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The effect of weathering on rock wall erosion and rockfall generation at La Cornalle, Switzerland

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Introduction

The weathering posing a significant influence on the rock wall retreat has been widely recognized. The purpose of this study is to make clear the link between surface weathering spatial distribution and location of erosion, rockfalls. In this study, multi-methods monitoring is designed to detect the erosion and rockfall activity on a rockslide cliff composed of marl-sandstone (maybe mixed with limestone) in Western Switzerland. Automated recordings of rock temperature and influencing meteorological factors (air temperature, humidity, and precipitation) collected by a weather station. As a result, the role of the freeze-thaw cycle and thermal fluctuation playing in the rockfall initiation and rock face erosion is explored. This work provides a model of weathering and rockfall estimation.

Study area

The rock cliff of La Cornalle is located in the town of Bourg-en-Lavaux (Vaud, Switzerland) (figure 1, figure 2). In the area of Epesses, the hillside of Lavaux is carved in a marl-sandstone molasse belonging to the lower freshwater Molasse of probably higher stampian age. The Cornalle cliff is formed by an alternation of marl and sandstone layers(Bersier et al., 1975).

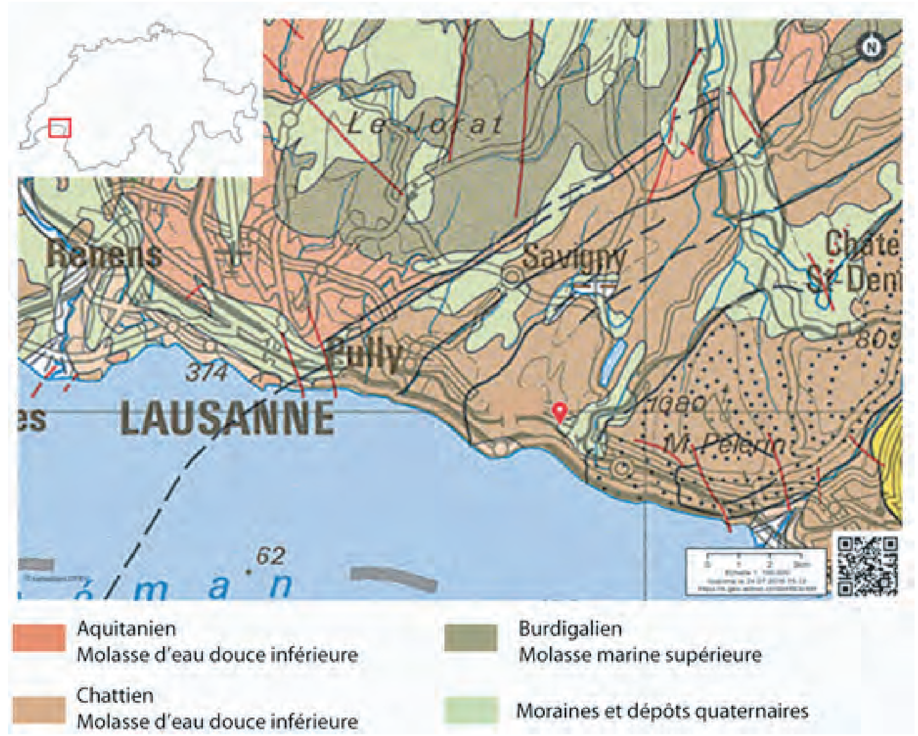

Figure 1: Location and geological map(Lefeuvre et al.)

