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**Emplacement of the Middle Triassic Monzoni Intrusive Complex
(Dolomites, Italy): Insights from Analogue Models and Field
Observations**

Settore Scientifico Disciplinare: GEO/07

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Σας ευχαριστώ όλους από καρδιάς

“Σα βγεις στον πηγαιμό για την Ιθάκη, να εύχεσαι νά ‘ναι μακρύς ο δρόμος, γεμάτος περιπέτειες, γεμάτος γνώσεις”.[...] Πλούσιος με όσα κέρδισες στον δρόμο, μη προσδοκώντας πλούτη να σε δώσει η Ιθάκη. Η Ιθάκη σ’ έδωσε τ’ ωραίο ταξίδι.”

Κ.Π. Καβάφη

“Ιθάκη”

“As you set out on the way to Ithaca, may the way be long, full of adventure, full of knowledge. [...] wealthy with all you have gained on the way, not expecting Ithaca to make you rich. Ithaca gave you the marvellous journey”

C. P. Cavafy

“Ithaka”

Abstract

The Dolomites form the central-eastern portion of the Southern Alps, in Northern Italy. The stratigraphic framework of the Dolomitic area includes mainly Permian to Cretaceous terrains, while it is largely dominated by the magnificent Triassic carbonate platforms and basinal systems. The area of the Dolomites recorded several tectonic and magmatic events, from Permian up to Cretaceous. During the Middle Triassic transtensional tectonics, associated with differential subsidence and uplifting, the south-western part of the Dolomites has witnessed a massive and short-lived Ladinian (Middle Triassic) tectono-magmatic event, forming a series of significant magmatic features. The Monzoni, Predazzo and Cima Pape Intrusive Complexes are situated in the southwestern Dolomites and represent the main intrusive expressions of the Ladinian magmatism. This PhD project offers new insights regarding the emplacement mechanisms of the Monzoni Intrusive Complex, by combining fieldwork data and analogue models on magma emplacement.

The Monzoni pluton is located parallel to San Pellegrino Valley and appears elongated, with an NE-SW orientation, covering an area of approximately 4.0 km². The main characteristics of Monzoni pluton, that is the elongated shape and the shoshonitic orogenic affinity, suggest a potential correlation and emplacement control by the Triassic developing and/or reactivated inherited strike-slip structure. The generation, ascent and emplacement of Monzoni pluton and its relation to strike-slip faulting, is still a matter of debate. The lack of direct field observations attributed to the volcano-tectonic activity, keeps the mechanisms of magma–strike-slip fault interactions poorly understood.

Updated geological maps, based on field campaign data, bring new insights regarding intrusion, fault-controlled boundaries and deformational pattern of the pluton and host-rock formations. In addition, investigations on anisotropy of magnetic susceptibility (AMS) on Monzoni pluton, reveal zonation within the pluton and indicate the presence of magmatic feeder in the north-eastern part of the intrusion. Finally, the 3D modelling of the Monzoni Intrusive Complex, projecting all geological data, constrains the pluton's volume to 4.35km³ and offers a simplified profile-view projection of the pluton/host-rock system.

The Monzoni Intrusive Complex, due to its excellent three-dimensional exposure, is particularly suited for the study of volcano-tectonic systems allowing the application

and comparison to analogue models. During this project we conducted sandbox-type analogue modelling experiments on magma emplacement along crustal scale strike-slip fault zones. We investigate two tectonic regimes, strike-slip and transtension, and three temporal relationships between magmatism and tectonics; pre-tectonic, syn-tectonic and post-tectonic intrusion. Experimental results show that there is a strong interaction between tectonic structures, evolving or inherited, and magmatism and that the geometrical characteristics of the experimental plutons represent a good indicator for the classification of plutons, defining the timing and tectonic setting of emplacement. The combination of all applied methodologies suggests magmatic emplacement in transtensional tectonic regime with two possible kinematic scenarios; a left lateral strike-slip direction along the N70° fault set or a right-lateral strike slip direction, along the N30° faults.

La messa in posto del Complesso Intrusivo Medio-Triassico dei Monzoni (Dolomiti, Italia): Approfondimenti mediante Modelli Analogici ed Osservazioni di Campagna

Riassunto

Le Dolomiti formano la parte centro-orientale delle Alpi meridionali, nel Nord Italia. L'organizzazione stratigrafica dell'area dolomitica comprende principalmente terreni dal Permiano al Cretaceo, mentre è in gran parte dominata dalle magnifiche piattaforme carbonatiche triassiche e dai relativi bacini. L'area delle Dolomiti ha registrato numerosi eventi tettonici e magmatici, dal Permiano fino al Cretaceo. Durante la tettonica transtensionale del Triassico medio, associata a subsidenza differenziale, la parte sud-occidentale delle Dolomiti è stata soggetta a un evento tettonico-magmatico Ladinico (Medio Triassico) di breve durata, sviluppando una serie di rilevanti strutture magmatiche. I complessi intrusivi di Monzoni, Predazzo e Cima Pape sono situati nelle Dolomiti sud-occidentali e rappresentano le principali espressioni intrusive del magmatismo Ladinico. Questo progetto di dottorato offre nuove conoscenze sui meccanismi di messa in posto del Complesso Intrusivo dei Monzoni, combinando dati sul campo e modelli analogici su postazioni di magma.

