107-1 國立台灣大學 自然地理專題與海外實習

蒸氣岩漿噴發
Phreatomagmatic Eruptions

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報告大綱

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2. 詳述機制 Mechanism
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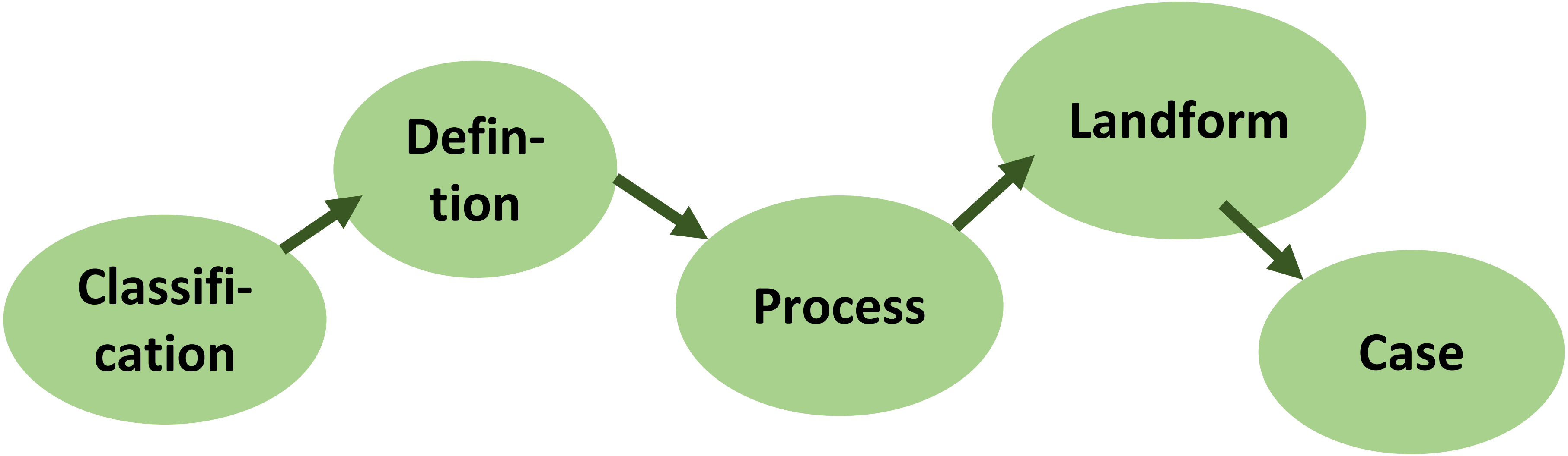
Ⅰ.簡介 Introduction



I.1 Three main volcano eruption mechanisms

a. **Magmatic eruptions**
   Decompression of gas within magma that propels it forward.

b. **Phreatic eruption**
   Driven by the superheating of steam via contact with magma with often exhibit no magmatic release.

c. **Phreatomagmatic**
   Driven by the compression of gas within magma, the direct opposite of the process powering magmatic activity.

I.2 Definition of Phreatomagmatic Eruption

Simply put,

Phreato + magmatic

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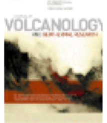
Journal of Volcanology and Geothermal Research

Volume 286, 1 October 2014, Pages 397-414



Perils in distinguishing phreatic from phreatomagmatic ash; insights into the eruption mechanisms of the 6 August 2012 Mt. Tongariro eruption, New Zealand

Natalia Pardo [a], Shane J. Cronin [a], Károly Németh [a], Marco Brenna [a], C. Ian Schipper [b, c], Eric

I.3. Mechanism

Simply put, explosive thermal contraction of particles under rapid cooling from contact with water.

Academically, the process of mechanism is called “fuel-coolant interactions”, and abbreviated as “FCI”.

