Preliminary Petrographic and Geochemical Study of Metarodingites from Cerro del Almirez (Betic Cordillera, S. Spain)

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INTRODUCTION

Rodingites are metasomatized igneous rocks composed of a variety of silicates, principally grossular, epidote, diopside and chlorite. These rocks are formed by metasomatism of basalts and/or gabbros induced by alkaline fluids rich in calcium and depleted in silica, associated with oceanic serpentinization of ultramafic rocks (Seyfried et al., 2007). After their formation, rodingites may be affected by metamorphism during subduction. Metamorphic reactions may lead to partial inversion of previous mass transference between fluids and rocks. This complex poly-metamorphic interaction between minerals and fluids may hinder the interpretation of phase relationships in rodingites and the implications they have for the main geochemical processes taking place during subduction.

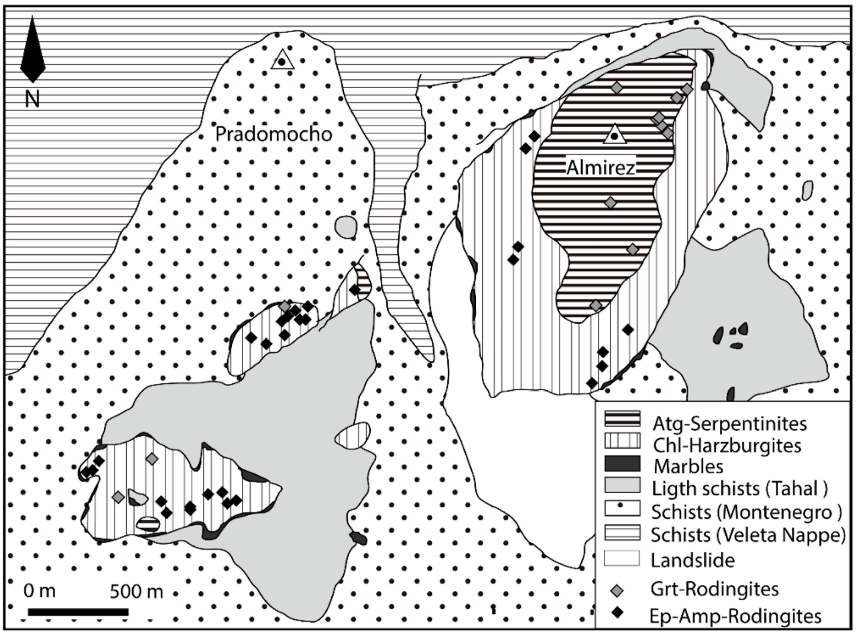

fig 1. Geological map of Cerro del Almirez with locations of the studied samples.

The Cerro del Almirez metarodingites (Betic cordillera, S. Spain) crop out in two different ultramafic rocks, namely antigorite serpentinites and chlorite harzburgites (Fig. 1). The transition between these two main lithologies is discordant to the serpentinite foliation and marks the front of antigorite dehydration to olivine + orthopyroxene + chlorite at ~ 1.6-1.9 GPa (~ 60 km) and 680-710 °C (Padrón-Navarta et al., 2011). This transformation is one of the most important reactions that release fluids in subduction zones.

Metarodingites from the Atg-serpentinite and chlorite harzburgite domains differ in terms of mineralogy, texture and bulk rock chemistry. In this contribution we present a petrographic and geochemical study of the Cerro del Almirez metarodingites highlighting the main changes they experienced during subduction and dehydration of enclosing ultramafic rocks.

GEOLOGICAL SETTING

The Cerro del Almirez massif is an ultramafic body that crops out on the top of the sequence of the Nevado-Filábride Complex, the lowermost tectonometamorphic unit of the Internal Zones of the Betic cordillera (Fig. 1). The Almirez serpentinite was metamorphosed in the Middle Miocene under eclogite-facies conditions during subduction, (López Sánchez-Vizcaíno et al., 2001). During this event, antigorite serpentinite dehydrated to prograde chlorite harzburgite (Padrón-Navarta et al., 2011). Later extensional tectonics thinned, dismembered and exhumed the upper sequence of the Nevado-Filábride Complex.

Metarodingites constitute boudin lenses enclosed in the ultramafic rocks. The size of lenses ranges from 1 to 20 m in length and from 30 cm to 2 m in thickness. The volume of rodingites is about 1-2% the total volume of the Almirez ultramafic body.

palabras clave: Rodingitas, Subducción, Macizo del Almirez, Hidratación, Deshidratación, Nevado-Filábride.	*key words:* Rodingites, Subduction, Almirez Massif, Hydration, Dehydration, Nevado-Filábride.

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RESULTS

Petrography

Metarodingites in antigorite serpentinites mainly consist of massive (titanium-rich) grossular, Mg-chlorite, diopside, amphibole and titanite. Accessory minerals are ilmenite, magnetite, zircon, allanite and apatite. Quartz, pentlandite, and goethite are rarely observed.

