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Lower crustal sulphides under St Vincent, Lesser Antilles Arc

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The formation and accumulation of magmatic sulphides in volcanic arcs is sensitive to changes in pressure, temperature, oxygen fugacity and magma composition during differentiation [1]. Investigation of the occurrence and composition of sulphides provides information on magmatic processes in the crust. The Lesser Antilles Arc (LAA), the subject of this study, is a key location to investigate sulphide formation and accumulation, due to the abundance of crustal xenoliths which provide insight into magmatic processes at a range of depths [2].

From St Vincent, 66 crustal xenoliths, 42 of which are sulphide-bearing, were examined petrographically to identify sulphide relationships with host phases and volume proportions (e.g. Figure 1). Cumulate and plutonic crustal xenoliths, predominantly derived from the mid-crust in a pressure range of ~4 – 7.2 kbar, showed a range of compositions dominated by olivine gabbro. The composition of sulphide-hosting silicate minerals in the xenoliths, measured via electron probe micro-analysis, was used in thermobarometric calculations to estimate the pressure and temperature conditions of silicate crystallisation. This was then used to constrain the conditions at which sulphur concentration at sulphide saturation (SCSS) was reached within the magma. Finally, a mass balance approach was used to calculate the mass of sulphur and copper stored within the lower-mid crust below St Vincent, which was used alongside literature data to develop a sulphur budget for this magmatic system.

Results show the importance of amphibole and titanomagnetite fractionation in multi-stage sulphide saturation during magmatic differentiation. SCSS was reached at ≥ mid-crustal pressures with a temperature range of 930 – 1060 ^{o}C. Mass balance calculations, using the estimated LAA magma production rate over the St Vincent arc segment [3], suggested significant storage (~3.5 x10^{-4} kg S/kg magma) of sulphur and copper within mid-lower crustal sulphide accumulations below St Vincent.

Ongoing work is extending this methodology to crustal sulphides from other islands along the LAA, to investigate how sulphide composition and abundance varies along arc and in relation to subduction zone parameters.

[1] Wallace & Carmichael (1992), *Geoch. Cosm. Act.* 56(5), 1863-1874.

[2] Melekhova *et al.* (2019), *EPSL* 516, 12-24.

[3] Jicha & Jagoutz (2015), *Elements* 11(2), 105-111.

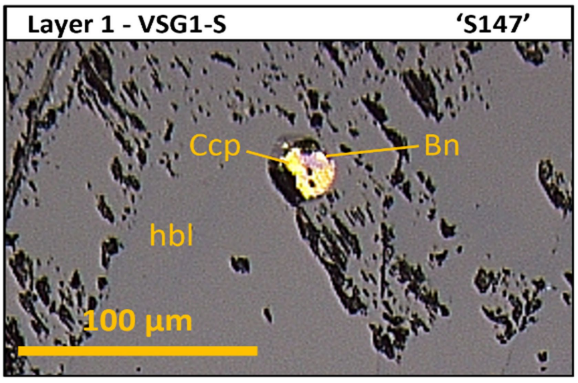

Figure 1: Reflected light photomicrograph of a hornblende-hosted sulphide globule (chalcopyrite, Ccp; bornite, Bn) within layered cumulate xenolith, VSG1.