I.4 Landform

Tuff Ring

凝灰岩環

Tuff Cone

凝灰錐

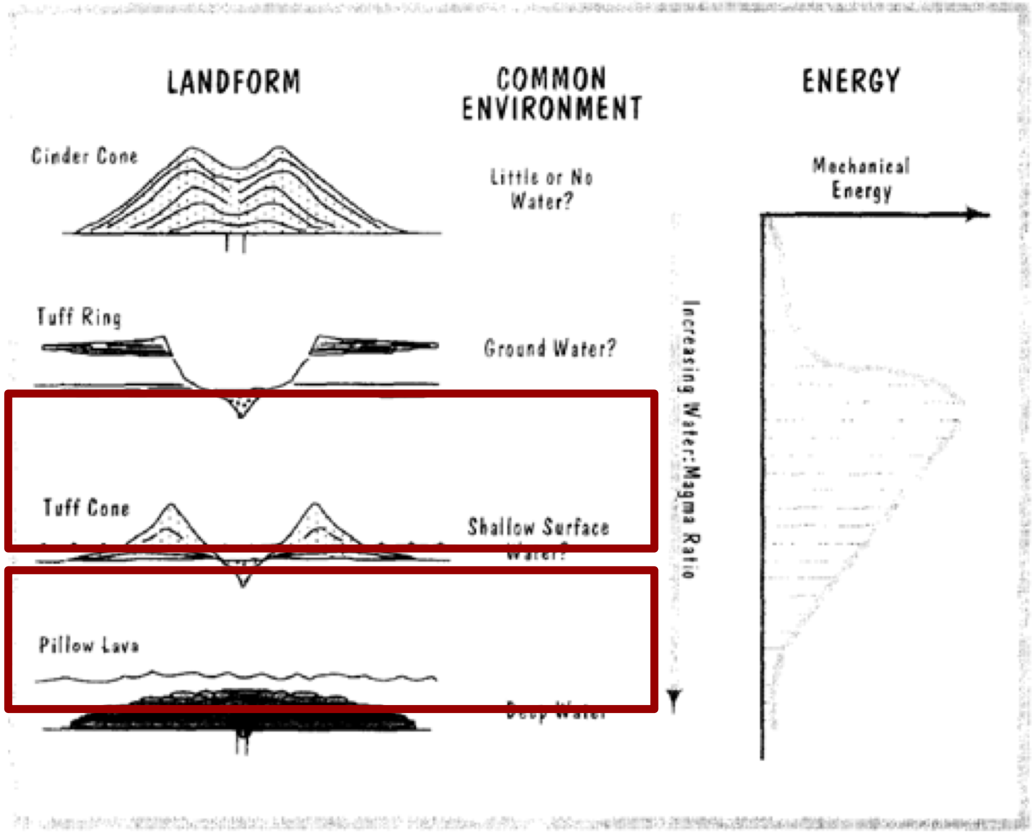


Image resource （Wohletz and Heiken, 1992）

I.4 Landform 2

- 彈道塊體裙帶

  （ballistic block aprons）
- 內聚性湧出沉積物

  （cohesive surge deposits）
- 剝落沉積物的下風葉瓣

  （downwind lobes of fall deposits）

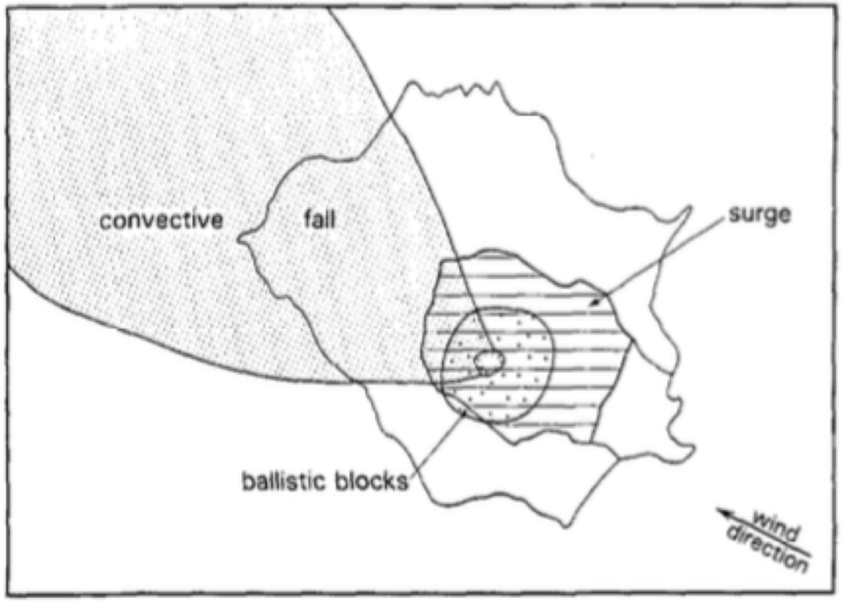


Fig. 9. Distribution of pyroclastic surge and fall deposits and ballistic blocks from a typical large discrete phreatomagmatic eruption at White Island

