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1 **Differentiated Neogene bauxitization of volcanic rocks (Western**
2 **Cameroon): Morpho-geological constraints on chemical erosion**

3
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Abstract

Lateritic weathering of Miocene volcanic rocks from western Cameroon highlands formed duricrusted bauxitic profiles. Two weathering profiles on ca. 14 Ma basalt and ca. 16 Ma trachyte were studied using geochemical mass balance functions. Less mobile elements Ti and Zr were used as references to quantify volumetric change (strain, ϵ), element transfer rate (τ) and geochemical mass transfers during the bauxitization process of basalt and trachyte. Conversion of parent rocks to kaolinite and goethite rich saprolites evolved to Al-Fe rich bauxites, mostly composed of gibbsite and iron oxy-hydroxides (goethite and hematite). However, formation of Al-Fe bauxitic profiles required higher Si leaching on trachyte than on basalt. Our results document that chemical weathering of a larger thickness of trachyte than basalt has been required to form a unit meter of weathering profile, implying differential rates of rock chemical erosion and topographic decay of landscapes. Rates of chemical erosion and formation of lateritic weathering profiles in western Cameroon have been mostly controlled by drainage conditions and volcanic rocks composition (mostly SiO₂ content differences), that also resulted in contrasted landscapes evolution during the Neogene.

Keywords: bauxite; lateritic weathering; geochemical mass balance; chemical erosion; volcanic rocks; Cameroon

Highlights:

Differential bauxitization of trachyte and basalt in western Cameroon
Mass transfers document differences in chemical weathering and landscapes evolution
Drainage and rocks composition control chemical erosion and bauxitic weathering

51 **1. Introduction**

52 Lateritic regoliths of tropical shields generally have formed by long-term rock
53 weathering under warm / humid and seasonally contrasted climates (Tardy, 1997). In
54 tropical landscapes, lateritic paleosurfaces bearing bauxites and ferricretes have been
55 relatively well preserved over geological times scale (Beauvais and Chardon, 2013).
56 Formation of bauxite or ferricrete depends on climatic and morpho-tectonic conditions that
57 control solute leaching processes and aluminum or iron accumulations in lateritic
58 weathering profiles formed on erosional landforms (Bardossy and Aleva, 1990; Thomas,
59 1994; Valeton, 1999), including duricrusted Fe-cemented pediments (Chardon et al., 2018).

60 In Africa, bauxites have formed by intense lateritic weathering of various lithologies
61 (Boulangé and Millot, 1988) mostly from ca. 59 to ca. 45 Ma (Beauvais et al., 2008) upon
62 the African surface that extends from West to East and South-East Africa (Beauvais and
63 Chardon, 2013; Burke and Gunnell, 2008; see also Pérello et al., 2020; De Putter and
64 Ruffet, 2020). Likewise, thick bauxitic profiles later formed from weathering of 14 Ma to
65 23 Ma old trachyte and basalt are well preserved at altitudes of 1500 to 1800 m in the
66 eastern Nigeria (Schwarz, 1997). With the mid-Miocene climatic optimum, Lateritic
67 weathering intensified in Africa (e.g., Beauvais et al., 2008; De Putter and Ruffet, 2020),
68 and more generally on continents of the inter-tropical belt (Retallack, 2010) even at
69 relatively high altitudes, e.g., upon elevated continental margins (Jean et al., 2020), where
70 transported-limited erosion regimes have potentially controlled landscapes evolution over
71 the Cenozoic.

72 Previous studies established the geochemical variability of bauxitic profiles with regard
73 to underlying parent rocks, as well as the link with local morphoclimatic conditions that
74 prevailed during lateritic weathering, as exemplified in West Africa (Boulangé, 1984;
75 Valeton and Beißner, 1986), Asia (Zarasvandi et al., 2012), Eastern Australia (Eggleton et

76 al., 1987), Southern America (Boulangé and Colin, 1994; Soler and Lasaga, 2000; Soares
77 de Oliveira et al., 2011), and India (Babechuk et al., 2014). Chemical weathering of basalt
78 and volcanic rocks has been recently considered into the frame of major surface processes
79 that govern the Critical Zone (Brantley and Lebedeva, 2011; Babechuk et al., 2015; Wille et
80 al., 2018).

81 In situ formed bauxitic profiles are suitable to quantify geochemical mass transfers
82 during long-term rock weathering. Since the pioneering introduction from Millot and
83 Bonifas (1959), and mathematical formalization by Brimhall and Dietrich (1987) and
84 Brimhall et al. (1988), the geochemical mass balance approach was commonly used for
85 quantifying the accumulation or depletion of major and trace elements during weathering
86 processes (e.g., Colin et al., 1992; Beauvais and Colin, 1993; Braun et al., 1993; Tematio
87 and Olson, 1997; Temgoua et al., 2003, among others). However, few studies have
88 addressed elemental geochemical mass balance of lateritic bauxitic profiles (e.g., Boulangé
89 and Colin, 1994; Eggleton et al., 2008). In western Cameroon region and on the Adamaoua
90 plateau above the Central Cameroonian shear zone (CCSZ, Fig. 1), bauxitic regolith formed
91 on high altitude surfaces (up to ~1900 m) from lateritic weathering of mid- to lower
92 Miocene volcanic rocks of the Cameroon volcano-tectonic line. Here, we have quantified
93 element mass transfers (gains and losses of major chemical elements) in lateritic weathering
94 profiles formed upon mid-Miocene basalt and trachyte from the western highlands of
95 Cameroon. Our results document differential morpho-geological controls on the rate of
96 rock chemical erosion, formation of bauxitic regolith and landscapes evolution in western
97 Cameroon over the Neogene.

98

99 **2. Geological and morphological setting**

100 In the western highlands of Cameroon, wide Cenozoic volcanic complexes (e.g.
101 Mounts Bambouto and Bamenda; Fig. 1) including mafic and felsic plutons have been
102 extruded through the Neoproterozoic granito-gneissic basement (Kwekam *et al.*, 2010).
103 Tertiary to recent strato-volcanoes culminate up to 3000 m a.s.l., above low-relief lateritic
104 landsurfaces and grabens (Deruelle *et al.*, 2007; Nkouathio *et al.*, 2008), i.e., Mbo (ca 700
105 m a.s.l.), Noun (ca 1100 m a.s.l.) and Tikar (ca 750 m a.s.l.) plains (Fig. 1b).

106 Volcanic activity has begun in Cameroon from the Eocene with the early establishment
107 of the Bamoun plateau between 51.8 and 46.7 Ma (Moundi *et al.*, 2007) and Mount Bangou
108 between 44.7 and 43.1 Ma (Fosso *et al.*, 2005). Peaks of magmatic activity also generated
109 (1) Oligo-Miocene basaltic flows (31 to 14 Ma) of little differentiated silicic magmas from
110 an asthenosphere source, and (2) most evolved Mio-Quaternary (15 Ma to 4 Ma) silicic
111 magmas from amphibole bearing lithospheric mantle source (Marzoli *et al.*, 1999; Marzoli
112 *et al.*, 2000).

113 Between longitudes 09°50'' and 11°00'' and latitudes 05°10'' and 06° 40'' (Fig. 1b),
114 volcanic rocks have been intensively weathered since mid- Miocene. Studied lateritic
115 weathering profiles are mostly bauxitic and formed upon trachyte of ca. 16 Ma at Fongo
116 Tongo and on basalt of ca. 14 Ma at Doumbouo (Nkouathio *et al.*, 2008) in the
117 southernmost part of the western Cameroon highlands (Fig. 1b and Fig. 2). Sparse pre-
118 Neogene lateritic profiles topped by ferricretes also overly gneissic basement.

119 On trachyte around Fongo Tongo (Figs. 2a-b), a low-relief lateritic landscape with
120 smooth hilly landforms at altitudes ranging from ca. 1570 m to ca. 1650 m is drained by a
121 first order dense alveolar drainage network ca. hundred meters meshed, and bounded by
122 incisions of ca. 150 m to ca. 200 m deep from West to East (Fig. 2a-b and supplementary
123 Fig. DR1a). On basalt near Doumbouo (Fig. 2b), relatively flat lateritic plateaus at altitudes

124 between ca. 1545 m to ca. 1585 m are drained by a first order linear drainage network and
125 incised from ca. 100 to 120 m deep (Fig. 2b and supplementary Fig. DR1b). High altitude
126 grasslands cover the two landscapes that are both subject to sub-equatorial climate (Kengni
127 et al., 2009) with ~1600 mm mean annual rainfall and 18.1°C of mean annual temperature.

128

129 **3. Materials and Methods**

130 Two pits were dug through thick lateritic mantles representative of the two landscapes
131 (Fig. 2), on the basis of a previous geomorphological study in the region (Momo Nouazi et
132 al., 2016). The first profile (5° 31' 51.16''N / 9° 58' 34.99''E) formed upon trachyte at
133 Fongo-Tongo, while the second one (5° 25' 19.36''N / 10° 05' 46.98''E) formed upon
134 basalt at Doumbouo (Figs. 2a-b; see also Figs. DR1a-b). After detailed macroscopic
135 descriptions along side pits walls, twenty samples (~2 kg) representative of ca. one cubic
136 meter in the different horizons of profiles were collected based on their petrographic
137 structures. Fresh trachyte was sampled in nearby quarry excavation, and basalt under the
138 saprolite of its weathering profile.

139 Petrographic studies were carried out on thin sections of fresh rocks and weathered
140 samples to describe textures of weathering products and their mineral composition.
141 Samples were crushed to a sieve size < 63 µm for mineralogical and geochemical analysis.
142 Mineralogical analyses were performed using XRD (X-Ray Diffractometry), with an X'Pert
143 Panalytical diffractometer using CuK α radiation (1.79 Å) in the range of 2° to 78° 2 θ and at
144 a speed of 0.2°/min (10s counting time every 0.033°). Minerals were identified upon
145 diffraction spectra using High Score X'Pert Plus software (Version 3.0) and compared with
146 known standards (American Mineralogist Crystal Structure Database, 2016). A Rietveld
147 Refinement process (Rietveld, 1969; Ufer et al., 2008) was also applied for semi-
148 quantifying the proportion (%) of each mineral. Each Mineral proportion is obtained by the

149 ratio between the surface areas of specific XRD peaks of each mineral to the total surface
150 of the sample XRD pattern. Geochemical analyses were obtained using ICP methods from
151 pulverized samples fraction. Major and trace elements were analyzed by ICP-AES
152 (Inductively coupled plasma-Atomic emission spectrometry).

