Relationship between water equivalent hydrogen abundances and slope streaks distribution in the Medusae Fossae Formation

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Slope streaks are dark linear features on the slopes of Mars which appear at a certain time and gradually fade away over a period of 10 years (Sullivan et al., 2001). In general, slope streaks are frequently observed in the equatorial to subequatorial dusty regolith regions with low thermal inertia (Kreslavsky & Head, 2009). Recent studies have shown that the global distribution of slope streaks is consistent with the regions with high abundances of Gamma-Ray Spectrometer-derived water-equivalent hydrogen on Mars (Bhardwaj et al. 2017). Even though the formation mechanism of slope streaks is still unclear, both wetting mechanisms, such as subsurface ice melting, and drying mechanisms, including the movement of the granules, have been proposed (Ferris et al. 2002; Bulmer et al. 2008; Bhardwaj et al. 2018). Bhardwaj et al. (2017) suggest that the formation of slope streaks is due to the interaction of regolith with atmospheric water on a daily scale. Therefore, it is supposed that a hypothesis that takes into account both dry and wet processes can provide a more comprehensive explanation of all morphological diversity of the observed slope streaks (Bhardwaj et al. 2018).

The Medusae Fossae Formation (MFF) has geologic features that indicate wind erosion of low-density material near the equator (Ojha et al., 2018) and is one of the regions where a large number of slope streaks have been observed (Ferris et al. 2002). It is also one of the regions with high-water equivalent hydrogen abundances (Bhardwaj et al. 2017). Since some hypotheses on the formation process of slope streaks are based on the melting of subsurface ice (Ferris et al. 2002), the MFF is an ideal place to study the formation process of slope streaks due to the number of slope streaks, the amount of hydrogen, and the possibility of the existence of subsurface ice.

We mapped the distribution of slope streaks in and around the MFF in detail. As a result, it was found that the distribution of slope streaks was consistent with that of water equivalent hydrogen content in the MFF. We believe that the formation mechanism of slope streaks is related to the enrichment of hydrogen concentration.

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1. Introduction

Slope streaks are linear Martian surface features. They are darker than their surroundings that gradually fade over decadal timescales, and finally their disappearance (Sullivan et al., 2001). On a global scale, their distribution corresponds to the abundance of water equivalent hydrogen (WEH) (Bhardwaj et al. 2017). However, their formation mechanism has not been clear yet and there are both dry and wet origin hypotheses (Bhardwaj et al. 2019) has been proposed.

Medusae Fossae Formation (MFF) is one of the highest WEH abundances and hosts numerous slope streaks (Bhardwaj et al. 2017). Here, we have considered their relationship and the formation mechanism of slope streaks with the WEH.

