VOLUMETRIC/MORPHOMETRIC ANALYSIS OF IMPACT CRATERS IN THE NORTHERN HEMISPHERE LOWLANDS, MARS. K. Kurita and Y. Ogawa, Earthq.Res.Inst., University of Tokyo, Yayoi 1-1-1,Bunkyo-ku,Tokyo 113-0031,Japan kurikuri@eri.u-tokyo.ac.jp.

Introduction: At the early stage of the martian history, a dense thick atmosphere has been suggested to exist. Considering the present state of thin atmosphere, large amount of CO2 should be stored somewhere in the martian crust. To detect, characterize and quantify this volatile reservoir is one of the important tasks expected for the geomorphological study on the martian surface features. To determine the amount of this reservoir and to understand its formation process are the direct target of these researches.

Among several surface features morphology of impact craters is expected as an potential measure for the subsurface reservoir of the volatiles since excavation process associated with cratering efficiently plows the subsurface region. Several investigations have been conducted on rampart craters. Barlow and Bradley [1] suggest the target properties containing the volatiles control the lobate structure. Kuzmin[2] report spatial distribution of subsurface volatiles based on the onset size of rampart crater. Costard[3] focuses on the extent of fluidized ejecta to infer the volatile distribution. Here we will report results of volumetric/morphometric analysis of fresh impact craters in Utopia Planitia and south of Acidalia regions with an intention to characterize subsurface reservoir of volatiles.

Data set: The basic data sets are MOLA MEGDR(gridded 1/128 deg/pix data set) and Viking and MOC high resolution images. In the volumetric analysis we evaluated how the ejecta volume is partitioned around the cavity by subtracting the pre-craterinrg topography from the present one. The pre-cartering topography was estimated by interpolating the surrounding topography. We restricted the size of craters for the analysis between 8 to 20 km. 8 km is a minimum size for reliable estimate of ejecta volume based on the MEGDR MOLA data. We selected two regions in the northern hemisphere, region A;Utopia Planitia (225W-275W and 15N-45N) and region B;south of Acidaliaa (30W –75W and 15N-45N). Region A has been strongly suggested to stock the ground ice because the characteristic features such as polygons are exclusively observed on the surface[4]. Both regions cover the low elevation area where the water from the outflow channels could be inevitably ponded.

Results:

1) crater classification

In these two regions we could identify two different types of morphology as for the fluidized ejecta in the diameter range of 8 to 20 km. Fig. 1 represents typical features of these two types. Type A covers pedestal type craters and double-lobed rampart craters. The key feature of this type is existence of well-developed inner lobe with a faint trace of outer lobe. The volume of the inner lobe is almost equivalent to the cavity volume except for the several cases at the high latitudes. Clear high resolution images indicate almost all pedestal type craters have aureole-like albedo change around the voluminous pedestal ejecta, which would be equivalent to the outer lobe of the double-lobed rampart craters in these regions. High resolution images also show radial striations/scours on the surface of the inner lobe, which are scratches caused by the flow event resulting in deposition of the outer lobe. This indicates the deposition sequence of two events;the inner lobe formed first and the outer lobe later. As a summary for the features of type A craters, double occurrence of ejecta deposition with different characteristics by a single impact event is a distinct nature. Particularly the existence of the delayed explosive event is remarkable. Type B on the other hand is basically single lobed rampart crater. In several cases multiple lobes are observed but they lack of well developed inner lobe.

2) Spatial distribution

We could classify craters into two types ant their spatial distribution was determined. In the northern and low elevation regime in region A, Type A is dominant and in the southern and high elevation regime, Type B is dominant. Similar pattern can be seen in region B. Fig. 2 shows the histogram of crater counts in terms of the elevation. At the transition boundary of the elevation of –4000m the dominant type changes in both region A and B. It is interesting that this value coincides with the elevation of the Contact 1 of the paleo-shoreline in these regions proposed by Head et al[5]. If paleo-ocean existed, it can be said that Type A craters were formed in the region once water covered.

Speculation on the formation of Type A crater: To generate double deposition events by a single impact in the case of Type A craters, a process with time-delayed nature should be involved. Formation of vapor plume above the cavity[6] and segregation in the ejecta curtain[7] can explain time-delayed vapor-rich explosive event. Formation of striation/scours on the surface suggests icy blocks are contained in this gas-rich flow. Since Type A is dominant in the paleo-ocean region we suspect large and extensive development of subsurface reservoir of volatiles in this region.

