



Centro Regional de Sismología para América del Sur

REGIONAL CENTER FOR SEISMOLOGY FOR SOUTH AMERICA

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CERESIS

REGIONAL CENTER FOR SEISMOLOGY FOR SOUTH AMERICA

INTRODUCTION

The Regional Center for Seismology for South America, CERESIS, is a unique organization. It is not usual for governments to sign an Agreement - an International Treaty - ratified by the respective Congress, to work together to reduce the country's vulnerability to earthquakes and related phenomena, and to obligate themselves to support the Center financially. The Executive branch of eleven South American governments, and Spain, have signed the Multilateral Agreement; all but three have ratified the Agreement (Treaty).

Member States pay CERESIS a modest annual quota, - just enough to cover domestic expenses of the Central Coordinating and Administrative Office located in Lima, Peru. Operating funds to support regional projects are generated by projects financed by donor countries, national and international funding Agencies, donations and Grants. It is a real achievement for CERESIS to have functioned continuously during the past 35 years.

The report does not pretend to reflect the consolidated opinion of the twelve member States. To avoid subjective points of view, the report presents a fairly detailed account of its activities as documented by the Minutes of the 21 ordinary and extraordinary Meetings of the Directive Council. Council meetings were hosted by the member States. The report ends with some apprehensions concerning the future of CERESIS.

I. BACKGROUND

Efficient International cooperation, on a global scale, is a basic condition for the advancement of seismology. The importance of regional centers was recognized soon after the beginning of instrumental seismology. At the suggestion of Markus Bath, Uppsala, the International Seismological Summary, at a meeting held in Paris, July 1961, discussed the subject and adopted a Resolution recommending that such centers be established in regions of the world with few seismological stations and little or no exchange of data across national borders.

At the VIIth General Assembly of the Pan American Institute for Geography and History (PAIGH) held in August, 1961 in Buenos Aires, a motion was approved to promote the creation of a Latin American Seismological Society.

Later that same year, a Unesco Mission of experts in seismology, presided by Prof. V.V. Belousov, visited several of the Latin American

countries to learn of the situation in each; the mission concluded its reconnaissance with a general meeting in Santiago attended by seismologists and earthquake engineers from Latin American countries to summarize the information obtained and to propose relevant measures to improve each country's capability to cope with the earthquake hazard. One of the main conclusions (Recommendation 1.2) was that a regional center be established to coordinate, stimulate and further seismological activities, including a data bank. Another important result of this meeting was the creation of the "Asociación Latinoamericana de Sismología e Ingeniería Sísmica" (ALSIA).

At the XIIIth I.U.G.G. General Assembly in Berkeley, California, August 1963, the Latin American participants resolved to request UNESCO to sponsor a meeting of experts in the fields of seismology and associated disciplines. Representatives from 11 countries, from Mexico to Argentina, met in Lima, Peru, December 16 to 20, 1963. The government of Peru hosted the event, also attended by the Director of the International Seismological Center, P.L. Willmore.

Participants discussed the establishment of one or more regional seismological centers in Latin America. The resulting report to Unesco recommended as an immediate objective the establishment of a center for South America; that it be located in Peru or Brazil, subject to consultation with the respective government authorities, but bearing in mind that other countries might offer better logistic and technical facilities. It was also proposed that a high gain seismic array be installed in Brazil, linked to the Regional Center. Unesco was requested to take proper action.

In April 1964, Paris, Unesco sponsored an Inter-Governmental Conference on Seismology and Earthquake Engineering was held. The conference recommended the establishment of Regional Centers in Latin America.

At the XIIIth General Conference of Unesco, Paris, October 1964, Resolution No 2.2241 was adopted authorizing the Director General to promote and facilitate international cooperation for the study of earthquakes and measures to mitigate their effects, stipulating that support for specific projects should be limited to a maximum of five years.

The Advisory Committee on Seismology and Earthquake Engineering met in June, 1965 in Tbilisi. The Committee passed Resolution No 2 to the effect that the Regional Center for South America be supported by Unesco.

Coincident with steps being taken to create the Regional Center, the Carnegie Institution of Washington established in Lima, Peru, a temporary Seismic Analysis Center (S. Suyehiro, G. Saa and others), to analyze seismograms from Carnegie sponsored local seismic nets in Bolivia, Chile and Peru. It is relevant to mention this project, since it favored Lima as a site for the proposed Regional Center.

In February, 1965, J. H. Hodgson, president of the International Association of Seismology and Physics of the Earth's Interior (IASPEI), and E.M. Fournier d'Albe, Department of Environmental Sciences, Unesco, visited Peru and other South American countries. They reaffirmed that the Regional Center be located in Lima, and proceeded to consult the Government of Peru. The Government agreed, in principle, to support a regional seismological center located in Lima and to do so jointly with Unesco.

Considering the situation, UNESCO signed a two-and-a-half year contract with Ramon Cabre, S.J. (Bolivia) in August, 1965, as pro tem CERESIS Director, to consolidate its creation.

II. ESTABLISHMENT OF THE PERU-UNESCO REGIONAL CENTER

An editorial published by "El Comercio", Peru's foremost newspaper, on December 12, 1965, supported enthusiastically a government announcement that a regional center for seismology for South America would soon be established in Lima.

The Geophysical Institute of Peru (IGP) provided Father Cabre with an office and logistic support. An Agreement between Unesco and the Government of Peru, to establish the Regional Center for Seismology for South America, was submitted to the Government of Peru by the Director General of Unesco, Rene Maheu, on 1 February, 1966. It was signed by both parties on **9 May, 1966**. Supreme Resolution No. 260 (Ministry of Foreign Relations of Peru) of the same date, validates the Agreement, - the birthday of CERESIS.

The most significant clauses of the Agreement were:

- a) South America, for the purpose of CERESIS, is the region which includes all of the countries in continental South America and Trinidad and Tobago, but excludes British Guiana, Surinam and French Guiana. The Government of Peru agreed to inform the States of the region of the establishment of the Center and to invite them to participate in its activities and share responsibility for its scientific guidance as members of the Directive Council;
- b) The main functions of the Center were to (i) support seismological projects within the region; (ii) establish links between seismological stations and institutions of the region and these with international centers; (iii) compile, process and publish seismic data – focal parameters and intensities;
- c) UNESCO was to provide financial resources, as authorized under Resolution 2.2241 of the XIIIth General Conference and subsequent authorizations, through 31 December 1970; the Government of Peru provided suitable premises, furniture, equipment, supplies, and

qualified personnel; the member States would be invited to make voluntary contributions of funds, services and chattel.

The Ministry of Public Works of Peru fulfilled Peru's obligations; The Geophysical Institute of Peru (IGP) donated office equipment, UNESCO a portable 16-mm film copier and a radio transceiver; the United States Coast and Geodetic Survey donated 35-mm film copies of WWNSS seismograms and a micro-film reader-printer; the Carnegie Seismic Analysis Lima Center donated CERESIS a radio station, additional furniture, a copy machine and an important collection of regional seismograms; IGP provided a full-time secretary from its staff -Isabel Santillan, and the Mines Division of the Ministry of Public Works, a professional seismologist - Enrique Silgado.

By January 1968, seven countries besides Peru had indicated their intention to participate officially as member States of CERESIS: Argentina, Bolivia, Chile, Colombia, Ecuador, Trinidad-Tobago and Venezuela. Brazil, Paraguay and Uruguay requested that they be allowed to participate as "observers".

IASPEI's General Assembly, September 1969, reaffirmed its support of CERESIS' objectives and, considering CERESIS' performance since it was created, recommended that the countries in the region make sure of their continued support and thus contribute to CERESIS' stability and development.

III. CERESIS ACTIVITIES UNDER PERU-UNESCO AGREEMENT 1966 – 1970 PERIOD

FIRST MEETING OF THE CERESIS DIRECTIVE COUNCIL

Ramon Cabre, as Director of CERESIS, convened the meeting which was held in **Lima, march 23 - 25, 1968**. The delegates of the governments of the countries identified as CERESIS Member States were recognized as the CERESIS Directive Council. They were: Enrique Silgado (Peru) who presided the Council, Simon Gershanik (Argentina), Pablo Aparicio (Bolivia), Edgar Kausel (Chile), Jesús E. Ramírez, S.J. (Colombia), Hugo Davila (Ecuador) and Gunther Fiedler (Venezuela). E. M. Fournier d'Albe and Cinna Lomnitz (Unesco), F.R. de Souza (Brazil), Enrique Gajardo (Chile), Oswaldo Ramirez L. (Ecuador), Alberto Giesecke and Anibal Rodríguez (Peru), also attended the meeting as Observers.

Ramon Cabre, reported on his activities from august 1966 through march 1968:

- He visited seismological institutions throughout the region to promote CERESIS. He microfilmed historical seismograms, provided technical assistance (e.g. training of personnel at the Quito, Ecuador, station), distributed publications, technical documents, seismicity maps and a Directory of the region's seismic stations;

- Organized a meeting of south American geophysicists in Lima , under the auspices of Unesco, September 1966, to create the Andean Geophysical Program (GPA), soon after integrated to the Upper Mantle Project (six of the GPA participants were later appointed as national representatives to the CERESIS Directive Council);
- Informed the Xth General Assembly of PAIGH (Guatemala, August 1965) and the XIVth IUGG General Assembly (Zurich, September 1967) of CERESIS and of seismology in South America. In Zurich, IASPEI officially recognized CERESIS as a Regional Center;
- Participated in the inauguration ceremony for the Large Aperture Seismic Array (LASA) in Billings, Montana, USA (October 1965); Giesecke, Ramirez and Kausel also attended this event;
- Participated in the meeting of experts organized by the Organization of American States (OAS) held in Lima (November, 1967) to discuss the creation of multinational centers of excellence for graduate study in geophysics;
- Inspected the Seismic Array installed in Brasilia by the University of Edinburgh, with support from the University of Brasilia, the Geophysical Institute of Peru and CERESIS (January, 1968);
- Conducted a seminar on seismology (with Alberto Giesecke) at the National Engineering University in Lima (May, 1967);
- Organized and supervised the first regional course for personnel responsible for the operation of seismological stations. It was held in Lima (September, October 1967) with 13 students from 8 countries and 11 professors from 5 countries. This was the first of a series of eight 3-4 week comprehensive regional courses, held every two or three years, sponsored by the principal seismological institution in the host country and by CERESIS;
- Coordinated the first UNESCO-CERESIS Reconnaissance Mission to study the 17 October 1966, magnitude 7.5 (MS) earthquake, which caused considerable damage in Lima;
- Prepared and published a CERESIS Bulletin.

Cinna Lomnitz, under contract to UNESCO, assisted the CERESIS Director from October 1967 to March 1968 as a Consultant.

In view of the fact that Father Cabre could no longer continue as Director of CERESIS because of his duties at the San Calixto Observatory in La Paz, the Directive Council elected Alberto Giesecke part-time Director, ad-honorem. He was authorized to recruit a full-time Associate Director: Enrique Gajardo, Chile, was hired soon after the meeting for the period April 1968 - December

1970. Giesecke at the time was the Executive Director of the Geophysical Institute of Peru.

The terms of the bilateral Agreement Peru-UNESCO were adopted as by-laws for CERESIS. The Council adopted guidelines for voting procedures and amendments and decided to meet every two years.

The participants recommended that an official delegate from UNESCO and one from the Geophysics Commission of PAIGH be invited members of the CERESIS Directive Council, without the right to vote. The Executive Director was to be elected by the Directive Council for two-year periods.

