*minerals*

MDPI

*Supplementary Material*

# The Role of Mineral Assemblages in The Environmental Impact of Cu-Sulfide Deposits: A Case Study from Norway

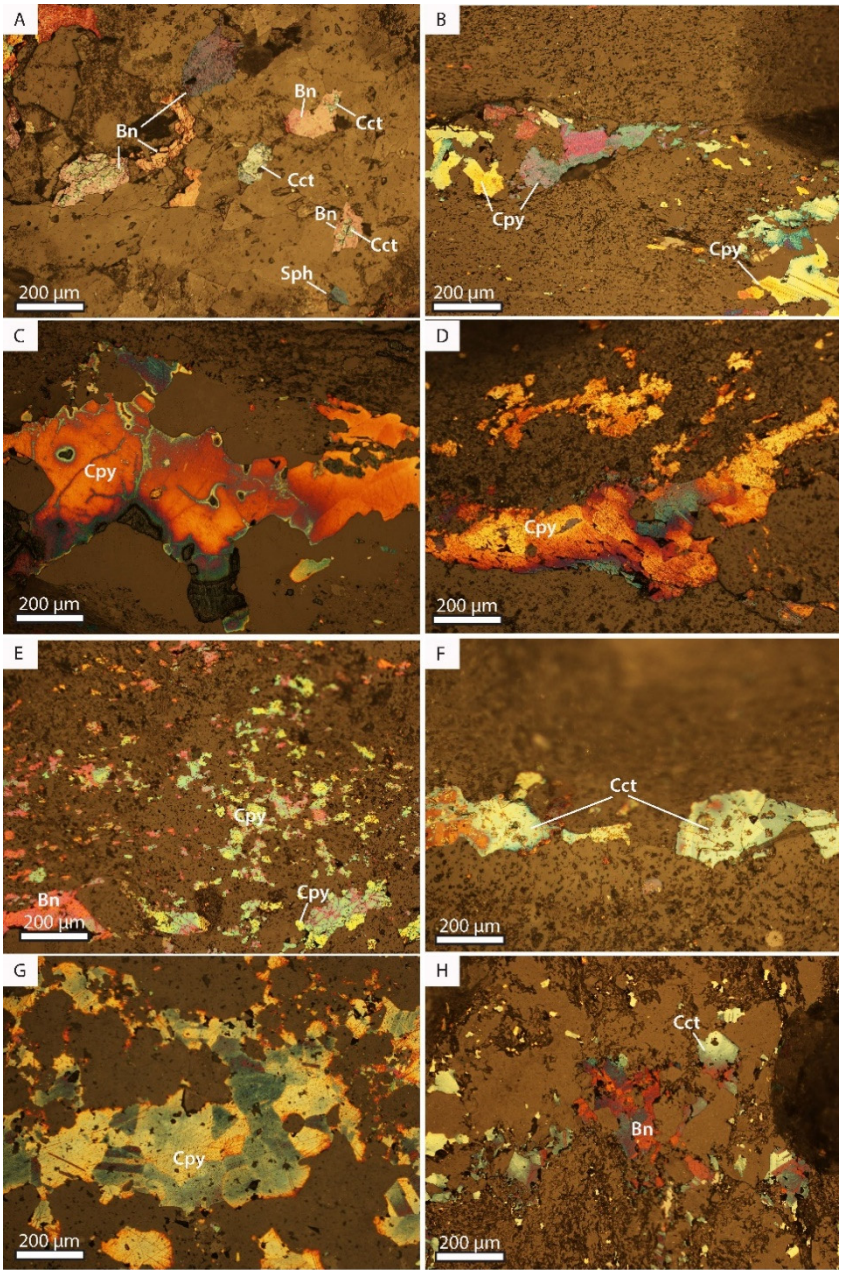


**Figure S1.** Microphotographs demonstrating the Nusir sulfides reaction after 90-day tests: (**A–C**) chalcopyrite (Cpy), chalcocite (Cct), bornite (Bn), and sphalerite (Sph) weathering after test #2; (**D–F**) weathering of chalcopyrite, bornite and chalcocite after test #4; (**G**) oxidation of chalcopyrite under the conditions of test #5; (**H**) bornite and chalcocite alteration under the conditions of test #6.

