國立中央大學

National Central University

What is this?

Discussion on rock avalanche dynamics based on the surface microscopic examination of quartz grains from avalanche basal facies

Yufeng Wang

20 May, 2016

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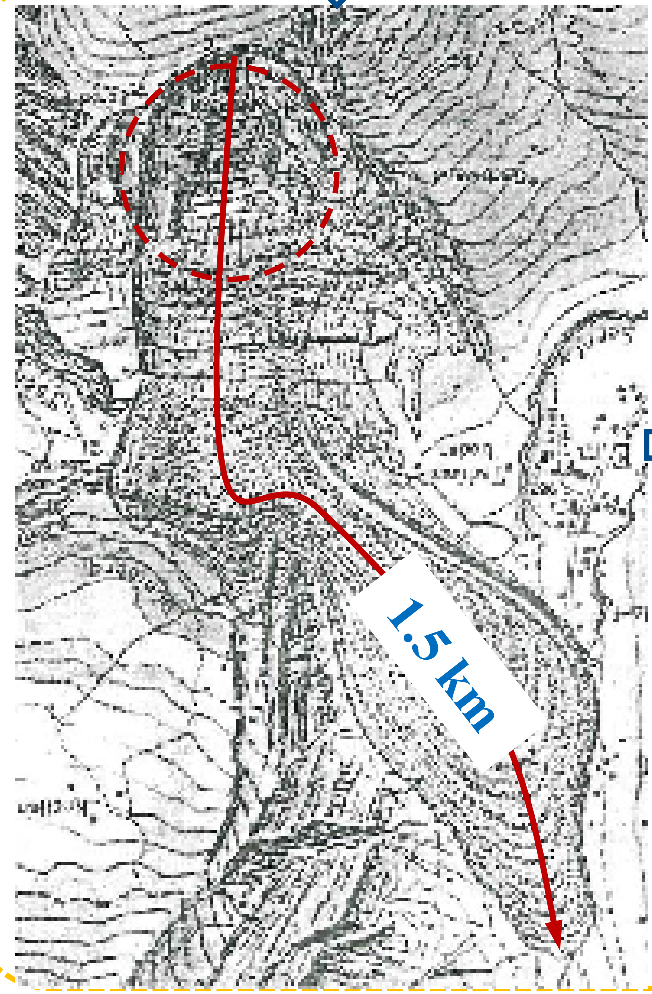
Introduction

1881 Elm rock avalanche → Heim → 1932 "Bergsturz und menschenleben"



One million m^3

Killed 115 people

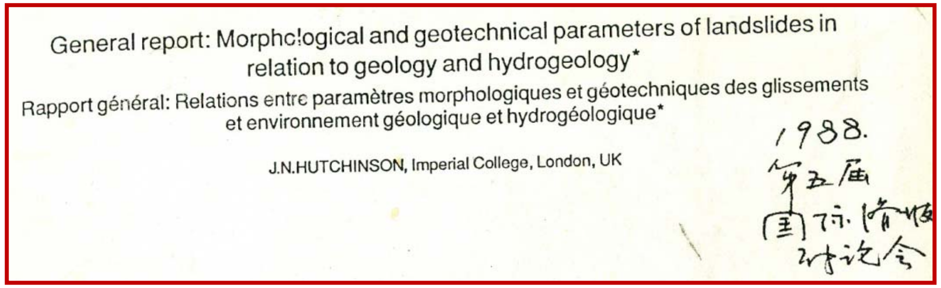
Sturzstroms

1989 Nigel Skermer

Landslides & Human Lives

Rock avalanche

Introducti


General report: Morphological and geotechnical parameters of landslides in relation to geology and hydrogeology*

Rapport général: Relations entre paramètres morphologiques et géotechniques des glissements et environnement géologique et hydrogéologique*

J.N.HUTCHINSON, Imperial College, London, UK

1988.

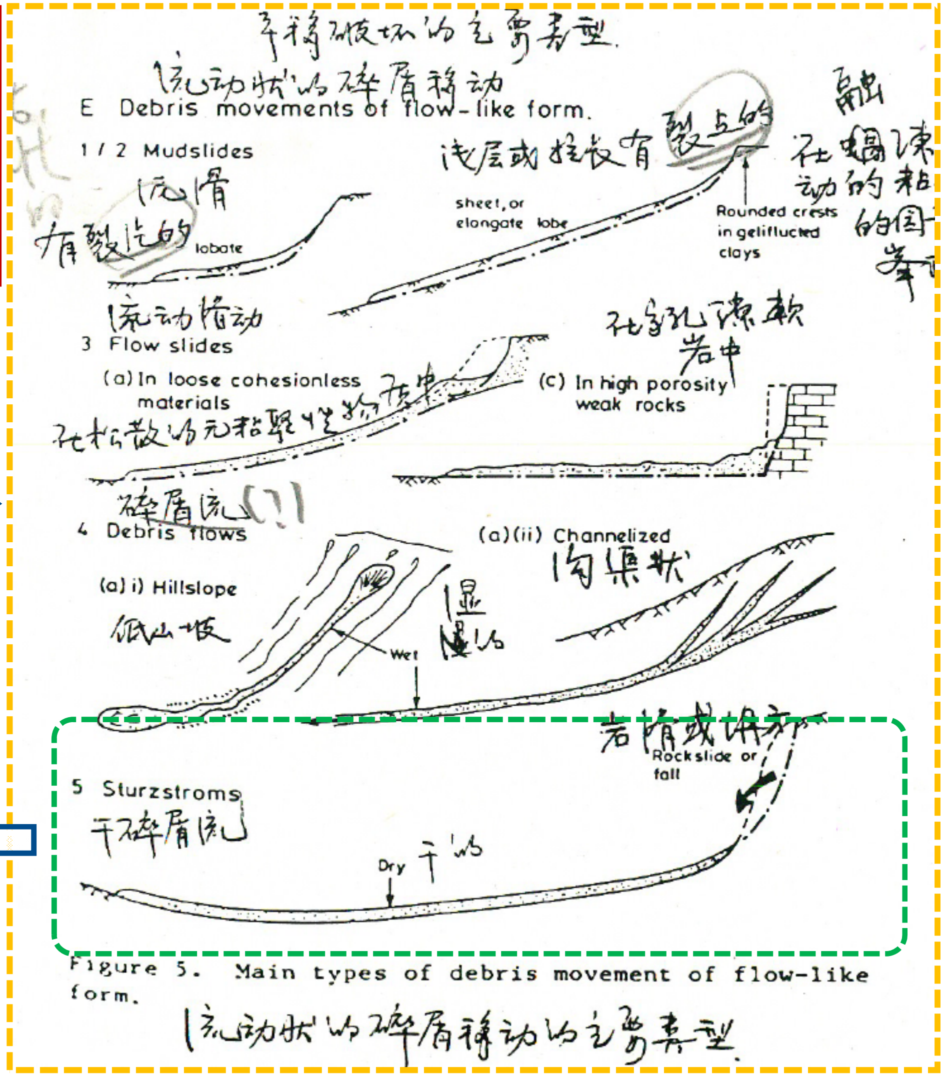


Figure 5. Main types of debris movement of flow-like form.

