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Supercooled rocks: development and significance of varioles, spherulites, dendrites and spinifex in Archaean volcanic rocks, Abitibi Greenstone belt, Canada

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Abstract

Many intriguing crystallization textures of Archaean volcanic rocks are 'supercool' in the sense that they are visually striking, and because they owe their origin to substantial undercooling of the silicate liquids from which they grew. Under conditions of high undercooling kinetic effects arise such that spherulitic, acicular or platy mineral habits are stabilized. The term variole refers to globular and spherical centimetre-scale, generally leucocratic masses visible on the weathered surfaces of mafic rock. At many localities the varioles can be shown to be plagioclase spherulites that grew near the quench margins of aphyric mafic lavas. Elsewhere, the varioles are droplets of felsic magma frozen into mafic magma as a result of magma mingling. Platy olivine spinifex in komatiites arises from a coupled process of hydrothermal cooling and constrained crystallization. Shrinkage of the komatiite crust during submarine cooling causes fracturing and sea water ingress such that a self-propagating vertically directed cooling/cracking-front develops. Within the magma below this front, forsterite crystals transport heat from the melt upwards to the hydrothermally cooled crust. Because of their higher thermal conductivity and greater transparency to near infrared thermal radiation, Mg-rich olivine crystals transfer heat more efficiently than the surrounding relatively Fe-rich liquid. The olivine forms vertically oriented platy crystals that cool the liquid directly in front of their tips and are thus self-propagating. © 2002 Published by Elsevier Science B.V.

Keywords: Archaean; Komatiites; Varioles; Spherulites; Spinifex; Olivine

1. Introduction

Meta-volcanic rocks within Archaean terrains commonly have conspicuous primary textures. Many of these are formed in response to the cooling environment. As such, they can be useful

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