The two year program of activities and the budget for 1968-70, were approved. Besides routine activities relevant to its basic objectives, the program considered:

- The compilation of a roster of experts in seismology, geology, neotectonics, landslides, earthquake engineering, building codes, and others, available in or outside the region, willing to participate, at a moment's notice, in post-earthquake "Reconnaissance Missions", and to donate to CERESIS their time and expertise.
- The preparation of a proposal for a regional south American seismicity project (similar to the Balkan project), to be presented to the United Nations Development Program (UNDP)

The CERESIS budget considered \$14,000 contributed by UNESCO and voluntary contributions from the members countries. \$ 7,500, were ear-marked for specific items (e.g. purchase of three portable seismographs, preparation of epicenter and seismic energy release maps for south America).

The Council asked its members, as representatives of the governments of participating countries, to urge their respective governments to make substantial voluntary contributions to CERESIS. CERESIS had to face the fact that after 31 December 1970 it had to be supported with funds generated by the Member States themselves.

SECOND MEETING OF THE CERESIS DIRECTIVE COUNCIL

The meeting was held in **St. Augustine, Trinidad Tobago, July 13 - 17, 1970** at headquarters of the Seismic Research Unit of the University of West Indies.

The Directive Council included official representatives of the seven member States - Argentina (Simon Gershanik), Bolivia (Luis Fernandez), Colombia (Rene van Hissenhoven), Chile (Edgar Kausel), Ecuador (Hugo Davila), Peru (Enrique Silgado) and Trinidad-Tobago (John Tomblin); the UNESCO delegate (E.M. Fournier d'Albe), the PAIGH delegate (James Jordan -

USGS) and Associate Director Enrique Gajardo. Selwyn Sacks (Carnegie Institution of Washington); delegates from institutions of Brazil, Guadalupe, Martinique, Trinidad-Tobago, Peru, and the United States of America attended as Observers.

The Director's report to the Council covered CERESIS activities for the report period, March 68 – June 70; it was presented by Associate Director Enrique Gajardo; Director Giesecke was unable to attend the meeting.

- CERESIS participated in discussions held at UNESCO in Paris concerning the future of the International Seismological Center and the cooperation between ISC and CERESIS. CERESIS was asked to urge South American countries to report punctually to ISC the required seismological information.
- The US Geological Survey donated to CERESIS a complete set of world-wide seismograms, on 35 mm. film, and a large Reader-Copier.
- A draft of the South America Seismicity Project proposal was revised by the Member States. The Peru May 31, 1970 catastrophic earthquake made government authorities of Peru and other Andean countries more aware of the earthquake hazard and of the importance of mitigation measures. It also made governments conscious of CERESIS. It was a window of opportunity to insist that governments contribute a more substantial yearly quota to CERESIS, and to promote the proposed South America Seismicity Project (SASP).

It was expected that the SASP proposal would soon be presented to the United Nations Development Fund (UNDP).

- Compilation and analysis of existing information to reevaluate and study Magnitudes of South American earthquakes reported during the last 40-45 years.
- Steps were taken to have on hand at CERESIS, and "ready to go", at least three transportable seismic stations for aftershock studies, to be deployed by the Reconnaissance Missions. It was recommended that the Missions include the study of secondary effects which, as was evident in the case of the large May 31, 1970 earthquake in Peru, can be even more dangerous than the main shock.
- The Carnegie Institution in Washington installed regional seismic nets. They provided 30 stations which were deployed in Argentina, Bolivia, Chile and Peru. The area for each net was about two hundred by three hundred kilometers. The instruments were to operate during a period of one year each in Argentina, Bolivia, Chile and Peru, with the cooperation of CERESIS Liaison institutions..
- Some of the Council members of CERESIS were of the opinion that since South America suffers severely from frequent destructive

earthquakes which kill and injure large numbers of persons and cause considerable damage, the Center should focus on those aspects of seismology and related disciplines that are directly pertinent to mitigation and the protection of human lives and to concentrate on producing knowledge useful for that purpose. The Council as a whole did not concur with that idea..

The \$42,000 budget through 1971, excluded the Director's salary. The following activities were executed: a) compilation of seismic data transmitted daily by radio to CERESIS and transferred to IBM cards; b) a catalog of epicenters and magnitudes for south American shocks; c) operation of the CERESIS regional radio communication net using amateur radio frequencies (communications were fairly well established between Lima and the rest of the continent - the system worked very well thanks to team spirit, specially in the case of strong regional earthquakes recorded by several stations. The institutions were equipped with visual seismic recorders, alarms, continuous monitoring of the assigned radio frequency, immediate analysis and transmission of the data to the affected country and to CERESIS headquarters. The system was able to produce reliable epicenter locations, magnitudes and other focal parameters, in less than one after the shock occurred; d) determination of seismic noise for location of new stations ; f) a special effort to standardize observatory practice; g) technical assistance in case of malfunction of equipment and spare parts; h) publication of a Latin American directory on seismology and earthquake engineering (this project was supported by UNESCO's regional office in Uruguay))

Two other important items on the agenda were 1) the "Multinational Agreement for the Prosecution of CERESIS Activities" to make CERESIS an independent regional international organization, and 2) to discuss the expected financial support of each member States. UNESCO offered to fund specific activities.

Considering that the Unesco – CERESIS Agreement would end December 31, 1970, and that Director Alberto Giesecke would not be able to work full-time at CERESIS, Enrique Gajardo was elected Director for a six month period, until CERESIS formally became an autonomous regional International Organization, (hopefully by 1 July 1971).

Peru's catastrophic earthquake, May 31 1970

At 3:23 p.m. local time on May 31, 1970, an Ms 7.8 earthquake, h 60 km, occurred 40 km off shore between Chimbote and Casma. About 60,000 people died, an avalanche from the Huascarán glacier buried the town, MM Intensity X was observed in some localities. Extensive destruction of towns and communities was the result of strong shaking and typical adobe construction throughout the area. The scars from this catastrophic event are still. CERESIS worked with and assisted the many experts who came to study the earthquake and its effects.

THIRD MEETING OF THE CERESIS DIRECTIVE COUNCIL

The Council met in **Buenos Aires, Argentina, 28 October 1970** to discuss the continuation of CERESIS.

The Upper Mantle Conference on Solid Earth Problems took place in Buenos Aires, October 26 – 31, 1970, under the auspices of several organizations and institutions. Most of the CERESIS Council members attended the Conference, so it was possible to convene a formal meeting of the Council; at the time it was still not certain that CERESIS would be able to continue after 31 December 1970.

Present were the representatives from Argentina (Simon Gershanik), Bolivia (R. Cabre, L. Fernandez), Chile (E. Kausel), Colombia (Jesus E. Ramirez S.J., C. Garavito), Ecuador (H. Davila), Peru (E. Silgado), Trinidad – Tobago (J. Tomblin), Venezuela (G. Fiedler), UNESCO (A. de Veciana), PAIGH (James Jordan), and Associate Director (E. Gajardo); and Observers from Argentina, Brazil, Chile (E. Kausel), Peru (M. Casaverde) and the United States of America (Selwyn Sacks).

The participants were informed by the Associate Director that three meetings had been held in Lima with high ranking diplomats from countries interested in CERESIS (Argentina, Bolivia, Brazil, Chile, Ecuador, Colombia, Peru, Uruguay and Venezuela). With CERESIS, they drafted a proposed Multilateral Agreement which had been sent by the government of Peru to governments of the region for opinion. It was expected that a version of the document, acceptable to four or more governments, plus Peru, would be ready by mid-April 1971. It was assuring to know the governments of South America were of the opinion that CERESIS had to continue.

The draft of the Multilateral Agreement stipulated that CERESIS would be officially created if a majority of the countries expressed their approval of the Agreement and the governments of the host country (Peru) and of at least three other countries would sign it. The goal was to create CERESIS by 1 July 1971.

The Council formally passed the following Resolution:

The Directive Council of the Regional Center for Seismology for South America (CERESIS).

CONSIDERING:

THAT the bilateral Agreement entered into by the government of Peru and UNESCO, creating the Regional Center for Seismology for South America (CERESIS) terminates on 31 December 1970;

THAT the Center is needed for the development of seismology in this part of the world;

THAT the results obtained by the Center in the advancement of seismology and earthquake studies for South America are technically most satisfactory and already the practical benefits derived from these studies have caught our attention;

THAT therefore the work done by CERESIS should continue and be intensified in the future, bearing in mind that the excellent results obtained so far could only be as a result of the existence of a multinational Regional Center, as foreseen by the Bilateral Agreement signed by the government of Peru and Unesco;

RESOLVES:

To request the Director of the Center to continue, with the cooperation of the government of Peru, to direct his best efforts to obtain at the earliest possible date, a consensus approval of a draft for a multinational agreement that will guarantee the continuity of the Center, as envisaged by the bilateral Peru – Unesco Agreement.

**IV. CERESIS AS INDEPENDENT INTERNATIONAL ORGANIZATION
1970 – 1975 PERIOD**

FOURTH MEETING OF THE CERESIS DIRECTIVE COUNCIL

The meeting took place in **Quirama, Colombia, 13–17 March 1972**, 30 years ago. This was the first meeting of the Directive Council of CERESIS, as an independent International Organization.

The CERESIS Council, with Enrique Silgado (Peru) presiding and Alberto Giesecke as Secretary, met for the first time as an independent regional "International Organization". Council members present were: Bolivia (R. Cabre), Colombia (Jesus E. Ramirez S.J.), Ecuador (J. Egred), Peru (E. Silgado), Trinidad – Tobago (J. Tomblin), Venezuela (J. Grases), Executive Director (A. Giesecke), Unesco (E.M. Fournier d'Albe), PAIGH (Reynaldo Salgueiro). Observers from OAS (A. Quesada), Brasil (J.A. Cuervo) and Colombia (Clemente Garavito, Rafael Goberna S.J.).

Before proceeding with other business, Enrique Silgado requested the Council to reconfirm Alberto Giesecke as CERESIS Director. The Council agreed. He also reminded the Council that he had served as president more than five years in accordance with the terms of the Peru-UNESCO Agreement, and that the Council should elect another member to replace him. Jesus Emilio Ramirez S.J. (Colombia) was duly elected.

The Director was asked to report on events leading to CERESIS' new status and to its recovery from the critical financial situation it faced when the Council last met in Buenos Aires in 1970. The Director reported the following for the period October 1970 through March 1972:

- In December 1970, Associate Director E. Gajardo stated that since CERESIS's future was uncertain, he would resign. Consequently Gajardo's contract and that of the auxiliary personnel on the CERESIS payroll were terminated as of 21 January 1971.
- On 31 January 1971, CERESIS had \$ 1,090 dollars in the bank, and no income in sight.
- Confronted with this critical situation, the Government of Peru, UNESCO and the CERESIS' Director, adopted and implemented the following emergency measures:
 - a) UNESCO and the Government of Peru amended the Bilateral Agreement, extending its duration six months, - through 30 June 1971.
 - b) The Government of Peru granted A. Giesecke leave of absence, with pay, from his post as Director General of the Geophysical Institute of Peru (IGP), so he could serve as full-time CERESIS Director, if the CERESIS Council accepted, for such a time as the financial situation of CERESIS improved.
 - c) E. Silgado, a professional seismologist with the Geological Institute of Peru, was transferred on loan to CERESIS; Isabel Santillan, an IGP administrative secretary was transferred on loan to CERESIS.
 - d) The government of Peru granted CERESIS \$ 6,850 for general expenses; UNESCO approved a grant of \$ 6,000 for CERESIS to carry out its activities.

These actions helped CERESIS overcome its immediate financial difficulties.

