Response to Prof. Dr. Veerle Vanacker

Thank you for your constructive feedback and comments on our revised manuscript. In our point-by-point response your comments are in italics and our responses are in bold. The line numbers refer to the manuscript you have commented.

The revised manuscript adequately addresses the main comments raised by previous reviewers. The manuscript is well written, and nicely illustrated.

Thank you for your appreciation of the manuscript.

A few minor issues might deserve the authors' attention before publication. They mainly concern the (hydro)climatic characterization of the area and the hydrological control on the weathering reactions.

1-Given the focus on the climatic control on chemical weathering, it would be helpful to have more information on the climate regimes in both sites. The soil water balance - and soil water fluxes - is controlled by precipitation, infiltration and evapotranspiration, and temperature and precipitation variability directly affect variation in soil water content. Information on actual evapotranspiration and infiltration is often difficult to collect, but data on the (intra-annual variability of the) precipitation and temperature regimes (and eventually ETp or ETa) would already be helpful to understand the differences in overall water balance between the two sites.

Unfortunately, the infiltration and evapotranspiration are unknown for the study sites. However, there is a published set of meteorological station data from the study sites that was collected over a period of several years. We cite this data set in the description of the study sites (Übernickel et al., 2020) but we see the necessity to emphasize it more. Thus, we added the following sentence (Line 90 and 106) to give the reader more information on the climate regimes in both sites:
"Records of long-term meteorological data (e.g., precipitation at ground level, soil water content, air temperature, relative humidity) from a weather station near the study site can be found in Übernickel et al. (2020)."
We also cite recently published information on MAP and MAT published in Scheibe et al. (2023) (see further below).

2-Water availability is cited as an important (hydro)climatic control on weathering, and the authors make a direct link between precipitation, water availability and infiltration/percolation rates (L411-413; L420-422; L501). A simple proxy of soil water balance (like P/ETp) can be helpful to characterize the overall soil water balance & link it with soil water fluxes in the two sites (e.g. Schoonejans et al., 2016). The schematic summary presented in Fig10 illustrates the soil system when ETp and P are roughly in balance. Would it still hold when there is a significant water deficit or surplus (see e.g. discussion in Reis et al. 2017)? In how far differences in soil water balance can have an effect on soil infiltration/percolation and water flow within soil and regolith?

Unfortunately, the potential evapotranspiration (ETp) is unknown for the study sites and the necessary parameters to evaluate the soil water balance have not been measured in La Campana and Nahuelbuta. Thus, we cannot provide information on the soil water balance. Our information on water availability and infiltration are solely relative between the study sites. We hope this is acceptable.
However, we think that Schoonejans et al. (2016) is a valuable addition to our explanation of the conditions in La Campana. Therefore, we added the following sentence to the manuscript (Line 419):
“This would also concur with the finding that water availability in the soil and soil residence time are the limiting factors for weathering processes in dry environments (Schoonejans et al., 2016).”

Detailed comments.

L31/33: I find it more informative to have the main characteristics (mean annual precip, mean annual temp, mean annual ETp) of both climate regimes ("Mediterranean" and "humid" climate) in the introduction.

We agree with your suggestion. However, the mean annual potential evapotranspiration (ETp) is unknown for the study sites. The MAT and MAP are listed in a recent publication (Scheibe et al., 2023). Therefore, we added the following to the text (new text in green; Line 72-73):
One profile is located in a Mediterranean (mean annual temperature: 14.9 °C, mean annual precipitation: 436 mm yr^{-1}) and another in a humid climate zone (mean annual temperature: 14.1 °C, mean annual precipitation: 1084 mm yr^{-1}) (Scheibe et al., 2023), and both developed from weathering of granitic rock.

L94/95 + 110/114: To allow for comparison between uplift and denudation rates, can you express all values in the same units? (either mm yr-1 or t km-2 yr-1)?