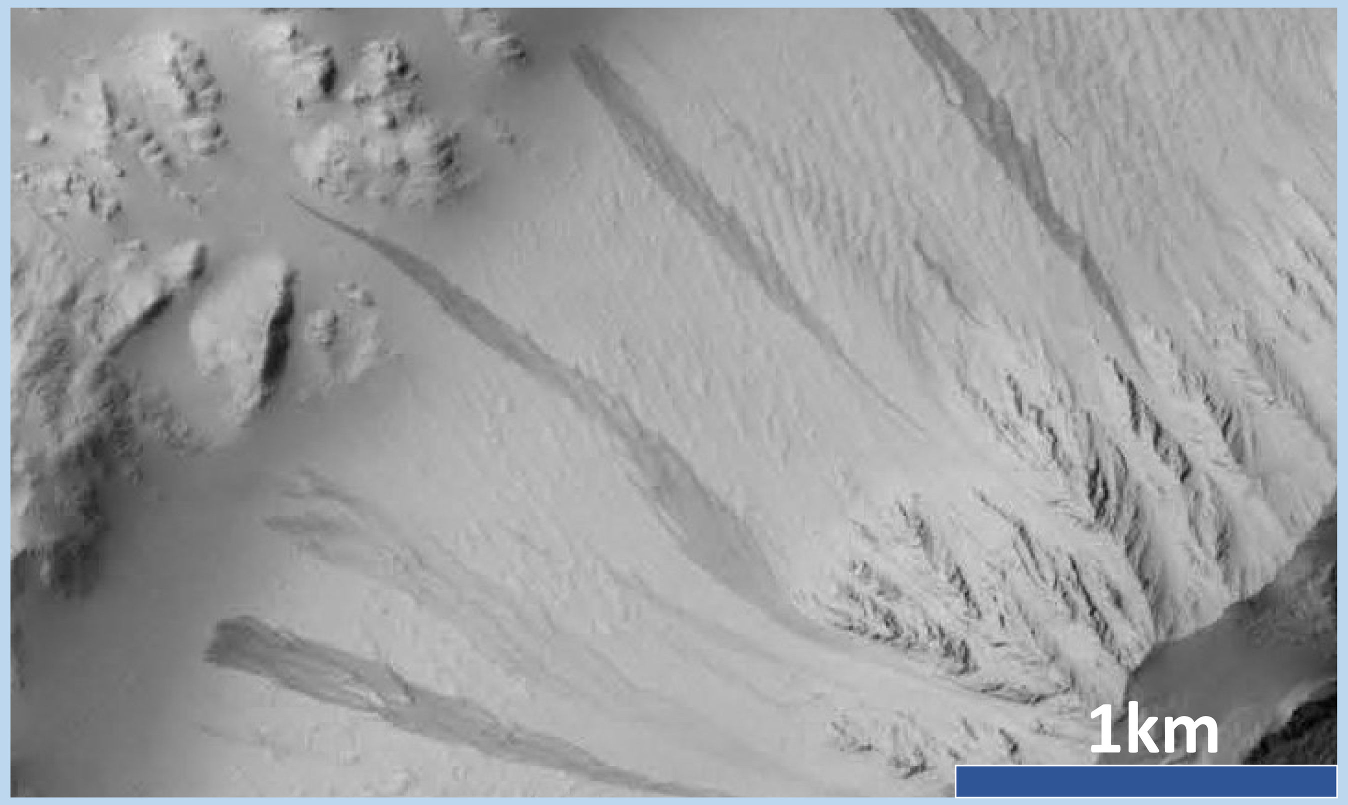

Fig. 1 Slope streaks originated from a crater wall of the MFF

2. Methodology

1. Slope streaks were mapped through high-resolution context (CTX) camera images (Malin et al. 2007) in an ArcGIS environment.

2. Then, we compared the existence of the slope streaks in the areas with the high WEH regions and those with low WEH regions observed by the Gamma-Ray Spectrometer (Byonton et al. 2007, Pathare et al. 2018).

3. Relationship between WEH abundances and slope streaks distribution

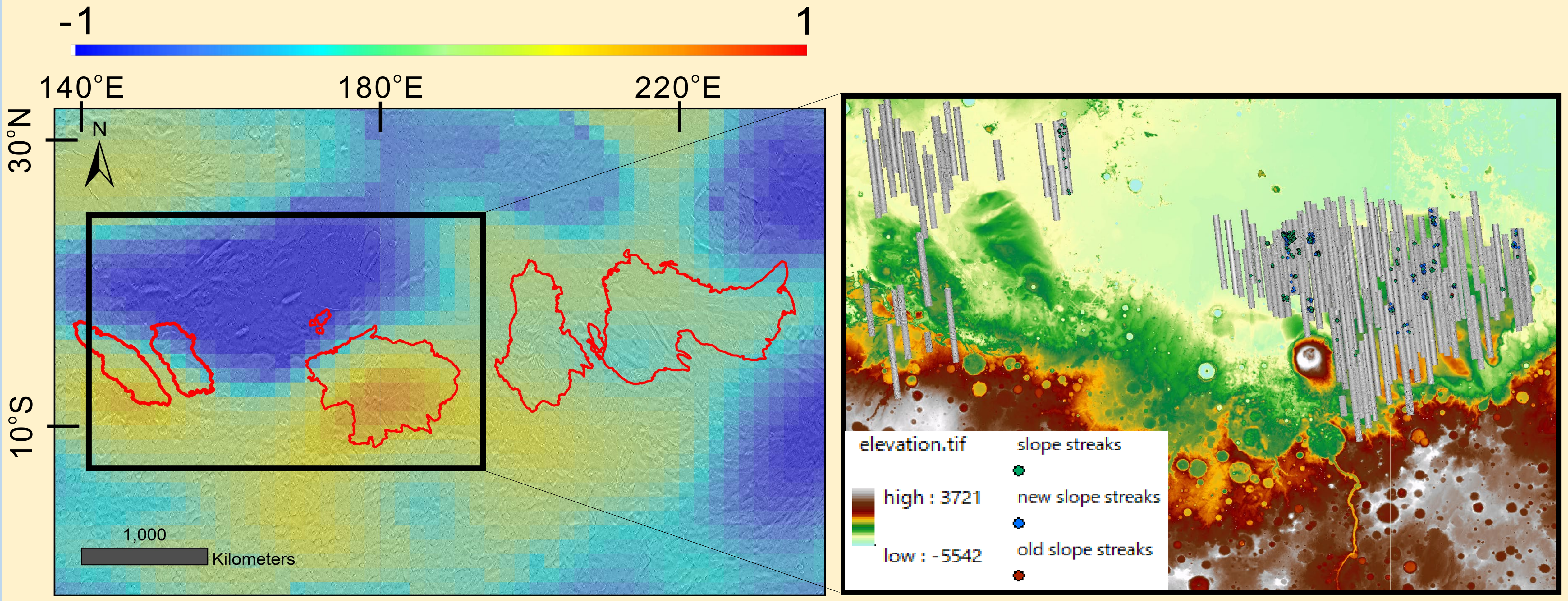

Fig. 2 Distribution of WEH abundances and slope streaks.

