



Short Course

Fluids in the Earth

September 9-13, 2019

Dipartimento Scienze dell'Ambiente e della Terra
Università di Milano - Bicocca
Milano, Italy

Presented by

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PROGRAM

1. Monday, September 9, 2019

1.1 - Introduction to phase equilibria and thermodynamics (All; 4 hours; 9:00-13:00)

The Gibbs Phase Rule; the Clausius-Clapeyron relationship; activity, fugacity; chemical potential and equilibrium; the definition of free energy and how it can be estimated from PVT data; solubility and saturation of volatiles in melts and fluids; melting diagrams for solid solutions; equilibrium between melts and simple solid solutions, the effects of changing melt/crystal proportions on the compositional evolution of solid solutions during crystallization; the effect of volatiles on crystallization temperatures of primitive magmas as a function of pressure.

1.2 - Introduction to fluid inclusions and fluid phase equilibria (Bodnar; 4 hours; 14:30-18:30)

Identification, analysis and application of fluid inclusion studies to geologic problems.

2. Tuesday, September 10, 2019

2.1 - Applications of fluid inclusions in different geological environments (Bodnar; 4 hours; 9:00-13:00)

2.2 - Introduction to fluid inclusions and fluid phase equilibria in deep C-O-H fluids (Frezzotti; 4 hours; 14.30 – 18.30)

Identification, analysis, and application of fluid inclusions to the study of deep rocks and Earth's volatile cycling.

3. Wednesday, September 11, 2019

3.1 - Introduction to melt inclusions (Danyushevsky; 4 hours; 9:00-13:00)

Melt inclusions are small portions of melt trapped by crystals growing during magma evolution, and thus can represent 'snapshot' of the conditions that existed during crystallisation. In this



lecture, trapping mechanisms of melt inclusions, their post-entrapment modifications, and experimental studies of melt inclusions will be discussed.

3.2 - Fluid and melt inclusions studies on Vesuvius and Campi Flegrei (De Vivo; 2 hours; 14:30-16:30)

3.3 - Using melt inclusions to constrain the origin of phenocrysts in strongly-phyric volcanic rocks; Timing crystallisation processes using melt inclusions; (Danyushevsky; 2 hours; 16:30-18:30)

An important implication of melt inclusions is to assess whether crystals in volcanic rocks crystallised from the same magma type as represented by the transporting melt (i.e., the groundmass of the rock), or are xenocrysts. Different examples from subduction-related volcanic suites will be shown. Post-entrapment re-equilibration of melt inclusions with their hosts can be used to assess crystallisation rates of individual phenocrysts.

4. Thursday, September 12, 2019

4.1 - Partitioning of volatiles and metals between felsic melts and the magmatic fluid phase (Bodnar; 2 hours; 9:00-11:00)

4.2 - Using melt inclusions to determine komatiite melt compositions; melt inclusion studies on Vesuvius (Danyushevsky; 2 hours; 16:30-18:30)

Melt inclusions can be a powerful tool for recovering melt compositions in ancient volcanic suites, when the groundmass in the lavas is chemically modified by alteration. A summary of recent melt inclusion studies of Vesuvius will be presented.

4.3 - Analytical techniques M.I. (Danyushevsky; 2 hours; 14:30-16:30)

An overview of micro-analytical techniques for analysis of melt and fluid inclusions.

4.4 - Raman spectroscopy for fluid and melt inclusion analysis (Frezzotti; 2 hours; 16:30-18:30)

Introduction to Raman spectroscopy for analysis of melt and fluid inclusions.



5. Friday, September 13, 2019

5.1 - General discussion (All; 2 hours; 9:00-11:00)

5.2 - Exam on material covered in the short course (2 hours; 11:00-13:00)

5.3 – Graduation and presentation of certificates (1 hour; 13:00-14:00)

**Timetable
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September 9-13th, 2019**

TIME	9.00-11.00	11.00-13.00	13.00-14.30	14.30-16.30	16.30-18.30
Monday Sept. 9th	ALL 1.1	ALL 1.1	Lunch break	RB 1.2	RB 1.2
Tuesday Sept. 10th	RB 2.1	RB 2.1	Lunch break	MLF 2.2	MLF 2.2
Wednesday Sept. 11th	LD 3.1	LD 3.1	Lunch break	BD 3.2	LD 3.3
Thursday Sept. 12th	RB 4.1	LD 4.2	Lunch break	LD 4.3	MLF 4.4
Friday Sept. 13 th	ALL 5.1	EXAM 5.2	GRADUATION 5.3		

RB = Robert Bodnar; LD= Leonid Danyushevsky; BDV = Benedetto De Vivo; MLF = Maria Luce Frezzotti; (numbers indicate the topics).