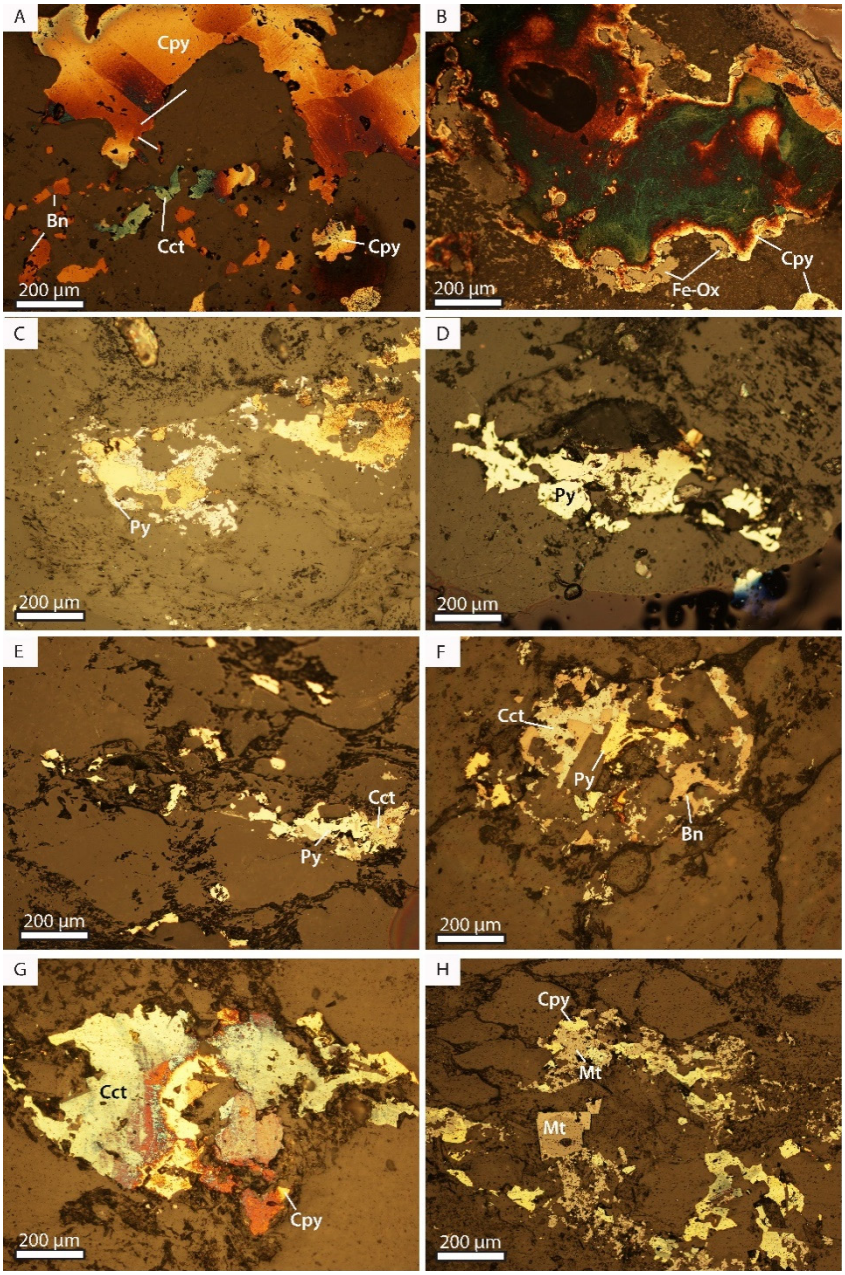


**Figure S2.** Microphotographs taken under a reflected light microscope, demonstrating: (**A**) partly weathered chalcopyrite (Cpy) grain in the vicinity of oxidized chalcocite (Cct) and bornite (Bn) from the Nussir deposit under the experimental test #6; (**B**) intensively oxidized Nussir chalcopyrite after the 90-day test #8; (**C**) partly oxidized pyrite (Py) from the Ulveryggen deposit after test #2; (**D**) well-preserved pyrite grain from the Ulveryggen sample (test #3); (**E**) well-preserved Ulveryggen pyrite and chalcocite after test #4; (**F**) the assemblage of preserved chalcocite, pyrite and bornite from the Ulveryggen after test #5; (**G**) partly oxidized chalcocite with an inclusion of chalcopyrite (Ulveryggen, test #5); (**H**) micro-assemblage of chalcopyrite and magnetite (Mt) after test #5 (Ulveryggen).

