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Geochemical characteristics of mafic lavas from the Neotethyan ophiolites in western Turkey: implications for heterogeneous source contribution during variable stages of ocean crust generation

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Abstract – The Late Triassic to Late Cretaceous age mafic lavas from the Neotethyan suture zone ophiolites in western Turkey exhibit a wide diversity of geochemical signatures, indicating derivation from extremely heterogeneous mantle sources. The rocks as a whole can be divided into three broad subdivisions based on their bulk-rock geochemical characteristics: (1) mid-ocean ridge basalts (MORB) that range in composition from light rare earth element (LREE)-depleted varieties (N-MORB; $(La/Sm)_N < 1$) through transitional MORB to LREE enriched types (E-MORB; $(La/Sm)_N > 1$); (2) the ocean island basalt (OIB)-type alkaline volcanic rocks with significant enrichment in LILE, HFSE and L-MREE, and a slight depletion in HREE, relative to normal mid-ocean ridge basalts (N-MORB); and (3) the supra-subduction zone (SSZ)-type tholeiites originated from arc mantle sources that are characterized by selective enrichments in fluid-soluble large ion lithophile elements (LILE) and LREE relative to the high field strength elements (HFSE). The formation of MORB tholeiites with variable enrichments and depletions in incompatible trace elements is probably related to the processes of crust generation along an oceanic spreading system, and the observed MORB–OIB associations can be modelled by heterogeneous source contribution and mixing of melts from chemically discrete sources from sub-lithospheric reservoirs. Evaluation of trace element systematics shows that the inferred heterogeneities within the mantle source regions are likely to have originated from continuous processes of formation and destruction of enriched mantle domains by long-term plate recycling, convective mixing and melt extraction. The origin of SSZ-type tholeiites with back-arc basin affinities, on the other hand, can be attributed to the later intra-oceanic subduction and plate convergence which led to the generation of supra-subduction-type oceanic crust as a consequence of imparting a certain extent of subduction component into the mantle melting region. Mixing of melts from a multiply depleted mantle source, which subsequently received variable re-enrichment with a subduction component, is suggested to explain the generation of supra-subduction-type oceanic crust. The geodynamic setting in which much of the SSZ-type ophiolitic extrusive rocks from western Turkey were generated can be described as an arc-basin system that is characterized by an oceanic lithosphere generation most probably associated with melting of mantle material along a supra-subduction-type spreading centre.

Keywords: MORB heterogeneity, mid-plate basalts, back-arc basin basalts, Neotethyan ophiolites, western Turkey, mantle heterogeneity.

1. Introduction

Magmatic products from the crustal parts of ophiolite complexes can provide important information on the processes of melt generation during variable stages of lithosphere production, contribute to our understanding of the original tectonic setting for the formation of oceanic lithosphere, and help in understanding the processes of crustal accretion in variable tectonic systems. Geochemical studies of basaltic products from obducted slabs of old oceanic lithospheres are especially important in identifying the structure and magmatic evolution of oceanic crust formed in ancient spreading centres and in interpreting the geological history of regions which comprise various tectonic units of accreted terranes (e.g. accreted units of arc-basin systems: Shervais, 2001; Pearce, 2003).

The geological characteristics of many of the ophiolite fragments across Turkey reflect the evolution of the Late Triassic to Late Cretaceous terranes of the eastern Mediterranean and have long been central to our understanding of the Neotethyan evolution in this region, as well as the Late Cretaceous tectonics of Anatolia (e.g. Şengör & Yılmaz, 1981; Dilek *et al.* 1999; Robertson, 2002). It is commonly accepted that the northern part of the present Anatolian plate (Şengör & Yılmaz, 1981) comprises a number of terranes (Göncüoğlu, Dirik & Kozlu, 1997) or continental

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