

## New Technology for Volcanic Monitoring

By Cristina Ramos

The Instituto Geofísico [Institute of Geophysics of Ecuador] has been responsible for seismic and volcanic monitoring throughout the country since 1983. Early warning of volcanic eruption is essential so that appropriate precautionary measures can be taken.



The institute's mission is to improve disaster preparedness and lessen the impact of seismic and volcanic phenomena throughout Ecuador via constant monitoring, scientific research

and technology. The institute can issue early warnings based on risk maps produced by scientists. The dedication to seismic and volcanic monitoring warned thousands of people and saved countless lives in the recent eruptions of the Tungurahua Volcano in April and in 2006, 2008 and 2010.

The institute's monitoring network has increased because of new needs, technological advances and the involvement of international organizations that have donated equipment and trained personnel. However, with such rapid progress, new problems and challenges have surfaced.

The primary challenge was to build a real-time telemetry network capable of transmitting data. Previously, no adequate data collection equipment for seismic and volcanic monitoring, much less digital technology, had been installed in the country. The existing equipment could not transmit information and collected only local data. This meant time and money to visit remote sites to collect the data.

Digital telemetry was used for applications that didn't require continuous transmission in real time, and the data was transmitted in regular time

intervals. With new technology in place, there were no interference problems, but the equipment was not robust enough for the climate conditions in which it needed to operate.

FreeWave Technologies' data radios transmitted data of the deformation of the Cotopaxi Volcano and the Galapagos Islands. The technology reduced maintenance of monitoring stations to zero. One of the institute's engineers set up a photographic camera with serial transmission using the units for the Reventador Volcano.

These changes took place around 2002, and the institute staff gained more experience in using the radios and became familiar with programming. The system's connections have proven reliable, as well as its performance in extreme conditions.

The institute added the radios to many of its monitoring networks and used them in various monitoring applications and implementation activities. Among the primary monitoring applications are real-time broadband seismic stations in the active volcanoes and tectonic faults, accelerometers located in the cities, meteorological stations, stations to monitor volcanic gases, deformation stations using GPS technology and borehole sensors, remote digital cameras and stations to quantify mud flow.

The institute has a challenge with implementing the geological and volcanic national survey in Ecuador. It plans to install 150 more stations with different applications and with many telecommunication solutions to get data in real time. The units connect two monitoring instruments allocated at the same site. The institute will soon use a high-throughput radio, useful when many signals are concentrated at the same node and after they are transmitted together to the other node.

During the past six years, the tech-

nology has met the institute's expectations. Performance in extreme conditions, as evidenced by a radio that transmits images from the top of the highest active volcano in the world, operating at below zero-degree temperatures from a height of 5,947 meters above sea level, has met its needs. For this application, a camera network was installed in the Tungurahua volcano for visualizing the volcano from four critical zones in real time.

For the latest models of deformation equipment, GPS technology with transmission using the TCP/IP protocol was used. The institute's network consists of five GPS receivers on the Cotopaxi, four on the Tungurahua, one on the Chimborazo, one on the Antizana volcanoes and seven around the country. This year, 50 additional GPS receivers will be installed.

Each piece of equipment is connected to the institute's internal network, allowing access to the equipment from any part of the network. Seismic broadband monitoring made it possible for the institute to give early warning about the eruptions, because the connected sensors allowed it to see signs that other sensors didn't see.

Engineers at the institute continue to consider this transmission equipment the best option for different applications and projects under way. The cost/benefit ratio is excellent, and the technology plays an important role in warning people at risk. ■

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