PTtoolbox

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Thermometers & Barometers used in PTtoolbox

Temperature is listed in Celsius (C) and pressure in kilobars (kbar). Mathematical operators are listed based on compatibility with MATLAB. User input (ex. Grt Fe) is entered in cations per formula unit.

---- Garnet-Biotite ----

Grt XFe = Fe/(Fe+Mg+Ca+Mn)
Grt XMg = Mg/(Fe+Mg+Ca+Mn)
Grt XCa = Ca/(Fe+Mg+Ca+Mn)
Grt XMn = Mn/(Fe+Mg+Ca+Mn)
Bi XTi = Ti/(Ti+Al+Fe+Mg+Mn)
Bi XAl = Al/(Ti+Al+Fe+Mg+Mn)
Bi XFe = Fe/(Ti+Al+Fe+Mg+Mn)
Bi XMg = Mg/(Ti+Al+Fe+Mg+Mn)
Bi XMn = Mn/(Ti+Al+Fe+Mg+Mn)
lnKd = log((Grt Fe/Grt Mg)/(Bi Fe/Bi Mg))

Thompson, A. B. (1976). Mineral reactions in pelitic rocks; I, Prediction of PTX (Fe-Mg) phase relations. American Journal of Science, 276(4), 401-424.

T76=(2739.3+0.0234*P*1000)/(lnKd+1.56)-273.15

Goldman, D. S., & Albee, A. L. (1977). Correlation of Mg/Fe partitioning between garnet and biotite with O18/O16 partitioning between quartz and magnetite. Am. J. Sci., 277(6).

GA77=sqrt((-1.4315e6)/(-lnKd-0.522))-273.15

Holdaway, M. J., & Lee, S. M. (1977). Fe-Mg cordierite stability in high-grade pelitic rocks based on experimental, theoretical, and natural observations. Contributions to Mineralogy and Petrology, 63(2), 175-198.

HL77=(3095+0.0124*P*1000)/(lnKd+1.978)-273.15

Ferry, J. T., & Spear, F. S. (1978). Experimental calibration of the partitioning of Fe and Mg between biotite and garnet. Contributions to Mineralogy and Petrology, 66(2), 113-117.

FS78=(-12454-0.057*P*1000)/((5.961*-lnKd)-4.662)-273.15

Hodges, K. V., & Spear, F. S. (1982). Geothermometry, geobarometry and the Al2SiO5 triple point at Mt. Moosilauke, New Hampshire. American Mineralogist, 67(11-12), 1118-1134.

HS82=(12454+0.057*P*1000+9900*(grt_XCa^2+grt_XFe*grt_XCa+grt_XCa*grt_XMn+grt_XMg*grt_XCa))/(4.5*(grt_XCa^2+grt_XFe*grt_XCa+grt_XCa*grt_XMn+grt_XMg*grt_XCa)-5.961*-lnKd+4.662)-273.15

Perchuk, L. L., & Lavrent'eva, I. V. (1983). Experimental investigation of exchange equilibria in the system cordierite-garnet-biotite. In Kinetics and equilibrium in mineral reactions (pp. 199-239). Springer, New York, NY.

PL83a=(7843.7-0.0577*(P*1000-6000))/(1.987*lnKd+5.699)-273.15

PL83b=(7843.7-0.0246*(P*1000-6000))/(1.987*lnKd+5.699)-273.15

Ganguly, J., & Saxena, S. K. (1984). Mixing properties of aluminosilicate garnets: constraints from natural and experimental data, and applications to geothermo-barometry. American Mineralogist, 69(1-2), 88-97.

GS84=(1175+P*1000*0.00945+(((grt_XFe*2500+grt_XMg*200)/(grt_XFe+grt_XMg))*(grt_XFe-grt_XMg)+3000*grt_XCa+3000*grt_XMn)/1.987)/(0.782+lnKd)-273.15

Indares, A., & Martignole, J. (1985). Biotite–garnet geothermometry in the granulite facies: the influence of Ti and Al in biotite. American Mineralogist, 70(3-4), 272-278.