Il plutone dei Monzoni, che si trova parallelo alla Valle di San Pellegrino, appare allungato, con orientamento NE-SO, coprendo un'area di circa 4,0 km². Le principali caratteristiche del plutone dei Monzoni, la forma allungata e l'affinità shoshonitica orogenica, suggeriscono una potenziale correlazione e controllo della messa in posto da parte di strutture trascorrenti ereditate o medio-triassiche.

La generazione, l'ascesa e la messa in posto del plutone dei Monzoni e il suo rapporto con le strutture trascorrenti, sono ancora oggetto di dibattito. La mancanza di osservazioni dirette sul campo attribuite all'attività vulcano-tettonica, rende difficile la comprensione dei meccanismi di interazione tra faglie e magmatismo.

Le mappe geologiche aggiornate basate sui nuovi dati di terreno, forniscono nuove informazioni sui limiti di intrusione controllati da faglie e sul modello deformativo delle formazioni incassanti e del plutone. Inoltre, indagini su anisotropia di suscettività magnetica (AMS) sull'intrusione dei Monzoni, rivelano la zonazione all'interno del plutone e indicano la presenza di un condotto di alimentazione principale nella parte

nord-orientale dell'intrusione. Infine, la modellazione geologica 3D del complesso intrusivo dei Monzoni, coerente con i dati geologici, limita il volume del plutone a 4.35 km³ e offre una visione - semplificata dei rapporti tra plutone e rocce incassanti.

Il Complesso Intrusive di Monzoni, grazie alla sua eccellente esposizione tridimensionale, è particolarmente adatto allo studio di sistemi vulcano-tettonici, permettendo anche l'applicazione e il confronto con modelli analogici. Durante questo progetto, sono stati condotti esperimenti di modellazione analogica di tipo sandbox, su lungo zone di taglio trascorrenti a scala crostale. Sono stati distinti due regimi tettonici, trascorrenza pura e transtensione, e tre relazioni temporali tra magmatismo e tettonica; intrusione pre-tettonica, sin-tettonica e post-tettonica. I risultati sperimentali mostrano che esiste una forte interazione tra le strutture tettoniche, in evoluzione o ereditate, ed il magmatismo e che le caratteristiche geometriche dei plutoni sperimentali rappresentano un buon indicatore per la classificazione dei plutoni, definendo i tempi e l'ambiente tettonico della messa in posto. La combinazione di tutte le metodologie applicate, suggerisce la messa in posto del plutone durante un regime tettonico transtensionale con due possibili scenari cinematici; una transtensione sinistra - direzione N70° o una transtensione destra lungo faglie N30°.

Summary

1 Chapter 1 – General Introduction	25
1.1 Introduction.....	25
1.1 Research objectives – Methods.....	29
1.1.1 Field campaign.....	29
1.1.2 Analogue modelling.....	29
1.2 Outline of the thesis.....	30
2 Chapter 2 – Geological and Tectonic Setting	33
2.1 Introduction.....	33
2.2 The Contribution of the Dolomites to the history of Geology	34
2.3 Regional Stratigraphy	36
2.3.1 Variscan basement, Permian and Lower Triassic units	37
2.3.2 Anisian low relief carbonate platform.....	40
2.3.3 Carbonate platforms and basinal systems (Upper Anisian – Late Ladinian) 40	
2.3.4 Post-Volcanic Units (Late Ladinian – Upper Triassic).....	42
2.3.5 Jurassic and Cretaceous Units.....	44
2.4 Magmatic Events in the Eastern Southern Alps	46
2.4.1 Permian magmatism in the Southern Alps	47
2.4.2 Triassic Magmatism	48
2.4.3 Middle Triassic Magmatism (Anisian-Ladinian)	48
2.4.4 Middle Triassic Magmatism (Upper Ladinian).....	50
2.4.5 Late Triassic Magmatism (Lower Carnian)	51
2.5 Regional tectonic framework	53
2.6 Tectonic framework of Middle Triassic magmatism.....	56
3 Chapter 3 - Fieldwork	59
3.1 Introduction.....	59
3.2 Methodology.....	59
3.3 The Monzoni Intrusive Complex	60

3.4	Description of sedimentary formations.....	65
3.4.1	Permian Volcanics (PORF)	65
3.4.2	Val Gardena Sandstone (GAR / GARM)	67
3.4.3	Bellerophon Formation Permian (BEL /BELM)	68
3.4.4	Werfen Formation (Induan-Olenekian) (WER / WERM)	71
3.4.5	Richthofen Conglomerate (Anisian) (RIC)	73
3.4.6	Morbiac Limestone (Anisian) (CTR)	73
3.4.7	Contrin Formation(Anisian) (CTR).....	73
3.4.8	Moena Formation (Anisian) (MNA).....	74
3.4.9	Livinallongo Formation (Anisian/Ladinian) (LVN).....	75
3.4.10	Sciliar Formation (SCIS/SCIM).....	75
3.5	Petrographic description of Monzoni Intrusive Complex	76
3.6	Magmatic rock petrography	77
3.6.1	Clinopyroxenites	77
3.6.2	Olivine-gabbros.....	78
3.6.3	Gabbros.....	81
3.6.4	Monzogabbros	81
3.6.5	Monzonites	81
3.6.6	Quartz-Syenitic-basaltic dyke system.....	82
3.7	Fault and Intrusion Boundary surfaces around Mt. Monzoni	84
3.7.1	Fault Surfaces around Monzoni Intrusion.....	86
3.7.2	Intrusion boundaries.....	90
3.8	(Manuscript in preparation) Emplacement modes of the Ladinian intrusives of the Dolomites: insights from anisotropy of magnetic susceptibility Emplacement modes of the Ladinian intrusives of the Dolomites: insights from Anisotropy of Magnetic Susceptibility	92
3.8.1	Introduction	93
3.8.2	Geological setting	95
3.8.2.1	Age and duration of Ladinian magmatic event.....	99
3.8.2.2	Ladinian tectonics in the Dolomites	100

