

Supplementary Materials:

1. Raman microspectroscopy. The corrosion products detected on the Pompeii flute fragments by Raman analysis are presented below, accompanied by the standard reference:

- cuprite Cu_2O detected on AN2 fragment (Figure 1);

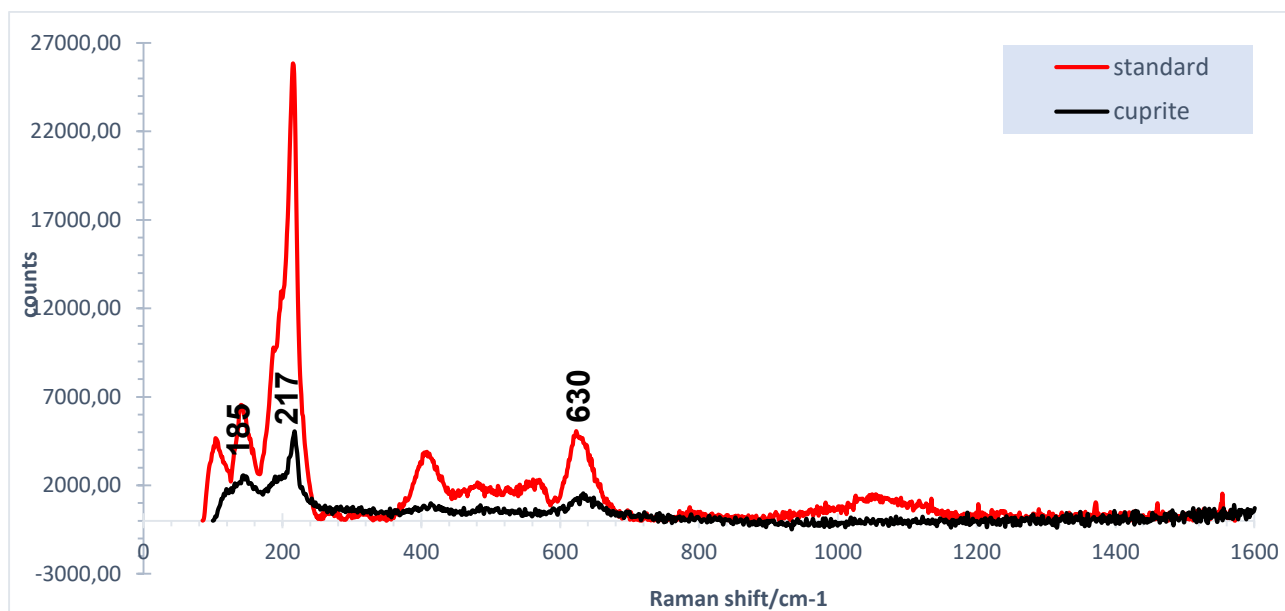


Figure S1. Cuprite Raman spectrum revealed on AN2 and cuprite standard.

Raman bands: 143-150 (m), 179-185-197 (s), 213-217 (vs), 298 (w), 420 (w) 515 (w), 630 (poorly crystallised).

Standard: <https://rruff.info/Cuprite/R050374>.

- azurite $2\text{CuCO}_3(\text{OH})_2$ revealed on AN2 (Figure 2);