Extremely rapid flows of dry debris

Extremely rapid flows of debris

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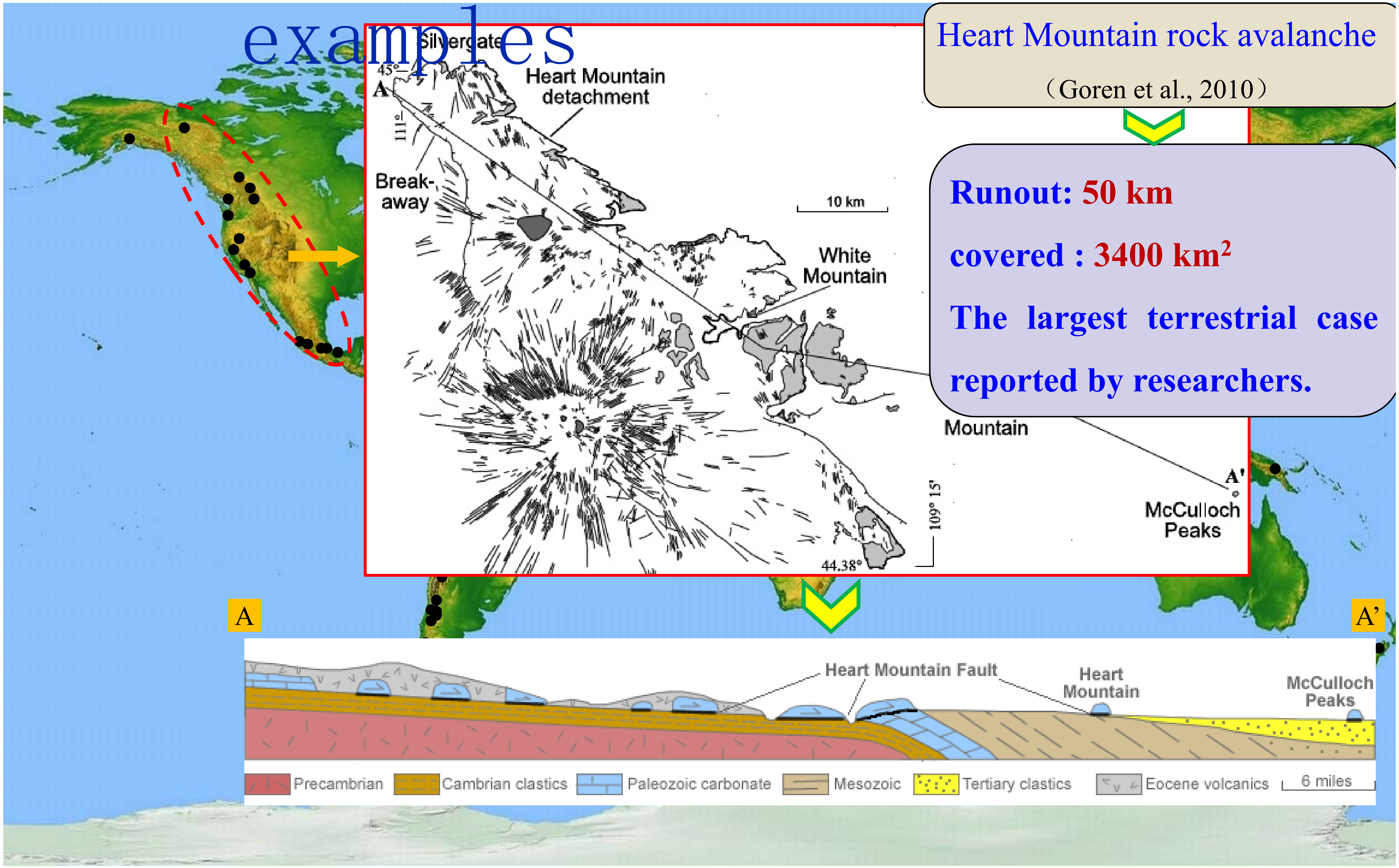
Typical examples



Heart Mountain rock avalanche

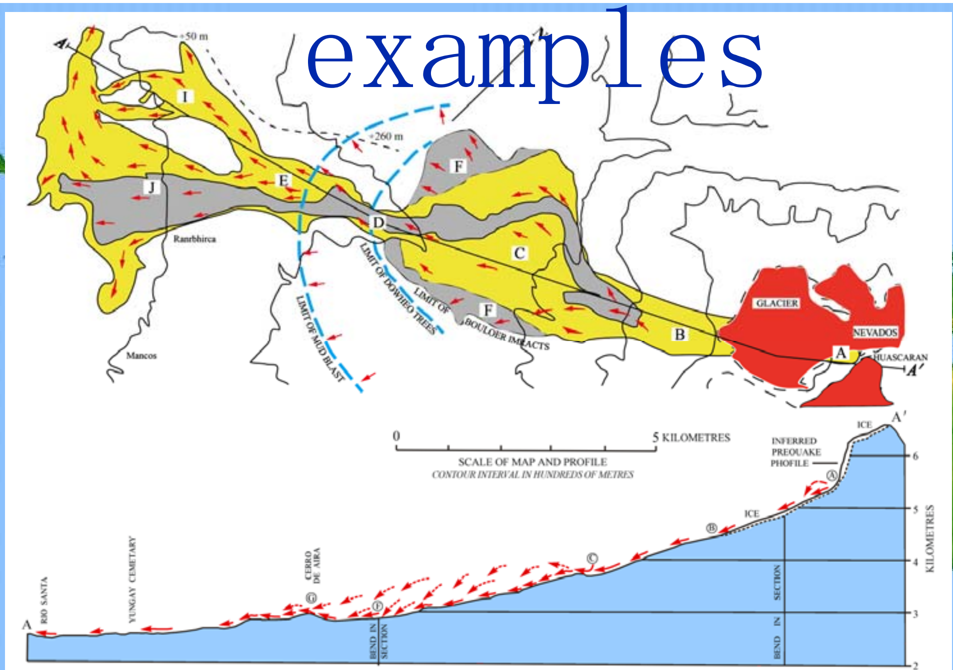
（Goren et al., 2010）

Runout: 50 km

covered : 3400 km^2

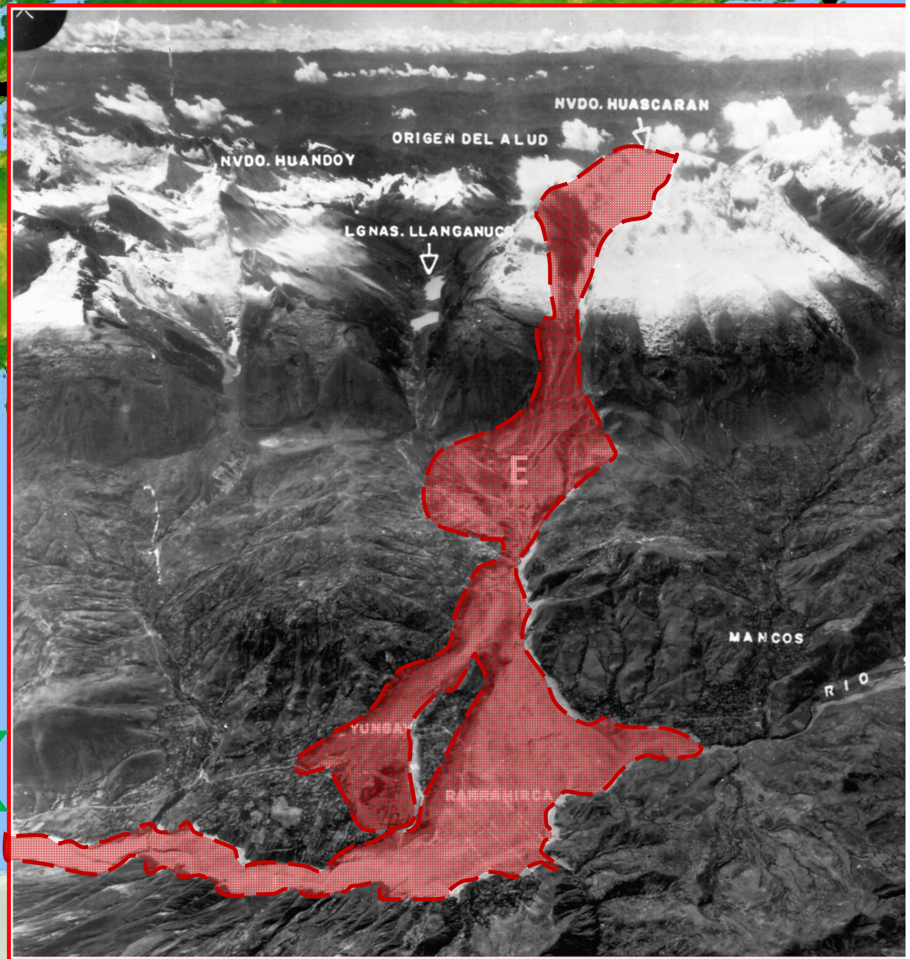
The largest terrestrial case reported by researchers.