By assuming a density of 2.6 g cm^{-3} we converted the unit [t km^{-2} yr^{-1}] to [mm yr^{-1}] and added this information in Line 95 and 113 (new text in green):
"The soil denudation rate in the nearby La Campana National Park is 53.7 ± 3.4 (S-facing slope) to 69.2 ± 4.6 t km^{-2} yr^{-1} (N-facing slope) (Oeser et al., 2018) or assuming a material density of 2.6 g cm^{-3}, 0.024 mm yr^{-1} on average."
"The soil denudation rate in the nearby Nahuelbuta National Park ranges between 17.7 ± 1.1 (N-facing slope) to 47.5 ± 3.0 t km^{-2} yr^{-1} (S-facing slope) (Oeser et al., 2018) or assuming a material density of 2.6 g cm^{-3}, 0.013 mm yr^{-1} on average."

L149 & L153-157: The equation for the CDF is somewhat different than Eq. 1 in Riebe et al. (2003)? Can you briefly explain the difference in the text?

Thank you very much for spotting this mistake. We calculated the CDF values correctly, but the terms in the brackets of Equation 1 (Line 149) are incorrect as the subscript "N" of Zr already indicates the normalisation. The modification of the CDF equation is explained in the data publication. To make that clear, we added "(see Hampl et al., 2022b)" in the explanation of the equation (Line 156, 157) and deleted the brackets in Equation 1 as well as the explanation of sum^w, LOI^w, sum^b and LOI^b (new text in green):
"Zr_N^b = zirconium content of the bedrock normalized to a LOI-free sum of 100 % (see Hampl et al., 2022b), Zr^w = concentration of Zr in the weathered sample, Zr_N^w = zirconium content of the weathered sample normalized to a LOI-free sum of 100 % (see Hampl et al., 2022b)."

Oxalate- and dithionite-extractable Fe, Si, and Al are often noted with subscripts "o" or "d" in the literature.

Thank you for this hint. As our abbreviations do not cause any confusion, we would like to keep them and do not want to change "did" to "d" and "ox" to "o".

L335-337: Are these values wt.% of Mg-oxides?

Thank you for the question. As shown in Figure 7 the unit of the magnetite content is vol.%. We will add "vol." to the values in question (new text in green, Line 335-337):

"A relative magnetite enrichment was detected in the uppermost 40 cm of the LC profile (1–1.6 vol.%) whereas the rest of the profile shows approximately constant magnetite contents (mean ~0.9 vol.%) close to the value of the investigated bedrock (0.94 vol.%; Fig. 7c)."

L513: Clay migration (illuviation) can also play a role in the decrease of porosity.

Thank you for this comment. Since we do not see evidence for illuviation, we prefer not to add this topic.

Fig1: would be useful to have latlong added to the map -> panel(a)?

The latitude and longitude are added to panel (a) of Figure 1.

Fig2 & 3 & 4: Very nice figures

Thank you.

Fig7: Does the "pebble-size" material correspond to the fraction of the sample that is coarser than 2 mm? If so, you could also refer to "gravel" following the Udden-Wentworth grain-size scale.

The term is changed in Figure 7 and the sentence mentioning the result is adapted to (new text in green, Line 339):
"The soil pit profile of NA is characterized by a much higher gravel- and silt/clay-size content compared to LC (Fig. 7d)."
We also changed it in the corresponding data publication.

Fig10: Schematic summary is a great addition to the paper.

Thank you.

References

Hampl, F. J., Schiperski, F., Schwerdhelm, C., Stroncik, N., Bryce, C., von Blanckenburg, F., and Neumann, T.: Mineralogical and geochemical data of two weathering profiles in a Mediterranean and a humid climate region of the Chilean Coastal Cordillera, GFZ Data Services [data set], https://doi.org/10.5880/fidgeo.2022.035, 2022b.