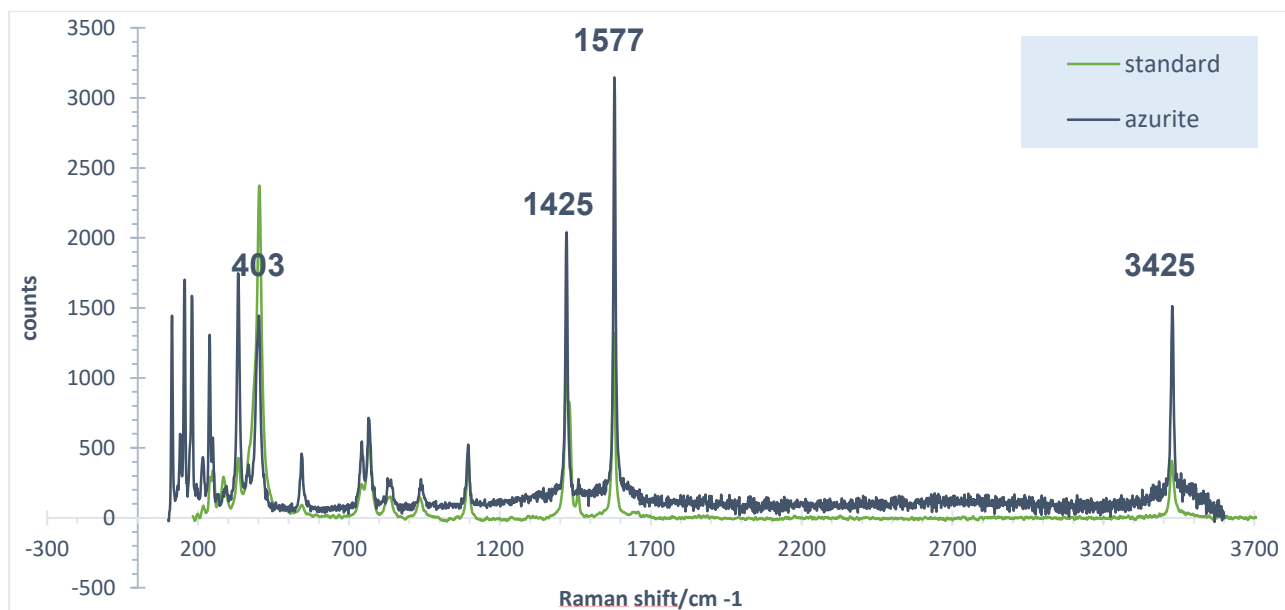


Figure S2. Azurite Raman spectrum revealed on AN2 and azurite standard.

Raman bands: 130-175 (w), 244 (m), 280 (m), 333 (m), 403 (vs), 540 (w), 740-766 (m), 833 (w), 932 (w), 1092 (m), 1425 (s)-1460(w), 1577 (s), 3425(s).
Standard: VRJIE database [1].

- malachite $\text{CuCO}_3\text{Cu(OH)}_2$ detected on AN2 (Figure 3):

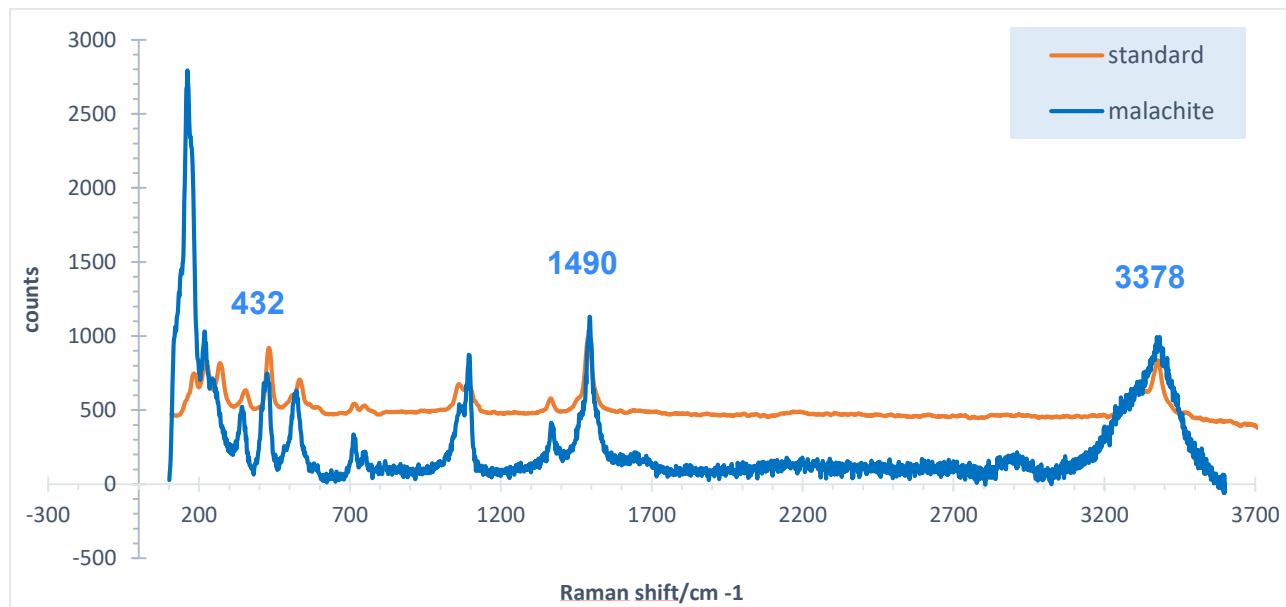


Figure S3. Malachite Raman spectrum revealed on AN2 and malachite standard.

Raman bands: 153 (vs), 220-240 (s), 351 (m), 432(s), 510 (m), 717-749-765 (w), 1057-1097(m); 1365 (m), 1490(vs), 3311(m)-3378(s).