153

154 3.1. Element mass transfer function

155 The element mass transfer function (Brimhall and Dietrich, 1987) was applied as it
156 accounts for the chemical composition and bulk density of weathered horizons and parent
157 rocks, allowing to estimate the porosity and volume change or strain (ϵ) across the
158 weathering profile. This function also requires a reference element, which is generally
159 included in resistant minerals and considered as less mobile during weathering. The
160 reference elements commonly used are Zr, Ti, and Th (Brimhall and Dietrich, 1987;
161 Beauvais and Colin, 1993; Boulangé and Colin, 1994; Braun et al., 1993; White et al.,
162 2001; Tematio et al., 2009). Finally this mass transfer function allows quantifying the
163 accumulation or depletion of elements during weathering.

164 Physical parameters of weathering horizons are first measured to establish:

$$165 \quad \phi = 1 - \frac{\rho_b}{\rho_g} \quad (1)$$

166 ϕ is the porosity, while ρ_b and ρ_g in g.cm^{-3} refer to bulk density and grain density of each
167 sample representative of a given weathering horizon. Bulk density, ρ_b , of dried samples was
168 estimated after weighing and coating them with molten paraffin wax, followed by their
169 immersion in water to measure displaced volume. Grain density, ρ_g , was measured using
170 water picnometer. Both densities were measured with an accuracy of $\sim \pm 1\%$.

171 Strain, ϵ , is then defined by:

$$\varepsilon_{i,w} = \left(\frac{\rho_p \times C_{i,p}}{\rho_w \times C_{i,w}} \right) - 1 \quad (2)$$

172

173 Where i refer to the element considered as the less mobile during weathering, ρ is the bulk
 174 density and C the concentration of the reference element in g/100g in weathered sample (w)
 175 and parent rock (p). Measurement of strain, ε , allows quantification of the volumetric
 176 change across weathering profile owing to its collapse (Brimhall and Dietrich, 1987; see
 177 also Chadwick et al., 1990).

178 Then, transfer rate, τ , (gain or loss) of a mobile element j either by relative or absolute
 179 accumulation (including physical translocation) or solute depletion is defined from:

180

$$\tau_{j,w} = \left[\frac{\rho_w \times C_{j,w}}{\rho_p \times C_{j,p}} \times (\varepsilon_{i,w} + 1) \right] - 1 \quad (3)$$

181

182

183 Quantification of the mass of element j , $m_{j,w}$, in kg/m³ transferred through a unit volume (1
 184 m³) of profile during both saprolite formation and bauxitization can also be obtained by:

185

$$m_{j,w} = \left(\frac{C_{j,p}}{100} \times \rho_p \times V_p \right) \times \tau_{j,w} \quad (4)$$

186

187

188 The total mass of element j , $M_{j,w}$ in kg, transferred through a cross section of weathering
 189 profile during the chemical weathering of a given height or thickness of parent rock is
 190 derived by integrating $\tau_{j,w}$ as a function of depth. However, knowledge of initial height z of
 191 parental rock (or protolith layer thickness) that has been chemically weathered to form the
 192 investigated profile of thickness Δz_w is required. According to Egli and Fitze (2000) this is

193 obtained by relating Δz_w to Δz using the strain, $\varepsilon_{i,w}$, such as: $\Delta z = \Delta z_w (1/\varepsilon_{i,w} + 1)$. Therefore,
 194 the higher is $\varepsilon_{i,w}$ the higher is the thickness of protolith layer that has been chemically
 195 weathered to form a given profile. The masses of elements $M_{j,w}$ (gain or loss) transferred
 196 through each profile horizon during the chemical weathering of a corresponding thickness
 197 of parent rock is then integrated upon the total profile depth, D , as established by Egli and
 198 Fitze (2000):

$$M_{j,w}(z_w) = \left(\frac{C_{j,p}}{100} \times \rho_p \right) \times \left(\frac{1}{\varepsilon_{i,w} + 1} \right) \times \int_{z_w=0}^{z_w=D} \tau_{j,w} \times dz_w \quad (5)$$

201 4. Results

202 4.1. Lateritic weathering on trachyte

203 Trachyte outcrops on steep slopes and in talwegs, and is deeply weathered with bauxite
 204 formed on top of flat to gently sloping interfluves. Trachyte has a microlitic texture with no
 205 or few porphyric minerals (Fig. 3a), and made up of an assemblage of microcrystalline
 206 plagioclases (Pl), clinopyroxenes (cpx), Fe-Ti oxides, and scarce Cpx phenocrysts (up to 1
 207 mm) (Figs. 3b and 3c). These minerals also include anorthoclase ($An_{25-11}Ab_{70-54}Or_{22-19}$) and
 208 alkali feldspars, i.e., sanidine to Na-sanidine ($Or_{15-55}Ab_{35-85}An_{0-6}$), sodic Cpx ($En_{3-4}Aeg_{33-}$
 209 $35Fs_{62-65}$) or hedenbergite ($Wo_{45-47}En_{26-30}Fs_{40-44}$) and titanomagnetite (94-25 mol%
 210 ulvöspinel) (see Nkouathio et al. 2008).

211 Lateritic bauxitic profiles have been formed in-situ on trachyte, whose the structure is
 212 coarsely preserved in saprolite, but transported materials may also be reworked on
 213 pediments established around the bauxitic hilly landforms at lower altitudes (See Momo
 214 Nouazi et al., 2019). The weathering profile includes a saprolite (C), a blocky bauxitic
 215 duricrust (B5), a massive bauxitic duricrust (B3) and a loose nodular bauxitic horizon on
 216 top (B1) (Fig. 4a, see Momo Nouazi et al., 2019). The saprolite is porous (Tab. 1), with

217 inter-connected voids resulting from eluviation process of less cohesive clays (Fig. 5a). It is
218 made up of a grey brown matrix of kaolinite and gibbsite (61% and 16%, respectively), and
219 it also contains goethite formed by pseudomorphosis of Px, Cpx and Fe-Ti oxides, and
220 some anatase and maghemite. The horizon B5 shows decimeter-size blocks of porous
221 reddish bauxitic duricrust mixed with centimeter size nodules embedded in a loose matrix.
222 Compared to saprolite, the mineralogical composition (Table DR1a, see Momo Nouazi et
223 al., 2019) shows a total conversion of kaolinite into gibbsite (57%), and goethite
224 coating/infilling (29% to 58%) in bauxitic blocks. The massive bauxite duricrust is made up
225 of a reddish brown matrix mixing gibbsite (up to 68%) and goethite (up to 33%) and
226 preserving some residual features of parent minerals (e.g, pyroxene). It is crossed by
227 micrometer to millimeter voids coated with thick Al- and Fe-rich accumulations (Fig. 5b),
228 while showing centimeter size sub-horizontal laminated iron cementations at its bottom
229 (Fig. 4a). The surface horizon (B1) is made up of a loose matrix embedding fragments of
230 bauxite duricrusts and bauxitic nodules whose petrographic structures are quite similar to
231 that of the underlying massive bauxite. The horizon B1 has more kaolinite (22%) than the
232 massive bauxite (B3) and less gibbsite and goethite (31 and 18%, respectively), with up to
233 18% of quartz of detrital origin.

234 Main geochemical trends highlight relative enrichment of Al_2O_3 , Fe_2O_3 , compared to
235 parental trachyte (Fig. 4a and Fig. 6), while SiO_2 with alkaline/alkaline-earth elements are
236 depleted (see also Table DR2a, and Momo Nouazi et al., 2019). Noted that locally soils and
237 upper parts of profiles formed also on trachyte from the same area (Tematio et al., 2009)
238 may be more siliceous but less rich in Al_2O_3 and/or Fe_2O_3 than our samples (Fig. 6). The
239 SiO_2 content decreases from the trachyte (59.5 wt.%) to its minimum content in the massive
240 bauxitic duricrust (0.73 wt.%), and increases toward the surface to 19.25 wt.% (Fig. 4a).
241 The Al_2O_3 and Fe_2O_3 contents increase from the trachyte (15.5 wt.% and 8.4 wt.%) to their

242 maximum contents in the massive bauxite duricrust (51.8 wt.% and 25.9 wt.%),
243 respectively, and then decrease toward the surface (Fig. 4a). Note the increase in Fe₂O₃ and
244 decrease in Al₂O₃ at the transition between B3 and B5 horizons where ca. 1 m thick iron
245 rich accumulations occurred (Fig. 4a). The TiO₂ content increases from 0.62 wt.% in the
246 trachyte to 3.39 wt.% in the massive bauxitic duricrust, while P₂O₅ increases in the
247 saprolite and then slightly decreases in the upper duricrusted bauxitic horizons (Fig. 7a and
248 Table DR2a). Along the profile, trace elements, Nb, Zr, Ga, Cu, Ni, Co, Cr, V, As, Pb, Th,
249 Hf, U and Ta contents are higher, while Y, Sr, Rb, contents are lower than those in trachyte
250 (see also Momo Nouazi et al., 2019 for more details; and Tab. DR3a).

251

252 4.2. Lateritic weathering on basalt

253 Porphyritic basalt is deeply weathered and occurs as boulders on slopes. Phenocrysts
254 are clearly identified on field samples (Fig. 3d), and represent up to 30% of the sample
255 (Figs. 3e and 3f). Parent minerals of this basalt also include large olivine (Fo₆₆₋₈₇),
256 diopsides (Wo₄₅₋₄₈En₄₃₋₅₂Fs₈₋₁₇), augites (Wo₃₈₋₄₄En₄₃₋₅₃Fs₁₀₋₂₃), scarce phenocrysts and
257 microcrystalline plagioclases (An₄₆₋₇₂) and Fe-Ti oxydes (71-19 mol% ulvöspinel) (see
258 Nkouathio et al. 2008).

259 The lateritic profile is located on top of a flat interfluvium limited by incisions (Fig. 2b
260 and Fig. DR1b). From the bottom to the top, the profile includes a saprolite (C), a mottled-
261 clays layer (B4), a massive bauxitic duricrust (B3), a nodular bauxitic duricrust (B2) and a
262 loose nodular horizon on top (B1) (see Fig. 4b). The saprolite is more porous than on
263 trachyte (Tab. 1), and composed of a greyish-brown kaolinite matrix (57%) dotted with
264 residual porphyritic olivines/pyroxenes. It is studded by millimeter sized dissolution voids
265 preserving the original shapes of ol and cpx phenocrysts (Fig. 5c). It also shows dark-brown
266 goethite (30%) and maghemite (9%). The mottled-clays have lost the basalt structure and

267 are composed of a brown argillic frame of kaolinite (46%), goethite (24%), and minor
268 amount of maghemite (5%); the mottled clays also have centimeter size gray volumes of
269 microcrystalline gibbsite (18% of the total horizon), and Al-Fe cutans fillings voids and
270 cracks. The structure of the massive bauxitic duricrust is quite similar to mottled-clays, but
271 the brown argillic plasma bears microcrystalline gibbsite. Clay-ferruginous materials refill
272 voids and later differentiate into Fe-rich cutans (Fig. 5d). The bulk mineral composition of
273 this bauxitic duricrust shows lesser kaolinite (4%) than mottled-clays, more gibbsite (41%)
274 and goethite (27%) and up to 15% hematite (see also Table DR1b). Centimeter size nodules
275 of the nodular bauxitic duricrust represent 75% of the horizon. They are composed of a
276 brown argillic matrix of goethite and kaolinite locally preserving the basalt structure and
277 are rimed with millimeter size dark brown cortex. The reddish inter-nodular matrix is
278 mostly composed of goethite and microcrystalline gibbsite filling millimeter size cracks.
279 The bulk mineral composition of the horizon shows more kaolinite (10%), gibbsite (46%)
280 and goethite (38%), but lesser hematite (> 5%) than the massive bauxite duricrust. The
281 surface nodular horizon (B1) is composed of a mixture of fine earth and centimeter size
282 nodules, with an internal structure similar to that of massive and nodular duricrusts.
283 Kaolinite content increases to 15%, while gibbsite and goethite decrease to 35 and 23%,
284 respectively (Table DR1b). However, this horizon contains also up to 15% quartz, which is
285 probably, as on profile of trachyte, of detrital origin.

