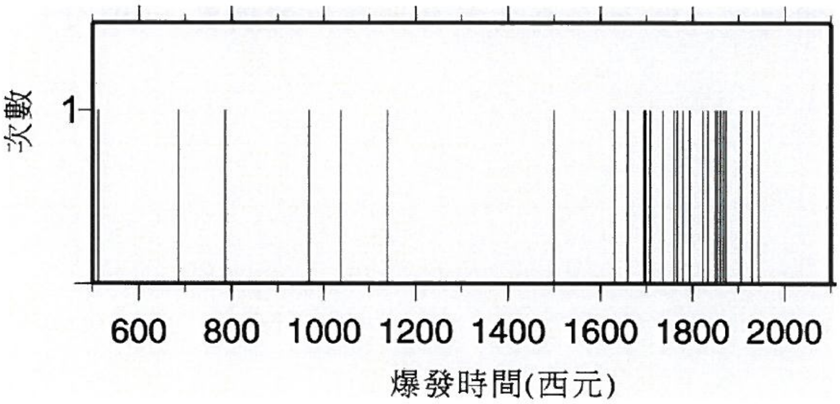
國立臺灣師範大學103學年度碩士班招生考試試題

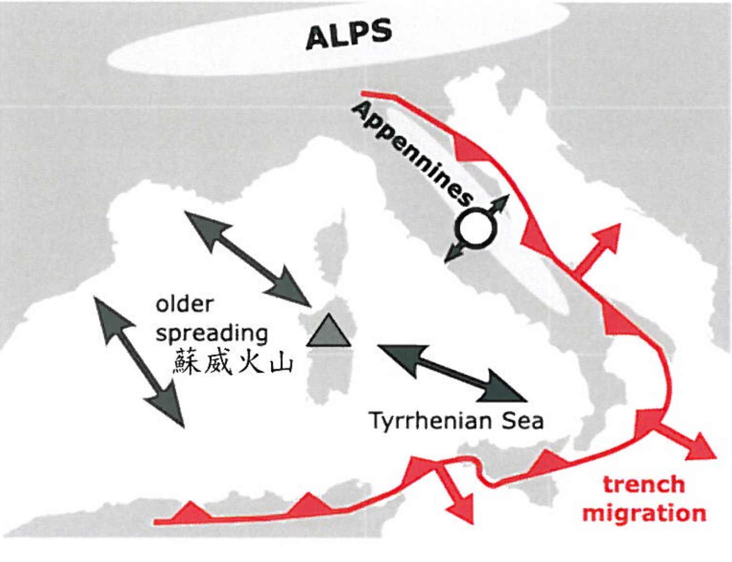
科目：**地球物理學**　　適用系所：**地球科學系**

注意：1.本試題共 4 頁，請依序在答案卷上作答，並標明題號，不必抄題。2.答案必須寫在指定作答區內，否則不予計分。

一、 2000 年前，義大利西南的維蘇威火山摧毀了古羅馬城市龐貝，活埋了數千人。在這裡中酸性的火成岩使得黏滯性較大、不易流動、使氣體難以有效散失，因此，此處火山爆發的特性是，具有濃稠、帶有大量氣泡的熔岩。這些熔岩氣泡在接近地表時會猛烈的爆開有如威力強大的爆炸、讓周圍岩漿和岩石四處飛射。維蘇威火山非常活躍，其爆發歷史如下圖所示。請問：(1)監測火山爆發的手段有哪些？(2)你覺得維蘇威火山爆發能不能被預測呢？你的論點為何？(10 分)



二、 續上題，義大利半島的簡單介紹為：半島的脊樑，亞平寧山脈，是阿爾卑斯山的支脈，其跨過海洋延伸成為西西里島。半島東側多斷層海岸，而半島的北部是波河平原，賴阿爾卑斯山的水電，成為義大利主要工業地帶。這個地方多火山、地震，尤其是半島的西南部及西西里島火山活動頻繁。其詳細的構造背景示意圖如下所示。請問，在這個半島有哪些構造作用在進行？而哪種構造活動可能造成大地震(規模大於七)？(20 分)



三、 哪些地球物理手段，能幫助我們了解地球內部的結構？(10 分)

四、 請描述P波、S波、表面波的(1)定義 (2)和地表晃動方式的關係 (3)在哪一個分量的地震圖較容易被判別？為什麼？(20 分)

五、 某時間序列 $a(t)$的傳立葉頻譜(Fourier spectrum)為 $A(\omega)$, 而另一時間序列 $b(t)$的傳立葉頻譜為 $B(\omega)$. 其摺積(*convolution*)*表示為* $c(t)$*，計算為* $c(t) = a(t) * b(t)$*. 試問* $c(t)$ *的*傳立葉頻譜 $C(\omega)$ 為何？(10 分)

六、 閱讀自下頁起之短文，試回答 (1) 此文章要回答什麼科學問題？ (2) 幫這篇文章取個題目 (3) 幫這篇文章寫個簡短的摘要。(30 分)

If you have ever felt the eerie ground-shaking that accompanies an earthquake, then you are one of millions of people who have briefly experienced the dance of the tectonic plates that slowly drift across the Earth's surface. But earthquakes account for only a fraction of the plate displacements that are predicted by models of present-day plate velocities, thereby indicating the existence of a 'seismic slip deficit'[1,2]. Using a relatively new technique for measuring active crustal deformation, Heki and colleagues (page 595 of this issue[3]) demonstrate that seismically invisible slip following earthquakes accounts for some of this deficit. Their work, when combined with other observations of strain release along plate boundaries, bolsters the case that steady motion between plates is accommodated by a continuum of processes that include slow-rupture earthquakes[4–6], silent earthquakes[7], aseismic creep[8] and afterslip[9,10] (Fig. 1).

