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LATE-STAGE HYDROTHERMAL ALTERATION PRODUCTS OCCURING IN THE STEWART MINE, SAN DIEGO CO., CALIFORNIA, U.S.A.

by

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Summary
Several different minerals were identified in the Stewart Mine, San Diego Co., California, U.S.A., as late-stage hydrothermal alteration products, including montmorillonite-15Å, montmorillonite-18Å, and illite. In the areas of the mine that show a higher degree of alteration the primary elbaite was transformed to cookeite to a greater degree. We can conclude that this transformation is more extensive when the material is more soft and turbid.

Introduction
During a field trip at the GIA Gemological Research Conference in San Diego (Aug. 26-27, 2006) different samples were collected in the Stewart Mine, San Diego Co., California, U.S.A. Most of the gem-bearing pegmatites of Southern California have been intruded into rocks of the Cretaceous-age Peninsular Ranges Batholith - also known as the Southern California Batholith (FISHER, 2002). The Stewart Mine has been an important source of gem-quality elbaite (pink, red, and grape colored tourmalines) in the Pala pegmatite district. Different samples were collected in areas of the mine, which show a higher degree of alteration.

Results and Discussion
All phases were identified by X-ray powder diffraction analysis. Soft, pink to pale red material was identified mainly as montmorillonite-15Å, with minor amounts of quartz, albite, and montmorillonite-18Å. Soft, white material was identified as poorly crystallized montmorillonite-15Å. Maybe montmorillonite occurs as weathering product of the primary pegmatitic feldspar. The Mg content of the montmorillonite possibly derived from the surrounding rocks. Soft, violet, fine grained material, which fills veins (up to ~1 cm) in quartz, was identified as illite. Illite often occurs as an alteration product of muscovite and feldspar in weathering and hydrothermal environments.

Cookeite, a Li-bearing mineral of the chlorite group, occurs generally as a late-stage hydrothermal alteration product of Li-bearing minerals like elbaite or lepidolite in pegmatites.

Different pinkish samples with the morphology of tourmaline crystals were taken and also checked by X-ray powder diffraction analysis. All degrees of mixtures between elbaite and cookeite were found. While clear material (from pockets and also completely embedded in quartz or fine-grained lepidolite) was identified as elbaite, soft, turbid material, with a light pink color, was completely transformed into cookeite (grown in feldspar originally, which is now transformed into montmorillonite). But elbaite crystals were also found which were partly transformed into cookeite. Alteration of tourmaline into cookeite was previously described from different pegmatites in Maine, U.S.A., by LANDES (1925). Borocookeite (ZAGORSKY et al., 2003), also a late-stage pocket mineral, was not found. VIDAL & GOFFÉ (1991) report that the low thermal extent of the stability field of cookeite + quartz (260–480°C) makes cookeite a valuable indicator of low temperature conditions within a wide range of pressures (1–14 kbar). SHIGLEY & BROWN (1985) give the temperatures for the hydrothermal alteration of lithiophilite in the Stewart Mine pegmatite as 275-350°C.

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