

The Highly Pressurized Natural Gas in Underground for the Cause of Earthquakes, Huge Rock Landslides and Ice-Rock Avalanches

Zhong-qi Yue^{1,2*}

¹Harbin Institute of Technology (Shenzhen), Shenzhen, P. R. China

²Formerly The University of Hong Kong, Hong Kong, P. R. China

(*Corresponding E-mail: yueqzq@hku.hk)

Abstract: This oral presentation will cover the following aspects: 1) Methane Gas Infilling Fault Theory of Tectonic Earthquakes; 2) The 25 April 2015 Gorkha Nepal Earthquake; 3) The 18 April 2015 Ice-rock Avalanche-Debris Flow at South Slope of Mount Everest; 4) The 26 August 2026 Rasuwa Disaster; 5) The rapid Increase in Methane Gas Production after 2008 Wenchuan Earthquake, Sichuan, P. R. China; 6) Possible Huge Mass of Methane Gas in Deep Underground of Nepal. The main objective is to show that a) the earthquakes, huge rock landslides and ice-rock avalanches occurred in Nepal are due to the methane gas from deep underground and b) there is possible huge mass of methane gas in deep underground of Nepal.

Keywords: Methane gas, Earthquake, Rock landslide, Ice-rock avalanche, Initiation, Volumetric expansion.

Introduction

Since September 1979, the author has been studying and investigating the causes and mechanisms of major geological hazards, particularly earthquakes, landslides and volcanic activities, from the perspectives of geomechanics and geology (Yue, 1988, 1995; Yue and Selvadurai, 1995; Yue et al., 2003, 2004; Yue, 2009, 2010, 2012, 2013a–e, 2014a–b, 2015a–c, 2020, 2023). These investigations have focused on understanding the geological processes, underground stress conditions and physical mechanisms responsible for sudden and destructive natural events. Particular attention has been given to the relationship between tectonic movements, rock mass instability and the possible influence of deeply trapped gases on geological failures.

Among the major disasters investigated by the author are the 25 April 2015 Gorkha Earthquake in Nepal, the ice-rock avalanche and debris flow associated with Mount Everest in April 2015, and the 26 August 2026 Rasuwa disaster. These events involved different geological processes but resulted in significant ground instability, rapid mass movements and widespread destruction. The 2015 Gorkha Earthquake was primarily caused by the continuous convergence of the Indian Plate and the Eurasian Plate, which produces enormous compressive stresses within the Himalayan region. The accumulation and sudden release of these

stresses along the Main Himalayan Thrust resulted in strong ground shaking and triggered numerous landslides and avalanches. In contrast, high-altitude ice-rock avalanches are influenced by factors such as glacier conditions, changing temperatures, rock fractures and slope instability. Climate change and global warming may further contribute to these failures by accelerating glacier melting and altering the thermal and mechanical conditions of mountain slopes.

The 26 August 2026 Rasuwa disaster provides another important example of the complex nature of Himalayan geological hazards. Preliminary investigations indicate that a large ice-rock mass detached from a high-altitude slope and entered the Lhunde Khola, generating a destructive debris flow and flood along the Bhote Koshi–Trishuli river system. The event demonstrates how sudden slope failures can mobilize large quantities of rock, ice, sediment and water, producing severe impacts far beyond the original source area. Such disasters emphasize the importance of examining both surface geological processes and possible subsurface conditions when investigating the causes of large-scale mountain failures.

Based on several decades of research, the author has proposed an alternative hypothesis suggesting that highly pressurized methane gas trapped within deep geological formations may represent a common contributing mechanism behind certain earthquakes and large-scale landslides or avalanches. According to this hypothesis, methane gas accumulated under high pressure within the Earth's crust may influence underground stress conditions and rock mass stability. If such gas escapes or expands rapidly through geological fractures and faults, the resulting pressure changes could potentially contribute to rock fracturing, displacement and sudden ground failure. The author therefore suggests that the influence of deep underground gas pressure should be examined alongside conventional tectonic, geological and climatic explanations when investigating major geological disasters.

However, the proposed methane-gas mechanism remains a scientific hypothesis rather than an established explanation for these disasters. The tectonic origin of the Gorkha Earthquake is supported by extensive seismic and geological evidence, while investigations of ice-rock avalanches emphasize the roles of slope conditions, seismic shaking and climatic influences. Further geological investigations, field measurements and geomechanical analyses would be required to determine whether deeply pressurized methane gas contributed to any of the events discussed. Understanding these potential mechanisms may help broaden research into complex geological hazards and improve future approaches to disaster risk assessment in the Himalayan region.

The gas cause of earthquakes

A tectonic earthquake suddenly releases a large to extremely large amount of kinetic energy in the Earth and/or near ground surface within few to two hundreds seconds, generates seismic waves locally and/or globally, and can induce ground displacement and damage over a narrow area of several to hundreds kilometer long and several to tens kilometer wide. The pregnant period at an earthquake fault is tens to thousand years.