- e) The Ambassadors to Peru from Bolivia, Colombia, Uruguay and Venezuela and the Minister of Foreign Affairs of Peru, representing their respective governments, signed the **Multinational Agreement for the Continuation of the Activities of the Regional Center for Seismology for South America (CERESIS)**, on June 18, 1971. The Agreement went into effect on July 1, 1971.

Enrique Silgado noted that since July 1, three other countries had signed the Multilateral Agreement - Argentina, Ecuador and Trinidad Tobago. Chile was expected to sign in the near future; the total would be 9 countries. Only Brazil and Paraguay were left.

Significant clauses of the **Multinational Agreement**:

- a) The countries considered (for seismological purposes) as South America are Argentina, Bolivia, Brazil, Colombia, Chile, Ecuador, Guyana, Paraguay, Peru, Surinam, Trinidad -Tobago, Uruguay and Venezuela. They become member States of CERESIS when they sign the Multinational Agreement and accept the CERESIS Statutes. [Note: As of this date (Yr. 2002), CERESIS is constituted by 12 member States: 11 South American countries (all except Surinam and Guyana) and Spain. Any country outside of the region can become a Member State if it has a legitimate interest in south American seismology, its petition is accepted by the Council's unanimous vote, and it signs the Multinational Agreement.]
 - b) Each member State, unless its Constitution does not so require it, is expected to ratify the Multinational Agreement as is the case with any international Treaty. The annual quota to CERESIS is then considered a part of the country's external debt. All Member States are obliged to pay an annual quota.
 - c) CERESIS is recognized by the governments of member States as an International Organization and is granted diplomatic privileges and immunities.
 - d) The highest authority of CERESIS is the Directive Council. Council members are the national representatives (preferably earth scientists or earthquake engineers) of governments of the member States. Non-voting Council members are: the UNESCO representative, the PAIGH Geophysics Commission representative and the Executive Director.
 - e) Each member State must designate a CERESIS National Liaison Institution.
- On August 1971, a Unesco evaluation mission visited CERESIS and other Centers established by UNESCO in Latin America and the Caribbean. The mission's report on CERESIS corresponds to Chapter XI, pp 151-160 of the publication entitled in Spanish "Integracion Regional de America Latina en las Esferas de Competencia de la Unesco" – Unesco/Minelsa/4, Paris, 15 Octubre de 1971. The mission's main conclusion was "given the nature of its programs and tasks, this Center is a clear example of an organism with possibilities of cooperative action propitiating regional integration. It is recommended therefore that the material contributions (to CERESIS) be increased and that Latin American professionals of the highest level be incorporated". It approved the financial statement specially prepared for the Mission.
 - In April 1971, the organization of American States organized in Lima a meeting of the Andean countries to discuss research in geophysics, geology and earthquake engineering; CERESIS co-sponsored the event.

- At its meeting in Washington, 1971, the Directive Council of PAIGH, granted CERESIS \$ 6,000 dollars, for FY 1971 - 72, as a contribution to its budget.
- The CERESIS Director, as a member of the Scientific Committee for Oceanographic Research (SCOR) attended a meeting in Honolulu in September 1971. On the return trip he visited St. Augustine (Trinidad-Tobago); Caracas (Venezuela); Bogotá (Colombia); and Quito (Ecuador), to consolidate the participation of those countries in CERESIS.
- CERESIS and IGP accepted the responsibilities of a Local Organizing Committee for the 1973 IASPEI General Assembly, to be held in Lima.
- CERESIS provided the University of Chile, at its request, two portable stations and operators to observe aftershock activity during a three-month period, after the 9 July 1971 earthquake off the coast of Chile, opposite Valparaiso. At UNESCO's suggestion, CERESIS undertook the study of the focal mechanism of the main event and of the largest aftershock..
- Ecuador requested technical assistance to determine the location of a new seismological station in Guayaquil and the relocation of the Quito Station to Cuenca.

Publications relevant to observatory practice were widely distributed. E. Silgado prepared the Seismological History of Peru for the period 1513 – 1970 and a map of seismic energy liberated during the period 1960-1970; Ruth B. Simon's book "Earthquake Interpretation" was translated to Spanish as well as NOAA's booklet "Earthquakes"

A. Giesecke and L. Ocola published an article on nuclear tests in the Pacific Ocean; Peru's military government stated that the Mururoa Atoll Nuclear Tests in the Pacific were the cause of earthquakes affecting Peru, including the catastrophic 31 May 1970 event. CERESIS published an article in the press asserting that small nuclear bombs, exploded on top of towers, at a distance of several thousand kilometers, could not possibly be the cause of earthquakes in Peru.

- The radio communications net operated efficiently; the CERESIS stations were located in the Director's office and his home in Lima. The same was the case in San Juan, La Paz, Brasilia, Bogotá, Pasto (Colombia), Santiago, Galapagos and Quito, Washington D.C., and Saint Augustine. Routine daily contacts were made on the 20m and 15m "amateur radio" bands. Isabel Santillan operated the station in Lima. Data for hundreds of events were received by radio and transferred to IBM cards.
- CERESIS cooperated with the Carnegie Institution of Washington in a project setting off 1-2 ton. explosions at a depth of one thousand meters

off the coast of Peru. Similar tests were carried out in Brazil with 2–5 ton explosions.

- CERESIS was specially invited to give a talk on its activities at the 25th anniversary celebration of the InterAmerican Geodetic Survey (IAGS) in April 1971, in Panama

FIFTH MEETING OF THE CERESIS DIRECTIVE COUNCIL

The Council met on **July 9-17, 1975, in San Pedro, Costa Rica**, at the Escuela Centroamericana de Geologia on the campus of the University of Costa Rica. Council member present were: Jesus Emilio Ramirez, President (Colombia), Simon Gershanik (Argentina), Ramon Cabre (Bolivia, Jose Egred (Ecuador), Enrique Silgado (Peru), John Tomblin (Trinidad and Tobago), Aldo Brussoni (Uruguay), Günther Fiedler (Venezuela), E.M.Fournier d'Albe (UNESCO), Edgar Kausel (PAIGH), Alberto Giesecke (Executive Director), Luis Fernandez (Associate Director).

More than 20 Observers were accredited including official delegates from Brazil and Chile.

The dates for the meeting were such CERESIS Council members and observers were able to participate actively in the OAS sponsored Seminar on Seismic and Volcanic Risks held on July 14-17 on the same University campus and to visit the still active El Arenal Volcano over the week-end. It also offered the opportunity for informal CERESIS meetings with Central American colleagues.

After the Fourth meeting in Colombia (1972) the Directive Council met informally in Lima on two occasions: in August 1973, during the XVIIth General Assembly of IASPEI and September 1974, during the Seminar on Methodologies for the Evaluation of Seismic Risk. Members of the Directive Council also met with each other at meetings in Bologna–Italy, September 1973; Honolulu-Hawaii December 1974; San Juan- Argentina, April 1975; and Caracas-Venezuela, May 1976. These frequent contacts, at no cost, helped Council members keep in touch with CERESIS activities.

Dr. Luis Fernandez, a well regarded seismologist in South America, formerly at San Calixto in La Paz and at the time a member of the Geological Survey of the Republic of South Africa, joined the CERESIS staff on March 1975 at no cost to CERESIS. This was a good will gesture to South America on the part of South Africa. Dr. Fernandez was appointed CERESIS Associate Director for a 9-month period through November 1975; he had no difficulty understanding the purpose and workings of CERESIS and from the beginning was a valuable asset to CERESIS.

Council members reported on activities in their respective countries. Most of the national reports are on file at the CERESIS Lima office. The Increase of

activity in seismology and earthquake engineering, over the years, both in scope and degree of sophistication, is noteworthy; to a large extent due to CERESIS.

The Director reported on progress since the Quirama, Colombia meeting, i.e. from march 1972 through July 1975. At Quirama the Council had discussed in detail a Regional Project to be submitted to UNDP (\$ 958,000 dollars) for funding. Notwithstanding UNESCO's backing, and expert advice from Cinna Lomnitz and Robin McGuire, the project was not considered by UNDP. Other projects and activities;

- **Project SISAN and PRO - SISAN**

The Organization of American States, OAS, sponsored an Andean Seismicity Project for Bolivia, Colombia, Ecuador and Peru, identified as Project SISAN. CERESIS accepted was responsibility for the coordination and management of the project.

SISAN (Sismicidad Andina). The 3-4 year project involved Bolivia, Colombia, Ecuador and Peru. A broad objective: to relate seismicity studies with national development plans. The project was to produce preliminary seismotectonic maps, seismic risk maps, preliminary maps of hypocenters and earthquake catalogs for each country. Three portable seismographs were bought and kept at CERESIS for aftershock observations, computer programs and a vehicle for field work for each country. Besides the important results expected, the experience gained from this project would be useful for future multinational projects sponsored by CERESIS.

PRO-SISAN. The OAS requested CERESIS to put together a project entitled "Proteccion Sismica de Ciudades Latino- Americanas", that would make use of the data obtained by SISAN. The project was to identify and evaluate the seismic variables that are relevant to earthquake engineering., to promote the acquisition and installation of accelerographs and data interpretation centers, investigate the dynamic response of structures, the soil-structure inter-reaction and to facilitate permanent exchange of knowledge.

- Working Groups were established for both projects at Costa Rica, during the 5th CERESIS Council,

- **UNESCO Support**

Contracts with UNESCO to support activities carried out during the period February 1971- September 1975, generated counterpart funds from participating institutions and motivated the execution of new projects relevant to the objectives of CERESIS, sponsored and financed by OAS, PAIGH and other agencies, and involved CERESIS. Pertinent reports to UNESCO are on file at CERESIS and also at UNESCO. The activities were reported to the Council at Quirama. The following is a summary:

- Compilation on microfilm of historical seismograms on file at institutions in the region. CERESIS visited those institutions and copied original seismograms on micro-film; reinterpretation of records to attempt to determine a Magnitude for each important event (with additional PAIGH support);
- Project Nariño - A multinational project coordinated by the Instituto Geofísico de los Andes Colombianos in Bogota. Seismic Refraction observations to investigate the submarine plate, measure the crustal thickness, study its structure and the tectonics of the Pasco "knot" (Nudo de Pasco). Forty professionals and technicians from CERESIS countries participated actively in the project; some of them received travel grants. CERESIS helped organize the project, sponsored IGP's participation by providing logistic and financial support.. A copy of the project report is available at CERESIS.
- Seismic microzonation of Guayaquil, Ecuador, using the Kanai method; two members of CERESIS attended the Conference on Microzonation at Seattle, October 1972.
- CERESIS Mission to Central Chile after the 9 July 1970 event worked with the University of Chile. 500 significant aftershocks were observed during four months, the focal mechanism was determined, a 60 km dip-slip fault off-shore was located and a correlation of energy liberated vs. degree of damage was found. The Mission reported to UNESCO in march 1972.
- CERESIS Reconnaissance Mission to evaluate damage caused by the 23 December 1972 Managua earthquake. In the central part of the city MM IX-X Intensities - serious damage; rapid attenuation; moderate damage in outskirts. The Mission's report was UNESCO's sole reliable reference for several days.
- **Publications distributed to CERESIS Member States:**
 - Earthquake resistant construction, A. Oshiro
 - Managua Antisísmica, Gabriel Estrada Uribe
 - Poster on Temblores de Tierra, J.E.Ramírez
 - Booklet: Precautions in schools against earthquakes
 - Latin-America Directory for Seismology and Earthquake Engineering
- **CERESIS and IGP - local organizers of IASPEI's XVIIth General Assembly**, in Lima, 20-31 August 1973 (400 participants).

