# "The New Martian Chronicles, Counting Edition"

# -Enjoying "Crater Chronology" with High School Students-


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## Introduction

After NASA's MRO and MGS missions, many Martian high-resolution satellite images can be provided via some websites. However there are still few attempts to use these images for K-12 geoscience classes. We carried out some class room exercises using these images to study Martian surface history employing "Martian crater chronology (Hartmann, 2005)". A combination both high–tech satellite images and a low-tech procedure makes a new exercise for geoscience classes. Results of re-counting by myself are also presented to compare them with those of students'.

## Materials and Methods

The items used in this study;

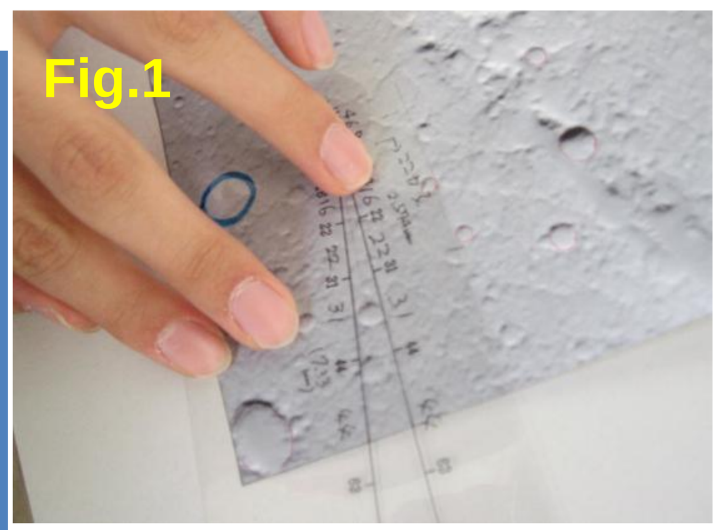
1) A0 printed Hirise satellite images downloaded from web sites (title back).
2) Hartmann's isochrones diagram 2005 (references).
3) A hand-made ruler to classify craters into each size (Fig.1).

Procedure;

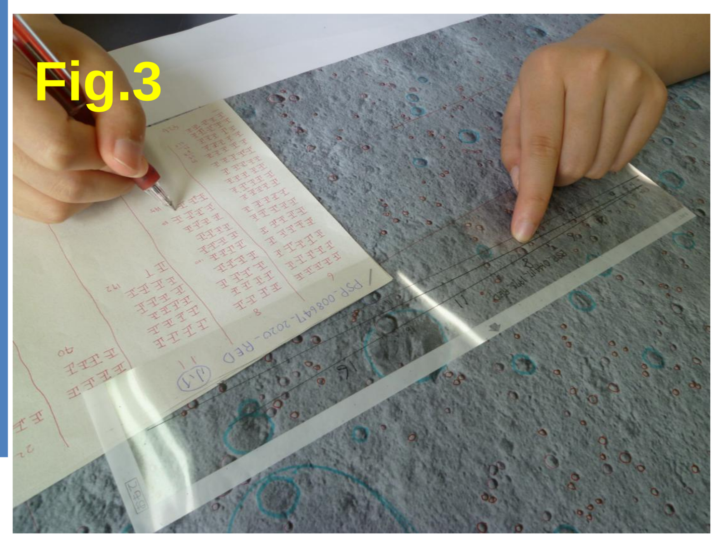
1) Check craters with color marking pens and counting their populations at each size column using a hand-made ruler (Fig.2).
4) Record crater numbers at each size using a Kanji character "正" = "1,2,3,4,5" (Fig.3).
5) Plot data onto the isochrones chart to estimate the surface age (Fig.4).
6) Discuss the reasons for the miss-fitted data with isochrones.
7) **Compare students' results with my own counts.**

Related Study:

1) Lava flows, faults, cracks, eroded planes, rivers, valleys, drainage networks etc..
2) The observed phenomena are used to comparison with our planet's landscapes to develop a regional scenario of Martian surface evolution.





