

Plate tectonics and subduction zone earthquakes

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50 years ago Harry Hess published a paper that started a revolution in the Earth Sciences, though we now know that almost all of what he said in that paper was wrong. The revolution began slowly. In 1963 Fred Vine and Drum Matthews proposed that Hess's idea of sea floor spreading could account for the linear magnetic anomalies that had been discovered off the NW coast of the USA. Vine spent his Ph.D. looking at magnetic anomalies in the Atlantic, trying to find evidence that his suggestion was correct. He had little success. In 1965 the situation suddenly changed, when Vine found that the US survey contained a symmetrically spreading ridge. This discovery, together with Tuzo Wilson's analysis of the behaviour of transform faults, resulted in an avalanche of new ideas. The final version of the theory, which is now known as the theory of plate tectonics, was put together by Jason Morgan and myself in 1967, working independently on the E and W coast of the U.S. This is why you have invited me here to come and talk! It has provided an accurate and detailed theory of the Earth's tectonics, and has remained essentially unchanged for 45 years.

The recent Tohoku earthquake in Japan has shown in extraordinary detail how the Pacific Plate is being subducted beneath Japan, how this process accounts for the huge tsunami, and the vertical and horizontal motions recorded by continuous GPS. The tectonics of northern India along the Himalayan front in many ways resemble that of the Japanese arc. The steady movement of India northwards towards Tibet has generated large elastic strains. If these are released in a few large earthquakes similar in size to the Tohoku and Indonesian earthquakes, the death toll in northern India is expected to exceed a million people.