The dates coincided with the mid-term vacation period at the Catholic University of Peru. Hence CERESIS was able to utilize universities facilities at no cost: - Auditorium, small and large meeting rooms, offices,

three campus restaurants, transportation, communications and auxiliary personnel (students), closed circuit TV to rooms where students and the public could "attend" the sessions. The discussions most publicized were those on Plate Tectonics and Continental Drift.

- 46 Latin Americans from 13 countries, 24 Peruvians, and 3 from Spain, Met invited by CERESIS to consider the creation of the Ibero American Geophysical Society, with a Secretariat in Spain. The CERESIS Director was elected Honorary President.
- CERESIS organized an Assembly symposium on regional seismicity in South America emphasizing determination of focal parameters, intensity scales, magnitude, local magnitude, magnitude-intensity and frequency-magnitude relations, the seismotectonic regime, focal mechanisms and earthquake engineering. Of particular interest were the problems of magnitude. It was recommended that a IASPEI Working Group be formed to study the physical basis for the concept of magnitude. As a result of this initiative a seminar on magnitude scales was to be held in Grenoble, France.

Dr. S. J. Duda was invited by CERESIS for a period of 4 months to study systematically the problem of magnitudes in South America. CERESIS obtained existing seismograms for 4 selected events. In order to assign one value of magnitude for a given event it will be necessary to adjust calibration curves to attain homogeneous response. The magnitude determinations differ up to one unit between different stations, according to the type of instrument which recorded the event. This is a very important problem for the region because of peculiar wave propagation characteristics.

In February 1974 a major rockslide dammed the Mantaro river in the Central Andes of Peru, forming a lake 40 km long and 400 meters deep. The Civil Defense Organization of Peru requested CERESIS to recommend the equipment needed to monitor the area.

- a) CERESIS organized a Multinational Seminar on Methodologies for Evaluation of Seismic Risk. It was held in Lima on 2-6 September, 1974, with the participation of seismologists and earthquake engineers of CERESIS countries. Six Conferences by Dr. S.T. Algermissen and one each by participants from Argentina Bolivia, Colombia, Chile, Ecuador, Peru and Venezuela, were offered to professionals, students and the public in general. Minutes of the Meeting are available from CERESIS.
- b) The Ms 7.6 October 3, 1974 Lima earthquake produced ground accelerations over 0.10 gal, during more than 80 seconds. Low frequency shaking caused what appeared to be minor damage to buildings but careful inspection pointed to significant structural damage in many multiple story buildings, costly to repair. It was a temptation to use "seismic" paint to cover up "cracks" rather than spending money for honest repair. CERESIS cooperated with City

authorities to reduce this malpractice to a minimum. Several accelerographs deployed in different parts of the city guided by the damage pattern; "fortunately" a strong Ms 7.2 aftershock occurred on 9 November. The records obtained, interpreted by CERESIS, provided city Authorities with a reliable reference for a zoning map.

- c) The fifth meeting of the working group on Tsunamis in the Pacific was scheduled to take place in Lima in February 1976. The Intergovernmental Oceanographic Commission asked CERESIS to organize the meeting.
- d) The President of the CERESIS Directive Committee and the Executive Director were invited to give a talk at a meeting on International Cooperation on Marine Sciences, at the University of Bologna – Italy, in September 1973. CERESIS was considered a good example of international cooperation.
- e) USGS–CERESIS sub-Regional Center. The Center was established for the purpose of supplying spare parts, recording paper, and special equipment to the WWNSS South American stations. USGS provided these items to CERESIS. The reasons: Lima was a hub in South America for most of the airlines; CERESIS was in radio contact with the institutions with WWNSS stations, CERESIS engineers and technicians (from Argentina and Peru) had been trained in Albuquerque. CERESIS was able to provide materials and emergency maintenance to WWNSS stations faster than Albuquerque.
- f) The Instituto de Investigaciones Antisismicas, of the National University at San Juan, Argentina, donated CERESIS two seismoscopes built by the University; 70 seismoscopes had been deployed in Argentina.
- g) South American Seismicity and Associated Risks at Quirama, the Proposed project, focused on the northern Andes: Colombia, Ecuador, Peru, Trinidad and Venezuela. However the Council decided at the time that CERESIS should organize small sub-regional meetings to discuss the proposed project in detail. These were held in San Juan (Argentina), Santiago, Bogotá, Caracas and Mexico. One such sub-regional meeting had already taken place, in San Juan, May 1975. Dr. Fernandez, Associate Director, attended these meetings. In San Juan, he met with seismologists and earthquake engineers from Argentina, Bolivia and Chile. He noted that numerous seismicity studies had been carried out in each country, using different methodologies and data from different sources, so results differ. With modern methods and better data it is possible to improve significantly the estimation of seismicity and seismic risk for most of the regions of South America and obtain uniform results; the countries have good institutions and capable investigators; they guarantee the success of regional programs in the future. What is

needed is somebody to coordinate local capabilities with those of neighboring countries, the implementation of higher density and uniform seismic nets to facilitate data exchange across borders; advice from experts to introduce and make use of the most appropriate and efficient existing methods to define seismicity in a language readily understood by scientists, engineers, planners, political authorities and the public in general.

Funds for the three sub-regional meetings were provided by UNESCO and the host country. Although south American seismicity is largely a subduction problem along the Pacific and Caribbean coasts, there are many continental areas with a high level of seismicity, evidently from other causes. The problem is not simple.

SIXTH MEETING OF THE CERESIS DIRECTIVE COUNCIL

The Council met in **Caracas, Venezuela on November 24 - 25, 1977**, at the Observatorio Cagigal of the Navigation and Hydrographic Office of the Navy. Council members present were: Simon Gershanik, President, National members: Juan Carlos Castano (Argentina), Ramon Cabre (Bolivia), Jesus Emilio Ramirez (Colombia), Jose Egred (Ecuador), Enrique Silgado (Peru), Günther Fiedler (Venezuela); Luis Fernandez (Associate Director Secretary). Executive Director Alberto Giesecke was unable to attend. Also present were observers from Spain (Julio Mezcuca), Panama (Bert Shelton), Venezuela (Luis Urbina and Jose Grases), Peru (L. Ocola) and USA (Gilbert Mead, chief of the NASA's Geophysics Section)

Shortly after Prof. Gershanik opened the meeting, the Council learned that a destructive earthquake had occurred the night before, in the Province of San Juan, Argentina. The Cagigal Observatory recorded an event of M7, about 5000 km south of Caracas. There was no telephone communication with San Juan because of the earthquake; via the Venezuelan Navy's radio facilities and the CERESIS radio system, communications were established with INPRES (Instituto Nacional de Prevision Sismica) at San Juan. Juan C. Castano, Director of INPRES, representing Argentina on the CERESIS Council, was able to talk with his people and coordinate immediate actions. 25 years before, in 1952, an MS 7.0 shock practically destroyed the city of San Juan; hundreds were killed or badly injured. San Juan was rebuilt with strict observance of the new building code. The 23 November 1977 earthquake was a unique test of the value of enforcing an adequate building code. There were a few victims and no serious damage except to housing that had not been retrofitted after the 1952 shock. The event was a shallow shock, h=30 km followed by at least 250 aftershocks with magnitude M >4.5.

The meeting continued with the Director's report for the period 1975-1977, as follows:

- A proposed continental telemetric seismic net, with support from NASA, USGS, and CERESIS, was discussed at workshops held in Argentina, Chile, Peru and at NASA headquarters. The preliminary design envisaged 10 to 20 stations, use of the GOES satellite to relay data from the stations to a central receiving site at the Ancon, Peru satellite tracking station, run by IGP. Data Collection Platforms would be installed at the seismological stations. Preliminary tests with the GOES satellite were successful. The Council suggested as one goal for the project, to locate earthquakes which occur in the south American countries and off shore events up to 500 km from the Pacific coast, in three dimensions with an accuracy of 10 Kms. or less; events with M 4.0 or larger, to be located 6 hours or less after their occurrence. Further discussion was needed on the minimum magnitude of the event to be detected, the geographic area of greatest interest, the duration of the transmitted signal, etc. The initial budget was estimated at \$30,000 dollars. Dr. Mead participated in these discussions.
- Radio communication between CERESIS institutions was satisfactory although 1976 and 1977 corresponded to the minimum of the sun-spot cycle, which affected normal propagation of radio waves.
- Travel grants were authorized for seismologists, earthquakes engineers and others, to attend relevant events, such as the XVIth General Assembly of IUGG, the ISC Council, the UNESCO Intergovernmental Conference on "Evaluation and Reduction of Seismic Risk" in Paris (CERESIS proposed that it be incorporated as a member of the UNESCO and UNDRO Consultative Committee on Seismic Risk); the IUGG Tsunami Symposium in Mexico, a Meeting on Seismic Security in Lima and a Symposium, also in Lima, on the 1970 Peru earthquake. CERESIS was represented by L. Ocola at the 4th session of the ad-hoc Group of Experts at the U. N. Disarmament Conference in Geneva . (This first contact developed in later years to active participation in Disarmament activities.)
- At the request of the Universidad Federal do Norte in Brazil, Jesus Berrocal and Norberto Puebla visited the WWSSN station at Natal to calibrate the station; Norberto Puebla also visited the three WWSSN stations in Chile. In Uruguay he discussed the establishment of a seismic station. A CERESIS Mission visited Panama at the request of the University of Panama to discuss the construction of a new station to replace Balboa Heights (BHP). CERESIS made tests of site, advised on the design for the station and the instruments. The Instituto de Geociencias was created on the University of Panama campus.
- Several accelerographs were obtained from the USGS, on loan to the Instituto Nacional de Prevision Sismica at San Juan Argentina.
- CERESIS cooperated with the coordination and administration of the seismic refraction program in southern Peru. The institutions that participated were the Carnegie Institution of Washington, the Universities

of Washington (Seattle), Wisconsin, Texas (Dallas), Berlin, Tokyo, and the Universidad del Norte (Chile); the Instituto Geofísico del Perú; and the Observatorio San Calixto at La Paz.

- Two other missions were organized during this period. One to Ecuador to study abnormal seismic activity generated by the Cotopaxi Volcano, near Quito, and the Reconnaissance Mission to Guatemala after the 4 February 1976, earthquake. The CERESIS mission was coordinated by Gunther Fiedler, with Yolanda Molina (Venezuela), J.C. Castano, and J. L. Zamarbide, (Argentina). - The reports of these missions are available at CERESIS.
- A number of publications were distributed to the member States, many of the CERESIS translations of English language publications. Of particular interest was the Directory of Seismological Stations in Latin America and the Caribbean. The Directory includes name of the station, location, geographic coordinates, geology of the site, date when it began operating, description of the instruments and the dates they operated, type of records (smoked paper, photographic paper, magnetic tape, etc.); characteristics of the seismometers (period, damping, etc.); and information on the institution responsible for safe-keeping of the records,
- Project Sisan ended; publication of maps and catalogs was pending.
- Promissory contacts were made with the U.S. Agency for International Development and the Office of Foreign Disaster Assistance (OFDA), to discuss financial support for an Andean Seismicity Project.
- The fifth reunion of the International Coordination Group for the Tsunami Alert System in the Pacific took place in Lima, February 1976.
- The 3 October 1974 earthquake which affected Lima and many places along the coast south of Lima, and its unusual aftershock sequence, interested Bryan Brady (U.S. Bureau of Mines) in relation to a deterministic prediction of a large earthquake to occur in the near future. CERESIS was consulted by the National Research Council of Peru.
- The Federal Republic of Germany expressed its interest in supporting Dr. Duda's 1973 research on magnitudes. CERESIS formally requested this cooperation.
- It was decided that a 5th Course for Seismic Station personnel be scheduled for 1978, in Panama

Enrique Silgado commented that the lack of knowledge about the great earthquakes which occurred during the XVIth, XVIIth, XVIIIth and IXth centuries in South America could be offset by researching the Archivo de Indias in Sevilla, Spain. This tedious work takes time, patience and is needed to know how to interpret the abundant documents with descriptive texts of catastrophic events and extract relevant information which might be converted to focal parameters

(duration, area of perception, damage,...). He requested the Council to consider this comment for a future project.

