Introducing GGIMFis - A new sphalerite geothermometer?

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A detailed meta-analysis of trace element concentrations in sphalerite shows that there are systematic, statistically significant differences in the mean concentrations of Ga, Ge, In, Fe and Mn between sphalerites from major types of Zn-Pb deposits [1]. A principal component analysis demonstrates that these differences are approximately one-dimensional, being expressible in terms of a single number. This number correlates strongly with the homogenisation temperature of fluid inclusions ($R^2 = 0.82$, $p < 2\text{x}10^{-16}$), and can be expressed as follows:

$$\text{PC 1*} = \ln\left(\frac{c_{\text{Ga}}^{0.22} \cdot c_{\text{Ge}}^{0.22}}{c_{\text{Fe}}^{0.37} \cdot c_{\text{Mn}}^{0.20} \cdot c_{\text{In}}^{0.10}}\right)$$

with Ga, Ge, In and Mn concentrations in ppm, and Fe concentration in wt.%. The relationship is sufficiently strong to be used as a geothermometer, which we propose to call GGIMFis (= Ga, Ge, In, Mn and Fe in sphalerite) [1]:

$$T(°C) = (54.4 \pm 7.3) \cdot \text{PC 1*} + (208 \pm 10)$$

Application of GGIMFis to specific examples shows that it allows for the prediction of mean homogenisation temperatures to within ~ 50–70 °C. If future work could demonstrate that GGIMFis is applicable not just to differences in the mean formation temperatures of deposits, but also at much smaller scales, e.g. individual growth bands within chemically zoned crystals, it would offer the possibility to study variations in fluid temperatures during ore-forming processes at much higher spatial, and therefore temporal, resolution than state-of-the-art fluid inclusion micro-thermometry.

[1] Frenzel, Hirsch & Gutzmer (2016), *Ore Geology Reviews* 76, 52-78.