Optical Maturity On Different Crater Using Chandrayaan-1 M3 Data

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Abstract: Optical Maturity (OMAT) is term used in moon surface for understanding the space weathering effect on the soil of craters. Space weathering is the term used to determine which portion of the lunar soil is affected by the exposure of space weathering which causes the change in their optical properties. OMAT is also used for understanding the age of the craters. In this paper we discuss four craters is used to determine the effect of OMAT on the age of craters. It is found that if the value of OMAT is high means it is immature(Fresh Crater) and If OMAT value is low means the crater is mature craters.In this work it is found that Tycho having high average OMAT value which means this is fresh carters among all other craters.

Index Terms: Absolute Age, Chandrayaan-1, Craters, OMAT, Moon Mineralogical Mapper, Space weathering, Origin optimization, Refelctance,

1. INTRODUCTION

Moon is the key element of planetary research because the moon environment is not dynamic therefore all the information related to earth-moon evaluation is preserved in moon. Space weathering is important phenomenon specially where there is no magnetic field exists[1]. Space weathering changes the optical property of soil present in regolith and it also causes changes in the maturity indexes[12]. Optical Maturity is a unitless value it acts as a degree which is modified by exposure to weathering effect in lunar soil. Optical Maturit[8,9] parameter is a tool to measure the surface exposure of lunar soil, based on the reflectance spectra. Mathematically optical maturity is defined as the Euclidian distance from hypothetically matured origin to the area of interest in terms of reflectance [13] . OMAT parameter is important for determining the absolute age of the carters. lower OMAT values shows greater maturity. Lower OMAT value means the crater is old and higher OMAT value shows the frash crater in that way maturity is helpful for age determination[4].

2 METHODOLOGY

In this paper, OMAT Index of craters derived by using the [8,9] (1)

$$OMAT=[(R750-X_0)^2+((R950/R750)-Y_0)^2)^{1/2}] \quad (1)$$

Where
R750 reflectance at 750 nm of a pixel, R950 reflectance at 950 nm of a pixel, X_0 shows the origin at R750 and Y_0 at R950/R750
Origin Optimization and OMAT Calculation Methodology workflow shown in Fig. 2.1[8].

X_0 and Y_0 Depends on the specific sensor type and spectral Library which is used in calculation of reflectances(Lucey et al., 2000) Because here, we used M3 data so again calculate X_0 and Y_0 for this we use M3 data of Apollo 17 landing site M3G20090107T011405_V03_L1B.LBL from Lunar ODE .

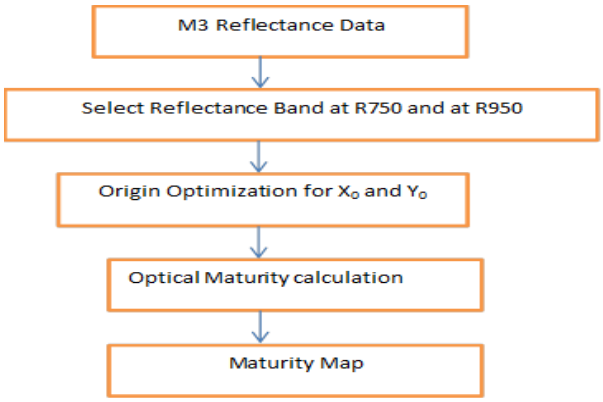

***Fig. 2.1** Workflow of Methodology*

3 RESULT AND DISCUSSION

3.1 Origin Optimization

Table 3.1 shows the value of R950/R750 and R750 for the M3 data for Apollo 17 landing site which we take as a reference for all the craters. Fig 3.1shows the scatter plot of all the probable origin in our we use probable origin as (0.06,1.16).

