系所組：地學研究所地質組碩士班 M-3-4

日期節次：/00年3月20日第1節09：00-10：30

科目：科學論文閱讀

1.閱讀理解(60%):請寫出下列文章的主要論述為何，使用何種方法，在地質問題上有何重要貢獻等，每題不得少於50字。每題15分

(1). Subduction of rocks into the mantle results in high-pressure metamorphism and the formation of eclogites from basaltic precursor rocks. At the Earth's surface, eclogites often occur as isolated fragments embedded in crustal rocks that lack evidence for high-pressure conditions. The high-pressure rocks are therefore often viewed as dismembered fragments that have been assembled and intercalated with rocks devoid of any high-pressure history at shallow crustal levels, forming a tectonic mélange. Such mélange models were supported by age discrepancies among high-pressure rocks from the Adula nappe (Central Alps), which was thought to represent a classic example of such a situation. Here we present Lu–Hf age data from two populations of the high-pressure mineral garnet, found within a single eclogite sample taken from Trescolmen, in the Central Adula nappe. We report a minimum Variscan age of 332.7 Myr and a maximum Alpine age of 38 Myr for the two populations. We suggest that the Trescolmen eclogite was subducted to mantle depth and subsequently exhumed, becoming part of a continental crust during the Variscan orogeny. Later, during the Alpine orogeny, the Adula nappe must have been subducted to—and exhumed from—mantle depth a second time, as one coherent unit. We conclude that the Adula nappe is not a mélange, and therefore, the crustal rocks that envelope the eclogites have also been subjected to high-pressure conditions through deep subduction during the Alpine event.(*Nature Geoscience*, Vol. 4, 178-183(2010))

(2). Deep river canyons are thought to form slowly over geological time, cut by moderate flows that reoccur every few years. In contrast, some of the most spectacular canyons on Earth and Mars were probably carved rapidly during ancient megaflood events. Quantification of the flood discharge, duration and erosion mechanics that operated during such events is hampered because we lack modern analogues. Canyon Lake Gorge, Texas, was carved in 2002 during a single catastrophic flood. The event offers a rare opportunity to analyze canyon formation and test palaeohydraulic- reconstruction techniques under known topographic and hydraulic conditions. Here we use digital topographic models and visible/near-infrared aerial images from before and after the flood, discharge measured during the event, field measurements and sediment-transport modeling to show that the flood moved meter-sized boulders, excavated ~7m of limestone and transformed a soil-mantled valley into a bedrock canyon in just ~3 days. We find that canyon morphology is strongly dependent on rock type: plucking of limestone blocks produced waterfalls, inner channels and bedrock strath terraces, whereas

abrasion of cemented alluvium sculpted walls, plunge pools and streamlined islands. Canyon formation was so rapid that erosion might have been limited by the ability of the flow to transport sediment. We suggest that our results might improve hydraulic reconstructions of similar megafloods on Earth and Mars. (*Nature Geoscience*, Vol. 3, 477-481(2010))

(3). The Namib Sand Sea is one of the world's oldest and largest sand deserts, yet little is known about the source of the sand in this, or other large deserts. In particular, it is unclear whether the sand is derived from local sediment or comes from remote sources. The relatively uniform appearance of dune sands and low compositional variability within dune fields make it difficult to address this question. Here we combine cosmogenic-nuclide measurements and geochronological techniques to assess the provenance and migration history of sand grains in the Namib Sand Sea. We use U–Pb geochronology of detrital zircons to show that the primary source of sand is the Orange River at the southern edge of the Namib desert. Our burial ages obtained from measurements of the cosmogenic nuclides 10Be, 26Al and 21Ne suggest that the residence time of sand within the sand sea is at least one million years. We therefore conclude that, despite large climatic changes in the Namib region associated with Quaternary glacial–interglacial cycles, the area currently occupied by the Namib Sand Sea has never been entirely devoid of sand during the past million years. (*Nature Geoscience*, Vol. 3, December, 2010)

(4). A fundamental problem in fault mechanics is whether slip instability associated with earthquake nucleation depends on absolute fault strength. We present laboratory experimental evidence for a systematic relationship between frictional strength and friction rate dependence, one of the key parameters controlling stability, for a wide range of constituent minerals relevant to natural faults. All of the frictionally weak gouges (coefficient of sliding friction, $\mu < 0.5$) are composed of phyllosilicate minerals and exhibit increased friction with slip velocity, known as velocity-strengthening behavior, which suppresses frictional instability. In contrast, fault gouges with higher frictional strength exhibit both velocity-weakening and velocity-strengthening frictional behavior. These materials are dominantly quartzofeldspathic in composition, but in some cases include certain phyllosilicate-rich gouges with high friction coefficients. We also find that frictional velocity dependence evolves systematically with shear strain, such that a critical shear strain is required to allow slip instability. As applied to tectonic faults, our results suggest that seismic behavior and the mode of fault slip may evolve predictably as a function of accumulated offset. (*Geology*, January 2011; v. 39; no. 1; p. 83–86)

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2.英文譯成中文(40%):每題10分

(1). Two of the largest concentrations of gold on Earth occur in the Archean-age Witwatersrand basin in South Africa and the lower-Palaeozoic Great Basin of Nevada, near the town of Carlin. However, the deposits found in these two settings of sedimentary rocks are very different, and how they formed has been the subject of much debate. (*Nature Geoscience*, Vol.4, February, 2010)

(2). Mid-ocean ridges are the locations where the Earth's crust is renewed. Here, the tectonic plates that form the sea floor spread apart and new oceanic crust is generated from upwelling magma. Studies of ancient oceanic crust have led to the idea that it forms in simple layers. However, in 1983, large faults that expose rocks from deep below the mid-ocean ridge were discovered at the Mid-Atlantic Ridge. These structures have since been identified in most ocean basins. (*Nature Geoscience*, Vol.3, July, 2010)

(3). Andesitic volcanic rocks were identified early in the development of plate tectonic theory to represent new additions to continental crust. They are abundant in subduction zones and resemble average continental crust in composition. When one tectonic plate dives beneath another in a subduction zone, the magnesium- and iron-rich (mafic) oceanic crust it is carrying might partially melt to yield andesite. Or, in a later theory, water from that crust escapes and causes hot mantle above it to partially melt. When formed from a solid source and collected into a body, such magma is called primary. (*Nature Geoscience*, Vol.3, September, 2010)

(4). Volcanic tremor is a ubiquitous feature of explosive eruptions. This oscillation persists for minutes to weeks and is characterized by a remarkably narrow band of frequencies from about 0.5 Hz to 7 Hz. Before major eruptions, tremor can occur in concert with increased gas flux and related ground deformation. Volcanic tremor is thus of particular value for eruption forecasting. (*Nature* 470, 522-525 (2011))