Coronitic metagabbros from the Sobrado Unit (Órdenes Complex, NW Iberian Massif). I: Geological setting and mineral assemblages

Metagabros coroníticos de la Unidad de Sobrado (Complejo de Órdenes, NW del Macizo Ibérico). I: Contexto geológico y paragénesis minerales

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ABSTRACT

A HP-HT unit exposed in the core of the Sobrado tectonic window (Órdenes Complex, NW Iberian Massif) contains a lithological ensemble of arc affinity, affected by Lower Ordovician metamorphism and which reached highest conditions in the high-P granulite facies and in the eclogite facies. Alternating with metasediments, map-scale bands of metabasites include a large number of metagabbro bodies ranging from several meters to 2 km in length. The metagabbros were variably affected by the regional metamorphism. Well-preserved gabbros with almost intact igneous textures and mineralogy can be found, as well as metagabbros showing a diversity of reactional coronitic textures, and highly recrystallized types with no preserved igneous features and wholly transformed into granoblastic rocks. This contribution deals with the coronitic types, where the variety of textures and assemblages in the coronas is interpreted as reflecting the prograde reaction history of the metagabbros. Three groups of coronas have been distinguished: I) Amp+Opx; II) (Amp)+(Cpx)+Opx+Grt; III) (Amp)+Cpx+Opx+Grt (subordinate phases in brackets).

RESUMEN

La unidad de alta-P y alta-T que aflora en el núcleo de la ventana tectónica de Sobrado (Complejo de Órdenes, NW del Macizo Ibérico) contiene un conjunto litológico con afinidades de arco, afectado por metamorfismo de edad Ordovícico Inferior y que alcanzó condiciones en la facies de las granulitas de alta-P y en la facies de las eclogitas. Alternando con metasedimentos, algunas bandas cartografiables de metabasitas incluyen gran número de cuerpos gabroicos con un tamaño variable entre unos pocos metros y 2 km. Los metagabros fueron afectados variablemente por el metamorfismo regional. Así, pueden encontrarse tanto tipos de gabros bien preservados y con la textura y mineralogía ígneas intactas, como metagabros que muestran una diversidad de texturas coroníticas reaccionales, y tipos muy recristalizados sin rasgos ígneos preservados y completamente transformados en rocas granoblásticas. Este trabajo se centra en los tipos coroníticos, considerándose que la diversidad de texturas y paragénesis de las coronas refleja la historia reaccional progradа de los metagabros. Se han distinguido tres grupos de coronas: I) Amp+Opx; II) (Amp)+(Cpx)+Opx+Grt; III) (Amp)+Cpx+Opx+Grt (las fases subordinadas aparecen entre paréntesis).

Key words: *Coronitic metagabbros, corona assemblages, Órdenes Complex, NW Iberian Massif.*

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Introduction

In the Allochthonous Complexes of the NW Iberian Massif, the upper units overlie structurally the ophiolites and can be subdivided into high-P and high-T units (HP-HT units; Fig. 1) and uppermost units with intermediate-P metamorphism (IP units; Fig. 1) (Martínez Catalán et al., 1999). The HP-HT units consist of paragneisses, mafic and ultramafic rocks. The characteristic rocks are metabasites, commonly garnet-clinopyroxene granulites and eclogites, variably retrogressed to the amphibolite facies (Vogel, 1967). Gabbros occur in several stages of transformation, from virtually undeformed and scarcely affected by the metamorphism, to coronitic metagabbros and high-P granulites. The tectonothermal evolution of these units includes a former high-P granulite to eclogite-facies metamorphism, followed by decompression and partial melting and then, successively, by a penetrative mylonitic event in the amphibolite facies, recumbent folding and thrusting in the greenschist facies (Vogel, 1967; Marcos et al., 1984; Gil Ibarguchi et al., 1990; Arenas, 1991).

U-Pb dating of zircon, monazite, titanite and rutile reveals the presence of an Early Ordovician metamorphic event at *c.* 500-480 Ma and a later, Early

