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Internal architecture of La Réunion (Indian Ocean) inferred from geophysical data

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The island of La Réunion (Indian Ocean) is a large oceanic volcanic system of which most of the volume is submerged. We present a study of its internal structure using geophysical methods. Subaerial and marine gravity and magnetic measurements have been compiled with terrestrial-based electromagnetic surveys. Geophysical models have been constructed using geological constraints and results from previous geophysical interpretations. The magnetic data allow us to differentiate the structures pre- and post-dating the Brunhes-Matuyama magnetic reversal (0.78 Ma). The main gravity features are used to detect and characterize the dense intrusive complexes, and to derive the internal structure of the coastal formations and of the submarine flanks. The electromagnetic data allow us to determine the distribution of electrical resistivities which we interpret in terms of water saturation of rocks, hydrothermal alteration and the presence of hydrated mineral.

At Piton de La Fournaise, the dense gravity coverage allows us to unambiguously distinguish the shallow and deep sources. The shallow ones correspond to the filling of ancient depressions by dense lavas flows, to the Central Cone, largely composed of low density material, and to a level of breccias at the base of the large southern valleys. The deep structures are associated with intrusive complexes within Les Alizés volcano and the Ancient Shield of the Piton de la Fournaise. Gravity variations associated with the collapse of the Dolomieu crater in April 2007 are studied in terms of mass displacements within the edifice. The analysis of magnetic anomalies suggests that the products from Piton de la Fournaise are rather thin to the north and to the east of the massif. It also indicates the presence of a body of weakly magnetized rocks underneath the central zone, correlated with the presence of a hydrothermal system, well characterized by a dome of rocks with low resistivity, and with an inferred shallow magma reservoir. Beneath the Ancient Shield, a region of weak resistivity may correspond to an ancient hydrothermal system. The Piton des Neiges is depicted as a huge volcano structured around a large hypovolcanic system (~20 km in diameter and ~4 km thick). The blanket of Brunhes formations is not continuous over Piton des Neiges and shows large thickness variations. Only the western flank, the summit zone and, to a lesser degree the northern flank, present significant thicknesses of these products. Topographical barriers predating Bruhnes-Matyama reversal, such as those created by collapses, or subsequent large landsides could explain the discontinuous distribution of these formations at the scale of the massif. In addition, we observe a close correlation between the extent of the intrusive complex and the topographical depressions of the massif. This suggests a possible relationship between a subsidence of the complex and that of the overlying formations.

On the immerged part of the volcanic system, two large ancient volcanic constructions are identified in the continuation of sub-aerial ones: (1) to the east of the Piton de la Fournaise (the eastern flank of Les Alizés volcano) and (2) to the south-west of Piton des Neiges (Etang Salé Submarine Ridge). At the land-sea transition, the coastal shelf is interpreted in terms of accumulation of hyaloclastites and pillow-lavas, such as the examples of La Montagne Massif, to the north, or of the offshore continuation of the rift zones, to the north-east and south-east of Piton de la Fournaise. On the immerged flanks, gravity and magnetic analyses show that the four submarine bulges are mostly composed of low density and brecciated material which correspond well to accumulations of mass wasting deposits as proposed by geological studies.

At the scale of the entire construction, we have been able to reconstruct the morphology of the top of the submarine volcanic constructions and that of the top of the island at the Brunhes-Matuyama reversal.

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