Standard: VRJIE database [1].

- brochantite $\text{Cu}_4[(\text{OH})_6|\text{SO}_4]$ and posnjakite $\text{Cu}_4(\text{SO}_4)(\text{OH})_6(\text{H}_2\text{O})$ detected on AN3 (Figure 4);

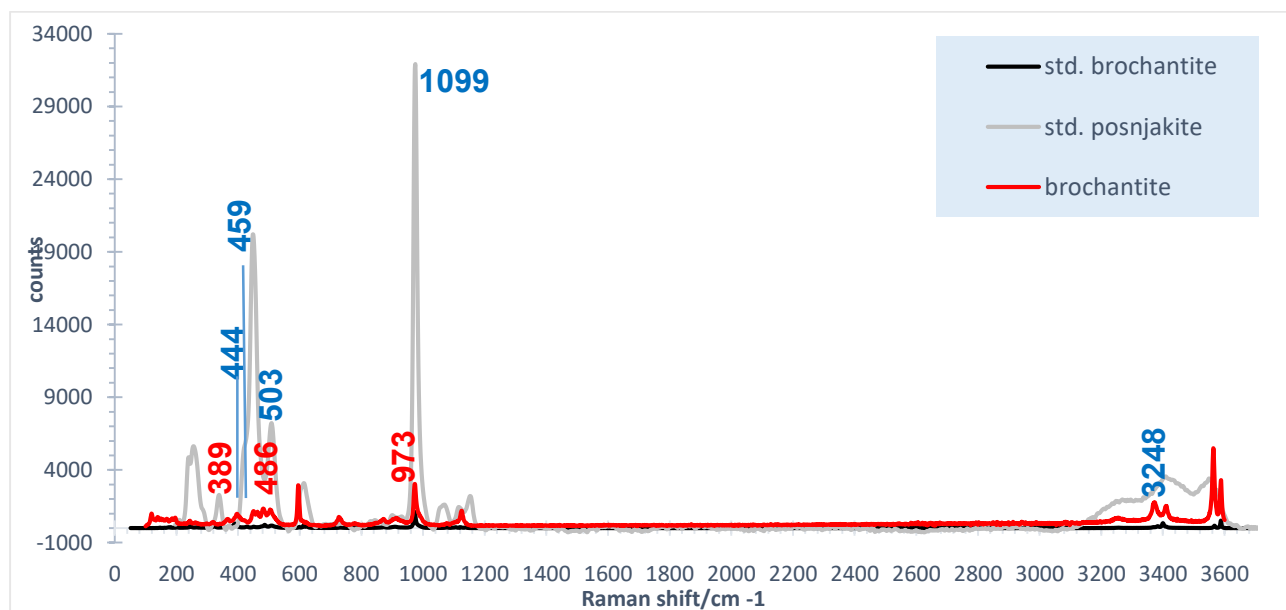


Figure S4. Brochantite Raman spectrum end posnjakite peaks revealed on AN3 and brochantite and posnjakite standard.

Brochantite Raman bands: 147 (w), 174-182(w), 203(w), 246(m), 321(m), 371(sh), 389(m), 428-451(w), 486(m), 507(m), 598(w)-612(m)-622(w), 730(w), 872(w), 908(w), 973(vs), 1078-1106(w), 1119-1138(w), 3382(m)-3400(s), 3567(m)-3588(s).

Posnjakite additional bands: 444, 459, 503, 1099, 3248.

Standard: VRJIE database [1].

- **clinoatacamite** $\text{Cu}_2[(\text{OH})_3|\text{Cl}]$ detected on AN11 (Figure 5);