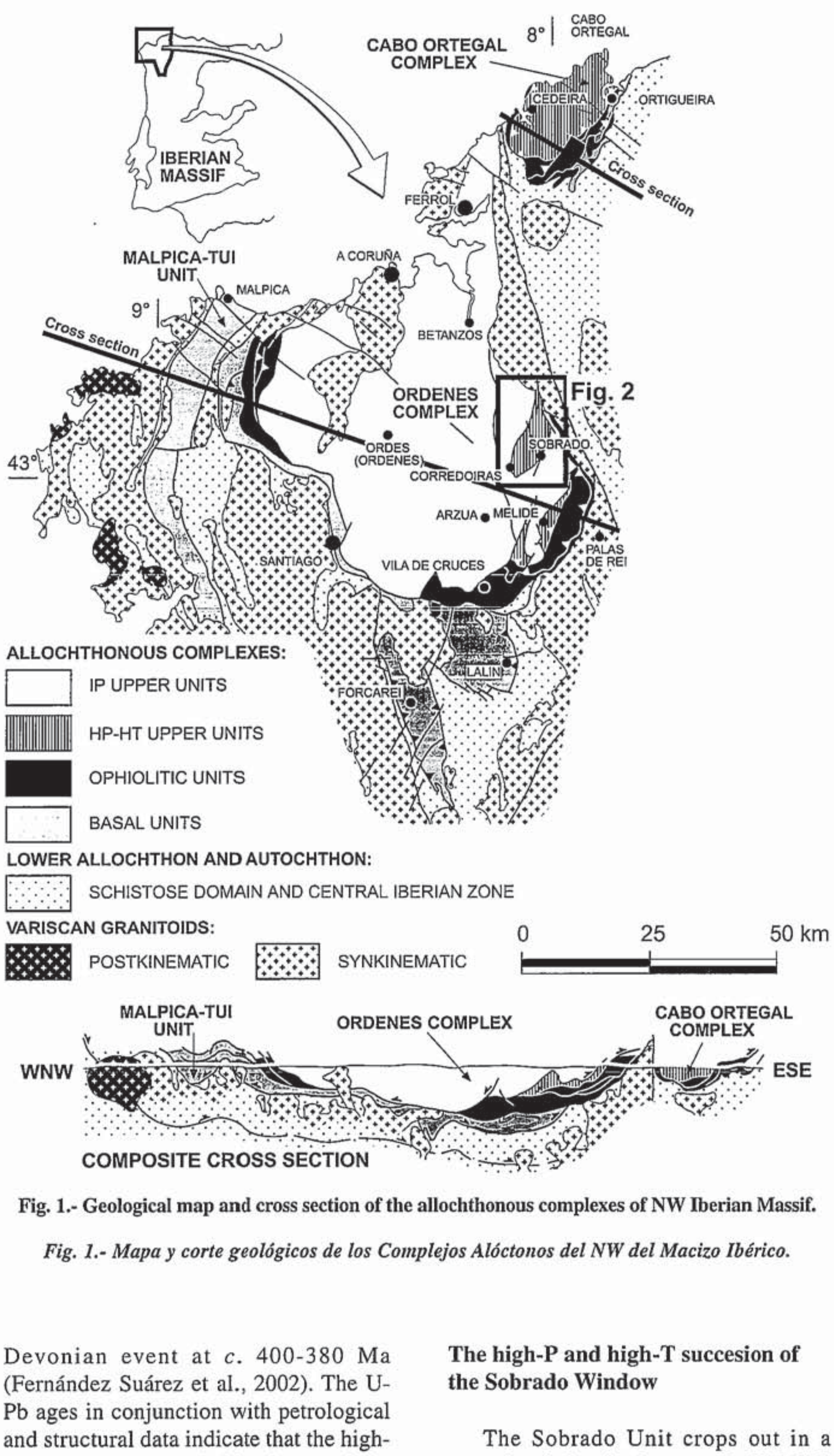

Fig. 1.- Geological map and cross section of the allochthonous complexes of NW Iberian Massif.

Fig. 1.- Mapa y corte geológicos de los Complejos Alóctonos del NW del Macizo Ibérico.

Devonian event at *c.* 400-380 Ma (Fernández Suárez et al., 2002). The U-Pb ages in conjunction with petrological and structural data indicate that the high-pressure event recorded by these rocks is Early Ordovician in age. This is also the age suggested for corona growth in the metagabbros. A slightly older Early Ordovician age has been proposed for the protoliths of equivalent metagabbros both in the Órdenes and Cabo Ortegal complexes (Abati et al., 1999; Ordoñez Casado et al., 2001), which must have been generated just before of the high-P event probably in an arc setting (Abati et al., 1999; Andonaegui et al., 2003).

The high-P and high-T succesion of the Sobrado Window

The Sobrado Unit crops out in a tectonic window in the core of a NE-SW-striking antiform (Fig. 2). It is surrounded by the Corredoiras Orthogneiss with a mylonitic band, 300-600 m thick at its base (Martínez Catalán and Arenas, 1992; Díaz García et al., 1999), which belongs to the overlying IP upper units (Fig. 2). The mylonites developed during the emplacement of the IP over the HP-HT upper units along the Corredoiras Detachment, of extensional character, and the antiform seems related to thrusting, because the Sobrado Unit consists of three tectonic slices forming an antiformal stack (Figs. 2 and 3). The three slices are made of HP-HT rock-types but show differences in the lithologic association and the P-T conditions reached during metamorphism.

