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Quartz-tourmaline orbicules: Record of magmatic melt immiscibility in the Land's End granite, SW England

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Spherical quartz-tourmaline aggregations are a common sight throughout the Cornubian batholith in SW England. In the outer parts of the Land's End granite smaller rounded orbicules occur in a coarse-grained megacrystic biotite granite. The interior parts of the orbicules show poikilittic textures with fine-grained euhedral quartz chadacrysts enclosed by skeletal tourmaline oikocrysts, with outer zones showing typical replacement textures. Cathodoluminescence of quartz show at least two growth stages after the megacrystic stage. The quartz phenocrysts show an even, concentric zoning pattern, sometimes with a darker core indicating growth during stable physiochemical conditions. The orbicular quartz is strongly zoned with bright cores and darker rims, similar to the fine-grained quartz in the granite matrix. Ti content of quartz corresponds to the CL zoning, with 125 – 180 μg/g in the bright cores and 60 – 80 in the darker main stage orbicular quartz. Tourmaline in the orbicules is weakly zoned form dark to pale brown, but the zoning is more pronounced compared to tourmaline in the granite matrix. Chemically, both are well within the schorl field, and cannot be differentiated based on major elements. The B-isotope signature is also overlapping. Matrix tourmaline has higher Sc and V content, but lower Nb, Ta and Sn, and matrix and orbicule tourmaline can be distinguished using trace elements. The geometry and composition of the orbicules is difficult to explain by fractional crystallization alone, since the total FeO content of the granite is low, and Fe is bound primarily to magmatic phases such as ilmenite and biotite. A prolonged fractional crystallization sequence would have depleted the magma in respect to Fe, and Fe derived from breakdown of nearby biotite is not sufficient to stabilize orbicule tourmaline. Orbicular tourmaline is conspicuously different, both chemically and texturally, from the typical hydrothermal tourmaline in the area, and replacement by an extrinsic hydrothermal fluid is unlikely. We propose that the orbicules formed from an immiscible hydrous B-Fe rich melt that coalesced to the orbicules, and crystallized in a eutectic manner during the last stages of crystallization.