SOLUTION AND PRELIMINARY EXPLANATIONS FOR GRAVITY FIELD OF THE MOON.

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Summary: Lunar gravity is a significant potential field that can directly represent constitution and structure of interior of the Moon. I transplanted GEODYN II software from workstation system into microcomputer. And then LG-53 at degree and order 53, a spherical harmonic coefficient model was built with the transplanted GEODYN II, using orbital tracking data of SELENE. After corrections of the topographic model STM359_grid02_180, the Bouguer gravity anomaly of the Moon was established. To obtain reasonable and reliable geological explanations for the gravity field, other results, we suggested, must be considered as complementary and necessary constraints. In the method of repeat forward modeling and correction, the thickness of the uplifted Moho subsurface in Mare Serenitatis, Mare Crisium and Mare Imbrium was calculated to 23.3 kilometers, 24.5 kilometers and 16 kilometers, respectively.

Introduction: Lunar gravity is a significant potential field that can comprehensively represent how densities distribute in the interior of the moon. Meanwhile, it can provide reliable constraints for lunar constitution and structure. How to build gravity anomalies fields of the Moon from satellite gravimetry and to explain geological structure of the Moon with lunar gravity field and other constraints are crucial to study origin and evolution of the Moon. We must know the key steps presented in **Methods** below.

Methods:

a) Principals of dynamics of satellite orbits[1] to calculate the gravity model of the Moon, and key parameters that determine its accuracy and solution (Fig.1).

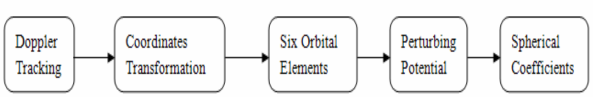

Fig.1 *Flow chart of process to solve gravity coefficient model using orbital tracking data*

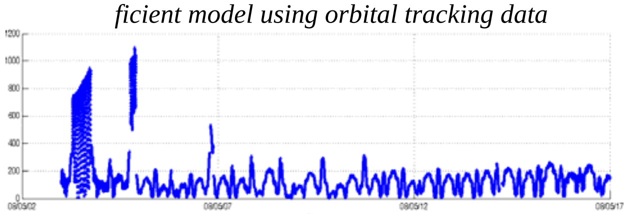

Fig.2 *Comparison between simulated tracking data produced by the transplanted software and observations by SELENE in a 14-day arc*

b) Transplantation of GEODYN II software on workstation system into microcomputer (Fig.2).

c) With the transplanted GEODYN II and orbital tracking data from SELENE(Provided by JAXA) in 60 seconds of interval of sampling at 100 kilometers altitude, LG-53 at degree and order 53 (Fig. 3) was built.

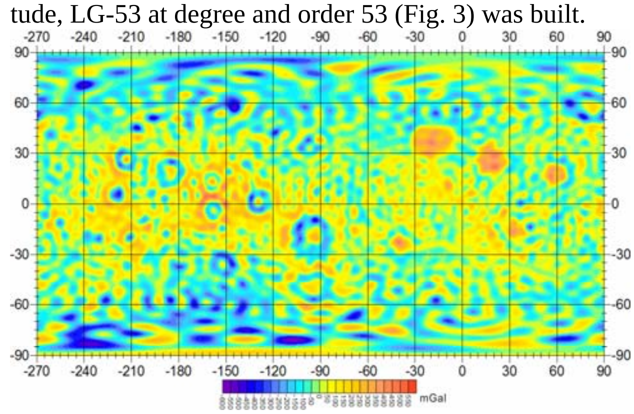

Fig.3 *A map of free air gravity anomalies of the moon in global at degree and order 53 computed at a radius of 1738.0 km*

d) In the gravity reduction, the difference of Bouguer correction based on a satellite and on ground should be taken into consideration. The tesseroid method[2] was chosen to calculate the Bouguer anomaly field of the Moon.

e) According to other constraints, like distributions of some materials on lunar surface, evolution history of the moon and etc., three basic models were built, and then the thickness of the elevated Moho subsurface in the three basins were calculated.

Results:

a) The transplanted version of GEODYN II indicated that in the same cost of hardware, it cannot only provide the reliable and consistent results, but reduce by 5 to 10 times in time consuming than that by workstation system.

b) Free air gravity anomalies of the Moon calculated with LG-53 spherical coefficient model (Fig.3).

c) Comparisons of free air gravity anomalies of the farside of the Moon and Crater Apollo calculated by LG-53 with those by LP165P, SGM100h models (Fig.4, Fig.5)