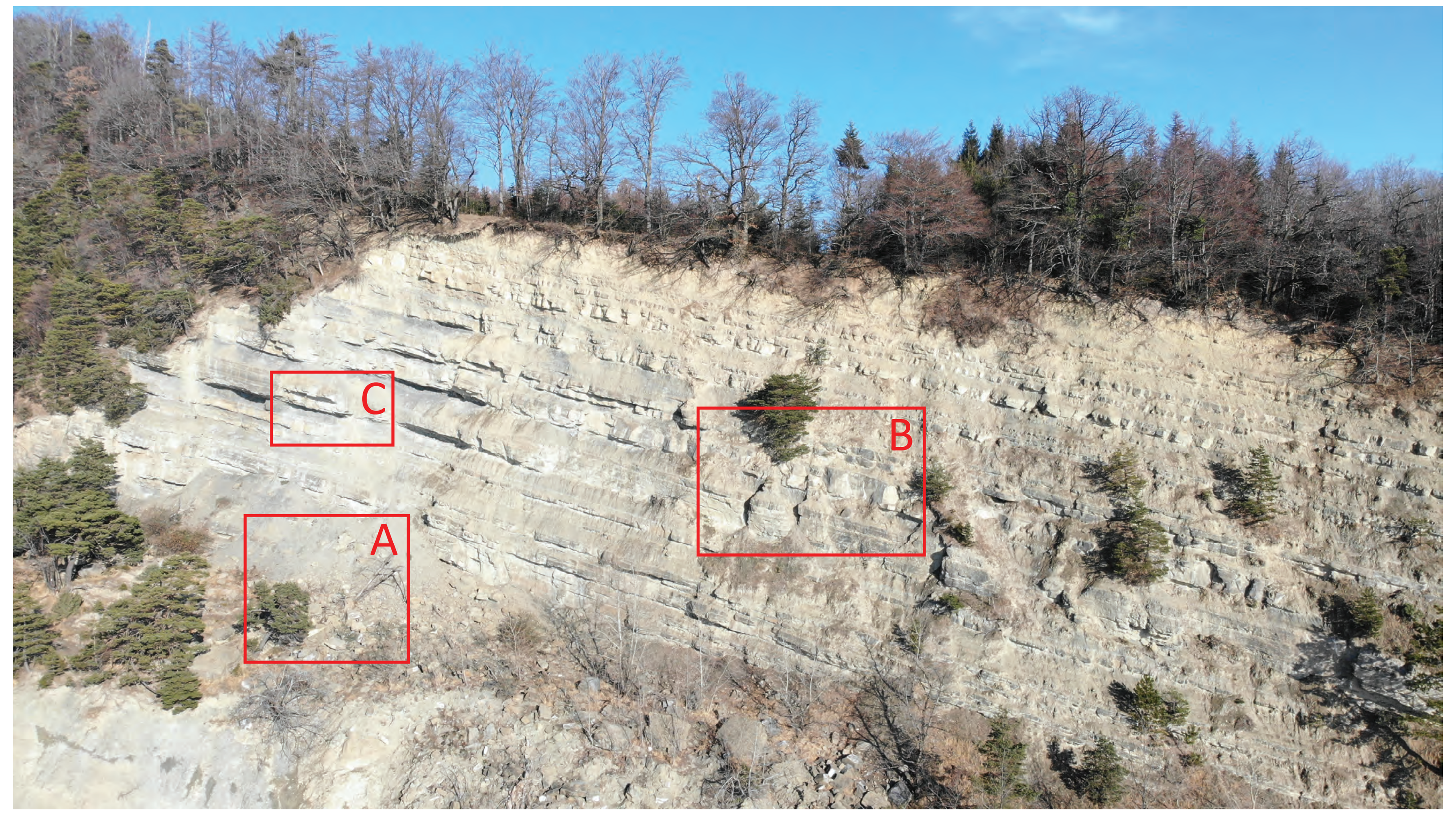

Figure 2: Panorama of La Cornalle cliff

Field survey

Some fractures are filled with calcite which might lead to a zone of weakness in the rock mass. During the field survey, we saw some calcite crystals covering on the rock block surface in the deposit area and exposed on rock cliff outcrop (figure 3). We suppose that some rockfalls are generated along those discontinuities filled with calcite where the chemical reaction is active when there is constant water infiltrating during rainfall season.