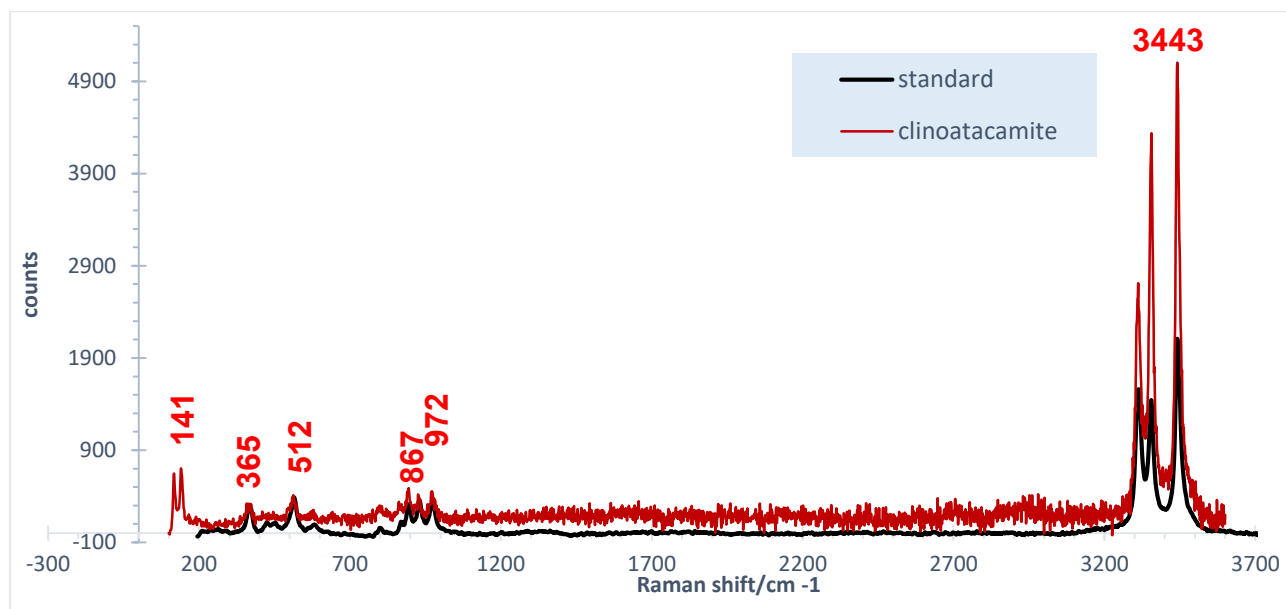


Figure S5. Clinoatacamite Raman spectrum revealed on AN11 and clinoatacamite standard.

Raman bands: 141(vs), 168(m), 262(w), 365(s), 421-445(m), 512(vs), 577(m), 798(m), 867(m), 893-928-972(s), 3312-3335(s), 3443(vs)

Standard: VRJIE database [1].

- **atacamite** $\text{Cu}_2\text{Cl}(\text{OH})_2$ revealed on AN4 (Figure 6);

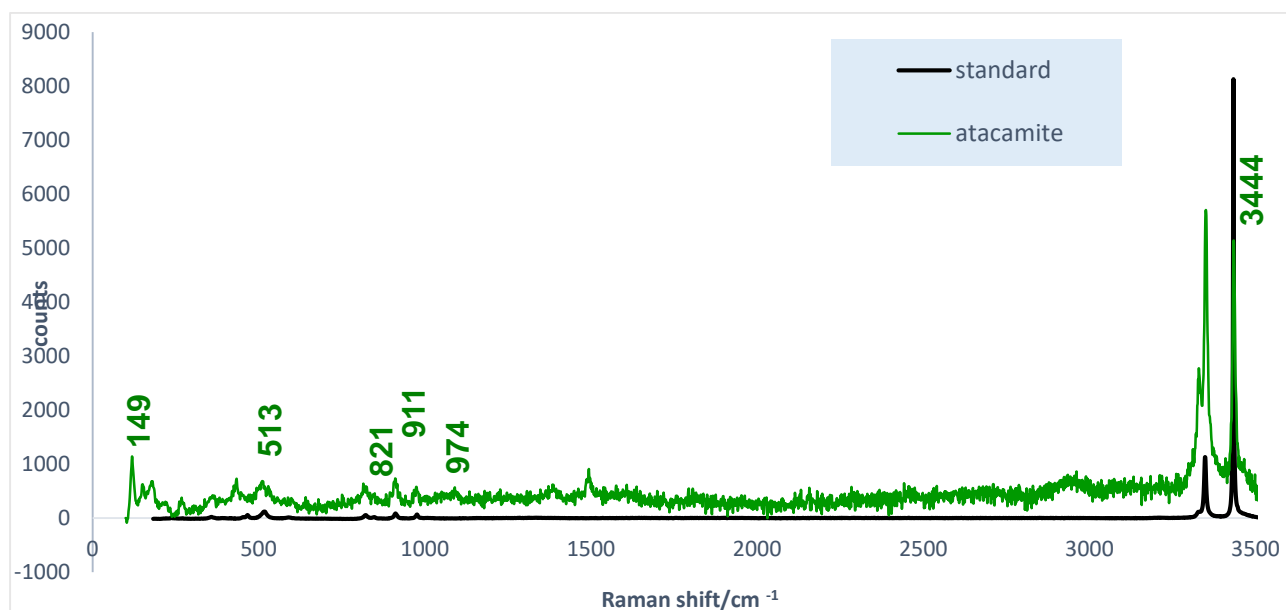


Figure S6. Atacamite Raman spectrum revealed on AN4 and atacamite standard.