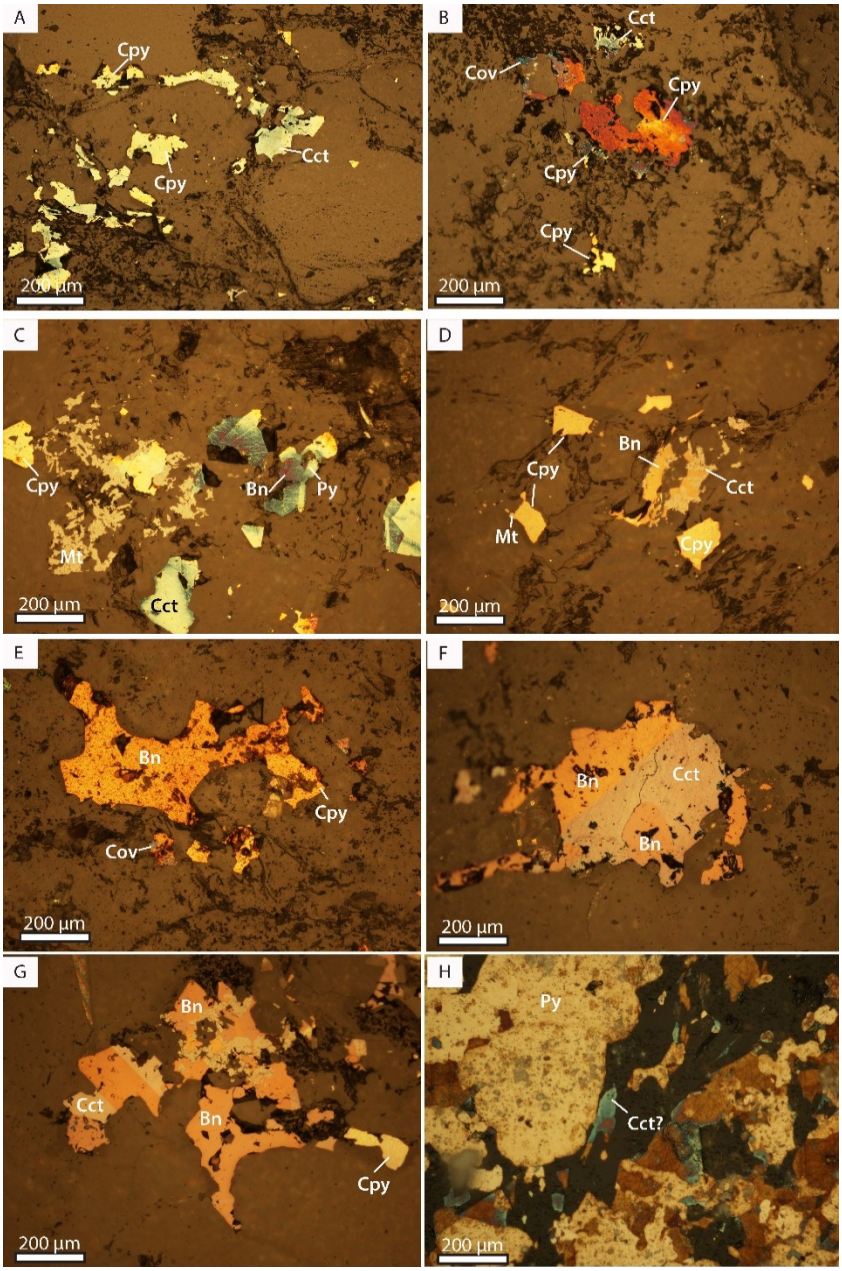


**Figure S3:** Microphotographs taken under reflected light: (**A**) well-preserved chalcopyrite grains in Table 5. (**B**) partly weathered and preserved chalcopyrite (Cpy) with covellite (Cov) and partly oxidized chalcocite (Cct, Ulveryggen, test #6); (**C**) intensively oxidized bornite and partly weathered chalcocite in the assemblage with chalcopyrite, pyrite (Py) and magnetite (Mt, Ulveryggen, test #7); (**D**) well-preserved Cu sulfides and magnetite (Ulveryggen, test #7); (**E**) bornite (Bn) intergrown with chalcopyrite and small inclusion of covellite; (**F–G**) intergrowth of bornite and chalcocite. Chalcocite has a thin weathering film on the surface while bornite is well-preserved (**F**), chalcopyrite is not weathered (G, Ulveryggen, test #8); (**H**) Røros pyrite with brownish iron oxides. A weathered blue grain of presumed chalcocite is in the middle (test #1).