Typical examples



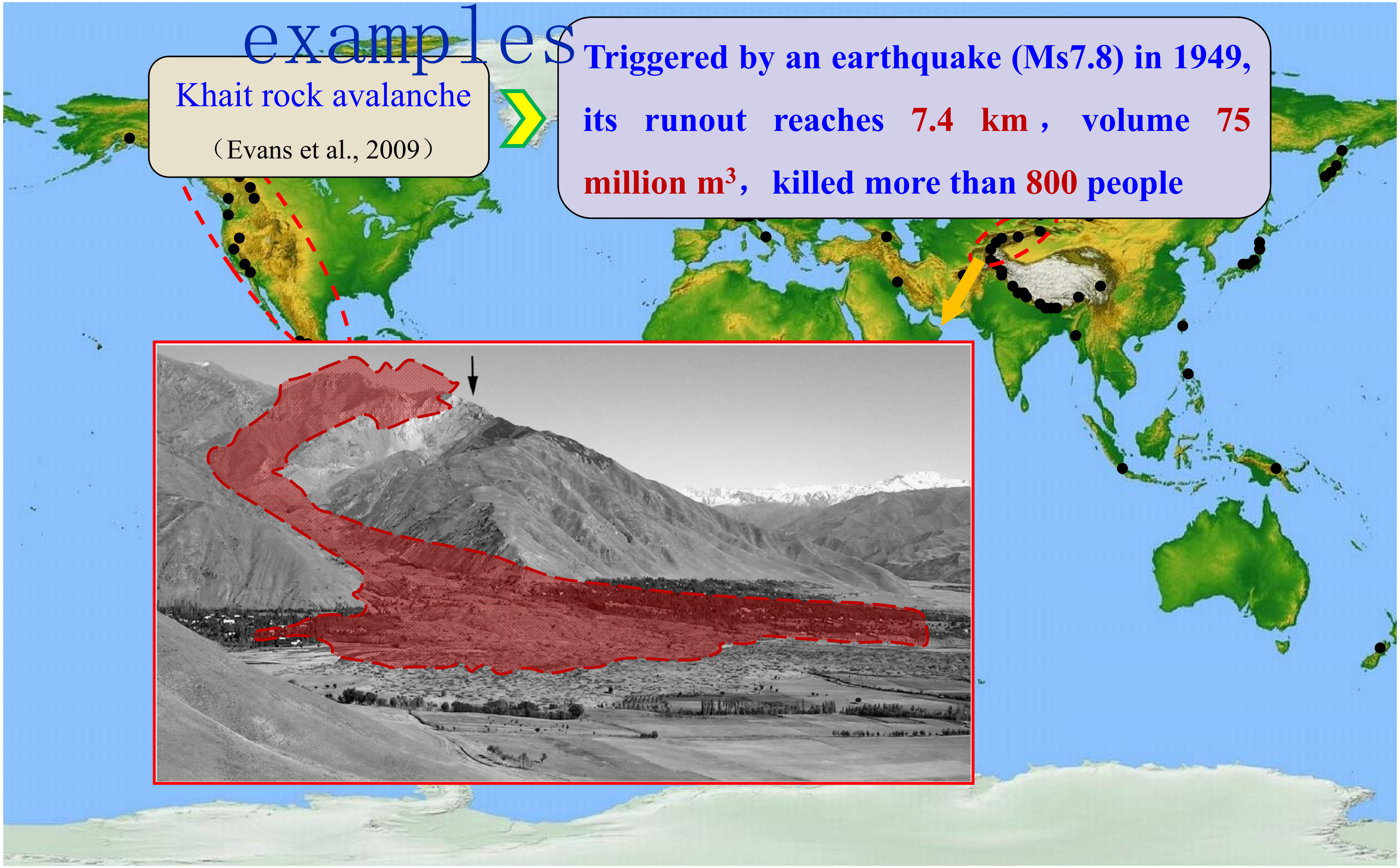
Nevados Huascaran rock avalanche

（Evans et al., 2009）



Triggered by an earthquake (Ms7.8) in 1970, volume: 100 million m^3， horizontal runout: 16 km， vertical difference: 4 km; averaged velocity: 78 m/s; covered area: 22.5 km^2, killed more than 18000 people

