

An experimental study of trace-element partitioning between Ti-Al-clinopyroxene and melt: Equilibrium and kinetic effects including sector zoning

GARY E. LOFGREN,^{1,*} GARY R. HUSS,^{2,†} AND G.J. WASSERBURG²

¹KT, NASA Johnson Space Center, Houston, Texas 77058, U.S.A.

²Lunatic Asylum, Division of Geological and Planetary Sciences, 170-25, Caltech, Pasadena, California 91125, U.S.A.

ABSTRACT

Equilibrium and dynamic crystallization experiments were used to determine distribution coefficients (*D*-values) for the REE and the trace elements Sc, V, Rb, Sr, Y, Zr, Nb, Ba, Hf, Th, and U between Ti-Al-clinopyroxene and melt. Equilibrium values for *D* correlate well with previous studies where values have been determined. The *D*-values were also studied as a function of cooling rate. Increased cooling rates produce higher growth rates. At growth rates that exceed the diffusion rates in the crystals, the *D*-values increase to near unity and the HREE *D*-values exceed unity only at the most rapid crystal growth rates. The increase in *D*-values is the result of the inclusion of components into the growing pyroxene from the boundary layer that develops at the crystal-melt interface because of the disparity between the growth and diffusion rates. The origin of sector zoning is best explained as an interplay of primarily crystallographic control with kinetic effects.

Keywords: Partitioning of trace elements, clinopyroxene-melt, equilibrium experiments, rare earth elements, dynamic crystallization experiments, distribution coefficients