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Permian $^{40}Ar/^{39}Ar$ ages for post-Variscan minor intrusions in the Iberian Range and Spanish Central System

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ABSTRACT

$^{40}Ar/^{39}Ar$ dating of biotite from a calc-alkaline gabbro stock NW of Loscos in the Iberian Range yielded a slightly disturbed gas release spectrum. It has an early Permian, 288.5 ± 1.4 Ma total gas age, interpreted as the minimum emplacement age. The $^{40}Ar/^{39}Ar$ apparent age of the gabbro agrees with the Autunian stratigraphic age of related volcanic rocks. $^{40}Ar/^{39}Ar$ step-heating dating of amphibole phenocrysts from an alkaline camptonite dyke ca. 4 km SE of El Hoyo de Pinares in the Sierra Guadarrama sector of the Spanish Central System yielded a mid-Permian 264 ± 3 Ma plateau age, interpreted as the emplacement age. The age is indistinguishable from published $^{40}Ar/^{39}Ar$ amphibole ages for N-S trending camptonite dykes from the western, Sierra de Gredos segment of the Central System. This suggests that the camptonite dykes from both sectors belong to the same generation.

KEYWORDS **Argon dating. Permian. Post-Variscan dykes. Lamprophyre. Spanish Central System. Iberian Range.**

INTRODUCTION

The late Palaeozoic geological evolution of the Variscan Orogen in Europe is characterised by widespread and voluminous igneous activity. In the high-grade internal parts of the Orogen and its northern foreland large volumes of early to late Carboniferous calc-alkaline and/or peraluminous granitoids intruded during and immediately after terrane accretion and collision. Post-orogenic magmatic activity continued into late Carboniferous - mid-Permian times (e.g., Timmerman, 2004 and references therein). In the Iberian Peninsula, subordinate volumes of magmas intruded as dykes or erupted as volcanic rocks during this late period (e.g., Innocent et al., 1994; Bea et al., 1999; Lago et al., 2001, 2004a, b; Perini et al., 2004). In the Central System and the Pyrenees, magmatic rocks changed in composition from early calc-alkaline to later alkaline (Bixel, 1988; Cabanis and Le

Fur-Balquet, 1989; Huertas and Villaseca, 1994; Innocent et al., 1994). The late Carboniferous to Permian magmatism in the Iberian Peninsula has been explained in terms of strike-slip and extensional tectonics, or rising mantle models (Doblas et al., 1994; Villaseca et al., 2004).

The ages of many late Variscan intrusions in the Iberian Peninsula are still uncertain and only few radiometric ages are available. This paper presents two new $^{40}Ar/^{39}Ar$ step-heating data for mineral separates from selected magmatic rocks: a post-collisional gabbro intrusion from the Iberian Range, and an alkaline camptonitic dyke from the Spanish Central System. The major and trace element geochemistry of the samples have been published in Perini et al. (2004). The time scale used is that of Gradstein et al. (2004).

GEOLOGICAL SETTING

Spanish Central System

The Central System is a Variscan basement complex in central Spain that was uplifted during alpine movements, exposing Neoproterozoic to lower Palaeozoic sediments containing small volumes of late Neoproterozoic orthogneisses. These rocks were variably deformed and metamorphosed due to Viséan-age crustal thickening during the Variscan orogeny (337-326 Ma, Escuder Viruete et al., 1998; Bea et al., 2003). Following the peak of metamorphism, emplacement of often composite, hybrid or anatectic, crust-derived granitoid intrusions took place in an extensional setting (including the Ávila batholith; Fig. 1). Rb-Sr whole rock and $^{207}Pb/^{206}Pb$ zircon evaporation ages for the various granitoid stages from the Sierra de Gredos area (Fig. 1) range from c. 352 Ma to c. 295 Ma (Bea et al., 1999; Montero et al., 2004). Subsequently, the metasediments and granitoids were intruded by several generations of dykes and dyke swarms of varying composition and orientation (Huertas and Villaseca 1994; Villaseca et al., 2004; Scarrow et al., 2006).

Broadly E-W trending dykes of rather altered porphyritic granite and fine-grained diorite ("episyenites") from the Sierra de Guadarrama (Fig. 1) have 266 ± 3 Ma to 276 ± 9 Ma Rb-Sr mineral isochron ages and 216 ± 4 Ma to 265 ± 5 Ma amphibole and biotite K-Ar ages. The wide age range is attributed to element mobility during