Typical examples

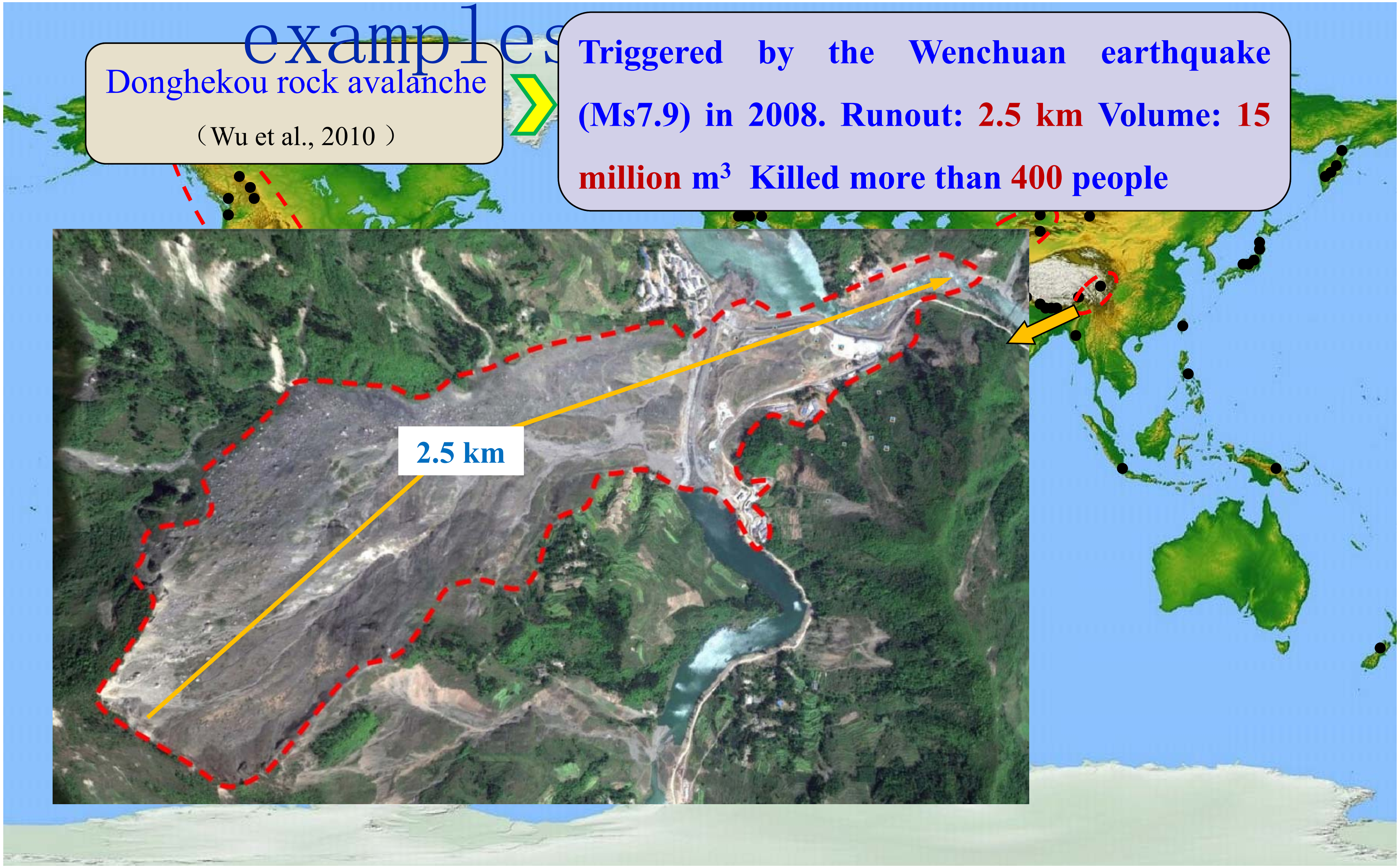


Khait rock avalanche

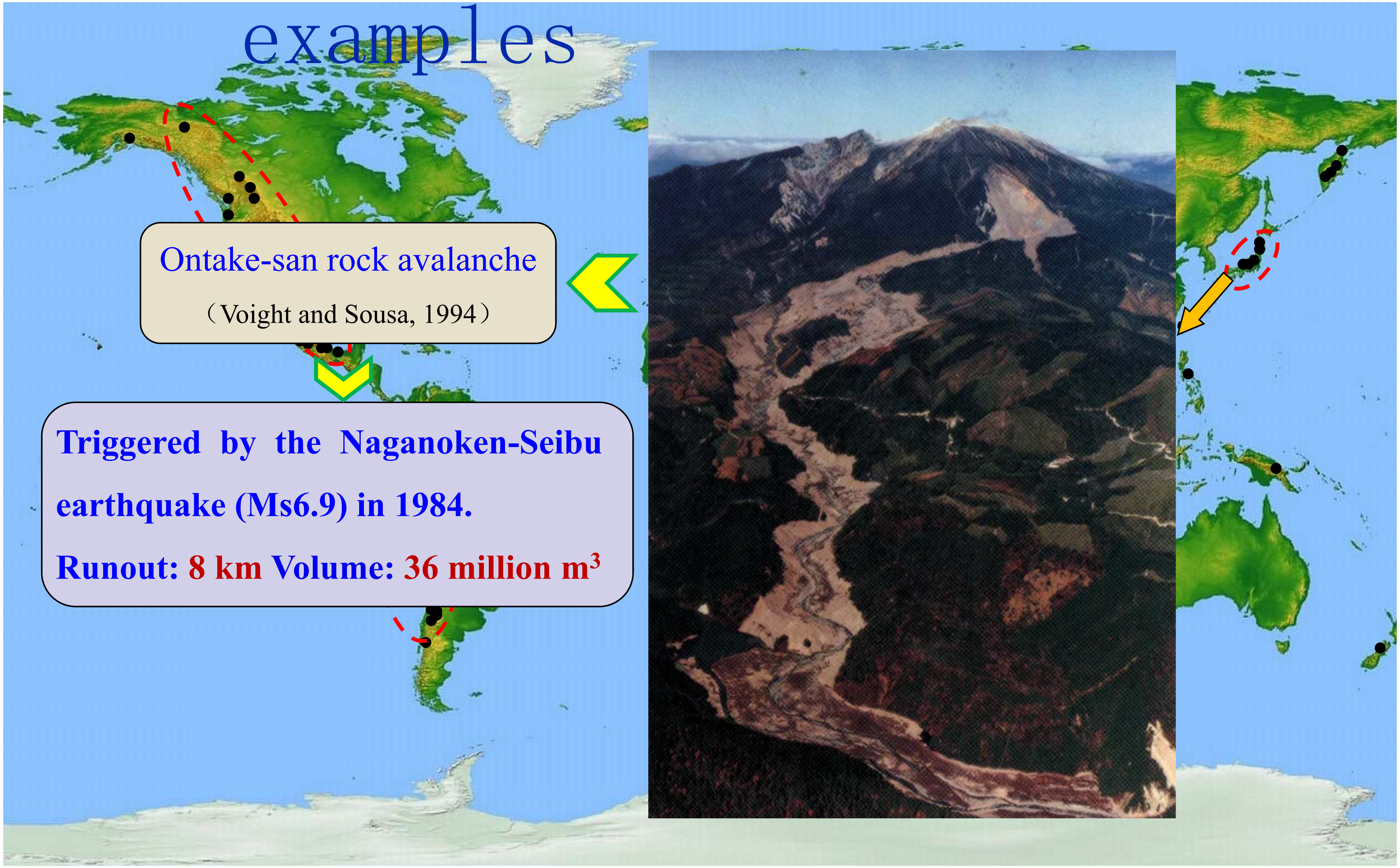
（Evans et al., 2009）

Triggered by an earthquake (Ms7.8) in 1949, its runout reaches 7.4 km， volume 75 million m^3， killed more than 800 people

Typical examples



Typical examples



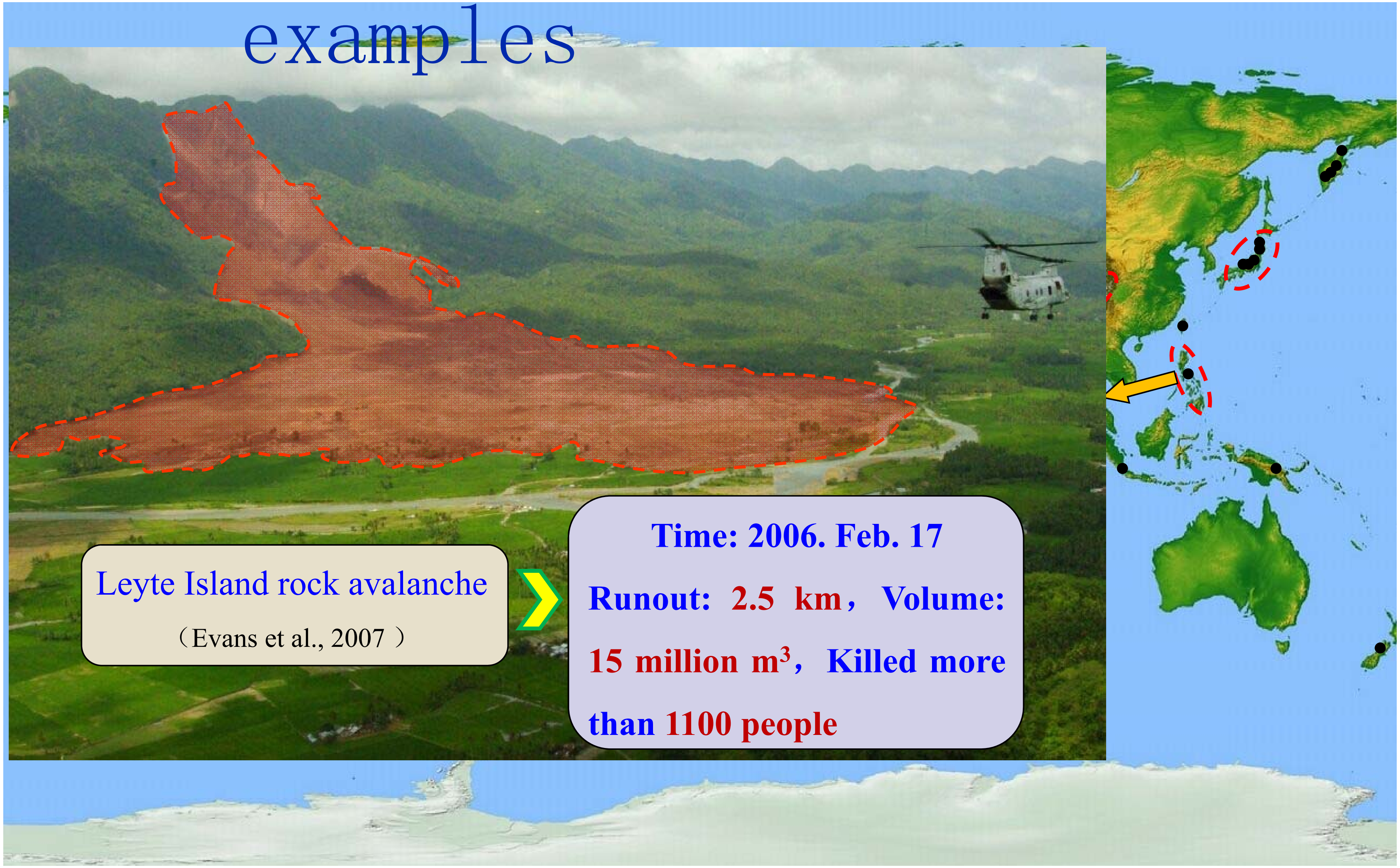
Ontake-san rock avalanche

(Voight and Sousa, 1994)

Triggered by the Naganoken-Seibu earthquake (Ms6.9) in 1984.

Runout: 8 km Volume: 36 million m^3

Typical examples



Rock avalanche

A kind of geodisasters with amazing features

- Huge volume (>10^6 m^3)
- Extremely high velocity (usually >10 m/s)
- Long runout (usually >1 km)
- High energy
- High mobility
- ………

air or vapor lubrication
(Kent 1966; Shreve 1968)

mechanical fluidization
(Bagnold 1954; Davies 1982)

acoustic fluidization
(Melosh 1986)

riding on basal pressure waves
(Kobayashi 1994)

fragmentation spreading
(Davies et al. 1999)

random kinetic energy model
(Preuth et al. 2010)

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1 **Introduction of rock avalanche**

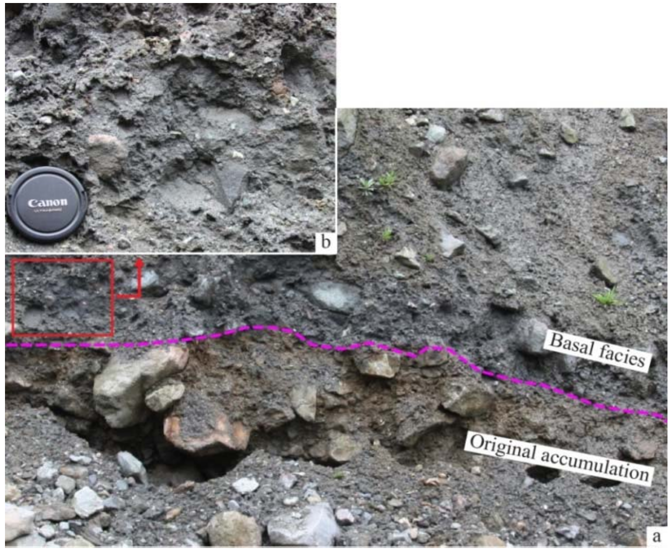
2 **Typical examples of rock avalanche**