286 Main geochemical trends first show higher Al_2O_3 and Fe_2O_3 compared to basalt, while
287 SiO_2 is depleted from the profile (Figs. 4b and 6), with P_2O_5 and alkaline/alkaline-earth
288 elements (see Table DR2b). The SiO_2 content decreases from the basalt (42.0 wt.%) to its
289 minimum content in the massive bauxitic duricrust (1.77 wt.%), and increases toward the
290 surface to 18.35 wt.% (Fig. 4b). The Al_2O_3 and Fe_2O_3 contents increase from the basalt
291 (13.0 and 14.25 wt.%) to maximum contents in the duricrusted horizons (36.0 and 34.2

292 wt.%), respectively, and then decrease toward the surface (Fig. 4b). The TiO₂ content also
293 increases from 3.69 wt.% in basalt to 8.83 wt.% in the mottled clays (Fig. 7a and Table
294 DR2b). Compared to basalt, trace elements Sc, V, Cr, Zn, Ga, Zr, Nb, Hf, Ta, Pb, Th and U
295 have higher contents, while Ni, Cu, As, Rb, Sr, Y and Ba contents are lower along the
296 profile (see Tab. DR3b).

297

298 4.3. Element mass transfers during weathering and bauxitization

299 Because samples from the upper part of profiles may integrate some reworked
300 materials of potentially allochthonous origin (e.g., colluvia), which include detrital quartz
301 and anomalous silica content (Fig. 6; see also Tables DR1 and DR2) and possibly detrital
302 heavy minerals (ex: zircon on basalt, Fig. 7a), mass balance calculations have been only
303 applied on ten and five samples in the profiles formed in-situ on trachyte and basalt,
304 respectively (Fig. 4).

305

306 4.3.1. *Characterization of reference elements*

307 Reference elements, Zr and Ti, are characterized by their relatively low mobility during
308 bauxitization. Their distribution across the weathering profiles compared to their amount in
309 parent rocks allows documenting changes in chemical and physical processes in different
310 horizons of profiles. Here, Zr and Ti show a differentially correlated distribution across the
311 weathering profiles (Figs. 7a), as previously observed by Schwarz (1997) and Tematio et
312 al., (2009) in comparable morphogeological settings (Fig. 7b). The distributions of Zr and
313 Ti in the different profiles are comparable (Figs. 7a-b). These two elements show parallel
314 behavior along the profiles (Fig. 7c), but Zr varies less than Ti on trachyte, while Ti is
315 better expressed than Zr and most stable on basalt (Figs. 7d and 7e). However, departures

316 from stoichiometric distributions owe to possible physical enrichments of Ti and Zr
317 bearing-heavy minerals in different horizons of profiles (Figs. 7a and 7b).

318 Despite this, trachyte petrologic pattern is coarsely preserved in different horizons,
319 although eluviation processes produce 20% to 30% porosity while illuviation forms
320 secondary crystallizations of gibbsite and clay-Fe cutans cementations in duricrusted
321 horizons (see Fig. 5). This results in grain density ρ_g of weathering samples close to that of
322 the fresh trachyte (see Tab. 1a and Figs. 8a-b). These physical changes are all indicative of
323 noticeable volumetric variations across the profile (Fig. 8c; see also Tab. 1). However, the
324 overall variation of ϵ_{Zr} is ~13% less than that of ϵ_{Ti} , with a mean value of -51% (against -
325 64 % for ϵ_{Ti}) in the profile (Fig. 8c), supporting that Zr is the best reference element for
326 mass balance calculations on trachyte. On the other hand, in the profile on basalt where
327 porosity may increase to ca. 40 % (Fig. 9b), ϵ_{Ti} varies much less than ϵ_{Zr} (Fig. 9c) and a
328 better correlation between volumetric change ϵ_{Ti} and measured physical parameters validate
329 Ti as most suitable reference element for mass balance calculation in the profile on basalt
330 (see Table. 1b and Fig. 9d).

331 In the next sections, the element mass transfers involved during formation of the two
332 weathering profiles are reported in the tables 2 and 3 and synthetized in the figure 10. The
333 table 2 reports masses ($m_{j,w}$) of elements transferred through a unit volume (1 m^3)
334 calculated from eq. 4. The table 3 shows masses transferred $M_{j,w}$, of these elements
335 calculated from eq. 5, and integrated over the investigated profiles depth related to the
336 corresponding height or thickness of chemically weathered rock.

337 338 4.3.2. *Element mass transfers in weathering profile on trachyte*

339 Ti shows a transfer rate of 35% in the saprolite relative to the trachyte (Tab. 1a and Fig.
340 8d) that results in 3.3 kg/m^3 or 11 kg of Ti concentrated in 1.5 m thick saprolite (Tab. 2a

341 and 3a, and Fig. 10a). Above the saprolite, the blocky bauxite (B5) and the massive bauxite
342 (B3) horizons together show transfer rates of Ti from 21% to 56% that corresponds to ca. 2
343 to 8 kg/m³ (Table 2a), or ca. 64 kg of Ti concentrated in ca. 10 m thick bauxitic duricrusted
344 horizons (Table 3a and Fig. 10a). Al is depleted by 44% in the saprolite (Tab. 1a; Fig. 8d),
345 corresponding to ca. 92 kg/m³ or ca. 308 kg of Al exported from 1.5 m thick saprolite (Tabs
346 2a and 3a, and Fig. 10a). However, during formation of lateritic bauxitic duricrusts, the
347 transfer rate of Al ranges from - 33 % to + 35 % corresponding to transferred mass of ca. –
348 68 to + 72 kg/m³ (Tabs. 1a-2a), resulting in concentration of ca. 147 kg Al integrated over
349 ca. 10 m thick lateritic profile (Tab. 3a and Fig. 10a). Fe is also depleted by 48% in the
350 saprolite (Tab. 1), with a loss of - 72 kg/m³ implying that ca. 240 kg of Fe is released during
351 the formation of 1.5 m thick saprolite (Tabs. 2a and 3a and Fig. 10a). The transfer rate of Fe
352 ranges from – 40% to + 97% in the bauxitic duricrusts corresponding to transferred masses
353 of – 58 to + 144 kg/m³ and at least ca. 708 kg Fe exported by the formation of 10 m thick
354 bauxitic duricrusted profile, despite concentration of ca. 140 kg/m³ at the base of
355 duricrusted horizons (Tab. 2a and 3a and Fig. 10a).

356 In summary, Ti is the most enriched element in the trachyte profile, followed by Al, while
357 Si, and P are the most depleted elements along the profile (Tab. 1a; Fig. 8d). Formation of
358 1.5 m thick saprolite resulted in export of a total mass of ca. 2084 kg of Si at a rate of - 625
359 kg/m³, while a mass of ca. 15898 kg was exported by formation of 10 m thick lateritic
360 duricrusted horizons (Tab. 2a and Fig. 10a). Mass changes calculation of trace elements
361 highlights enrichment of V, Co, Ni, As, Nb, Hf, Ta, Pb, U and Th, while Ba, Ga, Y, Sr, and
362 Rb are depleted. Compared to major elements, their exported/accumulated masses are very
363 low, with mean values of ± 0.001 to 0.1 kg, except Ba released up to -141 kg (see Tab.
364 DR4a).

365

366 4.3.3. *Element mass transfers in weathering profile on basalt*

367 Al is gradually enriched throughout the profile from 6% in the saprolite to 134%
368 integrated in lateritic horizons (B2 + B3 + B4), despite slight depletion of 16% in the
369 mottled clays (Tab. 1b; Fig. 9d). This corresponds to ca. 20 kg Al concentrated in ca. 2 m
370 thick saprolite (C) at a rate of 11 kg/m³, while ca. 680 kg of Al concentrated in ca. 8 m
371 thick lateritic horizons (Tabs. 2b and 3b and Fig. 10b). Fe is depleted by 8% to 16% in the
372 saprolite and the mottled clays, respectively, and enriched up to 90% in the nodular bauxite
373 (Tab. 1b; Fig. 9d). These result in ca. 41 kg of Fe exported during saprolite formation at a
374 rate of 22.5 kg/m³, while a total mass of ca. 414 kg of Fe concentrated in bauxitic lateritic
375 horizons (Tabs. 2b and 3b, and Fig. 10b).

376 In summary, Al is the most enriched element in the basalt profile, followed by Fe, while Si,
377 Mn and P are mostly depleted (Tabs. 2b and 3b; Figs. 9d and 10b). Si is strongly leached
378 with a total mass of ca. 570 kg exported by the formation of 2 m thick saprolite, while 4867
379 kg of Si has been released by that of 8 m thick duricrusted lateritic horizons (Tab. 3b and
380 Fig. 10b). The overall mass changes in trace elements show depletions in Rb, Sr, Y, Ba and
381 transitions elements, Co, Ni, Cu and Zn along the profile, while Nb, Zr, Ga, Cr, V, Th, Hf,
382 U and Ta are enriched in the upper 6 m of profile (Tab. DR4b). Most mass transfer values
383 are very low except that of Cr (5.1 kg) and Sr (-10.8 kg) in the upper meter of profile
384 (nodular bauxite) (see Tab DR4b).

385

386 **5. Discussion**

387 5.1. Differential bauxitic weathering and chemical erosion of volcanic rocks

388 The two bauxitic duricrusted profiles show different weathering and geochemical paths
389 from saprolite to lateritic duricrusted horizons. Owing to strong leaching of silica and
390 alkaline/alkaline earth elements, intense lateritization process resulted in gibbsite

391 replacement of kaolinite and formation of iron oxy-hydroxides (goethite and hematite)
392 under redox conditions favorable to Al and Fe concentration (see Beauvais and Colin,
393 1993; Schellmann, 1994; Eggleton et al., 2008; Beauvais, 2009), which are illustrated by
394 secondary gibbsite crystallizations, and clay-Fe coatings or cutans (Fig. 5b and 5d; see also
395 Momo Nouazi et al., 2019).

