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Map and Database of Quaternary Faults and Folds in Costa Rica and its Offshore Regions

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A project of the International Lithosphere Program Task Group II-2, Major Active Faults of the World

Data and map compiled by

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INTRODUCTION

As part of the International Lithosphere Program's "World Map of Major Active Faults," the U.S. Geological Survey is assisting in the compilation of a series of digital maps of Western Hemisphere countries that will show the locations, ages, and activity rates of major earthquake-related features such as faults and fault-related folds, and a relational database that describes these features and documents current information on their activity in the Quaternary. The project is a key part of the Global Seismic Hazards Assessment Program (ILP Project II-0) for the International Decade for Natural Hazard Disaster Reduction.

Prior to initiating this project, no modern or digital map of active or Quaternary faults existed for Costa Rica or any other country within Central America, even though understanding the extent and character of active and older Quaternary faults are critical elements of seismic-hazards analysis. Creation of this map and the accompanying database will help extend the relatively short record of instrumental and felt seismicity in Costa Rica by creating a paleoseismic record of surface deformation associated with large (M>6.5) earthquakes.

Although basic fault data are available for most of the country, the degree of completeness, which varies greatly and often is a function of degree of remoteness and vegetation cover. A few faults have been the subject of recent investigations involving modern paleoseismic techniques (see for example, Cowan and others, 1997). Other regions and faults have been studied in some detail, usually in association with concerns about hazards to urban areas or the safety of critical facilities such as lifelines, oil-and-gas pipelines, or power-generating facilities. Thus, considerable effort was required from the primary authors in order to compile information from a wide variety of sources and insure that the national product is up.to date and provides fairly uniform coverage for the entire country. Nevertheless, the general state of knowledge for faulting in Costa Rica is probably best described as of a reconnaissance nature. Little is known in a collective sense about the overall rates of fault activity and fault chronology—information that is difficult to acquire but critical to seismic hazard assessments. Hopefully, additional paleoseismic studies will help augment this map and database.

The project is sponsored by the International Lithosphere Program and funded by the U.S. Geological Survey's National Earthquake Hazards Reduction Program. The primary elements of the project are general supervision and interpretation of geologic/tectonic information (Michael N. Machette, Project Chief), data compilation and entry for fault catalog (all personnel), database design and management (Kathleen M. Haller), and digitization and manipulation of data (Richard L. Dart) in †ARCINFO. For the compilation of data, we engaged experts in Quaternary faulting, neotectonics, paleoseismology, and seismology. These experts are the primary authors of this report, and questions about individual fault descriptions should be directed to them. Questions about the project, its status, and the GIS map should be directed to the USGS authors.

STRATEGY AND PURPOSE

For the Costa Rican map, we relied on known, productive experts with strong local or regional knowledge of Costa Rica who were willing to participate in this international project. Given the limited time to produce the map, the project was restricted to compilation of just those elements needed for ILP's Global Seismic Hazards Assessment Program (see database). We anticipate that the project will point out the shortcomings of past and current research on Quaternary faulting in Costa Rica in terms of quantity, quality, scope, and regional coverage and should help promote new efforts to collect paleoseismological data in neglected or critical areas.

In many cases, seismicity has been used to define some potentially active faults, especially along active plate margins. However, recent faulting events in the Western Hemisphere have shown that much of the faulting away from active plate margins occurs along faults with no significant level of seismicity and that only a fraction of active faults are characterized by ongoing seismicity. Thus, the information on Quaternary faulting included within this database should help extend the modern (past several hundred year) record of seismicity into prehistoric time, and allow better assessments of active and potentially active faults in Costa Rica and other Western Hemisphere countries.

THE MAP

The map of Quaternary faults and folds of Costa Rica was compiled on and digitized from base maps at 1:200,000 scale (50-minutes of latitude by 1.5° of longitude). This scale allows output as a single-country map (1:500,000 to 1:750,000 scale) or provincial and regional maps (1:200,000 to 1:500,000 scale) while retaining all significant digital information. In addition to fault location and style, the map shows time of most recent movement and estimates of slip rate (as a proxy for fault activity).

Although as many as five categories of Quaternary faults can be depicted on the Western Hemisphere maps, only three categories were used in Costa Rica:

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† Any use of trade names (such as this and others in the report) does not emply endorsement by the U.S. Geological Survey.

- Historic (generally <200 years),
- Holocene and latest Pleistocene (<15,000 years or <15 ka),
- Quaternary (<1,600,000 years or <1.6 Ma).

Categories for the late Quaternary (<130 ka) and late and middle Quaternary (<750 ka) were not used owing to the general lack of stratigraphic and chronological control needed to make these age differentiations. This categorical time scheme allows some flexibility in reporting between countries owing to the differing levels of investigation and abilities to date prehistoric faulting.

Four ranges of slip rates depicted by differing lines can be shown on the map in order to differentiate known rates of fault activity:

- >5 mm/yr—Plate boundary faults and subduction zones
- 1-5 mm/yr—Lesser strike-slip and major extensional faults, and
- <0.2-1 mm/yr—Most extensional and intraplate faults.
- <0.2 mm/yr—Most extensional and intraplate faults.

Most faults in Costa Rica with "unknown slip rates" are drawn with the <0.2-1 mm/yr line thickness.

THE DATABASE

The purpose of the text-based (and eventual) computer database is to provide a large quantity of fault data that can be accessed quickly and efficiently using a variety of parameters. For this database, we anticipate that the user would want search-and-retrieve capabilities from a personal computer. The user may want to sort the data by such parameters as fault name, time of most recent movement (one of three categories), slip rate (one of three categories), sense of movement, or by multiple parameters.

The process of data compilation starts with data acquisition and synthesis. In the case of faults, the compiler must determine if the structure is a simple one, or if it qualifies as having sections (increasing complexity of geometry or fault history). Then using the appropriate form, the compiler tabulates information on the fault's parameters. The forms were built in Microsoft Word for the Macintosh.

After this report is released, we will incorporate suggested changes and additions and then import the data to the computer database. Each of the fields are potential search objects. The use of a computer database program allows us to custom format the reporting of data, and to collapse unused fields or notes. The basic fields are restricted to 256 characters, but we use the note option for more explanatory information (shown under comments in this report).

The fault and fold data will be released in several forms. This open-file report constitutes a traditional hard-copy catalog (database and map) for Costa Rica. The Costa Rica data will eventually be part of a larger relational database for the Western Hemisphere that should be available on the World Wide Web (WWW). This interactive WWW product should allow the user to browse, sort, and print the data. However, we do not anticipate allowing the database to be altered using only the run-time WWW version of the database program.

PREPARATION OF THE DATABASE AND MAP

This compilation show evidence for activity on Quaternary faults and folds in Costa Rica and regions offshore of Costa Rica. The data were compiled during 1996-98 from the literature (through 1998), recent geological investigations, and from interpretation of aerial photographs by Walter Montero, Percy Denyer, Rafael Barquero, Guillermo Alvarado, and Hugh Cowan. Michael Machette edited most of the data and map compilation and provided guidance for the project under the International Lithosphere Program's Task Group II-2 "Major Active Faults and Folds of the World," for which he is the Co-chairman (Western Hemisphere). The surface traces of the Quaternary faults and folds were compiled on topographic base maps at a scale of 1:200,000. Offshore traces are based primarily on marine geophysical studies and bathymetric maps; these traces are inherently less well defined and located, and should be considered approximate.

The maps were produced using GIS (Geographic Information System) technology by Richard Dart. The fault and fold traces were digitized, attributed for age, sense of slip, and line type (continuous, discontinuous, and concealed or inferred), and reprojected using a Mercator projection. The maps were prepared with ARC/INFO version 7.1.2 running under Solaris version 2.5.1 on a Unix workstation. The GIS data is scale independent but should not be used at scales greater (more detailed) than 1:200,000. Data for the fault endpoints, length, and average strike were generated from the ARC/INFO files.

The base map information is taken from the Digital Chart of the World for use with ARC/INFO (copyright 1993 by the Environmental Systems Research Institute, Inc.). The Digital Chart of the World was compiled at a scale of 1:1,000,000, but is reasonably detailed at the printed scale of the map (1:750,000). It was originally developed for the United States Defense Mapping Agency (DMA) and is primarily from the DMA Operational Navigation Chart (ONC) Series.

NEOTECTONIC AND SEISMOLOGIC SETTING OF COSTA RICA

Costa Rica is located in a very dynamic geologic environment. Depending on which plate tectonic models you accept, either three or four plates interact in this region. They are the Cocos, Caribbean and Nazca Plates and the Panamá Microplate. On the Pacific (western) side of the country, the northwestern portion of the Mid-Americas Trench defines the subduction boundary between the Cocos and Caribbean Plates (or between the Cocos Plate and the Panamá Microplate). The bathymetric expression of the subduction zone is a deep depression, which ends in front of the Nicoya Peninsula, in northwestern Costa Rica. To the southeast, the trench is deformed by collision with the northeastern portion of the Cocos Ridge. This ridge is a fossil trace of a hotspot that is carried by the Cocos Plate. According to Lonsdale and Klitgord (1978), the Cocos Ridge met with the Mid-Americas Trench about 1 Ma. The collision of the Cocos Ridge with southern Costa Rica produces indentation, uplift, and faulting, and is the cause for a general absence of volcanism and other geologic changes in this region (Kolarsky and others, 1995; Montero, 1994).

To the south, the subduction zone ends at a triple junction on the Pacific side of the Costa Rican-Panamánian border area. Here, the trench joins two other plate tectonic boundaries. The first is the northern Panamá Fracture Zone, a dextral transform fault system and defines the boundary between the Nazca and Cocos Plates. The second is an oblique convergent margin trending nearly E-W (MacKay and Moore, 1990), which represent the plate tectonic limit between the Nazca and the Caribbean Plates (or between the Nazca Plate and the Panamá Microplate). This second boundary borders the southern Pacific side of Panamá.

In Costa Rica, the Benioff zone of the Cocos Plate has a variety of geometric configurations. In the northwestern region, the terminus (down-dip end) is at about 600 km depth, but most earthquake focal depths are around 200 km depth. In the central Pacific region there is a change in the zone's dip, and the maximum depth of earthquakes diminishes to 100-120 km below central Costa Rica (Protti and others, 1995). In southeastern part of Costa Rica, the Benioff zone is very shallow (low dip), and the maximum focal depths are at about 50 km. The origin of these geometrical changes is related to interaction of the Cocos Ridge and Cocos Plate and/or to different ages of lithosphere that comprise structural provinces of the Cocos Plate being subducted in this region (Burbach and others, 1984; Protti and others, 1995).

Although the Benioff zone is the most active seismic zone in Costa Rica and produces the largest earthquakes, there are other important seismic sources in the country. Along the volcanic arc in northwestern Costa Rica there cortical earthquakes occur on faults parallel or transverse to the arc. Also, across central Costa Rica (between the entrance of the Nicoya Gulf and the Caribbean Coast) there is a neotectonic system of faults that has been associated with the western boundary between the Panamá microplate and the Caribbean plate (Montero, 1994). In this region, there are sinistral strike slip faults trending principally to the northeast, dextral faults trending to the northwest and east-west thrust faults. On the Caribbean side of Costa Rica and Panamá, the North Panamá Deformed Belt, defines a seismically active thrust and fold belt that is the northern boundary of the Panamá microplate.

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Burbach, G.V., Frohlich, C., Pennington, W.D., and Matumoto, T., 1984, Seismicity and tectonics of the subducted Cocos Plate: Journal of Geophysical Research, v. 8, p. 7719-7735.

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Montero, W., 1994, Neotectonics and related stress distribution in a subduction collisional zone—Costa Rica, *in* Seyfried, Hartmut, and Hellman, Wiebke (eds.), Geology of an evolving island arc—Southeastern Central America: Profil, v. 7, p. 125-141.

Protti, M., Güendel, F., and McNally, K., 1995, Correlation between the age of the subducting Cocos plate and the geometry of the Wadati-Benioff zone under Nicaragua and Costa Rica, *in* Mann, P. (ed.), Geological and Tectonic Development of the Caribbean Plate Boundary in southern Central America: Geological Society of America Special Paper 295, p. 309-326.

DEFINITION OF DATABASE TERMS

Specialized fields (in both Spanish and English) provide abstracted data, most of which will be in searchable fields when the digital database is released. In addition to the searchable fields, more detailed information is provided in the following "Comments" section. If a field is empty, no pertinent information was found in the published literature. The following description provides definitions of fields (in alphabetic order) and indicates where various information, if known, can be found. In-text citations of references are in a traditional format with the exception of a reference-specific number at the end, in lieu of the traditional alpha character following the publication year. All fault numbers cited in the text are bounded by brackets ([ ]).

Average dip General down-dip direction of the structure defined by compass quadrants.

Average strike The length-weighted average strike of the trace of the structure in azimuthal degrees followed by one standard deviation of the strike. The standard deviation is given to provide a general impression of the sinuosity or variability in strike of the mapped structure. The azimuthal values are confined to the northwest and northeast quadrants of the compass (*i.e.*, 0°-90° and 271°-359°).

Compiler, affiliation and date of compilation The name and affiliation of the person(s) primarily responsible for compilation or update of data presented for the structure. Also shown is the date when data were compiled for this project (*e.g.*, January 1997).

End points These are the GIS determined end points for a fault, fault zone, or collection of faults. The first point is for the upper or left (map) end of the fault; the second point is for the lower or right (map) end of the fault.

Fault geometry This includes geographic information pertinent to the fault or fault being described. The data include end points, length, average strike, average dip, and sense of movement.

Geomorphic expression General description of the structure's geomorphic expression including information on the the presence or absence of fault scarps, offset streams, monoclines, shutter ridges, associated landslides, etc.

Historical Surface Faulting This field(s) describe evidence for surface faulting associated with historical earthquakes. Also included is seismological information for the historical earthquake.

Length This field specifies the end-to-end length of the Quaternary-age fault as measured from the most distal ends of the trace. The ends of overlapping or echelon traces are projected to a line defined by the average strike and the length is then determined from those projected end points. Also shown is the cumulative length of all surface traces included in the fault, fault zone, or collection of faults.

Name (**Fault name** or **Section name**) The earliest referenced name for a structure, fault segment or fault section (where appropriate) generally is given preference, except in cases where a more commonly accepted name is widely used in the recent literature. "Comments" also contains other names and references in which they are used, the geographic limits of the structure, north to south or west to east, as shown in this compilation; various geographic limits that are different in other studies are also included. Minor changes in original name may have been made for reasons of clarity or consistency (such as segment to section).where appropriate. We have found no faults in Costa Rica that justify using the segment nomenclature.

Number

Structure number The structure (fault or fold) is assigned a number that is preceeded by a two character abbreviation (CR, Costa Rica) that is unique to each of the countries in the Western Hemisphere. References to the same structure shown in other compilations, such as CR-50 and PA-12 are included in "Comments".

Section number A lower-case alpha character is assigned to the northernmost or westernmost section of a fault (*e.g.*, fault CR-50 has two sections: CR-50a and CR-50b).

Number of sections (only used for faults with sections) Numeric value for number of sections (*e.g.*, 4) defined in studies that do not meet the minimum requirements for segments established for this compilation. "Comments" include reference in which sections are discussed; if the term "segment" is used in the literature, an explanation of why "section" is used in the database is provided.

Recurrence interval Time interval in yr (based on historic data, calendric or calibrated radiocarbon dates), in ^{14}C yr (based on uncalibrated radiocarbon dates), or in k.y. (thousand years, based on less precise dating methods, stratigraphy, or geomorphology). . Unknown is shown if there is no published recurrence interval value. Also included is the time interval (in parenthesis) for which this recurrence interval is valid. (*e.g.*, 10-130 k.y.) Alternative published recurrence intervals, starting with that which applies to the most recent time interval, are included in "Comments. "

References A bibliographic citation (USGS style) is included for all references pertinent to each structure.

Section A geographic, geometric, structural portion of a fault or collection of faults that appear(s) to have a different character than adjacent portions of the fault (or fold). Typically, not enough information exists to show that this portion of the fault acts independently of adjacent portions, and thus does not qualify as a bona fide "segment" of a fault in a paleoseismic sense. There are no known faults with proven segments in Costa Rica, and only one fault (CR-50) is described as having sections. Further research is needed to document additional faults with sections or segments.

Section name (see **Name**)

Section number (see **Number**)

Sense of movement Includes thrust (T), less than 45° dip; reverse (R), greater than 45° dip; dextral, right lateral (D); sinistral, left lateral (S); or normal (N). For oblique slip, principle sense of movement is followed by secondary sense (*i.e.*, DT). Ratios of the slip components are included, where known, in order to better characterize sense of movement (*i.e.*, DT 3:1).

Slip rate The primary field shows an actual value or one of several slip-rate categories used for the map part of this compilation: <0.2 mm/yr, 0.2-1 mm/yr, 1-5 mm/yr, or >5 mm/yr. "Unknown" precedes the suspected slip-rate or slip rate categore category if no published slip rate is known. "Comments" may include a synopsis of published slip rates and pertinent documentation. Generally speaking, there are two types of slip rates. The first type is termed a "Geologic slip rate" and is derived from the age and amount of offset of surficial geologic deposits. These rates are not precise, but allow one to place broad limits on possible slip rates, and hence characterize the fault in one of the above-mentioned categories. The second type of slip rate is termed a "Paleoseismic slip rate" and is derived from times of faulting events and amounts of offset of geologic datums or piercing point. This type of slip rate is more precise, but are rare owing to the extensive amount of work involved (*i.e.*, detailed paleoseismologic studies involving trenching and numeric dating).

Fault/fold name (see **Name**)

Fault/fold number (see **Number**)

Synopsis and geologic setting This field provides a short summary that describes the level of study, provides a snapshot of the scope of data that follows in the database and provides a generalized perspective of the fault in terms of its regional geologic setting, amount of total offset, and general age of offset strata

Timing of most recent paleoevent (faulting or folding event) The primary field shows one of the two prehistoric time categories: latest Quaternary (Holocene and latest Pleistocene, <15 ka) or Quaternary (<1.6 Ma). This field only documents prehistoric surface faulting. If there is historical surface faulting or folding, it is documented under a discussion of "Historical Surface Faulting".

Type of studies: This field briefly summarizes the types of studies conducted on the fault.

CR-01, CAÑO NEGRO FAULT

NUMERO DE LA FALLA/FAULT NUMBER: CR-01
Comentarios/Comments: Shown as fault CRL-01 on original compilation sheets.

NOMBRE DE LA FALLA/FAULT NAME: Caño Negro

SINOPSIS Y AMBIENTE GEOLOGICO/SYNOPSIS AND GEOLOGIC SETTING: Fault referred to by Dengo (1962), Dóndoli and others (1968), and Sandoval and others (1982). Fault located on the oriental (east) side of volcanoes Rincón de la Vieja and Miravalles. It seems to be a prolongation of the Nicaragua graben and puts Quaternary volcanic rocks in contact with back-arc basin sediment.

COMPILADOR, AFILIACION Y FECHA DE COMPILACION/COMPILER, AFFILIATION, & DATE OF COMPILATION: Rafael Barquero and Guillermo Alvarado, Departamento de Geología, Instituto Costarricense de Electricidad (ICE), 1996.

TIPOS DE ESTUDIOS/TYPE OF STUDIES: Air photo interpretation and preliminary field survey.

GEOMETRIA DE LA FALLA/FAULT GEOMETRY
END POINTS: 10°58'45.26"N, 85°18'41.52"W (upper or left); 10°44'54.50"N, 85°1'35.53"W (lower or right):
LONGITUD/LENGTH: End-to-end 41.0 km; cumulative 41.3 km
RUMBO PROMEDIO/AVERAGE STRIKE: N 51° W ± 7°
INCLINACION PROMEDIO/AVERAGE DIP: Unknown
SENTIDO DE MOVIMIENTO/SENSE OF MOVEMENT: Normal
Comentarios/Comments: Shown as a normal fault by Dengo (1962) and Dóndoli and others (1968).

EXPRESION GEOMORFOLOGICA/GEOMORPHIC EXPRESSION This fault forms a 200-m-high scarp that is clearly visible on air photos, topographic maps, and in the field (Alvarado and others, 1986).

INTERVALO DE RECURRENCIA/RECURRENCE INTERVAL: Unknown

TASA DE MOVIMIENTO/SLIP RATE: Unknown

EDAD DEL ULTIMO MOVIMIENTO/TIME OF MOST RECENT OF MOVEMENT: Quaternary (<1.6 m.y.)
Comentarios/Comments: Seismic swarms in 1984, 1985, 1987, and 1995 could be related to the fault.

REFERENCIAS/REFERENCES

Alvarado, G., Barquero, R., Boschini, I., Carr, M., and Chiesa, S., 1986, Relación entre la neotectónica y el vulcanismo en Costa Rica: Bogotá, Simposio Int. Sobre Neotectónica y Riesgos Volcánicos, Rev. CIAF, 11 (1-3), p. 246-264.

Dengo, G., 1962, Tectonic-igneous sequence in Costa Rica, *in* Engel, A.E.C., James, H., and Leonard, B. (eds.), Petrologic studies—A volume in honor of A. F. Buddington: Geological Society of America, p. 133-161.

Dóndoli, C., Dengo, G., and Malavassi, E., 1968, Mapa Geológico de Costa Rica: San José, Costa Rica, Ministerio de Industria y Comerico, Dirección de Geología, Minas, y Petróleo; printed by Instituto Geográfico Nacional escala 1:700,000.

Sandoval, L. F, Sáenz, R., Acuña, J., Castro, J. F., Gómez, M., López, A., Mederos, B., Monge, A., Vargas, J., Fernández, T., Ulate, R., and Ramírez, C., 1982, Mapa Geológico de Costa Rica: San José, Costa Rica, Instituto Geográfico Nacional, 9 sheets, scale 1:200,000.

CR-02, LIMÓNES-CAÑAS FAULT

NUMERO DE LA FALLA/FAULT NUMBER CR-02
Comentarios/Comments: Shown as fault CRN-01 on original compilation sheets.

NOMBRE DE LA FALLA/FAULT NAME: Limónes-Cañas

SINOPSIS Y AMBIENTE GEOLOGICO/SYNOPSIS AND GEOLOGIC SETTING First reference to the Limónes-Cañas fault was by Sandoval and others (1982). Hare and Gardner (1985) suggested it is a neotectonic fault. It has high-angle, down to northwest movement, transverse to the fore-arc region of Nicoya Peninsula. Neotectonic vertical displacement amounts are a minimum of 90 m to a maximum of 219 m (Hare and Gardner, 1985). Location of fault is based on 1:200,000 scale map of Sandoval and others (1982). Fault extends from Junquillal beach (on the southwest) to a swampy area between Cartagena and Santa Cruz towns (on the northeast).

COMPILADOR, AFILIACION Y FECHA DE COMPILACION/COMPILER, AFFILIATION, & DATE OF COMPILATION: Walter Montero, Central American School of Geology, University of Costa Rica; March 6, 1995.

TIPOS DE ESTUDIOS/TYPE OF STUDIES: Fault has a preliminary level of study. Detailed studies have not been performed.

GEOMETRIA DE LA FALLA/FAULT GEOMETRY
END POINTS: 10°19'43.70"N, 85°38'32.63"W (upper or left); 10°9'13.85"N, 85°48'37.89"W (lower or right).
LONGITUD/LENGTH: End-to-end 27.1 km; cumulative 27.1 km
RUMBO PROMEDIO/AVERAGE STRIKE: N 44° E ± 0°
INCLINACION PROMEDIO/AVERAGE DIP: Unknown, dip to northwest
SENTIDO DE MOVIMIENTO/SENSE OF MOVEMENT: Normal
Comentarios/Comments: Normal fault according to geomorphic interpretation of Hare and Gardner (1985).

EXPRESION GEOMORFOLOGICA/GEOMORPHIC EXPRESSION: Fault follows a linear valley (valley of Limónes and Andamojo rivers). It corresponds with a geomorphic boundary between the Finca Carrera Buena and Montaña Quaternary geomorphic surfaces (Hare and Gardner, 1985). The region southeast of the fault is uplifting, whereas that to the northwest is relative stable or possibly subsiding. In addition, each of these areas (provinces) have greatly differing drainage asymmetry factors (Hare and Gardner, 1985), thus indicating tectonic control on drainage development.

INTERVALO DE RECURRENCIA/RECURRENCE INTERVAL: Unknown

TASA DE MOVIMIENTO/SLIP RATE: Unknown; probably < 1 mm/yr.
Comentarios/Comments: More detailed studies are required to constrain an actual slip rate.

EDAD DEL ULTIMO MOVIMIENTO/TIME OF MOST RECENT OF MOVEMENT: Quaternary (<1.6 m.y.)

REFERENCIAS/REFERENCES

Hare, P. W., and Gardner, T. W., 1985, Geomorphic indicators of vertical tectonism along convergent plate margins, Nicoya Peninsula, Costa Rica, *in* Hack, J. and Morisawa, M., eds., Tectonic Geomorphology: Proceedings, 15th Geomorphology Symposia series, Binghamton, New York, p. 76-104.

Sandoval, L. F, Sáenz, R., Acuña, J., Castro, J. F., Gómez, M., López, A., Mederos, B., Monge, A., Vargas, J., Fernández, T., Ulate, R., and Ramírez, C., 1982, Mapa Geológico de Costa Rica: San José, Costa Rica, Instituto Geográfico Nacional, 9 sheets, scale 1:200,000.

CR-03, COTE-ARENAL FAULT

NUMERO DE LA FALLA/FAULT NUMBER: CR-03
Comentarios/Comments: Shown as fault CRSC-01 on original compilation sheets.

NOMBRE DE LA FALLA/FAULT NAME: Cote-Arenal

SINOPSIS Y AMBIENTE GEOLOGICO/SYNOPSIS AND GEOLOGIC SETTING: The Cote-Arenal fault was shown on geological maps of Dengo (1962), Dóndoli and Chavez (1968), and Sandoval and others (1982). Fault is located at the eastern side of the Arenal graben, Guanacaste Range. It is a curved fault that extends from the Cote Lagoon to near Arenal Volcano, along the northern part of Arenal Lake. The fault cuts Holocene tephras of Arenal Volcano.

COMPILADOR, AFILIACION Y FECHA DE COMPILACION/COMPILER, AFFILIATION, & DATE OF COMPILATION: Rafael Barquero and Guillermo Alvarado, Departamento de Geología, Instituto Costarricense de Electricidad (ICE), 1996.