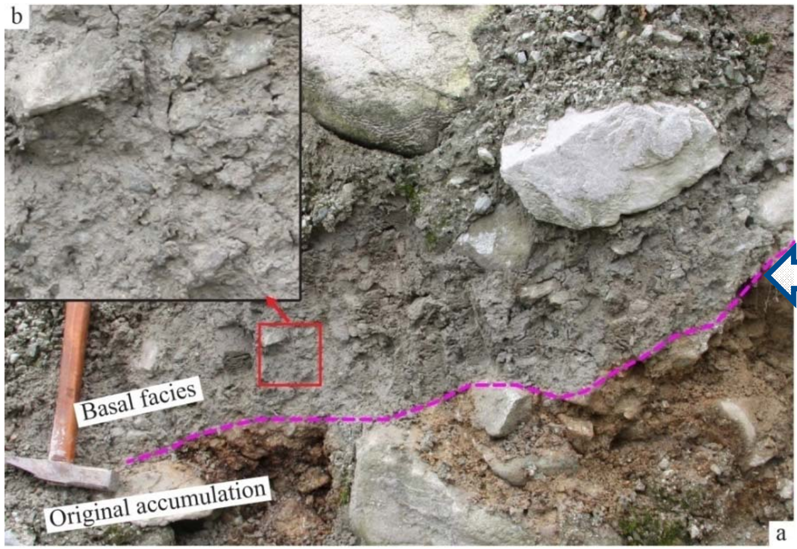
3 **My study**

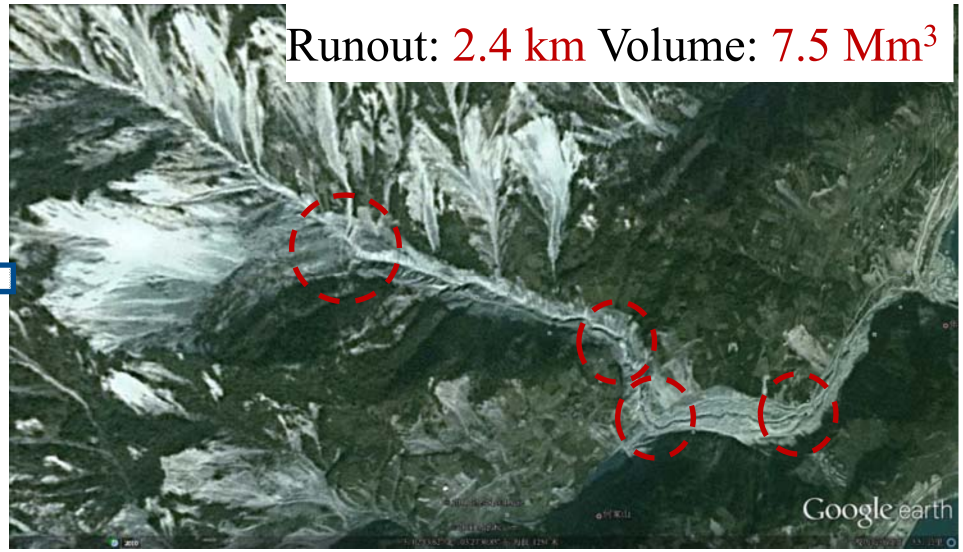
"Discussion on rock avalanche dynamics based on quartz grains surface structures"

- Field investigation and lab analysis
- Discussion and Conclusion

My study—Field investigation and lab analysis







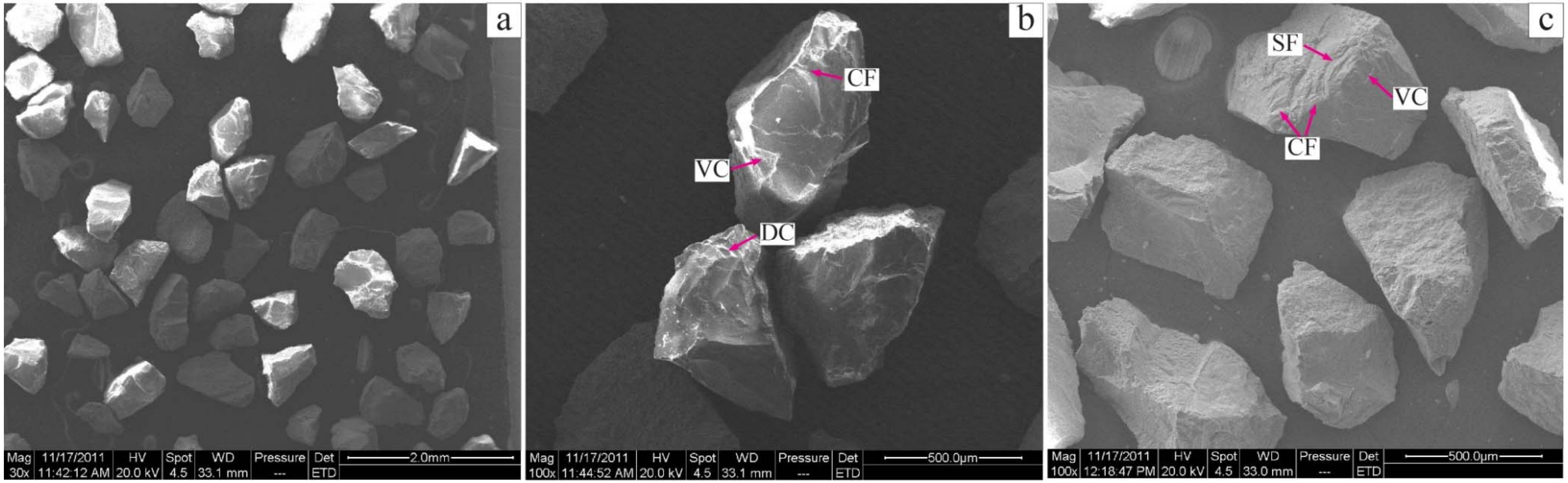
My study-Field investigation and lab analysis

Among each sample, grains with long axes from 500 to 900 μm were selected for analysis. The fracture textures used in analysis are listed in following table.

The breakage textures used in analysis

Number	Surface textures	Abbreviation
1	Conchoidal fractures	CF
2	Step fractures	SF
3	Dish-shaped concavities	DC
4	U-shaped concavities	UC
5	Curved grooves	CG
6	Cracks or fissures	C or F
7	Scratched lines	SL
8	V depressions	VD
9	V marks	VM
10	Triangle-shaped marks	TM
11	Upturned plates	UP
12	Impact pits	IP

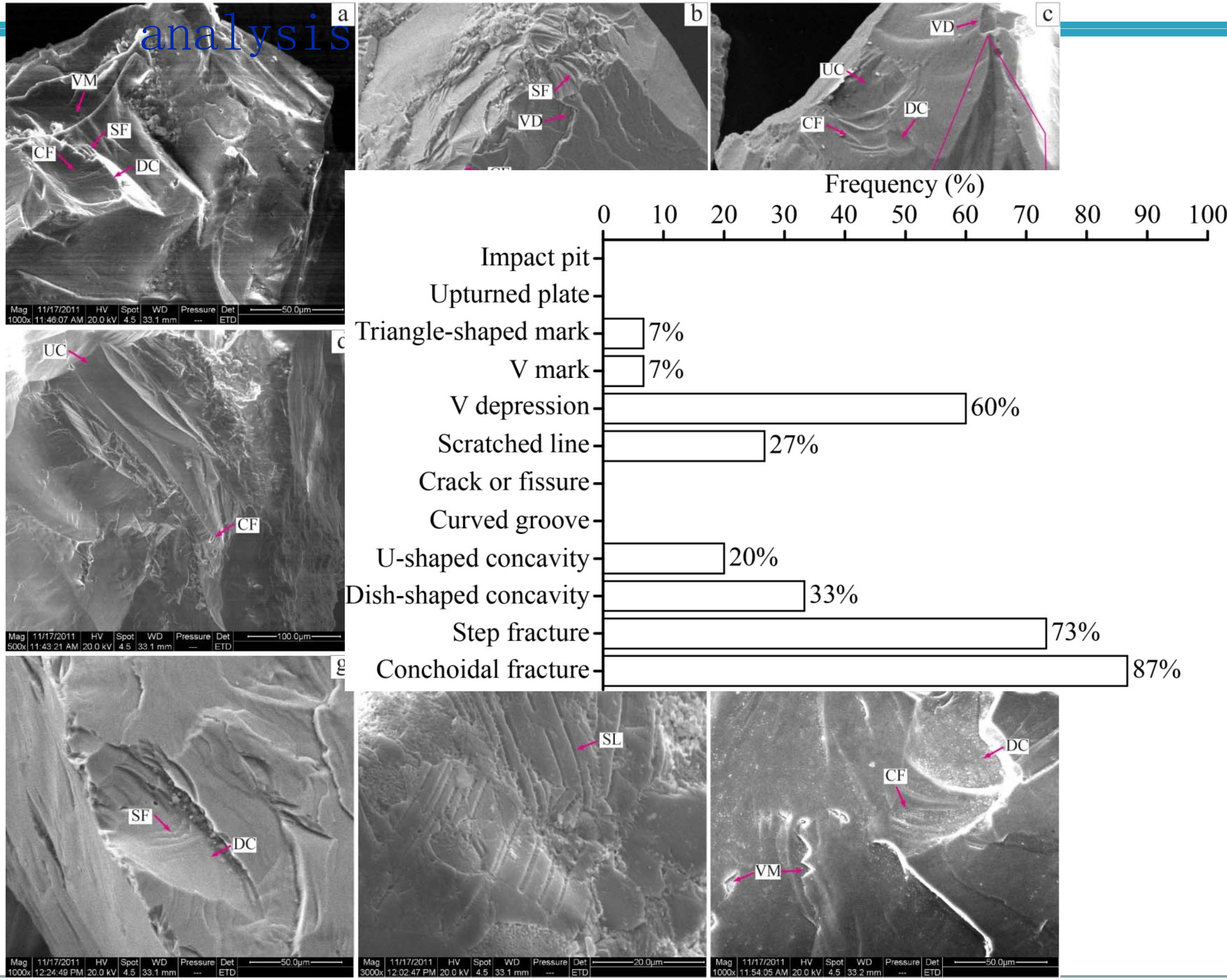
My study–Field investigation and lab analysis



