Petrography and mineralogy of ultramafic rocks in Nain Ophiolite (Central Iran)

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Abstract
This area has been divided into three geological units: An ophiolitic mélangé zone consisting a mixture of ophiolite, limestone and radiolarites trending North- North west through the middle of the area; A Tertiary volcanic zone in the west; A Tertiary sedimentary zone in the east (Davoudzadeh, 1976; Alaie Mahabadi & Foudazi, 2005). The ophiolitic mélangé zone consist of ultramafic rocks, isotropic gabbrros, diabasic dikes, sheeted dikes, pegmatoid gabbroic dikes, pillow lavas and sheet flows, radiolarian cherts and pelagic limestone which have Upper Cretaceous microfunas, and metamorphic rocks are amphibolites and glaucophan schists (Alaie Mahabadi & Foudazi; 2006, 2009). The ultramafic rocks consist of peridotite predominantly tectonised harzburgite that locally grade into lherzolite, harzburgitic dikes bearig plagioclase, serpentinite, wherlitic dikes, dikes of dunite and pyroxenite.

In petrographic study most of the harzburgite have granular, xenomorphic granular, schistose, and mylonitic texture. In the eastern part of the ophiolitic melange zone one to several kilometer harzburgite bodies with very low lenses of dunite are situated along the major North-North west trending faults. In these rocks olivine are partly serpenitised (chrysotile and lizardite) and clinopyroxene have been very low altered to tremolite-actinolite, chlorite and talc. Harzburgites consist of olivine (Fo93.76Fa6.23), orthopyroxene (En89.9Fs8.4Wo1.56), exsolution lamellae of clinopyroxene (E2.10F3.9, W0.15) and subhedral to euhedral chrom spinels. Lherzolites have porphyroblastic texture; they consist of olivine, orthopyroxene, clinopyroxene, and Cr-spinel.

Harzburgitic dikes bearing plagioclase have been cut serpentinised peridotites and isotropic gabbrros. These rocks have cumulate texture, and consist of olivine (Fo94Fa6), orthopyroxene (E2.10F3.9, W0.15) in rim to (En89.31Fs7.81W0.28) in center and very low plagioclase (anortite). Serpentinites formed by serpenitisation of various kinds of peridotite (spatially harzburgites) and essentially occur as a main of the mélangé in this area. These rocks have mesh texture is well developed by alteration of olivine (Forsterite). In serpentinites occurrence of bastite derived from total alteration of orthopyroxene is distiguished.

Dunite can be found as thin dikes or in lenticular form in harzburgite, and consist mostly of olivine (Fo92.13Fa7.87).

Wherlite and pyroxenite (webstrite-olivine webstrite) occur as small dikes in this ophiolitic melange zone and have been cut isotropic gabbrros and sheeted dikes. Pyroxenite have granular texture, and consist of orthopyroxene, clinopyroxene and very low serpenitised olivine in olivine websterits. Pyroxenites have been cut isotropic gabbrros consist mostly of clinopyroxene (E32.3F9.9, W0.41,1) and orthopyroxene (E89.6Fs7.4Wo2.41), and pyroxenite have been cut sheeted dikes consist of clinopyroxene (E32.3F9.9, W0.41,1) and orthopyroxene (E89.6Fs7.4Wo2.41).
Introduction

Iran enjoys a unique stance in terms of ecological and geological issues. Remains of the oceanic crusts (Ophiolites), Thethys and Neothethys found in different parts of the country including North of Nain (Central Iran), Eastern Iran (Birjand, Nehbandan, Zahedan), Northeastern Iran (Torbat Heidari, Fariman, Sabzevar), Western Iran (Khoy), Southern Iran (Esfandagheh, Minab), and Northeastern Iran (Mashad)(Fig.1)

Geological map of ultramafic and maficrocks in Iran (Pessagno, E.A; Ghazi, A.M; Kariminia, M; Duncan, R.A; and Hassanipak, A.A;( 2005)(Fig.1)
Satelite map of Nain Ophiolite and ophiolitic melang ; Tertiary volcanic zone in the west; A tertiary sedimentary zone in the east(Fig.2)

Geology

The Nain ophiolite comprise of mantle and crustal sequences. The mantle sequence consist of lherzolite, harzburgite which mark mantle deformation, cut across by plagioclase-bearing harzburgite, wherlite and pyroxenite dikes and dunitic pods. The isolated diabasic dike cut all of the mantle sequence. The plutonic part of crustal sequence contain isotropic gabbro, diabase sheeted dike complex and pegmatite gabbro. The extrusive sequence comprise of pillow lavas and sheet flows, radiolarite, chert and pelagic limestone which have Upper Cretaceous microfunas.

