Near-isothermal exhumation of lower crust in the Caledonian Orogen: Metamorphic path of kyanite eclogite from the Danmarkshavn area, North-East Greenland Caledonides

Wentao Cao, Jane Gilotti, and Hans-Joachim Massonne

1Department of Geology & Environmental Sciences, State University of New York at Fredonia, Fredonia, NY, USA (cao@fredonia.edu)
2Department of Earth & Environmental Sciences, University of Iowa, Iowa City, IA, USA (jane-gilotti@uiowa.edu)
3School of Earth Sciences, China University of Geosciences, Wuhan, China (h-j.massonne@mineralogie.uni-stuttgart.de)
4Fakultät Chemie, Universität Stuttgart, Stuttgart, Germany

Kyanite eclogite from the North-East Greenland Caledonides – the upper plate of the Caledonian orogeny – preserves a mineral assemblage and petrographic texture that are consistent with an initial near-isothermal exhumation path. Two medium-grained kyanite eclogites from the Danmarkshavn area (76°46'N, 18°40'W) located west of the Germania Land shear zone contain the peak assemblage of garnet + omphacite + kyanite + phengite + amphibole + rutile. Subhedral garnet encloses monomineralic omphacite and polymineralic inclusions of clinopyroxene + plagioclase ± quartz ± amphibole ± K-feldspar ± kyanite. X-ray mapping of garnet indicates a homogenous core with a composition of Py\textsuperscript{51–52} Alm\textsuperscript{28–29} Gr\textsuperscript{19–20} Sp\textsuperscript{0–1}, along with a slightly zoned rim of Py\textsuperscript{54} Alm\textsuperscript{31} Gr\textsuperscript{15} Sp\textsuperscript{1} that is replaced by a corona of symplectitic amphibole + plagioclase. Omphacite (X\textsubscript{Na} up to 0.41), rarely present in the matrix, is indicated by symplectite of clinopyroxene + amphibole + plagioclase. Symplectites of corundum + plagioclase, spinel + plagioclase and sapphirine + plagioclase replace former kyanite. These symplectites are typically surrounded by a plagioclase corona with decreasing Ca (from X\textsubscript{An} = 92–97 to X\textsubscript{An} = 47–53) from the symplectite to the matrix. Isochemical phase equilibrium modeling along with homogenous garnet core and peak omphacite compositions yielded a peak metamorphic pressure-temperature (P-T) condition at 1.9 GPa, 840 °C. Assuming local equilibrium at the microscopic scale, an attempt to model a symplectite of spinel + sapphirine + plagioclase after kyanite using a pseudosection yielded estimated P-T conditions at 0.8–1.3 GPa and 700–900 °C. Integrating the calculated P-T conditions and previous geochronological results, an initial exhumation path from 1.9 GPa to ~1.0 GPa from ~415–390 Ma to ~375 Ma is nearly isothermal at around 800 °C.