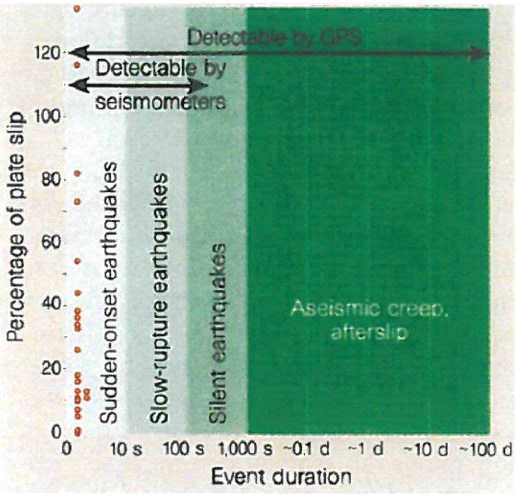


Figure 1 **Processes that accommodate long-term motion of tectonic plates. Event duration is the time required for the majority of slip to occur; circles show slip released by sudden-onset earthquakes along different plate boundary segments as a fraction of the long-term plate slip (ref. 1). Along most plate boundaries, sudden-onset earthquakes account for less than half of the total slip since 1900. Measurements from the Global Positioning System (GPS) should in the future define the amount of slip accommodated over intervals longer than a few seconds.**

During a typical earthquake, crustal strain that has accumulated over decades or longer is released in a period of seconds to minutes. Seismic waves radiating out from the earthquake source region are recorded by seismometers, instruments designed to measure ground motions and accelerations induced by high-speed fault ruptures. Seismic data collected over the past century have yielded a plethora of information about the earthquake source process, the structure of the Earth's interior and the nature of present-day crustal deformation.

In contrast, attempts to study slip processes that occur over periods longer than a few minutes have been hindered by the lack of an inexpensive and reliable technique for measuring long-term ground displacements. The completion of the Global Positioning System (GPS) satellite constellation in the 1990s dramatically improved the prospects for such studies by enabling sub-centimetre determinations of the absolute and relative locations of points nearly anywhere on Earth. Since October 1994, the Geographical Survey Institute (GSI) of Japan has used a network of 200 continuously operating GPS receivers to monitor displacements associated with the earthquake zones that surround Japan.

On 28 December 1994, a magnitude 7.6 earthquake west of northern Honshu ruptured the fault that accommodates motion between the subducting Pacific plate and overlying continental margin[11]. The GPS array precisely recorded crustal displacements during the earthquake, and afterwards Heki and colleagues tracked the motions of 16 of the sites closest to the rupture zone. During the ensuing year, the post-rupture displacements of all but one of these sites exceeded their coseismic displacements, thereby indicating that significant earthquake afterslip had occurred.

No large earthquakes occurred along the fault plane during this period, implying that the afterslip was accommodated by aseismic creep. Modelling of the postseismic displacement vectors indicates that the energy released by the aseismic afterslip was comparable to that released during the earthquake, but was more evenly spread across the original rupture zone than was the coseismic motion.

These results have important implications for our understanding of the seismic cycle and of how faults accommodate plate motions. For example, large earthquakes along this part of the Japan Trench have periodically relieved the strain that accumulates as the Pacific plate subducts beneath Japan. Historically, the energy released by these earthquakes has equalled only 20 per cent of the convergence rate (about 80 mm yr^{-1}), thereby raising the question of how the remaining 80 per cent occurs. Heki and colleagues demonstrate that significant aseismic slip can occur during the interval after an earthquake ruptures the asperities that are locking the subduction fault and before new asperities limit further motion. Other processes such as slow-rupture earthquakes accommodate additional slip[4,5]; however, how much slip is unknown because slow-rupture earthquakes are largely undetectable by conventional seismometers. Continuous GPS observations should help to answer this question in the coming decades.

Heki and colleagues' results also add to the body of evidence that suggests that the concept of a 'stick-then-slip' seismic cycle is overly simplistic. Fault slip instead appears to vary in both space and time as a function of numerous variables including the geometric configuration of fault asperities, the frictional properties of materials bounding a fault, and changes in crustal stresses due to slip along nearby faults. Knowledge of fault slip during one seismic cycle may not necessarily imply predictability of fault slip in the future — which bodes ill for those who have hopes of earthquake prediction. At the least, many more observations are needed.

Over the past two-to-three years, continuously operating GPS receivers have been installed in actively deforming zones around the globe although none matches the impressive Japanese network employed by Heki and colleagues. Measurements from these receivers should provide many additional observations of fault slip before, during and after earthquakes. These will help to define whether significant aseismic afterslip is characteristic of interplate earthquakes or is instead peculiar to particular earthquakes and fault zones. In either case, our understanding of the manner in which the crust accommodates the unceasing motion of the tectonic plates will be greatly improved.

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