TABLE 3.1
ORIGIN OPTIMIZATION

Station	Latitude (N)	Longitude(E)	R750	R950/R750	R950
LM	20.199	30.742	0.05	1.26	0.063
S1	20.157	30.754	0.05	1.3	0.065
S2	20.099	30.496	0.112	1.1428571	0.128
S3	20.172	30.534	0.08	1.2125	0.097
S5	20.183	30.693	0.056	1.1428571	0.064
S6	20.289	30.771	0.051	1.1372549	0.058
S7	20.293	30.785	0.051	1.1372549	0.058
S8	20.278	30.848	0.052	1.1538462	0.06

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S9	20.227	30.802	0.057	1.0701754	0.061
L1	20.178	30.655	0.058	1.1896552	0.069
L2	20.181	30.612	0.075	1.1733333	0.088
L3	20.181	30.596	0.075	1.16	0.087
L4	20.107	30.517	0.099	1.1515152	0.114
L5	20.184	30.557	0.089	1.1348315	0.101
L6	20.194	30.563	0.088	1.1704545	0.103
L7	20.213	30.634	0.067	1.1492537	0.077
L8	20.203	30.662	0.059	1.1355932	0.067
L9	20.233	30.75	0.055	1.1272727	0.062
L10	20.283	30.753	0.05	1.18	0.059
L11	20.276	30.841	0.053	1.1320755	0.06
L12	20.197	30.781	0.054	1.1111111	0.06

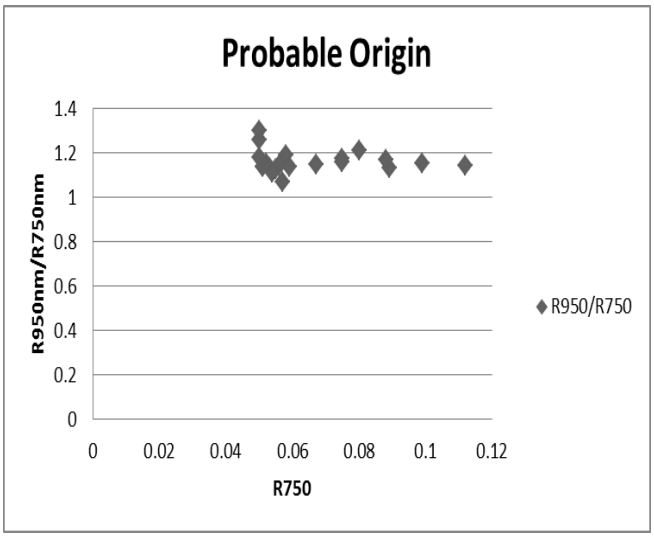

Fig 3.1 plot of probable Origin

3.2 OMAT Index Calculation

Understanding of mature and immature index is done by optical Maturity . higher OMAT index shows immature (fresher) surface, while lower OMAT shows mature surface of craters[4].

- From Fig 3.2 it is found that mean of range is taken as the OMAT 0.05-0.14.The OMAT of the Bullialdus crater possess low value (blue) at rim which shows the high maturity and at peak OMAT possess high value represent the immature Crater and the peak having value 7.27-10.91.
- From Fig 3.3 it is found that mean of range is taken as the OMAT 0.0001-0.11.The OMAT of the Aristoteles crater possess low value at rim which shows the high maturity and at peak OMAT is very high value represent the immature Crater and the peak having value 0.22-0.33.
- From Fig. 3.4 it is found that mean of range is taken as the OMAT 0.09-0.16.The OMAT of the Tycho crater has very low value at rim which shows the high maturity at peak OMAT is very high which represent the immature Crater and the peak having value14.54-18.17.
- From Fig. 3.5 the mean range is taken as the OMAT 0.14-0.29.The OMAT of the Cassini Crater crater having low content (blue) at rim which shows the high maturity and at peak OMAT is very high which represent the immature Crater and the peak having value 7.27-10.91