Metarodingites in antigorite serpentinites suggest an original ophitic igneous texture (Fig. 2A). During seafloor metamorphism, phenocryst and matrix plagioclase were replaced by massive titanium-rich grossular that was locally enriched in Fe and depleted in Ca during prograde metamorphism. Fe-rich, Ca-poor grossular mostly appears in the matrix and in metamorphic veins associated with chlorite, diopside and titanite. On the other hand, phenocrysts of original igneous pyroxene mainly recrystallized as diopside. Pargasitic and Mg-hastingsitic idiomorphic amphibole are present as minor phases in the matrix.

Metarodingites in chlorite harzburgites mainly consist of epidote and amphibole with minor diopside, Mg-chlorite and titanite. Occasionally, garnet relicts (grossular of re-equilibrated composition) are present. Accessory minerals are ilmenite, magnetite, zircon and apatite. In some samples, rutile is present instead of titanite. Metarodingites in chlorite harzburgites poorly preserve the original igneous texture. These rocks present a granoblastic texture mainly formed by epidote and amphibole (Fig. 2B) which occasionally define a mineral lineation. Epidote is noticeably zoned and presents rims richer in Fe. Amphibole is also zoned, as the cores have tremolitic and edenitic compositions richer in Ca, whereas the rims have hornblendic, pargasitic or hastingsitic compositions richer in alkalis and Mg. Some deformed bodies present a new generation of idiomorphic garnet with composition equal to 10-30% pyrope, 30-40% grossular and 35-55% almandine + spessartine.

Transitional lithologies between the two main types of metarodingites crop out close to the antigorite-dehydration front and consist principally of epidote and diopside.

Blackwall rocks are present at the

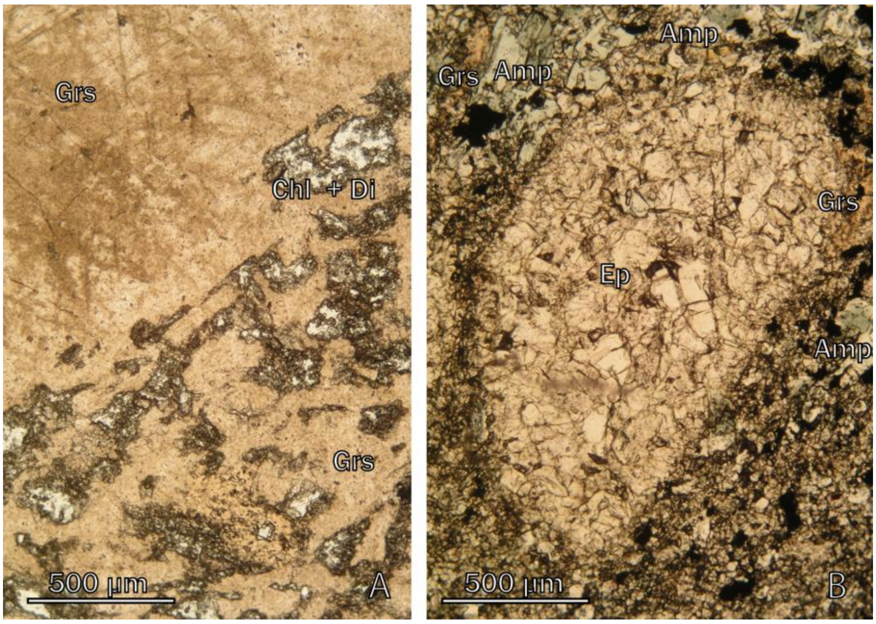

fig 2. *Representative microscopic pictures of metarodingites in Atg-serpentinite (A) and Chl-harzburgite (B). Grs = grossular, Di = diopside, Chl = chlorite, Ep =epidote, Amp =amphibole.*

contact between metarodingites and ultramafic rocks. This bi-metasomatic rock-type is composed mainly of Mg-chlorite and diopside, with high abundance of Fe-oxides and titanite. The blackwall is richer in chlorite closer to metarodingites and in diopside closer to ultramafic rocks. In some outcrops, transitional lithologies between the blackwall and metarodingites have been observed and mainly consist of diopside, chlorite and olivine.

The difference in mineralogy between metarodingites in antigorite serpentinites and in chlorite harzburgites can be explained by the following hydration reactions: garnet + H_2O → epidote + diopside; diopside + H_2O → epidote + amphibole. Formation of amphibole may have involved some mass transference, whereas the other reaction is isochemical (Evans et al., 1979).

Geochemistry

Preliminary analyses of bulk rocks show similar concentrations of SiO_2 (37.3-46.0 anhydrous wt.%), Al_2O_3 (13.8-19.0 anhydrous wt.%), FeOt (5.8-11.4 anhydrous wt.%) and TiO_2 (1.8-3.0 anhydrous wt.%) in metarodingites at both sides of the antigorite-out isograd. Inverse correlations exist between CaO and MgO and CaO and Na_2O + K_2O in both types of metarodingites. Compared to metarodingites in antigorite serpentinites, metarodingites in chlorite harzburgites are generally enriched in alkalis (0.1-2.5 versus 0.1-0.6 anhydrous wt.%) and MgO (6.6-19.0 versus 6.2-9.1 anhydrous wt.%) and depleted in CaO (10.7-24.7 versus 22.6-29.0 anhydrous wt.%).

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