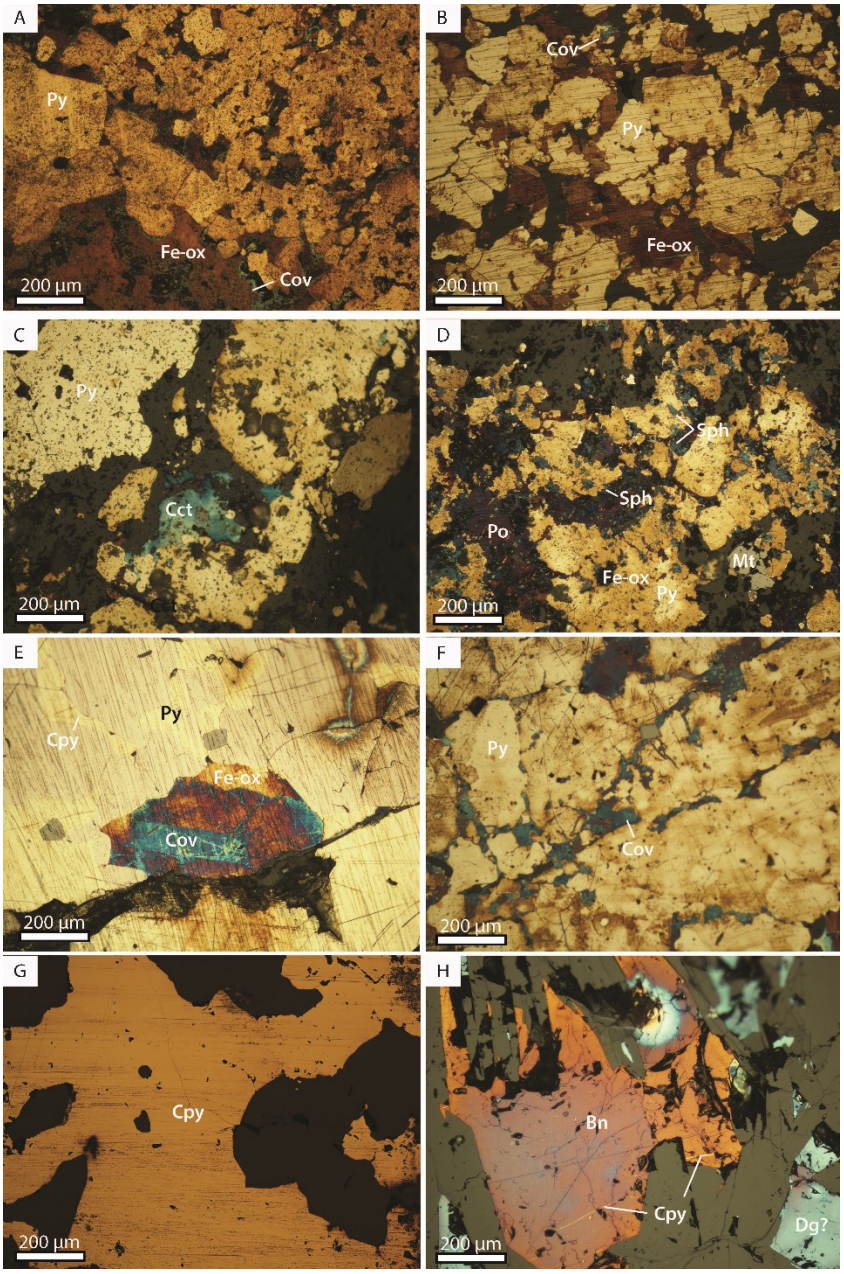


**Figure S4:** Microphotographs of Røros samples under reflected light: (**A**–**B**) weathering of pyrite (Py) after test #1, small covellite (Cov) grains are found along the rim or filling the space between the grains; pyrite is tarnished with iron oxy-hydroxides (Fe-ox); (**C**–**E**) samples after test #2 demonstrating partly oxidized chalcocite (Cct) and intensively oxidized pyrrhotite (Po). Pyrite has a rim of iron hydroxides (Fe-ox); (**F**–**G**) relatively well-preserved pyrite and chalcopyrite (Cpy) with covellite in the cracks in pyrite (test# 3); (**H**) weathered bornite and likely digenite (Dg) after the experimental test #4. Note non-weathered chalcopyrite veins cross-cutting bornite grain.