IM85a=(12454+0.057*P*1000+3*(-464*bi_XAl-6767*bi_XTi)+9900*grt_XCa)/(4.662-5.9616*-lnKd+4.5*grt_XCa)-273.15;

IM85b=(12454+0.057*P*1000+3*(-1590*bi_XAl-7451*bi_XTi)-3*(-3000*(grt_XCa+grt_XMn)))/(4.662-5.9616*-lnKd)-273.15

Perchuk, L. L., Aranovich, L. Y., Podlesskii, K. K., Lavrant'eva, I., Gerasimov, V. Y., Fed'Kin, V. V., ... & Berdnikov, N. V. (1985). Precambrian granulites of the Aldan shield, eastern Siberia, USSR. Journal of Metamorphic Geology, 3(3), 265-310.

P85=(3720+2871*grt_XCa+0.038*P*1000)/(lnKd+0.625*grt_XCa+2.868)-273.15

Dasgupta, S., Sengupta, P., Guha, D., & Fukuoka, M. (1991). A refined garnet-biotite Fe− Mg exchange geothermometer and its application in amphibolites and granulites. Contributions to Mineralogy and Petrology, 109(1), 130-137.

D91=(4301+3000*grt_XCa+1300*grt_XMn-495*(grt_XMg-grt_XFe)-3595*bi_XAl-4423*bi_XTi+1073*(bi_XMg-bi_XFe)+0.0246*P*1000)/(1.85-1.987*-lnKd)-273.15

Bhattacharya, A., Mohanty, L., Maji, A., Sen, S. K., & Raith, M. (1992). Non-ideal mixing in the phlogopite-annite binary: constraints from experimental data on Mg− Fe partitioning and a reformulation of the biotite-garnet geothermometer. Contributions to Mineralogy and Petrology, 111(1), 87-93.

B92a=(20286+0.0193*P*1000-(2080*grt_XMg^2-6350*grt_XFe^2-13807*grt_XCa*(1-grt_XMn)+8540*grt_XFe*grt_XMg*(1-grt_XMn)+4215*grt_XCa*(grt_XMg-grt_XFe))+4441*(2*bi_XMg-1))/(13.138+8.3143*lnKd+6.276*grt_XCa*(1-grt_XMn))-273.15

B92b=(13538+0.0193*P*1000-(837*grt_XMg^2-10460*grt_XFe^2-13807*grt_XCa*(1-grt_XMn)+19246*grt_XFe*grt_XMg*(1-grt_XMn)+5649*grt_XCa*(grt_XMg-grt_XFe))+7972*(2*bi_XMg-1))/(6.778+8.3143*lnKd+6.276*grt_XCa*(1-grt_XMn))-273.15

---- Garnet-Chlorite ----

Grt XFe = Fe/(Fe+Mg+Ca+Mn)
Grt XMg = Mg/(Fe+Mg+Ca+Mn)
Grt XCa = Ca/(Fe+Mg+Ca+Mn)
Grt XMn = Mn/(Fe+Mg+Ca+Mn)
Chl XFe = Fe/(Fe+Mg)
Chl XMg = Mg/(Fe+Mg)
lnKd = log((Grt Fe/Grt Mg)/(Chl Fe/Chl Mg))

Dickenson MP III, Hewitt DA (1986). A garnet-chlorite geothermometer (abstract). Geol Soc Am Abstracts Program 18:584

DH86=((-51906-(0.438*P*1000))/(-7.541+(1.987*(15*-lnKd))))-273.15

Grambling, J. A. (1990). Internally-consistent geothermometry and H 2 O barometry in metamorphic rocks: the example garnet-chlorite-quartz. Contributions to Mineralogy and Petrology, 105(6), 617-628.

G90=((-24156-(0.05*P*1000)-(4607*-lnKd))/-19.02)-273.15

Perchuk, L. L. (1991). Derivation of a thermodynamically consistent set of geothermometers and geobarometers for metamorphic and magmatic-rocks. Progress in metamorphic and magmatic petrology.

P91=3973/(lnKd+2.773)-273.15

---- Garnet-Clinopyroxene ----

Grt XFe = Fe/(Fe+Mg+Ca+Mn)
Grt XMg = Mg/(Fe+Mg+Ca+Mn)
Grt XCa = Ca/(Fe+Mg+Ca+Mn)
Grt XMn = Mn/(Fe+Mg+Ca+Mn)
Cpx XFe = Fe/(Fe+Mg+Ca)
Cpx XMg = Mg/(Fe+Mg+Ca)
Cpx XCa = Ca/(Fe+Mg+Ca)
lnKd = log((Grt Fe/Grt Mg)/(Cpx Fe/Cpx Mg))

Mysen, B. O., & Heier, K. S. (1972). Petrogenesis of eclogites in high grade metamorphic gneisses, exemplified by the Hareidland eclogite, western Norway. Contributions to Mineralogy and Petrology, 36(1), 73-94.