The lowest slice is constituted, from bottom to top, by highly-serpentinized ultramafic rocks with some mafic inclusions and a layer of metabasites with a thickness of *c.* 500 m (Figs. 2 and 3). The mafic rocks include eclogites and related clinopyroxene-garnet rocks without primary plagioclase. The intermediate slice contains a 1000 m thick package of felsic gneisses (mainly paragneisses), with frequent inclusions of high-P granulite-facies mafic rocks (Figs. 2 and 3). Relicts of the igneous protoliths are not preserved neither in the lower nor in the intermediate slice. The upper slice includes felsic gneisses and layers of mafic rocks derived from deformed and recrystallized gabbros, that locally grade to undeformed gabbro bodies that preserve intact igneous textures (Pablo Maciá and Martínez Catalán, 1984; see Figs. 2 and 3). The metamorphic transformation of the gabbros shows different prograde stages, ranging from coronitic textures to the total recristallyzation of the gabbros into high-P granulites. Later on, these metabasites were affected by variable rates of partial melting and, finally, developed a regional foliation in the amphibolite facies, whose common products include amphibolic gneisses, flaser amphibolites and fine-grained amphibolites. Partial melting and later mylonitization also affected the metabasites of the intermediate slice, as well as the felsic gneisses.

Coronitic metagabbros: textures and mineral assemblages

The gabbros of the upper slice were variably affected by the regional metamorphism. Well-preserved types with almost intact igneous textures and mineralogies (Pl+Cpx+Opx±Ol±Bt) can be found, together with metagabbros showing a diversity of reactional coronitic textures, and highly recrystallized types with no preserved igneous features and wholly transformed into granoblastic rocks. This evolution, which is considered the prograde transformation of the gabbros into high-P granulites, can be recognized even to the outcrop scale. The corona textures were initially originated by reaction between all the ferromagne-

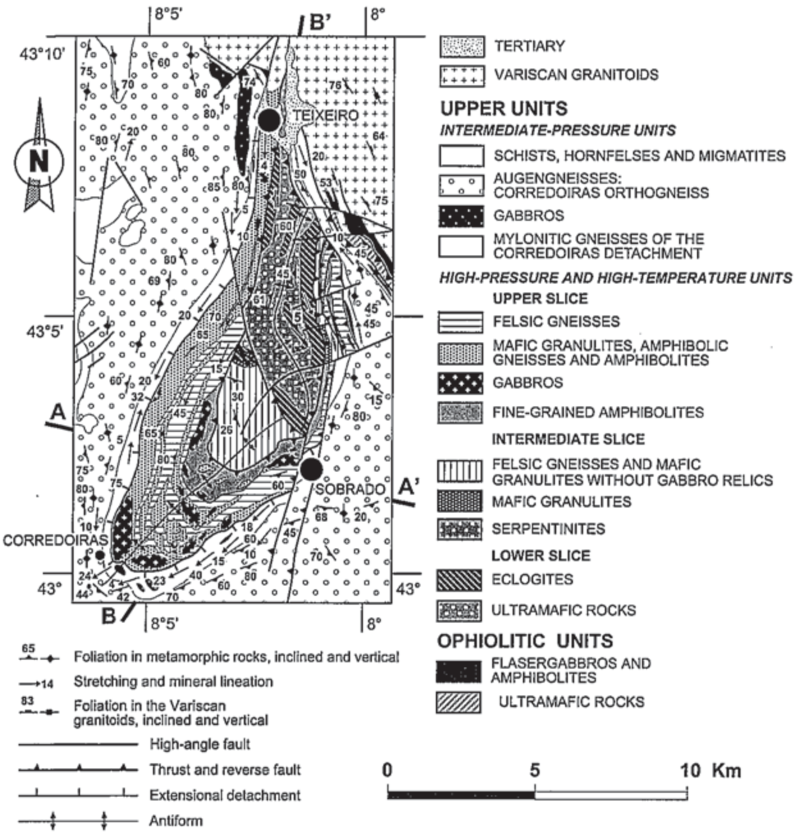

Fig. 2.- Geological map of the Sobrado Unit. See location in Fig. 1.

