Ore Geology Reviews 67 (2015) 279–296

Contents lists available at ScienceDirect

Ore Geology Reviews

journal homepage: www.elsevier.com/locate/oregeorev

Heterogeneously depleted Precambrian lithosphere deduced from mantle peridotites and associated chromitite deposits of Al'Ays ophiolite, Northwestern Arabian Shield, Saudi Arabia

Ahmed Hassan Ahmed [a,b,*], Abdelmonem Habtoor [a]

[a] Faculty of Earth Sciences, King Abdulaziz University, Jeddah, Saudi Arabia
[b] Geology Department, Faculty of Science, Helwan University, Cairo, Egypt

ARTICLE INFO

Article history:
Received 13 September 2014
Received in revised form 13 December 2014
Accepted 22 December 2014
Available online 24 December 2014

Keywords:
Mantle heterogeneity
Recycling
Chromitite
Highly depleted peridotites
Al'Ays ophiolite
Saudi Arabia

ABSTRACT

The mantle section of Al'Ays ophiolite consists of heterogeneously depleted harzburgites, dunites and large-sized chromitite pods. Two chromitite-bearing sites (Site1 and Site2), about 10 km apart horizontally from one another, were examined for their upper mantle rocks. Cr-spinels from the two sites have different chemistry; Cr-rich in Site1 and Al-rich in Site2. The average Cr-ratio = (Cr/(Cr + Al) atomic ratio) of Cr-spinels in harzburgites, dunites and chromitites is remarkably high 0.78, 0.77 and 0.87, respectively, in Site1, compared with those of Site2 which have intermediate ratio averages 0.5, 0.56 and 0.6, respectively. The platinum-group elements (PGE) in chromitites also show contrasting patterns from Site1 to Site2; having elevated IPGE (Os, Ir, Ru) and strongly depleted in PPGE (Rh, Pt, Pd) with steep negative slopes in the former, and gentle negative slopes in the latter. The oxygen fugacity ($\Delta\log fO_2$) values deduced from harzburgites and dunites of Site1 show a wide variation under reducing conditions, mostly below the FMQ buffer. The Site2 harzburgites and dunites, on the other hand are mostly above the FMQ buffer. Two magmatic stages are suggested for the lithospheric evolution of Al'Ays ophiolite in response to a switch of tectonic setting. The first stage produced a peridotites–chromitites suite with Al-rich Cr-spinels, possibly beneath a mid-ocean ridge setting, or most likely in back-arc rift of a supra-subduction zone setting. The second stage involved higher degrees of partial melting, produced a peridotites–chromitites suite with Cr-rich Cr-spinels, possibly in a fore-arc setting. The coexistence of compositionally different mantle suites with different melting histories in a restricted area of an ophiolite complex may be attributable to a mechanically juxtaposed by mantle convection during recycling. The mantle harzburgites and dunites are apt to be compositionally modified during recycling process; being highly depleted (Site1 case) than their original composition (Site2 case).

© 2014 Elsevier B.V. All rights reserved.

1. Introduction

The Earth's mantle is compositionally heterogeneous both on a large scale, from the size of ocean basin, to a minor scale, down to kilometer or even a meter scale (e.g., Hart et al., 1992; Liu et al., 2008). The mantle heterogeneity may result from various processes such as: (1) melt depletion, (2) refertilization (metasomatism), (3) melt-rock reaction, and (4) mantle recycling (e.g., Dick et al., 1984; Sharma and Wasserburg, 1996; Liu et al., 2009). Recycling process, in particular, of the relatively rigid mantle lithosphere is the main cause of the Earth mantle heterogeneity, where a crustal material comes back to mantle at subduction zones (e.g., Liu et al., 2008; Foley, 2011). It can modify the composition of the mantle, and it provides important information to understand the convection processes within the Earth (e.g., Foley, 2011). Both fertile and refractory mantle can be juxtaposed within the mantle lithosphere. Ophiolites are good windows of the mantle lithosphere exposed on the Earth's surface from which mantle heterogeneity can be examined.

Ophiolites are the oldest known oceanic fragments of the Arabian shield and adjoining regions, where they are used to identify sutures between converging blocks of lithosphere. The Arabian shield ophiolites are abundant as varyingly dismembered mafic–ultramafic assemblages and have suffered multiple phases of alteration, deformation and greenschist facies metamorphism (e.g., Al-Shanti and Gass, 1983; Nassif et al., 1984; Ahmed and Harriri, 2008). In some places, including the present locality, less-altered well-preserved primary features of some ophiolite complexes were described that help in the recognition and characterization of ophiolitic rocks. Arabian Shield ophiolites display a variety of tectonic environments, from low degrees of partial melting at mid-ocean ridge (MORB) settings to higher degrees in arc-related environments (e.g., Dilek and Ahmed, 2003; Stern et al., 2004; Ahmed et al., 2012). Mantle melts and residues formed in each setting have

* Corresponding author at: Faculty of Earth Sciences, P.O. Box 80206, P. code 21589 Jeddah, Saudi Arabia.
E-mail addresses: ahmh2jp@yahoo.com, ahmohammed@kau.edu.sa (A.H. Ahmed).

http://dx.doi.org/10.1016/j.oregeorev.2014.12.018
0169-1368/© 2014 Elsevier B.V. All rights reserved.

characteristic genetic geochemical fingerprints. Petrological studies on Arabian Shield ophiolites are less known to the world (Bakor et al., 1976; Pallister et al., 1988; Al-Shanti and El-Mahdy, 1988; Dilek and Ahmed, 2003; Johnson et al., 2003; Stern et al., 2004), and deserve to be brought into the international academic community to better understand the deep-seated mantle processes involved in the evolution of the Precambrian oceanic lithosphere. Detailed studies on the petrology and mineralization of the mantle section of the Arabian Shield ophiolites are very limited (Prichard et al., 2008; Ahmed et al., 2012).

