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Extraction of metals from bedrock

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*A study within CPM, Centre for Environmental
Assessment of Product and Material Systems*

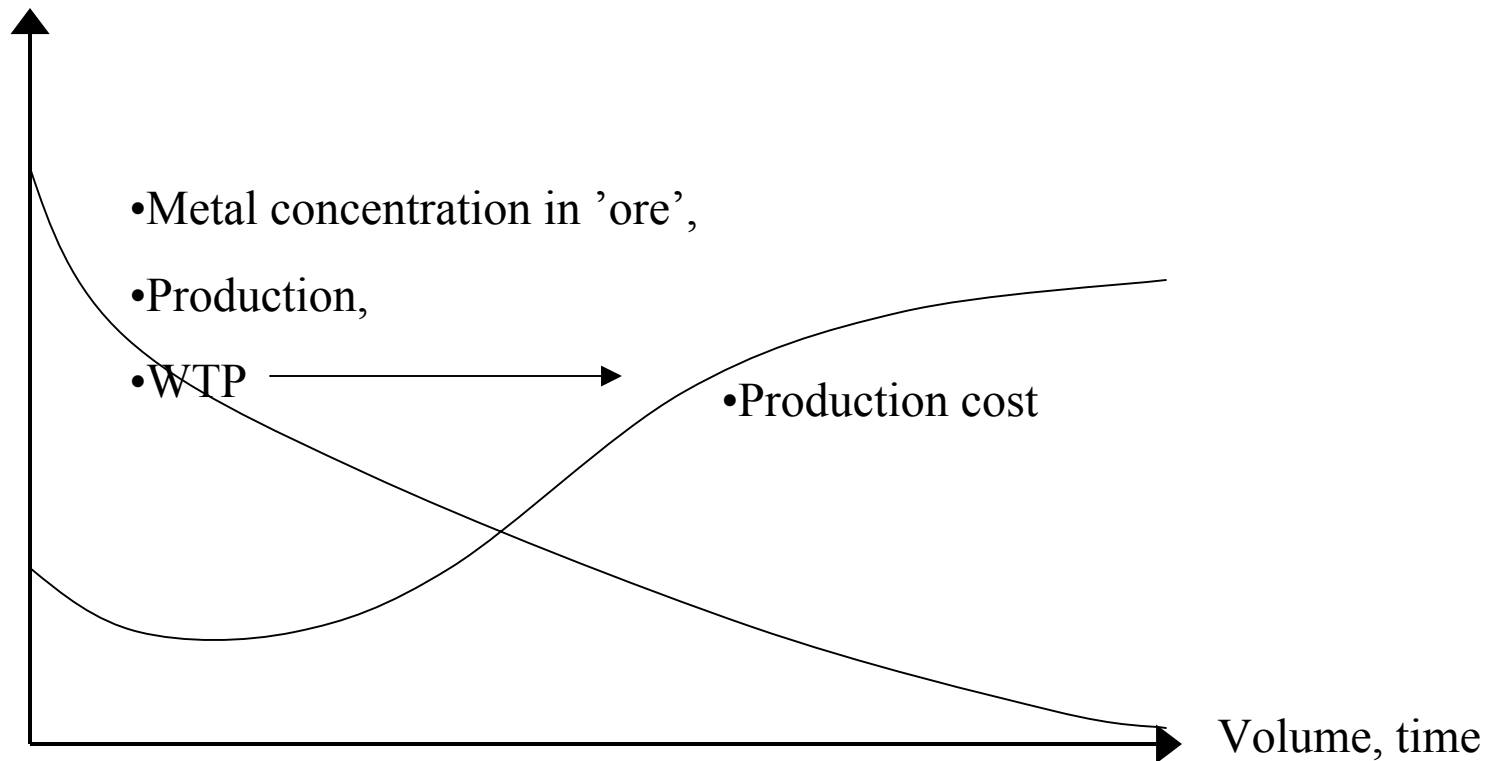
Gold ore



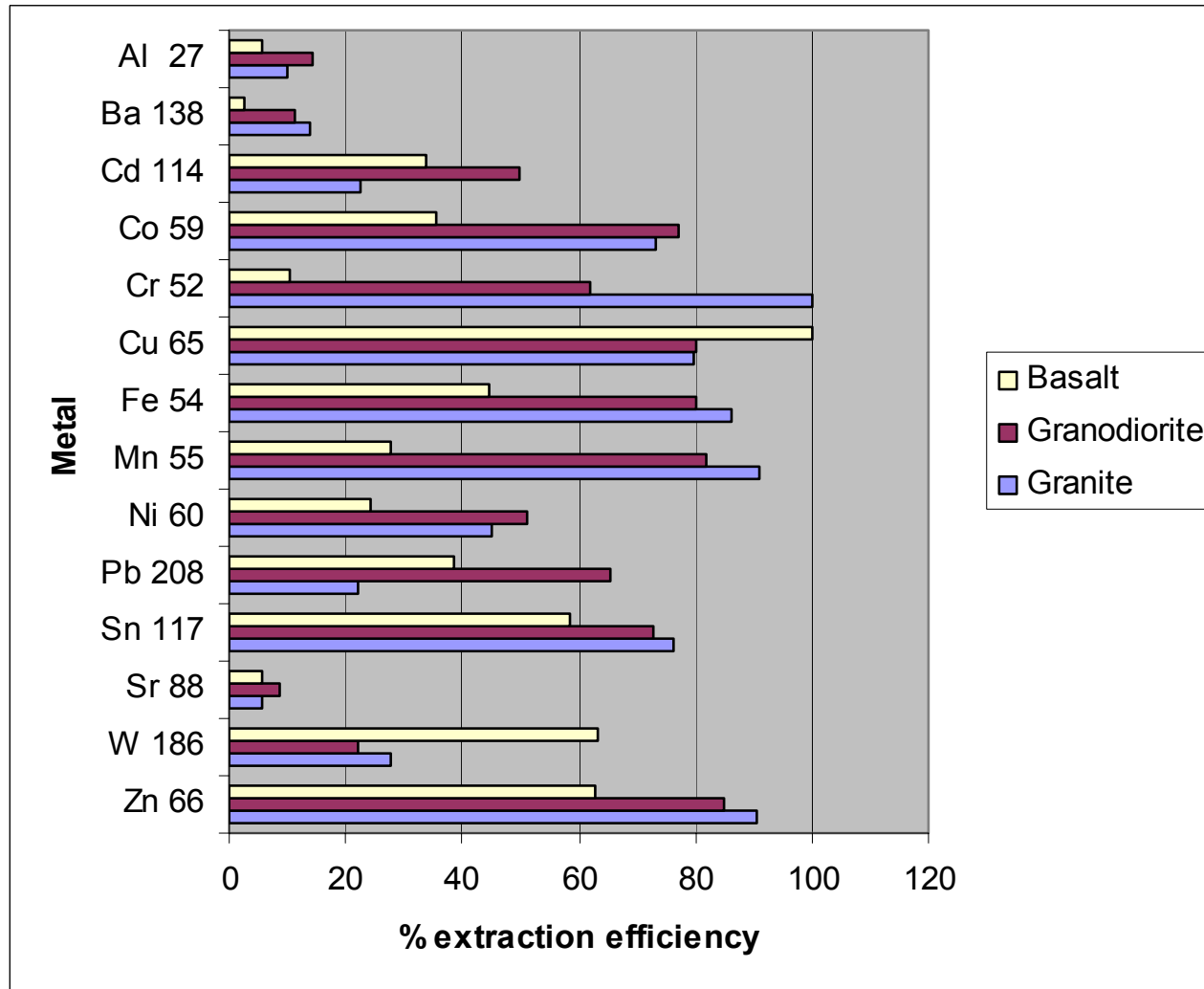
Granite



Likely future scenario

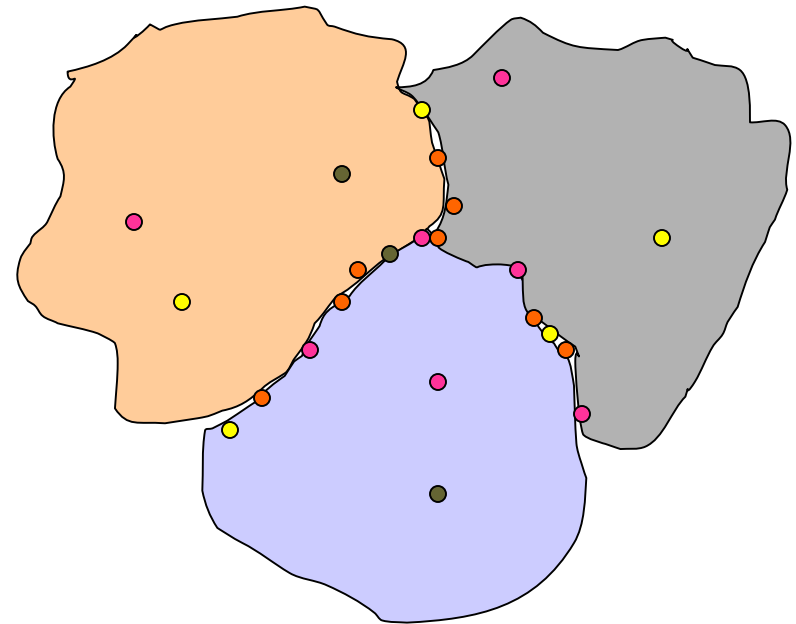


HCl leaching of bedrock

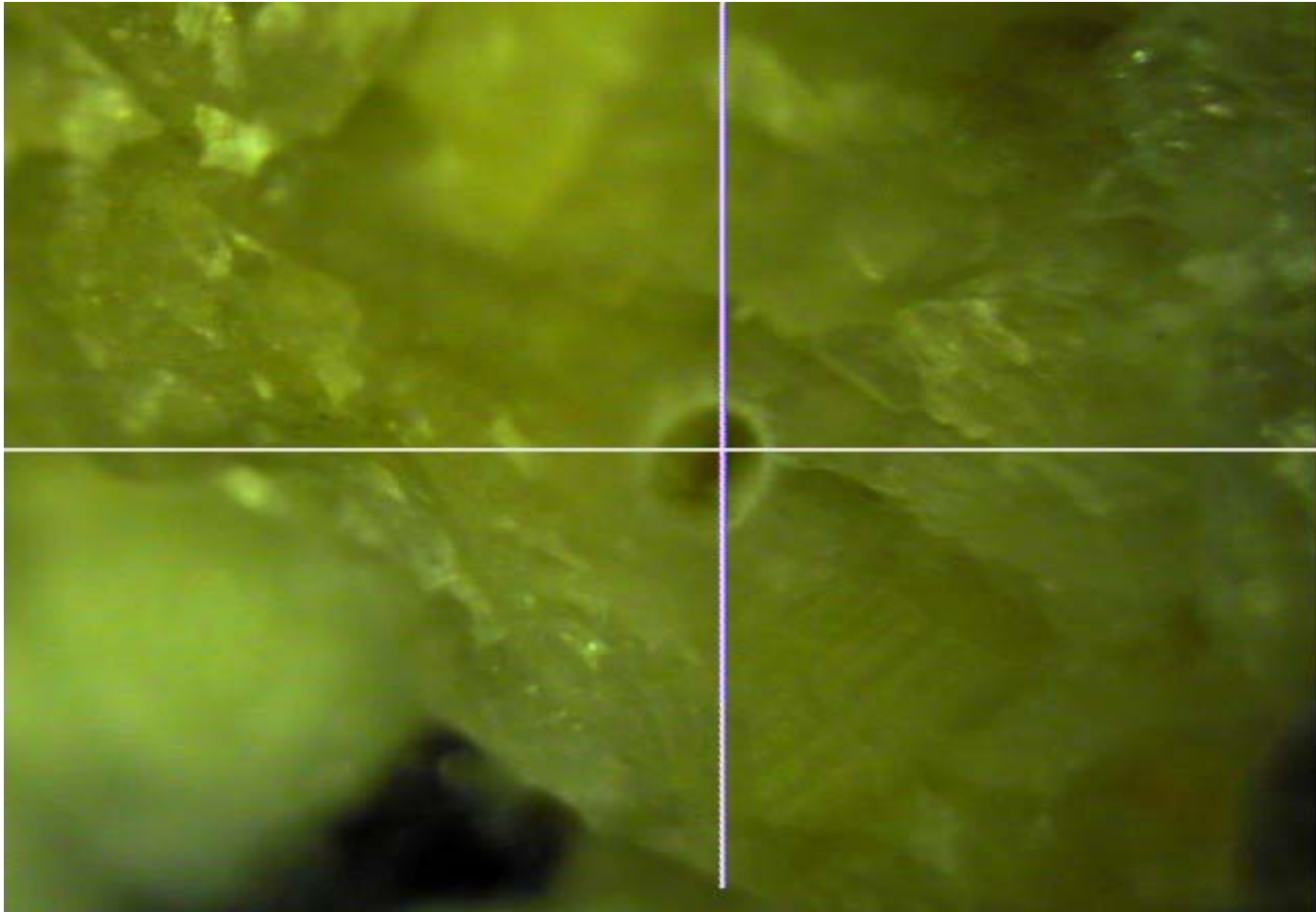


Hypothesis

- When mineral crystals were formed, metals not belonging to the main lattice or being similar to the dominating metals, were pushed out to the borders



