TropSOC Database

3.2.2. Cropland – Mineral Soil Layers – Physicochemical soil properties from laboratory methods

When using these data, please cite the database and the key publication in ESSD:

Doetterl, S.; Bukombe, B.; Cooper, M.; Kidinda, L.; Muhindo, D.; Reichenbach, M.; Stegmann, A.; Summerauer, L.; Wilken, F.; Fiener, P. (2021): TropSOC Database. V. 1.0. GFZ Data Services. https://doi.org/10.5880/fidgeo.2021.009

Doetterl S., Asifiwe R.K., Baert G., Bamba F., Bauters M., Boeckx P., Bukombe B., Cadisch G., Cizungu L.N., Cooper M., Hoyt A., Kabaseke C., Kalbitz K., Kidinda L., Maier A., Mainka M., Mayrock J., Muhindo D., Mujinya B.B., Mukotanyi, S.M., Nabahungu L., Reichenbach M., Rewald B., Six J., Stegmann A., Summerauer L., Unseld R., Vanlauwe B., Van Oost K., Verheyen K. Vogel C., Wilken F., Fiener P. Organic matter cycling along geochemical, geomorphic and disturbance gradients in forests and cropland of the African Tropics - Project TropSOC Database Version 1.0. *Earth System Science Data*. https://doi.org/10.5194/essd-2021-73, 2021.

Additionally more details are given in:

Bukombe B., Fiener P., Hoyt A., Doetterl S. Controls on heterotrophic soil respiration and carbon cycling in geochemically distinct African tropical forest soils. *Soil Discussion (pre-print).* https://doi.org/10.5194/soil-2020-96, 2021.

Reichenbach M., Fiener P., Garland G., Griepentrog M., Six J., Doetterl S. The role of geochemistry in organic carbon stabilization in tropical rainforest soils. *Soil Discussion* (*pre-print).* https://doi.org/10.5194/soil-2020-92, 2021.

Introduction

The dataset comprises a unique sample identifier and 192 additional soil variables derived from physical and chemical laboratory analyses for TropSOC's cropland plots. Most data are given for three soil depths 0 - 10 cm, 30 - 40 cm, and 60 - 70 cm (partly 90 - 100 cm). For all other soil depths missing values are indicated by -9999. This data set is among the data sets providing the basis for the spectrometer calibration, resulting in a more comprehensive data set for 'all' soil depths. Data on most parameters for missing soil depth increments is provided using NIR-MIR spectroscopy (see 323_soil_spec.csv/pdf). Note: Details regarding plots and plot design can be found in 3_cropland.pdf.

Data structure

No.	Variable	Explanation	Unit
1	sampleID	unique identifier of any soil or vegetation sample taken in the field	-
2	clay	clay [<2 µm] fraction of fine soil [<2 mm]	%
3	silt	silt [2-53 µm] fraction of fine soil [<2 mm]	%
4	sand	Sand [53-2000 µm] fraction of fine soil [<2 mm]	%
5	BD_m_soil	bulk density of mineral soil layer	g cm^{-3}
6	WHC	water holding capacity [H_2O g / soil g]	wt %
7	pH_KCl	pH measured in 1 Mol KCl solution	-
8	P_bray	soil plant available phosphorus (Bray-P)	mg kg^{-1}