References:

[1] Barlow,N. and T.L.Bradley,(1990) Icarus 87,156-179. [2] Kuzmin, et al.,(1989) Solar System Res.,22,121-133, [3] Costard,F.,(1989) Earth Monn & Planets,45,265-290, [4] Hiesinger and J.Head,(2000) JGR 105,11999-12022,[5] Head et al.,(1999) Science 286,2134-2137,

[6] Stewart et al.,(2001) Lunar Planet.Sci. XXXII,2092,
[7] Scultz,P.(1992) JGR 97,975-1005,Barnouin-Jha,O.S. and P.Scultz (1996) JGR 101,21099-21115

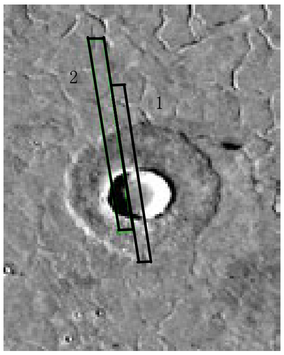

Fig 1a. Type A

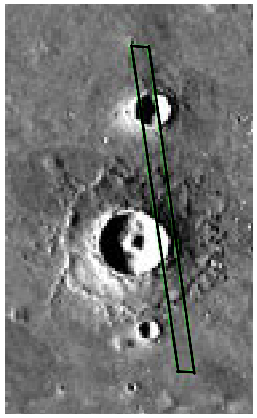

Fig 1b. Type B

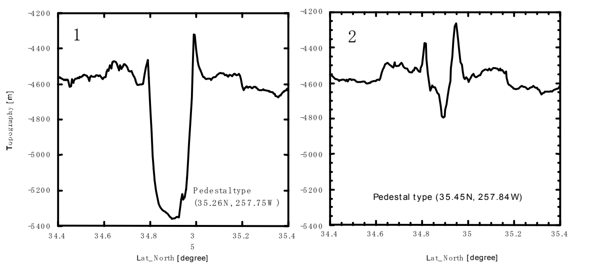

Fig.1c Topography profile of Type A along the inserted lines in Fig 1a.

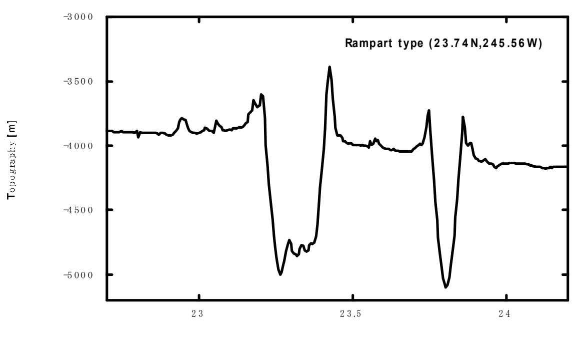

Fig.1d Topopgraphy profile of Type B along the inserted line in Fig 1b.

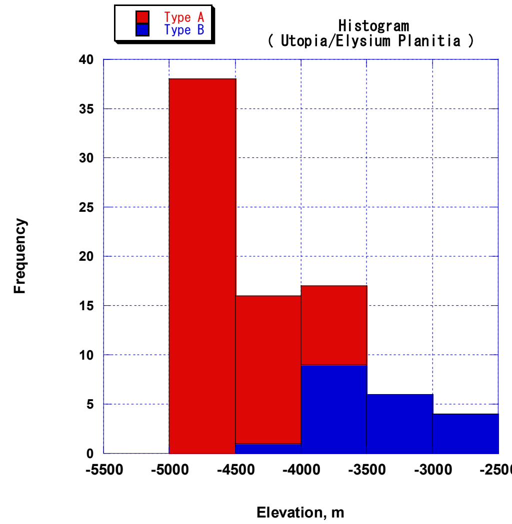

Fig.2a. Histogram of crater counts with elevation in region A

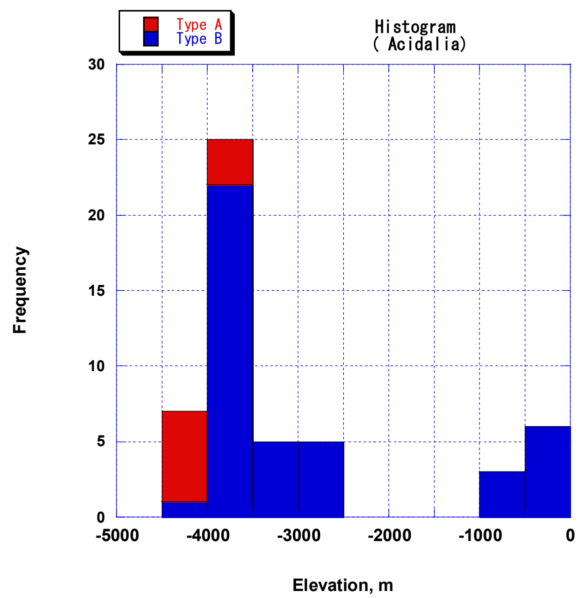

Fig 2b. Histogram of crater counts with elevation in region B