

Ancient Chinese Seismometer

A seismometer -- an earthquake detector, also called a seismograph -- was invented in 132 A.D., by Chang Heng, a brilliant mathematician and scientist in the Han Dynasty of China.

The ancient Chinese believed seismic events, with their death and destruction, were important signs from heaven. So it was important to the Chinese leaders to be alerted to earthquakes occurring anywhere in the kingdom. A correct call about an earthquake occurring won a person immortal fame, as in Chang Heng's case. A wrong call about an earthquake resulted in disgrace and punishment.

What did the original seismometer look like?

Cheng Heng's original seismometer was lost. Luckily, its description survived. It was a cast bronze vessel with a domed lid, resembling a wine jar. The working insides, of were hidden. The surface of the vessel was decorated with motifs of mountains, tortoises, birds, animals and antique writing. Around the vessel were eight dragons whose mouths each held a ball. Around the base of the vessel sat eight corresponding toads with their mouths open, looking upwards. (Fig. 1)



Fig. 1 – Ancient Chinese seismometer. Notice the dragons around the vessel and the toads beneath them.

The sign for an earthquake was the falling of a ball from the dragon into the mouth of a toad. The direction of the earthquake is indicated by the position of the toad which swallowed the ball. This instrument was most remarkable.

On one occasion one of the dragons let fall a ball from its mouth though no perceptible shock could be felt. All the scholars at the capital were astonished at this strange effect occurring without any evidence of an earthquake to cause it. But several days later a messenger arrived, bringing news of an earthquake in Lung-Hsi (400 miles away). Upon this everyone admitted the mysterious power of Chang Heng's instrument.

The workings of Chang Heng's seismometer were never revealed. Most experts agree however, that it worked on the principle of inertia. A mass is suspended. An earthquake shakes the vessel, causing a slight displacement between the mass and the vessel. This movement is transmitted via levers and gears to push out a ball.



Fig. 2 – A cut-away look at the inside workings of the ancient Chinese seismometer.

In the design of any instrument, the goal is to make the instrument sensitive to a desired signal while, at the same time, rejecting any false signals. In other words, Chang Heng had to design his seismometer so that it would “activate” when it detected shaking from an earthquake, but he did not want the seismometer to “activate” because of people or animals walking near the instrument.

Chang Heng's seismometer was described as having a diameter of "eight chih"! (A little more than 6 ft.) His device appears to be incredibly scientifically designed for that time period! In 132 A.D., did Chang really know what we know today? Or did he hit on it by pure luck? Earthquakes occurred so infrequently, how did Chang study it so accurately? Consider also the expense of making bronze castings the size of a horse way back then. Another question you may want to ponder is why did Chang Heng take such pains to decorate his instrument with celestial motifs. What was the real purpose of these decorations? Do you think this helps the instrument to function better? Or might there have been other reasons for the elaborate decorations.