MH72=2475/(lnKd+0.781)-273.15

Råheim, A., & Green, D. H. (1974). Experimental determination of the temperature and pressure dependence of the Fe-Mg partition coefficient for coexisting garnet and clinopyroxene. Contributions to Mineralogy and Petrology, 48(3), 179-203.

RG74=(3686+28.35*P)/(lnKd+2.33)-273.15

Mori, T., & Green, D. H. (1978). Laboratory duplication of phase equilibria observed in natural garnet lherzolites. The Journal of Geology, 86(1), 83-97.

MG78=2800/(lnKd+1.19)-273.15

Ellis, D. J., & Green, D. H. (1979). An experimental study of the effect of Ca upon garnet-clinopyroxene Fe-Mg exchange equilibria. Contributions to Mineralogy and Petrology, 71(1), 13-22.

EG79=(3104*grt_XCa+3030+10.86*P)/(lnKd+1.9034)-273.15

Saxena, S. K. (1979). Garnet-clinopyroxene geothermometer. Contributions to Mineralogy and Petrology, 70(3), 229-235.

cpx_XFe=cpx_Fe/(cpx_Fe+cpx_Mg+cpx_Ca+(cpx_Al-cpx_Na)/2)

cpx_XMg=cpx_Mg/(cpx_Fe+cpx_Mg+cpx_Ca+(cpx_Al-cpx_Na)/2)

cpx_XCa=cpx_Ca/(cpx_Fe+cpx_Mg+cpx_Ca+(cpx_Al-cpx_Na)/2)

cpx_XAl=1-cpx_XFe-cpx_XMg-cpx_XCa

Q1=2710*(grt_XFe-grt_XMg)+3150*grt_XCa+2600*grt_XMn

Q2=-6594*(cpx_XFe*(cpx_XFe-2*cpx_XMg))-12762*(cpx_XFe-cpx_XMg*(1-cpx_XFe))-11281*(cpx_XCa*(1-cpx_XAl)-2*cpx_XMg*cpx_XCa)+6137*(cpx_XCa*(2*cpx_XMg+cpx_XAl))+35791*(cpx_XAl*(1-2*cpx_XMg))+25409*cpx_XCa^2-55137*(cpx_XCa*(cpx_XMg-cpx_XFe))-11338*(cpx_XAl*(cpx_XFe-cpx_XMg))

S79=(8288+0.0276*P*1000+Q1-Q2)/(1.987*lnKd+2.4083)-273.15

Dahl, P. S. (1980). The thermal–compositional dependence of Fe2+–Mg distributions between coexisting garnet and pyroxene: applications to geothermometry. American Mineralogist, 65(9-10), 852-866.

D80=(2324+0.022*P*1000+1509*grt_XFe*grt_XMg+2810*grt_XCa+2855*grt_XMn)/(1.987*lnKd)-273.15

Powell, R. (1985). Regression diagnostics and robust regression in geothermometer/geobarometer calibration: the garnet-clinopyroxene geothermometer revisited. Journal of Metamorphic Geology, 3(3), 231-243.

P85=(2790+10*P+3140*grt_XCa)/(lnKd+1.735)-273.15

Krogh, E. J. (1988). The garnet-clinopyroxene Fe-Mg geothermometer—a reinterpretation of existing experimental data. Contributions to Mineralogy and Petrology, 99(1), 44-48.

K88=(-6173*grt_XCa^2+10*P+6731*grt_XCa+1879)/(lnKd+1.393)-273.15

Ai, Y. (1994). A revision of the garnet-clinopyroxene Fe2+-Mg exchange geothermometer. Contributions to Mineralogy and Petrology, 115(4), 467-473.

grt_XMg=grt_Mg/(grt_Fe+grt_Mg)

A94=(-1629*grt_XCa^2+3648.55*grt_XCa-6.59*grt_XMg*100+1987.98+17.66*P)/(lnKd+1.076)-273.15

Ravna, K. (2000). The garnet–clinopyroxene Fe2+–Mg geothermometer: an updated calibration. Journal of Metamorphic Geology, 18(2), 211-219.

grt_XMg=grt_Mg/(grt_Fe+grt_Mg)

R00=((1939.9+3270*grt_XCa-1396*grt_XCa^2+3319*grt_XMn-3535*grt_XMn^2+1105*grt_XMg-3561*grt_XMg^2+2324*grt_XMg^3+169.4*P/10)/(lnKd+1.223))-273.15

Nakamura, D. (2009). A new formulation of garnet–clinopyroxene geothermometer based on accumulation and statistical analysis of a large experimental data set. Journal of Metamorphic Geology, 27(7), 495-508.

