Researchers distinguish waves from mine collapses from other seismic activities

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Researchers have devised a technology that can distinguish mine collapses from other seismic activity. Using the large seismic disturbance associated with the Crandall Canyon mine collapse last August, Lawrence Livermore National Laboratory scientists and colleagues from the Berkeley Seismological Laboratory at UC Berkeley applied a method developed to detect underground nuclear weapons tests to quickly examine the seismic recordings of the event and determine whether that source was most likely from a collapse.

They also found an additional string of secondary surface seismic waves that occurred when the mine collapsed, which are like no other mine collapse events in recent history. The new research appears in the July 11 edition of the journal *Science*.

The tragic collapse of a Utah coal mine on Aug. 6 resulted in the deaths of six miners. Ten days later, another collapse killed three rescue workers.

The event was recorded on the local network of seismic stations operated by the U.S. Geological Survey as well as the National Science Foundation Earthscope USArray stations. The collapse registered as a 3.9 magnitude event.

"Our group had already been working on a full seismic waveform matching technique as a means to distinguish between nuclear explosions, earthquakes and collapse events by their seismic signals," said Bill Walter, one of the LLNL researchers.

The new study could help researchers better differentiate underground nuclear tests from earthquakes, mine collapses, mine blasts and other events that generate seismic waves.

UC Berkeley graduate student and LLNL Lawrence Scholar Sean Ford was able to quickly collect the data from the Crandall Canyon seismograms at the time and plug it into the Laboratory algorithm that pointed to a collapse rather than an earthquake.

"These results were posted within a few days after the event and were helpful in resolving the source of the magnitude 3.9 seismic signal," Ford said.

The new technique compares model seismograms to the observed seismograms at local to regional distances (0-1,500 kilometers) at intermediate periods (five to 50 seconds).

Another notable fact about the collapse: The team detected Love waves (also named Q waves - surface seismic waves that cause horizontal shifting of the earth). Typically small in instances such as large mine collapses or hole collapses that sometimes follow nuclear tests, Walter said the Love waves from the Crandall Canyon collapse are "larger than expected for a pure vertical collapse due to gravity."

Though the cause of the Love waves is not fully known, there are several theories, according to Walter.

"One speculative explanation consistent with the data is that the collapse was uneven, with one side closing more than the other," he said. But he said further studies are necessary.

Ford said the Crandall Canyon event was relatively small, magnitude wise. "The fact that we could identify the Crandall Canyon event from its seismic signature gives us confidence that it would be possible to identify even relatively small nuclear explosions using this technique."

"We are excited about the potential of this regional seismic full waveform matching technique and are continuing to develop and test it on other events in others parts of the world to fully understand it," Walter said.

Source: Lawrence Livermore National Laboratory

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