

Supplementary Information (S1) – EMP Operating Parameters, Standards, and Data Quality

EMP Operating Parameters

Quartz Ti measurements utilized a 15 kV accelerating voltage with a focused beam current of 200 nA and generally followed the approach of Nachlas and Hirth (2015). Non-quartz WDS measurements utilized a 15 kV accelerating voltage and 20nA beam current; spot sizes varied depending on the minerals analyzed (garnet and pyroxene: 1 μm spot size, biotite and plagioclase: 5 μm spot size).

EMP Standards

Ti-in-quartz measurement standards for Al and Ti included corundum and rutile, respectively, with natural and synthetic quartz. Natural quartz standards consisted of Herkimer quartz with approximately zero parts per million (ppm) Ti and variable Al (Kohn and Northrup, 2009); synthetic quartz standards were synthesized by Will Nachlas and Jay Thomas and contain variable, well-constrained Ti and Al concentrations. Garnet standards included almandine (Al, Fe, Si), rhodonite (Mn), diopside (Ca, Mg), chromite (Cr), and rutile (Ti) (Ti-in-garnet measurements utilized titanite for Ti). Biotite standards included almandine (Al, Fe, Si), sanidine (K), diopside (Ca, Mg), rhodonite (Mn), albite (Na), barite (Ba), chromite (Cr), rutile (Ti), fluorite (F), and tugtupite (Cl). Plagioclase standards included albite (Si, Na), plagioclase (Al, Ca), sanidine (K), almandine (Fe), and barite (Ba). Pyroxene standards included diopside (Ca, Mg, Si), hypersthene (Fe), rhodonite (Mn), almandine (Al), jadeite (Na), sanidine (K), chromite (Cr), and rutile (Ti).

EMP Detection Limits and Precision

Ti detection limits for quartz and garnet WDS measurements were 1-2 ppm and 25 ppm, respectively. Precision in weight percent oxide measurements for the remaining WDS analyses determined by replicate analysis of secondary standards is $\pm 0.36\%$ SiO_2 , $\pm 0.12\%$ Al_2O_3 , $\pm 0.07\%$ MgO , $\pm 0.34\%$ FeO , $\pm 0.07\%$ MnO , $\pm 0.04\%$ CaO , $\pm 0.06\%$ Na_2O , $\pm 0.03\%$ K_2O , $\pm 0.02\%$ BaO , $\pm 0.28\%$ TiO_2 , $\pm 0.01\%$ Cr_2O_3 , and $\pm 0.01\%$ Cl.

References

- Kohn, M.J. and Northrup, C.J.: Taking mylonites' temperatures, *Geology*, 37, 47-50, <https://doi.org/10.1130/G25081a.1>, 2009.
- Nachlas, W. and Hirth, G.: Experimental constraints on the role of dynamic recrystallization on resetting the Ti-in-quartz thermobarometer, *J Geophys Res-Sol Ea*, 120, 8120-8137, <https://doi.org/10.1002/2015JB012274>, 2015.