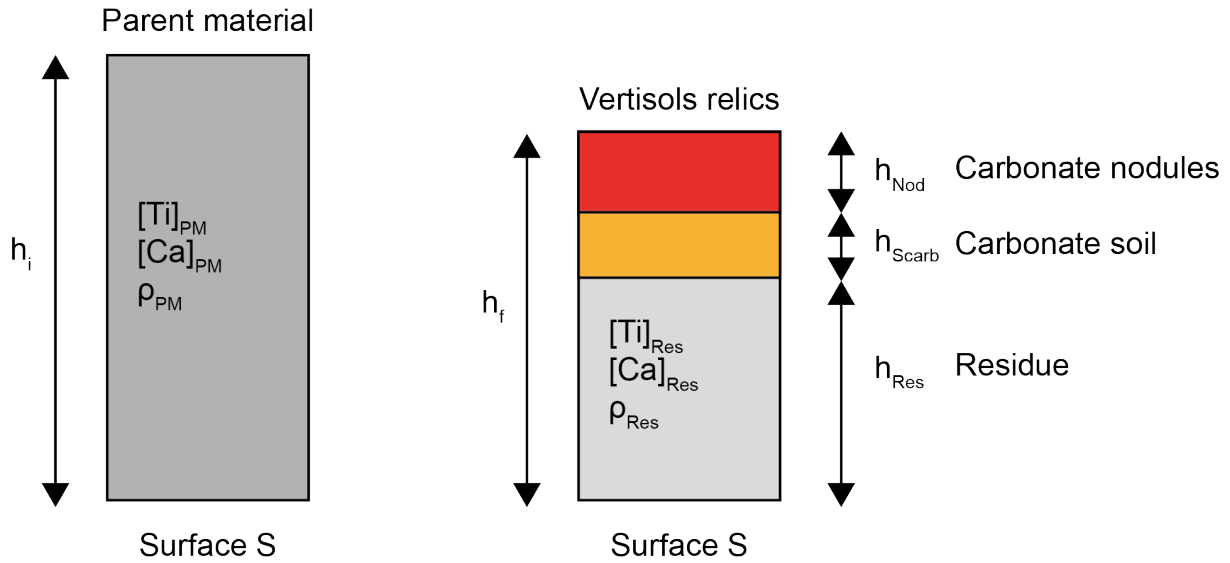**Supplementary materials C: Calculation of Ca depletion and accumulation**

Initial mass m_{PM}
$$m_{PM} = h_i * S * \rho_{PM}$$
$$m(Ti)_{PM} = [Ti]_{PM} * m_{PM}$$
$$m(Ca)_{PM} = [Ca]_{PM} * m_{PM}$$

Mass residue m_{Res}
$$m_{Res} = h_i * S * \rho_{Res}$$
$$m(Ti)_{Res} = [Ti]_{Res} * m_{Res}$$
$$m(Ca)_{Res} = [Ca]_{Res} * m_{Res}$$

Ti is conservative, then
$$[Ti]_{PM} * h_{PM} * S * \rho_{PM} = [Ti]_{Res} * h_{Res} * S * \rho_{Res}$$

The depletion can be express as:
$$\frac{h_{Res}}{h_{PM}} = \frac{[Ti]_{PM} * \rho_{PM}}{[Ti]_{Res} * \rho_{Res}} = \varepsilon$$

Ca depletion in the residue of Vertisol relics compared to the parent material can be defined as:
$$Ca_{Depletion} = \frac{m(Ca)_{Res}}{m(Ca)_{PM}}$$
$$= \frac{[Ca]_{Res} * m_{Res}}{[Ca]_{PM} * m_{PM}}$$
$$= \frac{[Ca]_{Res} * m_{Res}}{[Ca]_{PM} * m_{PM}}$$

$$= \frac{[Ca]_{Res} * [Ti]_{PM}}{[Ca]_{PM} * [Ti]_{Res}} = \frac{\left(Ca/Ti\right)_{Res}}{\left(Ca/Ti\right)_{PM}}$$

For the accumulation in the carbonate phases, the normalization with Ti is not pertinent. Therefore, it is proposed to compare 1 volume of parent material with 1 volume of Vertisol relics. Nevertheless, the loss of volume has to be taken into account and the volume of the present-day soil (Vertisol relics) needs to be corrected with ε value, defined above.

Ca accumulation in the carbonate soil of the Vertisol relics can be defined as:

$$Ca_{SCarb-Acc} = \frac{m(Ca)_{SCarb}}{m(Ca)_{PM}}$$

$$= \frac{[Ca]_{SCarb} * m_{SCarb}}{[Ca]_{PM} * m_{PM}}$$

$$= \frac{[Ca]_{SCarb} * h_{SCarb} * S * \rho_{SCarb}}{[Ca]_{PM} * h_i * S * \rho_{PM}}$$

$$= \frac{[Ca]_{SCarb} * h_{SCarb} * S * h_{Res} * \rho_{SCarb}}{[Ca]_{PM} * h_i * S * h_{Res} * \rho_{PM}}$$

$$= \frac{[Ca]_{SCarb} * \rho_{SCarb}}{[Ca]_{PM} * \rho_{PM}} * \frac{\alpha_{Scarb}}{\alpha_{Res}} * \varepsilon$$

where α is the fraction in volume of the soil carbonate or the residue in the Vertisols relics.

Similarly, the Ca accumulation in the carbonate nodules of the Vertisol relics can be defined as:

$$Ca_{Nod-Acc} = \frac{[Ca]_{Nod} * \rho_{Nod}}{[Ca]_{PM} * \rho_{PM}} * \frac{\alpha_{Nod}}{\alpha_{Res}} * \varepsilon$$