

UNITED STATES DEPARTMENT OF THE INTERIOR
GEOLOGICAL SURVEY

THE USGS/USAID VOLCANO DISASTER
ASSISTANCE PROGRAM: THE NEXT FIVE YEARS

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Open-File Report 93-379

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September 1993

INTRODUCTION

The Volcano Disaster Assistance Program (VDAP) is a joint USGS/USAID-OFDA program designed to assist foreign governments to mitigate the effects of volcanic unrest and volcanic eruptions. The primary goal of the VDAP is to reduce loss of life and economic damage in countries that experience volcanic eruptions.

The decade of the 1980's was a period of frequent destructive volcanic eruptions. Indeed, the 1980's registered more eruption-related deaths than in any ten-year period since 1902. This destructive trend has continued through the first several years of the 1990's. As rapidly growing populations in developing countries encroach on areas of high volcano hazard, there is every reason to expect that the potential for volcano-related casualties will increase. VDAP has the capability to mitigate volcano hazards through technology transfer, training, and rapid response to volcano unrest. In the following pages we describe the current status of VDAP, our operating strategies, and the framework within which we propose to operate in the next five years.

In order to maintain an international volcano-hazards-mitigation capability over the next five years, we believe that VDAP should continue to support the core Volcano Crisis Assistance Team (VCAT) in Vancouver, Washington and the institutions and observatories that VDAP has helped to develop in Latin America and the Philippines. We also propose a five-year plan that places additional emphasis on Guatemala, El Salvador, and Nicaragua to assist those countries to become more self-sufficient in mitigating volcano hazards within their borders. This emphasis is designed to provide technical training and assistance in volcano-hazards assessment, volcano monitoring, and hazards mitigation through workshops held in Costa Rica as well as through specific in-country assistance by USGS personnel.

BACKGROUND

Since 1986 the VDAP has helped several countries, most notably Ecuador, Colombia, Guatemala, and the Philippines, by providing various types of assistance before, during, and after volcanic unrest or eruptive

activity. VDAP assistance typically includes some combination of the following:

- 1) preparation for volcano emergencies well in advance through training and long-term collaboration on building and maintaining monitoring networks, and on hazard-assessment activities.
- 2) rapid-response assistance in volcano monitoring to determine if magma is moving under a volcano, whether it is likely to reach the surface, and where;
- 3) rapid-response assistance in volcano-hazard assessment to determine the nature and timing of past eruptive and associated hydrologic activity and the distribution of products from past eruptions;
- 4) assistance in interpreting monitoring and hazard-assessment data and communicating results to local officials;
- 5) assessment of watershed conditions following eruptive activity and analysis of subsequent hazards associated with landslides, debris flows, floods, and high-sediment yields;
- 6) assistance in deploying flow monitors to detect debris flows and floods along drainages that threaten communities.

Summaries of specific VDAP activities can be found in "The USGS-OFDA Volcano Disaster Assistance Program and recent non-VDAP contributions to international volcano-hazards mitigation: Interim Report to OFDA" by Ewert and Lockhart (1992) and "Evaluation of the Volcano Disaster Assistance Program: Guatemala, Ecuador and Philippines" by Hammelton and others (1993).

The Volcano Crisis Assistance Team

There are two main components of VDAP: the Volcano Crisis Assistance Team (VCAT), and the cache of volcano monitoring equipment. The core of VCAT consists of a small, full-time group of geologists, volcanologists, and hydrologists located at the Cascades Volcano Observatory in Vancouver, Washington. Additional scientists from within and outside of the USGS supplement the core group as needed to provide additional personnel and expertise. VCAT (1) participates in all VDAP responses, (2) collaborates with counterparts in target countries, (3) assists in development of new, more effective volcano-monitoring instrumentation, (4) develops, writes, and publishes training aids, and (5) organizes and provides most of VDAP training.