TIPOS DE ESTUDIOS/TYPE OF STUDIES: Air photo interpretation, field survey, detail stratigraphic research.

GEOMETRIA DE LA FALLA/FAULT GEOMETRY
END POINTS: 10°39'54.78"N, 84°56'47.29"W (upper or left); 10°28'4.05"N, 84°47'46.57"W (lower or right).
LONGITUD/LENGTH: End-to-end 27.8 km; cumulative 28.6 km
RUMBO PROMEDIO/AVERAGE STRIKE: N 37° W ± 14°
INCLINACION PROMEDIO/AVERAGE DIP: Unknown
SENTIDO DE MOVIMIENTO/SENSE OF MOVEMENT: Normal
Comentarios/Comments: At an outcrop near Arenal Volcano, Holocene tephras clearly show normal displacement by the fault. Shown as a normal fault on different geological maps (for example, Dóndoli and others, 1968).

EXPRESION GEOMORFOLOGICA/GEOMORPHIC EXPRESSION: Fault has a prominent scarp with the western block downdropped.

INTERVALO DE RECURRENCIA/RECURRENCE INTERVAL: About 1000 yrs.
COMENTARIOS /COMMENTS According to radiometric dating done by Alvarado (1989).

TASA DE MOVIMIENTO/SLIP RATE: 1.8 mm/year
Comentarios/Comments: Radiocarbon dating and possible historical earthquakes.

EDAD DEL ULTIMO MOVIMIENTO/TIME OF MOST RECENT OF MOVEMENT: Holocene or post glacial (<15 ka)
Comentarios/Comments: Tephras dated at 450 to 3000 yrs B.P. are affected by faulting. To the north, the fault movement may be older (Pliocene to lowere Quaternary) or it may have been active for a long period.

REFERENCIAS/REFERENCES

Alvarado, G., 1989, Consideraciones neotectónicas en los alrededores de la laguna de Arenal: Costa Rica Bol. Observ. Vulcan. del Arenal, Instituto Costarricense de Electricidad, Departamento de Geología, v. 3, p. 6-27.

Dengo, G., 1962, Estudio geológico de la región de Guanacaste, Costa Rica: San José, Costa Rica, Instituto Geografico Nacional, 112 pp.

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Dóndoli, C., Dengo, G., and Malavassi, E., 1968, Mapa Geológico de Costa Rica: San José, Costa Rica, Ministerio de Industria y Comerico, Dirección de Geología, Minas, y Petróleo; printed by Instituto Geográfico Nacional escala 1:700,000.

Sandoval, L. F, Sáenz, R., Acuña, J., Castro, J. F., Gómez, M., López, A., Mederos, B., Monge, A., Vargas, J., Fernández, T., Ulate, R., and Ramírez, C., 1982, Mapa Geológico de Costa Rica: San José, Costa Rica, Instituto Geográfico Nacional, 9 sheets, scale 1:200,000.

CR-04, CHIRIPA FAULT

NUMERO DE LA FALLA/FAULT NUMBER: CR-04
Comentarios/Comments: Shown as fault CRS-01 on original compilation sheets.

NOMBRE DE LA FALLA/FAULT NAME: Chiripa

SINOPSIS Y AMBIENTE GEOLOGICO/SYNOPSIS AND GEOLOGIC SETTING: Fault located to the east-southeast of the city of Tilarán, Guanacaste Province. Fault was first described by Matumoto and Latham (1976) and later by Alvarado (1989). It cuts Quaternary volcanic deposits of the Inner Arc region, which is the transition between the Quaternary Guanacaste Volcanic Cordillera (Inner Arc Region). and the Miramar-Tilaran Mountain Range. The fault extends south from Lake Arenal about 20 km; its trace lies about 1 km east of the town of Chiripa.

COMPILADOR, AFILIACION Y FECHA DE COMPILACION/COMPILER, AFFILIATION, & DATE OF COMPILATION: Rafael Barquero and Guillermo Alvarado, Departamento de Geología, Instituto Costarricense de Electricidad (ICE), 1996.

TIPOS DE ESTUDIOS/TYPE OF STUDIES Air photo interpretation, field survey, tephra analysis, and seismology.

GEOMETRIA DE LA FALLA/FAULT GEOMETRY
END POINTS: 10°32'2.34"N, 84°55'12.75"W (upper or left); 10°22'13.50"N, 84°52'23.24"W (lower or right).
LONGITUD/LENGTH: End-to-end 19.1 km; cumulative 19.2 km
RUMBO PROMEDIO/AVERAGE STRIKE: N 16° W ± 9°
INCLINACION PROMEDIO/AVERAGE DIP: Unnknown
SENTIDO DE MOVIMIENTO/SENSE OF MOVEMENT: Dextral strike slip

EXPRESION GEOMORFOLOGICA/GEOMORPHIC EXPRESSIO: On air photos, the fault is observed as forming a series of discontinuous alignments and trenches.

INTERVALO DE RECURRENCIA/RECURRENCE INTERVAL: Unknown
Comentarios/Comments: May be as little as 60 to 500 years based on earthquakes of 1853, 1911, and 1973.

TASA DE MOVIMIENTO/SLIP RATE: Unknown, probably 0.2-1 mm/yr

EDAD DEL ULTIMO MOVIMIENTO/TIME OF MOST RECENT OF MOVMENT: Holocene or post glacial (<15 ka)
Comentarios/Comments: May have historic movement, but not confirmed. May be associated with an earthquake of magnitude 6.5 that took place on April 14, 1973. Its aftershocks were located along the Chiripa fault (Matumoto and others, 1976; Alvarado, 1989).

REFERENCIAS/REFERENCES

Alvarado, G., 1989, Consideraciones neotectónicas en los alrededores de la laguna de Arenal: Costa Rica Bol. Observ. Vulcan. del Arenal, Instituto Costarricense de Electricidad, Departamento de Geología, v. 3, p. 6-27.

Matumoto, T., and Latham, G., 1976, Results from the Arenal Seismic Network: Instituto Costarricense de Electricidad, Departamento de Geología (Internal Report), San José. 33 pp.

Matumoto, T., Latham, G., Othake, M., Umaña, J., 1976, Seismicity studies in northern Costa Rica: EOS, Transactions of the American Geophysical, Union, v. 57, p. 290.

Montero, W., 1986, Períodos de recurrencia y tipos de secuencias sísmicas de los temblores intraplaca y interplaca de Costa Rica: Rev. Geol. Amér. Central, no. 5, p. 35-72.

CR-05, DANTA FAULT

NUMERO DE LA FALLA/FAULT NUMBER: CR-05
Comentarios/Comments: Shown as fault CRS-36 on original compilation sheets.

NOMBRE DE LA FALLA/FAULT NAME: Danta

SINOPSIS Y AMBIENTE GEOLOGICO/SYNOPSIS AND GEOLOGIC SETTING: Fault was first referred to by Alvarado (1989). Fault cuts Tertiary and Quaternary volcanic units of the Guanacaste Volcanic Cordillera (Inner Arc Region). The offset Quaternary units are associated with the Arenal-Chato volcanic centers. The fault trends north-south and bisects the Arenal Volcano.

COMPILADOR, AFILIACION Y FECHA DE COMPILACION/COMPILER, AFFILIATION, & DATE OF COMPILATION: Walter Montero, Central American School of Geology, University of Costa Rica; March 1997.

TIPOS DE ESTUDIOS/TYPE OF STUDIES Photointerpretation and field work.

GEOMETRIA DE LA FALLA/FAULT GEOMETRY
END POINTS: 10°30'4.09"N, 84°42'14.40"W (upper or left); 10 24 39.93"N, 84 41 53.20"W (lower or right).
LONGITUD/LENGTH: End-to-end 10.2 km; cumulative 10.2 km
RUMBO PROMEDIO/AVERAGE STRIKE: N 4° W ± 6°
INCLINACION PROMEDIO/AVERAGE DIP: High-angle fault (nearly 90°).
SENTIDO DE MOVIMIENTO/SENSE OF MOVEMENT: Normal
Comentarios/Comments: High-angle fault according to its topographic trace and direct measurements of the fault plane (see Alvarado, 1989). Normal sense of fault movement according to field data of Alvarado (1989).

EXPRESION GEOMORFOLOGICA/GEOMORPHIC EXPRESSION: Linear valleys and scarps. Most prominent on distal flanks of Arenal Volcano.

INTERVALO DE RECURRENCIA/RECURRENCE INTERVAL: Unknown

TASA DE MOVIMIENTO/SLIP RATE: 0.2-1 mm/yr
Comentarios/Comments: Alvarado (1989) defined a minimum of 1.2 m of vertical displacement of Arenal volcano tephras. A tree trunk within a paleolake layer between the tephras yielded a radiometric age of 50 yr B.C. (Alvarado, 1989). From this data, the Danta fault probably fits in the above range of slip rates.

EDAD DEL ULTIMO MOVIMIENTO/TIME OF MOST RECENT OF MOVEMENT: Holocene or post glacial (<15 ka)
Comentarios/Comments: See information about slip rate, which constrains the time of movement as about 2 ka.

REFERENCIAS/REFERENCES

Alvarado, G., 1989, Consideraciones neotectónicas en los alrededores de la laguna de Arenal: Costa Rica Bol. Observ. Vulcan. del Arenal, Instituto Costarricense de Electricidad, Departamento de Geología, v. 3, p. 6-27.

CR-06, PE ÑAS BLANCAS FAULT

NUMERO DE LA FALLA/FAULT NUMBER: CR-06
Comentarios/Comments: Shown as fault CRS-02 on original compilation sheets.

NOMBRE DE LA FALLA/FAULT NAME: Peñas Blancas

SINOPSIS Y AMBIENTE GEOLOGICO/SYNOPSIS AND GEOLOGIC SETTING: Fault located at the Tilarán Range, northwest of the city of Ciudad Quesada, Alajuela Province. It cuts Quaternary and middle Pleistocene alluvium and volcanic deposits of the Inner Arc Region (Tilaran Mountain Range). Fault is shown on the geological map of Sandoval and others (1982; see also Alvarado, 1989). The fault strikes northeast along Río Penas Blancas, northwest of Cerro Poco Sol and southeast of Lake Arenal.

COMPILADOR, AFILIACION Y FECHA DE COMPILACION/COMPILER, AFFILIATION, & DATE OF COMPILATION: Rafael Barquero and Guillermo Alvarado, Departamento de Geología, Instituto Costarricense de Electricidad (ICE), 1996.

TIPOS DE ESTUDIOS/TYPE OF STUDIES: Air photo interpretation, field survey.

GEOMETRIA DE LA FALLA/FAULT GEOMETRY
END POINTS: 10°21'19.86"N, 84°39'2.80"W (upper or left); 10°17'50.25"N, 84°45'31.00"W (lower or right).
LONGITUD/LENGTH: End-to-end 13.7 km; cumulative 13.7 km
RUMBO PROMEDIO/AVERAGE STRIKE: N 61° E ± 6°
INCLINACION PROMEDIO/AVERAGE DIP: Unknown
SENTIDO DE MOVIMIENTO/SENSE OF MOVEMENT: Normal with possible strike-slip component.

EXPRESION GEOMORFOLOGICA/GEOMORPHIC EXPRESSION: The escarpment of the fault is clear on air photos and there are both active and fossil hot springs along the trace of the fault. Faulting has caused a deepening of the channel of the Peñas Blancas River, which has left several abandoned causeways (side channels) as much as 220 m above the present level of the river.

INTERVALO DE RECURRENCIA/RECURRENCE INTERVAL: Unknown

TASA DE MOVIMIENTO/SLIP RATE: Unknown

EDAD DEL ULTIMO MOVIMIENTO/TIME OF MOST RECENT OF MOVEMENT: Quaternary (<1.6 m.y.)
Comentarios/Comments: Fault cuts Quaternary and middle Pleistocene alluvium and volcanic deposits.

REFERENCIAS/REFERENCES

Alvarado, G., 1989, Consideraciones neotectónicas en los alrededores de la laguna de Arenal: Costa Rica Bol. Observ. Vulcan. del Arenal, Instituto Costarricense de Electricidad, Departamento de Geología, v. 3, p. 6-27.

Sandoval, L. F, Sáenz, R., Acuña, J., Castro, J. F., Gómez, M., López, A., Mederos, B., Monge, A., Vargas, J., Fernández, T., Ulate, R., and Ramírez, C., 1982, Mapa Geológico de Costa Rica: San José, Costa Rica, Instituto Geográfico Nacional, 9 sheets, scale 1:200,000.

CR-07, JABILLOS FAULT

NUMERO DE LA FALLA/FAULT NUMBER: CR-07
Comentarios/Comments: Shown as fault CRS-03 on original compilation sheets.

NOMBRE DE LA FALLA/FAULT NAME: Jabillos

SINOPSIS Y AMBIENTE GEOLOGICO/SYNOPSIS AND GEOLOGIC SETTING Fault is located at the Tilarán Range, northwest of Ciudad Quesada, Alajuela Province, as shown by Alvarado (1989). It cuts Quaternary and middle Pleistocene alluvium and volcanic deposits of the Inner Arc Region. The fault trends east-northeast through the towns of San Pedro, Jabillos, and Peje Viejo.

COMPILADOR, AFILIACION Y FECHA DE COMPILACION/COMPILER, AFFILIATION, & DATE OF COMPILATION: Rafael Barquero and Guillermo Alvarado, Departamento de Geología, Instituto Costarricense de Electricidad (ICE), 1996.

TIPOS DE ESTUDIOS/TYPE OF STUDIES Air photo interpretation and field survey.

GEOMETRIA DE LA FALLA/FAULT GEOMETRY
END POINTS: 10°24'36.55"N, 84°27'26.81"W (upper or left); 10°22'0.60"N, 84°36'55.76"W (lower or right).
LONGITUD/LENGTH: End-to-end 18.3 km; cumulative 18.3km
RUMBO PROMEDIO/AVERAGE STRIKE: N 75 E ± 6°
INCLINACION PROMEDIO/AVERAGE DIP: Unknown
SENTIDO DE MOVIMIENTO/SENSE OF MOVEMENT: Normal with possible strike -slip component.

EXPRESION GEOMORFOLOGICA/GEOMORPHIC EXPRESSION: The fault escarpment is clear on air photos and causes a prominent alignment of the Peñas Blancas River.

INTERVALO DE RECURRENCIA/RECURRENCE INTERVAL: Unknown

TASA DE MOVIMIENTO/SLIP RATE: Unknown

EDAD DEL ULTIMO MOVIMIENTO/TIME OF MOST RECENT OF MOVEMENT: Quaternary (<1.6 m.y.)
Comentarios/Comments: Timing of faulting based on Quaternary and middle Pleistocene alluvium and dated volcanic deposits.

REFERENCIAS/REFERENCES

Alvarado, G., 1989, Consideraciones neotectónicas en los alrededores de la laguna de Arenal, Costa Rica: Instituto Costarricense de Electricidad, Departamento de Geología, Bol. Observ. Vulcan. del Arenal, v. 3, p. 6-27.

CR-08, ZARCERO FAULT

NUMERO DE LA FALLA/FAULT NUMBER: CR-08
Comentarios/Comments: Shown as fault CRS-16 on original compilation sheets.

NOMBRE DE LA FALLA/FAULT NAME: Zarcero

SINOPSIS Y AMBIENTE GEOLOGICO/SYNOPSIS AND GEOLOGIC SETTING: Fault is shown as an unnamed fault by Alvarado and others (1988). Fault cuts through Quaternary volcanic formations located on the western slopes of the Porvenir-Platanar volcanoes, which are on the western side of the Central Volcanic Cordillera. The fault trends north-northwest for about 6 km and lies just west of Zarcero and Laguna in the province of Alajuela.

COMPILADOR, AFILIACION Y FECHA DE COMPILACION/COMPILER, AFFILIATION, & DATE OF COMPILATION: Walter Montero, Central American School of Geology, University of Costa Rica; May 8, 1996.

TIPOS DE ESTUDIOS/TYPE OF STUDIES: Photogeologic and reconnaissaince studies (Alvarado and others, 1988; W. Montero, unpublished data).

GEOMETRIA DE LA FALLA/FAULT GEOMETRY
END POINTS: 10°13'38.62"N, 84°24'34.23"W (upper or left); 10°10'41.59"N, 84°23'27.06"W (lower or right).
LONGITUD/LENGTH: End-to-end 5.9 km; cumulative 5.9 km
RUMBO PROMEDIO/AVERAGE STRIKE: N 21° W ± 8°
INCLINACION PROMEDIO/AVERAGE DIP: Probably to the east.
SENTIDO DE MOVIMIENTO/SENSE OF MOVEMENT: Normal with a probable sinistral strike-slip component.
Comentarios/Comments: Normal displacement has been confirmed by field work (W. Montero, unpublished data). A sinistral strike-slip component is suspected from photogeologic interpretation of a releasing bend and from displacement associated with an escarpment work (W. Montero, unpublished data).

EXPRESION GEOMORFOLOGICA/GEOMORPHIC EXPRESSION: Prominent geomorphic expression with linear escarpments facing to the east (upslope) and interrupting regional slope direction; also forms notches. River terraces have been uplifted along one part of the fault work (W. Montero, unpublished data).

INTERVALO DE RECURRENCIA/RECURRENCE INTERVAL Unknown
Comentarios/Comments: No dating has been done on this fault.

TASA DE MOVIMIENTO/SLIP RATE Unknown
Comentarios/Comments: No trenching or detailed mapping of displaced features has been done on this fault.

EDAD DEL ULTIMO MOVIMIENTO/TIME OF MOST RECENT OF MOVEMENT: Quaternary (<1.6 m.y.)
Comentarios/Comments: Due to the young escarpments found along some parts of the fault, it is certainly Quaternary and probably as young as Holocene.

REFERENCIAS/REFERENCES

Alvarado, G.E., Morales, L.D., Montero, W., Climent, A., and Rojas, W., 1988, Aspectos sismológicos y morfotectónicos en el extremo occidental de la Cordillera Volcánica Central de Costa Rica: Revista Geologica América Central, v. 9, p. 75-98.

CR-09, CONGO FAULT

NUMERO DE LA FALLA/FAULT NUMBER: CR-09
Comentarios/Comments: Shown as fault CRS-14 (251) on original compilation sheets.

NOMBRE DE LA FALLA/FAULT NAME: Congo
Comentarios/Comments: An early reference to this fault was by Alvarado and others (1988). This fault extends from the southwest side of Platanar Volcano (on the north) to the western side of El Siete Hill (on the south) in the Central Volcanic Cordillera.

SINOPSIS Y AMBIENTE GEOLOGICO/SYNOPSIS AND GEOLOGIC SETTING: High-angle, down to east, normal fault that crosses the flank of Porvenir Volcano. Minimun vertical offset is 40 m in the Quaternary (Alvarado and others, 1988). Fault is well described at a general level, but only source of data is Alvarado and others (1988).

COMPILADOR, AFILIACION Y FECHA DE COMPILACION/COMPILER, AFFILIATION, & DATE OF COMPILATION: Walter Montero, Central American School of Geology, University of Costa Rica; October 10, 1995.

TIPOS DE ESTUDIOS/TYPE OF STUDIES: Photogeologic and reconnaissance studies.

GEOMETRIA DE LA FALLA/FAULT GEOMETRY
END POINTS: 10°17'31.45"N, 84°22'40.09"W (upper or left); 10°14'52.02"N, 84°22'31.32"W (lower or right).
LONGITUD/LENGTH: End-to-end 5.0 km; cumulative 5.0 km
RUMBO PROMEDIO/AVERAGE STRIKE: N 3° W ± 5°
INCLINACION PROMEDIO/AVERAGE DIP: Unknown
SENTIDO DE MOVIMIENTO/SENSE OF MOVEMENT: Normal
Comentarios/Comments: Inferred from geomorphic and topographic data.

EXPRESION GEOMORFOLOGICA/GEOMORPHIC EXPRESSION: The Congo fault has a prominent but little-dissected fault scarp (mean height is about 40 m). An ephemeral lake has formed as the result of blockage of a west-flowing stream by the fault scarp. Fault trace was transfered from base map at 1:50 000 scale (Montero, unpublished map).

INTERVALO DE RECURRENCIA/RECURRENCE INTERVAL: Unknown
Comentarios/Comments: Trenching and datable material are required to define this parameter.

TASA DE MOVIMIENTO/SLIP RATE: Unknown; probably 1-5 mm/yr
Comentarios/Comments: Based on presence of a young 40-m-high fault scarp, some of which is probably of Holocene age.

EDAD DEL ULTIMO MOVIMIENTO/TIME OF MOST RECENT OF MOVEMENT: Quaternary (<1.6 m.y.)
Comentarios/Comments: Fault offsets late Quaternary volcanic deposits, but movement may be as young as Holocene.

REFERENCIAS/REFERENCES

Alvarado, G.E., Morales, L.D., Montero, W., Climent, A., and Rojas, W., 1988, Aspectos sismológicos y morfotectónicos en el extremo occidental de la Cordillera Volcánica Central de Costa Rica: Revista Geologica América Central, v. 9, p. 75-98.

CR-10, PORVENIR FAULT

NUMERO DE LA FALLA/FAULT NUMBER: CR-10
Comentarios/Comments: Shown as fault CRS-15 on original compilation sheets.

NOMBRE DE LA FALLA/FAULT NAME: Porvenir

SINOPSIS Y AMBIENTE GEOLOGICO/SYNOPSIS AND GEOLOGIC SETTING: High-angle normal fault flanking eastern side of Porvenir Volcano. Fault is poorly studied; only reference is Alvarado and others (1988). Fault extends about 2 km from Bajo Minas (on the north) to Pelon Hill (on the south) in the Central Volcanic Cordillera.

COMPILADOR, AFILIACION Y FECHA DE COMPILACION/COMPILER, AFFILIATION, & DATE OF COMPILATION: Walter Montero, Central American School of Geology, University of Costa Rica; October 10, 1995.

TIPOS DE ESTUDIOS/TYPE OF STUDIES: Photogeologic interpretation and fieldwork.

GEOMETRIA DE LA FALLA/FAULT GEOMETRY
END POINTS: 10°16'56.85"N, 84°21'19.65"W (upper or left); 10°15'46.39"N, 84°21'28.56"W (lower or right).
LONGITUD/LENGTH: End-to-end 2.2 km; cumulative 2.2 km
RUMBO PROMEDIO/AVERAGE STRIKE: N 7° E ± 4°
INCLINACION PROMEDIO/AVERAGE DIP: East
SENTIDO DE MOVIMIENTO/SENSE OF MOVEMENT: Normal
Comentarios/Comments: Inferred from geomorphic and field data (Alvarado and others, 1988).

EXPRESION GEOMORFOLOGICA/GEOMORPHIC EXPRESSION: Volcanic slopes are offset about 200 m vertically, whereas recent scarps are only 4- to 6-m-high (Alvarado and others, 1988). Fault trace was transfered from a 1:50,000 scale map (Montero, unpublished information).

INTERVALO DE RECURRENCIA/RECURRENCE INTERVAL: Not determined
Comentarios/Comments: Trenching and datable material are required to define this parameter.

TASA DE MOVIMIENTO/SLIP RATE: Unknown

EDAD DEL ULTIMO MOVIMIENTO/TIME OF MOST RECENT OF MOVEMENT: Holocene or post glacial (<15 ka)
Comentarios/Comments: Landslide deposits are ruptured by the fault and a young scarp of 4-6 m height has formed (Alvarado and others, 1988). Elsewhere, recent (Holocene) to upper Quaternary volcanic units are offset as much as 200 m by the fault. Preservation of a scarp on the landslide supports interpretation of Holocene movement of the fault.

REFERENCIAS/REFERENCES

Alvarado, G.E., Morales, L.D., Montero, W., Climent, A., and Rojas, W., 1988, Aspectos sismológicos y morfotectónicos en el extremo occidental de la Cordillera Volcánica Central de Costa Rica: Revista Geologica América Central, v. 9, p. 75-98.

CR-11, VIEJO-AGUAS ZARCAS FAULT

NUMERO DE LA FALLA/FAULT NUMBER: CR-11
Comentarios/Comments: Shown as fault CRS-04 (252) on original compilation sheets.

NOMBRE DE LA FALLA/FAULT NAME: Viejo-Aguas Zarcas

SINOPSIS Y AMBIENTE GEOLOGICO/SYNOPSIS AND GEOLOGIC SETTING: Poorly studied high-angle scissor fault located in the western side of the Central Volcanic Cordillera. Early and only references to this fault are by Sandoval and others (1982) and Alvarado and others (1988). Fault extends from about 5 km north of Aguas Zarcas (town, on the north) to 5 km south of Cerros Viejo Volcano (on the south) in the Central Volcanic Cordillera. Fault trace was transferred from a base map at 1:50,000 scale (Montero, unpublished map).

COMPILADOR, AFILIACION Y FECHA DE COMPILACION/COMPILER, AFFILIATION, & DATE OF COMPILATION: Walter Montero, Central American School of Geology, University of Costa Rica; August 11, 1995.

TIPOS DE ESTUDIOS/TYPE OF STUDIES: Photogeologic interpretation.

GEOMETRIA DE LA FALLA/FAULT GEOMETRY
END POINTS: 10°25'7.19"N, 84°20'57.46"W (upper or left); 10°13'35.35"N, 84°19'10.77"W (lower or right).
LONGITUD/LENGTH: End-to-end 21.9 km; cumulative 22.2 km
RUMBO PROMEDIO/AVERAGE STRIKE: N 9° W ± 10°
INCLINACION PROMEDIO/AVERAGE DIP: Unknown, probably high-angle
SENTIDO DE MOVIMIENTO/SENSE OF MOVEMENT: Normal
Comentarios/Comments: Scissor fault (Alvarado and others, 1988); up to the east on the north and up to the west on the south.

EXPRESION GEOMORFOLOGICA/GEOMORPHIC EXPRESSION: Strong escarpment facing to the west on east side of the faults. North half of fault follows linear valleys of Agua Zarcas River and Explayada Creek. Notches are prominent in the mountainous portion of the fault trace.

INTERVALO DE RECURRENCIA/RECURRENCE INTERVAL: Unknown

TASA DE MOVIMIENTO/SLIP RATE: Unknown

EDAD DEL ULTIMO MOVIMIENTO/TIME OF MOST RECENT OF MOVEMENT: Quaternary (<1.6 m.y.)
Comentarios/Comments: Fault displaces Quaternary volcanic deposits. Earthquakes in 1911, 1912, and 1955 could be related to this fault (Alvarado and others, 1988), but no historic surface ruptures have been confirmed.