A=0.5*grt_XCa*(grt_XMg-grt_XFe-grt_XMn)

B=0.5*grt_XCa*(grt_XMg-grt_XFe+grt_XMn)

C=0.5*(grt_XCa+grt_XMn)*(grt_XMg-grt_XFe)

cpx_XMg=cpx_Mg/(cpx_Al+cpx_Fe+cpx_Mg)

cpx_XFe=cpx_Fe/(cpx_Al+cpx_Fe+cpx_Mg)

N09=(2784+14.52*P+(2601+1.44*P)*(2*grt_XCa*grt_XMg-A)+(1183+6.98*P)*(grt_XCa^2-A)-105*(2*grt_XCa*grt_XFe+B)+(814.6+3.61*P)*(grt_XCa^2+B)-(254.6+8.42*P)*(2*grt_XMg*grt_XFe-grt_XFe^2+C)-83.6*grt_XMg^2-2*grt_XMg*grt_XFe+C)+1388*grt_XMn-462*(cpx_XMg-cpx_XFe))/(lnKd+1.431+0.695*(2*grt_XCa*grt_XMg+grt_XCa^2-2*A)+0.203*(grt_XCa^2-2*grt_XCa*grt_XFe)+0.922*grt_XMn)-273.15

---- Garnet-Cordierite ----

Grt XFe = Fe/(Fe+Mg+Ca+Mn)
Grt XMg = Mg/(Fe+Mg+Ca+Mn)
Grt XCa = Ca/(Fe+Mg+Ca+Mn)
Grt XMn = Mn/(Fe+Mg+Ca+Mn)
Crd XFe = Fe/(Fe+Mg)
Crd XMg = Mg/(Fe+Mg)

lnKd = log((Grt Fe/Grt Mg)/(Crd Fe/Crd Mg))

Currie, K. L. (1971). The reaction 3 cordierite= 2 garnet+ 4 sillimanite+ 5 quartz as a geological thermometer in the Opinicon Lake region, Ontario. Contributions to Mineralogy and Petrology, 33(3), 215-226.

C71=4515/(6.37-lnKd)-273.15

Thompson, A. B. (1976). Mineral reactions in pelitic rocks; I, Prediction of PTX (Fe-Mg) phase relations. American Journal of Science, 276(4), 401-424.

T76=(2725+0.0155*P*1000)/(lnKd+0.896)-273.15

Holdaway, M. J., & Lee, S. M. (1977). Fe-Mg cordierite stability in high-grade pelitic rocks based on experimental, theoretical, and natural observations. Contributions to Mineralogy and Petrology, 63(2), 175-198.

HL77=(3095+0.0153*P*1000)/(lnKd+1.354)-273.15

Perchuk, L. L., Aranovich, L. Y., Podlesskii, K. K., Lavrant'eva, I., Gerasimov, V. Y., Fed'Kin, V. V., ... & Berdnikov, N. V. (1985). Precambrian granulites of the Aldan shield, eastern Siberia, USSR. Journal of metamorphic Geology, 3(3), 265-310.

P85=(3087+0.018*P*1000)/(lnKd+1.342)-273.15

Bhattacharya, A., Mazumdar, A. C., & Sen, S. K. (1988). Fe-Mg mixing in cordierite; constraints from natural data and implications for cordierite-garnet geothermometry in granulites. American Mineralogist, 73(3-4), 338-344.

B88=(1814+0.0152*P*1000+1122*(crd_XMg-crd_XFe)-1258*(grt_XMg-grt_XFe)+1510*(grt_XCa+grt_XMn))/(1.028+lnKd)-273.15

Bhattacharya, S. (1993). Refinement of geothermobarometry for cordierite granulites. Proceedings of the Indian Academy of Sciences-Earth and Planetary Sciences, 102(4), 537.

