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UNITED STATES
DEPARTMENT OF THE INTERIOR
U. S. GEOLOGICAL SURVEY

FIRST ANNUAL REPORT

of

the

VOLCANO EARLY WARNING AND DISASTER ASSISTANCE PROGRAM

VDAP

6 August 1986 -- 30 September 1987

by

Norman G. Banks
Program Chief

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Program conducted in cooperation with the
Office of Foreign Disaster Assistance
Agency for International Development
Department of State
PASA (OTR-0000-P-IC-6116-01)

This report is preliminary and has not been reviewed for conformity with U. S. Geological Survey standards

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6 August 1987 -- 30 September 1987

ORGANIZATION OF THE REPORT

This is the First Annual Report of the U. S. Geological Survey (USGS) and Office of Foreign Disaster Assistance (OFDA) Volcano Early-Warning and Disaster Assistance Program (VDAP). The report is organized for reader convenience into six main sections:

I. HIGHLIGHTS OF THE REPORT
II. BACKGROUND AND DESCRIPTION OF THE PROGRAM
III. FY 87 PROJECTED AND ACTUAL BUDGET, ACTIVITIES, AND ACCOMPLISHMENTS
IV. FY 88 PROJECTED BUDGET, ACTIVITIES, AND ACCOMPLISHMENTS
V. SUMMARY OF ACTIVITY AT LATIN AMERICAN AND CARIBBEAN VOLCANOES IN FY 87
VI. SUPPORTING APPENDICES

It is recommended to those wishing only an overview of the accomplishments, problems, and recommendations of VDAP's first year experiences that they read section I. Those wishing more detail can refer to the other sections of interest.

I. HIGHLIGHTS OF THE REPORT

SUMMARY OF SIGNIFICANT RESULTS AND ACCOMPLISHMENTS

Although VDAP is a new program and by charter design must be flexible enough to respond to unanticipated emergencies, the actual activities, accomplishments, and expenditures were remarkably close to those projected for FY 87 in the 1986 USGS WORK PLAN.

<u>Generation of the Core Team</u>

USGS Funded (Assigned)

- Program Chief and Volcanologist - Norman Banks
- Volcanological Seismologist - David Harlow, half time; Randy White, half time
- Logistics Technician - Michael Doukas

OFDA Funded (Hired)

- Electronics/Seismic Technician - Andrew Lockhart

- o Deformation Specialist - John Ewert
- o Database Specialist - Deferred to FY88, various USGS professionals and technicians assigned to accelerate development of seismic system.

Development of Equipment Cache

- o Seismic system - Purchased and borrowed parts sufficient to field 6-station telemetered net with two back-ups: development of real-time computer processing at base station ahead of schedule.

- o Dry tilt system - Purchased remaining parts of total station, provides wide aperture tilt (new system) and trigonometric leveling, developed data reduction programs for the two methods.

- o Digital telemetry system

  - Completed hardware/radio purchase/development sufficient to field 5 telemetered tiltmeters, 2 repeater stations, and 3 base stations.
  - Deferred work on telemetered fumarole monitors in favor of accelerating development on "smart" telemetry and mudflow alarms; purchased parts for 5 mudflow alarms that use the smart telemetry.

Development of Computer (and information/map/photo) Database

- o Slowed owing to diversion of available resources to the development of the seismic system. Nonetheless, there was significant progress in acquisition of base maps and background literature covering about 50-70 % of the Latin American and Caribbean volcanoes of concern.

Assessment of Activity, Latin American High-risk Volcanoes.

- o Provided OFDA with preliminary report on overall volcano hazards and state of knowledge on known high-risk volcanoes.
- o Made on-site visits in Colombia, Ecuador, Costa Rica, Guatemala.
- o Made new hazard evaluation maps for two Guatemalan volcanoes.

Response to Volcano Unrest

- o Fielded 3-person crew (13 person weeks) in response to a request from Guatemala to evaluate and mitigate the hazards of 4 volcanoes showing

activity.

Coordination International Hazard Mitigation groups, United Nations (UNESCO, UNDRO) and World Organization of Volcano Observatories (WOVO).

- o Conducted a 1-month training workshop on deformation monitoring with Ecuadorian, Costa Rican, and Guatemalan trainees: UNESCO/WOVO funded.
- o Conducted joint VDAP/UNDRO evaluation of volcano preparedness in Ecuador.
- o Wrote proposals to WOVO and Nordic Volcanologic Institute; resulted in training in Iceland of personnel from Observatorio Vulcanologico de Colombia.

Liaison/Evaluation Trips and Activities

- o Two trips to Ecuador
- o Two trips to Colombia
- o One trip to Costa Rica
- o Two trips to Guatemala/Mexico
- o Two trips to El Salvador (earthquake related)
- o Extensive telephone, telex, and letter traffic, including provision of technical literature, data, equipment, and other requested assistance throughout Latin America and other third world countries.

Establishment of Baselines and Other Monitors

- o Deformation monitors established in 1 Costa Rican volcano.
- o Deformation monitors placed on 3 Ecuadorian volcanoes.
- o Provided parts requested to recommission telemetered tiltmeter in Ecuador.
- o Deformation monitors (including 1 telemetered) placed on 4 Guatemalan volcanoes.
- o Assisted in expansion of monitors on Ruiz Volcano.
- o Loaned small-array EDM equipment to Ecuador, Guatemala, Costa Rica; included on-site training.

Additional Activities, Not Projected by 1986 USGS WORK PLAN

- o Finalized delivery and commissioning of all equipment deficiencies resulting from the 1985 Ruiz crisis.
- o Assembled kit for geothermal water/condensate geochemical analysis.
- o Upgraded the portable computer hardware/software.
- o Upgraded geology/observation equipment.
- o Upgraded tool/repair-instrument inventory.
- o Wrote proposal and obtained $338,000 in operational

expenses, salary, travel, and overhead from the USAID Mission in Guatemala for a 2.5 year, phase 1 program to develop a governmental volcano hazards monitoring/mitigation group in Guatemala.

- o Obtained $10,000 from UNESCO through the World Organization of Volcano Observatories to support participants for the workshop in Ecuador.
- o Obtained travel funds from USAID, Guatemala, to field a third member of VDAP during emergency assistance to the Instituto Nacional de Sismologia Vulcanologia Meterologia y Hidrologia.
- o Produced together with Maurice Krafft (France) and Bill Rose (University of Michigan) the first draft of an educational video on the hazards of pyroclastic flows.

Summary of Expenditures

USGS FUNDS	PROJECTED	ACTUAL
Salaries	$ 116,000	116,026
Benefits	$ 13,700	13,700
Contracts	$ 9,000	9,228
Equipment	$ 16,800	19,341
Travel	$ 2,280	2,200
Operations	$ 4,450	4,089
Overtime	$ 1,500	1,556
Overhead including Administrative and Technical Services	$ 97,200	97,200
	$ 260,930	262,840
OFDA		
Salaries	$ 65,000	65,169
Benefits	$ 6,900	6,900
Overtime	$ 3,000	3,094
Contracts	$ 20,000	0 #
Equipment (seismic and telemetry)	$ 50,000	50,534
Travel	$ 44,400	31,195 #
Operations	$ 8,700	8,734
Overhead	$ 79,000	66,189 #
	$ 277,000	231,809 #

 # = Expenditure of $20,000 in contracts and $13,200 in travel (plus related overhead) deferred to FY88.

PROBLEMS IN FY87 - ADAPTATIONS FOR FY88

Scope of the Program

Two problems became apparent during VDAP's maiden year owing

to the scope of VDAP's stated objectives versus the program's level of funding, number of staff, and projected duration. The first concerns a growing load in responses to communication and specific requests for assistance from Latin America and elsewhere. The second concerns the scope of effort involved in generating the necessary liaisons and information files that allow adequate response to volcano unrest.

VDAP received heavy telephone, telex, mail, and site-visit traffic in FY87, and this load grew throughout the year as word of VDAP spread in Latin America, other third world countries, and international assistance organizations. The traffic ranged from simple requests for information to requests that caused considerable VDAP effort in literature or product research as well as the provision of guidance, equipment, program reviews, and training.

VDAP team members attempted to respond fully and speedily to all such requests, in keeping with the intent of VDAP. However, in view of the growing interest and need for our services, it is obvious that to continue to fully respond to all of them could seriously impinge upon progress on the core objectives of the program. If this occurs, it may be necessary to request a fourth OFDA-supported position, dedicated solely to responding to these requests, because to ignore or to treat them with a less-than-obliging attitude would seriously impinge upon future cooperation from the agencies that VDAP is established to assist.

The second problem of scope that crystallized during VDAP's maiden year is the size of the job of becoming adequately informed about and sufficiently responsive to the many high-risk volcanoes along the 15,000 mile length of Latin America. The number (and funding) of the agencies in Latin America that are qualified and equipped to evaluate, monitor, and mitigate volcanic hazards is dwarfed by the problems and needs that face them. Given the staff size, funding, and its' expected 5-year program life, VDAP can not hope to become sufficiently informed on all problems and at the same time provide appropriate and adequate assistance to all interested agencies in all of Latin America and the Caribbean. Moreover, to attempt to do so would dilute overall VDAP contributions to questionable levels and might risk a culpable failure of hazards mitigation during some future emergency response.

Extensive discussions by VDAP with Latin American counterparts revealed that their wish for long-term and full guidance toward independence is equal to their need for more and better monitoring systems. Moreover, our own on-site observations of aid programs, in progress or planned by other countries in volcanology, are that they generally are funded at a higher levels and for longer-term compared to many U.S. efforts including VDAP. This assures us that to follow a course of dilute attention would be worse for U.S. diplomatic and commercial

interests than no program at all. Thus, we recommend that we maintain high-quality service and response by VDAP, by adopting the following program changes:

- o That VDAP be viewed, at least in principle, as a 15-20 year, multiphase program.
- o That the VDAP emergency response umbrella be reserved for Latin America and only a few other carefully-considered instances elsewhere where risk is high and perceived to require VDAP's rapid deployment capabilities.
- o That VDAP, during the first phase (5-10 years), concentrate efforts on liaison contact, data base development, training, and system building for only 3-4 countries; for example in the 4 main South American countries, which have minimum but developing experience in volcano hazards and where VDAP/OFDA has already invested heavily (Colombia and Ecuador).

Such restructuring announces long-term and serious interest by the U.S. toward the almost overwhelming problems in volcano hazards faced by Latin America, a posture that our Latin American associates assure us will generate good will for the U.S. and its' interests. A South American focus would allow VDAP to gain more in-depth expertise and knowledge about fewer volcanoes and volcano-hazard agencies along one contiguous belt of more manageable size. Moreover, the ice and snow fields that cap South American volcanoes constitute a potential, from even small eruptions, for large mudflows that can reach a larger population than can eruptions of similar size in Central America.

This does not suggest that Central America should or would be ignored. Low-level and crisis-related assistance would be maintained. STAGE 1 of the Guatemala addendum would be completed. However, STAGE 2 of the Guatemala plan (currently unfunded) would not be pursued nor would major system building be initiated in the other Central America nations until they became the focus of Phase 2 of VDAP. Moreover, this delay in focus on Central America makes logistical sense. Although Central American volcanoes erupt more often than those in South American, it is virtually impossible to do field work at this time in Nicaragua and El Salvador; Costa Rica has a viable volcano hazards unit already addressing their own problems; Mexico has shown recent reluctance to invite U.S. government agencies to in assist their hazards programs; and neither Panama nor Honduras have large populations at risk to volcanoes.

Staff

The problems of scope discussed above are in part augmented by staffing adjustments and problems in FY87 that continue as

this report is being written.

First, VDAP was physically divided between two centers, the Cascades Volcano Observatory (CVO) and Menlo Park, California. This division of VDAP takes advantage of the large pool of expertise in seismology in Menlo Park, but required restructuring of staff. Because only one electronics/seismic specialist (based at CVO) is provided by the PASA, the California-based seismologist(s) required additional technical aid in FY87 to assure a proper schedule of development of the seismic system. This assistance was accomplished by deferral of hiring of the Database Specialist to FY 88 and use of the released funds to support additional Menlo Park technicians and professionals on the VDAP seismic system.

A major consequence of this restructuring of staff was greatly decreased progress on the building of the information/map database required for efficient and knowledgeable rapid response to volcano emergencies. There are too many volcanoes and agencies in Latin America to properly obtain, catalogue, and track all necessary information and data without a Database Specialist dedicated to these tasks (as described by the 1986 USGS WORK PLAN and in the OFDA PASA). An additional result of the division of VDAP into two centers and two Branches of the USGS, was an uneven load of the administrative obligations and operational duties on the CVO-based members.

Efforts are underway to increase integration of the seismic component of VDAP with the main group at CVO. However, hiring of the Database Specialist at the beginning of FY has been and still is delayed by a hiring freeze. In addition, the hiring of an assistant budgeted for and funded by the Guatemala Project (Task 7, Appendix IV) was been caught by the same hiring freeze. This assistant was planned and is needed to avoid degradation of the core objectives of VDAP while the team extends assistance to INSIVUMEH.

The combination of the restructuring and continued staff shortages has delayed the achievement of crisis readiness at the level anticipated by the 1986 USGS WORK PLAN for the PASA. Failure in either the efforts to integrate the staff or to hire the two missing staff will require formal inter-agency agreements to reduce the product expectations of VDAP.

Logistics of Crisis Response

A chronic problem for VDAP has been timely arrival at crisis sites and the transportation of equipment for both crisis response and baseline studies. Arrival times at a volcano are governed more by airline schedule and seat availability than by readiness of the team or the gravity of the situation. -Deregula-

tion of the airlines has compounded problems inherent in the transport of VDAP equipment to volcano crises. Airlines now make a practice of bumping excess baggage in favor of higher-paying (per weight) passengers and air-freight. Thus, VDAP frequently arrives at either the intended destination or the home base without critical equipment. On average, about 80 % of the trips end up with 1-4 days of delay in baggage delivery. This August, an unannounced policy change for excess baggage required air-freighting of the equipment cache, a subsequent 10-day impoundment of the cache. VDAP would not have been able to respond to a crisis during that time.

VDAP recommends that OFDA investigate how VDAP can take advantage of military or Air National Guard transportation for both our planned baseline/liaison and emergency trips. These groups are required to fly a set number of flights annually anyhow, and ferrying of VDAP when it is ladened with equipment should offer them a practical use of government funds.

Another chronic problem (although not experienced in FY 87 since the initiation of VDAP), has been the increasingly lengthy lead times required to obtain non-emergency foreign travel authorization. Travel requests not fitting current definitions of an emergency must be submitted approximately 2 months prior to a trip. Clearly, some volcano crises develop on a schedule that may not be deemed an emergency somewhere along the approval channels. An example was Ruiz, where the tragedy took at least 11 months to develop. Just as clearly, the volcano monitoring groups in Latin America do not operate on a similar 2-month advance-notice schedule. Thus, VDAP has lost "targets of opportunity" to contact groups, individuals, and projects that are critical to VDAP objectives when important meetings have developed and take place in a matter of a few weeks.

To minimize failures in hazard mitigation and to avoid embarrassment in Latin America concerning VDAP's purported readiness and rapid response capabilities, it might be wise if VDAP had pre-approved travel authorization for at least 4 unscheduled, 2-person trips per year that are activated by a simple telephone notification/approval scheme, so that unique opportunities and potential catastrophes are not missed by the USGS/OFDA Early-Warning Disaster Assistance Program.

II. BACKGROUND AND DESCRIPTION OF THE PROGRAM

BACKGROUND

VDAP has had a varied history (summarized in APPENDIX I) that includes unilateral USGS as well as joint USGS and OFDA activities. Both the USGS and joint USGS/OFDA activities were done on an ad hoc basis from 1981 until FY 85, when a formal project termed the Volcano Crisis Assistance Team (VCAT) was initiated by the USGS. In August of 1986, the USGS was joined by OFDA in the 5-year VDAP program covered by PASA OTR-0000-P-IC-6116-01.

VDAP had its origins in the emergency response of the USGS to the Mount St. Helens eruption in Washington in 1980, when it was dramatically emphasized that volcano crises can and do develop faster than unprepared emergency monitoring and hazard mitigation systems can be emplaced. Thus, in January of 1981, the USGS began building a mobile cache of volcano monitoring equipment that has been used in a series of volcano emergencies:

- Mount Pagan (Marianas, 1981-83-84)
- Rabaul Caldera (Papua New Guinea, 1983-84)
- Mayon Volcano (the Philippines, 1984)
- Ruiz Volcano (Colombia, 1985-86)
- Pacaya/Fuego/Santiaguito/Tacana Volcanoes (Guatemala, 1987-continuing).

The equipment was also been used to teach volcano monitoring techniques in several countries that are developing or upgrading their volcano monitoring and hazard mitigation systems.

Prior to the August 1986 agreement to cooperatively fund VDAP, mobilizations were funded by the USGS and OFDA on a case-by-case basis. Thus, both limited funding and the small size of the core team resulted in channeling of a disproportionately large part of VDAP's response effort into the development of an equipment cache and into assistance to colleagues during volcano crises; there was rarely sufficient funding to provide pre-crisis assistance. The change from the ad-hoc to the long-term funding agreement between the two agencies allowed a more comprehensive commitment to the mitigation of volcano hazards through expansion of the core staff, development of a better equipment inventory, and, significantly, provision of more resources for, and thus stronger focus on, assisting colleagues in upgrading their early-warning and hazard-mitigation systems before a crisis. The pre-eruption objectives of the program include assistance to requesting agencies in establishing baseline and early-warning monitoring, in improving hazard evaluations, in upgrading equipment inventories and monitoring techniques, in development of information and database files, and in training personnel through workshops and the generation of

educational/training aids such as pamphlets and video tapes.

OBJECTIVES OF THE PROGRAM

The overall objectives of the program are an amalgam of three independent documents that resulted from the varied history of VDAP noted above:

- The USGS Volcano Crisis Assistance Team (VCAT) Project (APPENDIX II)
- The 1986 USGS Work Plan for the PASA (APPENDIX III)
- The obligating PASA document (APPENDIX IV)

These three documents have essentially the same objectives, although not all place equal emphasis on the same objective. To reduce the confusion that arises from the three parallel obligating documents, these objectives are restated below:

OBJECTIVE 1 -- To develop and maintain a core team (2-3 professionals, 4-5 technical and support aids) with experience in methods of volcano monitoring and hazard evaluation for the purpose of rapid and effective response to volcanic unrest when requested by appropriate agencies, with emphasis on Latin America and the Caribbean (USGS VCAT PROJECT, OBJECTIVE 1, APPENDIX II; USGS WORK PLAN (implied); PASA TASK 1, Appendix IV).

OBJECTIVE 2 -- To develop and maintain a cache of monitoring equipment and data processing systems dedicated and ready for rapid, risk-minimum, and responsible assistance to volcano unrest (USGS VCAT PROJECT, OBJECTIVE 3, APPENDIX II; USGS WORK PLAN, OBJECTIVE 3, APPENDIX II; OFDA PASA TASK 2, APPENDIX IV).

OBJECTIVE 3 -- To establish and maintain political and scientific liaisons with national and international agencies and graduate's of the team's training courses in order to facilitate rapid and logistics-minimal response to emergency requests (USGS VCAT PROJECT, OBJECTIVE 6, APPENDIX II; USGS WORK PLAN, OBJECTIVE 2, APPENDIX III; OFDA PASA TASK 4, APPENDIX IV).

OBJECTIVE 4 -- To generate support for monitoring groups in Latin America and the Caribbean and develop educational aids, public awareness, early-warning monitoring systems, hazard mitigation programs, and preparedness for volcano unrest (USGS WORK PLAN, OBJECTIVE 2, APPENDIX III; PASA TASKS 5 & 6, APPENDIX IV).

OBJECTIVE 5 -- To assist requesting agencies in establishing hazard evaluations, baseline monitors, and early-warning forecasts to reduce loss of property and life and to

minimize political instability through assistance :

a) prior to signs of unrest, and

b) during times of volcano emergencies.

(USGS VCAT PROJECT, OBJECTIVES 1 & 2, APPENDIX II; USGS WORK PLAN, OBJECTIVE 4, APPENDIX III; PASA TASKS 2, 5 & 6, APPENDIX IV).

OBJECTIVE 6 -- To create and maintain database files, bibliographic material, and map-photo libraries to track and provide instant background on currently-active and potentially-active volcanoes in Latin America and the Caribbean (USGS VCAT PROJECT, OBJECTIVE 4, APPENDIX II; USGS WORK PLAN OBJECTIVE 1, APPENDIX III; OFDA PASA TASK 3, Appendix IV).

OBJECTIVE 7 -- To assist developing countries to achieve independence in volcano hazards evaluation, monitoring, and forecasting through workshops, technology transfer, development of teaching and educational aids; and direct teaching and training (USGS VCAT PROJECT, OBJECTIVE 5, APPENDIX II; USGS WORK PLAN, OBJECTIVES 2 & 4, APPENDIX III; OFDA PASA TASKS 3, 5 & 6, APPENDIX IV).

OBJECTIVE 8 -- To improve ability of the volcanological community to decipher and understand volcano processes through frequent intercourse with international counterparts and interactive exposure to many volcanoes in various states of unrest and in eruption with modern monitoring equipment and methods (PASA TASKS 4, 5 & 6, APPENDIX IV).

OBJECTIVE 9 -- To improve skills in the volcanological community in hazard mitigation through observing and sharing, during frequent real exercises, the problems and successes in hazards reduction measures (PASA TASKS 5 & 6, APPENDIX IV).

III. FY 87 PROJECTED AND ACTUAL ACTIVITIES, ACCOMPLISHMENTS, AND EXPENDITURES

INTRODUCTION

VDAP is a new program and, as such, it was necessary to make several adjustments and adaptations in FY87 that were not anticipated at the time of writing the 1986 USGS WORK PLAN. In addition, the program, by it's charter design, must be flexible enough to respond to unanticipated emergencies. Nonetheless, the actual FY 87 activities, accomplishments, and expenditures were remarkably close to those presented in the 1986 USGS WORK PLAN

(APPENDIX III).

ACTIVITIES AND ACCOMPLISHMENTS, FY 86 PROJECTED AND FY 87 ACTUAL

There were eight major tasks listed in the Projected Schedule of Pasa Activities for FY 87 (20 of the 1986 USGS WORK PLAN; see APPENDIX III). These are listed below and each is followed by an itemization of actual activities on them.

1) To identify and bring on board the remaining members of the core team (VCAT) (OBJECTIVE 1, above):

NOTE 1: Program Chief and Volcanologist, Norman Banks (GS14), established by USGS VCAT project prior to the PASA Agreement.

o Volcanological Seismologist (GS12)
  - Assigned to 1/2 time duty 10/86 David Harlow (GS12)
  - Assigned to 1/2 time duty 10/86 Randy White (GS12)
o Deformation Specialist (GS11)
  - Hired Deformation Specialist 10/86 John Ewert (GS7), promoted to GS9 in 1987...See NOTE 2 below
o Logistics Technician (GS9)
  - Assigned 10/86 Michael Doukas GS7 (promotion to GS9 in progress)
o Electronics/Seismic Technician (GS11)
  - Hired 10/87 Andrew Lockhart GS9 Electronics Non-Seismic Geophysicist...See NOTE 2 below
o Computer Specialist (GS11)
  - See NOTE 2 below

NOTE 2: The geographical distribution of the Team (2 in Menlo Park, CA, and the rest at the Cascades Volcano Observatory, WA) required a restructuring of the Projected staff for FY 87 as follows:

- The Deformation and Electronics Specialists hired also had experience in computer programing.

- Several technicians of the Branch of Seismology (Menlo Park, CA) were assigned for FY 87 to assemble the telemetered seismic station network. The CVO-based Electronics person will receive training in installation and care of the seismic system in FY 88.

- Hiring of the Computer Specialist (intended to create and maintain the data and information files) was deferred to FY 88 to provide FY 87

funding for the seismic technicians in Menlo Park. The activities in Menlo Park included assembly of the seismic hardware as well as the development of a PC-based seismic acquisition/processing system, to be completed in FY 88.

- Insufficient funds were budgeted in FY 87 to support the number of liaison trips required for the program. Thus lower-grade hires were made to provide the funds for these liaison trips (Reference 1 December 1986 Memo to Mary Ellen Williams and Don Klick (USGS) and 5 February 1987 letter to Paul Krumpe (OFDA).

2) To purchase and develop the equipment needed for the equipment cache (OBJECTIVE 2, above):

o To provide an adequate seismic system (6-station telemetered seismic system).

- ITEM 1 - 6 PS2 seismographs were loaned from Branch of Seismology for exclusive use by VDAP until replaced by equipment top be purchased by VDAP. This change was made because of the expectations of the ITEM 3 below. In addition, all needed components were purchased to construct 6 telemetry (with 2 backups) units and a base station.

- ITEM 2 - Full mobilization readiness (i.e. departure on the day of emergency request) of the telemetered 6-station system is 7 months behind schedule. Current expected mobilization time of the system is 3-5 days. Projected date for 1-day-departure readiness of the 6-station net is now 1 March 88.

- ITEM 3 - The hardware and approximately half of the software needed to produce a PC-based real-time picker-digitizing capability at the base station was codeveloped by VDAP and the Branch of Seismology. This development accelerated availability of this modern system and is expected to reduce the number of recording seismographs needed at the base station. The original projected start date of FY88 for this system was advanced to FY87 owing to freeing of funds intended for purchase of the PS2's (see ITEM 1). See APPENDIX V for details of this new system.

o To complete a dry tilt system

- ITEM 1 - A new VDAP-developed (wide aperture) system of dry tilt was made operational in FY87 and necessary data-reduction programs were developed, tested and applied in the field. See APPENDIX VI for summary of this system.

o To assemble the digital telemetry system and supply 3 telemetered tilt and 3 telemetered fumarole monitors (see p. 12 of 1986 USGS WORK PLAN (or APPENDIX III, SUMMARY PROJECTED EXPENDITURES FOR THE USGS). See APPENDIX VII for description of this system.

