Estimation of emplacement pressure for 2350 Ma high-Mg tholeiite dykes, Vestfold Hills, Antarctica

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Abstract: Emplacement pressures of the 2350 Ma old, high-Mg tholeiite dyke suite in the Vestfold Hills block have been previously estimated to be 7 - 8 kbar. New data suggest that previous estimates are too high. The depth of emplacement has been estimated using two different approaches: (1) Geobarometry based on aluminium exchange between clinopyroxene and plagioclase and (2) examination of high pressure liquidus mineralogy of the high-Mg tholeiites. Geobarometry applied to groundmass assemblages (clinopyroxene + plagioclase) indicates across-dyke variations. Samples from the chilled margins give higher pressure estimates (max. 7 kbar) than more slowly cooled samples from the dyke interior (1 to max. 5 kbar, corresponding to a depth of ~ 3 - 16 km). The variations of the liquidus mineralogy (opx + ol) from chilled margins and from dyke interior samples are consistent with the results derived from the Al-exchange geobarometry. It is inferred that pressure estimates from the dyke interior (1 to max. 5 kbar) represent the ambient emplacement pressures, whereas pressure estimates derived from phenocryst assemblages (ol + opx) in chilled margins may represent crystallization pressures prior to dyke emplacement. The results suggest a much shallower emplacement depth (1 - max. 5 kbar) of the 2350 Ma old tholeiites than previously thought (7 - 8 kbar).

Key-words: geobarometry, Ca-Tschermaks molecule, liquidus mineralogy, magma evolution, PT-t path.

Introduction

The depth of emplacement of the 2350 Ma old, high-Mg tholeiites was previously suggested to be ~ 28 km (7 - 8 kbar) by Kuehner (1986, 1987, 1992). This conclusion was derived from the occurrence of olivine and orthopyroxene phenocrysts and microphenocrysts in the chilled margins of these dykes and the reproduction of these phases as the liquidus assemblage in bulk compositions corresponding to the chilled margins at pressures of 7 - 8 kbar (Kuehner, 1986, 1992). At higher pressure, orthopyroxene is the sole liquidus phase and at lower pressure olivine is the liquidus phase. Use of clinopyroxene + plagioclase + quartz groundmass assemblages to estimate pressure, using the method of Ellis (1980), also yielded pressures of ~ 8 kbar (Kuehner, 1986, 1987, 1992; Kuehner & Green 1987).

The aim of this paper is to critically examine previous pressure estimates. This re-examination is based on the recognition that the chilled margins may contain phenocrysts or microphenocrysts crystallized at and transported from deeper levels, i.e. the pressure of crystallization of olivine and orthopyroxene from these compositions may be correctly estimated, but crystallization of these phases may have occurred at appreciably greater depth than the final emplacement and chilling of the dykes.

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