



## Earthquake Hazards Program

# Earthquake Technology Fights Crime

Scientists with the U.S. Geological Survey have adapted their methods for quickly finding the exact source of an earthquake to the problem of locating gunshots. On the basis of this work, a private company is now testing an automated gunshot-locating system in a San Francisco Bay area community. This system allows police to rapidly pinpoint and respond to illegal gunfire, helping to reduce crime in our neighborhoods.

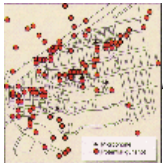
The sound of gunshots has become an all too familiar and unwelcome occurrence in many communities across the Nation. When shots ring out, 911 calls from worried citizens may come from a large area. Unfortunately, even with numerous reports, police are often frustrated in their efforts to silence this gunfire because they cannot pinpoint the location of gunshots rapidly. During the late 1980's and early 1990's, the occurrence of illegal gunfire increased dramatically in some San Francisco Bay area communities. In 1992, residents in and near one such community were subjected nightly to the loud sounds of weapons fire and lived in fear of being struck by a stray bullet. A U.S. Geological Survey (USGS) seismologist working and living in Menlo Park, on the edge of this community, recognized that sound waves traveling through the air away from a gunshot are basically similar to the sound (seismic) waves traveling through the ground away from an earthquake. Seismologists have long known that by precisely measuring the different times of arrival of a seismic wave at several distant locations they can pinpoint an earthquake's exact source. Over many years they have developed the electronic instruments and computer programs needed to locate the source of a temblor quickly and automatically.



*(Click on image for full size version - 77K).*

*Field testing of a gunshot-locating system inspired by earthquake technology began in Redwood City, California, in 1995. During acceptance trials in the spring of 1996, police officers fired both .38-caliber pistol and 12-gauge shotgun blanks from various sites in the City. In these tests, the system was able to determine within 50 or 60 feet the locations from which blanks had been fired.*

To test whether this earthquake technology could be adapted to locating the source of gunshots, USGS scientists with the encouragement and cooperation of the Menlo Park police installed a network of five microphones around one of the gunshot-terrorized neighborhoods. Sounds from these microphones were radioed to a personal computer running earthquake-detection programs. Computer programs that were originally designed to track the low-frequency sound waves from an earthquake were modified to monitor high-frequency sound waves from a gunshot. After only a few weeks of testing and improving the software, the system was locating many signals that were clearly associated with gunfire. Automatic weapons fire was the easiest to identify because of the regular time interval between individual shots. The system was more sensitive during the night, when there was less background noise from traffic and other urban activity.



*(Click on image for full size version - 117K).*

*In 1992, seven weeks of testing in this gunshot-terrorized San Francisco Bay area neighborhood demonstrated that a prototype gunshot-locating system developed by U.S. Geological Survey (USGS) scientists from earthquake technology was feasible. Microphones installed in the neighborhood picked up sounds that were then radioed to a USGS computer running programs originally developed for precisely locating earthquakes. The system detected and located numerous potential gunshots. Many of these correlated with incidents of illegal gunfire later documented in*

*police reports.*

In this test the prototype gunshot-locating system worked remarkably well, and according to Commander Dominick Peloso of the Menlo Park Police Department, "This system, when fully developed, holds great promise for assisting police in controlling and reducing violent crime." When the results of the test were made public, there was an enthusiastic response from San Francisco Bay area residents, who asked local government officials to implement such systems in their communities. Interest was also expressed by private firms and law enforcement agencies both in California and elsewhere in the nation. Robert Showen, founder of a company that is now marketing a gunshot-locating system, said, "the USGS experiment...demonstrated beyond a doubt that the concept was feasible and could be implemented quickly. Without this test, I would have been hesitant to invest in the development of my product."



*(Click on images for full size versions - 60K, 67K).*

*In this cartoon of a neighborhood protected by a gunshot-locating system, sound waves from an illegal gunshot travel outward in all directions and are heard by an array of microphones with radio transmitters. The microphones are monitored by a central police computer. When a loud sound is heard by several of the microphones, the computer determines if the sound is a potential gunshot. It then pinpoints the location of the sound's source from slight differences in the sound's time of arrival at each microphone. The computer immediately prints out the street address of the gunshot, allowing police officers to be rapidly dispatched to the area.*

In 1995, responding to citizens' petitions, Redwood City (near Menlo Park) began field testing the gunshot-locating system developed by Showen's company. By the spring of 1996, the system was undergoing final acceptance trials. Captain Jim Granucci of the Redwood City Police Department stated that "even before the system was in use, the number of illegal gunshots declined as word of

its existence spread." Other cities across the nation, including Washington D.C., are now considering the use of similar systems. Such systems may also be useful for combating snipers during overseas peace-keeping operations, helping to protect the lives of Americans in uniform.

This story of the development of a gunshot-locating system shows how scientific research in one field can aid society in a seemingly unrelated area. It also illustrates how the technology and concepts developed by government employees for one purpose can be used to aid and encourage private enterprise to bring useful new products to the marketplace.

**John C. Lahr, Peter L. Ward, Peter H. Stauffer, and James W. Hendley II**  
**Graphic design by Sara Boore and Susan Mayfield**

**COOPERATING AGENCIES AND COMPANIES**

Menlo Park, California, Police Department

Redwood City, California, Police Department

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U.S. Geological Survey Fact Sheet-096-96