Multiconfiguration Electromagnetic induction survey for characterising A FORMER URBAN landfill in THE MARQUESAS ISLANDS (French Polynesia)

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This study is part of a project to build a sawmill on the Toovii Plateau in the center of Nuku Hiva, an island in the Marquesas Archipelago, French Polynesia. This plateau was previously occupied by a village that was destroyed a few years ago. However, no data concerning the destruction debris management or the presence of uncontrolled waste dumps and/or landfills has been archived.

The development of industrial facilities on an island brownfield site significantly increases the risk of anthropogenic pollution. As a counterpart, the environmental vulnerability of water resources limits considerably the possibilities of industrial development. It is important to note that in these geographically-isolated environments, the ecosystems are extremely vulnerable due to the endemic character of its fauna and flora. It is therefore important to systematically associate geophysical surveys with brownfield development projects in order to evaluate their feasibility and impact on the environment. In this context, one of the main objectives of the geophysical surveys is to help identify polluted areas requiring decontamination.

To assess the possible presence of waste in the subsoil due to the uncontrolled landfill of different types of man-made materials (mainly construction and metallic debris), we carried out electromagnetic induction (EMI) prospections with multiple configurations over several hectares at the site of the former village. Maps of the in-phase and quadrature components of the primary and secondary field ratios are acquired using two types of instruments: 1. a CMD-Explorer from GF instruments, s.r.o. (3 offsets between transmitter coil and receiver coils, and two coil orientations, VCP - Vertical Co-Planar & HCP - Horizontal Co-Planar) and 2. a GEM-2 from Geophex Ltd. (5 frequencies of the transmitter coil signal ranging between 10 and 95kHz and two orientations, VCP & HCP). The combination of inter-coils offsets and orientations allows the measurements to be associated to several depths of investigation, with approximately six meters for the largest offset of 4.49 m. In complement, the different frequencies allow, for favorable signal to noise ratio and when measurements are far enough from metallic debris, to assess the relative part of soil polarization and/or magnetic contribution from the in-phase signal.

Two main issues were explored in our study: first, imaging the intrinsic variability of an urban landfill of a few hectares, and at few meter resolution in depth and surface, and for a depth of investigation of almost six meters. Secondly, identifying the main anomalies due to the uncontrolled landfill and the presumed typology of the buried waste (metallic debris, diffuse pollution, inert fills, ...). In a marked 3D context including strong metallic anomalies (interpreted from high in-phase component values), the inversion of EM signals using classical 1D assumptions is in general not recommended, while the analysis of apparent estimated parameters can already provide the necessary spatial information. Nevertheless, in some less disturbed areas the inversion of calibrated EMI data is tested. The different configurations of EMI prospections allow to discriminate what is of the order of the natural variability of what could correspond to an anthropogenic waste. The results show that on landfill sites with potential contamination and metallic debris, EMI mapping using several coil spacings, several coil orientations and several frequencies is an asset to discriminate the main areas on which decontamination efforts should be carried out.