

Distribution Coefficients among Co-existing Accessory Minerals (Zircon, Apatite and Titanite) in Three Well-Studied Tuffs

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Accurate measurement of mineral/melt distribution coefficients (K_D) in rocks is hampered by the determination of the melt composition. Commonly, whole rocks are poor models of melt composition, but glass shards in tuffs can be sampled as the melt. Even resorting to tuffs, we discovered variability in glasses and minerals. Major and minor elements of proximal mineral pairs/trios were analysed and contrasted with isolated representative crystals using JEOL 8350X EPMA and Agilent 8800 ICPMS in thin sections. We built a database of K_D s between accessory phase pairs to test whether other competing accessory minerals might be reflected in mineral element concentrations (REE patterns) as noted by [1]. We examined ZAT (zircon, apatite, and titanite) from Miocene tuffs in the western United States known for the unusual presence of titanite in silicic volcanic rocks. They are Fish Canyon (FCT), Peach Spring (PST), and Apache Leap (ALT, n=2).

Figure 1 (only ALT displayed) shows the following general consistent relationships for averages. Titanite 'wins' all REEs over apatite, but the latter favours Rb, Sr, and Ba. The most variable distributions are Ta, Nb, and Hf. Titanite takes in the REEs more readily than zircon, except Y, Yb and Lu, which are shared. Sr and Rb reside more in titanite. For zircon verse apatite, La to Tb are more concentrated in apatite, Y and Dy are shared, while HREE resides in zircon, with Ta exhibiting the most variability.

On closer inspection, closely spaced mineral pairs yield different titanite/apatite K_D s than isolated grains relative to sample average apatite. In Figure 2, ALT-6544 displays shapes of the K_D s that are similar but fanned with differential partitioning of HREE (variable zircon competition), and the relative sizes of Eu anomaly in titanite and apatite vary. The other rock (ALT-6545) yields a tight cluster with K_D s near 1. Detailed examination of mineral-pair relationships will aid in identification of co-crystallizing phases.

[1] Loader, M.A., Wilkinson, J.J., and Armstrong, R.N. (2017). The effect of titanite crystallisation on Eu and Ce anomalies in zircon and its implications for the assessment of porphyry Cu deposit fertility. *Earth and Planetary Science Letters* 472, 107–119.

