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# XIV CONGRESO LATINOAMERICANO DE GEOLOGÍA
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"LAS GEOCIENCIAS PARA EL DESARROLLO DE LATINOAMÉRICA"

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**300 million years of magmatism in western Venezuela: A record of the closure of the Iapetus Ocean and the fragmentation of western Pangaea**

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The tectonic, metamorphic and palaeogeographic origin of the basement terranes of the circum–Maracaibo region are poorly understood. A majority of the reconstructions of western Pangaea place the Merida Terrane of western Venezuela between the Guyana Shield, Mexican and Central American terranes, and hence unravelling its tectonic history is a key step to reconstructing western Pangaea. We aim to develop a robust framework for the age and tectonic origin of the Merida Terrane.

Previous authors used multigrain, discordant U–Pb data and Rb/Sr model ages to propose that the Merida

Terrane was separated from Gondwana by oceanic crust that was being subducted to the southeast, forming the Caparo Arc on a Braziliano aged mobile belt of the South American Plate. The fundamental implication is that the Merida Terrane may be allochthonous to South America. We test this hypothesis using *in situ* U–Pb zircon geochronology and whole rock, trace element and REE geochemistry obtained from basement rocks exposed in the Merida Terrane, which we combine with previously published stratigraphic constraints. Widespread S–Type magmatism and amphibolite facies metamorphism of sedimentary rocks of the Iglesias Complex occurred between the late Cambrian and early Devonian. Detrital zircons from these metasedimentary rocks are early Cambrian and older, which provide a maximum age for deposition. Zircon U–Pb data from granitoids of the Caparo Arc show that previous Rb/Sr model ages and multigrain U–Pb ages obtained from S–Type granites are not crystallisation ages, but are a consequence of the combined effects of inherited radiogenic material and daughter isotope loss. Our data show that granitoids within the Caparo Arc crystallized in the Late Cambrian – Early Ordovician, and are coeval with magmatism in the Merida Terrane. Furthermore, no robust evidence of Brasiliano aged magmatism or metamorphism of the Caparo Arc has been found. We propose that the Caparo Block and the Merida Terrane formed a single geological terrane.

To the south of the Merida Andes, the Apure Fault separates an Early Palaeozoic igneous and metamorphic beltfrom the Guyana Shield. The latter exhibits extensive Cambrian rifts which were reactivated in the Jurassic and K/Ar dates obtained from biotite and feldspar from the basement rocks of the Guyana Shield suggests that the Palaeoproterozoic crust has not experienced a significant thermal event since ~1Ga. Therefore, we propose that i) the Apure Fault is the southeastern boundary of the Merida Terrane, and ii) the northwestern margin of Gondwana remained passive prior to the formation of Pangea. The location of the western boundary of the Merida Terrane is uncertain, although parts of the Palaeozoic basement exposed in the Colombian Andes may share a similar history.

A compilation of previous work suggests that faunal assemblages from several locations in the Merida Terrane reveal significant assemblage transitions. Faunal affinities change from Gondwanan in the Cambrian, to Acado–Baltican in the Ordovician, to Appalachian in the Silurian. This shift is also characteristic of the Avalonia microcontinent, which rifted off Gondwana in the Cambrian and accreted to Baltica and finally Laurentia in the Silurian.

The Merida Terrane experienced greenschist facies metamorphism in the Carboniferous, which reset the K–Ar isotope systematics in micas. Late Carboniferous, non–metamorphosed molasse uncomformably overlies the metamorphic rocks. Permian arc rocks have been found in the Paraguana Peninsula and in the Perijá foothills. High temperature metamorphism in the Triassic generated migmatites and S–Type granites in the Merida Terrane, and may have been a consequence of upwelling of the asthenosphere during continental rifting. Similar rocks are found along the Palaeomargins of Ecuador and Colombia, although they appear to young towards the Merida Terrane, suggesting that separation may have been diachronous. Finally, new zircon U–Pb ages of the basal volcanics of the syn–rift, La Quinta Formation within the Merida Terrane confirm that rifting did not occur in Venezuela before the latest Triassic, least 10 Ma after crustal anatexis.

We hypothesise that the Merida Terrane rifted off Gondwana during the Cambrian, during the closure of the Iapetus Ocean, and accreted with the basement rocks of the Appalachians in the late Ordovician – Silurian. Similar histories have previously been proposed for Oaxaquia, and it is widely accepted that Gondwana derived terranes such as Avalonia and Carolina can be found throughout the Appalachians. The Merida terrane was transferred back to Gondwana as a result of the Carboniferous closure of the Rheic Ocean. Subsequent breakup of Pangaea in the Triassic–Jurassic left the Merida Terrane in its current position, and the northern South American margin became active with the onset of arc magmatism in the latest Triassic.



**New LA–ICP–MS U–Pb zircon dating, 40Ar–39Ar and Sm–Nd model ages: Evidence of the Grenvillian event in the basement of the Falcón and Maracaibo Basins, northwestern Venezuela**

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Palabras claves: Grenvillian orogeny, Falcón basin, Maracaibo basin, U–Pb zircon, Venezuela.