9	exch_acidity_Al	exchangeable Al^{3+} of ECEC	meq 100 g^{-1} [= cmol(+) kg^{-1}]
10	exch_acidity_H	exchangeable H^{+} of ECEC	meq 100 g^{-1} [= cmol(+) kg^{-1}]
11	exch_bases_Na	exchangeable Na^{2+} of ECEC	meq 100 g^{-1} [= cmol(+) kg^{-1}]
12	exch_bases_K	exchangeable K^{+} of ECEC	meq 100 g^{-1} [= cmol(+) kg^{-1}]
13	exch_bases_Ca	exchangeable Ca^{2+} of ECEC	meq 100 g^{-1} [= cmol(+) kg^{-1}]
14	exch_bases_Mg	exchangeable Mg^{2+} of ECEC	meq 100 g^{-1} [= cmol(+) kg^{-1}]
15	ECEC	effective cation exchange capacity	meq 100 g^{-1} [= cmol(+) kg^{-1}]
16	bases_in_ECEC	base saturation of effective cation exchange capacity	%
17	CEC	potential cation exchange capacity	meq 100 g^{-1} [= cmol(+) kg^{-1}]
18	bases_in_CEC	base saturation of potential cation exchange capacity	%
19	mean_Ca_bulk_OES	mean Ca in mass percent of the bulk soil	%
20	sd_Ca_bulk_ICPOES	standard deviation of mean Ca in mass percent of the bulk soil	%
21	no_Ca_bulk_ICPOES	number of measurements for mean Ca of the bulk soil	%
22	mean_Ca_agg_ICPOES	mean Ca in mass percent of water-stable microaggregates	%
23	sd_Ca_agg_ICPOES	standard deviation of mean Ca in mass percent of water-stable microaggregates	%
24	no_Ca_agg_ICPOES	number of measurements for mean Ca of water-stable microaggregates	%
25	mean_Ca_s+c_ICPOES_	mean Ca in mass percent of the free silt and clay fraction	%
26	sd_Ca_s+c_ICPOES	standard deviation of mean Ca in mass percent of the free silt and clay fraction	%
27	no_Ca_s+c_ICPOES	number of measurements for mean Ca of the free silt and clay fraction	%
28	mean_Cu_bulk_ICPOES_	mean Cu in mass percent of bulk soil	%
29	sd_Cu_bulk_ICPOES	standard deviation of mean Cu in mass percent of the bulk soil	%
30	no_Cu_bulk_ICPOES	number of measurements for mean Cu of the bulk soil	%
31	mean_Cu_agg_ICPOES	mean Cu in mass percent of water-stable microaggregates	%
32	sd_Cu_agg_ICPOES	standard deviation of mean Cu in mass percent of water-stable microaggregates	%
33	no_Cu_agg_ICPOES	number of measurements for mean Cu of water-stable microaggregates	%
34	mean_Cu_s+c_ICPOES	mean Cu in mass percent of the free silt and clay fraction	%
35	sd_Cu_s+c_ICPOES	standard deviation of mean Cu in mass percent of the free silt and clay fraction	%
36	no_Cu_s+c_ICPOES	number of measurements for mean Cu of the free silt and clay fraction	%

37	mean_K_bulk_ICPOES	mean K in mass percent of bulk soil	%
38	sd_K_bulk_ICPOES	standard deviation of mean K in mass percent of the bulk soil	%
39	no_K_bulk_ICPOES	number of measurements for mean K of the bulk soil	%
40	mean_K_agg_ICPOES	mean K in mass percent of water-stable microaggregates	%
41	sd_K_agg_ICPOES	standard deviation of mean K in mass percent of water-stable microaggregates	%
42	no_K_agg_ICPOES	number of measurements for mean K of water stable soil aggregates	%
43	mean_K_s+c_ICPOES	mean K in mass percent of the free silt and clay fraction	%
44	sd_K_s+c_ICPOES	standard deviation of mean K in mass percent of the free silt and clay fraction	%
45	no_K_s+c_ICPOES	number of measurements for mean K of the bulk soil	%
46	mean_Mg_bulk_ICPOES	mean Mg in mass percent of the bulk soil	%
47	sd_Mg_bulk_ICPOES	standard deviation of mean Mg in mass percent of the bulk soil	%
48	no_Mg_bulk_ICPOES	number of measurements for mean Mg of the bulk soil	%
49	mean_Mg_agg_ICPOES	mean Mg in mass percent of water-stable microaggregates	%
50	sd_Mg_agg_ICPOES	standard deviation of mean Mg in mass percent of water-stable microaggregates	%
51	no_Mg_agg_ICPOES	number of measurements for mean Mg of water-stable microaggregates	%
52	mean_Mg_s+c_ICPOES	mean Mg in mass percent of the free silt and clay fraction	%
53	sd_Mg_s+c_ICPOES	standard deviation of mean Mg in mass percent of the free silt and clay fraction	%
54	no_Mg_s+c_ICPOES	number of measurements for mean Mg of the free silt and clay fraction	%
55	mean_Na_bulk_ICPOES	mean Na in mass percent of the bulk soil	%
56	sd_Na_bulk_ICPOES	standard deviation of mean Na in mass percent of the bulk soil	%
57	no_Na_bulk_ICPOES	number of measurements for mean Na of the bulk soil	%
58	mean_Na_agg_ICPOES	mean Na in mass percent of water-stable microaggregates	%
59	sd_Na_agg_ICPOES	standard deviation of mean Na in mass percent of water stable soil aggregates	%
60	no_Na_agg_ICPOES	number of measurements for mean Na of water-stable microaggregates	%
61	mean_Na_s+c_ICPOES	mean Na in mass percent of the free silt and clay fraction	%
62	sd_Na_s+c_ICPOES	standard deviation of mean Na in mass percent of the free silt and clay fraction	%
63	no_Na_s+_ICPOES	number of measurements for mean Na of the free silt and clay fraction	%
64	mean_P_bulk_ICPOES	mean P in mass percent of the bulk soil	%
65	sd_P_bulk_ICPOES	standard deviation of mean P in mass percent of the bulk soil	%
66	no_P_bulk_ICPOES	number of measurements for mean P of the bulk soil	%
67	mean_P_agg_ICPOES	mean P in mass percent of water-stable microaggregates	%