K-FELDSPAR LASER ABLATION (DIAM. OF HOLE 350 μm)



Allocated costs for the production of various metal concentrates

| Metal | Abundance in earth's crust (g/ton) | Cost of 'ore' production from granite metal EUR/kg | Cost of 'ore' production from granodiorite metal EUR/kg | Cost of 'ore' production from basalt metal EUR/kg | Weighted average cost of 'ore' production EUR/kg metal |
|-------|------------------------------------|--|---|---|--|
| Cd | 0.102 | 76400 | 38800 | 77400 | 67700 |
| Co | 11.6 | 206 | 222 | 646 | 262 |
| Cr | 35 | 50.1 | 91.1 | 745 | 141 |
| Cu | 14.3 | 149 | 172 | 186 | 159 |
| Mn | 527 | 3.66 | 4.59 | 18.2 | 5.60 |
| Ni | 18.6 | 210 | 208 | 586 | 254 |
| Pb | 17 | 467 | 178 | 408 | 392 |
| Sn | 2.5 | 920 | 1080 | 1830 | 1060 |
| W | 1.4 | 4540 | 6330 | 3000 | 4780 |
| Zn | 52 | 37.2 | 44.7 | 81.4 | 44.2 |

Best estimates of costs for production of ore-like metal concentrates compared to some market prices of today for pure metals

| Metal | Weighted average cost of 'ore' production EUR/kg metal | Today's price levels EUR/kg metal |
|-------|---|--------------------------------------|
| Cd | 67700 | 0.5-16 |
| Co | 262 | 8 |
| Cr | 141 | 8 |
| Cu | 159 | 1.7 |
| Mn | 5.60 | 0.5 |
| Ni | 254 | 6.8 |
| Pb | 392 | 0.6 |
| Sn | 1060 | 4.5 |
| W | 4780 | 0.03-0.2 |
| Zn | 44.2 | 0.9 |

Conclusions

- Concentrates of many metals may be produced from ordinary bedrock in a sustainable way
- The value of present ore concentrates to future generations is considerable
- When processing low grade bedrock, several metals will be produced at the same time, and allocation is likely to be a problem
- The average concentration in earth upper crust may be used for building category indicators, but several subgroups of substances may be an advantage