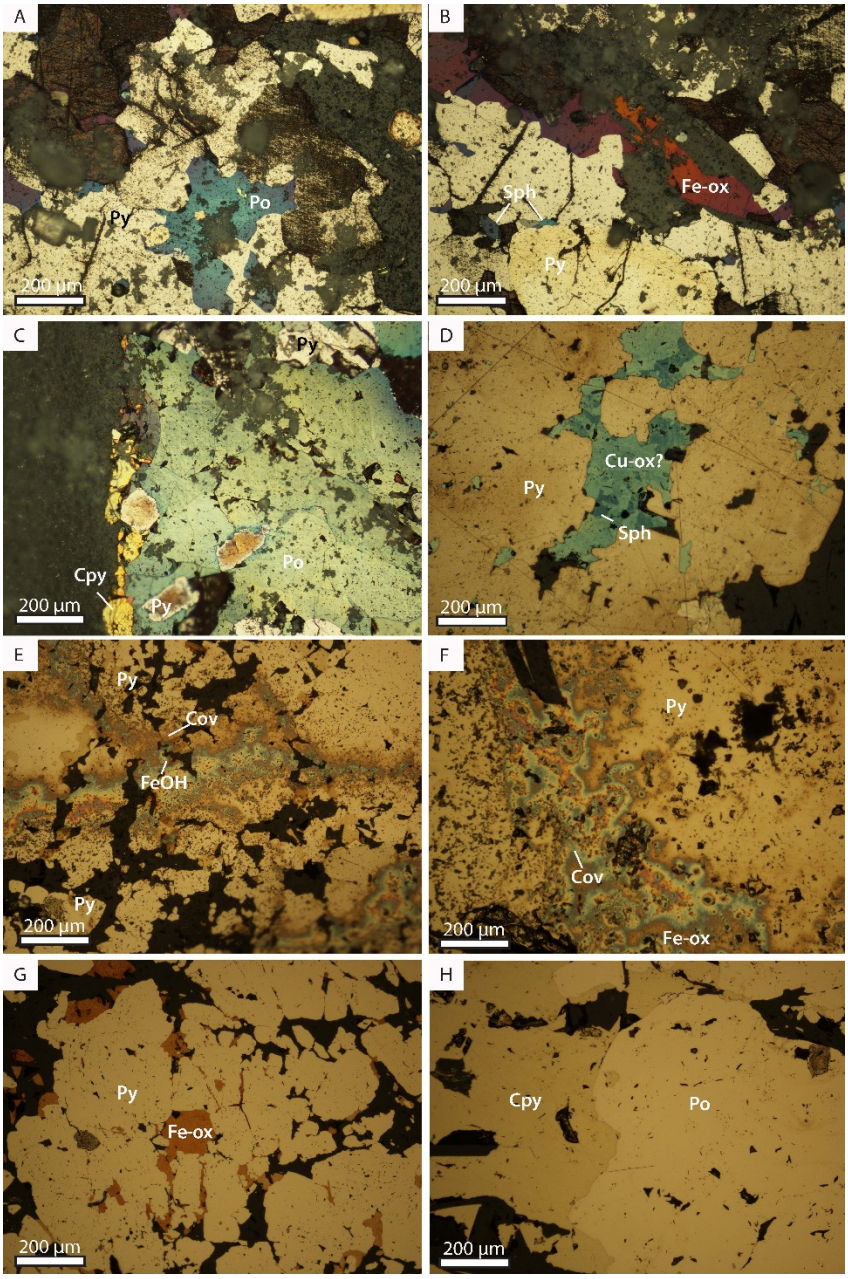


**Figure S5:** Microphotographs of Røros samples under the reflected light microscope after 90-days of experimental tests: (**A**–**C**) the photos demonstrate the oxidation degree after test #5; (**D**) pyrite (Py) containing presumably copper oxide (Cu-ox) and weathered sphalerite (Sph, test #6); (**E**,**F**) relatively well preserved pyrite tarnished with covellite (?Cov) after test #7; (**G**,**H**) non-weathered pyrite, chalcopyrite (Cpy) and pyrrhotite (Po) after test #8.

**Table S1:** Total organic carbon (TOC) of gravity core HH-12-002-MF-GC obtained from Repparfjord. The marine sediments were used to create reductive conditions.

| Name | Description | Carbon Avg. (%) | |
|---|---|---|---|
| **HH12-002-MF0312** | | | |
| **Sample Mass (g)** | **Sample (depth, cm)** | **TOC (%)** | **Sulfur (%)** |
| 0.4739 | 15–16 | 0.9629 | |
| 0.4438 | 16–17 | 0.9787 | |
| 0.4849 | 17–18 | 1.187 | |
| 0.4730 | 18–19 | 1.120 | |

| | | | |
|---|---|---|---|
| 0.4699 | 19–20 | 1.117 | |
| 0.4455 | 20–21 | 1.059 | |
| 0.4849 | 17–18 | 1.187 | |
| 0.4730 | 18–19 | 1.120 | |
| 0.4699 | 19–20 | 1.117 | |
