

New mineralogical record of guano-associated phosphates in Colombo Cave (Toirano, Liguria, Italy)



Carbone C.¹, Balestra V.², Belmonte D.¹, Audra P.³, Columbu A.⁴, D'Angeli I.M.⁵, Chiesa R.⁶ & De Waele J.⁷

¹ Department of Earth Sciences, Environment, and Life, Università degli Studi di Genova, University of Genova

² Department of Environment, Land and Infrastructure Engineering, Politecnico di Torino.

³ Polytech'Lab - UPR 7498, Polytech Nice Sophia, Université Côte d'Azur

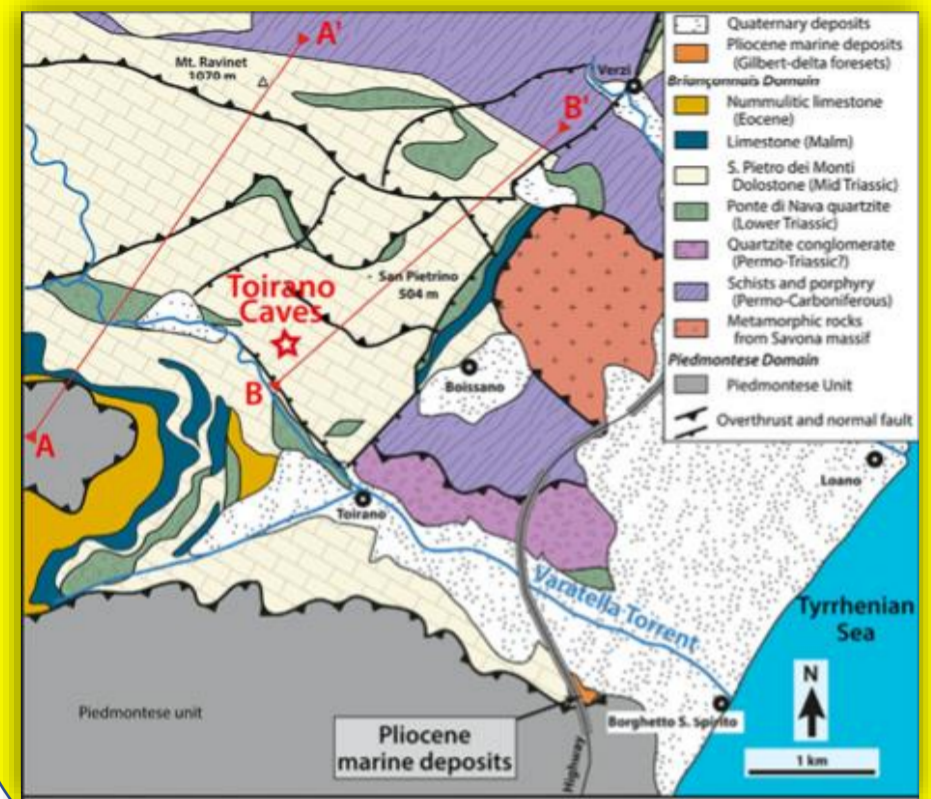
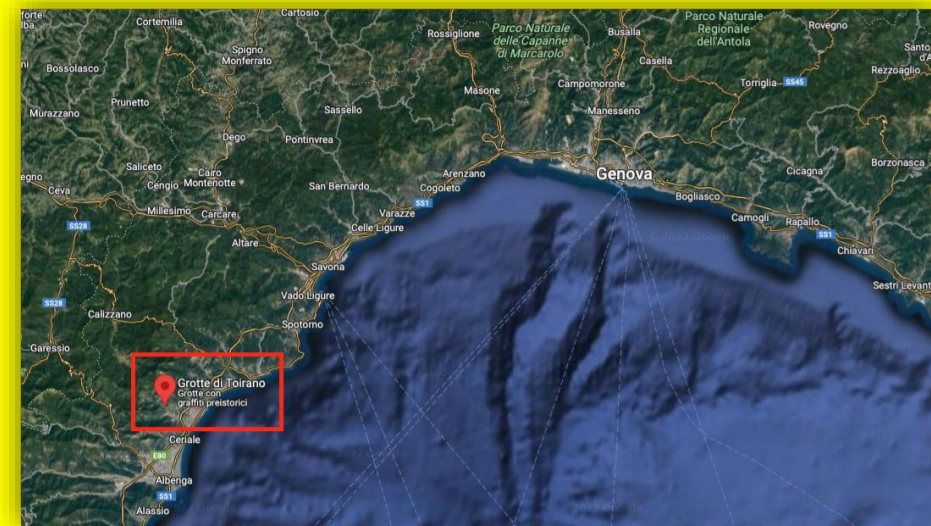
⁴ Department of Chemistry, Life Sciences and Environmental Sustainability, Earth Sciences Division, University of Parma

⁵ Department of Geosciences, University of Padova

⁶ Gruppo Speleologico Cynus, Toirano

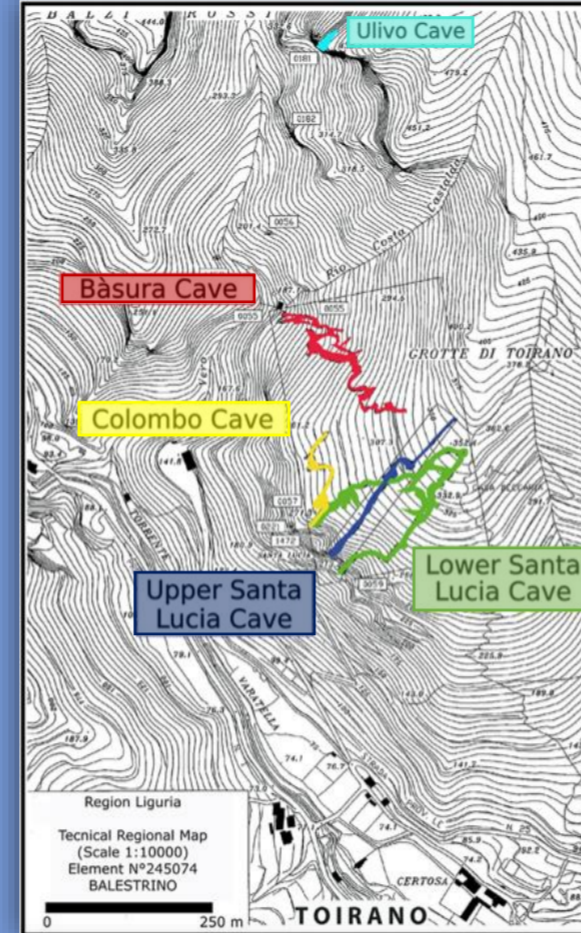
⁷ Department of Biological, Geological and Environmental Sciences, University of Bologna