REFERENCIAS/REFERENCES

Alvarado, G.E., Morales, L.D., Montero, W., Climent, A., and Rojas, W., 1988, Aspectos sismológicos y morfotectónicos en el extremo occidental de la Cordillera Volcánica Central de Costa Rica: Revista Geologica América Central, v. 9, p. 75-98.

Sandoval, L. F, Sáenz, R., Acuña, J., Castro, J. F., Gómez, M., López, A., Mederos, B., Monge, A., Vargas, J., Fernández, T., Ulate, R., and Ramírez, C., 1982, Mapa Geológico de Costa Rica: San José, Costa Rica, Instituto Geográfico Nacional, 9 sheets, scale 1:200,000.

CR-12, SAN MIGUEL FAULT

NUMERO DE LA FALLA/FAULT NUMBER: CR-12
Comentarios/Comments: Shown as fault CRS-05 on original compilation sheets.

NOMBRE DE LA FALLA/FAULT NAME: San Miguel

SINOPSIS Y AMBIENTE GEOLOGICO/SYNOPSIS AND GEOLOGIC SETTING: West-northwest-trending fault located on the northern flank of Congo Volcano, Central Volcanic Cordillera. First suggested as a neotectonic fault by Borgia and others (1990). Located at the boundary between the volcanic arc and the back-arc area. Fault cuts Quaternary volcanic rocks, epiclastic and pyroclastic rocks of the Congo Volcano. Fault trends east-southeast from near Venecia to about 5 km east of San Miguel, Alajuela Province.

COMPILADOR, AFILIACION Y FECHA DE COMPILACION/COMPILER, AFFILIATION, & DATE OF COMPILATION: Rafael Barquero and Guillermo Alvarado, Departamento de Geología, Instituto Costarricense de Electricidad (ICE), 1996.

TIPOS DE ESTUDIOS/TYPE OF STUDIES: Air photo interpretation and field survey.

GEOMETRIA DE LA FALLA/FAULT GEOMETRY
END POINTS: 10°21'4.1"N, 84°17'22.77"W (upper or left); 10°18'7.66"N, 84°8'20.49"W (lower or right).
LONGITUD/LENGTH: End-to-end 17.6 km; cumulative 18.1 km
RUMBO PROMEDIO/AVERAGE STRIKE: N 72° W ± 15°
INCLINACION PROMEDIO/AVERAGE DIP: Unknown
SENTIDO DE MOVIMIENTO/SENSE OF MOVEMENT: Reverse
Comentarios/Comments: Meridional (southwest) block uplifted.

EXPRESION GEOMORFOLOGICA/GEOMORPHIC EXPRESSION: Forms a fault scarp about 15 km long that affects the Río Sarapiquí drainage (pattern). The scarps are related to long west-northwest-trending sublinear ridges, some of which have 100-200 m of topographic relief. Scarps face away (to the north) from the volcanic range and have fresh morphology (rectangular facets) (Borgia and others, 1990; Montero, unpublished data). There are some hot springs associated with the trace of the fault (Alvarado and others, 1988)

INTERVALO DE RECURRENCIA/RECURRENCE INTERVAL: Unknown

TASA DE MOVIMIENTO/SLIP RATE: Unknown

EDAD DEL ULTIMO MOVIMIENTO/TIME OF MOST RECENT OF MOVEMENT: Probably Holocene or post glacial (<15 ka)
Comentarios/Comments: Some 5,000 yr old pyroclastic rocks are not deformed, but Holocene activity is suggested by the fresh morphology of the fault scarps; this the most recent faulting may be early Holocene.

REFERENCIAS/REFERENCES

Alvarado, G.E., Morales, L.D., Montero, W., Climent, A., and Rojas, W., 1988, Aspectos sismológicos y morfotectónicos en el extremo occidental de la Cordillera Volcánica Central de Costa Rica: Revista Geologica América Central, v. 9, p. 75-98.

Borgia, A., Burr, J., Montero, W., Alvarado, G., and Morales, L.D., 1990, Fault propagation folds induced by gravitational failure and slumping of the Costa Rica Volcanic Range: Implications for large terrestrial and Martian edifices: Journal of Geophysical Research, v. 95, p. 14,357-14,382.

Soto, G., 1990, Consideraciones vulcanológicas y tectónicas preliminares del área de Laguna Hule: Departamento de Geología, Instituto Costarricense de Electricidad (ICE), Inf. Interno, 14 pp.

Soto, G., 1998, Estudio geológico para el Proyecto Hidroeléctrico Laguna Hule, Geología Regional, *in* Estudio Geologico-Geotecnico del P.H. Hule: San José, Costa Rica, Departamento de Geología, Instituto Costarricense de Electricidad (ICE), Inf. Interno, in press, Hoja Poás a escala 1:50,000.

CR-13, CARBONERA FAULT

NUMERO DE LA FALLA/FAULT NUMBER: CR-13
Comentarios/Comments: Shown as fault CRS-06 on original compilation sheets.

NOMBRE DE LA FALLA/FAULT NAME: Carbonera

SINOPSIS Y AMBIENTE GEOLOGICO/SYNOPSIS AND GEOLOGIC SETTING: North-trending fault located at the occidental (western) flank of Poás Volcano, Central Volcanic Cordillera. Fault cuts Quaternary volcanic deposits and extends from east of Bajos del Toro (town, on the north) to Fila Carbonera (on the south). Early reference to neotectonic activity of this fault is by Alvarado and others (1988).

COMPILADOR, AFILIACION Y FECHA DE COMPILACION/COMPILER, AFFILIATION, & DATE OF COMPILATION: Rafael Barquero and Guillermo Alvarado, Departamento de Geología, Instituto Costarricense de Electricidad (ICE), 1996.

TIPOS DE ESTUDIOS/TYPE OF STUDIES: Air photo interpretations, satellite images, and field survey.

GEOMETRIA DE LA FALLA/FAULT GEOMETRY
END POINTS: 10°13'25.31"N, 84°16'10.82"W (upper or left); 10°10'28.25"N, 84°15'44.88"W (lower or right).
LONGITUD/LENGTH: End-to-end 5.6 km; cumulative 6.7 km
RUMBO PROMEDIO/AVERAGE STRIKE: N 8° W ± 10°
INCLINACION PROMEDIO/AVERAGE DIP: Unknown
SENTIDO DE MOVIMIENTO/SENSE OF MOVEMENT: Dextral strike slip with a probable normal component.
Comentarios/Comments: Stream channels are displaced dextrally at southern end of fault.

EXPRESION GEOMORFOLOGICA/GEOMORPHIC EXPRESSION: Prominent escarpment, linear valleys, fault saddles, and laterally displaced streams.

INTERVALO DE RECURRENCIA/RECURRENCE INTERVAL: Unknown

TASA DE MOVIMIENTO/SLIP: Unknown

EDAD DEL ULTIMO MOVIMIENTO/TIME OF MOST RECENT OF MOVEMENT: Quaternary (<1.6 m.y.)

REFERENCIAS/REFERENCES

Alvarado, G. E., Morales, L. D., Montero, W., Climent, A., and Rojas, W., 1988, Aspectos sismológicos y morfotectónicos en el extremo occidental de la Cordillera Volcánica Central de Costa Rica: Revista Geologica América Central, v. 9, p. 75-98.

Morales, L.D., Alvarado, G., Montero, W., and Climent, A., 1986, Recurrencia de temblores y evaluación del peligro sísmico del noroeste del Valle Central, Costa Rica: San José, Costa Rica, IV Seminario Latinoam. de Ingeniería Sismo-resistente, 10 pp.

CR-14, ANGEL FAULT

NUMERO DE LA FALLA/FAULT NUMBER: CR-14
Comentarios/Comments: Shown as fault CRS-07 on original compilation sheets.

NOMBRE DE LA FALLA/FAULT NAME: Angel

SINOPSIS Y AMBIENTE GEOLOGICO/SYNOPSIS AND GEOLOGIC SETTING: Fault extends north-northwest for about 5 km across the oriental (east) flank of Poás Volcano, Alajuela Province. Fault cuts Quaternary volcanic deposits. Early reference to neotectonic activity of this fault was by Alvarado and others (1988).

COMPILADOR, AFILIACION Y FECHA DE COMPILACION/COMPILER, AFFILIATION, & DATE OF COMPILATION: Rafael Barquero and Guillermo Alvarado, Departamento de Geología, Instituto Costarricense de Electricidad (ICE), 1996.

TIPOS DE ESTUDIOS/TYPE OF STUDIES: Air photo interpretation and field survey.

GEOMETRIA DE LA FALLA/FAULT GEOMETRY
END POINTS: 10°13'49.01"N, 84 11 55.43"W (upper or left); 10°10'08.29"N, 84 10 40.15"W (lower or right).
LONGITUD/LENGTH: End-to-end 6.4 km; cumulative 6.4 km
RUMBO PROMEDIO/AVERAGE STRIKE: N21° W ± 9°
INCLINACION PROMEDIO/AVERAGE DIP: Unknown
SENTIDO DE MOVIMIENTO/SENSE OF MOVEMENT: Normal
Comentarios/Comments: Eastern block uplifted, possible sinistral displacement.

EXPRESION GEOMORFOLOGICA/GEOMORPHIC EXPRESSION: Clear topographic escarpment; rivers flowing perpendicular to (across) the fault change direction along the trace.

INTERVALO DE RECURRENCIA/RECURRENCE INTERVAL: Unknown

TASA DE MOVIMIENTO/SLIP RATE: Unknown

EDAD DEL ULTIMO MOVIMIENTO/TIME OF MOST RECENT OF MOVMENT: Quaternary
Comentarios/Comments: Fault cuts Quaternary volcanic deposits. However, some recent short-lived seismic swarms could be related to this fault.

REFERENCIAS/REFERENCES

Alvarado , G., Morales, L.D., Montero, W., Climent, A, and Rojas, W, 1988, Aspectos sismológicos y morfotectóniocos de la Cordillera Volcánica Central de Costa Rica: Rev. Geol. Amér. Central, v. 9, p. 75-98.

Soto, G., 1998, Estudio geológico para el Proyecto Hidroeléctrico Laguna Hule, Geología Regional, *in* Estudio Geologico-Geotecnico del P.H. Hule: San José, Costa Rica, Departamento de Geología, Instituto Costarricense de Electricidad (ICE), Inf. Interno, in press, Hoja Poás a escala 1:50,000.

CR-15, GUÁPILES FAULT

NUMERO DE LA FALLA/FAULT NUMBER: CR-15
Comentarios/Comments: Shown as fault CRS-08 (257) on original compilation sheets.

NOMBRE DE LA FALLA/FAULT NAME: Guápiles

SINOPSIS Y AMBIENTE GEOLOGICO/SYNOPSIS AND GEOLOGIC SETTING: This east-trending fault is poorly known and no detailled studies had been done at the time of this compilation. First suggested as a neotectonic fault by Borgia and others (1990). Fault defines boundary between southern Quaternary volcanic deposits and probable uplifted Quaternary sedimentary units of the Central Volcanic Cordillera (distal northern slopes of Irazú Volcano) and the northern alluvial plain (back-arc basin). Fault extends east-west from Guápiles to the Río Chirripo.

COMPILADOR, AFILIACION Y FECHA DE COMPILACION/COMPILER, AFFILIATION, & DATE OF COMPILATION: Walter Montero, Central American School of Geology, University of Costa Rica; March 26, 1996.

TIPOS DE ESTUDIOS/TYPE OF STUDIES Photogeological and reconnaissance studies.

GEOMETRIA DE LA FALLA/FAULT GEOMETRY
END POINTS: 10°12'28.29"N, 83°48'15.44"W (upper or left); 10°11'57.03"N, 83°55'13.02"W (lower or right).
LONGITUD/LENGTH: End-to-end 13.0 km; cumulative 13.2 km
RUMBO PROMEDIO/AVERAGE STRIKE: N 86° E ± 12°
INCLINACION PROMEDIO/AVERAGE DIP: South (suspected)
SENTIDO DE MOVIMIENTO/SENSE OF MOVEMENT: Probably thrust.
Comentarios/Comments: Although probably a thrust fault, Borgia and others (1990) originally proposed that this structure could be a fold-propagation fault (See also Montero, 1994).

EXPRESION GEOMORFOLOGICA/GEOMORPHIC EXPRESSION: Fault is defined by a prominent scarp that faces north. Scarp has rectangular (east) and triangular (west) facets and is substantially higher (200 meters high) in the west than in the east (40 meters high). Ridges are well preserved in the western and central parts of the fault.

INTERVALO DE RECURRENCIA/RECURRENCE INTERVAL: Unknown

TASA DE MOVIMIENTO/SLIP RATE: Unknown, probably 0.2-1 mm/yr
Comentarios/Comments: Suspected slip rate from relatively young-appearing scarps.

EDAD DEL ULTIMO MOVIMIENTO/TIME OF MOST RECENT OF MOVEMENT: Quaternary (<1.6 m.y.)
Comentarios/Comments: Last movement could be Holocene based on similar style and orientation of faulting that occurs to the east along the Baja Talamanca (CR-14) thrust fold system. Also, tectonically uplifted Holocene terraces are suspected on the eastern border of the fault.

REFERENCIAS/REFERENCES

Borgia, A., Burr, J., Montero, W., Morales, L.D, and Alvarado, G., 1990, Fault propagation folds induced by gravitational failure and slumping of the Costa Rica Volcanic Range—Implications for large terrestrial and Martian edifices: Journal of Geophyical Research, v. 95, p. 14,357-14,382.

Montero, W., 1994, Neotectonics and related stress distribution in a subduction collisional zone—Costa Rica, *in* Seyfried, Hartmut, and Hellman, Wiebke (eds.), Geology of an evolving island arc—Southeastern Central America: Profil, v. 7, p. 125-141.

CR-16, BARRANCA FAULT

NUMERO DE LA FALLA/FAULT NUMBER: CR-16
Comentarios/Comments: Shown as fault CRS-17 on original compilation sheets.

NOMBRE DE LA FALLA/FAULT NAME: Barranca

SINOPSIS Y AMBIENTE GEOLOGICO/SYNOPSIS AND GEOLOGIC SETTING: Fault first mentioned in detail by Madrigal (1970), but previously shown on the geological map of Dóndoli and others (1968). Quaternary activity of the Barranca fault was suggested by Fischer (1980) and described in more detail by Fisher and others (1994). Barboza and others (1995) and Fernández and others (1997) proposed extending this fault offshore. This northeast-trending fault cuts upper Tertiary sedimentary rocks and Quaternary alluvial deposits. It is located at the Forearc basin of the central Pacific coast of Costa Rica, east of Puntarenas.

COMPILADOR, AFILIACION Y FECHA DE COMPILACION/COMPILER, AFFILIATION, & DATE OF COMPILATION: Walter Montero, Central American School of Geology, University of Costa Rica, January 1997.

TIPOS DE ESTUDIOS/TYPE OF STUDIES: Air photo interpretation, field work, and marine geophysical studies.

GEOMETRIA DE LA FALLA/FAULT GEOMETRY
END POINTS: 9°58'38.93"N, 84°42'44.01"W (upper or left); 8°59'55.15"N, 85°7'1.09"W (lower or right).
LONGITUD/LENGTH: End-to-end 118.6 km; cumulative 125.7 km
RUMBO PROMEDIO/AVERAGE STRIKE: N 22° E ± 20°
INCLINACION PROMEDIO/AVERAGE DIP: Northwest
SENTIDO DE MOVIMIENTO/SENSE OF MOVEMENT: Sinistral-normal
Comentarios/Comments: Fisher and others (1994) suggested that the Barranca fault is transtensional. Sinistral component could be larger than normal component, but no measurements of lateral offset have been made.

EXPRESION GEOMORFOLOGICA/GEOMORPHIC EXPRESSION: Fault forms linear valley of the Río Barranca and causes drainage-basin asymetry with the left (north) side being significantly larger than the right (south) side (Fisher and others, 1994). Elevated marine bioerosional benches along the coast were found on the southeastern block of the fault (Fischer, 1980). Location of the fault offshore is based on interpretation of seismic data by Barboza and others (1995) and Fernández and others (1997).

INTERVALO DE RECURRENCIA/RECURRENCE INTERVAL: Unknown

TASA DE MOVIMIENTO/SLIP RATE: Unknown.
Comentarios/Comments: Probably less than 0.1 mm/yr in the vertical component (according to data in Fisher and others, 1994; see above). Sinistral component could be larger than normal component, but no measurements of lateral offset have been made.

EDAD DEL ULTIMO MOVIMIENTO/TIME OF MOST RECENT OF MOVEMENT: Quaternary (<1.6 m.y.)
Comentarios/Comments: Fisher and others (1994) documented 30 m of uplift (southeast side up) of the El Diablo terrace (<1.2 Ma) of the Río Barranca at a point about 11 km upstream from the Pacific coast..

REFERENCIAS/REFERENCES

Alvarado, G.E., Morales, L.D., Montero, W., Climent, A., and Rojas, W., 1988, Aspectos sismológicos y morfotectónicos en el extremo occidental de la Cordillera Volcánica Central de Costa Rica: Revista Geologica América Central, v. 9, p. 75-98.

Barboza, G., Barrientos, J., and Astorga, A., 1995, Tectonic evolution and sequence stratigraphy of the Central Pacific margin of Costa Rica: Revista Geologica América Central, v. 18, p. 43-63.

Dóndoli, C., Dengo, G., and Malavassi, E., 1968, Mapa Geológico de Costa Rica: San José, Costa Rica, Ministerio de Industria y Comerico, Dirección de Geología, Minas, y Petróleo; printed by Instituto Geográfico Nacional escala 1:700,000.

Fernández, A., Aguilar, A., Barboza, G., Bottazzi, G., Campos, L., Obando, J., Tejera, R., Arrieta, L., Barrientos, J., Bustos, I., Escalante, G., Pizarro, D., Valerín, E., Astorga, A., Bolaños, X., Calvo, C., Laurito, C., Rojas, J.F. and Valerio A., 1997, Mapa geológico de Costa Rica: Ministerio del Ambiente y Energía Refinadora Costarricense de Petróleo, escale 1:7,500,000.

Fischer, R., 1980, Recent tectonic movements of the Costa Rican Pacific coast: Tectonophysics, v. 70, p. T25-T33.

Fisher, D. M., Gardner, T. W., Marshall, J., and Montero, W., 1994, Kinematics associated with the late Cenozoic deformation in Central Costa Rica—Western boundary of the Panamá microplate: Geology, v. 22, p. 263-266.

Madrigal, R:, 1970, Geología del mapa básico Barranca, Costa Rica: San José, Costa Rica, Ministerio de Energía, Industria y Comercio, Informe Técnico IX (37), 59 pp.

CR-17, MATA DE LIMÓN FAULT

NUMERO DE LA FALLA/FAULT NUMBER: CR-17
Comentarios/Comments: Shown as fault CRS-18 on original compilation sheets.

NOMBRE DE LA FALLA/FAULT NAME: Mata de Limón

SINOPSIS Y AMBIENTE GEOLOGICO/SYNOPSIS AND GEOLOGIC SETTING: Information regarding this fault is based on Montero (unpublished data). Fault is not shown in any previous geological map. This northeast-trending fault is located at the Forearc basin of the central Pacific region and cuts upper Tertiary sedimentary rocks and Quaternary volcanic rocks and sediments. It extends about 10 km inland from the coast.

COMPILADOR, AFILIACION Y FECHA DE COMPILACION/COMPILER, AFFILIATION, & DATE OF COMPILATION: Walter Montero, Central American School of Geology, University of Costa Rica, January 1997.

TIPOS DE ESTUDIOS/TYPE OF STUDIES: Air photo interpretation

GEOMETRIA DE LA FALLA/FAULT GEOMETRY
END POINTS: 9°57'24.38"N, 84°40'35.80"W (upper or left); 9°55'20.96"N, 84°43'34.03"W (lower or right).
LONGITUD/LENGTH: End-to-end 6.7 km; cumulative 6.8 km
RUMBO PROMEDIO/AVERAGE STRIKE: N 55° E ± 10°
INCLINACION PROMEDIO/AVERAGE DIP: Southeast
SENTIDO DE MOVIMIENTO/SENSE OF MOVEMENT: Sinistral, normal
Comentarios/Comments: Sense of movement suggested because it is part of a larger system of parallel sinistral-normal faults that also appear to be Quaternary (Barranca CR-16; Jesús María CR-18; and Tárcoles CR-19) (see Fisher and others, 1994). Southeast-facing scarp suggests a normal component of displacement with the northwestern block uplifted (Montero, unpublished data).

EXPRESION GEOMORFOLOGICA/GEOMORPHIC EXPRESSION: Scarp faces to the southeast.

INTERVALO DE RECURRENCIA/RECURRENCE INTERVAL: Unknown

TASA DE MOVIMIENTO/SLIP RATE: Unknown

EDAD DEL ULTIMO MOVIMIENTO/TIME OF MOST RECENT OF MOVEMENT: Quaternary (<1.6 m.y.)
Comentarios/Comments: Suggested as Quaternary by its relatively fresh escarpment and association with larger system of Quaternary sinistral-normal faults.

REFERENCIAS/REFERENCES

Fisher, D.M., Gardner, T.W., Marshall, J., and Montero, W., 1994, Kinematics associated with the late Cenozoic deformation in Central Costa Rica: Western boundary of the Panamá microplate: Geology, v. 22, p. 263-266.

CR-18, JESÚS MARÍA FAULT

NUMERO DE LA FALLA/FAULT NUMBER: CR-18
Comentarios/Comments: Shown as fault CRS-19 on original compilation sheets.

NOMBRE DE LA FALLA/FAULT NAME: Jesús María

SINOPSIS Y AMBIENTE GEOLOGICO/SYNOPSIS AND GEOLOGIC SETTING: Fault first referred to by Madrigal (1970). Neotectonic activity was proposed by Fischer (1980) and Fisher and others (1994). This northeast-trending fault is located in the Forearc basin of the central Pacific region. It cuts Upper Tertiary sedimentary rocks and Quaternary volcanic and alluvial terraces, and extends inland about 15 km from the Pacific coast. Barboza and others (1995) and Fernández and others (1997) proposed extending this fault offshore.

COMPILADOR, AFILIACION Y FECHA DE COMPILACION/COMPILER, AFFILIATION, & DATE OF COMPILATION: Walter Montero, Central American School of Geology, University of Costa Rica, January 1997.

TIPOS DE ESTUDIOS/TYPE OF STUDIES: Air photo interpretation, field work, and interpretation of marine seismic data.

GEOMETRIA DE LA FALLA/FAULT GEOMETRY
END POINTS: 9°57'38.89"N, 84°36'48.58"W (upper or left); 9°52'29.75"N, 84°43'1.97"W (lower or right).
LONGITUD/LENGTH: End-to-end 15.0 km; cumulative 18.9 km
RUMBO PROMEDIO/AVERAGE STRIKE: N 56° ± 25°
INCLINACION PROMEDIO/AVERAGE DIP: Southwest
SENTIDO DE MOVIMIENTO/SENSE OF MOVEMENT: Sinistral-normal (transtensional).
Comentarios/Comments: Transtensional movement was suggested by Fisher and others (1994). Normal component also suggested by Madrigal (1970) and Fischer (1980).

EXPRESION GEOMORFOLOGICA/GEOMORPHIC EXPRESSION: Scarp face to the southeast, with the northwestern fault block uplifted. This fault and the Barranca fault (CR-16, located to the northwest) define the margins of the uplifted Esparza Block (see Fisher and others, 1994). Location of the fault offshore is based on interpretations of marine seismic data by Barboza and others (1995) and Fernández and others (1997).

INTERVALO DE RECURRENCIA/RECURRENCE INTERVAL: Unknown

TASA DE MOVIMIENTO/SLIP RATE: Unknown, probably <1 mm/yr (normal component only)
Comentarios/Comments: Fisher and others (1994) found that late Tertiary to Quaternary lahars are offset by the fault with a northwest-side-up stratigraphic separation of about 120 m. If this entire vertical separation occurred during the Quaternary (1.6 Ma), the long-term slip vertical rate would be about 0.1 mm/yr.

EDAD DEL ULTIMO MOVIMIENTO/TIME OF MOST RECENT OF MOVEMENT: Quaternary (<1.6 m.y.)
Comentarios/Comments: See Fisher and others (1994) for documentation of Quaternary activity (also, see above).

REFERENCIAS/REFERENCES

Barboza, G. Barrientos, J., and Astorga, A., 1995, Tectonic evolution and sequence stratigraphy of the Central Pacific margin of Costa Rica: Revista Geologica América Central, v. 18, p. 43-63.

Fernández, A., Aguilar, A., Barboza, G., Bottazzi, G., Campos, L., Obando, J., Tejera, R., Arrieta, L., Barrientos, J., Bustos, I., Escalante, G., Pizarro, D., Valerín, E., Astorga, A., Bolaños, X., Calvo, C., Laurito, C., Rojas, J.F. and Valerio A., 1997, Mapa geológico de Costa Rica: Ministerio del Ambiente y Energía Refinadora Costarricense de Petróleo, escale 1:7,500,000.

Fischer, R., 1980, Recent tectonic movements of the Costa Rican Pacific coast: Tectonophysics, v. 70, p. T25-T33.

Fisher, D. M., Gardner, T. W., Marshall, J., and Montero, W., 1994, Kinematics associated with the late Cenozoic deformation in Central Costa Rica: Western boundary of the Panamá microplate: Geology, v. 22, p. 263-266.

Madrigal, R., 1970, Geología del mapa básico Barranca, Costa Rica: San José, Costa Rica, Ministerio de Energía, Industria y Comercio, Informe Técnico IX (37), 59 pp.

CR-19, TÁRCOLES FAULT

NUMERO DE LA FALLA/FAULT NUMBER: CR-19
Comentarios/Comments: Shown as fault CRS-20 on original compilation sheets.