3.8.2.3	The Predazzo intrusive complex	101
3.8.2.4	The Monzoni intrusive complex	102
3.8.2.5	Sedimentary cover of the intrusions	104
3.8.3	Sampling and Methods	104
3.8.3.1	Sampling.....	104
3.8.3.2	Petrographic analysis.....	105
3.8.3.3	Anisotropy of Magnetic Susceptibility and magnetic mineralogy.....	105
3.8.3.3.1	Anisotropy of low-field magnetic susceptibility	105
3.8.3.3.2	Anisotropy of high-field magnetic susceptibility (HF-AMS) and magnetic mineralogy	106
3.8.4	Results.....	107
3.8.4.1	Petrographic description	107
3.8.4.2	Magnetic fabric results	110
3.8.5	Discussion	115
3.8.5.1	Emplacement mode of the Predazzo pluton	119
3.8.5.2.1	Emplacement mode of the Monzoni pluton.....	120
3.8.6	Conclusions	122
3.8.7	Acknowledgements for the paper	123
3.8.8	Appendix A: Petrographic description	123
3.8.8.1	<u>Predazzo pluton</u>	123
3.8.8.1.1	Clinopyroxenite (PA12, PA11a, b, c).....	123
3.8.8.1.2	Cumulitic gabbro (PR 10)	123
3.8.8.1.3	Diorite (PA06).....	124
3.8.8.1.4	Monzonites (PA02, PA10), monzodiorites (PA08, PR14c, PA09) and monzogabbro (PR12).....	124
3.8.8.1.5	Granite group (PA01, PA03, PA04, PA05, PA07, PA13, PA17)	125
3.8.8.1.6	Monzonite to Syenite (PA11)	126
3.8.8.2	<u>Monzoni pluton</u>	126
3.8.8.2.1	Gabbroic Rock (olivine-gabbros, gabbros, monzogabbros)	126
3.8.8.2.2	Monzogabbros (PA21).....	126

3.8.8.2.3	PA 16 Gabbros (non-cumulate)	127
3.8.8.2.4	Gabbros (PA15) (cumulate)	127
3.8.8.2.5	Olivine-gabbros (PA20, PA18)	127
3.8.8.2.6	Monzonite (PA22, 22A, 23, 24)	128
4	Chapter 4 - Analogue Modelling	131
4.1	Introduction	131
4.2	Experimental setups	133
4.2.1	Potsdam setup	133
4.2.2	Oslo setup	135
4.2.2.1	Experimental apparatus and materials	135
4.2.2.2	Experimental work-flow	136
4.2.2.3	Experimental Observations	138
4.3	(Submitted manuscript) Pre-, syn- and post-tectonic magma emplacement along strike-slip and transtensional fault zones: Insights from analogue models of surface deformation and intrusion geometry	139
4.3.1	Introduction	140
4.3.2	Experimental setup and materials	141
4.3.2.1	Experimental setup	141
4.3.2.2	Analogue materials	143
4.3.2.3	Scaling and Similarity	144
4.3.2.4	Monitoring and Analysis	146
4.3.3	Experimental observations and interpretation	146
4.3.3.1	Reference models (Group R)	147
4.3.3.2	Intrusion models in the strike-slip Regime (Group A)	149
4.3.3.2.1	Effect of intrusion on fault evolution	149
4.3.3.2.2	Effect of deformation on intrusion geometry	151
4.3.3.3	Intrusion models in the transtensional regime (Group B)	154
4.3.3.3.1	Effect of intrusion on fault evolution	154
4.3.3.3.2	Effect of deformation on intrusion geometry	156
4.3.4	Discussion of experimental results	158

4.3.4.1	Model boundary conditions, simplifications and limitations	158
4.3.4.2	Comparison with previous results.....	160
4.3.4.2.1	Controlling parameters on pluton emplacement.....	160
4.3.4.2.2	Interactions between deformation and pluton shape	160
4.3.4.3	Comparison to nature.....	162
4.3.4.3.1	Strike-slip setting	162
4.3.4.3.2	Transtension setting	163
4.3.5	Conclusions	164
4.3.5.1	Acknowledgments of the paper	165
5	Chapter 5 - 3D model of Monzoni Intrusion	167
5.1	Introduction.....	167
5.2	Fault and Intrusion Boundary modelling.....	169
5.3	Stratigraphical Surfaces modelling	172
5.4	Final 3D grid.....	173
6	Chapter 6 – Discussions (Proposed Monzoni pluton-emplacement models)	177
7	Chapter 7- Concluding remarks	186
8	References	189

