# Hydrogeochemical processes and isotopes analysis. Case of study: "La Línea Tunnel", Colombia

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**Abstract**

Hydrogeochemical and stable isotopes analysis have been widely used to identify recharge and discharge zones, flowpaths, type, origin and age of water, chemical processes between minerals and groundwater or effects caused by anthropogenic or natural pollution. In order to identify interactions between groundwater and surface water, we described the field work performed in la Línea Massif in the Central Cordillera of the Colombian Andes, formed by two igneous-metamorphic fractured complexes of different ages (Cajamarca and Quebradagrande Group) and andesithic porphyry rocks (Tad) from the Terciary. Main and pilot Tunnels were used as natural laboratory. Here, eight main fault zones related with some surface creeks were identified. Main inflows inside Tunnels were reported in these zones. 63 water samples were collected in surface and inside the tunnel in fault zones in two different years, 2010 and 2015. To classify water samples, a multivariate statistical analysis combining factor analysis with hierarchical cluster analysis was performed. Then, analyses of the major chemical elements and stable water isotopes ($\delta^{18}$O, $\delta^{2}$H and $^{3}$H) were used to define the origin of dissolved components and to analyse the evolution in time. Most samples were classified as bicarbonate calcite water or bicarbonate magnesium water type. Isotopes analysis show a characteristic behavior for each geologic group. Surface samples behave according to the Colombian meteoric line as inflows related with the La Gata, Alaska, La Vaca and Cristalina faults. However, El Viento, La Estación and samples from Pzc inflows show a different signature. Finally, it was observed a decrease of pH, conductivity and $Mg^{2+}$ among the tunnel samples between the years 2010 and 2015. This may affect the temporal evolution related with precipitation/dissolution or silicate weathering that

affect the spacing in fractures and consequently, the hydraulic properties.

*Keywords:* Hydrogeochemistry, Isotopes, Tunnel, Multivariate Statistical Analysis, Igneous and Metamorphic Rocks, Fractured Massif

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