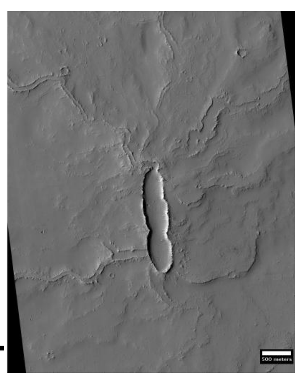


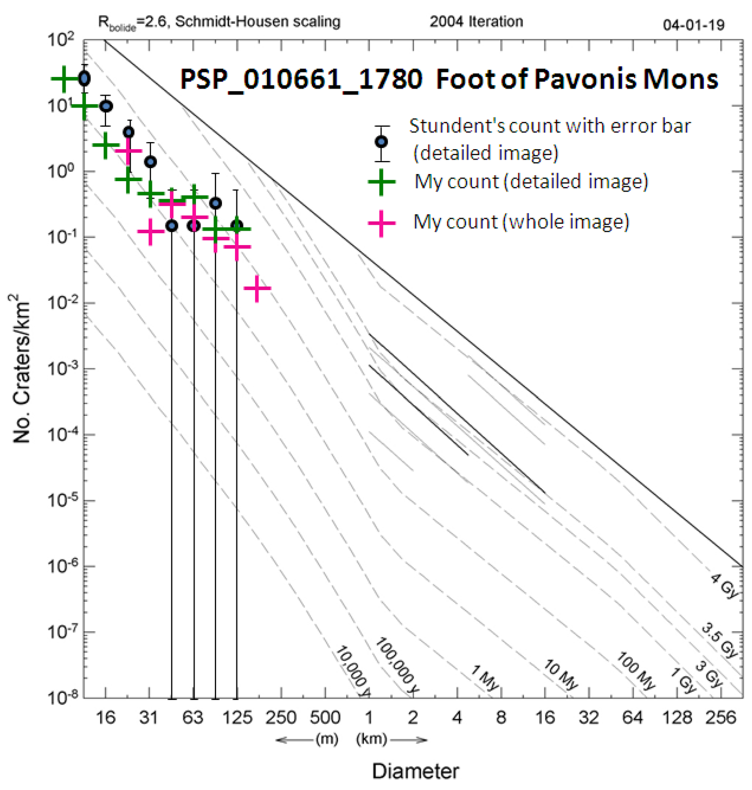


## Results: Counting Examples

Ex.1 Young Lava Flow of Pavonis Mons.

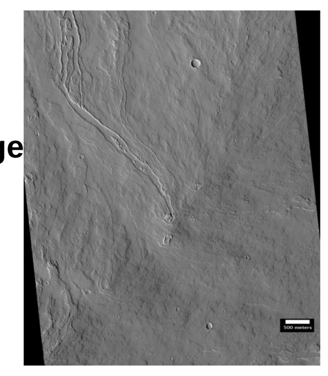
Student's result indicates slightly older ages at small craters than my counts. My counts are shifted one column left at each size. It may be from ruler problem.

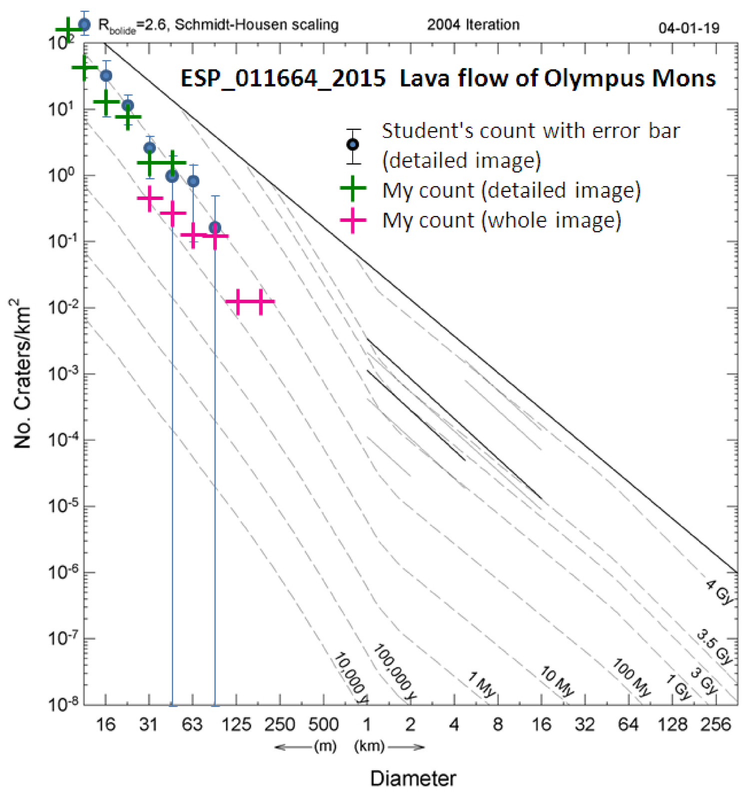





Ex.2 Young Lava Flow of Olympus Mons.

