Online Resource 1: Ellenbergerite mode calculation

Our data and previous studies (Chopin et al, 1986, Schertl et al, 1991) have broadly identified three end members of ellenbergerite in P-Ti-Zr space. P-rich ellenbergerites (>10 wt% P_2O_5) have low TiO_2 (<0.5 wt%) and low to moderate ZrO_2 (<2 wt%). P-poor ellenbergerites (<0.5 wt% P_2O_5) show substitution of Zr and Ti, forming an almost pure Ti endmember, and a mixed Ti, Zr endmember. ZrO_2 content ranges from 0-3.3 wt%, and TiO_2 from 1.8-4.2 wt%. We estimate the ellenbergerite mode present in the sample during prograde metamorphism by comparing ellenbergerite compositions with bulk P (c.a. 0.08 wt%), Zr (c.a. 200 µg/g) and Ti (c.a. 0.40 wt%) contents of whiteschists reported by Schertl and Schreyer, 2008. Using the maximum Zr and P contents observed in our ellenbergerites, and assuming all Zr and P is hosted in ellenbergerite, results in ellenbergerite modes of 0.83 and 0.63 % respectively. Incorporation of Zr in zircon and P in apatite, both of which are present as accessory minerals (Schertl et al, 1991) would reduce these modes. Lower P and Zr contents would result in higher modes. However, lower P and Zr requires higher Ti, and the availability of Ti is limited by the rutile mode, which dominates the Ti budget of the rock. If all ellenbergerite was the Ti-rich endmember, then rutile mode has to be <0.02 % in order to produce 5 % ellenbergerite. This does not include Ti in other phases, principally phengite and phlogopite, which would reduce rutile mode further. Rutile mode in the matrix was estimated at 0.7 % from point counting on sample DM5.2. The average ellenbergerite composition will not be any of these pure endmembers but even with intermediate compositions it is difficult to construct a situation where ellenbergerite mode can reasonably be >5 %. We therefore suggest that ellenbergerite mode during prograde metamorphism was between 1-5 %.

References:

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