Fig. 2.- Mapa geológico de la Unidad de Sobrado. Su localización se muestra en la Fig. 1.

sian igneous phases and plagioclase. In order to study the early metamorphic evolution of the metagabbros, the more significant coronas are those caused by the breakdown of olivine with adjacent plagioclase. These are the coronas studied in this contribution and they have been divided into three groups in terms of the resulting mineralogy (subordinate phases in brackets):

I)- Amp+Opx
II)- (Amp)+(Cpx)+Opx+Grt
III)- (Amp)+Cpx+Opx+Grt

Modal abundance of metamorphic phases and the degree of recrystallization increase from group I to III, in agreement with a path that can be considered as prograde. This interpretation is based upon both the textural evolution and the corona mineral assemblages and reactional history. Bulk compositions of the studied samples exhibit a limited spread and, therefore, it does not seem to be responsible for differences in mineralogy between samples.

Group I coronas are characterized by Mg-rich anthophyllite-tremolite aggregates (±Fe-oxide) pseudomorphic after olivine, surrounded by a thick corona of orthopyroxene (inner; X_{Mg} = 65-70, Al_2O_3 = 1-4%) and brown pargasite (outer), or by orthopyroxene-pargasite symplectite. Intercumulus clinopyroxene is Na-poor augite clouded with ilmenite-rutile exsolutions. Plagioclase laths have composition of labradorite and contain sparse corundum inclusions.

Group II coronas are characterized by an inner orthopyroxene (X_{Mg} = 70-76, Al_2O_3 = 1.3-4%) and an outer garnet (Grs = 15-25%, Alm = 42-35%) corona between olivine and plagioclase. Olivine occurs as a heavily oxidized relict or is pseudomorphosed by orthopyroxene aggregates. Garnet contains abundant pargasite inclusions. Small clinopyroxene grains occur at the outer rim of the coronas, and as inclusions in garnet or plagioclase. Intercumulus clinopyroxene contains abundant rutile and orthopyroxene exsolutions; both intercumulus and granoblastic clinopyroxene have the composition of sodic augite (Jd up to 10%). Plagioclase composition is in the range of labradorite and displays a systematic decrease in An content towards garnet from 60-70% to 40-50%. The local presence of relic olivine and the absence of amphibole aggregates at the centre of the olivine domains suggest that group II textures did not evolved via the anthophyllite-tremolite stage.

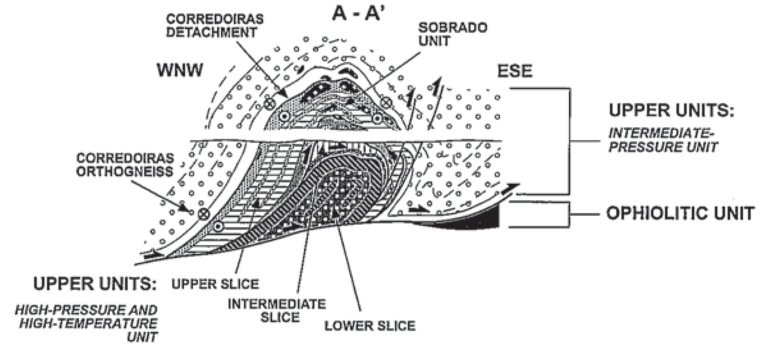

Fig. 3.- Transverse (A-A') and longitudinal (B-B') sections across the Sobrado tectonic window. See location in Fig. 2. Note "top-to-the-NE" sense of motion of the Corredoiras Detachment (section B-B´), and subsequent SE-directed thrusting (section A-A´).

Fig. 3.- Secciones transversal (A-A') y longitudinal (B-B') a través de la ventana tectónica de Sobrado. Su localización se muestra en la Fig. 2. Observar el sentido de movimiento de "techo-hacia-el-NE" del Detachment de Corredoiras (corte B-B´), así como el cabalgamiento subsecuente dirigido hacia el SE (corte A-A´).

Group III coronas are the most recrystallized of all. They display orthopyroxene aggregates (X_{Mg} = 75-80, Al_2O_3 = 0.5-1.5%), locally surrounding olivine relics, separated from plagioclase by clinopyroxene (inner; Na-augite with Jd = 7-14%) and garnet (outer; Grs = 15-40%) coronas. Garnet coronas contain inclusions of pargasite and clinopyroxene and, at the outer rim, corundum. Locally, pargasite occurs between garnet and clinopyroxene, and/or at garnet-plagioclase interfaces. Plagioclase laths are partly recrystallized and contain abundant inclusions of kyanite and corundum. Intercumulus clinopyroxene has the same composition as that of the granoblastic types in coronas. Plagioclase displays a decrease in An towards garnet from 40-50% to 30-38%.

As has been suggested in previous sections, the variety of textures and assemblages in the coronas is interpreted to reflect the prograde reaction history of the metagabbros. The thermobarometry of this prograde evolution, together with the P-T path followed by the coronitic metagabbros, and some general inferences will be presented in an companion contribution (Arenas and Martínez Catalán, this volume).

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