Index of figures

Figure 1.1 - Simplified geological map of the central Western region of the Dolomites and the study area of the Monzoni Intrusive Complex (after Bosellini, 1996).	25
Figure 1.2 - Topographic map of the Monzoni (from the IGM map 1:25.000)	25
Figure 1.3 - Geological profile of the Monzoni intrusion from the milestone “Die Dolomit-Riffe von Sudtirol und Venetien” by Mojsisovics (1879).	27
Figure 1.4 - Distribution of the Ladinian intrusive bodies in the Dolomite region.	28
Figure 2.1 - a) Structural scheme of the Alps (simplified from Bigi et al., 1990; Castellarin et al., 2006;) with the location of the TRANSALP profile (TAP), b) Zoom-in map of the simplified tectonic outline of the Southern Alps (Doglioni, 1987), c) Simplified cross-section of the Dolomite region and major tectonic features (Castellarin et al., 2006).	33
Figure 2.2 - This area, and particularly the Predazzo intrusion, was crucial in the international debate between Plutonist and Neptunist during IXX century. Many geologists visit this mountain after the note of Marzari Pencati of 1820: “..... attorno a Canzocoli il calcare alpino, che giace sotto le rocce cristalline, assume un aspetto granulare, simile a quello del conosciuto marmo di Carrara ... La osservata sovrapposizione del granito sul calcare alpino, come sul calcare del Giurassico, è un dato di fatto estremamente importante e testimonia la messa in posto di questo tipo roccioso in età molto recente ...”. The outcrop “Canzocoli” in a sketch by a geologist in 1849 (Museo di Predazzo collection), the “Kalkstein” (metamorphosed limestone), surrounds a large intrusive body of “granite” (a Monzonite-Syenite).....	35
Figure 2.3 – (A-C):Schematic representation of the bio-chronostratigraphic framework of the lithostratigraphic units forming the Triassic of the Dolomites. BSS: Metamorphic basement; Vp: Permian porphyries; GAR: Val Gardena Sds; BEL: Bellerophon Fm; WER: Werfen Fm; LSI: Lower Serla Dm; PPS: Piz da Peres Cgm; DAD: Gracilis Fm; NTR: Mt. Rite Fm; VTG: Voltago Cgm; SLS: Upper Serla Dm; DON: Dont Fm; RIC: Richthofen Cgm; MRB: Morbiac Fm; CTR: Contrin Lms; BIV: Mt. Bivera Fm; MBT: Ambata Fm; SCI: Sciliar Fm; LVN: Livinallongo/Buchenstein Fm; V: Ladinian volcanics; ADZ: Zoppè Sds; AQT: Acquatona Fm; IMF: Mt. Fernazza Fm; WEN: Wengen Fm; DCS: Cassian Dm; SCS: San Cassiano Fm; HKS: Heiligkreutz Fm; TVZ: Travenanzes Fm; DPR: Dolomia Principale; DAH: Dachstein Lms; CG: Calcarei Grigi; ARV: Ammonitico Rosso Veronese; PUE: Puez Marls (modified from Gianolla et al. 2009).....	36
Figure 2.4 - Cross-section of the thick Permian Volcanic succession recording the tectono-volcanic (rifting) phase that affected the Dolomites during the Early Permian and the several calderas filled by volcanoclastics. The volcanic succession and the metamorphic basement horst (BSS) are covered by a blanket of fluvial sands, the Val Gardena Sandstone (Piccin et al., 2009).	37
Figure 2.5 - View of the Uppermost Permian Bellerophon Formation, overlain by the Lower Triassic Formation of Werfen, in Passo Valles (WER=Werfen Fm, Tesero, Mazzin, Andraz and Siusi Mbs.). The P/T boundary is placed close to the base of the first steep wall (Tesero Horizon). The clinostratified, high relief carbonate platform of the Pale di San Martino (SCI = Sciliar Fm) is visible.	38

