Fluid evolution recorded by alteration minerals along the P2 reverse fault and associated with the McArthur River U-deposit

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The basement rocks along the P2 fault are extensively altered, particularly where they host the McArthur River Zone 2 uranium ore body. Two generations of tourmaline occur along the P2: i) early, euhedral-subhedral, coarse-grain (>0.5 mm), 1-2 cm wide veins and isolated grains of dravite (Mg-tourmaline), and ii) later fine-grain (<0.2 mm), radial magnesiofoitite (alkali-deficient dravite) forms veinlets (< 2 mm), overgrowths on earlier dravite, and grains disseminated within fine-grain illite. Fe-clinochlore, coarse-grain illite, rutile and hematite are ubiquitous along the P2 and occur as pervasive replacement minerals or veins, and post-date dravite crystallization.

To ensure minerals were free of inclusions, individual grains were first inspected with BSE-SEM at highest magnification and elemental peaks were then carefully monitored during trace element analysis (LA-ICPMS). Dravite $[(\square_{0.4}Na_{0.6})(\square_{0.2}Mg_{1.9}Fe_{0.5}Ca_{0.2}Ti_{0.2})(Al_{5.9}Fe_{0.1})(Si_{5.7}Al_{0.3}O_{18})(BO_3)_3(OH_{3.8}F_{0.2})]$ contains 1.24 (± 0.09, 1σ) wt% TiO_2, 89 – 280 ppm Zn, 51 - 630 ppm Cr, 190 - 1500 ppm V, and atomic F/Cl ratios range 98 – 11000. Magnesiofoitite $[(\square_{0.7}K_{0.1}Na_{0.2})(\square_{0.4}Fe_{0.1}Mg_{2.0}Al_{0.5})Al_6(Al_{0.1}Si_{5.9}O_{18})(BO_3)_3(F_{0.02}OH_{3.98})]$ contains 65 – 260 ppm V, 2.9 - 110 ppm Cr, 0.2 – 3.7 ppm U, and 0.2 – 34 ppm Th, and ranges 3.2 - 80 atomic F/Cl. Dravite and magnesiofoitite contain low Li (< 12 ppm) and high Ni (1 – 28, 13 – 250 ppm, respectively); however, they also show contrasting trace element behaviours: dravite is enriched in LREE relative to HREE ($[Ce]_N/[Ce]^*_N$) > 1, and has a positive Eu anomaly, whereas, magnesiofoitite is enriched in HREE relative to LREE ($[Ce]_N/[Ce]^*_N$) < 1, and has a negative Eu anomaly. Chlorite $[(Fe_{1.9}Mg_{2.6}Al_{1.4})(Si_{2.7}Al_{1.3}O_{10})(OH)_8]$ contains significant Li (40 - 669 ppm), and Mn (803 – 4083 ppm); illite $[(K_{0.9})\ (Al_{1.8}Mg_{0.1}Fe_{0\cdot1})(Si_{3.2}Al_{0.8}O_{10})(OH)_2]$ contains significant B (17 – 250 ppm), Li (<4.9 – 144 ppm), Ti (36 – 14500 ppm), Rb (343 - 692 ppm), U (<0.01 – 0.6 ppm), Sn (1.2 – 148 ppm), and Ba (78 – 1670 ppm); and both minerals show atomic F/Cl ratios > 10. High F/Cl, U, Th and B, and a negative Eu anomaly in alteration phases suggests a contribution of pegmatite to the fluid.

The non-trivial limitation of methanogenesis in the deep sediment of Lake Kinneret (Israel)

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The goal of this study was to investigate the non-trivial ending of methanogenesis in the deep sediments of Lake Kinneret, where substrate is still available. *in situ* profiles showed that in the deep sediment acetate and dissolved organic carbon concentrations increase. Incubation experiments showed acetate accumulation in the non-treated samples with time in the deep sediment, indicating that this substrate is not used, and that acetogenesis rather methanogenesis dominate the deeper sediments. Addition of substrates (acetate; dimethyl sulfide (DMS); H_2/CO_2 4:1 atmosphere) did not significantly enhance methanogenesis in the deep sediments within the first 3 weeks. After 100 days of incubation with DMS methane concentration increased in all depths and in the deep sediment there was a change in the colour from brown to black as a result of iron sulfide mineral precipitation. The results indicate that methanogenesis is limited in the deep sediment of Lake Kinneret and that acetate or other electron donors are not limiting factors. The results give indication for the mechanism of methanogenesis inhibition.