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Ammonium in epithermal quartz-adularia deposits indicating the interactions of fluids with sediments and a contribution of mantle-derived low ^{15}N fluids to high gold samples

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Low-sulphidation epithermal gold deposits form at shallow depths, <400 m, from near neutral-pH fluids at <250 C. Deposits consist of veins of quartz-adularia (hydrothermal K-feldspar), with minor illite and smectite, with alteration halos of the same minerals. Since K minerals can incorporate NH^{4+} into the K^+ site of crystals, adularia and illite incorporate significant NH^{4+}. The presence of ammonium has been reported from many epithermal gold deposits based on spectroscopic data. The mineralogy, ammonium concentrations, and N isotope values of NH^{4+} were examined for veins and altered rocks from two locations: 74 samples from the Waihi gold field (~ 260 t Au) in New Zealand, and 41 samples from the Hishikari deposit (>420 t Au) in Japan. The Waihi field of ~ 6 Ma contains several deposits hosted by andesitic to rhyolitic rocks that overlying Jurassic metasedimentary basement, whereas most of the Hishikari deposit, 1 Ma, is hosted by Cretaceous metasedimentary basement. In NZ, the K-mineral is adularia in the Martha (>190 t Au) and Wharekirauponga (~12 t Au) deposits, and illite in the Favona (17 t Au) mine. The host at Hishikari is a mixture of adularia and illite. KCl leaching of adsorbed ions confirm that much of ammonium in samples is in the crystal structures. $d^{15}N$ values of NH^{4+} are similar, whether ammonium is hosted by adularia or illite, and range from +0.5 to +7.9$\%_o$ at Waihi and from -4.9 to +3.7$\%_o$ at Hishikari. The data suggest the auriferous fluids interacted with metasedimentary rocks, which kept the fluids in reduced conditions. Low 15N values at Hishikari, <0$\%_o$, are associated with exceptionally high Au samples (up to 1.12 %). Although oxidation of aqueous NH^{4+} followed by its subsequent reduction back to aqueous NH^{4+} could cause a low $d^{15}N$ value, such a complicated process is unlikely, considering the similar mineralogy and textures of all samples. Therefore, low ^{15}N in NH^{4+} from high Au samples indicates a contribution from fluid with low ^{15}N. Since crustal rocks in the entire areas have high $d^{15}N$, we suggest an input of mantle-derived fluids for exceptionally high grade Au samples.