- ITEM 1 - All parts were purchased and assembled ready for immediate departure and fielding of 5 telemetered tiltmeters and 3 base stations. This is 2 tiltmeters and 2 base stations more than projected in the USGS WORKPLAN. Currently one telemetered tiltmeter and a base station is on loan and installed on Fuego Volcano, Guatemala. This unit is being replaced through the Guatemalan PASA.

- ITEM 2 - Development of 3 fumarole monitors projected for FY 87 was deferred to FY 88 in order to begin earlier development of the higherr-priority inexpensive mudflow alarm systems. To date all parts were purchased to develop 5 digital telemetered mudflow alarms. Parts of the hardware and software needed to make these units operational were also developed in 1987. The prototype is expected to be completed in early 1988, and the operational units are expected to be operational by the close of FY 88. See APPENDIX VIII for details of the VDAP-developed alarm system.

3) To begin a computer (and information/map/photo) database system on high risk volcanoes in populated areas of Latin America and the Caribbean (OBJECTIVE 6, above).

NOTE 3: Progress on this activity was below expectations owing to deferral of hiring of the Computer Specialist (see NOTE 2 above). Nonetheless, progress was made in this activity.

ITEM 1 - Obtained all unclassified topographic and geologic maps of the volcanic terrane in Guatemala, plus 1:50,000 scale aerial photographs of Fuego, Acatenango, Agua, and

Pacaya Volcanoes.

ITEM 2 - Obtained most unclassified topographic and geologic maps of the volcanic terrane in Ecuador plus aerial photographs of Pichincha, Cotopaxi, Cuicocha, and Tungurahua.

ITEM 3 - Obtained all unclassified topographic and geologic maps of the volcanic terrane in Colombia.

ITEM 4 - Obtained all unclassified topographic maps available of the volcanic terrane in Costa Rica.

ITEM 5 - Improved the literature collection for all Latin American and Caribbean volcanoes.

ITEM 6 - Added topographic maps to the Ecuador collection.

4) To provide OFDA with a preliminary assessment of the activity of the high-risk volcanoes (OBJECTIVE 6, above).

- ITEM 1 - As with Item 1 of activity (3) above, Progress on this activity was much below projected achievement levels owing to deferral of hiring of the Computer Specialist (see NOTE 2 of (1) above). Nonetheless, VDAP provided OFDA with:

Banks, N. G., Ewert, J. W. and Doukas, M. P., 1987, Preliminary compilation and evaluation of high-risk volcanoes in Latin America and the Caribbean: Administrative Report to USGS, OFDA, U.S. Embassy; 7 pp, 7 figures, 13 tables, 1 Appendix.

Banks, N. G., and Lockhart, A. B., 1987, Volcano hazards and preparedness in Guatemala; Preliminary report of the USGS/OFDA Volcano Crisis Assistance Team: Administrative Report to USGS, OFDA, U.S. Embassy, 10 pp.

Banks, N. G., 1987, Preliminary assessment of the volcano hazards of Pacaya Volcano: Unnumbered INSIVUMEH Publication, 25 pp., 5 maps

Banks, N. G., Ewert, J. W. Lockhart, A. B., 1987, Volcano hazards in Guatemala; Preparedness and suggested program for their mitigation: Administrative Report to USGS, OFDA, U.S. Embassy, 48 pp.

Doukas, M. P. and Ewert, J. W., 1987, Preliminary Report on the activities of the USGS/OFDA Volcano Early Warning and Crisis Assistance Program Report in Ecuador 1987: Administrative Report to USGS, OFDA, U.S. Embassy, 15 pp.

Rose, W. I., Mercado, Reinaldo, Maitas, Otoniel, and Giron, Jorge, 1987, Volcano hazards of Fuego Volcano, Guatemala; Preliminary report: Unnumbered INSIVUMEH Publication, 25 pp., 2 maps

White, R. A., and Harlow, D. H., 1988, Hypocentral parameters of significant shallow volcanic chain earthquate of Central America: submitted to journal.

5) To respond, if necessary to a volcano crisis (OBJECTIVE 5, above).

- ITEM 1 - VDAP fielded a 3-person crew in response to a request from Guatemala to evaluate and mitigate the hazards of 4 volcanoes in Guatemala; included 13 person-weeks of field work and training, production of a preliminary hazard map of Pacaya Volcano, establishment of deformation monitoring on 4 volcanoes, evaluation of the current activity and overall hazards of Pacaya, Fuego, Santiaguito, and Tacana Volcanoes; development and funding through USAID, Guatemala, of a 2.5 year program in volcano hazard evaluation and monitoring for INSIVUMEH. See APPENDIX IX for summary of VDAP activities on this mission.

6) To coordinate activities with the interagency early-warning groups, UNESCO, and WOVO (OBJECTIVE 3, above).

- ITEM 1 - Conducted a 1-month training workshop on deformation monitoring with Ecuadorian, Costa Rican, and Guatemalan trainees in an exercise that established deformation monitors on three high-risk Ecuadorian volcanoes. Cofunded by UNESCO and WOVO.

NVI (Nordic Volcanologic Institute) that resulted in training of personnel from OVC (Observatorio Vulcanologico de Colombia) in Iceland.

- ITEM 3 - Coordinated fact-finding mission in Colombia and Ecuador with UNDRO mission (see APPENDIX XI).

7) To conduct a regional workshop and meet with staff of the volcano studies centers in Colombia, Ecuador, and Costa Rica to discuss development of cooperative international programs and existing disaster mitigation plans (OBJECTIVES 4,5, &7, above).

ITEM 1 - No funding was provided by the FY 87 PASA for this activity. However, VDAP members visited all three countries at least once, and as noted above in # 6 ITEM 1, also conducted a UNESCO-WOVO funded workshop in Ecuador.

8) To make 3 liaison/evaluation trips to volcano sites and/or volcano monitoring organizations (p. 13 of the 1986 USGS WORK PLAN; OBJECTIVES 3, 4, 5, 8, and 9, above). VDAP exceeded expectations in this category.

ITEM 1 - In August/September 1986 (see APPENDIX XI for details), 3 project members travelled to:

- o Colombia to maintain relationships with USAID, and various universities and to evaluate progress at the Observatorio Vulcanologico de Colombia.

- o Ecuador to establish relationships with Esquela Politecnioca Nacional (ESPONA), USAID, and Inter AMerican Geodetic Service (IAGS). Pichincha and Cuicocha volcanoes were visited and examined.

- o Costa Rica to establish relationships with the Observatorio Volcanoligia y Sismologia de Costa Rica (OVISCORI) of the Universidad Nacional Autonoma, Universidad de Costa Rica, and USAID. Arenal, Poas, Barba, Irazu, and Turrialba volcanoes were visited and examined. A short-range total station system was loaned (APPENDIX XIII) to OVSICORI to maintain and expand OVSICORI's deformation networks.

ITEM 2 - In December 1986, 1 team member visited

Colombia at the request of OFDA and evaluated and assisted progress at the Observatorio Vulcanologico de Colombia. See APPENDIX XII.

ITEM 3 - In January 1987, 2 team members worked with 2 staff members of the Observatorio Vulcanologico de Colombia to prepare and present papers at the International Association of Volcanology and the Chemistry of the Earth's Interior in Hawaii.

ITEM 4 - In April 1987, 2 members of VDAP visited El Salvador and Guatemala to evaluate and assist progress on seismic monitoring systems and volcano hazard mitigation.

ITEM 5 - Preliminary contact was made with Mexican hazard mitigation groups (Universidad Nacional Autonoma and Defensa Civil) while evaluating Tacana Volcano for Guatemala in February 87.

ITEM 6 - Three VDAP members attended the IAVCEI Symposium on How Volcanoes Work to maintain and initiate contacts with a wide variety of national and international scientists working on many aspects of volcanology.

ITEM 7 - Letter, telex, and telephone communication was heavy in FY 87 with a wide variety of individuals and organizations that have had past, have present, or probably will have future association with the project. A significant portion of these contacts included requests for research and equipment that entailed appreciable time on the part of project staff. See APPENDIX XIV for list of more important letter, telephone, and telex communication in 1987.

ADDITIONAL ACTIVITIES AND ACCOMPLISHMENTS, NOT PROJECTED IN FY 86 PLANS

The following are additional accomplishments by VDAP that were not projected as FY 87 activities.

Additional Activities on the Equipment Cache (OBJECTIVE 2)

- Finalized delivery and commissioning of all equipment deficiencies resulting from the 1985 Ruiz crisis.

- Assembled kit for geothermal water/condensate geochemical analysis.

- Upgraded the portable computer hardware/software.

- Upgraded geology/observation equipment.

- Upgraded tool/repair-instrument inventory.

Additional Activities on Generation of Support for Latin American Volcano Monitoring Groups (OBJECTIVE 4)

- ITEM 1 - Wrote proposal and obtained $238,000 in operational expenses, salary, travel, and overhead from the USAID Mission in Guatemala for a 2.5 year, phase 1 program to develop a governmental volcano hazards monitoring/mitigation group in Guatemala.

- ITEM 2 - Obtained $10,000 in G.E. and travel from UNESCO through the WOVO to support participants in a workshop in Ecuador on deformation monitoring of volcanoes.

- ITEM 3 - Obtained travel funds from USAID, Guatemala, to field a third member of VDAF to provide emergency assistance to INSIVUMEH.

Support of Hazard Evaluation and Baseline Data (Objective 5)

ITEM 1 - Guatemala

- o Provided preliminary hazards maps of Fuego and Pacaya Volcanoes.
- o Provided evaluations of Santiaguito and Tacana Volcanoes to INSIVUMEH and USAID, Guatemala.
- o Established limited but useful deformation monitoring at 4 volcanoes targeted as hazardous by INSIVUMEH (Fuego, Pacaya, Santiaguito, and Tacana).
  expand the deformation network established by VDAF.
- o Established a real-time telemetered tiltmeter on Fuego Volcano.

ITEM 2 - Ecuador

- o Established deformation networks on Cotopaxi, Pichincha, and Cuicocha Volcanoes
- o Loaned a short-range total station (APPENDIX XIV) to ESPONA to maintain and expand the deformation networks established.

ITEM 3 - Costa Rica

- o Made site visits to assist OVISCORI in volcano hazards evaluations of Arenal, Poas, Barba, Irazu, and Turrialba Volcanoes.

- o Loaned short-range EDM system to expand the deformation networks being monitored by OVISCORI.
- o Assisted USAID, Costa Rica, in evaluating progress and needs of a recessed hazards program sponsored by USAID.
- o Established EDM monitors on Arenal Volcano.

Training/educational Videos (OBJECTIVE 7, above)

ITEM 1 - Produced with Maurice Krafft (France) and Bill Rose (University of Michigan) the first draft of an educational video:

Krafft, Maurice, 1987, The 1902 eruption of Mont Pelee, the interaction between man and volcanoes; the devastation produced by pyroclastic flows - 28 minute educational video: preliminary edition.

ITEM 2 - Proposed use of some OFDA contract funding to support another video initiative by I.A.V.C.E.I. (This initiative pending OFDA approval to suggestions to Krumpe and Swan in 10 September and 17 December 1987 letters).

Additional Products in FY 87

VDAP STAFF, 1987, Profile of the USGS/OFDA Volcano Early-Warning Crisis Assistance Team - August 1987 Edition: 7 pp.

Ewert, J. W., 1987, Use of the Citation EDM, T-2, and T-16 theodolites for deformation monitoring: Proceedures and considerations.

White, R. A., and Harlow, D. H, 1988, Hypocentral parameters of significant shallow volcanic chain earthquakes of Central America: Submitted to journal, 35 pp.

FY 87 BUDGET, PROJECTED AND ACTUAL

As seen in the Summary Table below, actual expenditures for VDAP were close to those projected (note the * footnote to the table). Details of the expenditures may be seen in APPENDICES XV and XVI. **The exceptions (Noted with a # in the Summary Table) to the close match between the actual and projected expenditures involve underspending of OFDA funds of $20,000 for Contracts, $13,200 for Travel, and $13,200 for Overhead. These funds will be expended in FY 88 through expanded activities in travel and contracts. Note that the figures in the Actual column represent bookkeeping by VDAP members. Final Official FY 87 figures will be furnished by the Office of International Geology, U. S. Geological Survey.**

SUMMARY TABLE OF VDAP PROJECTED AND ACTUAL EXPENDITURES
FUNDING PERIOD - OFDA for 8/86 - 9/30/87; USGS for FY 87

	*PROJECTED	^ACTUAL
USGS		
Salaries and Benefits	$ 116,000	116,026
Banks, Norman - Volcanologist		
Doukas, Michael - Physical Science Technician		
Harlow, David; Randy White (1/2 time each) Seismologists		
Benefits	$ 13,700	13,700
Contracts	$ 9,000	9,228
Equipment	$ 16,800	19,341
Travel	$ 2,280	2,200
Operations	$ 4,450	4,089
Overtime	$ 1,500	1,556
Overhead including Administrative and Technical Services	$ 97,200	97,200
	$ 260,930	262,840
OFDA		
Salaries	$ 65,000	65,169
Lockhart, Andy - Operational geophysicist		
Ewert, John - Operational Geologist		
Unnamed - Seismologists and Electronic Technicians		
Benefits	$ 6,900	6,900
Overtime	$ 3,000	3,094
Contracts		
Smithsonian	$ 10,000	0 #
Translation and data entry	$ 8,000	0 #
Software development	$ 2,000	0 #
Equipment (seismic and telemetry)	$ 50,000	50,534
Travel	$ 44,400	31,195 #
Operations	$ 8,700	8,734
Overhead	$ 79,000	66,189
	$ 277,000	231,809 #

* = Projected as per 1 December 1986 memorandum to Mary Ellen Williams and Don Klick (1986) and 5 February Letter to Paul Krumpe (OFDA).

^ = Figures in this column subject to adjustment pending final closing of FY 87 books by USGS book keepers.

= Expenditure of $20,000 in contracts and $13,200 in travel deferred as per 10 September 1987 memorandum to Swan and Krumpe.

SUMMARY TABLE OF VDAP EXPENDITURES ON GUATEMALA PROJECT
FUNDING PERIOD - OFDA for 8/86 - 9/30/87

Production of Preliminary Hazard Map Fuego Volcano

Travel Expenses - Rose and Mercado	$ 5,819
Support and Publication Expenses	Incom.
Total Expenditures	Incom.

IV. FY 88 PROJECTED BUDGET, ACTIVITIES, AND ACCOMPLISHMENTS

PROJECTED FY 88 ACTIVITIES

Overall Program activities will be essentially the same in FY 88 as in FY-87. However, emphasis in some categories will be shifted in accordance with the experience gained in the first year of VDAP operation (See earlier section on PROBLEMS IN FY87-ADAPTATIONS FOR FY88). Objectives for the year could be restructured if a significant crisis response is required during the year. In addition, attainment of listed objectives is dependent on early filling of positions still vacant at the beginning of FY88.

Emphasis in FY 88 will be:

(a) To identify additional funding (in-country and international agencies, USAID/OFDA) that is not present in the VDAP program but is necessary to train and provide instrumentation for those groups in Latin America interested in achieving self-sufficiency in volcano early-warning and hazard mitigation (CVO and Menlo Park Team Members).

(b) To maintain already established scientific and governmental liaisons required for efficient emergency responses, with emphasis on Colombia and Ecuador (CVO and Menlo Park Team Members).

(c) To establish preliminary scientific and governmental liaisons required for efficient emergency responses, with emphasis on Chile and Peru (CVO and Menlo Park Team Members).

(d) To acquire, develop, and maintain additional portable monitoring equipment needed for safe and capable emergency responses to volcanic crises, with emphasis on commissioning of the mudflow alarm system, software for real-time earthquake locations, development on film/video monitoring techniques, development of telemetered crater-lake monitors, and development of telemetered fumarole monitors (CVO and Menlo Park Team Members).

Specific purchases for the equipment cache will be as follows:

USGS FUNDS

- o Completion of the classical dry-tilt system
- o Purchase of modest numbers of maps/photos for the volcano files
- o Upgrading of cameras
- o Research parts for a frame-by-frame telemetered TV monitor

OFDA FUNDS

- o Modest upgrading of the Automatic Data Processing hardware and software
- o Modest upgrading of the gas/water geochemistry kit
- o Addition of voice repeaters (deferred from FY 87)
- o Purchase of one seismograph
- o Continued progress on the real-time picking/locating capabilities of the seismic system
- o Telemetered Monitors
  - addition of 3 more data telemetry units
  - addition of 2 more data repeating stations
  - parts to develop air refraction monitors (EDM)
  - parts to complete 2 additional mudflow tripwire units
  - parts to develop fumarole monitoring units
  - parts to develop crater lake monitoring units
- o Modest upgrading of tools, laboratory equipment, and training aids.

(e) To continue development of the map/photo library and analytical data bases of currently- and potentially-active domestic and foreign volcanoes, with emphasis on Colombia, Chile, Ecuador, and Peru (CVO and Menlo Park Team Members).

(f) To add and train 2 additional team members (CVO Team Members):

- o The Database Specialist
- o Technical aid to assist the Guatemalan Project

(g) To continue the development of training and educational videos and pamphlets (CVO and Menlo Park Team Members).

(h) To respond to requests for emergency assistance or teaching/baseline assistance by foreign agencies (CVO and Menlo Park Team Members).

(i) To continue USGS guidance, training, counseling at the volcano monitoring groups established previously through VDAP

support in Colombia (CVO and Menlo Park Team Members).

(j) -- To implement the following parts of Stage 1 improvement of volcanological capabilities of the Instituto Sismologia, Vulcanologia, Meteorologia y Hidrologia (INSIVUMEH, Guatemala) (see TASK 7, APPENDIX IV).

a - Upgrade INSIVUMEH's hazards mapping and evaluation program (CVO Team Members) by:

- providing a basic geology kit for geologic studies.
- assisting in preparation of a preliminary hazard maps of Santiaguito Volcano.
- training of a INSIVUMEH geologist in volcanology
- providing eruption-duty training to 2 INSIVUMEH personnel (if no crisis occur in FY 88, this unit will be deferred to FY 89

b - Upgrade the seismic surveillance of the 4 targeted volcanoes (Menlo Park Team Members) by:

- redirection of existing telemetry and the purchase of 2 portable units
- redirection of existing telemetry units
- training of a INSIVUMEH seismologist in volcanologic seismology
- providing advice to INSIVUMEH as they establish the 4 field observatory posts around Fuego, Santiaguito, Pacaya, and Tacana Volcanoes, as per conditions of the convenue with USAID, Guatemala

c - Establish limited but useful capabilities in deformation monitoring (CVO Team Members) through:

- training of a INSIVUMEH geologist in deformation monitoring
- purchase of replacements for and transfer to ISIVUMEH of the USGS equipment now on loan by VCAT
- purchase of additional deformation monitoring equipment
- establishing or upgrading EDM and dry tilt monitoring on Fuego, Santiaguito, Pacaya, and Tacana Volcanoes

d - To be done in FY 89

e - Provide a basic field kit for geology studies (CVO Team Members).

f - To be done in FY 89

g - Provide the basic necessary reference materials for

general volcanology and monitoring (CVO and Menlo Park Team Members).

h - Provide basic training and support required to service, operate, and interpret the new systems (CVO and Menlo Park Team Members).

PROJECTED FY 88 BUDGET

Expenditures of Funds Carried Over From FY87

As noted under FY 87 BUDGET, PROJECTED AND ACTUAL above, expenditure of $20,000 of FY 87 contract funds and $13,200 of FY 87 travel/liaison funds was deferred to FY 88. Projected uses of these funds in FY 88 are as follows:

- o Contracts

  $10,000 for codevelopment (with USGS, UNESCO, and other donors) of an educational video on volcano hazards.
  $10,000 to develop data bases for Latin American volcanoes and hazard-mitigation programs.

- o Travel/Liaison

  $11,000 for visits of three team members to Peru, Ecuador, and Colombia.
  $ 2,200 for attendance of team member Harlow at the Ruiz Conference in Colombia March 1987.

Projected USGS-OFDA FY 88 Expenditures

As noted in a memorandum of 12 July 1987 to Alan Swan and Paul Krumpe (OFDA) that accompanied the FY 88 budget for VDAP, the FY 88 projected budget again calls for OFDA funding that follows the 1986 USGS WORK PLAN (as modified by the memoranda of 1 December and 2 December 1986 -- transmitted to OFDA 5 February 1987 by Mary Ellen Williams).

As in FY 87, VDAP will adhere as closely as possible to the budget submitted, but will maintain the flexibility required of a major emergency response, a reawakening volcano, a new avenue in technology, or development of a more innovative method of monitoring.

SUMMARY
USGS/OFDA FY 88 PROJECTED EXPENDITURES
1 October 87 - 1 October 88

USGS FY 88

	1986 Workplan	1988 Projected
Salaries and Benefits	$ 125,000	$ 131,400
Contracts		$ 9,000
Equipment	$ 25,000	$ 12,000
Travel		$ 3,900
Operations/Supplies/Repairs		$ 7,600
Overtime		$ 1,500
Overhead	75,000	$ 106,600
TOTAL USGS	$ 225,000	$ 272,000

OFDA FY 88 *

Personnel Service	$ 89,000	$ 75,548
Contracts	$ 15,000	$ 15,000
Equipment	$ 40,000	$ 49,027
Travel	$ 40,000	$ 40,400
Expendable and Operations	$ 5,000	$ 9,023
Overhead	76,000	$ 76,000
TOTAL OFDA	$ 265,000	$ 265,000

* = lower grades allow transfer of $13,462 (1986 USGS WORK PLAN) to Equipment + Travel (as per 1 & 2 December 1986 memoranda.

DETAIL
USGS PROJECTED EXPENDITURES
1 October 87 - 1 October 88

USGS

Salaries	$ 118,000
Banks, Norman - Volcanologist	
Doukas, Michael - Operational Geologist	
Harlow/White, David/Randy (1/2 time each) - Seismologist	
Benefits	$ 13,400
Contracts	$ 9,000
Thin Sections	
Spanish Lessons	
Data Base Entry (various)	
Training Aids	
Equipment ($ 12,000)	
Office	$ 250
Data Base	$ 1,810
Deformation	$ 7,095
Hazards/Documentation/Geology	$ 2,845
Travel	$ 3,900
Banks to Reston/Washington	
Banks to Menlo Park	
Harlow to Vancouver	
Operations/Supplies/Repairs	$ 7,600
Overtime	$ 1,500
Overhead including administrative/technical services	$ 106,600
TOTAL USGS	$ 272,000

DETAIL
OFDA PROJECTED EXPENDITURES
1 October 87 - 1 October 88

OFDA

* Personnel Services ($ 75,548)		
Salaries	$	65,207
Lockhart, Andy - Operational geophysicist, GS9/1		
Ewert, John - Operational Geologist, GS9/1		
Unnamed - Database Specialist, GS7-9/1		
Benefits	$	7,341
Overtime	$	3,000
Contracts ($ 15,000)		
Data/Information Development		
Smithsonian	$	5,000
Translation/entry, software (various)	$	5,000
Training support (various)	$	5,000
Equipment ($ 49,029)		
Laboratory	$	700
Automatic Data Processing	$	2,950
Gas Geochemistry	$	3,395
Logistics	$	188
Safety	$	3,916
Seismic (including 2 PS2 seismographs)	$	20,010
Telemetered Monitors	$	12,095
Tools	$	3,125
Training	$	2,650
Travel ($ 40,423)		
Banks to Sakurajima Symposium	$	3,000
One person to Caribbean volcanoes, 2 weeks	$	2,860
One person to Central American volcanoes, 3 weeks	$	2,860
One person to South American volcanoes, 2 trips	$	4,380
Emergency Response/Baseline, 3 persons, 4 weeks	$	18,300
Expendable and Operations	$	9,023
Overhead	$	70,000
TOTAL OFDA	$	250,000

Projected Guatemalan Expenditures

SUMMARY OF
VDAP TASK 7 PROJECTED EXPENDITURES
GUATEMALA PROJECT
1 August 87 - 1 October 88

+ TRAINING and SUPPORT		
Program advisor travel	$	2,700
Contract or temporary hire assistants	$	20,300
Overtime to purchasing agents and assistants	$	800
Miscellaneous Training costs/support	$	1,445
* Eruption (duty, tickets/perdiem/miscl (2 persons)	$	10,000
SEISMIC		
Equipment and shipping	$	20,700
+ Training	$	13,650
Other	$	3,435
DEFORMATION		
Equipment and shipping	$	45,900
+ Training	$	16,250
Other	$	4,015
HAZARD EVALUATION		
Equipment and shipping	$	2,500
+ Training	$	20,445
Other	$	3,295
OVERHEAD	$	48,807
TOTAL	$	214,197

+ = NOTE that student and advisor travel expenses for training have been included with the appropriate training category

* = This expenditure will be deferred to FY 89, if no eruption occurs in FY 88.

V. ACTIVITY AT LATIN AMERICAN AND CARIBBEAN VOLCANOES IN FY 87

This section provides a brief description of the volcanoes that have VDAP's attention because of current unrest. Absence of a volcano from this list may be a reflection of poor monitoring or infrequent observation. Rather than assuring a tranquil state, Countries and volcanoes are arranged in north-south order.

MEXICO

Colima - repose interval exceeds average interval, dome growth continues and there was a major dome collapse in 1987, increased fumarolic and seismic activity in 1987.
People at risk = unknown
Tacana - increased fumarolic activity and seismicity in 1985; continued seismicity.
People at risk > 50,000.

GUATEMALA

Tacana - see Mexico
Santiaguito - continued, possibly accelerated dome growth, one particularly large collapse of dome flank in December 86, mudflows during rainy season causing flooding and some evacuations from El Palmer.
People at risk = many thousands
Fuego - repose interval exceeds average interval, increased fumarolic and seismic activity plus ejection of incandescent blocks in 1987.
People at risk = unknown but many thousands
Pacaya - increase in explosivity of eruptions in 1987; caused evacuations.
People at risk > 10,000.

EL SALVADOR

No activity reported.

NICARAGUA

Masaya -lava still visible in crater, degassing continues, occasional crater collapse.
People at risk = unknown

COSTA RICA

Rincon de la Vieja - small eruptions in December 1986 and April 1987.
People at risk = unknown.
Arenal - continued seismicity, lava flows, explosions, tephra eruptions.
People at risk = unknown.