Prof. Gershanik informed the Council that the following actions had already been taken with regard to the San Juan earthquake:

- UNESCO had been contacted and funds for a CERESIS Mission approved; candidates for the Mission had been contacted;
- FUNVISIS (Fundacion Venezolana para la Investigación Sísmologica, the recently created Venezuelan Institution to take over from the Navy) volunteered the services of an earthquake engineer and an expert in soil mechanics;
- Spain (Julio Mezcua) offered to provide 5 portable seismographs and three accelerographs, to be sent in two days;
- Chile (Alfredo Eisenberg) would also be sending field equipment.

The Mission was to document the response of the structures built after the 1952 earthquake.

1. EXTRAORDINARY MEETING OF THE CERESIS DIRECTIVE COUNCIL AND CERESIS AWARD

The CERESIS Council held an Extraordinary Meeting in **Canton, China, on September 1 - 3, 1979**. The meeting took place during the visit to China invited by the State Seismological Bureau (SSB), through 19 August through September 5 1979. On this occasion the Director of SSB was presented its first **CERESIS Award**, to the SSB of China. This award was created to honor institutions or persons who had made outstanding contributions for the advancement of seismology in South America or as in the case of China, for a contribution that would lead to the saving of lives world-wide such as a reliable prediction.

SEVENTH MEETING OF THE CERESIS DIRECTIVE COUNCIL

The Council met in **San Juan, Argentina on November 16 - 18, 1980**, hosted by INPRES (Instituto Nacional de Prevision Sismica), the CERESIS Liaison Institution with Argentina.

Council members present were: Günther Fiedler (Venezuela - President), Juan Carlos Castano (Argentina), Ramon Cabre (Bolivia), Rafael Goberna, S.J. (Colombia), Enrique Silgado (Peru), Adhemar Pigni (Uruguay), PAIGH (Edgar Kausel), Alberto Giesecke (Executive Director), Luis Fernandez (Associate Director) and Observers Julio S. Aguirre (Argentina), Daniel Huaco,

Leonidas Ocola (Peru), Alfonso Lopez Arroyo (Spain), David Smith, Lynn Wigbels (USA-NASA), Javier Aparicio (Venezuela-Guyana Corp.)

The Council meeting was immediately followed by the International Seminar on Earthquake Prediction and Evaluation of Seismic Risk, also held at INPRES, on October 20-25.

The Director's report covers the period November, 1977 - September, 1980. In the interim the Council held an extraordinary meeting in Canton, China in 1979. Principal activities:

- **Modification of CERESIS Statutes**

The wording of the original CERESIS Statutes, when translated to portuguese, did not explicitly state that being a Member State of CERESIS did not in anyway hinder implementation of seismological regional activities carried out by one or more countries on their own initiative, without any participation of CERESIS as such. Therefore it was necessary to reword the pertinent articles. At the same time the Statutes were edited to improve the language in general.

- **Publications produced:**

- Manual of Seismological Observatory Practice, Willmore & Karnik (in spanish), Post-Earthquake Reconnaissance Mission reports:
Lima, Peru - 3 October 1974, A. Giesecke et al;
Guatemala - 4 February 1976, G. Fiedler et al
- The Assessment and Mitigation of Earthquake Risk, UNESCO (in spanish)
- "Historia de los Sismos mas Notables Ocurridos en Peru", 1513-1974, E. Silgado
- Earthquake Interpretations, Ruth Simon (in spanish)
- Fundamental Principles for the Interpretation of Seismograms, F. Neumann
- Recurrence of Tsunamis in the Western Coast of South America, E.Silgado
- Catalog of Tsunamis in South America, E.Silgado

- **Pending approval:**

- Earthquake Reconnaissance Mission. San Juan (Caucete), Argentina, 23 November 1977, J.C.Castano et al
- Directory of Seismological Stations in Latin America and Caribbean
CERESIS Visit to China

- **Fifth Course for Seismological Station Operators.**

The Course was held in Panama in Ft, Clayton, July 5-27. PAIGH and the Inter-American Geodetic Survey were co-sponsors. 29 station operators participated, of which 20 were from Central America and

Caribbean countries. The instructors were Günther Fiedler, Norberto Puebla (INPRES), Lautaro Ponce (Mexico), Daniel Huaco (Peru), Bert Shelton (Panama), David Harlow, Charles Knudson (USGS) and Luis Fernandez (Associate director).

- **Reconnaissance Missions.**

CERESIS organized (1) A mission to Arequipa Peru which was severely shaken by the 16 February 1979. The goal was to evaluate structural damage and correlate structural parameters, age, location, quality of materials and design with seismological, geological, and soil parameters; (2) The 23 November 1979 (Manizales Colombia) earthquake, which was organized by The Instituto Geofisico de los Andes Colombianos; and (3) the UNESCO financed mission to study the Tumaco, Colombia earthquake of 12 December 1979.

- **Historical Seismicity at "Archivo General de Indias" in Seville.**

Enrique Silgado spent nearly 11 month in Sevilla with support from UNESCO and the Centro Ibero-Americano de Cooperacion, studying documents of the XVIth to XIXth centuries. Silgado spent the next several months at CERESIS analyzing the information.

- **Project SISRA - Earthquake Mitigation Program in the Andean Region.**

For several years CERESIS had written proposals for the study of seismicity and seismic risk in the Andean region. The efforts to obtain financial support from the United Nations (UNDP) were not successful. However, discussions with the Agency for International Development of the U.S. State Department (USAID), were encouraging. A meeting was held at UNESCO's Paris office in September with officers of the US Geological Survey, the Office of Foreign Disaster Assistance (OFDA), and UNESCO (E.M. Fournier d'Albe). The US Geological Survey would be the Executing Agency. The initial amount of funds from OFDA/AID would be \$500,000 and possibly additional funds. Dr. S. T. Algermissen of the USGS was recognized as the Project Coordinator and would prepare a final draft proposal with CERESIS. OFDA / AID in September 1980 approved the proposal.

- **Visit To China**

Discussions that began early 1978 with Government officials of the Popular Republic of China, resulted in an agreement for (1) a visit to China by the CERESIS Director in January 1979, to discuss details of a visit by a CERESIS delegation to China for three weeks. On February 5 1979, the vice-Director of the State Seismological Bureau (SSB), Dr. Wei T. Ching, and Alberto Giesecke formally agreed that SSB would host the visit of ten CERESIS seismologists and underwrite all local costs during three weeks in China plus airfare Paris - Beijing and return. The visit of

the CERESIS delegation took place from 19 August through September 5 1979. It visited many localities and institutions throughout China including Haicheng, the place for which an accurate prediction by SSB saved the lives of 300,000 to 400,000 people. The 7.3 Ms. Earthquake occurred on February 4, 1975 devastating a very large area (intensity MM IX) in the vicinity of Haicheng. CERESIS and SSB agreed to cooperate in the future, particularly in the area of prediction and participation of the population in volunteering all the information that could be considered as a possible earthquake precursor.

- **Meetings and Seminars:**

- Application of Space Technology to Seismic Processes and Geodynamics in South America. The Seminar was held on 9-11, August 1978 in Lima at the Instituto Geografico Militar, under the auspices of NASA, CERESIS, and PAIGH. The discussions were relevant to research on the processes which originate earthquakes, the relevance with geodesy and the production of maps.
- Urban Seismic Microzonation Seminar held, 23-27 October in Lima, organized by CERESIS, sponsored by the Organization of American States (OAS) and IGP. Approximately 150 persons from 15 countries participated.
- International Seminar on Earthquake Prediction and Evaluation of Seismic Risk, organized by UNESCO and held in Paris 9 -12, April 1979. A similar regional meeting for South America was proposed by CERESIS; UNESCO, UNDRO, and PNUMA, seconded the proposal.

- **The Brady Prediction**

In 1976, Bryan T. Brady published in Pure and Applied Geophysics an article on the theory of earthquakes and mentioned the possibility of a large earthquake along the western coast of South America from Lima to the south. In 1977 CERESIS asked the USGS to invite Brady to explain his forecast (prediction) in Boulder CO. Again in May 1979, the USGS convoked a meeting in Golden CO; present were Peruvian Embassy officials, USGS seismologists, representatives of OFDA/AID, Carnegie Institution and CERESIS. The prediction was of particular interest because it was made by a reputable scientist of the US Bureau of Mines, it affected a foreign country and the magnitude of the event would be compatible with an off shore rupture about 1700 km long, from 12° to 27° Lat. S, causing severe damage to Lima and to many cities and towns along and near the coast of southern Peru and northern Chile. It was important to confront the prediction, to avoid public panic and unnecessary losses. It was arranged by CERESIS for Bryan Brady and his colleague William Spence to present their theory at the International Seminar on Earthquake Prediction to be held in San Juan.

- **International Seminar on Earthquake Prediction**

The organizing committee members for the Seminar were Ramon Cabre, (chairman), J.C.Castano (secretary), John Filson (USGS), Stephan Mueller (Zurich), Lautaro Ponce (Mexico), Alberto Giesecke and Enrique Silgado (Ceresis). The committee met on several occasions. The meeting would be held 20 - 25 October, immediately after the VIIIth CERESIS Council Meeting, also at INPRES. The scientific secretariat for the seminar was set up under J.C. Castano in San Juan. About 100 participants from South America, other Latin American countries, the United States, China and ten European countries..

- **USGS Centennial**

The CERESIS Director was invited to present a paper on Seismic Hazard and Mitigation in the Andean Region at the International Centennial Symposium of the US Geological Survey on 14 - 19, October 1979.

- **The USGS CERESIS Sub regional Center**

The contract with the USGS for October 1977- September 1978 was extended through September 1979.

- **UNESCO International Consultative Committee on Seismic Risk**

The Committee held it's third meeting in April 1980 at UNDRO's office in Geneva. Of importance to CERESIS was the fact that UNDRO, UNESCO and UNEP confirmed their decision to fund the CERESIS International Seminar on Earthquake Prediction in San Juan.

- **UNDRO Technical Advisory Group**

In august 1979 the CERESIS Director was invited to be one of the five members of UNDRO's Technical Advisory Group, under the UN Under-Secretary General for natural disasters. Minutes of UNDRO meetings are available from CERESIS.

- **Educational Pilot Project - Ministry of Education Peru**

This project was financed by UNESCO for CERESIS to develop material for insertion of earthquakes and other natural disasters in the school curricula. CERESIS collected relevant material from CERESIS member States which had progressed in this matter. Organized working groups with teachers, parents, and students took place to develop courses to be tested beginning July 1981.

EIGHTH MEETING OF THE CERESIS DIRECTIVE COUNCIL

This meeting took place in **Quito, Ecuador on June 20 – 24, 1983**, hosted by Escuela Politecnica Nacional de Quito, the CERESIS Liaison Institution for Ecuador.