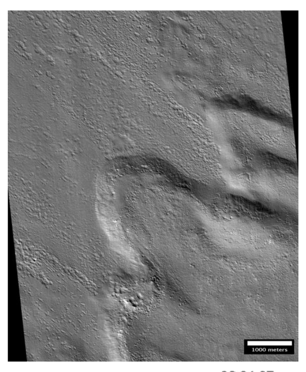
Counts on a detailed image show slightly older ages than on a whole image (Fig6). ->Scattering bias of large craters?

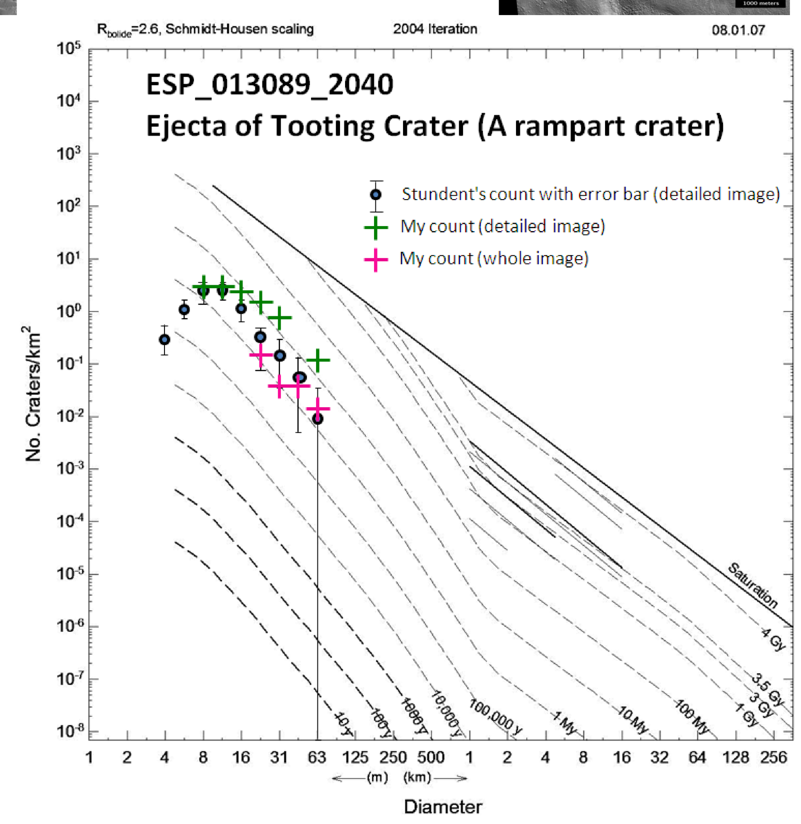





Ex.3 "Tooting Crater" as a Rampart Crater.

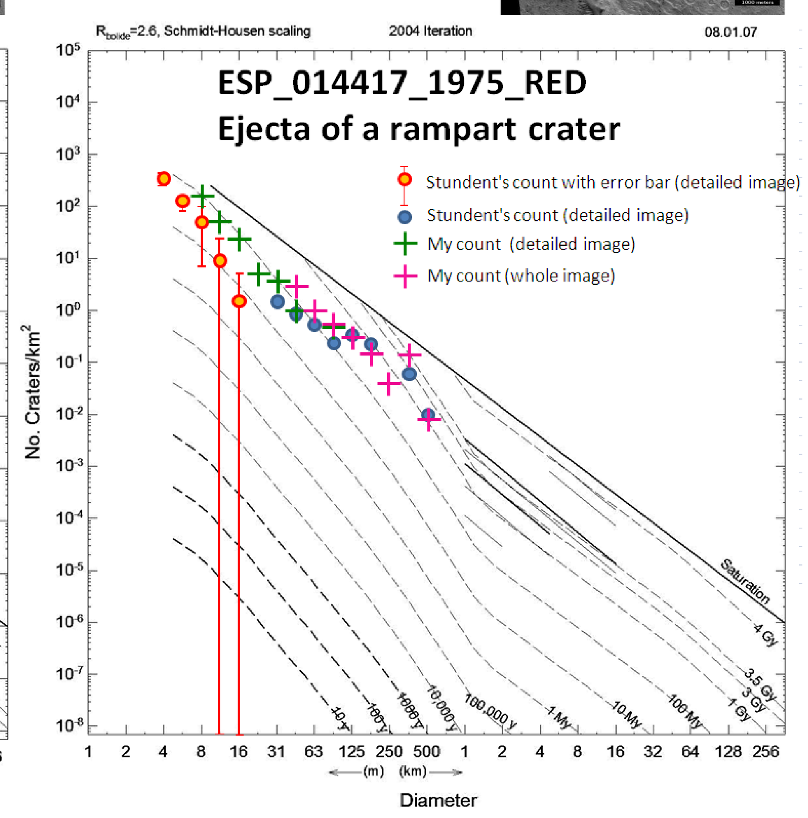
Counts from ejecta of this crater show a very young age. In this crater, counts from detailed image show larger densities of all sizes.

