The timing and mechanism of incipient charnockite formation at Kurunegala, Sri Lanka

KEVIN W. BURTON
Dept. of Earth Sciences, University of Cambridge, Downing Street, Cambridge, CB2 3EQ, U.K.

Incipient charnockite formation at Kurunegala in Sri Lanka is characterized by the growth of orthopyoxene at the expense of amphibole and biotite in an originally homogeneous gneiss. Mineral equilibria in the charnockite assemblage record pressure temperature (P-T) conditions of 738±60° C and 6.9±1.2 kbar at 17.0 + 1.2 log fO_2 and aH_2O - 0.18±0.16. Whole rock measurements indicate that charnockite formation was accompanied by a systematic depletion of K, Sm, Rb, Pb, U, Sr and Nd, with a fractionation of Rb/Sr, Sm/Nd,Th/U and K/Na ratios. Amphibolite-facies minerals record a 238U/206Pb age of 552± 7Ma. The best estimate for the time of charnockite depletion is derived from a ^{87}Rb - ^{86}Sr whole-rock age of 535±5 Ma. Constituent charnockite minerals record a ^{147}Sm -^{143}Nd age of 524±9 Ma indistinguishable from the time of whole-rock depletion, whereas ^{207}Pb-^{206}Pb and ^{87}Rb-^{86}Sr ages for the same minerals of 501±5 Ma and 486±1 Ma, respectively, indicate slow cooling in the first 50 Ma after the time of charnockite formation. Trace element data for both amphibolite and charnockite minerals show that depletion on a whole rock scale can be accounted for either by changes in mineral modes or trace element abundances, within the immediate area of dehydration. The fractionation of Sm/Nd and Rb/Sr on a whole-rock scale is controlled by the breakdown and growth of the major mineral phases, whereas U, Th and Pb are largely controlled by the behaviour of accessory phases. Modelling of dehydration-melting involving the breakdown of amphibole, biotite and alkali-feldspar to produce orthopyoxene and a silicate melt reproduces the observed elemental and isotopic fractionation, and indicates the loss of small melt fractions, on a cm scale, from the charnockite. These observations suggest that partial melting is the most plausible means of effecting both dehydration and depletion that accompanies charnockite formation.