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Comment on bg-2020-467

Anonymous Referee #1

Referee comment on "Microbial and geo-archaeological records reveal the growth rate, origin and composition of desert rock surface communities" by Nimrod Wieler et al., Biogeosciences Discuss., https://doi.org/10.5194/bg-2020-467-RC1, 2021

In the manuscript "Estimating the growth rate in desert biological rock crusts by integrating archaeological and geological records" by Wieler et al., the authors propose a creative method for dating the age of archeological sites by evaluating the growth rates of the rock-crust of biological origin. Although a helpful and required method, the assumptions and constraints made should be better specified.

Below are my comments.

- It is not clear to me whether the studied rocks are defined as desert varnish rocks, or under a broader case of rock crust. On one hand, the authors reference varnished rock studies but do not term them as such. I'm afraid that in some cases, this may mislead the readers. For example, the paper by Lang-Yona et al. does indicate that fungi are scars in type I varnished rocks, but this does not mean that other rock-crusts (or other types of varnished rocks) will have the same microbial composition. Varnished rocks can be clustered into five categories, based on their elemental composition, formation rate, and structure, implying possible differences in their formation mechanisms (Macholdt et al., 2017).

Therefore, a more precise definition of the type of studied rock-crust is needed, in addition to accuracy in citing other types of crust structures.

- The authors estimate a general growth rate value for biological rock crust (BRC), based on the chalk and limestone crust thickness and the assumption of crust accumulation starts with the establishment of the site. While the idea is creative and provides a helpful tool for archeological dating, I am not convinced that this equation can be

applied to other environments and different types of rock crusts for the following reasons:

- As the results show, the thickness of the chalk crust is 1-fold smaller than that of the limestone (line 72-74), and the thickness is not even over the same rock, as in limestone. This indicates that either the rate of formation is not even over different locations, or that the crust degrades/falls off with time. In the first case, one cannot assume a constant rate of formation, and in the latter case, how can the actual thickness of the crust representing the zero-starting point of crust accumulation can be determined? I presume assumptions have been made here, but they should be clearly stated, in order for this tool to be applied.
- The type of stone is only one constrain. Others include the directionality of the stone and exposure to sun radiation, the porosity of the stone, mineral content, humidity, slope directionality, etc. The authors should constrain their proposed rates to hold safe under specific conditions, and as an average rate with possible upper and lower limits.
- I am missing a validation test for this method. Did the author sample other sites and tried calculating the age of the stone based on the thickness of the BRC?

- The statement of bio-crust causing the difference in $d^{13}C$ between the rock types is thin. The authors do not present analyses of negative control rocks with no bio-crust, to prove that the difference in $d^{13}C$ values between chalk and limestone indeed comes from the crust activity. Therefore, I am not convinced that this is the reason for the difference, rather than the age of the rock, the structure, porosity, density, etc.
- In figure 4C, how does the stone type impact the coordinates of the samples' bacterial composition? This would be a valuable addition of information into the analysis. In addition, PCoA or other such analysis linking different parameters to the microbial composition may also be a valuable addition. For example, the impact of porosity, surface-to-volume ratio of the crust, crust thickness, and other parameters on the distribution of community composition of the samples in the coordinate matrix may give a hint on key microbes' preference under different conditions.

Reference:

Macholdt, D.S., Jochum, K.P., Pohlker, C., Arangio, A., Forster, J.-D., Stoll, B., et al, (2017) Characterization and differentiation of rock varnish types from different environments by microanalytical techniques. Chem Geol 459: 91.