NOMBRE DE LA FALLA/FAULT NAME: Tárcoles

SINOPSIS Y AMBIENTE GEOLOGICO/SYNOPSIS AND GEOLOGIC SETTING: First reference to the Tárcoles fault is by Weyl (1961), but it was later shown by Dóndoli and others (1968), Madrigal (1970), and Sandoval and others (1982). First reference to its neotectonic activity is by Fischer (1980) and more details about its neotectonic activity can be found in Fisher and others (1994) and Montero (1994). This north-trending fault is located in the Forearc basin of the central Pacific region, southwest of Orotina. The fault cuts upper Tertiary sedimentary rocks and Quaternary lahars and alluvial deposits.

COMPILADOR, AFILIACION Y FECHA DE COMPILACION/COMPILER, AFFILIATION, & DATE OF COMPILATION: Walter Montero Pohly, Central American School of Geology, University of Costa Rica; January 1997.

TIPOS DE ESTUDIOS/TYPE OF STUDIES: Air photo interpretation and field work

GEOMETRIA DE LA FALLA/FAULT GEOMETRY
END POINTS: 9°49'38.55"N, 84°34'48.81"W (upper or left); 8°59'45.96"N, 85°0'1.00"W (lower or right).
LONGITUD/LENGTH: End-to-end 104 km; cumulative 141 km
RUMBO PROMEDIO/AVERAGE STRIKE: N 32° E ± 22°
INCLINACION PROMEDIO/AVERAGE DIP: Northwest
SENTIDO DE MOVIMIENTO/SENSE OF MOVEMENT: Sinistral, normal
Comentarios/Comments: Fisher and others (1994) suggested that the Tárcoles is a transtensional fault, whereas Madrigal (1970) had proposed it is a normal fault. Based on the relative position of coastal bioerosional platforms, Fischer (1980) found evidence that supports uplift of the southeastern block and subsidence of the northwestern block.

EXPRESION GEOMORFOLOGICA/GEOMORPHIC EXPRESSION: Fault partially follows the Grande de Tárcoles River, which has a highly asymmetric drainage basin (Fisher and others, 1994). The Tárcoles fault defines the southeastern boundary of the Orotina Block. The northwestern boundary of the block is formed by the Jesús María fault (CR-19) (Fisher and others, 1994). The Orotina Block has been downdropped and gently tilted to the northwest during the Quaternary, relative to the Esparza Block and to the Cretaceous and Tertiary rocks to the southeast (Fisher and others, 1994).

INTERVALO DE RECURRENCIA/RECURRENCE INTERVAL: Unknown

TASA DE MOVIMIENTO/SLIP RATE: Unknown, probably <1 mm/yr (normal component only)
Comentarios/Comments: Marshall (1994) found a vertical separation of 10- 50 meters in welded tuffs and river terraces of Quaternary age.

EDAD DEL ULTIMO MOVIMIENTO/TIME OF MOST RECENT OF MOVEMENT: Quaternary (<1.6 m.y.)
Comentarios/comment: Fault offsets welded tuffs and river terraces of Quaternary age.

REFERENCIAS/REFERENCES

Dóndoli, C., Dengo, G., and Malavassi, E., 1968, Mapa Geológico de Costa Rica: San José, Costa Rica, Ministerio de Industria y Comerico, Dirección de Geología, Minas, y Petróleo; printed by Instituto Geográfico Nacional escala 1:700,000.

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Madrigal, R., 1970, Geología del mapa básico Barranca, Costa Rica: San José, Costa Rica, Ministerio de Energía, Industria y Comercio, Informe Técnico IX (37), 59 pp.

Marshall, J., 1994, Evolution of the Orotina fan, Pacific coast, Costa Rica—Late Cenozoic tectonism along the western boundary of the Panamá microplate: Geol. Soc. Am. Abstracts with Programs, v. 26, p. A 207.

Montero, W., 1994, Neotectonics and related stress distribution in a subduction collisional zone—Costa Rica, *in* Seyfried, Hartmut, and Hellman, Wiebke (eds.), Geology of an evolving island arc—Southeastern Central America: Profil, v. 7, p. 125-141.

Sandoval, L. F, Sáenz, R., Acuña, J., Castro, J. F., Gómez, M., López, A., Mederos, B., Monge, A., Vargas, J., Fernández, T., Ulate, R., and Ramírez, C., 1982, Mapa Geológico de Costa Rica: San José, Costa Rica, Instituto Geográfico Nacional, 9 sheets, scale 1:200,000.

Weyl, R., 1961, Die Geologie Mittelamerika: Berlin, Borntraeger, 226 pp.

CR-20, TRONCO NEGRO FAULT

NUMERO DE LA FALLA/FAULT NUMBER: CR-20
Comentarios/Comments: Shown as fault CRS-21 on original compilation sheets.

NOMBRE DE LA FALLA/FAULT NAME: Tronco Negro

SINOPSIS Y AMBIENTE GEOLOGICO/SYNOPSIS AND GEOLOGIC SETTING: The Tronco Negro fault is first referred to in this compilation and is based on data obtained by Montero (unpublished data). The name is given informally. The north-trending Tronco Negro fault is located at a transition zone between the Forearc basin and the Forearc in the central Pacific region of Costa Rica and could be related to the Tárcoles fault (CR-19) to the west. The fault cuts volcanic and sedimentary rocks of Tertiary and Quaternary age (Madrigal, 1970). It strikes north-south and extends from the Río Turrubares (on the south) to about 2 km southwest of Orotina (on the north).

COMPILADOR, AFILIACION Y FECHA DE COMPILACION/COMPILER, AFFILIATION, & DATE OF COMPILATION: Walter Montero, Central American School of Geology, University of Costa Rica; January 1997.

TIPOS DE ESTUDIOS/TYPE OF STUDIES: Air photo interpretation

GEOMETRIA DE LA FALLA/FAULT GEOMETRY
END POINTS: 9°54'20.42"N, 84°32'53.28"W (upper or left); 9°50'17.37"N, 84°32'41.55"W (lower or right).
LONGITUD/LENGTH: End-to-end 7.6 km; cumulative 7.6 km
RUMBO PROMEDIO/AVERAGE STRIKE: N 3° W ± 7°
INCLINACION PROMEDIO/AVERAGE DIP: West
SENTIDO DE MOVIMIENTO/SENSE OF MOVEMENT: Sinestral-normal
Comentarios/Comments: Normal component suggested from scarps; sinestral component suggested from presence of possible pull-apart-related structures.

EXPRESION GEOMORFOLOGICA/GEOMORPHIC EXPRESSION: Fault defined by scarps that face to the west.

INTERVALO DE RECURRENCIA/RECURRENCE INTERVAL: Unknown

TASA DE MOVIMIENTO/SLIP RATE: Unknown

EDAD DEL ULTIMO MOVIMIENTO/TIME OF MOST RECENT OF MOVEMENT: Quaternary (<1.6 m.y.)
Comentarios/comments: Cuts volcanic and sedimentary rocks of Tertiary and Quaternary age (Madrigal, 1970).

REFERENCIAS/REFERENCES

Madrigal, R., 1970, Geología del mapa básico Barranca, Costa Rica: San José, Costa Rica, Ministerio de Energía, Industria y Comercio, Informe Técnico IX (37), 59 pp.

CR-21, SAN JUAN DE MATA FAULT

NUMERO DE LA FALLA/FAULT NUMBER: CR-21
Comentarios/Comments: Shown as fault CRS-22 on original compilation sheets.

NOMBRE DE LA FALLA/FAULT NAME: San Juan de Mata
Comentarios/Comments: Name given informally in this compilation.

SINOPSIS Y AMBIENTE GEOLOGICO/SYNOPSIS AND GEOLOGIC SETTING: Fault is first referred to in this compilation based on data obtained by Montero (unpublished information). The northeast-trending San Juan de Mata fault is located at the transition between the Forearc and the Inner Arc in the central Pacific region of Costa Rica. It cuts sedimentary and volcanic Tertiary and Quaternary rocks (for geology of the region see Madrigal, 1970). The San Juan de Mata may be related to the Tárcoles fault (CR-19, similar strike and sense of movement), but seems to terminate the northern end of the Candelaria fault (CR-29).

COMPILADOR, AFILIACION Y FECHA DE COMPILACION/COMPILER, AFFILIATION, & DATE OF COMPILATION: Walter Montero, Central American School of Geology, University of Costa Rica; January 1997.

TIPOS DE ESTUDIOS/TYPE OF STUDIES: Air photo interpretation and field work.

GEOMETRIA DE LA FALLA/FAULT GEOMETRY
END POINTS: 9°55 10.69"N, 84°29 57.98"W (upper or left); 9°51 12.69"N, 84°30 55.51"W (lower or right).
LONGITUD/LENGTH: End-to-end 7.6 km; cumulative 7.6 km
RUMBO PROMEDIO/AVERAGE STRIKE: N 13° E ± 2°
INCLINACION PROMEDIO/AVERAGE DIP: West
SENTIDO DE MOVIMIENTO/SENSE OF MOVEMENT: Sinistral-normal
Comentarios/Comments: Normal movement suggested by scarps facing to the west, whereas sinistral component is suggested by lateral displacement of drainages.

EXPRESION GEOMORFOLOGICA/GEOMORPHIC EXPRESSION: Scarps, fault saddles, linear and fault valleys, and drainage displacement.

INTERVALO DE RECURRENCIA/RECURRENCE INTERVAL: Unknown

TASA DE MOVIMIENTO/SLIP RATE: Unknown

EDAD DEL ULTIMO MOVIMIENTO/TIME OF MOST RECENT OF MOVEMENT: Quaternary (<1.6 m.y.) (<1.6 m.y.)
Comentarios/Comments: Quaternary alluvial units are offset by the fault.

REFERENCIAS/REFERENCES

Madrigal, R., 1970, Geología del mapa básico Barranca, Costa Rica: San José, Costa Rica, Ministerio de Energía, Industria y Comercio, Informe Técnico IX (37), 59 pp.

CR-22, ALAJUELA FAULT

NUMERO DE LA FALLA/FAULT NUMBER: CR-22
Comentarios/Comments: Shown as fault CRS-09 on original compilation sheets.

NOMBRE DE LA FALLA/FAULT NAME: Alajuela

SINOPSIS Y AMBIENTE GEOLOGICO/SYNOPSIS AND GEOLOGIC SETTING: This fault is relatively well studied. It is interpretated as a fold-propagation fault (thrust fault and associated anticline) that bounds the southern flank of Poas Volcano of the Central Quaternary Volcanic Cordillera. Total offset is about 200 m to the south, away from the volcanic axis (Borgia and others, 1990) with movement during the past 20,000 yr. Holocene and late Quaternary sedimentary and volcanic deposits are displaced by the fault. Early references are by Romanes (1912), Schaulfelberger (1935), and Williams (1952), with the fault shown on geological maps of Dóndoli and others (1968) and Sandoval and others (1982). More detailed studies have been reported by Borgia and others (1990), and Montero and others (1989). Fault trace was transferred from a base map at 1:50,000 scale (Montero and others, 1989). This east-trending sinous fault extends from Grecia (on the west) to Santa Barbara (on the east).

COMPILADOR, AFILIACION Y FECHA DE COMPILACION/COMPILER, AFFILIATION, & DATE OF COMPILATION: Walter Montero, Central American School of Geology, University of Costa Rica; March 3, 1995.

TIPOS DE ESTUDIOS/TYPE OF STUDIES: Photogeology, field studies, geologic mapping, and one trench has been excavated. No datable material was recovered (Montero, unplished data).

GEOMETRIA DE LA FALLA/FAULT GEOMETRY
END POINTS: 10°4'3.63"N, 84°19'42.10"W (upper or left); 10°1'46.07"N, 84°9'17.16"W (lower or right).
LONGITUD/LENGTH: End-to-end 19.8 km; cumulative 20.9 km
RUMBO PROMEDIO/AVERAGE STRIKE: N78° W ± 19°
INCLINACION PROMEDIO/AVERAGE DIP: North-northeast
SENTIDO DE MOVIMIENTO/SENSE OF MOVEMENT: Thrust
Comentarios/Comments: Thrust and associated fold (anticline) according to field data and geological model by Borgia and others (1990). Previous studies by Romanes (1912), Schaulfelberger (1935), Williams (1952) and Dóndoli and others (1968) proposed it as a normal fault.

EXPRESION GEOMORFOLOGICA/GEOMORPHIC EXPRESSION: Thrust fault forms long sublinear ridges (anticlines) and related scarps. Ridges have 50-200 m of topographic relief, are 200-400 m wide, and extend laterally for 20 km north of the thrust forming a festoon-like pattern. Scarps face away (south) from the Cordillera and have one or two steps, suggesting multiple near-surface faults. Topography of the ridge shows frequent en echelon offsets across rivers (Borgia and others, 1990).

INTERVALO DE RECURRENCIA/RECURRENCE INTERVAL: Unknown

TASA DE MOVIMIENTO/SLIP RATE: Probably 10 mm/yr
Comentarios/Comments: Based on Borgia and others (1990) data, an estimate of 10 mm/yr is obtained by using 200 m of displacement during the past 20,000 yr.

EDAD DEL ULTIMO MOVIMIENTO/TIME OF MOST RECENT OF MOVEMENT: Holocene or post glacial (<15 ka)
Comentarios/Comments: Borgia and others (1990) document faulting of Holocene alluvial deposits, as well as late Quaternary (<20 ka) sedimentary and volcanic deposits. See Borgia and others (1990) for details of stratigraphic units displaced by the fault.

REFERENCIAS/REFERENCES

Borgia, A., Burr, J., Montero, W., Alvarado, G., and Morales, L.D., 1990, Fault propagation folds induced by gravitational failure and slumping of the Costa Rica Volcanic Range: Implications for large terrestrial and Martian edifices: Jour. Geophy. Res., v. 95, p. 14357-14382.

Dóndoli, C., and Chavez, R., 1968, Mapa Geológico del Valle Central: San José, Costa Rica, Ministerio de Industria y Comerico, Dirección de Geología, Minas, y Petróleo; printed by Instituto Geográfico Nacional escala 1:150,000.

Montero, W., Madrigal, R., Mora, R., Seeley, M., Alt, J., and Cline, M., 1991, Lineaments suggestive of recent fault activity, scale 1: 50,000 (unpublished map).

Romanes, J., 1912, Geology of a part of Costa Rica: Quat. Jour. Geol. Soc. London, v. 68, p. 103-139.

Sandoval, L. F, Sáenz, R., Acuña, J., Castro, J. F., Gómez, M., López, A., Mederos, B., Monge, A., Vargas, J., Fernández, T., Ulate, R., and Ramírez, C., 1982, Mapa Geológico de Costa Rica: San José, Costa Rica, Instituto Geográfico Nacional, 9 sheets, scale 1:200,000.

Schaulfelberger, P., 1935, Un estudio geológico de la Meseta Central Occidental: Rev. Inst. Def. Café Costa Rica, v. 2, 15 p.

Williams, H., 1952, Volcanic History of the Meseta Occidental, Costa Rica: Univ. Calif. Publ. Geol. Sci., v. 29, no. 4, p. 145-180.

CR-23, GARITA FAULT

NUMERO DE LA FALLA/FAULT NUMBER: CR-23
Comentarios/Comments: Shown as fault CRS-25 on original compilation sheets.

NOMBRE DE LA FALLA/FAULT NAME: Garita

SINOPSIS Y AMBIENTE GEOLOGICO/SYNOPSIS AND GEOLOGIC SETTING: This northeast-trending sinistral strike-slip fault offsets Quaternary pyroclastic rocks. It forms a prominent alignment on aerial photographs and topographic maps. It had been mapped by Arias and Denyer (1990) as an inferred fault, and Montero (1994) recognized it as neotectonic feature. The fault extends from near Garita (on the north) southwest to Balsa.

COMPILADOR, AFILIACION Y FECHA DE COMPILACION/COMPILER, AFFILIATION, & DATE OF COMPILATION: Percy Denyer, University of Costa Rica; March 1997.

TIPOS DE ESTUDIOS/TYPE OF STUDIES: Field geology and photogeology.

GEOMETRIA DE LA FALLA/FAULT GEOMETRY
END POINTS: 9°59'47.73"N, 84°20'0.76"W (upper or left); 9°56'51.50"N, 84°22'7.85"W (lower or right).
LONGITUD/LENGTH: End-to-end 6.8 km; cumulative 6.8 km
RUMBO PROMEDIO/AVERAGE STRIKE: N 37° E ± 9°
INCLINACION PROMEDIO/AVERAGE DIP: Unknown
SENTIDO DE MOVIMIENTO/SENSE OF MOVEMENT: Sinistral strike slip
Comentarios/Comments: This movement corresponds with the sense of movement inferred by Arias and Denyer (1990) and Montero (1994).

EXPRESION GEOMORFOLOGICA/GEOMORPHIC EXPRESSION: Very clear geomorphic expression; forms alignments on aerial photographs and topographic maps.

INTERVALO DE RECURRENCIA/RECURRENCE INTERVAL: Unknown

TASA DE MOVIMIENTO/SLIP RATE: Unknown

EDAD DEL ULTIMO MOVIMIENTO/TIME OF MOST RECENT OF MOVEMENT: Quaternary (<1.6 m.y.)
Comentarios/Comments: Welded tuffs, lava flows, and alluvial deposits of Quaternary age are cut by the fault.

REFERENCIAS/REFERENCES -

Arias, O., and Denyer, P., 1990, Geología de la hoja Río Grande: San José, Costa Rica, Instituto Geográfico Nacional, escala 1:50,000.

Montero, W., 1994, Neotectonics and related stress distribution in a subduction collisional zone—Costa Rica, *in* Seyfried, Hartmut, and Hellman, Wiebke (eds.), Geology of an evolving island arc—Southeastern Central America: Profil, v. 7, p. 125-141.

CR-24, VIRILLA FAULT

NUMERO DE LA FALLA/FAULT NUMBER: CR-24
Comentarios/Comments: Shown as fault CRS-35 on original compilation sheets.

NOMBRE DE LA FALLA/FAULT NAME: Virilla

SINOPSIS Y AMBIENTE GEOLOGICO/SYNOPSIS AND GEOLOGIC SETTING: Fault was referred to for the first time by Montero and others (1991). It forms the boundary between the southwestern side of the Central Valley and the northwestern side of the Talamanca Cordillera (Inner Arc region). The fault cuts Tertiary and Quaternary volcanic units and extends northeast about 4 km from Piedras Negras, west of Colon.

COMPILADOR, AFILIACION Y FECHA DE COMPILACION/COMPILER, AFFILIATION, & DATE OF COMPILATION: Walter Montero, Central American School of Geology, University of Costa Rica; January 1997.

TIPOS DE ESTUDIOS/TYPE OF STUDIES: Air photo intrepretation and field work

GEOMETRIA DE LA FALLA/FAULT GEOMETRY
END POINTS: 9°56'23.27"N, 84°17'41.61"W (upper or left); 9°55'6.79"N, 84°19'22.91"W (lower or right).
LONGITUD/LENGTH: End-to-end 3.9 km; cumulative 3.9 km
RUMBO PROMEDIO/AVERAGE STRIKE: N53° E ± 7°
INCLINACION PROMEDIO/AVERAGE DIP: High-angle
SENTIDO DE MOVIMIENTO/SENSE OF MOVEMENT: Suspected sinistral strike slip
Comentarios/Comments: Supported by field data and focal mechanism of recent earthquake related to the fault (Montero and others, 1991).

EXPRESION GEOMORFOLOGICA/GEOMORPHIC EXPRESSION: Partially follows the valley of the Virilla River near its junction with the Jaris River.

INTERVALO DE RECURRENCIA/RECURRENCE INTERVAL: Unknown

TASA DE MOVIMIENTO/SLIP RATE: Unknown

EDAD DEL ULTIMO MOVIMIENTO/TIME OF MOST RECENT OF MOVEMENT: Quaternary (<1.6 m.y.), possibly historic (1990).
Comentarios/Comments: The Ms 5.7 Piedras Negras earthquake of December 22, 1990 was related to this fault (Montero and others, 1991). Some geologic evidences suggests rupture on a small northern part of the fault related with this seismic event, but the evidence is not conclusive (Montero and others, 1991). The remainder of the fault cuts Tertiary and Quaternary volcanic units and has clear evidence of Quaternary movement.

REFERENCIAS/REFERENCES

Montero, W., Rojas, W., Boschini, I., Barquero, R., and Flores, H., 1991, Neotectónica de la región de Puriscal: Origen de la sismicidad de mayo-diciembre de 1990: Memorias 5° Seminario Nacional de Geotécnia-Ier Encuentro Centroamericano de Geotecnistas, v. 4, p. 38-51.

CR-25, PICAGRES FAULT SYSTEM

NUMERO DE LA FALLA/FAULT NUMBER: CR-25
Comentarios/Comments: Shown as fault CRS-34 on original compilation sheets.

NOMBRE DE LA FALLA/FAULT NAME: Picagres

SINOPSIS Y AMBIENTE GEOLOGICO/SYNOPSIS AND GEOLOGIC SETTING: This fault system was first referred to in Montero and others (1991) and Arias and Denyer (1991), and is well known at the general level. Both studies suggested neotectonic activity on these faults. This system of north-trending (but sinous) strike-slip faults are located on the northwestern side of the Talamanca Cordillera (Inner Arc region), near the boundary with the southwestern side of the Central Valley. These faults cut Upper Tertiary volcanic and sedimentary rocks, north and east of Santiago. Montero and others (1991) originally named the eastern two traces (shown on the compilation) as the San Antonio fault and the western trace was named the Picagres fault.

COMPILADOR, AFILIACION Y FECHA DE COMPILACION/COMPILER, AFFILIATION, & DATE OF COMPILATION: Walter Montero, Central American School of Geology, University of Costa Rica; January 1997

TIPOS DE ESTUDIOS/TYPE OF STUDIES: Air photo interpretation and field work

GEOMETRIA DE LA FALLA/FAULT GEOMETRY
END POINTS: 9°54'2.36"N, 84°19'25.19"W (upper or left); 9°49'53.32"N, 84°18'2.40"W (lower or right).
LONGITUD/LENGTH: End-to-end 8.2 km; cumulative 13.5 km
RUMBO PROMEDIO/AVERAGE STRIKE: N 25° W ± 22°
INCLINACION PROMEDIO/AVERAGE DIP: High-angle
SENTIDO DE MOVIMIENTO/SENSE OF MOVEMENT: Suspected dextral strike slip with normal component.
Comentarios/Comments: According to field data and supported by earthquake focal-mechanisms for events that are aligned with the trace of the fault (see Montero and others, 1991; Arias and Denyer, 1991).

EXPRESION GEOMORFOLOGICA/GEOMORPHIC EXPRESSION: Located along a linear valley. Fault scarps observed to bound the eastern block.

INTERVALO DE RECURRENCIA/RECURRENCE INTERVAL: Unknown

TASA DE MOVIMIENTO/SLIP RATE: Unknown

EDAD DEL ULTIMO MOVIMIENTO/TIME OF MOST RECENT OF MOVEMENT: Holocene or post glacial (<15 ka)
Comentarios/Comment: River terraces of probable Holocene age are cut by small faults associated with this system (Montero and others, 1991). Earthquakes having magnitudes lower than Ms 5.0 between May and August, 1990, occurred along the trace of the fault, but surface ruptures were not positively related to the fault itself. However, suspected fault ruptures were found on the San Antonio fault trace, which is nearly parallel to the Picagres fault (Montero and others, 1991).

REFERENCIAS/REFERENCES

Arias, O. ,y Denyer, P., 1991, Aspectos neotectónicos y geológicos de Puriscal y alrededores, Costa Rica: Rev. Geol. Amér. Centr. , v. 12, p. 83-95.

Montero, W., Rojas, W., Boschini, I., Barquero, R., and Flores, H., 1991, Neotectónica de la región de Puriscal: Origen de la sismicidad de mayo-diciembre de 1990: Memorias 5° Seminario Nacional de Geotécnia-Ier Encuentro Centroamericano de Geotecnistas, v. 4, p. 38-4.51.

CR-26, JARIS FAULT

NUMERO DE LA FALLA/FAULT NUMBER: CR-26
Comentarios/Comments: Shown as fault CRS-26 on original compilation sheets.

NOMBRE DE LA FALLA/FAULT NAME: Jaris

SINOPSIS Y AMBIENTE GEOLOGICO/SYNOPSIS AND GEOLOGIC SETTING: This dextral fault crosses (cuts) Miocene sedimentary rocks and Quaternary pyroclastic rocks. It was mapped by Dóndoli and Chaves (1968) and more recently by Arias and Denyer (1990). The fault trends northwest and extends from near Piedras Negas (on the north) to near Palmicnal (on the south).

COMPILADOR, AFILIACION Y FECHA DE COMPILACION/COMPILER, AFFILIATION, & DATE OF COMPILATION: Percy Denyer, University of Costa Rica; March 1997.

TIPOS DE ESTUDIOS/TYPE OF STUDIES: Field geology, photogeology and seismology.

GEOMETRIA DE LA FALLA/FAULT GEOMETRY
END POINTS: 9°55'7.60"N, 84°18'57.73"W (upper or left); 9°50'3.31"N, 84°12'18.30"W (lower or right).
LONGITUD/LENGTH: End-to-end 15.6 km; cumulative 15.9 km
RUMBO PROMEDIO/AVERAGE STRIKE: N 53° W ± 12°
INCLINACION PROMEDIO/AVERAGE DIP: Unknown
SENTIDO DE MOVIMIENTO/SENSE OF MOVEMENT: Dextral
Comentarios/Comments: Based on Miocene structural data (Arias and Denyer, 1990) and supported by recent seismological data (Montero and Morales, 1984).

EXPRESION GEOMORFOLOGICA/GEOMORPHIC EXPRESSION: Very clear expression in the valley of the Jaris River, as well as a pronounced alignment seen on aerial photographs and topographic maps.

INTERVALO DE RECURRENCIA/RECURRENCE INTERVAL: Unknown

TASA DE MOVIMIENTO/SLIP RATE: Unknown

EDAD DEL ULTIMO MOVIMIENTO/TIME OF MOST RECENT OF MOVEMENT: Quaternary (<1.6 m.y.)
Comentarios/Comments: Fault cuts Quaternary pyroclastic rocks. Montero and Morales (1984) suggested a spatial relationship between this fault and seismicity recorded during the past several years.

REFERENCIAS/REFERENCES

Arias, O, y Denyer, P., 1990, Geología de la hoja Río Grande: San José, Costa Rica, Instituto Geográfico Nacional, escala 1:50,000.

Dóndoli, C., and Chavez, R., 1968, Mapa Geológico del Valle Central: San José, Costa Rica, Ministerio de Industria y Comerico, Dirección de Geología, Minas, y Petróleo; printed by Instituto Geográfico Nacional escala 1:150,000.