Study area



The Toirano karst system develops along the lower slopes of Mt. Carmo di Loano (1389 m a.s.l.), half a kilometre north to the small village of the same name (Savona Province, Liguria Region, north-western Italy). The caves develop in the slopes on the hydrographic left of the Varatella torrent, at the outlet of its gorges, upstream of the coastal plain; the shoreline is located only 4.5 km downstream from the caves. This area belongs to the Briançonnais domain of the Ligurian Alps, being part of a complex dome structure dipping here 20–30° toward the NE (Boni et al., 1971; Cavallo, 2001). On the basis of the geomorphological observations, supported by geochemical analyses and radiometric dating, the origin of these complex caves cannot be attributed to a “classical” epigene vadose phreatic speleogenetic model only. Columbu et al., 2021 supposed that the Bàsura-Santa Lucia-Colombo caves formed by the action of rising hypogenic fluids that followed deep-rooted subvertical fractures.

Colombo Cave

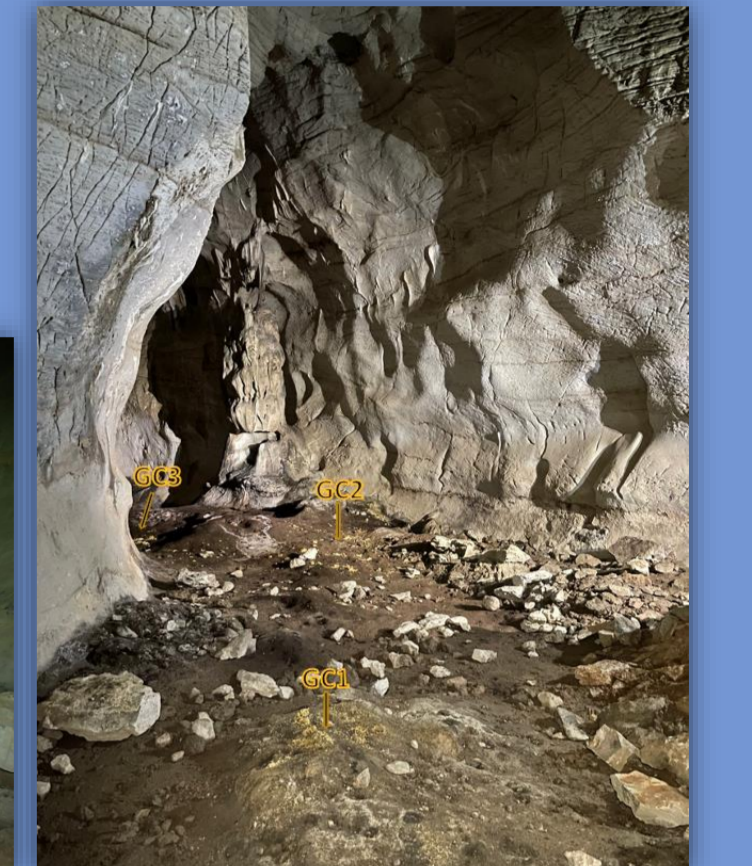
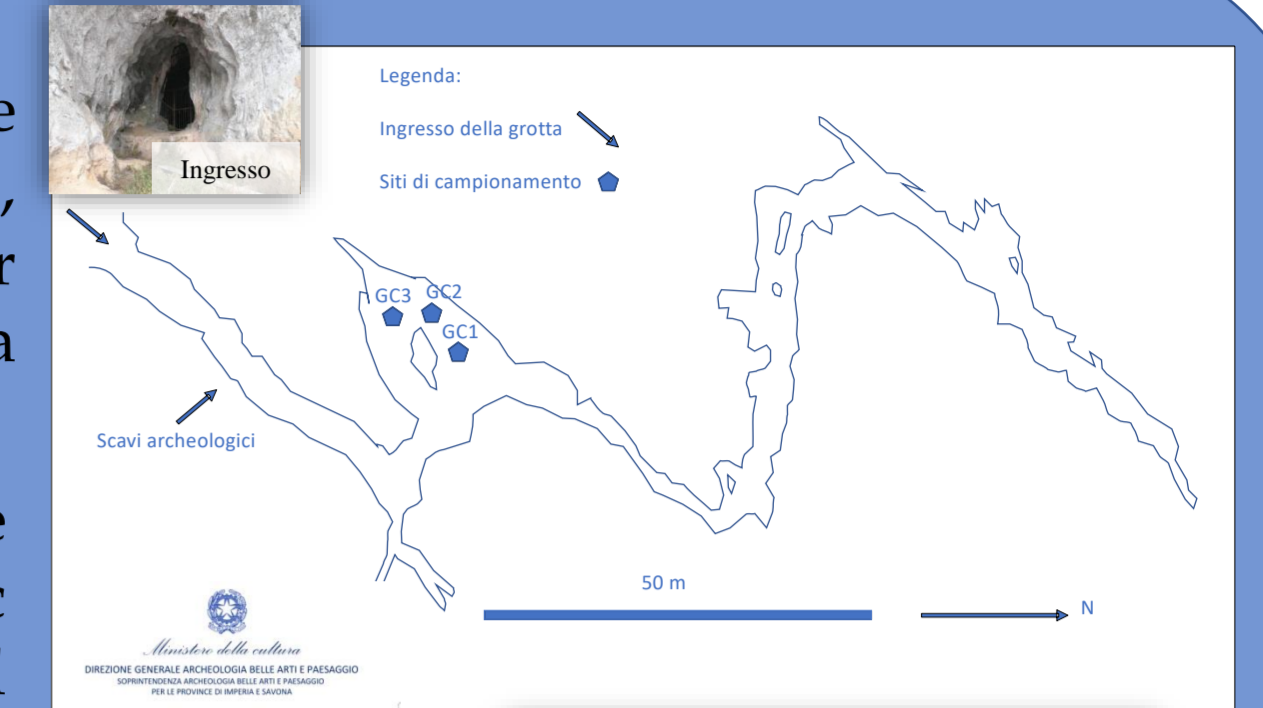


The Toirano karst system includes Ulivo Cave (27 m long), Colombo Cave (310 m long), Upper Santa Lucia Cave (378 m long), Lower Santa Lucia Cave (778 m long) and the Bàsura Cave (890 m long) (Chiesa, 2007).

