URI geologist develops improved seismic model for monitoring nuclear explosions in Middle East

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Geologists from the University of Rhode Island and Princeton University, in collaboration with Lawrence Livermore National Laboratory, have taken an important step toward helping the United States government monitor nuclear explosions by improving a 3-dimensional model originally developed at Harvard University. The improvements make the model more accurate at detecting the location, source and depth of seismic activity.

The results of their research were presented today at a meeting of the American Geophysical Union in San Francisco.

The National Nuclear Security Administration uses numerous seismic models in its efforts to monitor the globe for underground nuclear explosions detonated by nations that seek to keep their nuclear activities undetected. But not only is it difficult to identify exactly where an explosion takes place, it is especially challenging to differentiate the seismic waves generated by nuclear explosions from those generated by earthquakes, volcanic activity and mine collapses.

"The goal is to build a model of the Earth that will locate seismic events and characterize those events precisely while reducing potential errors," said Brian Savage, URI assistant professor of geosciences.

The model spans the politically sensitive region from Turkey to India,

including Iran, Iraq and Afghanistan, a region Savage describes as "tectonically complex."

Savage and his colleagues analyzed data from 200 earthquakes collected by 150 seismic stations in the region between 1990 and 2007. They compared the data with that from simulated earthquakes to identify deficiencies in the model, then propagated the simulated earthquakes in reverse to determine where to improve and update the model.

Different types of seismic waves travel in different ways and at different speeds. P-waves, for instance, are the first waves recorded from an earthquake or explosion, and they behave similar to sound waves. S-waves are secondary waves that travel in a snake-like side-to-side fashion. Surface waves are a combination of the two traveling much slower with much larger amplitude.

"Depending on the material the waves travel through, it may slow down or speed up the waves," said Savage, who notes that the model requires a great deal of computer power to run. "So when you look at the relative timing of the waves, you can tell what the material is that it's traveling through."

The improvements the researchers made to the model focused on long period surface waves and identifying the magnitude of a seismic event.

"The amplitude ratios of different wave types is a key factor in discriminating whether an event is manmade or not," Savage said.

The improved model is expected to be complete by next summer. The research was funded by he National Nuclear Security Administration and the Air Force Research Laboratory.