68	sd_P_agg_ICPOES	standard deviation of mean P in mass percent of water-stable microaggregates	%
69	no_P_agg_ICPOES	number of measurements for mean P of water-stable microaggregates	%
70	mean_P_s+c_ICPOES	mean P in mass percent of the free silt and clay fraction	%
71	sd_P_s+_ICPOES	standard deviation of mean P in mass percent of the free silt and clay fraction	%
72	no_P_s+_ICPOES	number of measurements for mean P of the free silt and clay fraction	%
73	mean_Ti_bulk_ICPOES	mean Ti in mass percent of the bulk soil	%
74	sd_Ti_bulk_ICPOES	standard deviation of mean Ti in mass percent of the bulk soil	%
75	no_Ti_bulk_ICPOES	number of measurements for mean Ti of the bulk soil	%
76	mean_Ti_agg_ICPOES	mean Ti in mass percent of water-stable microaggregates	%
77	sd_Ti_agg_ICPOES	standard deviation of mean Ti in mass percent of water-stable microaggregates	%
78	no_Ti_agg_ICPOES	number of measurements for mean Ti of water-stable microaggregates	%
79	mean_Ti_s+c_ICPOES	mean Ti in mass percent of the free silt and clay fraction	%
80	sd_Ti_s+c_bulk_ICPOES	standard deviation of mean Ti in mass percent of the free silt and clay fraction	%
81	no_Ti_s+c_bulk_ICPOES	number of measurements for mean Ti of the free silt and clay fraction	%
82	mean_Zn_bulk_ICPOES	mean Zn in mass percent of the bulk soil	%
83	sd_n_bulk_ICPOES	standard deviation of mean Zn in mass percent of the bulk soil	%
84	no_Zn_bulk_ICPOES	number of measurements for mean Zn of the bulk soil	%
85	mean_Zn_agg_ICPOES	mean Zn in mass percent of water-stable microaggregates	%
86	sd_Zn_agg_ICPOES	standard deviation of mean Zn in mass percent of water-stable microaggregates	%
87	no_Zn_agg_ICPOES	number of measurements for mean Zn of water-stable microaggregates	%
88	mean_Zn_s+c_ICPOES	mean Zn in mass percent of the free silt and clay fraction	%
89	sd_Zn_s+c_ICPOES	standard deviation of mean Zn in mass percent of the free silt and clay fraction	%
90	no_Zn_s+c_ICPOES	number of measurements for mean Zn of the free silt and clay fraction	%
91	mean_Al_bulk_ICPOES	mean Al in mass percent of the bulk soil	%
92	sd_Al_bulk_ICPOES	standard deviation of mean Al in mass percent of the bulk soil	%
93	no_Al_bulk_ICPOES	number of measurements for mean Al of the bulk soil	%
94	mean_Al_agg_ICPOES	mean Al in mass percent of water-stable microaggregates	%
95	sd_Al_agg_ICPOES	standard deviation of mean Al in mass percent of water-stable microaggregates	%
96	no_Al_agg_ICPOES	number of measurements for mean Al of water-stable microaggregates	%

