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1988 Annual Report on the Volcanic and Earthquake Hazards Mitigation Program for the Valle Central, Costa Rica

January 1989

Prepared by:
Roy F. Weston, Inc.
with support from:
Universidad Nacional Autonoma de Costa Rica
Universidad de Costa Rica
Instituto Costarricense de Electricidad
Comision Nacional de Emergencia

Prepared for:
RET Corporation under USAID Contract No. OTR-0000-C-00-6108-04

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January 31, 1989

Mr. Raul E. Truffat, President
RET Corporation
P.O. Box 366
Herndon, VA 22070-0366

Re: 1988 Annual Report for the Volcanic and Earthquake Hazards Study of the Valle Central, Costa Rica
Contract No. 2906-01-02-0001

Dear Mr. Truffat:

Transmitted with this letter is the 1988 Annual Report for the Volcanic and Earthquake Hazards Study of the Valle Central, Costa Rica. The report summarizes Fiscal Year 1988 activities and accomplishments, and outlines planned activities for Fiscal 1989. The major accomplishments of 1988 are summarized below:

- ratification of the Memorandum of Understanding (MOU) between the Universidad de Costa Rica (UCR), the Universidad Nacional Autonoma (UNA), the Instituto Costarricense de Electricidad (ICE), the Comision Nacional de Emergencia (CNE), and the U.S. Agency for International Development (USAID);

- establishment of the Comision de Mitigacion de Riesgos Volcanicos y Sismicos (MIRVYS Commission) under the CNE to coordinate all technical and administrative activities;

- identification of responsibilities and detailed tasks and schedules for the activities to be completed under the MOU;

- development of final equipment lists and purchase of major portions of the equipment;

- completion of computer literature search and initiation of a technical library of pertinent documents for the program;

- initiation of earthquake database integration between the three Costa Rican technical organizations;

- preparation of preliminary fault lineament maps; and

- preparation of preliminary hazard map of the Poas volcano.

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WESTON

R. Truffat

While it took longer than anticipated to ratify the MOU, significant progress has been made on the technical tasks. Further details on Fiscal Year 1988 activities can be found in December 1987, April 1988, and June 1988 trip reports transmitted to you earlier. The field season for Fiscal 1989 has been initiated and considerable work is underway.

If you have any questions concerning this report, please contact me on (202) 646-6654.

Sincerely,

Roy F. Weston, Inc.

K. Michael Cline
Project Manager, P.G.

Approved by

R. Jackson, Vice President, P.G.

cc: D. Siefken

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1988 ANNUAL REPORT: VOLCANIC AND EARTHQUAKE HAZARDS MITIGATION PROGRAM FOR THE VALLE CENTRAL, COSTA RICA

1.0 INTRODUCTION

At the request of the Office of Foreign Disaster Assistance (OFDA) of the U.S. Agency for International Development (USAID) and the Comision Nacional de Emergencia (CNE) of the Government of Costa Rica (GCR), RET Corporation and its contractors (Roy F. Weston, Inc. and independent consultants) are conducting a volcanic and earthquake hazards mitigation program for the Valle Central, the population center of Costa Rica. This report reviews Fiscal Year 1987 (FY87) activities, summarizes Fiscal Year 1988 (FY88) activities, and outlines planned activities for Fiscal Year 1989 (FY89). A twelve-month calendar of planned activities for FY89 is attached (Attachment 1). This calendar includes the major tasks and subtasks detailed in Appendix A of the Memorandum of Understanding signed in October, 1987 by the participating organizations. Further details of the technical activities during FY88 can be found in the December 1987, April 1988, and June 1988 trip reports, copies of which were previously submitted to CNE and USAID.

1.1 Review of FY87 Activities

Fiscal Year 1987 (FY87) activities primarily consisted of developing a working agreement, the Memorandum of Understanding (MOU), between the Costa Rican technical counterparts (Counterparts): the Universidad de Costa Rica (UCR); the Universidad Nacional Autonoma (UNA); and the Instituto Costarricense de Electricidad (ICE). FY87 activities also focused on developing an organizational structure through the CNE. The organizational structure, known as the Comision de Mitigacion de Riesgos Volcanicos y Sismicos (MIRVYS Commission), consists of an Executive Committee made up of the Vice Rectors from the Universities, the Technical Director of ICE and representatives of CNE and the Colegio de Ingenieros; and a Technical Committee made up of technical leads from UNA, UCR and ICE. Near the completion of FY87, the CNE requested that RET Corporation and its contractors (collectively referred to as the Consultants) modify the contract with USAID to provide additional management support to the MIRVYS Commission for the Counterparts. This contract modification was approved by USAID for FY88.

The MIRVYS Commission identified a series of technical subtasks to be completed by the Counterparts with support from the Consultants. Completion of these subtasks will provide data and analyses for a preliminary evaluation of volcanic and earthquake hazards. Attachment 1 lists all of these subtasks and identifies those subtasks that have been completed. The schedule has been modified periodically to meet the needs of the program.

1.2 Overview of FY88 Activities

Fiscal Year 1988 activities consisted primarily of the following work and achievements:

- signature of the MOU in October, 1987;
- finalization of equipment lists and partial purchase of equipment for the Universities and ICE.
- aerial photo interpretation and field studies to identify late Quaternary faulting and fault lineaments in the Valle Central and region surrounding the Valle Central;
- field investigations to identify and correlate the late Quaternary volcanic stratigraphy, focusing on the Holocene (last 10,000 yr), to evaluate the eruptive volcanic histories of Poas, Barva, Irazu and Turrialba volcanoes.
- compilation of the historical (instrumentally recorded) earthquake record of the Valle Central utilizing the data from the UNA, UCR and ICE, and evaluation of that database.

Attachment 1 identifies what has been completed in FY88 and the schedule with projected milestones for FY89. The milestones will vary as the program proceeds into FY89. Because the MOU required more time than anticipated and due to funding constraints and the complexity of the geology, it is anticipated that some activities of this program will extend into Fiscal Year 1990. The schedule (Attachment 1) reflects the extension into Fiscal 1990.

2.0 SUMMARY OF ADMINISTRATIVE ACTIVITIES

At the beginning of FY88, the MOU was signed and ratified by all participant organizations. The MOU details the agreements reached between the participants as to lead responsibilities for each subtasks. Some of the subtasks were initiated immediately, including a review of the equipment needs listed by the Counterparts. The initial equipment lists supplied by the Counterparts were priced by the Consultants.

2.1 Project Management

The Consultants played a key role in developing the structure of the MOU and the assignment of lead responsibilities for the technical subtasks identified in it. Recognizing the need for close project management, Dr. Herman Kruse, the Director of the CNE, requested that the Consultants modify their work plan to provide more management support. Consequently, more of the Consultants time was allocated to project management.

After ratification of the MOU, the Colones (Costa Rican national currency) budget needed to be allocated consistent with the task responsibilities. The Consultants provided guidance to CNE concerning this allocation. Subsequent to that, the Consultants provided guidance to the Counterparts in developing their budget proposals for their subtasks.

2.2 Equipment Purchases

The Consultants provided support to the Counterparts in identifying equipment needs and purchase of equipment. During FY88, Consultants met with representatives of the Escuela Centroamericano de Geologia (ECG) and the Instituto Nacional de Investigaciones Ingenieria (INII) of UCR, and the Observatorio Volcanologico y Sismologico de Costa Rica (OVSICORI) at UNA to evaluate equipment lists and develop purchase and shipping orders. Considerable effort went into evaluating equipment lists generated by the Counterparts relative to the status of existing equipment and specific needs for this program. New equipment purchases were found to be less essential than repairing and providing spare parts inventories for existing equipment.

A partial equipment order was completed for the Escuela Centroamericano de Geologia. The balance of the list, which includes geological field equipment such as stereoscopes, altimeters, etc., will be purchased and shipped in early FY89. Equipment purchases for INII have been deferred until FY 89 because of changing needs and costs. The equipment lists prepared in 1987 were not fully representative of the needs. The lists, designed to acquire additional accelerographs, exceeded the budget available by a considerable amount. A new list identifying highest priority items was completed in late FY88. The components of the list are currently being priced by the Consultants. The remaining equipment list is to be purchased and shipped in FY89.

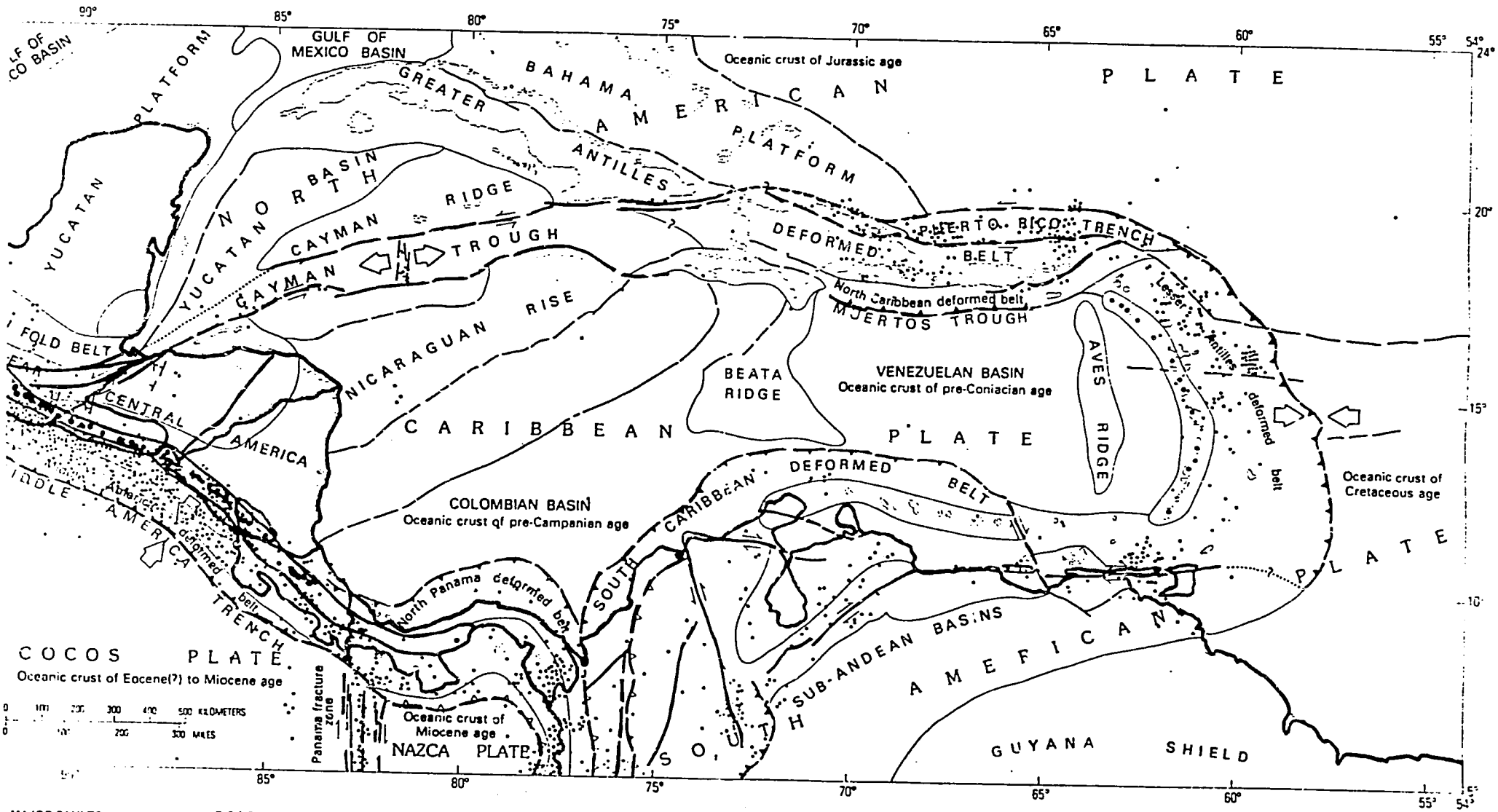
The UNA equipment was evaluated, and most of the equipment requested was ordered, purchased and shipped in FY88. This included primary components for completing a twelve-station regional seismic network, equipment for monitoring volcanic activity, maintenance equipment and spare parts.

In addition to supporting UCR and UNA on equipment purchases, the Consultants began to evaluate the status and needs of the ICE equipment used for their regional seismologic network. A report on this evaluation will be prepared in FY89.

3.0 SUMMARY OF FY88 TECHNICAL ACTIVITIES AND PRELIMINARY FINDINGS

3.1 Geologic Overview

The Valle Central is a complex regional tectonic feature whose origin is both structural and volcanic. It is a structural basin filled with a thick volcanic sequence that separates the Cordillera Central volcanic chain to the north and the uplifted Talamanca mountain chain to the south. The Holocene volcanism prevalent in Central America terminates at the Valle Central. The Valle Central trends westward and coincides with an apparent west trending break in the dip of the subducting Cocos plate at the Middle Americas Trench (see Figure 1). The Cocos plate dips at a much greater angle under the volcanic chain to the north. The tectonic origin of the Valle may be due, in part, to evacuation of magma and subsequent subsidence. The structural pattern and extent of faulting in the Valle Central is unknown; however, faulting has been observed bounding the Valle. The south side of the Valle appears to be bound by a complex series of west-trending range front faults. The north side is bound by faults on the flanks of the volcanoes that include the Alejuela escarpment fault. Faulting on the north side of the Valle is more difficult to recognize because of the thick blanket of recent volcanic deposits that mask the geomorphic expression of faulting.



MAJOR FAULTS

COUNTY BOUNDARIES

VOLCANIC CENTERS

HISTORIC EARTHQUAKES

MAP OF CARIBBEAN REGION SHOWING SOME MAJOR TECTONIC-GEOMORPHIC PROVINCES

"Oceanic" crust, as used below, denotes mafic to ultramafic crust, 5–20 km thick, probably formed at spreading ridges. "Continental" crust denotes crust having substantial components of Precambrian and(or) Paleozoic intermediate to felsic igneous and metamorphic rocks. Continental crust tends to be 25–45 km thick. On land segments of oceanic crust tend to have positive (+25 to +150 mgal) Bouguer anomalies, segments of continental crust negative (−25 to −150) Bouguer anomalies.

NEOGENE VOLCANIC BELT –Shows active or recently active volcanoes

Figure 1. Regional tectonic map after J. case, and T.L. Holcombe (USGS) 1980

The valley is filled with a thick sequence of Quaternary volcanic deposits consisting of lava flows, pyroclastic flows, lahars and ashfall tuffs. The active volcanoes of Poas, Irazu, and Turrialba, and the dormant volcano Barva bound the northern flanks of the valley. Historic volcanism has been limited to localized lahars and relatively small ash eruptions on the flanks of the volcanoes. Currently, geyser eruptions are occurring on Poas and fumaroles are present on Irazu and Turrialba. Little is known about the recent activity of Barva.