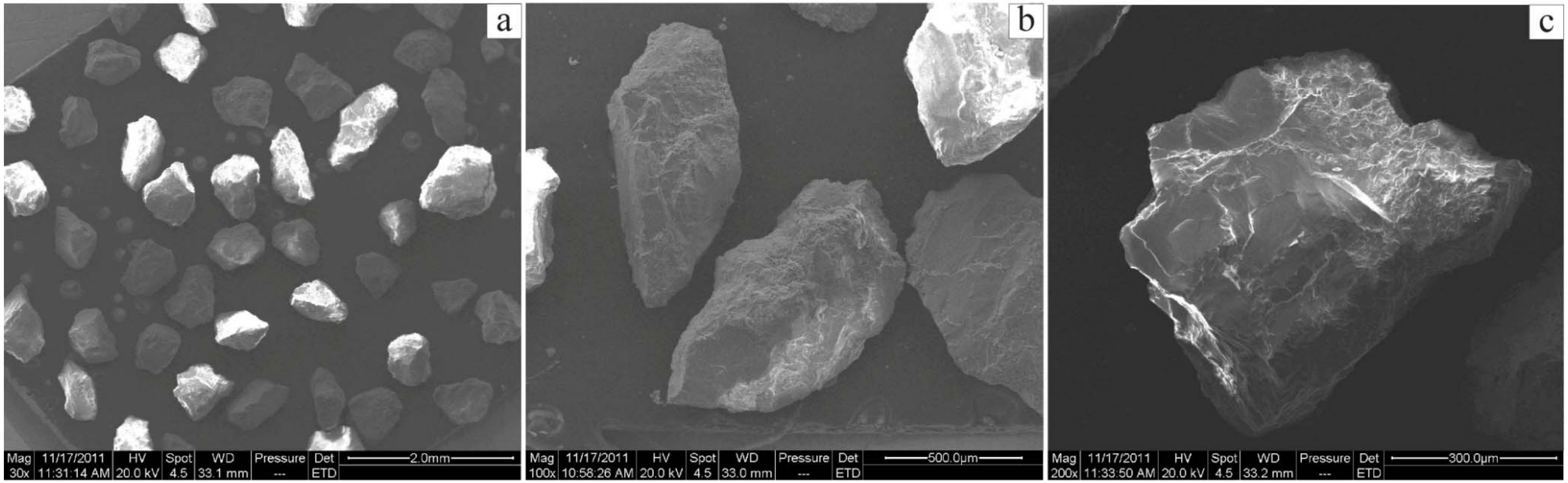
Shapes of the quartz grains from the Xiejiadianzi rock avalanche

The roundness of the quartz grains is almost unchanged, with more than 90% of the grains classified as having angular shapes and the rest classified as having subangular shapes.

My study-Field investigation and lab analysis



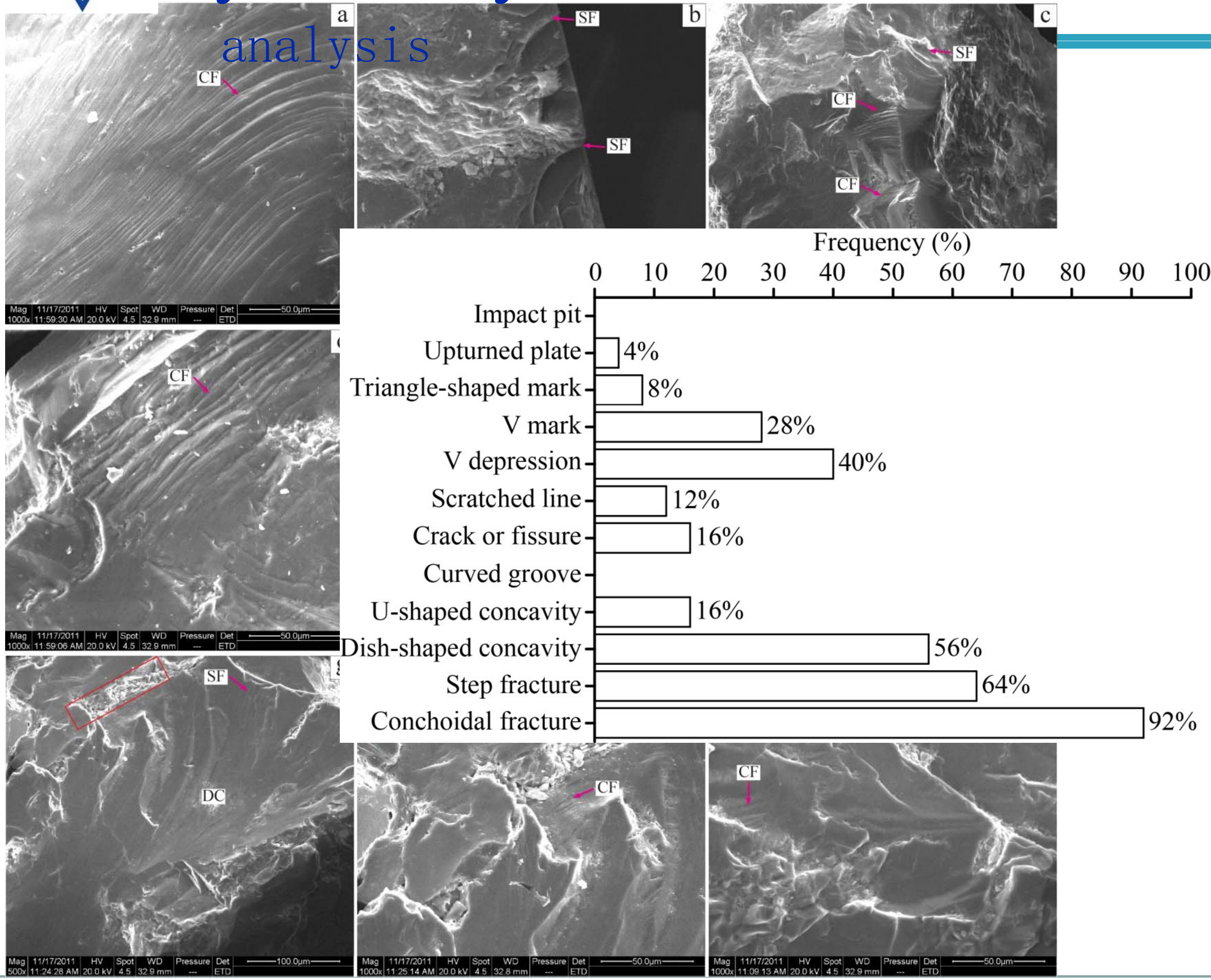
My study–Field investigation and lab analysis



Shapes of the quartz grains from the Niujuangou rock avalanche

The proportion of the angular-shaped quartz grains exceeds 80%, and the rest grains are in subangular shapes

My study–Field investigation and lab analysis



My study-Discussion

Mechanical textures

High angularity

Conchoidal fractures, step fractures, concavities, V depressions or marks……

Most of the fractures are relatively smooth with obviously structurally controlled shapes

Mechanical behavior

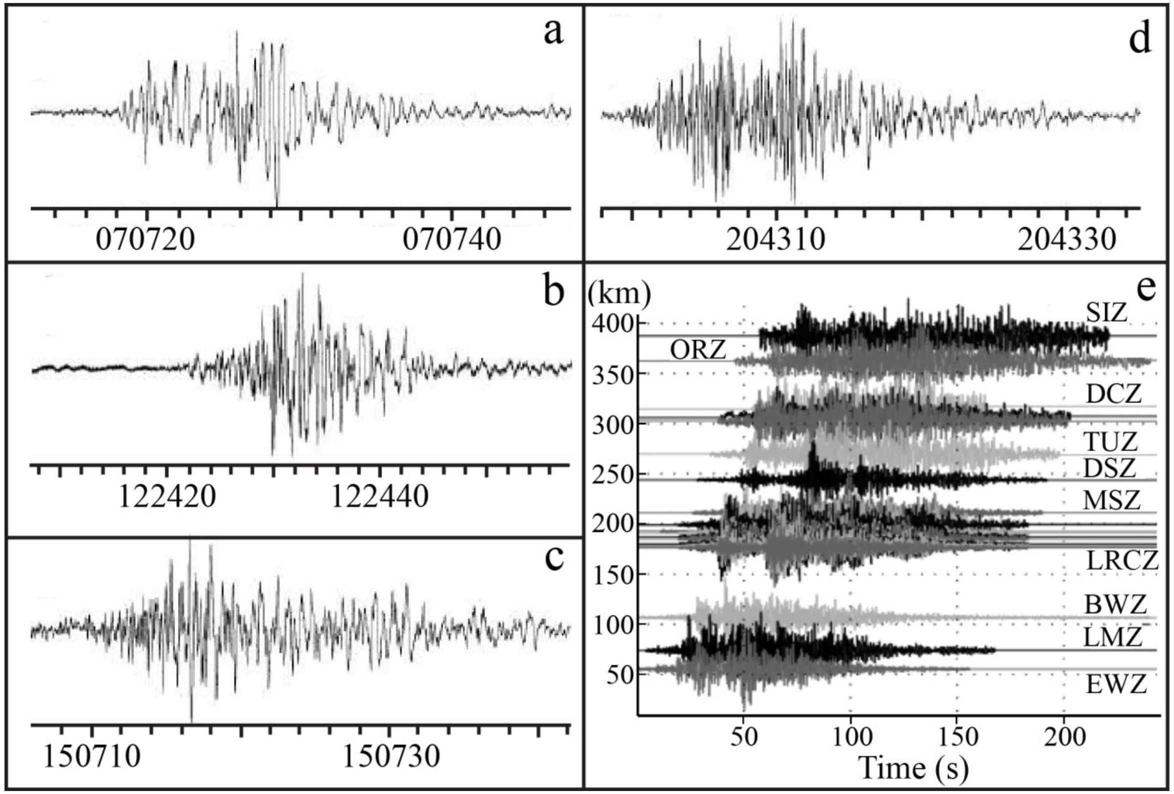
Brittle fracturing behavior

Stress history

To generate such high-pressure contact environments, the occurrence of high-velocity collisions or intensive shearing processes may be indispensable .