396 Element mass transfers point out important Al and Fe concentrations in the profile
397 formed on basalt, while Al and Fe were seemingly exported from some bauxitic horizons of
398 the profile formed on trachyte (Tab. 2 and Fig. 10) correlatively to the anomalous increase
399 in reference elements Zr and Ti in these horizons (see Figs. 7c-d, Fig. 8 and Table DR2a).
400 Enrichment of Zr and Ti, along with irregular Zr/Ti ratios during formation of trachyte
401 profile may owe to their heterogeneity in the fresh trachyte (Brimhall et al., 1991; Schwarz,
402 1997). Mechanical reworking of weathering-resistant carrier heavy minerals (zircon,
403 ilmenite and rutile) may also occur during long-term complex evolution of lateritic profiles
404 (e.g., Brimhall et al., 1991; Colin et al., 1992; see also Beauvais, 2009). Given translocation
405 marks in many lateritic weathering profiles (e.g., Fig. 5d), physical release of small size
406 fractions of Zr and Ti carrier minerals (mostly zircon and titanomagnetite), which migrated
407 downward into the compacted residual weathering profile, was also previously observed
408 (e.g., Fig. 5d; see also Schwarz, 1997; Brimhall et al., 1988, 1991; Colin et al., 1992).
409 Hence, this complex and differential behavior of Zr and Ti during the formation and
410 evolution of residual lateritic profiles has resulted in differential strains implying the
411 chemical weathering of protoliths (parent-rocks) of different thickness (see eq. 5).

412 Given the ages of parent rocks (16 Ma for trachyte and 14 Ma for basalt),
413 quantification of their initial thickness before onset of weathering that produced the lateritic
414 profiles allows estimating average minimum rates of rock chemical erosion over the
415 Neogene. Upon basalt, calculations with Ti give an integrated chemical rock-weathering

416 rate of ca. 0.84 m/my over the last 14 Myr. A basalt thickness of ca. 12 m is required to
417 produce the investigated residual ca. 10 m thick weathering profile at a rate of 0.70 m/my.
418 This also implies a topographic erosion of only ca. 2 m owing to congruent rock chemical
419 erosion at a rate of ca. 0.14 m/my during the same period that is consistent with an almost
420 isovolumetric basalt weathering (average $\varepsilon_{Ti,w} = -0,07$; Tab. 1). Congruent chemical
421 weathering of 2m³ thick basalt ($\rho = 2.74 \text{ t/m}^3$) corresponds to net exports of ca. 1076 kg Si,
422 377 kg Al and 546 kg Fe. Upon trachyte, calculations with Zr give an integrated chemical
423 rock-weathering rate of c. 1.625 m/my. Here, chemical weathering of ca. 26 m thick
424 trachyte led to formation of the 12 m thick studied profile consistently with an average
425 strain value of $\varepsilon_{Zr,w} = -0,51$ (Tab. 1). This implies a topographic decay of similar height of
426 14 m corresponding to the thickness of rock layer, which has been chemically eroded
427 congruently over the last 16 Myr at a rate of 0.875 m/my, while the residual weathering
428 profile formed at rate of ca. 0.75 m/my that is comparable with the rate of profile formation
429 upon the basalt. Upon formation of the 12 m thick lateritic profile, the congruent chemical
430 erosion of 14 m³ trachyte ($\rho = 2.53 \text{ t/m}^3$) resulted in net exports of ca. 9849 kg Si, 2904 kg
431 Al and 2083 kg Fe.

432 Therefore, differential chemical erosion of trachyte and basalt is primarily dependent
433 on differences of strain ($\varepsilon_{i,w}$) in profiles (Egli et Fitze, 2000). This implies formation of an
434 equal 1 m thick bauxitic profile from the chemical weathering of a ca. 2.2 m thick layer of
435 trachyte against 1.2 m thick basalt layer over 1 My and 1.8 My, respectively. However,
436 such differences call further discussion on parent-rocks geochemical differences and
437 potential geomorphological constraints.

438

439 5.2. Constraints to differentiated bauxitic weathering in highland western Cameroon

440 Under similar climatic and floristic constraints, differential chemical erosion and
441 bauxitic weathering potentially depend on parent rocks composition differences, but also
442 from drainage constraints upon profiles and landscape owing to local differential tectonics
443 related to the volcanic dynamics of Cameroon.

444 Although olivines are known to be more weathering-reactive than plagioclase and
445 pyroxenes (Eggleton et al., 1987; Schwarz, 1997), these minerals present grossly similar
446 weathering rates (Nesbitt and Wilson, 1992), no matter the grain size (Israeli and
447 Emmanuel, 2018). This suggests no direct (or little) influence of differential mineral
448 sensitivity on weathering rates and geochemical transfers on different volcanic rocks.
449 Nonetheless, Basalt carry mainly Fe-Mg minerals (olivine and clinopyroxene), while
450 trachyte are mostly Si-Al rich with dominant plagioclases and pyroxenes. However, the
451 total mass of Si released during rock weathering and formation of evolved bauxitic profiles
452 (sum of element masses exported as synthesized in Fig. 10) is a few more than thrice on Si-
453 rich trachyte than on basalt (17982 kg against 5437 kg), whose the lateritic bauxitic profile
454 has accumulated a few four time more Al than on trachyte (Tab. 3b and Fig. 10b).

455 According to Braun et al. (2016), chemical weathering rate is primarily controlled by
456 groundwater capacity to export solutes (e.g., dissolved silica, see also Schopka and Derry,
457 2012) far from the reacting solid-fluid interface to impede saturation of the weathering
458 system. This requires continuous and efficient drainage to sustaining propagation of the
459 weathering front into the bedrock (Braun et al., 2012; Prestrud Anderson et al., 2017, and
460 references there-in). Weathering in profile on trachyte may have been enhanced by
461 interconnected porosity (Momo Nouazi et al., 2019) that was formed by eluviation process
462 of less cohesive clayey matrix (Fig. 5a). On the other hand, compact and Fe-coated clay
463 matrix upon basalt has slowed rock weathering (Fig. 5c). This resulted here in rates lower

464 than overall estimates in different geological and climatic contexts (Australia, Northern and
465 Southern America; see Stockmann et al., 2014), despite high alterability of basalt.

466 However, rock-weathering rates, geochemical transfers and residual profile growth are
467 primarily dependent on silica content of parent rock to be exported by groundwater to
468 streams (Schopka and Derry, 2012). Higher Si abundance in trachyte relative to basalt
469 (Figs. 4 and 6) is thus a major geochemical constraint to the growth of weathering profiles.
470 Optimal drainage upon weathering front was instrumental for rapid dissolution of abundant
471 Si carrier minerals (plagioclases) in trachyte, which turned into weathering rate-controlling
472 minerals. A volcanic-related tectonic instability during Miocene (and later) has potentially
473 led to rapid deepening of base level and landscape incision in Mount Bambouto (location in
474 Fig. 2; see also Figs. DR1-a-b). This resulted in landscape rejuvenation, and optimal
475 drainage that sustained eluviation processes in soils and weathering profiles, thus favoring
476 silica export. Hence, saprolite production rate has been higher on trachyte than on basalt
477 extruded at lower altitude, and where lateritic plateaus are less incised further away from
478 tectonic influences (e.g., Prestud Anderson et al., 2007; Brantley et al., 2007; Schopka and
479 Derry, 2012). Furthermore, differences in geomorphic processes resulted in differential
480 evolution of profiles over Neogene, with an almost iso-volumetric formation on basalt
481 ($\epsilon_{Ti,w} = -0,07$), while the profile on trachyte underwent substantial collapse ($\epsilon_{Zr,w} = -0,51$).

482 Therefore, geochemical differences in volcanic rocks compositions (mostly silica
483 content) and geomorphological constraints potentially controlled by differential tectonics
484 have resulted together in differentiation of chemical erosion and bauxitic weathering in
485 highland western Cameroon (see also Samonil et al., 2020). The current bauxitic plateaus
486 stand as long-lived elevated but differentially incised landforms (Figs. DR1a-b; see also
487 Momo Nouazi et al., 2016). This implies the protolith-regolith interface has seemingly

488 moved downward non-uniformly with respect to differentially eroded/incised geomorphic
489 surfaces on trachyte and basalt over the last 15 My.

490

491 **6. Conclusion**

492 Comparative geochemical mass balances of lateritic weathering of Mid-Miocene aged
493 trachyte and basalt in highland western Cameroon document different processes of
494 chemical erosion and weathering profile formation. Reference elements Zr and Ti have
495 been used from their relative stability for calculating element mass transfers in weathering
496 profiles. Despite some geochemical anomalies in Zr or Ti owing to possible heterogeneity
497 in parent photoliths and physical enrichments of carrier heavy minerals in residual profiles,
498 element mass transfers indicate higher Si depletion and lower Al-Fe concentrations on
499 trachyte than on basalt. Our results document the formation of 1 m thick bauxitic profile
500 from lateritic weathering of 1.2 m of basalt or 2.2 m of trachyte, implying chemical erosion
501 and weathering rates lower on basalt than on trachyte. Different strain pattern in the
502 investigated weathering profiles imply a congruent dissolution (net chemical erosion) of
503 initial protolith layer larger on trachyte (14 m) than on basalt (2 m). Differential chemical
504 weathering rates are mostly controlled by drainage conditions at the regolith-photolith
505 interface and the Si content of volcanic rocks to be released to form bauxitic regolith.
506 Finally, our results point out combined influence of differential local tectonics, and
507 geochemical differences of volcanic rocks on chemical erosion and bauxitic weathering,
508 with implications on the evolution of western Cameroon landscapes over the Neogene.

509

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521

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706 **FIGURES CAPTION**

707 **Figure. 1.** a) Location of the Western Cameroon Highlands. The main geological features
708 (Adapted from Nkouathio et al., 2008) are superimposed to the digital elevation model of
709 Cameroon. CCSZ=Central Cameroonian shear zone; b) Morphology of the Western
710 Cameroon Highlands and location of the study area with main occurrences of bauxite and
711 ferricrete bearing surfaces.

712 **Figure. 2.** a) Geological map of the Western Cameroon Highland and mapped bauxitic
713 surfaces (Bamileke plateau, see insert in Figure 1b). b) Morpho-geological section showing
714 the topographic location of studied bauxitic profiles. See section trace on Figure 2a.

715 **Figure. 3.** a) Macroscopic view of trachyte sample; b and c) Crossed-polarized microscope
716 photomicrographs of the porphyric trachyte. d) Macroscopic view of basalt sample; d) and
717 e) Crossed-polarized microscope photomicrographs of the porphyric basalt. 1=
718 plagioclases; 2= olivine; 3= titanomagnetite; 4= clinopyroxenes.