A large number of slope streaks were found in the regions with high WEH abundances, whereas a significantly low number of slope streaks were observed around the WEH-poor regions. This probably indicates that the WEH abundance is stimulated by the presence of slope streaks in the MFF.

4. Properties of slope streaks

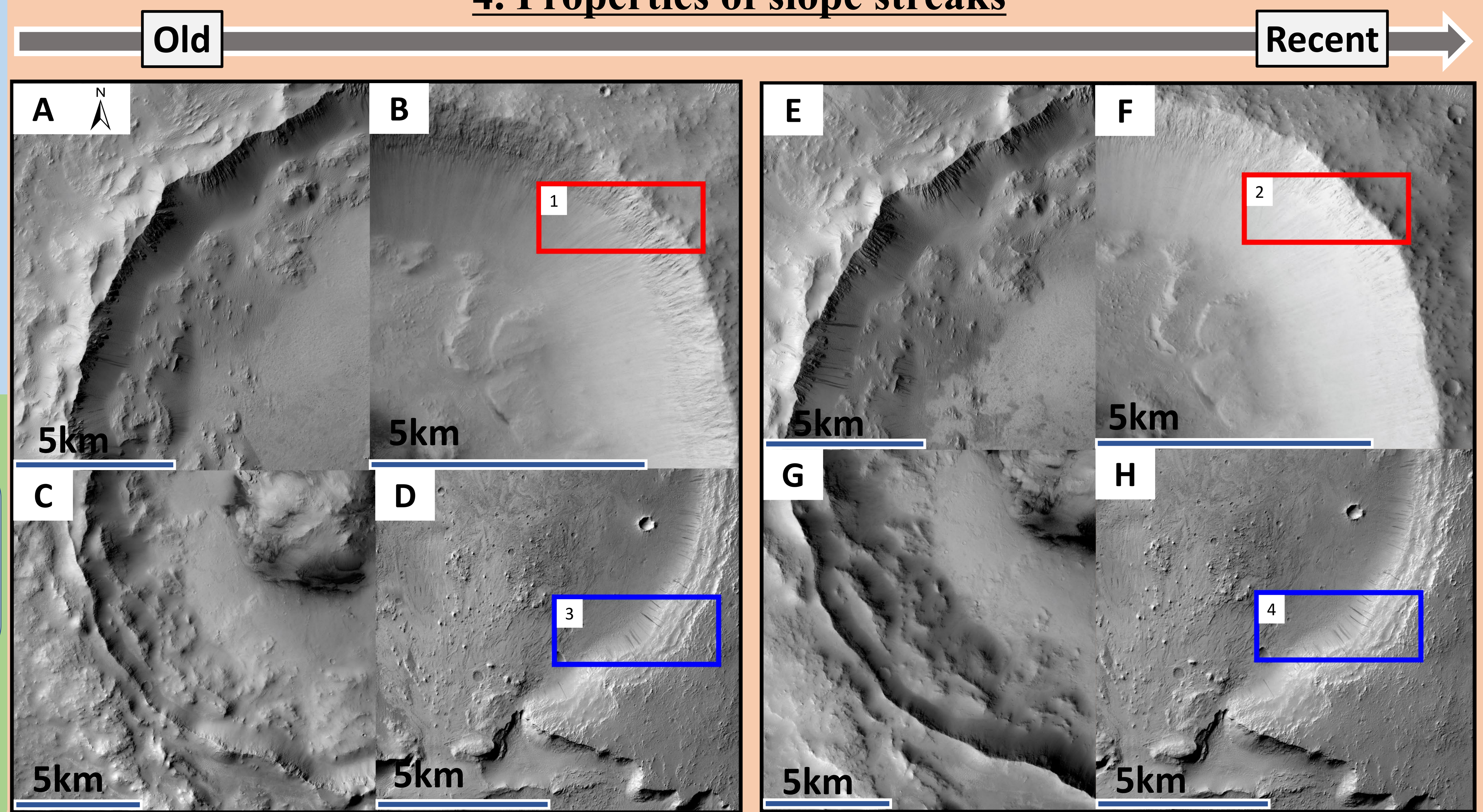

Fig. 3 Comparison of slope streaks on the slope of the crater wall of the area with high WEH regions and low WEH regions at a different year. The figure on the left (A-D) is older and the figure on the right (E-H) is more recent at the same craters. The black boxes of each figure are focused on slope streaks that appear. These four craters are selected from two different areas with high WEH abundances (A, D, E, H) and two areas with low WEH abundances (B, C, F, G), respectively.