Figure 2.6 - Stratigraphy of the upper Permian interval in the Dolomite Region showing the relationship between Val Gardena Sandstones (AVG) and Bellerophon Formation (B) (Neri, 2007).	39
Figure 2.7 - View of the stratigraphic sequence from Catinaccio/Rosengarten platform. as seen from Passo Costalunga, recording more than 5 km of progradation of late Anisian to early Ladinian slopes (after Gianolla et al., 2011).	41
Figure 2.8 Panoramic view of the Agnello massif as seen from Rifugio Torre di Pisa (from the north). The Ladinian volcanic products are overlapping on the platform and the other sedimentary formations (Gianolla et al., 2010)	42
Figure 2.9 - Regional geological cross-section at the Ladinian-Carnian boundary. The volcanic edifices were dismantled, and the submarine morphology partially levelled by the Marmolada Conglomerate and by the Wengen Fm volcanoclastic accumulation. On the topographic highs, the growth of a new generation of carbonate platforms was favoured (Cassian Dolomite), prograding onto shallowing basins. WEN: Wengen Fm and Marmolada Conglomerate; SCS: S. Cassiano Fm; DCS: Cassian Dolomite (from Bosellini, 1996).	43
Figure 2.10 - View of the post-volcanic stratigraphic sequences of the Tofana di Rozes, close to Cortina d'Ampezzo	44
Figure 2.11 - Early Jurassic Paleogeography of the Dolomites.	45
Figure 2.12 - Distribution of present-day Permian and Ladinian plutonic and volcanic rocks. The formation of Permian volcanites is connected to syn-volcanic extensional tectonics with NW-SE and NE-SW trending faults with half graben geometries. CL = Calisio paleo-line, VL = Val Sugana paleo-line. (from Brandner et al., 2016)	46
Figure 2.13 - Schematic bio-chrono-stratigraphic scheme of the Middle-Upper Triassic succession of the Dolomites with the most important magmatic pulse recorded as ash falls, tephros or effusives. The position of the known possible source volcanic areas from the Southern Alps is indicated. In the subsurface of Venetian Plain, a significant number of volcanic products (mainly effusives and intrusive) is known (eg Brusca et al., 1980) Lithostratigraphic abbreviations: WER: Werfen Formation; SLI: Lower Serla Dolomite; PPS: Piz da Peres Conglomerate; FCL: Collalto Formation; NTR: Monte Rite Formation; GLS: Gracilis Formation; VTG: Voltago Conglomerate; DON: Dont Formation; REC: Recoaro Limestone; SLS Upper Serla Dolomite/Formation; MRB/RIC: Richtigshofen Conglomerate and Morbiac dark Limestone; BIV: Bivera Formation; MBT: Ambata Formation; MNA: Moena Formation; CTR: Contrin Formation; BHL: Livinallongo Formation; SCI: Sciliar Formation; ADZ: Zoppè Sandstone; AQT: Acquatona Formation; IMF: Fernazza Volcanic Complex; WEN: Wengen Formation; SCS: San Cassiano Formation; DCS: Cassian Dolomite; HKS: Heiligkreuz Formation; TVZ: Travenanzes Formation; DPR: Dolomia Principale. Lithologies: a) cherty limestone; b) sandstone; c) sandy limestone; d) volcanics and volcanoclastics; e) oolitic-bioclastic limestone; f) black platy limestone or dolostone, black shale; g) dolostone; h) marlstone, claystone and shale; i) marly limestone; j) conglomerate; k) evaporites; l) tuffs, pyroclastics; m) lava, pillow-lava-pillow breccia; n) volcanoes with mainly explosive eruptions; o) volcanoes with mainly effusive eruptions. LPV, MPV, UPV= Lower -Middle - Upper	

Pietra Verde. Ages from GTS 2012 modified after Kent et al. (2017) and Wotzlaw et al. (2017).	50
Figure 2.14 - Overview of the Anisian - Ladinian carbonate platforms, basins and Late Ladinian intrusions.....	52
Figure 2.15 - Simplified tectonic map of the eastern Southern Alpine realm (Castellarin et al., 1998b)	53
Figure 2.16 - Block-diagram reconstruction of the main tectonic phases in the upper crust of the Dolomites. i) Permo-Mesozoic rifting; ii) Middle Triassic transcurrent tectonics along the N70°E axis; iii) Paleogene, E-W compression (modified after Doglioni, 1987).	54
Figure 2.17 – a) Main structural systems of Mesozoic and Cenozoic, in the Southern Alps, b) Present azimuthal direction of the main structural systems of the Eastern Southern Alps (Castellarin et al., 1998).	55
Figure 2.18 - Map of the major Middle Triassic tectonic features of Dolomites as interpreted originally by Doglioni, 1987. Red box indicates the study area of Mt Monzoni (modified after Doglioni, 1987).	57
Figure 3.1 - Data recording with the mobile GIS, during fieldwork in the Monzoni study area.	60
Figure 3.2 - N-Western-view of the Monzoni Intrusive Complex (dark unit) within the Permo-Triassic sedimentary cover.	61
Figure 3.3 - Simplified geological of the Monzoni Intrusive Complex and its host-rock formations with a schematic ESE- WSW cross section. GARM: Val Gardena Sandstones (metamorphosed), PORF: Permian Volcanics, BELM: Bellerophon Formation (metamorphosed), WER: Werfen Formation, SCIM: Sciliar Formation (metamorphosed) Lithological units of Intrusion: MONG: Monzograbbro, GABB: Gabbros, OGAB: Olivine-Gabbros, PIRO: Pyroxenite, MON: Monzonite, VULF: Major Volcanic dykes; VUL: Lavas and pillow lavas)	62
Figure 3.4 – (NEXT PAGE) Simplified geological map of the Monzoni Intrusive Complex and its host-rock formations. On the map the Boundaries and Fault surfaces are projected. GARM: Val Gardena Sandstones (metamorphosed), PORF: Permian Volcanics, BELM: Bellerophon Formation (metamorphosed), WER: Werfen Formation, SCIM: Sciliar Formation (metamorphosed). Lithological units of Intrusion: MONG: Monzograbbro, GABB: Gabbros, OGAB: Olivine-Gabbros, PIRO: Pyroxenite, MON: Monzonite, VULF: Major Volcanic dykes; VUL: Lavas and pillow lavas.	62
Figure 3.5 - a) The Permian Volcanics in the crest of Cima Bocche, b) Exposure of Permian Volcanics, in the southern flank of the mountain, c) View from Col Margherita, of the southern side, Fango and Uomo Boundaries, of Mt Monzoni, that bring in contact the Permian Volcanics (triangular facets) with the Intrusion and regionally with the overlying Formation of Val Gardena Sandstone. Are visible also the uppermost units of Bellerophon Formation.	66
Figure 3.6 - a) The Val Gardena Sandstones outcropping in the Colifon plateau, b) Metamorphosed outcrop of Val Gardena Formation, along the Eastern boundary of Monzoni intrusion.	68
Figure 3.7 - The Bellerophon Formation at the San Nicolò Pass, involved in the diapiric deformation	69