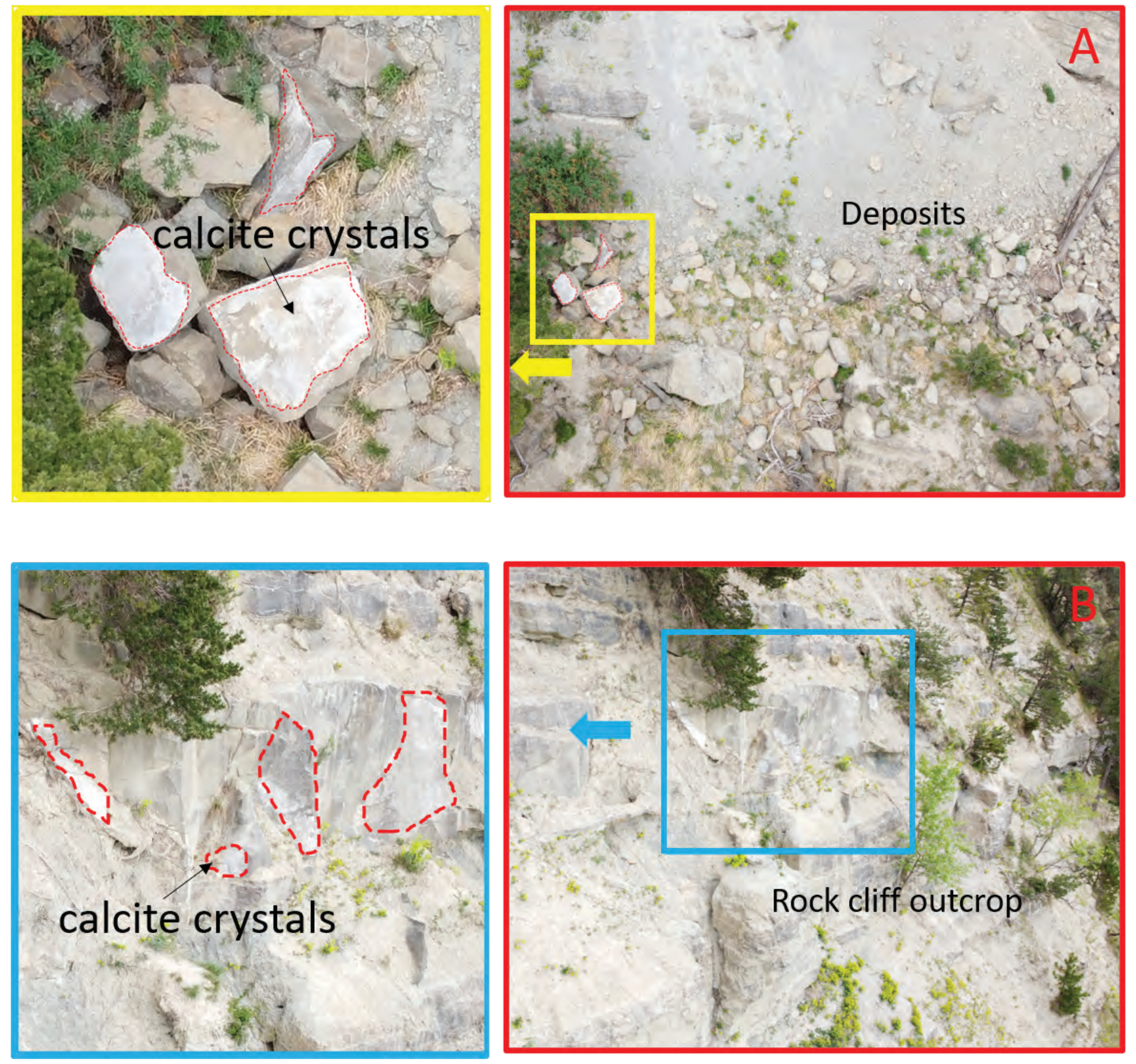

Figure 3: Calcite crystals exposed on the surface of rock block at the deposits area and outcrop