The most important and basic question that must be asked and addressed is where does the kinetic energy come from? Its huge amount can suddenly go outburst, rapidly release and quickly vanish in the Earth's crust within a few seconds to a few hundred seconds over large to extremely large ground area. It cannot be observed and noticed by human beings on the ground before its out-bursting and during its pregnancy over tens to several thousand years.

My answer to the source of the kinetic energy released by tectonic earthquakes is mainly the volumetric expansion energy of highly compressed methane gas escaped from deep trap. As shown in Figure 1, the process of earth quaking can be described as follow. An earth-quaking is the rapid expansion, penetration, fracturing and flow of a large amount of highly dense and compressed methane gas from deep crust to shallow ground with speed of 1 to 3 km/s along tectonic faults. The gas expansion absorbs heat and cools the surrounding materials in the ground and sky. The crustal rock mass would settler and release the gravity potential energy of the crustal rock mass during land subsidence due to gas escaping. More details can be found in Yue (2009, 2010, 2013a-c, 2014a, 2020, 2023).

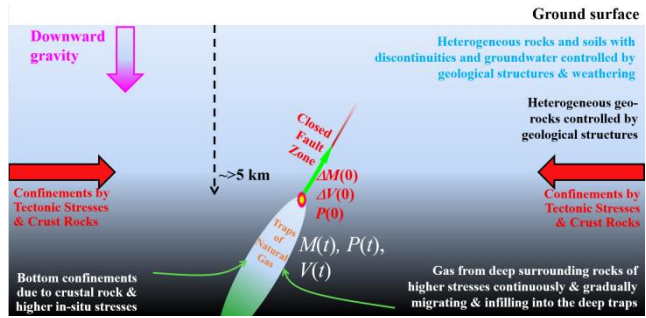


Figure 1, The gas cause theory of earthquakes.

The gas cause of Ice-Rock avalanches

The gas cause of ice-rock avalanches is shown in Figure 2. The discontinuities of rock mass is completely infilled, glued, cemented and sealed by the ice. The tensile strength of ice is between 0.7 MPa and 3.1 MPa. From temperature -10°C to -20°C , the compressive strength of ice is from 5 MPa to 25 MPa and increases as temperature decreases. The elastic moduli of ice $E = 1$ GPa (field) and 9 GPa (indoor). The fracture toughness of ice is between 50 and 150 $\text{kPa m}^{1/2}$. In other words, the ice can make the rock mass as an intact rock without discontinuities and the permeability of the iced rock for gas flow is almost zero.

According to Yue (2012, 2013d-e, 2014b), highly pressurized gas trapped within deep underground rock formations may migrate toward the upper rock mass through geological discontinuities such as faults, fractures and joints. These discontinuities act as pathways through which gas can gradually move upward and accumulate beneath relatively impermeable ice-rock layers. As the quantity of trapped gas increases, pressure may build up within the confined space, exerting additional forces on the surrounding rock mass. This increasing pressure could weaken existing fractures, reduce the stability of the overlying ice-rock mass and create conditions that may eventually lead to slope failure.

When the accumulated gas pressure becomes sufficiently high, it may cause the surrounding rock mass to fracture or rupture, allowing the trapped gas to expand and escape suddenly. According to the proposed hypothesis, this rapid expansion could contribute to the displacement and ejection of rock and ice, potentially triggering an ice-rock avalanche. Once the material begins moving downslope, gravitational forces accelerate its movement, carrying additional rocks, ice and debris along the way. Such avalanches may also enter river channels and develop into destructive debris flows or floods. However, the role of highly pressurized underground gas in triggering these events remains a proposed mechanism that requires further geological investigation and scientific verification.

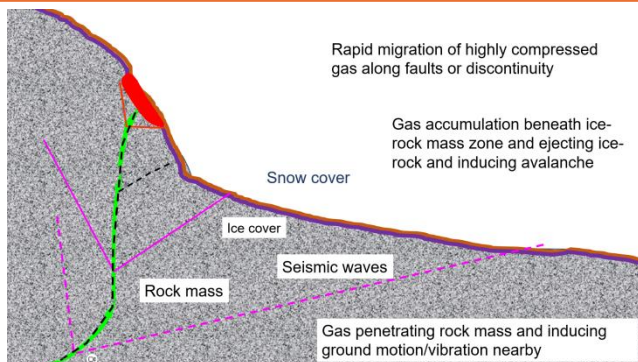


Figure 2, The gas cause theory of ice-rock avalanches.

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Author contributions

Yue wrote all the manuscript.

Data availability

No datasets were generated or analyzed during this study.

Declarations

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this article.

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