Poas - increased seismic and fumarolic activity in 1986 and 1987.
People at risk = unknown.

CARIBBEAN

Micotin (Dominica) - intermittent shallow seismicity.
People at risk = unknown.
Morne Patates (Dominica) - occasional swarms (first noted March 86).
People at risk = unknown.
Mont Pelee (Martinique) - seismic swarms periodically reported.
People at risk > 100,000.

COLOMBIA

Ruiz - seismic activity, gas emission, and occasional small eruptions: another serious eruption in this cycle is still possible.
People at risk > 50,000.

ECUADOR

Cotopaxi - is in it's longest repose period in recorded history and has had seismic swarms since 1976, with possibly increased frequency in the last 5 years.
People at risk > 120,000.
Guagua Pichincha - phreatic and seismic activity in 1985.
People at risk ~ 5,000 in near field, >1,000,000 in Quito.

PERU

Misti - is in it's longest repose interval in recorded history; increased seismic and fumarolic activity reported in 1949 since 1984.
People at risk >1,000,000
Sabancaya - onset of strong fumarolic activity during the past 2 years; volcano previously thought to be dormant, snow and ice clad.
People at risk = several thousand in near field, ?? in far field.

CHILE

Peteroa - new fumarole field opened in January 1987, last eruption in 1967, average repose interval = 27 years.
People at risk = unknown.
Tolguaca - Active fumarolic field discovered, previously considered dormant.
People at risk = unknown.
Lascar - Brief but strong (to 15 km) phreatic? eruptions in

September 1986.
People at risk = unknown.
Villarrica - Intermittent seismicity, snow and ice clad.
People at risk = unknown.

VI. APPENDICES

APPENDIX I. -- Program History and description of pre FY-87 progress towards overall objectives.

The USGS/OFDA VDAP program has had three phases of activity:

AD-HOC STATUS (FY-82 to FY-84) -- Approximately 20 % of the equipment required for the project was purchased or developed during this phase, and ad-hoc teams responded to requests for assistance to volcanic unrest in the Marianas (3 times) and Papua New Guinea (2 times). In addition, the equipment and project chief were used to support teaching of volcano observers in Indonesia and Papua New Guinea, under programs funded jointly by the USGS and U. S. Department of State's USAID/OFDA.

OFFICIAL STATUS USGS PROJECT (FY-85 & 86) -- During this period, the project operated under restricted staffing and funding. However, the equipment cache was brought up to about 35 % of full capacity, principally in the catagories of deformation monitoring and safety equipment. In addition, an ad-hoc team responded to requests from the Philippines to assist PHIVOLCS to monitor and provide hazard forecasts and evaluations during the September-October 1984 eruption of Mayon Volcano. Also, an ad-hoc team, supported by VCAT equipment, developed and presented parts of UNESCO-funded courses for volcano observers in the Philippines, to students of the host country and from Indonesia, Papua New Guinea, and Costa Rica. The project also maintained liaisons with Papua New Guinea and Indonesia, while developing or strengthening ties with volcanologists in the Philippines, New Zealand, Australia, Japan, Colombia, Chile, Costa Rica, France, England, Germany, and Italy. VDAP was almost totally occupied in FY 86 with the training of a new volcano observatory, and replacement and standardization of the project's equipment cache used to establish the observatory following the catastrophic eruption of Ruiz Volcano, Colombia, of November 1985. One VCAT member and VCAT equipment also assisted in the eruption of Augustine volcano in Alaska in 1986. In addition, funding initiatives were explored with UNESCO, the World Organization of Volcano Observatories (WOVO), and USAID/OFDA to obtain the staffing and operational support required to complete the objectives of the project.

OFFICIAL STATUS USGS/OFDA PROJECT (FY-86/87) -- The project obtained co-funding from USAID/OFDA in August 1986 in a program called the USGS/OFDA Volcano Early Warning and Disaster Assistance Program (VDAP). With this new arrangement, direct relationships were established with volcano hazards and civil defense groups in Colombia, Ecuador, Costa Rica, and Guatemala and various types of training was given to the volcano groups in these countries. Working arrangements were also developed with the United Nations Disaster Relief Organization (UNDRO) and WOVO.

A major accomplishment was VCAT's major role in establishing, equipping, and training a new volcano observatory in Colombia.

APPENDIX II. -- Objectives of the USGS Volcano Crisis Assistance Team (VCAT) Project.

OBJECTIVE 1 -- Maintain a small core team with experience in methods of volcano monitoring and hazard evaluation for the purpose of rapid response to volcanic activity when requested by domestic and foreign agencies.

OBJECTIVE 2 -- Provide assistance in establishing base-line monitors on volcanoes when requested by domestic and foreign agencies.

OBJECTIVE 3 -- Maintain and develop a portable but state-of-the-art inventory of monitoring equipment so that the team can operate at maximum functional capacity during response efforts.

OBJECTIVE 4 -- Create and maintain a computer file and map-photo library of currently-active and potentially-active volcanoes of the world.

OBJECTIVE 5 -- Teach courses in the basic skills of volcano monitoring and hazard evaluation to U.S. graduate students and professors and, more importantly, to technically-qualified candidates from countries with active volcanoes but little capability in volcanology.

OBJECTIVE 6 -- Establish and maintain political and scientific liaisons with graduates of the team's courses in order to facilitate rapid and logistics-minimal response to emergency requests.

APPENDIX III. -- Summary of 1986 USGS Work Plan for VDAP; Budgets, Objectives, and Tasks.

PROJECTED FY 87 USGS EXPENDITURES

	PAY PERIODS	
SALARIES, BENEFITS		
VOLCANOLOGIST GS14	26.2	
SEISMOLOGIST GS12	26.2	
LOGISTICS TECHNICIAN GS7	26.2	
SUBTOTAL		110.0
PERSONNEL CONTRACT GS 11/1		9.0
EQUIPMENT AND SUPPLIES		
SEISMIC SYSTEM		
DIGITAL TELEMETRY		
SUBTOTAL		25.0
OVERHEAD		72.0
TOTAL		217.0

PROJECTED FY 87 OFDA EXPENDITURES (per actual PASA)

	PAY PERIODS	
SALARIES, BENEFITS		
DEFORMATION SPECIALIST GS11	26.2	
ELEC./SEISMIC TECH. GS11	26.2	
COMPUTER SPECIALIST GS 11	26.2	
SUBTOTAL		85.0
CONTRACTS* SUBTOTAL		20.0
EQUIPMENT AND SUPPLIES		
SEISMIC SYSTEM		
SUBTOTAL		50.0
TRAVEL and PERDIEM		32.3
MISCL. AND EXPENDABLE SUPPLIES		10.6
OVERHEAD		79.1
TOTAL		277.0

* Including but not exclusively for funds for the Smithsonian [ADDED NOTE: * indicates authorization to contract all necessary sources for database information, including translation, data entry, database modification, map/photo acquisition and compilation, literature searches, etc.].

APPENDIX III. -- Continued.

OBJECTIVES OF THE PROGRAM

OBJECTIVE 1. Create and maintain a database of the high-risk volcanoes of the world that can be used assess the potential volcanic activity that might threaten populated regions.

Task 1.1: Acquire computer hardware and software for high-risk volcano database.

Task 1.2: Compile database of pertinent information on eruption histories, current local seismicity, and other factors.

Task 1.3: Acquire maps and photos of potentially active volcanoes.

Task 1.4: Coordinate with the Smithsonian Institution's Scientific Alert Network (SEAN) and WOVO in the acquisition and sharing of data.

Task 1.5: Analyze data and provide periodic assessments of location, character, and likelihood of future volcanic eruptions.

Task 1.6: Advise OFDA on requests made by foreign countries for assistance in monitoring potentially active and active volcanoes. The nature of the assistance is covered under Objective 4, discussed later.

OBJECTIVE 2: Form liaisons with international agencies and provide technical assistance in eruption early-warning and hazard mitigation and in volcano-disaster preparedness for members of appropriate organizations within participating countries.

Task 2.1: Establish liaisons with representatives of principal geoscience institutions in selected Central and South American and Caribbean countries.

Task 2.2: Work in concert with country representatives to develop regional volcano hazards mitigation centers in Colombia, Ecuador, and Costa Rica.

Task 2.3: Provide technical assistance in volcano hazards monitoring for Central and South America and Caribbean scientists.

NOTE: Line item funding was not provided by the PASA for Task 2.2. Thus progress on this Task will depend on success in developing host-country and multinational funding for these activities on a case-by-case basis.

Task 2.4: Conduct seminars and/or workshops, and generate public awareness programs to transfer knowledge on volcano disaster-preparedness measures to local government officials, emergency-services and medical personnel, and utilities representatives.

NOTE: Line item funding was not provided by the PASA for Task 2.7. Thus progress on this Task will depend on success in developing host-country and multinational funding for these activities on a case-by-case basis.

OBJECTIVE 3: Complete and maintain a dedicated scientific equipment cache for rapid, safe, and responsible assistance in volcano disasters.

Task 3.1: Complete the acquisition of the VCAT equipment cache in a phased year-by-year manner. The cache consists of equipment in the following areas: (1) seismic monitoring, (2) deformation monitoring, (3) visual and geologic monitoring, (4) safety equipment, (5) support equipment, (6) data processing.

OBJECTIVE 4: Use the VCAT personnel and host-country volcanological experts (a) to establish baseline early-warning seismic and deformation monitors on identified high-risk volcanoes and (b) to provide emergency response during times of crisis, particularly in Central and South America and the Caribbean.

Task 4.1: Establish agreements with Central and South America and Caribbean countries that have high-risk volcanoes, to enact volcano-watch criteria and to facilitate rapid, duty-free importation of VCAT equipment during times of crisis.

Task 4.2: With the concurrence of OFDA, USGS, DOS embassies, and by invitation of the host government, conduct seismic and deformation monitoring on high-risk volcanoes that have short recurrence intervals or that show signs of possible eruption.

Task 4.3: With the concurrence of OFDA, USGS, DOS embassies, and by invitation of the host government, deploy the VCAT to provide critical monitoring in the months or weeks prior to a volcanic eruption. Such monitoring is essential to attempt to quantify the time, place, size, and type of eruption and to enable local officials to provide accurate hazards alerts and timely evacuation advice.

APPENDIX III. -- Continued.

Task 4.4: Assist the host government in interpreting volcano monitoring data to make emergency decisions regarding evacuations of populace, escape routes, road closings, etc.

Task 4.5: Provide data to assist the early and safe return of the evacuated populace to minimize the disruption and expense of the post-eruption period.

PROJECTED SCHEDULE OF PASA ACTIVITIES - FIRST YEAR

1) To identify and bring on board the remaining members of the core team (VCAT):

- o Volcanological Seismologist
- o Deformation Specialist
- o Logistics Technician
- o Electronics/Seismic Technician
- o Computer Specialist

(NOTE: Program Chief and Volcanologist, Norman Banks, established prior to the PASA Agreement).

2) To purchase and develop the equipment needed:

- o To provide an adequate seismic system
- o To complete the dry tilt system
- o To perfect the digital telemetry system

3) To begin a computer database system on high risk volcanoes in populated areas of the world.

NOTE: This should have read "To begin an information and database system including computer databases on high risk ....."

4) To provide OFDA with a preliminary assessment of the activity of the high-risk volcanoes.

NOTE: This should have read "high-risk volcanoes of Latin America and the Caribbean"

5) To respond, if necessary to a volcano crisis.

6) To coordinate activities with the interagency early-warning groups, UNESCO, and WOVO.

7) To conduct a regional workshop and meet with staff of the volcano studies centers in Colombia, Ecuador, and Costa Rica to discuss development of cooperative international programs and existing disaster mitigation

APPENDIX III. -- Continued.

8) To make 3 liaison/evaluation trips to volcano sites and/or volcano monitoring organizations (p. 13 of the 1986 USGS WORK PLAN).

PROJECTED SCHEDULE OF PASA ACTIVITIES - SECOND YEAR

Operations as in the first year with the specific additional objectives of:

- o Addition of telemetry to the seismic system
- o Purchase and fabrication additional equipment for the VCAT cache.
- o Additions and improvements to the information/data bases
- o Identification of host-country participants for possible technology-transfer/teaching activities at U.S. volcano observatories.
- o Development of work plan to develop volcano hazards and disaster mitigation centers in Colombia, Ecuador, and Costa Rica

APPENDIX IV -- List of the tasks of PASA QTR-0000-P-IC-6116-00.

TASK 1 -- Establish and maintain in operational readiness, a Volcano Crisis Assistance Team (VCAT) for Latin America, staffed by pre-qualified experts familiar with the constraints and limitation of providing Latin American Countries technical assistance.

TASK 2 -- Establish and maintain in operational readiness, a dedicated volcano monitoring equipment cache for rapid deployment and use in volcano emergencies in Latin America.

TASK 3 -- Prepare and maintain comprehensive databases (historical data, maps, on-site measurement) on the high-risk volcanoes in the Latin American region suitable for use in assessing potential volcano hazard activity and threat.

TASK 4 (*) -- Establish technical and disaster management liaison with appropriate host country officials, institutions, and agencies associated with volcano emergency evacuation planning and preparedness, crisis management, and volcano monitoring. Maintain similar liaison with appropriate international institutions (WOVO, UNDRO, UNESCO, OAS, IDB, etc.)

NOTE:

(*) Command authority in civil disaster management, mitigation, and evacuation planning is not part of the scope, expertise, and responsibility of the USGS other than in the limited context of coordinating with civil defense and relief agencies in the interpretation of hazard evaluations and eruption forecasting. This distinction was clarified orally (September 1986) and in writing (October 1986, and 5 February 1987) with OFDA's Paul Krumpe.

TASK 5 -- Provide ongoing technical and managerial assistance in support of regional centers for volcano hazards analysis, monitoring, mitigation, and preparedness in Colombia, Ecuador, and Costa Rica, in cooperation with appropriate international organizations and other donors, in order to promote interagency cooperation and mutual exchange of data, technical assistance, and mitigation methodologies.

TASK 6 -- Implement all detailed tasks as presented in the USGS Volcano Early-Warning Disaster Assistance Program (VDAP) 1986 USGS Work Plan (pp. 12-19) and Schedule of Activities (pp. 20-21). Such plan is contained in the proposal for the development of an Interagency Volcano Early-Warning Disaster Assistance Program (VDAP) with emphasis on Central and South America and the Caribbean, transmitted by Dr. David P. Russ's May 28, 1986, letter.

APPENDIX IV -- Continued

TASK 7 -- Stage 1 improvement of volcanological capabilities of the Instituto Sismologia, Vulcanologia, Meteorologia y Hidrologia (INSIVUMEH) of Guatemala to take place August 87 through December 89:

a - Provide preliminary hazards maps of Fuego and Santiaguito Santa Maria Volcanoes.

b - Upgrade the seismic surveillance of the 4 targeted volcanoes by redirection of existing telemetry and the purchase of 2 portable units.

c - Establish limited but useful capabilities in deformation monitoring.

d - Establish limited but useful real-time deformation monitoring at the 4 targeted volcanoes (Fuego, Pacaya, Santiaquito, and Tacana).

e - Provide a basic geology kit for geologic studies.

f - Provide a basic geochemistry kit to monitor hot springs, condensates, and the health hazards of ash-contaminated surface waters.

g - Provide the basic necessary reference materials.

h - Provide basic training and support required to service, operate, and interpret the new systems.

NOTE: This Task was added in August of 1987 under separate funding from USAID, Guatemala, as administered by OFDA

APPENDIX V. -- Description of VDAP's Seismic System in FY87

Radio-telemetered seismograph system. All components for a six-station radio-telemetered seismograph network were ordered and received in FY87. All the components except six portable seismographs were purchased with VDAP project money. However, equivalent seismographs are on loan from the Branch of Seismology until a complement of seismographs are purchased by VDAP in subsequent years. Currently, this system can be assembled for shipment in 3 to 4 days should a volcano crisis arise. Field testing and packaging of the seismograph system for departure within a few hours is currently under way.

Compilation of a data base on volcano related seismic activity. A literature search on volcanic seismicity related to eruptive activity was begun FY87 with the goal of identifying the types of activity that are harbingers of eruptive activity. The hope was that the literature contained the criteria that could be used to assess the eruption potential during a volcanic crisis, when adequate instruments such as those being developed by VDAP are installed to record precursory seismic activity.

The study found some useful data, but also many instances of seismic activity at volcanoes that were not followed by eruptions. Because of the wide range of instrumental coverage of volcanic eruptions and the rapidly changing views on the mechanisms that produce precursory seismic activity, it is not possible to use much of the seismic data in the literature to develop sound statistical models that would be useful for better predictions in a crisis situation. Instead it appeared necessary that VDAP generate a recording system that we and other monitoring groups can use to generate the data required to identify source mechanisms of specific types of seismic events. For example, harmonic tremor or continuous ground vibration is related to the near-surface movement of magma, gasses, or ground water. A careful analysis of data from Ruiz Volcano, Colombia, indicates that subtle, but detectable changes in the frequency and amplitude of the tremor preceded eruptions by a few to several hours. What causes tremor is currently the subject of some debate and the focus of theoretical studies. Nevertheless, the Ruiz results are encouraging and point to the need for enhanced analysis capabilities for responses to future volcanic crises. The portable seismograph system emplaced at Ruiz is adequate for current eruption forecasting, but it is incapable of providing data amenable to use by the newly-developed methods in seismology.

Thus VDAP began in FY87 to codevelop a portable-computer-based data acquisition and analysis system to deploy with the seismic network. The system will allow real-time, automated event picking, location, and analysis. It will also record data that can be compared with theoretical results with the goal of more precise eruption forecasting. This system is described below.

APPENDIX V. -- Continued.

Implementation of a PC-based seismic data acquisition and analysis system. After several months of planning and discussions, four USGS groups at Menlo Park joined forces to implement a PC-based data acquisition and analysis system for seismic events. The main goals are (1) a 16-channel seismic data acquisition system that performs real time digitizing of analog seismic data, and automatic earthquake location, and (2) an offline seismic analysis system for seismological research, especially using digital seismic waveform data from the acquisition system.

The two main groups in this effort are the Microearthquake Data Analysis Group and VDAP. The Alaska Network Group are involved technically but have no official funds or staff on the project. The fourth group is actively programming PC's to analyze waveform data collected by their GOES systems. Software developed by the GOES Group will be indirectly useful to VDAP through availability of programming techniques and applicable subroutines.

Outside the USGS, other groups are working to develop seismology related programs. For example, some of the software on waveform analysis will come from the University of Nevada.

VDAP contributed $13K on an IBM PS/2-80 32 bit system (VDAP property) and about $36K on salary and support to the programming groups. In return, VDAP gained use of two IBM/AT's and peripherals worth about $14K, and what will amount to $30 to $40K in software development.

The IBM/AT system was chosen for the first edition of the system over currently more-powerful portable machines because (1) IBM/AT systems are available and serviceable everywhere, especially in developing countries, (2) both the PS2 technology and developments by independent PC-dependent companies are likely, within the next several years to produce the required processing powers in the PC's. Currently, the IBM/PS2 processes data at about 10 times the speed of the AT and will replace both AT's as the operating systems promised by IBM become available.

The two AT system will do data analysis on-line, in near real time, permitting us to continuously and automatically analyze the incoming seismic data. This will cut down the lag time, for example, between the occurrence of critical seismic events and our analysis of what it means in terms of previously-recognized seismic forecasters. Some of this analysis will undoubtedly be automated as recognition of the critical seismic parameters are recognized through repeated use of the VDAP system on many volcanoes. The automated system IBM/PS2 system, like the first-edition AT system, will require 2 computers.

APPENDIX VI. - Description of VDAP's Deformation Monitoring System in FY87.

VDAP currently has the capability of measuring both horizontal and vertical deformation with several complete and one incomplete surveying systems. In the cache is a K&E Ranger V EDM that is used to measure horizontal deformation trilateration networks and is capable of measuring line lengths up to 25 Km. VDAP's HP 3808 EDM can also be used to measure trilateration networks and is capable of measuring line lengths up to 8 Km. A WILD T-2000 electronic theodolite and DI-5 EDM system is used to measure vertical deformation via dry tilt arrays or trigonometric level lines. The T-2000 system can also be used for small trilateration networks. The cache includes, in addition, four WILD T-16 theodolite and Citation EDM systems that can be used for short range trilateration networks. The classical dry tilt system is still incomplete, consisting of a WILD NAK2 level and micrometer plate but as yet no precision rods. The precision rods will be purchased in FY 88.

In the past year the deformation section of VDAP has accomplished the following:

IMPROVEMENT OF MONITORING SYSTEMS

1) Developed a new method of measuring wide-aperture dry tilt with a T-2000 and DI-5 theodolite-EDM pair. Dry tilt (tilt-leveling) is used to detect vertical deformation by precisely differencing the relative elevations of three points of a triangle. This new method allows dry tilt triangles up to 225 meters on a side to be read with no limitations on site location due to topography. The classical dry tilt method is limited to triangles no more than 60 meters on a side and to sites which are relatively flat (2.9 m maximum relief which is rare on volcanoes). The larger size of the tilt triangle allows a longer baseline to be measured and thus a more accurate measure of deformation to be obtained. In addition, the T-2000 dry tilt system is much lighter and more compact than the classical system, can be easily deployed from a small helicopter, and can be set up and read in less time and with fewer personnel.

2) Computer programs were written to process the dry tilt data and data from T-2000 trigonometric level lines.

3) A computer program was written to process data from all of VCAT's EDMs. Better graphics capabilities are planned for the coming year.

TECHNOLOGY TRANSFER AND TRAINING AIDS

1) Short range theodolite-EDM systems were left on loan in Costa Rica, Guatemala, and Ecuador.

APPENDIX VI. -- Continued.

2) A preliminary edition of a short manual explaining how to operate the VDAP short range EDM system was written and included with the loaned systems.

3) Responded to inquiries about deformation monitoring from Costa Rica, Ecuador, Columbia, Guatemala, and Papua New Guinea.

TRAINING WORKSHOPS

A four week-long volcano deformation workshop was given in Ecuador with financial help from WOVO. One participant from both Guatemala and Costa Rica attended as well as two people from Ecuador (ESPOL). The workshop was a hands-on training workshop incorporated into the baseline data gathering trip to Ecuador (see below). See APPENDIX X for a summary of VDAP activities in Ecuador.

BASELINE DATA GATHERING

Began deformation monitoring of volcanoes in Costa Rica (Arenal), Guatemala (Tacana, Santa Maria, Fuego, and Pacaya) and Ecuador (Cotopaxi, Guagua Pichincha, and Quicocha).

APPENDIX VI -- continued

VOLCANIC DEFORMATION MONITORING SYSTEMS CURRENTLY USED BY VCAT

PROJECT, YEAR PURCHASED U=USGS O=OFDA	DESCRIPTION ITEM	MANUFACTURER VENDOR	HAVE	NEED	UNIT COST	TOTAL COST	PRICE CODE 1=Actual 2=Last PO 3=Estim.	USE CODE E=Expenda L=Loanabl P=Permane
	SHORT RANGE EDM SYSTEM							
U 86	T16 theodolite/tribrach	WILD/NESCO	4	4	$4,495	$4,495	1	L
U 86	Citation EDM	WILD/NESCO	4	4	$3,995	$3,995	1	L
U 86	Citation batteries	WILD/NESCO	12	12	$215	$2,580	3	L
U 86	Battery chargers/miscl.					$500	3	L
	* Three short range EDM systems on loan to Guatemala, Costa Ric and Ecuador.							
	LONG DISTANCE EDM SYSTEM							
U 86	Ranger 5A EDM	CUBIC PRECISION	1	1	$24,500	$24,500	2	P
U 86	tribrach, heavy	CUBIC PRECISION	1	1	$995	$995	3	P
U 86	Tripod, HEAVY	CUBIC PRECISION	1	1	$1,025	$1,025	1	P
U 86	battery, 12 vdc		2	2	$70	$140	3	P
U 86	battery box	PLATT ELECTIRC	1	2	$28	$56	2	P
U 86	Cable set	CUBIC PRECISION	2	2	$90	$181	1	P
U 86	Back pack	CUBIC PRECISION	1	1	$174	$174	2	P
U 86	Repair kit	CUBIC PRECISION	1	1	$100	$100	1	P
	* Long range system weighs over 75 Kg; should be replaced w Wild DI-3000 system that weighs less than 5 Kg.							
	INTERMEDIATE DISTANCE EDM SYSTEM							
U 85	HP 3808A EDM	HEWLETT PACKARD	1	1	$6,000	$6,000	3	P
U 85	tribrach	HEWLETT PACKARD	1	1	$300	$300	3	P
	T-2000 DRY TILT/LEVELING SYSTEM							
U 86	T-2000 DIGITAL THEODOLITE	WILD/NESCO	1	2	$17,995	$17,995	1	P
U 86	DI-5	WILD/NESCO	1	2	$9,995	$9,995	1	P
U 86	extra DI-5 battery	WILD/NESCO	1	1	$215	$215	1	P
U 86	quickset tripods	WILD/NESCO	3	3	$166	$497	1	P
U 86	plumbing pole	WILD/NESCO	3	3	$176	$527	1	P
U 86	GPH1 reflector	WILD/NESCO	3	3	$250	$750	1	P
U 86	Instrument tripod	WILD/NESCO	1	1	$225	$225	1	P

APPENDIX VI -- continued

VOLCANIC DEFORMATION MONITORING SYSTEMS CURRENTLY USED BY VCAT

PROJECT, YEAR PURCHASED U=USGS O=OFDA	DESCRIPTION ITEM	MANUFACTURER VENDOR	HAVE	NEED	UNIT COST	TOTAL COST	PRICE CODE 1=Actual 2=Last PO 3=Estim.	USE CODE E=Expenda L=Loanabl P=Permane
	CLASSICAL DRY TILT/LEVELING SYSTEM							
U 86	NAK-2 Level	WILD/NESSCO	1	1	$1,995	$1,995	1	P
U 86	Micrometer	WILD/NESSCO	1	1	$875	$875	1	P
	2 Precision rods	WILD/NESSCO	0	2	$2,195	$2,195	3	P
	** Rods to be purchased in FY 88							
	REFRACTION CORRECTION							
U 86	Ultimeter	PEET BROS	5	5	$179	$537	1	P
U 86	temp. sensor cable	PEET BROS	5	5	$15	$45	1	P
U 86	temp shield	CLIMATRONICS	3	5	$100	$300	3	P
U 86	altimeter, Thommens	WAREHOUSE	2	4	$115	$345	1	P
U 86	binoculars	WAREHOUSE	1	3	$200	$200	3	P
	REFLECTORS							
U 86	Reflectors, permanant	LEWIS + LEWIS		72				
O 87	Reflectors, permanent	LEWIS + LEWIS		28	$83	$8,300	2	E,L
U 86	triclusters, retroray w/adaptor	LEWIS + LEWIS	4	4	$135	$270	2	P
U 86	tribrachs for reflectors	WILD/NESSCO	2	2	$355	$710	2	P
	BENCHMARK/PRISM INSTALLATION							
U 86	Hammer, drill	PORTLAND CONTR. SUPP	2	2	$346	$692	2	P
U 86	batteries		4	4	$74	$149	2	P
O 87	Rock Anchors	PORTLAND CONTR. SUPP		100	$3	$283	2	E
U 87	EDM Benchmarks	WAREHOUSE	50	50	$1	$74	1	E
O 87	Tilt/Leveling benchmarks	PORTLAND BRASS	94	94	$10	$939	1	E
	DATA REDUCTION SYSTEM							
U 87	TRS-80, computer	RADIO SHACK	1	1	$500	$500	2	P
U 87	TRS-80, printer	RADIO SHACK	1	1	$150	$150	2	P
U 87	TRS-80, diskdrive	RADIO SHACK	1	1	$450	$450	2	P
U 87	TRS-80, support & supplies	RADIO SHACK		1	$100	$100	2	E

APPENDIX VII. -- Description of VDAP's Digital Telemetry Systems in 1987.

