

CHINA EARTHQUAKE 2008: CAUSES AND CONSEQUENCES

by Michael Ashby

ON MONDAY 12 MAY 2008 at 14:28 local time, a major earthquake struck the southern Chinese province of Sichuan causing 87,652 deaths (69,185 official deaths and 18,467 missing and presumed dead) (USGS). Seismographs gave a reading of 7.9 on the Richter scale.

Plate tectonics

Earthquakes cannot be properly studied unless there is a general understanding of plate tectonics. Figure 1 shows how the core at the centre of the Earth is surrounded by molten rock called the mantle. The crust is the outermost layer and is made up globally of seven large and many other smaller tectonic plates. Rising hot convection currents within the mantle force the tectonic plates to move closer together, further apart or past each other. Forces caused by friction can build up at the moving plate boundaries and their sudden release causes earthquakes.

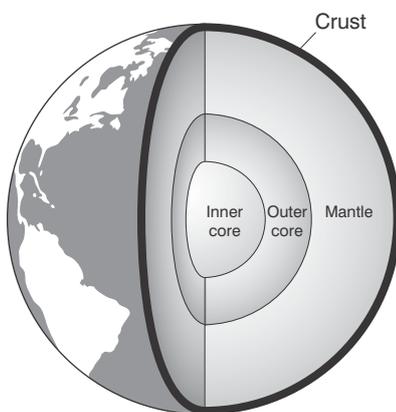


Figure 1 Cross-section of the Earth

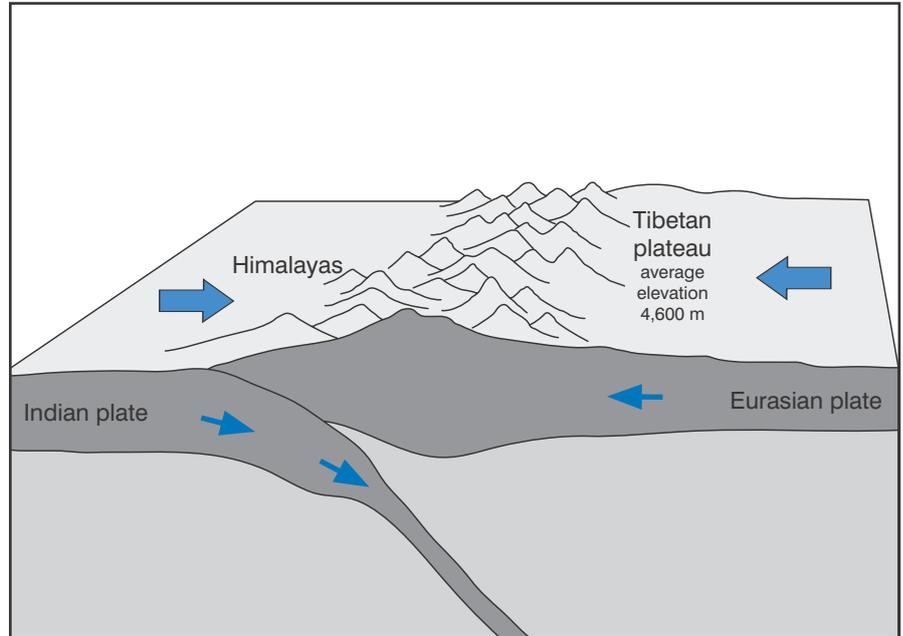


Figure 2: Convergence of the Indian and Eurasian plates

Source: US Geological Survey

About 225 million years ago Africa, India, Australia and Antarctica were joined as one large southern continent called Gondwanaland. When Gondwanaland began to disintegrate, India began moving northwards at about 5–10 cm per year before colliding into Tibet about 40 million years ago, creating the fold mountains of the Himalayas. In the collision zone parts of India were pushed under Tibet. Both the Indian (part of the Indo-Australian) and the Eurasian plates consist of relatively light continental crust, so neither plate sank. This doubling of the crust's thickness created the Tibetan Plateau. Parts of Asia including China were forced to slip sideways creating numerous cracks in the plates, called faults (Figure 2).

Causes of the recent earthquake in China

The friction of the large converging sheets of rock means that faults might stay locked for centuries before eventually giving in to the pressure of the Indian plate being thrust under the Eurasian plate, causing a jolt and the violent earthquakes common in China.