I.5 Case Study, White Island

Bull Volcanol (1991) 54:25–49

Bulletin of Volcanology

The 1976–1982 Strombolian and phreatomagmatic eruptions of White Island, New Zealand: eruptive and depositional mechanisms at a 'wet' volcano

BF Houghton and IA Nairn

DSIR Geology and Geophysics, PO Box 499, Rotorua, New Zealand

I.5 Case Study, White Island

Two styles of phreatomagmatic eruption in 1976-1982

Weak, near-continuous gas and ash emission

Larger, intense, discrete phreatomagmatic explosions.

Image from https://www.rankers.co.nz/experiences/194-White_Island_Tours

II.Mechanism

熔融物與冷卻劑反應

(Fuel-coolant interaction, FCI)

II. FCI過程（Fuel-coolant interaction）

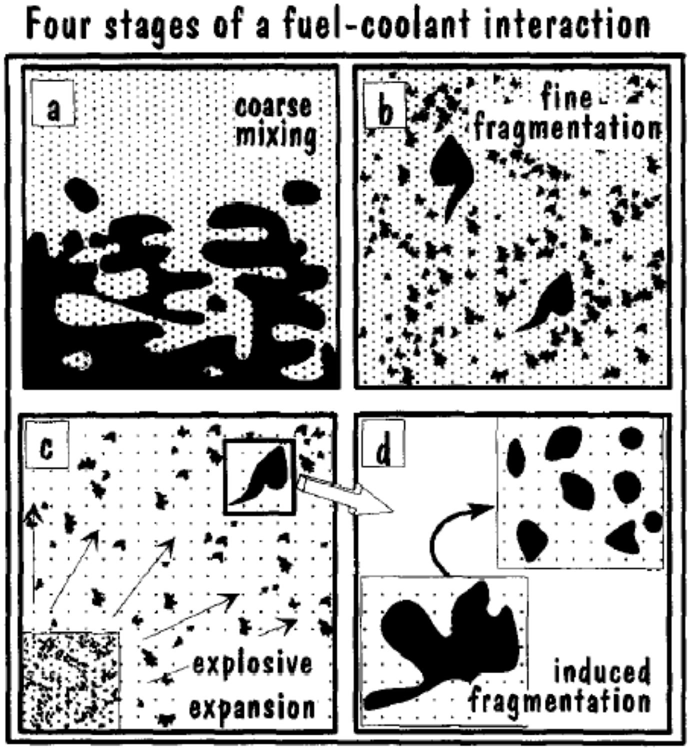


Image resource: (James D.L. White, 1996)

Phreatomagmatic eruptions' explosivity is widely accepted to result from fuel-coolant interaction (FCI) processes. (White,1996)

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Journal of Volcanology and Geothermal Research 74 (1996) 155–170

Journal of volcanology and geothermal research

Impure coolants and interaction dynamics of phreatomagmatic eruptions

James D.L. White *

II.1. Coarse mixing

Image resource: (James D.L. White, 1996)

Formation of stable vapour films generally prevents immediate explosive interaction(Carlisle. 1963: Dullforce et al.. 1976; Zimanowski et al., 1991).