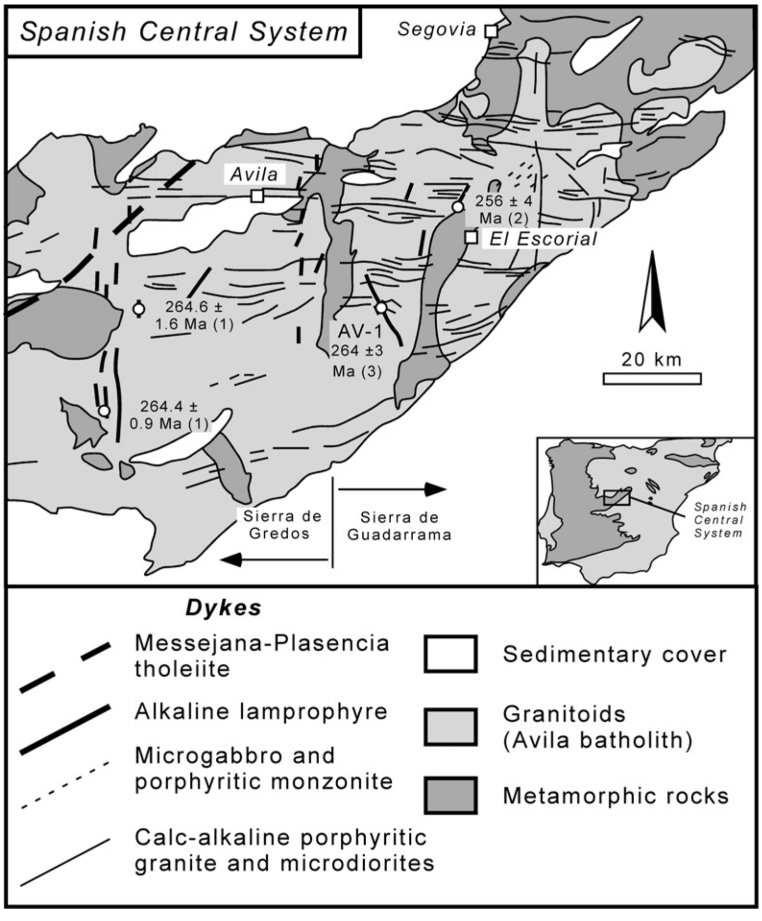

FIGURE 1 **General geological map of the Spanish Central System (after Villaseca et al. 2004) and location of sample AV1. The inset shows the Variscan massifs of the Iberian Peninsula. Published ages for camptonite dykes: (1) $^{40}Ar/^{39}Ar$ amphibole plateau ages of Scarrow et al. (2006); (2) U-Pb zircon age of Fernández-Suárez et al. (2006). (3) = $^{40}Ar/^{39}Ar$ amphibole plateau age, this study. The Messejana-Plasencia tholeiite dyke yielded an early Jurassic, 203 ± 2 Ma $^{40}Ar/^{39}Ar$ biotite plateau age (Dunn et al., 1998).**

hydrothermal alteration of probably Permian age (Caballero et al., 1993; Caballero Donoso, 1993).

Camptonite dykes from the Sierra de Gredos area (SW of Ávila, Fig. 1) yielded a 283 ± 30 Ma Rb-Sr whole rock isochron age and 264.6 ± 1.6, 264.3 ± 0.9 and 264.4 ± 0.9 Ma $^{40}Ar/^{39}Ar$ amphibole plateau ages (Bea et al., 1999; Scarrow et al., 2006). The camptonite dykes generally strike N-S and have alkaline compositions (Bea et al., 1999; Perini et al., 2004; Orejana et al., 2007). Some of the camptonite dykes contain pyroxenite, hornblendite and/or middle to lower crustal xenoliths (Lago et al., 2005; Fernández-Suárez et al., 2006; Orejana et al., 2006). Younger, 256 ± 4 Ma and 222.7 ± 3.2 Ma ages were reported for rims of zircons from a lower crustal felsic granulite xenolith. The ca. 256 Ma age was inferred to be the crystallization age of the camptonite host, and the 223 Ma age attributed to zircon growth during hydrothermal or uplift-related low-temperature processes (Fernández-Suárez et al., 2006).

Locally present, NE-SW trending dykes form an alkaline, shoshonitic monzogranite-monzodiorite suite (Huertas and Villaseca, 1994; Villaseca et al., 2004). One of these dykes yielded a 245 ± 7 Ma K-Ar whole-rock age, although this age might be too young due to alteration (Galindo et al., 1994).

Further extension in latest Carboniferous to early Permian times led to the formation of post-collisional half-grabens that were filled with continental sediments associated with pyroclastic rocks and sub-volcanic intrusions of mainly calc-alkaline, andesitic geochemical composition; basalt, dacite and rhyolite are less represented (Lago et al., 2005, 2004a). The Messejana-Plasencia tholeiite dyke, which constitutes the latest magmatic stage in the area, yielded an early Jurassic, 203 ± 2 Ma $^{40}Ar/^{39}Ar$ biotite plateau age (Dunn et al., 1998).

Iberian Range

In the Iberian Range (Fig. 2), shallow intrusive and volcanic rocks of calc-alkaline affinity are widespread but of small volume (Muñoz et al., 1985; Lago et al., 1996, 2001, 2004a, b). The Iberian Range comprises a thick (c. 8 km) sequence of Lower Palaeozoic sandstones and shales (Julivert and Martínez, 1987), which were deformed in Carboniferous times and are locally overlain by sediments and volcanic rocks of Permian and younger age. The Permian volcanic rocks comprise volcaniclastic rocks and ash-flows that were deposited in half-grabens in (fluvio-) lacustrine environments (Muñoz et al., 1985; Lago et al., 2004a). The palaeoflora from intercalated sediments indicates an early Permian age, which is corroborated by K-Ar ages of 292 ± 2.5 Ma and 287 ± 12 Ma for biotites from volcanic bombs (Conte et al., 1987; Hernando et al., 1980), and by a 293 ± 2.5 Ma K-Ar age for biotite from a shallow gabbro intrusion (Lago et al., 2001 and references therein). The compositions of the volcanic and intrusive rocks range from calc-alkaline basaltic andesite, andesite, and dacite to rhyolite, but andesites predominate (Muñoz et al., 1985; Lago et al., 1996, 2004a, b; Perini et al., 2004). Locally, the rocks are unconformably overlain by Upper Permian to Lower Triassic terrigenous sediments (Lago et al., 2001 and references therein).

