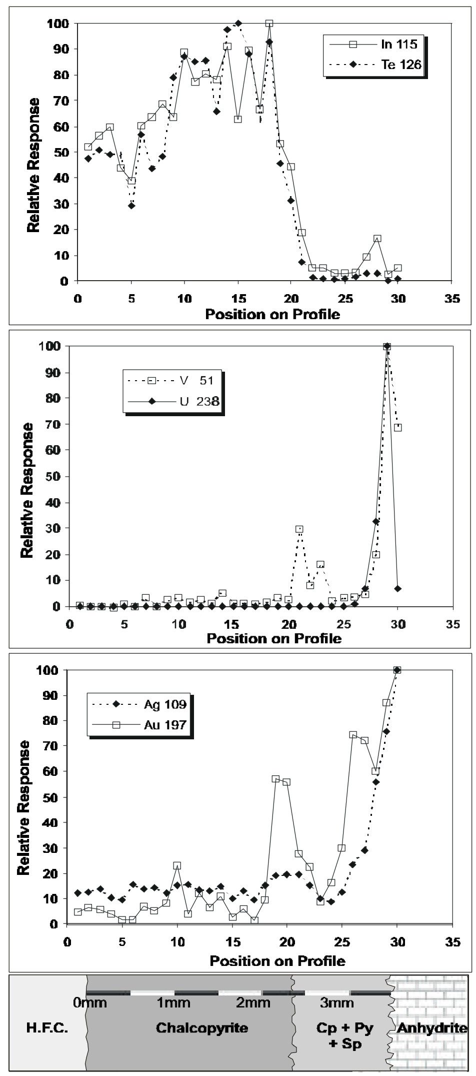
MICRO-SCALE TRACE ELEMENT AND S ISOTOPE DISTRIBUTIONS IN HYDROTHERMAL SULPHIDES. I. B. Butler[1], R. W. Nesbitt[2] and A. E. Fallick[3], [1]Department of Earth Sciences, Cardiff University, Park Place, Cardiff, CF1 3YE, Wales, UK (ButlerIB@Cardiff.ac.uk), [2]School of Ocean and Earth Sciences, Southampton Oceanography Centre, University of Southampton, Southampton, SO14 3ZH, UK, (R.W.Nesbitt@soc.soton.ac.uk), [3]Isotope Geosciences Unit, Scottish Universities Research and Reactor Centre, East Kilbride, G75 0QF, Scotland, UK.

Introduction: The interaction of ~350°C hydrothermal fluid and 2°C seawater during black smoker activity generates steep physico-chemical gradients which control mineralogical and trace element zoning in hydrothermal precipitates. Hydrothermal sulphides from the Broken Spur vent site (29°10'N, MAR) have been characterised using laser sampling methods to determine fine scale trace element and S isotope distributions. A combination of high sensitivity ICPMS and UV (266nm) laser ablation (resolution = 30mm) provides detection limits of <100ppb for trace elements in sulphide. IR (1064nm) laser extraction of sulphur as SO_2, and isotopic analysis using gas phase mass spectrometry allows sampling resolutions of better than 1mm with an analytical precision of $d^{34}S = \pm 0.3‰$ CDT [1,2].

Trace Metals: LA-ICPMS analysis of the chalcopyrite wall of a black smoker chimney, demonstrates non-random V, Ag, In, Te, Ba, Au, Pb, and U distributions (see figure) [3]. Enrichments of In and Te in the inner zone of the wall are attributed to lattice incorporation during high temperature sulphide precipitation. Enrichments of U and V within the outer part of the wall are caused by seawater incursion and redox immobilisation of metals on sulphide surfaces. Enrichments of Au, Ag, Pb, and Ba in the outer wall may be related to hydrothermal fluid-seawater mixing. However, comparison of distribution data with reaction-transport models suggests a possible pH control on precipitation. Distribution data, combined with textural studies, indicate a progressive change of flow regimes in the chimney wall. Initial outward fluid advection causes chalcopyrite precipitation, anhydrite replacement and permeability reduction. This permits later inward advection of seawater into the outer part of the chimney wall.

S Isotopes: A mature, diffuser structure shows complex mineralogical zoning [4], with the central pyrrhotite core surrounded by a collomorphic marcasite crust. S isotope data show a range of $d^{34}S = -4.55‰$ to $+4.8‰$ (N= 20). The data show distinct zoning, with core and outer crust materials showing ^{32}S depleted signatures, and mid-crust material showing ^{32}S enriched signatures. The ^{32}S enriched signatures cannot be modeled by mixing of hydrothermal fluid ($d^{34}S \approx 0‰$) and reduced seawater sulphate ($d^{34}S = +21‰$). Thus, ^{32}S enriched signatures may result from i) bacterial sulphate reduction in the outer zones of the diffuser, or ii) isotopic fractionation by sulphide precipitation from an evolving fluid.



References: [1] Kelley S.P. and Fallick A.E., (1992), GCA, 54, 883-888. [2] Fallick A.E., McConville P., Boyce A.J., Burgess R. and Kelley S.P. (1992) Chem. Geol. (Isotope Geosci.), 101, 53-61. [3] Butler I.B. and Nesbitt R.W. (1999) EPSL, 167, 335-345. [4] Butler I.B., Fallick A.E., and Nesbitt R.W. (1998) J. Geol. Soc. Lond., 155, 773-785.