Montero, W., and Morales, L.D., 1984, Sismotectónica y niveles de actividad de microtemblores en el suroeste del Valle Central, Costa Rica: Revista Geofísica, v. 21,p. 21-40.

CR-27, DELICIAS FAULT

NUMERO DE LA FALLA/FAULT NUMBER: CR-27
Comentarios/Comments: Shown as fault CRS-27 on original compilation sheets.

NOMBRE DE LA FALLA/FAULT NAME: Delicias

SINOPSIS Y AMBIENTE GEOLOGICO/SYNOPSIS AND GEOLOGIC SETTING: The fault trace crosses (cuts) Cretaceous igneous rocks (basalts) of the Nicoya Complex. The fault strikes northeast and extends from an intersection with the Pirris fault (CR-40, on the south) to Parrita (on the north).

COMPILADOR, AFILIACION Y FECHA DE COMPILACION/COMPILER, AFFILIATION, & DATE OF COMPILATION: Percy Denyer, University of Costa Rica; March 1997.

TIPOS DE ESTUDIOS/TYPE OF STUDIES: Field geology, photogeology, and seismology.

GEOMETRIA DE LA FALLA/FAULT GEOMETRY
END POINTS: 9°42'23.48"N, 84°7'29.36"W (upper or left); 9°38'18.76"N, 84°11'40.58"W (lower or right).
LONGITUD/LENGTH: End-to-end 10.9 km; cumulative 10.9 km
RUMBO PROMEDIO/AVERAGE STRIKE: N 46° E ± 3°
INCLINACION PROMEDIO/AVERAGE DIP: Unknown
Comentarios/Comments: Based on seismic profiles, Barquero and others (1989) thought that the fault is nearly vertical (Barquero et al., 1989).
SENTIDO DE MOVIMIENTO/SENSE OF MOVEMENT: Sinistral strike slip
Comentarios/Comments: The sense of movement was not based on neotectonic data, but from evidence of older Tertiary deformation.

EXPRESION GEOMORFOLOGICA/GEOMORPHIC EXPRESSION: Very clear in the valley of the Delicias River. The trace of the fault is seen clearly on aerial photographs and from topographic maps.

INTERVALO DE RECURRENCIA/RECURRENCE INTERVAL: Unknown

TASA DE MOVIMIENTO/SLIP RATE: Unknown

EDAD DEL ULTIMO MOVIMIENTO/TIME OF MOST RECENT OF MOVEMENT: Quaternary (<1.6 m.y.), probably historic (1989).
Comentarios/Comments: The last movement on the Delicias fault was probably during the earthquake of February 26, 1989, which had epicenter close to this fault. The parameters of this earthquake were Md 4.7, time 12:21:09.68 (GMT), epicenter at latitute 09° 40.13' N. and longitude 84° 14.29'W., and depth 26 km. Portable seismologic stations installed after this earthquake showed an aftershock pattern that suggested possible movement on the Delicias and the Pirris (CR-40) faults (Barquero and others, 1989).

REFERENCIAS/REFERENCES

Arias, O., and Denyer, P., 1990, Geología de la hoja Caraigres: San José, Costa Rica, Instituto Geográfico Nacional, escala 1:50,000.

Barquero, R., Rojas, W., and Climent, A., 1989, El temblor del 26 de febrero de 1989: San José, Costa Rica, Instituto Costarricense de Electricidad y University of Costa Rica (informe interno), 18 pp.

CR-28, TULÍN FAULT

NUMERO DE LA FALLA/FAULT NUMBER: CR-28
Comentarios/Comments: Shown as fault CRS-23 on original compilation sheets.

NOMBRE DE LA FALLA/FAULT NAME: Tulín

SINOPSIS Y AMBIENTE GEOLOGICO/SYNOPSIS AND GEOLOGIC SETTING: The fault traces cross (cut) Cretaceous igneous rocks (basalts) of the Nicoya Ophiolite Complex, north of Rancho Largo. This east-northeast-trending fault causes an alignment of the Tulín River for about 5 km. It was mapped by Dóndoli and Chaves (1968) and Dóndoli et al. (1968), whereas the sense of movement was determined by Denyer and Arias (1990).

COMPILADOR, AFILIACION Y FECHA DE COMPILACION/COMPILER, AFFILIATION, & DATE OF COMPILATION: Percy Denyer, University of Costa Rica; March 1997.

TIPOS DE ESTUDIOS/TYPE OF STUDIES: Field geology, photogeology, and geomorphologic work.

GEOMETRIA DE LA FALLA/FAULT GEOMETRY
END POINTS: 9°45'56.85"N, 84°23'59.22"W (upper or left); 9°44'9.88"N, 84°27'59.00"W (lower or right).
LONGITUD/LENGTH: End-to-end 8.2 km; cumulative 9.7 km
RUMBO PROMEDIO/AVERAGE STRIKE: N 70° E ± 6°
INCLINACION PROMEDIO/AVERAGE DIP: Unknown
SENTIDO DE MOVIMIENTO/SENSE OF MOVEMENT: Sinistral strike slip
Comentarios/Comments: The sense of movement is based on striae and evidence of displacement found in basalts.

EXPRESION GEOMORFOLOGICA/GEOMORPHIC EXPRESSION: Very clear expression in the valley of the Tulín River. The traces of the fault are seen clearly on aerial photographs and from topographic maps, and form an en echelon, left-stepping pattern and pressure ridges(?).

INTERVALO DE RECURRENCIA/RECURRENCE INTERVAL: Unknown

TASA DE MOVIMIENTO/SLIP RATE: Unknown

EDAD DEL ULTIMO MOVIMIENTO/TIME OF MOST RECENT OF MOVEMENT: Quaternary (<1.6 m.y.)
Comentarios/Comments: The presence of uplifts (pressure ridges?) is evidence of Quaternary movement. In 1990 and 1991, the citizens of the small town of Bajo Lajas reported several sounds (as thunder) in this valley. These sounds could correspond with relatively shallow (*i.e.*, superficial) seismicity.

REFERENCIAS/REFERENCES

Denyer, P., and Arias, O., 1990, Geología de la hoja Candelaria: San José, Costa Rica, Instituto Geográfico Nacional, escala 1:50,000.

Dóndoli, C., and Chavez, R., 1968, Mapa Geológico del Valle Central: San José, Costa Rica, Ministerio de Industria y Comerico, Dirección de Geología, Minas, y Petróleo; printed by Instituto Geográfico Nacional escala 1:150,000.

Dóndoli, C., Dengo, G., and Malavassi, E., 1968, Mapa Geológico de Costa Rica: San José, Costa Rica, Ministerio de Industria y Comerico, Dirección de Geología, Minas, y Petróleo; printed by Instituto Geográfico Nacional escala 1:700,000.

CR-29, CANDELARIA FAULT

NUMERO DE LA FALLA/FAULT NUMBER: CR-29
Comentarios/Comments: Shown as fault CRS-24 on original compilation sheets.

NOMBRE DE LA FALLA/FAULT NAME: Candelaria

SINOPSIS Y AMBIENTE GEOLOGICO/SYNOPSIS AND GEOLOGIC SETTING: This fault is shown on geological maps of Dóndoli and others (1968) and Sandoval and others (1982). First suggestion of its neotectonic activity was by Arias and Denyer (1991), later supported by Montero (1994). Originally, it was considered part of the Longitudinal fault (CR-48). Nevertheless, Arias and Denyer (1991) considered it as a separate fault and named it the Candelaria fault (for the Río Candelario). The fault is poorly studied and only regional studies have been performed. It is a high-angle, northwest-trending range-front fault, probably with dextral strike-slip movement. The fault defines a boundary between Cretaceous ophiolitic rocks on the west and Tertiary sedimentary and volcanic rocks on the east; it is located between the Forearc and the Inner Arc. It extends from the San Juan de Mata fault (CR-21) near San Mateo southeast along the Río Candelario to the latitude of Parrita.

COMPILADOR, AFILIACION Y FECHA DE COMPILACION/COMPILER, AFFILIATION, & DATE OF COMPILATION: Walter Montero, Central American School of Geology, University of Costa Rica; May 8, 1996.

TIPOS DE ESTUDIOS/TYPE OF STUDIES: Photogeological interpretation and regional field studies.

GEOMETRIA DE LA FALLA/FAULT GEOMETRY
END POINTS: 9°53'7.96"N, 84°30'26.90"W (upper or left); 9°31'28.38"N, 84°9'6.88"W (lower or right).
LONGITUD/LENGTH: End-to-end 56.6 km; cumulative 57.5 km
RUMBO PROMEDIO/AVERAGE STRIKE: N 44° W ± 7°
INCLINACION PROMEDIO/AVERAGE DIP: High-angle
Comentarios/Comments: Dips variable (west and east) along strike.
SENTIDO DE MOVIMIENTO/SENSE OF MOVEMENT: Dextral strike slip
Comentarios/Comments: Dextral strike-slip slip fault according to Arias and Denyer (1991) and Montero (1994). Has components of normal or reverse motion on different part of the fault. The southern portion of the fault is mapped as an east-dipping reverse fault.

EXPRESION GEOMORFOLOGICA/GEOMORPHIC EXPRESSION: Prominent trace defined by linear valleys, escarpments facing to east and west with triangular facets, deflected and adapted streams, and fault saddles.

INTERVALO DE RECURRENCIA/RECURRENCE INTERVAL: Unknown

TASA DE MOVIMIENTO/SLIP RATE: Unknown

EDAD DEL ULTIMO MOVIMIENTO/TIME OF MOST RECENT OF MOVEMENT: Quaternary (<1.6 m.y.)
Comentarios/Comments: Quaternary alluvial river terraces appeared to be offset by the fault in an aerial reconnaissance study. The terraces are probably Holocene, but this has not been proved by dating.

REFERENCIAS/REFERENCES

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Dóndoli, C., Dengo, G., and Malavassi, E., 1968, Mapa Geológico de Costa Rica: San José, Costa Rica, Ministerio de Industria y Comerico, Dirección de Geología, Minas, y Petróleo; printed by Instituto Geográfico Nacional escala 1:700,000.

Montero, W., 1994, Neotectonics and related stress distribution in a subduction collisional zone—Costa Rica, *in* Seyfried, Hartmut, and Hellman, Wiebke (eds.), Geology of an evolving island arc—Southeastern Central America: Profil, v. 7, p. 125-141.

Sandoval, L. F, Sáenz, R., Acuña, J., Castro, J. F., Gómez, M., López, A., Mederos, B., Monge, A., Vargas, J., Fernández, T., Ulate, R., and Ramírez, C., 1982, Mapa Geológico de Costa Rica: San José, Costa Rica, Instituto Geográfico Nacional, 9 sheets, scale 1:200,000.

CR-30, HIGUITO FAULT

NUMERO DE LA FALLA/FAULT NUMBER: CR-30
Comentarios/Comments: Shown as fault CRS-28 on original compilation sheets.

NOMBRE DE LA FALLA/FAULT NAME: Higuito

SINOPSIS Y AMBIENTE GEOLOGICO/SYNOPSIS AND GEOLOGIC SETTING: This northwest-trending fault is located in the border region between the Central Valley and the northern side of the Talamanca Cordillera. The fault cuts and affects Quaternary deposits that fill the Central Valley, southeast of San José, and upper Tertiary volcanic and sedimentary rocks on the northeast margin of the Escazú hills (Miocene intrusive rocks). As mapped by Denyer and Arias (1990), the fault extends from about 2 km east of Escazú, southeast14 km to the southern limit of San José Province.

COMPILADOR, AFILIACION Y FECHA DE COMPILACION/COMPILER, AFFILIATION, & DATE OF COMPILATION: Percy Denyer, University of Costa Rica; March 1997.

TIPOS DE ESTUDIOS/TYPE OF STUDIES: Field geology and photogeology.

GEOMETRIA DE LA FALLA/FAULT GEOMETRY
END POINTS: 9°55'30.23"N, 84°7'14.03"W (upper or left); 9°50'43.43"N, 84°1'54.90"W (lower or right).
LONGITUD/LENGTH: End-to-end 13.3 km; cumulative 13.4 km
RUMBO PROMEDIO/AVERAGE STRIKE: N 48° W ± 7°
INCLINACION PROMEDIO/AVERAGE DIP: Unknown
SENTIDO DE MOVIMIENTO/SENSE OF MOVEMENT: Dextral, normal
Comentarios/Comments: This fault is dextral with a minor component of normal dip slip. Focal mechanisms from several seismic events show similar sense of movement in the area of Higuito fault.

EXPRESION GEOMORFOLOGICA/GEOMORPHIC EXPRESSION: Very clear. The trace of the fault is seen clearly on aerial photographs and topographic maps.

INTERVALO DE RECURRENCIA/RECURRENCE INTERVAL: Unknown

TASA DE MOVIMIENTO/SLIP RATE: Unknown

EDAD DEL ULTIMO MOVIMIENTO/TIME OF MOST RECENT OF MOVEMENT: Quatenary
Comentarios/Comments: The fault cuts Quaternary as well as Upper Tertiary volcanic and sedimentary rocks. Several small earthquakes have been aligned along this fault according to Montero and Morales (1984).

REFERENCIAS/REFERENCES

Denyer, P., and Arias, O., 1990, Geología de la hoja Abra: San José, Costa Rica, Instituto Geográfico Nacional, escala 1:50,000.

Montero, W., 1994, Neotectonics and related stress distribution in a subduction collisional zone—Costa Rica, *in* Seyfried, Hartmut, and Hellman, Wiebke (eds.), Geology of an evolving island arc—Southeastern Central America: Profil, v. 7, p. 125-141.

Montero, W., and Morales, L.D., 1984, Sismotectónica y niveles de actividad de microtemblores en el suroeste del Valle Central, Costa Rica: Revista Geofísica, v. 21, p. 21-40.

CR-31, AGUA CALIENTE FAULT

NUMERO DE LA FALLA/FAULT NUMBER: CR-31
Comentarios/Comments: Shown as fault CRS-29 on original compilation sheets.

NOMBRE DE LA FALLA/FAULT NAME: Agua Caliente

SINOPSIS Y AMBIENTE GEOLOGICO/SYNOPSIS AND GEOLOGIC SETTING: Early references to this fault are by Dóndoli and Torres (1954) and Montero and Miyamura (1989). We follow the original name "Agua Caliente" fault, although it was later renamed the Guarco fault and the Valley de Coris fault (Woodward-Clyde Consultants, 1993). This high-angle strike slip fault traverses the southern border of the Cartago and Coris valleys, cutting between the Carpintera and Tablazo hills. It is located inside the central Inner Arc. The fault trace, which extends from Patarra (town on the west) southeast to Paraiso (on the east), was tranferred from a base map at 1:50,000 scale (Montero and others, 1989).

COMPILADOR, AFILIACION Y FECHA DE COMPILACION/COMPILER, AFFILIATION, & DATE OF COMPILATION: Walter Montero, Central American School of Geology, University of Costa Rica; May 17, 1995.

TIPOS DE ESTUDIOS/TYPE OF STUDIES: Fault is relatively well studied at the general level. Two trenches have been excavated and dDatable material was recovered from one trench (Woodward-Clyde Consultants, 1993).

GEOMETRIA DE LA FALLA/FAULT GEOMETRY
END POINTS: 9°52'24.33"N, 84°3'3.45"W (upper or left); 9°49'53.04"N, 83°51'25.6"W (lower or right).
LONGITUD/LENGTH: End-to-end 22.1 km; cumulative 28.0 km
RUMBO PROMEDIO/AVERAGE STRIKE: N 77° W ± 15°
INCLINACION PROMEDIO/AVERAGE DIP: Unknown
SENTIDO DE MOVIMIENTO/SENSE OF MOVEMENT: Dextral strike slip (?)
Comentarios/Comments: Sense of movement is still controversial. Geomatrix (1994) suggested that it is a dextral strike-slip fault.

EXPRESION GEOMORFOLOGICA/GEOMORPHIC EXPRESSION: Characterized by alignment of truncated ridge spurs, alignment of thermal hot springs (Coris Valley and Hervidero), and a linear valley. Fault observed in wall of exploratory trench has a sinuous trace (Woodward and Clyde Consultants, 1993), suggesting strike-slip movement.

INTERVALO DE RECURRENCIA/RECURRENCE INTERVAL: Unknown

TASA DE MOVIMIENTO/SLIP RATE: Unknown

EDAD DEL ULTIMO MOVIMIENTO/TIME OF MOST RECENT OF MOVEMENT: Holocene or post glacial (<15 ka)
Comentarios/Comments: Based in faulted horizons that contain paleo-indian artifacts dating from 2,300 yr B.P. Fault offsets Quaternary alluvium, lake and lahar deposits, Pliocene volcanic units, and Miocene sedimentary rocks. Seismic activity has been associated with this fault (see Montero and Miyamura, 1981).

REFERENCIAS/REFERENCES

Dóndoli, C., and Torres, A., 1954, Estudio geoagronómico de la región oriental de la Meseta Central: Costa Rica, Ministerio de Agricultura e Industria, 180 pp.

Geomatrix Consultants, 1994, Informe Final Acueducto de Orosi—Sub-Estudio de la Vulnerabilidad Sísmica de la Conducción, El Llano a Tres Ríos, Provincia de Cartago, Costa Rica: Walnut Creek, California, Geomatrix Consultants, 75 pp., 16 tablas, 47 figuras, 10 fotografías, y 4 apéndices.

Montero, W., and Miyamura, S., 1981, Distribución de intensidades y estimación de los parámetros focales de los terremotos de Cartago de 1910, Costa Rica, América Central: Revista Inst. Geogr. Nacional, Julio-Diciembre, p. 9-34.

Montero, W., Montalto, F., Alt, J., and Cline, M., 1989, Preliminary hazard map for surface-fault rupture and ground failure, *in* Woodward-Clyde Consultants (1993, see below), escala 1:50,000, (inédito).

Woodward-Clyde Consultants, 1993, A preliminary evaluation of earthquake and volcanic hazards significant to the major population centers of the Valle Central, Costa Rica: San Francisco, California, Woodward-Clyde Consultants, 71 pp., with appendices and maps.

CR-32, CORIS FAULT

NUMERO DE LA FALLA/FAULT NUMBER: CR-32
Comentarios/Comments: Shown as fault CRS-30 on original compilation sheets.

NOMBRE DE LA FALLA/FAULT NAME: Coris

SINOPSIS Y AMBIENTE GEOLOGICO/SYNOPSIS AND GEOLOGIC SETTING: Fault originally defined in Montero and others (1989) using the name Norte de Valle de Coris, but this cumbersome name is shortened to Coris fault for this compilation. Other references to the fault are found in Woodward-Clyde Consultants (1993), Montero (1994), and Geomatrix (1994). This southeast-trending fault cuts upper Tertiary sedimentary rocks and Quaternary deposits. It traverses valleys and mountains located near the boundary between the Cordillera de Talamanca and the Central Volcanic Cordillera Cartago and joins the Agua Caliente fault (CR-31) to the southeast. Fault is located between the cities of San José and Cartago and to the south of Cartago.

COMPILADOR, AFILIACION Y FECHA DE COMPILACION/COMPILER, AFFILIATION, & DATE OF COMPILATION: Walter Montero, Central American School of Geology, University of Costa Rica; March 26, 1996.

TIPOS DE ESTUDIOS/TYPE OF STUDIES: Photogeological and reconnaissance studies.

GEOMETRIA DE LA FALLA/FAULT GEOMETRY
END POINTS: 9°53'22.61"N, 84°3'25.65"W (upper or left); 9°2'3.03"N, 83°58'53.07"W (lower or right).
LONGITUD/LENGTH: End-to-end 8.8 km; cumulative 11.9 km
RUMBO PROMEDIO/AVERAGE STRIKE: N 69° W ± 20°
INCLINACION PROMEDIO/AVERAGE DIP: High-angle
Comentarios/Comments: High-angle dip suggested by topographic signature.
SENTIDO DE MOVIMIENTO/SENSE OF MOVEMENT: Suspected dextral stike-slip.
Comentarios/Comments: Sense of slip suspected from geometric characteristics.

EXPRESION GEOMORFOLOGICA/GEOMORPHIC EXPRESSION: Weak to strong expression; characterized by break in slope, linear valleys, notched ridge, and changes in vegetation in flatter areas; has arcuate form (Woodward-Clyde Consultants, 1993).

INTERVALO DE RECURRENCIA/RECURRENCE INTERVAL: Unknown

TASA DE MOVIMIENTO/SLIP RATE: Unknown

EDAD DEL ULTIMO MOVIMIENTO/TIME OF MOST RECENT OF MOVEMENT: Quaternary (<1.6 m.y.)
Comentarios/Comments: Fault cuts Quaternary deposits

REFERENCIAS/REFERENCES

Geomatrix Consultants, 1994, Informe Final Acueducto de Orosi—Sub-Estudio de la Vulnerabilidad Sísmica de la Conducción, El Llano a Tres Ríos, Provincia de Cartago, Costa Rica: Walnut Creek, California, Geomatrix Consultants, 75 pp., 16 tablas, 47 figuras, 10 fotografías, y 4 apéndices.

Montero, W., 1994, Sismicidad y neotectónica, in el Atlas Geológico Gran Area Metropolitana, Percy Denyer y Siegfried Kussmaul, Editores: Editorial Tecnológica de Costa Rica, p. 147-160, escala 1:200,000.

Montero, W., Montalto, F., Alt, J., and Cline, M., 1989, Preliminary hazard map for surface-fault rupture and ground failure, *in* Woodward-Clyde Consultants (1993, see below), escala 1:50,000, (inédito).

Woodward-Clyde, 1993, A preliminary evaluation of earthquake and volcanic hazards significant to the major population centers of the Valle Central, Costa Rica: Final Report prepared for Ret Corporation, 89 pp., 6 plates.

CR-33, LARA FAULT SYSTEM

NUMERO DE LA FALLA/FAULT NUMBER: CR-33
Comentarios/Comments: Shown as fault CRS-10 (258) on original compilation sheets.

NOMBRE DE LA FALLA/FAULT NAME: Lara (system)

SINOPSIS Y AMBIENTE GEOLOGICO/SYNOPSIS AND GEOLOGIC SETTING: Fault is poorly known and only pertinent reference is by Montero and Alvarado (1995). Fault is comprised of three north-trending traces and a northeast-trending cross fault that connects the three. This system of faults traverses Quaternary volcanic deposits along the western slopes of Irazú Volcano and extends from near Cerro Hondura (on the north) to Ochomongo (on the south), which is about 5 km north of Cartago.

COMPILADOR, AFILIACION Y FECHA DE COMPILACION/COMPILER, AFFILIATION, & DATE OF COMPILATION: Walter Montero, Central American School of Geology, University of Costa Rica; March 26, 1996.

TIPOS DE ESTUDIOS/TYPE OF STUDIES: Photogeological and geomorphic reconnaissance studies.

GEOMETRIA DE LA FALLA/FAULT GEOMETRY
END POINTS: 10°4'16.71"N, 83°58'7.42"W (upper or left); 9°54'2.51"N, 83°56'31.68"W (lower or right).
LONGITUD/LENGTH: End-to-end 19.4 km; cumulative 29.7 km
RUMBO PROMEDIO/AVERAGE STRIKE: N 7° W ± 49°
Comentarios/Comments: Large variation in strike caused by several faults at nearly perpendicular angles.
INCLINACION PROMEDIO/AVERAGE DIP: High-angle
Comentarios/Comments: High-angle dip deduced from its topographic expression.
SENTIDO DE MOVIMIENTO/SENSE OF MOVEMENT: Dextral and normal.
Comentarios/Comments: A combination of dextral and normal components deduced for different sectors of the fault from photogeology and neotectonic analysis. Normal component also deduced from a geomorphic field inspection; fault scarps are especially prevalent in the southern sectors.

EXPRESION GEOMORFOLOGICA/GEOMORPHIC EXPRESSION: Fault is defined by linear valleys, fault valley, fault saddles, fault trenches, scarps facing to the west, and suspected displacement of streams.

INTERVALO DE RECURRENCIA/RECURRENCE INTERVAL: Not known

TASA DE MOVIMIENTO/SLIP RATE: Unknown, probably 1-5 mm/yr
Comentarios/Comments: Suspected rate determined from geomorphic expression of the fault.

EDAD DEL ULTIMO MOVIMIENTO/TIME OF MOST RECENT OF MOVEMENT: Quaternary (<1.6 m.y.)
Comentarios/Comments: Fault is certainly Quaternary based on offset Quaternary volcanic deposits along the western slopes of Irazú Volcano. However, faulting may be as young as Holocene and there appears to be historic seismic activity, but this has yet to be proved.

REFERENCIAS/REFERENCES

Montero, W., and Alvarado, G., 1995, El terremoto de Patillos del 30 de diciembre de 1952 (M_S = 5,9) y el contexto neotectónico de la región del volcán Irazú, Costa Rica: Revista Geologica América Central, v. 18, p. 25-42.

CR-34, RÍO SUCIO FAULT

NUMERO DE LA FALLA/FAULT NUMBER: CR-34
Comentarios/Comments: Shown as fault CRS-11 on original compilation sheets.

NOMBRE DE LA FALLA/FAULT NAME: Río Sucio

SINOPSIS Y AMBIENTE GEOLOGICO/SYNOPSIS AND GEOLOGIC SETTING: Fault is poorly known and only pertinent reference is by Montero and Alvarado (1995). Fault cuts Quaternary volcanic deposits located on the northwestern slopes of Irazú Volcano (Central Quaternary Volcanic Cordillera), just west of the Alto Grande fault (CR-35). It extends for about 13 km, north-northwest from the summit of Irazú Volcano.

COMPILADOR, AFILIACION Y FECHA DE COMPILACION/COMPILER, AFFILIATION, & DATE OF COMPILATION: Walter Montero, Central American School of Geology, University of Costa Rica; March 26, 1996.

TIPOS DE ESTUDIOS/TYPE OF STUDIES: Photogeological studies

GEOMETRIA DE LA FALLA/FAULT GEOMETRY
END POINTS: 10°4'35.03"N, 83°55'9.11"W (upper or left); 9°58'56.10"N, 83°50'52.01"W (lower or right).
LONGITUD/LENGTH: End-to-end 13.2 km; cumulative 17.7 km
RUMBO PROMEDIO/AVERAGE STRIKE: N 43° W ± 17°
INCLINACION PROMEDIO/AVERAGE DIP: High-angle
Comentarios/Comments: Deduced from topographic signature.
SENTIDO DE MOVIMIENTO/SENSE OF MOVEMENT: Dextral slip (suspected)
Comentarios/Comments: Suspected from geometric characteristics of fault trace.