My study–Discussion

Prove 1-Landquakes



Supported by the seismic signals (non-earthquake triggered) recorded during rockfalls, rockslides, and rock avalanches.

My study–Discussion

Prove 2- Leidenfrost effect

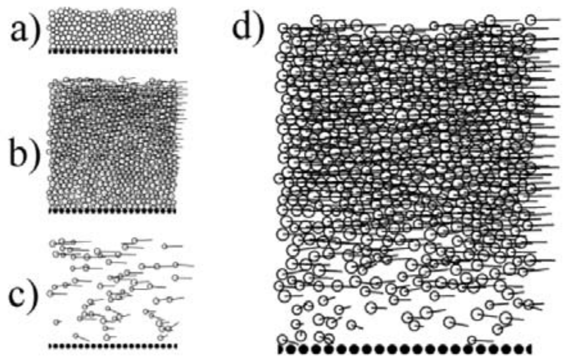


Fig. 1. Snapshots from the 2D simulation for different values of $\tilde{N}$ and V_0 on a horizontal bumpy base. (a) Quasi-static regime, $\tilde{N} = 6.4$ and $V_0/\sqrt{gd} = 0.7$; (b) dense flow, $\tilde{N} = 24$ and $V_0/\sqrt{gd} = 14$; (c) gaseous regime, $\tilde{N} = 2.4$ and $V_0/\sqrt{gd} = 100$; (d) supported regime, $\tilde{N} = 24$ and $V_0/\sqrt{gd} = 57$.

Density inversion in rapid granular flows: the supported regime

N. Taberlet[1,a], P. Richard[1], J.T. Jenkins[2], and R. Delannay[1]

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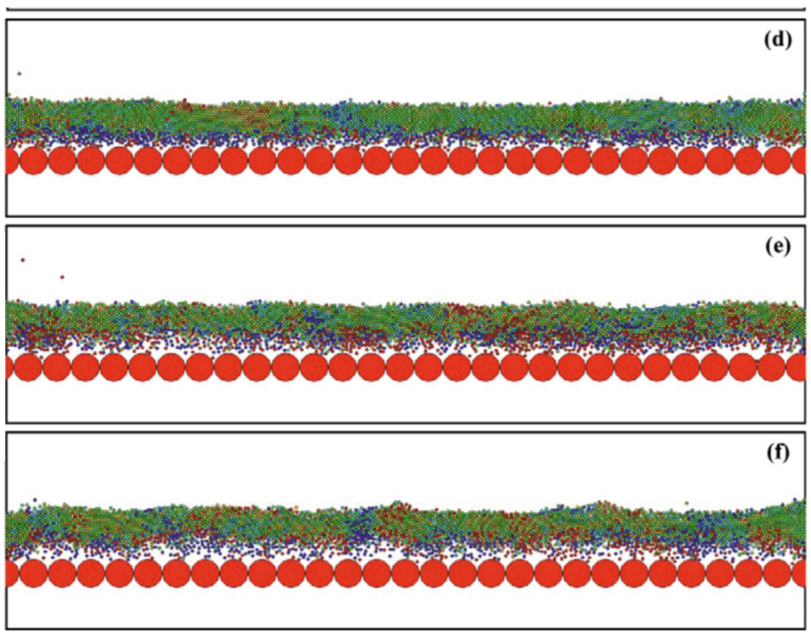
[2] Theoretical and Applied Mathematics, Cornell University, 210 Kimball Hall Ithaca, NY 14853, USA



Granular Leidenfrost effect in vibrated beds with bumpy surfaces

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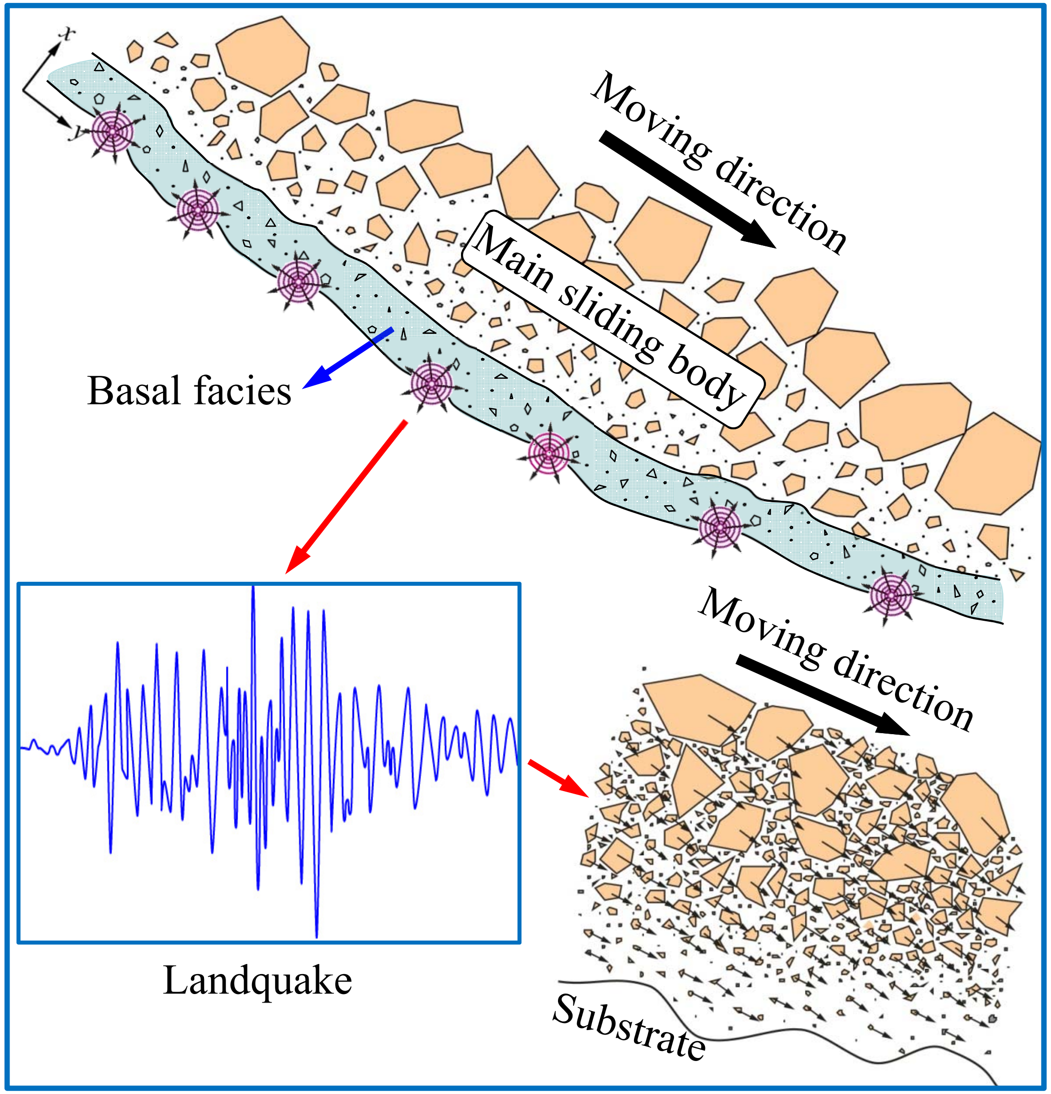
My study–Discussion

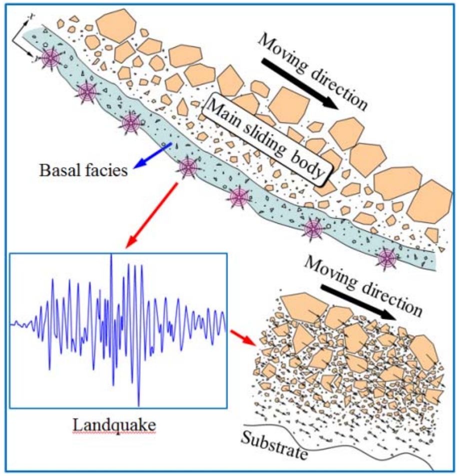
Based on the geological conditions, material composites, and accumulated depths of samples and the display of the surface textures on the micro-scale, we propose that, during the extremely rapid transport of the sliding mass, the occurrence of particle fragmentation in the basal facies of rock avalanche most likely results from the alternate effects of the self-excited vibration energized by the undulated slip surface and the overburden pressure, as exhibited in follow.

