



UNIVERSITÀ DEGLI STUDI DI CATANIA

DIPARTIMENTO DI SCIENZE GEOLOGICHE

DOTTORATO DI RICERCA IN

Geodinamica e Sismotettonica XXIV Ciclo

**SEISMIC STRUCTURE OF SUBDUCTION ZONE OF
THE LESSER ANTILLES – STRUTTURA SISMICA
DELLA ZONA DI SUBDUZIONE DELLE PICCOLE
ANTILLE**

Dott. Rosario Raffaele

Il Coordinatore

Chiar.mo Prof. Carmelo Monaco

Il Tutore

Chiar.mo Prof. Sebastiano Imposa

Il Cotutore

Chiar.mo Prof. Alfred Hirn

December 2011

“If I have seen further, it is by standing on the shoulders of giants.”

Letter from Isaac Newton to Robert Hooke, 5 February 1676

“Se ho visto più lontano, è perché stavo sulle spalle di giganti.”

Lettera di Isaac Newton a Robert Hooke, 5 Febbraio 1676

Table of contents

Abstract - Riassunto	1
1 Introduction.....	5
1.1 Tectonic settings of Lesser Antilles Arc.....	6
1.2 Previous constraints on the seismicity.....	10
1.3 Theory of Local earthquake tomography (LET)	16
1.4 The approach for the 3D inversion.....	22
2 SISMAANTILLES I experiment and a-priori location..	25
2.1 Network layout and quality of earthquake data.....	25
2.2 Determination of first arrivals times.....	28
2.3 The a-priori velocity models.....	34
2.4 The use of S-wave readings in hypocenter locations.....	36
2.5 The earthquake selection for the 1-D inversion	39
2.6 Magnitudes of the selected events.....	43
2.7 Hypocentral locations from SISMAANTILLES I data.....	44
3 Minimum 1-D model.....	49
3.1 The concept of Minimum 1-D model.....	49
3.2 Coupled Hypocenter Velocity Model Problem.....	50
3.3 The search of the Minimum 1-D Model.....	51

3.4 Details about the use of VELEST software.....	54
3.5 1-D inversion of the SISMANTILLES I data-set.....	60
3.6 Earthquake relocation with the computed minimum 1-D models and comparison with a-priori locations.....	69
3.7 Accuracy of the Hypocentre Locations.....	78

4 Three-dimensional seismic structure of the Lesser Antilles region.....81

4.1 SIMULPS14 and 3-D simultaneous inversion.....	81
4.2 Relocation with the computed 1-D model, input-data and model setup.....	83
4.3 SIMULPS14 input files compilation with respect to the SISMANTILLES I data-set	88
4.4 Local Earthquake Tomography of Lesser Antilles area.....	92
4.5 Resolution assessment with the traditional tools.....	92
4.6 Resolution assessment of the SISMANTILLES I data-set with synthetic tests of check-board model.....	95
4.7 3-D V_p/V_s Model.....	97

5 Discussion of seismological results..... 100

5.1 Earthquake localization after 3-D inversion.....	100
5.2 Tomographic model of island arc structure	104
5.3 Concluding remarks.....	106

References.....	107
Acknowledgments.....	116