Raman bands: 122(m)-149(s), 215(w), 238(w), 271(w), 298(w), 360(m), 412(w), 449(w), 513(vs), 584(w), 821(s)-846(m), 911(vs), 974(m), 3348(m), 3434(vs).
Standard: VRJIE database [1].

- rosasite ($\text{Cu, Zn}_2[(\text{OH})_2|\text{CO}_3]$) detected on AN2 (Figure 7);

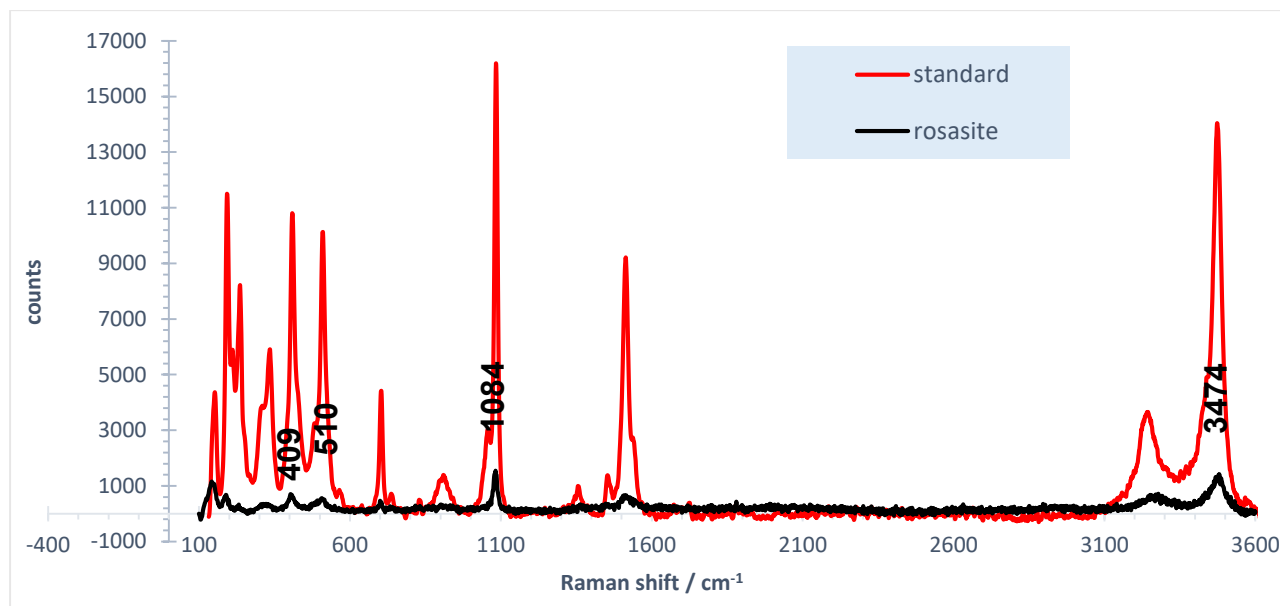


Figure S7. Rosasite Raman spectrum revealed on AN2 and rosasite standard.

Raman bands: 150(m), 192(s)-210(m)-236(s), 331(m), 409(s), 510(s), 703(m), 907(w), 1084(vs), 1356(w), 1454(w)-1513(s), 3239(m), 3474(vs).
Standard: VRJIE database [1].

- aurichalcite ($\text{Zn, Cu}_5(\text{CO}_3)_2(\text{OH})_6$) revealed on AN7 (Figure 8);