The rapid deposition of young volcanic materials, active tectonism, and extensive erosion have produced a landscape with strong relief that is prone to landsliding and large-scale mass wasting. The landsliding and mass wasting generally occurs in the young surficial materials which are generally pyroclastic on the north side of the valley, and thick laterite soils on the south side of the valley onto the flanks of the Talamanca range. The landsliding in the Valle Central poses significant potential hazards to numerous population centers in the Valle Central.

3.2 Fault Hazard Studies (Task I)

During FY88, fault hazard studies were focused on completion and review of relevant documentation, and mapping of photo lineaments suggestive of late Quaternary faulting. The latter was accomplished through the use of 1:80,000 scale infrared imagery and 1:60,000 scale black and white imagery, followed with both air and ground reconnaissance. The lineaments identified are subparallel to known mapped faults and represent possible late Quaternary activity along those faults. In addition, work also focused on earthquake-triggered landsliding. This section summarized the activities of UCR and the Consultants in FY88.

3.2.1 Compilation of Existing Data

Various geologic literature and reports have been compiled and reviewed and are on file either in the project office at CNE or in the UCR library. A bibliography of geologic literature using Geo-Ref was prepared for the study area, and is on file in the project office. Copies were provided to the Counterparts. The bibliography was useful in identifying pertinent geologic literature. Existing geologic maps of the study area and topographic maps at different scales were purchased from Instituto Geografico Nacional (IGN) and are available in the project office.

A fault map of the Valle Central and surrounding region was compiled by W. Montero and P. Denyer (UCR). The map has been printed in color by IGN at a scale of 1:150,000. A preprint was obtained for the project and is available in the project office. The map also provides a list of references that were used in the compilation.

S. Mora (ICE) compiled a geologic and fault map of the Rio Parrita drainage basin which includes southern portion of the study area. The map is at a scale of 1:50,000 and includes a list of references. It was prepared as part of an internal report for ICE, and was made available to the project by S. Mora. A copy is also on file in the project office.

S. Kussmaul (UCR) has prepared a compilation of existing age dates for Costa Rica. The compilation has been made available to the project. This compilation will be used to aid in evaluation of fault and volcanic activity.

3.2.2 Preparation of a Preliminary Map of Faults and Lineaments

False-color infrared positive transparency images (1:80,000 scale) of the study area were interpreted by the Consultants. The Consultants prepared a project report in June of 1988 in which eight major lineaments that may represent Quaternary faulting were identified, described and plotted. Lineament plots on the 1:200,000 and 1:50,000 project maps are maintained in the project office. Discussion of this activity and a description of the lineaments are presented in Attachment 2. A reduction of the 1:200,000 scale preliminary fault lineaments map is shown in Figure 2.

Black and white aerial photographs of the study area at a scale of 1:60,000 were interpreted by R. Madrigal (UCR consultant) and used to prepare both a preliminary fault lineament map and a photo-geologic map of the study area (scale 1:100,000). A reduced version of this map is shown in Figure 3. The aerial photography interpretation did not identify any major faults or lineaments that had not been previously mapped. The map does show a number of shorter lineaments and more detail that is helpful in evaluating faults.

Field reconnaissance of known faults and mapped lineaments was carried out in July and August of 1988 by W. Montero of UCR, and the Consultants. Geomorphic evidence of possible Quaternary activity was identified on several of the faults. It is important to note that these faults appear to be broad zones (up to 1-2 kms) of deformation consisting of multiple traces within each zone. These faults are discussed in more detail in the following paragraphs.

Agua Caliente fault: This fault, possibly associated with the 1910 Cartago earthquake, projects from Rio Agua Caliente northwestward across the valley south of Cartago and may continue westward south of San Jose (see Figure 2). The eastern trace of the fault is not well understood. The fault may project southeast and connect to the Orosi fault, or it may project more easterly toward the Cachi area. The late Quaternary evidence of faulting along the segment south and southwest of Cartago is expressed by an alignment of apparent sag ponds and hot springs, and an east-facing scarp on the west side of the valley. In the Coris Valley, apparent active traces are observed on both sides of the valley. This suggests a more complex fault zone than previously recognized. Potential trench sites were identified at several locations along the fault segments in the Coris Valley. Final trench site selections will be made after further reconnaissance of the fault.

Rio Orosi fault: This fault has been mapped on the west side of Orosi Valley (see Figure 2). The fault is characterized by well-developed triangular facets, an alignment of hot springs, and apparent breaks in alluvial fans crossing the surface projections of the fault. Because of the relatively high level of microseismicity in the area, more detailed investigations are planned to help define the activity of the fault. The structural relationship between the Orosi fault and the Agua Caliente fault to the north are presently not well understood. Plans have been made to investigate this relationship in more detail.

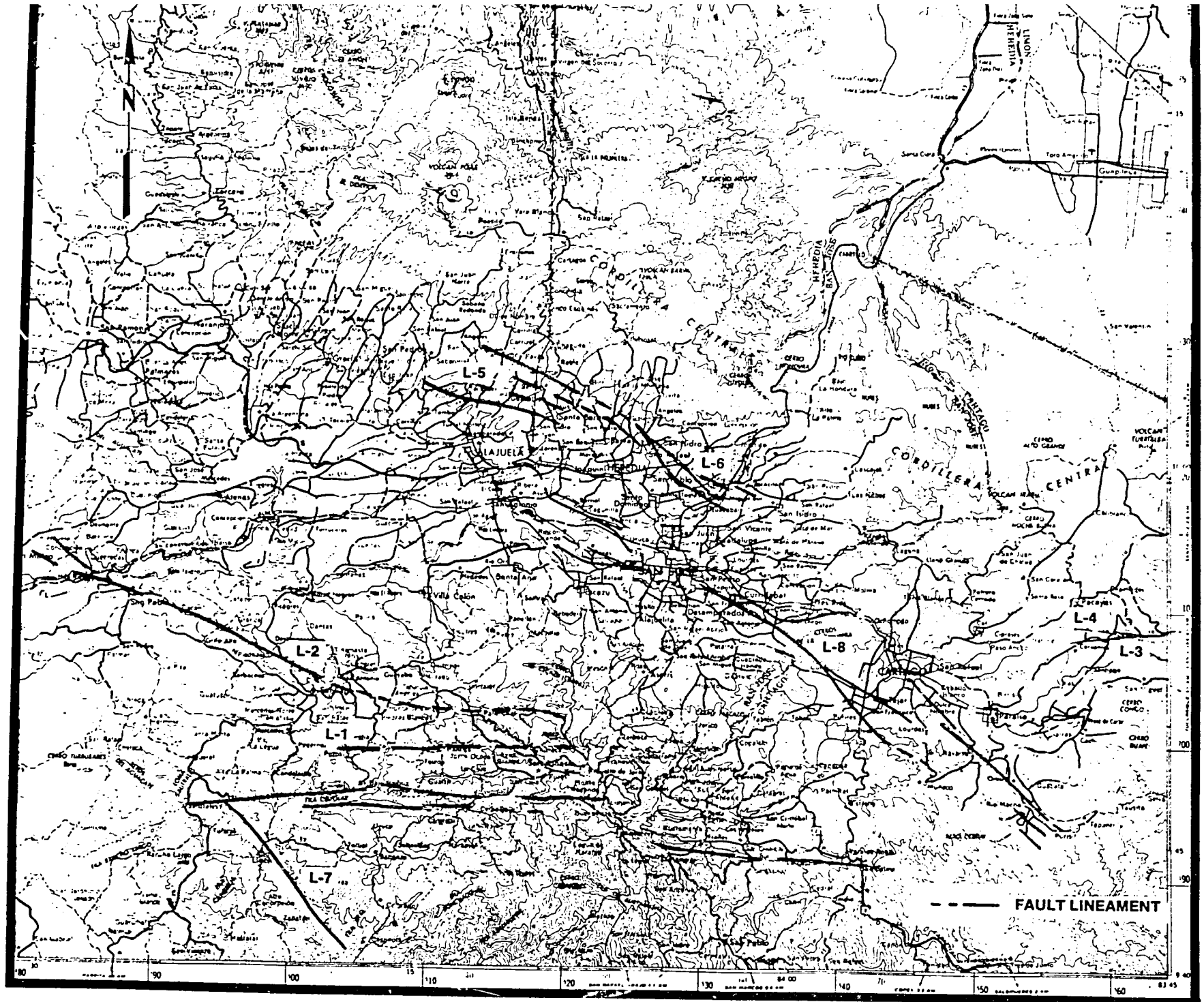


Figure 2. Preliminary fault lineament map based on 1:200,000 topographic map San Jose quadangle.

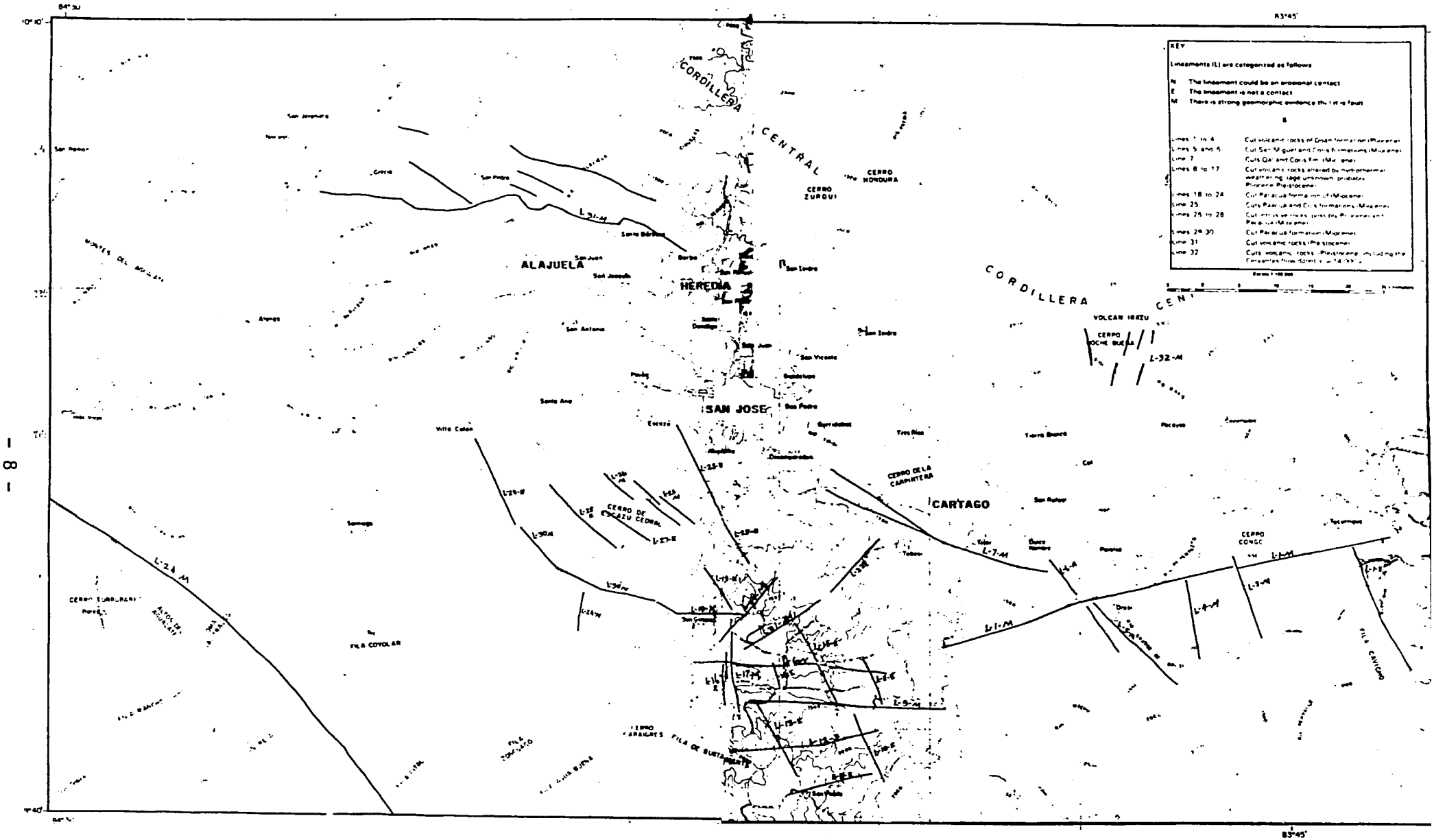


Figure 3. Preliminary lineament map of the Valle Central at scale of 1:100,000 prepared by R. Madrigal, UCR.

Alajuela fault: Investigations of the Alajuela fault scarp continue. Early reconnaissance and aerial photo interpretation studies suggest the fault zone is very broad, up to two kilometers, and that the style of faulting is very complex. Inflection points in alluvial fans coming off the volcanoes suggest that traces of the fault break young material. Charcoal was recovered at the base of a recent pyoclastic flow that crosses several of the lineaments associated with the Alajuela fault zone. The charcoal will be collected for age dating to provide information on the maximum age of an overlying ashfall tuff (see Section 2.3). If applicable, the dated unit will be used in evaluating fault activity. A quarry near Tacares provides an excellent exposure of the Alajuela fault. With additional investigations including detailed mapping, significant data should be compiled on the displacement history of the fault at the quarry.

Talamanca Range-front fault: A reconnaissance was made of this fault west of the study area. The fault strikes north-northwest and appears to be a reverse fault associated with the forearc system along the western margin of the Caribbean plate where active subduction of the Cocos plate along the Middle Americas Trench is occurring. There is some geomorphic evidence to suggest that there is also a component of left-laterial slip along this fault. The geomorphic expression of Quaternary movement along this fault is supported by strong relief, offset river terraces, discordant bedding, anomalous terrace slopes, and aligned valleys. The geomorphic expression suggests that the fault has a relatively high slip rate and a very broad zone consisting of fault segments.

Rio Candelaria fault: Air reconnaissance and photo interpretation of this fault suggests it parallels the strike of Cretaceous bedding in the Talamanca Range. The fault trends west and is defined by aligned river valleys, ridges, and ridge saddles.

3.2.3 Earthquake-related Landslide Mapping

An earthquake in 1888 (estimated Richter magnitude of 6) caused numerous landslides in the Fraijanes area on the south flank of Poas. One of the slides resulted in the formation of Laguna Fraijanes. Mapping of these and other recent landslides has been started by R. Mora of UCR. R. Mora is mapping the landslides using the 1:60,000 aerial photographs purchased by the project. Field checking is being done for selected locations.

In order to evaluate the potential of landsliding related to future earthquakes, several types of maps presenting basic slope stability data are being prepared. Presently, the maximum slope angle is being digitized from the 1:50,000 quads in the study area using a 500M grid. These data are being compiled by R. Mora with input and advice from S. Mora of ICE. The slope angle data will be evaluated with respect to other data, such as rock type, to identify areas with the highest potential for slope failure.

3.3 Investigations of Volcanic Hazards (Task II)

Investigations of volcanic hazards have been focused in two specific geographic areas during the past year. Technical counterparts at UCR have concentrated their efforts on the volcanic stratigraphy of the western Valle Central, especially in the San Jose metropolitan area. Counterparts at UNA have continued their ongoing monitoring activity of the entire volcanic chain but have concentrated their monitoring and field investigation activities on Poas volcano. Poas has demonstrated increased activity in recent months; therefore, efforts have been dirrcted at this volcano over the other three bounding the Valle Central.

