Integrating monazite thermometry and geochronology into the P-T-t-D path of the Al2SiO5 triple-point rocks of the Picuris mountains, Taos County, New Mexico, USA

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Summary

The Picuris mountains, north-central New Mexico, USA, preserve metamorphic rocks that equilibrated at conditions close to the Al_2SiO_5 triple-point of Holdaway (1971). Aluminous quartzites and schists of the Ortega Formation preserve spectacular examples of coexisting kyanite, sillimanite and andalusite. Kyanite is strongly deformed, fractured and embayed, and shows polymorphic replacement by sillimanite or andalusite. Kyanite is aligned subparallel to S0/S1 and L1. Sillimanite occurs as both fibrolite and prismatic crystals. Fibrolite is aligned in S_1 and folded about S_2 crenulation cleavage. Prismatic sillimanite is oriented both parallel to and at a high angle to S_2. Fibrolite to prismatic sillimanite rim or crosscut kyanite. Sillimanite is only observed as inclusions within andalusite, and typically shows fractures and embayments, patchy extinction and partial replacement by muscovite or andalusite. Andalusite occurs as cm-scale porphyroblasts that pseudomorphs muscovite aligned in both S_1 and S_2. Andalusite porphyroblasts display relatively uniform extinction and contain inclusions of kyanite, folded fibrolite and prismatic sillimanite. Locally, kyanite, sillimanite and andalusite show minor, patchy alteration to pyrophyllite. The occurrence of strongly deformed, embayed kyanite, crenulated fibrolite and embayed prismatic sillimanite within relatively undeformed andalusite shows that andalusite growth post-dates both fibrolite and prismatic sillimanite for these aluminous bulk compositions. Peak metamorphic temperatures are estimated at 510–525°C, and 4.0–4.2 kbar based upon mineral chemistry and phase equilibria constraints.

Monazite are abundant within both quartzite and schist samples. Monazite occur as inclusions within kyanite, mats of sillimanite and andalusite porphyroblasts. Monazite grains are typically aligned sub-parallel to the dominant regional foliation (S_0/S_1 or S_2) and extension lineation (L_1). Xenotime are less common but shows textural relationships similar to monazite. Backscatter electron images and X-ray maps of monazite reveal distinct core, mantle and rim compositional domains. Monazite–xenotime thermometry from the mantle and rim domains yields temperatures of 405–470 °C (±50 °C) and 500–520 °C (±50 °C), respectively, consistent with the prograde to peak metamorphic growth of monazite. In situ, ion microprobe analyses from five monazites yield an upper intercept age of 1417 ± 9 Ma. Near-concordant to concordant analyses yield 207Pb–206Pb ages from 1434 ± 12 Ma (core) to 1390 ± 20 Ma (rim). We find no evidence of older regional metamorphism related to the ~1650 Ma Mazatzal Orogeny or that the triple-point assemblage reflects multiple metamorphic cycles.

References

Holdaway, M., 1971, Stability of andalusite and the aluminum silicate phase diagram. American Journal of Science, 271, 97-131.