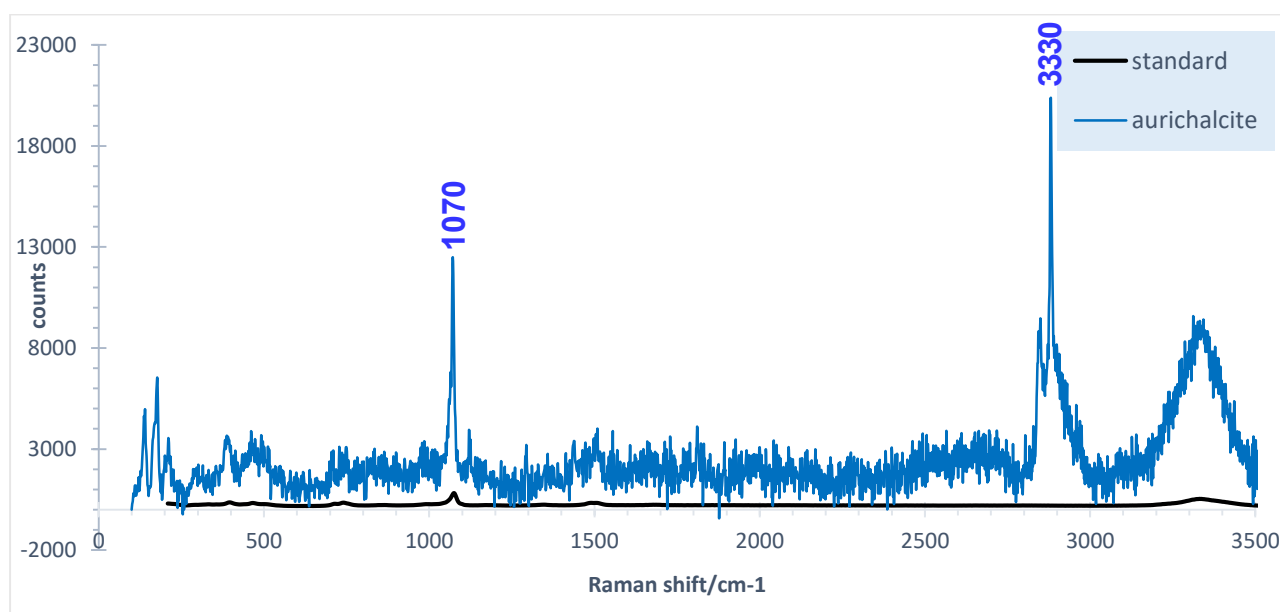


Figure S8. Aurichalcite Raman spectrum revealed on AN7 and aurichalcite standard.

Raman bands: 115(m), 140(m), 170(m), 210(m)-390(m), 430(w), 460 (m) 495 (m), 710(w), 737(w), 752(w), 1070(vs), 1170(w), 1375(w), 1480(w)-1510(w), 3330(vs).

Standard: <https://rruff.info/aurichalcite/display=default/R050297>.

- hydrocerussite $\text{Pb}_3(\text{CO}_3)_2(\text{OH})_2$ revealed on AN4 (Figure 9):

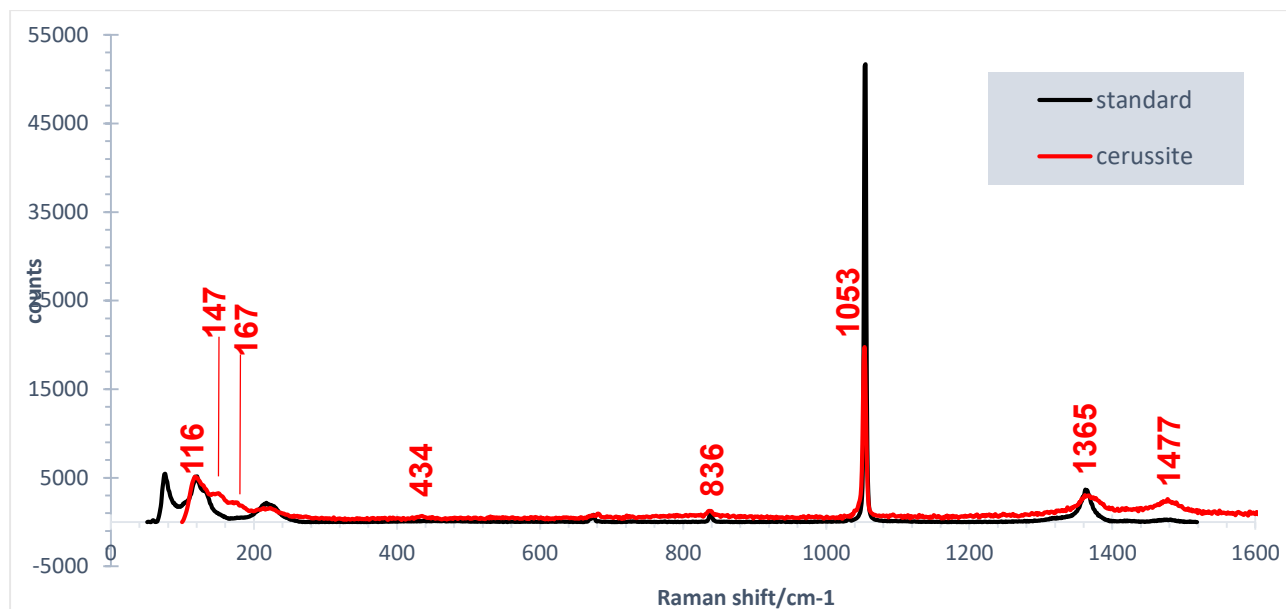


Figure S9. Hydrocerussite Raman spectrum revealed on AN4 and hydrocerussite standard.