II.2 Fine mixing and ,fragmentation with superheating

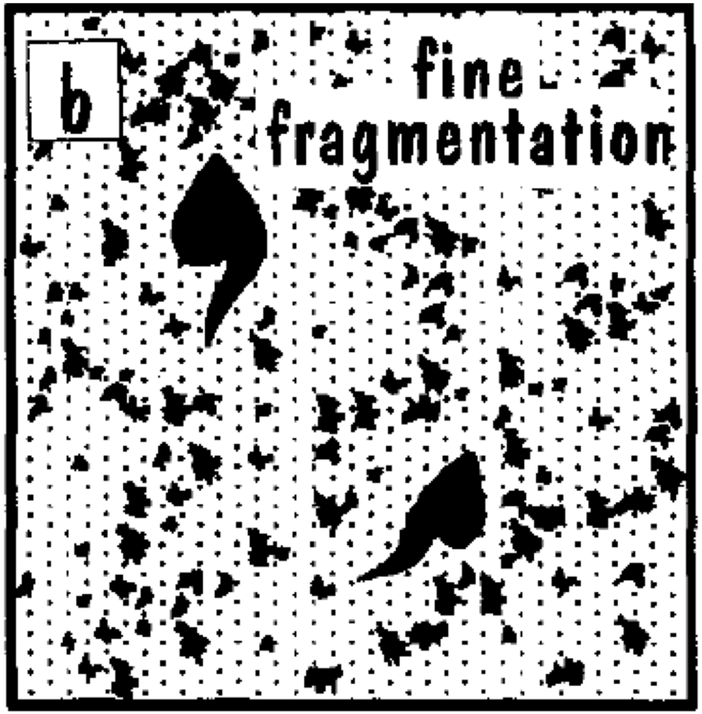


Image resource: (James D.L. White, 1996)

1. A very brief, apparently thermally driven, phase of fine mixing.
2. Fragmentation and rapid heat transfer.
3. Coolant directly contacts and fragments the melt but without significant vapor generation orexpansion.

II.3 Explosive expansion

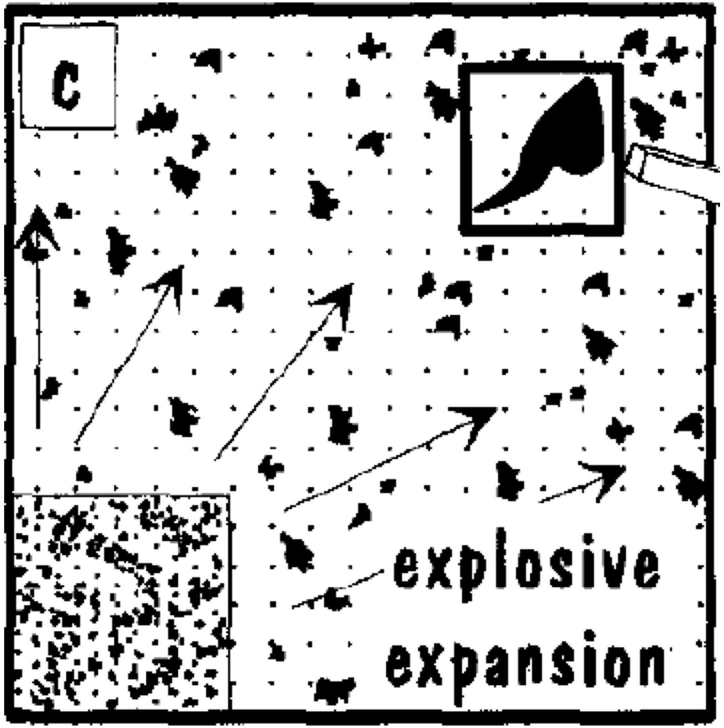
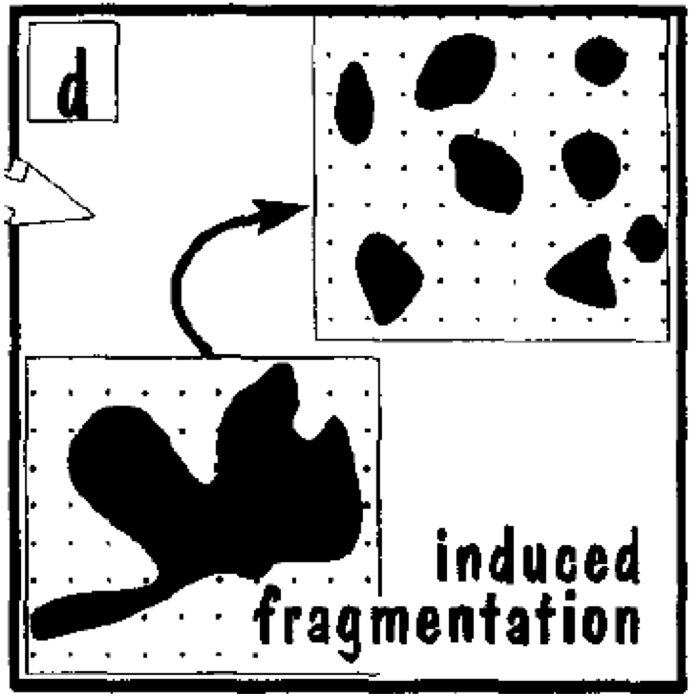


