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Comment on 'Petrotectonic characteristics, geochemistry, and U—Pb geochronology of Jurassic plutons in the Upper Magdalena Valley-Colombia: Implications on the evolution of magmatic arcs in the NW Andes' by Rodríguez et al. (2018)

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1. Introduction

Rodriguez et al. (2018) provided an important set of single crystal U—Pb LA-ICP-MS ages in zircons and whole rock geochemistry from southern Colombia batholiths. They use these new data along with other data presented in recent works from the central Colombia, and make some inferences about the evolution of the Jurassic magmatism in the Central Cordillera of Colombia and the Upper Magdalena Valley (UMV).

In their paper, they affirm that the UMV magmatism comprises plutonic and volcanic rocks from two Jurassic magmatic belts with different geochemical composition and mineral content. A western belt characterized by rocks with intermediate composition and ages ranging from ca. 195 to 178 Ma, and the eastern belt with a more felsic composition and crystallization ages that range from ca. 173 to 169 Ma. The areal expression of this Jurassic magmatism also increase from west to east. Rodriguez et al. (2018) interpret these age and compositional differences as the result of the migration of the magmatism from west to east due to subduction erosion. The UMV Jurassic rocks are correlated with volcanic and plutonic rocks from northernmost Colombia (Serranía de San Lucas and Sierra Nevada de Santa Marta) due to their similar age and tectonic position. The authors also emphasize that both the magmatic rocks from the UMV and those from northern Colombia intrudes Precambrian, Permian and Triassic basement rocks, so they are part of the same magmatic arc.

Another Jurassic magmatic arc was also built after a ca. 10 m y. magmatic gap that resulted when allochthonous terranes collided with the continental margin during middle Jurassic modifying the geometry of the subduction. Hence, magmatism resumed at ca. 158 Ma represented by the northernmost exposure of the Ibagué batholith. Rodriguez et al. (2018) arguments that the latter was formed in a different Jurassic magmatic arc because it intrudes a Jurassic metamorphic basement, has a different composition and record younger crystallization ages than the UMV rocks, but they also claim that it records a west to east migration.

In the following, we will show that the points presented by Rodriguez et al. (2018) omitted fundamental Nd and Hf isotopic information already published, as well as U—Pb ages in zircons from basement rocks from the Central Cordillera (Leal-Mejía, 2011; Álvarez-Galindez, 2013; Cochrane et al., 2014; Bustamante et al., 2016). These data are the basis for the current tectonic models on the evolution of the Jurassic arc magmatism of the Northern Andes. We will show that the proposed model of Rodríguez et al. (2018) requires further refinements and needs a deeply evaluation of data available as well as the models that are under current debate.

2. Discussion

Subduction erosion is an important mechanism that explains the inland migration of magmatic arcs (Kay et al., 2005). This mechanism involves the incorporation of forearc crust into the mantle wedge with the consequence of increasing the amount of contamination in the subarc magma source, as evidenced by the higher $^{87}Sr/^{86}Sr$ ratios and lower εNd_i with time (Stern, 1991; Kay et al., 2005; Stern et al., 2011). In their manuscript, Rodriguez et al. (2018) did not discuss the Hf and Nd isotopic data from Jurassic magmatic rocks of the Andes of Colombia and Ecuador, presented in Leal-Mejía (2011), Álvarez-Galindez (2013), Cochrane et al. (2014), Spikings et al. (2015) and Bustamante et al. (2016). Despite the contrasting interpretations of the Hf and Nd trends with time, whether if it is related to slab rollback (Lael-Mejía, 2011; Cochrane et al., 2014) or to a progressively more oblique convergence (Bustamante et al., 2016), it is shown that the magmatism is getting a progressively more juvenile signal through time (see Figure 15 in Bustamante et al., 2016). This trend is opposed to what is expected in a subduction erosion setting (Kay et al., 2005). Instead, Rodríguez et al. (2018) only used petrographic descriptions and whole rock

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geochemistry data for their interpretations totally discarding the isotopic information that has to be evaluated in their petrotectonic model.

