國立臺灣師範大學 100 學年度碩士班招生考試試題

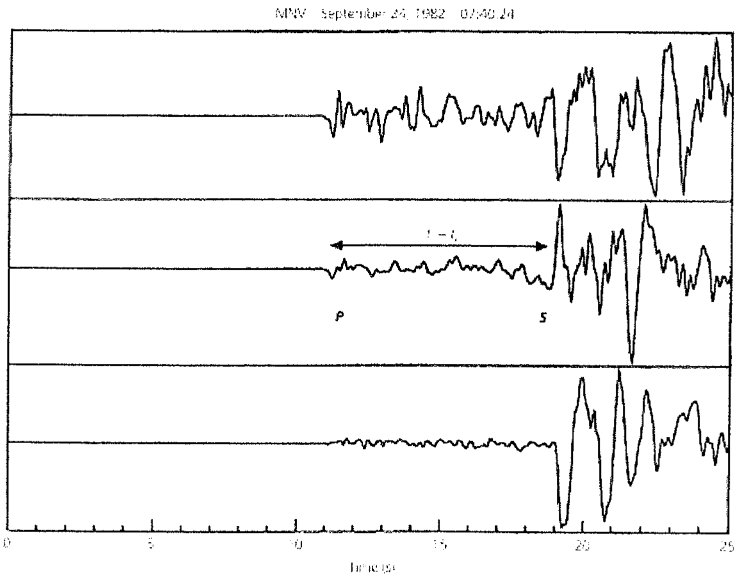
科目：**地球物理學**　　　　　　　　　　適用系所：**地球科學系**

注意：1.本試題共 3 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。

1. (1) 為何地球會有磁場？ (2) 哪幾種最常用來描述地磁場的參數？其各自定義為何？ (3) 試說明地磁在空間、時間的變化。(30 分)

2. 請詳述 P 波、S 波、表面波(Love wave and Rayleigh wave)的定義及基本內涵。並從波速快至慢排序列出。(10 分)

3. 下圖為一個地震事件到測站MNV的三個分量震波圖，請問(A), (B), (C) 哪一個是垂直方向的震波？你的判定依據為何？(10分)



(A)

(B)

(C)

4. 某時間序列a(t)的傅立葉頻譜(Fourier spectrum)為A(ω), 而另一時間序列b(t)的傅立葉頻譜為B(ω). 其摺積(*convolution*)表示為 *c(t)*，計算為$c(t) = a(t) * b(t)$. 試問c(t)的傅立葉頻譜C(ω) 為何？ (10分)

5. 請畫出走向滑移斷層、逆斷層、正斷層的震源機制（海灘球）。(10分)

6. 讀下頁之短文，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) [此題並無標準答案，請盡己所能理解此文]

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).

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 peri-

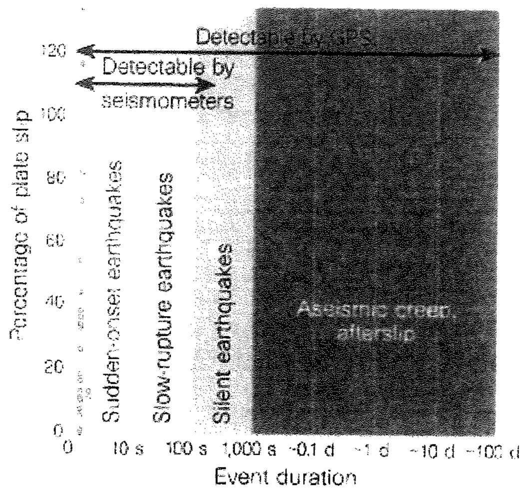


Figure 1 **Processes that accommodate long-term motion of tectonic plates. Event duration is the time required for the majority of slip to occur; circles show slip released by sudden-onset earthquakes along different plate boundary segments as a fraction of the long-term plate slip (ref. 1). Along most 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.**

odically 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. □

Charles DeMets is in the Department of Geology and Geophysics, University of Wisconsin-Madison, Madison, Wisconsin 53706, USA.

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