EXPRESION GEOMORFOLOGICA/GEOMORPHIC EXPRESSION: Fault forms strong lineament defined by linear valley and scarps facing to the west. Possible tensional release (pull-apart) structure is present near fault's southern termination.

INTERVALO DE RECURRENCIA/RECURRENCE INTERVAL: Unknown

TASA DE MOVIMIENTO/SLIP RATE: Unknown

EDAD DEL ULTIMO MOVIMIENTO/TIME OF MOST RECENT OF MOVEMENT: Quaternary (<1.6 m.y.)
Comentarios/Comments: Fault cuts Quaternary and possibly Holocene deposits (not confirmed). Montero and Alvarado (1995) suggested that the Patillos earthquake of December 30, 1952 (Ms 5.9) could be related to this fault.

REFERENCIAS/REFERENCES

Montero, W., and Alvarado, G., 1995, El terremoto de Patillos del 30 de diciembre de 1952 (M_S = 5,9) y el contexto neotectónico de la región del volcán Irazú, Costa Rica: Revista Geologica América Central, v. 18, p. 25-42.

CR-35, ALTO GRANDE FAULT

NUMERO DE LA FALLA/FAULT NUMBER: CR-35
Comentarios/Comments: Shown as fault CRS-12 on original compilation sheets.

NOMBRE DE LA FALLA/FAULT NAME: Alto Grande

SINOPSIS Y AMBIENTE GEOLOGICO/SYNOPSIS AND GEOLOGIC SETTING: Fault is located on the northern flank of Irazú Volcano (Central Quaternary Volcanic Cordillera), between the Río Sucio fault (CR-34) and the Blanquito fault (CR-36), where it cuts Quaternary volcanic deposits. First suggested as a neotectonic fault by Montero and Alvarado (1995). The fault extends about 6 km north-northwest from a point north of Cerro Alto Grande on Irazú Volcano.

COMPILADOR, AFILIACION Y FECHA DE COMPILACION/COMPILER AFFILIATION, & DATE OF COMPILATION: Walter Montero, Central American School of Geology, University of Costa Rica; January 1997.

TIPOS DE ESTUDIOS/TYPE OF STUDIES: Air photo interpretation

GEOMETRIA DE LA FALLA/FAULT GEOMETRY
END POINTS: 10°5'2.51"N, 83°51'43.53"W (upper or left); 10°2'16.52"N, 83°50'9.51"W (lower or right).
LONGITUD/LENGTH: End-to-end 5.9 km; cumulative 6.0 km
RUMBO PROMEDIO/AVERAGE STRIKE: N 29° W ± 7°
INCLINACION PROMEDIO/AVERAGE DIP: High angle
Comentarios/Comments: High angle suspected from topographic signature.
SENTIDO DE MOVIMIENTO/SENSE OF MOVEMENT: Normal
Comentarios/Comments: Montero and Alvarado (1995) suggested that the fault forms a west-facing scarp and displaces the surface of the volcanic shield about 10 m.

EXPRESION GEOMORFOLOGICA/GEOMORPHIC EXPRESSION: Prominent scarps and deep linear valleys are found along the fault trace (Montero and Alvarado, 1995).

INTERVALO DE RECURRENCIA/RECURRENCE INTERVAL: Unknown

TASA DE MOVIMIENTO/SLIP RATE: Unknown, probably <1 mm/yr
Comentarios/Comments: Montero and Alvarado (1995) suggested a low vertical slip rate from the limited offset of the surface of the volcanic shield (about 10 m).

EDAD DEL ULTIMO MOVIMIENTO/TIME OF MOST RECENT OF MOVEMENT: Quaternary (<1.6 m.y.)
Comentarios/Comments: Fault offsets middle(?) Quaternary (<0.5 Ma) volcanic deposits of Irazú Volcano.

REFERENCIAS/REFERENCES

Montero, W., and Alvarado, G., 1995, El terremoto de Patillos del 30 de diciembre de 1952 (M_S = 5,9) y el contexto neotectónico de la región del volcán Irazú, Costa Rica: Revista Geologica América Central, v. 18, p. 25-42.

CR-36, BLANQUITO FAULT

NUMERO DE LA FALLA/FAULT NUMBER: CR-36
Comentarios/Comments: Shown as fault CRS-13 on original compilation sheets.

NOMBRE DE LA FALLA/FAULT NAME: Blanquito

SINOPSIS Y AMBIENTE GEOLOGICO/SYNOPSIS AND GEOLOGIC SETTING: Fault is located on the northern flank of Irazú Volcano (Central Quaternary Volcanic Cordillera). It cuts Quaternary volcanic deposits and was first mentioned as a neotectonic fault in Montero and Alvarado (1995). The fault extends about 8 km north-northwest from a point north of Cerro Alto Grande on the Irazú Volcano.

COMPILADOR, AFILIACION Y FECHA DE COMPILACION/COMPILER, AFFILIATION, & DATE OF COMPILATION: Walter Montero, Central American School of Geology, University of Costa Rica: January 1997.

TIPOS DE ESTUDIOS/TYPE OF STUDIES: Air photo interpretation

GEOMETRIA DE LA FALLA/FAULT GEOMETRY
END POINTS: 10°6'25.11"N, 83°50'49.56"W (upper or left); 10°2'39.02"N, 83°49'39.36"W (lower or right).
LONGITUD/LENGTH: End-to-end 7.4 km; cumulative 7.4 km
RUMBO PROMEDIO/AVERAGE STRIKE: N 17° W ± 7°
INCLINACION PROMEDIO/AVERAGE DIP: High angle
Comentarios/Comments: High angle according to topographic signature.
SENTIDO DE MOVIMIENTO/SENSE OF MOVEMENT Normal
Comentarios/Comments: Sense of movement suggested in Montero and Alvarado (1995).

EXPRESION GEOMORFOLOGICA/GEOMORPHIC EXPRESSION: Defined by linear fault scarps, regressive (fault-line) scarps, and fault valleys (Montero and Alvarado, 1995).

INTERVALO DE RECURRENCIA/RECURRENCE INTERVAL: Unknown

TASA DE MOVIMIENTO/SLIP RATE: Unknown, probably <1 mm/yr
Comentarios/Comments: Probable low slip rate as suggested by the low height of the original fault scarps (<10 m) (see Montero and Alvarado, 1995).

EDAD DEL ULTIMO MOVIMIENTO/TIME OF MOST RECENT OF MOVEMENT: Quatenary
COMENTARIOS/COMMENS: Fault cuts Quaternary volcanic deposits of the Irazú Volcano.

REFERENCIAS/REFERENCES

Montero, W., and Alvarado, G., 1995, El terremoto de Patillos del 30 de diciembre de 1952 (M_S = 5,9) y el contexto neotectónico de la región del volcán Irazú, Costa Rica: Revista Geologica América Central, v. 18, p. 25-42.

CR-37, NAVARRO FAULT

NUMERO DE LA FALLA/FAULT NUMBER: CR-37
Comentarios/Comments: Shown as fault CRS-31 on original compilation sheets.

NOMBRE DE LA FALLA/FAULT NAME: Navarro

SINOPSIS Y AMBIENTE GEOLOGICO/SYNOPSIS AND GEOLOGIC SETTING: Fault first shown by Dóndoli and others (1968); it is also on geological maps of Sandoval and others (1982) and Berrange and Whittaker (1977). It was suggested as a neotectonic fault by Montero and others (1989) and Woodward and Clyde Consultants (1993), but first confirmed as such by Geomatrix (1994). Faults cuts upper Tertiary sedimentary rocks as well as Quaternary volcanic rocks and sediments. The fault is located near the boundary between the Cordillera de Talamanca and the Central Volcanic Cordillera. It extends northeast from Estrella (about 1 km south of Paridiso) and terminates near Maravilla.

COMPILADOR, AFILIACION Y FECHA DE COMPILACION/COMPILER, AFFILIATION, & DATE OF COMPILATION: Walter Montero, Central American School of Geology, University of Costa Rica: March 26, 1996.

TIPOS DE ESTUDIOS/TYPE OF STUDIES: Photogeological, regional, and local field work. A trench into the fault zone documented displacement of upper Pleistocene deposits (Geomatrix, 1994).

GEOMETRIA DE LA FALLA/FAULT GEOMETRY
END POINTS: 9°53'31.12"N, 83°45'17.69"W (upper or left); 9°46'52.70"N, 83°57'33.26"W (lower or right).
LONGITUD/LENGTH: End-to-end 25.9 km; cumulative 27.3 km
RUMBO PROMEDIO/AVERAGE STRIKE: N 62° E ± 20°
INCLINACION PROMEDIO/AVERAGE DIP: High-angle
Comentarios/Comments: High-angle according to its topographic expression
SENTIDO DE MOVIMIENTO/SENSE OF MOVEMENT: Sinistral strike-slip
Comentarios/Comments: Sense of slip based in geometry of pull-apart structures and slickensides found in local outcrops and in an exploratory trench.

EXPRESION GEOMORFOLOGICA/GEOMORPHIC EXPRESSION: Characterized by a deep linear valley (along the Río Navarro), notched ridges, fault trenches (grabens), breaks in slope, local small scarps, and fault saddles.

INTERVALO DE RECURRENCIA/RECURRENCE INTERVAL: Unknown

TASA DE MOVIMIENTO/SLIP RATE: Unknown, probably 1-5 mm/yr.

EDAD DEL ULTIMO MOVIMIENTO/TIME OF MOST RECENT OF MOVEMENT: Holocene or post glacial (<15 ka)
Comentarios/Comments: Based on a trench into the fault zone, which exposed displaced upper Pleistocene deposits (Geomatrix, 1994). Fault probably cuts the Cervantes lava flow (13-14 ka).

REFERENCIAS/REFERENCES

Berrange, J.P., and Whittaker, J.F., 1977, Reconnaissance geology of the Tapantí Quadrangle, Talamanca Cordillera, Costa Rica: London, Institute of Geological Sciences, Overseas Division Report 37, 72 pp.

Dóndoli, C., Dengo, G., and Malavassi, E., 1968, Mapa Geológico de Costa Rica: San José, Costa Rica, Ministerio de Industria y Comerico, Dirección de Geología, Minas, y Petróleo; printed by Instituto Geográfico Nacional escala 1:700,000.

Geomatrix Consultants, 1994, Informe Final Acueducto de Orosi, Sub-Estudio de la Vulnerabilidad Sísmica de la Conducción: El Llano a Tres Ríos, Provincia de Cartago, Costa Rica: San Francisco, California, Geomatrix Consultants Report, 75 pp., 16 tablas, 47 figuras, 10 fotografías, y 4 apéndices.

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Sandoval, L. F, Sáenz, R., Acuña, J., Castro, J. F., Gómez, M., López, A., Mederos, B., Monge, A., Vargas, J., Fernández, T., Ulate, R., and Ramírez, C., 1982, Mapa Geológico de Costa Rica: San José, Costa Rica, Instituto Geográfico Nacional, 9 sheets, scale 1:200,000.

Woodward-Clyde Consultants, 1993, A preliminary evaluation of earthquake and volcanic hazards significant to the major population centers of the Valle Central, Costa Rica: Final Report prepared for Ret Corporation, 89 pp., 6 plates.

CR-38, OROSI FAULT

NUMERO DE LA FALLA/FAULT NUMBER: CR-38
Comentarios/Comments: Shown as fault CRS-32 on original compilation sheets.

NOMBRE DE LA FALLA/FAULT NAME: Orosi

SINOPSIS Y AMBIENTE GEOLOGICO/SYNOPSIS AND GEOLOGIC SETTING: The fault trace crosses (cuts) Miocene sedimentary and volcanic rocks as mapped by Dóndoli and Chaves (1968). Montero (1994) had categorized this fault as neotectonic with Quaternary activity. The fault trends southeast through Orosi, and extends from the Río Narvarro (northwest of Orosi) to 3 km southeast of Purisil.

COMPILADOR, AFILIACION Y FECHA DE COMPILACION/COMPILER, AFFILIATION, & DATE OF COMPILATION: Percy Denyer, University of Costa Rica; March 1997.

TIPOS DE ESTUDIOS/TYPE OF STUDIES: Field geology, photogeology and seismology

GEOMETRIA DE LA FALLA/FAULT GEOMETRY
END POINTS: 9°48'39.44"N, 83°52'25.25"W (upper or left); 9°44'14.97"N, 83°48'13.23"W (lower or right).
LONGITUD/LENGTH: End-to-end 11.3 km; cumulative 11.4 km
RUMBO PROMEDIO/AVERAGE STRIKE: N 43° W ± 9°
INCLINACION PROMEDIO/AVERAGE DIP: Unknown
SENTIDO DE MOVIMIENTO/SENSE OF MOVEMENT: Dextral, normal
Comentarios/Comments: Movement seems to be dextral with normal dip-slip component.

EXPRESION GEOMORFOLOGICA/GEOMORPHIC EXPRESSION: Very clearly expressed in the valley of the Orosi River; in addition, itforms alignments on aerial photographs and topographic maps.

INTERVALO DE RECURRENCIA/RECURRENCE INTERVAL: Unknown

TASA DE MOVIMIENTO/SLIP RATE: Unknown

EDAD DEL ULTIMO MOVIMIENTO/TIME OF MOST RECENT OF MOVEMENT: Quaternary (<1.6 m.y.)
Comentarios/Comments: Based very clearly expressed geomorphic features. Further studies are needed to confirm displacement of Quaternary sediment.

REFERENCIAS/REFERENCES

Dóndoli, C., and Chavez, R., 1968, Mapa Geológico del Valle Central: San José, Costa Rica, Ministerio de Industria y Comerico, Dirección de Geología, Minas, y Petróleo; printed by Instituto Geográfico Nacional escala 1:150,000.

Montero, W., 1994, Neotectonics and related stress distribution in a subduction collisional zone—Costa Rica, *in* Seyfried, Hartmut, and Hellman, Wiebke (eds.), Geology of an evolving island arc—Southeastern Central America: Profil, v. 7, p. 125-141.

CR-39, DUÁN FAULT

NUMERO DE LA FALLA/FAULT NUMBER: CR-39
Comentarios/Comments: Shown as fault CRS-33 on original compilation sheets.

NOMBRE DE LA FALLA/FAULT NAME: Duán

SINOPSIS Y AMBIENTE GEOLOGICO/SYNOPSIS AND GEOLOGIC SETTING: Fault originally shown by Berrange (1977), but included on geological map of Sandoval and others (1982). Fault is poorly known with only photogeological and field reconnaissance studies having beeen done. Montero and others (1989) suggested that it has neotectonic activity (see also Montero, 1994; Woodward-Clyde Consultants, 1993; and Geomatrix, 1994). Fault cuts sedimentary and volcanic rocks of upper Tertiary age at the northern border of the Talamanca Cordillera. The fault trends south-southeast from south of the Río Reventazon, past Cerro Duan to the headwaters of the Río Taus.

COMPILADOR, AFILIACION Y FECHA DE COMPILACION/COMPILER, AFFILIATION, & DATE OF COMPILATION: Walter Montero, Central American School of Geology, University of Costa Rica; May 8, 1996.

TIPOS DE ESTUDIOS/TYPE OF STUDIES: Photogeologic and field reconnanssaince studies.

GEOMETRIA DE LA FALLA/FAULT GEOMETRY
END POINTS: 9°50'45.81"N, 83°47'58.46"W (upper or left); 9°47'20.5"N, 83°46'12.42"W (lower or right).
LONGITUD/LENGTH: End-to-end 7.2 km; cumulative 7.4 km
RUMBO PROMEDIO/AVERAGE STRIKE: N 27° W ± 16°
INCLINACION PROMEDIO/AVERAGE DIP: High-angle
SENTIDO DE MOVIMIENTO/SENSE OF MOVEMENT: Dextral strike slip
Comentarios/Comments: Suspected from photogeologic studies.

EXPRESION GEOMORFOLOGICA/GEOMORPHIC EXPRESSION: Fault produces prominent lineaments, linear valleys, fault saddles, and faceted scarps (Woodward-Clyde Consultants, 1993).

INTERVALO DE RECURRENCIA/RECURRENCE INTERVAL: Unknown

TASA DE MOVIMIENTO/SLIP RATE: Unknown

EDAD DEL ULTIMO MOVIMIENTO/TIME OF MOST RECENT OF MOVEMENT: Quaternary (<1.6 m.y.)
Comentarios/Comments: Fault movment is considered to be of probable Quaternary age on the basis of its strong geomorphic expression.

REFERENCIAS/REFERENCES

Berrange, J.P., and Whittaker, J.F., 1977, Reconnaissance geology of the Tapantí Quadrangle, Talamanca Cordillera, Costa Rica: London, Institute of Geological Sciences, Overseas Division Report 37, 72 pp.

Geomatrix Consultants, 1994, Informe Final Acueducto de Orosi, Sub-Estudio de la Vulnerabilidad Sísmica de la Conducción—El Llano a Tres Ríos, Provincia de Cartago, Costa Rica: San Francisco, California, Geomatrix Consultants, 75 pp., 16 tablas, 47 figuras, 10 fotografías, and 4 apéndices.

Montero, W., 1994, Sismicidad y neotectónica, en el Atlas Geológico Gran Area Metropolitana, P. Denyer y S. Kussmaul, Editores: Editorial Tecnológica de Costa Rica, p. 147-160.

Montero, W., Montalto, F., Alt, J., and Cline, M., 1989, Preliminary hazard map for surface-fault rupture and ground failure, *in* Woodward-Clyde Consultants (1993, see below), escala 1:50,000, (inédito).

Sandoval, L. F, Sáenz, R., Acuña, J., Castro, J. F., Gómez, M., López, A., Mederos, B., Monge, A., Vargas, J., Fernández, T., Ulate, R., and Ramírez, C., 1982, Mapa Geológico de Costa Rica: San José, Costa Rica, Instituto Geográfico Nacional, 9 sheets, scale 1:200,000.

Woodward-Clyde Consultants, 1993, A preliminary evaluation of earthquake and volcanic hazards significant to the major population centers of the Valle Central, Costa Rica: Final Report prepared for Ret Corporation, 89 pp., 6 plates.

CR-40, PIRRIS FAULT

NUMERO DE LA FALLA/FAULT NUMBER: CR-40
Comentarios/Comments: Shown as fault CRQ-01 on original compilation sheets.

NOMBRE DE LA FALLA/FAULT NAME: Pirris

SINOPSIS Y AMBIENTE GEOLOGICO/SYNOPSIS AND GEOLOGIC SETTING: The fault trace crosses (cuts) Cretaceous igneous rocks (basalts) of the Nicoya Complex and a Quaternary alluvial fan. The fault trends northwest for about 6 km from its intersection with the Delicias fault (CR-27).

COMPILADOR, AFILIACION Y FECHA DE COMPILACION/COMPILER, AFFILIATION, & DATE OF COMPILATION Percy Denyer, University of Costa Rica; March 1997.

TIPOS DE ESTUDIOS/TYPE OF STUDIES Field geology, photogeology, and seismology

GEOMETRIA DE LA FALLA/FAULT GEOMETRY
END POINTS: 9°39'24.52"N, 84°14'42.80"W (upper or left); 9°37'57.35"N, 84°11'59.01"W (lower or right).
LONGITUD/LENGTH: End-to-end 5.8 km; cumulative 5.8 km
RUMBO PROMEDIO/AVERAGE STRIKE: N 62° W ± 8°
INCLINACION PROMEDIO/AVERAGE DIP Unknown, probably vertical
Comentarios/Comments: Dip suggested by focal mechanism of February 26, 1989 earthquake.
SENTIDO DE MOVIMIENTO/SENSE OF MOVEMENT: Dextral strike slip
Comentarios/Comments: Sense of slip from geologic investigations supported by the focal mechanism of the February 26, 1989 earthquake. One of the nodal planes corresponds with the strike of this fault and also with the general sense of movement of similar-trending faults in this area.

EXPRESION GEOMORFOLOGICA/GEOMORPHIC EXPRESSION: Very clearly expressed in the valley of the Pirris River. It is also possible to recognize the alignment from aerial photographs and topographic maps.

INTERVALO DE RECURRENCIA/RECURRENCE INTERVAL: Unknown

TASA DE MOVIMIENTO/SLIP RATE: Unknown

EDAD DEL ULTIMO MOVIMIENTO/TIME OF MOST RECENT OF MOVEMENT: Quaternary (<1.6 m.y.), probably Historic.
Comentarios/Comments: Fault offsets an alluvial fan of Quaternary age. However, the Pirris fault may have been activated during the earthquake of February 26, 1989, which had an epicenter close to this fault. The parameters of this earthquake were Md 4.7, time 12:21:09.68 (GMT), epicenter at latitute 09° 40.13' N. and longitude 84° 14.29' W., and depth of 26 km. Portable seismographs installed after this earthquake showed an aftershock pattern that suggested possible movement on the Delicias (CR-27) and Pirris faults (Barquero and others, 1989).

REFERENCIAS/REFERENCES

Barquero, R., Rojas, W., and Climent, A., 1989, El temblor del 26 de febrero de 1989: San José, Costa Rica, Instituto Costarricense de Electricidad y University of Costa Rica, 18 pp. (Internal Report).

CR-41, SIQUIRRES-MATINA FAULT

NUMERO DE LA FALLA/FAULT NUMBER: CR-41
Comentarios/Comments: Shown as fault CRLI-02 on original compilation sheets.

NOMBRE DE LA FALLA/FAULT NAME: Siquirres-Matina

SINOPSIS Y AMBIENTE GEOLOGICO/SYNOPSIS AND GEOLOGIC SETTING: Neotectonic activity on the Siquirres-Matina Fault was first suggested by Soulas (1989) (see also Boschini, 1989). The Siquirres-Matina Fault is located at the transition zone between the Inner Arc (Northeastern Talamanca Cordillera sector) and the backarc basin (Limón basin). The fault trends east and southeast from Siquirres to Liverpool, about 10 km west of Limón, where it joins the historically active Río Blanco fault (CR-42).

COMPILADOR, AFILIACION Y FECHA DE COMPILACION/COMPILER, AFFILIATION, & DATE OF COMPILATION: Walter Montero, Central American School of Geology, University of Costa Rica; January 1997.

TIPOS DE ESTUDIOS/TYPE OF STUDIES: Air photos and field surveying work.

GEOMETRIA DE LA FALLA/FAULT GEOMETRY
END POINTS: 10°6'30.83"N, 83°31'41.27"W (upper or left); 9°59'31.72"N, 83°8'3.75"W (lower or right).
LONGITUD/LENGTH: End-to-end 45.8 km; cumulative 56.1 km
RUMBO PROMEDIO/AVERAGE STRIKE: N 73° W ± 38°
Comentarios/Comments: Large variation in strike causes by arcuate thrust fault traces.
INCLINACION PROMEDIO/AVERAGE DIP: Unknown, probably to the south
SENTIDO DE MOVIMIENTO/SENSE OF MOVEMENT: Thrust
Comentarios/Comments: According to Soulas (1989) and Boschini (1989), the geomorphology of the Siquirres-Matina fault suggests it is a thrust fault system (see below). Soulas (1989) mentioned that along some parts of the fault it shows multiple scarps, which suggests that the fault locally has an imbricate pattern.

EXPRESION GEOMORFOLOGICA/GEOMORPHIC EXPRESSION FAULT: Fault is defined by scarps that are little dissected. Scarps are between 200-300 meters high, although the most recent ones have heights less than 100 m. In some areas, the scarps are simple and in others they are complex (multiple) (Soulas, 1989; Boschini, 1989). Uplifted river terraces and deeply incised canyons are preserved upvalley from the trace of the fault.

INTERVALO DE RECURRENCIA/RECURRENCE INTERVAL: Unknown

TASA DE MOVIMIENTO/SLIP RATE: Probably <1 mm/yr
Comentarios/Comments: Soulas (1989) suggested a deformation rate of 0.5 mm/year.

EDAD DEL ULTIMO MOVIMIENTO/TIME OF MOST RECENT OF MOVEMENT: Quaternary (<1.6 m.y.)
Comentarios/Comments: Certainly Quaternary, but may be Holocene or post glacial (<15 ka) on basis of its young geomorphic expression.

REFERENCIAS/REFERENCES

Boschini, I. M., 1989, Incidencia de las fuentes sísmicas en la región caribe de Costa Rica: San José, Escuela Centroamericana de Geología, Universidad de Costa Rica, 97 pp. (tesis inédita).

Soulas, J. P., 1989, Tectónica activa: Informe de Misión de Consultoría P. H. Siquirres, Depto Geología, Instituto Costarricense de Electricidad (included in Boschini, 1989; see above).

CR-42, RÍO BLANCO FAULT

NUMERO DE LA FALLA/FAULT NUMBER: CR-42
Comentarios/Comments: Shown as fault CRL1-01 on original compilation sheets.

NOMBRE DE LA FALLA/FAULT NAME: Río Blanco

SINOPSIS Y AMBIENTE GEOLOGICO/SYNOPSIS AND GEOLOGIC SETTING: Fault cuts Tertiary to Quaternary sediment of the Limón Basin. The faults trace was recognized after the April 1991 Limón earthquake (Denyer et al., 1994); it corresponds to the northern edge of the rupture zone and is one of the secondary tear faults (see also CR-43) activated during movement on the main thrust fault (PA-12a) that moved during this offshore earthquake. This particular northeast-trending fault has two parts that form a left-stepping en echelon pattern. The trace of the fault is along the Río Blanco, about 10 km west of Limón.

COMPILADOR, AFILIACION Y FECHA DE COMPILACION/COMPILER, AFFILIATION, & DATE OF COMPILATION: Percy Denyer, University of Costa Rica; March 1997

TIPOS DE ESTUDIOS/TYPE OF STUDIES: Field geology conducted two weeks after the earthquake. In addition, the power lines crossing the trace of the fault in an east-west trend were surveyed three months before and about one year after the earthquake, thereby allowing a fairly accurate estimate of horizontal slip. This survey was made by the Instituto Costarricense de Electricidad (ICE).