97	mean_Al_s+c_ICPOES	mean Al in mass percent of the free silt and clay fraction	%
98	sd_Al_s+c_ICPOES	standard deviation of mean Al in mass percent of the free silt and clay fraction	%
99	no_Al_s+c_ICPOES	number of measurements for mean Al of the free silt and clay fraction	%
100	mean_Fe_bulk_ICPOES	mean Fe in mass percent of the bulk soil	%
101	sd_Fe_bulk_ICPOES	standard deviation of mean Fe in mass percent of the bulk soil	%
102	no_Fe_bulk_ICPOES	number of measurements for mean Fe of the bulk soil	%
103	mean_Fe_agg_ICPOES	mean Fe in mass percent of water-stable microaggregates	%
104	sd_Fe_agg_ICPOES	standard deviation of mean Fe in mass percent of water-stable microaggregates	%
105	no_Fe_agg_ICPOES	number of measurements for mean Fe of water-stable microaggregates	%
106	mean_Fe_s+c_ICPOES	mean Fe in mass percent of the free silt and clay fraction	%
107	sd_Fe_s+c_ICPOES	standard deviation of mean Fe in mass percent of the free silt and clay fraction	%
108	no_Fe_s+c_ICPOES	number of measurements for mean Fe of the free silt and clay fraction	%
109	mean_Mn_bulk_ICPOES	mean Mn in mass percent of the bulk soil	%
110	sd_Mn_bulk_ICPOES	standard deviation of mean Mn in mass percent of bulk soil	%
111	no_Mn_bulk_ICPOES	number of measurements for mean Mn of the bulk soil	%
112	mean_Mn_agg_ICPOES	mean Mn in mass percent of water-stable microaggregates	%
113	sd_Mn_agg_ICPOES	standard deviation of mean Mn in mass percent of water-stable microaggregates	%
114	no_Mn_agg_ICPOE	number of measurements for mean Mn of water-stable microaggregates	%
115	mean_Mn_s+c_ICPOES	mean Mn in mass percent of the free silt and clay fraction	%
116	sd_Mn_s+c_ICPOES	standard deviation of mean Mn in mass percent of the free silt and clay fraction	%
117	no_Mn_s+c_ICPOES	number of measurements for mean Mn of the free silt and clay fraction	%
118	Na_XRF	mass percent of Na in the bulk soil	%
119	Mg_XRF	mass percent of Mg in the bulk soil	%
120	Al_XRF	mass percent of Al in the bulk soil	%
121	Si_XRF	mass percent of Si in the bulk soil	%
122	P_XRF	mass percent of P in the bulk soil	%
123	S_XRF	mass permille of S in the bulk soil	$\mu g\ g^{-1}$
124	Cl_XRF	mass permille of Cl in the bulk soil	$\mu g\ g^{-1}$
125	K_XRF	mass percent of K in the bulk soil	%
126	Ca_XRF	mass percent of Ca in the bulk soil	%
127	Sc_XRF	mass permille of Sc in the bulk soil	$\mu g\ g^{-1}$
128	Ti_XRF	mass percent of Ti in the bulk soil	%
129	Cr_XRF	mass permille of Cr in the bulk soil	$\mu g\ g^{-1}$

