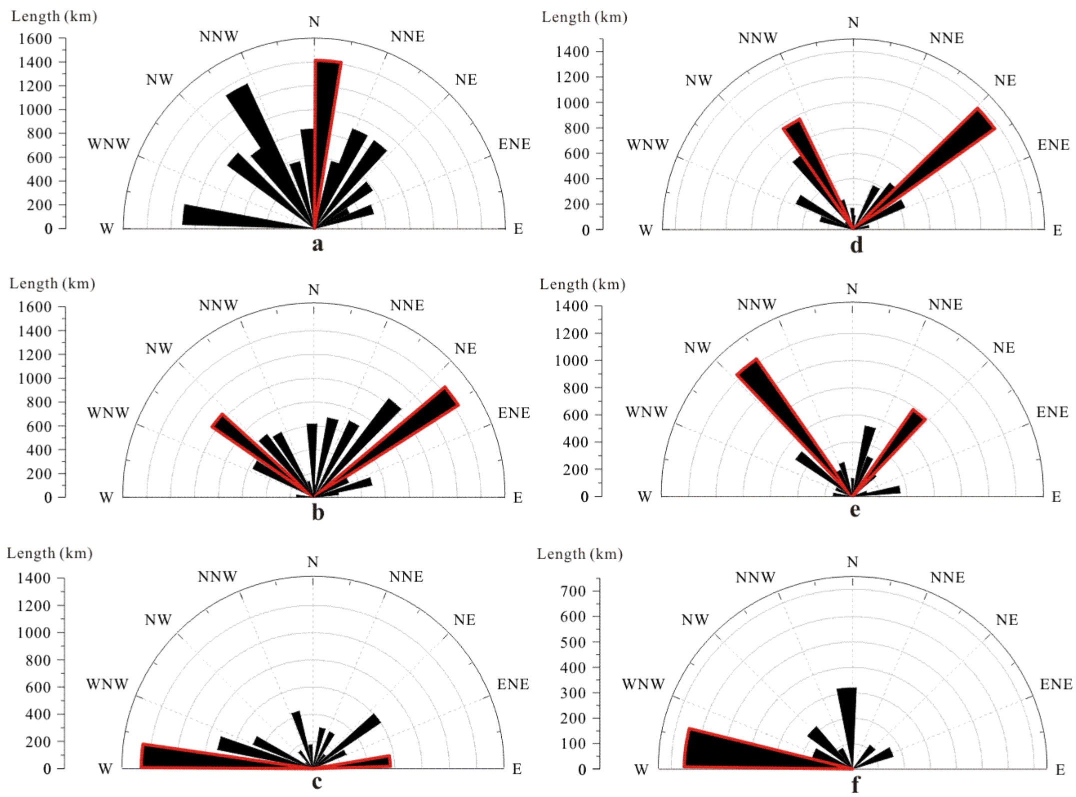

Figure 2. Rose diagrams of faults at different latitudes. (a) Low latitudes of the northern hemisphere; (b) Middle latitudes of the northern hemisphere; (c) High latitudes of the northern hemisphere; (d) Low latitudes of the southern hemisphere; (e) Middle latitudes of the southern hemisphere; (f) High latitudes of the southern hemisphere. The red frame refers to the preferred orientations.

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