719 **Figure. 4.** Petrographic structures, location of samples collected (squares), and variations
720 of major oxides content in weathering profiles formed on a) trachyte, and b) basalt. Grey
721 squares= samples analyzed for mass transfer balance.

722 **Figure. 5.** Transmitted natural light microscopic photomicrographs of a) saprolite and b)
723 bauxitic duricrusts from lateritic profile on trachyte; and from lateritic profile on basalt, c)
724 saprolite showing weathering of primary plagioclases and cpx phenocrystal; and d)
725 bauxitic duricrust. 1= primary gibbsite crystallizations; 2= Ferruginous argillic matrix; 3=
726 void; 4= primary gibbsite with Fe-coating; 5= goethite rich Fe clay cutan; 6= Clay
727 ferruginous infill; 7= secondary gibbsite crystallizations; 8= gey-argillic matrix with
728 primary gibbsite and Fe-coating; 9= translocated heavy minerals.

729 **Figure. 6.** Distribution of major oxides composition of parent rocks, saprolite and
730 duricrusted horizons in profiles formed on trachyte and basalt.

731 **Figure. 7.** Variations in the content of reference elements Zr and Ti in weathering profiles
732 formed on trachyte and basalt. a) and b) Diagrams Zr vs. Ti (see Figure 6 for explanations
733 of symbols; Black straight lines indicate stoichiometric distributions); c) Zr/Ti vertical
734 variations along both profiles; Zr and Ti variations along profile on d) trachyte, and e)
735 basalt.

736 **Figure. 8.** Variation of physical parameters along the profile on trachyte. a) Densities; b)
737 Porosity; c) Strain; and, d) Transfer rates of major elements.

738 **Figure. 9.** Variation of physical parameters along the profile on basalt. a) Densities; b)
739 Porosity; c) Strain; and, d) Transfer rates of major elements.

740 **Figure. 10.** Comparative transferred masses of major elements over integrated thicknesses
741 of protolith layers chemically weathered to form the saprolite (yellow) and bauxitic
742 duricrusted horizons (pink) in the weathering profile formed on a) trachyte and b) basalt.
743 (Masse calculated from equation 5; see also Table 3).

744

745 TABLES CAPTION

746 **Table. 1.** Variations of bulk and grain density (ρ_b and ρ_g in g.cm^{-3}), porosity, ϕ , strain,
747 ϵ , and elements transfer rates, τ , in weathering profiles formed upon (a) trachyte (ϵ
748 calculated with reference element Zr), and (b) basalt (ϵ calculated with reference element
749 Ti). Calculated from the equations 1 to 3, respectively. The true depth of trachyte being
750 unknown we simply mentioned a depth in parentheses for graphical easiness of figures.

751 **Table. 2.** Elements mass transfers in kg per unit volume (1 m^3) in weathering profiles
752 formed on (a) trachyte and (b) basalt. Calculated from the equation 4.

753 **Table. 3.** Transferred masses of elements integrated over the investigated profile horizons
754 thickness (Δz_w), related to the corresponding height or thickness of chemically weathered
755 rock layer (Δz), in profile on a) trachyte, and b) basalt. Calculated from the equation 5.

756

757

(a)	Horizon	Depth (m)	ρ_b	ρ_g	Φ	ϵ_{Zr}	τ_{Si}	τ_{Al}	τ_{Fe}	τ_{Ti}	τ_{Ca}	τ_{Mg}	τ_{Na}	τ_{K}	τ_{Mn}	τ_P
P2-FO-2	B3	2.50	1.73	2.28	24.0	-0,48	-0.99	0.17	-0.40	0.32	-1.00	-0.98	-1.00	-1.00	-0.95	-0.27
P2-FO-3	B3	4.50	1.93	2.50	22.7	-0,68	-1.00	-0.30	-0.26	0.36	-1.00	-1.00	-1.00	-1.00	-0.96	-0.46
P2-FO-4	B3	6.00	1.90	2.32	18.4	-0,54	-1.00	0.09	-0.16	0.21	-1.00	-1.00	-1.00	-1.00	-0.96	-0.44
P2-FO-5	B3	8.00	1.69	2.47	31.7	-0,65	-1.00	-0.33	-0.30	0.27	-0.99	-1.00	-1.00	-1.00	-0.96	-0.44
P2-FO-6	B3	9.00	1.87	2.43	23.3	-0,50	-0.99	0.22	-0.24	0.26	-1.00	-1.00	-1.00	-1.00	-0.92	-0.63
P2-FO-7	B3	10.0	1.83	2.35	22	-0,44	-0.99	0.35	-0.16	0.33	-1.00	-1.00	-1.00	-1.00	-0.92	-0.32
P2-FO-7.1	B3	10.5	2.76	2.82	2.06	-0,30	-0.98	0.17	0.97	0.36	-1.00	-1.00	-1.00	-1.00	-0.67	1.55
P2-FO-8	B5	11.0	1.74	2.46	29.2	-0,46	-0.99	0.19	-0.10	0.56	-1.00	-1.00	-1.00	-1.00	-0.93	-0.42
P2-FO-8.1	B5	11.5	1.64	2.42	32.3	-0,49	-0.97	-0.16	0.03	0.52	-0.99	-0.91	-1.00	-1.00	-0.91	-0.15
P3-FO-3	C	12.0	1.41	2.04	30.9	-0,55	-0.89	-0.44	-0.48	0.35	-1.00	-0.99	-1.00	-1.00	-0.95	-0.14
Trachyte		(13.0)	2.53	2.55	0.78	0,00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
(b)							ϵ_{Ti}									
P1-SA	B2	1.00	2.33	2.58	9.69	0.14	-0.78	1.68	0.90		-1.00	-0.99	-1.00	-0.98	-0.83	-0.50
P1-SA-2	B3	4.00	2.06	2.78	25.9	-0.39	-0.98	0.25	0.10		-1.00	-0.99	-1.00	-1.00	-0.88	-0.91
P1-SA-3	B4	6.50	1.36	2.21	38.6	0.00	-0.76	0.05	-0.08		-1.00	-0.98	-1.00	-0.98	-0.74	-0.80
P1-SA-4	B4	8.00	1.66	2.51	34	-0.31	-0.84	-0.16	-0.16		-1.00	-0.97	-1.00	-1.00	-0.78	-0.49
P1-SA-5	C	9.50	1.38	2.25	38.8	0.21	-0.58	0.06	-0.08		-0.99	-0.91	-1.00	-0.95	-0.44	-0.42
Basalt		10.5	2.74	2.74	0.0	0.00	0.00	0.00	0.00		0.00	0.00	0.00	0.00	0.00	0.00

Table. 1

(a)	Horizon	Depth (m)	m _{Si}	m _{Al}	m _{Fe}	m _{Ti}	m _{Ca}	m _{Mg}	m _{Na}	m _K	m _{Mn}	m _P
P2-FO-2	B3	2.5	-695.3	34.6	-58.8	3.0	-51.5	-3.2	-81.7	-106.5	-7.2	-0.5
P2-FO-3	B3	4.5	-700.4	-62.4	-39.1	3.3	-51.4	-3.3	-81.7	-106.7	-7.3	-0.8
P2-FO-4	B3	6.0	-700.6	18.3	-24.4	1.9	-51.5	-3.3	-81.7	-106.7	-7.3	-0.8
P2-FO-5	B3	8.0	-701.4	-68.0	-44.1	2.6	-51.3	-3.3	-81.7	-106.7	-7.3	-0.8
P2-FO-6	B3	9.0	-695.8	45.8	-35.4	2.4	-51.5	-3.3	-81.7	-106.7	-6.9	-1.1
P2-FO-7	B3	10.0	-697.3	72.2	-24.2	3.1	-51.5	-3.3	-81.7	-106.7	-7.0	-0.6
P2-FO-7.1	B3	10.5	-688.7	35.4	144.3	3.4	-51.5	-3.3	-81.7	-106.6	-5.1	2.7
P2-FO-8	B5	11.0	-696.6	39.9	-15.1	5.3	-51.6	-3.3	-81.7	-106.6	-7.1	-0.7
P2-FO-8.1	B5	11.5	-680.6	-32.8	4.1	4.9	-51.2	-3.0	-81.7	-106.3	-6.9	-0.3
P3-FO-3	C	12.0	-625.3	-92.3	-72.0	3.3	-51.4	-3.2	-81.7	-106.7	-7.2	-0.2
Trachyte		(13.0)	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00

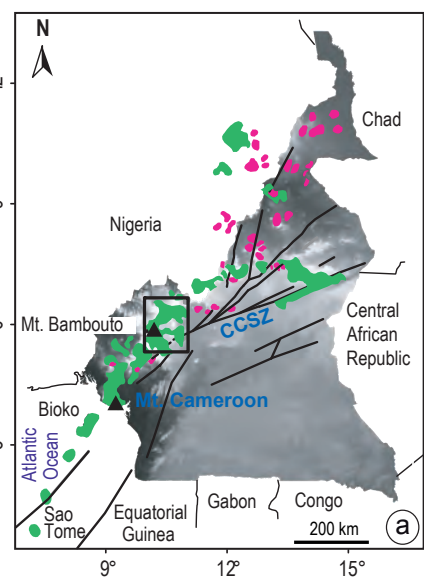
(b)												
P1-SA	B2	1.0	-421.7	316.6	246.0		-177.2	-182.8	-42.7	-21.2	-4.1	-3.3
P1-SA-2	B3	4.0	-527.4	46.4	28.5		-177.5	-183.1	-42.7	-21.7	-4.3	-5.9
P1-SA-3	B4	6.5	-408.0	9.6	-22.7		-177.1	-180.7	-42.7	-21.2	-3.7	-5.3
P1-SA-4	B4	8.0	-453.1	-29.8	-43.5		-176.9	-179.5	-42.7	-21.6	-3.9	-3.2
P1-SA-5	C	9.5	-313.7	10.8	-22.5		-176.4	-168.6	-42.7	-20.5	-2.2	-2.8
Basalt		10.5	0.0	0.0	0.0		0.0	0.0	0.0	0.0	0.0	0.0

Table 2.