130	Mn_XRF	mass percent of Mn in the bulk soil	%
131	Fe_XRF	mass percent of Fe in the bulk soil	%
132	Co_XRF	mass permille of Co in the bulk soil	µg g^{-1}
133	Ni_XRF	mass permille of Ni in the bulk soil	µg g^{-1}
134	Cu_XRF	mass permille of Cu in the bulk soil	µg g^{-1}
135	Zn_XRF	mass permille of Zn in the bulk soil	µg g^{-1}
136	As_XRF	mass permille of As in the bulk soil	µg g^{-1}
137	Se_XRF	mass permille of Se in the bulk soil	µg g^{-1}
138	Br_XRF	mass permille of Br in the bulk soil	µg g^{-1}
139	Rb_XRF	mass permille of Rb in the bulk soil	µg g^{-1}
140	Sr_XRF	mass permille of Sr in the bulk soil	µg g^{-1}
141	Y_XRF	mass permille of Y in the bulk soil	µg g^{-1}
142	Zr_XRF	mass permille of Zr in the bulk soil	µg g^{-1}
143	Mo_XRF	mass permille of Mo in the bulk soil	µg g^{-1}
144	Ag_XRF	mass permille of Ag in the bulk soil	µg g^{-1}
145	Cd_XRF	mass permille of Cd in the bulk soil	µg g^{-1}
146	In_XRF	mass permille of In in the bulk soil	µg g^{-1}
147	Sn_XRF	mass permille of Sn in the bulk soil	µg g^{-1}
148	Sb_XRF	mass permille of Sb in the bulk soil	µg g^{-1}
149	Te_XRF	mass permille of Te in the bulk soil	µg g^{-1}
150	I_XRF	mass permille of I in the bulk soil	µg g^{-1}
151	Cs_XRF	mass permille of Cs in the bulk soil	µg g^{-1}
152	Ba_XRF	mass permille of Ba in the bulk soil	µg g^{-1}
153	La_XRF	mass permille of La in the bulk soil	µg g^{-1}
154	Ce_XRF	mass permille of Ce in the bulk soil	µg g^{-1}
155	Pr_XRF	mass permille of Pr in the bulk soil	µg g^{-1}
156	Nd_XRF	mass permille of Nd in the bulk soil	µg g^{-1}
157	Hf_XRF	mass permille of Hf in the bulk soil	µg g^{-1}
158	Ta_XRF	mass permille of Ta in the bulk soil	µg g^{-1}
159	W_XRF	mass permille of W in the bulk soil	µg g^{-1}
160	Au_XRF	mass permille of Au in the bulk soil	µg g^{-1}
161	Hg_XRF	mass permille of Hg in the bulk soil	µg g^{-1}
162	Tl_XRF	mass permille of Tl in the bulk soil	µg g^{-1}
163	Pb_XRF	mass permille of Pb in the bulk soil	µg g^{-1}
164	Bi_XRF	mass permille of Bi in the bulk soil	µg g^{-1}
165	Th_XRF	mass permille of Th in the bulk soil	µg g^{-1}
166	U_XRF	mass permille of U in the bulk soil	µg g^{-1}
167	mean_Al_py_extract	mean mass percent of sodium-pyrophosphate extractable Al in mass percent of the bulk soil	%
168	sd_Al_py_extract	standard deviation of mean mass percent of sodium-pyrophosphate extractable Al of the bulk soil	%