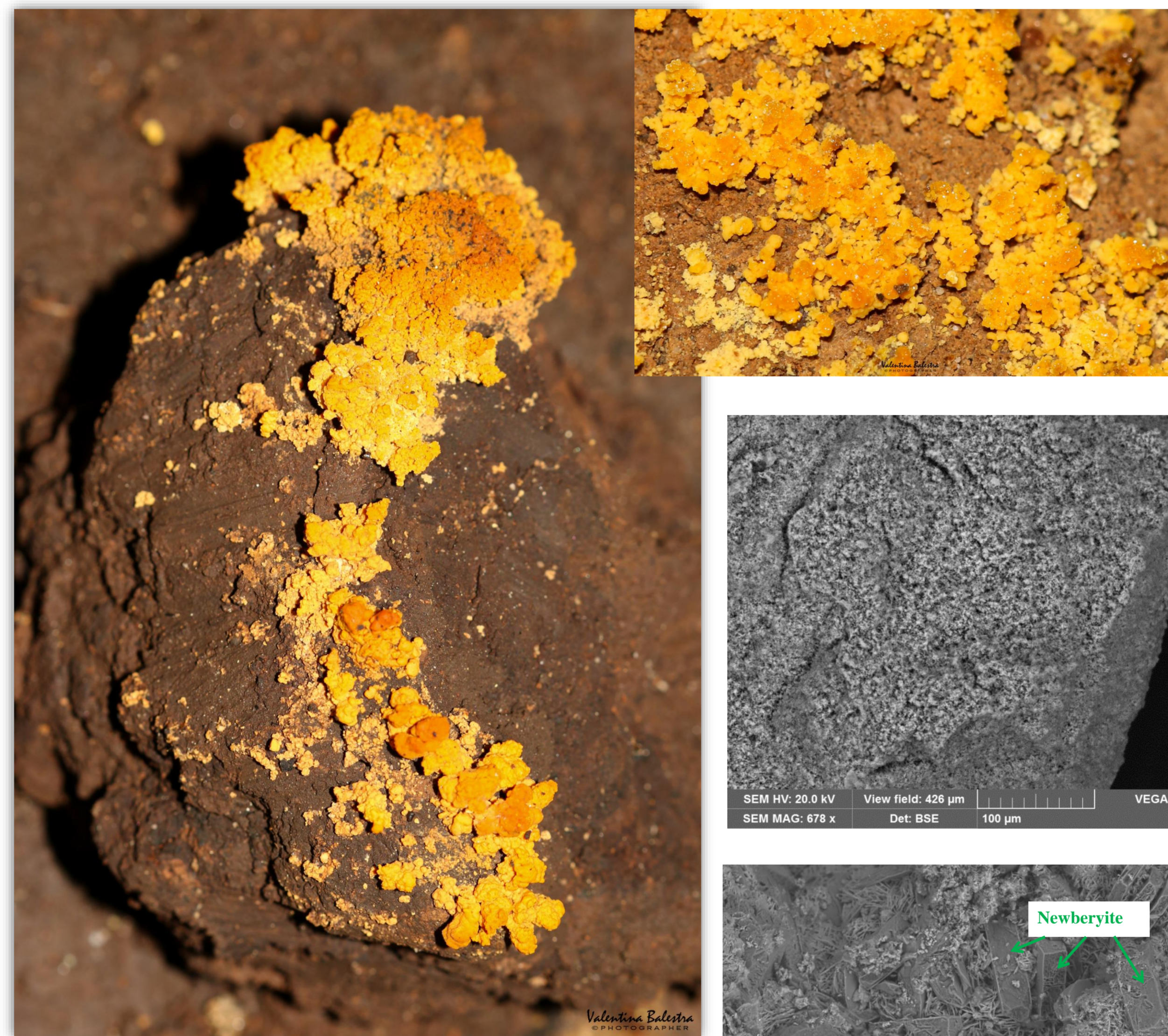
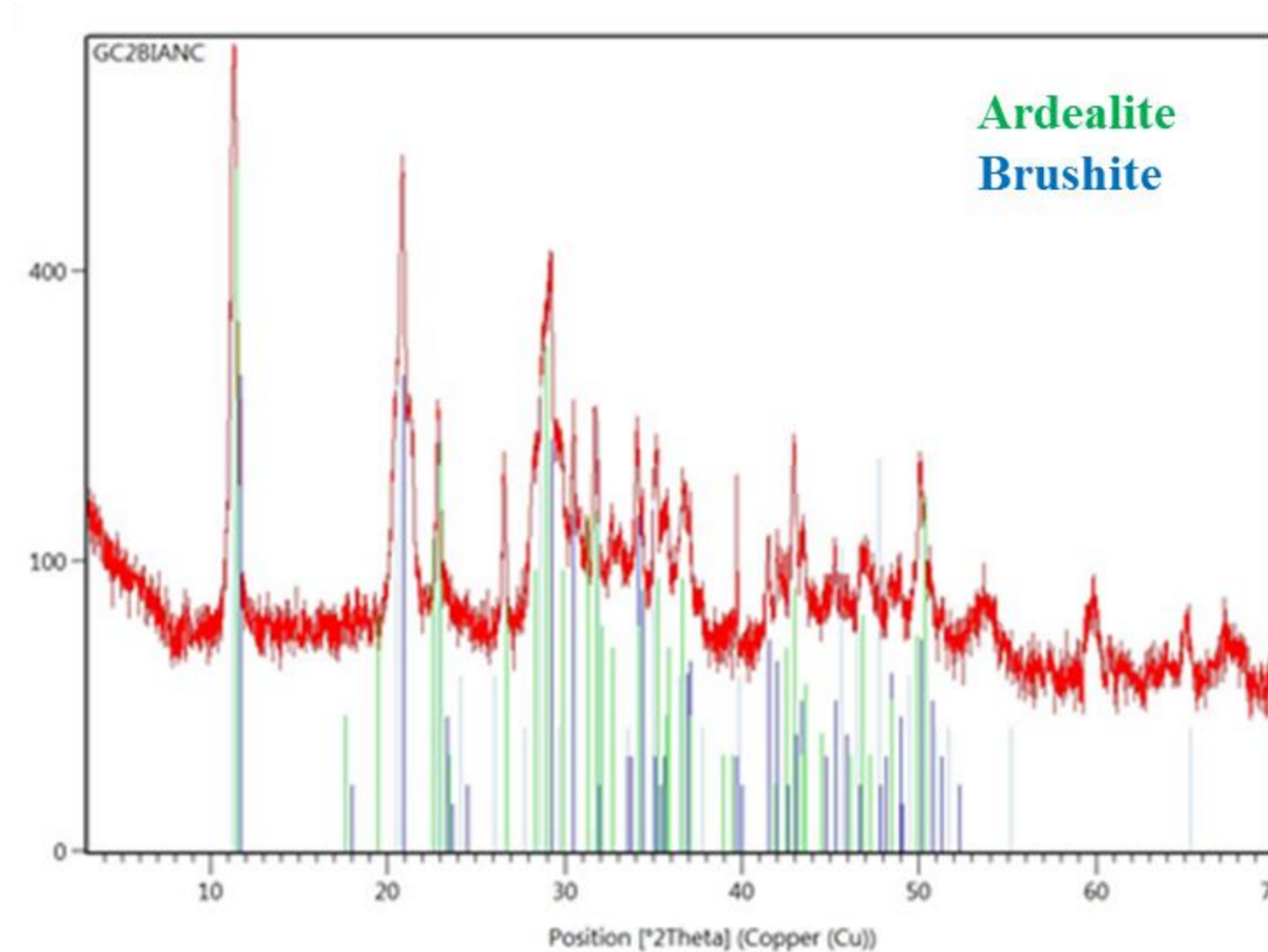
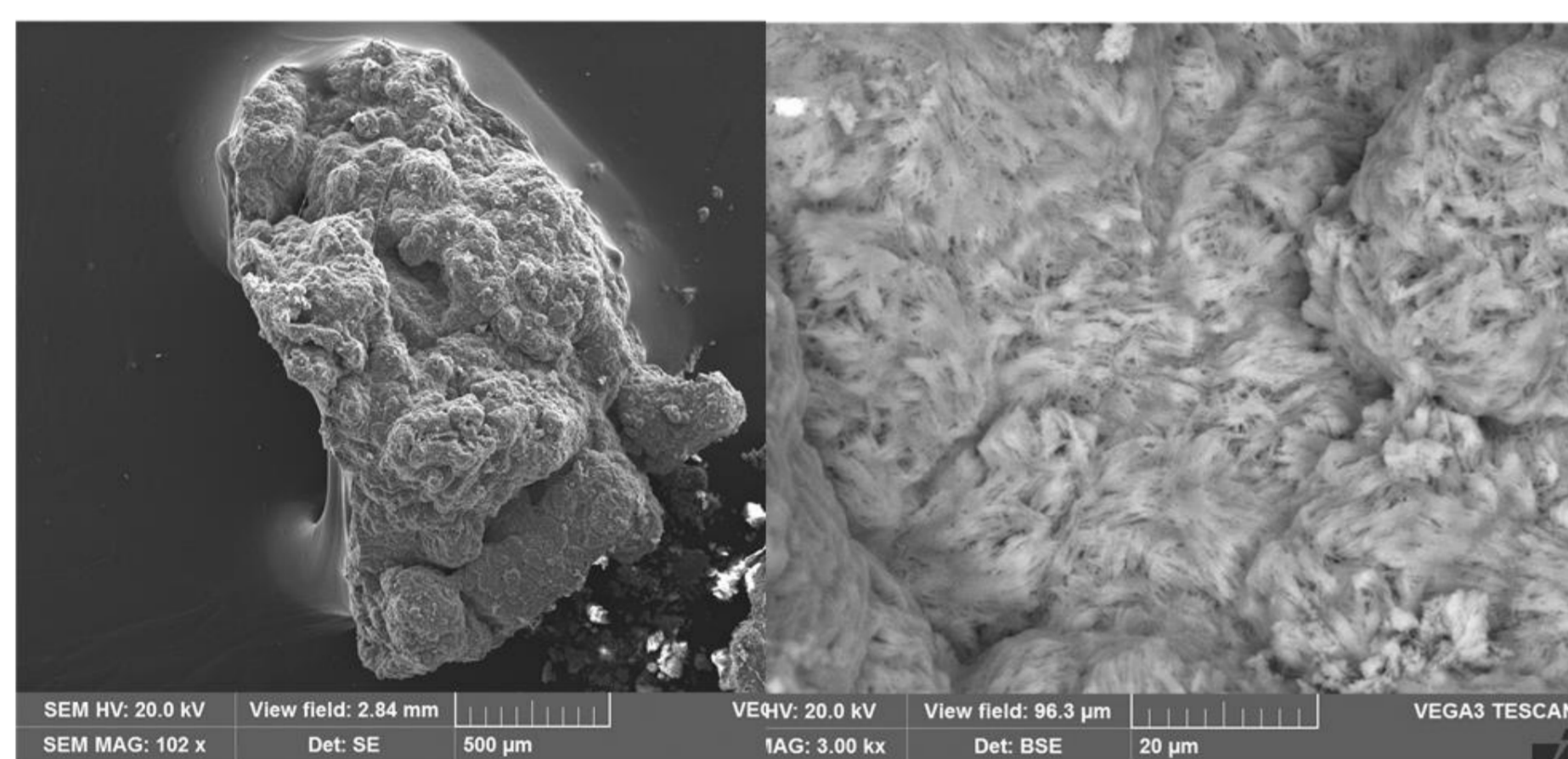
Colombo Cave opens at 247 m a.s.l. The wide entrance passage was used during prehistoric times, and a 4.5 m-deep archaeological excavation pit is present 10 m from the entrance. 25 m from the entrance, the passage opens in a large room of 10 m wide.