Tibet is moving eastwards, overriding the flat Sichuan Basin and creating the Longmenshan mountain range in southern China. Sichuan Province has a long history of earthquakes. In August 1933 it is believed that more than 9,300 people were killed by an earthquake measuring 7.5 on the Richter scale (USGS).

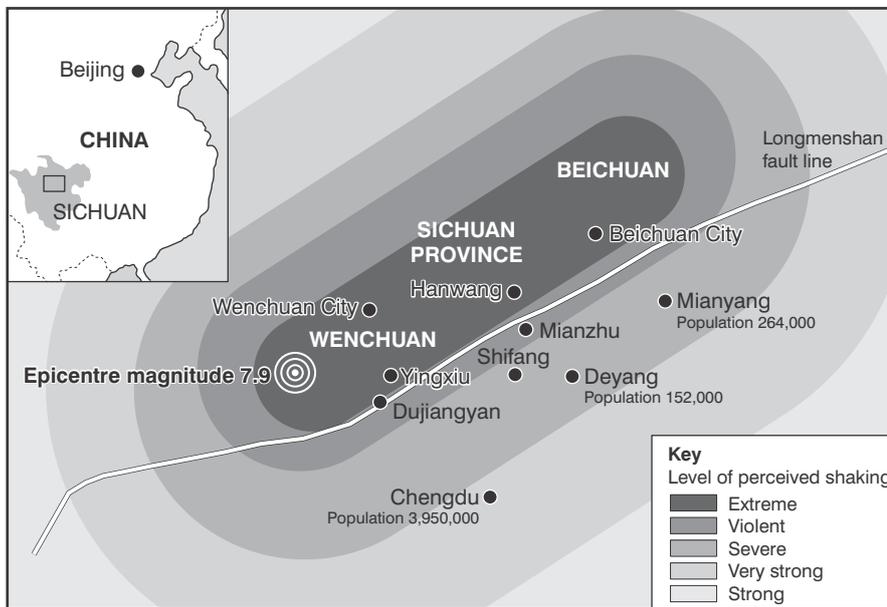


Figure 3: Some of the worst-affected places in the Sichuan earthquake

Source: US Geological Survey



Figure 4: Devastation following the Sichuan earthquake

Source: AP/PA

On 12 May 2008 tectonic stresses built up, and stored energy was released, rupturing along the Longmenshan fault. The earthquake's focus was 10 km below the ground, 92 km north-west of the city of Chengdu in Wenchuan County. The epicentre is the point on the Earth's surface directly above the focus.

Around 100 million people live in the Sichuan Basin and weak rock had built up through sedimentation. This weak material took on the properties of a liquid (liquefaction) and

amplified the effects of the shaking which, combined with the relatively shallow focus and steep relief in the mountains, meant that the shaking was intense and enduring. The shaking was felt as far away as Bangladesh, Vietnam and Taiwan.

Figure 3 shows the location and epicentre of the Sichuan earthquake. Its immediate effects were as follows:

- The death toll was 87,652 deaths (69,185 official deaths and 18,467 missing and presumed dead) including 11,000 killed in

collapsed school buildings. An estimated 374,000 were injured and 5 million made homeless (Figure 4).

- Damage caused by the earthquake and subsequent landslides is estimated to amount to \$86 billion and included destruction of, or damage to:
 - 5,300 km of roads and several bridges which slowed the arrival of relief
 - 8,000 km of water pipelines
 - many railways by landslides – and a train carrying refined fuel caught fire in a tunnel in Gansu Province
 - Chengdu Airport, which was temporarily closed, further complicating the relief effort
 - 2,380 dams which were weakened – the high annual rainfall and steep slopes make dam building for hydro-electric power attractive but the threat of seismic activity is always present.
- In Sichuan and neighbouring provinces, 5.36 million buildings collapsed and 21 million buildings were damaged.
- Public service buildings were destroyed, including many hospitals such as three in Hanwang, and many schools including the Juyuan Middle School in Dujiangyan where 900 staff and pupils died.
- In addition to the destruction of numerous factories, two chemical factories in Shifang collapsed, releasing toxic gas.
- The Food and Agricultural Organisation estimated that 32 million farm animals perished, including over 3 million pigs. Hundreds of thousands of hectares of farmland are dry, with ruined irrigation systems.
- Subsequent aftershocks up to 6.0 on the Richter scale created more damage. In the mountains landslides were common, especially with the intense rainfall following the earthquake. Many rivers were dammed by the debris from landslides. Thirty-four dammed barrier or 'quake lakes' formed and some threatened to break, creating floods and sweeping trees and vehicles into the towns.