Raman bands: 116, 147, 167, 220, 434, 674-680, 836, 1053, 1365, 1477.

Standard: <https://rruff.info/cerussite/display=default/R040069>.

- wax detected on AN3 (Figure 10):

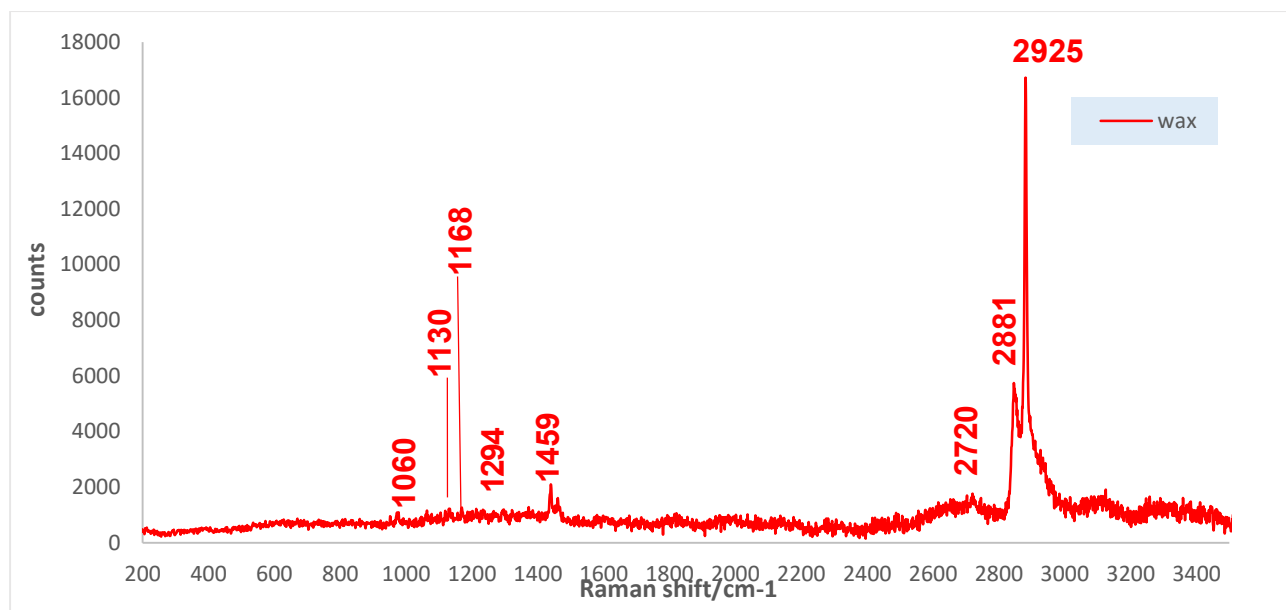


Figure S10. Wax Raman spectrum revealed on AN3.

Raman bands: 116, 147, 167, 220, 434, 674-680, 836, 1053, 1365, 1477

Standard (Figure 11): wax spectrum elaborated by Francesca Ospitali, University of Bologna.

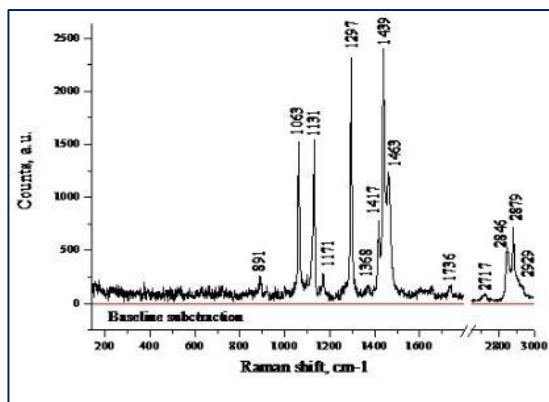


Figure S11. Wax Raman spectra revealed on AN3.