Council members present were: Ramon Cabre (Bolivia- President), Luis Urbina (Venezuela) , Juan Carlos Castano (Argentina), Rafael Goberna, S.J. (Colombia), Roberto Arellano (Ecuador), Enrique Silgado (Peru), Alberto Benavides (Uruguay), Edgar Kausel (Chile), Fernando Repeto (UNESCO), Minard Hall (PAIGH) Alberto Giesecke (Executive Director), Luis Fernandez (Associate Director), and Observers Alejandro Segovia, Hugo Yepes, Edgar Proaño and Fernando Robalino (Ecuador); Julio S. Aguirre (Argentina); S.T. Algermissen, (USGS - SISRA Project); Jose Egred, Leonidas Ocola and Gunther Fidler (SISRA). The director's report covered the period from October 1980 to may 1983.

Alberto Giesecke who was on loan from IGP, retired from government work service in may 1981, after 43 years of service. As of that date he was hired by CERESIS for full time work; Luis Fernandez, associate director returned to his post in south Africa in June 1981.

- International Seminar on Earthquake Prediction

As planned, the Seminar took place on 20 - 25 October 1980 at INPRES. The Seminar was very successful. Six morning sessions and five afternoon sessions were devoted to the presentation of papers related to seismic predictions, case histories, on going prediction situations for south America, and on public response to earthquake prediction. There was a great deal on interest from the media and the public in general. Several papers touched on prediction techniques available for the detection and identification of precursory phenomena to disastrous earthquakes. Surface deformation of the crust was rated as a most important parameter involving measurements of various kinds; it was emphasized that the data must be properly understood for correct interpretation. Presentations were made on space techniques applied to geodesy. Joint projects with NASA were of interest to several countries. The space time distribution is essential to long, medium and short term predictions; other relevant parameters are the identification of true gaps, active and quiescent periods are very relevant. It was noted that the present configuration of seismic stations on south America is not adequate for events of magnitude <4-5. Their precise location for a period of about 30 years would make it possible to analyze with confidence the seismicity and to identify patterns .

Papers from the Chinese delegation on the Haicheng earthquakes brought out the relevance of other precursory phenomena such as changes in the magnetic field, earth currents, atmosphere potential and anomalous animal behavior. It was emphasized that only a

multidisciplinary approach could lead to success. Certainly the various phenomena are not yet fully understood, and there is need for a physically well founded theory of prediction. It was concluded that only in a very exceptional case would it be possible to issue a prediction with a high degree of confidence.

One paper (Brady and Spence), described the prediction of two very large magnitude earthquakes (MW 9.2) to occur in the July-September 1981 period off the coast in central Peru, rupturing several hundred kilometers. Participants were impressed but could not accept the idea of the extrapolation of laboratory results by several orders of magnitude. Such a model and the plausibility arguments presented to support the occurrence of such a large earthquake brought out the necessity for research to understand basic seismotectonic problems in the region, e.g. the origin of high interplate seismicity of the San Juan - Mendoza region in Argentina, as well as in eastern Peru and Bolivia, the peculiar distribution of deep earthquakes (500-600 focal depth), the absence of earthquakes at depths of between 300 and 500 km along the entire length of the Benioff zone. This paper also brought out the social consequences of a prediction. No clear practice has evolved on how a well-founded scientific prediction can be translated into an effective mitigation measure. A prediction can be as great a hazard as the earthquake itself, and this is where the problem lies. A book by R.S.Olson and J.M.Nigg "The Politics of Earthquake Prediction (Princeton University Press, 1989) analyzes Brady's prediction.

In conclusion it was noted that much activity is taking place in the region in both basic and applied research in seismology and that a significant amount of infrastructure exists in equipment and in human resources. To a large extent this encouraging situation can be attributed to the existence of a regional center.

The PAIGH Geophysics Commission's Revista Geofisica has published (Nos. 13, 14, 15 and 17) most on the papers presented at the San Juan meeting.

- **Project SISRA**

The contract for the execution of project SISRA was signed by the US Geological Survey and CERESIS on 15 September 1981. Eighteen months were estimated for the initial period.. The project began with a meeting in Lima of forty seismologists, geologists, and earthquake engineers from the nine member States of CERESIS, including most of the Council members. Three Regional Coordinators were appointed for the areas of Seismology (catalogs) - Leonidas Ocola; Tectonics (neotectonic map) - Gunther Fiedler; Seismic Hazard - J.C.Castano. A Consultative Committee with Drs. E.P.Arnold, Vit Karnik (representing UNDRO), R.E. Jackson, and K.V. Steinbrugge, was appointed.

On April 4 - 6, 1983, a meeting was held in Golden CO at USGS. Project Coordinator Dr. S. T. Algermissen, outlined the purpose of the meeting which was to (1) to review progress on the first phase of the project and to make certain that the principal products on the project i.e. the seismic catalog, the new tectonic map and the seismic hazard map for south America would be complete in time for review and approval of the CERESIS Council meeting scheduled for June 1983, and (2) to seek the review of the program of the project, and the opinion of the Consultative Committee. Paul Krumpe , coordinator of the project for the Office of Foreign Disaster Assistance (OFDA/AID), outlined the importance of the project for the development of disaster mitigation in South America. Alberto Giesecke, Director of the Project presented a detailed review of progress together with a review of the funding of the project; his report is in the SISRA files at CERESIS. Progress reports on Seismicity Studies by L. Ocola, Seismotectonic Studies by Gunther Fiedler, and Seismic Hazard Evaluation by J.C.Castano, together with a report on the study of economic effects of earthquakes in Latin America by M. Vega-Centeno concluded the presentations. The Consultative Committee presented their impressions and recommendations, as follows:

1. All original source data used in compilation of the seismic catalog must be preserved and made accessible to appropriate users.
2. In this and all succeeding programs CERESIS should endeavor to update the earthquake catalog and prepare seismicity maps.
3. Consideration should be given to the inclusion off-shore tectonics and qualitated estimates of crustal movements.
4. Observed tsunami run-up and surface faulting should be added to the maximum intensity map.
5. It is appropriate to initiate pilot studies of the economic impacts of earthquakes in south America.
6. All building codes and land use planning practices should be enhanced through international cooperation. It is urgent that engineers, architects and planners be included in this program as soon as possible.
7. Where the data permit intensity curves should be derived.
8. It has been demonstrated to this committee by the excellent progress being made in the project that an unusually high degree of international cooperation exists which is to be commended.

Alberto Giesecke's financial report, dated march 31 1983, indicated that \$ 309,730 dollars had been spent, and audited. The USGS Grant assigned \$417,000 for the first phase; Modification No. 1, a \$140,000 increase, is basically a continuation of the first phase, incorporating additional work; Modification No. 2 authorizes an additional \$150,000 for a the third phase which refers to the economic effects of earthquakes. Further modifications refer to additional work such as that recommended by the Consultative Committee and others, that might be approved by the CERESIS Council and the USGS.

- **Sixth Course for Seismic Station Operators**

The course took place in Cochabamba, Bolivia, on 10 - 30 October 1982, and continued through November 5 in La Paz. Seventeen students attended; seven instructors, three from Bolivia and four from other countries contributed their time.

It is important to mention that the CERESIS philosophy of "Horizontal Cooperation" for "Third World Countries" translates to a donation of services by the experts involved. Members of reconnaissance missions and instructors at the CERESIS courses have donated their time and expertise in all cases.

- **Reconnaissance Mission - Popayan, Colombia, Earthquake, march 31,1983**

The mission visited Popayan and surrounding areas during the period April 16 - 23 1983. Although the magnitude of the event was not very high (5.5 mb, 4.6Ms). It was a very shallow event (h=28 km). It caused severe damage to structures and generated moderate to large landslides. Maximum intensities were MM VIII. Although in the past Popayan has suffered from known earthquakes dating back to the XVIth century, of which the events of 1736 and 1885 were particularly destructive, there has been no special effort to retrofit historical monuments, a particularly difficult task without changing their historical value. To add to the hazard, the Purace Volcano, 25 km southeast of Popayan, is active with lava flow, piroclastics, lahars and ash clouds. The latter are a real threat to weak roofing that is apt to collapse specially if rain falls on the ash. The reconnaissance mission was integrated by Daniel Huaco (Peru), Rodolfo Saragoni (Chile), Minard Hall (Ecuador) and Alberto Sarria (Colombia).

- **Panama Station**

CERESIS provided technical assistance to finalize the installation of the seismological instruments at the new Panama station.

- **CERESIS National Reports**

Reports were presented by each of the member States. The reports contained very detailed description of national activity in seismology. One can observe from these reports over the past 12 years the increase in quantity and quality of national activities.

- **Brady Prediction**

Bryan T. Brady's deterministic prediction called for the occurrence of two large earthquakes, the first one on, or about 10, august 1981, and the second one on 16 September 1981, both with epicenter approximately 100 km southwest of the city of Lima. CERESIS was in touch with both

Bryan Brady and William Spence to whom CERESIS provided up to date information on seismic activity recorded by IGP stations along the coast. Neither CERESIS nor IGP made public statements; only "secret" reports to highest level government authorities. President Fernando Belaunde of Peru requested CERESIS' opinion of the Brady prediction. Dr. Cabre stated that CERESIS had on hand the opinion of the US National Earthquake Prediction Evaluation Council (NEPEC), which had met with Bryan Brady on 26 and 27 January 1981 to evaluate the prediction, and that CERESIS was in complete agreement with NEPEC's opinion which was:

"The members of the Council are unconcerned of the scientific validity of the Brady-Spence prediction. The Council has been shown nothing in the observed seismicity data or in the theory insofar as presented that lends substance to the predicted times, locations, and magnitudes of the earthquakes. ... We can not say with complete confidence that major earthquakes will not occur at the predicted times, but we judge the probability of this happening to be very low indeed ... Our rejection of the specific prediction of Drs. Brady and Spence should not be taken as minimizing the risk to lives and property from earthquakes in Peru ..."

The media exploited the prediction during many weeks before the date earthquake was to occur, publishing dramatic articles and "exclusive" (invented) interviews with Bryan Brady to keep the public interested in buying newspapers. The media did not publish NEPEC's opinion nor did they publish Brady's statement that "if a strong precursor did not occur sometime between 15 June and 10 July 1981, I will withdraw the prediction" and that Brady did retire his prediction. Social, economic and even political effects were notorious - rich people left the country, others sold their homes at prices below their value, specially those near the coast, and moved to the interior of the country, insurance rates went up, the number of tourists decreased significantly, the political opposition blamed the government for not being prepared for such an earthquake, and emotional stress affected many people, - a situation that continued until the day predicted for the earthquake. The USGS asked its vice-Director, John Filson, to visit Lima the day before the earthquake was supposed to happen; his visit was publicized by the government. Filson spent the day with CERESIS Director Alberto Giesecke, making himself visible and unconcerned, shopping, walking and visiting public places. President Belaunde chose that day to inaugurate a pier at Paracas, near the epicenter of the predicted earthquake epicenter; he declared publicly that NEPEC and CERESIS represented state of the art science and he respected their opinion much more than that of one person (Brady) whose prediction had been declared unfounded by his peers. Certainly one of the most useful lessons from this prediction is the great importance of providing the media and the public in general, accurate and intelligible information; these predictions can be exploited as "windows of opportunity" to talk about preparedness, prevention and mitigation since public awareness of earthquakes is very high.

- **UNDRO-UNESCO Seminar on Earthquake Prediction Case Histories.**

The Seminar was held in Geneva, on 12-15 October 1982. The CERESIS Director was invited to present the "Brady Prediction". Proceedings of the meeting include recommendations on Evaluation of Predictions; Response to Predictions "they must be taken seriously as soon as they begin to attract attention or seem likely to do so" and Code of Practice "publication of a prediction may give rise to undesirable consequences". The CERESIS Council independently adopted Guidelines on Procedure, in case it was involved in a prediction that targeted South America, and it also adopted Ethical Norms for the Scientist who might predict an earthquake.

