Formation of diamond from oxidized fluids/melts: δ^{13}C-N SIMS study of an eclogitic diamond from the Jericho kimberlite, Canada

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Diamonds are key to understanding the sources, speciation and cycling of carbon in the mantle, and together this information is crucial for the study of mantle redox processes. The carbon isotope composition of diamond provides essential information on both the source and redox-state dependent speciation of C reservoirs involved in diamond growth. Growth models are commonly based on xenocrystic diamonds sampled from kimberlites and usually represent mixed populations and multiple growth events. In contrast, *in situ* studies of single growth zones in individual diamonds are better suited for building diamond growth models. Here we present the results of a coupled CL-imaging and SIMS δ^{13}C-N study of a single, 0.5cm diamond from an eclogite xenolith from the Jericho kimberlite, Canada.

CL images of the diamond show a relatively homogeneous core mantled by oscillatory dark and light growth layers towards the rim. SIMS analyses of carbon isotope composition and nitrogen content in the core show systematic and coupled variations: N decreases rimwards from ~5000 to 1000 ppm and δ^{13}C increases from -4.1 to -2.7‰ in the same direction. We interpret these systematic co-variations to reflect fractional crystallization of diamond from a single melt/fluid pulse. Moreover, the coupled rimward enrichment in ^{13}C and depletion in N indicate diamond formation from an oxidized growth medium where N behaved compatibly in diamond relative to the medium. Modelling the core zone growth shows that the initial δ^{13}C value of the diamond-forming fluid/melt was between -2.3 and 0‰ (depending on temperature and C speciation, e.g. CO_3^{2-} or CO_2). The carbon source therefore was either subducted carbonates (δ^{13}C~0‰) that had undergone partial decarbonation causing ^{13}C depletion or primary mantle fluids/melts (-5‰) that had undergone extensive C fractionation prior to precipitation of the diamond investigated here. We favor a model where the carbon was sourced from a carbonatite-like medium, potentially derived from subducted sediments, as the host eclogites themselves have evidence for crustal protoliths and interaction with carbonatite-like metasomatic agents[1].

[1] Smart K.A. *et al*. (2009) *EPSL* **284** 527–537.

Biotic dissolution of Tl(I)jarosite by *Shewanella putrefaciens* CN32

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Jarosites (MFe$_3$ (SO$_4$)$_2$ (OH)$_6$) are precipitated in the Zn industry to scavenge iron, alkali metals and sulfate ions during base metal processing and often contain toxic metals such as Pb, Ag and Tl. During this process, large volumes of jarositic wastes are produced and often confined to large repositories. Despite the toxicity of Tl, few studies exist on the abiotic and biotic dissolution of thallium mineral phases. In this study we examined the dissolution of synthetic Tl (I)-jarosite (TlFe$_3$ (SO$_4$)$_2$ (OH)$_6$) by *Shewanella putrefaciens* CN32 using batch experiments under anaerobic circumneutral conditions.

ATP, Fe and Tl concentrations were measured over time and showed increased Fe(II) and Tl in inoculated versus control samples (Fig 1). Tl concentrations in inoculated samples increased by a factor of 2 compared to control samples (Fig 1). In contrast to previous studies with Pb and Ag-jarosite, SEM images of *S. putrefaciens* CN32 did not show precipitation of Tl nanoparticles associated with the cell surface thus suggesting an alternative mechanism for Tl detoxification [1, 2].

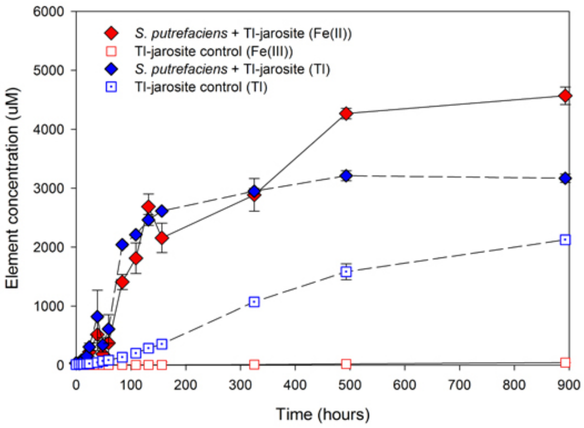

Figure 1: Fe and Tl release over time

[1] C.M. Smeaton *et al.* (2009) *Env. Sci. Tech.* **43**, 8091–8096.
[2] C.G. Weisener *et al.* (2008) *Geomicrobiology* Journal, **25**, 415- 421.