3.3.1 Investigations of Volcanic Hazards on the Flanks of Poas Volcano

Increased levels of phreatic ("geyser") activity, gas emission, deformation and seismic activity at Poas volcano have lead to a priority effort to identify potential hazards from a large phreatic event such as the one that took place at Poas in 1910 or a major Strombolian event such as the one at Poas in 1953-55. Historic records of activity at Poas indicate that relatively limited areas have been seriously impacted by such events. For that reason it was determined that volcanic mudflows or lahars represent the most significant hazard from a likely eruption at Poas in the near future. The UNA task group undertook a two-month effort aimed at identifying areas of present slope instability and past lahar activity utilizing aerial photo and map interpretation as well as field reconnaissance. The Counterparts from UCR and ICE have contributed to the UNA effort by providing recent reports on (1) a regional assessment of volcanic hazards, and (2) geologic studies of the Bajo de Toro Valley on the west flank of Poas. The interim product of the UNA assessment (shown in Figure 4) is a map-based analysis of the topography of the Poas summit, delineating probable lahar channels and areas of intermediate and high risk from lahars and airfall tephra. The UNA task group is currently preparing a more detailed assessment, including field checking of map and aerial photograph interpretations, of lahar hazards within a broader study area. This effort has pre-empted the previously defined MIRVYS tasks of field reconnaissance of Turrialba and Irazu volcanoes, but has not impacted UNA's ongoing volcanic monitoring effort.

3.3.2 Investigations of Volcanic Stratigraphy in the Valle Central

The investigation of the volcanic stratigraphy of the Valle Central by UCR Counterparts has assembled a bibliography of approximately 300 publications. This reference list consists of published and unpublished reports, including university theses and municipal water-well drilling logs. The Consultants provided a comprehensive list of publications generated by a computer search on the geology and geologic hazards of Costa Rica to the Counterparts. The Consultants are making copies of the more significant reports published in international journals.

During the June and September 1988 visits, the Consultants were able to identify and describe almost two dozen sites, and have now accompanied the Counterparts to several key sites to discuss both the stratigraphic units and a methodology for further refining the late Pleistocene/Holocene stratigraphy of the western Valle Central.

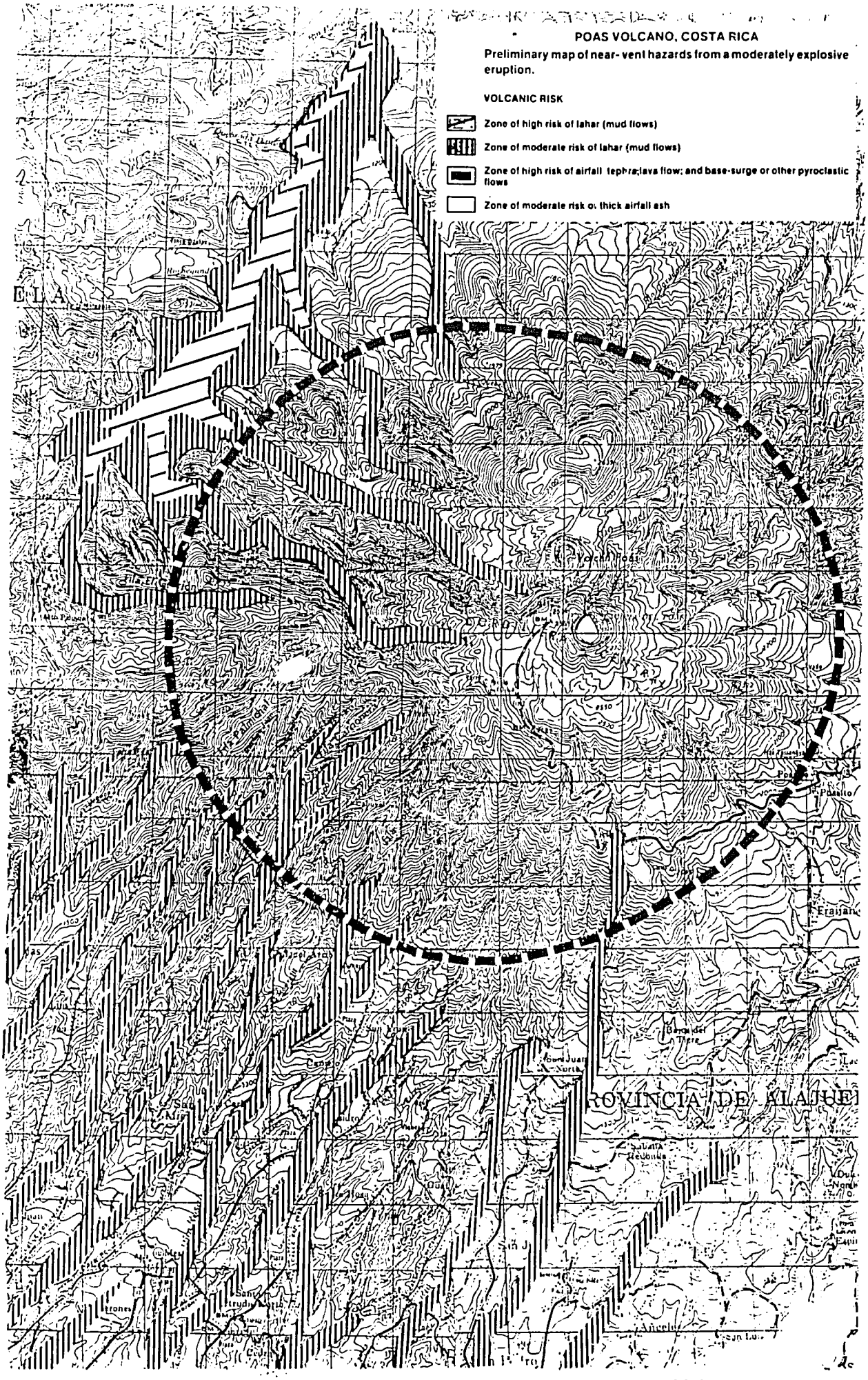


Figure 4. Preliminary volcanic hazard map of the Poas Volcano.

The UCR counterparts have recognized the need to pursue the study of units overlying the thick grey Tiribi pyroclastic flow(s) that pervasively underlie the San Jose region. The Consultants initiated a cooperative effort between ICE and UCR to produce a stratigraphic study of the "post-avalanche" (i.e., post-Tiribi) deposits in the San Jose area, including identification of through-going faults that affect the Tiribi and overlying formations. Carlos Rodriguez (ICE), will conduct such a study under the joint supervision of ICE and UCR professionals, in fulfillment of the thesis requirement for a Lic. degree in Geology. Field samples of the post-avalanche deposit collected by the Consultants in September 1988 have been turned over to the UCR for laboratory preparation by C. Rodriguez. The Consultants will assist Rodriguez in the preliminary analysis of residual mineral and lithic fractions of washed samples during a subsequent visit scheduled in early November.

3.4 Investigations of Earthquake Hazards (Task III)

Earthquake hazard studies in FY88 focused on data integration, identification of seismic sources in the Valle Central, and discussion on a proposed seismic reflection study of the Valle Central and the western region of Costa Rica. The first two activities are a part of the original subtasks indentified in the MOU while the third activity (seismic reflection) is new; however, the Valle Central portion of this reflection line is considered to be important for understanding the structural relationships of the Valle Central and the behavior of future earthquakes in the Valle Central. These activities of FY88 are summarized in the following sections.

3.4.1 Earthquake Data Base Integration

A subcommittee of the MIRVYS Commission, consisting of representatives of UNA, UCR, ICE, and the Consultants, and referred to as the Data Integration Supervisory Panel (DISP), outlined a preliminary plan for integration of seismic data collected by the three Counterpart institutions. The outline of the plan is contained in the attached minutes of the June 21-22, 1988 subcommittee meetings (Attachment 3). Subsequent to that meeting and in accordance with the outlined plan, F. Guendell (UNA) prepared a more detailed plan which deals with the integration in two phases: (1) past data, and (2) future data. The first phase of this plan has, in part, been implemented. ICE seismologists met with the UNA technical committee to discuss details of the second phase, but the UNA technical committee was unable to agree to specific points of the plan, including equal acknowledgement of the institutions in the unified seismological bulletins and sharing of computer software. UNA is continuing to produce monthly and annual catalogs, and ICE/UCR is producing quarterly and annual catalogs. A proposal for network integration was prepared independently by UNA, and submitted to the MIRVYS Executive Committee. The proposal has not been accepted by UCR or ICE, and has not been available for review by the Consultants.

UNA has provided data from their seismograph network for the period 1984 - May, 1988 to UCR for inclusion in the unified earthquake data base for the Valle Central. These data are all the earthquakes that have been located by UNA at depths of 25 km or less using the standard hypocenter location program (HYPOINVERSE), and have been carefully checked for errors. UNA has produced

an epicenter plot of these data at small scale, which has been given to UCR. UNA is currently working on relocating these shallow events using a standard velocity model (Matumoto, 1978, modified by Morales and Montero) for the Valle Central.

ICE provided data from all the portable seismograph networks operated at ICE hydroelectric projects located within the Valle Central during the period 1980-1985 directly to UCR. ICE and UCR have not yet been able to locate the original phase data files from any of their networks that were in operation before 1984. Therefore, UNA has not begun to relocate pre-1984 events. Events located by the ICE/UCR network during the period 1984-1988 that were not located by UNA will also be included in the Valle Central data base. ICE and UNA are currently identifying such events, which will be relocated using the standard program and velocity model.

3.4.2 Identification of Seismic Sources in the Valle Central

UCR has reviewed and compiled data on shallow earthquakes that have occurred in the Valle Central during the period 1841-1988. This preliminary data base (or catalog) contains over 1200 earthquakes. In addition to data from regional networks discussed above, other sources of data include:

(a) Historic and world-wide seismicity data for the period 1841-1974, taken from international data sources (ISC, NOAA, USGS, etc.) and from national and international published and unpublished studies of specific earthquakes. Studies of pre-1841 earthquakes are, at present, insufficient for these earthquakes to be included in the data base.

(b) Data from the UCR Valle Central network for the period 1973-83.

(c) Data from various UCR portable networks that have been operated in the Valle Central.

UCR is presently examining the catalog for duplicate and/or incorrect entries. UCR has developed software to sort the data according to a variety of parameters, so that subsets of the data can be selected for plotting and analysis. This is necessary because the variety of data sources and the fact that, at present, the ICE and UCR data have not been relocated using a standard program, mean that the data base is not homogeneous. In addition to hypocentral parameters, each data base entry includes the data source and an indicator of the quality of the hypocentral solution, based upon the precision of the input data.

The software developed by UCR can be used to generate three-dimensional seismicity plots of the Valle Central at a scale of 1:500,000 and cross-sections at any selected azimuth. The three-dimensional plots are a very useful form of display, and the software is being further developed to "zoom" onto selected portions of the data and to view the three-dimensional seismicity distribution from any angle. At present, the plots can be displayed only on an IBM PC screen, since UCR does not have facilities for producing hard copies. However, the plot files can be stored on diskette and hard copies could be produced using a computer and peripherals with hard-copy capability.

The ICE Department of Geology has secured use of ICE's new Houston Instruments DMP-60 full-scale plotter to produce plots of the seismicity data to overlay maps at any desired scale. The plotter is linked to an IBM PC and runs AUTOCAD plotting software. The Consultants will develop the interface software necessary to produce the plots from the earthquake data base.

Much of the data is discussed and interpreted in the numerous papers and reports collected by the MIRVYS project. UCR has begun to synthesize these interpretations.

3.4.3 Seismic Refraction Shot

The proposal for the deep crustal refraction experiment was submitted to CNE for consideration by the MIRVYS Commission. The Consultants estimated the amount and cost of explosives for Phase I (Valle Central, on-shore). It is estimated that 4000 lbs of explosive charge will be needed plus boosters, detonators and primacord.

F. Guendell (UNA) met independently with Dr. W. Mooney of the U.S. Geological Survey (USGS) in August to discuss the possibility of a joint USGS/UNA refraction experiment, which would involve both offshore-onshore and the Valle Central profiles. Dr. Mooney has a great deal of experience in crustal profiling studies, and the USGS can make available a large amount of specialized equipment (about 120 radio-telemetered seismographs). However, it is not clear how long it would take to set-up such a joint experiment (probably at least 1-2 years), or how it would be funded. The MIRVYS Commission must evaluate the pros and cons of proceeding with Phase I of the proposal, based on its technical merit, application to the MIRVYS goals and objectives, and in consideration of the possible involvement of the USGS.

3.5 Geotechnical Engineering (Task IV)

The geotechnical engineering task consists of three subtasks. ICE is the lead counterpart for this task. The three subtasks consist of compiling existing data on the physical properties of the soil sequence(s) in the Valle Central (subtask I), field support (subtask II), and technical support in geology, seismology and engineering (subtask III). Subtasks I and III were initiated in September 1988; therefore there is very little to report on for FY 1988. Subtask II will not be initiated until Spring of 1989.

3.5.1 Geotechnical Data Compilation

The soil sequence in the Valle Central is relatively thick consisting of an upper organic section generally in excess of 0.5 m. The organic section overlies a highly weathered sequence of pyroclastics that are generally in excess of 5 m thick. An understanding of the extent and properties of these soils is important for evaluating expected ground response from both near and far source earthquakes. ICE has initiated a review of all existing data including drill logs and geophysical data of the Valle Central from various sources.

3.5.2 Technical Support

ICE has identified three major landslides in the Valle Central that are active and pose a threat to nearby population centers. Independent of the MIRVYS program, ICE is monitoring the San Blas landslide and is considering a monitoring program for the Tapesco landslide. The landslides hazards are summarized in the following descriptions.

San Blas Area - This slide is located in the Rio Reventado watershed which drains through western Cartago. The slide consists of a series of remobilized lahars whose source was the upper flanks of the Irazu volcano. Recent volcanic activity has resulted in oversteepened slopes of unconsolidated deposits on the upper flanks of Irazu. The lahars have partially filled the drainage basin. The estimated volume of this massive slide is 40 million cubic meters. The slide has been active for some time. The lower half is currently moving as a massive unit at a rate of between 15 and 25 m per year (according to personal communication from S. Mora of ICE). Heavy rainfall during 1988 has increased its activity. Concern has been expressed over the potential for damming of the Rio Reventado due to mass movement which could lead to breaching of the natural dam and catastrophic flooding of western Cartago, similar to the 1968 event.

Tapesco landslide - The Tapesco slide is a large slump block located in a drainage on the upper slope of Cerro Escazu. The block consists of seven to eight million cubic meters of rock and soil. With the heavy rains during 1988, the block has been destabilized and a well developed head-scarp up to 10 to 15 m exists. According to S. Mora (ICE), the estimated rate of movement is 5 m per year. The presence of numerous sag ponds and free flowing water suggest that the block is nearly saturated. The southern side of the block is drained by an active quebrada which empties into the drainage that passes through a number of communities including the small town of Santana. Concern has been focused on the potential that the river may be dammed below the slide. This natural dam could subsequently breach, causing flooding of the communities downstream.

