Journal of African Earth Sciences 78 (2013) 1–15

Contents lists available at SciVerse ScienceDirect

Journal of African Earth Sciences

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

Mineralogy, geochemistry and geotectonic significance of mantle peridotites with high-Cr chromitites in the Neyriz ophiolite from the outer Zagros ophiolite belts, Iran

Mohammad Ali Rajabzadeh [a,*], Teimoor Nazari Dehkordi [a], Şemsettin Caran [b]

[a] Department of Earth Sciences, Faculty of Sciences, Shiraz University, Shiraz 71467-13565, Iran
[b] Department of Geology, Suleyman Demirel University, Isparta, Turkey

ARTICLE INFO

Article history:
Received 28 April 2012
Received in revised form 27 September 2012
Accepted 28 September 2012
Available online 13 October 2012

Keywords:
Mineralogy
Geochemistry
Chromitite
Peridotite
Neyriz ophiolite
Zagros

ABSTRACT

The Neyriz ophiolite containing chromitite pods from the outer Zagros ophiolite belt was studied in the Abadeh Tashk area. It appears as four detached massifs in an area with 125 km^2 in south of Iran and is comprised predominantly of peridotites. Harzburgites and dunites are the most ultramafics in the massifs with rare mafic and gabbroic rocks. Mineralogical composition of chromian spinel in chromitite and host peridotite of the Neyriz ophiolite in comparison with those of the Nain ophiolite, to tracing their geographical variations between outer and inner sectors of the Zagros ophiolite belt, shows that there are remarkable and striking compositional variations between these two ophiolites. Chromian spinels of the Neyriz mantle peridotite and chromitite pods are characterized by higher contents of Cr# (56–79; average, 71) in harzburgites and dunites, and higher Cr# (73–82), Mg# (62–71) and lower Al (9.1–13.9 wt% Al_2O_3) and Ti (up to 0.08 wt% TiO_2) in chromitite pods with respect to available data on samples from the Nain ophiolite (Cr# 40–61 of spinels in mantle harzburgites; Cr#: 59–73, Mg#: 60–70, Al_2O_3: 13.6–22.37 wt%, TiO_2: 0.13–0.40 wt% of spinels in chromitites). Based on geochemical affinities, we contend that the Neyriz mantle peridotites were largely affected by percolating hydrous boninitic melts, to produce high-Cr chromitites, whereas chromitites of the Nain mantle peridotites carry geochemical imprints of boninitic melts with MORB-like affinity, suggesting their distinct geotectonic setting. The presence of the high concentrations of wolfram (W: 275–1276 ppm) in the Neyriz mantle peridotites in comparison with those of the Nain mantle peridotites (W < 3 ppm), which is the one of the most striking geochemical features of these rocks, provides an additional evidence for the significant role of recycling of continental material such as subducted pelagic sediments into the sources of subduction zone magmas. Combining with the lithological variations of the Central Iran ophiolites from NE (harzburgite dominate Nain ophiolite with limited and small-size chromitite pods) to SW (harzburgite–dunite dominate Neyriz ophiolite with large potential of high-Cr chromitites), discernible geochemical tendencies of chromitites reveal that the Neyriz chromitites from the Zagros southern sectors (outer Zagros) are considered to be the product of typical of fore-arc-related boninitic melts, whereas the Nain chromitites of the inner Zagros ophiolite belt are associated with the back-arc basin-related boninitic parentage with affinities to MORB-like melts.

© 2012 Elsevier Ltd. All rights reserved.