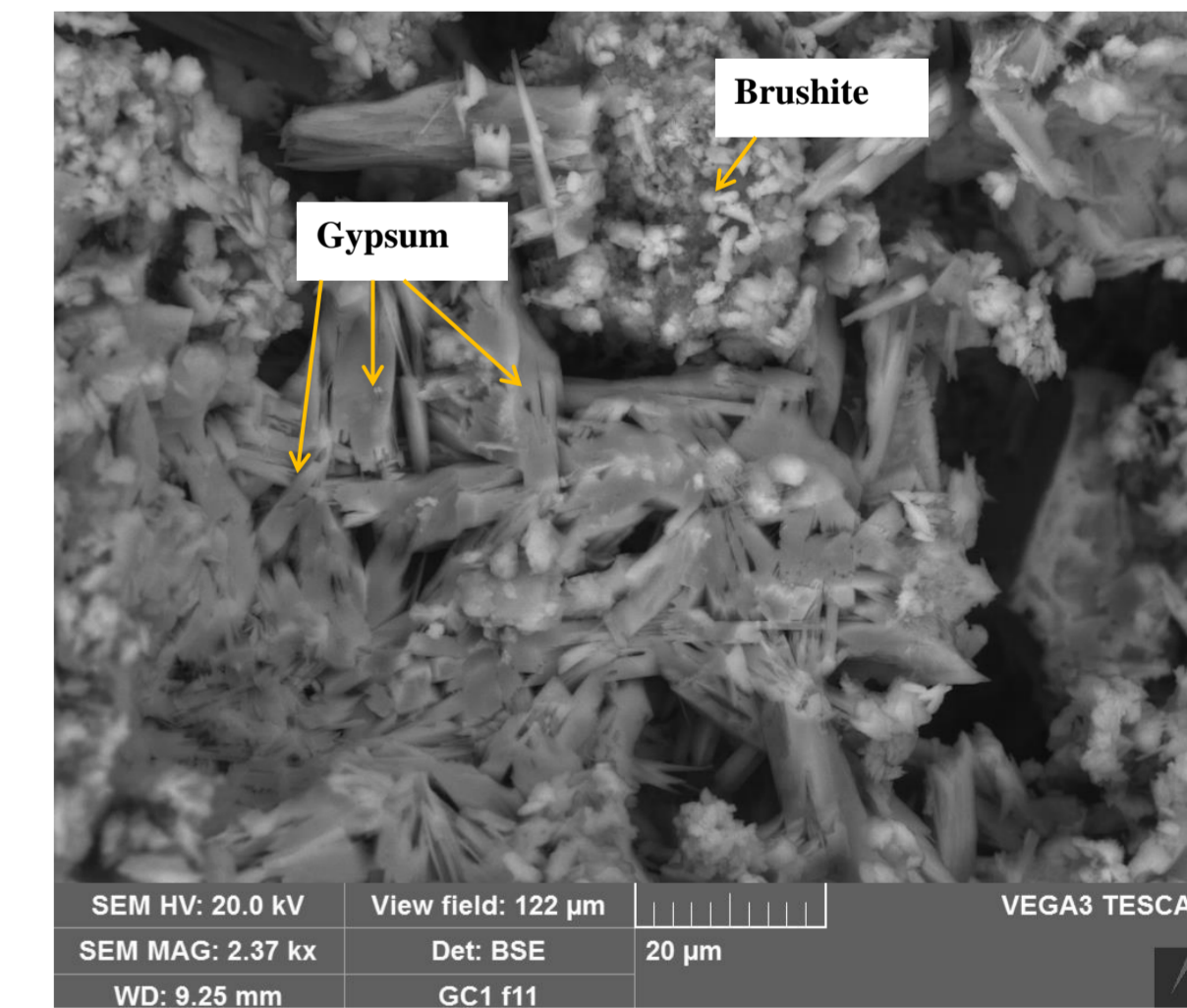
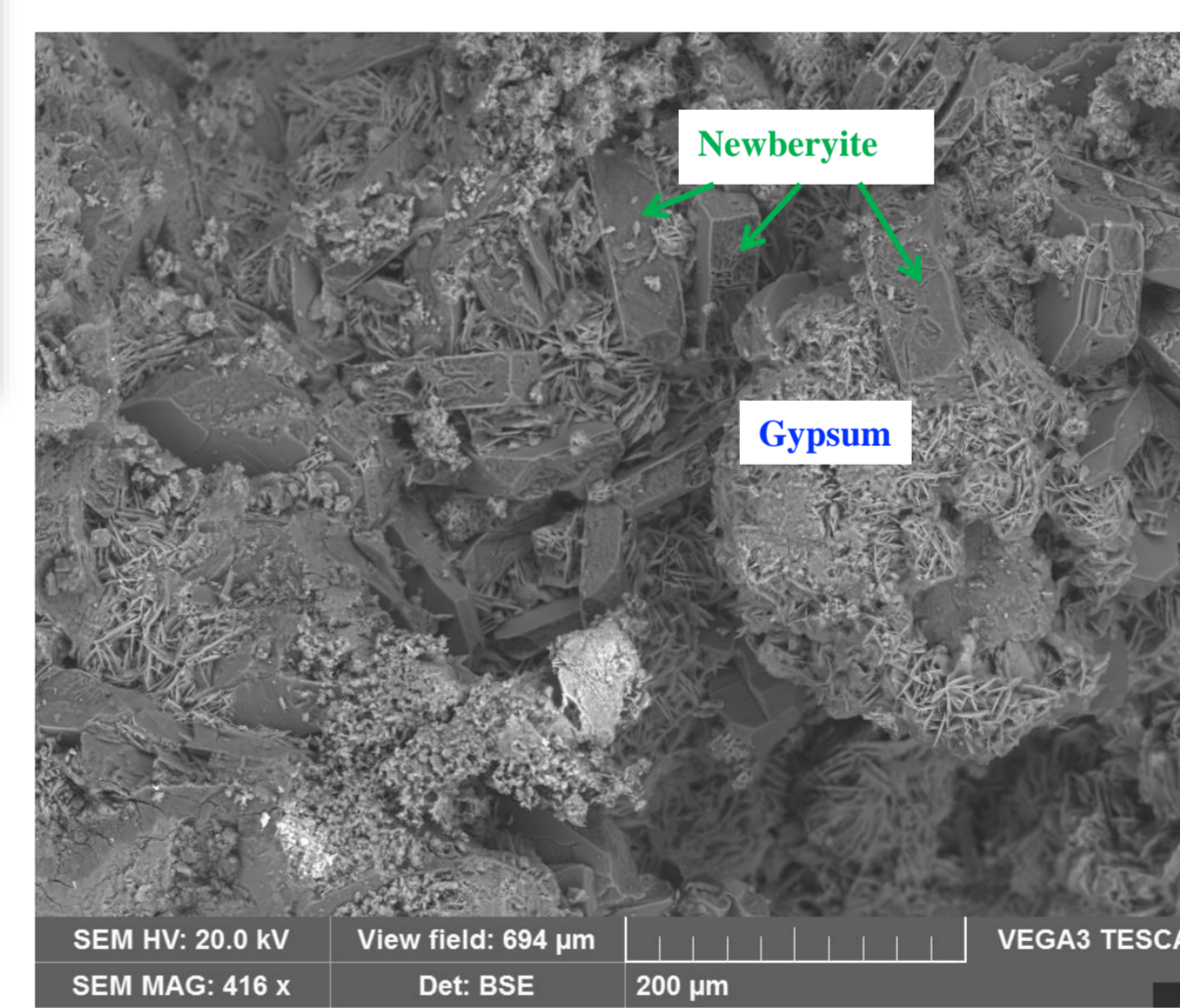
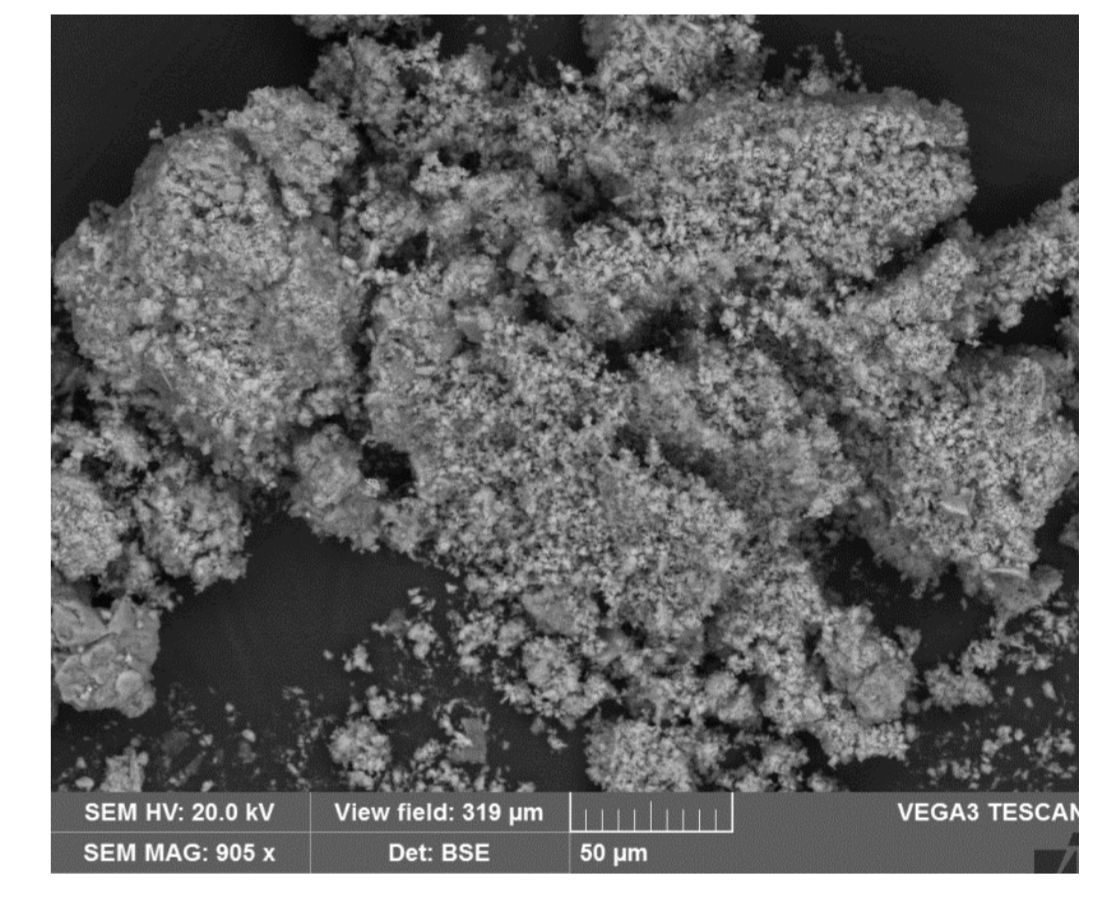
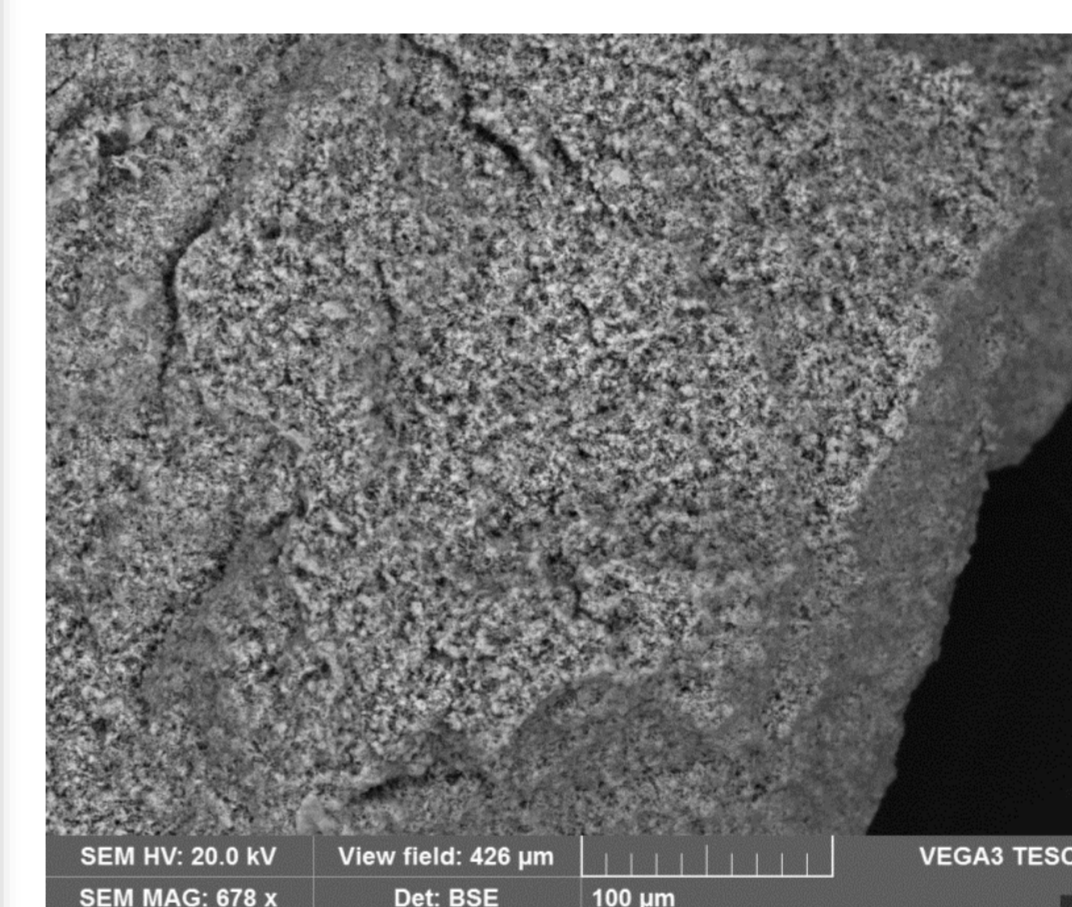
The walls of the entrance passage and the main room have an overall smooth and wavy appearance. The roofs are sculpted by cupolas and ascending channels, some are highlighted by the presence of orange coloured sediments