169	no_Al_py_extract	number of measurements for mean mass percent of sodium-pyrophosphate extractable Al of the bulk soil	%
170	mean_Al_ox_extract	mean mass percent of ammonium oxalate-oxalic acid extractable Al in mass percent of the bulk soil	%
171	sd_Al_ox_extract	standard deviation of mean mass percent of ammonium oxalate-oxalic acid extractable Al of the bulk soil	%
172	no_Al_ox_extract	number of measurements for mean mass percent of ammonium oxalate-oxalic acid extractable Al	%
173	mean_Al_dcb_extract	mean mass percent of dithionite-citrate-bicarbonate extractable Al in mass percent of the bulk soil	%
174	sd_Al_dcb_extrac	standard deviation of mean mass percent of dithionite-citrate-bicarbonate extractable Al of the bulk soil	%
175	no_Al_dcb_extract	number of measurements for mean mass percent dithionite-citrate-bicarbonate extractable Al of the bulk soil	%
176	mean_Fe_py_extract	mean mass percent of sodium-pyrophosphate extractable Fe in mass percent of the bulk soil	%
177	sd_Fe_py_extract	standard deviation of mean mass percent of sodium-pyrophosphate extractable Fe of the bulk soil	%
178	no_Fe_py_extract	number of measurements for mean mass percent of sodium-pyrophosphate extractable Fe of the bulk soil	%
179	mean_Fe_ox_extract	mean mass percent of ammonium oxalate-oxalic acid extractable Fe in mass percent of the bulk soil	%
180	sd_Fe_ox_extract	standard deviation of mean mass percent of ammonium oxalate-oxalic acid extractable Fe of the bulk soil	%
181	no_Fe_ox_extract	number of measurements for mean mass percent of ammonium oxalate-oxalic acid extractable Fe of the bulk soil	%
182	mean_Fe_dcb_extract	mean mass percent of dithionite-citrate-bicarbonate extractable Fe in mass percent of the bulk soil	%
183	sd_Fe_dcb_extract	standard deviation of mean mass percent of dithionite-citrate-bicarbonate extractable Fe of the bulk soil	%
184	no_Fe_dcb_extract	number of measurements for mean mass percent of dithionite-citrate-bicarbonate extractable Fe of the bulk soil	%
185	mean_Mn_py_extract	mean mass percent of sodium-pyrophosphate extractable Mn in mass percent of the bulk soil	%
186	sd_Mn_py_extract	standard deviation of mean mass percent of sodium-pyrophosphate extractable Mn of the bulk soil	%
187	no_Mn_py_extract	number of measurements for mean mass percent of sodium-pyrophosphate extractable Mn of the bulk soil	%
188	mean_Mn_ox_extract	mean mass percent of ammonium oxalate-oxalic acid extractable Mn in mass percent of the bulk soil	%
189	sd_Mn_ox_extract	standard deviation of mean mass percent of ammonium oxalate-oxalic acid extractable Mn of the bulk soil	%
190	no_Mn_ox_extract	number of measurements for mean mass percent of ammonium oxalate-oxalic acid extractable Mn of the bulk soil	%
191	mean_Mn_dcb_extract	mean mass percent of dithionite-citrate-bicarbonate extractable Mn in mass percent of the bulk soil	%
192	sd_Mn_dcb_extract	standard deviation of mean mass percent of dithionite-citrate-bicarbonate extractable Mn of the bulk soil	%

193	no_Mn_dcb_extract	number of measurements for mean mass percent of dithionite-citrate-bicarbonate extractable Mn of the bulk soil	%

Methods

Particle size analyses for soil texture [Variable 2 to 4]: Soil texture was analysed using the Bouyoucos hydrometer method (Bouyoucos 1962) and modified following Beretta et al. (2014). Briefly, 50 g of 2 mm sieved bulk soil were dispersed with a 10 % sodium hexametaphosphate $(NaPO_3)_6$ solution and freed of organic carbon by applying 6 % hydrogen peroxide H_2O_2 three times at 60 °C. After mixing the soil suspension and transferring it into a glass column, hydrometer readings on the density of the suspension at a certain depth of the column are taken after 40 seconds and 2 hours to distinguish between silt and clay fraction. These readings were based on Stokes law that describes the rate of sedimentation as a function of particle diameter. The sand fraction was assessed by wet sieving.

Bulk density (BD) [Variable 5]: Soil bulk density (BD) was assessed using depth-explicit samples with a Kopecky cylinder of known volume (98.13 cm^3) or derived from the known volume and weight of the soils sampled using percussion drilling and closed tube samples. Before bulk density measurements were conducted, all samples were oven-dried at 105 °C for 24 hours and weighed subsequently. Stone content was neglectable for all investigated soil samples. BD of the L and O horizons were assessed by sampling litter and organic soil layers at nine points along the border and in the centre of each forest plot. At each sampling point the thickness of the litter layer was measured with a ruler and then sampled within a 5 cm x 5 cm square. When the litter layer was too thin, the sampling square was expanded to 10 cm x 10 cm to retrieve enough sample material. The nine samples of each layer were combined to one composite sample representing a 40 x 40 m forest plot. Collected composite samples were then oven dried at 40 °C for 48 hours and subsequently weighted. The volume of each layer was calculated using the averaged thickness of each layer multiplied by the square area of all nine sampling points. The bulk density of each layer was then calculated by dividing the dry weight of the composite sample by its volume. Note that due to Covid-19 lockdown measures in 2020 we were not able to sample the bulk density of the L and O horizons of the felsic forest plots. Instead, we used average values of the L and O horizons at the according slope positions of the mafic and mixed sedimentary rock regions as a replacement.