Image resource: (James D.L. White, 1996)

Direct contact between liquid melt and coolant ceases in fully efficient explosions .(Froehlich et al., 1995)

II.4 Induced fragmentation Most



Additional melt fragmentation induced by hydrodynamic processes during the expansion driven by the main explosion stage

III. Variation

Sedimentary rock water involved **phreatomagmatic** eruption

III.1 Water in sedimentary rock involved eruption

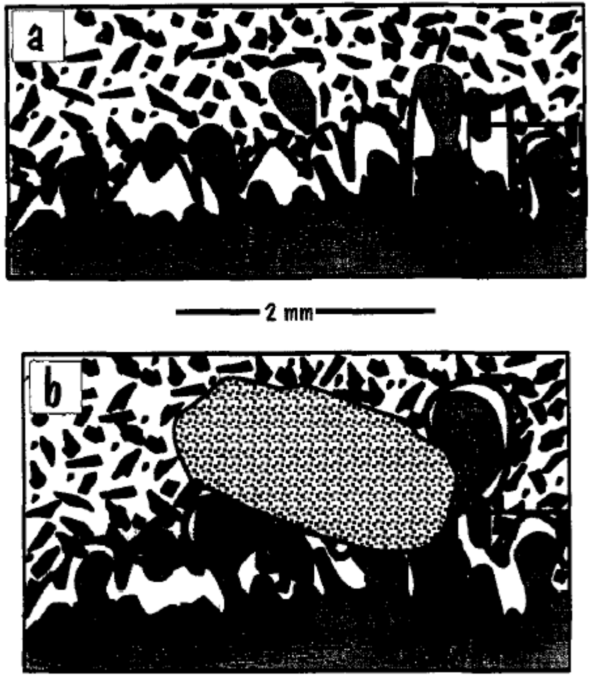


Image resource: (James D.L. White, 1996)

Coolant, boiling film and fuel interact to form a single fragment.。

- Sediment in the coolant lies within the domains.
- A larger fragment (ca. 2 mm) present, disrupting and extending.

Not be considered part of the coolant fluid.

III.2 Water in sedimentary rock involved eruption

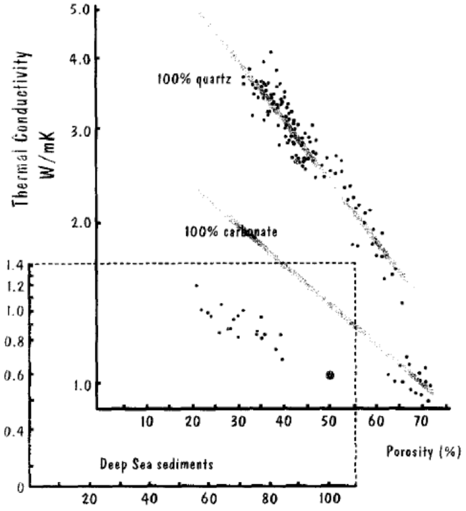


Table 1
Thermal properties of phreatomagmatic interactants

Material	Heat capacity ($kJ\,kg^{-1}\,K^{-1}$)	Mean thermal conductivity ($W\,m^{-1}\,K^{-1}$)
Basalt	1.05	1.8
Andesite	1.04	3.7
Dacite	1.17	0.69 (pumiceous)
Rhyolite	1.06	3.0
Quartz grai		8.58(Lovell, 1985)
Water	4.228	0.61 (Challoner and Powell, 1957)

Impure coolant effects

Suppressant and enhancing effects on FCI initiation .

↓

Increased nucleation sites and smaller bubble wetting angles favor FCI initiation.

↓

Increased density and viscosity are overriding effects,

↓

leading to a net increase in the triggering energy necessary to initiate FCI's.

IV.Conclusion：

Eruption and Jeju Island

IV.1：Preatomagmamtic eruption and Jeju Island

Jeju is a volcanic island. Rising from ocean in 180 million years ago with preatomagmatic eruption. Tuff rings and Tuff cones are left.

（陶奎元，2015）

IV.2：volcanic landform in Jeju Island

- Tuff Ring
- Tuff cone
- Lake

图 2　济州岛水月峰

Fig. 2　Surge tuff in Shuiyuefeng peak, Cheju Island, Korea

Thank For Listening

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