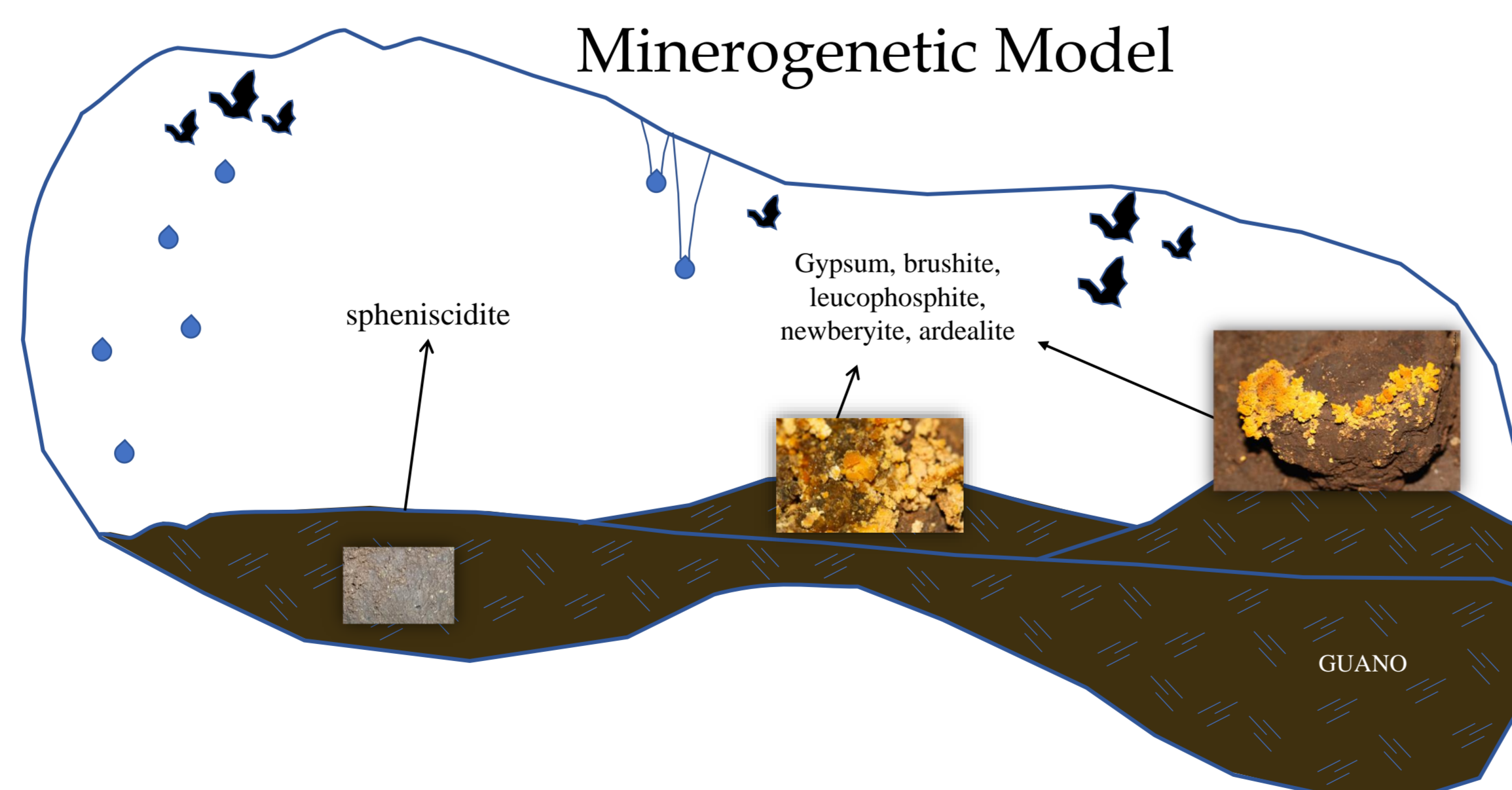
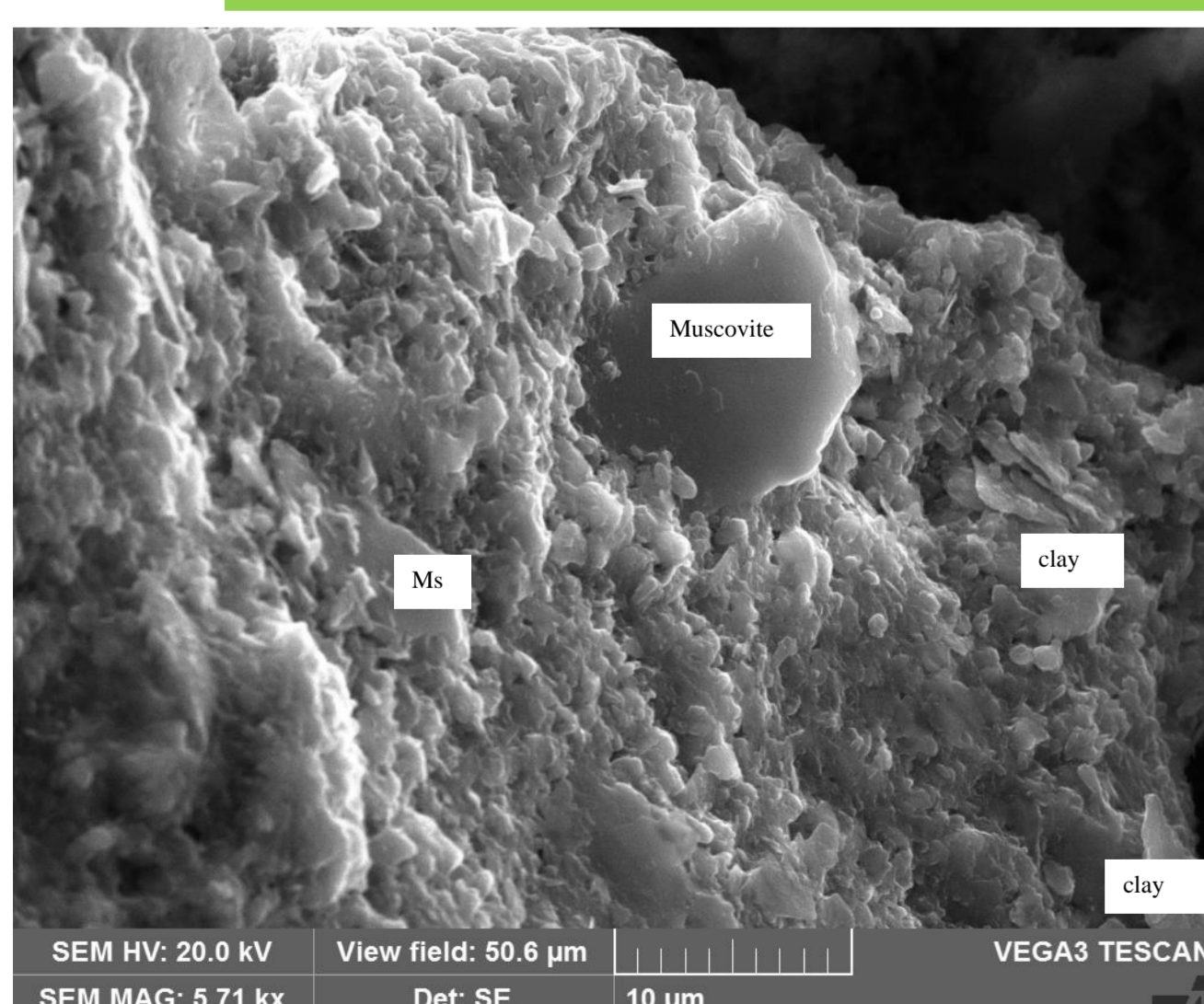
ARDEALITE $\text{Ca}_2(\text{PO}_3\text{OH})(\text{SO}_4) \cdot 4\text{H}_2\text{O}$