B93=(1928.61+0.0152*P*1000+1311*(grt_XFe-grt_XMg)+1573*(grt_XCa+grt_XMn)+991*(crd_XMg-crd_XFe))/(1+1.014*lnKd)-273.15

---- Garnet-Hornblende ----

Grt XFe = Fe/(Fe+Mg+Ca+Mn)
Grt XMg = Mg/(Fe+Mg+Ca+Mn)
Grt XCa = Ca/(Fe+Mg+Ca+Mn)
Grt XMn = Mn/(Fe+Mg+Ca+Mn)
Hbl XFe = Fe/(Fe+Mg)
Hbl XMg = Mg/(Fe+Mg)
lnKd = log((Grt Fe/Grt Mg)/(Hbl Fe/Hbl Mg))

Graham, C. M., & Powell, R. (1984). A garnet–hornblende geothermometer: calibration, testing, and application to the Pelona Schist, Southern California. Journal of metamorphic Geology, 2(1), 13-31.

GP84=(2880+3280*grt_XCa)/(lnKd+2.426)-273.15

Perchuk, L. L., Aranovich, L. Y., Podlesskii, K. K., Lavrant'eva, I., Gerasimov, V. Y., Fed'Kin, V. V., ... & Berdnikov, N. V. (1985). Precambrian granulites of the Aldan shield, eastern Siberia, USSR. Journal of metamorphic Geology, 3(3), 265-310.

Per85=3330/(lnKd+2.333)-273.15

Powell, R. (1985). Regression diagnostics and robust regression in geothermometer/geobarometer calibration: the garnet-clinopyroxene geothermometer revisited. Journal of metamorphic Geology, 3(3), 231-243.

Pow85=(2580+3340*grt_XCa)/(lnKd+2.2)-273.15

Ravna, E. K. (2000). Distribution of Fe2+ and Mg between coexisting garnet and hornblende in synthetic and natural systems: an empirical calibration of the garnet–hornblende Fe–Mg geothermometer. Lithos, 53(3-4), 265-277.

R00=(1504+1784*(grt_XCa+grt_XMn))/(lnKd+0.72)-273.15

---- Garnet-Ilmenite ----

Grt XFe = Fe/(Fe+Mg+Ca+Mn)
Grt XMg = Mg/(Fe+Mg+Ca+Mn)
Grt XCa = Ca/(Fe+Mg+Ca+Mn)
Grt XMn = Mn/(Fe+Mg+Ca+Mn)
Ilm XFe = Fe/(Fe+Mn)
Ilm XMn = Mn/(Fe+Mn)
lnKd = log((Grt Mn/Grt Fe)/(Ilm Mn/Ilm Fe))

Pownceby, M. I., Wall, V. J., & O'Neill, H. S. C. (1987). Fe-Mn partitioning between garnet and ilmenite: experimental calibration and applications. Contributions to Mineralogy and Petrology, 97(1), 116-126.

P87=((-4089+420*(2*ilm_XMn-1)-77*(2*grt_XMn-1))/(-1.987*lnKd-1.44))-273.15

Pownceby, M. I., Wall, V. J., & O'Neill, H. S. C. (1991). An experimental study of the effect of Ca upon garnet-ilmenite Fe-Mn exchange equilibria. American Mineralogist, 76(9-10), 1580-1588.

P91=((14918-2200*(2*ilm_XMn-1)+620*(grt_XMn-grt_XFe)-972*grt_XCa)/(8.314*lnKd+4.38))-273.15

Martin, A. J., Ganguly, J., & DeCelles, P. G. (2010). Metamorphism of Greater and Lesser Himalayan rocks exposed in the Modi Khola valley, central Nepal. Contributions to Mineralogy and Petrology, 159(2), 203-223.

M10=((14642-2200*(2*ilm_XMn-1)+539*(grt_XMn-grt_XFe)+12083*grt_XMg)/(8.314*lnKd+7.67*grt_XMg+4.203))-273.15

---- Garnet-Phengite ----

Grt XFe = Fe/(Fe+Mg+Ca+Mn)
Grt XMg = Mg/(Fe+Mg+Ca+Mn)
Grt XCa = Ca/(Fe+Mg+Ca+Mn)
Grt XMn = Mn/(Fe+Mg+Ca+Mn)
Ph XAl = Al/(Al+Fe+Mg)
Ph XFe = Fe/(Al+Fe+Mg)
Ph XMg = Mg/(Al+Fe+Mg)
lnKd = log((Grt Fe/Grt Mg)/(Ph Fe/Ph Mg))

Krogh, E. J., & Råheim, A. (1978). Temperature and pressure dependence of Fe-Mg partitioning between garnet and phengite, with particular reference to eclogites. Contributions to Mineralogy and Petrology, 66(1), 75-80.