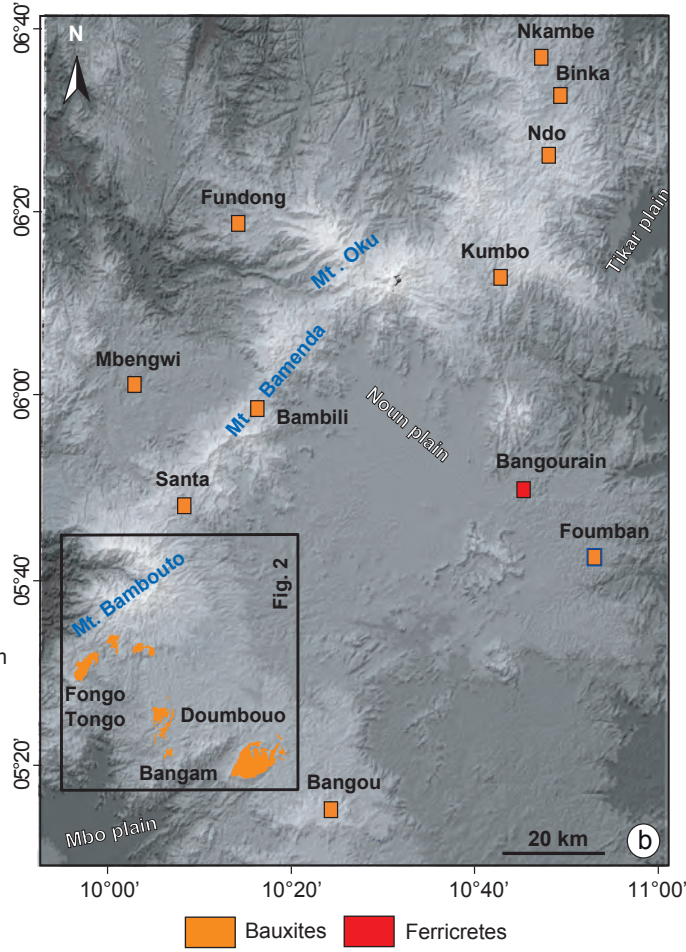
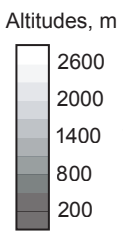
(a)	Horizon	Depth (m)	Δz (m)	Δz_w (m)	M_{Si}	M_{Al}	M_{Fe}	M_{Ti}	M_{Ca}	M_{Mg}	M_{Na}	M_K	M_{Mn}	M_P
P2-FO-2	B3	2.5	4.8	2.5	-3349	167	-283	15	-248	-16	-394	-513	-35	-2
P2-FO-3	B3	4.5	3.1	1.0	-2165	-193	-121	10	-159	-10	-253	-330	-23	-3
P2-FO-4	B3	6.0	6.0	2.75	-4216	110	-147	12	-310	-20	-492	-642	-44	-5
P2-FO-5	B3	8.0	2.9	1.00	-2017	-196	-127	7	-147	-9	-235	-307	-21	-2
P2-FO-6	B3	9.0	2.5	1.25	-1747	115	-89	6	-129	-8	-205	-268	-17	-3
P2-FO-7	B3	10.0	1.3	0.75	-937	97	-33	4	-69	-4	-110	-143	-9	-1
P2-FO-7.1	B3	10.5	0.7	0.50	-495	25	104	2	-37	-2	-59	-77	-4	2
P2-FO-8	B5	11.0	0.9	0.50	-641	37	-14	5	-48	-3	-75	-98	-7	-1
P2-FO-8.1	B5	11.5	0.5	0.25	-331	-16	2	2	-25	-1	-40	-52	-3	0
P3-FO-3	C	12.0	3.3	1.50	-2084	-308	-240	11	-171	-11	-272	-356	-24	-1
Trachyte		(13.0)	26.0		0	0	0	0	0	0	0	0	0	0

(b)	Horizon	Depth (m)	Δz (m)	Δz_w (m)	M_{Si}	M_{Al}	M_{Fe}	M_{Ti}	M_{Ca}	M_{Mg}	M_{Na}	M_K	M_{Mn}	M_P
P1-SA	B2	1.0	1.3	1.50	-556	417	324		-234	-241	-56	-28	-5	-4
P1-SA-2	B3	4.0	6.0	3.70	-3188	281	172		-1073	-1107	-258	-131	-26	-36
P1-SA-3	B4	6.5	1.5	1.55	-630	15	-35		-274	-279	-66	-33	-6	-8
P1-SA-4	B4	8.0	1.1	0.75	-492	-32	-47		-192	-195	-46	-24	-4	-4
P1-SA-5	C	9.5	1.8	2.20	-570	20	-41		-321	-306	-78	-37	-4	-5
Basalt		10.5	12.0		0	0	0		0	0	0	0	0	0

Table 3.



- Volcanics
- Plutonic complexes
- Faults
- Fig. 1b



- Bauxites
- Ferricretes

Fig. 1 (Catena10553)

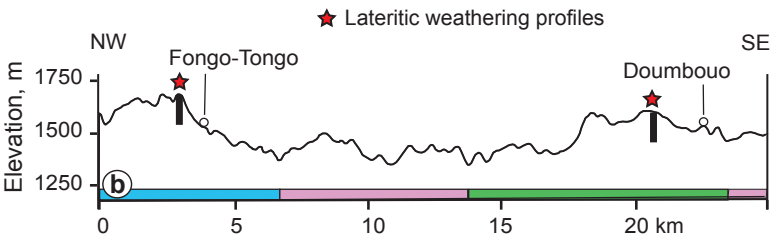
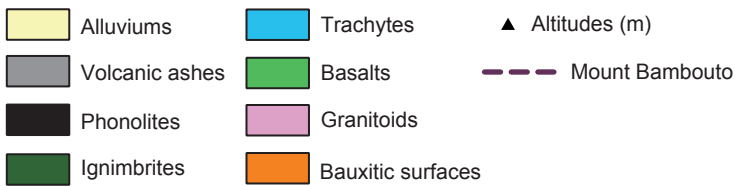
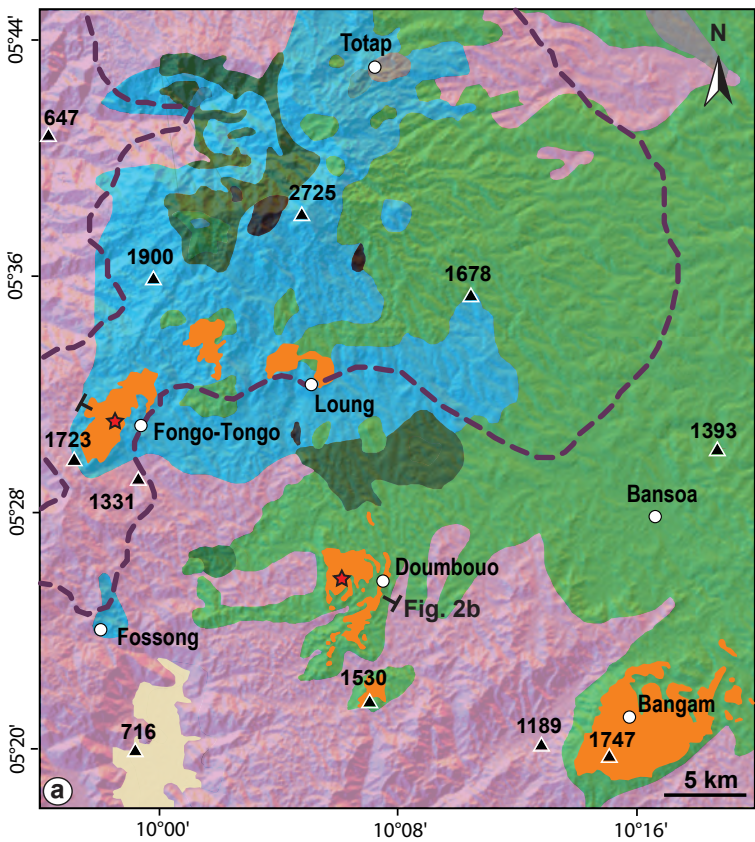


Fig. 2 (Catena10553)

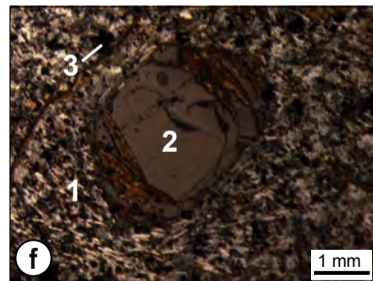
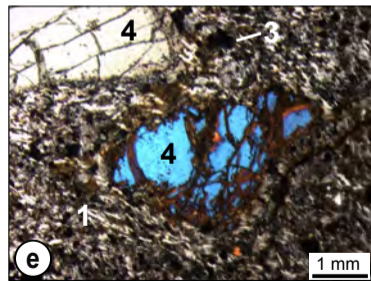
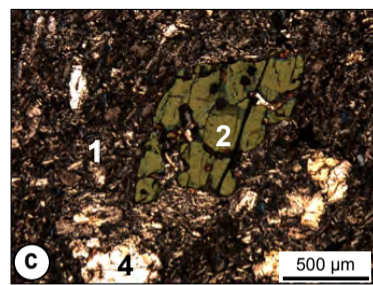
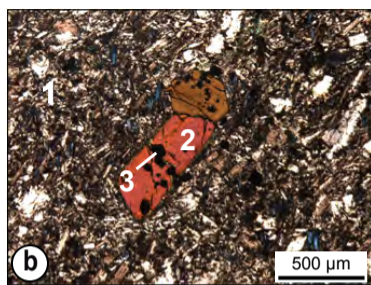


FIG. 3 (Catena10553)

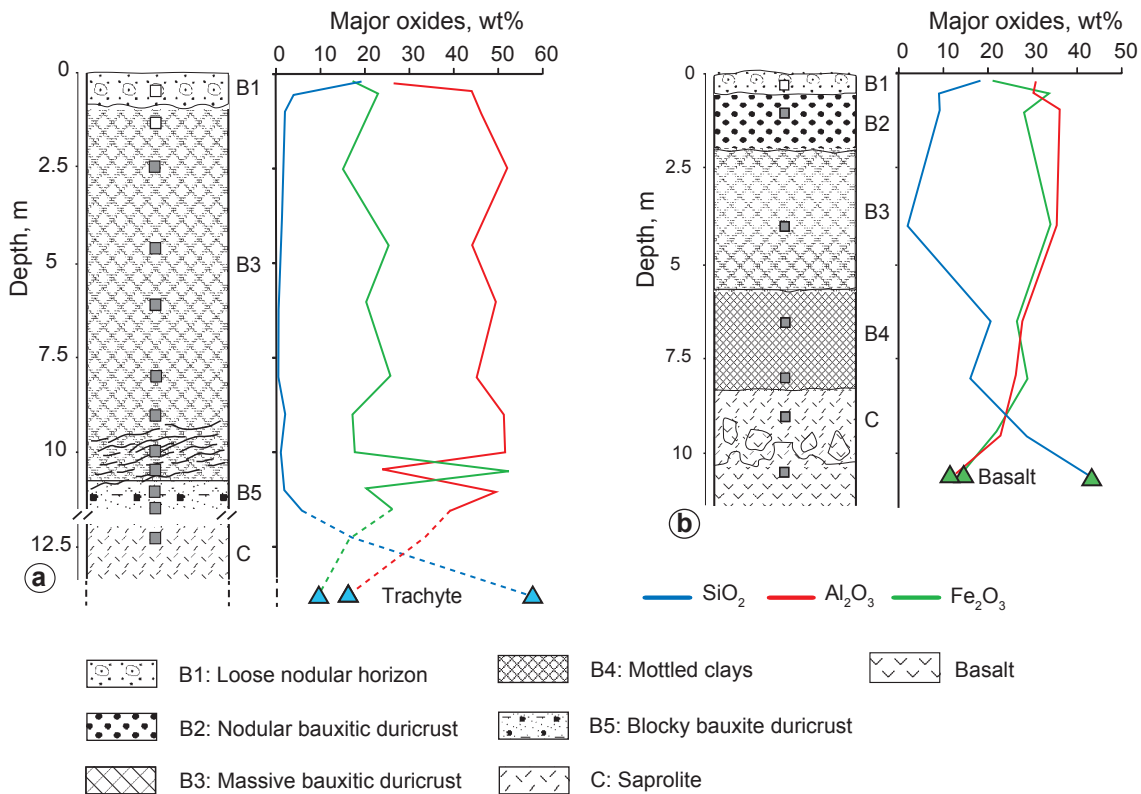


Fig. 4 (Catena10553)