Rio Chiquito landslide - This slide has not been observed by the Consultants; however, it is known to be active. It is located on the slopes of Irazu above the Town of Tres Rios.

3.6 Status of Strong Motion Network (Task V)

The Instituto Nacional de Investigaciones de Ingenieria (INII) of UCR has the primary responsibility for the seven subtasks of the strong motion task. The subtasks consist of an evaluation of the present strong motion network and additional equipment needs (Subtasks 1 and 2), an evaluation of the subsurface conditions at the accelerograph locations (Subtask 3), a review of the existing building code (Subtask 4), data analyses (Subtasks 6), and report preparation (Subtasks 5 and 7). Subtasks 1 and 2 were initiated in FY88; however, they are not scheduled to be completed until February, 1989. Subtask 6 is an ongoing activity. Subtasks 3 through 5 and Subtask 7 will be initiated in FY89.

3.6.1 Operation and Data Analysis

INII installed 18 accelerographs in the Valle Central and region during FY87. The accelerographs are located in a high rise buildings, (Holiday Inn Hotel), in other concrete structures, and in the field (both alluvial and rock sites). The accelerographs were installed by INII without direct Consultant assistance. INII is currently servicing both its network and the accelerograph stations of ICE. Data have been continually processed and analyzed. The Consultants will provide support in servicing the equipment and in data analyses.

4.0 PLANNED ACTIVITIES FOR FISCAL YEAR 1989

4.1. Planned Fault Hazard Evaluation (Task I)

During the first semester of FY89, studies will focus on refining the fault lineament of the Valle Central, on detailed mapping and exploratory trenching of selected lineaments believed to represent Quaternary faulting, and on identification of earthquake-induced landslides. Attachment 1 provides a schedule for this work. The second semester will focus on relating the microseismicity to the faults of the Valle Central and delineating the fault and landslide hazards.

An aerial reconnaissance will be conducted to select locations for exploratory trenching and detailed field mapping. Additional aerial photographs will be obtained from IGN to complete aerial photography coverage of the Valle Central. The photographs will be interpreted and any significant new lineaments identified will be added to the lineament map.

An exploratory trench will be excavated on one or more of the prominent west-trending lineaments south of the Cartago area. The trench(s) will be excavated under the direction of UCR geologists. It will be cleaned and logged by geologists from UCR in collaboration with the Consultants.

Field mapping and possible trenching will continue on other fault lineaments in the Cartago area, the lineament near Orotina, and the Alejuela Escarpment. UCR will prepare a detailed map of the quarry exposing the Alejuela fault near Grecia.
Strip maps of major exposures, natural or man-made (quarries and roadcuts) in the Valle Central will be made. This mapping will be done to verify the presence or absence of late Quaternary faulting. An analysis of the Holocene stratigraphy will be a component of this investigation. The work will be completed by UCR and ICE. The products of the work will be strip maps and a location map.

The air photograph interpretation work will include identification of landslides including possible earthquake-induced landslides in the Valle Central. This work will be done by ICE geologists.

4.2. Planned Volcanic Hazards Studies (Task II)

During the next six months, the Counterparts will focus on field activities necessary to complete MIRVYS Task II to produce a preliminary volcanic hazard zonation of the Valle Central. Published reports on the Holocene volcanic history of Poas, Irazu and Turrialba volcanoes will provide much of the basis for mapping the late Quaternary pyroclastic flow and lava flow hazard zones on the flanks of those three volcanoes. The Consultants intend to support the Counterparts in preparation of aerial photointerpretation-based maps of the volcanic complexes which will then be field checked to expedite progress on Barva, Irazu and Turrialba hazards assessment. In addition to field checking, the Counterparts will be asked to map late Quaternary deposits integrated onto a regional base map from published reports. Over the next three months, the Consultants intend to continue to invest their time in field investigations in coordination with the Counterparts.

4.3 Planned Earthquake Hazards Evaluation (Task III)

ICE is continuing to search for original earthquake phase data from its networks. S. Mora (ICE) indicated that his staff should be able to locate these data. L.D. Morales (UCR) will also continue to search for original phase data from the UCR and ICE networks. L.D. Morales is identifying the timing precision for each data source in the data base. Based on this, and once the original phase data have been located, the Data Integration Supervisory Panel (DISP) along with the Consultants will select those data sets that will be relocated by UNA. UNA will proceed with relocation of their 1984-1988 data set for the Valle Central using the shallow Valle Central velocity model, and will provide the updated data set to UCR. The final set of ICE/UCR events for the 1984-1988 period can then be selected, relocated by UNA, and included in the data base.

The preliminary data base listing will be supplied to ICE and UNA. These institutions will review the data base and suggest modifications, if necessary. The DISP is scheduled to meet at monthly intervals to achieve the objectives listed above, and to finalize the plan for future data integration. An agenda should be prepared in advance of each meeting. It will be important for the panel representative from each institution to participate in the development of the agenda. The recommendations of the DISP will be submitted to the MIRVYS Executive Committee.

The historical seismicity data base will continue to be refined in FY89. However, the final form of the data base, including entries for data quality and with errors and duplicates eliminated, should be completed in October 1988. The initial product from the data base will be epicenter plots to overlay base maps at a scale of 1:100,000. Plots will be available of subsets of the data, sorted according to date, latitude/longitude, depth, magnitude, data source, and data quality. Different symbols will be used to indicate instrumental or macroseismic (intensity) locations, and symbol size will be proportional to magnitude (or maximum intensity). Initial plots should be available in January 1989, at which time correlation of the seismicity data with geologic and lineament analyses can begin. The preliminary analyses will form the basis of selection of areas for detailed study.

Design of the portable microearthquake (MEQ) seismograph network(s) will be based on the initial correlation analyses. Commitment of portable seismographs from the 3 institutions were confirmed during December 1988. The plan is to deploy the MEQ network(s) in January, 1989. Figure 5 identifies a suggested configuration of possible areas for the portable network that provides coverage of the major faults in the Valle Central. A workshop will be organized in January or February involving all field and data processing personnel from the 3 institutions to set standardized MEQ survey field and data processing procedures.

ICE has indicated that R. Barquero (ICE) will start on the volcanic seismicity study immediately, using the ICE's existing volcanological and seismicity data base. Some waveform characterization studies will also be included. A preliminary report will be submitted on this subtask by ICE in February, 1989.

It will be important to set the investigation of Valle Central faulting and seismicity within the regional tectonic framework. For example, possible relationships between faulting and earthquakes in the vicinity of San Isidro and Buena Vista (1983 M_s 6.1) and along the Range Front Fault with those in the Valle Central will be investigated to examine the possible existence of regional tectonic structures related to oblique subduction, the Panama Fracture Zone, and the subduction of the Cocos Ridge.

Seismic network integration, i.e., reduction of duplication of instrument locations among the regional seismic networks of the participating organizations (see Figure 6 for comparison of UNA and ICE/UCR sites), is a major task confronting the MIRVYS Commission in FY89. Upon achieving integration of the earthquake data bases between the Counterparts, the Consultants will focus on integration of the networks. The Consultants will evaluate the integration issue and provide recommendations on the use of the networks and the possible relocation of instruments, if integration is concluded to be the best approach.

Discussions will continue with F. Guendell (UNA) concerning the probability and time-scale of a joint UNA/USGS deep profiling experiment. The MIRVYS Commission must decide whether or not to continue with the original proposal. This decision should be made early in FY89. If the MIRVYS Commission elects to go ahead with the proposal, the availability and cost of explosives in Costa Rica should be investigated. I. Boschini and S. Mora of ICE have identified LODINSA (tel: 27-0652) in San Jose as a possible supplier.

4.4 Planned Geotechnical Engineering Activities (Task IV)

During FY89, ICE will focus on compiling data and preparing a report on the physical properties of the soils of the Valle Central, and will provide geotechnical support to the landslide, seismic and volcanic hazards programs. S. Mora (ICE) is also considering a more active role in the landslide studies. The equipment budget identified for ICE may need to be augmented to purchase equipment such as pluviographs to aid in monitoring landslides. The landslides of interest are those discussed in Section 3.5.2 of this report.

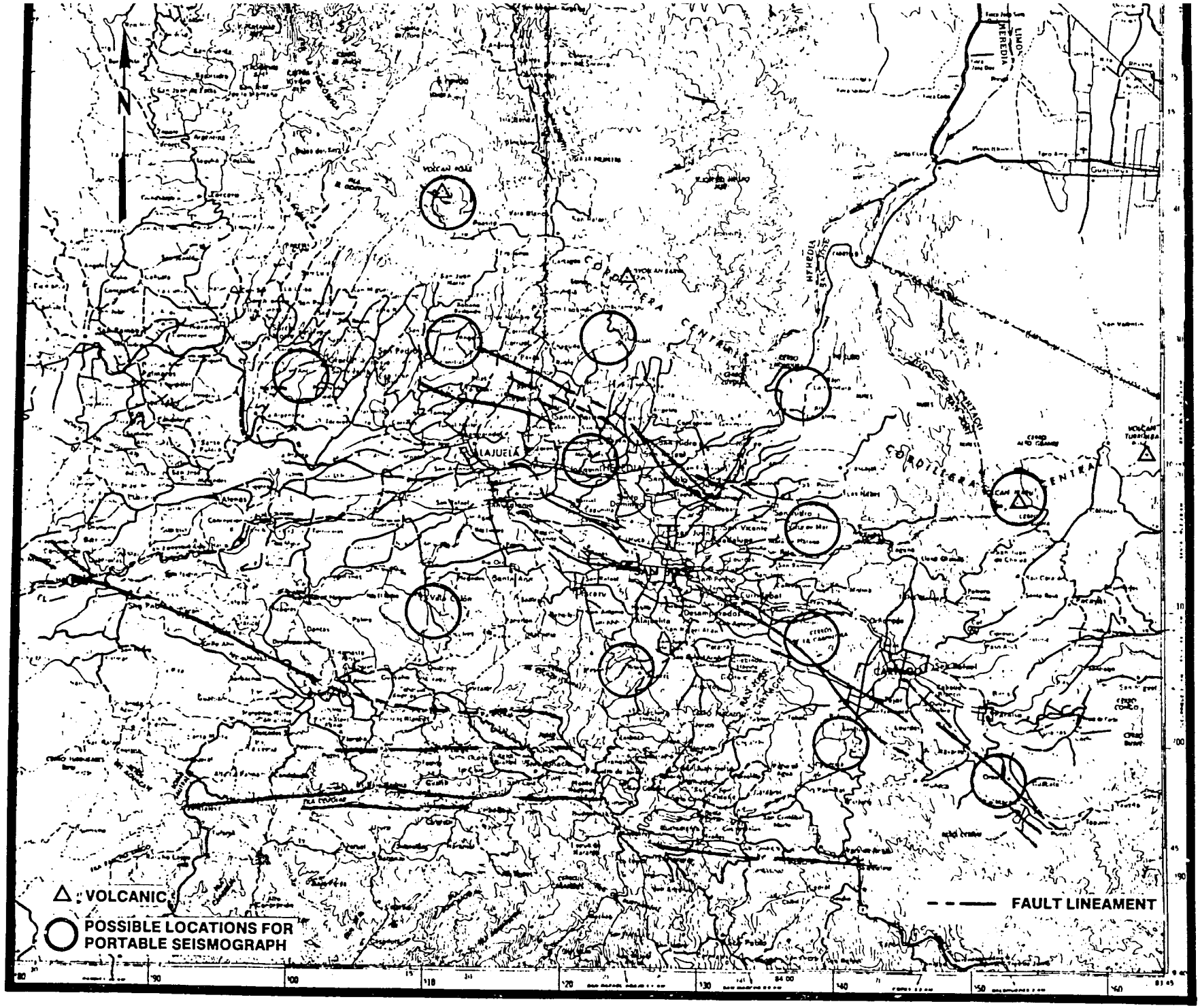


Figure 5. Preliminary fault lineament map with proposed seismograph network

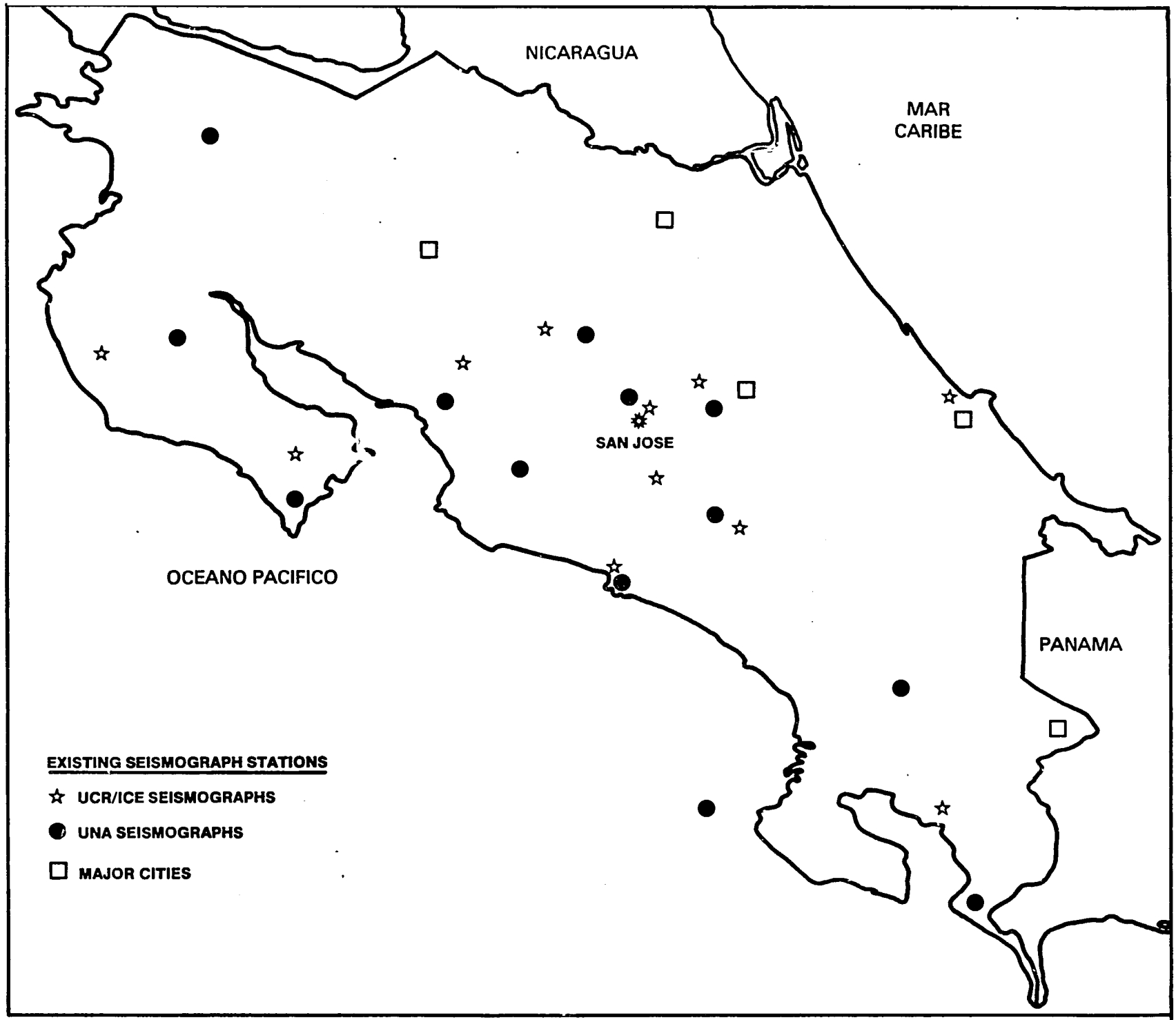


Figure 6 Existing Seismograph network in Costa Rica

4.5 Planned Activities for the Strong Motion Task (Task V)

During FY89, the equipment identified will be purchased and shipped to Costa Rica. The majority of the components are spare parts. This will help assure the continued operation of the accelerograph network.