U–Pb zircon ages of high–grade metamorphic rocks described in basement cores from the Ensenada de la Vela, Falcón Basin, Venezuela, revealed the presence of Grenvillian rocks. This new finding represents a breakthrough not only in terms of crustal growth processes, but also in providing new lines of evidence to initiate a review of the geodynamic models for the evolution of northern South America. This allochthonous block consist of a sequence of high–grade metamorphic rocks of dolomitic marble, calc–silicate rock, meta–anorthosite, felsic, mafic and ultramafic granulite, metapelite, garnet amphibolite and amphibolite. New LA–ICP–MS U–Pb zircon dating in metapelites and granulites from this block showed upper–intercept ages at about 1.3–1.2 Ga. interpreted as the crystallization age of inherited zircons and a concordant age *ca.* 0.92 Ga which may document the younger granulitic metamorphic event. In addition, $^{40}Ar$-$^{39}Ar$ ages from hornblende crystals in amphibolites, phlogopite crystals present in the dolomitic marble, and biotite crystals in the felsic granulite shows variable behavior. The hornblende preserves older apparent $^{40}Ar$-$^{39}Ar$ ages around 0.93 Ga, which can be related to younger metamorphic event, whereas phlogopite and biotite spectra do not define plateau ages. The apparent ages of the incremental steps vary between 837 Ma and 785 Ma, respectively. Igneous rock samples collected from well cores and outcrops around the Maracaibo Basin yielded Grenvillian–type Sm–Nd depleted mantle model ages ($T_{DM}$) of 1.3–1.2 Ga. They probably represent juvenile crustal material rather than evolved continental crustal fragments. This block exhibits a complex crustal history, and the radiometric ages here presented suggest that they probably formed part of a single Western South America terrane located initially in the northwestern margin of the Amazonian Craton during the Neoproterozoic. The geodynamic evolution envisioned for the allochthonous block involved an accordion–type of tectonics in which this terrain separated the South America craton during the break–up Gondwana and later docked against the South America margin during the Late Cretaceous – Middle Eocene collision of the Caribbean plate.

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## Geochronological and geochemical characterization of Permo – Triassic magmatic and metamorphic rocks along northwestern Gondwana, and their relationship to basement terranes of Central America

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Palabras claves: Crustal anatexis, Oaxaquia, Sunsus – Grenvillian belt, back–arc magmatism.

Rifting of continental plates is generally associated with asthenospheric upwelling leading to the formation of transitional crust and the generation of extensive high–temperature metamorphic belts. A = 1500 km long belt of migmatites, amphibolites and S–type granites can be tracked along the Permo – Triassic palaeo – margin of Colombia and Ecuador. The aim of this study is to present new U–Pb ages and geochemical data that constrain the timing of crustal anatexis, and draw correlations with potential conjugate margins within the basement units of Central America.

East–dipping subduction of Proto–Pacific crust formed a Permian arc through Mexico, and various Central American crustal blocks (e.g. Oaxaquia, Maya, Juchatengo – e.g. Nishimura et al., 1999; Weber et al., 2007; Keppie et al., 2008) during the assembly of western Pangaea in the Late Carboniferous – Permian. Mišković et al. (2009) describe peraluminous magmatism from 280–220 Ma in the central Eastern Cordillera of Peru, which these authors assign to a back–arc extending environment. Cardona et al. (2010) document Permian arc–related magmatism in the Santa Marta region of Northern Colombia, although few reliable data exist to confirm the presence of a Permian Arc within the Central and Eastern Cordilleras of Colombia and Ecuador, respectively.

We present ten concordant zircon U–Pb (LA–ICP–MS) ages of granitic and migmatitic leucosomes which range from 234–247 Ma within the Loja Terrane of Ecuador and from 237 to 276 Ma within the Cajamarca Complex and Precambrian basement of Colombia. The granites and migmatitic leucosomes are peraluminous, with relatively high average $K_20/Na_20$ ratios (>1.41) and trace element patterns that are indistinguishable from both the Palaeozoic metasedimentary basement schists, and average upper continental crust (Taylor and Mclennan, 1995). Furthermore, the absence of titanite as an accessory phase in all granites suggests Ilmenite is the stable Ti–bearing phase. Xenocrystic zircon cores are common suggesting that, i) the protoliths were sedimentary rocks derived from the Sunsas – Grenvillian (1.3–1.0 Ga) belt and other provinces within the Northern Andes, or ii) that the crustal melts directly sampled Sunsas–aged basement. Pending new isotopic data, these observations confirm the S–Type signature of the melts and reveal a lack of geochemical differences between Permo – Triassic melts within Colombia and Early Triassic anatectites within Ecuador. Major oxide and trace element analyses obtained from spatially associated amphibolites within the Cajamarca Complex (Colombia) and the Piedras Unit (Litherland et al., 1994) of Southern Ecuador reveal low $K_20$, tholeitic signatures with trace element patterns consistent with T–MORB. Geochronological data for these amphibolites includes: i) a ~221 Ma (U–Pb zircon – Litherland et al., 1994) age from the Piedras unit in Southern Ecuador and ii) a new U–Pb LA–ICP–MS age of ~240 Ma for an amphibolite collected within the Cajamarca Complex. We suggest that the protoliths of the amphibolites were mafic dykes that were emplaced during the rifting of western Pangaea.