The present study aims to discuss the tectonic setting and genesis of podiform chromitites hosted by contrasting heterogeneously depleted peridotites in Al'Ays ophiolite complex, northwestern Saudi Arabia.

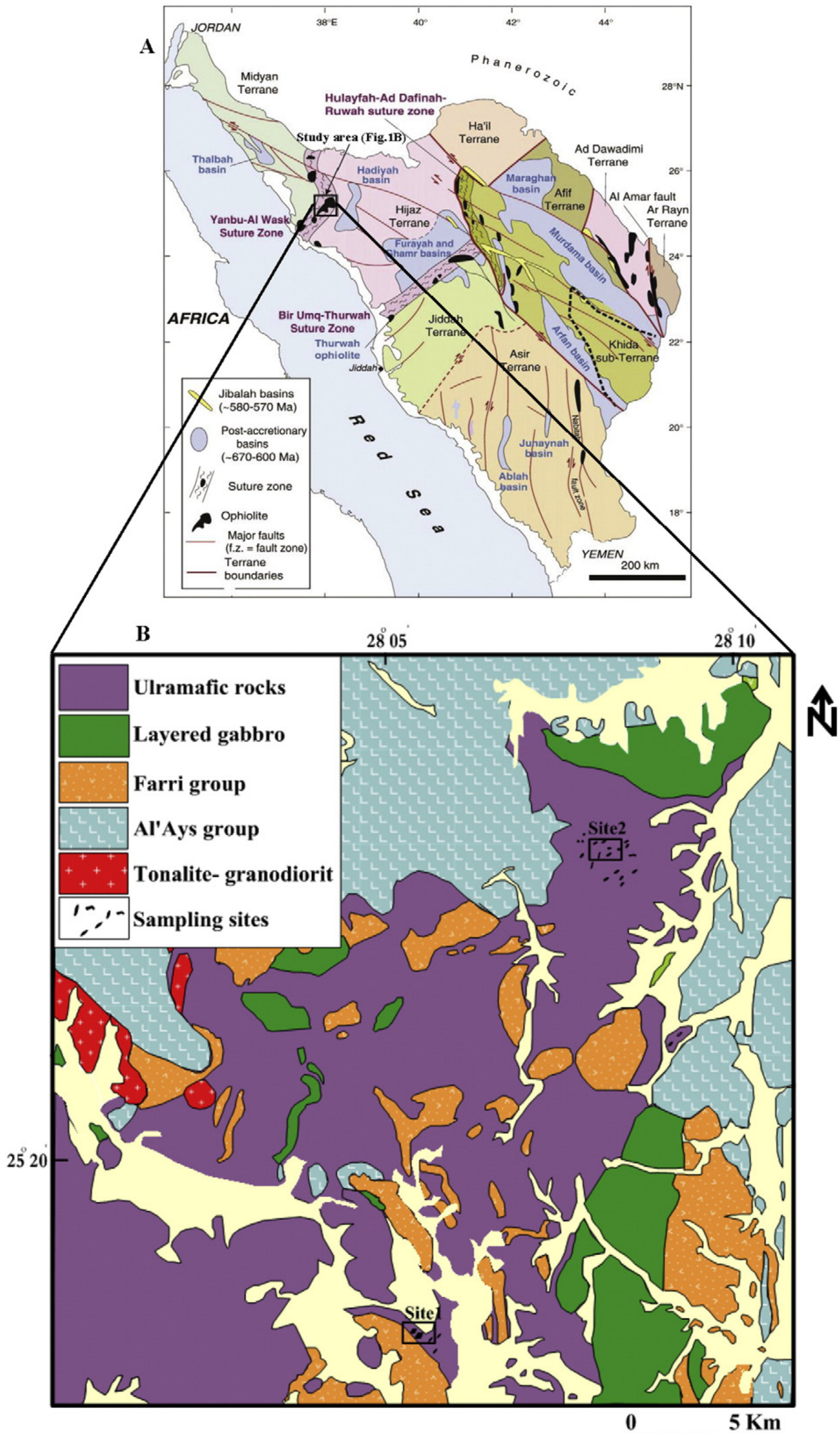

Fig. 1. (A) Tectonic map of the Arabian Shield showing the ophiolite belts in western Saudi Arabia (from Nehlig et al., 2002). The study area of Al'Ays ophiolite is defined by rectangle. (B) Simplified geological map of Al'Ays ophiolite (modified from Collenette and Grainger, 1994). The studied Site1 and Site2 are shown as small rectangles.

Download English Version:

https://daneshyari.com/en/article/6435894

Download Persian Version:

https://daneshyari.com/article/6435894

Daneshyari.com