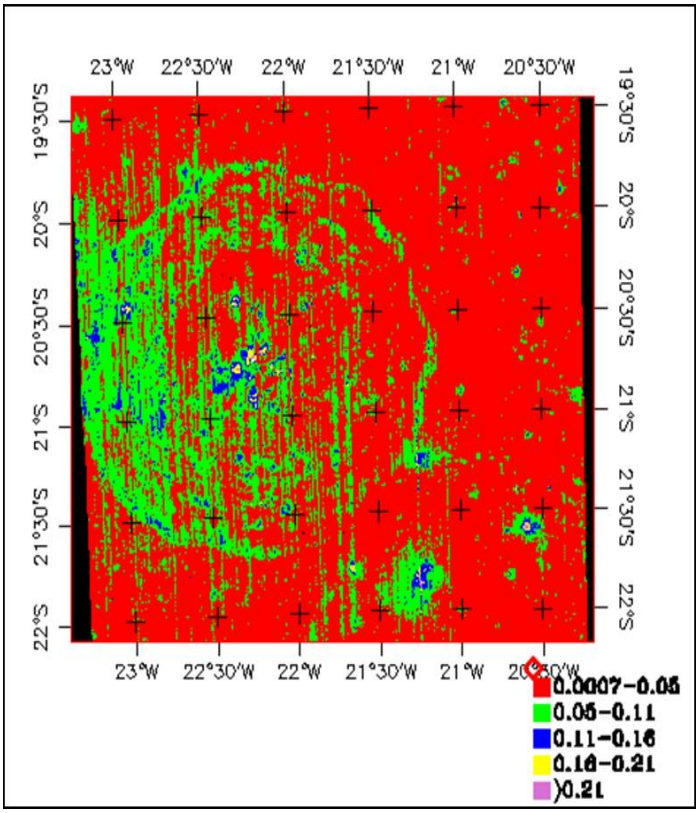

Fig.3.2 *OMAT value of Bullialdus Crater*

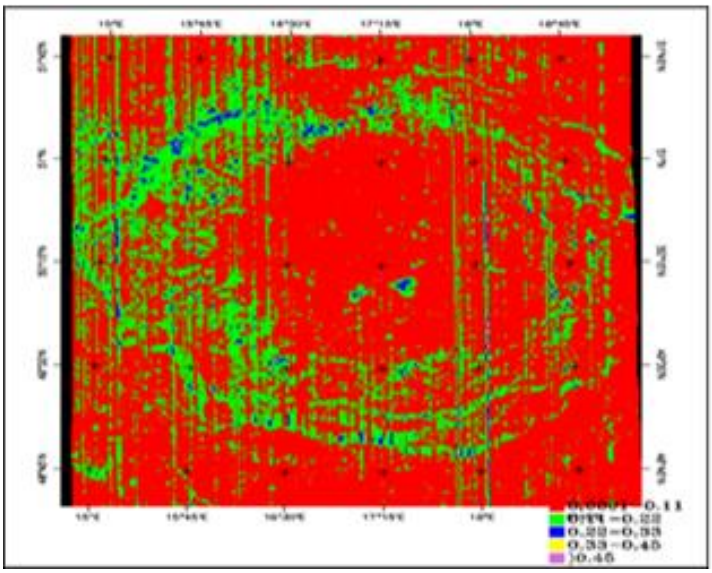

Fig.3.*3 OMAT value of Aristoteles Crater*

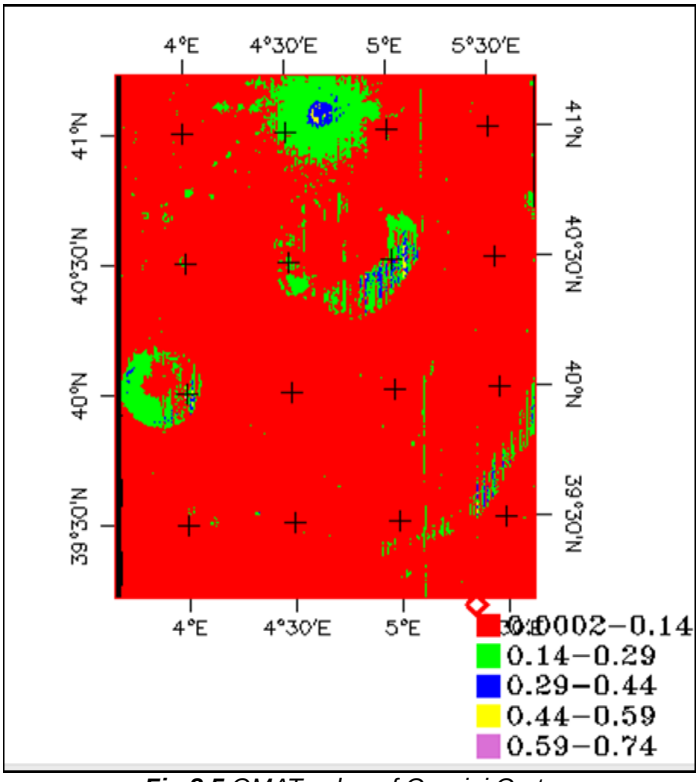

Fig.3.5 *OMAT value of Cassini Crater*

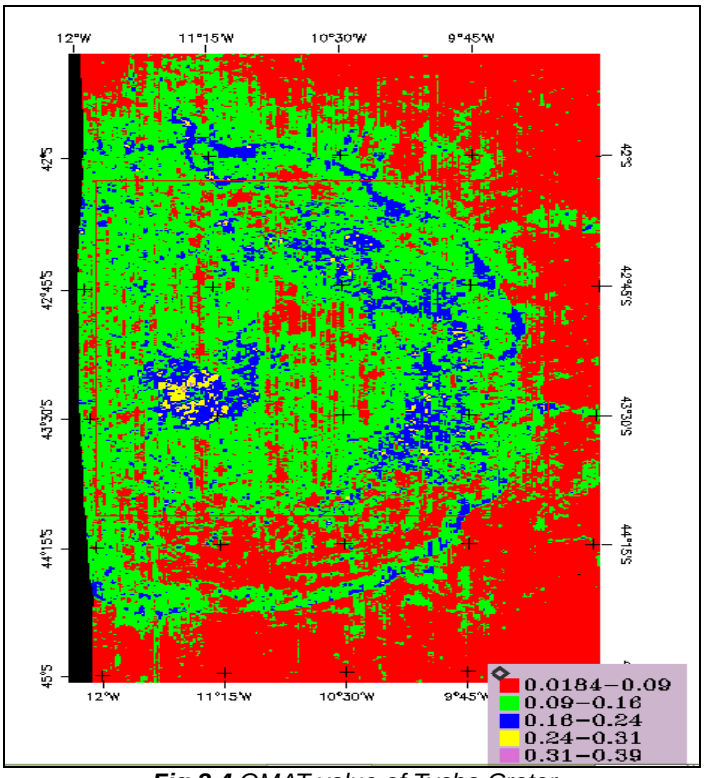

Fig.3.4 *OMAT value of Tycho Crater*

3.3 OMAT and Absolute Age

TABLE 3.2
OMAT RELATION OF CENTRAL PEAK AND CRATER RIM

Crater Name	Central Peak	Crater Rim
Bullialdus(South Pole)	0.16	0.05
Aristoteles(North Pole)	0.22	0.11
Tycho(South Pole)	0.24	0.09
Cassini(North Pole)	0.29	0.14

Table 3.2 shows the relationship of Central peak and crater rim From Fig. 3.2-3.5 shows that the Central Peak is immature than Crater rim because crater rim is always influence with space weathering so its optical properties are always change.

TABLE 3.3
OMAT AND GEOLOGICAL AGE

Crater Name	Mean OMAT Value	Geological Age
Bullialdus(SouthPole)	0.05-0.14	Eratosthenian(3.2by-1.1by)
Aristoteles(North Pole)	0.01-0.11	Eratosthenian(3.2by-1.1by)
Tycho(South Pole)	0.09-0.16(Fresh Crater)	Copernican(1.1by-present)
Cassini(North Pole)	0.0000-0.14(Older Carter)	Lower Imbrium (-3.85by—3.8by)

Table 3.3 Shows the relationship of OMAT and Geological age of the craters. From Table 3.3 it infers that the older (Lower Imbrium) the surface or mature surface having lower OMAT Value and Fresh surface having higher OMAT value. From our result we divide the OMAT range as for lower imbrium OMAT is 0.000-0.01, For Eratosthenian OMAT is 0.01-0.09 and For Copernican OMAT range of OMAT is 0.09-0.16.

4 CONCLUSION

From Table 3.1 and Fig 3.1 it is concluded that using correlation method origin is optimised to (0.06,1.16) for the calculation of optical Maturity.

From Fig. 3.2-3.5 and From Table 3.2 and Table 3.3 it is concluded OMAT parameter is very useful for the age estimation of crater. From our result we classify the OMAT range as for lower imbrium OMAT is 0.000-0.01, For Eratosthenian OMAT is 0.01-0.09 and For Copernican OMAT range of OMAT is 0.09-0.16.

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