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Florida manatees (3 metres long, on average) are susceptible to toxins from the red tide alga *Karenia brevis* (inset; cell diameter, 30–35 mm).

been restricted to the consumption of contaminated shellfish (neurotoxic shellfish poisoning). Although the accumulation of brevetoxins in live fish to the levels measured in the menhaden is probably short-lived and unusual, this finding, together with the dolphin deaths (given that dolphins are a sentinel species[9]), raises concerns that humans could also be poisoned by contaminated fish.

These findings show not only that brevetoxin-contaminated food webs pose a threat to marine mammals, but also that toxin vectors can result in delayed or remote animal exposure. Biological toxins should therefore be considered as possible culprits when investigating unusual marine animal mortalities, even in the absence of toxin-producing algae.

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SEISMOLOGY

Earthquake risk on the Sunda trench

On 28 March 2005 the Sunda megathrust in Indonesia ruptured again, producing another great earthquake three months after the previous one. The rupture was contiguous with that of the December 2004 Sumatra–Andaman earthquake, and is likely to have been sparked by local stress, although the triggering stresses at its hypocentre were very small — of the order of just 0.1 bar. Calculations show that stresses imposed by the second rupture have brought closer to failure the megathrust immediately to the south, under the Batu and Mentawai islands, and have expanded the area of increased stress on the Sumatra fault. Palaeoseismologic studies show that the Mentawai segment of the Sunda megathrust is well advanced in its seismic cycle and is therefore a good candidate for triggered failure.

The 1,300-km-long Sumatra–Andaman rupture of the Sunda megathrust that occurred on 26 December 2004 shed stresses on to other structures in the region. We previously identified two faults of particular concern: the continuation of the Sunda megathrust to the south, beneath the islands of Simeulue and Nias, and the vertical, strike–slip Sumatra fault[1]. On 28 March, rupture of the Simeulue–Nias segment generated a magnitude-8.7 earthquake, which caused widespread destruction on the islands and is estimated to have killed about 2,000 people.

Table 1 | **Hypocentral stresses in the Sumatran earthquake of 28 March 2005**

	Slip distribution Ref. 8	 Ref. 9
Co-seismic stress	0.005	0.110
Post-seismic stress	0.064	0.060
Total stress	0.069	0.170

Hypocentral stresses are shown in bars and are calculated using wave-form slip inversions[8,9] and an oceanic earth structure after ref. 10. The difference in co-seismic stresses is largely due to the difference in the southward extent of the 26 December rupture in the two slip models.

We have calculated the stresses induced by the Sumatra–Andaman rupture at the hypocentre of the Simeulue–Nias earthquake, including both the co-seismic[2] elastic effect and the effect of post-seismic[3] viscoelastic relaxation of the upper mantle. The total stress perturbation at the hypocentre was small (Table 1), between 0.07 and 0.17 bars. The size of this triggering stress illustrates the extreme non-linearity of the earthquake nucleation process.

Like its predecessor, the Simeulue–Nias earthquake has appreciably altered the state of stress in the surrounding region (Fig. 1a). Although it changed only slightly the level of stress on the section near Banda Aceh, which was most affected by the Sumatra–Andaman rupture, it has increased stresses on the Sumatra fault south of that section. As in the case of the Sumatra–Andaman rupture, the section of the megathrust just to the south has also been stressed appreciably (by as much as 8 bars on the section beneath the Batu islands and somewhat less on the segment beneath the Mentawai islands). Despite the smaller size of the Simeulue–Nias event, the magnitude of its stress perturbation on the Batu and northern Mentawai sections of the megathrust is similar to that which triggered the Simeulue–Nias earthquake. This stress may be expected to migrate further south over time as a result of viscoelastic effects.

The Batu section of the fault (Fig. 1b), from the Equator to about 0.7° S, last ruptured in 1935 during a magnitude-7.7 earthquake that resulted in about 2.3 metres of slip on a 70 km × 35 km patch of the megathrust[4,5]. Recent palaeogeodetic studies (manuscript