SAMPLE DESCRIPTION

Sample locations are shown in Figs. 1 and 2. Sample AV1 was taken from the east side of Cabeza Reguera hill, ca. 4 km SE of El Hoyo de Pinares village (coordinates X: 381401, Y: 4482029, UTM zone 30). AV1 was collected from a camptonitic dyke belonging to the N-S trending dykes in the Central System (Sierra de Guadarrama, Fig. 1). The dyke is *ca.* 150 cm wide and cuts a late Carboniferous cordierite-bearing granodiorite. It contains phenocrysts of kaersutite, Ti-augite, phlogopite and an opaque mineral set in a groundmass of plagioclase, kaersutite, sanidine and opaque minerals (Fig. 3). The kaersutite phenocrysts are up to 5 mm long, fresh, rounded (probably partially resorbed by the melt) and free of inclusions. The clinopyroxene phenocrysts are also up to

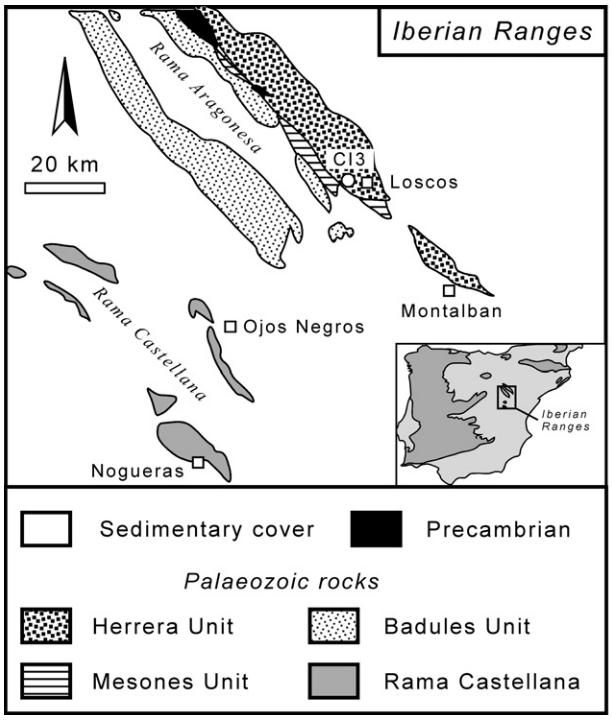

FIGURE 2 | **General geological map of the Iberian Range (after Lago et al., 2004a) and location of sample CI3. The inset shows the Variscan massifs of the Iberian Peninsula.**

5 mm long, idiomorph to sub-idiomorph crystals that show clear optical zoning (see also Orejana et al., 2007); many are altered along cracks and along grain margins to a mixture of fine-grained chlorite, white mica and calcite. The groundmass is composed of randomly oriented, fresh and idiomorph kaersutite needles, idiomorph feldspar laths (strongly altered to fine-grained white mica and calcite) and a few grains of clinopyroxene and opaque minerals. The sample has an alkaline major element composition (figure 4b in Perini et al., 2004).

Gabbro sample CI3 was taken from a small stock that intruded Devonian metamorphic rocks NW of Loscos village in the Iberian Range (Fig. 2; coordinates X: 661562, Y: 4550936, UTM zone 30). It has an ophitic texture, being composed of pyroxene, plagioclase, biotite and opaque minerals (Fig. 4). Pyroxene formed idiomorphic crystals of up to 3 mm long, but is now strongly altered to chlorite. Up to 3 mm long, idiomorphic, strongly zoned feldspar phenocrysts are also altered to fine-grained white mica. Olivine may have been a component judging from the presence of roundish chlorite aggregates. Biotite occurs as fox-brown, sub-idiomorphic grains of up to 0.5 mm long and occasionally contains zircon inclusions. The biotites are optically fresh, apart from a few grains that are partly overgrown by, or replaced to, secondary chlorite. Accessory minerals are opaque minerals, apatite needles, and quartz grains showing undulose extinction; the latter are probably xenocrysts derived from the host rocks. The gabbro has a calc-alkaline major element composition (figure 4a in Perini et al., 2004).

SAMPLE PREPARATION AND ANALYTICAL METHODS

In order to remove any carbonate minerals present, amphibole fraction AV1 was leached in ca. 1M HNO_3 for ca. 10 min in an ultra-sonic bath. This was followed by leaching in ca. 7% HF for ca. 10 min in order to remove alteration products on the surface and in cracks. The leached and dried fractions were hand-picked under methanol using a binocular microscope (up to 40 times magnification). Biotite fraction CI3 was not leached.

