8th International Symposium
on Andean Geodynamics
(ISAG)

New constraints on the geological and chronological evolution of the Cotacachi-Cuicocha Volcanic Complex (Ecuador)

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The Cotacachi-Cuicocha volcanic complex (CCVC), located to 60-70 km from Quito, is part of the volcanic front (Western Cordillera) of the Ecuadorian Andes. This complex is located inside the new Imbabura UNESCO Geopark, and it is surrounded by several highly populated cities like Cotacachi and Quiroga.

New geochemical, petrological and geochronological data (groundmass K – Ar and radiocarbon ages) were obtained for this volcanic complex, allowing to a better understanding of its evolution. The CCVC is constituted by at least four major eruptive stages. The main older and eroded Cotacachi edifice is formed by lava sequences of basaltic andesitic to andesitic compositions: Cotacachi I (Ol + Cpx + Opx + Pl) and Cotacachi II (Pl + Cpx + Opx + Amph ± Ol), as well as several satellite dacitic domes (Muyurcu, Loma Negra, Piribuela and Cuicocha) (Pl + Amph + Bio ± Cpx ± Opx ± Ol). In contrast, the Cuicocha volcanic center is a siliceous andesitic dome complex, characterized by an explosion caldera, whose pseudo-elliptical shape has an average diameter of 3 km. That was formed during an estimated VEI 5 explosive eruption. The CCVC rocks belong to a medium-K calc-alkaline series, varying from 54.7 to 64.8 wt. % of silica. Cuicocha rocks are compositionally depleted of the main trend of Cotacachi rocks, especially in potassium and other trace elements like: La, Th, Rb and Ba.

K-Ar dating yield ages between 173 to 108 ka for Cotacachi I and II edifices. During the formation of Cotacachi I, the most primitive products (133 to 113 ka) were erupted around the eastern flank. The satellite domes yield ages between 138 to 65 ka. Finally, one Cuicocha pre-caldera dome shows a Late Holocene age of around 4 ka. The caldera formation has been dated by radiocarbon at 2980 a BP, and the last activity of this volcanic center corresponds to the extrusion of the intra-caldera domes.

Cotacachi volcano suffered at least two flank collapses, whose deposits were identified in the present study. The northeastern avalanche (Estimated minimum volume: 0.18 km3) is distributed along the Ambi river valley. Its occurrence is interpreted between 108 ka and 65 ka and is possibly the youngest and smallest event attributed to Cotacachi II. The northwestern avalanche (Estimated minimum volume: 0.72 km3) is distributed along the Intag river valley. We do not have conclusive data on its age, but its litho-facies suggest it belongs to Cotacachi I structural evolution.