The VCAT equipment cache

The second critical component of VDAP is the VCAT cache of equipment. VCAT has developed and maintains a cache of equipment sufficient to establish a functional real-time volcano observatory near a restless volcano. The cache is portable and includes a variety of sensors, telemetry systems, and base-station equipment to gather, interpret, and archive monitoring data. The cache includes equipment necessary to monitor seismic and deformation activity in real-time, to conduct geodetic surveys around a volcano, to measure the flux of key indicator gases, and to detect the initiation and movement of volcanic ash, pyroclastic flows, debris flows, and lava flows. The cache utilizes networked personal computers (PC's) to archive and

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analyze data. Software utilized with the PC's is designed to make data accessible for easy analysis and interpretation, and to aid volcanologists in communicating current status of the volcano hazards to the lay authorities charged with mitigating the hazards.

The operating strategies of the VDAP are summarized below.

- 1) Rapid response to restless volcanoes is essential. Installation of a monitoring network and completion of geologic investigations to determine the character of past eruptions, and thus potential hazards, can take weeks to months to complete. The time interval between the beginning of unrest and eruptive activity can be short. The sooner a response is started, the better the chances of correctly interpreting what may happen and of issuing timely warnings.
- 2) VCAT is deployed by invitation only. To become involved in a crisis response VCAT requires an official request through diplomatic channels from the host country.
- 3) VDAP's operational philosophy is to work with local scientists to help them to provide timely information and analysis to emergency managers and public officials.
- 4) A long-term goal of VDAP is to help host countries to develop an independent capability to mitigate volcano hazards. VDAP aims to help host countries become self-sufficient in volcano monitoring and hazard assessment.
- 5) VDAP is developing a database on Latin American volcanism to assist in quick evaluations of future volcanic unrest. The database includes maps, literature, and data such as the magnitude and frequency of past eruptions, and people and property at risk at specific volcanoes.
- 6) The volcano-monitoring systems used by VDAP are designed specifically for ease of use in developing countries. The systems are standardized and non-proprietary, which permits regional sharing of technical expertise.

Present status of the VDAP

VCAT core staff consists of two volcanologists, a geophysicist, a hydrologist, and a database compiler. The core VCAT staff is supported half-time by OFDA and half-time by the USGS. Many other scientists and technicians, with a wide range of expertise, participate in VDAP activities on a part-time basis with support solely from the USGS.

The VCAT equipment cache has been replenished following its deployment during the Mount Pinatubo eruption and provision of equipment to observatories in Colombia and Ecuador. After crisis responses much of the VDAP equipment is left permanently in host countries, and thus, must be regenerated after each event. Modest additions of equipment to the cache over the next five years will maintain its readiness and enhance its effectiveness.

VCAT is continuing to improve and enhance the capabilities of monitoring hardware and software that are used in volcano-crisis response. One problem faced by scientists monitoring restless volcanoes is determining whether or not eruptive activity is occurring, especially during darkness or inclement weather. We are adding important new tools to our VCAT equipment cache including a doppler weather radar, a lightning-detection system, and a satellite-image-acquisition system. These new state-of-the-art tools should be operational in 1994. We believe that they will allow us to better identify hazardous events and provide information about them to disaster management authorities.

VDAP is currently supporting, with equipment and regular training/working visits, three volcano observatories in Colombia, a volcano observatory in Ecuador, two observatories in the Philippines, and an observatory in Guatemala. Continued modest assistance to these institutions on a regular basis is necessary to keep the observatories functioning. The VDAP has recently completed training programs on various aspects of volcano monitoring for staff members from Latin American and Philippine institutions. In Amendment II to the VDAP Participating Agency Service Agreement (PASA), we propose a new training initiative for Central America, described in detail below.

The VDAP has recently published Spanish translations of critical publications on volcano monitoring and hazard assessment. These published translations will aid our ongoing training efforts, and our ability to communicate effectively with hazards-mitigation authorities in Latin America. Additional documents will be translated and published over the next five years.

