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Thermobarometry of Jurassic and Early Cretaceous plutonic rocks from the Northern Andes: tracing magmatic and tectonic changes

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Plutonic rocks in magmatic arcs record variations in composition, thermal flux, and dynamics of subduction through time. In the northern Andes, arc magmatism of Jurassic age registers a complex history, including the fragmentation of Pangea at the end of the Triassic as well as the beginning of a new subduction zone in the Jurassic located at the western margin of South America. Two contrasting models have been proposed by previous researches to explain the evolution of this arc: i) continuous subduction with a slab-roll back that produced a crustal thinning and ii) oblique subduction associated with a crustal thickening.

We characterized the emplacement conditions and crustal thickness variations of the Jurassic and Early Cretaceous arc in the northern Andes from 170 to 130 Ma using a combination of thermobarometers and trace element signatures and reviewed the previously suggested evolution models. The zircon and apatite saturation temperatures indicate that the intermediate magma became Zr and P_2O_5 oversaturated at 695-739 °C and 849-909 °C, respectively. Pressures obtained with the Al-in-hornblende barometer shows that the magma emplacement pressures varied from 1.2 to 7.1 kbar, with two distinct trends. A low-pressure trend (<2 kbar) related to different stock size bodies emplaced through the arc formation and a high-pressure trend (>5 kbar), which is restricted to the southern segment of the arc at the end of the Jurassic. Low Sm/Yb and Dy/Yb ratios show that the magma interacted with an amphibole-rich crust, implying that the Northern Andes was characterized by a thin crust during the Jurassic.

The shallow emplacement pressures and thin crust suggest that the Jurassic magmatic arc record a predominant extensional tectonic style that could be linked with the Pangea breakup and the beginning of the arc magmatism. However, the younger magmatic pulses are characterized by higher emplacement pressures associated with an increase in crustal thickness during convergence. Such variation indicates that the Jurassic magmatism in the Northern Andes experienced significant changes in their tectonic controls and not a single dominant mechanism, as has been proposed.