Fig.1) Serpentinization in peridotites
Fig.2) Mantle deformation in harzburgites
Petrography and mineralogy of ultramafic rocks
In Nain Ophiolite serpentinite rocks has mesh texture (Fig 5a), and serpentinisation has been taken place in two phases in harzburgite tectonised rocks. In the first phase, serpentinisation has been occurred in a static condition and no mechanical transformation has taken place in these rocks. In the second stage, serpentinisation has been occurred with dynamic phase resulting from pressure of faults which has formed cracks and crevice and the non-economic mineral of asbest is replaced in little amount inside veins and veinlets. Mineral such as magnesite, chromite, amphibole and talc are in relation with these rocks. These minerals have been formed in different temperatures and pressures.

Base of the microscopic studies, most of harzburgite have granoblastic and porphyroclastic textures which confirm their mantle deformation (Fig 5c). Olivine is partly serpentinized, chrysotile and lizardite and clinopyroxene is fresh but locally altered to tremolite-actinolite, chlorite and talc.
In harzburgite the microprobe analysis of minerals indicate that the olivines mostly have forsterite composition \( \text{Fo}_{93.76} \text{Fa}_{6.23} \). The orthopyroxene have enstatite composition \( \text{En}_{89.9} \text{Fs}_{8.4} \text{Wo}_{1.56} \), bear exsolution lamellas of clinopyroxene with diopside composition \( \text{En}_{48.3} \text{Fs}_{3.7} \text{Wo}_{47.9} \) (Fig 5d). The Cr-spinel formed as subhedral to euhedral.

The plagioclase-bearing harzburgitic dikes have cumulate texture, and consist of olivine with forsterite composition \( \text{Fo}_{94} \text{Fa}_{6} \), orthopyroxene with enstatite composition \( \text{En}_{86.43} \text{Fs}_{10.5} \text{Wo}_{3.0.6} \). The plagioclase have anortite composition \( \text{AN}=90 \). Dunite have granular to granoblastic texture and mostly composed of olivine with forsterite composition \( \text{Fo}_{92.15} \text{Fa}_{7.33} \).

Pyroxenites have granular texture, and consist of orthopyroxene, clinopyroxene and very low serpentinitized olivine. The clinopyroxene have diopside composition from \( \text{En}_{86.06} \text{Fs}_{13.61} \text{Wo}_{2.3} \) to \( \text{En}_{82.7} \text{Fs}_{8.2} \text{Wo}_{4.1} \) and orthopyroxene have enstatite composition from \( \text{En}_{88.3} \text{Fs}_{10.3} \text{Wo}_{2.5} \) to \( \text{En}_{88.0} \text{Fs}_{3.7} \text{Wo}_{2.9} \).
Conclusion

Olivine with high grade mantle deformation (Fo%90-93), Orthopyroxene (En%89) bearing exsolution lamellas of clinopyroxene with diopside composition (En48%), subhedral and unhedral Cr-spinel, very low elements in microprobe study specially Nicle Oxide from Olivine in harzburgites and dunite (NiO=0.04wt%), Aluminium Oxide (Al2O3=2.8-3.4wt%), Titanium Oxide (TiO2=0.015-0.04wt%), (Na2O=0.16-0.4wt%) and (K2O=0.045wt%) show that mantle sequence of Nain Ophiolite is dominated by residual lherzolite.

The chondrite-normalized spider diagram of harzburgite show a depleted source for Nain peridotite but the cross cutting peridotite with cumulative character are moderately enriched.

References

Alai Mahabadi, S., Foudazi, M., 2006. Geology and Petrography of Nain ophiolite (Central Iran), Six International Symposium on Eastern Mediterranean Geology page 47

Alai Mahabadi, S., Foudazi, M., 2003. Geological map of Nain Quadrangle, Scale 1/100,000, Geological Survey Of Iran


Technoexport., 1984: Geological map of Ashin Quadrangle, Scale 1/100,000, Geological Survey Of Iran