Telemetered tilt

VDAP acquired three (current inventory total = 4) Applied Geomechanics precise (0.1 microradian) tiltmeters and one Sperry 10 microradian tiltmeter in FY87. Six USGS-designed digital telemetry platforms were constructed and fitted with radios, weatherproof cases, and solar charging backup. Currently 4 tiltmeters are tested and packed for instant departure from CVO (plus one backup telemetry unit and 2 computer-receiver base stations). The fifth tiltmeter, telemetry, and computer base station is on loan to Guatemala to monitor Fuego volcano.

VDAP also built two repeater stations in FY87, with radios and solar charging. These can be used for either seismic or for the low-frequency digital data acquisition.

VDAP's major effort in FY87 was a collaboratve effort with CVO in developing the next generation of telemetry. This new telemetry has "smart" logic and allows two-way communication: (1) data transfer to the base stations, and (2) ability to error check, trouble shoot, or change acquisition parameters at the field unit through computer commands from the base station. This new smart-telemetry electronics is the core of the mudflow alarm system being developed by VDAP. It is also part of our repeater system. Both the old and the new telemetry systems can be used to acquire other slow-data-rate information such as fumarole, crater lake, and temperature data when sensors are acquired or developed for these tasks next fiscal year.

Tool Cache

To develop and service the growing electronic and telemetry capabilities of VDAP, the support tool/instrument cache was augmented by several purchases in FY 87. In addition, a library of necessary repair manuals and technical information on the monitoring equipment was acquired or developed.

APPENDIX VII-- continued

VCAT NO.	MAIN VCAT SORT	AUX VCAT SORT	SUB VCAT SORT	DESCRIPTION ITEM	LOCATION COMMENTS	HAVE	RES- PONSE TAKE	REPLACEMENT COST	G-NUMBER
EQUIPMENT-ELECTRONIC TILT									
(see EQUIP.-DEF.-TELEM, TOOLS)									
EQUIPMENT-DEFORMATION-TELEMETRY									
radios									
V87-011	TELEM	RADIO	NEWPU	UHF programmable radio		4		$415.00	
V87-069	TELEM	RADIO	NEWPU	HF tranceivers		10		$35.95	
V86-094	DEFOR	EQUIP	TILT	UHF programmable radio		1		$2,588.00	
V86-139	DEFOR	EQUIP	TILT	UHF programmable radio		4		$0.00	
whip anten.									
P87-022C	EXPEN	DEFOR	TELEM	Base station adapter kit		6		$18.83	
P87-022B	EXPEN	DEFOR	TELEM	Antenna, NLA-406		6		$19.59	
yagi anten.									
V86-153	TELEM	EQUIP	ANTEN	Yagis		8		$159.80	
anten. connecters									
P87-023A	EXPEN	DEFOR	TELEM	N mate to UHF adapter		4		$6.79	
P87-023C	EXPEN	DEFOR	TELEM	Solder N female connector		10		$5.35	
P87-023D	EXPEN	DEFOR	TELEM	Solder N male connector		10		$4.80	
P87-023B	EXPEN	DEFOR	TELEM	N mate to N male adapter		5		$12.45	
telemetry units and boards									
V87-010	TELEM	TOMS	NEWPU	Tom's telem units		4		$1,000.00	
	TELEM			spare tom board		1		800	
	TELEM			smart telem boards		15		200	

APPENDIX VII-- continued

VCAT NO.	MAIN VCAT SORT	AUX VCAT SORT	SUB VCAT SORT	DESCRIPTION ITEM	LOCATION COMMENTS	HAVE	RES- PONSE TAKE	REPLACEMENT COST	G-NUMBER
solar panels									
V86-127	DEFOR	SUPPL	X	solar panels		10		$67.00	
lo freq. dig. repeater guts									
	TELEM			smart rpter guts		2		200	
base station gear									
V86-112	DEFOR	EQUIP	ETILT	Model 100 laptop		6		$265.15	
V86-142	DEFOR	EQUIP		Chipmunk DD		3		$449.00	
V86-218	DEFOR	EQUIP	TELEM	TTXpress printer		3		$135.48	
P87-032A	EXPEN	ETILT	NEWP	TRS-60 mod 102, manual		1		$15.00	
VCO/Discriminator pairs									
				VCO: 680,1020,1360hz		3		270	
				Disc: 680,1020,1360hz		3		150	
				Disc: 3060hz		1		400	
SEISMIC GEAR IN VANCOUVER									
				PS-2 seismograph		3		4500	
				L-4c geophone		2		600	
seismic supplies in Vancouver									
V87-110A	SEISM	PS-2	SUPPL	Stylus, Smoke		2		$36.00	
V87-110B	SEISM	PS-2	SUPPL	Capillary ink pen		2		$25.00	
V87-110C	SEISM	PS-2	SUPPL	Recording ink		2		$3.00	
V87-110D	SEISM	PS-2	SUPPL	Recording paper		1		$100.00	
TILTMETERS									
P87-036	EXPEN	ETILT	NEWP	AGI Tiltmeter-700		3		$2,100.00	
				Sperry tiltmeter 2140		1		1000	

APPENDIX VII-- continued

VCAT NO.	MAIN VCAT SORT	AUX VCAT SORT	SUB VCAT SORT	DESCRIPTION ITEM	LOCATION COMMENTS	HAVE	RES- PONSE TAKE	REPLACEMENT COST	G-NUMBER
EQUIPMENT-COMPUTER									
V87-014	COMPU	PRINT	UPGRA	JDL Tractor feed		1		$140.00	
V87-059	COMPU	MONITO	NEWPU	Amber Monitors		3		$150.00	
V87-060	COMPU	DRIVE	NEWPU	Disk Controller		1		$150.00	
V87-064	COMPU	COMPU	NEWPU	Toshiba 1100		1		$1,799.00	
V87-079	COMPU	SOFT	UPGRAD	Lotus 4		1		$89.00	
V87-089	COMPU	SOFT	UPGRAD	Micro quickbasic		1		$69.30	
V87-103A	COMPU	SOFT	UPGRAD	Norton Utilities		1		$47.98	
V87-103B	COMPU	SOFT	UPGRAD	Double DOS		1		$35.00	
V87-103C	COMPU	SOFT	UPGRAD	C: Program. Workshop		1		$49.95	
V87-098	OPERA	ADMIN	COMPU	Word Perfect 4.2		1		$183.15	
V87-120	COMPU	PRINT	NEWPU	Diconex printer		1		$322.79	
P87-012	EXPEN	COMPU	SUPPL	Printer ribbon		6		$4.45	
P87-008	EXPEN	COMPU	SUPPL	Bornoulli disks, 20 meg		3		$79.00	
P87-010	EXPEN	COMPU	SUPPL	Diskette box		5		$1.79	
P87-049	EXPEN	COMPU	UPGRA	Hard disk instal		1		$137.50	
V86-151	COMPU	EQUIP		JDL printer		1		$2,015.00	
V86-158	COMPU	EQUIP		Orchid accelerator		1		$989.00	
V86-181	COMPU	EQUIP		Toshiba lap top		1		$2,484.78	
V86-157	COMPU	EQUIP		20X20 Bournoulli box		1		$2,535.00	
V86-175	COMPU	EQUIP		vacuum cleaner		1		$49.95	
V86-150	COMPU	EQUIP		Epson FX 85		1		$399.00	
V86-164	COMPU	EQUIP		digitizer		1		$435.00	
V86-154	COMPU	EQUIP		Surge prot		1		$47.60	
V86-152	COMPU	EQUIP	POWER	Cuesta power supply		1		$500.00	
V86-143	COMPU	EQUIP		Printer		1		$479.00	
V86-039A	COMPU	REPLA	MACHI	Compaq+Boards		1		$7,542.00	
V86-039D	COMPU	REPLA	MACHI	Cables serial		1		$61.00	
V86-039B	COMPU	REPLA	MACHI	Printer		1		$370.00	
V86-039C	COMPU	REPLA	MACHI	Cables printer		1		$58.00	
V86-180	COMPU	SOFT		vax interface		0		$750.00	
EQUIPMENT-ELECTRONIC TOOLS									
V87-021C	TOOLS	ELECT	NEWPU	Power strip		1		$16.62	
V87-020	TOOLS	ELECT	NEWPU	Wire Strippers		3		$6.50	
V87-065	TOOLS	ELECT	NEWPU	Leathermans Tool		4		$33.00	
V87-075D	TOOLS	ELECT	NEWPU	Knife		1		$15.10	
V87-075E	TOOLS	ELECT	NEWPU	Eprom eraser		1		$24.95	
V87-090B	TOOLS	ELECT	NEWPU	Torx Tool		1		$19.87	
V87-092A	TOOLS	DEFOR	NEWPU	Bat term clean		1		$1.99	
V87-092B	TOOLS	DEFOR	NEWPU	Hex Key Set		1		$7.98	
V87-092C	TOOLS	DEFOR	NEWPU	Hacksaw blade. 32 t		1		$0.78	

APPENDIX VII-- continued

VCAT NO.	MAIN VCAT SORT	AUX VCAT SORT	SUB VCAT SORT	DESCRIPTION ITEM	LOCATION COMMENTS	HAVE	RES- PONSE TAKE	REPLACEMENT COST	G-NUMBER
EQUIPMENT-ELECTRONIC TOOLS--continued									
V87-092C	TOOLS	DEFOR	NEWPU	Hacksaw blade, 24t		1		$0.75	
V87-092D	TOOLS	DEFOR	NEWPU	Hacksaw		1		$5.59	
V87-102	TOOLS	ELECT	NEWPU	Wattmeter element		1		$50.00	
V87-101A	TOOLS	ELECT	NEWPU	Freq Counter		1		$558.00	
V87-101B	TOOLS	ELECT	NEWPU	Lab Power Supply		0		$0.00	
V87-101C	TOOLS	ELECT	NEWPU	Capacitance meter		1		$110.00	
V87-100A	TOOLS	ELECT	NEWPU	Sine/Square Wave Gen		1		$160.93	
V87-100B	TOOLS	ELECT	NEWPU	RF Signal Gen.		1		$149.15	
V87-116	TOOLS	ELECT	NEWPU	DC Power Supply		1		$59.95	
V87-119	TOOLS	ELECT	NEWPU	Eprom eraser		1		$359.00	
V87-107B	TOOLS	ELECT	NEWPU	Nibbler tool		1		$9.97	
V87-107B	TOOLS	ELECT	NEWPU	Hexadecimal, time		1		$21.95	
V87-107C	TOOLS	ELECT	SUPPL	Connector, solidless		2		$3.99	
V86-167	TOOLS	EQUIP		vise, bench		1		$13.90	
V86-117	TOOLS	EQUIP	X	Oscilloscope and accessories		1		$1,404.80	
V86-130	TOOLS	EQUIP	X	crimper, tool		1		$84.75	
V86-135	TOOLS	EQUIP		tool kit mini		1		$18.20	
V86-132	TOOLS	EQUIP	SOLDER	solder station		1		$79.95	
V86-138	TOOLS	EQUIP		Wattmeter		1		$737.00	
V86-140	TOOLS	EQUIP		Tool Bags		3		$15.00	
V86-059	TOOLS	REPLA	ELECT	solder gun, stand		1		$32.17	
P87-020B	EXPEN	DEFOR	TELEM	Probe		1		$16.95	
V86-182	TELEM	EQUIP		power supply		1		$79.95	
V86-126	TELEM	EQUIP	X	Bearcat Scanner		1		$160.00	
V86-168	DEFOR	TOOLS		Level, cross test		2		$22.50	
V86-166	DEFOR	TOOLS		open end wrench		6		$1.15	

APPENDIX VIII. -- Description of VDAP's Mudflow Alarms

THE VCAT MUDFLOW DETECTOR - PRELIMINARY

VDAP, with the assistance of CVO, is currently developing a low-cost, error-checking mudflow detector. Perhaps more than any system now being developed by VDAP, this is the one for which there is the most pressing need and interest in all volcanic regions of the world including Latin America and the United States.

Mudflows are one of the major causes of fatalities at erupting volcanoes (Blong, 1984). For example, in 1985 mudflows from Ruiz Volcano in Colombia killed over 25,000 people, as far from the volcano as 40 km only 45 minutes after initiation of the flow. In addition, mudflows are a common cause of destruction and fatalities at non-erupting volcanoes because of mobilization of loosely-consolidated debris during periods of strong seismic activity, such as the 1987 earthquakes in Ecuador.

The short lead times and the high cost in lives resulting from late alarms necessitate rapid and reliable warning systems for mitigation of mudflow hazards from volcanoes. The warnings should be triggered within minutes of onset of an event with sufficient redundancy to ensure a high degree of confidence in the warning transmitted. In addition, the sensors will often be deployed in deep mudflow channels and thus need repeated by radio to the base station receiver. For developing countries, the system must be inexpensive and use technology serviceable by local technicians.

The mudflow detector currently being developed at CVO is designed to give rapid, error-checked warning of dangerous mudflows as well as to provide information on their velocity and volume. The system will detect the onset of a mudflow within a few minutes of initiation, provide redundant volume and velocity measurements, relay the information through a smart repeater to the base station receiver where it is analyzed by a small computer, which in turn sets off alarms giving estimated times of arrival at population centers along the course of the mudflow. Cross-checking abilities and a high level of redundancy are built into the system, which is designed around a low-cost microprocessor-based digital telemetry platform developed at CVO by Richard LaHusen, Water Resources Division.

The system consists of three major components linked by radio: multi-fingered sacrificial sensors (2 each in a system), the smart telemetry unit, and the receiver, which is either manned or connected to an observatory alarm system. Simple tripwires are used as detectors (fingers), inexpensive CB radios as the sensor-repeater telemetry links, standard UHF radios as links between the base station and smart telemetry unit, and inexpensive computer-printer combination as the receiver/warning device. All these components are simple to use, and are either

available in-country or of technology in common use by volcano-monitoring groups in the United States and developing countries. The microprocessor-based digital telemetry unit is relatively sophisticated, but comes pre-programmed and set up for quick and inexpensive repair by minimally trained technicians in the event of failure. The basic sequence of events resulting from a mudflow is as follows:

1. The on-board microprocessor of the sensor monitors each of as many as six tripwires thousands of times a second and sends status reports to the smart telemetry unit at specified intervals of one to ten minutes.

2. A mudflow breaks loose from the flank of a volcano and courses down a channel. Impinging on the sensor, the mudflow breaks the first tripwire. This information is immediately telemetered to the smart telemetry unit. When the second tripwire is broken, this new status is also telemetered, and so on.

3. Upon receipt of a transmission from any sensor, the smart telemetry checks it for an identifying code keyed to each tripwire, which uniquely identifies the originating sensor and guards against spurious transmissions being mistaken for a triggered tripwire. It also labels the data with the time of receipt, and stores it. The smart telemetry unit listens for a short time to receive any other transmissions from the first sensor that indicate the cutting of other wires (all within a few seconds), labelling each one with the time of receipt. Next, the smart telemetry sends the data back to the base station, and returns to listening mode for the tripwire status transmissions of the second sensor. The base-station operator can at this time query the smart telemetry or either sensor package.

4. The base station receives the block of data from the smart telemetry unit containing tripwire breakage times from the first sensor. It has been in a wait mode, recording the periodic status reports transmitted by the sensors via the smart telemetry unit. Now, noting that tripwires have been broken, it activates a program which calculates the mudflow's velocity, estimates it's volume and arrival times at population centers along the expected path of the mudflow (using parameters previously determined by a hydrologist for the specific drainage). This data is printed, and if warranted, an alarm is issued to the printer, computer beeper, and if available, the Observatory bell or phone alarm. The base-station operator can recheck the alarm at this point by calling the field units and verifying the status of the trip wires and telemetry links.

5. The system then awaits confirmation of the mudflow from the second sensor located 0.5-1.0 minute downstream. If the sequence is repeated, the warning is reissued with a confirmation flag on

occurrence, velocity, volume, and expected arrival times. Redundancy and cross-checking are thus built into the system to prevent false alarms due to system failure, tampering, and telemetry problems. These features also allow polling by the base station if a tamper alarm, unclear transmission, or an unexpected sequence of tripwire status reports is received. The operator polling allows immediate system diagnosis, establishes more confidence in the system, reduces down-time of the alarm system, and makes it virtually impossible to have a system break-down without the operator knowing of the malfunction within minutes.

VDAP/CVO has a bench model of this mudflow alarm working and a prototype in the field. A fully-operational first-edition unit is expected to be field-tested in the spring of 1988. The test-modified units are expected to be ready for incorporation in the equipment cache in late summer or early fall.

For Latin American countries, the mudflow detector will provide a high level of vigilance against mudflows at a low cost. The estimated cost of systems configured for use in Latin American countries is shown in the follows. [NOTE: If used in the United States, FCC regulations requires more expensive radios be used at the sensor locations, raising the system cost by some $300 per sensor].

COST OF MUDFLOW ALARM SYSTEM

SENSOR UNIT			
Microprocessor unit	$135		
CB radio, antenna	40		
Case, cabling	100		
Battery	30		
		SUBTOTAL	$305 (each)
SMART TELEMETRY UNIT			
Microprocessor unit	$135		
CB radio, antenna	40		
UHF radio, antenna	500		
Case, cabling	70		
Solar panel	170		
Battery	60		
		SUBTOTAL	$975
RECEIVER			
UHF radio	$500		
Laptop computer	500		
Printer	150		
Case, cabling	50		
		SUBTOTAL	$1200
		TOTAL	$2785 (2 sensors)

APPENDIX IX. -- Summary of VDAP activities in Guatemala, February-March 1987.

CHRONOLOGY OF ACTIVITY OF THE TEAM

Banks and Lockhart

2/5 - Travel to Guatemala
- Conferences at USAID, INSIVUMEH, CONE
- Equipment check
- Inspection of seismograms of Pacaya, Tacana, Fuego

2/6-7
- Ground inspection of Jan. 87 eruption products of Pacaya
- Aerial inspection of Fuego and Pacaya
- Ground inspection of Fuego

2/8 Sunday

2/9 - Briefed USAID Guatemala on state of volcanoes and hazard preparedness
- Field, preparation for installing tiltmeter, meetings at IGM and CONE

2/10
- Preparation of Preliminary Report for USAID

2/11
- Finished Preliminary Report
- Began installation of Fuego tiltmeter

2/12
- Installation of Fuego tiltmeter

2/13
- Installation of EDM line Acatenango
- Installation of Fuego tiltmeter

2/14
- Installation of Pacaya EDM lines
- Installation of Fuego Tiltmeter

2/15 Sunday

2/16
- Completed Pacaya EDM lines
- Installation of Fuego tiltmeter

2/17
- Briefed USAID on progress
- Work at IGM and IAGS on obtaining and examining topographic maps and aerial photos of Pacaya and Fuego
- Installation of Fuego tiltmeter

2/18
- Field work on Pacaya Hazard maps
- Completed Fuego tiltmeter installation

2/19
- More work on aerial photos
- Briefed USAID
- More field work on Pacaya Hazard Maps

2/20
- Banks writing/drafting of Pacaya Hazards Report
- Lockhart ill

APPENDIX IX. -- Continued

2/21
- Banks writing/drafting of Pacaya Hazards Report
- Lockhart ill
- Ewert arrived

Banks, Ewert, Lockhart

2/22
- Travel and site evaluations of Santiaguito dome (Santa Maria Volcano)

2/23
- EDM monitoring and hazard evaluations of Tacana volcano
- Conferences with Mexican volcanologists

2/24
Banks and Ewert
- EDM monitoring and hazard evaluations of Tacana volcano
- Conferences with Mexican volcanologists
- Travel
- Lockhart, ill

2/25
- Banks and Ewert, evaluation and deformation monitoring of Santa Maria Volcano
- Lockhart, ill

2/26
- Banks and Lockhart, travel to Guatemala City
- Ewert, EDM monitoring on Santa Maria Volcano
- Lockhart, ill

2/27
- Banks
  - work on the Hazard Maps of Pacaya Volcano
  - meetings at USAID
- Ewert, EDM monitoring on Santa Maria Volcano
- Lockhart, ill

2/28
- Banks, work on the Hazard Maps of Pacaya Volcano
- Ewert, equipment upkeep
- Lockhart, ill

3/ 1
- Banks, work on the Hazard Maps of Pacaya Volcano, also other reports
- Ewert, development of training manuals
- Lockhart, packing

3/ 2
- Banks
  - work on the Hazard Maps of Pacaya Volcano
  - Recommendations to INSIVUMEH
- Ewert, measurements of 21 January eruption products of Pacaya and improvement of Pacaya EDM net
- Lockhart, departed for USA

APPENDIX IX. -- Continued

3/ 3

- Banks
  - work on the Hazard Maps of Pacaya Volcano
  - Recommendations to INSIVUMEH
  - Final memorandums
  - Debriefing at USAID, meeting at UNDRO
- Ewert, establishment at INSIVUMEH of analysis of deformation data at INSIVUMEH

3/ 4

- Banks, packing and travel to USA
- Ewert, deformation work at Fuego

3/ 5 to 3/10 Ewert

- Deformation work at Fuego and Pacaya
- Final details and instructions to INSIVUMEH on deformation monitoring

ACCOMPLISHMENTS OF THE TEAM

- Inventoried staff and equipment of INSIVUMEH
- Inventoried staff and equipment of Universidad Nacional Autonoma (Mexico, Tacana)
- Analyzed seismicity of 4 targeted volcanoes (Pacaya, Fuego, Santa Maria, and Tacana Volcanoes)
- Site visits and reconnaissance analysis of Pacaya, Fuego, Santa Maria, and Tacana Volcanoes
- Analysis of the 21 and 25 January eruptions of Pacaya Volcano
- Emplaced EDM monitor on Acatenango Volcano (1 line, E flank)
- Emplaced EDM (2 lines) and dry tilt (1) monitors on Fuego Volcano (E flank)
- Installed telemetered tiltmeter on Fuego, 4.5 km SE of crater, telemetered to Guatemala City
- Emplaced EDM monitor on Tacana Volcano (two lines on Mexican side)
- Emplaced EDM monitor on Pacaya Volcano (three lines, NW flank)
- Emplaced EDM (2 lines) and dry tilt monitor on Santa Maria Volcano (W flank)
- Provided Preliminary Evaluation/Recommendation to USAID
- Provided Memorandum of Recommendations for Volcano Studies and Hazard Preparedness of Guatemalan Volcanoes to INSIVUMEH
- Report and Maps of Preliminary Assessment of the Hazards of Pacaya Volcano
- Trained INSIVUMEH staff in EDM, dry-tilt, electronic-tilt monitoring
- Trained INSIVUMEH staff in production of risk maps and hazard evaluations of volcanoes
- Developed with INSIVUMEH and USAID an outline of long-term plan to move Guatemala toward independence in volcano monitoring and hazard mitigation.

APPENDIX X -- Summary of VDAP activities in Ecuador, July-August, 1987.

CHRONOLOGY OF ACTIVITY

7/15 - Begin travel to Quito
7/16 - Arrive Quito
7/17 - Briefing at USAID
- Begin work on locating air-shipped equipment
7/18 - Ground reconnaissance of Guagua Pichincha with Dr. Hall
7/19 - Sunday
7/20 - At USAID trying to locate equipment
- Met with Pete Hall at Geophysical Institute of ESPONA
7/21 - Ground reconnaissance of Cotopax.
- Rodolfo Van der Laat, Costa Rica, and Oscar Porras, Guatemala, arrive
7/22 - Planned installation of deformation monitors on Pichincha
- Equipment arrived on evening flight
7/23 - At ESPONA with Pete Hall reviewing hazards mapping done in Ecuador in 1986/1987
- Worked on getting equipment from customs
7/24 - National holiday in Ecuador
- Installed benchmarks on Pichincha for EDM instrument stations.
7/25 - Gave class on deformation monitoring using data from Mount St. Helens.
7/26 - Sunday
7/27 - Conference with Patricia Mothes (Defensa Civil) about risk evaluation in Ecuador.
7/28 - Received equipment from customs
- Checked equipment and prepared for fieldwork.
7/29 - Installed and measured radial level line on Pichincha.
- Installed and read wide aperture dry tilt array at summit of Pichincha.
7/30 - Installed and measured EDM line on Pichincha
7/31 - Remeasured EDM line on Pichincha
- Attempted to read dry tilt again, bad weather
8/1 - Classes in volcano deformation monitoring.
8/2 - Sunday
8/3 - Installed and measured two EDM lines on Cotopaxi
8/4 - Read ESPONA dry tilt triangle on N. side of Cotopaxi.
- Installed and read wide aperture dry tilt on N. side of Cotopaxi.
- Installed and measured EDM line on Cotopaxi.
8/5 - Installed and read two EDM lines on Cotopaxi.
8/6 - Read ESPONA dry tilt on E. side Cotopaxi
- Installed and read wide aperture dry tilt on E. side of Cotopaxi.
8/7 - Installed EDM line on Pichincha.
- Read wide aperture dry tilt at summit.