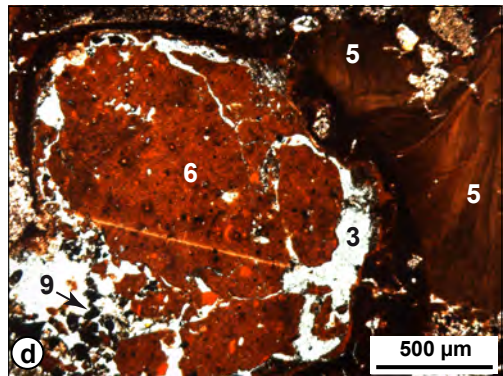
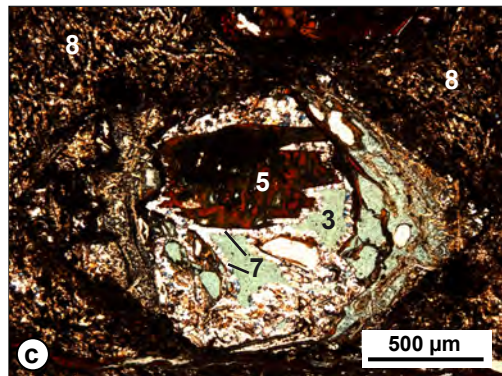
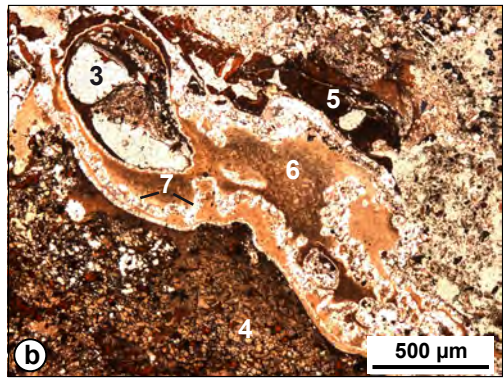
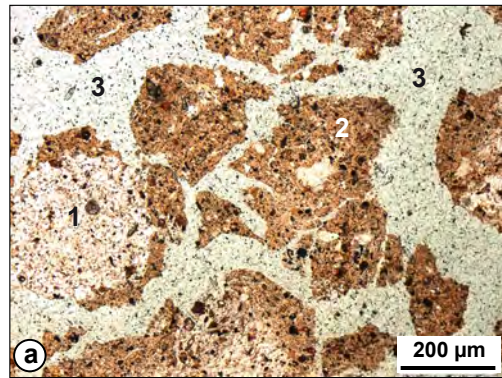


Fig. 5 (Catena10553)

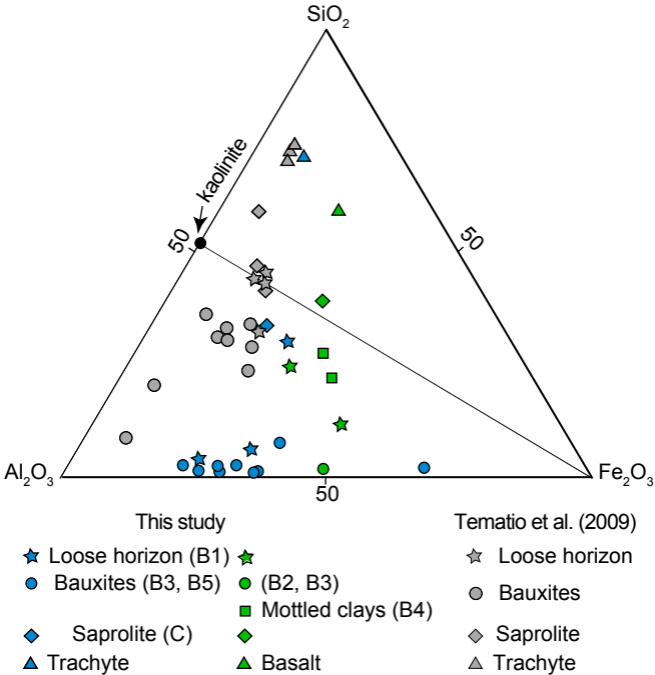
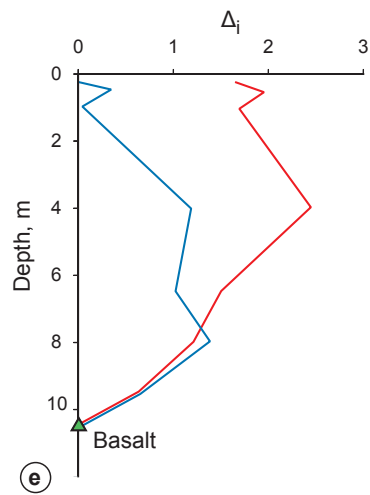
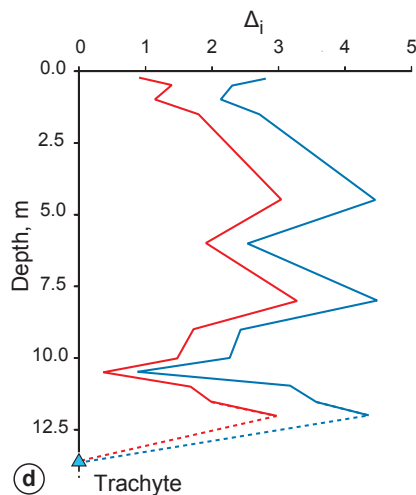
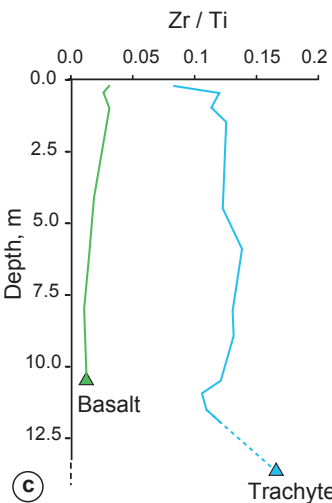
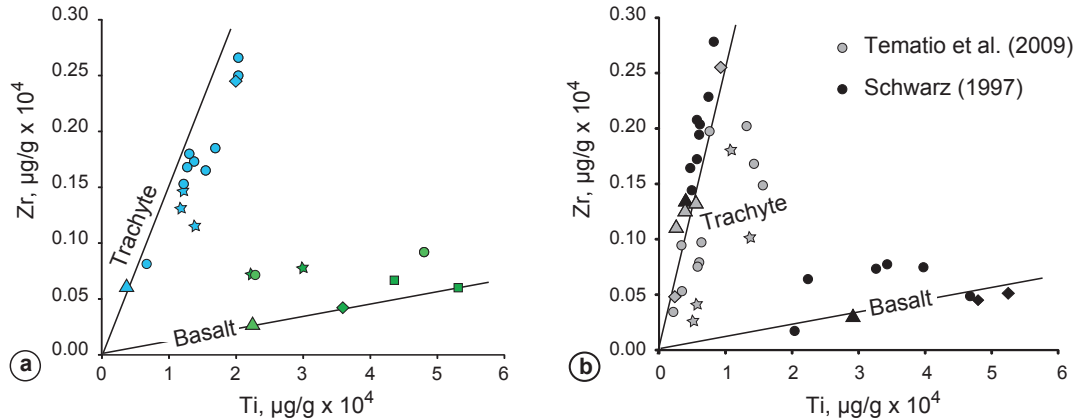


Fig. 6 (Catena10553)



$$\Delta_i = \frac{C_{i,w} - C_{i,p}}{C_{i,p}}$$

— Δ_{Zr}

— Δ_{Ti}

Fig. 7 (Catena 10553)