In addition to analyzing data, INII will initiate a program to evaluate the physical properties of the soils in the Valle Central to assess their anticipated behavior in earthquakes (both far and near source earthquakes). This investigation will result in a preliminary ground response map for the Valle Central. The Consultants will provide technical assistance to INII to train the investigators in making preliminary evaluations and to prepare a map.

To properly interpret accelerograms for local and regional earthquakes, INII will also run geophysical lines at the sites of their instruments to have specific site information. The data collected will then be more meaningful in terms of site specific ground response and refining the preliminary ground response map of the Valle Central. With the assistance of the Consultants, INII will provide input to the Colegio de Arquitectos y Ingenieros for possible revision of the building code currently in use for Costa Rica.

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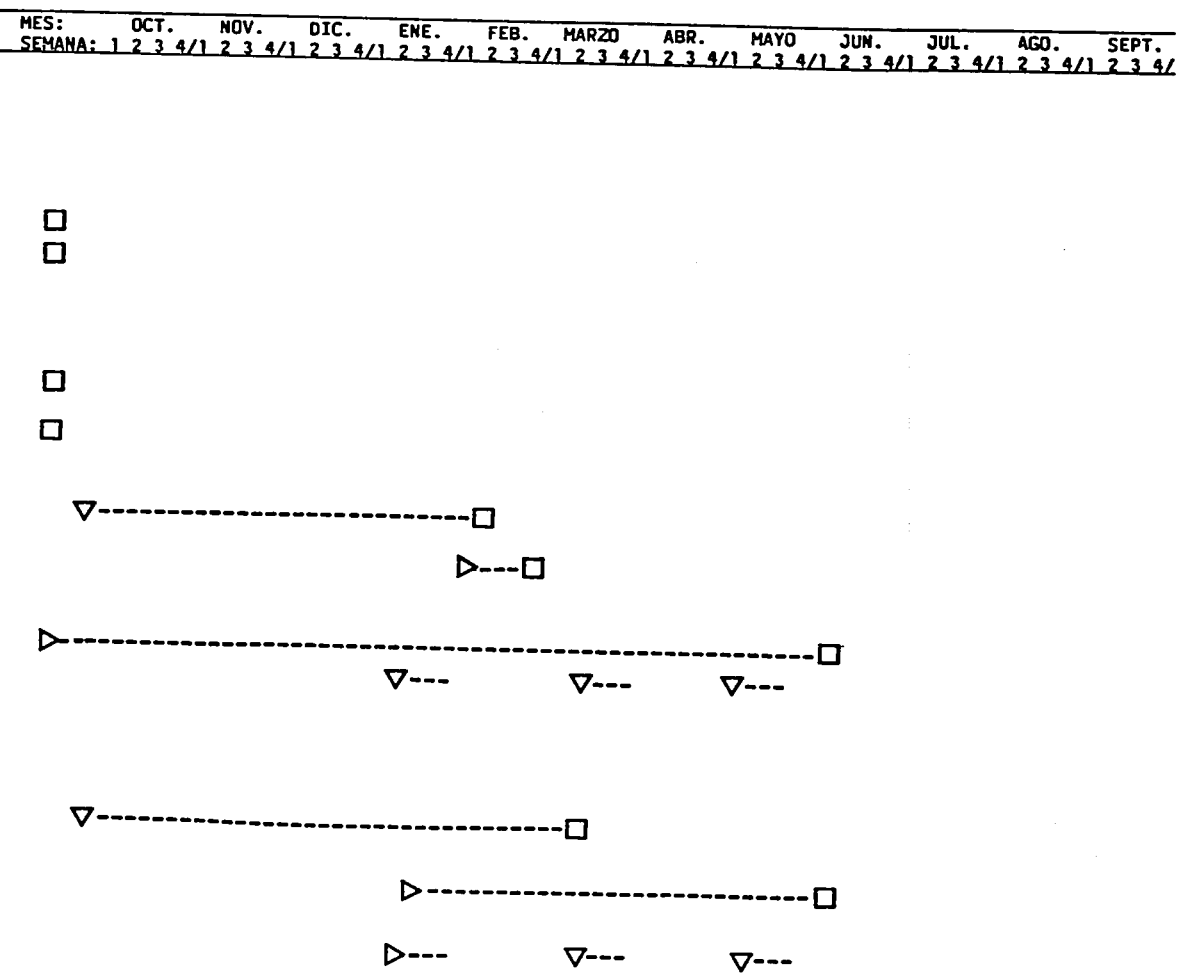
ATTACHMENT 1

TASK SCHEDULE FOR PLANNED FY89 MIRVYS ACTIVITIES

PROYECTO DE MITIGACION DE RIESGOS VOLCANICOS Y SISMICOS (MIRVYS)

PROGRAMACION DE TAREAS
OCTUBRE 1988 - SEPTIEMBRE 1989

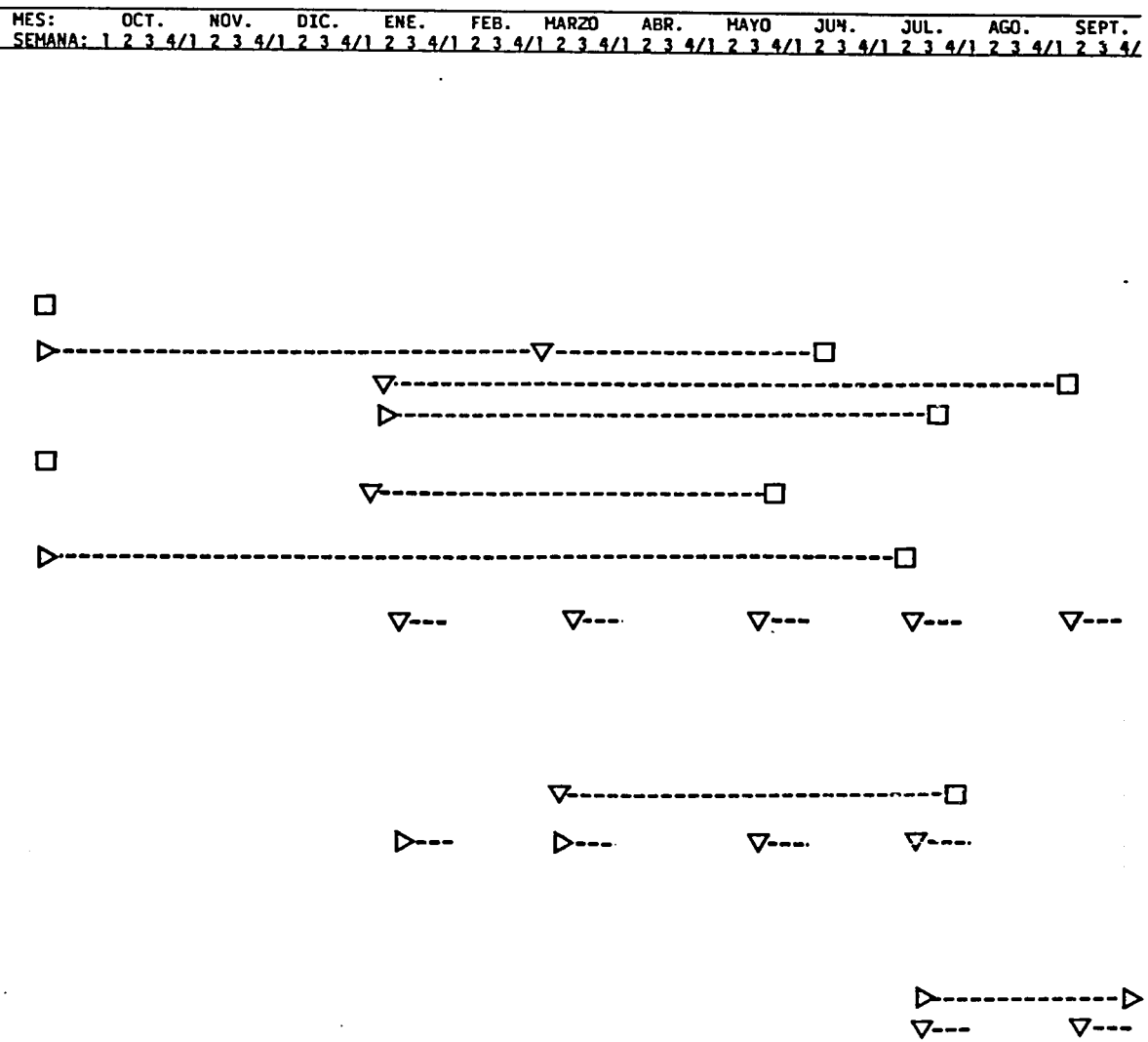
TAREA Y SUBTAREA	RESPONSABLE
I. INVESTIGACION DE FALLAS	
1. Compilacion y revision de los datos existentes	UCR
- recompilacion bibliografica	
* participacion de los Consultores en Costa Rica	
2. Preparacion de mapa preliminar de fallas y delineamientos utilizando aerofotografia y reconocimiento de campo	UCR
- mapa preliminar regional utilizando fotografia infrarroja	
- mapa preliminar del Valle Central utilizando fotos aereas de escala 1:60,000 (realizado por R. Madrigal)	
- comparacion/revision de mapas e intercambio de datos (realizado por R. Madrigal y M. Seeley)	
- mapa interpretativo preliminar (realizado por Madrigal, Denger, Montero, Alt y Cline)	
- comprobacion de campo de lineamientos y fallas seleccionados	
* participacion de los Consultores en Costa Rica	
3. Preparacion de mapa preliminar de deslizamientos generados por temblores utilizando aerofotografia y reconocimiento de campo	UCR
- mapa preliminar utilizando fotos aereas escala 1:60,000 (realizado por R. Mora)	
- mapa interpretativo preliminar comprobado mediante reconocimientos de campo (realizado por Mora, Montero, Alt, y Cline)	
* participacion de los Consultores en Costa Rica	



PROYECTO DE MITIGACION DE RIESGOS VOLCANICOS Y SISMICOS (MIRVYS)

PROGRAMACION DE TAREAS
OCTUBRE 1988 - SEPTIEMBRE 1989

TAREA Y SUBTAREA	RESPONSABLE
I. INVESTIGACION DE FALLAS (continuacion)	
4. Investigacion de campo dirigida a mapas geologicas especificas; excavaciones exploratorias, reconocimientos sismicos; y cronologia de desplazamientos de fallas y deslizamientos relacionados	UCR
- trabajos de campo en las terrazas del Rio Naranjo	
- trabajos de campo para mapear la escarpa de Alajuela	
- trabajos de campo para mapear los valles de Grosi y Cachi	
- trabajos de campo para mapear el valle del Rio Agua Caliente	
- reconocimientos de campo en el area de la falla Candelaria	
- trabajos de campo para mapear las quebradas y canteras de San Jose y Cartago	
- trabajos de campo para mapear areas de deslizamientos en la region del Valle Central	
* participacion de los Consultores en Costa Rica	
5. Analisis de informacion para correlaciones de fallas con sismos; evaluacion de fallas en conexion con actividad cuaternaria tardia; y evaluacion de deslizamientos en cuanto a su relacion con temblores.	UCR
- comparacion e evaluacion de los datos historicos	
* participacion de los Consultores en Costa Rica	
6. Preparacion de mapa preliminar de fallas y deslizamientos del Valle Central utilizando mapas de 1:50,000 y fallas de actividad cuaternaria conocida	UCR
- preparacion del mapa	
* participacion de los Consultores en Costa Rica	



PROYECTO DE MITIGACION DE RIESGOS VOLCANICOS Y SISMICOS (MIRVYS)

