

Suppl. material S1: Materials and method for the mineralogical/pH supplementary information.

Mineralogical compositions from sediments were analyzed using X-ray diffraction on ground samples in a silicon calibrated PANalytical X'Pert diffractometer, using the K-Alpha 1 of a copper anticathode at 40 kV and 40 mA, from 8 to 80°. Minerals were identified using the JCPDS-ICDD database via the DIFFRACPLUS Eva software. TOPAS software allowed the quantification of mineralogical phases based on the Rietveld refinement method (1969). pH levels were measured from a suspension of 2 g of sediment in 10 g of water, using a pH meter calibrated with buffer solutions at pH 4 and 7 following the protocol described by Baize (2000). Energy Dispersive X-Ray Fluorescence (ED-XRF) analysis were conducted with an AMETEK Spectro X-Sort equipped with a tungsten X-ray tube (40 kV, 0,01 mA) for 60 seconds. Since there is no calibration for this kind of matrix, fundamental parameters algorithm has been used for concentration calculations of potassium, calcium, phosphorus and iron (e.g. Jenkins et al., 1995).

Results and discussion:

Eight authigenic minerals and five detrital minerals are found throughout the deposit (Table S1-1). This mineral composition is relatively typical of Caribbean caves (Onac et al., 2009).

Mineral	Formula	Origin
Hydroxylapatite	$\text{Ca}_5(\text{PO}_4)_3(\text{OH})$	Authigenic phosphates
Whitlockite	$\text{Ca}_{18}\text{Mg}_2\text{H}_2(\text{PO}_4)_{14}$	
Tinsleyite	$\text{KAl}_2(\text{PO}_4)_2(\text{OH})\cdot 2\text{H}_2\text{O}$	
Leucophosphate	$\text{KFe}_2(\text{PO}_4)_2(\text{OH})\cdot 2\text{H}_2\text{O}$	
Taranakite	$(\text{K}_3\text{Al}_5(\text{HPO}_4)_6(\text{PO}_4)_2(\text{H}_2\text{O})_{18})$	
Crandallite	$\text{CaAl}_3(\text{PO}_4)_2(\text{OH})_5\cdot \text{H}_2\text{O}$	
Gypse	$\text{CaSO}_4\cdot 2\text{H}_2\text{O}$	Authigenic sulfate

Calcite + Dolomite	CaCO ₃ + CaMg(CO ₃) ₂	Detrital
Quartz	SiO ₂	
Montmorillonite	(Na,Ca) _{0.3} (Al,Mg) ₂ Si ₄ O ₁₀ (OH) ₂ ·x(H ₂ O)	
Labradorite	(Ca,Na)(Al,Si) ₄ O ₈	
Halite	NaCl	Seaspray

Table S1.1 - List of minerals identified in the Blanchard cave infilling.

Sample	Sedimentary level	Square	Depth (mm)	K (% FP)	Ca (% FP)	P (% FP)	Fe (% FP)	pH	Mineralogical composition (%)														
									Hydroxylapatite	Whitlockite	Tinsleyite	Leucophosphate	Taranakite	Crandallite	Gypsum	Calcite + Dolomite	Quartz	Montmorillonite	Plagioclase	Biotite	Halite		
GB 05.01	1	H33	-128	1.4	23	10.2	1.2	5.9	15	67	14												
GB 05.02	1	H33	-230	-	-	-	-	-	10	73	11											4	2
GB 07.07-08.29	2	H33	-333	1.3	17	8.3	1.2	5.2	17	59	16					4							4
GB 08.06	3	H33	-408	1.2	21	10.4	1.3	5.1	14	66	11		2										5
GB 08.05	3	H33	-483	0.8	21	9.4	0.9	5	15	82													3
GB 08.07	3	H33	-517	0.8	25	11.4	0.6	-	12	82			2										3
GB 05.03	4	H33	-666	0.5	24	2.4*	1.1	8.4	6	9						75		10					
GB 05.04	4	H33	-752	0.5	27	2.3*	0.9	8.5	2	6						87	1	4					
GB 07.09-08.34	5	H33	-909	0.5	22	8.9	0.8	8.2	17	75	4							1					
GB 07.08-08.35	5	H33	-975	0.6	20	7.8	1.2	8.3	12	80	3							1					3
GB 07.02	6	H33	-1051	0.6	26	10.6	0.6	6.2	17	64	5					7	1	5	1				
GB 08.08	6	H33	-1175	0.5	22	7.0	1.1	-	28	40						7	20	2	3				
GB 08.09	7	H33	-1275	0.5	23	7.4	1.4	8.2	32	46						2	14	1	3				
GB 08.11	8	H33	-1357	0.4	26	10.6	1.2	8	34	55						7	2	1	1				
GB 11.01	8	H33	-1414	0.4	24	9.7	1.3	7.8	28	66						4		1	1				
GB 11.02	8	H33	-1541	0.4	25	10.0	1.1	7.8	33	60						4			2				
GB 08.13	8	H33	-1609	0.4	27	10.8	0.7	7.7	29	65						5			1				
GB 08.14	8	H33	-1703	0.5	22	9.5	1.8	7.5	20	71						4		2	3				
GB 08.15	9	H33	-1797	0.6	22	9.2	2.3	8.1	26	68								1	4				
GB 08.16	10	H33	-1881	0.5	24	10.1	1.9	7.5	40	45						5		3	4				
GB 08.17	10	H33	-1959	0.4	25	9.9	1.7	7.8	59	25						10		3	2				
GB 14.05	11	H33	-2238	1.4	19	14.5	3.0	7.1	55	22	6	7				2	2	2	4				
GB 14.13	11	H31	-2254	1.3	28	13.4	2.5	6.8	57	23	10	6				2	1	2					
GB 14.07	12	H33	-2352	2.0	13	10.7	4.3	5.8	50	8	12	12				1	7	7					
GB 14.17	12	H31	-2399	2.2	15	11.2	3.6	6.8	56	7	16	10				1	2	4	4				
GB 14.08	Reaction layer	H33	-2410	0.5	27	12.5	2.2	6.6	78	10	5			3		2	2						
GB 14.09	Reaction layer	H33	-2422	-	-	-	-	7	51	49													
GB 14.20	Reaction layer	H31	-2710	0.3	37	16.3	0.4	-	65	13								3	14	5			