Figure 3.8 - a) Tectonic contact, at the southern boundary of the Intrusion, between the pluton and Bellerophon Formation, b) Southern boundary between Intrusion and Bellerophon and Val Gardena Formations, c) Bellerophon Formation, outcropping along the Colifon, in contact with the intrusion (Eastern Boundary).	70
Figure 3.9 - Outcrop of the Werfen Formation (Campil Member) on the southern side of the San Pellegrino Valley.....	72
Figure 3.10 - a) View of Costabella range, on the eastern side of the Intrusion. The sequence of Contrin, Livinallongo and Sciliar formations are outcropping. A basaltic sill intrudes along the Contrin - Livinallongo contact, b) The Livinallongo Formation close to the Rifugio Vallaccia, c) The Sciliar Formation widely outcrops in the Vallaccia area and in the Costabella range.	74
Figure 3.11. - K ₂ O-SiO ₂ diagram (Peccerillo & Taylor, 1976) for Mt. Monzoni rocks. Shaded area refers to the distribution of other middle Triassic magmatic occurrences in the Southern Alps (after Castellarin et al., 1988 and Sloman, 1989 and reference therein).	77
Figure 3.12 - View of the eastern side of the contact between the Monzoni Intrusion (Olivine-Gabbro unit) and the sedimentary cover (Bellerophon and Werfen Formations) on the crest of the Mt. Monzoni.....	78
Figure 3.13 (NEXT PAGE) - Geological map of the Monzoni Intrusive Complex and sedimentary cover without faults (GARM: Val Gardena Sandstones (metamorphosed), PORF: Permian Volcanics, BELM: Bellerophon Formation (metamorphosed), WER: Werfen Formation, SCIM: Sciliar Formation (metamorphosed)) and its lithological units (MONG: Monzogabbro, GABB: Gabbros, OGAB: Olivine-Gabbros, PIRO: Pyroxenite, MON: Monzonite, VULF: Major Volcanic dykes; VUL: Lavas and pillow lavas).....	79
Figure 3.14 - a) Monzonic outcrop; b) Monzo-gabbro outcrop at the crest of the Monzoni intrusion.	82
Figure 3.15 - Dyke swarm around the Middle Triassic Intrusive Centres.	82
Figure 3.16 - Dykes in the area of Monzoni. a-c) Dyke system along Costabella Formation, d) Dykes cutting the Monzoni Intrusion, e) Dykes cutting the sedimentary formations in crest Passo San Nicolò.	83
Figure 3.17 - Fault system in the broader area of the Ladinian magmatic centres in the Dolomites.	85
Figure 3.18 - Tectonic sketch of Monzoni Intrusion, illustrating the major Boundary and Fault surfaces identified in the study area.	87
Figure 3.19 - The gully developed along the Vallaccia Fault towards the Val di San Nicolò.	88
Figure 3.20 - a) Illustration of the position of the Northern and Western Intrusion Boundaries. View of the Cadin Bello Fault, b) View of the northern side of the Monzoni with the traces of Gardeccia Fault and the northern intrusion Boundary, c) Detailed view of Cima Undici (red square, b). Negative flower structure forming on top of the Sciliar platform.	89
Figure 3.21 - a) View of the Eastern, Northern and Western Intrusion Boundaries, b) of the contact between the Monzoni pluton and the Sciliar Formation (a: facing the south), c) Traces of the Northern Intrusion Boundary, from Rif. Vallaccia, d) Panoramic view of the Monzoni Eastern and Southern Boundaries (view from col Margherita).....	90

