

※ 考生請注意：本試題不可使用計算機。請於答案卷(卡)作答，於本試題紙上作答者，不予計分。

1. Translation: (70%)

a. The following abstract is adopted from [Olsen, E. L. and R. M. Allen (2005), The deterministic nature of earthquake rupture, *Nature*, v. 438, doi:10.1038/nature04214]. (35%)

Understanding the earthquake rupture process is central to our understanding of fault systems and earthquake hazards. Multiple hypotheses concerning the nature of fault rupture have been proposed but no unifying theory has emerged. The conceptual hypothesis most commonly cited is the cascade model for fault rupture. In the cascade¹ model, slip initiates on a small fault patch and continues to rupture further across a fault plane as long as the conditions are favorable. Two fundamental implications of this domino-like theory² are that small earthquakes begin in the same manner as large earthquakes and that the rupture process is not deterministic—that is, the size of the earthquake cannot be determined until the cessation of rupture. Here we show that the frequency content of radiated seismic energy within the first few seconds of rupture scales with the final magnitude of the event. We infer that the magnitude of an earthquake can therefore be estimated before the rupture is complete. This finding implies that the rupture process is to some degree deterministic and has implications for the physics of the rupture process.

附註：

¹ cascade (串聯)： a succession of stages or operations or processes or units.

² domino theory (chain reaction)：多米諾(骨牌)理論，指一國崩潰，其他鄰國就會相繼垮臺的政治局面。

b. The following abstract is adopted from [Nishikawa, T. and S. Ide (2014), Earthquake size distribution in subduction zones linked to slab buoyancy, *Nature Geoscience*, doi:10.1038/NGEO2279]. (35%)

The occurrence of subduction¹ zone earthquakes is primarily controlled by the state of stress on the interface between the subducting and overriding plates. This stress state is influenced by tectonic properties, such as the age of the subducting plate and the rate of plate motion. It is difficult to directly measure stress on a plate interface. However, the stress state can be inferred using the Gutenberg–Richter relationship²'s *b*-value, which characterizes the relative number of small compared to large earthquakes and correlates negatively with differential stress. That is, a subduction zone characterized by relatively frequent large earthquakes has a low *b*-value and a high stress state. The *b*-value for subduction zones worldwide varies significantly, but the source of this variance is

unclear. Here we use the Advanced National Seismic System earthquake catalogue to estimate b -values for 88 sections in different subduction zones globally and compare the b -values with the age of the subducting plate and plate motions. The b -value correlates positively with subducting plate age, so that large earthquakes occur more frequently in subduction zones with younger slabs, but there is no correlation between b -value and plate motion. Given that younger slabs are warmer and more buoyant, we suggest that slab buoyancy is the primary control on the stress state and earthquake size distribution in subduction zones.

附註：

¹ Subduction：隱沒、隱沒作用

² Gutenberg–Richter relationship or law (GR law)：expresses the relationship between the magnitude and total number of earthquakes in any given region and time period of at least that magnitude.

$$\log_{10} N = a - bM \quad \text{or} \quad N = 10^{a-bM}$$

Where:

- N is the number of events having a magnitude $\geq M$
- a and b are constants

2. Composition: (30%)

Please write a short article to clearly define, describe, and explain the natural phenomenon that most interested you.

附註：

From Wikipedia, the free encyclopedia

A natural phenomenon is an observable event which is not man-made. Examples include: sunrise, weather, fog, thunder, tornadoes; biological processes, decomposition, germination; physical processes, wave propagation, erosion; tidal flow, and natural disasters such as electromagnetic pulses, volcanic eruptions, and earthquakes.