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Reis, F. D. A. A., and S. L. Brantley (2017), Models of transport and reaction describing weathering of fractured rock with mobile and immobile water,J. Geophys.Res. Earth Surf.,122, 735–757, doi: 10.1002/2016JF004118.

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Übernickel, K., Ehlers, T. A., Ershadi, M. R., Paulino, L., Fuentes Espoz, J.-P., Maldonado, A., Oses-Pedraza, R., and von Blanckenburg, F.: Time series of meteorological station data in the EarthShape study areas in the Coastal Cordillera, Chile, GFZ Data Services [data set], https://doi.org/10.5880/fidgeo.2020.043, 2020.

Additions and changes to the manuscript

This is a structured compilation of the additions (in green) and changes to the manuscript. The line numbers we give here refer to the revised version (with accepted changes) of our manuscript.

Line 72-75: One profile is located in a Mediterranean (mean annual temperature: 14.9 °C, mean annual precipitation: 436 mm yr^{-1}) and another in a humid climate zone (mean annual temperature: 14.1 °C, mean annual precipitation: 1084 mm yr^{-1}) (Scheibe et al., 2023), and both developed from weathering of granitic rock.

Line 92-94: Records of long-term meteorological data (e.g., precipitation at ground level, soil water content, air temperature, relative humidity) from a weather station near the study site can be found in Übernickel et al. (2020).

Line 98-100: The soil denudation rate in the nearby La Campana National Park is 53.7 ± 3.4 (S-facing slope) to 69.2 ± 4.6 t km^{-2} yr^{-1} (N-facing slope) (Oeser et al., 2018) or assuming a material density of 2.6 g cm^{-3}, 0.024 mm yr^{-1} on average.

Line 111-113: Records of long-term meteorological data (e.g., precipitation at ground level, soil water content, air temperature, relative humidity) from a weather station near the study site can be found in Übernickel et al. (2020).

Line 119-120: The soil denudation rate in the nearby Nahuelbuta National Park ranges between 17.7 ± 1.1 (N-facing slope) to 47.5 ± 3.0 t km^{-2} yr^{-1} (S-facing slope) (Oeser et al., 2018) or assuming a material density of 2.6 g cm^{-3}, 0.013 mm yr^{-1} on average."

Line 156:

$$\mathrm{CDF} = 1 - \frac{Zr_N^b \cancel{\cdot (sum^w - LOI^w)}}{Zr_N^W \cancel{\cdot (sum^b - LOI^b)}}$$

Line 160-163: ~~LOI^b = loss on ignition of the bedrock, LOI^w = loss on ignition of the weathered sample, sum^b = measured total sum (wt.%) of the bedrock, sum^w = measured total sum (wt.%) of the weathered sample,~~ X^b = concentration of element X in the bedrock, X^w = concentration of element X in the weathered sample, Zr^b = concentration of Zr in the bedrock, Zr_N^b = zirconium content of the bedrock normalized to a LOI-free sum of 100 % (see Hampl et al., 2022b), Zr^w = concentration of Zr in the weathered sample, Zr_N^w = zirconium content of the weathered sample normalized to a LOI-free sum of 100 % (see Hampl et al., 2022b).

Line 341-343: A relative magnetite enrichment was detected in the uppermost 40 cm of the LC profile (1–1.6 vol.%) whereas the rest of the profile shows approximately constant magnetite contents (mean ~0.9 vol.%) close to the value of the investigated bedrock (0.94 vol.%; Fig. 7c).

Line 345: The soil pit profile of NA is characterized by a much higher gravel- and silt/clay-size content compared to LC (Fig. 7d).

Line 425-426: This would also concur with the finding that water availability in the soil and soil residence time are the limiting factors for weathering processes in dry environments (Schoonejans et al., 2016).

Line 608-609: The authors would also like to thank Prof. Dr. Peter Finke, Prof. Dr. Veerle Vanacker and Prof. Dr. Susan L. Brantley for their valuable comments and suggestions that greatly improved the manuscript.