The $^{40}Ar/^{39}Ar$ analyses of the amphibole separates were performed at Leeds University using a modified AEI MS10 mass spectrometer (Guise and Roberts, 2002). Approximately 0.02 to 0.06 gram of material was wrapped in aluminium foil and irradiated at the McMaster University Nuclear Reactor (Hamilton, Canada; Pidruczny et al., 1994). Interference correction factors

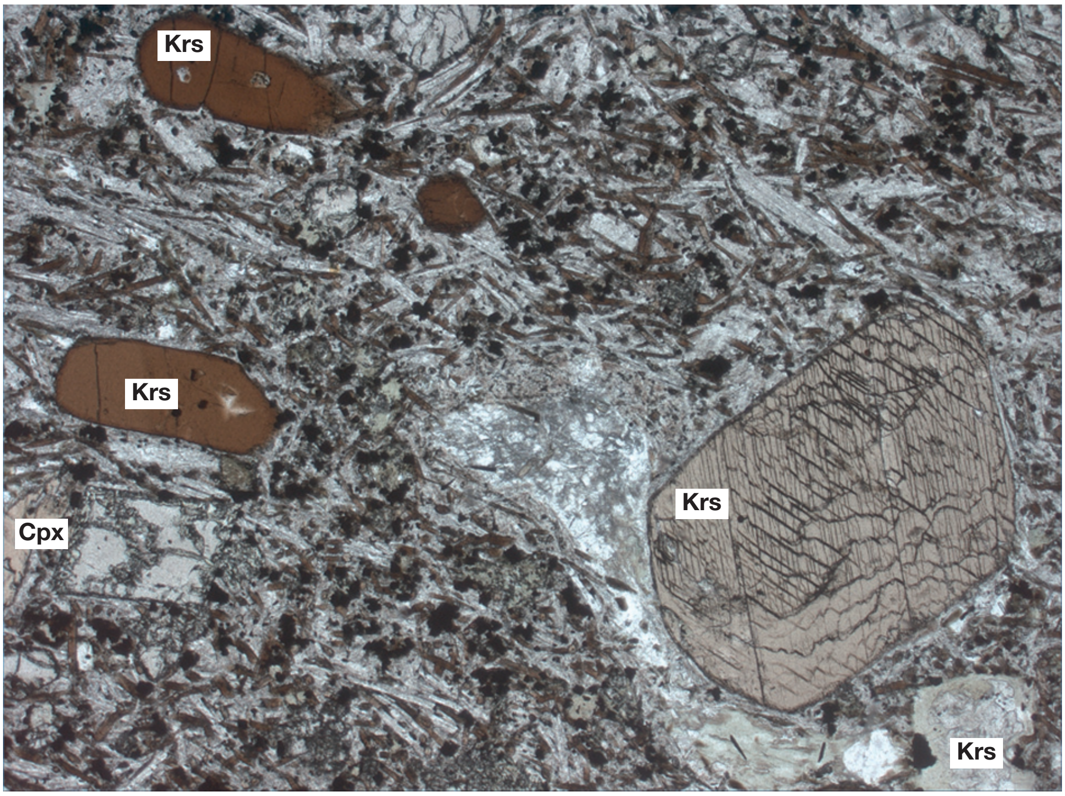

FIGURE 3 **Photomicrograph of camptonite sample AV1, showing corroded phenocrysts of kaersutite (Krs) and clinopyroxene (Cpx) in a fine-grained groundmass of kaersutite needles, feldspar laths and opaque minerals. (Crossed nicols, width of view 4.8 mm).**

were $(^{40}Ar/^{39}Ar)_K$ = 0.02, $(^{36}Ar/^{39}Ar)_{Ca}$ = 0.32 and $(^{37}Ar/^{39}Ar)_K$ = 1515. For both irradiations, the flux variation over the length of the canister was monitored by co-irradiated biotite standards Tinto (409.2 Ma, Rex and Guise, 1986) and LP-6 (Engels and Ingamells, 1971) and was of the order of 3%. The data were processed at Leeds University using in-house developed software and ages were calculated using "Isoplot for Excel" by Ludwig (2000). The analytical data are listed in Table 1. The error on the total gas age includes the uncertainty in the irradiation parameter (J), but the individual steps are reported with analytical errors only. All errors in Table 1 are quoted at the 1σ level. Plateau age and weighted-mean age criteria are those employed by Ludwig (2000).

$^{40}Ar/^{39}Ar$ STEP-HEATING RESULTS

$^{40}Ar/^{39}Ar$ step-heating dating of amphibole from camptonite sample AV1 yielded a 264 ± 3 Ma plateau age at 2-sigma level for gas fractions 1 to 9, comprising ca. 95% of the ^{39}Ar released (Fig. 5A). Ca/K ratios are constant over most of the gas release spectrum, indicating the absence of Ca- and/or K-bearing phases other than amphibole (Fig. 5B). The plateau-defining gas fractions 1 to 9 yield a 264 ± 2.5 Ma inverse isochron age that is well-defined (mean square of weighted deviates (MSWD) = 1.1) and indistinguishable from the plateau age and the 264 ± 1.3 Ma total gas age (Fig. 5C, Table 1). The 264 ± 3 Ma amphibole plateau age is interpreted to be the crystallization age of the camptonite.