2. Characterization of organic compounds via FTIR.

- Siccative oil detected on AN11 (Figure 12):

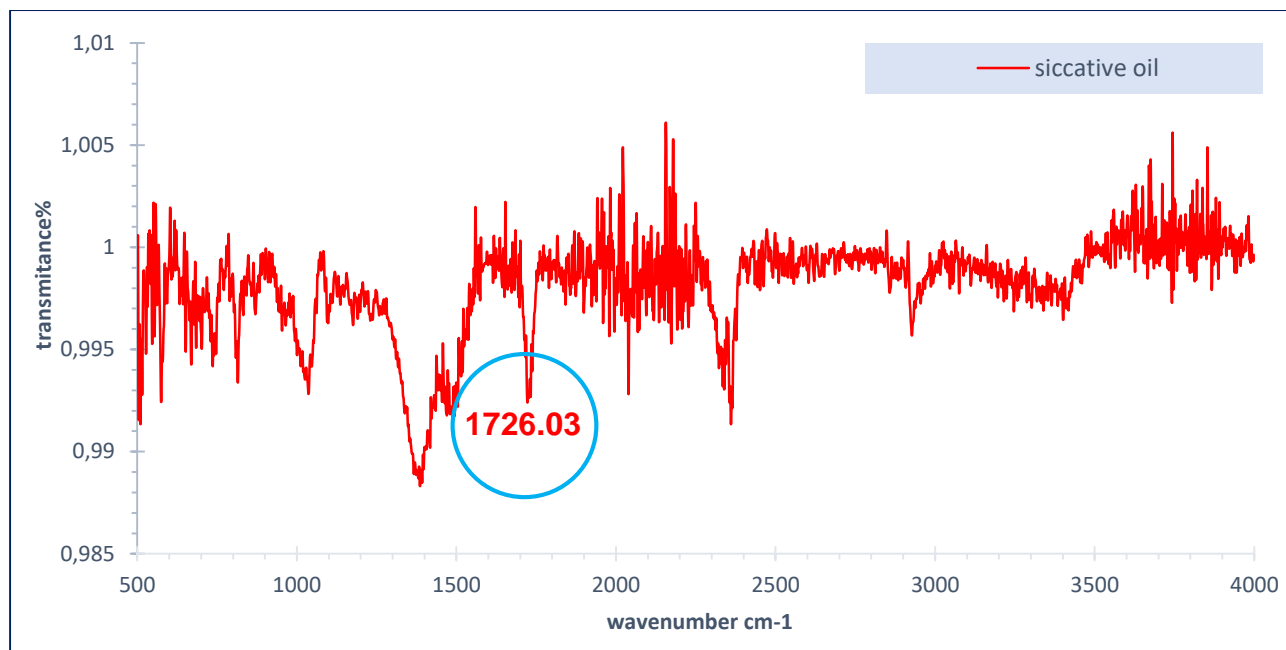
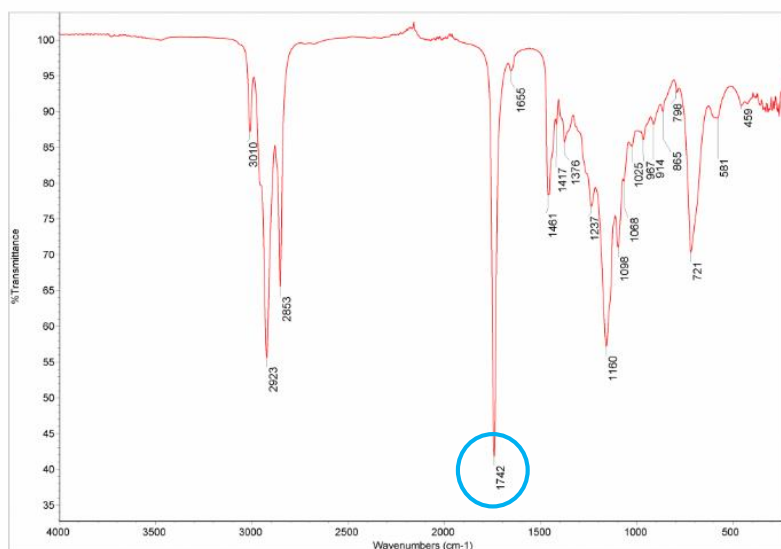


Figure S12. Siccative oil IR spectrum revealed on AN11.

Peaks corresponding to an ester-type C=O bond (1726.03) are visible (in addition to the malachite bands).

Standard: <https://spectra.chem.ut.ee/paint/binders/linseed-oil/>



Reference

- [1] V. Hayez e J. Guillaume, «Micro-Raman spectroscopy for the study of corrosion products on copper alloys: setting up of a reference database and studying works of art».