GEOMETRIA DE LA FALLA/FAULT GEOMETRY
END POINTS: 10°0'17.74"N, 83°6'41.07"W (upper or left); 9°58'8.34"N, 83°9'53.33"W (lower or right).
LONGITUD/LENGTH: End-to-end 7.2 km; cumulative 7.5 km
RUMBO PROMEDIO/AVERAGE STRIKE: N 60° E ± 12°
INCLINACION PROMEDIO/AVERAGE DIP: Unknown
SENTIDO DE MOVIMIENTO/SENSE OF MOVEMENT: Normal, sinistral strike slip
Comentarios/Comments: This fault has two mapped strands, but the behaviour of a single fault. Recognizing the trace of the historic faulting was difficult because it affected very incompetent deposits that also had liquefaction during the Limón earthquake of 1991. On the northeastern part, vertical movement was in the range of 1 meter; on the southwestern part the movement was oblique with subequal amounts of sinistral (1-1.4 m) and normal (1.5 m) offset (Denyer et al., 1994).

EXPRESION GEOMORFOLOGICA/GEOMORPHIC EXPRESSION: Very poor prior to Limón earthquake; only after the earthquake was it possible to recognize obvious changes in the topography and manmade structures. The offshore trace of the fault is poorly known and has not mapped in any significant detail.

INTERVALO DE RECURRENCIA/RECURRENCE INTERVAL: Unknown
Comentarios/Comments: See comments below.

TASA DE MOVIMIENTO/SLIP RATE: Unknown
Comentarios/Comments: A slip rate has not been determined because this fault was only recognized after the Limón earthquake and no paleoseismic studies have been conducted. However, radiometric dating of uplifted coastal platforms (S. Personius, pers. comm., 1996) would allow estimates of uplift rate and recurrence intervals to be made.

EDAD DEL ULTIMO MOVIMIENTO/TIME OF MOST RECENT OF MOVEMENT: Historic (1991)
Comentarios/Comments: Active during 1991 earthquake

NOMBRE DEL TERREMOTO/NAME OF EARTHQUAKE: Limón.
Comentarios/Comments: Epicenter at latitude 09° 36.6' N, longitude 83° 10.2'W., depth 23.5 km.

FECHA/DATE: April 21, 1991, 21:56 (15:56 local time)

MAGNITUD O INTENSIDAD/MAGNITUDE OR INTENSITY: Ms 7.6
Comentarios/Comments: Montero and others (1994).

MOMENT MAGNITUDE Mw 7.7
Comentarios/Comments: Wilfredo Rojas, pers. commun., 1997

LONGITUD DE RUPTURA/LENGTH OF SURFACE RUPTURE: 7.2 km (end-to-end)
Comentarios/Comments: This represents the northern, onshore rupture of the Limón earthquake, which was caused by reverse faulting (CR-50a) that projects to the submarine ocean floor offshore of Costa Rica; the fault plane dips southwest and it is related to the northward extension of the North Deformed Panamá Belt (see PA-12).

DESPLAZAMIENTO MAXIMO/MAXIMUM SLIP AT SURFACE: 1.5 m

SENTIDO DE MOVIMIENTO/SENSE OF MOVEMENT: Sinistral, normal

Comentarios/Comments: The confidence in measurement of the horizontal movement is higher than that of the vertical, because the vertical component was influenced by liquefaction. The measurement of horizontal movement was taken from displaced fences and manmade structures located along a road.

REFERENCIAS/REFERENCES

Denyer, P., Arias, O., and Personius, S., 1994, Efecto tectónico del terremoto de Limón: Revista Geológica de América Central, Special Volume (Terremoto de Limón), p. 39-52.

Montero, W., Camacho, E., Espinosa, A.F., and Boschini, I., 1994, Sismicidad y marco neótectonico de Costa Rica y Panama: Revista Geológica de América Central, Special Volume (Terremoto de Limón), p. 73-82.

CR-43, VALLE LA ESTRELLA FAULT

NUMERO DE LA FALLA/FAULT NUMBER: CR-43
Comentarios/Comments: Shown as fault CRL1-03 on original compilation sheets.

NOMBRE DE LA FALLA/FAULT NAME: Valle La Estrella

SINOPSIS Y AMBIENTE GEOLOGICO/SYNOPSIS AND GEOLOGIC SETTING: Fault cuts Quaternary sediment. It was recognized after the April 1991 Limón earthquake (Denyer et al., 1994) and corresponds to one of the secondary tear (see also CR-42) activated during movement on the main thrust fault (PA-12a) that moved during this offshore earthquake. The recognized trace of the fault is about 5 km long and it strikes east-northeast through the towns of Fortuna and Pandera, 30 km south of Limón.

COMPILADOR, AFILIACION Y FECHA DE COMPILACION/COMPILER, AFFILIATION, & DATE OF COMPILATION: Percy Denyer, University of Costa Rica; March 1997.

TIPOS DE ESTUDIOS/TYPE OF STUDIES: Field geology investigations started about 10 days after the earthquake.

GEOMETRIA DE LA FALLA/FAULT GEOMETRY
END POINTS: 9°44'36.57"N, 82°58'24.70"W (upper or left); 9°43'38.94"N, 83°1'3.73"W (lower or right).
LONGITUD/LENGTH: End-to-end 5.2 km; cumulative 5.2 km
RUMBO PROMEDIO/AVERAGE STRIKE: N 70° E ± 1°
INCLINACION PROMEDIO/AVERAGE DIP: Unknown
SENTIDO DE MOVIMIENTO/SENSE OF MOVEMENT: Sinistral strike slip
Comentarios/Comments: Sinistral movement was interpreted from deformation criteria (Riedel shears) found in unconsolidated sediment. This style of movement also corresponds with striations found on deformed Miocene-Pliocene sedimentary rock elsewhere along the fault.

EXPRESION GEOMORFOLOGICA/GEOMORPHIC EXPRESSION: Very poor; only after the earthquake occurred was it possible to trace a linear zone of deformation in unconsolidated sediment. Nevertheless, the fault corresponds with Miocene-Pliocene structures.

INTERVALO DE RECURRENCIA/RECURRENCE INTERVAL: Unknown

TASA DE MOVIMIENTO/SLIP RATE Unknown
Comentarios/Comments: This fault was only recognized after the Limón earthquake and no paleoseismic studies have been conducted, therefore a slip rate has not been determined.

EDAD DEL ULTIMO MOVIMIENTO/TIME OF MOST RECENT OF MOVEMENT Historic (1991)
Comentarios/Comments: Active during 1991 earthquake

NOMBRE DEL TERREMOTO/NAME OF EARTHQUAKE Limón.
Comentarios/Comments: Epicenter at latitude 09° 36.6' N, longitude 83° 10.2'W., depth 23.5 km. The Valle La Estrella is a tear fault located on the northern edge of the offshore thrust fault system (North Panamá Deformation Belt, PA-12) that moved during the Limón earthquake.

FECHA/DATE: April 21, 1991, 21:56 (15:56 local time)

MAGNITUD O INTENSIDAD/MAGNITUDE OR INTENSITY: Ms 7.6
Comentarios/Comments: Montero and others (1994).

MOMENT MAGNITUDE: Mw 7.7
Comentarios/Comments: Wilfredo Rojas, pers. commun., 1997.

LONGITUD DE RUPTURA /LENGTH OF SURFACE RUPTURE: 5.2 km (end-to-end)
Comentarios/Comments: This represents a second (more central) onshore rupture of the Limón earthquake, which was caused by reverse faulting (CR-50a) that projects to the submarine ocean floor offshore of Costa Rica; the fault plane dips southwest and it is related to the northward extension of the North Deformed Panamá Belt (see PA-12).

DESPLAZAMIENTO MAXIMO/MAXIMUM SLIP AT SURFACE: Unknown

SENTIDO DE MOVIMIENTO/SENSE OF MOVEMENTS: Sinistral
Comentarios/Comments: Sense was interpreted from soil fractures; for this reason our confidence in the sense of movement is very low.

REFERENCIAS/REFERENCES

Denyer, P., Arias, O., and Personius, S., 1994, Efecto tectónico del terremoto de Limón: Revista Geológica de América Central, Special Volume (Terremoto de Limón), p. 39-52.

Montero, W., Camacho, E., Espinosa, A.F., and Boschini, I., 1994, Sismicidad y marco neótectonico de Costa Rica y Panama: Revista Geológica de América Central, Special Volume (Terremoto de Limón), p. 73-82.

CR-44, ATIRRO FAULT

NUMERO DE LA FALLA/FAULT NUMBER: CR-44
Comentarios/Comments: Shown as fault CRLI-04 on original compilation sheets.

NOMBRE DE LA FALLA/FAULT NAME: Atirro

SINOPSIS Y AMBIENTE GEOLOGICO/SYNOPSIS AND GEOLOGIC SETTING: The fault trace crosses (cuts) Miocene and Pliocene-Pleistocene volcanic and sedimentary rocks. The Suretka Pliocene Formation (continental conglomerates) and the Doan Plio-Pleistocene Formation (lahares and pyroclastic flows) are the principal geologic units cut by this fault on its northwestern sector. The fault is located in the northeastern side of the Talamanca Cordillera (Inner Arc region) and trends southeast. One strand starts near Pavas (south of Turrialba) and extends south along the Río Atirro. The second strand starts near Tucurrique and extends southeast along Fila Omega. The two strands join near Río Nubes, and the resultant single trace continues southeast to at least the latitude of Cerro Buruy. The fault was continued south into the Talamance sheet (south of 9° 40') to the Río Chirrpó on the basis of photogeology by the compiler.

COMPILADOR, AFILIACION Y FECHA DE COMPILACION/COMPILER, AFFILIATION, & DATE OF COMPILATION: Percy Denyer, University of Costa Rica, March 1997.

TIPOS DE ESTUDIOS/TYPE OF STUDIES: This fault was shown on Sandoval and others (1982) geologic map, which was probably compiled using photogeology. Quesada (1986) mapped the rocks along the scarp and Montero (1994) has studied the neotectonics of the fault using photogeology and field information.

GEOMETRIA DE LA FALLA/FAULT GEOMETRY
END POINTS: 9°51'6.88"N, 83°42'46.66"W (upper or left); 9°37'48.27"N, 83°29'6.71"W (lower or right).
LONGITUD/LENGTH: End-to-end 35.5 km; cumulative 47.3 km
RUMBO PROMEDIO/AVERAGE STRIKE: N 42° W ± 15°
INCLINACION PROMEDIO/AVERAGE DIP: Unknown
SENTIDO DE MOVIMIENTO/SENSE OF MOVEMENT: Probably dextral
Comentarios/Comments: A scarp located on the eastern block of the fault suggests a component of gravitational movement. According to neotectonic evidence (for example, offset rivers and a pressure ridge), the regional tectonic context, and focal mechanisms, it should also have a component of dextral movement.

EXPRESION GEOMORFOLOGICA/GEOMORPHIC EXPRESSION: Very clear in the valley of the Atirro River. The scarp is more than 400 m high in the northeastern block. It is also possible to recognize fault-induced alignments from aerial photographs and from topographic maps. Linear valleys, fault saddles, rivers offset in dextral sense, and a pressure ridge are found along the fault trace (Montero, 1994; Montero et al, 1993). Alluvial terrace deposits were probably uplifted on the eastern side of the fault (along the Atirro valley) and where the Pejibaye River crosses the fault trace (Montero, 1994). The fault is expressed by aligned valleys and saddles from south of Cerro Buruy to the Río Chirrpó.

INTERVALO DE RECURRENCIA/RECURRENCE INTERVAL: Unknown

TASA DE MOVIMIENTO/SLIP RATE: Unknown

EDAD DEL ULTIMO MOVIMIENTO/TIME OF MOST RECENT OF MOVEMENT: Quaternary (<1.6 m.y.)
Comentarios/Comments: Based on the ages of rock and sediment that are affected by the fault and its clear geomorphic expression.

REFERENCIAS/REFERENCES

Quesada, J.D., 1986, Estudio geológico de los alrededores de La Esperanza, Pejibaye de Jiménez, Cartago, Costa Rica: Campaña Geológica, Escuela de Geología, Universidad de Costa Rica, 36 p., 2 mapas, escala 1:12,500.

Montero, W., 1994, Neotectonics and related stress distribution in a subduction-collisional zone, Costa Rica, *in* Geology of an evolving island arc, Southeastern Central America: Profil 7, p. 125-141.

Montero, W., Barquero, R., Peraldo, G., Climent, A., Mora, S., Cervantes, F., and Perazzo, E., 1993, El terremoto de Pejibaye de Turrialba del 10 de julio de 1993—Aspectos sismológicos, neotectónicos y geotécnicos: Report of the Instituto Costarricense de Electricidad, Dirección de Ingeniería Civil, Departamento de Geología, Oficina de Sismología y Vulcanología, 33 p.

Sandoval, L. F, Sáenz, R., Acuña, J., Castro, J. F., Gómez, M., López, A., Mederos, B., Monge, A., Vargas, J., Fernández, T., Ulate, R., and Ramírez, C., 1982, Mapa Geológico de Costa Rica: San José, Costa Rica, Instituto Geográfico Nacional, 9 sheets, scale 1:200,000.

CR-45, GOLFITO FAULT

NUMERO DE LA FALLA/FAULT NUMBER: CR-45
Comentarios/Comments: Shown as fault CRG-01 on original compilation sheets.

NOMBRE DE LA FALLA/FAULT NAME: Golfito

SINOPSIS Y AMBIENTE GEOLOGICO/SYNOPSIS AND GEOLOGIC SETTING: The Golfito fault has been shown on different geological maps (*i.e.*, Dóndoli and others, 1968; Sandoval and others, 1982), but it is newly suggested as a Quatenary feature in this compilation. The Golfito fault is located in the southeastern Pacific Forearc region of Costa Rica. It cuts Cretaceous and Paleocene volcanic and sedimentary units. Its trace has a sinuous southeasterly trend that starts southwest of Gamba and ends at Estero Colorado. The fault is coincident with and probably controls the position of the coastline at Golfito.

COMPILADOR, AFILIACION Y FECHA DE COMPILACION/COMPILER, AFFILIATION, & DATE OF COMPILATION: Walter Montero, Central American School of Geology, University of Costa Rica; January 1997.

TIPOS DE ESTUDIOS/TYPE OF STUDIES: Air photo interpretation and field work.

GEOMETRIA DE LA FALLA/FAULT GEOMETRY
END POINTS: 8°41'20.01"N, 83°13'56.02"W (upper or left); 8°30'55.65"N, 83°6'14.76"W (lower or right).
LONGITUD/LENGTH: End-to-end 24.1 km; cumulative 25.9 km
RUMBO PROMEDIO/AVERAGE STRIKE: N 36° W ± 21°
INCLINACION PROMEDIO/AVERAGE DIP: Northeast(?)
Comentarios/Comments: There are no reported measurements on the fault plane. The fault plane probably dips to the northeast as a thrust (see below).
SENTIDO DE MOVIMIENTO/SENSE OF MOVEMENT: Thrust
Comentarios/Comments: According to the geomorphological expression and the regional tectonic context, it appears to be a thrust fault. Kriz (1990) suggested that the Golfo Dulce Oriental (East) fault (nearly parallel and very close to the Golfito fault) is also a thrust fault.

EXPRESION GEOMORFOLOGICA/GEOMORPHIC EXPRESSION: It has prominent and little-dissected scarps, suggesting young tectonic activity. It is characterized by drainage reversals, linear valleys, fault valleys, and ponded alluvium (sag ponds) along different portions of the fault (Montero, unpublished data). The fault is coincident with and probably controls the position of the coastline at Golfito.

INTERVALO DE RECURRENCIA/RECURRENCE INTERVAL: Unknown

TASA DE MOVIMIENTO/SLIP RATE: Unknown

EDAD DEL ULTIMO MOVIMIENTO/TIME OF MOST RECENT MOVEMENT: Quaternary (<1.6 m.y.)
Comentarios/Comments Quaternary (or younger) movement is suggested by the young geomorphic expression of the fault.

REFERENCIAS/REFERENCES

Dóndoli, C., Dengo, G., and Malavassi, E., 1968, Mapa Geológico de Costa Rica: San José, Costa Rica, Ministerio de Industria y Comerico, Dirección de Geología, Minas, y Petróleo; printed by Instituto Geográfico Nacional escala 1:700,000.

Kriz, S., 1990, Tectonic evolution and origin of the Golfo Dulce gold placers in southern Costa Rica: Revista Geologica América Central, v. 11, p. 27-40.

Sandoval, L. F, Sáenz, R., Acuña, J., Castro, J. F., Gómez, M., López, A., Mederos, B., Monge, A., Vargas, J., Fernández, T., Ulate, R., and Ramírez, C., 1982, Mapa Geológico de Costa Rica: San José, Costa Rica, Instituto Geográfico Nacional, 9 sheets, scale 1:200,000.

CR-46, OSA FAULT

NUMERO DE LA FALLA/FAULT NUMBER: CR-46
Comentarios/Comments: Shown as fault CRG-02 on original compilation sheets.

NOMBRE DE LA FALLA/FAULT NAME: Osa
Comentarios/Comments: Referred to as an unnamed fault in Gardner and others (1992). Name is given informally in this compilation for its location near the Osa Peninsula.

SINOPSIS Y AMBIENTE GEOLOGICO/SYNOPSIS AND GEOLOGIC SETTING: This high-angle, down-to-the-southwest fault has a probable sinistral strike-slip component. It is located on the northeast side of the Peninsula de Osa (outer fore-arc) and is parallel to the Middle America Trench. The first indication of its neotectonic activity is in Gardner and others (1992). Only a preliminary level of study and mapping at the regional level has been conducted along the fault. Its trace was partly shown in Sandoval and others (1982) and Kriz (1990). Location of fault trace is based on information gathered from Gardner and others (1992) and from 1:50,000 scale maps made from photogeologic interpretations by Montero (unpublished work). Fault traces shown in Sandoval and others (1982) and Kriz (1990) are different than the interpretation shown in this compilation map. This northwest-trending fault extends from Playa Zapote (on the east) about 30 km northwest from the Golfo Dulce to Fila Matajambre (on the west).

COMPILADOR, AFILIACION Y FECHA DE COMPILACION/COMPILER, AFFILIATION, & DATE OF COMPILATION: Walter Montero, Central American Shool of Geology, University of Costa Rica; November 11, 1995.

TIPOS DE ESTUDIOS/TYPE OF STUDIES: Photogeologic interpretation, topical studies of faulted fluvial and shallow marine deposits of late Quaternary age (Gardner and others, 1992).

GEOMETRIA DE LA FALLA/FAULT GEOMETRY
END POINTS: 8°37'27.32"N, 83°32'45.83"W (upper or left); 8°30'22.4"N, 83°17'31.51"W (lower or right).
LONGITUD/LENGTH: End-to-end 31.2 km; cumulative 32.1 km
RUMBO PROMEDIO/AVERAGE STRIKE: N 65° W ± 14°
INCLINACION PROMEDIO/AVERAGE DIP: Angle unknown, dip to southwest
SENTIDO DE MOVIMIENTO/SENSE OF MOVEMENT: Normal, sinistral
Comentarios/Comments: Gardner and others (1992) proposed tha it is a normal-slip fault. However, photogeological interpretations also suggest a sinistral-slip component (Montero, unpublished data).

EXPRESION GEOMORFOLOGICA/GEOMORPHIC EXPRESSION: Strong to weak lineament defined by scarps facing to the southwest, stream deflections, and fault saddles.

INTERVALO DE RECURRENCIA/RECURRENCE INTERVAL: Unknown

TASA DE MOVIMIENTO/SLIP RATE: Unknown; probably <1 mm/yr.
Comentarios/Comments: At least 1.8 m of dip-slip motion has occurred during the past 35 k.y. according to Gardner and others (1992).

EDAD DEL ULTIMO MOVIMIENTO/TIME OF MOST RECENT OF MOVEMENT: Probably Holocene or post glacial (<15 ka)
Comentarios/Comments: Fluvial and shallow marine deposits that have radiocarbon ages between 20-35 ka (Gardner and others, 1992) have been faulted. This suggests the the most recent movement may be <15 k.y.

REFERENCIAS/REFERENCES

Gardner, T.H., Verdonck, D., Pinter, N.M., Slingerland, Furlong, K.P., Bullard, T.H., and Wells, S.G., 1992, Quaternary uplift astride the aseismic Cocos Ridge, Pacific coast, Costa Rica: Geological Society of America Bulletin, v. 104, p. 219-232.

Kriz, S., 1990, Tectonic evolution and origin of the Golfo Dulce gold placers in southern Costa Rica: Revista Geologica América Central, v. 11, p. 27-40.

Sandoval, L. F, Sáenz, R., Acuña, J., Castro, J. F., Gómez, M., López, A., Mederos, B., Monge, A., Vargas, J., Fernández, T., Ulate, R., and Ramírez, C., 1982, Mapa Geológico de Costa Rica: San José, Costa Rica, Instituto Geográfico Nacional, 9 sheets, scale 1:200,000.

CR-47, MEDIAL FAULT ZONE

NUMERO DE LA FALLA/FAULT NUMBER: CR-47 (also PA-03)
Comentarios/Comments: Fault extends across Panamá/Costa Rica boundaries. Shown as fault CRG-03 on original compilation sheets of Costa Rica.

NOMBRE DE LA FALLA/FAULT NAME: Medial (zone)
Comentarios/Comments Early reference to this fault was by Stewart (1977). Corrigan and others (1990) named it and did a more detailed investigation.

SINOPSIS Y AMBIENTE GEOLOGICO/SYNOPSIS AND GEOLOGIC SETTING: Fault zone is well defined in its general characteristics. It comes onshore on the Burica Peninsula of Costa Rica and Panamá, and extends north and northwest into Panamá. It is a high-angle, right-lateral strike-slip fault displaying 800-2,500 m of up-to-west vertical displacement. Fault accommodates deflection of the Middle America Trench along the eastern edge of the subducted Cocos Ridge (Corrigan and others, 1990). The fault offsets Pleistocene and Pliocene rocks of the Charco Azul Formation and Late Cretaceous basement rocks of the Upper Nicoya Complex. Fault trace was transferred by inspection from the small scale map of Corrigan and others (1990). Northern portion of the fault is based on photogeological interpretation by Montero (unpublished data). The northwestern limit of the fault is the headwaters of the Río Corotu, a small river located on the Burica Peninsula. To the south, the fault splays into several strands that enter the sea, so its southern border it is not determined.

COMPILADOR, AFILIACION Y FECHA DE COMPILACION/COMPILER, AFFILIATION, & DATE OF COMPILATION: Walter Montero, Central American School of Geology, University of Costa Rica; November 11, 1994.

TIPOS DE ESTUDIOS/TYPE OF STUDIES: Geologic mapping and photogeological interpretation

GEOMETRIA DE LA FALLA/FAULT GEOMETRY
END POINTS: 8°25'41.44"N, 83°2'55.22"W (upper or left); 8°8'12.87"N, 82°54'57.30"W (lower or right).
LONGITUD/LENGTH: End-to-end 35.8 km; cumulative 89.3 km
Comentarios/Comments: Large cumulative fault length caused by multiple overlapping strands.
RUMBO PROMEDIO/AVERAGE STRIKE: N 19° W ± 23°
INCLINACION PROMEDIO/AVERAGE DIP: Unknown
Comentarios/Comments Poorly exposed fault zone without reported dip or trend measurements.
SENTIDO DE MOVIMIENTO/SENSE OF MOVEMENT Dextral thrust
Comentarios/Comments: Magnitude of dextral-slip component is undetermined. Thrust component was defined by a left-stepping segment of the Medial fault zone near its northwest termination.

EXPRESION GEOMORFOLOGICA/GEOMORPHIC EXPRESSION: Fault forms a prominent 15-km-long and 600- to 1800-m-wide linear valley that strikes northward from the southwest coast of the Burica Peninsula to the headwaters of the Río Corotu. Near the headwaters of this river, the valley assumes a more northwestward trend and becomes poorly defined topographically (Corrigan and others, 1990).

INTERVALO DE RECURRENCIA/RECURRENCE INTERVAL: Unknown
Comentarios/Comments: More detailed studies are required to define individual paleoevents and thus recurrence intervals.

TASA DE MOVIMIENTO/SLIP RATE: Unknown

EDAD DEL ULTIMO MOVIMIENTO/TIME OF MOST RECENT OF MOVEMENT: Quaternary (<1.6 m.y.)
Comentarios/Comments: The fault offsets Pleistocene and Pliocene rocks of the Charco Azul Formation, but more detailed studies are required to define indivudual paleoevents or the timing of the most recent movement.

REFERENCIAS/REFERENCES

Corrigan, J., Mann, P. and Ingle, J. C., 1990, Forearc response to subduction of the Cocos ridge, Panamá-Costa Rica: Geol. Soc. Amér. Bull., v. 102, p. 628-652.

Stewart, R. H., 1977, Geology, seismicity, and design of structures in the Burica Peninsula area: Unpublished report, 28 pp. included in Corrigan and others, 1990 (see above).

CR-48, LONGITUDINAL FAULT

NUMERO DE LA FALLA/FAULT NUMBER: CR-48
Comentarios/Comments: Shown as fault CRT-01 on original compilation sheets.

NOMBRE DE LA FALLA/FAULT NAME: Longitudinal
Comentarios/Comments: An early reference to the Longitudinal fault is found in Dengo (1962) who named it the Río Esquinas fault. In Panamá, its southward extension is named the Ballena-Celmira fault (PA-1a) (Mann and Corrigan, 1990; Kolarsky and others, 1995).

SINOPSIS Y AMBIENTE GEOLOGICO/SYNOPSIS AND GEOLOGIC: There are various hypotheses concerning the Longitudinal fault's sense of displacement through different geological periods, including the Quaternary. It seems to be a high-angle, thrust fault vergent to the southwest with probable minor strike-slip movement; the total amount of offset unknown, but it is the longest mapped Quaternary fault in Costa Rica. Located at the range-front of the Fila Costeña, it represents the boundary between the Outer and Inner Fore-Arc basins. In Costa Rica, it extends northwest from Paso Canoas (boundary between Costa Rica and Panamá) to the north of Parrita. The fault starts near to and parallels the Pacific coast. At Corres, it forms the eastward margin of the delta of the Río Terraba. Further south, the fault extends inland through Río Claro and Neily. The fault is mapped as far southeast as the Río Chiriqui Viejo, at the Panamá border. The fault trace was transferred from 1:50,000 scale maps, after aerial photo interpretation (Montero, unpublished data).