Biotite from gabbro sample CI3 did not yield a plateau age according to the criteria of Ludwig (2000). The gas release spectrum is hump-shaped, and the apparent ages increase from 290 Ma for step 3 to a maximum of 298 Ma for step 6, decreasing to 289 Ma for steps 9 and 10 (Fig. 6A). Gas fractions 3 to 10 have a weighted mean age of 290 ± 1.4 Ma, comprising c. 95% of the ^{39}Ar released (Fig. 6B). The total gas age is 288.5 ± 1.4 Ma (Table 1). The disturbed spectrum most probably reflects irradiation-induced recoil of ^{39}Ar from the magmatic biotite into intergrown, secondary chlorite that formed during alteration (e.g., Lo and Onstott, 1989). The Ca/K ratios vary very little over most of the gas release spectrum (Fig. 6B). We suggest that the total gas age of ca.

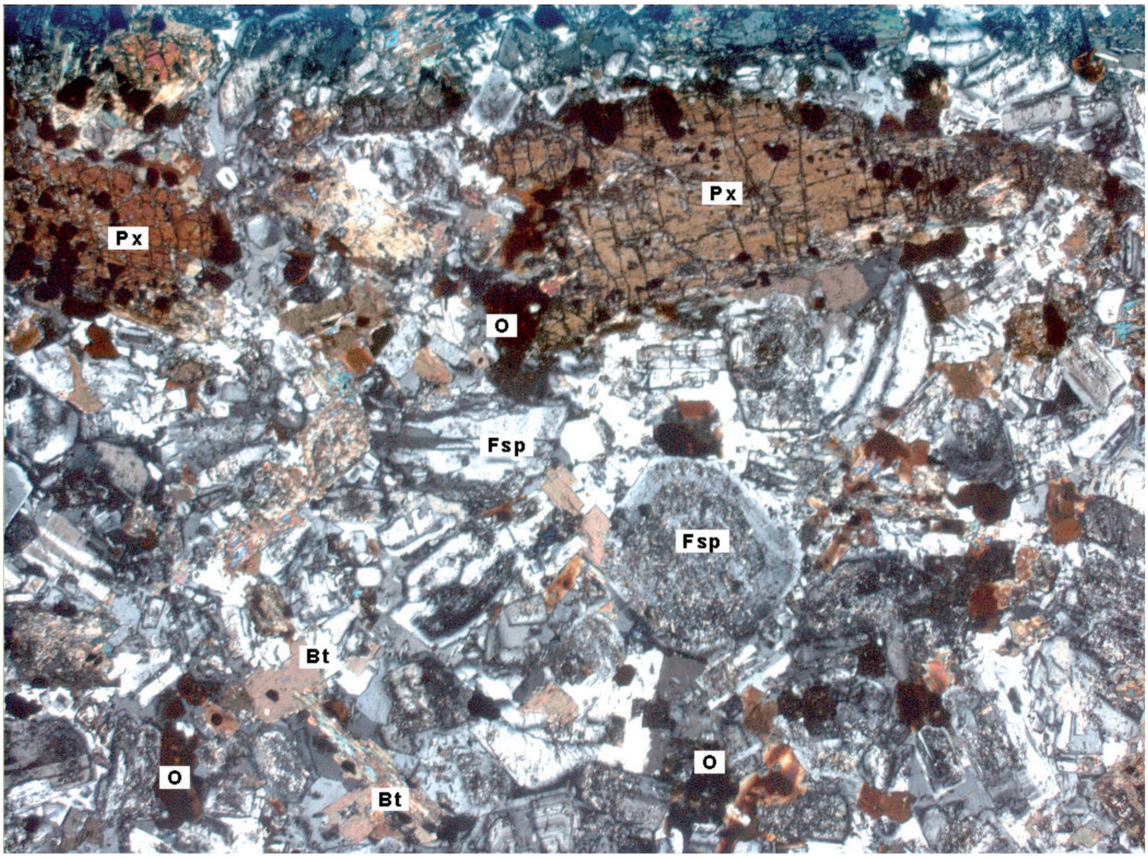

FIGURE 4 **Photomicrograph of gabbro sample CI3, showing plagioclase (Fsp), clinopyroxene (Px), biotite (Bt) and opaque minerals (O). (Crossed nicols, width of view 4.8 mm).**

TABLE 1 | **$^{40}Ar/^{39}Ar$ data (MS10 AEI, Leeds University) for mineral grain-size fractions from samples AV1 (amphibole) and CI3 (biotite). Argon volumes x 10^{-9} cm^3. Ages and age uncertainties in million years (Ma). The analytical uncertainties are presented at 1-sigma level. $^{*40}Ar$ ≡ volume of radiogenic ^{40}Ar, gas volumes corrected to standard temperature and pressure (STP).**

Amphibole AV1

Sample weight = 0.0590 g; K = 1.6 wt%; $^{40}Ar^*$ = 182 x 10^{-7} cm^3g^{-1}; J-value = 0.01165 ± 0.5 %