1. Introduction

Podiform chromitites in ophiolites are mainly located within the transitional zone, occasionally above the Moho or to the depth exceeding 1 km below it (Ahmed and Arai, 2002; Auge, 1987; Gervilla et al., 2005; Melcher et al., 1997; Nicolas, 1989; Proenza et al., 2004; Zhou et al., 1998). It is generally accepted that the chromitites crystallized from mafic melts in the upper mantle, but mechanisms that concentrate large amounts of chromite deposits are still a matter of debate. According to many authors, progressive differentiation of oxide-rich melt from parental mafic magma results in concentration of Cr in which chromitites crystallize. In this scheme, chromitites form from an immiscible Cr-rich heavy liquid phase in a closed magmatic system (Mcdonald, 1967; Peter and Kramers, 1974). Meanwhile many others have emphasized the role of melt-mantle interaction in the formation of chromite deposits (Caran et al., 2010; Lago et al., 1982; Parkinson and Pearce, 1998; Uysal et al., 2009; Varfalvy et al., 1996; Zhou et al., 1994, 1996). Lithological, mineralogical and

* Corresponding author. Tel./fax: +98 7112284572.
E-mail addresses: rajabzad@susc.ac.ir (M.A. Rajabzadeh), teimoornazari@yahoo.com (T. Nazari Dehkordi), sems@mmf.sdu.edu.tr (Ş. Caran).

1464-343X/$ - see front matter © 2012 Elsevier Ltd. All rights reserved.
http://dx.doi.org/10.1016/j.jafrearsci.2012.09.013

geochemical characteristics of mantle sections in ophiolites are important to understand the magmatic processes occurring at upper mantle, magmatic evolution throughout time and recognition the tectonic environments (e.g. supra-subduction or mid-ocean-ridge setting), in which the ophiolitic complexes were formed.

In the case of the Central Iran, harzburgites are the dominate mantle rocks in both inner and outer Zagros ophiolite belt. Lherzolite and gabbro are subordinate but common in both ophiolites, and dunite exposures are abundant in the outer Zagros belt. Crustal sequences of these ophiolites are dominated by pillow lavas. More-evolved felsic rocks (e.g. plagiogranites) and sheeted dyke complexes are also found in both ophiolites. Despite some similarities, there are some significant differences between these two groups of Zagros ophiolites are as follow:

(a) Chromitite bodies are limited and small in size in the inner Zagros ophiolites (e.g. Nain and Dehshir ophiolites) whereas large chromite pods and residual to cumulate dunitic lenses are restricted to the outer Zagros ophiolites (e.g. Agard et al., 2011; Ghazi et al., 2010, 2011; Rajabzadeh, 1998; Shafaii Moghadam and Stern, 2011a,b).
(b) Gabbroic impregnations and isotropic gabbros are common in the inner Zagros ophiolites whereas these rocks are rare in the outer Zagros ophiolites.

The focus of this paper is to describe the geology, petrography, mineralogy and geochemistry of the mantle section based on the representative sample set of rocks from the Abadeh Tashk area, as part of the Neyriz ophiolite, in south of Iran in order to develop a genetic model for the chromite enrichment in the mineralized rocks. The chromitites and mantle rocks data of the Nain ophiolites were compared with the Neyriz ophiolite in order to provide constraints on the tectonic setting for the inner and outer Zagros ophiolite belts.

2. Geological setting

The Neyriz ophiolite in Abadeh Tashk area (Fig. 1) is located in western border of Zagros Suture Zone in a distance of about 180 km from Shiraz city in Fars province, and south of Iran in which several chromite deposits are actively exploited. The ophiolite thrusted over limestone of Bangestan Formation in Early Cretaceous along its western contact and is conformably covered by shallow-water marly limestone of Late Cretaceous along its northeastern border indicating that the emplacement of ophiolite on the Iranian microcontinent which took place in the Maastrichtian (Alavi, 1980; Babaie et al., 2006; Rajabzadeh, 1998; Stoneley, 1981). The ophiolite in study area is exposed in an area with 12.5 km long and 10 km wide between the Bakhtegan depression lake to the southwest and the high mountains of the Zagros thrust zone to the northeast. The ophiolitic complex is mainly composed of ultramafic tectonites. The mantle section is composed of a nearly homogenous harzburgite with more than 2 km thickness that constitutes 80% of the ophiolitic sequence. Harzburgite is highly depleted and interlayered with numerous dunite dykes upward into the mantle-crust transition zone similar to those of other ophiolites. Dunite dykes within the clinopyroxene-bearing harzburgite generally range from 20 to 100 cm wide that grade into the host peridotite over a few centimeters to a few tens of centimeters (Fig. 2a). Minor lherzolite outcrops appear mainly as separated patches within the lower parts of the homogenous harzburgite without any distinct relation with host rock. The mantle peridotites records two successive episodes of plastic deformations, the first one is related to the igneous accretion of the lithosphere and the second one was developed during the first stage of the emplacement of the peridotites. These two events have been distinguished on the basis of microstructural criteria (Nadimi, 2003).