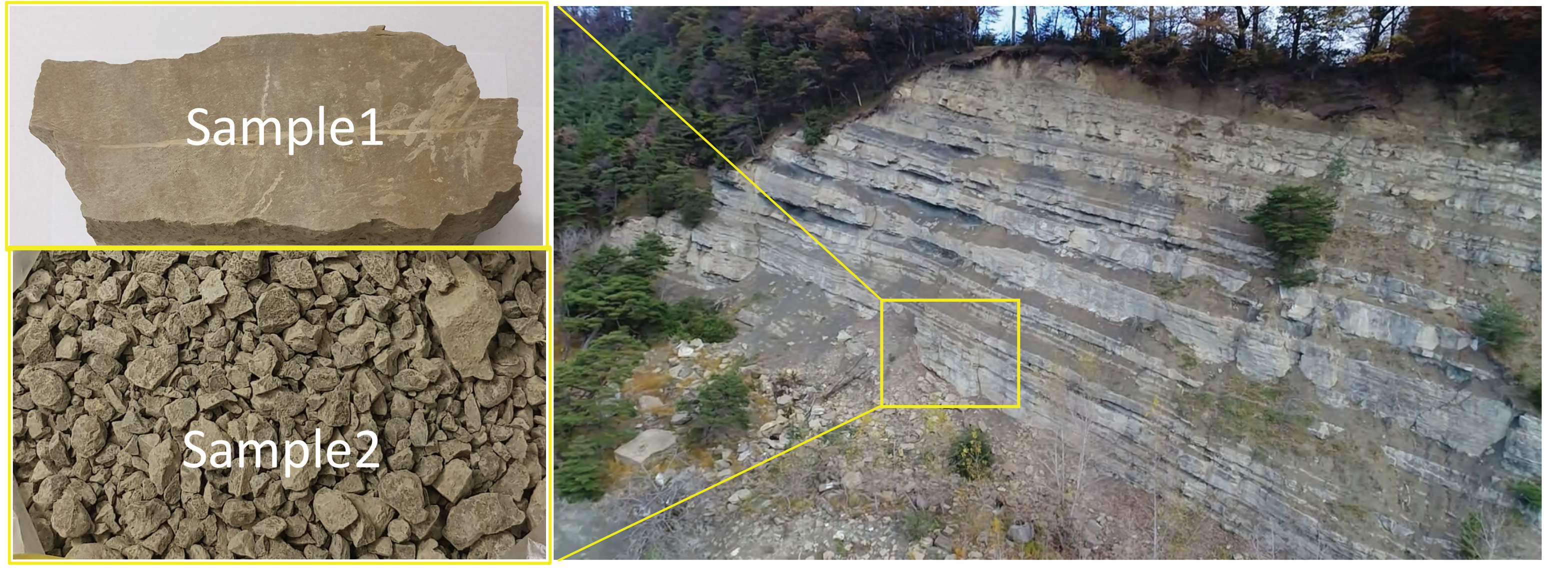

Figure 4: Two rock samples took from the bottom of the cliff

Preliminary mineral analysis

Table 1: Mineralogical composition by XRD diffraction, bulk rock, quantification using the external standards method (weight %)

Samples	Phyllosilicates	Quartz	Plagioclase-Na	Calcite	Dolomite	Ankérite	Indosés
sample 1.2	22.80	32.42	4.35	33.11	5.11	0.79	1.43
sample 2.2	39.95	26.53	2.18	24.23	3.93	0.86	2.32

Table 2: Clay fraction <2mu (%)

Samples	IS-Smectite	Illite-Smectite (2)	Mica	Chlorite	Kaolinite
sample 1.2	17.60	3.12	26.31	42.38	10.59
sample 2.2	13.25	11.42	35.56	32.82	6.95

It is shown(table1 and table2) that marls and sandstone(mixed with limestone) in the La Cornalle cliff consist of some smectite clay minerals that are prone to large volume changes(swelling and shrinking) that are directly related to changes in water content.