COMPILADOR, AFILIACION Y FECHA DE COMPILACION/COMPILER, AFFILIATION, & DATE OF COMPILATION: Walter Montero Pohly, Central American School of Geology, University of Costa Rica; May 4, 1995.; modified by Hugh Cowan, Instituto de Geociencias, Universidad de Panamá, Panamá City, Panamá; Oct. 10, 1996.

TIPOS DE ESTUDIOS/TYPE OF STUDIES: Fault is relatively well studied at the regional level and two trenches were excavated in April 1997.

GEOMETRIA DE LA FALLA/FAULT GEOMETRY
END POINTS: 9°27'10.89"N, 84°5'56.64"W (upper or left); 8°36'2.67"N, 82°51'56.55"W (lower or right).
LONGITUD/LENGTH: End-to-end 167.2 km; cumulative 184.0 km
RUMBO PROMEDIO/AVERAGE STRIKE: N 55° W ± 26°
INCLINACION PROMEDIO/AVERAGE DIP: High angle to northeast
Comentarios/Comments: Probably >70 degrees NE, based on relatively straight trace across topography, and reported observations near Villa Neilly (Woodward-Clyde Consultants, 1979, in Montero, 1994).
SENTIDO DE MOVIMIENTO/SENSE OF MOVEMENT: Thrust (uncertain)
Comentarios/Comments: Different authors agree that the late Cenozoic and Quaternary motion is predominantly ont of thrust faulting (Mora, 1979; Kolarsky and others, 1995) with a minor strike-slip component that could be dextral (Kriz, 1990). However, Dengo (1962) suggested it is a normal fault and Rivier (1985) suggested different kinds of displacement through different geological periods. Reverse fault geometry was exposed in trench Montero (1994) joins it with the Candelaria fault (CR-29) and suggested different kinds of displacements in different portions of the Longitudinal-Candelaria faults.

EXPRESION GEOMORFOLOGICA/GEOMORPHIC EXPRESSION: Forms boundary between the Fila Costeña Mountain (range) and the alluvial and coastal geomorphic provinces. Wells and others (1988) defined different geomorphic parameters along the frontal Fila Costeña range that may be related to fault history.

INTERVALO DE RECURRENCIA/RECURRENCE INTERVAL: Unknown

TASA DE MOVIMIENTO/SLIP RATE: Unknown; probably >5 mm/yr
Comentarios/Comments: According to Cowan and others (1997), the portion of the fault between Río Claro town and the Panamá-Costa Rica boundary has a slip rate of more than 5 mm/yr.

EDAD DEL ULTIMO MOVIMIENTO/TIME OF MOST RECENT OF MOVEMENT: Quaternary (<1.6 m.y.)
Comentarios/Comments: Minor offset of probable Holocene alluvial terraces, which could be related to the Longitudinal fault, suggests that this fault could be Holocene. Elsewhere, Tertiary sedimentary rocks of the Fila Costeña and Quaternary alluvial deposits are clearly offset by the fault (Alt and others, 1980).

REFERENCIAS/REFERENCES

Alt, J. N., Harpster, R. E., and Schwartz, D. P., 1980, Late Quaternary deformation and differential uplift along the Pacific coast of Costa Rica: Geological Society of America Abstracts with Programs, v. 12, p. 378-379.

Cowan, H., Montero, W., Salazar, G., Alvarado, G., Tapia, A., and Sánchez, L., 1997, Estudios de Fallas Activas en la Región Frontera Costa Rica-Panamá, Proyecto de Microzonificación de David, Panamá: Location, CEPREDENAC—NORAD, 79 p.

Dengo, G., 1962, Tectonic-igneous sequence in Costa Rica, *in* Engel, A.E.C., James, H., and Leonard, B. (eds.), Petrologic studies—A volume in honor of A. F. Buddington: Geological Society of America, p. 133-161.

Kolarsky, R., Mann, P., and Montero, W., 1995, Forearc deformation related to the subduction of the Cocos ridge, southeastern Costa Rica, *in* P. Mann, ed., Geologic and Tectonic development of the Caribbean plate boundary in southern Central America: Geological Society of America, Special Paper 295, p. 235-262.

Kriz, S., 1990, Tectonic evolution and origin of the Golfo Dulce gold placers in southern Costa Rica: Revista Geologica América Central, v. 11, p. 27-40.

Mann, P., and Corrigan, J., 1990, Model for late Neogene deformation in Panamá: Geology, v. 18, p. 558-562.

Montero, W., 1994, Neotectonics and related stress distribution in a subduction collisional zone—Costa Rica, *in* Seyfried, Hartmut, and Hellman, Wiebke (eds.), Geology of an evolving island arc—Southeastern Central America: Profil, v. 7, p. 125-141.

Mora, S., 1979, Estudio geológico de una parte de la región sureste del Valle del General, Provincia de Puntarenas, Costa Rica: San José, Universidad de Costa Rica, Licenciatura Thesis, 157 pp.

Rivier, F., 1985, Sección geológica del Pacífico al Atlántico a través de Costa Rica: Revista Geologica América Central, v. 2, p. 23-32.

Wells, S., Bullard, T., Menges, C., Drake, P., Karas, K., Kelson, K., Ritter, J., and Wesling, J., 1988, Regional variations in tectonic geomorphology along a segmented convergent plate boundary, Pacific coast of Costa Rica: Geomorphology, v. 1, p. 239-265.

CR-49, CANOAS FAULT ZONE

NUMERO DE LA FALLA/FAULT NUMBER: CR-49
Comentarios/Comments: Shown as fault PA-02 on original compilation sheets of Hugh Cowan

NOMBRE DE LA FALLA/FAULT NAME: Canoas (zone)
Comentarios/Comments: Recently named by Cowan (1997) for the nearby town of Canoas, which is near the Costa Rica-Panamá border.

SINOPSIS Y AMBIENTE GEOLOGICO/SYNOPSIS AND GEOLOGIC: Prominent surface trace on Holocene alluvium and Plio-Pleistocene lacustrine and alluvial sediments, extending NNE from the Panamá-Costa Rica border, west of the Panamánian town of Progreso. Majority of surface trace is in Costa Rica, although fault must extend south through Panamá. Provisionally interpretated as northernmost element of Panamá Fracture Zone (PA-09) based on geometry and dextral strike-slip kinematics. On the Costa Rican side of the border with Panamá, the southern end of the surface trace disappears in an area of swampy ground that probably coincides with an extensional right-step or bend. To the north, the fault curves northwestward and merges with the Longitudinal fault (CR-48) in Costa Rica. Fault recorded for the first time during fieldwork by H. Cowan on 15th Sept. 1996.

COMPILADOR, AFILIACION Y FECHA DE COMPILACION/COMPILER, AFFILIATION, & DATE OF COMPILATION: Hugh Cowan, Instituto de Geociencias, Universidad de Panamá, Panamá City, Panamá; Oct. 10, 1996.

TIPOS DE ESTUDIOS/TYPE OF STUDIES: Aerial photo interpretation, low-altitude overflight inspection, reconnaisance field survey, and two trenches.

GEOMETRIA DE LA FALLA/FAULT GEOMETRY
END POINTS: 8°36'4.30"N, 82°52'1.66"W (upper or left); 8°25'35.59"N, 82°52'57.18"W (lower or right).
LONGITUD/LENGTH: End-to-end 19.6 km; cumulative 20.0 km
RUMBO PROMEDIO/AVERAGE STRIKE: N 5° E ± 15°
INCLINACION PROMEDIO/AVERAGE DIP: Sub-vertical
SENTIDO DE MOVIMIENTO/SENSE OF MOVEMENT: Dominantly dextral strike-slip
Comentarios/Comments: Sense of movement inferred from geometric discontinuities and left-lateral offset of streams.

EXPRESION GEOMORFOLOGICA/GEOMORPHIC EXPRESSION: Excellent expression of well-defined surface trace with associated discontinuities, such as sag basins, pressure ridges and fault-trace furrows.

INTERVALO DE RECURRENCIA/RECURRENCE INTERVAL: Unknown
Comentarios/Comments: See comments below.

TASA DE MOVIMIENTO/SLIP RATE: Probably >5 mm/yr.
Comentarios/Comments: Long-term slip rate of roughly 7-13 cm/yr is suggested from 1.3 km of right-lateral offset of the distal margin of a large alluvial fan of probable late Pleistocene age (10-20 ka?) (Cowan, 1997; Cowan and others, 1997; and Cowan, unpublished data). Smaller dextral offsets of 4-65 m are preserved at several streams and shutter ridges along the surface trace.

EDAD DEL ULTIMO MOVIMIENTO/TIME OF MOST RECENT OF MOVEMENT: Holocene or post glacial (<15 ka)
Comentarios/Comments: Active in the late Holocene (Cowan and others, 1997) and is historic if active during July 18, 1934 earthquake (see below). Cowan and others (Cowan, 1997) trenched the the youngest expression of the Canoas fault (nears its southern tip, which passes beneath late Holocene fluvial overbank deposits) and found two buried soils and associated colluvial wedges. Dating of samples was not complete at the time of this compilation, but discovery of pumice and volcanic ash in the trenches, which probably corresponds with eruptions from Volcan Baru in Panamá, will allow estimates of the timing of individual faulting events and recurrence intervals . In addition, pre-Colombian artifacts (probably 500-1,500 yr B.P.) were recovered from the trench. The associated horizons of human occupation were faulted, supporting an interpretation of late Holocene to historic faulting.

FALLAMIENTO HISTORICO EN SUPERFICIE/*HISTORICAL SURFACE FAULTING*: Unknown, but the surface trace is fresh enough to be considered a possible candidate for rupture in the 1934 Puerto Armuelles earthquake. Extensive (200 m long) cracks were reported from west of Corredor (Villa Neilly) in what is now Costa Rica (unpublished data). For review of the seismological aspects of this earthquake, refer to Camacho (1991).

NOMBRE DEL TERREMOTO/NAME OF EARTHQUAKE: Puerto Armuelles.

FECHA/DATE: July 18, 1934

MAGNITUD O INTENSIDAD/MAGNITUDE OR INTENSITY: Ms 7.6

MOMENT MAGNITUDE: Unknown

LONGITUD DE RUPTURA /LENGTH OF SURFACE RUPTURE: Unknown
Comentarios/Comments: Region largely undeveloped at time of earthquake, hence their were no significant investigations of the extent of surface rupturing.

DESPLAZAMIENTO MAXIMO/MAXIMUM SLIP AT SURFACE: Unknown

SENTIDO DE MOVIMIENTO/SENSE OF MOVEMENT: Unknown

REFERENCIAS/REFERENCES

Camacho, E., 1991, The Puerto Armuelles earthquake (southwestern Panamá) of July 18, 1934: Revista Geologica América Central, v. 13, p. 1-13.

Cowan, H., 1997, Paleoseismology of the Cocos-Nazca-Caribbean Triple Junction: Southern California Earthquake (SCEC) Quarterly Newsletter (Summer 1997), v. 3, no. 2, p. 26-27.

Cowan, H., Montero, W., Salazar, G., Tapia, A., Alvarado, G., and Arias, R., 1997, Active faulting at the Cocos-Nazca-Caribbean Triple Junction, Southern Costa Rica and Western Panamá: Geological Society of America Abstracts with Programs, v. 29, no. 6, p. A-442.

CR-50, NORTH PANAMÁ DEFORMED BELT (NPDB)

NUMERO DE LA FALLA/FAULT NUMBER: CR-50
Comentarios/Comments: Equivalent to PA-12, offshore Panamá.

NOMBRE DE LA FALLA/FAULT NAME: North Panamá deformed belt

SINOPSIS Y AMBIENTE GEOLOGICO/SYNOPSIS AND GEOLOGIC SETTING: The North Panamá deformed belt (NPDB) is a landward-dipping thrust fault complex associated with an accretionary prism that bounds the northern margin of Panamá and the northeast coast of Costa Rica. Several different explanations have been advanced to explain the development of the NPDB; all involve differential shortening across the southern margin of the Caribbean plate boundary, but end-member models of driving mechanism include: (1) collision between the Panamá arc and South America, (2) cross-ithsmus left-lateral strike-slip block displacement relative to the Colombian Basin, and (3) collision of Costa Rica across the Caribbean plate boundary resulting from subduction of the buoyant Cocos Ridge (for introduction to all interpretations, see Silver and others, 1995 and references therein). Fault trace for section CR-50a is based on the geological map of Fernández and others (1997). Fault trace for section CR-50b is mainly offshore of northern Panama.

COMPILADOR, AFILIACION Y FECHA DE COMPILACION/COMPILER, AFFILIATION, & DATE OF COMPILATION: Hugh Cowan, Instituto de Geociencias, Universidad de Panamá, Panamá City, Panamá; Oct. 10, 1996

TIPOS DE ESTUDIOS/TYPE OF STUDIES: Seismological studies (see Adamek *et al.*, 1988 and references therein), marine seismic-reflection and bathymetric swath-mapping surveys (see Reed and Silver, 1995; Silver *et al.*, 1995 and references therein).

GEOMETRIA DE LA FALLA/FAULT GEOMETRY
END POINTS: 9°32'41.23"N, 82°31'6.44"W (upper or left); 9°24'56.55"N, 83°39'47.91"W (lower or right).
Comentarios/Comments: Endpoints for portion on map.
LONGITUD/LENGTH: End-to-end 86.4 km; cumulative 147.1 km
Comentarios/Comments: Length is portion on map, CR-50b continues much farther.
RUMBO PROMEDIO/AVERAGE STRIKE: N 51° W ± 29°
Comentarios/Comments: Strike for portion on map, CR-50b continues much farther southeast.

NUMERO DE SECCIONES/NUMBER OF SECTIONS: 3
Comentarios/Comments: Three sections were defined for the compilation of Panamá as follows: Section CR-50a (also known as PA-12a) denotes a thrust fault in the "western sector" of the North Panamá Deformed Belt that is inferred to have ruptured in the April 22, 1991 Limón earthquake. Sections CR-50b (also known as PA-12b) and PA-12c represent "central"and "eastern" sections of the offshoer North Panamá Deformed Belt based solely on the differing strike of the respective elements. Section PA-12c is entirely offshore of northern and eastern Panamá, and thus is not considered in this compilation of Costa Rican faults and folds.

CR-50A, LIMÓN FAULT

NUMERO DE LA SECCION/SECTION NUMBER: CR-50a
Comentarios/Comments: Also known as fault PA-12a in Panamá database.

NOMBRE DE LA SECCION/SECTION NAME: Limón fault
Comentarios/Comments: Probable surface projection of the thrust fault that ruptured in the April 22, 1991 Limón earthquake (Plafker and Ward, 1992).

GEOMETRIA DE LA SECCION/SECTION GEOMETRY
END POINTS: 10°0'19.31"N, 83°6'37.64" (upper or left); 9°37'43.78"N, 82°29'59.84"W (lower or right).
LONGITUD/LENGTH: End-to-end 80.0 km; cumulative 144.4 km
RUMBO PROMEDIO/AVERAGE STRIKE: N 47° W ± 27°
INCLINACION PROMEDIO/AVERAGE DIP: < 30 degrees, southwest.
Comentarios/Comments: Flattens at depth. According to modelling by Tajima and Kikuchi (1995), the rupture surface had a dip of 39 deg. at 7 km, decreasing to 16 deg. at 17 km.
SENTIDO DE MOVIMIENTO/SENSE OF MOVEMENT: NE-vergent thrust fault.

EXPRESION GEOMORFOLOGICA/GEOMORPHIC EXPRESSION: Unknown

INTERVALO DE RECURRENCIA/RECURRENCE INTERVAL: 200 to 1100 years
Comentarios/Comments: Plafker and Ward (1992) suggested a recurrence of 200-1,100 yrs based on uplifted Holocene coral platforms and assumptions about partitioning of Cocos-Caribbean plate motion.

TASA DE MOVIMIENTO/SLIP RATE: Unknown

EDAD DEL ULTIMO MOVIMIENTO/TIME OF MOST RECENT OF MOVEMENT: Historic (1991)
Comentarios/Comments: There was on documented submarine faulting of this (thrust) section of the fault, but the 1991 Limón earthquake produced extensive coastal uplift and localized subsidence (Plafker and Ward, 1992), thus we shown the entire section as having inferred historic movement. However, the Río Blanco (CR-42) and Valle la Estrella (CR-43) faults ruptured onshore during the 1991 event. Analysis of aftershock distribution indicates blind-thrusting (Tajima and Kikuchi, 1995) along CR-50a.

FALLAMIENTO HISTORICO EN SUPERFICIE/HISTORICAL SURFACE FAULTING (CR-50A, PA-12A)

NOMBRE DEL TERREMOTO/NAME OF EARTHQUAKE: Limón earthquake
Comentarios/Comments: Costa Rica earthquake (*e.g.* Plafker and Ward, 1992; Tajima and Kikuchi, 1995). Also termed the Valle de Estrella earthquake (*e.g.* Protti et al., 1995).

FECHA/DATE: April 22, 1991

MAGNITUD O INTENSIDAD/MAGNITUDE OR INTENSITY: Ms 7.6

MOMENT MAGNITUDE: Mw 7.7

LONGITUD DE RUPTURA/LENGTH OF SURFACE RUPTURE: Undocumented but inferred rupture is about 90 km from end-to-end 80.0 km.

DESPLAZAMIENTO MAXIMO/MAXIMUM SLIP AT SURFACE: No surface rupture observed (mostly offshore)

SENTIDO DE MOVIMIENTO/SENSE OF MOVEMENT: Thrust

CR-50B, CENTRAL SECTION

NUMERO DE LA SECCION/SECTION NUMBER: CR-50b
Comentarios/Comments: Also known as fault PA-12b in Panamá database.

NOMBRE DE LA SECCION/SECTION NAME: Central
Comentarios/Comments: Faults CR-50b and PA-12b represent the "central" section of the North Panamá Deformed Belt based solely its orientation. To the southeast, fault CR-50 continues as fault PA-12b, offshore from Costa Rica to Panama

GEOMETRIA DE LA SECCION/SECTION GEOMETRY
END POINTS: 9°32'41.23"N, 82°31'6.44"W (upper or left); 9°31'46.62"N, 82°29'59.97"W (lower or right).
Comentarios/Comments: Endpoints for portion on map, continues much farther southeast into offshore Panama
LONGITUD/LENGTH: End-to-end 2.7 km; cumulative 2.7 km
Comentarios/Comments: Length is portion on map, continues much farther southeast into offshore Panama
RUMBO PROMEDIO/AVERAGE STRIKE: N 51° W ± 1°
Comentarios/Comments: Strike for portion on map, continues much farther southeast into offshore Panama
INCLINACION PROMEDIO/AVERAGE DIP: <30 degrees, south and southeast
SENTIDO DE MOVIMIENTO/SENSE OF MOVEMENT: N- and NW-vergent thrust faults.

EXPRESION GEOMORFOLOGICA/GEOMORPHIC EXPRESSION: Unknown (offshore)

INTERVALO DE RECURRENCIA/RECURRENCE INTERVAL: Unknown

TASA DE MOVIMIENTO/SLIP RATE: Unknown

EDAD DEL ULTIMO MOVIMIENTO/TIME OF MOST RECENT OF MOVEMENT: Quaternary
Comentarios/Comments: Certainly Quaternary, but may be Holocene on basis of inferred deformation rate across North Panamá deformed belt (CR-50a). The earthquake of April 26, 1916 (M_S = 6.9) could be related to this section of the North Panamá Deformed Belt (Suarez and others, 1995).

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CR-51, BUENAVISTA FAULT

NUMERO DE LA FALLA/FAULT NUMBER: CR-51
Comentarios/Comments: Shown as fault CRT-02 on original compilation sheets.

NOMBRE DE LA FALLA/FAULT NAME: Buenavista

SINOPSIS Y AMBIENTE GEOLOGICO/SYNOPSIS AND GEOLOGIC SETTING: Fault first mentions as a neotectonic sturcture by Boschini and others (1988). Also included in the geologic map of Costa Rica published by Fernández and others (1997). Fault trends roughly north-south cutting Oligocene and Pliocene sedimentary rock of the Talamanca Cordillera.

COMPILADOR; AFILIACION Y FECHA DE COMPILACION/COMPILER, AFFILIATION, & DATE OF COMPILATION: Walter Montero, Central American School of Geology, University of Costa Rica; June 1998.

TIPOS DE ESTUDIOS/TYPE OF STUDIES: Air photo interpretation and field survey.

GEOMETRIA DE LA FALLA/FAULT GEOMETRY
END POINTS: 9°32'59.8"N, 83°40'34.08"W (upper or left); 9°24'56.55"N, 83°39'47.91"W (lower or right).
LONGITUD/LENGTH: End-to-end 15.1 km; cumulative 15.4 km
RUMBO PROMEDIO/AVERAGE STRIKE: N 5° W ± 12°
INCLINACION PROMEDIO/AVERAGE DIP: High angle to vertical
SENTIDO DE MOVIMIENTO/SENSE OF MOVEMENT: Dextral strike slip
Comentarios/Comments: Defined by Boshini and others (1988) as a dextral slip fault although vertical uplift could also occur locally.

EXPRESION GEOMORFOLOGICA/GEOMORPHIC EXPRESSION Defined along an asymmetric fault valley trending 350° (N 10° W). Trace of fault marked by triangular facets, pressure ridges, small transtensional structures, and uplifted terrraces.

INTERVALO DE RECURRENCIA/RECURRENCE INTERVAL: Unknown

TASA DE MOVIMIENTO/SLIP RATE: Unknown

EDAD DEL ULTIMO MOVIMIENTO/TIME OF MOST RECENT OF MOVEMENT: Quaternary (<1.6 m.y.)
Comentarios/Comments: Boschini and others (1988) suggested that the fault could be associated with the Buenavista earthquake of July 3, 1983 (M_S = 6.3), although no evidence of fault rupture are reported in the literature.

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TABLE 1. QUATERNARY FAULTS AND FOLDS OF COSTA RICA

Number	Name of structure	Primary map sheet (1:200,000)	Most recent faulting	Slip rate
CR-01	Caño Negro fault	Liberia	< 1.6 m.y.	Unknown
CR-02	Limónes-Cañas fault	Nicoya	< 1.6 m.y.	<1 mm/yr
CR-03	Cote-Arenal fault	San Carlos	< 15 k.y.	1-5 mm/yr
CR-04	Chiripa fault	San José	< 15 k.y.	Unknown
CR-05	Danta fault	San José	< 15 k.y.	0.2-1 mm/yr
CR-06	Peñas Blancas fault	San José	< 1.6 m.y.	Unknown
CR-07	Jabillos fault	San José	< 1.6 m.y.	Unknown
CR-08	Zarcero fault	San José	< 1.6 m.y.	Unknown
CR-09	Congo fault	San José	< 1.6 m.y.?	1-5 mm/yr
CR-10	Porvenir fault	San José	< 15 k.y.	Unknown
CR-11	Viejo-Aguas Zarcas fault	San José	< 1.6 m.y.	Unknown
CR-12	San Miguel fault	San José	< 15 k.y.	Unknown
CR-13	Carbonera fault	San José	< 1.6 m.y.	Unknown
CR-14	Angel fault	San José	< 1.6 m.y.	Unknown
CR-15	Guápiles fault	San José	< 1.6 m.y.?	0.2-1
CR-16	Barranca fault	San José	< 1.6 m.y.	Unknown
CR-17	Mata de Limón fault	San José	< 1.6 m.y.	Unknown
CR-18	Jesús María fault	San José	< 1.6 m.y.	<1 mm/yr
CR-19	Tárcoles fault	San José	< 1.6 m.y.	<1 mm/yr
CR-20	Tronco Negro fault	San José	< 1.6 m.y.	Unknown
CR-21	San Juan de Mata fault	San José	< 1.6 m.y.	Unknown
CR-22	Alajuela fault	San José	< 15 k.y.	10 mm/yr
CR-23	Garita fault	San José	1990	Unknown
CR-24	Virilla fault	San José	< 1.6 m.y.	Unknown
CR-25	Picagres fault system	San José	< 15 k.y.	Unknown
CR-26	Jaris fault	San José	< 1.6 m.y.	Unknown
CR-27	Delicias fault	San José	< 1.6 m.y.	Unknown
CR-28	Tulín fault	San José	< 1.6 m.y.	Unknown
CR-29	Candelaria fault	San José	< 1.6 m.y.	Unknown
CR-30	Higuito fault	San José	< 1.6 m.y.	Unknown
CR-31	Agua Caliente fault	San José	< 15 k.y.	Unknown
CR-32	Coris fault	San José	< 1.6 m.y.	Unknown
CR-33	Lara fault	San José	< 1.6 m.y.	Unknown
CR-34	Río Sucio fault	San José	< 1.6 m.y.	Unknown
CR-35	Alto Grande fault	San José	< 1.6 m.y.	Unknown
CR-36	Blanquito fault	San José	< 1.6 m.y.	Unknown

TABLE 1—CONTINUED. QUATERNARY FAULTS AND FOLDS OF COSTA RICA

Number	Name of structure	Primary map sheet (1:200,000)	Most recent faulting	Slip rate
CR-37	Navarro fault	San José	<15 k.y.	Unknown
CR-38	Orosi fault	San José	< 1.6 m.y.	Unknown
CR-39	Duán fault	San José	< 1.6 m.y.	Unknown
CR-40	Pirris fault	Quepos	< 1.6 m.y.	Unknown
CR-41	Siquirres-Matina fault	Limón	< 1.6 m.y.	<1 mm/yr
CR-42	Río Blanco fault	Limón	1991	Unknown
CR-43	Valle la Estrella fault	Limón	1991	Unknown
CR-44	Atirro fault zone	Limón	< 1.6 m.y.	Unknown
CR-45	Golfito fault	Golfito	< 1.6 m.y.	Unknown
CR-46	Osa fault	Golfito	<15 k.y.	Unknown
CR-47	Medial fault zone	Golfito	< 1.6 m.y.	Unknown
CR-48	Longitudinal fault	Golfito	< 1.6 m.y.	Unknown
CR-49	Canoas fault zone	Golfito	<15 k.y.	>5 mm/yr
CR-50a	North Panamá deformed belt, Limón fault	Offshore	1991	Unknown
CR-50b	North Panamá deformed belt, central section	Offshore	< 1.6 m.y	Unknown
CR-51	Buenavista fault	Talamanca	< 1.6 m.y	Unknown