T (ºC)	$^{39}Ar_{(K)}$	$^{37}Ar_{(Ca)}$	$^{38}Ar_{(Cl)}$	Ca/K	$^{40}Ar^*/^{39}Ar_{(K)}$	$\%^{40}Ar_{atm}$	Age	± 1σ	$\%^{39}Ar_{(K)}$
760	0.9	0.7	0.07	1.55	12.82	79.2	251.1	8.2	1.1
895	0.4	0.2	0.01	0.92	14.19	34.7	276.0	12.5	0.5
993	0.4	0.4	0.02	2.09	12.54	35.2	246.0	12.1	0.5
1026	0.8	1.8	0.06	4.51	13.66	12.5	266.5	8.1	1.0
1046	5.1	13	0.44	5.03	13.63	5.2	265.9	1.5	6.5
1063	13.1	33.2	1.10	5.07	13.56	2.8	264.5	0.6	16.5
1080	14.8	37.4	1.22	5.04	13.53	2.6	264.1	0.4	18.7
1097	16.7	42.3	1.35	5.03	13.52	2.9	263.8	0.3	21.1
1194	22.6	62.7	1.84	5.52	13.55	2.5	264.3	0.2	28.6
1252	4.4	15.2	0.36	6.87	13.44	12.6	262.4	1.0	5.6

Plateau age = 264 ± 3 Ma (gas fractions 1 to 9); total gas age = 264.1 ± 1.3 Ma.

Biotite CI3

Sample weight = 0.02578g; K = 7.0 wt%; $^{40}Ar^*$ = 850 x 10^{-7} cm^3g^{-1}; J-value = 0.01135 ± 0.5 %

T (ºC)	$^{39}Ar_{(K)}$	$^{37}Ar_{(Ca)}$	$^{38}Ar_{(Cl)}$	Ca/K	$^{40}Ar^*/^{39}Ar_{(K)}$	$\%^{40}Ar_{atm}$	Age	± 1σ	$\%^{39}Ar_{(K)}$
644	2.6	0.38	0.7	0.29	6.379	90.0	126.1	2.5	1.8
720	5.0	0.32	1.3	0.13	14.78	52.2	279.8	1.7	3.5
808	18.8	0.55	4.8	0.06	15.38	16.2	290.3	0.4	13.1
863	14.4	0.39	3.8	0.05	15.55	6.8	293.3	0.4	10.1
907	10.2	0.46	2.9	0.09	15.71	5.7	296.1	0.6	7.1
961	12.2	0.67	3.8	0.11	15.85	5.3	298.4	1.1	8.5
997	13.3	0.64	3.8	0.10	15.55	5.0	293.3	0.5	9.3
1035	17.6	0.5.0	4.3	0.06	15.37	4.2	290.1	0.3	12.3
1077	35.7	0.72	7.8	0.04	15.31	4.1	289.1	0.1	24.9
1147	13.1	0.87	2.8	0.13	15.30	4.9	288.9	0.5	9.1
1253	0.5	0.43	0.1	1.88	19.35	33.7	358.2	12.3	0.3

Weighted-mean age = 288.5 ± 1.4 (gas fractions 3 to 10); total gas age = 288.5 ± 1.4 Ma.

288 Ma represents a minimum age estimate for the biotite, and a minimum age estimate for crystallization of the gabbro intrusion.

DISCUSSION

Magmatic rocks of calc-alkaline and/or (per-) aluminous composition are typical for the Variscides of Spain and Portugal (Huertas and Villaseca, 1994; Innocent et al., 1994; Debon et al., 1996; Galán et al., 1996; Villaseca et al., 1998; Bea et al. 2003; Lago et al., 2004a, b; Perini et al., 2004). Of these, Carboniferous-age granitoids constitute the major volume (Debon et al., 1995; Villaseca et al., 1998; Bea et al. 1999; Castro et al., 1999), but dykes and volcanic rocks are more typical for the late Carboniferous to early Permian Variscan magmatic activity (e.g., Huertas and Villaseca, 1994; Innocent et al., 1994; Innocent and Brique, 1995; Debon et al., 1995; Bea et al. 1999; Perini et al., 2004). The geochemical composition of the younger, mid-Permian magmas changed significantly towards more alkaline compositions. This has been recognized in the Axial Zone of the western Pyrenees (Debon and Zimmermann, 1993; Innocent et al., 1994) and the Spanish Central System (Bea et al., 1999; Perini et al., 2004).

Despite the disturbed argon release spectrum of biotites from gabbro intrusion CI3 from the Iberian Range, a ca. 288.5 ± 1.4 Ma minimum age can be assigned to this calc-alkaline activity. The early Permian apparent age agrees with, and corroborates the Autunian stratigraphic age of the related volcanics. This indicates that the igneous activity in this area occurred not long after ca. 299 Ma, i.e. the inferred age of the Carboniferous-Permian boundary (Gradstein et al., 2004). The $^{40}Ar/^{39}Ar$ age furthermore agrees with published late Carboniferous to early Permian K-Ar ages of volcaniclastic rocks in this area (Hernándo et al., 1980; Conte et al., 1987).