APPENDIX X. -- Continued.

8/8 - Ground reconnaissance of Cuicocha
- Installed and read EDM line.
8/9 - Met with Pete Hall and discussed placement of mudflow monitors on Cotopaxi.
8/10 - Installed five EDM lines on Pichincha
- Work on Preliminary Report for USAID
- Read wide aperture dry tilt on summit of Pichincha
8/11 - Installed and read three EDM lines on Cotopaxi
- Installed and read wide aperture dry tilt on W. side of Cotopaxi.
- Work on Preliminary Report for USAID
8/12 - Read wide aperture dry tilt on Cotopaxi, bad weather
- Work on Preliminary Report for USAID
- Met with Vern Perdue I.A.G.S. regarding topographic maps/air photo coverage on Ecuadorian volcanoes.
8/13 - Met with Pete Hall concerning recommendations for further volcano hazard mitigation work in Ecuador.
- Work on Preliminary Report for USAID
8/14 - Briefing at USAID on accomplishments of our trip and presentation of recommendations for further monitoring efforts.
8/15 - Packed for return to U.S.
8/16 - Final meeting with Pete Hall about future work on volcano hazards in Ecuador.

ACCOMPLISHMENTS OF THE TEAM

Cotopaxi
- Site reconnaissance of Cotopaxi
- Installed 3 EDM lines, north side
- Installed 2 EDM lines, east side
- Installed 3 EDM lines, west side
- Established wide-aperture dry tilt triangle, north base
- Resurveyed old dry tilt triangle, north base
- Established wide-aperture dry tilt triangle, east side
- Resurveyed old dry tilt triangle, east side
- Established wide-aperture dry tilt triangle, west side
- Made site survey for mudflow detectors

Guagua Pichincha
- Site reconnaissance of Guagua Pichincha
- Installed 3 EDM lines, east side
- Installed 4 EDM lines, southeast side
- Established radial level line, southeast side
- Established wide-aperture dry tilt triangle at refugio

Cuicocha
- Site reconnaissance of Cuicocha caldera
- Installed EDM line across caldera

Led volcano deformation workshop co-sponsored by the WOVO

Trained personnel from ESPONA in geodetic volcano monitoring techniques.

Inventoried staff and equipment of ESPONA.

APPENDIX XI. -- Summary of VDAP activities in Colombia, Ecuador, and Costa Rica, fall 1986.

Banks, Harlow, Fisher

8/10-11/87- Travel to Colombia
8/12/87 - Meetings with USAID, Bogota, on trip objectives
- Meetings at IAGS, Bogota, to obtain topographic map coverage of Colombian volcanoes
- Meetings at INGEOMINAS, inventoried their current posture toward and activities in volcano hazards
8/13/87 - Travel to Manizales
- Meetings at OVC with Meyer and Parra (OVC) and S. Williams (Univ. Louisiana.) analyzing the state of the volcano and the state of the observatory
8/13-19/87- Meetings and working groups on data, techniques, and instrumentation status, repair, analysis
8/20/87 - Review of findings and recommendations with staff; arrangements for national meeting on Colombian volcano hazards
8/21/87 - Meeting with INGEOMINAS, OVC, Univ. Calle, Univ. Valle, and Inst. Geofis. directed at generation of a coherent, long-term, and coordinated national posture toward volcano hazards in Colombia; political maneuvering by INGEOMINAS reduced the anticipated scope and success of the meeting.
8/22-26/87- Report writing, more discussions with OVC staff and administration at OVC and with interested community groups; continued technical work with the seismic, deformation, and geology groups; joined by John Tomblin of UNDRO
8/27/85 - Travel to Bogota
- Meetings at the Presidencia with Secretary General and assistants, General of Defensa Civil, U.S. Ambassador, UNDRO and UNDP representatives, and RESUJIR (non-profit assistance group in Colombia) representatives (Colombian NSF); oral presentations to and discussions on Ruiz, OVC, national activity and needs in volcanology.
8/29/87 - Meetings at Embassy with Ambassador, USAID, and press; oral and written presentations to and discussions on Ruiz, OVC, national activity and needs in volcanology.
- Meeting with Counselor for US Commercial Affairs Officer concerning VDAP observations of heavy commercial interest and activity by Canada and Japan in volcanology in Colombia
- Travel to Ecuador

APPENDIX XI. -- Continued

Banks and Harlow

8/29/87 - Meeting at USAID, Quito, with USAID, Tomblin (UNDRO), and Hall (ESPONA) concerning state of volcanoes and volcano hazard mitigation in Ecuador, planning for UNDRO/OFDA program in volcanology/seismology with ESPONA
- Post meeting note preparations and discussions

8/30-31/87- Field trips to Cotopaxi and Guagua Pichincha to evaluate hazards and existing monitoring systems

9/01/87 - Obtained available maps on Ecuador volcanoes from IGM
- Met with and established working relationships with IAGS, Ecuador
- Meetings at ESPONA to evaluate and make plans to cope with Ecuadorian volcano hazards

9/02/87 - Field trip for brief site visits and evaluations of volcano hazards of some of the northern volcanoes

9/03/87 - Presented VDAP's evaluation of the hazards and existing monitoring agencies and systems to USAID, Ecuador

Banks, Harlow, Doukas

9/04/87 - Travel to Costa Rica
- Meetings with Paul Bell (USAID) and R. Van der Laat (OVSICORI) on volcano status, volcano hazards, and capabilities in Costa Rica to monitor and mitigate volcano hazards

9/05/87 - Continued discussion with Paul Bell and David Kitson (USAID) on Costa Rican volcanoes and problems, discussed McNalley and RET work on seismic systems in Costa Rica
- Meetings at IAGS to establish working relations and obtained maps
- Work at OSVISCORI on field equipment, inventory of the monitoring systems at OVSICORI

9/06-10/87- Field work, site visits to Arenal, Poas, Barba, Irazu, Turrialba; evaluated hazards and monitoring systems, established deformation monitors, trained staff in EDM instrumentation and techniques

9/11/87 - Catchup on notes, meetings at OVSICORI on future plans
- Meeting at USAID to present results, evaluations, and recommendations of VDAP visit

9/12/87 - Travel to US

APPENDIX XI. -- Continued

ACCOMPLISHMENTS

Colombia

- Obtained all published and unrestricted maps available for Colombian volcanoes.
- Inventoried status of operations and needs of Observatorio Volcanologia de Colombia
- Renewed liaisons with USAID, Defensa Civil, Presidencia, RESUJIR, INGEOMINAS, OVC, various universities
- Established liaisons with IAGS
- Assisted repair of seismic and deformation instrumentation and systems at OVC
- Assisted analysis and interpretation of data concerning Ruiz volcano
- Presented VDAP's analysis of the status of and needs at Ruiz and OVC to USAID and Ambassador, Bogota, and to INGEOMINAS and other national agencies including the Presidencia and Defensa Civil
- Arranged and conducted a meeting directed at generation of a coherent, long-term, and coordinated national posture toward volcano hazards in Colombia

Ecuador

- Obtained all published and unrestricted maps available for Ecuadorian volcanoes.
- Inventoried status of operations and needs of ESPONA
- Established liaisons with USAID, ESPONA, IAGS
- Assisted analysis and interpretation of data concerning Cotopaxi volcano
- Made site visits to evaluate hazards and monitoring programs or Cotopaxi, Guagua Pichincha, Cuicocha Volcanoes
- Presented to USAID VDAP's analysis of the status of and needs at ESPONA and for Ecuador in general

Costa Rica

- Obtained all published and unrestricted maps available for Costa Rican volcanoes
- Inventoried status of operations and needs of OVSICORI
- Assisted analysis and interpretation of data concerning various volcanoes
- Presented to USAID VDAP's analysis of the status of and needs in Costa Rica concerning volcanoes
- Established liaisons with USAID, OVSICORI, IAGS
- Made site visits to evaluate hazards and monitoring programs on Arenal, Poas, Barba, Irazu, Turrialba
- Established deformation monitors on Arenal Volcano
- Loaned EDM system, and trained OVSICORI staff in its use

APPENDIX XII. -- Summary of VDAP activities in Colombia, December 1986.

12/04/86 -- Meeting: P. Medina, C. Cadenas, A. Swan, P. Bell, J. Tomblin, and D. Harlow, at the UNDP offices, Bogota.

Topic = Reorganization of emergency response procedures in Colombia.

Results: New procedures to handle natural disasters were prepared by P. Medina. One goal is to have available equipment and trained personnel ready to respond to the early stages of impending volcanic eruptions. This group would be responsible for providing informed assessments of a volcano's eruptive potential to political decision makers.

12/05/87 -- Meeting: A. Swan, P. Bell, J. Tomblin, and D. Harlow met with A. Lobo-Guerrero and F. Zambrano at the INGEOMINAS, Bogota.

Topic = Dr. Lobo-Guerrero presented plan under which the volcano observatory would be changed from a regional office to a department within INGEOMINAS. This a good move administratively, but all observers were concerned that long term plans for the observatory did not include permanence.

-- Meeting: P. Medina, P. Bell, J. Tomblin, and D. Harlow with Hans Meyer, scientist in charge of OVC at Manizales.

Topics = Concerns were hightened that the observatory was not assured permanence. Current political problems of and within the observatory were aired, and long-term goals of the observatory were discussed. Bell suggested that the long- and short-term objectives and resources needed to accomplish the tasks be outlined and submitted to appropriate agencies inside and outside the government of Colombia.

Rest of trip - work with seismic group at the observatory evaluating progress, training, analyzing data, and developing long-term plans.

APPENDIX XIII -- List of deformation equipment on temporary loan to Costa Rica, Guatemala, Ecuador, and Mexico.

COSTA RICA - September, 1986

1. 1 ea. EDM - Infrared Distance Meter "Citation 450", with mounting yoke for T-16 theodolite, s.n. 513.
2. 1 ea. Theodolite "WILD T-16" s.n. 216377 w/ tribrach.
3. 6 ea. prisms
4. 2 ea. battery chargers with cables
5. 3 ea. batteries

EXPENDABLE
April, 1987

1. 3 ea. 6 conductor phone jacks.
2. 4 ea. prisms
3. 10 ea. bench marks,
4. 12 ea. rock anchors,
5. 1 ea. measuring tapes, etc.

GUATEMALA - March 1987

1. 1 ea. EDM - Infrared Distance Meter "Citation 450", with mounting yoke for T-16 theodolite, s.n. 813.
2. 5 ea. batteries for Citation
3. 3 ea. battery chargers.
4. 1 ea. Theodolite "WILD T-16" s.n. 217012 w/ tribrach.
5. 3 ea. prisms.
6. 1 ea. AGI 2 axis tiltmeter, w/ temp., s.n. TILT001
7. 1 ea. USGS Digital Telemetry system., s.n. TEL001
8. 1 ea. field case and cabling.
9. 1 ea. USGS Variable Control Oscillator (VCO)., s.n. VCO001.
10. 1 ea. TRS-80, Model 100, Tilt reciever computer., s.n. 309005839
11. 1 ea. Chipmunk disk drive, s.n. 5518
12. 1 ea. TRS express printer, Model 1280., s.n. 1010933
13. 1 ea. power supply and cabling
14. 1 ea. USGS discriminator, s.n. DSCR001
15. various manuals

EXPENDABLE

1. 30 ea. stainless steel rock bolts; mounts for EDM prisms
2. 10 ea. sets of misc'l prism attachments.
3. 12 ea. Tilt benchmarks.
4. 10 ea. Benchmarks.
5. 6 ea. prisms
6. various instrument manuals.
7. Various bolts, pipes, signaling mirrors, orange flagging, star drill (1)

APPENDIX XIII. -- Continued.

ECUADOR - August, 1987

1. 1 ea. EDM - Infrared Distance Meter "Citation 450", with mounting yoke for T-16 theodolite, s.n. 615.
2. 1 ea. Theodolite "WILD T-16" s.n. 223969 w/ tribrach.
3. 12 ea. prisms.
4. Various battery chargers, cables and batteries

EXPENDABLE

1. 20 ea. stainles steel rock bolts; mounts for EDM prisms
2. 10 ea. sets of misc'l prism attachments.
3. 6 ea. Tilt benchmarks.
4. 6 ea. Benchmarks.
6. various instrument manuals.
7. Various bolts, pipes, orange flagging,

MEXICO - March 1987

EXPENDABLE

1. 3 ea. prisms
2. 3 ea. prism mounting hardware

APPENDIX XIV. -- Summary of significant Letter, Phone, and Telex communication with/by VDAP in FY 87

09/11/86 MEMO + EQUIPMENT to OVSICORI Costa Rica - temporary loan of short-range EDM equipment for volcano monitoring.

October MEMO to M. Hall (ESPONA, Ecuador) - included design and pricing of USGS 8-station seismic monitoring network, considerable amount of time involved.

10/16/86 MEMO to G. Sigvaldason (NVI, Iceland) - provided requested evaluation and recommendations for $200,000 aid to improve OVC

11/13/86 LETTER D. Rojas (OVSICORI, Costa Rica) - provided requested suggestions for UNA monitoring systems and techniques.

11/18/86 LETTER to M. Hall (ESPONA, Ecuador) - provided a solicited commercial 8-station seismic net design.

12/11/86 LETTER to E. Malavasi (OVSICORI, Costa Rica) - Obtained and sent long list of requested information and literature.

02/11/87 - MEMO to Richard Burke (MDRO, USAID Guatemala) - described preliminary assessments of and suggestions for action on Guatemalan volcano hazards.

02/14/87 MEMO to Eddy Sanchez (Subdirec. INSIVUMEH, Guatemala) providing requested preliminary suggestion for action by INSIVUMEH on Guatemalan volcano hazards.

03/02/87 MEMO to Eddy Sanchez (Subdirec. INSIVUMEH, Guatemala) - providing requested detailed suggestions for action by INSIVUMEH on Guatemalan volcano hazards

03/02/87 MEMO and EQUIPMENT to Richard Burke (MDRO, USAID Guatemala) - temporary loan of deformation monitoring equipment to INSIVUMEH through USAID

03/03/87 MEMO to Richard Burke (MDRO, USAID Guatemala) - transmitting preliminary report of VDAP/VCAT activities in the Feb/Mar response to activity at Fuego, Pacaya, Santiaguito, and Tacana Volcanoes

03/04/87 - MEMO to John Tomblin (UNDRO, Geneva) - transmitted and described results of Feb-Mar work in Guatemala; made recommendations to UNDRO for additional assistance needed

03/16/87 LETTER to ICE (Instituto Costa Rica Electricidad, Costa Rica) - in response to their request for mapping on Costa Rican volcanoes

04/1/87 CALL to Eddy Sanchez (INSIVUMEH, Guatemala) - checkup and coordination of new volcanology program

04/2/87 CALL to Richard Burke (MDRO, USAID Guatemala) -- discussed details of how to set up USAID-sponsored Stage 1 training program for INSIVUMEH in volcano monitoring and hazard mitigation.

4/03/1987 LETTER to R. Van der Laat (OVSICORI, Costa Rica) - response to request for information, included significant amount of research and literature, design of several deformation networks.

APPENDIX XIV. -- Continued.

04/03/1987 LETTER to E.R. Munoz-R (Guatemala) - response to request for information, included significant amount of research and gathering of literature.

04/05/87 LETTER to Ian Gass (IAVCEI, Open Univ., England) - provided requested slides of talk presented in Italy 1985 on mobile volcano observatories

04/14/19 CALL + EQUIPMENT to R. Van der Laat (OVSICORI, Costa Rica) - to inform him that requested EDM prisms and benchmarks had been sent.

04/14/87 MEMO to John Tomblin (UNDRO, Geneva) - transmitted and described final results of Feb-Mar work in Guatemala

04/15/1987 LETTER, D. Rojas (OVSICORI, Costa Rica) - response to request for information of monitoring equipment, included significant research and gathering of literature, pricing, and specifications

04/17/87 CALL from G. Sigvaldason (NVI, WOVO, Iceland) -- request for VDAP to use $10,000 UNESCO/WOVO funds in a volcano hazards/monitoring program in Latin America, suggested a workshop in deformation monitoring and equipment in Ecuador for summer 87

04/21/87 CALL to E. Parra (OVC, Colombia) -- checking on activity at Ruiz and operational status of OVC

04/22/1987 CALL from M. Hall (ESPONA, Ecuador) -- reported on possible increased activity on Antisano, Cayambe, and Cotopaxi Volcanoes; mudflows near Reventador

04/22/87 CALL to M. Hall (ESPONA, Ecuador) -- rechecking on earlier activity report and setting up summer deformation program

04/23/87 LETTER to T. Simkin and L. McClellan (Smithsonian Inst.) - addressing initiation of VDAP/Smithsonian efforts on volcano databases

4/23/1987 LETTER to S. Williams (Louisiana State Univ.)- response to request for information on monitoring techniques, included provision of literature.

4/26/87 CALL to R. Stoiber (Dartmouth) -- negotiating summer contract work on VDAP database

4/27/1987 LETTER, H. Meyer (OVC, Colombia) - response to request for information of monitoring techniques, included provision of literature.

04/29/87 MEMO to G. Sigvaldason (WOVO, NVI, Iceland) through R. Tilling (USGS) - requested proposal for use of UNESCO (IMEWS) funding for Latin American volcano hazards

04/30/87 MEMO to Richard Burke (MDRO, USAID Guatemala) - transmitting final report on the Feb/Mar work of VDAP in Guatemala, including suggestions for a course of action for USAID Guatemala and INSIVUMEH

04/30/87 CALL to Maurice Krafft (France) -- negotiating the making of an educational video using Mont Pelee sequence by Krafft

APPENDIX XIV. -- Continued

Early May SERIES of LETTERS and CALLS to USGS, WOVO, Ecuador - response to request for setting up a summer workshop in Ecuador with UNESCO funding, a significant effort in design and coordination.

5/12/87 CALL from John Tomblin (UNDRO, Geneva) -- report on Santiaguito Volcano, Guatemala, slight change in activity pattern

5/12/87 CALL to Eddy Sanchez (Subdirector INSIVUMEH, Guatemala) - Check on report from Tomblin, fumaroles are not in new area, but fumarolic activity has noticeably increased; made recommendations for monitoring actions

5/12/87 CALL to Tom Kellerman (USAID, Guatemala) -- informed him about activity reported by Tomblin and Sanchez: discussed Mission's plans to provide funding for INSIVUMEH training

5/13/87 Call to W. Rose (Michigan Tech. Univ.) -- alerted him to the activity pattern at Santiaguito

5/22/87 CALL from John Tomblin (UNDRO, Geneva) -- to coordinate UNDRO/VDAP liaison meetings in South America during the summer

5/27/87 CALL from Tom Lucas (CINEWORKS) -- to express interest in making a NOVA documentary on VDAP

6/5/87 LETTER and MATERIAL to Tom Lucas (CINEWORKS, New York) - sent requested articles giving general background in volcanology

06/08/87 LETTER Rabaul Volc. Obser. (Papua New Guinea) - provided information requested on new type of EDM prisms.

06/08/87 LETTER to Jim Smith (USAID, Colombia) - Requested Embassy/USAID support in assuring Hans Jurgen Meyer's position at OVC

6/9/87 CALL from Hans Meyer (OVC, Colombia) -- notification of trip to US in summer, coordination on summer 88 workshop in Ecuador, report on increased activity at Ruiz, consultation on courses to take in monitoring and mitigation

6/9/87 CALL from L. McClellan (SEAN, Wash,) -- more detail on increased activity at Ruiz

6/9/87 CALL to Hans Meyer (OVC, Colombia)-- checking on increased activity at Ruiz

6/10/87 CALL to Hans Meyer (OVC, Colombia)-- checking on increased activity at Ruiz

6/11/87 CALL from L. McClellan (SEAN, Wash,) -- more detail on increased activity at Ruiz; report on activity at Fuego in Guatemala

6/11/87 CALL to Hans Meyer (OVC, Colombia)-- check up on increased activity at Ruiz, consultation on courses to take in monitoring and mitigation

6/16/87 CALL to Rene Quebec (INSIVUMEH, Guatemala) -- to obtain report on increased activity on FUEGO and strong eruption at Pacaya

APPENDIX XIV. -- Continued.

6/17/87 VISIT by Alberto Giesecke (CERESIS,Peru) - review of CERESIS activities, review of Peru volcanism and hazards preparedness, presentation of VDAP equipment and objectives, tour of CVO, planning for VDAP work in Peru, review of CERESIS activities at Ruiz, Colombia

6/18/87 CALL from L. McClellan (SEAN, Wash) - report on decrease of activity at Ruiz

06/18/87 LETTER and MATERIAL to David Kitson (USAID, Costa Rica) - providing requested video of Ruiz fieldwork 1985

6/25/87 INQUIRY from G. Sigvaldason (NVI, WOVO, Iceland) - for names of designated trainees for summer 87 workshop in Ecuador.

Late-June/Early-July - LETTERS AND MEMOS - budget and details for USAID, Guatemala, of Stage 1 project to develop Guatemalan Hazard Mitigation Program

7/02/87 CALL from J. Tomblin (UNDRO, Geneva) - to request a tour of CVO and Mount St. Helens

7/2/87 CALL from E. Parra (OVC, Colombia) - coordination on the summer 87 workshop in Ecuador, general exchange of information on status of the Observatorio

7/6/87 CALL from Wisen-Booth (NEWSDAY, Los Angeles) - to obtain information on St. Lucia..this is return call, left message

7/9/87 CALL to G. Sigvaldason (NVI, WOVO, Iceland) - to finalize finances for summer 1987 workshop in Ecuador

7/9/87 CALL to E.Parra (OVC Colombia) - coordination on the summer 87 workshop in Ecuador,

7/9/87 CALL to M. Hall (ESPONA, Ecuador) - to coordinate the summer 1987 deformation workshop; he made request for computer chip

7/9/87 CALL to Eddy Sanchez (INSIVUMEH, Guatemala) - to coordinate initiation of the PASA amendment providing equipment and training in volcanology to INSIVUMEH

7/09/87 CALL to W. Rose (Mich. Tech. Univ.) - to coordinate initiation of contract work on Fuego hazards map

7/10/87 CALL to W. Rose (Mich. Tech. Univ.) - to coordinate initiation of contract work on Fuego hazards map

7/15/87 CALL from R. Van der Laat (OVSICORI, Costa Rica)--report on new geyser activity at Poas Volcano

7/15/1987 CALL from Fernando Munoz (OVC, Colombia) -coordination on the summer 87 workshop in Ecuador,

7/16/1987 CALL to Alberto Giesecke (CERESIS, Peru) - to gain more information on the CERESIS meeting about Ruiz Volcano in Colombia, to get information about Peruvian volcano hazards preparedness

7/16/87 LETTER to R. Burke (MDRO, USAID, Guatemala) - to assure development of proper convenios with INSIVUMEH to support the PASA training and equipment purchases

APPENDIX XIV. -- Continued.

7/16/87 LETTER to Eddy Sanchez (INSIVUMEH, Guatemala) - to coordinate Guatemalan participation in the summer 1987 workshop in Ecuador and INSIVUMEH action o the new PASA

8/02/87 LETTER to Dr. R. Stoiber (Dartmouth College) - plans for contracting to do volcano reports for Latin American volcanoes

8/05/87 LETTER to Dr. A. W. Malone (Hong Kong) - in response to request for tour of HVO

8/5/87 CALL from L. McClelland (SEAN, Wash.) - coordination on similar work on Latin American maps

8/10/87 INQUIRY from G. Sigvaldason (WOVO, NVI, Iceland) - on the summer 87 workshop, details and accomplishments

8/12/87 CALL to M. Krafft (France) - coordination and progress report on the Mont Pelee video

8/12/87 LETTER to Prof. R. T. Lubala (Univ. Lumbashi, Zaire) - response to request for more information on VDAP, request for cooperative work in Zaire

8/12/87 LETTER to Dr. Yosihiro Sawada (Japan Meteror. Inst.) - response to reprints sent by Sawada

8/13/87 MEMO + EQUIPMENT to ESPONA (Ecuador) - temporary loan of short-range EDM equipment for volcano monitoring.

8/13/87 MEMO N. Meriwether MDRO USAID, Ecuador - Volcano hazards and preparedness in Ecuador, Preliminary report on team in Ecuador

8/18/87 CALL from Tom Lucas (CINEWORKS, New York) - to check up on volcano activity

8/15-17/87 VISIT TO CVO by John Tomblin (UNDRO, Geneva) - tour of CVO and St. Helens, discussions hazards mitigation in Latin America, discussions about VDAP services needed in Latin America and coordination with UNDRO

8/23-31/87 VISIT TO CVO by Hans Meyers (Univ.Valle, Colombia) -tour of CVO, discussions about Obser. Vulcan. Colombia, discussion about Univ. Valle seismic/volcanology program, discussions about Colombia hazards mitigation and VDAP services needed in Colombia

08/28/87 LETTER to G. Sigvaldason (WOVO,NVI, Iceland) - report on the Workshop on Deformation Monitoring held in Ecuador in July/August.

8/28/87 REPORT to Jorge Quesada (OVSICORI, Costa Rica) - Rodolfo Van der Laat's attendance at Deformation Workshop in Ecuador, 22 July, 1987.

8/28/87 REPORT to Eddy Sanchez (INSIVUMEH, Guatemala) - Oscar Porras' attendance at Deformation Workshop in Ecuador, 22 July, 1987.

8/28/87 REPORT to Gudmundur Sigvaldason (WOVO, NVI, Iceland) - results and evaluation of VDAP deformation workshop held in Ecuador.

8/28/87 LETTERS to G. Sigvaldason (WOVO, Iceland) - reports on the Workshop on Deformation Monitoring held in Ecuador in July/August.

APPENDIX XIV. -- Continued.

