THE EFFECT OF RADIATION ON WATER AND LEAD IN POTASSIUM FELDSPAR

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Trace amounts of water in a mineral can control its response to gamma-radiation. For potassium feldspar, this is demonstrated by amazonite, wherein interaction of water, lead, and radiation produces a tangible physical property: color. We have probed the interaction by studying the color through visible, infrared, and resonance Raman spectroscopy, and by gamma-irradiation. We have examined 16 samples of various colors provided and chemically analyzed by E. Foord. Resonance Raman spectra show that the ion responsible for the color is much heavier than potassium and occupies the K site in the lattice. This is consistent with lead causing the color. Our experiments in thermal dehydration, and hydration by diffusion reveal that the color intensity of a given sample depends linearly on the structural water concentration. Water's fundamental role in coloration is corroborated by ion-exchange experiments: lead doped anhydrous K-spars are colorless. However, the variation of color in natural hydrous K-spar depends on lead content. Samples with < 1000 ppm Pb are blue due to an intense polarized absorption at 630 nm. Samples with > 1.5 wt % Pb are colored yellow-green by a similar band at 720 nm. Those with intermediate lead content possess both absorptions and are green. The interplay of lead and water is shown in plots of color intensity vs. the product of lead and structural water concentration: all samples with the 630 nm singlet plot on one line, while those with the 730 nm singlet define a separate line, and the intermediates with both absorptions lie between the two lines. We propose that coupling of lead and water impurities through gamma-radiation damage causes amazonite color through a mechanism involving oxidation of water and reduction of lead.