| 0.4455 | 20–21 | 1.059 | |
| 0.4700 | 21–22 | 1.010 | |
| 0.4731 | 22–23 | 0.9756 | |
| 0.4618 | 23–24 | 0.9133 | |
| 0.4291 | 24–25 | 0.9265 | |
| 0.4462 | 25–26 | 0.9107 | |
| 0.4539 | 26–27 | 0.8134 | |
| 0.4679 | 27–28 | 0.7246 | |
| 0.451 | 28–29 | 0.6462 | **0.1478** |
| 0.4629 | 29–30 | 0.7155 | |
| 0.4471 | 30–31 | 0.6976 | |
| 0.4850 | 31–32 | 0.6871 | |
| 0.4790 | 32–33 | 0.6725 | |
| 0.4742 | 33–34 | 0.6936 | |
| 0.4669 | 34–35 | 0.5720 | |
| 0.4803 | 35–36 | 0.5732 | |
| 0.4810 | 36–37 | 0.6312 | |
| 0.4601 | 37–38 | 0.6474 | |
| 0.4527 | 38–39 | 0.6088 | |
| 0.4548 | 39–40 | 0.5902 | |
| 0.4740 | 40–41 | 0.6485 | |
| 0.4973 | 41–42 | 0.6372 | |
| 0.4515 | 42–43 | 0.6282 | |
| 0.4588 | 43–44 | 0.6312 | |
| 0.4531 | 44–45 | 0.7393 | |
| 0.4622 | 45–46 | 0.6436 | |
| 0.4544 | 46–47 | 0.6261 | |
| 0.4540 | 47–48 | 0.5921 | |
| 0.4711 | 48–49 | 0.6754 | |
| 0.4593 | 49–50 | 0.6062 | |
| 0.4567 | 50–51 | 0.5877 | |
| 0.4753 | 51–52 | 0.5558 | |
| 0.4735 | 52–53 | 0.5581 | |
| 0.4611 | 53–54 | 0.5141 | |
| 0.4635 | 54–55 | 0.4840 | |
| 0.4779 | 55–56 | 0.4480 | |
| 0.4613 | 56–57 | 0.5572 | |
| 0.4564 | 57–58 | 0.7328 | |

[1] Tables may have a footer.