The crustal section comprises a thick massive serpentinized dunite occurs immediately on the mantle-crust transition zone (including depleted harzburgite and subordinate dunite) and grades progressively into wehrlite. Gabbros are virtually absent from the ophiolite blocks in the study area. The peridotites are locally cut by diabasic (up to 10 m thick) and orthopyroxenitic (up to 3 m thick) dykes concordant with the foliation of the host ultramafic tectonite. Mantle foliation strikes N20–35°W, 35–45°NE to the southwest. The rock foliation is clearly observed in the basal part of the harzburgite but discontinuously disappears upwards. Chromite deposits and their dunitic halos with increasing distance from ore-peridotite contact are surrounded predominantly by (residual) dunite and harzburgite respectively. This is a general feature of podiform chromite deposits (Duke, 1988; Zhou et al., 2001). Most podiform deposits are suboriented to the foliation of the host rock. They are essentially concordant to subconcordant regard to their attitude in the surrounding rock. This may indicates that the ore bodies were emplaced early during the solid-state flow (Paktunc, 1990). The chromitite layers were stretched and ruptured by deformation and are formed as lenses and boudins. The boundaries of the chromitite pods (generally massive, nodular, banded, leopard) with enclosing dunite are generally sharp, but diffuse in some deposits along a zone of disseminated ore, meanwhile dunite dyke margins are gradational with the host residual dunite and harzburgite. When chromitites of different textures are present, usually massive ones are in the centers of the bodies whereas the other is more common towards the rims. In the study area, there are nine relatively small deposits of high-Cr chromitite ores. The largest one, Cheshmeh Bid, has a tabular shape with 0.5–8 m in thickness, 35–50 m in wide, and up to 450 m in length (including 120,000 tons of ore). Ultramafic cumulates of the mantle-crust transitional zone occur as dismembered fragments at the top of ophiolite pile that consists of dunite, orthopyroxenite, wehrlite and minor uneconomic disseminated chromitite (Fig. 2b). The major structures in the study area are parallel to Zagros Suture Zone and trending NW–SE (Rajabzadeh, 1998). To the west and southwestern part the ophiolite, the faults overlapped the ophiolite over a widely extended colored mélange that includes pillow lava, radiolarian chert with accessory manganese deposits, globotruncana limestone (Turonian-Maastrichtien) and exotic blocs. Basalts were altered in zeolite facies conditions. The colored mélange is covered by younger sedimentary formations of Tertiary and Quaternary ages (Fig. 1).

3. Analytical methods

One hundred-twenty representative samples were systematically selected throughout the ophiolitic rocks on the bases of vertical section toward ore-peridotite contacts. The polished thick and thin sections of the rocks were carefully studied using conventional reflected and refracted light microscopy. Despite the inevitable difficulties caused by strong serpentinization, 25 samples for major elements and some of trace elements were analyzed using Inductively Coupled Plasma-Mass Spectrometer (ICP-MS) at ACME Analytical Laboratories Ltd., Canada, following fusion with lithium metaborate/tetraborate and digestion by nitric acid. Detection limits of ICP-MS lie typically between 0.04% and 0.01% for the major elements analyzed. Owing to the low concentration of many of the elements of interest, special care is required to minimize sample contamination. Sample preparation was undertaken in clean-air laminar-flow hoods. Briefly the procedure is as follows. Into a Teflon vial, 4 ml HF and 1 ml HNO_3 (SPA, ROMIL Cambridge) are added to 100 mg of powdered sample, the vial is sealed and left

Download English Version:

https://daneshyari.com/en/article/4728997

Download Persian Version:

https://daneshyari.com/article/4728997

Daneshyari.com