BRUSHITE - $\text{Ca}(\text{PO}_3\text{OH}) \cdot 2\text{H}_2\text{O}$ GYPSUM - $\text{CaSO}_4 \cdot 2\text{H}_2\text{O}$ NEWBERYITE



LEUCOPHOSPHITE $\text{K}(\text{Fe}^{3+})_2(\text{PO}_4)_2(\text{OH}) \cdot 2\text{H}_2\text{O}$



REFERENCES

- Boni, A., Cerro, A., Gianotti, R., Vanossi, M., 1971. Note illustrative carta geologica d'Italia. Foglio 92-93. Albenga - Savona. Servizio Geologico d'Italia, Roma.
- Cavallo, C., 1990. Indagine idrogeologica su alcune sorgenti del Toiranesi. (PhD thesis). Univ. of Genova (160 p).
- Columbu A. Audra P., Gázquez F., D'Angeli I.M., Bigot J., Koltai G., Chiesa R., Yug T., Hu H., Shen C., Carbone C., Heresanui V., Nobécourt J., De Waele J. (2021). Hypogenic speleogenesis, late stage epigenic overprinting and condensation-corrosion in a complex cave system in relation to landscape evolution (Toirano, Liguria, Italy). *Geomorphology*, 376, 107561. Pag 1-20.

SPHENISCIDITE $(\text{NH}_4\text{K})(\text{Fe}^{3+}, \text{Al})_2(\text{PO}_4)_2(\text{OH}) \cdot 2\text{H}_2\text{O}$