PROGRAMACION DE TAREAS
OCTUBRE 1988 - SEPTIEMBRE 1989

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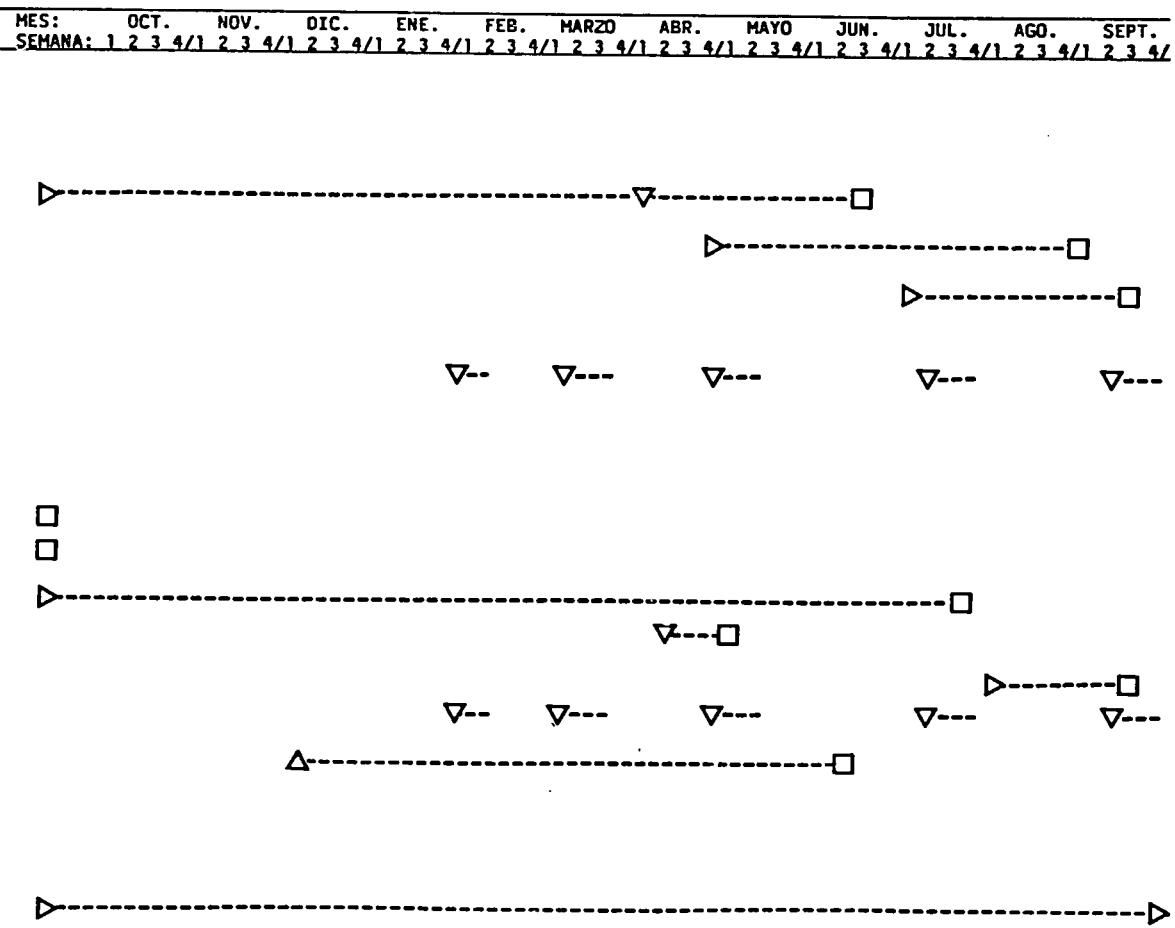
TAREA Y SUBTAREA	RESPONSABLE
I. INVESTIGACION DE FALLAS (continuacion)	
7. Zonificacion preliminar de fallas de superficie y riesgos de deslizamiento	UCR
- preparacion del mapa	
* participacion de los Consultores en Costa Rica	
8. Preparacion de informes anuales basicos sobre nuevas fallas, deslizamientos asociados y nuevos hallazgos sobre fallas cuaternarias tardias y deslizamientos en el Valle Central	UCR
* participacion de los Consultores en Costa Rica	
II. INVESTIGACION DE RIESGOS VOLCANICOS	
1. Compilacion y revision de informacion existente	UNA
- recompilaciones bibliograficas	
* participacion de los Consultores en Costa Rica	
2. Investigaciones de campo de cimas y laderas de los centros volcanicos incluyendo estilo eruptivo y modo de emplazamiento de las unidades clave; espesor de las unidades clave; edad de las unidades clave; y sintesis historica de cada centro volcanico	UNA
- investigaciones de campo en el area del Volcan Poas	
- investigaciones de campo en el area del Volcan Irazu	
- preparacion de un mapa preliminar de zonas de riesgos volcanicos del Volcan Poas y del Volcan Irazu	

PROYECTO DE MITIGACION DE RIESGOS VOLCANICOS Y SISMICOS (MIRVYS)

PROGRAMACION DE TAREAS
OCTUBRE 1988 - SEPTIEMBRE 1989

TAREA Y SUBTAREA	RESPONSABLE
II. INVESTIGACION DE RIESGOS VOLCANICOS (continuacion)	
2. (continuacion) - investigaciones de campo en el area del Volcan Turrialba - investigaciones de campo en el area del Volcan Barva - preparacion de un mapa preliminar de zonas de riesgos volcanicos del Volcan Turrialba y del Volcan Barva * participacion de los Consultores en Costa Rica	
3. Investigacion de campo de la estratigrafia volcanica del Valle Central en las proximidades de San Jose y Cartago - recompilacion de datos existentes de pozos de perforacion de SENARA - reconocimientos de campo para identificar sitios de estudios - levantamientos de secciones estratigraficas - preparacion de un informe de progreso - preparacion de informe final * participacion de los Consultores en Costa Rica	UCR
4. Complementar la instrumentacion de volcanes seleccionados mediante la instalacion de inclinometros y sismografos * participacion de los Consultores en Costa Rica	UNA
5. Continuar la supervision pasiva de volcanes seleccionados	UNA



PROYECTO DE MITIGACION DE RIESGOS VOLCANICOS Y SISMICOS (MIRVYS)

PROGRAMACION DE TAREAS
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TAREA Y SUBTAREA	RESPONSABLE
II. INVESTIGACION DE RIESGOS VOLCANICOS (continuacion)	
6. Identificacion y delimitacion de areas de riesgos volcanicos	UNA
- analisis y sentesis de los datos provenientes de las tareas II.2 y II.3	
- preparacion de mapa e informe final	
* participacion de los Consultores en Costa Rica	
7. Preparacion de informes basicos sobre actividad volcanica reciente y nuevos hallazgos sobre actividad cuaternaria tardia	UNA
* participacion de los Consultores en Costa Rica	
III. INVESTIGACION DE PELIGROS SISMICOS	
1. Producir catalogos sismicos mensuales y anuales conteniendo informacion basica de una red nacional unificada, con datos de la UNA, UCR, y ICE, y mantener un archivo/base de datos accesibles de las tres instituciones	UNA
- catalogo mensual	
- catalogo anual	
- propuesta a MIRVYS sobre programacion de integracion	
- respuesta de la Comision MIRVYS	
- primer intercambio de datos	
* participacion de los Consultores en Costa Rica	

PROYECTO DE MITIGACION DE RIESGOS VOLCANICOS Y SISMICOS (MIRVYS)

PROGRAMACION DE TAREAS
OCTUBRE 1988 - SEPTIEMBRE 1989

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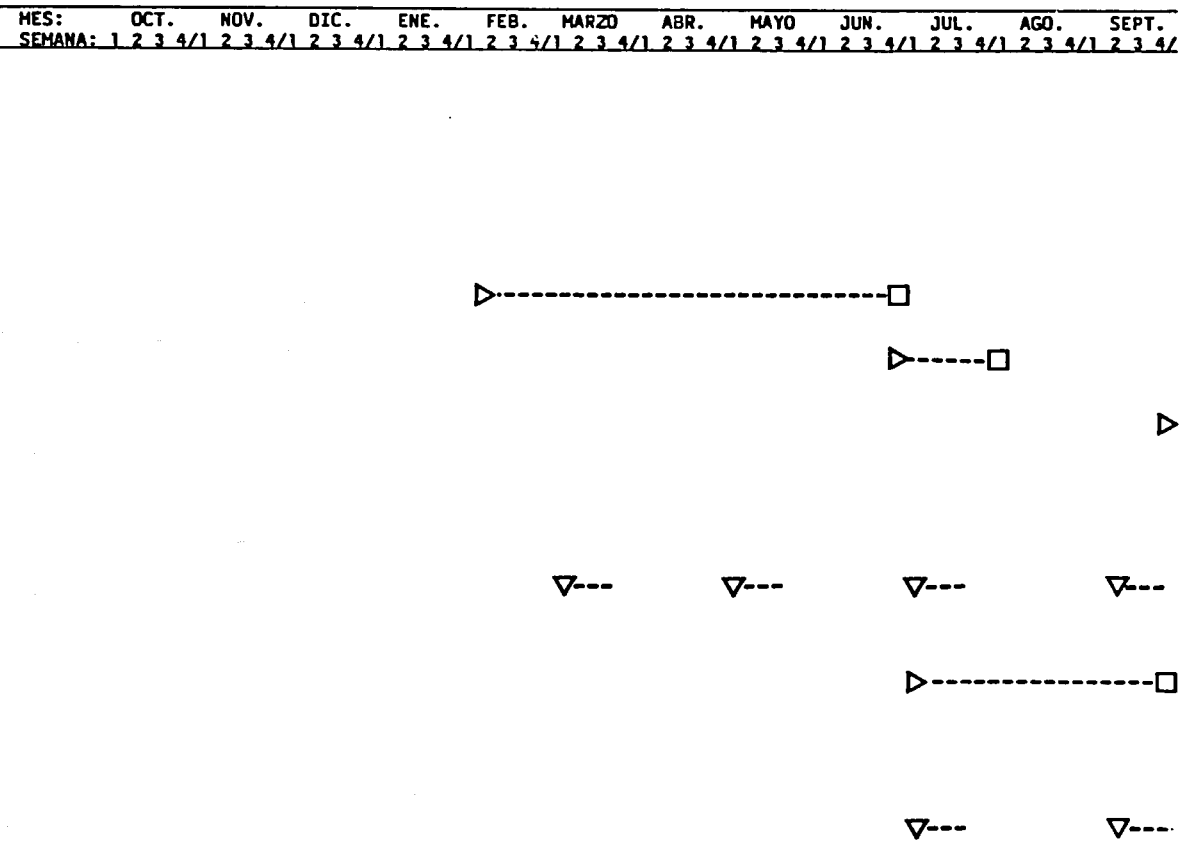
TAREA Y SUBTAREA	RESPONSABLE
III. INVESTIGACION DE PELIGROS SISMICOS (continuacion)	
2. Producir un modelo de velocidades de la corteza y ecuaciones de magnitud aceptables para el analisis de datos en cooperacion con la UCR y el ICE	UNA
- revision de la propuesta	
- informe de factibilidad	
- informe sobre costos	
- preparacion de la red sismica	
- explosion	
* participacion de los Consultores en Costa Rica	
3. Identificar fuentes sismicas en el Valle Central utilizando datos existentes y una red portatil para la evaluacion de fallas y actividad volcanica	UCR
- revision de datos historicos y seleccion de eventos superficiales	
- graficar eventos historicos en el mapa #I-2 (1:200,000)	
- presentar un informe identificando fuentes sismicos potenciales	
- seleccion de sitios para un red de estaciones portatiles	
- instalacion de un red de sismografos portatiles (incluyendo reparacion de equipos)	
* participacion de los Consultores en Costa Rica	

PROYECTO DE MITIGACION DE RIESGOS VOLCANICOS Y SISMICOS (MIRVYS)

PROGRAMACION DE TAREAS
OCTUBRE 1988 - SEPTIEMBRE 1989

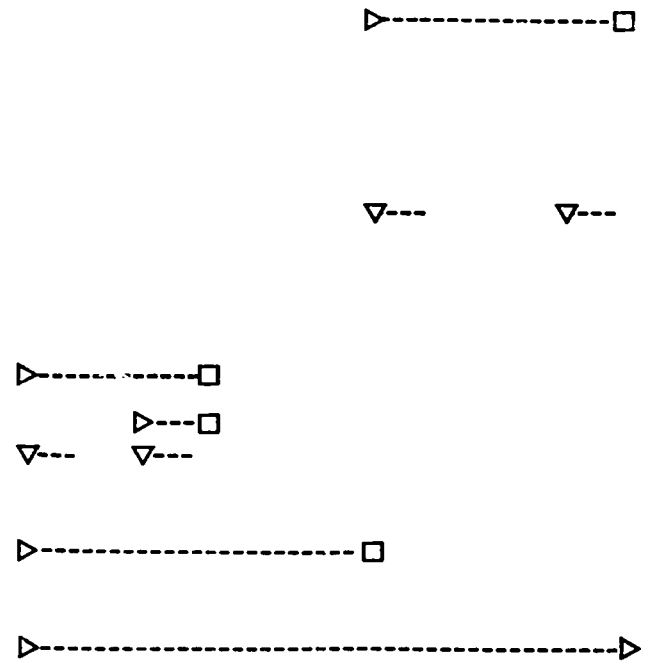
TAREA Y SUBTAREA	RESPONSABLE
III. INVESTIGACION DE PELIGROS SISMICOS (continuacion)	
4. Identificar fuentes sismicas regionales utilizando datos existentes para la evaluacion de fallas y actividad volcanica	UNA
- revision de datos historicos y seleccion y re-evaluacion de eventos superficiales	
- graficar eventos historicos en el mapa regional #I-2 (1:200,000)	
- presentar un informe identificando fuentes sismicos potenciales	
- seleccion de sitios para un red de estaciones portatiles	
- instalacion de un red de sismografos portatiles (4-6 meses) (incluyendo reparacion de equipos)	
* participacion de los Consultores en Costa Rica	
5. Preparar informes basicos que incluyan graficado epicentral basado en datos de la red portatil y otras estaciones del Valle Central; graficado epicentral de sismos registrados que puedan ser relacionados a fallas y/o zonas fuente; cortes de sismicidad; y reportaje sobre la sismicidad del Valle Central	UCR
* participacion de los Consultores en Costa Rica	



PROYECTO DE MITIGACION DE RIESGOS VOLCANICOS Y SISMICOS (MIRVYS)

PROGRAMACION DE TAREAS
OCTUBRE 1988 - SEPTIEMBRE 1989

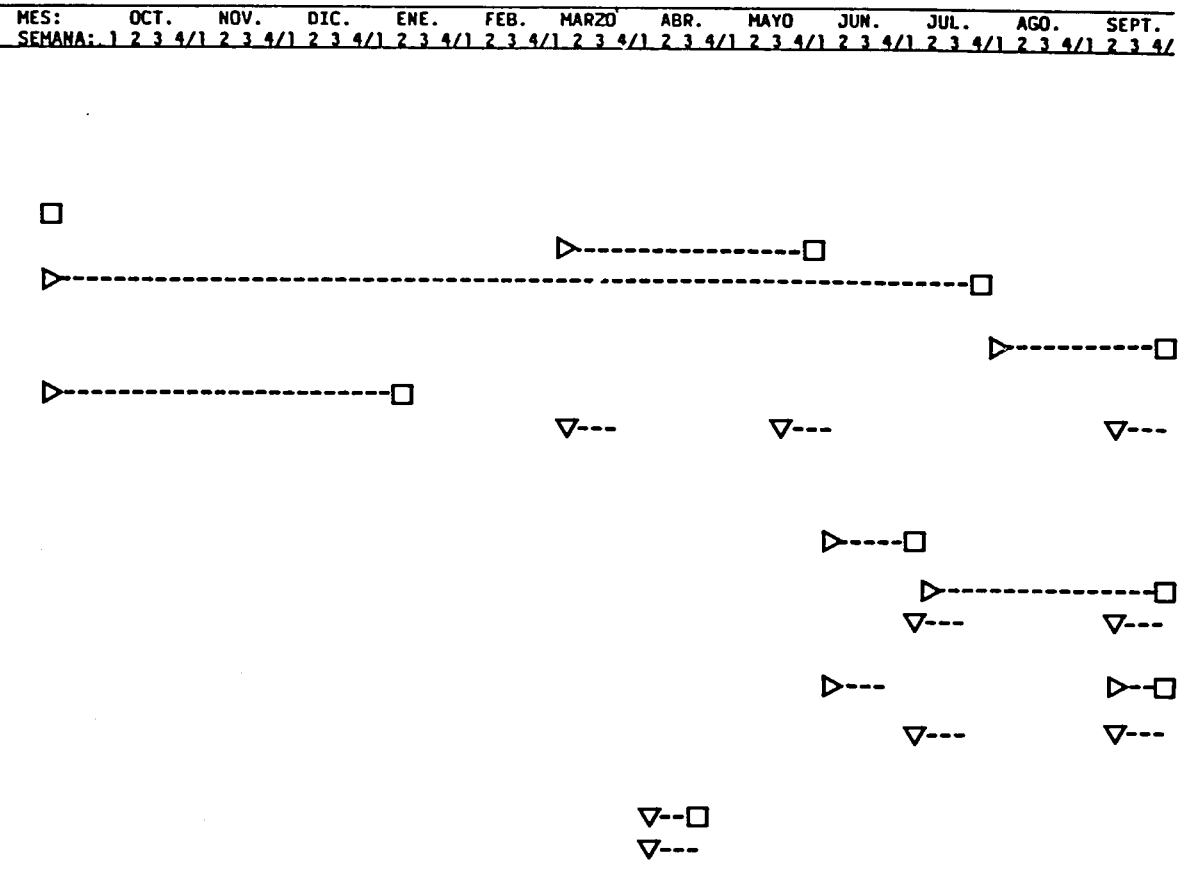
TAREA Y SUBTAREA	RESPONSABLE
III. INVESTIGACION DE PELIGROS SISMICOS (continuacion)	
6. Preparar informes basicos que incluyan graficado epicentral basado en datos de estaciones de la region; graficado epicentral de sismos registrados que puedan ser relacionados a fallas y/o zonas fuente; cortes de sismicidad; y reportaje sobre la diferentes zonas fuente de la region	UNA
* participacion de los Consultores en Costa Rica	
IV. INGENIERIA GEOTECNICA	
1. Compilar datos de las propiedades fisicas de la subsuperficie del Valle Central	ICE
- compilacion y sintesis de datos existentes (pozos y geofisica)	
- preparacion de un informe de propiedades de suelos	
* participacion de los Consultores en Costa Rica	
2. Proveer servicios de excavacion	ICE
- excavacion de las trencheras	
3. Proveer apoyo a las investigaciones en geologia, volcanologia, sismologia e ingenieria sismica a las instituciones participantes	
- proveer apoyo tecnico	



