

## Noble gases in metamorphic diamonds from Kokchetav massif, Kazakhstan, revisited

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Metamorphic microdiamonds from the Kokchetav massif, northern Kazakhstan have been known for their “unprecedentedly” high <sup>3</sup>He/<sup>4</sup>He up to 400 R<sub>A</sub> associated with high He content [1, 2]. The high <sup>4</sup>He concentrations have been well explained by implantation of  $\alpha$ -particle produced from decay of U, Th-series elements in the surrounding rocks [2]. On the other hand, anomalously abundant <sup>3</sup>He has left only nucleogenic <sup>3</sup>He production via <sup>6</sup>Li (n,  $\alpha$ ) <sup>3</sup>H as plausible source [2]. To produce <sup>3</sup>He after the diamond formation, however, anomalous high Li content is required in the diamonds or ~20  $\mu$ m vicinity in the host rocks even if host rock contain 1% of U as neutron source [2].

Researches show that the Kokchetav microdiamonds were crystallized from a C-O-H fluid during ultra-high pressure metamorphism of metasedimentary rocks subducted to the depth of 190-280 km; such diamonds contain nanometric solid/fluid inclusions as a relic of the fluid [3]. The fluid inclusions have a potential to preserve noble gas signature trapped during the diamonds formation. We have performed noble gas analysis of the Kokchetav microdiamonds applying two gas extraction techniques, *in vacuo* crushing and stepwise heating. Helium extracted by the stepwise heating show similar <sup>3</sup>He/<sup>4</sup>He values to those previously reported [1], whereas the <sup>3</sup>He concentration is several orders of magnitude lower. The total <sup>4</sup>He concentration obtained by the stepwise heating agrees with the previous data [1, 2], suggesting universal flux of  $\alpha$ -particle in the diamond-bearing rock. The fact that most <sup>3</sup>He was extracted by the crushing indicates <sup>3</sup>He residence in the inclusions. Since recoil length of <sup>3</sup>He-to-be <sup>3</sup>H in the <sup>6</sup>Li (n,  $\alpha$ ) reaction is much larger than the size of the inclusions, the *in situ* production and retention of the nucleogenic <sup>3</sup>He are unlikely to be the major source of the high-concentration <sup>3</sup>He in the inclusions. The result implies that He from different sources including both mantle and crustal might be heterogeneously distributed in the diamonds.

[1] Shukolyukov *et al.* (1993) *Petrol.* **1**, 110-119. [2] Verchovsky *et al.* (1993) *EPSL* **120**, 87-102. [3] Dobrzhinetskaya *et al.* (2006) *EPSL* **243**, 85-93.

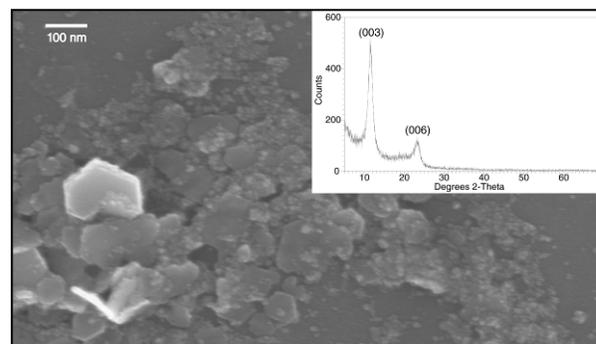
## Formation of lactate intercalated Green Rust via the reductive dissolution of ferrihydrite

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The oxidation of low molecular weight organic acids (e.g. lactate, acetate) coupled to the reduction of ferric oxyhydr(oxides) such as ferrihydrite (FHY) to Fe(II) drives the mineralization of highly reactive mixed ferric-ferrous phases such as green rust (GR) and magnetite (MGT) in non-sulfidogenic anoxic environments. Organic acids not only act as electron acceptors to bacteria but can also alter the surface properties of minerals via sorption processes, thus impacting the kinetics and pathways of secondary mineralization. In this study, the impact of lactate on the abiotic transformation of FHY in the presence of Fe(II) and/or sulphate was investigated. The reaction products were characterised by synchrotron-based infrared microspectroscopy, combined with powder diffraction and high-resolution imaging.

In the absence of lactate [Fe(II)/Fe(III)=0.5, pH 9], FHY completely transformed to MGT, via sulphate-GR within 2 hours. Increasing the lactate/sulphate ratio drastically retarded the rate of GR crystallisation and its transformation to MGT. At 100% lactate, the FHY transformed into lactate green rust and the conversion into magnetite required > 24 hours while at Fe(II)/Fe(III) ratios of 1 to 3 lactate-GR also formed, but these higher lactate concentrations inhibited the conversion to MGT. Lactate-GR formation has previously been reported via the oxidation of lactate containing Fe(II) solutions, yet, the XRD data of the lactate-GR formed from FHY differed from lactate-GR formed via Fe(II) oxidation indicating that a novel polymorph of lactate-GR is formed via the FHY pathway.



**Figure 1:** Photomicrograph of hexagonal lactate-GR platelets [Fe(II)/Fe(III)=3, pH 9], inset shows corresponding XRD plot