9/8/87 CALL TO Eddy Sanchez (INSIVUMEH, Guatemala) -- discussion of staffing of new Seccion Volcanologia, agreed on plan of equipment acquisition under the newly-enacted PASA

9/8/87 CALL FROM Bill Rose (Mich. Tech.Univ.) -- to discuss results of his trip to Guatemala, status of the new Seccion Volcanologia, plans for upcoming training

9/11/87 CALL FROM R. Van der Laat (OVSICORI, Costa Rica) - to discuss status of OVSICORI program in volcanology, to inform VDAP of UNESCO-funded course by OVSICORI in Costa Rica for Latin American volcanologists

9/11/1987 CALL TO Edd, Sanchez (INSIVUMEH, Guatemala) - to coordinate the upcoming training program, to check on activity at Guatemalan volcanoes

9/15/87 CALL FROM T. Taylor (Global Broadcasting) - request for information on VDAP

9/15/87 CALL from John Tomblin (UNDRO, Geneva) - to coordinate plans for joint efforts in Peru, Ecuador, and Colombia in October

9/15/87 CALL TO M. Summers (SEAN, Wash.) - to request information on Latin American volcanoes, to obtain report on eruption of Pagan, Marianas

9/15/87 CALL TO W. Rose (Mich. Tech. Univ.) -- to coordinate arrival and training of Guatemalan volcanologist

9/15/87 CALL TO Selwyn Saks (Carnegie Inst., Wash.) - to obtain information about Peruvian volcanoes.

9/17/87 LETTER TO Richard Burke (MDRO USAID, Guatemala)- reporting on budget and coordinating upcoming visit of Harlow

9/17/87 LETTER TO Eddy Sanchez (INSIVUMEH, Guatemala)- provided FY 88 budget and training schedule for the assistance program for INSIVUMEH

9/19/87 LETTER TO W. Rose (Mich. Tech. Univ.) - details of October/November training schedule for INSIVUMEH

9/22/87 CALL TO Neal Meriwether (MDRO, USAID, Ecuador) - to pass on and obtain information on the 2, M=6.0 earthquakes of the morning SE of Quito, coordinated trip schedule for October

9/22/87 CALL TO Minard Hall (ESPONA, Ecuador) - to pass on and obtain information on the 2, M=6.0 earthquakes of the morning SE of Quito, coordinated trip schedule for October

9/22/87 CALL TO James Smith (MDRO, USAID, Colombia)-- to coordinate trip schedule for October trip

9/22/87 CALL TO Eddy Sanchez (INSIVUMEH, Guatemala) - to coordinate October/November training trip, to check on activity at Guatemalan volcanoes

9/24/87 CALL TO Eduardo Parra (OVC, Colombia) - to coordinate October visit to Colombia

APPENDIX XIV. -- Continued.

9/24/87 CALLS TO Alberto Parodi (Univ. San. Aug., Peru), Alberto Giesecki (CERESIS, Peru) - to coordinate October visit to Peru

9/24/87 CALL FROM Eddy Sanchez (INSIVUMEH, Guatemala) - to discuss October/November training program

9/24/1987 CALL TO Richard Burke (MDRO USAID, Guatemala) - to discuss October/November training program and overall program objectives

9/25/87 LETTER TO F. G. Longo (DGM, Dominican Republic) - response to request for volcano monitoring assistance and literature.

9/25/87 LETTER J. Garcia-D, Univ. Ecuador Guayaquil- response to request for volcano monitoring assistance and literature

9/25/87 VISIT BY Pason Sheets (Univ. Colorado) - discussion of uses of archaeology in volcanology, obtained information on El Salvador volcanoes and workers

9/28/87 CALL FROM William Rose (Mich. Tech. Univ.) - to discuss October/November training program for INSIVUMEH, to discuss progress on the video on Mont Pelee

9/28/1987 CALL TO Hans Jurgen Meyer (Univ. Valle, Colombia) - to coordinate October visit to Colombia

9/29/87 LETTER J. Gaitan-M (Univ. Baja Calif., Mexico) - response to request for volcano monitoring assistance and literature.

Late September MEMOS, LETTERS, CALLS - coordinating the initial INSIVUMEH trainee trip to US.

APPENDIX XV -- Unofficial ledger of USGS Operational Expenses in FY 87

File
87VCTSRT.WK1 1987 LEDGER last update 27-Jan-88

	STARTING BALANCE	CURRENT BALANCE
	$34,000.00	($174.43)

********** SUMMARY **********

	STARTING FUNDS	FUNDS SPENT	FUNDS REMAINING
TOTAL PERS SERV	$0	$0.00	
TOTAL CONTRACTS	$9,000	$9,084.05	($84.05)
TOTAL EQUIPMENT	$16,792	$19,609.96	($2,817.96)
DBASE	$0	$321.17	($321.17)
DEFORM	$10,873		($163.69)
TILT		$1,962.45	
EDM		$513.07	
TELEM		$8,561.37	
COMP	$2,913	$3,347.92	($434.92)
GAS/GEO	$0	$0.00	$0.00
GEO/OBS	$5	$836.65	($831.65)
LAB	$394	$0.00	$394.00
LOGIS	$0	$552.60	($552.60)
OFFIC	$600	$288.89	$311.11
SAFETY	$560	$1,313.00	($753.00)
SEISMIC	$0	$0.00	$0.00
TOOLS	$1,447	$1,912.84	($465.84)
TOTAL OPERATIONS AND EXPENDABLES	$5,950	$5,362.42	$587.58
ADMIN	$2,000	$1,631.72	$368.28
OFFIC	$350	$350.00	$0.00
COMP	$750	$1,046.55	($296.55)
DEFOR	$500	$553.28	($53.28)
GAS/GEO	$500	$545.74	($45.74)
GEO/OBS	$750	$822.85	($72.85)
LAB	$0	$35.40	($35.40)
LOGIS	$350	$28.12	$321.88
SHIP	$0	$72.01	($72.01)
SEISMIC	$0	$228.00	($228.00)
TOOLS	$750	$48.75	$701.25
	$950		$587.58
TOTAL TRAVEL	$2,280	$118.00	$2,162.00
TOTAL		$34,174.43	

********** SUMMARY **********

APPENDIX XV. CONTINUED

********** DETAILS **********

	VCAT ORDER NO.	MAIN VCAT SORT	AUX VCAT SORT	SUB VCAT SORT	ACTIV-ITY ITY	DESCRIPTION OF ITEM	MANUFACTURER VENDER	NUMBER PUR.	UNIT COST	UNIT SHIPPING COST	TOTAL COST
CONTRACTS						$9,000.00					
X	V87-040C	CONTR	LANGU	TRAIN	VCAT	Spanish 102, John	CLARK COLLEGE	1	$49.10	$0.00	$49.10
X	V87-040B	CONTR	LANGU	SUPPL	VCAT	Spanish 101, ancy, libro	CLARK COLLEGE	1	$70.20	$0.00	$70.20
X	V87-040A	CONTR	LANGU	TRAIN	VCAT	Spanish 101, ancy	CLARK COLLEGE	1	$123.00	$0.00	$123.00
X	V87-040G	CONTR	LANGU	SUPPL	VCAT	Spanish 103, Norm, libro	CLARK COLLEGE	1	$56.25	$0.00	$56.25
X	V87-040E	CONTR	LANGU	SUPPL	VCAT	Spanish 103, Mike, libro	CLARK COLLEGE	1	$56.25	$0.00	$56.25
X	V87-018	CONTR	LANGU	SUPPL	VCAT	Spanish 102, John	CLARK COLLEGE	1	$122.75	$0.00	$122.75
X	V87-040D	CONTR	LANGU	TRAIN	VCAT	Spanish 103, Mike	CLARK COLLEGE	1	$48.25	$0.00	$48.25
X	V87-040F	CONTR	LANGU	TRAIN	VCAT	Spanish 103, Norm	CLARK COLLEGE	1	$122.75	$0.00	$122.75
X	V87-121	CONTR	LANGU	TRAIN	VCAT	Spanish 203, VCAT	CLARK COLLEGE	1	$508.00	$0.00	$508.00
X	V87-001	CONTR	LOGIS	STOR	VCAT	Storage, VCAT	SAFEGUARD STORAGE	4	$78.00	$0.00	$312.00
O	V87-001A	CONTR	LOGIS	STOR	VCAT	Projected	SAFEGUARD STORAGE	8	$78.00	$0.00	$624.00
X	V87-057	CONTR	DBASE	VIDEO	VCAT	Krafft Mt. Pelee'	KRAFFT FILMS	1	$200.00	$0.00	$200.00
X	V87-058	CONTR	DBASE	VIDEO	VCAT	Tape P.A.L. to N.T.S.C.	CALIFORNIA VIDEO	1	$179.50	$3.00	$182.50
O	V87-061	CONTR	DBASE	REFMA	VCAT	Consult DBASE	L & J CONSULTING	1	$2,500.00	$0.00	$2,500.00
O	V87-062	CONTR	DBASE	NAMES	VCAT	Provide NAMES	AMBOY BUSI	0	$775.00	$0.00	$0.00
O	V87-063	CONTR	DBASE	VOLHAZ	VCAT	Provide MAPS	CLARK COLL.	1	$2,450.00	$0.00	$2,450.00
X	V87-055	CONTR	OFFIC	GRAPH	VCAT	Itek Processor	ITEK CORP	1	$500.00	$0.00	$500.00
X	V87-118	CONTR	DBASE	VIDEO	VCAT	Krafft Video	MICH) TECH	1	$1,156.00	$3.00	$1,159.00
				TOTAL		$9,084.05	($84.05)				
EQUIPMENT						$16,792.00					
EQUIPMENT-DATA BASE						$0.00					
X	V87-039A	DBASE	COMPU	SUPPL	VCAT	Mike Carr, pet. anal.	Michael Carr	1	$99.00	$0.00	$99.00
X	V87-039B	DBASE	COMPU	SUPPL	VCAT	Mike Carr, data base	Michael Carr	1	$25.00	$0.00	$25.00
X	V87-031	TRAIN	VIDEO	SUPPL	VCAT	Video tape, 1/2 120 min	A & G ASSOCIATES	15	$4.79	$0.00	$71.85
X	V87-029	TRAIN	VIDEO	NEWPU	VCAT	Etna lava diversion	F.H.MARKETING	1	$20.97	$0.00	$20.97
	V87-068	DBASE	REFS	NEWPU	VCAT	Calderas & Associated ig	AMERICAN GEOPHYS.	1	$14.00	$0.00	$14.00
X	V87-099	DBASE	NOMEN	NEWPU	VCAT	Geological Nomenclature	PROF BOOKSTORE	1	$90.35	$0.00	$90.35
				TOTAL		$321.17	($321.17)				
EQUIPMENT-DEFORMATION						$10,873.00					
EQUIPMENT-DEFORMATION-TILT											
X	V87-004D	DEFOR	TILT	T2000	VCAT	Wild T2000 Cable	NESSCO SUPPLY	1	$135.00	$0.00	$135.00
X	V87-004C	DEFOR	TILT	T2000	VCAT	Wild Carrier	NESSCO SUPPLY	3	$72.00	$0.00	$216.00

APPENDIX XV. CONTINUED

********** DETAILS **********

	VCAT ORDER NO.	MAIN VCAT SORT	AUX VCAT SORT	SUB VCAT SORT	ACTIV-ITY ITY	DESCRIPTION OF ITEM	MANUFACTURER VENDER	NUMBER PUR.	UNIT COST	UNIT SHIPPING COST	TOTAL COST
X	V87-004B	DEFOR	TILT	T2000	VCAT	Wild Plumbing pole	NESSCO SUPPLY	1	$175.50	$0.00	$175.50
X	V87-004A	DEFOR	TILT	T2000	VCAT	Wild Prism Tripod	NESSCO SUPPLY	3	$165.75	$0.00	$497.25
X	V87-106	DEFOR	TILT	BM'S	VCAT	Bench Marks, Tilt	OREGON BRASS WORKS	90	$10.43	$0.00	$936.70
				SUBTOTAL		$1,962.45					

EQUIPMENT-DEFORMATION-EDM

X	V87-026D	DEFOR	EDM	TOOL	VCAT	1/4" carbide bit	PORTLAND CONTRACTO	1	$7.20	$0.00	$7.20
X	V87-026A	DEFOR	EDM	TOOL	VCAT	Bosch,rotary hammer dri	PORTLAND CONTRACTO	1	$229.00	$0.00	$229.00
X	V87-026B	DEFOR	EDM	TOOL	VCAT	Battery pack, Bosch	PORTLAND CONTRACTO	1	$79.47	$0.00	$79.47
X	V87-026F	DEFOR	EDM	TOOL	VCAT	3/4 " carbide bit	PORTLAND CONTRACTO	1	$27.90	$0.00	$27.90
X	V87-026C	DEFOR	EDM	TOOL	VCAT	Chuck adapter	PORTLAND CONTRACTO	1	$29.50	$0.00	$29.50
X	V87-026E	DEFOR	EDM	TOOL	VCAT	1/2" carbide bit	PORTLAND CONTRACTO	2	$12.60	$0.00	$25.20
X	V87-008	DEFOR	EDM	TOOL	VCAT	Chuck acapter	PORTLAND CONTR.	1	$30.00	$0.00	$30.00
X	V87-076A	DEFOR	EDM	TOOL	VCAT	Psychrometer	FISHER SCI.	1	$44.50	$0.00	$44.50
X	V87-076B	DEFOR	EDM	TOOL	VCAT	Psychrometer, wick	FISHER SCI.	1	$6.30	$0.00	$6.30
X	V87-094	DEFOR	EDM	TOOL	VCAT	Battery Charger, Gel Cel	RADAR ELECTRIC	2	$17.00	$0.00	$34.00
				SUBTOTAL		$513.07					

EQUIPMENT-DEFORMATION-TELEMETRY

X	V87-012	TELEM	CASE	NEWPU	VCAT	Pelican Cases, small	PELICAN PRODUCTS	3	$33.00	$0.00	$98.91
X	V87-013	TELEM	CASE	PARTS	VCAT	Aluminum boxes	MOUSER ELECT	10	$6.70	$5.47	$72.47
X	V87-043	TELEM	ETILT	PARTS	VCAT	Electronics	NORVACK	1	$89.46	$0.00	$89.46
X	V87-042B	TELEM	ETILT	PARTS	VDAP	3216	NORVACK	1	$3.40	$0.00	$3.40
X	V87-042F	TELEM	ETILT	PARTS	VDAP	15-5L	NORVACK	1	$1.65	$0.00	$1.65
X	V87-042C	TELEM	ETILT	PARTS	VDAP	HIX 3/16	NORVACK	2	$2.12	$0.00	$4.24
X	V87-042E	TELEM	ETILT	PARTS	VDAP	8172	NORVACK	1	$15.71	$0.00	$15.71
X	V87-042A	TELEM	ETILT	PARTS	VDAP	B700-RT24	NORVACK	2	$7.20	$0.00	$14.40
X	V87-042D	TELEM	ETILT	PARTS	VDAP	HIX 3/8	NORVACK	1	$2.98	$0.00	$2.98
X	V87-042G	TELEM	ETILT	PARTS	VDAP	LMB	NORVACK	1	$16.56	$0.00	$16.56
X	V87-044	TELEM	ETILT	NEWP	VCAT	Mod 953-B, EPROM burn	SINTEC	1	$59.95	$0.00	$59.95
X	V87-011	TELEM	RADIO	NEWPU	VCAT	Syntex Radios	BOWITZ ELECT.	4	$415.00	$27.00	$1,687.00
X	V87-015	TELEM	RICKS	PARTS	VCAT	Integrated circuit	HAMILTON-AVNET	5	$11.49	$0.00	$57.47
X	V87-010	TELEM	TOMS	NEWPU	VCAT	Six Toms units, no case	CVO	7	$500.00	$0.00	$3,500.00
X	V87-051A	TELEM	RICKS	PARTS	VCAT	Elect. Parts, I.C.s	WESTERN MICROTECH	32	$5.65	$2.97	$183.77
X	V87-051B	TELEM	RICKS	PARTS	VCAT	Elect. Parts, I.C.s	WESTERN MICROTECH	32	$3.10	$0.00	$99.20
X	V87-051C	TELEM	RICKS	PARTS	VCAT	Elect. Parts, I.C.s	WESTERN MICROTECH	32	$4.34	$0.00	$138.88
X	V87-052A	TELEM	RICKS	PARTS	VCAT	I.C. 74HC943N	HAMILTON-AVNET	32	$10.45	$0.00	$334.40
X	V87-052B	TELEM	RICKS	PARTS	VCAT	I.C. 74HC138	HAMILTON-AVNET	32	$0.82	$0.00	$26.24

APPENDIX XV. CONTINUED

********** DETAILS **********

VCAT ORDER NO.	MAIN VCAT SORT	AUX VCAT SORT	SUB VCAT SORT	ACTIV-ITY ITY	DESCRIPTION OF ITEM	MANUFACTURER VENDER	NUMBER PUR.	UNIT COST	UNIT SHIPPING COST	TOTAL COST
X V87-052C	TELEM	RICKS	PARTS	VCAT	I.C. 74HC373	HAMILTON-AVNET	32	$2.67	$0.00	$85.44
X V87-052D	TELEM	RICKS	PARTS	VCAT	I.C. 74HC11	HAMILTON-AVNET	32	$0.50	$0.00	$16.00
X V87-052E	TELEM	RICKS	PARTS	VCAT	I.C. 74 C14	HAMILTON-AVNET	32	$0.80	$0.00	$25.60
X V87-052F	TELEM	RICKS	PARTS	VCAT	I.C. LM4250C	HAMILTON-AVNET	32	$1.75	$0.00	$56.00
X V87-052G	TELEM	RICKS	PARTS	VCAT	I.C. ICM7170IPG	HAMILTON-AVNET	32	$9.40	$0.00	$300.80
X V87-053A	TELEM	RICKS	PARTS	VCAT	Elect. Parts, xtl	DIGI-KEY	30	$2.25	$1.87	$69.37
X V87-053B	TELEM	RICKS	PARTS	VCAT	Elect. Parts, xtl	DIGI-KEY	30	$2.38	$0.00	$71.25
X V87-053C	TELEM	RICKS	PARTS	VCAT	Elect. Parts, xt	DIGI-KEY	30	$1.25	$0.00	$37.50
X V87-053D	TELEM	RICKS	PARTS	VCAT	Elect. Parts, xstr	DIGI-KEY	30	$0.53	$0.00	$15.75
X V87-053E	TELEM	RICKS	PARTS	VCAT	Elect. Parts, cap	DIGI-KEY	30	$1.20	$0.00	$36.09
X V87-053F	TELEM	RICKS	PARTS	VCAT	Elect. Parts, v. rel	DIGI-KEY	30	$1.38	$0.00	$41.40
X V87-053G	TELEM	RICKS	PARTS	VCAT	Elect. Parts, rrf511	DIGI-KEY	50	$1.06	$0.00	$53.10
X V87-054A	TELEM	RICKS	PARTS	VCAT	Elect. Parts, I.C.	MOUSER ELECTR.	32	$0.99	$0.00	$31.68
X V87-054B	TELEM	RICKS	PARTS	VCAT	Elect. Parts, box	MOUSER ELECTR.	20	$5.70	$0.00	$114.00
X V87-054C	TELEM	RICKS	PARTS	VCAT	Elect. Parts, xstr	MOUSER ELECTR.	50	$0.13	$0.00	$6.50
X V87-054D	TELEM	RICKS	PARTS	VCAT	Elect. Parts, caps	MOUSER ELECTR.	50 X		$0.00	$0.00
X V87-054E	TELEM	RICKS	PARTS	VCAT	Elect. Parts, caps	MOUSER ELECTR.	30	$0.25	$0.00	$7.50
X V87-054F	TELEM	RICKS	PARTS	VCAT	Elect. Parts, caps	MOUSER ELECTR.	300	$0.10	$0.00	$30.00
X V87-054G	TELEM	RICKS	PARTS	VCAT	Elect. Parts, caps	MOUSER ELECTR.	300	$0.06	$0.00	$16.50
X V87-054H	TELEM	RICKS	PARTS	VCAT	Elect. Parts, caps	MOUSER ELECTR.	200	$0.06	$0.00	$11.00
X V87-054I	TELEM	RICKS	PARTS	VCAT	Elect. Parts, xfmr	MOUSER ELECTR.	40 X		$0.00	$0.00
X V87-054J	TELEM	RICKS	PARTS	VCAT	Elect. Parts, cell hold	MOUSER ELECTR.	20	$0.72	$0.00	$14.40
X V87-054K	TELEM	RICKS	PARTS	VCAT	Elect. Parts, DIP	MOUSER ELECTR.	22	$0.96	$0.00	$21.12
X V87-054L	TELEM	RICKS	PARTS	VCAT	Elect. Parts, DIP	MOUSER ELECTR.	44	$1.33	$0.00	$58.52
X V87-054M	TELEM	RICKS	PARTS	VCAT	Elect. Parts, DIP	MOUSER ELECTR.	44	$1.46	$0.00	$64.24
X V87-054N	TELEM	RICKS	PARTS	VCAT	Elect. Parts, DIP	MOUSER ELECTR.	44	$2.10	$0.00	$92.40
X V87-054O	TELEM	RICKS	PARTS	VCAT	Elect. Parts, DIP	MOUSER ELECTR.	22	$2.54	$0.00	$55.88
X V87-054P	TELEM	RICKS	PARTS	VCAT	Elect. Parts, DIP	MOUSER ELECTR.	44	$2.75	$0.00	$121.00
X V87-054Q	TELEM	RICKS	PARTS	VCAT	Elect. Parts, DIP	MOUSER ELECTR.	22	$3.98	$0.00	$87.56
X V87-054R	TELEM	RICKS	PARTS	VCAT	Elect. Parts, rstr	MOUSER ELECTR.	100	$0.02	$0.00	$1.70
X V87-054S	TELEM	RICKS	PARTS	VCAT	Elect. Parts, rstr	MOUSER ELECTR.	100	$0.02	$0.00	$1.70
X V87-054T	TELEM	RICKS	PARTS	VCAT	Elect. Parts, rstr	MOUSER ELECTR.	100	$0.02	$0.00	$1.70
X V87-054U	TELEM	RICKS	PARTS	VCAT	Elect. Parts, rstr	MOUSER ELECTR.	100	$0.02	$0.00	$1.70
X V87-054V	TELEM	RICKS	PARTS	VCAT	Elect. Parts, rstr	MOUSER ELECTR.	100	$0.02	$0.00	$1.70
X V87-054W	TELEM	RICKS	PARTS	VCAT	Elect. Parts, rstr	MOUSER ELECTR.	100	$0.02	$0.00	$1.70
X V87-054X	TELEM	RICKS	PARTS	VCAT	Elect. Parts, rstr	MOUSER ELECTR.	100	$0.02	$0.00	$1.70
X V87-066	TELEM	RADIO	PARTS	VCAT	Microphone plug 6 pin	SYNTHEX	35	$5.85	$3.00	$207.75
X V87-069	TELEM	RADIO	NEWPU	VCAT	Walkie Talkie, 3 chan	Radio Shack	10	$35.95	$0.00	$359.50
X V87-090A	TELEM	MUD	NEWPU	VCAT	25 Cond. Ribbon Cable	NORVAC	1	$6.43	$0.00	$6.43
X V87-107G	OPERA	ELECT	NEWPU	VCAT	1 uf Cap.	NORVAC	150	$0.19	$0.00	$28.50
			SUBTOTAL		$8,561.37					
			TOTAL		$11,036.89	($163.89)				

APPENDIX XV. CONTINUED

********** DETAILS **********

VCAT ORDER NO.	MAIN VCAT SORT	AUX VCAT SORT	SUB VCAT SORT	ACTIV-ITY ITY	DESCRIPTION OF ITEM	MANUFACTURER VENDER	NUMBER PUR.	UNIT COST	UNIT SHIPPING COST	TOTAL COST
EQUIPMENT-COMPUTER					$2,913.00					
X V87-014	COMPU	PRINT	UPGRA	VCAT	JOL Tractor feed	WESTCOM	1	$140.00	$0.00	$140.00
X V87-059	COMPU	MONITO	NEWPU	VCAT	Amber Monitors	WESTCOM	3	$150.00	$10.00	$460.00
X V87-060	COMPU	DRIVE	NEWPU	VCAT	Disk Controller	WESTCOM	1	$150.00	$0.00	$150.00
X V87-064	COMPU	COMPU	NEWPU	VCAT	Toshiba 1100	WESTCOM	1	$1,799.00	$0.00	$1,799.00
X V87-079	COMPU	SOFT	UPGRAD	VCAT	WordStar 4	MICROPRO	1	$89.00	$1.75	$90.75
X V87-089	COMPU	SOFT	UPGRAD	VCAT	Micro cursbasic	G T S I	1	$69.30	$0.00	$69.30
X V87-103A	COMPU	SOFT	UPGRAD	VCAT	Norton Utilities	G T S I	1	$47.98	$0.00	$47.98
X V87-103B	COMPU	SOFT	UPGRAD	VCAT	Double DOS	G T S I	1	$35.00	$0.00	$35.00
X V87-103C	COMPU	SOFT	UPGRAD	VCAT	C: Program Workshop	POWER-UP	1	$49.95	$0.00	$49.95
X V87-098	OPERA	ADMIN	COMPU	VCAT	Word Perfect 4.2	G T S I	1	$183.15	$0.00	$183.15
V87-120	COMPU	PRINT	NEWPU	VCAT	Diconex printer	CTEI	1	$322.79	$0.00	$322.79
			TOTAL		$3,347.92	($434.92)				
EQUIPMENT-GAS/CONDENSATE			GEOCHEM		$0.00					
			TOTAL		$0.00	$0.00				
EQUIPMENT-GEOLOGY/OBSERVATION					$5.00					
X V87-056	GEOL	VIDCAM	EXCESS	VCAT	B & W Vid. Cam	EXCESS PROP	1	$0.00	$74.85	$74.85
V87-096A	GEOL	CAMER	NEWPU	VCAT	Minolta x-700 body	MINOLTA	1	$219.95	$0.00	$219.95
V87-096B	GEOL	CAMER	NEWPU	VCAT	Multi finction back	MINOLTA	1	$149.95	$10.00	$159.95
V87-096C	GEOL	CAMER	NEWPU	VCAT	zoom lens, 35-105	MINOLTA	1	$289.95	$0.00	$289.95
V87-096D	GEOL	CAMER	NEWPU	VCAT	soft case, long nose	MINOLTA	2	$40.00	$0.00	$80.00
V87-096E	GEOL	CAMER	NEWPU	VCAT	IR filter	MINOLTA	1	$11.95	$0.00	$11.95
			TOTAL		$836.65	($831.65)				
EQUIPMENT-LABORATORY					$394.00					
			TOTAL		$0.00	$394.00				
EQUIPMENT-LOGISTICS					$0.00					
X V87-024	LOGIS	EQUIP	MISCL	VCAT	padlock	HARRY'S LOCKSMITH	1	$15.60	$0.00	$15.60
x V87-123	LOGIS	EQUIP	newpu	VCAT	Jensen case	JENSEN	3	$179.00	$0.00	$537.00
			TOTAL		$552.60	($552.60)				
EQUIPMENT-OFFICE					$600.00					
X V87-009	OFFIC	EQUIP	MISCE	VCAT	Stapler	GSA	1	$1.50	$0.00	$1.50