PROYECTO DE MITIGACION DE RIESGOS VOLCANICOS Y SISMICOS (MIRVYS)

PROGRAMACION DE TAREAS
OCTUBRE 1988 - SEPTIEMBRE 1989

TAREA Y SUBTAREA	RESPONSABLE
V. RED DE ACELEROGRAFOS	
1. Evaluar el emplazamiento de los acelerografos	UCR
- impacto ambiental y cultural	
- evaluacion de la configuracion de la red	
- evaluacion de los substratos de sitios propuestos (incluyendo reconocimientos geofisicos)	
- presentacion del mapa y descripciones de sitios al Colegio	
- compilacion de datos existentes de sitios especificos	
* participacion de los Consultores en Costa Rica	
2. Evaluacion preliminar de la respuesta de corteza del Valle Central	UCR
- analisis del informe de ICE sobre propiedades de suelos	
- preparacion de mapa de zonificacion	
* participacion de los Consultores en Costa Rica	
3. Evaluar las necesidades para un nuevo codigo de construcciones	UCR
* participacion de los Consultores en Costa Rica	
4. Cursos de entrenamiento tecnico en mantenimiento è operacion de equipos	UCR
* participacion de los Consultores en Costa Rica	



PROYECTO DE MITIGACION DE RIESGOS VOLCANICOS Y SISMICOS (MIRVYS)

PROGRAMACION DE TAREAS
OCTUBRE 1988 - SEPTIEMBRE 1989

TAREA Y SUBTAREA	RESPONSABLE	MES: OCT.	NOV.	DIC.	ENE.	FEB.	MARZO	ABR.	MAYO	JUN.	JUL.	AGO.	SEPT.
		SEMANA: 1 2 3 4/1	2 3 4/1	2 3 4/1	2 3 4/1	2 3 4/1	2 3 4/1	2 3 4/1	2 3 4/1	2 3 4/1	2 3 4/1	2 3 4/1	2 3 4/
V. RED DE ACELEROGRAFOS (continuacion)													
5. El procesamiento de los datos generados por los instrumentos. Digitalizacion, correcciones, analisis y publicacion	UCR												
- digitalizacion, correcciones, analisis y publicacion		▷----------	----------	----------	----------	----------	----------	----------	----------	----------	----------	----------	----------▷
* participacion de los Consultores en Costa Rica				▽---		▽---		▽---			▽---		▽---
6. Estudio de factibilidad para la integracion de los datos de UCR/INII/ICE								▷--□					
* participacion de los Consultores en Costa Rica								▽---					

ATTACHMENT 2

PRELIMINARY REGIONAL LINEAMENT ANALYSIS AND
DESCRIPTION OF LINEAMENTS
IDENTIFIED FROM 1:80,000 SCALE
INFRARED AERIAL PHOTOGRAPHY

PRELIMINARY REGIONAL LINEAMENT ANALYSIS
COSTA RICA GEOLOGIC HAZARDS STUDY
VALLE CENTRAL, COSTA RICA

1.0 INTRODUCTION

The study of lineaments can be useful in detecting the presence of faults, but lineament studies are only one of several methods of detecting faults, and the usefulness of such studies varies from area to area. Factors such as type and scale of imagery, terrain, geology, vegetative cover, climate, and cultural development all affect the usefulness of the method. In this particular study area the youthfulness of some of the geologic formations is an additional limitation. Widespread late Quaternay volcanic deposits can mask some active and potentially active faults.

This Basic Data Report presents an evaluation and documentation of lineaments detected during a preliminary analysis of large scale (1:80,000) color infrared (IR) aerial photography of the Valle Central region of Costa Rica.

2.0 OBJECTIVE OF TASK

The objectives of this task were 1) to conduct a preliminary lineament analysis of regional color IR air photos, 2) identify regional lineaments that are potentially fault related or warrant further evaluation from through air photo analysis or field reconnaissance, and 3) to document the lineament analysis method. Each lineament that was identified on the color IR photographs was evaluated in a preliminary way with regard to its potential for being fault related.

3.0 METHOD

The images used during this task were color IR stereo-pair transparencies at a scale of 1:80,000 taken in March, June and July 1984. Analysis was made by a geologist experienced in air photo interpretation using a light table and a Leitz/Sokkisha MS-27 mirror stereoscope with 3X power optics. During analysis of the photos, lineaments were identified, and the "significant" and "possibly significant" lineaments were selected for further analysis. Those lineaments that appeared to have a high to moderate potential for being faults were plotted on the transparencies, numbered and documented on lineament analysis forms (attached). Those lineaments are recommended for additional aerial photo analysis or for field reconnaissance to determine the origin of the linear features and to further evaluate whether or not they are faults.

This preliminary analysis is not intended to be definitive in scope but rather to select target areas for further more detailed study.

4.0 SCOPE

The lineaments were evaluated based on geomorphic expression and color tone contrasts and alignments. No trenches were excavated across any of the lineaments nor were any geophysical surveys conducted across the lineaments. Mapped geology was not available and so it was not used in the evaluations. The evaluations in this Basic Data Report are based entirely on geomorphic and vegetative evidence as interpreted from the imagery. Lineaments that were very subtle and/or apparently cultural were not plotted or documented. Likewise very short lineaments, not part of a longer regional trend were not plotted or documented. The specific air photos interpreted for this study are as follows:

R-4, L-8 SE,	Frames 5	through 11,	July 4,	1987
R-5, L-6 SE,	Frames 27	through 31,	March 4,	1984
R-5, L-7 N,	Frames 65	through 71,	March 4,	1984
R-5, L-9 N,	Frames 117	through 124,	June 4,	1984
R-5, L-10 SE,	Frames 132	through 141,	June 4,	1984

The photo quality was excellent and there was no cloud cover. The lineaments were plotted directly on the air photo transparencies and numbered sequentially from L-1 to L-8. The attached Lineament Analysis forms document observations and interpretations. The lineaments were not plotted on topographic maps at this time.

5.0 DATES OF WORK ON TASK

The task commenced on June 1, 1988 and was completed on June 10, 1988. Approximately 32 man hours were required to complete this task (logistics, interpretation documentation and report preparation).

6.0 LINEAMENTS

There were basically two types of lineaments evaluated and documented during this task. These included lineaments with geomorphic expression such as breaks in slope, linear valleys, aligned notches, and linear stream segments. The second type of lineaments were those defined by vegetative contrasts and alignments which were observable on flat terrain as well as on hillslopes. Most of the lineaments are complex and include segments of both types of lineaments. Short lineaments (less than 1 km in length) were not considered important unless they were part of a longer structural trend. Generally only lineaments comprising zones longer than about 2 km were plotted

and documented. As described below only "significant" lineaments were evaluated.

The "significance" of a lineament in this study was based on evaluation of the six characteristics:

1. The length of the lineament and its relationship to other lineaments in a regional trend.

2. The prominence of the lineament (the strength of its geomorphic and/or vegetative expression).

3. The photogeologic interpretation of the lineament (i.e. not cultural and likely related to structure).

4. The relationship of the lineament to the geology as interpreted from the air photos.

These characteristics are discussed in more detail in the following paragraphs.

6.1.1 Length

Lineaments as short as 1 km were studied in the photo analysis for this task. However, the shortest lineament plotted was approximately 4 1/2 km long and it was part of a longer regional trend (L-5). In general, the longer the lineament the more significant it is because of the potential for it being related to a significant seismic source. For this reason, length of the lineament was chosen as one criteria in determining the significance of the lineament.

6.1.2 Prominence

The prominence scale is an important characteristic used for this study in the evaluation of the significance of lineaments. The scale consists of three ratings; "subtle", "moderate", and "strong". These ratings are brief verbal descriptions of the visual prominence of the lineaments as observed on the imagery. This classifications scale is, of course, subjective, as are almost all air photo interpretation classifications. Since many subtle lineaments are often no more than unrelated alignments of tone contrasts and/or topographic features, this part of the evaluation is useful in helping to identify and screen out lineaments that are fortuitous alignments, and not in any way related to structure or to fault caused soil developments or vegetative contrasts.

Identification of subtle lineaments is often very subjective. Different image analysts may not detect the same subtle lineaments, or may interpret the same subtle lineaments in

different ways. Strong lineaments are the most distinct lineaments which show up readily on the imagery, sometimes without the aid of a stereoscopic view. The identification of the "strong" lineaments is the least subjective. "Moderately" pronounced lineaments are judged to be more significant than "subtle" lineaments. In regional interpretations subtle lineaments are usually not considered important. If they are short and isolated their significance is even less.

6.1.3 Photogeologic Interpretation

The third characteristic used in this lineament analysis (and one that is given somewhat more weight than the prominence scale) is the photogeologic interpretation. This characteristic considers the interpretation of what the lineament is caused by. If, for example, the lineament is, with a great deal of certainty, determined to be purely an erosional feature along a lithologic contact, this would have a strong impact in determining the lineament to be either "not significant" or only "possibly significant". However, if the photogeologic interpretation suggests that the lineament might be jointing or some other structural feature, this might (depending on its relationship to other regional trends) result in the lineament being categorized as either "significant" or "possibly significant". Thus, it can be seen that the photogeologic interpretation characteristic is subjective, but at the same time it is useful because it sometimes attaches quantitative or definite causes to the lineament. If a definite cause can be determined then the significance of the lineament can be more readily determined.

6.1.4 Relationship to Interpreted Geology

The fourth characteristic used in determining "significance" of lineaments for this study is the relationship of the lineament to the geology. In this study, mapped geology was not available, however interpretation of geology was possible to a certain extent. For example, volcanic flows, Quaternay alluvium, and sedimentary bedrock terrains could be differentiated.

The relationship to geology is both significant and useful in selecting lineaments to be studied further on larger scale air photos or in the field. For example, if a lineament is crossed by a marker bed or by a geologic contact and the marker bed or the contact is not displaced and in no way affected by the lineament, then the potential for the lineament to be fault related is low and it would have a low priority to be field checked. Lineaments which are not interpreted to have such relationships to the geology are generally considered to be either "possibly significant" or "significant", depending on the other criteria.

6.2 Criteria for Determining "Significance" of Lineaments

Since all regional lineaments judged to be "possibly significant" or "significant" were plotted on the photos and documented, whether they were categorized as either "possibly significant" or "significant" is not of critical importance. However, it is important to note that lineaments could only be categorized as being "not significant" if they met a set of very conservative criteria.

The criteria for determining lineaments to be not significant are outlined below.

A. Lineaments were categorized as being "not significant", and were not plotted on the photos, nor documented if any of the following criteria were met:

   1. The lineament is less than 1 km long and is not part of a lineament trend.

   2. The lineament is crossed by a marker bed or geologic contact that is not displaced and shows no geomorphic or photogeologic expression indicative of faulting.

   3. The lineament is interpreted to be cultural in origin.

   4. The lineament is along a geologic contact and there is no evidence of the contact being disconformable or otherwise fault related.

All lineaments categorized as "significant" or "possibly significant" are recommended for further study.

6.3 Conclusions

Although the study accomplished for this task was not able to determine the exact cause of many of the lineaments which were identified, it did determine that there are at least eight regional lineaments in the Valle Central area that have a reasonable potential to be faults. This does not imply that there are no other such lineaments that could be faults. Nor does it imply that the eight identified lineaments are active faults. As discussed in the introduction, there are limitations to the methodology. The use of other types of imagery, correlation of interpretations with mapped geology, and field and/or air reconnaissance could result in the identification of additional lineaments that are potentially fault related. Such studies are also needed to evaluate further the origin of the eight documented lineaments.

LINEAMENT ANALYSIS FORM LINEAMENT NO. L-1

I. AREA: Valle Central, Costa Rica, IMAGE ANALYST: MWS
Image Type: Color IR
Image No.: R-5 #66, Image Date: 3-4-84
Image Scale: 1:80,000

II. ORIENTATION:

Map Measure: NW,
LENGTH: Photo measure: 5 1/2" (6.9 mi, 11 km),
Comments: appears to parallel regional geologic structure
FORM: linear

III. NATURAL FEATURES DEFINING LINEAMENT

1. Veg. Type: contrast and alignment
Comments: both types in various places

2. Veg. Tone: contrast
Comments: in some places

3. Topographic: break in slope
Comments: along the side of a linear valley

4. Springs: none observed
Comments:

5. Groundwater Barrier: none observed
Comments:

6. Displacement: not known
Comments: none apparent

7. Other: Strong to moderate expression

IV. PHOTOGEOLOGIC INTERPRETATION

Fairly prominent feature, potentially related to bedding and or regional jointing.

V. PLACES TO FIELD CHECK

There are a number of places where roads and streams cross it. There should be good exposures in these cuts. After plotting on map these locations can be identified.

LINEAMENT ANALYSIS FORM LINEAMENT NO. L-2

I. AREA: Valle Central, Costa Rica, IMAGE ANALYST: MWS
Image Type: Color IR
Image No.: R-5 #65-#69, Image Date: 3-4-84
Image Scale: 1:80,000

II. ORIENTATION:

Map Measure: NW
LENGTH: Photo measure: 13", (16 mi, 26 km)
FORM: Sinuous,

III. NATURAL FEATURES DEFINING LINEAMENT

1. Veg. Type: contrast and alignment
Comments: varies along the lineament

2. Veg. Tone: contrast and alignment
Comments: varies along the lineament

3. Topographic: linear valley(s), depression, break in slope
Comments: breaks in slope are most common, there are also a few depressions and linear valleys

4. Springs: not observed
Comments:

5. Groundwater Barrier: not observed
Comments:

6. Displacement: ?
Comments: Evidence of displacement not readily observable

7. Other: The expression of the lineament varies from strong to moderate.

IV. PHOTOGEOLOGIC INTERPRETATION

Appears to be structural, possibly a fault

V. PLACES TO FIELD CHECK

After plotting on map, select accessible river/stream banks and road cuts.