Figure 3.22 - Simplified geological map of the Southern Alps. Alps: 1) Australpine, Penninic and Helvetic units; 2) Southern Alps units. Apennines: 3) Apenninic units; 4) Tertiary and Quaternary volcanic and plutonic bodies; 5) foreland units; 6) foreland basin units; 7) Dinaric units; 8) normal faults; 9) thrust faults. Redrawn and simplified from Bigi et al. (1990). The dashed rectangle shows the location of the map of Figure 3.23.	93
Figure 3.23 - Simplified geological map of the central Western region of the Dolomites.	96
Figure 3.24 - Schematic bio-chrono-stratigraphic scheme of the Middle-Upper Triassic succession of the Dolomites with the most important magmatic pulse recorded as ash falls, tephra or effusives. The position of the known possible source volcanic areas from the Southern Alps is indicated. In the subsurface of Venetian Plain, a significant number of volcanic products (mainly effusive and intrusive) is known (eg Brusca et al., 1980) Lithostratigraphic abbreviations: WER: Werfen Formation; SLI: Lower Serla Dolomite; PPS: Piz da Peres Conglomerate; FCL: Collalto Formation; NTR: Monte Rite Formation; GLS: Gracilis Formation; VTG: Voltago Conglomerate; DON: Dont Formation; REC: Recoaro Limestone; SLS Upper Serla Dolomite/Formation; MRB/RIC: Richtigofen Conglomerate and Morbiac dark Limestone; BIV: Bivera Formation; MBT: Ambata Formation; MNA: Moena Formation; CTR: Contrin Formation; BHL: Livinallongo Formation; SCI: Sciliar Formation; ADZ: Zoppè Sandstone; AQT: Acquatona Formation; IMF: Fernazza Volcanic Complex; WEN: Wengen Formation; SCS: San Cassiano Formation; DCS: Cassian Dolomite; HKS: Heiligkreuz Formation; TVZ: Travenanzes Formation; DPR: Dolomia Principale. Lithologies: a) cherty limestone; b) sandstone; c) sandy limestone; d) volcanics and volcanoclastics; e) oolitic-bioclastic limestone; f) black platy limestone or dolostone, black shale; g) dolostone; h) marlstone, claystone and shale; i) marly limestone; j) conglomerate; k) evaporates; l) tuffs, pyroclastics; m) lava, pillow-lava-pillow breccia; n) volcanos with mainly explosive eruptions; o) volcanos with mainly effusive eruptions. LPV, MPV, UPV= Lower -Middle - Upper Pietra Verde. Ages from GTS 2012 modified after Kent et al. (2016) and Wotzlaw et al. (2017).	98
Figure 3.25 - Fault system in the broader area of magmatic centres.	100
Figure 3.26 - Geological map of the Predazzo area (from Visonà, 1997), showing the location of the sampling sites.....	102
Figure 3.27 - Geological map of the Monzoni area, showing the location of the sampling sites. ...	103
Figure 3.28 - Geological map of the Predazzo area (from Visonà, 1997), showing the location of the sampling sites and the relative measured magnetic foliations and lineations.	108
Figure 3.29 - Geological map of the Monzoni area, showing the location of the sampling sites and relative measured magnetic foliations and lineations.	109
Figure 3.30 - Magnetic mineralogy results for selected samples from Predazzo and Monzoni plutons. a-d) Thermomagnetic curves; red and blue lines represent the heating-cooling cycle respectively; e-h) Hysteresis loops, corrected for the paramagnetic linear trend; i-l) IRM acquisition curves (green lines) and backfield applications (black lines).....	110
Figure 3.31 - Shape parameters for the analyzed sites: a) F-L diagram; b) P'-T diagram.	111
Figure 3.32 - Low-field AMS plots for representative sites in the Predazzo (a-f) and Monzoni (i-l) intrusive bodies. Data are plotted on lower hemisphere, equal area projections. Squares, triangles	

and circles represent maximum, intermediate and minimum axes, respectively, plotted relative to geographic coordinates.	113
Figure 3.33 - Lower hemisphere equal area projections of the principal axes of the low-field/room temperature (black symbols), high-field paramagnetic (red symbols) and high-field ferromagnetic (blu symbols) susceptibility ellipsoids. Percentages of the relative contribution of ferromagnetic and paramagnetic susceptibility to the magnetic fabric is also reported for each specimen. ...	115
Figure 3.34 - (a, b, c, d, e, f) Photomicrographs showing a clear shape-preferred orientation of minerals (magmatic foliation); a, b) Clinoprexcnte sample from Predazzo; c, d, e, f) Olivine gabbro from Monzoni.	117
Figure 3.35 (a, b) Photomicrographs showing primary magmatic structures (e.g. poikilitic texture; a, Monzogabbros from Monzoni; b, Monzodiorite from Predazzo). c, d) Photomicrograph showing granophyric and perthitic textures which formed in subsolidus stage in biotite-granite; e) Photomicrograph showing completely altered biotite to chlorite and sericite in Albitized granite; f) Photomicrograph showing kinked biotite in Monzonite from Predazzo.	118
Figure 4.1 - Simplified illustration of the proposed major theories, regarding the tectonic control on the emplacement mechanisms of magma. a) Magma is channelled by the inherited fault structure, b) magma emplacement, without following the tectonic surface.	131
Figure 4.2 - a) Construction of the experimental apparatus (linear actuator, mobile plates, side walls), used for the experiments in Potsdam, b) oblique view of the experimental apparatus for transtensional deformation, c) preparation of the experimental setup: sieving model materials (d) for the brittle layer, e) oblique view of the experimental apparatus before deformation.	133
Figure 4.3 - Description of experimental apparatus, used for the experiments in Oslo. a) Schematic illustration of the experimental setup (modified from Galland, 2012; Galland et al., 2006), b) Experimental box. Half of the box base, is movable, for strike-slip deformation, c) syringe injecting the vegetable oil in the box.	136
Figure 4.4 - Illustration of the workflow. a) Top view of flattened initial upper surface, before the experimental run, b) Top view of final surface deformation, in strike slip regime, c) Dismantle of the box side-walls, after the experimental run, for the brittle layer removal, d) Final experimental stage. Side-view of intrusion model	137
Figure 4.5 - Views from all model-plutons, emplaced within a deformed and non-deformed brittle layer, of low (A) intermediate (B) and high (C) cohesion.	138
Figure 4.6 - Oblique view of experimental apparatus for (a) strike-slip and (b) transtensional deformation. Arrows indicate the direction of plate movement.	142
Figure 4.7 - Details of the experimental set-up. (a) Schematic cut-out 3D view depicting its various components; (b) Model layering, (c) Kinematic basal boundary conditions I) simple shear/strike-slip, d= 310 mm; and II) Transtension (obliquity $\alpha=15^\circ$) with the initial (yellow) and final (green) positions of the mobile plates ($w= 40$ mm, $w'= 55.5$ mm, $d= 360$ mm, $d'= 375.5$ mm.	143
Figure 4.8 - Surface deformation pattern of reference experiments. Shown are snapshots of typical early (a, e, i), intermediate (b, f, j) and late (c, g, k) stages of the experimental evolution. (d-h) Cumulative shear strain in strike-slip and transtensional regime. See text for discussion.	148