APPENDIX XV. CONTINUED

********** DETAILS **********

	VCAT ORDER NO.	MAIN VCAT SORT	AUX VCAT SORT	SUB VCAT SORT	ACTIV-ITY ITY	DESCRIPTION OF ITEM	MANUFACTURER VENDER	NUMBER PUR.	UNIT COST	UNIT SHIPPING COST	TOTAL COST
X	V87-003	OFFIC	FURNI	MISCE	VCAT	Shelving lumber	STANDARD BUILDING	1	$92.64	$0.00	$92.64
X	V87-047	OFFIC	NEWP	NEWP	VCAT	Polaroid Processor	POLAROID CORP	1	$61.50	$0.00	$61.50
	V87-081	OFFIC	FURNI	NEWP	VCAT	Chair, Office	ECK ADAMS, CORP	1	$133.25	$0.00	$133.25
				TOTAL		$288.89	$311.11				
EQUIPMENT-SAFETY						$5[illegible].00					
X	V87-045	OPERA	SAFET	SUPPL	VCAT	Motorola kits	MOTOROLA	7	$118.57	$0.00	$830.00
X	V87-106	OPERA	SAFET	NEWPU	VCAT	Short Wave Radio	WENGER	1	$279.00	$0.00	$279.00
X	V87-002	CONTR	SAFET	RADIO	VCAT	Radio maintenance	MOTOROLA	1	$204.00	$0.00	$204.00
				TOTAL		$1,313.00	($753.00)				
EQUIPMENT-SEISMIC						$0.00					
				TOTAL		$0.00	$0.00				
EQUIPMENT-ELECTRONIC TOOLS						$1,447.00					
X	V87-021A	TOOLS	ELECT	SUPPL	VCAT	Chem-wix	NORVAC	1	$1.27	$0.00	$1.27
X	V87-021	TOOLS	ELECT	SUPPL	VCAT	De solder	NORVAC	1	$9.95	$0.00	$9.95
X	V87-021C	TOOLS	ELECT	NEWPU	VCAT	Power strip	NORVAC	1	$16.62	$0.00	$16.62
X	V87-020	TOOLS	ELECT	NEWPU	VCAT	Wire Strippers	EOFF ELECT	3	$6.50	$0.00	$19.50
X	V87-065	TOOLS	ELECT	NEWPU	VCAT	Leathermans Tool	LEATHERMAN TOOL CO	4	$33.00	$0.00	$132.00
X	V87-075A	TOOLS	ELECT	NEWPU	VCAT	V. reg	NORVAC	2	$1.62	$0.00	$3.24
X	V87-075B	TOOLS	ELECT	NEWPU	VCAT	ZIF socket	NORVAC	1	$15.59	$0.00	$15.59
X	V87-075C	TOOLS	ELECT	NEWPU	VCAT	IC Socket	NORVAC	1	$2.05	$0.00	$2.05
X	V87-075D	TOOLS	ELECT	NEWPU	VCAT	Knife	NORVAC	1	$15.10	$0.00	$15.10
X	V87-075E	TOOLS	ELECT	NEWPU	VCAT	Eprom eraser	NORVAC	1	$24.95	$0.00	$24.95
X	V87-075F	TOOLS	ELECT	NEWPU	VCAT	25 cm cable	NORVAC	1	$19.97	$0.00	$19.97
X	V87-090B	TOOLS	ELECT	NEWPU	VCAT	Torx Tool	NORVAC	1	$19.87	$0.00	$19.87
X	V87-090C	TOOLS	ELECT	NEWPU	VCAT	CMOS Books	NORVAC	1	$74.70	$0.00	$74.70
X	V87-092A	TOOLS	DEFOR	NEWPU	VCAT	Bat term clean	PARKROSE	1	$1.99	$0.00	$1.99
X	V87-092B	TOOLS	DEFOR	NEWPU	VCAT	Hex Key Set	PARKROSE	1	$7.98	$0.00	$7.98
X	V87-092C	TOOLS	DEFOR	NEWPU	VCAT	Hacksaw blade. 32 t	PARKROSE	1	$0.78	$0.00	$0.78
X	V87-092C	TOOLS	DEFOR	NEWPU	VCAT	Hacksaw blade, 24t	PARKROSE	1	$0.78	$0.00	$0.78
X	V87-092D	TOOLS	DEFOR	NEWPU	VCAT	Hacksaw	PARKROSE	1	$5.59	$0.00	$5.59
X	V87-102	TOOLS	ELECT	NEWPU	VCAT	Wattmeter element	BIRD ELEC. CORP	1	$50.00	$0.00	$50.00
X	V87-101A	TOOLS	ELECT	NEWPU	VCAT	Freq Counter	FORDHAM RADIO	1	$558.00	$0.00	$558.00
X	V87-101B	TOOLS	ELECT	NEWPU	VCAT	Lab Power Supply	FORDHAM RADIO	0	$0.00	$0.00	$0.00
X	V87-101C	TOOLS	ELECT	NEWPU	VCAT	Capacitance meter	FORDHAM RADIO	1	$110.00	$0.00	$110.00
X	V87-100A	TOOLS	ELECT	NEWPU	VCAT	Sine/Square Wave Gen	LEADER INSTR.	1	$160.93	$0.00	$160.93
X	V87-100B	TOOLS	ELECT	NEWPU	VCAT	RF Signal Gen.	LEADER INSTR.	1	$149.15	$0.00	$149.15
X	V87-116	TOOLS	ELECT	NEWPU	VCAT	DC Power Supply	RADIO SHACK	1	$59.95	$0.00	$59.95
X	V87-119	TOOLS	ELECT	NEWPU	VCAT	Eprom eraser	BAY TECH ASSOC.	1	$359.00	$0.00	$359.00

APPENDIX XV. CONTINUED

********** DETAILS **********

VCAT ORDER NO.	MAIN VCAT SORT	AUX VCAT SORT	SUB VCAT SORT	ACTIV-ITY ITY	DESCRIPTION OF ITEM	MANUFACTURER VENDER	NUMBER PUR.	UNIT COST	UNIT SHIPPING COST	TOTAL COST
X V87-107A	TOOLS	ELECT	NEWPU	VCAT	'Linear' Data book	NORVAC	1	$16.95	$0.00	$16.95
X V87-107B	TOOLS	ELECT	NEWPU	VCAT	Nibbler tool	NORVAC	1	$9.97	$0.00	$9.97
X V87-107F	TOOLS	ELECT	NEWPU	VCAT	Terminal strip	NORVAC	6	$4.15	$0.00	$24.90
X V87-107H	TOOLS	ELECT	NEWPU	VCAT	Terminal strip	NORVAC	1	$4.15	$0.00	$4.15
X V87-116A	TOOLS	ELECT	SUPPL	VCAT	Connector, solderless	RADIO SHACK	2	$3.99	$0.00	$7.98
X V87-107B	TOOLS	ELECT	NEWPU	VCAT	Hexadecimal, time	RADIO SHACK	1	$21.95	$0.00	$21.95
X V87-107C	TOOLS	ELECT	SUPPL	VCAT	Connector, solderless	RADIO SHACK	2	$3.99	$0.00	$7.98
			TOTAL		$1,910.84	($1,447.00)				
OPERAMENT-ELECTRONIC TOOLS					$2,000.00					
X V87-036	OPERA	ADMIN	OVTIM	VCAT	Overtime Costa Rica	USGS, DOUKAS	1	$151.56	$0.00	$151.56
X V87-037	OPERA	ADMIN	OVTIM	VCAT	Overtime Guatemala	USGS, DOUKAS	1	$405.94	$0.00	$405.94
X V87-114	OPERA	ADMIN	OVTIM	VCAT	Overtime Ecuador	USGS, DOUKAS	1	$948.12	$0.00	$948.12
X V87-048	OPERA	ADMIN	FILM	VCAT	film, Gass & Schwinke	CITIZEN PHOTO	1	$31.92	$0.00	$31.92
X V87-084	OPERA	ADMIN	LANGU	VCAT	Audio Tapes	GSA	50	$0.70	$0.00	$35.00
X V87XXX	OPERA	ADMIN	FILM	VCAT	film,	PRO LAB	1	$1.75	$0.00	$1.75
X V87XXX	OPERA	ADMIN	FILM	VCAT	film,	TYMERS	1	$5.23	$0.00	$5.23
X V87-111	OPERA	ADMIN	IDENT	VCAT	Identification labels	OMEGA PRINT	1	$52.20	$0.00	$52.20
			TOTAL		$1,631.72	$368.28 overti		1505.62	-5.62	
OPERATIONAL-ADMINISTRATION-OFFICE					$350.00					
X V87-019	OPERA	OFFIC	SUPPL	VCAT	Rubber Stamp	QUIKSTAMP	1	$14.35	$2.00	$16.35
X V87-038B	OPERA	OFFIC	SUPPL	VCAT	mech. pencil	GSA	1	$13.90	$0.00	$13.90
X V87-038C	OPERA	OFFIC	SUPPL	VCAT	date, stamp	GSA	1	$0.88	$0.00	$0.88
X V87-049	OPERA	OFFIC	SUPPL	VCAT	Rubber Stamp	QUIKSTAMP	2	$14.35	$2.00	$30.70
X V87-126	OPERA	OFFIC	SUPPL	VCAT	Drafting supply	SHANNON	1	$25.30	$0.00	$25.30
			TOTAL		$87.13	$262.87				
OPERATIONAL-COMPUTER/DATA PROCESS					$750.00					
X V87-038A	OPERA	COMPU	SUPPL	VCAT	Disk box	GSA	3	$2.21	$0.00	$6.63
X V87-022A	OPERA	COMPU	SUPPL	VCAT	Inkjet cartridge	PORTLAND STATE BOO	4	$9.95	$1.24	$41.04
X V87-025B	OPERA	COMPU	SUPPL	VCAT	diskette boxes, 3 1/2''	SMITH BROS	2	$3.96	$0.00	$7.92
X V87-025A	OPERA	COMPU	SUPPL	VCAT	disk bx, 3 1/2',cap 50	SMITH BROS	1	$15.96	$0.00	$15.96
X V87-022B	OPERA	COMPU	SUPPL	VCAT	Dysan 3 1/2 disk	WESTCOM	3	$25.00	$0.00	$75.00
X V87-046	OPERA	COMPU	PARTS	VCAT	Printer Cable	NORVAC	1	$16.67	$0.00	$16.67
X V87-050	OPERA	COMPU	REPAIR	VCAT	CRT board, monitor	PRINCETON GRAPHICS	1	$44.00	$0.00	$44.00
X V87-083	OPERA	COMPU	SUPPL	VCAT	Memorex 3 1/2 disk	GSA, MENLO	6	$23.70	$0.00	$142.20
X V87-086	OPERA	COMPU	REPAIR	VCAT	Compaq, power suppl	WESTCOM	1	$45.00	$0.00	$45.00

APPENDIX XV. CONTINUED

********** DETAILS **********

	VCAT ORDER NO.	MAIN VCAT SORT	AUX VCAT SORT	SUB VCAT SORT	ACTIV-ITY ITY	DESCRIPTION OF ITEM	MANUFACTURER VENDER	NUMBER PUR.	UNIT COST	UNIT SHIPPING COST	TOTAL COST
X	V87-104	OPERA	COMPU	REPAIR	VCAT	Epson, Printer	XEROX COMP. REPAIR	1	$221.18	$0.00	$221.18
	V87-097A	OPERA	ADMIN	COMPU	VCAT	Bernoulli Disk	WESTCOM	1	$245.00	$0.00	$245.00
	V87-097B	OPERA	ADMIN	COMPU	VCAT	Mini-crtrdg-Irwin tape	WESTCOM	1	$171.00	$0.00	$171.00
X	V87-021B	DBASE	REFS	NEWPU	VCAT	64K Computer	NORVAC	1	$14.95	$0.00	$14.95
				TOTAL			$1,046.55	($296.55)			
OPERATIONAL-DEFORMATION							$500.00				
X	V87-067	OPERA	DEFOR	SUPPL	VCAT	AAA Batteries	F & H MARKETING	30	$0.66	$0.00	$19.80
X	V87-070	OPERA	DEFOR	REPAIR	VCAT	T-16 repair	NESSCO	1	$70.00	$0.00	$70.00
X	V87-077	OPERA	DEFOR	REPL	VCAT	Ultim temp sensor	PEET BROS	1	$8.00	$1.74	$9.74
X	V87-080	OPERA	DEFOR	REPAIR	VCAT	Ship Tubes	STAR LUMBER	1	$22.69	$0.00	$22.69
X	V87-088A	OPERA	DEFOR	SUPPL	VCAT	Prsm, mnt, 8" FLAT bar	HANKS WELDING	31	$0.40	$0.00	$12.34
X	V87-088B	OPERA	DEFOR	SUPPL	VCAT	Prsm, mnt, 36" ROUND bar	HANKS WELDING	1	$0.47	$0.00	$0.47
X	V87-007	DEFOR	DEFOR	SUPPL	VCAT	pipe	PARKROSE	10	$1.15	$0.00	$11.45
X	V87-030	DEFOR	DEFOR	SUPPL	VCAT	Liquid steel	PARKROSE	3	$2.19	$0.00	$6.57
X	V87-112A	OPERA	DEFOR	SUPPL	VCAT	C Batteries	PARKROSE	6	$2.89	$0.00	$17.34
X	V87-112B	OPERA	DEFOR	SUPPL	VCAT	AA Batteries	PARKROSE	4	$3.49	$0.00	$13.96
X	V87-112B	OPERA	DEFOR	SUPPL	VCAT	AA Batteries	PARKROSE	2	$2.99	$0.00	$5.98
X	V87-112B	OPERA	DEFOR	SUPPL	VCAT	Gloves	PARKROSE	3	$10.98	$0.00	$32.94
X	V87-124	OPERA	DEFOR	REPAIR	VCAT	Citation repair	NESSCO	1	$330.00	$0.00	$330.00
				TOTAL			$553.28	($53.28)			
OPERATIONAL-GEOCHEMISTRY							$500.00				
X	V87-073A	OPERA	GEOCH	SUPPL	VCAT	Pipet, Eppendorf, 500 u	VWR	1	$102.00	$2.30	$104.30
X	V87-073B	OPERA	GEOCH	SUPPL	VCAT	Pipet, Eppendorf, 1000 u	VWR	1	$102.00	$0.00	$102.00
X	V87-073C	OPERA	GEOCH	SUPPL	VCAT	Vol. Flask, 1 liter	VWR	2	$18.80	$0.00	$37.60
X	V87-073D	OPERA	GEOCH	SUPPL	VCAT	Sodium Hydroxide, 500 g	VWR	2	$10.62	$0.00	$21.24
X	V87-074A	OPERA	GEOCH	SUPPL	VCAT	Bottle, 1000 ml, 6pac	MARKSON	1	$10.95	$4.43	$15.38
X	V87-074B	OPERA	GEOCH	SUPPL	VCAT	Bottle, 250 ml, 10 pac	MARKSON	3	$8.55	$0.00	$25.65
X	V87-074C	OPERA	GEOCH	SUPPL	VCAT	Bottle, drop, 2 oz, 12 p	MARKSON	1	$11.55	$0.00	$11.55
X	V87-074D	OPERA	GEOCH	SUPPL	VCAT	Bottle, drop, 4 oz, 12 p	MARKSON	1	$12.20	$0.00	$12.20
X	V87-074E	OPERA	GEOCH	SUPPL	VCAT	Pocket pH, ind	MARKSON	1	$14.95	$0.00	$14.95
X	V87-074F	OPERA	GEOCH	SUPPL	VCAT	Grad. Cyl. 100 ml.	MARKSON	2	$3.25	$0.00	$6.50
X	V87-074G	OPERA	GEOCH	SUPPL	VCAT	Beaker, 250 ml, 8 pac	MARKSON	2	$9.45	$0.00	$18.90
X	V87-074H	OPERA	GEOCH	SUPPL	VCAT	Stir rod	MARKSON	2	$6.95	$0.00	$13.90
X	V87-085A	OPERA	GEOCH	SUPPL	VCAT	Pipett tips, 1000 ea	MARKSON	1	$22.00	$3.05	$25.05
X	V87-085B	OPERA	GEOCH	SUPPL	VCAT	Vol Flsk, 100 ml, 3 pac	MARKSON	1	$17.50	$0.00	$17.50
X	V87-087A	OPERA	GEOCH	SUPPL	VCAT	Sodium Floride, 125 g	VWR	1	$22.05	$0.00	$22.05
X	V87-087B	OPERA	GEOCH	SUPPL	VCAT	Potassium Nitrate, 125 g	VWR	1	$18.65	$0.00	$18.65
X	V87-091A	OPERA	GEOCH	SUPPL	VCAT	Articulate Arm	MARKSON	1	$44.00	$0.00	$44.00
X	V87-091B	OPERA	GEOCH	SUPPL	VCAT	Spatulas	MARKSON	2	$6.95	$0.00	$13.90

APPENDIX XV. CONTINUED

********** DETAILS **********

VCAT ORDER NO.	MAIN VCAT SORT	AUX VCAT SORT	SUB VCAT SORT	ACTIV-ITY ITY	DESCRIPTION OF ITEM	MANUFACTURER VENDER	NUMBER PUR.	UNIT COST	UNIT SHIPPING COST	TOTAL COST
X V87-093	OPERA	GEOCH	SUPPL	VCAT	cases	GSA	2	$10.21	$0.00	$20.42
			TOTAL		$545.74	($45.74)				
OPERATIONAL-GEOLOGY/OBSERVATIONAL					$750.00					
X V87-041	OPERA	ADMIN	FILM	SEIS	film develop, LYN	TYMERS	1	$24.60	$0.00	$24.60
X V87-072	OPERA	ADMIN	FILM	VCAT	Film Print. Pacaya	CITIZEN'S	15	$1.80	$0.00	$27.00
X V87-028B	DBASE	REFS	NEWPU	VCAT	Expl. Volcan., SHERIDAN	PROF. BOOKSTORE	1	$97.60	$0.00	$97.60
X V87-023B	DBASE	REFS	NEWPU	VCAT	Tazieff & Sabroux	PROF. BOOKSTORE	1	$67.70	$0.00	$67.70
X V87-028A	DBASE	REFS	NEWPU	VCAT	Arc Volcanism, ARAMAKI	PROF. BOOKSTORE	1	$101.40	$0.00	$101.40
X V87-023A	DBASE	REFS	NEWPU	VCAT	Biong	PROF. BOOKSTORE	1	$68.85	$0.00	$68.85
X V87-082	OPERA	OBSER	SUPPL	VCAT	Video Cam. Batteries	ELECTROMATIC INC	4	$65.00	$5.00	$265.00
X V87-109	OPERA	OBSER	SUPPL	VCAT	Video Cam. 20 min tape	A&G Associates	10	$5.47	$0.00	$54.70
X V87-125	OPERA	OBSER	REPAIR	VCAT	Minolta camera clean	TYMERS	1	$116.00	$0.00	$116.00
			TOTAL		$822.85	($72.85)				
OPERATIONAL-LABORATORY					$0.00					
X V87-038D	OPERA	LAB	SUPPL	VCAT	Duct tape	GSA	12	$2.95	$0.00	$35.40
			TOTAL		$35.40	($35.40)				
OPERATIONAL-LOGISTICS					$0.00					
X V87-027	OPERA	LOGIS	SUPPL	VCAT	cardboard boxes	FED. HIGHWAYS	1	$16.12	$0.00	$16.12
X V87-038E	OPERA	LOGIS	SUPPL	VCAT	Shipping box	GSA	2	$6.00	$0.00	$12.00
			TOTAL		$28.12	($28.12)				
OPERATIONAL-LOGISTICS-SHIPPING					$0.00					
X V87-005	SHIP	LIAIS	SHIP	HISYM	Hawaii Symposium	DHL	1	$0.00	$4.94	$4.94
X V87-006	OPERA	ADMIN	SHIP	MENLO	papers	DHL	1	$0.00	$4.94	$4.94
X V87-071A	OPERA	ADMIN	SHIP	?	papers	DHL	1	$0.00	$4.94	$4.94
X V87-071B	OPERA	ADMIN	SHIP	?	papers	DHL	1	$0.00	$4.94	$4.94
X V87-081	OPERA	ADMIN	SHIP	?	papers	DHL	1	$0.00	$4.94	$4.94
X V87-105	OPERA	ADMIN	TRUCK	VCAT	FURNITURE	SALEM, BLM	1	$37.43	$0.00	$37.43
X V87-117	OPERA	ADMIN	SHIP	?	papers	DHL	1	$0.00	$4.94	$4.94
X V87-113	OPERA	ADMIN	SHIP	ECUAD	papers	DHL	1	$0.00	$4.94	$4.94
			TOTAL		$72.01	($72.01)				

APPENDIX XV. CONTINUED

********** DETAILS **********

VCAT ORDER NO.	MAIN VCAT SORT	AUX VCAT SORT	SUB VCAT SORT	ACTIV-ITY ITY	DESCRIPTION OF ITEM	MANUFACTURER VENDER	NUMBER PUR.	UNIT COST	UNIT SHIPPING COST	TOTAL COST
OPERATIONAL-SEISMIC					$0.00					
V87-110A	SEISM	PS-2	SUPPL	VOAP	Styrofoam, Spare	KINEMETRICS	2	$36.00	$0.00	$72.00
V87-110E	SEISM	PS-2	SUPPL	VOAP	Capillary ink pen	KINEMETRICS	2	$25.00	$0.00	$50.00
V87-110C	SEISM	PS-2	SUPPL	VOAP	Recording ink	KINEMETRICS	2	$3.00	$0.00	$6.00
V87-110D	SEISM	PS-2	SUPPL	VOAP	Recording paper	KINEMETRICS	1	$100.00	$0.00	$100.00
			TOTAL		$226.00	($226.00)				
OPERATIONAL-TOOLS					$750.00					
X V87-107C	OPERA	DEFOR	NEWPU	VCAT	Mini Driver	NORVAC	1	$6.95	$0.00	$6.95
X V87-107D	OPERA	DEFOR	NEWPU	VCAT	Portaso. Iron	NORVAC	1	$24.95	$0.00	$24.95
X V87-107E	OPERA	DEFOR	NEWPU	VCAT	Spare tip	NORVAC	1	$16.85	$0.00	$16.85
			TOTAL		$48.75	$701.25				
TRAVEL					$2,280.00					
X V87-300	TRAVE	ADMIN	SCIE	VCAT	banks, hi., sym	VOUCHER	1	$118.00	$0.00	$118.00
			TOTAL		$118.00	$2,162.00				
								TOTAL	$50.72	$33,911.56

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APPENDIX XVI -- Unofficial ledger of USGS Operational Expenses in FY 87

File
87PASSRT.WK1 87 LEDGER

Last Update	27-Jan-88
STARTING BALANCE	CURRENT BALANCE
$198,000.00	$32,541.84

********** SUMMARY ***** **********

FUNDING CATEGORY	STARTING FUNDS	FUNDS SPENT	FUNDS REMAINING	
TOTAL ASSESSMENT 40%	$79,200	($66,183.27)	$13,016.73	
TOTAL PERSONAL SERVICES	$74,900	($74,994.76)	($94.76)	
TOTAL CONTRACTS	$20,000	$0.00	$20,000.00	
TOTAL TRAVEL	$44,400	($31,195.32)	$13,204.68	
TOTAL TRANSPORT			$0.00	
TOTAL OTHER			$0.00	
TOTAL EQUIPMENT	$50,000	($50,533.50)	($533.50)	
TOTAL EXPENDABLE	$8,700	($8,734.58)	($34.58)	
SUBTOTALS no assessment	$198,000	($165,458.16)	---	
GRAND TOTALS	$277,200	($231,641.43)	$45,558.57	TOTAL CARRY OVER