Water holding capacity [Variable 6]: Water holding capacity (WHC) was assessed in triplicates for samples that were selected later on for laboratory incubation following standard procedures of the American Society for Testing Materials (ASTM 2003). Briefly, 10 g of 12 mm sieved soil that was placed in a Haines Funnel (Ø 8 cm) on top of Whatman Grade 42, ashless filter paper. Then, samples were saturated with distilled water and left to drain for approximately 30 minutes. Wet filters as well as dry and wet samples were weighed and the WHC was derived by the weight difference of the dry versus the wet, saturated soil (after subtracting the filter weight).

pH value [variable 7]: Soil pH values were determined following the protocol by Black (1965) potentiometrically with a glass electrode using a portable multiparameter Meter HI9828 (Hanna Instruments US Inc., USA) on 20 g of 2 mm sieved bulk soil sample material. Prior to measurements the bulk soil material was stirred for 10 minutes and followed by response time of 30 min in a 1:2.5 soil (weight) / solution (volume) ratio in in a 1 M potassium chloride (KCl) solution.

Plant available P [variable 8 of the Data structure table]: The amount of plant available P was measured on 2 mm sieved bulk soil using the Bray 2 method (Okalebo et. a. 2002). 50 ml of a 0.03 N NH_4F and 0.1 M HCl solution were added to 2.5 g of bulk soil. After shaking for 5 minutes, the extract is filtered and analysed on a spectrophotometer where the amount of P in solution is determined colorimetrically by measuring the intensity of signal turbation at 880 nm when the filtrate is treated with a molybdate-ascorbic acid reagent.

CEC, ECEC, base saturation and exchangeable acidity [variables 9 to 18]: Potential cation exchange capacity (CEC) was analysed on 2 mm sieved bulk soil by percolation with $BaCl_2$ at pH 8.1, whereas the effective cation exchange capacity (ECEC) was measured via NH_4Cl percolation at soil pH. The percolate was analysed for exchangeable bases via flame photometry and atomic absorption spectrophotometry (Pauwels et. al. 1992). Exchangeable acidity (i.e. exchangeable Al^{3+} and H^+) and the total percent base saturation (BS), defined as the relative availability of all base cations (i.e. the sum of all base cations Na, K, Mg, Ca) for CEC, was calculated in percent of ECEC.

Soil fractionation [variables 19 to 117]: A subsample of 80 g was fractionated for each soil and depth layer to derive functional C fractions. This procedure was based on a conceptual C fraction model method proposed by Steward et al. (2008) and was modified according to Doetterl et al. (2015). The scheme consists of a series of physical fractionation techniques applied in order to isolate C fractions, differentiated based on different stabilization mechanisms (chemical, biochemical, and physical). These different fractions can also be associated with different turnover times and varying C stability. Using a microaggregate isolator, C was fractionated into coarse particulate organic matter C (CPOM, > 250 µm), water-stable microaggregate associated C (mAgg 250 – 53 µm), and non-aggregated silt and clay C (s+c, < 53 µm). Note that that the variability of this procedure was determined by executing about 20 % of all measurements in triplicates. For a scientific interpretation of the results of this fractionation scheme see Reichenbach et al. (2021).