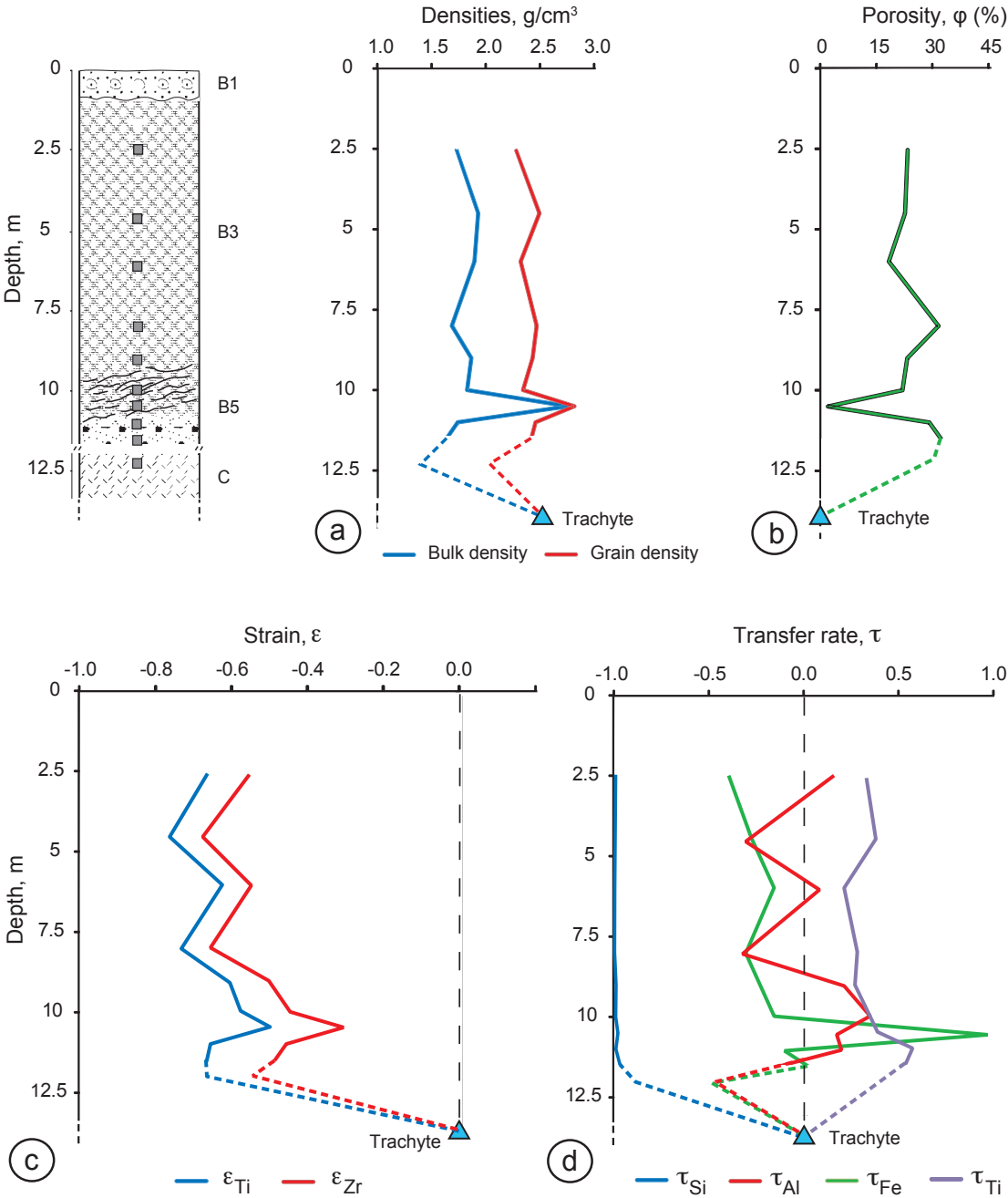


FIG. 8 (Catena10553)

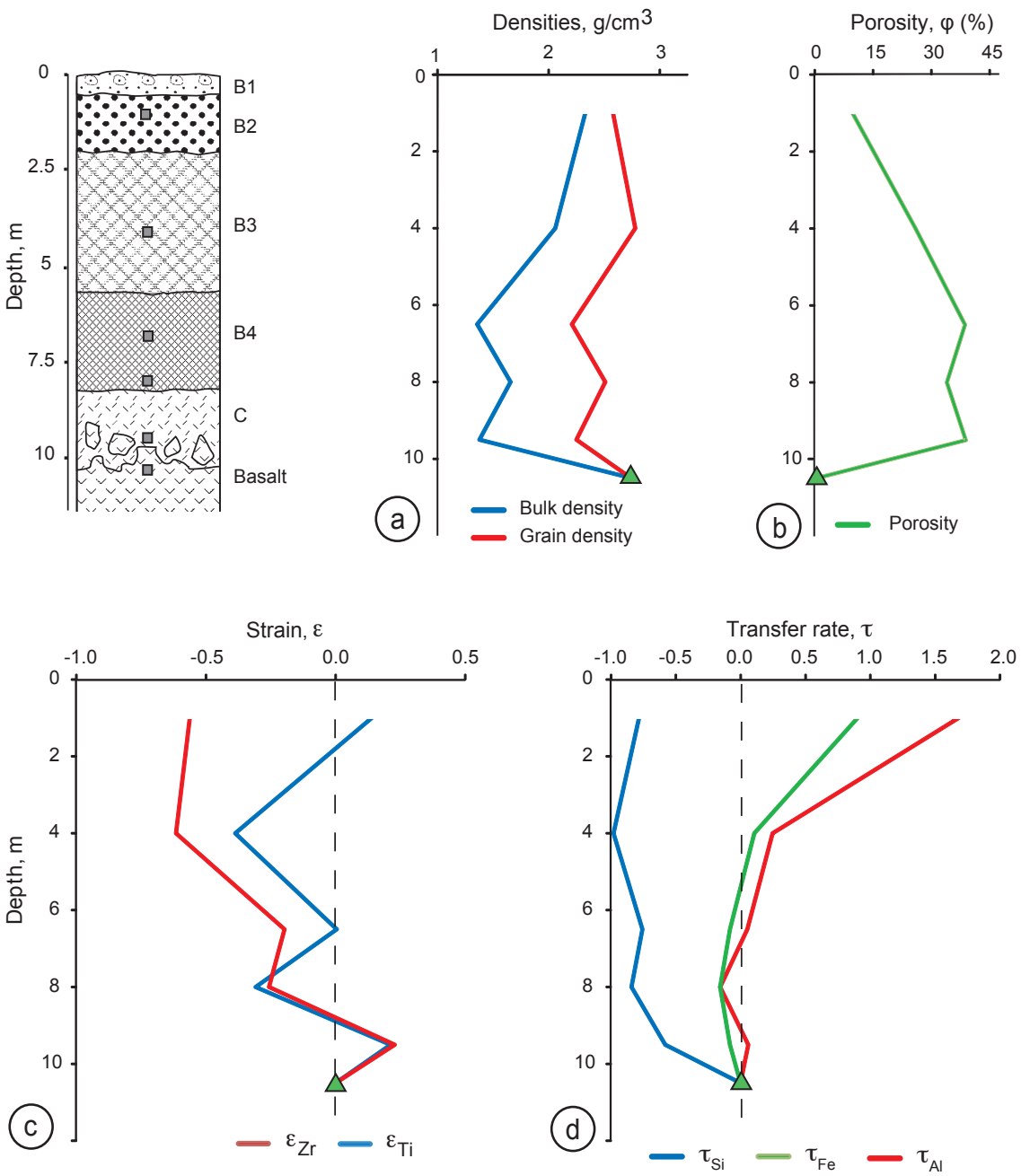


Fig. 9 (Catena10553)

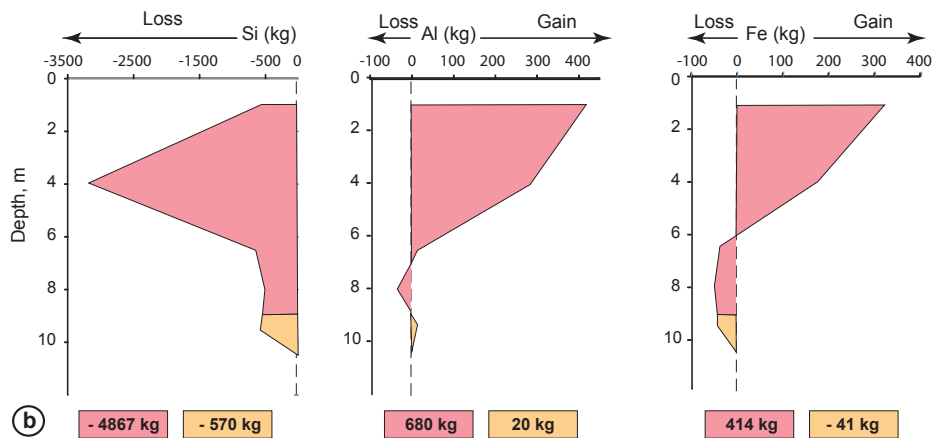
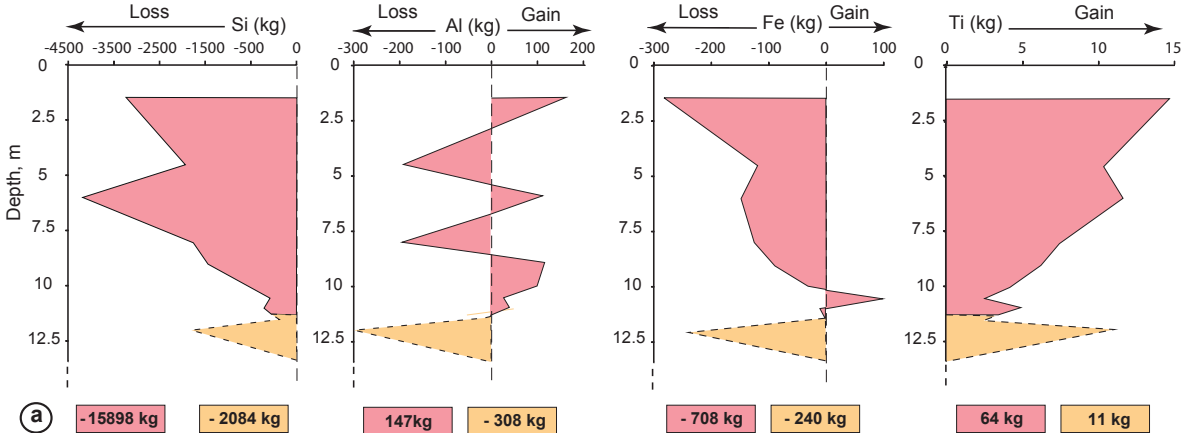


FIG. 10 (Catena10553R2)

Supplementary information for the article:

Differentiated Neogene bauxitization of volcanic rocks (Western Cameroon): Morpho-geological constraints on chemical erosion

Mathieu Nouazi Momo, Anicet Beauvais, Paul Tematio, Martin Yemefack

Supplementary information supplies a figure of the landscapes encompassing the study sites in our article (Fig. DR1a-b). We also provide tables of mineralogical (Table DR1a-b) and geochemical (Table DR2a-b and DR3a-b) compositions of each horizon composing the lateritic weathering profiles formed on trachyte and basalt from the highland western Cameroon. Trace elements transfer rates and transferred masses are also provided (Table DR4a-b) based on calculations from equations (3), (4) and (5) in the associated manuscript.

Figure DR1. Topographic attributes of landscapes on (a) trachytes around Fongo Tongo and (b) basalts near Doumbouo in highlands western Cameroon (Google Earth, image Landsat/Copernicus Image © 2020 Maxar Technologies).

Table DR1. X ray diffraction mineralogical composition of samples collected in weathering profiles formed on (a) trachyte and (b) basalts. (–) = Mineral present but below calculation limits (< 5%); Ka = kaolinite; Gi = gibbsite; Go = Goethite; An = Anatase; He = Hematite; Ma = Maghemite; Fl = Florencite; Qz =quartz.

Table DR2. Major elements composition of samples collected in weathering profile formed on (a) trachyte and (b) basalt. Major elements in wt.%; LOI=Loss Of Ignition; (–) = below detection limit (0.01 wt.%). The true depth of trachyte being unknown we simply mentioned a depth in parentheses for graphical easiness of figures in the associated article.

Table DR3. Trace elements composition of samples collected in weathering profile formed on (a) trachyte and (b) basalt. Detection limits are indicated.

Table DR4. Trace elements transfer rates, trace elements mass transfers in kg per unit volume (1 m³), and transferred masses of elements integrated over the investigated profile horizons

depth (Δz_w) related to the corresponding height or thickness of chemically weathered rock layer (Δz), in profile on a) trachyte, and b) basalt.

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