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APPENDIX XVI. CONTINUED

********** DETAILS ***** **********

VCAT ORDER NO.	MAIN VCAT SORT	AUX VCAT SORT	SUB VCAT SORT	ACTIV-ITY	DESCRIPTION OF ITEM	MANUFACTURER VENDER	NUMBER PUR.	UNIT COST	UNIT SHIPPING COST	TOTAL COST
ASSESSMENT					$79,000.00					$79,000.00
			TOTAL		$79,000.00	$0.00				
PERSONAL SERVICES					$74,900.00					
	PERSN				BENEFITS	USGS	1	$0.00	0	$6,900.00
	PERSN	OVERTIME		X	LOCKHART, GUAT	USGS	1	$691.76	0	$691.76
	PERSN	OVERTIME		Y	EWERT, GUAT	USGS	1	$677.95	0	$677.95
P87-004	PERSN	WAGES	REGUL	VDAP	USGS,Seis.techs 24.16PP	USGS, SALARY	1	$24,300.00	$0.00	$24,300.00
P87-003	PERSN	WAGES	REGUL	VDAP	USGS, JOHN 26 PP	USGS, SALARY	1	$18,200.00	$0.00	$18,200.00
P87-002	PERSN	WAGES	REGUL	VDAP	USGS, ANDY 26 PP	USGS, SALARY	1	$22,500.00	$0.00	$22,500.00
	PERSN	OVERTIME		Z	EWERT, ECUADOR	USGS	1	$277.00	0	$277.00
	PERSN	OVERTIME		Z	LOCKHART,ANDY	USGS	1	$268.05	0	$268.05
	PERSN	OVERTIME		Y	EWERT, J	USGS	1	$640.00	0	$640.00
	PERSN	OVERTIME		Y	LOCKHART,ANDY	USGS	1	$540.00	0	$540.00
			TOTAL		$74,994.76	($94.76)				
CONTRACT (OTHER)					$20,000.00					
			TOTAL		$0.00					
TRAVEL					$44,394.00					
X P87-015C	TRAVE	ADMIN	VEHIL	VDAP	Banks, D.C.	TA 5599, 11/87	1	$22.90	$0.00	$22.90
X P87-015B	TRAVE	ADMIN	PDIEM	VDAP	Banks, D.C.	TA 5599, 11/87	1	$148.55	$0.00	$148.55
X P87-015A	TRAVE	ADMIN	FARE	VDAP	Banks, D.C.	TA 5599, 11/87	1	$458.00	$0.00	$458.00
X P87-025	TRAVE	EMERG	FARE	VDAP	Banks, Guat,	TA 0059, 2-3/87	1	$884.00	$0.00	$884.00
X P87-025	TRAVE	EMERG	PHONE	VDAP	Banks, Guat,	TA 0059, 2-3/87	1	$236.00	$0.00	$236.00
X P87-025	TRAVE	EMERG	MISCL	VDAP	Banks, Guat,	TA 0059, 2-3/87	1	$179.39	$0.00	$179.39
X P87-025	TRAVE	EMERG	EXCES	VDAP	Banks, Guat,	TA 0059, 2-3/87	1	$1,189.00	$0.00	$1,189.00
X P87-025	TRAVE	EMERG	PDIEM	VDAP	Banks, Guat,	TA 0059, 2-3/87	1	$2,220.50	$0.00	$2,220.50
X P87-027B	TRAVE	EMERG	MONEY	VDAP	Lockhart, Guat	TA 0060, 2-3/87	1	$16.00	$0.00	$16.00
X P87-027D	TRAVE	EMERG	MISC	VDAP	Lockhart, Guat	TA 0060, 2-3/87	1	$13.02	$0.00	$13.02
X P87-027C	TRAVE	EMERG	EXCES	VDAP	Lockhart, Guat	TA 0060, 2-3/87	1	$176.78	$0.00	$176.78
X P87-027A	TRAVE	EMERG	HOSPIT	VDAP	Lockhart, Guat	TA 0060, 2-3/87	1	$250.26	$0.00	$250.26
X P87-027E	TRAVE	EMERG	FARE	VDAP	Lockhart, Guat	TA 0060, 2-3/87	1	$847.00	$0.00	$847.00
X P87-005C	TRAVE	LIAIS	VEHIC	VDAP	Banks, Co/Ec/CoRi	TA 0213, 8-9/86	1	$99.72	$0.00	$99.72
X P87-005B	TRAVE	LIAIS	PDIEM	VDAP	Banks, Co/Ec/CoRi	TA 0213, 8-9/86	1	$2,509.25	$0.00	$2,509.25
X P87-005A	TRAVE	LIAIS	FAIR	VDAP	Banks, Co/Ec/CoRi	TA 0213, 8-9/86	1	$1,344.00	$0.00	$1,344.00
X P87-005D	TRAVE	LIAIS	EXCES	VDAP	Banks, Co/Ec/CoRi	TA 0213, 8-9/86	1	$533.85	$0.00	$533.85
X P87-024	TRAVE	LIAIS	PHONE	VDAP	Banks, hawaii	TA 0049, 1-2/87	1	$99.84	$0.00	$99.84
X P87-024	TRAVE	LIAIS	POIEM	VDAP	Banks, hawaii	TA 0049, 1-2/87	1	$729.60	$0.00	$729.60
X P87-024	TRAVE	LIAIS	VEHIC	VDAP	Banks, hawaii	TA 0049, 1-2/87	1	$333.96	$0.00	$333.96
X P87-024	TRAVE	LIAIS	FARE	VDAP	Banks, hawaii	TA 0049, 1-2/87	1	$408.00	$0.00	$408.00
X P87-006D	TRAVE	LIAIS	EXCES	VDAP	Doukas, CoRi	TA 0217, 9/87	1	$725.00	$0.00	$725.00

APPENDIX XVI. CONTINUED

********** DETAILS ***** **********

	VCAT ORDER NO.	MAIN VCAT SORT	AUX VCAT SORT	SUB VCAT SORT	ACTIV-ITY	DESCRIPTION OF ITEM	MANUFACTURER VENDER	NUMBER PUR.	UNIT COST	UNIT SHIPPING COST	TOTAL COST
X	P87-006B	TRAVE	LIAIS	PDIEM	VDAP	Doukas, CoRi	TA 0217, 9/87	1	$677.50	$0.00	$677.50
X	P87-006C	TRAVE	LIAIS	VEHIC	VDAP	Doukas, CoRi	TA 0217, 9/87	1	$34.25	$0.00	$34.25
X	P87-006A	TRAVE	LIAIS	FARE	VDAP	Doukas, CoRi	TA 0217, 9/87	1	$1,050.00	$0.00	$1,050.00
X	P87-007B	TRAVE	LIAIS	PDIEM	VDAP	Harlow, Co/Ec/CoRi	TA 0211, 8-9/86	1	$1,037.00	$0.00	$1,037.00
X	P87-007A	TRAVE	LIAIS	FARE	VDAP	Harlow, Co/Ec/CoRi	TA 0211, 8-9/86	1	$1,344.00	$0.00	$1,344.00
X	P87-014B	TRAVE	LIAIS	PDIEM	VDAP	Harlow, Manizales	TA 0035, 12/87	1	$322.75	$0.00	$322.75
X	P87-014A	TRAVE	LIAIS	FARE	VDAP	Harlow, Manizales	TA 0035, 12/87	1	$1,014.00	$0.00	$1,014.00
X	P87-014C	TRAVE	LIAIS	MISCL	VDAP	Harlow, Manizales	TA 0035, 12/87	1	$80.71	$0.00	$80.71
X	P87-056D	TRAVE	LIASI	PHONE	VDAP	Doukas, Ecuador	TA-0187, 6/15/87	1	$50.66	$0.00	$50.66
X	P87-056A	TRAVE	LIASI	PDIEM	VDAP	Doukas, Ecuador	TA-0187, 6/15/87	1	$2,373.50	$0.00	$2,373.50
X	P87-056H	TRAVE	LIASI	SHOT	VDAP	Doukas, Ecuador	TA-0187, 6/15/87	1	$8.00	$0.00	$8.00
X	P87-056G	TRAVE	LIASI	EXIT	VDAP	Doukas, Ecuador	TA-0187, 6/15/87	1	$20.00	$0.00	$20.00
X	P87-056E	TRAVE	LIASI	CUSTOM	VDAP	Doukas, Ecuador	TA-0187, 6/15/87	1	$75.97	$0.00	$75.97
X	P87-056B	TRAVE	LIASI	VEHIC	VDAP	Doukas, Ecuador	TA-0187, 6/15/87	1	$12.40	$0.00	$12.40
X	P87-056F	TRAVE	LIASI	BAGGAG	VDAP	Doukas, Ecuador	TA-0187, 6/15/87	1	$22.06	$0.00	$22.06
X	P87-056C	TRAVE	LIASI	CHECK	VDAP	Doukas, Ecuador. tc	TA-0187, 6/15/87	1	$13.00	$0.00	$13.00
X	P87-068	TRAVE	LIASI	FARE	VDAP	Doukas, Ewert. Ecuador	TA-0187, 6/15/87	2	$1,331.00	$0.00	$2,662.00
X	P87-054	TRAVE	LIASI	EXCESS	VDAP	Ecuador trip, DOWN	VO-H-1256	1	$1,215.50	$0.00	$1,215.50
X	P87-067	TRAVE	LIASI	EXCESS	VDAP	Ecuador trip, UP	TA-0187, 6/15/87	1	$800.00	$0.00	$800.00
X	P87-055E	TRAVE	LIASI	BAGGAG	VDAP	Ewert, Ecuador	TA-0186, 6/15/87	1	$45.00	$0.00	$45.00
X	P87-055A	TRAVE	LIASI	PDIEM	VDAP	Ewert, Ecuador	TA-0186, 6/15/87	1	$2,373.50	$0.00	$2,373.50
X	P87-055C	TRAVE	LIASI	CUSTOM	VDAP	Ewert, Ecuador	TA-0186, 6/15/87	1	$56.68	$0.00	$56.68
X	P87-055D	TRAVE	LIASI	PHONE	VDAP	Ewert, Ecuador	TA-0186, 6/15/87	1	$20.22	$0.00	$20.22
X	P87-055B	TRAVE	LIASI	CHECK	VDAP	Ewert, Ecuador	TA-0186, 6/15/87	1	$15.00	$0.00	$15.00
X	P87-053	TRAVE	LIASI	PDIEM	VDAP	Harlow, Guatemala	TA 0106, 3/30/87	1	$300.50	$0.00	$300.50
X	P87-027F	TRAVE	LIASI	PDIEM	VDAP	Lockhart, Guat	TA 0060, 2-3/87	1	$1,846.00	$0.00	$1,846.00
X	P87-052	TRAVE	LIASI	PDIEM	VDAP	White, Guatemale	TA 0105, 3/30/87	1	$300.50	$0.00	$300.50
						TOTAL BALANCE	$31,195.32	$13,198.68			
	TRANSPORT						$0.00				
						TOTAL	$0.00				
	OTHER						$0.00				
						TOTAL	$0.00				
	EQUIPMENT						$50,044.00				
	P87-061	SEISM	SYST	NEWPU	VDAP	Seismometers, L-4c	HARLOW	8	$670.00	$0.00	$5,360.00
	P87-059	SEISM	SYST	NEWPU	VDAP	UHF radio pairs	HARLOW	8	$1,050.00	$0.00	$8,400.00
	P87-058	SEISM	SYST	NEWPU	VDAP	Solar Panels	HARLOW	10	$87.50	$0.00	$875.00
	P87-057	SEISM	SYST	NEWPU	VDAP	UHF antennas	HARLOW	16	$170.00	$0.00	$2,720.00
	P87-060A	SEISM	SYST	NEWPU	VDAP	GOES Satellite Clock	HARLOW	1	$3,750.00	$0.00	$3,750.00

APPENDIX XVI. CONTINUED

********** DETAILS ***** **********

VCAT ORDER NO.	MAIN VCAT SORT	AUX VCAT SORT	SUB VCAT SORT	ACTIV-ITY	DESCRIPTION OF ITEM	MANUFACTURER VENDER	NUMBER PUR.	UNIT COST	UNIT SHIPPING COST	TOTAL COST
-060B	SEISM	SYST	NEWPU	VDAP	GOES Satellite Antenna	HARLOW	0	$0.00	$0.00	$0.00
-060C	SEISM	SYST	NEWPU	VDAP	Trigger, time output	HARLOW	1	$525.00	$0.00	$525.00
P87-062	SEISM	SYST	NEWPU	VDAP	VCO	VANSHAACK	8	$270.00	$0.00	$2,160.00
P87-063	SEISM	SYST	NEWPU	VDAP	Discriminators	VANSHAACK	8	$150.00	$0.00	$1,200.00
P87-064	SEISM	SYST	NEWPU	VDAP	Rack, Pwr Suppl, Misc.	VANSHAACK	1	$300.00	$0.00	$300.00
P87-065	SEISM	SYST	NEWPU	VDAP	Cables, Connectors	VANSHAACK	1	$1,000.00	$0.00	$1,000.00
P87-048A	SEISM	SYST	NEWPU	VDAP	PS-2	KINEMETRICS	2	$4,500.00	$0.00	$9,000.00
P87-066	SEISM	SYST	NEWPU	VDAP	A/D Board and software	HARLOW	1	$0.00	$0.00	$0.00
P87-066	SEISM	SYST	NEWPU	VDAP	Phone wire LAN	HARLOW	1	$0.00	$0.00	$0.00
P87-066	SEISM	SYST	NEWPU	VDAP	250Mb WORM Disk DRv	HARLOW	1	$0.00	$0.00	$0.00
P87-066	SEISM	SYST	NEWPU	VDAP	IBM/PS-2 w/math coproces	HARLOW	1	$0.00	$0.00	$0.00
P87-066	SEISM	SYST	NEWPU	VDAP	IBM Proprinter	HARLOW	1	$13,129.50	$0.00	$13,129.50
P87-050	TEST	SYST	NEWPU	VDAP	mastek,PC Power supply	WESTCOM	2	$75.00	$0.00	$150.00
P87-074	SEISM	SYST	NEWPU	VDAP	Zenith, laptop	ZENITH	1	$1,964.00	$0.00	$1,964.00
			TOTAL		$50,533.50	($489.50)				
EXPENDABLE ASSISTANCE SUPPLIES					$8,723.00					
X P87-013	DBASE	COMPU	UPGRA	VDAP	256 K MOS dyn. ram IC	WESTERN MICRTECH	32	$3.65	$3.00	$126.20
X P87-012	EXPEN	COMPU	SUPPL	VDAP	Printer ribbon	BETA BUSINESS	6	$4.45	$0.86	$27.56
X P87-008	EXPEN	COMPU	SUPPL	VDAP	Bornoulli disks, 20 meg	WESLUND	3	$79.00	$3.70	$240.70
X P87-010	EXPEN	COMPU	SUPPL	VDAP	Diskette box	GLOBAL	5	$1.79	$3.73	$12.68
X P87-051	EXPEN	COMPU	REPAIR	VDAP	TTXpress printer	PURPLE COMPUTER	1	$50.00	$0.00	$50.00
X P87-049	EXPEN	COMPU	UPGRA	VDAP	Hard disk instal	WESTCOM	1	$137.50	$0.00	$137.50
X P87-069	EXPEN	COMPU	REPAIR	VDAP	Princeton Monitor	PRINCETON GRAPHICS	1	$30.60	$10.79	$41.39
					SUBTOTAL	$636.03				
X P87-023A	EXPEN	DEFOR	TELEM	VDAP	N mate to UHF adapter	PORTLAND RADIO	4	$6.79	$0.00	$27.16
X P87-023C	EXPEN	DEFOR	TELEM	VDAP	Solder N female connecto	PORTLAND RADIO	10	$5.35	$0.00	$53.50
X P87-023D	EXPEN	DEFOR	TELEM	VDAP	Solder N male connector	PORTLAND RADIO	10	$4.80	$0.00	$48.00
X P87-020D	EXPEN	DEFOR	TELEM	VDAP	Clips	NORVAC	6	$3.15	$0.00	$18.90
X P87-020E	EXPEN	DEFOR	TELEM	VDAP	Book, DOS	NORVAC	1	$24.95	$0.00	$24.95
X P87-023B	EXPEN	DEFOR	TELEM	VDAP	N mate to N male adapter	PORTLAND RADIO	5	$12.45	$0.00	$62.25
X P87-022C	EXPEN	DEFOR	TELEM	VDAP	Base station adapter kit	LARSEN, ELECT	6	$18.83	$0.00	$112.98
X P87-020A	EXPEN	DEFOR	TELEM	VDAP	Trial	NORVAC	1	$2.28	$0.00	$2.28
X P87-020C	EXPEN	DEFOR	TELEM	VDAP	tubing	NORVAC	1	$2.12	$0.00	$2.12
X P87-020B	EXPEN	DEFOR	TELEM	VDAP	Probe	NORVAC	1	$16.95	$0.00	$16.95
X P87-022B	EXPEN	DEFOR	TELEM	VDAP	Antenna, NLA-406	LARSEN, ELECT	6	$19.59	$0.00	$117.54
					SUBTOTAL	$486.63				
X P87-034B	EXPEN	EDM	SUPPL	VDAP	Bosch Battery	PORTLAND CONTRACTO	1	$79.47	$0.00	$79.47
X P87-033	EXPEN	EDM	SUPPL	VDAP	Prism in container	LEWIS AND LEWIS	28	$83.00	$0.00	$2,324.00

APPENDIX XVI. CONTINUED

********** DETAILS ***** **********

VCAT ORDER NO.	MAIN VCAT SORT	AUX VCAT SORT	SUB VCAT SORT	ACTIV-ITY	DESCRIPTION OF ITEM	MANUFACTURER VENDER	NUMBER PUR.	UNIT COST	UNIT SHIPPING COST	TOTAL COST
X P87-029B	EXPEN	EDM	SUPPL	VDAP	Mirrors	USGS WAREHOUSE	2	$5.15	$0.00	$10.30
X P87-034A	EXPEN	EDM	SUPPL	VDAP	Rock Anchor	PORTLAND CONTRACTO	100	$2.83	$3.63	$286.63
X P87-029A	EXPEN	EDM	SUPPL	VDAP	Benchmarks	USGS WAREHOUSE	50	$1.48	$0.00	$74.00
X P87-019A	EXPEN	EDM	SUPPL	VDAP	AAA Batteries, NICAD	F. H. MARKETING	30	$1.89	$0.00	$56.70
X P87-038	EXPEN	EDM	SUPPL	VDAP	Battery, 12 voc, 5 an	RADAP ELECTRIC	4	$29.80	$3.64	$122.84
X P87-041	EXPEN	EDM	SUPPL	VDAP	hardware	VAN BOLT	1	$15.89	$0.00	$15.89
X P87-056I	EXPEN	EDM	SUPPL	VDAP	Doukas, Ecuador, gasol	TA 0105, 3/30/87	1	$5.08	$0.00	$5.08
X P87-056J	EXPEN	EDM	SUPPL	VDAP	Doukas, Ecuador, tools	TA 0105, 3/30/87	1	$8.63	$0.00	$8.63
X P87-056K	EXPEN	EDM	SUPPL	VDAP	Doukas, Ecuador, AT batt	TA 0105, 3/30/87	1	$26.50	$0.00	$26.50
					SUBTOTAL	$3,010.04				
X P87-037H	EXPEN	ETILT	SUPPL	VDAP	lit 217002	NORVAC	10	$0.66	$0.00	$6.63
X P87-037A	EXPEN	ETILT	SUPPL	VDAP	Chassis box	NORVAC	1	$15.08	$0.00	$15.08
X P87-037G	EXPEN	ETILT	SUPPL	VDAP	elm 100 ufd	NORVAC	6	$0.50	$0.00	$3.00
X P87-032B	EXPEN	ETILT	SUPPL	VDAP	thermal paper, TTX press	RADIO SHACK	1	$24.95	$0.00	$24.95
X P87-030A	EXPEN	ETILT	NEWP	VDAP	Diskdrv Chipmunk	PORTABLE COMP. SUP	1	$399.00	$0.00	$399.00
X P87-037F	EXPEN	ETILT	SUPPL	VDAP	elm 1000ufd	NORVAC	12	$0.77	$0.00	$9.24
X P87-037C	EXPEN	ETILT	SUPPL	VDAP	power jacks	NORVAC	6	$0.72	$0.00	$4.32
X P87-030B	EXPEN	ETILT	SUPPL	VDAP	Diskettes, Chipmunk	PORTABLE COMP. SUP	2	$50.00	$0.00	$100.00
X P87-037B	EXPEN	ETILT	SUPPL	VDAP	perf board	NORVAC	1	$11.35	$0.00	$11.35
X P87-037D	EXPEN	ETILT	SUPPL	VDAP	soldering tip	NORVAC	1	$8.20	$0.00	$8.20
X P87-032A	EXPEN	ETILT	NEWP	VDAP	TRS-80 mod 102, manual	RADIO SHACK	1	$15.00	$0.00	$15.00
X P87-036	EXPEN	ETILT	NEWP	VDAP	AGI Tiltmeter-700	APPLIED GEOMECHANI	1	$2,100.00	$11.75	$2,111.75
X P87-037E	EXPEN	ETILT	SUPPL	VDAP	jim 671-3b	NORVAC	3	$0.79	$0.00	$2.37
X P87-031	EXPEN	ETILT	NEWP	VDAP	Batt. Printer, TRS 80	TRAVELING SOFTWARE	1	$129.00	$5.00	$134.00
X P87-019B	EXPEN	ETILT	SUPPL	VDAP	AA Batteries, ALKAL	F. H. MARKETING	48	$0.64	$0.00	$30.72
X P87-039	EXPEN	ETILT	SUPPL	VDAP	Safe Skin	MERRITT	2	$29.95	$2.05	$61.95
X P87-040	EXPEN	ETILT	SUPPL	VDAP	Pelican case	PELICAN PROD.	1	$32.87	$2.69	$35.56
X P87-046	EXPEN	ETILT	NEWP	VDAP	TRS-80 mod 102	RADIO SHACK	1	$103.84	$0.00	$103.84
X P87-076	EXPEN	ETILT	REPAIR	VDAP	TAD Radios	TAD	1	$110.00	$1.65	$111.65
					SUBTOTAL	$3,486.61				
X P87-077	EXPEN	GEOLO	FILM	VDAP	Film developing	CITIZEN"S	1	$4.50	$0.00	$4.50
X P87-021	EXPEN	GEOLO	FILM	VDAP	Film developing	PROLAB	1	$4.75	$0.00	$4.75
X P87-071	EXPEN	GEOLO	FILM	VDAP	Film developing, Ecuador	SANDY"S	1	$28.70	$0.00	$28.70
X P87-070	EXPEN	GEOLO	FILM	VDAP	Film developing, Ecuador	SANDY"S	1	$30.75	$0.00	$30.75
X P87-005E	EXPEN	GEOLO	MAPS	VDAP	Banks, Co/Ec/CoRi	TA 0213, 8-9/86	1	$22.60	$0.00	$22.60
X P87-006E	EXPEN	GEOLO	MAPS	VDAP	Doukas, CoRi	TA 0217, 9/87	1	$37.60	$0.00	$37.60
X P87-025	EXPEN	GEOLO	MAPS	VDAP	Banks, Guat,	TA 0059, 2-3/87	1	$5.00	$0.00	$5.00
X P87-007E	EXPEN	GEOLO	MAPS	VDAP	Harlow, Co/Ec/CoRi	TA 0211, 8-9/86	1	$257.63	$0.00	$257.63
X P87-025	EXPEN	GEOLO	PHOTO	VDAP	Banks, Guat,	TA 0059, 2-3/87	1	$120.00	$0.00	$120.00
X P87-056M	EXPEN	GEOLO	PHOTS	VDAP	Doukas, Ecuador, volcano	TA 0105, 3/30/87	1	$55.84	$0.00	$55.84
X P87-024	EXPEN	GEOLO	REF	VDAP	Banks, hawaii	TA 0049, 1-2/87	1	$18.00	$0.00	$18.00

APPENDIX XVI. CONTINUED

DETAILS

	VCAT ORDER NO.	MAIN VCAT SORT	AUX VCAT SORT	SUB VCAT SORT	ACTIV-ITY	DESCRIPTION OF ITEM	MANUFACTURER VENDER	NUMBER PUR.	UNIT COST	UNIT SHIPPING COST	TOTAL COST
X	P87-025	EXPEN	GEOLO	VIDEO	VDAP	Banks, Guat,	TA 0059, 2-3/87	1	$20.00	$0.00	$20.00
X	P87-073	EXPEN	LOGIS	REPLAC	VDAP	Shipping cases, Jensen 2	JENSEN	1	$179.00	$0.00	$179.00
X	P87-026	EXPEN	LOGIS	SUPPL	VDAP	USGS decal 1-5/6	USGS WAREHOUSE	100	$0.07	$0.00	$7.00
X	P87-056L	EXPEN	METEORDATA		VDAP	Doukas, Ecuador, REPORT	TA 0105, 3/30/67	1	$15.23	$0.00	$15.23
X	P87-072	EXPEN	OPERA	COPY	VDAP	film, process, Gatemala	TYMERS	1	$34.44	$0.00	$34.44
X	P87-ZZZ	EXPEN	OPERA	COPY	VDAP	1/2" star drill	PARKROSE	1	$4.39	$0.00	$4.39
X	P87-ZZZ	EXPEN	OPERA	COPY	VDAP	Pipe	PARKROSE	1	$12.00	$0.00	$12.00
X	P87-ZZZ	EXPEN	OPERA	COPY	VDAP	AAA Batteries	PARKROSE	1	$5.97	$0.00	$5.97
X	P87-ZZZ	EXPEN	OPERA	COPY	VDAP	3/4"star drill	PARKROSE	1	$6.48	$0.00	$6.48
X	P87-016	EXPEN	OPERA	COPY	VDAP	Ceniza, paper	NTIS	5	$5.80	$0.00	$29.00
X	P87-035	EXPEN	OPERA	COPY	VDAP	Repo. Pacaya map	TYMERS	5	$2.00	$0.00	$10.00
X	P87-026	EXPEN	OPERA	SHIP	VDAP	SF1175 Banks&Lockhart	DHL	1	$4.94	$0.00	$4.94
X	P87-009C	EXPEN	TRAIN	VIDEO	VDAP	Video tape, 1/2 10 min	A&G ASSOCIATES	5	$3.83	$0.00	$19.15
X	P87-075	EXPEN	TRAIN	VIDEO	VDAP	Gulunggung tape convcert	CALIFORNIA VIDEO	1	$73.50	$5.00	$78.50
X	P87-011	EXPEN	TRAIN	VIDEO	VDAP	Vid tape, JVC 1/2 10 min	A&G ASSOCIATES	10	$5.47	$2.25	$54.70
X	P87-018	EXPEN	TRAIN	VIDEO	VDAP	T-2000 train slide	TYMERS	1	$4.75	$0.00	$4.75
X	P87-009B	EXPEN	TRAIN	VIDEO	VDAP	Video tape, 1/2 30 min	A&G ASSOCIATES	5	$3.88	$0.00	$19.40
X	P87-009A	EXPEN	TRAIN	VIDEO	VDAP	Video tape, 1/2 90 min	A&G ASSOCIATES	5	$4.59	$0.00	$22.95
				TOTAL		$6,734.56	($11.56)				
								TOTAL		$59.74	$165,458.16