KR78=((3685+77.1*P)/(lnKd+3.52))-273.15

Green, T. H., & Hellman, P. L. (1982). Fe-Mg partitioning between coexisting garnet and phengite at high pressure, and comments on a garnet-phengite geothermometer. Lithos, 15(4), 253-266.

GH82a=((5560+0.036*P*1000)/(lnKd+4.65))-273.15

GH82b=((5680+0.036*P*1000)/(lnKd+4.48))-273.15

GH82c=((5170+0.036*P*1000)/(lnKd+4.17))-273.15

Hynes, A., & Forest, R. C. (1988). Empirical garnet–muscovite geothermometry in low-grade metapelites, Selwyn Range (Canadian Rockies). Journal of Metamorphic Geology, 6(3), 297-309.

HF88=((4726+17*P)/(lnKd+4.16))-273.15

Wu, C. M., Wang, X. S., Yang, C. H., Geng, Y. S., & Liu, F. L. (2002). Empirical garnet–muscovite geothermometry in metapelites. Lithos, 62(1-2), 1-13.

Ga=12.4*grt_XFe^2+22.09*grt_XMg^2-12.02*grt_XCa^2+23.01*grt_XMn^2-68.98*grt_XFe*grt_XMg+37.33*grt_XFe*grt_XCa+18.165*grt_XFe*grt_XMn+35.33*grt_XMg*grt_XCa+27.855*grt_XMg*grt_XMn+35.165*grt_XCa*grt_XMn

Gb=-0.05*grt_XFe^2-0.034*grt_XMg^2-0.005*grt_XCa^2-0.014*grt_XMn^2+0.168*grt_XFe*grt_XMg+0.1565*grt_XFe*grt_XCa-0.022*grt_XFe*grt_XMn-0.2125*grt_XMg*grt_XCa-0.006*grt_XMg*grt_XMn-0.0305*grt_XCa*grt_XMn

Gc=-22265*grt_XFe^2-24166*grt_XMg^2+3220*grt_XCa^2-39632*grt_XMn^2+92862*grt_XFe*grt_XMg-67328*grt_XFe*grt_XCa-38681.5*grt_XFe*grt_XMn-99262*grt_XMg*grt_XCa-40582.5*grt_XMg*grt_XMn-79669.5*grt_XCa*grt_XMn

W02a=((969.9+P*(1.3-9.1*Gb)-0.0091*Gc-4393.8*(ph_XFe-ph_XMg)+200.4*ph_XAl)/1+0.0091*(3*8.3144*lnKd+Ga)))-273.15

W02b=((-1167.3-P*(0.2+8.8*Gb)-0.0088*Gc-6878.1*(ph_XFe-ph_XMg)+2469*ph_XAl)/(1+0.0088*(3*8.3144*lnKd+Ga)))-273.15

---- Garnet-Orthopyroxene ----

Grt XFe = Fe/(Fe+Mg+Ca+Mn)
Grt XMg = Mg/(Fe+Mg+Ca+Mn)
Grt XCa = Ca/(Fe+Mg+Ca+Mn)
Grt XMn = Mn/(Fe+Mg+Ca+Mn)
Opx XAl = (Al/2)/(Al/2+Fe+Mg)
Opx XFe = Fe/(Al/2+Fe+Mg)
Opx XMg = Mg/(Al/2+Fe+Mg)
lnKd = log((Grt Fe/Grt Mg)/(Opx Fe/Opx Mg))

Mori, T., & Green, D. H. (1978). Laboratory duplication of phase equilibria observed in natural garnet lherzolites. The Journal of Geology, 86(1), 83-97.

MG78=1300/(lnKd+0.12)-273.15

Dahl, P. S. (1980). The thermal–compositional dependence of Fe2+–Mg distributions between coexisting garnet and pyroxene: applications to geothermometry. American Mineralogist, 65(9-10), 852-866.