Table S1.2 – Major element proportion derived from XRF analysis, pH and mineralogical composition of samples from the Blanchard Cave deposit. Symbol (*) indicates overestimated phosphorus value as a consequence of calcium escape line artifact.

The proportion of gypsum is relatively low (Table S1-2) compared to other caves on the island (Lenoble et al., 2009). Detrital elements are mainly derived from forms connected to the weathering of the surrounding rock. While these elements are more significant in the lower part of the cave fill, evaporite components, such as halite with a seaspray origin, are abundant in the upper part of the deposit (Table S1-2), in relation with the Holocene sea-level highstand.

The most abundant minerals are constituted by authigenic phosphates derived from biological inputs (Hill and Forti, 1997), apart from the level 4 where carbonates minerals dominated and phosphates are rare, due to this level's short period of formation as well as the origin of the material (limestone debris, *cf.* main text).

Phosphates were found as minerals formed by reactions with clays derived from the surrounding limestone. Potassium aluminium (tinsleyite) or iron-potassium forms (leucophosphite) are present but the majority of minerals are calcium and calcium-magnesium phosphates (hydroxylapatite and whitlockite, respectively). These latter minerals are produced by reactions with calcium or magnesium-rich sediment connected to the degradation of the host rock. Their occurrence indicates a low degree of sediment weathering (Karkanis et al., 1999), which is also evident in the high levels of pH measured through the deposit (Table S1-2). The low diagenetic transformation of the sediment indicated by phosphate minerals supports phosphate input by low trophic-level animals, such as frugivorous bats (Shahack-Gross et al., 2004). The low variations of both mineral assemblages and phosphate abundance measurements throughout the deposit suggest no significant change in biogenic

source related to a shift in trophic level, apart from the level 11. Indeed, this level presents a phosphorous content as high as those from the reaction layer, and also a high proportion of the insectivorous bat *Tadarida brasiliensis*, which is very different from other levels (Stoetzel *et al.*, 2016). It is noteworthy that the isotopic ratio of this bioturbated level obtained from one averaged sample does not depart from surrounding values. With the possible exception of this level, all these evidenced combined with the observation of fragmented vegetal tissues and the high level of organic matter in the sediment point to the deposit being primarily formed of fruit-bat guano.

References:

- Baize, D., 2000. Guide des analyses en pédologie: 2e édition, revue et augmentée. Editions Quae.
- Hill, C.A., Forti, P., 1997. Cave minerals of the world, second edition: Hunstville, Alabama, National Speleology Society, 463 p.
- Jenkins, R., Gould, R.W., Gedcke, D., 1995. Quantitative X-ray spectrometry. CRC Press, New York, 491 p.
- Karkanias, P., Kyparissi-Apostolika, N., Bar-Yosef, O., Weiner, S., 1999. Mineral assemblages in Theopetra, Greece: a framework for understanding diagenesis in a prehistoric cave. *Journal of Archaeological Science* 26, 1171-1180.
- Lenoble, A., Stouvenot, C., Courtaud, P., Grouard, S., Scalliet, M., Serrand, N., 2009. Formes et remplissages du karst littoral guadeloupéen, in Vanara, N. and Douat, M., eds, *Le karst, indicateur performant des environnements passés et actuels*, *Karstologia Mémoire*, v. 17, p. 226-233.
- Onac, B.P., Sumrali, J., Mylroie, J.E., Kearns, J., 2009. *Cave Minerals of San Salvador Island, Bahamas*: Tampa, University of South Florida Tampa library, Environmental Sustainability Publications, 70 p.
- Rietveld, H., 1969. A profile refinement method for nuclear and magnetic structures. *Journal of applied Crystallography* 2, 65-71.
- Shahack-Gross, R., Berna, F., Karkanias, P., Weiner, S., 2004. Bat guano and preservation of

archaeological remains in cave sites. *Journal of Archaeological Science* 31, 1259–1272.