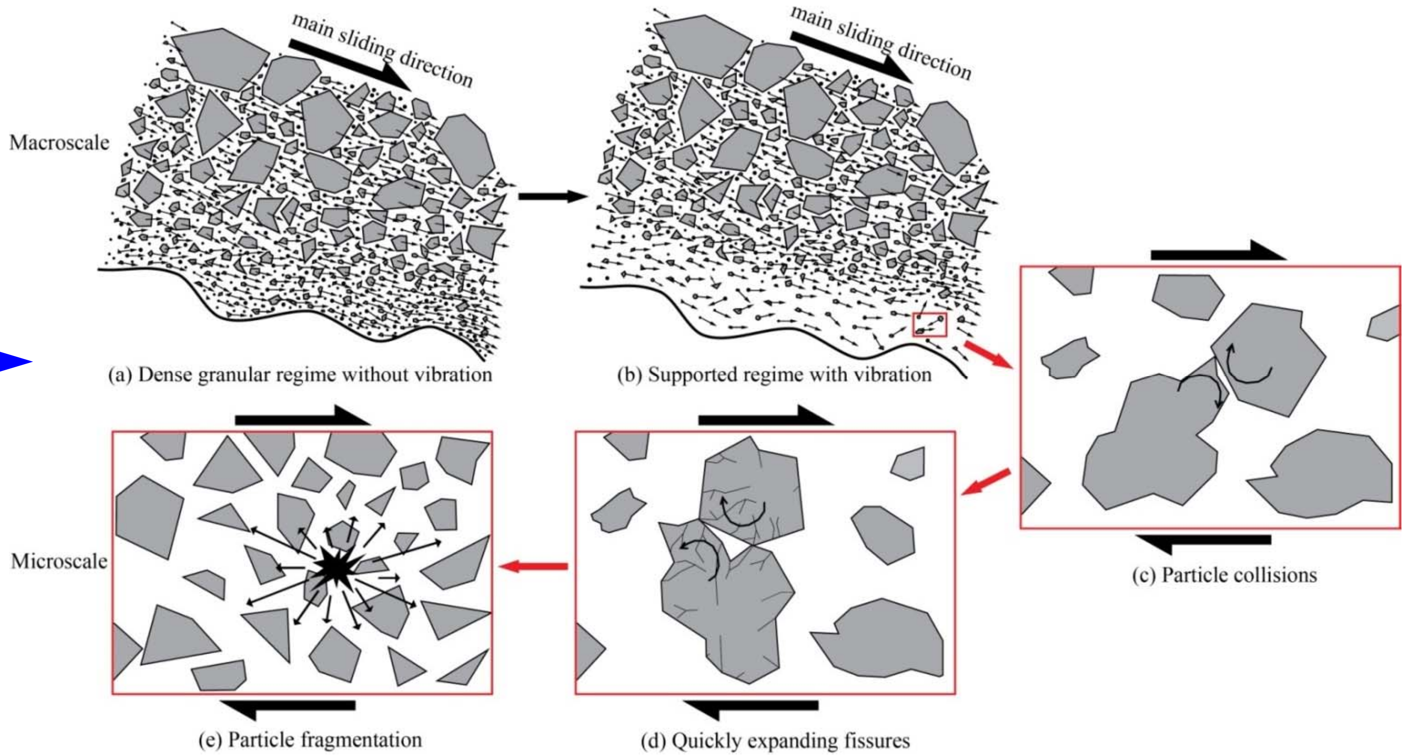


My study–Discussion

Particle fragmentation induced by self-excited vibration

Rock avalanche local magnitudes (M_L: Richter magnitude) usually range from 1 to 3 with their energies varying from 2×10^6 to 2×10^9 J.

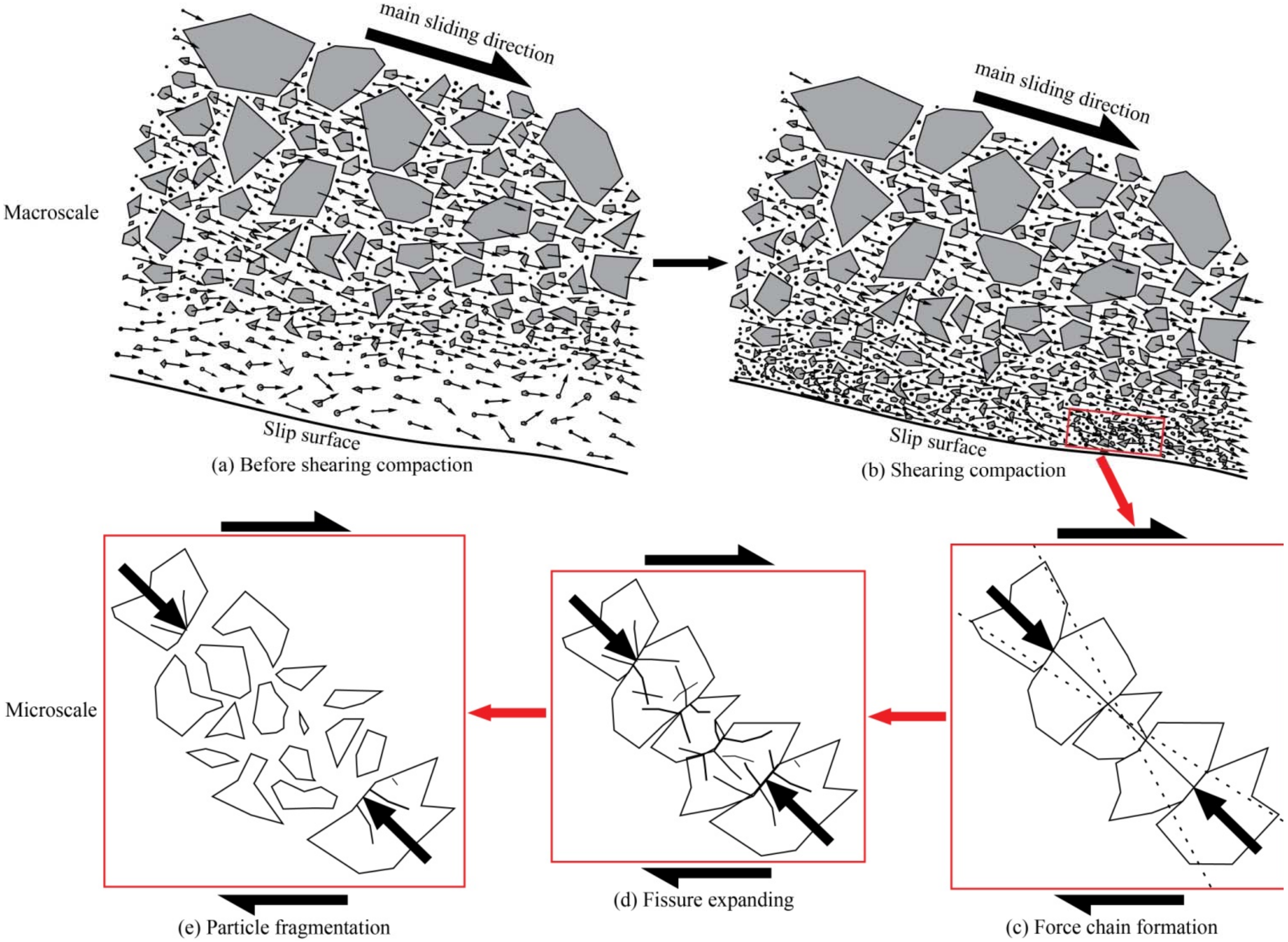




My study–Discussion

Particle fragmentation induced by overburden pressure

Hence, we propose that when the sliding mass moves along a relatively smooth part of the slip surface, the intensity of self-excited vibration will decrease rapidly, and the role of overburden pressure will dominate with a dense granular flow formed in the basal facies.



(a) Before shearing compaction
(b) Shearing compaction
(c) Force chain formation
(d) Fissure expanding
(e) Particle fragmentation

My study–Conclusion

During the extremely rapid transport of rock avalanche, the occurrence of particle fragmentation in the basal facies of rock avalanche most likely results from:

1.) self-excited vibration energized by the undulated slip surface

2.) overburden pressure

Thanks for your attention

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