

## LITTLE BLACK BLOBS IN THE BACKGROUND

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Bernard J. Wood

I am sure that many of us remember “mineralogy” from our student days as beginning with the orthosilicate group, passing quickly through sorosilicates to beryl, then through pyroxenes and amphiboles, and on to micas, feldspars, and the silica minerals. Amphiboles were studied to exhaustion, their nomenclature (now mostly discarded) being then regarded as of prime importance. Sulfides, on the other hand, were almost completely ignored, despite their economic importance and significance, as we now know, as agents of climate cooling. In petrography classes, sulfides were classified together with oxides as “opaques” and dismissed from further consideration. In this issue, therefore, the balance will be redressed as we review the complexity and beauty of sulfide mineralogy, geochemistry, and petrology. *Elements* has considered sulfur before (“Sulfur”, v6n2, 2010), but principally from environmental and biogeochemical standpoints. The current issue focusses more on sulfide behaviour in high-temperature environments, with just a single article devoted to sedimentary sulfides and environmental conditions in terrestrial oceans over geologic time (Rickard et al. 2017 this issue).

Despite being present at a total concentration of only 0.025% in the mantle and crust, sulfur forms a large number of stable minerals with *d*- and *p*-block elements (Vaughan and Corkhill 2017 this issue). Sulfur is insoluble in silicate minerals, and there are only small amounts of iron–nickel-rich sulfides present in the mantle source regions of magmas. However,  $S^{2-}$  does have a low solubility in silicate melts, so the small amounts of sulfur inherited from the source result in most magmas becoming saturated in (Fe,Ni,Cu)<sub>S</sub> sulfide liquid or monosulfide solid solution (mss) as they approach the surface. This sulfide precipitation completely controls the behaviour of many chalcophile elements during igneous differentiation (Kiseeva et al. 2017 this issue), most notably those which are relatively incompatible in silicates [e.g. Cu, Ag, Au, Pb, As, Sb, Bi, Tl, Re, Hg, and the platinum group elements (PGEs)]. Oxidation of the sulfur in the later stages of igneous differentiation frequently leads to degassing of large quantities of SO<sub>2</sub> (Edmonds and Mather 2017 this issue). The dramatic eruptions in 1783 of Laki (Iceland), for example, are estimated to have released 122 megatons of SO<sub>2</sub> which the southeasterly winds carried over much of Europe as a summer-long ‘dry sulfurous fog’. The latter was largely responsible for unusually high death rates in France (5% of the population) and England (double the normal rate), particularly among agricultural workers. In cases where, instead of being oxidised, sulfur is retained in the silicate liquid or external crustal sulfur is incorporated into the melt, precipitation of such ‘melt sulfide’ occasionally leads to large magmatic sulfide deposits, the major economic resources for

Ni and the PGEs (Barnes et al. 2017 this issue). If the melt becomes saturated in aqueous fluid prior to sulfide saturation then many of the chalcophile elements can become concentrated into the evolved fluid phase, a situation that occurs in some volcanic arcs (Fontboté et al. 2017 this issue) and that leads to lower temperature hydrothermal sulfide deposits. Sulfide minerals in hydrothermal deposits are the primary sources of Cu, Zn, Pb, and a large number of other, lower concentration, metals. Although these minor and trace elements are normally quite dilute in major element sulfides and sulfosalts they occasionally form the many separate sulfides that we find in the best museum collections. I hope this brief excursion through our issue has whetted and stimulated your interest! If you are dedicated to silicates, however, I can, among others, recommend the *Elements* issues on “Garnet” (v9n6), “Tourmaline” (v7n5) and “Zircon” (v3n1).

It is particularly gratifying to note that, unusually, both our guest editors are women: Marie Edmonds (University of Cambridge, UK) and Ekaterina (Kate) Kiseeva (University of Oxford, UK). And both certainly qualify as young, or “junior”, academics. The editors are occasionally asked about gender imbalance in the guest editors and authors of *Elements* articles. One reason for an imbalance is that, in order to establish an issue of the magazine, we first need a viable proposal. Senior colleagues, principally male, are the people most likely to make such a proposal. And there is a natural tendency for the guest editors to ask people they have known for a long time to write the articles. When *Elements*' principal editors review proposals, they almost invariably ask the proposers for more female authors and greater geographic diversity. Frequently the guest editors accept our suggestions, but sometimes, for various reasons, they are unable to do so. A compromise may then be reached and the end result is the mixture of authors and guest editors that you find in a typical issue. In this case, however, we specifically asked Kate and Marie to propose the sulfide issue. And we are actively looking for female and younger male colleagues to propose issues which we think will be of general interest. If you have an interesting idea, please contact us because we can help you turn your idea into a viable proposal. Now, which of you is going to send me a proposal for “Amphiboles”?

**Bernard J. Wood**  
Principal Editor

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