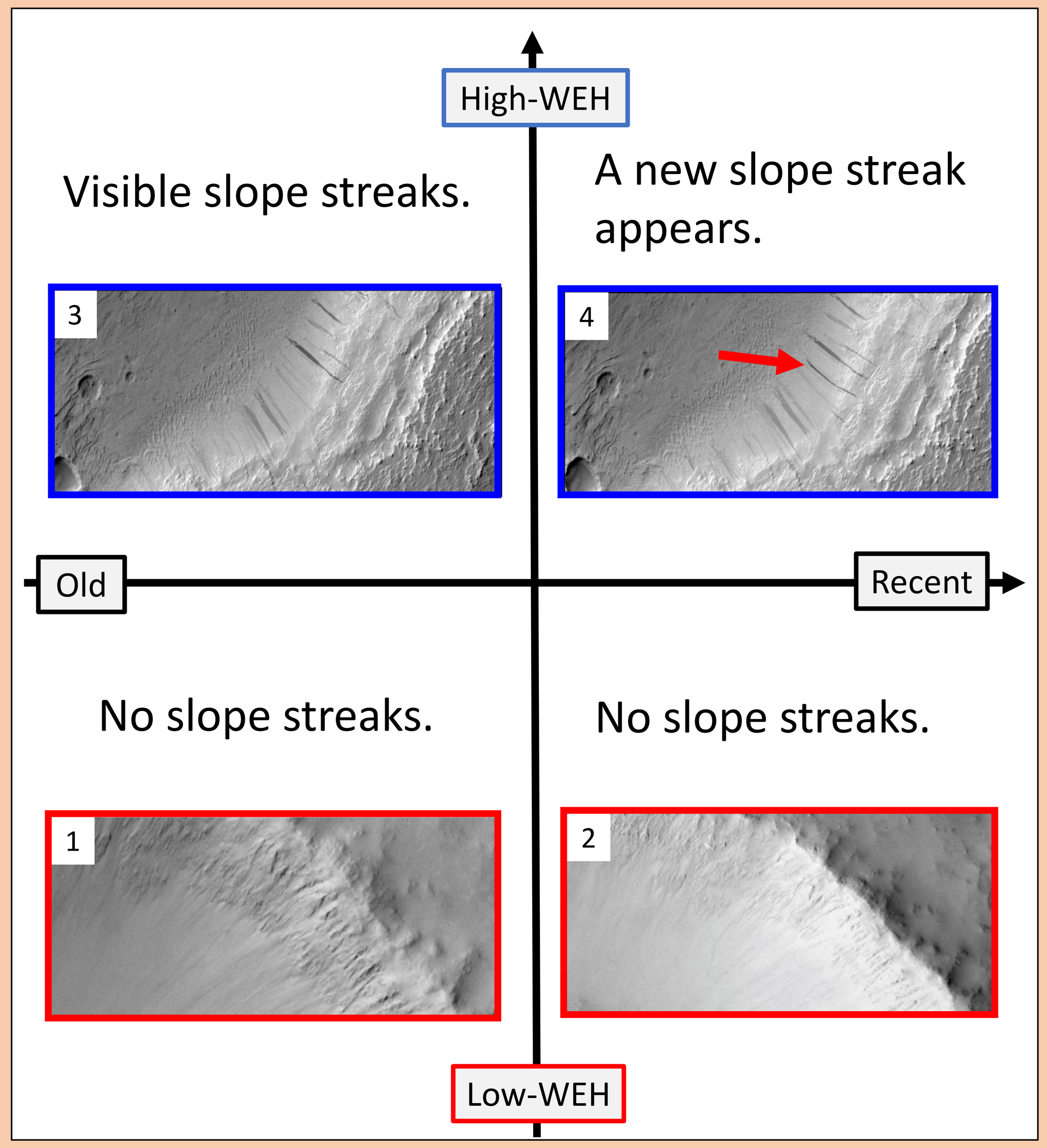

Fig. 4 A relationship between the number of slope streaks, WEH abundances, in due time.

5. Conclusion and Future plan

The high WEH abundances indicate the possibility of available water in the accessible subsurface despite being in the low latitude distribution. The slope streaks and the high WEH abundances in the MFF have the possibility that they are mutually related.

We plan to count all slope streaks of the MFF and its surroundings including the area with high WEH abundances and low WEH abundances and understand how the WEH abundances and the number of slope streaks are related.

References

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