AL-SOLUBILITY IN ORTHOPYROXENE IN EQUILIBRIUM WITH GARNET: A REINTERPRETATION OF EXISTING EXPERIMENTAL DATA AND THE PETROGENETIC IMPLICATIONS IN GARNET PERIDOTITE XENOLITH.

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Finnerty and Boyd (1984)discovered that the application of available correction schemes for solution of other components (concerning MAS) in pyroxenes and garnet decreased both accuracy and precision of P,T estimates. The discrepancies are likely to be a result of imprecision in activity models for silicates. The proposed orthopyroxene - garnet geobarometer is recalibrated incorporating the determination of the high temperature equilibrium fractionation of elements between different sites in orthopyroxene structure,based on the statistical thermodynamic principles We took into account the experiments in MAS,CMAS,FMAS,CFMAS systems and obtained a close agreement with thermochemical properties of minerals. Only three empirical constants are used (ΔS^o and ΔH^o of the reaction $Mg_2 Si_2 O_6 + Mg Al_2 Si O_6 = Mg_3 Al_2 Si_3 O_{12}$ and V^c - Function of Mg-Tschermak component).

The results of isopleth calculations and of estimated stability fields in P,T space of some garnet peridotite xenolith in CFMAS (and partly Cr) system are shown on Fig.1,2.

The remarkable feature of the new P,T determinations is that the equilibrium field of diamond - bearing peridotite and inclusions in diamond (vertical bars on Fig.2) are drawnd along the line of conductive geotherm for surface heat flow 40 mW/m² calculated by Pollack et al (1977) (fat solid line on Fig.2).The T estimates were made with two-pyroxene (Wells,1977 and Lindsley,1983) and garnet-olivine (O'Neill,Wood,1979) geothermometers. The field of diamond-bearing peridotite covers a temperature range T>1000 C which satisfies the diamond-graphite constraint.Temperature of other garnet peridotite xenoliths (dotty area on Fig.2) are higher in relation to "cool" shield geotherm.The estimated boundary between this field and the field of P,T distributions for suits of garnet lherzolite from southeast Australia,Solomon Islands (Malaite),Canada (Ile Bizard) as well as from alkali basalts ,lamprophires and some carbonatites (dashed area on Fig.2)-- lies near the ledge on the solidus for peridotite-CO_2-H_2O after Wylli,1979 (broken fat line on Fig.2).
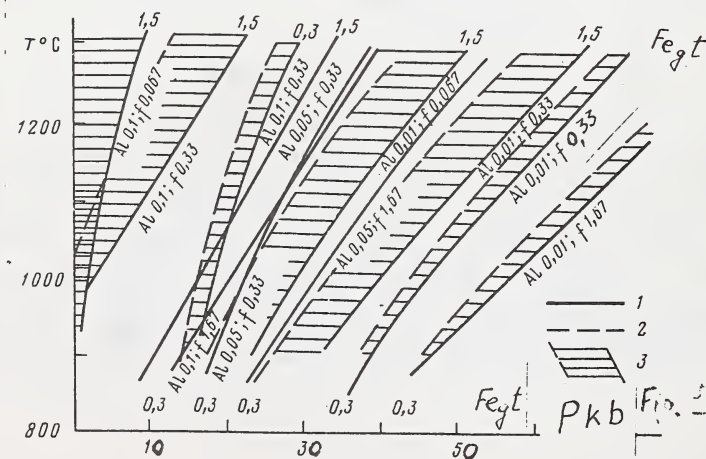
FIGURE CAPTIONS

Fig.1   Calculated data on the alumina solubility in orthopyroxene in equilibrium with garnet in the CFMAS system.

1. $Al/2 = Al(VI)$ - isopleth in orthopyroxene as well as isopleth of iron fractionation "f" between coexisting garnet and orthopyroxene:
$f = Fe_{opx}/Fe_{gt}$
,where Fe_{opx} - the iron amount in $(Fe,Mg,Al)_2(Si,Al)_2O_6$.
   Fe_{gt} - the iron amount in $Ca_{0.3}(Fe,Mg)_{2.7}Al_2Si_3O_{12}$.
   All Fe is assumed to be divalent.
   2. The garnet composition $Ca_{0.6}(Fe,Mg)_{2.4}Al_2Si_3O_{12}$ at other same compositions of opx. and gt.
   3. A Ca content shift in garnet.

Fig.2   Fields of P,T estimates for garnet lherzolite nodules.
   (diamond-graphite equilibrium - after Kennedy,1976 ;other explanations are in text).

Fig 2