Tuesday, February 21, 2012 Science & Life

Forecasting earthquake forces

Researchers used their model to help explain the stresses that act on Earth's tectonic plates. Those stresses result in earthquakes not only at the boundaries between tectonic plates, where most earthquakes occur, but also in the plate interiors, where the forces are less understood.

Stony Brook University researchers have devised a numerical model to help explain the linkage between earthquakes and the powerful forces that cause them, according to a research paper scheduled to be published in the journal Science on Feb. 17. Their findings hold implications for long-term forecasting of earthquakes

William E. Holt, Ph.D., a professor in the Geosciences Department at Stony Brook University, and Attreyee Ghosh, Ph.D., a post doctoral associate, used their model to help explain the stresses that act on Earth's tectonic plates. Those stresses result in earthquakes not only at the boundaries between tectonic plates, where most earthquakes occur, but also in the plate interiors, where the forces are less understood, according to their paper, "Plate Motions and Stresses from Global Dynamic Models."

"If you take into account the effects of topography and all density variations within the plates -- the Earth's crust varies in thickness depending on where you are -- if you take all that into account, together with the mantle convection system, you can do a good job explaining what is going on at the surface," said Dr. Holt.

Their research focused on the system of plates that float on Earth's fluid-like mantle, which acts as a convection system on geologic time scales, carrying them and the continents that rest upon them. These plates bump and grind past one another, diverge from one another, or collide or sink (subduct) along the plate boundary zones of the world. Collisions between the continents have produced spectacular mountain ranges and powerful earthquakes. But the constant stress to which the plates are subjected also results in earthquakes within the interior of those plates.

"Predicting plate motions correctly, along with stresses within the plates, has been a challenge for global dynamic models," the researchers wrote. "Accurate predictions of these is vitally important for understanding the forces responsible for the movement of plates, mountain building, rifting of continents, and strain accumulation released in earthquakes."

Data for their global computer model came from Global Positioning System (GPS) measurements, which track the movements of Earth's crust within the deforming plate boundary zones; measurements on the orientation of Earth's stress field gleaned from earthquake faults; and a network of global seismometers that provided a picture of Earth's interior density variations. They compared output from their model with these measurements from Earth's surface.

"These observations -- GPS, faults -- allow one to test the completeness of the model," Dr. Holt said.

Drs. Ghosh and Holt found that plate tectonics is an integrated system, driven by density variations found between the surface of Earth all the way to Earth's core-mantle boundary. A surprising find was the variation in influence between relatively shallow features (topography and crustal thickness variations) and deeper large-scale mantle flow patterns that assist and, in some places, resist plate motions. Ghosh and Holt also found that it is the large-scale mantle flow patterns, set up by the long history of sinking plates, that are important for influencing the stresses within, and motions of, the plates.

Topography also has a major influence on the plate tectonic system, the researchers found. That result suggests a powerful feedback between the forces that make the topography and the 'push-back' on the system exerted by the topography, they explained.

While their model cannot accurately predict when and where earthquakes will occur in the short-term, "it can help at better understanding or forecasting earthquakes over longer time spans," Dr. Holt said. "Nobody can yet predict, but ultimately given a better understanding of the forces within the system, one can develop better forecast models."

Source: Science Daily