Hydrogeological functioning of Martinique Island revealed by helicopter-borne geophysical survey

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Water resources exploration on volcanic islands is challenging as these territories frequently face high population densities with increasing water demands. Improving the hydrogeological knowledge of these islands is thus a major objective in order to achieve a sustainable management of their water resources.

We take advantage of a SkyTEM helicopter-borne geophysical survey over Martinique Island (Lesser Antilles) which allow, overcoming dense vegetation and steep slope constraints, providing information's on the first 200 m depth. We conducted multidisciplinary studies at different spatial scales in order to interpret resistivity data in terms of hydrogeological structures and properties for constraining hydrogeological conceptual models.

We firstly demonstrated, at the aquifer scale, that heterogeneous hydrodynamic properties and channelized flows result from aquifer compartmentalization along structural directions imaged by resistivity and magnetic maps. Furthermore, we show that the most fractured compartments have lower resistivity and higher transmissivity. Compartmentalization and transmissivity contrasts thus protect the studied coastal aquifer from seawater intrusion.

At the watershed scale, we put in evidence that the main geological structures lead to preferential flow circulations and that hydrogeological and topographical watersheds can differ, influencing river flowrates. Correlation between resistivity, geology and hydraulic conductivity data of four aquifers also reveals that the older the formation, the lower its resistivity and the older the formation, the higher its hydraulic conductivity.

Finally, our approach allows characterizing the properties of aquifer and aquitard units of Martinique, leading to the proposition of hydrogeological conceptual models that suits the complexity of the island at different scale, with heterogeneous geological formations presenting high lateral and vertical variability. Moreover, our study offers new guidelines for addressing relations between resistivity, geology and hydraulic conductivity for volcanic islands.