LINEAMENT ANALYSIS FORM LINEAMENT NO. L-3

I. AREA: Valle Central, Costa Rica, IMAGE ANALYST: MWS
Image Type: Color IR
Image No.: R-5 L-9N0 #118, Image Date: 6-4=84
Image Scale: 1:80,000

II. ORIENTATION:

Measure: SW,
LENGTH: photo measure: 3 1/2" (4 1/2 mi, 7 km).
FORM: sinuous,

III. NATURAL FEATURES DEFINING LINEAMENT

1. Veg. Type: contrast and alignment
Comments:

2. Veg. Tone: contrast
Comments: only in a few places

3. Topographic: Break in Slope
Comments: Notches in spur ridges

4. Springs: not observed
Comments:

5. Groundwater Barrier: not observed
Comments:

6. Displacement: not observed
Comments:

7. Other: Moderate Expression

IV. PHOTOGEOLOGIC INTERPRETATION

Possible fault

V. PLACES TO FIELD CHECK

After plotting on map, look at road map for road cut locations; There appear to be a few stream cuts where exposures may be found

LINEAMENT ANALYSIS FORM LINEAMENT NO. L-4

I. AREA: Valle Central, Costa Rica, IMAGE ANALYST: MWS
Image Type: Color IR
Image No.: R-5 L-9NO #118, Image Date: 6-4-84
Image Scale: 1:80,000

II. ORIENTATION:

Measure: SW,
LENGTH: photo measure: 2 1/2" (3 mi, 4.8 km),
FORM: linear

III. NATURAL FEATURES DEFINING LINEAMENT

1. Veg. Type: no contrasts on alignments
Comments:

2. Veg. Tone: contrast
Comments:

3. Topographic: break in slope
Comments: notches in ridge

4. Springs: not observed
Comments:

5. Groundwater Barrier: not observed
Comments:

6. Displacement: possible
Comments: possibly in deflected drainage

7. Other: possible deflected drainages, moderate to weakly expressed

IV. PHOTOGEOLOGIC INTERPRETATION

Possible branch fault of a longer structure

V. PLACES TO FIELD CHECK

Stream cuts

LINEAMENT ANALYSIS FORM LINEAMENT NO. L-5

I. AREA: Valle Central, Costa Rica, IMAGE ANALYST: MWS
Image Type: Color IR
Image No.: R-5 L9NO#122-123-124,
Image Date: 6-4-84
Image Scale: 1:80,000

II. ORIENTATION:

Measure: NW
LENGTH: photo measure: 11" (14 mi, 22 km)
FORM: linear

III. NATURAL FEATURES DEFINING LINEAMENT

1. Veg. Type: contrast and alignment
Comments: subtle, discontinuous

2. Veg. Tone: contrast and alignment
Comments: discontinuous

3. Topographic: break in slope
Comments: alignment of notches in spur ridges; discontinuous

4. Springs: not observed
Comments:

5. Groundwater Barrier: not observed
Comments:

6. Displacement: possibly vertical
Comments:

7. Other: Complex series of parallel to subparallel, mostly subtle lineaments, pattern is suggestive of tectonic range front structure. Overall moderately expressed.

IV. PHOTOGEOLOGIC INTERPRETATION

Could be a regional fault structure and/or related to jointing.

V. PLACES TO FIELD CHECK

Numerous road/stream cuts

LINEAMENT ANALYSIS FORM LINEAMENT NO. L-6

I. AREA: Valle Central, Costa Rica, IMAGE ANALYST: MWS
Image Type: Color IR
Image No.: R5-L9 NO#124, Image Date: 6-4-84
Image Scale: 1:80,000

II. ORIENTATION:

Photo Measure: NW
LENGTH: Photo measure: 3 1/2" (4.4 mi, 7 km)
FORM: linear

III. NATURAL FEATURES DEFINING LINEAMENT

1. Veg. Type: no contrasts or alignments
Comments:

2. Veg. Tone: contrast
Comments: slight

3. Topographic: break in slope
Comments: predominant break in slope

4. Springs: not observed
Comments:

5. Groundwater Barrier: not observed
Comments:

6. Displacement: possible vertical
Comments: may be associated with foldingas well as faulting.

7. Other: Appears to be Alajuela escarpment. There are a number of short branch lineaments. Down slope is a parallel lineament and between the two, there appears to be graben.

IV. PHOTOGEOLOGIC INTERPRETATION

This appears to be a structural feature, probable fault. It might be structurally related to L-7.

V. PLACES TO FIELD CHECK

Numerous road cuts, quarries, stream cuts; needs closer look with larger scale air photos.

LINEAMENT ANALYSIS FORM LINEAMENT NO. L-7

I. AREA: Valle Central Costa Rica, IMAGE ANALYST: MWS
Image Type: Color IR
Image No.: R-5,L6-SE, #29, Image Date: 3/4/84
Image Scale: 1:80,000

II. ORIENTATION:

Photo Measure: NW, Comments: strong, prominent feature
LENGTH: Photo measure: 13" (16 mi, 26 km), Comments: may be longer.
FORM: linear, Comments: sinuous in places

III. NATURAL FEATURES DEFINING LINEAMENT

1. Veg. Type: not observed
Comments:

2. Veg. Tone: contrast
Comments: in some places

3. Topographic: linear valleys, break in slope
Comments: break in slope near base of slopes and higher up along side of range front slopes, aligned drainage.

4. Springs: not observed
Comments:

5. Groundwater Barrier: not observed
Comments:

6. Displacement: vertical ?
Comments: possible

7. Other: Major structural lineament, strongly expressed.

IV. PHOTOGEOLOGIC INTERPRETATION

Possible jointing and/or fault

V. PLACES TO FIELD CHECK

Possibly along river, few roads, access does not look good.

LINEAMENT ANALYSIS FORM LINEAMENT NO. L-8

I. AREA: Valle Central Costa Rica, IMAGE ANALYST: MWS
Image Type: Color IR
Image No.: R-4, L8SE #9, Image Date: 7-4-84
Image Scale: 1:80,000

II. ORIENTATION:

Photo Measure: NW
LENGTH: Photo measure: 6"(7 1/2 mi, 12 km)
FORM: linear and arcuate, Comments: form varies along trend.

III. NATURAL FEATURES DEFINING LINEAMENT

1. Veg. Type: not observed
Comments:

2. Veg. Tone: contrast
Comments: in flatter area (valley) and along base of slopes

3. Topographic: linear valleys and notch in ridge
Comments: appears to parallel bedrock structure

4. Springs: possibly
Comments:

5. Groundwater Barrier: possibly in valley
Comments:

6. Displacement: not observed
Comments:

7. Other: Trends toward San Jose, should be looked at more closely with larger scale air photos, and in field reconnaissance.

IV. PHOTOGEOLOGIC INTERPRETATION

May be longer (appears to extend off of air photos), possibly a fault or mega joint.

V. PLACES TO FIELD CHECK

Bedrock outcrops in ridges, road cuts

ATTACHMENT 3

MINUTES OF THE JUNE, 1988 TASK III SUBCOMMITTEE MEETINGS
TO DEVELOP PLANS FOR INTEGRATION OF SEISMIC DATA

MINUTES OF MEETINGS ON MIRVYS TASK III: JUNE 21/22, 1988
San Jose, Costa Rica

PURPOSE: To finalize subtask contents and schedules for Task III, described in the draft Programacion de Tareas for the Mirvys Project.

JUNE 21, 1988

PARTICIPANTS: Geol. Ileana M. Boschini - ICE
Dr. Federico Güendell - UNA
M.Sc. Luis Diego Morales - UCR
Mr. Bill Foxall - RET/Weston

The meeting convened at 14:00 at the CNE office in San Jose.

Subtask 1

Güendell stated that the next meeting with the Vice-Minister of Science and Technology will be on July 7, when it is expected that significant progress towards agreement upon integration of the ICE, UCR and UNA seismic networks will be made. Following that meeting, a proposal for integration of the networks will be prepared by the three institutions for the MIRVYS Commission. The schedule for reconfiguration of the networks will be determined at that time.

It was agreed that the process of integrating data from the three separate networks to produce a single National Earthquake Data Base is to begin immediately. The primary objective of this process is to standardize data processing and analysis procedures in order to produce data of uniformly high quality.

It was agreed that F. Güendell will prepare a detailed plan for integration of the data for submission to the MIRVYS Executive Committee on June 31, 1988. The plan will be based upon the following items of agreement:

1. A Supervisory Panel, composed of I. Boschini (ICE), F. Güendell (UNA) and L.D. Morales (UCR), is to be responsible for executing the integration plan. The Panel will subsequently meet on a regular basis to evaluate data processing and analysis procedures, and to decide upon modifications to the procedures.

2. For as long as the seismic networks are operated separately, each institution will be responsible for reading the seismograms recorded by its network. P- and S-wave readings and time corrections will be transmitted to UNA on a weekly basis.

3. UNA will be responsible for computing earthquake hypocenters and other data that will be included in the National Earthquake Data

Base, for maintenance of the Data Base, and for publishing monthly and annual National Earthquake Bulletins.

4. The computerized Data Base will be freely available to the three institutions. To facilitate efficient transmission of data to UNA and access to the Data Base by UCR and ICE, RET will plan the installation of telephone data links and associated software (e.g., Kermit). Meanwhile, data will be transmitted on Diskettes.

5. The National Earthquake Bulletin will acknowledge the three institutions equally.

6. UCR and ICE will continue to publish a separate bulletin containing data from the LCR broad-band station.

7. The program HYPOINVERSE is adopted as the standard hypocenter location program. A modified (see Subtask 3) form of the HYPOINVERSE summary output format will be used for the Data Base.

8. The Supervisory Panel will decide upon standardized procedures for data processing and analysis, and the members of the Panel will work together to implement the standard procedures at each institution.

9. Copies of computer programs developed at each institution to manipulate the data base will be made available to the other institutions.

10. Seismograms from each network will be made freely accessible to the other institutions for research purposes, etc.

The plan for integration will be implemented immediately upon its approval by the MIRVYS Executive Committee.

Subtask 2

It was agreed that the deep seismic refraction experiment should be divided into two phases. The first phase will be a reversed profile along the Valle Central, the second an offshore-onshore profile. F. Güendell has already identified potential shot points for Phase 1, and has made preliminary contact with property owners.

Güendell committed seven UNA MEQ-800 seismographs plus seven UC Santa Cruz MEQ-800s to the experiment. UCR and ICE will each provide five MEQ-800s plus a twelve-channel shallow refraction seismograph. Some of the ICE and UCR seismographs need repairs, which should be completed before the experiment.

F. Güendell will revise the original proposal to provide a detailed description and cost estimate for Phase 1, and an outline of Phase 2. The proposal will be submitted to RET by July 5. B. Foxall will provide a cost estimate for explosives by June 30.

In the meantime, the Matumoto (1977) crustal velocity model as modified by UNA is adopted as the standard for analysis of regional data, and the model

developed by UCR for the Valle Central as the standard for Shallow Valle Central earthquakes.

L.D. Morales and I. Boschini left the meeting at 16:30. E. Güendell and B. Foxall discussed sources of data for Subtask 3.

June 22, 1988

PARTICIPANTS: Geol. Ileana Boschini - ICE
M.Sc. Luis Diego Morales - UCR
Mr. Dan Haymond - RET/Weston
Mr. Bill Foxall - RET/Weston

The meeting re-convened at 14:30 at UCR.

Subtask 3

L.D. Morales summarized progress to date on this subtask. UCR has assembled Costa Rican and international sources of data for significant Costa Rican earthquakes and produced a catalog of historical earthquakes. Magnitudes of earthquakes that occurred during the period 1822-1904 have been estimated from intensity data. Recent locations of larger events by F. Güendell and intensity studies by ICE will be added to this data set. UNA has USGS/NOAA/ISC teleseismic locations for Costa Rican earthquakes for the period 1904-1985 on diskette, a copy of which will be given to UCR.

Various seismic networks have been operated in Costa Rica for various periods of time since 1968, data from which have been compiled into separate catalogs. Different computer programs have been used to analyze the data, and the formats of the catalogs vary. It was agreed that a very important element of Subtask 3 is to make these data sets consistent by: (1) relocating the earthquakes, whenever possible, using the standard velocity models and computer program specified under Subtask 1, above, and (2) reformatting the catalogs to the standard format (see Subtask 1). These data can then be incorporated into the Data Base.

UNA has relocated all the earthquakes in their catalog since 1984 according to (1) above. It was agreed that the entire UNA catalog for the period 1984-present will be incorporated into the Data Base, with the addition of events contained in the UCR/ICE catalog that were not located by UNA. The latter events will be relocated as described above by UNA, using the original phase data (P and S arrival times) supplied by UCR/ICE.

Phase data and/or the catalogs themselves for some of the pre-1984 data sets have not been preserved as computer files. Therefore, to relocate some of the earthquakes the printed phase data would have to be re-entered into a computer manually. I. Boschini will investigate the availability and form of each of the data sets and catalogs, in consultation with UCR and UNA, in order to assess the practicability of relocating the events, and reformatting the

catalogs (see below).[1] It was agreed that UNA will be responsible for relocating events for which phase data can be produced in computer-readable form.

Catalogs that currently exist in computer-readable form (i.e., computer files) will be reformatted into HYPOINVERSE summary output format with the addition of entries for maximum felt intensity and the data source, using reformatting software that will be developed by UNA. I. Boschini will work with F. Güendell to determine the format.

Epicenter plots and cross-sections will be produced by computer to overlay 1:100,000 base maps. I. Boschini will discuss with ICE computer personnel the software requirements for plotting on ICE's MV-1000 system by June 31. F. Güendell and B. Foxall will look for suitable programs to manipulate the Data Base.

It was agreed that ICE will take the lead in investigating volcanic seismicity, in collaboration with UNA and UCR. Initial work will include review of existing studies, creation of a seismicity baseline for volcanoes of interest, based upon data and analyses available at all three institutions, and correlation of earthquake activity with other volcanological observations.

The siting of the portable micro-earthquake network will be selected based upon the preliminary results of Tasks I and III. It is anticipated that the network will be installed during January, 1989. The five UCR MEQ-800s will be available for the portable network. Availability of the ICE instruments will depend upon other ICE requirements at the time of installation. Seven UNA MEQ-800s will be available.

Various details of Subtask 3 were discussed. B. Foxall will produce an amplified description of this subtask to accompany the modified Task Program.

The meeting was closed at 17:00.[2]

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[1]It is suggested that this task be completed by July 13.

[2]The concurrence on items of agreement from the June 22 meeting was obtained from F. Güendell during a telephone conversation with B. Foxall on June 23.