One additional point related to the subduction erosion model proposed by the authors is the eastward migration of the magmatism. However, in the map shown in their manuscript (Figure 2 in Rodríguez et al., 2018), it is clear that their studied area is almost 70 km in width and the distance from the "western" and "eastern" plutons is between 25 and 35 km. However, it has been broadly proposed that arc width has a negative correlation with the subduction angle, ranging from 100 to 180 km for subduction angles between 40° and 20° respectively (Tatsumi, 2005). As a consequence, the migration proposed is within the limits of an average arc width. Hence, a full explanation is needed for proposing such migration, since it has been recently an important topic of debate on the evolution of the Jurassic magmatic arcs of the Northern Andes (Aspden et al., 1987; Cochrane et al., 2014; Spikings et al., 2015; Bustamante et al., 2016).

The Jurassic granite batholiths of the Colombian Andes are intruding Proterozoic (Cuadros et al., 2014) and mostly Permian to Triassic (Bustamante et al., 2017; Rodríguez et al., 2017a) gneisses, amphibolites and calcareous rocks. In their manuscript, Rodríguez et al. (2018) claims for a different magmatic arc active during Jurassic and represented in what they denominates as the "Northern Ibagué Batholith" (NIB) suggesting that this intrudes sintectonically a Jurassic basement (Tierradentro unit). Two late Jurassic U–Pb ages in zircons from metamorphic rocks reported in a conference paper (Rodríguez et al., 2017b), were used as the main argument for defining a new arc. According to the authors, this is the age of the host rocks (Tierradentro unit). However, the authors fail in avoid discussing the data presented in Bustamante et al. (2017), where clear Permian and Triassic U–Pb in zircon ages are reported in gneisses and amphibolites intruded by the so called "Northern Ibagué Batholith" (Figure 2). In that paper, U–Pb ages along with Hf isotopic information is presented and compared with other Permo-Triassic basement rocks of the Andes of Colombia and Ecuador, showing that this basement shares the same age and isotopic characteristics (Figure 8 in Bustamante et al., 2017). The latter means that also the NIB is intruding a Permo-Triassic basement, as well as the other batholiths mentioned by Rodriguez et al. (2018).

One of the main features of the batholith belts is that they can extend for hundreds to thousands kilometers in length, can be constructed for over 70 m y. and as a consequence may present pretrographic and geochemical variations trough time (Gill, 2010; Winter 2014). For that reasons, it is not clear why it is necessary to appeal for a different magmatic arc represented by the NIB, which hardly reach 60 km in length and is located in the middle of the Central Cordillera batholiths belt (Figure 1 in Rodríguez et al., 2018). In that sense, the geotectonic scenario presented in the Rodriguez et al. (2018) manuscript lack of a clear explanation on how was the along-margin distribution of the magmatic arc that they proposed and if the 10 m y. magmatic gap is due to sampling bias.

3. Conclusion

The model presented by Rodríguez et al. (2018) regarding on the Jurassic arc magmatism of the Central Cordillera has to be reevaluated taking into account their omission on evaluating the vast isotopic information available as well as the precise U–Pb ages already reported. If the authors are proposing a petrotectonic model as their title says, it is mandatory to evaluate almost 300 Hf in zircon and 40 Nd isotopic data available until now. Their new data presented as well as those recently published by different authors that follows different lines of argumentation should be considered when the subduction erosion model is discussed. It is fundamental to clearly evaluating the feasibility of an eastward migration of arc magmatism, the existence of a second and smaller Jurassic continental arc and its tectonic position and the nature of the basement (age, protolith and composition) with its further geotectonic implications.

Despite the inconsistencies of the paper in question, it reports a very valuable amount of geochemical and geochronological data from very inaccessible areas in southern Colombia that deserves a deeply analysis and will serve to improve the tectonic models of those who are currently dealing with the Jurassic evolution of the Northern Andes.

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