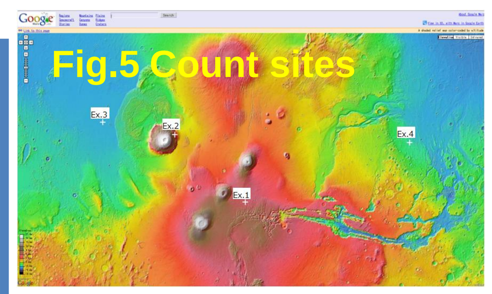


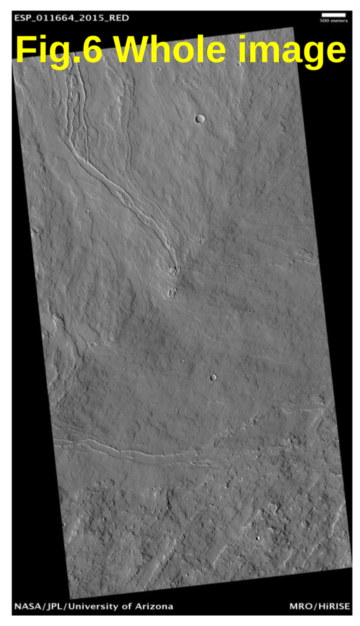



Ex.4 A degrade Rampart Crater (expanded in Fig.7).

Students' counts show slightly low density in small to mid range craters. This may be caused from the counts of small areas.





## Discussion

The key points of our exercise;

1) To choose appropriate areas for crater counting from huge image archives. -> Avoid degraded areas. ->Good fitting to isochrones.
2) Miss-fitting data with isochrones are also interesting for further study about "degraded processes" on Martian surfaces such as weathering, erosion, fluvial and glacier effects, lava flow activities or the existence of ancient seawater.

Evaluation of results:

1) Counts for smaller size craters cause sometimes a systematic shift. It may be from inappropriate using of ruler or marking craters.
2) A discrepancy in larger craters is caused by a biased scattering of large craters or too little sample to count.
3) In spite of these difficulties, the estimations by our students show plausible crater ages on the whole.

Further study:

1) Understand the degraded processes and establish how to distinguish the flesh craters and the degraded ones.
4) To count more samples is also required to evaluate this method.

## Conclusions

Through these exercises, we confirm;

1) "Crater Chronology on Mars" is a suitable exercise for K12 geoscience class and is also relatively easy-making.
2) The derived ages, especially of young lava flows and ejecta of "rampart craters" are mainly consistent with professional researchers' results.
3) The discrepancies of some results are caused by inappropriate using of ruler, marking or too little sample and/or a bias of crater distribution.
4) Typical Martian surface topographies are quite useful in geosciences class to introduce the important basis of geology; i) "Cross-cutting relationships" ii) Erosion and sedimentary landscapes by fluvial and glacier processes; without artificial modification.
5) These exercises introduces the "Power Laws" of natural phenomena. Students can approach "Complex Sciences" through these study.
6) Results are also used to introduce the famous hypothesis on the origin of the Earth-Moon system, such as "the Late Heavy Bombardment" or "the Giant Impact Theory", which strongly inspire students' curiosity for the dawn of the solar system and our planet.

## Acknowledgements & References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<Reference> William K.Hartmann：Martian cratering 8: Isochron refinement and the chronology of Mars, Icarus 174, 294–320, 2005

<Images of HiRISE> http://marsoweb.nas.nasa.gov/HiRISE/