- **International Experimental Sites for Research on Earthquake Prediction.**

The Panel of Experts that met in Paris at UNESCO, in April 1979, to discuss the scientific, social and economic aspects of a prediction, recommended consideration of the possibility of establishing experimental sites for such studies. The basic idea was to provide in situ facilities in regions with potential for the generation of large and frequent earthquakes, where different groups could study the same area with different techniques to identify and evaluate precursors, compare results and eventually predict an earthquake. Members were selected by IASPEI, as individuals. The Working Group met in London, Ontario, June, 1981, with the Secretary General of IASPEI and Dr. Kitazawa of UNESCO, who confirmed UNESCO's decision to support the WG. In order to maximize the probabilities of success, three different geotectonic environments were selected, - subduction zones, transcurrent or transform faults, and intra-plate activity. The CERESIS Director, one of the members, proposed for subduction the region of southern Peru-northern Chile and the El Pilar transcurrent fault in Venezuela. Several steps would have to be taken before any work begins, for example, acceptance by the governments in whose territory the experimental site would operate, survey of the proposed sites by international experts.

- **NASA's Crustal Dynamics Program**

CERESIS facilitated NASA's contacts with the institutions involved with TLRs-2 measurements using the LAGEOS satellite. One of these units has operated continuously in Easter Island since March 5, 1983 and will continue until August or September this year. 14 baselines were established from Easter Island, incorporating fixed LRS stations as the one in Arequipa, Peru. The accuracy of these baselines is on the order of 2 to 4 cm. good enough to measure the relative movement between the Nazca Plate and the Pacific and South American Plates which is estimated at 8 to 12 cm per year. Beginning in 1984 a TLRs-2 will be set

up in the Galapagos and at various sites in Ecuador, Peru, Bolivia, Chile and Argentina.

- **CERESIS-PAIGH Relations**

The Director of CERESIS was elected president of the Geophysics Commission of PAIGH for the period 1973 - 1982; Edgar Kausel, CERESIS Council member representing Chile was appointed president of the Solid Earth Committee of the Commission. These appointments made for close and mutually beneficial relations between CERESIS and PAIGH. Some of the joint projects carried out:

- "Improvement of the Determination of Focal Parameters". The project was motivated by observing an apparent decrease of seismicity in the South Atlantic and parts of South America, as was evident from data published in catalogs of world data centers. To corroborate or negate this impression, data recorded several years by a selected number of stations was analyzed. There was no evidence at all of a decrease in seismicity. The results were published in the Revista Geofisica. (Note: the Editor of RG, from 1975 through year 2000, was the CERESIS Director).
- Seismological Station in Uruguay at Salto Grande Dam. A temporary station was installed by INPRES between Uruguay and Argentina. Local operators were trained.
- Seminar on Fundamentals of Seismology and Digital Processing of Data. The Seminar was requested by Yacimientos Petroliferos Fiscales (YPF), the National Oil Company in Argentina; 7 students from other CERESIS countries attended.
- Microfilming of historical seismograms continued with the support of World Data Center-A. CERESIS was provided a special camera and reader.

- **Carnegie Institution of Washington - (CIW-DTM)**

CERESIS continued to provide logistic support to the Seismological stations at Trujillo and Cusco. Data was recorded on very slow running magnetic tape; the data was analyzed at DTM-CIW to identify shadow zones. The data is at DTM (Department of Terrestrial Magnetism).

With IGP, DTM (Selwyn Sacks) installed seven Volume Strain Meters in various locations in Peru and a central processing facility. The instruments are placed at a depth of 100 mt. in rock; they are expected to provide information relevant to the occurrence of earthquakes.

2. EXTRAORDINARY MEETING OF THE CERESIS COUNCIL.

The main purpose of the meeting was to discuss Project SISRA. Other activities were briefly discussed. The meeting was held in **San Juan, Argentina, on 29 September 1984**. Present were Council members Edgar Kausel (president), Juan C. Castano (Argentina), Angel Vega (Bolivia), Rafael Goberna (Colombia), Roberto Arellano (Ecuador), Enrique Silgado (Peru), Alberto Benavides (Uruguay), Luis Urbina (Venezuela), Fernando Repetto (UNESCO), Minard Hall (PAIGH), Alberto Giesecke (Executive Director), Luis Fernandez (Associate Director). Invited Observers: S.T. Algermissen (USGS and Project SISRA Coordinator), E.M. Fournier d'Albe (Unesco), Simon Gershanik (Argentina), Edgar Proaño (Ecuador), Julio S. Aguirre R. (Argentina).

SISRA had reached its final stages. The project was the most ambitious and extensive one carried out by CERESIS. The Advisory Committee, E.M. Fournier d'Albe, Karl Steinbrugge, William Savage, and James F. Devine had participated at the SISRA Conference of September 24-28, 1984 in San Juan, which was organized to present scientific results publicly and to give Advisory Board members the opportunity to evaluate results presented by the responsible person. Fifty five scientists from the region attended. The Project Coordinator, the CERESIS Director, SISRA Area Coordinators, SISRA national representatives and SISRA participants in general; they presented and discussed 45 reports. Advisory Board members met the evening of the 28th to draft their Evaluation Report. The Report consists of two components: 1. A discussion of the scientific presentations and an evaluation of the overall accomplishments of the project, and 2. A discussion of recommendations for near term and continuation of the scientific effort.

OBJECTIVE 1

Develop basic and geologic and seismologic data critical to the evaluation on seismic data and risk.

Evaluation:

The compilation of a unified hypocenter catalog with a comprehensive effort to remove duplication, errors, and misidentifications has been accomplished for each country of project SISRA and for Brazil. This represents the most important first step for any future hazard assessment of the area. The need for an accurate and complete catalog cannot be overemphasized and it aids in disaster planning. It is a major contribution to all future seismic work in south America.

Of equal importance as the hypocenter catalog is the earthquake intensity catalog. The subjectivity of intensity evaluations results in a data set with inherent limitations. Consequently a coordinated effort to evaluate and compile intensity data using common techniques is essential for regional analysis. Project SISRA has produced such a databank. This second major step in seismic data analysis will provide a consistent base upon which many additional derivative products can be built, e.g. frequency distributions of microseismic intensity and thus of damage degree. Although they are obviously less reliable than those based on complete analysis of hazard and vulnerability,

they may nevertheless prove very useful pending the compilation of more complex investigations.

OBJECTIVE 2

Prepare interpretative maps from the regional maps of South America.

Evaluation :

Four interpretative maps have been prepared. Each one represents a level of scientific information not previously available. The first, a map showing the epicenters of all earthquakes greater than magnitude 4.5 that have been reported since 1471, represents, as does the catalog, the first and most important step in the process of seismic hazard and risk evaluations.

The map showing maximum observed intensities is a logical next step in the interpretation of the observed earthquake data. Individual intensities have only limited value in understanding earthquake ground motions. However when the data are combined in a manner as shown in this map, the historical intensity data set becomes very useful in providing a general picture of the severity of ground motion and when used carefully, will assist in assessing future distribution and severity of damaging ground motions.

It is doubtful however if the map which is at a scale of 1:5,000,000 , can be used as it is for seismic zoning or for physical planning. Maps on a much larger scale are needed for this effort. Additional information on potential earthquake sources and on local site conditions must also be included. The present map will, nevertheless, provide starting point for the preparation for additional maps at larger scales for each country. This first intensity map is an excellent example of an evaluation that could not be accomplished by individual countries without communications with each other.

The third map showing areas of observed ground failure and landslides provides the basic for the evaluation of ground effects that may or may not have been caused by earthquakes.

The fourth map presents a compilation of recent volcanic and geologic activity and the resulting soil and rock configuration at the surface of the earth. This neotectonic map aids considerably in the correlation of tectonic and geologic observations of earthquake data presented in the previous maps. A great deal of work has obviously gone into the preparation of this map which may prove useful for many purposes besides those discussed in this project.

OBJECTIVE 3

Conduct Interdisciplinary meetings for geologists, seismologists and engineers.

Evaluation :

This Meeting of project SISRA held on September 24-28 1984, is one of a series of interdisciplinary meetings set for the project. More importantly, the type and quality of the discussions among the geologists, seismologists and engineers have demonstrated a vast increase in a knowledge and awareness of the scientific disciplines of each other. The usefulness of earthquake information may be judged by the extent to which it is used by public officials, design engineers, and city planners.

Meetings such as these are seen as the major conduit for transferring these data to the using community. Another transfer technique is the presentation of technical courses. Project SISRA has sponsored several courses on seismicity, seismic safety and building codes.

EVALUATION SUMMARY

It was obvious to the Review Board that a large amount of very high quality work has been accomplished by the scientists in this project, and that the basic objectives have been met. This goal could certainly not have been achieved by each country working independently.

One additional element needs a comment. Studies of the economic impacts of the earthquake of Ancash (Peru) in 1970, of Caracas (Venezuela) in 1967, and of Caucete (Argentina) in 1977, were presented at the meeting to illustrate the methodology worked out for the sub-project ECOSIS. The work, still in its initial stages, is obviously hampered by a lack of objective economic data on the consequences, both primary and secondary, of earthquake damage. However the accomplishments, thus far represent a major improvement in the understanding on the seismic risk in south America. Clearly, the project has been successful in stimulating significant work in this field.

Special recognition must be given to the work of more than 150 south American scientists and engineers who contributed their expertise and enthusiasm to make Project SISRA a success. Another important element was the leadership of a strong, well focused and highly effective administrator and coordinator, Dr. S.T. Algermissen, of the US Geological Survey, with the CERESIS Director, Alberto Giesecke, a very competent and innovative implementer and, most certainly, the CERESIS team. As project SISRA neared completion it was appropriate to discuss possible future activities. The long term purpose of SISRA namely the mitigation of earthquake effects, requires continued international collaboration of many scientists, engineers and public officials to achieve the objectives.

The Council took note that 500 sets of 14 Project SISRA Volumes plus 1500 sets of 4 large maps and 2 descriptive Volumes, had been published by CERESIS in Lima and in Santiago. 35% of complete sets were distribute to CERESIS member States, and others in Latin America and the Caribbean, 45% to the USGS for world-wide distribution, 12% to UNESCO and other international organizations, and 8% kept in Lima for delivery when requested.

Project SISRA 2 was only a possibility. There were no funding offers. The Council approved the scope and objectives of the proposal and requested the Director to contact possible donors, particularly OFDA-USAID.

NINTH MEETING OF THE CERESIS DIRECTIVE COUNCIL

The meeting took place in **La Paz, Bolivia on December 2 – 6, 1985**, hosted by the San Calixto Observatory

Council members present were: Edgar Kausel (Chile - President), Ramon Cabre S.J. (Bolivia), Rafael Goberna, S.J. (Colombia), Roberto Arellano (Ecuador), Daniel Huaco (Peru), Alberto Benavides (Uruguay), Andre Singer (Venezuela) , Fernando Repeto (UNESCO), Jose Telleria (PAIGH); Alberto Giesecke (Executive Director), and Observers ; S.T. Algermissen, (USGS - SISRA Project); Hernan Claure , Angel Vega, Salvador del Pozo (Bolivia), Oscar Gonzalez-Ferran (Chile), Edgar Proaño (Ecuador). Edgar Kausel was re-elected president of the Council. National Reports were presented by the Council members. The director's report covers the period from October 1984 to November 1985.

On December 6, as the meeting ended, Rafael Goberna S.J. suffered a stroke from which he did not recover; he died ten days later. He had worked 30 years at the Belen Observatory in La Habana, Cuba and transferred to Bogotá Colombia to work with Jesus Emilio Ramirez.