D80=(1391+1509*(grt_XFe-grt_XMg)+2810*grt_XCa+2855*grt_XMn)/(1.987*lnKd -273.15

Raith, M., Raase, P., Ackermand, D., & Lal, R. K. (1983). Regional geothermobarometry in the granulite facies terrane of South India. Earth and Environmental Science Transactions of The Royal Society of Edinburgh, 73(4), 221-244.

R83=1684/(lnKd+0.334)-273.15

Harley, S. L. (1984). An experimental study of the partitioning of Fe and Mg between garnet and orthopyroxene. Contributions to Mineralogy and Petrology, 86(4), 359-373.

H84=(3740+1400*grt_XCa+22.86*P)/(1.987*lnKd+1.96)-273.15

Sen, S. K., & Bhattacharya, A. (1984). An orthopyroxene-garnet thermometer and its application to the Madras charnockites. Contributions to Mineralogy and Petrology, 88(1-2), 64-71.

SB84=(2713+0.022*P*1000+3300*grt_XCa+195*(grt_XFe-grt_XMg))/(-1.9872*-lnKd+0.787+1.5*grt_XCa)-273.15

Lee, H. Y., & Ganguly, J. (1984). Fe, Mg fractionation between garnet and orthopyroxene: experimental data and application. In Geological Society of America Abstract (No. 52733).

LG84=(2187+1510*(grt_XCa-grt_XMn)+8.6*P)/(lnKd+1.071)-273.15

Perchuk, L. L., Aranovich, L. Y., Podlesskii, K. K., Lavrant'eva, I., Gerasimov, V. Y., Fed'Kin, V. V., ... & Berdnikov, N. V. (1985). Precambrian granulites of the Aldan shield, eastern Siberia, USSR. Journal of metamorphic Geology, 3(3), 265-310.

P85=(4766+2533*(opx_XFe-opx_XMg)-5214*opx_XAl+5704*grt_XCa+0.023*P*1000)/(1.987*lnKd+2.65+1.86*(opx_XFe-opx_XMg)+1.242*grt_XCa)-273.15

Lee, H. Y., & Ganguly, J. (1988). Equilibrium compositions of coexisting garnet and orthopyroxene: experimental determinations in the system FeO-MgO-Al2O3-SiO2, and applications. Journal of Petrology, 29(1), 93-113.

LG88=(1981+1509.66*(grt_XCa-grt_XMn)+11.91*P)/(lnKd+0.97)-273.15

Aranovich, L. Y., & Podlesskii, K. K. (1989). Geothermobarometry of high-grade metapelites: simultaneously operating reactions. Geological Society, London, Special Publications, 43(1), 45-61.

A=-626*grt_XCa^2-6642*grt_XFe*grt_XCa-8100*grt_XMg*grt_XCa+grt_XCa*(grt_XMg-grt_XFe)*1051.5

B=1.266*grt_XCa^2+2.836*grt_XFe*grt_XCa+3*grt_XMg*grt_XCa+grt_XCa*(grt_XMg-grt_XFe)*(-0.908)

AP89=((P*1000-1)*0.02342+4766-A_AP89+(opx_XFe-opx_XMg)*2372-5204*opx_XAl)/(1.987*lnKd+2.654+B_AP89+1.69*(opx_XFe-opx_XMg))-273.15

Perchuk, L. L., & Lavrent'eva, I. V. (1990). Garnet-orthopyroxene and garnet-amphibole geothermobarometry: Experimental data and thermodynamics. International Geology Review, 32(5), 486-507.

PL90=(4066-347*(opx_XMg-opx_XFe)-17484*opx_XAl+5769*grt_XCa+23.42*P)/(1.987*lnKd+2.143+0.0929*(opx_XMg-opx_XFe)-12.8994*opx_XAl+3.846*grt_XCa)-273.15

Bhattacharya, A., Krishnakumar, K. R., Raith, M., & Sen, S. K. (1991). An improved set of a—X parameters for Fe—Mg—Ca garnets and refinements of the orthopyroxene–garnet

thermometer and the orthopyroxene—garnet—plagioclase—quartz barometer. Journal of Petrology, 32(3), 629-656.

A=-1220*grt_XFe*grt_XMg-441*grt_XCa*(grt_XMg-grt_XFe)-136*grt_XMg^2+746*grt_XFe^2

B91 =(1611+0.021*P*1000+906*grt_XCa+A+477*(2*opx_XMg-1))/(lnKd+0.796)-273.15