Recalibration of the GASP geobarometer in light of recent garnet and plagioclase activity models and versions of the garnet-biotite geothermometer

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ABSTRACT

The garnet-Al silicate-plagioclase (GASP) geobarometer has been recalibrated using four recent garnet activity models, four analogous garnet-biotite temperature models, and two recent plagioclase activity models. A typical sillimanite-bearing sample that formed at about 5.25 kbar, 575 °C shows a possible P range of ~0.7 kbar due to T error, ~1 kbar due to range of garnet activity model, ~0.9 kbar due to range of plagioclase activity model, and ~5.4 kbar due to range of experimental end-member reversals extended by one sigma.

Calibrations were further constrained with the kyanite-sillimanite (K-S) phase boundary such that the best fit of 76 pelitic schist samples from 11 localities provides an individual end-member calibration for each of the eight possible combinations of garnet and plagioclase activity models with the appropriate geothermometer. Samples with low grossular or anorthite component were rejected. The end-member calibrations are constrained to pass through the the best-determined portion of the GASP experimental reversals at 1230 °C, 26.6 kbar. These individual end-member calibrations provide self-consistent models that tend to compensate for error in the garnet and plagioclase activity expressions. The models were also tested on a set of 59 samples from the Alps.

The recommended calibration is the average garnet activity model and average garnet-biotite T model of Holdaway (2000), the Fuhrman and Lindsley (1988) plagioclase activity model, and $H_{Grs} = -6628521$, $S_{Grs} = 258.76$ to combine with the remaining phases in the Berman database to produce the optimum end-member GASP curve. These thermodynamic data are for the GASP geobarometer only. Error is about ±0.8 kbar absolute and about ±0.6 kbar relative. Geological error is the largest component of error in many of these samples. Care should be taken to be sure that analyzed plagioclase and biotite are near analyzed garnet, that the peak-T portions of garnet and plagioclase are selected, that the peak-T Al silicate is determined, and that the T calculated is the most accurate possible. These calibrations represent an improvement over previous published GASP calibrations. These eight models are available for distribution as three programs (T, P, P-T intersection) for the DOS-based personal computer.