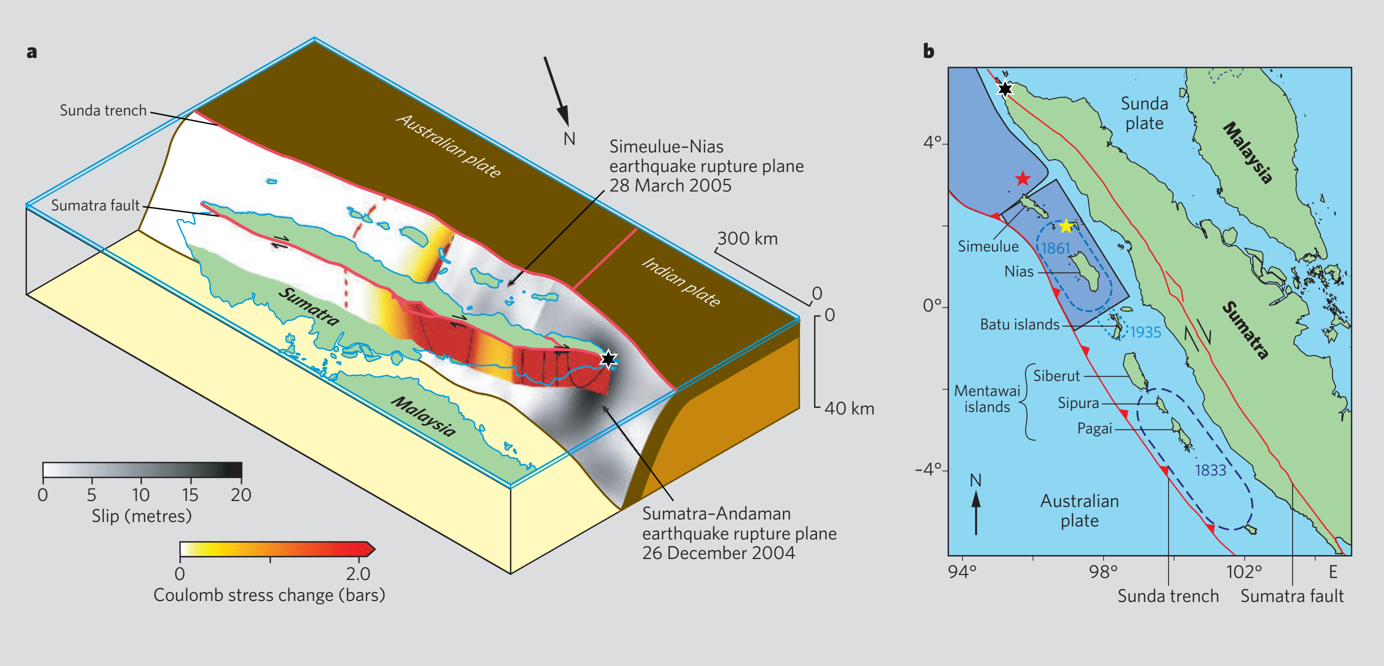

Figure 1 | The faults around Sumatra and the Sunda trench. **a,** Schematic of the Sumatran subduction zones with the overlying plates removed. Calculated three-dimensional stresses, including contributions from both earthquakes resolved directly on to the structures of interest, have been projected on to a diagram of the structural geometry and geography of the region. Here we use a low-value coefficient of effective friction, 0.4, although the main results are robust to large ranges of this value. Grey-scale values on the rupture plane represent the amount of slip in metres experienced on the southernmost 450 km of the Sumatra–Andaman earthquake and on the Simeulue–Nias earthquake. Colour-scale values represent the co-seismic stress change on the Sunda-trench subduction zone and the Sumatra fault. Stress contours are in 2-bar intervals. Red dashed contours indicate zero co-seismic stress. Black star indicates the location of Banda Aceh. **b,** Locations of ruptures of recent and historical earthquakes on the Sunda trench. Dotted lines indicate approximate extents of historical ruptures (1833, 1861 and 1935); solid lines surrounding dark-blue areas indicate seismological inversions of recent earthquakes; red star, epicentre of December 2004 event; yellow star, epicentre of March 2005 event; black star, Banda Aceh. The rupture area of the 1797 event, which is not shown here, probably overlaps significantly with the 1833 event under Sipura and Pagai Islands and may extend under Siberut Island. The precise extent of this event strongly influences the estimated slip deficit on the megathrust.

submitted) show that the megathrust is slipping aseismically both above and below this narrow patch. The slippage occurs at the rate of plate convergence. Furthermore, the 1935 patch (Fig. 1b) has been slipping during the past century at about half the rate at which the plate is moving. Therefore, accumulated strains and hence stresses on the Batu patch are probably low. The Mentawai segment, on the other hand, presents a greater threat.

Our palaeoseismic investigations (manuscript submitted) show that the megathrust has not ruptured under the island of Siberut (0.7 to 2° S) since 1797. The latest ruptures farther south involved a few metres of slip in 1797 (magnitude >8; 2.0–3.5° S) and a 10-metre rupture in 1833 (magnitude >8.5; 2.0–5.5° S)[6]. Both of these events produced large tsunamis on the islands and mainland coast[7]. Events similar to 1833 seem to occur every 230 years on average.

These observations, in conjunction with the stress changes mentioned, suggest that the greatest current seismic threat from the Sunda megathrust comes from the Mentawai section, between about 0.7 and 5.5° S. Slip on the northern part of this section could be greater than 10 metres, depending on the timing of the last rupture (based on a convergence rate of 5 cm yr^{-1}). Slip on the southern portion could be as great as in 1833: that is, up to 10 metres. The historical record and the experience of the Sumatra–Andaman and Simeulue–Nias events indicate that a tsunami could be a possibility. The threat of an earthquake of magnitude 7.0–7.5 on the Sumatra fault north of 4° N has not receded.

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PLANT BIOCHEMISTRY

Anthocyanin biosynthesis in roses

Anthocyanin is the principal pigment in flowers, conferring intense red-to-blue cyanic colours on petals and helping to attract pollinators. Its biosynthesis involves glycosylation steps that are important for the stability of the pigment and for its aqueous solubility in vacuoles[1,2]. Here we describe anthocyanin biosynthesis in roses (*Rosa hybrida*), which is unlike the pathway used in other flowers in that it relies on a single enzyme to achieve glycosylation at two different positions on the precursor molecule. Phylogenetic analysis also indicates that this previously unknown glucosyltransferase enzyme may be unique to roses, with glycosylation having apparently evolved into a single stabilizing step in other plants.