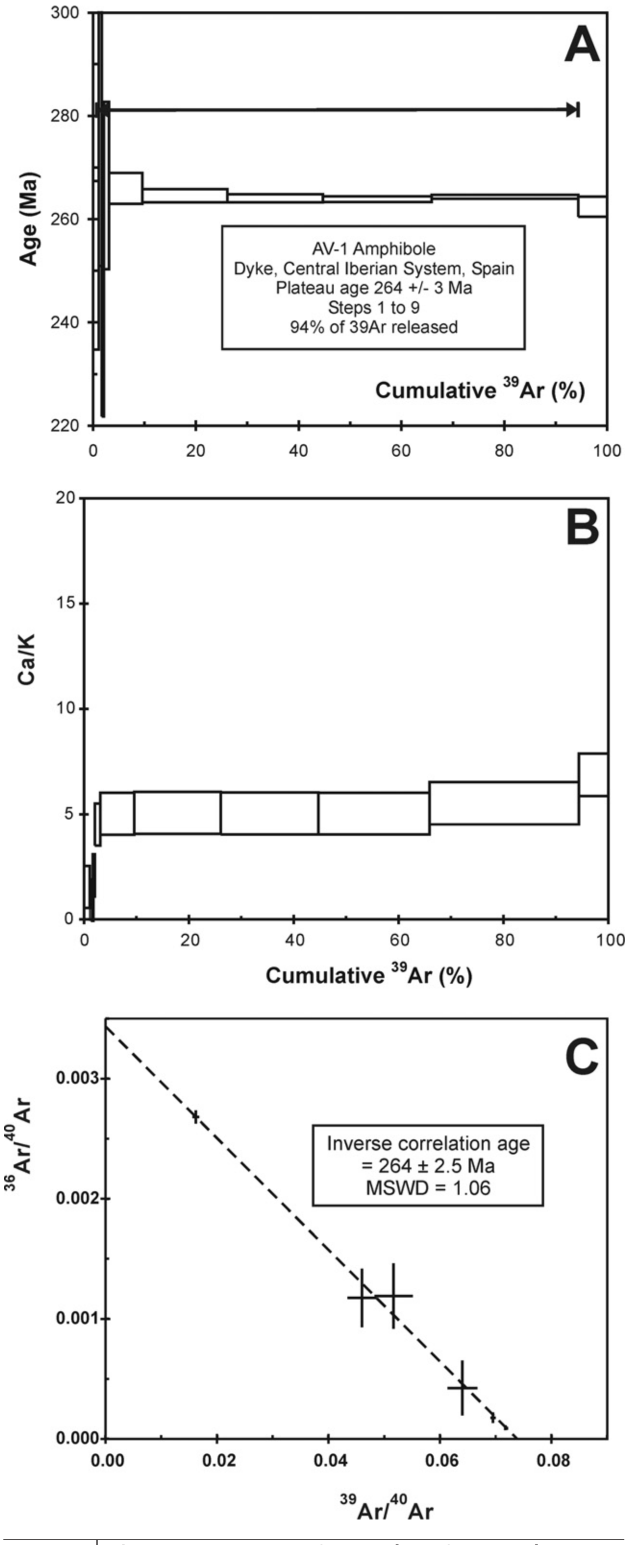

FIGURE 5 | **A) Argon age spectrum for amphibole from alkaline camptonitic dyke AV1, Central System. B) Ca/K vs. cumulative ^{39}Ar diagram. The uncertainty on each step is set at 1%. C) Inverse isotope correlation age for the plateau-defining gas fractions 1 to 9; MSWD = mean square of weighted deviates.**

The 264 ± 3 Ma argon plateau age of camptonite dyke AV1 from the Central System indicates that alkaline magmatic activity took place in the mid-Permian. A lag of about 30 Ma occurred between their emplacement and intrusion of the oldest E-W trending, calc-alkaline dykes dated at ca. 296 Ma (Galindo et al., 1994). The age for sample AV1 is identical to the 264.6 ± 1.6, 264.3 ± 0.9 and 264.4 ± 0.9 Ma amphibole $^{40}Ar/^{39}Ar$ plateau ages for camptonite dykes from the Gredos segment of the Central System (Scarrow et al., 2006), which suggests they belong to the same generation. The ca. 264 Ma argon ages are nearly 10 Ma older than the 256 ± 4 Ma U-Pb ages reported by Fernández Suárez et al. (2006) for two in situ analyses of zircon rims in camptonite-hosted felsic xenoliths. These authors suggested the 256 ± 4 Ma age to be the crystallization age of the camptonite melt. Despite the concordant U-Pb ages, they could not rule out the possibility that lead loss caused younger apparent ages. The ca. 264 Ma $^{40}Ar/^{39}Ar$ amphibole step-heating ages were obtained for four fractions of clearly magmatic amphibole from three different, widely separated dykes by two different laboratories (Scarrow et al., 2006, and this study), and are indistinguishable within analytical uncertainty. Therefore, we suggest that the camptonite dykes crystallized at ca. 264 Ma.