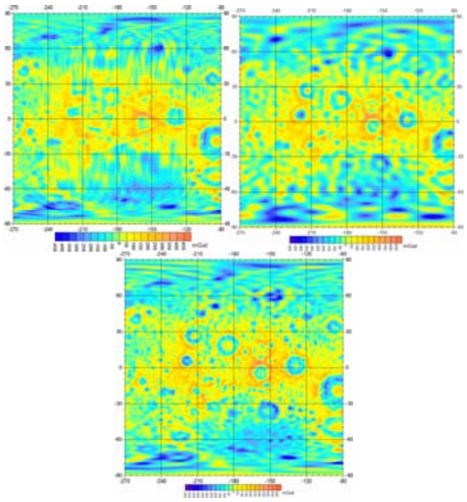

Fig.4 *Comparison of free air gravity anomalies of the farside of the moon calculated by LP165P (top left), LG-53 (top right), and SGM100h (lower)*

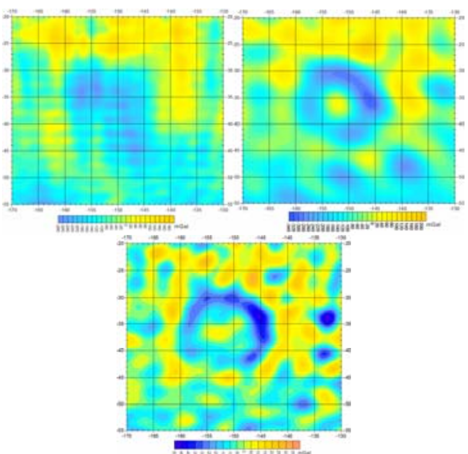

Fig.5 *Comparison of free air gravity anomalies at Crater Apollo calculated at a radius of 1738 km with SGM90d (top left), LG-53 (top right), SGM100h-53*rd *(lower)*

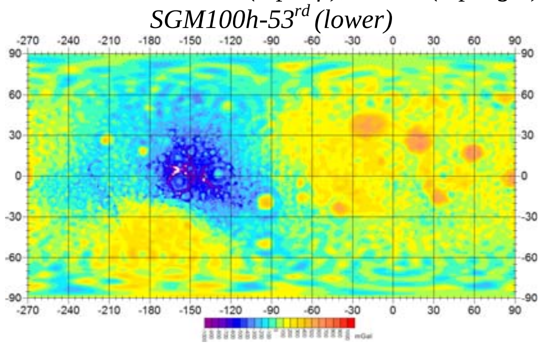

Fig. 6 *Bouguer anomalies of the Moon reduced with potential field model LG-53 and topographic model STM359_grid02_180*

d) A map of Bouguer anomalies field of the Moon (Fig.6).

e) With the forward modeling and correction for several times and some information produced by other constraints[4], the thickness of the uplifted Moho subsurface in Mare Serenitatis, Mare Crisium and Mare Imbrium was calculated to 23.3 kilometers, 24.5 kilometers and 16 kilometers, respectively. (Fig.7)

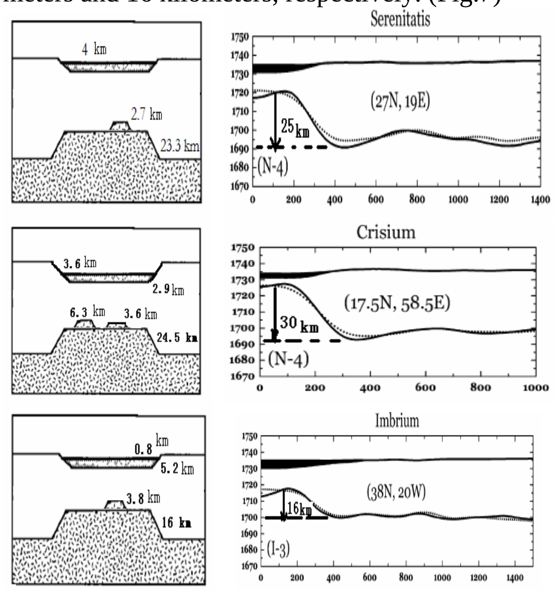

Fig.7 *Thickness of Moho uplifted beneath the three basins (left column) and Thickness of Moho uplifted from Hajime and Wieczorek[5]*

Conclusions:

a) I transplanted the GEOGYN II with high efficiency with reducing by 5 to 10 times in time consuming.

b) LG-53 model was built with the transplanted software and orbital tracking data from SELENE. And free-air gravity anomaly field of the Moon calculated with LG-53 was consistent with the field models by LP165P and SGM100h. Bouguer gravity anomaly field model was built afterwards.

c) The height of the Moho subsurface uplifted beneath the three basins based on a basic model and other constraints were consistent with the results from Hajime and Wieczorek[5].

References: [1] Hofmann-wellenhof Bernhard, Moritz H. (2005) *Physical Geodesy*. [2] Heck B., Seitz K., (2007) *Journal of Geodesy*. [3] Konopliv A S, Asmar S W, Carranza E, Sjogren W L, Yuan D N. (2001) *Icarus*. [4] Wieczorek M A, Jolliff B L, Khan A, etc. (2006) *Review in Mineralogy and Geochemistry*. [5] Hajime H., Mark A. W., (2007) *Icarus*.