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Geochemical evidence in clinopyroxenes from gabbroic sequence for two distinct magmatisms in the Oman ophiolite

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Abstract

In the Oman ophiolite, one of the best preserved and most studied ophiolites in the world, two distinct petrogenetic suites of gabbroic rocks from the layered gabbro sequence of the Wadi Haymiliyah section is established using trace element chemistry of Ca-rich clinopyroxenes. The earlier GB1 suite is characterized by plagioclase with lower An (Ca/(Ca+Na)) content and clinopyroxene with low large-ion lithophile elements (LILE) concentrations. The later DWGB2 suite contains plagioclase with rather high An content and clinopyroxene with high LILE. This difference in clinopyroxene chemistry can be extended to the extrusive rocks in this section: lower, (earlier) HV1 suite with low LILE clinopyroxene and upper (later) HV2 suite with high LILE clinopyroxene. Difference in LILE concentration of clinopyroxenes is essentially due to geochemical difference in parental magmas. The GB1/HV1 suites formed at fast-spreading MOR setting and DWGB2/HV2 suites at SSZ setting, supporting a model of transition from mid-oceanic ridge to supra-subduction zone settings of the Oman ophiolite. Our results indicate that geochemical signature of clinopyroxene is a very strong tool for identification of tectonic setting of ophiolites.

Keywords: Oman ophiolite; Clinopyroxene; Trace elements; Mid-ocean ridges; Gabbros

1. Introduction

Ophiolites have been recognized as fragments of oceanic lithosphere and have played a significant role for understanding of geological processes occurring beneath mid-oceanic ridges (e.g. [1,2]). However, coexistence of mid-ocean ridge basalt (MORB)-type extrusives and extrusive rocks with so-called “arc signature” in many ophiolite complexes suggests a possibility that the entire ophiolitic complex or all constituents of a single ophiolite complex were not formed at mid-ocean ridges [3–6]. While such arc-like extrusive rocks are characterized by enrichment in large-ion lithophile elements (LILE), concentrations in high-field strength elements (HFSE) and rare earth elements (REE), and Nd isotopic compositions are, in many cases, almost similar to those reported from MORB [6–8]. Unfortunately, the extrusive rocks in ophiolite complexes were strongly altered by post-magmatic hydrothermal processes and intact compositions of lavas and dikes are rarely preserved. In particular, LILEs are known as highly mobile elements during alteration (e.g. [9]). Due to such ambiguities, several different tectonic settings, such as mid-oceanic

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ridge (MOR), supra-subduction zone (SSZ) and a combination of the two end members have been proposed for even well preserved single ophiolites [3,10–12], and therefore, clear geochemical evidence representing their tectonic setting still remains as a pending problem. In this paper, we distinguish two suites of gabbroic rocks based on petrography and trace element geochemistry of unaltered Ca-rich clinopyroxenes from layered gabbro sequence of the Oman ophiolite. Clinopyroxene geochemistry also makes a successful correlation between gabbroic rocks and extrusive rocks. We discuss the origin of those two distinct magmatisms and provide petrologic and geochemical constraints on the tectonic setting of the Oman ophiolite.

2. Background

2.1. Geological background of extrusive sequence of the Oman ophiolite

Based on geological, petrological and geochemical data, extrusive rocks of the Oman ophiolite were

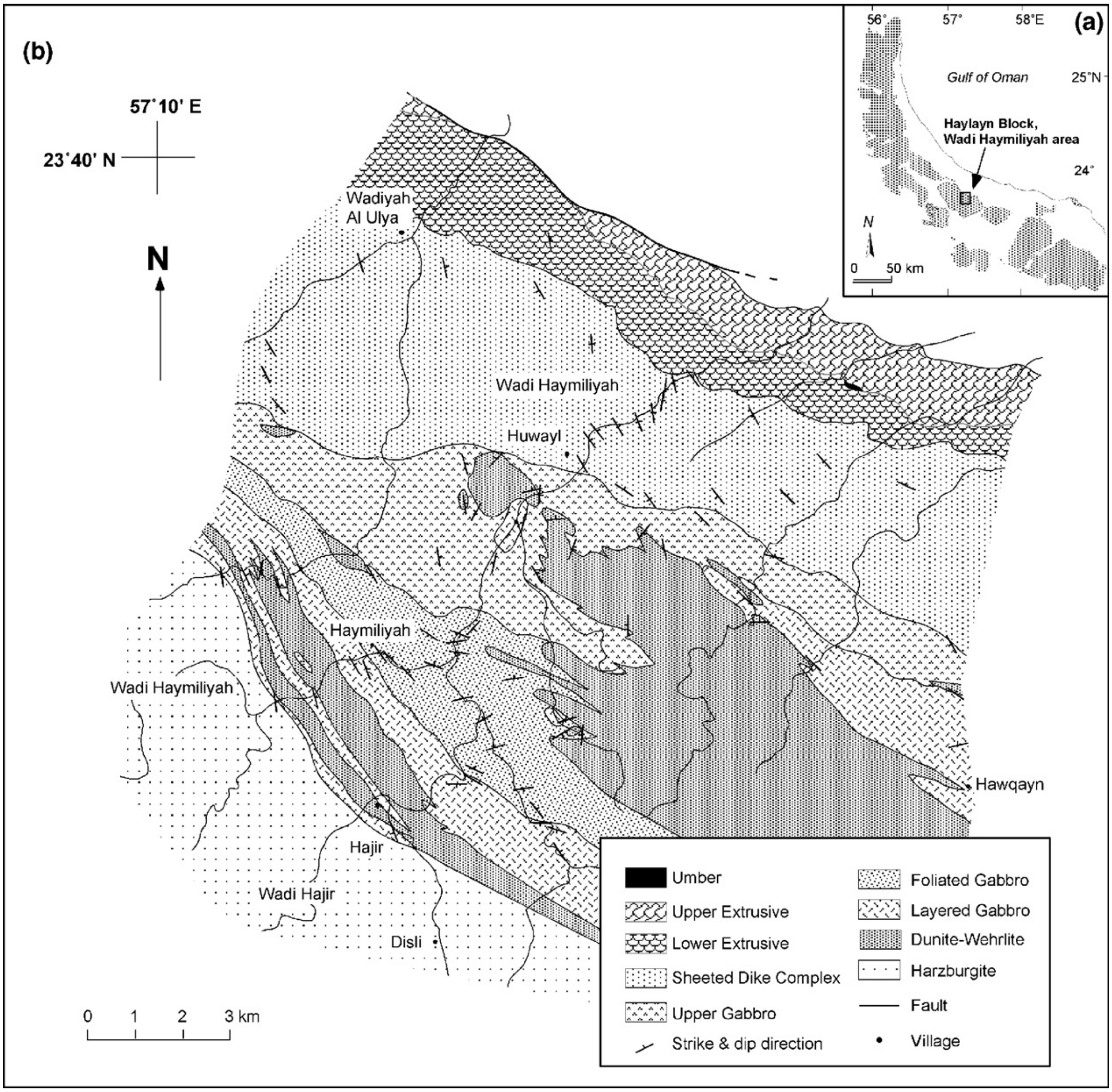

Fig. 1. Location and geologic map of the Wadi Haymiliyah area. (a) Location map of the Haylyn block, (b) geologic map of the Wadi Haymiliyah area.