

Index

0.1:Abstract	1
0.2:Riassunto	3
1.Introduction	5
1.1: Why investigating basalt-fluid interaction: CO ₂ geological storage	5
1.2: Why investigating Carrara marbles-fluid interaction: Apennine seismic sequences	9
2.Methods	11
2.1: Experimental methods	11
2.1.1: Slow to High Velocity Apparatus (SHIVA)	11
2.1.2: Experiments with H ₂ O- and CO ₂ -rich fluids	13
2.1.2.1: Pressurizing system and pressure vessel	13
2.1.2.2: Evaluation of the CO ₂ content in the pressurized vessel	18
2.1.2.3: Determination of the temperature of the rock	22
2.1.3: Sample preparation	25
2.1.3.1: Rock drilling	25
2.1.3.2: Epoxy and mortar filling	26
2.1.3.3: Sample grinding	26
2.1.4: Experimental procedure	28
2.1.4.1: Torque and pore pressure control experiments	28
2.1.4.2: Standard test conditions	29
2.2: Microanalytical and microphysical techniques	31
2.2.1:X-ray fluorescence (XRF)	32
2.2.2: X-ray powder diffraction (XRPD)	32
2.2.3: Helium pycnometer	32
2.2.4 Micro-Raman spectroscopy	32
2.2.5 Ion chromatography	33
2.3:Petrography and microstructure of the investigated rocks	34
2.3.1:CAMP and Columbia River basalts	34
2.3.1.1: Petrographic observations: mineralogy, structures and textures	35
2.3.1.2: Chemical and mineralogical analysis	36
2.3.2:Carrara marbles	38
2.3.3: Selected hollow-cylinders couples for the experiments	38
3.Results	41
3.1: Mechanical data	41
3.1.1: Main instabilities events	47
3.1.1.1: Basalts	47
3.1.1.2: Carrara marbles	49
3.1.2:Slip weakening distance Dw ₁	51
3.1.2.1 Dw ₁ in basalts	51
3.1.2.2 Dw ₁ in Carrara marbles	54
3.1.3 Precursory events	55
3.1.3.1 Precursory events: basalts	57
3.1.3.1 Precursory events: Carrara marbles	61
3.1.4 LVDT & DCDT data	62
3.1.4.1 LVDT & DCVT data: basalts	64

3.1.4.2 LVDT & DCVT data: Carrara marbles	65
3.2: Microanalytical data	66
3.2.1: Basalts	66
3.3: Chemical data	70
3.3.1: Fluid analysis after the experiments	70
3.3.1.1: Fluid analysis after the experiments: basalts	71
3.3.1.2: Fluid analysis after the experiments: Carrara Marbles	71
3.4: Temperature measurements and estimates	75
3.4.1: Temperature measurements	75
3.4.2: Temperature estimates	78
4. Discussion	80
4.1: Basalts and interaction with H ₂ O- and CO ₂ - rich fluids	80
4.1.1: Mechanical data	80
4.1.1.1: Main instability events	80
4.1.1.2: Slip bursts and creep events before the main instability	84
4.1.2: Chemical data	86
4.1.3: Evidence of mineral carbonation	87
4.2: Carrara marble and interaction with H ₂ O- and CO ₂ - rich fluids	88
4.2.1: Mechanical data	88
4.2.2: Chemical data	89
4.3: Comparison between basalt and calcite-built marbles	89
4.4: Implications for CO ₂ storage in basalts	92
4.5: Implications for seismicity in calcite-built rocks	92
5. Conclusions	93
6. References	95
APPENDIX A	98