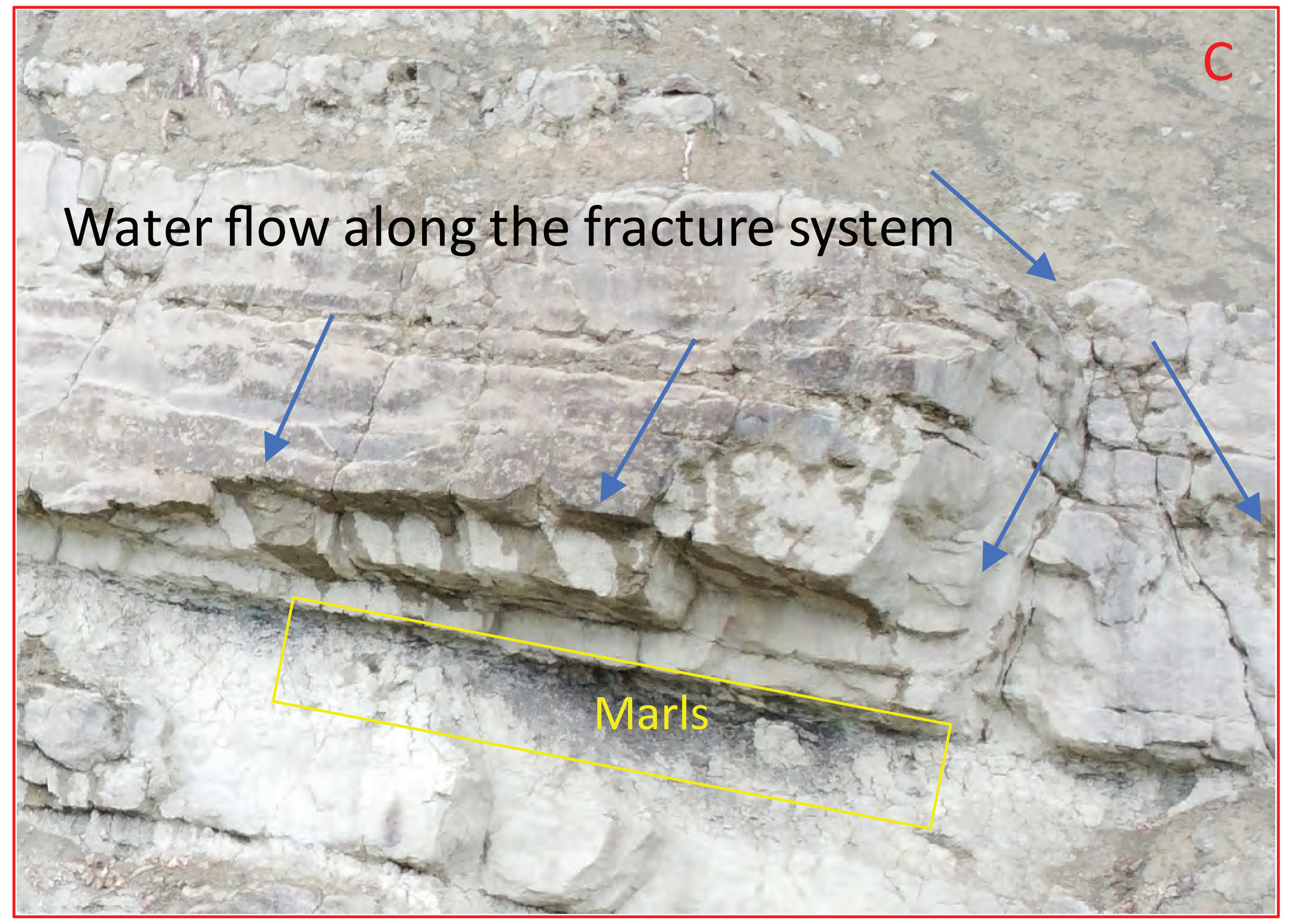

Figure 5: The water flow on the surface through the fracture system

The water from rainfall penetrates into the rock mass through the discontinuities nets and reaches the layer of marls(figure 5). In this case, marls probably swell and disintegrate that lead to its retreat. Consequently, this will conversely lead to failure of the growing overhang sandstone or limestone layers.

Rock wall activities

In order to detect rockfall and erosion activities, we acquired four 3D point clouds models(20191219, 20200121,20200406,20200427) using LiDAR and SfM photogrammetry from December 2019 to April 2020. Then we do a comparison between each other. According to the results, it is known that 2 rockfalls occurred from 19th December 2019 to 21st January 2020, 5 rockfalls occurred between 21st January 2020 and 6th April 2020, and one rockfall from 6th April 2020 to 27th April 2020. In order to correlate those activities to the weather condition, the meteorological data of Station Pully that is 10km away from the cliff site are collected from the IDAWEB website.