To maintain a strong and effective VDAP in the future we believe that the core components and activities of VDAP should be maintained, and that they should be combined with new training programs for parts of Latin America. Current VDAP plans are listed below. The first six objectives represent continuation of the ongoing program. The seventh and eighth objectives are new initiatives.

- 1) VDAP should maintain a VCAT staff of experienced volcanologists, geophysicists and hydrologists to respond effectively to future crises.
- 2) VDAP should maintain the VCAT monitoring-equipment cache.
- 3) We propose to continue to support volcano observatories in Ecuador, Colombia, and the Philippines with equipment and collaboration in order to help maintain their readiness.
- 4) We propose to continue VDAP training activities in VDAP-supported countries.
- 5) We propose to continue to improve the capabilities of monitoring hardware and software that are used by the VCAT and VCAT-supported observatories in other countries.
- 6) We propose to continue to develop documentation and training aids and to translate them into Spanish.

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Central American training program

- 7) We propose that VDAP begin a small group of pilot projects to identify and monitor hazards at selected Central American volcanoes to give members of local observatories experience in assessing and monitoring hazards.
- 8) We propose that VDAP begin a new training program aimed specifically at Central America.

During an evaluation trip to Central America in spring 1993 we held discussions with representatives of civil defense, Red Cross, USAID, the OFDA regional advisor for Latin America, and government agencies responsible for hazard assessment and monitoring in each country. Of the four Central American countries that have significant volcano hazards to contend with, only Costa Rica was found to be well positioned to mitigate volcano hazards. Guatemala, El Salvador, and Nicaragua all need assistance to develop the capability to successfully identify hazards, monitor unrest, and mitigate the effects of future eruptions. All three countries lack equipment and trained personnel to adequately assess and monitor volcanic hazards that threaten significant populations. Representatives of Instituto Nacional de Sismologia, Vulcanologia, Meteorologia, e Hidrologia (INSIVUMEH), Guatemala, Centro de Investigaciones Geotecnicas (CIG), El Salvador, and Instituto Nicaraguense de Estudios Territoriales (INETER), Nicaragua, have requested assistance from the VDAP to help them to more effectively monitor and assess hazards at their high-risk volcanoes.

Guatemala had been the focus of an AID-funded program for VDAP training and technology transfer from 1987 through 1990. As a result of this, and subsequent efforts by the Swiss Disaster Relief Fund and the Centro de Coordinacion para la Prevencion de Desastres Naturales en America Central (CEPRENAC), INSIVUMEH improved its volcano-hazards assessment and monitoring capabilities, but not to the point of self-sufficiency.

Successful mitigation of future eruptive activity in Central America requires adequate monitoring tools and analytical skills, reliable baseline data, and completed hazard assessments. Most volcanoes in Guatemala, El Salvador, and Nicaragua lack baseline deformation and seismic data with which to compare future measurements should the volcanoes become restless. Ideally, each potentially dangerous volcano should have, at a minimum, one¹ or more telemetered seismometers on or near it, plus baseline surveys designed to detect future ground deformation. Furthermore, volcanic-hazard assessments and hazard-zonation maps have not been completed for many volcanoes in Guatemala, El Salvador, and Nicaragua. All three countries lack personnel who are adequately trained to conduct monitoring and hazard-assessment activities.

¹ One telemetered seismometer allows recognition of seismic activity; four or more seismic stations located near a volcano are necessary to determine locations and migration of earthquakes for purposes of eruption prediction.

**Cooperation with
OVSICORI**

We propose a 5-year plan to assist El Salvador and Nicaragua, and to continue to assist Guatemala to become more self-sufficient in mitigating volcano hazards. Working in conjunction with the Observatorio Volcanologico y Sismologico de Costa Rica (OVSICORI) at the Universidad Nacional, Costa Rica, we plan to provide intensive training programs and workshops for scientists, public officials, and representatives of civil defense agencies from Guatemala, El Salvador, and Nicaragua.