Total element composition in different soil based on ICP-OES measurements [variables 19 to 117]: Total elemental composition was determined using inductively coupled plasma optical emission spectrometry (ICP-OES) (5100 ICP-OES Agilent Technologies, USA) for the determination of calcium (Ca), magnesium (Mg), sodium (Na), potassium (K), phosphorous (P), aluminium (Al), iron (Fe) and manganese (Mn). The analysis was performed on bulk soil and physically separated mineral fractions of soil. For soil and rock samples, 1 g of powdered sample material was placed in a digestion tube and was boiled for 90 minutes at 120 °C in aqua regia (2 ml bi-distilled water, 2 ml 70 % nitric acid (HNO_3), 6 ml 37 % hydrochloric acid (HCl)) using a DigiPREP digestion system (DigiPREP MS SCP Science, Canada). All extracts, including calibration standards, were then filtered through a 41 grade Whatman filter and diluted with a dilution ratio of 1:2 for Ca, Mg, Na, K, P, and 1:1000 for Al, Fe, Mn using a diluting system (Hamilton 100, USA) before ICP-OES measurements. For plant samples, 200 mg of sample material was placed in digestion tubes and boiled for 90 minutes at 120 °C in a mix of 15 ml of 65 % HNO_3 and heated using a DigiPREP digestion system (DigiPREP MS SCP Science, Canada). After 30 minutes of cooling, 3 ml of 30 % hydrogen peroxide (H_2O_2) were added to the plant sample mix and this was again heated for another 90 minutes at 120 °C. All extracts, including calibration standards, were then transferred into 50 ml PE-Tubes, filtered through a 41 grade Whatman filter and digestion tubes rinsed three times bi-distilled water to remove potential residues before measurement of the extract.

Total element composition based on XRF measurements [variables 118 to 166]: Total elemental composition of the bulk soil and rock samples of the parent material were conducted using X-ray fluorescence (XRF) for Silica (Si), Titanium (Ti) and Zirkonium (Zr) following the procedure of Karathanasis and Hajek (1996). 4 g of powdered sample material and 1 g of CEROX wax were mixed for approximately 2 minutes using a vibrating mill (Mixer Mill MM 200 Retsch, Germany) before producing a pellet by applying pressure of 25 tons per cm^2 on the samples using a manual hydraulic press (Specac, USA).

The stable and mixed pellet is then subsequently analysed using a XEPOS SEP03 XRF (Spectro Analytical Instruments GmbH, Germany).

Sequential extraction of pedogenic oxides [variables 167 to 193]: A three-step sequential extraction scheme of Fe, Al, and Mn bearing pedogenic organo-mineral associations and oxy-hydroxides (Stucki et al., 1988) was carried out in in the following order: 1. extraction with sodium-pyrophosphate at pH 10 following a procedure by Bascomb (1968), 2. extraction with ammonium oxalate-oxalic acid at pH 3 following a procedure by Dahlgren (1994), and 3. extraction with dithionite-citrate-bicarbonate (DCB) at pH 8 following a procedure by Mehra and Jackson (1960). This allows for the assessment of the amount of Mn, Fe and Al-bearing phases in the different fractions and their correlation with organic C in the different SOC fractions. The specific extraction was performed on bulk soil of samples that were selected for fractionation and incubation (see Bukombe et al. 2021, Reichenbach et al. 2021). All extracts, including calibration standards, were filtered through a 41 grade Whatman filter and diluted (1:1000) and then analysed on the ICP-OES (5100 ICP-OES Agilent Technologies, USA). In our sequential extraction, pyrophosphate (py) extractable components are interpreted as predominantly organically complexed metals. Oxalate (ox) extractable components reflect the amorphous secondary Fe and Mn oxides and poorly crystalline aluminosilicates (imogolite-type materials, ITM). Dithionite (dcb) extractable components included predominantly crystalline oxy-hydroxides of Mn, Mg, Fe and Al. Several authors have shown that pyrophosphate extractable Al may not be attributable only to Al bound to organo-metallic complexes since the alkaline extractant could also extract Al from Al hydroxide phases and from poorly crystalline aluminosilicates (i.e. Schuppli et al., 1983; Kaiser and Zech, 1996). Therefore, results of the pyrophosphate extraction must be treated with caution due to uncertainty on the origin of the extracted minerals. Hence, we limit our analysis to interpreting the abundance and spatial patterns of the various extractable components in the bulk soil and discuss the pedological implications of the observed carbon/mineral correlations. For a scientific interpretation of these results see Reichenbach et al. (2021).

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