HOU DEQIANG/XINHUA

Figure 1 | At fault. The 400-km-long rupture along the Kunlun fault on the Tibetan plateau that occurred in 2001 was the longest of those studied by Wesnousky[1]. According to his analysis, the ultimate size of an earthquake is primarily determined by the local fault structure.

differs for large and small earthquakes. Olsen and Allen[6], for example, examined the frequency content of the early stages of 71 seismic ruptures from $M=3$ to $M=8.3$. The predominant frequency of these earthquakes decreased with increasing magnitude; in other words, small earthquakes released a higher proportion of their energy as higher-frequency waves than did large earthquakes. That seemed to indicate that the final magnitude of an earthquake is determined before the end of the event, and so is at least partially controlled by the rupture initiation process.

An explanation for the seeming contradiction of these conclusions[1,6] could lie in the detailed structure of the fault planes themselves. Earlier research, much of it by Wesnousky and colleagues[7,8], showed that the more a fault slips over its lifetime, the smoother the slip surface becomes. The structure of faults with small displacements is therefore likely to be much more complex than that of faults that have accommodated tens to hundreds of kilometres of displacement.

It is not surprising that earthquakes nucleated on smooth faults generate less energy at high frequencies right from the start than do earthquakes nucleated on rougher, less-developed faults. Each small-scale structural feature of a fault acts as a separate source of high-frequency energy. Olsen and Allen's correlation[6] might thus simply reflect the fact that small earthquakes can occur on small faults that have not accommodated significant displacements over their lifetimes. Many of these earthquakes may occur in the zone of damaged rock surrounding large faults.

Large earthquakes, by contrast, necessarily occur on large faults — the largest earthquake examined in Wesnousky's study[1], an event of $M=7.8$ in 2001, ruptured the Kunlun fault on the Tibetan plateau for a distance of more than 400 kilometres (Fig. 1). Such large faults are much more likely to have accommodated significant displacements, and are likely to be much smoother than the innumerable small faults that generate the earthquakes of $M<5.5$ that are ubiquitous features of Earth's crust.

Interestingly, although the relationship between magnitude and wave frequency noted by Olsen and Allen[6] is quite pronounced for smaller magnitudes between 3 and 5.5, there is no obvious variation in the predominant frequency of energy radiated in the first few seconds of $M>6$ earthquakes. The radiation of energy at relatively low frequencies for these larger earthquakes could tell us which of the ruptures are starting on large, smooth faults, and therefore might be capable of generating large earthquakes — if the structural and stress conditions of the fault are favourable.

Wesnousky's data[1], on the other hand, show that the ultimate size of the earthquake is largely controlled by the structure of the fault zone, rather than by the dynamics of the rupture nucleation. They thus validate the continued use of mapped structural complexities (steps and bends in the fault surface, intersections with other faults) in forward modelling of the potential limits of future ruptures. Such data are the basis for many seismic-hazard models in use today[9].

Thus, combining these two sets of observations[1,6] in automated form could result in more accurate assessments of likely earth-

50 & 100 YEARS AGO

50 YEARS AGO

It is not without significance that the opening by the Queen of Britain's first nuclear power station has almost coincided with the approval by a conference of eighty-two nations of the draft statute for the International Atomic Energy Agency... The urgent need is for some arrangement whereby the technical skill of Britain and those other nations within reasonable distance of producing nuclear power on a commercial scale can be made available to those less fortunate nations; but it still remains to be seen how widely the new statute will be ratified by governments, and in particular how ready the smaller and undeveloped countries will be to accept the provisions of Article 12 of the statute... The safeguards imposed by that article and the limitations of national sovereignty implied in it have become the more essential and reasonable; yet...in many parts of the world where nuclear power offers the greatest possibilities of benefit to human welfare, the growth of nationalism has made those countries more impatient and suspicious of restraint.

From *Nature* 17 November 1956.

100 YEARS AGO

A statement has recently obtained currency that the French people themselves, after a hundred years' use of the metric system, cannot claim that it has been adopted throughout France, and a free translation of a circular issued to chambers of commerce in France by the French Minister of Commerce has been employed to support the statement... [The Minister] makes it clear that the circular is directed only against the use of *old names* in certain trades, and that the English translation misinterprets its meaning and conveys a wholly wrong impression. It is satisfactory to find, in view of such endeavours to retard the acceptance of the metric system by this country, that it has recently been adopted in the works of Messrs. Joseph Crosfield and Sons, Ltd., and steadily grows in popularity.

From *Nature* 15 November 1906.