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Provenance analysis and radiometric dating of the Silante Formation; implications for the Miocene evolution of the Western Andes of Ecuador

S. Almagor[1], C. Vallejo[1], J-L. Herrera[2], P. Vermeesch[3], B. Beate[1]

[1]Departamento de Geología, Escuela Politécnica Nacional, Ladrón de Guevara E11-253, Quito, 170517, Ecuador

[2]GIDAC, Escuela Superior Politécnica de Chimborazo, Riobamba, 060105, Ecuador

[3]London Geochronology Centre, Department of Earth Sciences, University College London, London WC1E 6BT, U.K.

The Silante Formation, is a sedimentary unit exposed at the eastern flank of the Western Cordillera of Ecuador. This formation has a continental origin and unconformably overlie the allochthonous oceanic basement of the Cordillera. The Silante Formation is intruded by high level intrusions, that have an economic importance for porphyry copper exploration. The absence of clear stratigraphic relationships with adjacent formations, together with the lack of sedimentological and stratigraphic studies, and reliable radiometric dating prevented to determine the origin of this formation, and its relationship with the evolution of the Western Cordillera. Previous studies proposed depositional ages ranging from the Maastrichtian to the Oligocene. In this study we present results obtained from sedimentological studies, combined with stratigraphic field sections, heavy mineral analysis (HM), petrographic analysis (QFL) and U-Pb LA-ICPMS detrital zircon dating. The studied sections are located northwest of Quito, along the Nono-Tandayapa and Calacalí-Nanegalito road sections.

The analysis of provenance in heavy minerals (HM) combined with the QFL petrographic analysis suggest that the sediments of this formation are related to the erosion of a continental volcanic arc, composed of igneous rocks of calc-alkaline composition, as suggested by the single grain geochemistry of pyroxenes.

The lithofacies observed in the Silante Formation include: laminated red mudstones (Fl), massive siltstones (Fsm), massive sandstone (Sm), horizontal laminated sandstones (Sh), massive pebbly sandstones (Smp), matrix-supported conglomerates with sandy matrix (Gmm1), clast-supported conglomerates with muddy matrix (Gcm1), clast-supported conglomerates with sandy matrix (Gcm2), and clast supported volcanic breccias (Gmm2). The lithofacies association suggest an alluvial fan environment, where debris flow processes prevailed during the deposition of the fan. Paleocurrent data indicate that the alluvial fan was derived from the west.

Maximum depositional ages from the U-Pb zircon dating obtained in this study range between 25 to 16 Ma, whereas the intrusions that crosscut the Silante Formation yielded a U-Pb zircon age of 10.34-0.15 Ma. These radiometric ages indicate that the Silante Formation was deposited during the latest Oligocene to early Miocene.

Alluvial fans are formed in tectonically active areas, therefore, we suggest that during the Miocene the Western Andes were in a process of rapid exhumation, as it is also suggested by previous thermochronological studies of the Western Cordillera. Furthermore, Miocene alluvial fans are also recognized in southern Ecuador, including the Biblian and Burrohuiaco formations, as well as in the foreland region: Arajuno, Chambira and Chalcana formations. This suggest that a regional tectonic event affected the Ecuadorian Andes during the Miocene, coeval with the deposition of the Silante Formation.