Figure 4.9 - Reference experiments from final surface deformation (a-c), with the additional surface measured digital elevation models, obtained from structure from motion (d-f).....	149
Figure 4.10 - Surface deformation pattern of strike-slip experiments (Group B). Shown are snapshots of typical early (a, e, i), intermediate (b, f, j) and late (c, g, k) stages of the experimental evolution. (d-h) panels show the cumulative shear strain in strike-slip regime. See text for discussion...	150
Figure 4.11 - (a, c, e). Finite surface deformation and emplacement pattern in strike-slip experiments (Group A), shown as top-view photos for pre-, syn-, and post-tectonic experimental series. (b, d, f) Digital elevation model and main faults, for each strike-slip experiment.	151
Figure 4.12 - Images of finite pre-, syn-, and post- tectonic inner-models in strike-slip regime (Group A). From top to bottom: a) Oblique view of pluton; b) digital elevation model of the final pluton; c) Pluton sketch, illustrating the final pluton shape, in map view, and calculation of the aspect ratio (L/W); d) Orientation (trend) of pluton long axis, relative to the basal shear zone. (Red and grey quadrants, indicate extension and compression, respectively)	153
Figure 4.13 - Surface deformation pattern of transtension experiments (Group B). Shown are snapshots of typical early (a, e, i), intermediate (b, f, j) and late (c, g, k) stages of the experimental evolution. (d-h) panels show the cumulative shear strain in transtensional regime. See text for discussion.....	155
Figure 4.14 - Finite surface deformation and emplacement pattern in transtensional experiments (Group B), shown as top-view photos for Pre-, Syn-, and Post-tectonic experimental series (a, c, e). (b, d, f) for every scenario, DEM of final surface deformation is shown, with the amount of subsidence and lines illustrating the main fault structures active during the last stages.....	156
Figure 4.15 - Finite pre-, syn-, and post- tectonic intrusion geometries in the transtensional regime (Group B). From top to bottom: a) Oblique view of pluton; b) digital elevation model of the final pluton; c) Pluton sketch, illustrating the final pluton shape, in map view, and calculation of the aspect ratio (L/W); d) Orientation of pluton long axis, α , relative to the basal shear zone. Hypothetical directions of minimum and maximum horizontal stress (Red and grey quadrants, indicate extension and compression, respectively).....	157
Figure 4.16 - Shape of plutons developed in strike slip environments in natural examples. The Tazenakht Pluton (Ennih and Liegeois, 2001, Gasquet et al., 2008); the Cabeza de Araya Pluton (Vigneresse and Bouchez, 1997; Fernandez and Castro, 1999; Corti et al., 2005) and the Vila Pouca de Aguiar pluton (Sant'Ovaia et al., 2000).	163
Figure 4.17 - Shape of plutons in transtensional environment in natural examples. The Eđrigöz pluton is a pre-tectonic intrusion affected by rotation due to the transtensional deformation occurring after the emplacement (Erkül et al., 2017). The Monzoni Pluton developed within a transtensional tectonic environment (Bonadiman et al., 1994). La Tojiza Pluton is a clear example of post-tectonic intrusion only slightly reactivating the previous transtensional tectonic structures (Aranguren et al., 2003).	164
Figure 5.1 – Workflow for the 3D model construction	167
Figure 5.2 - Model boundaries (red rectangle) overlying the DEM.	168
Figure 5.3 - Example of interpolation of the fault surface, deriving from the trace of Cadin Bello Fault (blue line).....	169

Figure 5.4 - Screenshot of the Petrel dialogue window regarding the fault and boundary relationships.	170
Figure 5.5 - 3D view of the modelled Monzoni fault and boundary surfaces. Schmidt diagram for the dip azimuth and dip angle of the fault and boundary surfaces around the Monzoni intrusion..	171
Figure 5.6 - Model of the Top of the Permian Volcanics surface	173
Figure 5.7 – Resulting discrete 3D model of the intrusive body of Monzoni.	173
Figure 5.8 – Generated 3D grid at different stratigraphic levels, showing the main faults of the area. A) Top of Permian Volcanics, B) Top of Werfen Formation, C) Top Contrin/Moena Formations, D) Top Sciliar Formation.	174
Figure 5.9 – 3D model with the indication of the formations and the profiles A, B; A) Profile A, oriented in W-E direction; B) Profile B, oriented in the N-S direction.....	175
Figure 6.1 - Tectonic sketch of the Predazzo – Monzoni area.....	178
Figure 6.2 – Shape of the Monzoni intrusion with the assumed controlling faults with direction N30° and N70°	179
Figure 6.3 – Comparison among the outcropping (4.15 km ²) and hypothetical (5.5km ²) intrusion of Monzoni (a) with the results of the analogue transtensional model and the computed 3D geological model (c).	181
Figure 6.4 – Comparison of the identified faults and boundaries (a) with final deformation of syntectonic intrusion in transtension (b) and the 3D faults and boundaries model.	182
Figure 6.5 – Kinematic scenarios, Model A and Model B, suggested for the emplacement of Monzoni intrusion.....	183