- In Beichuan, 80% of the buildings in the old town and 60% in the new town were destroyed. 400 pupils and teachers were killed in one school. The rescue effort was hampered by the damage to roads and rescue workers and medical staff could not reach the town for three days which resulted in more of the trapped and injured dying. The ‘quake lake’, Lake Tangjiashan, above the city threatened to burst its banks.

The consequences

The devastation following the earthquake led to various national and international responses.

- The government’s response to the disaster was rapid in providing emergency response and Chinese Premier Wen Jiabao visited the area with UN Secretary General Ban Ki-moon. The Chinese government sent in 140,000 troops by boat, on foot, by helicopter and even parachute, and 100,000 volunteers including rescue and medical teams along with helicopters, water and food. The rescue effort was impeded by the mountainous terrain and the damage to roads. (This was in contrast to the government of Myanmar whose response to Cyclone Nargis which killed over 135,000 people earlier in the same month included the reluctance to provide foreign aid agencies with easy access, making the initial relief effort inadequate and causing the death toll to rise.)
- Many foreign governments and aid organisations sent aid.
- The lack of clean water, poor sanitation and cramped living conditions led the World Health Organisation to warn of a disease threat in the area.
- Temporary camps were quickly established around Sichuan Province.
- 250,000 residents were evacuated from downstream of the unstable Lake Tangjiashan, formed by a landslide. 2,000 soldiers excavated earth and used explosives to widen the drainage channel.
- The loss of factories, hydro-electric power generation and tourist revenues will be felt for many years.

- Because the earthquake occurred in the afternoon, an estimated 11,000 children died in school buildings. Some schools, such as the Xinjian Primary School in Dujiangyan, were the only buildings to collapse in an area. This prompted complaints of poor building quality. Lack of reinforcement meant that floors collapsed onto each other, leaving little space for those trapped to survive. The government promised to crack down on any incompetent or corrupt building of schools.
- Beichuan sustained such severe damage that it is planned to build the whole city in a new location.
- The government made last-minute changes to the route of the August 2008 Olympics torch itinerary to include visiting the earthquake zone but even the Olympic spirit cannot overcome the problems in Sichuan Province.
- Because of the one-child policy, many people lost their only child. The one-child policy is being relaxed in Sichuan Province and the Chinese government was reportedly sending medics to reverse sterilisation operations.
- By 14 June, roads to 248 out of 254 towns in the damaged area were repaired.

Conclusion

The short-term outlook for 5 million people in the region is poor and an immense rebuilding programme is now in place. However, people, communities and buildings need to be prepared and the wisdom of having large settlements in earthquake-prone mountainous areas should be questioned. Indeed the Chinese government believes that many settlements are too dangerous for living in. Disasters such as the Indian Ocean tsunami of 2004, Hurricane Katrina of 2005 and the China earthquake of 2008 have led leading hazard experts such as Professor Iain Stewart of the University of Plymouth to comment that whilst the physical presence of natural hazards such as earthquakes make communities hazard-prone, the scale of the disaster is

determined by social, economic and political factors:

‘While hazards happen, disasters are caused – incurred by a lack of preparedness within communities, and by the inability of political authorities to organise and provide resources to guard against or withstand hazard effects. In this sense, there is little that is “natural” about hazards.’

Source: Stewart, I. and Donovan, K. (2008) ‘Natural Hazards’ in Buckingham S. and Turner, M. *Understanding Environmental Issues*, Sage: London, p215

Activities

- What is the most common scale used to measure the magnitude of earthquakes?
 - What instrument is used to measure the magnitude of earthquakes?
 - What was the final death toll (the official figure including the presumed dead) of the China earthquake?
 - Initially press reports said that the death toll was lower. Why do you think the official death toll rose in the days after a disaster?