The staff at Universidad Nacional, Costa Rica, is ideally suited to provide, or to help provide, much of this training. OVSICORI has a strong program of volcano monitoring and hazard assessment and a staff of highly trained scientists, some of whom have received OFDA assistance towards graduate degrees in earth science. OVSICORI has offered to work in cooperation with their Central American neighbors by providing various training programs in cooperation with VDAP. Working in cooperation with OVSICORI in Central America would provide strong regional linkage among the people and institutions responsible for monitoring and mitigating volcano hazards.

**The Central American
mobile volcano
observatory**

OVSICORI plans to develop and deploy a mobile volcano observatory capable of reaching the vicinity of any volcano in Central America within 24 hours. The observatory would be capable of gathering and evaluating real-time seismic and deformation data within a few days of its deployment. We believe that a mobile volcano observatory in Central America will greatly enhance rapid responses to volcanic unrest and we believe that the VDAP should support OVSICORI in this enterprise.

Training courses

We propose that VDAP organize and participate in, together with the staff of OVSICORI, in specialized training programs each year at OVSICORI for participants from INSIVUMEH, CIG, and INETER. Courses would last from one to several weeks and be conducted in Spanish. Course subjects would change each year. The first workshop would be an introductory course on volcanic hazards and hazards mitigation for scientists, civil defense and public officials using the recently translated and published "Peligros Volcanicos" (Tilling, 1993) and "Vigilando Volcanes" (Ewert and Swanson, 1993) as course notes and reference materials. In some instances, representatives of civil defense, Red Cross, government ministries, and other local and federal agencies will be invited to participate in courses. Subsequent annual workshops would cover volcanic seismology, volcano-deformation monitoring, debris flow monitoring, and volcanic-hazard assessment and hazard-zonation mapping. Other workshops will be planned as appropriate. Training programs and workshops developed for Central America will be carefully coordinated with the OFDA regional advisor for Latin America, the Swiss Disaster Relief Fund, and CEPREDENAC), a Swedish- and Norwegian-sponsored organization providing hazard-mitigation assistance to Central America.

Demonstration projects

Working visits to each country by VDAP staff would follow each course to assist in implementation of techniques and procedures learned in classes. Because of manpower and funding constraints associated with instrumenting and investigating every potentially active volcano in each Central American country, a demonstration project would be conducted at a high-risk volcano in each country

to implement monitoring and hazard-assessment techniques. Equipment required for the demonstration projects would be provided to each country by VDAP. Demonstration projects would provide hands-on training opportunities for scientists from each country, would set an example of how to conduct monitoring and hazard assessment activities, and, could provide the basis for each country to solicit funds and support for additional monitoring and hazard-assessment work from other agencies such as CEPREDENAC, UNDRO, or other potential donor institutions.

We also propose to establish a number of smaller pilot projects to assess or monitor hazards at selected volcanoes. One such project would involve mapping one or more Central American volcanoes that are known to have had large explosive eruptions, to learn the history and frequency of these dangerous eruptions. Another project would involve instrumentation and monitoring of a volcano that frequently produces a particular hazard (debris flows, for example). Such pilot projects would serve two important functions; they would (1) identify and help to mitigate the hazards posed by the volcanoes, and (2) train Central American observatory workers in hazards assessment and monitoring techniques.

The proposed Central American training program would provide specific training on hazards-mitigation procedures, in Spanish, and would foster cooperation and exchange among scientists from Guatemala, El Salvador, Nicaragua, and Costa Rica. Training workshops would provide the opportunity to bring scientists, civil defense, and other public officials together to discuss volcanic hazards and their mitigation, affording them the opportunity to learn about their respective roles and responsibilities. Furthermore, participation by VDAP would integrate VDAP staff into the Central American volcanologic community so that when the next volcanic crisis develops, close working relationships are already established. We believe that through this program substantial improvements can be made, over a several-year period, to the infrastructure and volcanic-hazard-mitigation capabilities of Central American countries.

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