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Uranium as a possible criterion for the hydro-chemical alteration of betafite

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Hydro-chemical processes significantly alter the original composition of metamict minerals. Since many of them are deemed to be natural analogues of aged radioactive waste forms, it is of interest to evaluate the extent of material loss and to try and reproduce their original chemical composition. In the work presented here, an attempt was made to reconstruct the chemical composition of betafite in the earlier stages of its geological history. The time scale is determined by the leaching rate of the isotope 238U, a process that takes its course in line with first-order kinetics, or something close to it. The leaching rate constant of this uranium isotope was assessed. Based on available data in the literature, the hydro-chemical behavior of various atoms in group A of betafite was analyzed. The chemical composition of the mineral was calculated considering the total charge of the cations that the betafite had at the time it was formed, or possibly the last time it was completely reformed as a result of diverse endogenic processes. To determine the chemical composition of a betafite in the early stages of its existence a methodology was developed in which the time scale is arranged in units of T1/2 that is in the half-leaching periods of the 238U isotope. When calculating the original formula of the mineral, the following factors were borne in mind: 1. The constancy of formula coefficients of atoms not subjected to leaching; 2. The possible neutralization of a surplus positive charge for atoms in group A because the presence of tri- and tetravalent atoms in group B; 3. The formation of betafite in the canonical form A2B2O7 as a result of two processes: the replacement of divalent atoms with tetravalent atoms and the formation in group A of cation vacancies in the composition of divalent atoms. The calculations showed that the ratio between the leaching rates of calcium and uranium has very little effect on the original betafite formula. All that can be observed is a greater or lesser shift in the moment the mineral was formed, according to the time scale.

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