Relationship of Gravity Variations and Prediction of Earthquake Behavior (Extended abstract) by

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Interestingly some relationship ought to exist between Earth's gravity field variation and prediction of Earthquake behavior. What does the force that causes objects to fall to the ground and the moon to orbit around the earth have to do with the unpredictable ground trembling of an earthquake?
Latest researches have led to the findings that within subduction zones, the regions where one of the earth's plates slips below another, areas where the attraction due to gravity is relatively high are less likely to experience large earthquakes than areas where the gravitational force is relatively low.
Until now, researchers studying earthquake behavior generally considered one of four approaches:
1) analyzing seismograms generated by earthquakes
2) studying frictional properties of various types of rock in the laboratory or in the field,
3) measuring the slow accumulation of strain between earthquakes with survey techniques
4) large-scale dynamic models of earthquakes and tectonics.

Alternatively, instead of using one of these approaches, variations in the gravity field can also be considered as a predictor of seismic behavior.

A gravity anomaly occurs when gravity is stronger or weaker than the regional average. For example, a mountain or an especially dense rock would tend to increase the nearby gravity field, creating a positive anomaly. Likewise, a valley or salt dome emerging in the Khewra Salt mine (Pakistan) would tend to create a negative anomaly (unpublished findings yet by Ahmad Z., et al. 2009).

Some Scientists like Song and Simons examined existing data from satellite-derived observations of the gravity field in subduction zones. Comparing variations in gravity along the trenches with earthquake data from two different catalogs going back 100 years, it is revealed that, within a given subduction zone, areas with negative gravity anomalies correlated with increased large earthquake activity. Areas with relatively high gravity anomalies experienced fewer large earthquakes.

Besides, most of the energy released in earthquakes was in areas of low gravity. In comparsion, subduction zone earthquakes with magnitude greater than 7.5 since 1976 are associated with low negative gravity anomaly. Asmuch as the total energy released in those earthquakes, 44 percent came from regions with the most strongly negative gravity anomalies, though these regions made up only 14 percent of the total area (Song and Simons).

When compared the location of large earthquakes with the topography of the subduction zones, findings revealed that areas of low topography (such as basins) also corresponded well to areas with low gravity and high seismic activity.
One possible clue or link is assigned by means of the frictional behavior of the fault. When two plates rub up against each other, friction between the plates makes it harder for them to slide. If the friction is great enough, the plates will stick. Over long periods of time, as the stuck plates push against each other, they may deform, creating spatial variations in topography and gravity.

In addition to deforming the plates, friction causes stress to build up. When too much stress builds up, the plates will suddenly jump, releasing the strain in the sometimes violent shaking of an earthquake.

If there were no friction between the plates, they would just slide right by each other smoothly, without bending or building up the strain that eventually results in earthquakes. So in subduction zones, areas under high stress are likely to have greater gravity and topography anomalies, and are also more likely to have earthquakes.

Topographic undulation and gravity variations persist over periods of time much longer than the typical time between earthquakes, 50, 100 to 1,000 years, **large earthquakes should be consistently absent from areas with large positive gravity anomalies**.

Though no one can tell when or where the next major earthquake will occur, Global Positioning System (GPS) measurements can possibly show where strain is accumulating. Areas with high gravity will have low strain, and thereby result in insignificant Earthquakes and vice versa. Large earthquakes occur where gravity and topography are low, there are low-gravity areas in subduction zones with no seismic activity.

Variations in Earth’s gravity field before and after the occurrence of Earthquake is hard to find at this stage of new development of scientific hypotheses. Slight variation may be possible but that may be short lived and may not have any plausible effect on the density contrast.

Department of Earth Sciences, Quaid-i-Azam University has purchased a latest equipment CG-5 Autograv (made by Scintrix, Canada) from the fundings of the Higher Education Commission (HEC). This gravity meter is capable of applying automatic corrections (drift, latitude, and Bouguer etc) and acquiring elliptical ground elevation data with built in Garmin GPS.

CG-5 Autograv (made by Scintrix, Canada)