The late Carboniferous to early Permian calc-alkaline dykes and volcanic rocks in the Iberian Peninsula have an "orogenic", subduction-like geochemical signature with high LILE/HFSE and LREE/HFSE ratios (Lago et al., 2001; Perini et al., 2004 and references therein). In the Iberian Range, volcanic and sub-volcanic magmatism of this age (including gabbro CI3) is of calc-alkaline composition too (Conte et al., 1987; Hernando et al., 1980; Lago et al., 2001). In contrast, in the Central System magma compositions were alkaline in the mid-Permian. Indeed, the 264 Ma old camptonite dyke AV1 is a primitive alkaline rock enriched in incompatible elements (compared to a primitive mantle source), lacks HFSE negative anomalies and has some geochemical characteristics that resemble ocean island basalts (OIB; figure 7a in Perini et al., 2004).

Predominantly crustal sources and major crustal contributions have been recognised for the early to mid-Carboniferous calc-alkaline and aluminous/peraluminous plutonic complexes in the Iberian Peninsula (e.g., Ben Othman et al., 1984; Villaseca et al., 1998; Bea et al.,

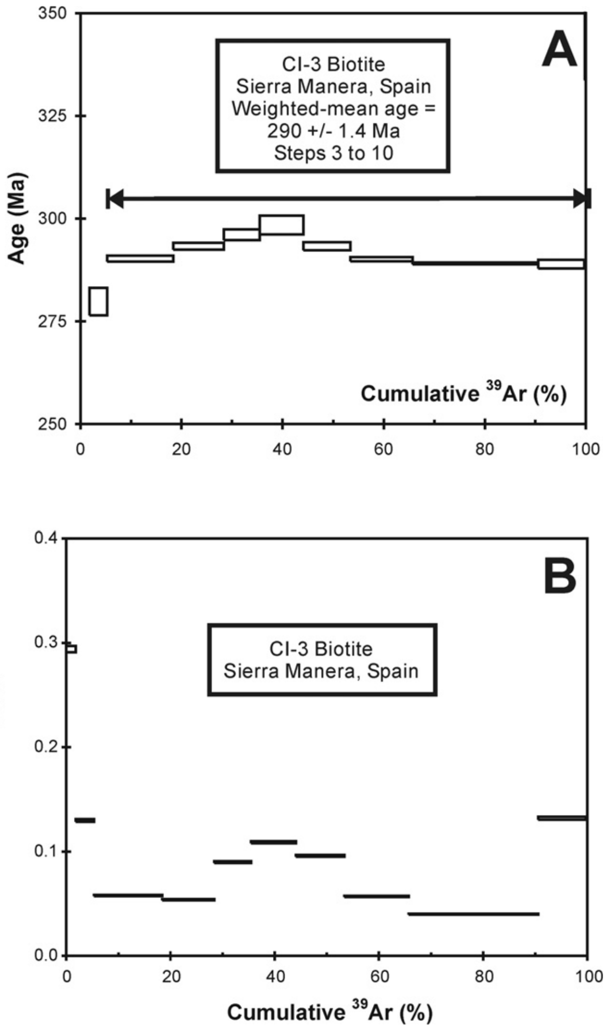

FIGURE 6 **A) Argon age spectrum for biotite from gabbro CI3, Iberian Range. B) Ca/K vs. cumulative ^{39}Ar diagram. The uncertainty on each step is set at 1%.**

1999). Late Carboniferous to early Permian calc-alkaline (sub-) volcanic rocks in the Central System and the Iberian Range seem to be formed by the contamination of mantle-derived magmas with crustal material (Huertas and Villaseca, 1994; Perini et al., 2004), direct melting of older calc-alkaline crust, or derivation from subduction-modified mantle sources. The younger, mid-Permian mafic magmatism in the Central System is mantle-derived, of much smaller volume and has a more anorogenic, intra-plate geochemical signature (Perini et al., 2004), reflecting a change in the type of reservoir involved in the magma genesis. The alkaline camptonites may originate from deep lithospheric mantle, perhaps by decompression melting (Bea et al., 1999; Perini et al., 2004) or infiltration of small fractions of asthenospheric melt, which may explain the OIB-like signature (Perini et al., 2004).

CONCLUSIONS

A calc-alkaline gabbro intrusion from the Iberian Range has a ca. 288.5 ± 1.4 Ma, early Permian total gas age, interpreted to be the minimum emplacement and crystallization age. The apparent age agrees with the Autunian stratigraphic age of the related volcanics. This intrusion fits well in the assemblage of “orogenic”, subduction-like igneous rocks that developed in Iberia during the Late Carboniferous-Early Permian time span.

Kaersutite phenocrysts from an alkaline camptonite dyke from the Sierra de Guadarrama sector of the Central System have a mid-Permian 264 ± 3 Ma $^{40}Ar/^{39}Ar$ plateau age, interpreted to be the age of crystallization and emplacement. The age is indistinguishable from the 264.6 ± 1.6, 264.3 ± 0.9 and 264.4 ± 0.9 Ma amphibole $^{40}Ar/^{39}Ar$ plateau ages for camptonite dykes from the Gredos segment of the Central System (Scarrow et al., 2006). This suggests that the camptonite dykes from both sectors belong to the same generation. This minor mid Permian magmatism was mantle derived, anorogenic and shows an intraplate signature.

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