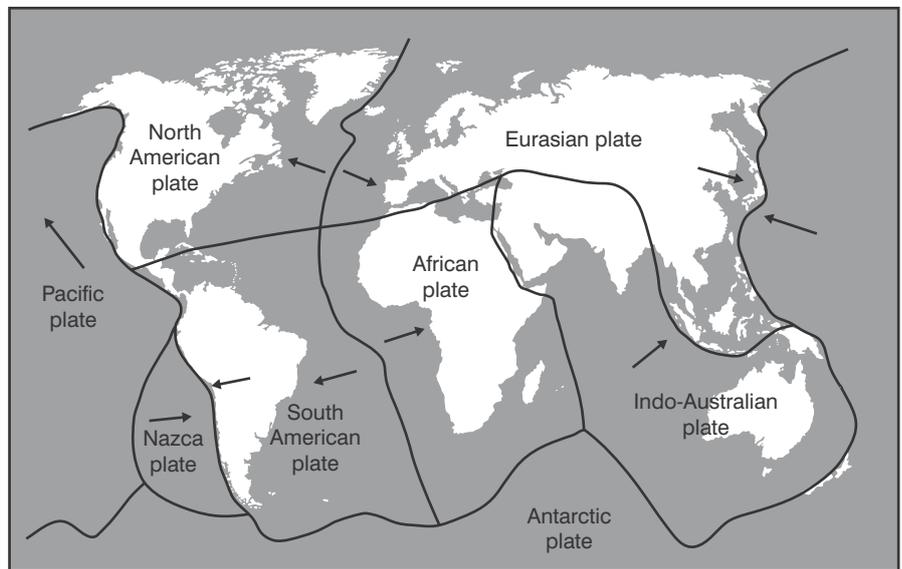


Figure 6: The Earth's continental plates and their direction of movement

2 Study Figures 5 and 6.

(a) The China earthquake was at a collision plate boundary between the Indian (part of the Indo-Australian) and the Eurasian plates. Find examples of two plates whose types of plate boundary are:

- compressional/destructive
- constructive/tensional
- conservative/transform.

(b) What caused the China earthquake?

3 (a) Make a list of the effects of the China earthquake. Try to give specific figures if they are quoted, such as the number of deaths.
 (b) Some people classify the effects into primary effects, which are the immediate death and damage caused by the earthquake such as falling buildings, roads and railways, and secondary effects which come later and include fire, landslides, tsunamis, disease, famine and lack of water.
 From your answer to (a), name

Date	Magnitude	Fatalities	Region
12/05/2008	7.9	87,652	Eastern Sichuan, China
15/08/2007	8.0	514	Near the coast of Central Peru
26/05/2006	6.3	5,749	Java, Indonesia
08/10/2005	7.6	80,361	Kashmir, Pakistan
26/12/2004	9.1	227,898	Off west coast of northern Sumatra
26/12/2003	6.6	31,000	Bam, south-east Iran

Figure 7: The world's deadliest earthquakes, 2003–08

three primary effects and three secondary effects.

4 (a) What made the distribution of relief aid in China more challenging?
 (b) Make a list of responses that the authorities took in the aftermath of the China earthquake.

5 Figure 7 shows the deadliest earthquakes in the five years preceding the one in China in 2008 China.

(a) Using an atlas, plot these on a world map.

(b) Do you think there is a relationship between the magnitude on the Richter scale and the number of fatalities? Are there any anomalies (exceptions)? Why do think this is?

6 What issues does Professor Iain Stewart raise (see 'Conclusion')?

Extension activity

7 You have been asked by your newspaper editor to write the front page and any supporting pages covering the China earthquake. You should cover the causes, the effects and the solutions and use illustrations. Some useful websites for reference are:

- www.usgs.gov
- www.bbc.co.uk
- www.sln.org.uk/geography

Type of plate boundary	Description
Compressional/destructive	An oceanic plate is forced under a lighter continental plate and melts into the mantle (subducts)
Constructive/tensional	The plates move in opposite directions; magma rises up from the mantle below
Conservative/transform	The plates slide past each other
Collision	Two continental plates collide

Figure 5: Types of plate boundary