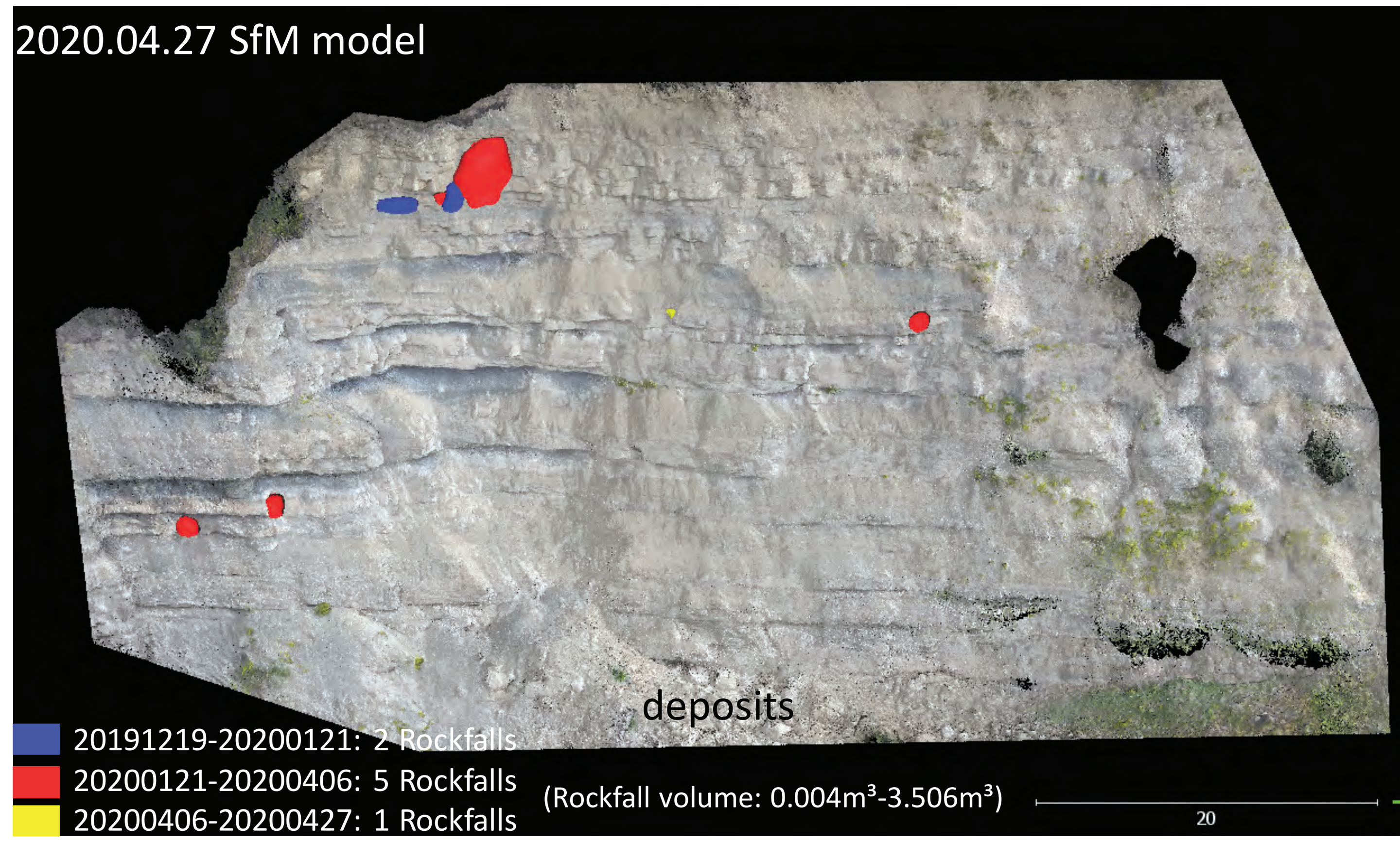

Figure 6: The locations of rockfall

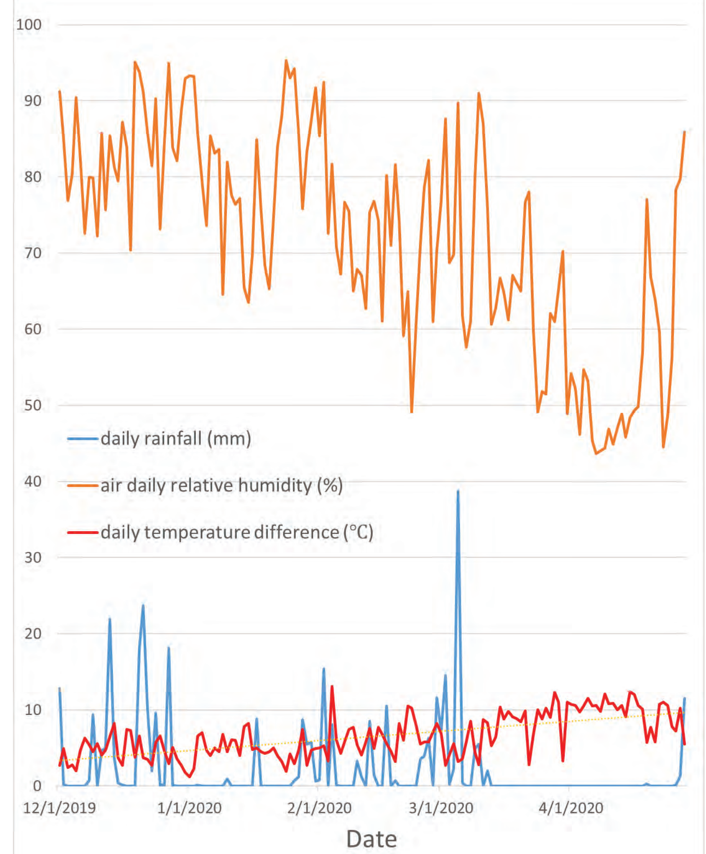

Figure 7: Meteorological curves

The meteorological curve(figure 7) shows that daily temperature difference increases while the rainfall and air relative humidity decreases from December 2019 to the end of April 2020. The rainfall and temperature difference in February occupy the median value among the 5 months.

Conclusion

Based on the field survey, rock layers mineral analysis, and the rockfall activities distribution in the different months until now, the weathering may pose a significant influence on the rock wall retreat. The moisture and thermal conditions in the rock surface are two key factors in the weathering process. Actually, we need continuous monitoring and tests to make clear the link between rock wall retreat and weathering.

References

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