- **Large Events and Reconnaissance Missions**

During 1985 three large events occurred:

- (a) the 3 march Ms 7.5 Central Chile, subduction earthquake, - the worst since the 19 September 1906 Ms 7.9 event in the same area; the Mission's report has been published.
- (b) the 13 November eruption of the Nevado El Ruiz volcano and the lahar which covered the city of Armero (21,000 + victims) and damaged other towns in Colombia (see below)
- (c) the 19 September Mexico Ms 7.0 subduction (Michoacan, Guerrero) event with MM Intensities of IX in the central part of Mexico City, (10,000+ victims). The Mission's report has been published

- **The Nevado El Ruiz Volcanic Eruption**

On 13 November 1985 the Nevado El Ruiz volcano that had generated lahars in 1595 and 1845 erupted, melting the ice cap at the top of its cone, producing once again a large lahar which caused 23,000 victims in the localities of Armero and Chinchina. Armero was situated about 55 km from the El Ruiz volcano; it takes about one hour for a lahar to travel from the volcano to Armero, situated where the Lagunillas river meets the Magdalena river valley, a fertile and prosperous area for its 28,000 inhabitants. The 16th and 19th century lahars also destroyed property and killed many persons. This tragedy is a particularly good example of how adequate preparedness and prevention could have saved the lives of possibly all of Armero's inhabitants. All that was needed was a real time warning as soon as the lahar started. The people would have had a true warning one hour before the lahar arrived, time enough to evacuate their homes and watch the lahar from the nearby high ground. This case motivated CERESIS to present a proposal to the International Development Research Center of Canada (IDRC) to study the social, institutional and scientific aspects of El Ruiz disaster. IDRC funded the proposal and under the CERESIS Director, the project team was

appointed including volcanologists, social scientists, and government officials from Colombia, Peru, Ecuador, Nicaragua and Chile. The published report was well received by the Colombian government and institutions in general; a Video was also produced and widely distributed.

- **Publications**

- A monograph "Enseñanzas Derivadas de los Estudios de las Misiones Post-Terremoto de UNESCO y de CERESIS – UNESCO", Alberto Sarria M. (Colombia), 1986 - a summary of the lessons learned from post-earthquake reconnaissance missions
- A course on "Research Oriented to the Prediction of Earthquakes- Algorithms, Software and Data Processing" was approved. The course would be held in August or September 1986, at the National Engineering University (UNI) in Lima. A UNESCO Grant of \$3,000 to CERESIS was confirmed as was one from the International Center for Theoretical Physics in Trieste (ICTP), for \$ 20,000. The Academy of Sciences of the Soviet Union authorized the participation of Professors V. I. Keilis-Borok, I. Kuznetsov, V.G. Kossovokov, and A.A. Solovjev
- A brief history of CERESIS was prepared for UNESCO

- **VII Course for qualified Seismic Station Operators**

It was held in San Juan, Argentina, on November 3 - 30, 1985, hosted by INPRES, with 30 participants designated by the responsible institutions in 9 countries. Professors from Argentina, Brazil, Chile, USA and CERESIS, contributed their time and shared their expertise..

- **Membership of Spain and Brazil**

The ministry of Foreign Affairs of Spain confirmed that they expect to satisfy the necessary bureaucratic requirements so the Spanish government can formally apply to become a CERESIS Member State. The matter was under consideration by the Spanish Parliament. There was no official communication from the government of Brazil. The community of earth scientists in Brazil was lobbying to obtain a favorable decision.

- **International Sites For Research on Earthquake Prediction**

CERESIS organized two missions to study the proposed sites in South America: (1) Tacna-Arica (Peru - Chile) border; and (2) the El Pilar fault in Venezuela. Ramon Cabre (Bolivia), Jesus Berrocal (Brazil) and Michel Sebrier (France), visited the first site. Analysis of available seismological information from SISRA catalogs allowed the mission to estimate that the occurrence probability of a large destructive earthquake in the next 30 or forty years, in or near the proposed site, is higher than for most other

subduction zones. In both Chile and Peru there is considerable scientific and technical data available on geophysics, particularly seismology, neotectonics, geology, topography, hydrology, geodesy and gravity, relevant and to the area of interest. Scientific logistics in both countries allows good support for the experimental project. The mission recommended additional studies in the area. The mission (remembering the Brady prediction) also referred to the potential for harmful psychological reaction of the population as a consequence of public notice taken of the increased activity of numerous scientists and seismic stations dedicated to the study of the "large forthcoming earthquake".

The second mission, John Shepherd, Y. P. Aggarwal and Michel Sebrier, reported on the El Pilar fault zone. The mission strongly recommended that the El Pilar zone be designated as an international experimental site since it forms part of a major transcurrent plate boundary and has a demonstrated potential for major earthquakes. Extensive information is available for a variety of interrelated experimental techniques; the level of technological sophistication of the country is high, so scientific, field assistance and field repair of instruments is readily available. The mission made no recommendation about the way UNESCO should encourage and support international earthquake prediction experiments since this is the responsibility of UNESCO's ad-hoc committee, after the site is selected. In any case the support of the Venezuela government for this project is assured.

- **CERESIS Award**

The 1985 CERESIS Award recognized Dr. Gunther Fiedler (Venezuela), as the pioneer of Venezuelan seismology and his many contributions to the region in general.

- **International Symposium on Central Andes Tectonic and Relation to Natural Resources**

The meeting took place at La Paz Bolivia, October 1 - 6, 1984, hosted by the Faculty of Geologic Sciences of the San Andres University in a Paz. It addressed the following subjects: The Andes as a subduction zone. Structure and evolution of the lithosphere in the Region. Distribution and behavior of rocks. Volcanoes, earthquakes and recent movement of the Plate. Minerals, oil and tectonic evolution. Remote sensors and tectonics. CERESIS co-sponsored the meeting

- **" Appraisal of Seismic Risk of Large Engineering Constructions "**

The course, offered in Quito, Ecuador, January, 14 -18 1985, was hosted by the Escuela Politecnica Nacional (ESPONA). CERESIS co-organized the meeting. The purpose of the course was to revise and propose criteria for geologic and seismologic evaluation of seismic hazard in places selected for large engineering constructions, and to specify parameters of ground movements for engineering analysis. The course

was offered by E.L. Krinitzsky, and W.F. Marcuson III (Corps of Engineers Vicksburg), S.T. Algermissen (USGS). ESPONA offered to publish and distribute the technical material used in the course. 31 participants from 13 Latin American countries.

3. EXTRAORDINARY MEETING OF THE CERESIS COUNCIL.

. The government of Spain invited the Council to celebrate CERESIS's XXth anniversary, and to announce that Spain was about to become a member State of CERESIS. The meeting was hosted by the government of Spain and the Astrophysical Institute of Canarias.

The Council met informally in **Madrid on the 7th, in Tenerife on the 8th to 10th and in Madrid on the 12th, September 1986**. Council members present were Edgar Kausel (president - Chile), Juan C. Castano (Argentina), Ramon Cabre (Bolivia), Alberto Sarria (Colombia), Roberto Arellano (Ecuador), Enrique Silgado (Peru), John Shepherd (Trinidad Tobago), and Alfonso Lopez Arroyo (Spain a.i.), Alberto Giesecke (Executive Director), Luis Fernandez (Associate Director). Invited Observers: Marcelo Assumpcao (Brazil), Rodolfo Saragoni (Chile), (Eddy Sanchez (Guatemala), Zenon Jimenez J. (Mexico), Alejandro Rodriguez (Nicaragua), Angel Arevalo Barroso, Juan Galan, Antonio Jesus Martin and Julio Mezcuca, Agustin Udiaz (Spain).

Dr. Angel Arevalo Barroso, Director General of the Instituto Geografico Nacional of Spain, in Madrid, inaugurated the CERESIS seminar held on September 8 - 10, at the Astrophysical Institute of Canarias, and continued in Madrid on the 12th. Presentations by participants were published by the Spain's National Geographic Institute - "Comunicaciones y Ponencias 5.", September 1986.

Participants from Central America and Mexico urged CERESIS to interest their governments to either join CERESIS or create their own Center for Central America.

UNESCO invited CERESIS representatives to visit with Secretary General M'Bow in Paris, on the 11th, after the meeting in Tenerife, to celebrate the 20th anniversary of the UNESCO-PERU creation of CERESIS (May 1966). Also present were Assistant Secretary General for Science Abdul - Razzad Kaddoura, and members of the Earth Science Division. Ramon Cabre and Alberto Giesecke represented CERESIS; they recalled UNESCO's crucial role in the establishment and survival of CERESIS.

The session in Madrid, on 12 September, at the Geophysics Department of the Instituto (IGN), focused on future joint activities CERESIS-Spain, which may include: continental seismic profiling; historical seismicity; loan of instruments for the region south Peru-north Chile, and seismicity studies in the Caribbean, north of Venezuela and use of IGN's publishing facility.

The Director's report for the period January - September 1986 referred to the following topics:

- **Project SISRA**

Most of the SISRA volumes are expected to be ready for distribution by the end of November. The continuation of project SISRA was discussed with the OFDA Director who visited CERESIS in Lima to express his satisfaction with the results of the SISRA project. In his opinion, there were possibilities for funding SISRA 2.

- **Meetings and Courses**

- International Seminar on Earthquake Risk and Insurance
The Peruvian Insurance Association (APESEG) and CERESIS organized the Seminar, held in Lima, January 1986.
- Earthquake Engineering - Buenos Aires, November 1985
CERESIS sponsored the participation of four non-argentine engineers
- Course : International School on Earthquake Prediction Research: Algorithms, Software and Data Handling. The four week course held in Lima in the Faculty of Civil Engineering of the UNI (National Engineering University) was financed by: the International Center of Theoretical Physics \$ 27,500; UNESCO \$ 3,500, and CERESIS \$9,500. It began on September 1st 1996. It was the responsibility of professors V.I. Keilis Borok, V.G. Kosovokov, A.A. Soloviev, I.V. Kusnetzov, from the "Physics of the Earth Institute of the Academy of Sciences of URSS". They came one month in advance to prepare for the course at CERESIS, remaining in the country for two months, and supported by CERESIS. The book " Algorithms of Long-Term Earthquakes Prediction" was prepared by A.M. Gabrielov for being used in the course. The course was attended by eighteen students from ten countries.

TENTH MEETING OF THE CERESIS DIRECTIVE COUNCIL

Oscar Gonzalez Ferran, Alternate Council member for Chile, suggested to the Government of Chile to invite the CERESIS Council to hold its **10th Ordinary Meeting in the Antarctic, Chile on October 5 to 10, 1987**, and to participate in the International Seminar organized by the University of Chile commemorating the 30th anniversary of the International Geophysical Year. Chile provided CERESIS with transportation from Santiago, and lodging.

The three hour flight Santiago-Punta Arenas on the 5th was uneventful. It was necessary to change to an airplane that could land safely at Chile's Tnte.

Marsh Base in the Antarctic. However, bad weather postponed the 3-hour Punta Arenas-Antarctic flight until the 8th; two attempts on the 6th and 7th failed.. So CERESIS held its first three sessions at Punta Arenas on October 5, 6 and 7. Council members participated in the Seminar at the Chile Antarctic Base Tnte. Marsh on the 8th and the Council continued its meeting on the 9th and 10th. Scientists from the relatively close Bellinghausen (Russia), Great Muralla (China), and Artigas (Uruguay) Bases attended some of the CERESIS COUNCIL sessions.

The following Council members attended the meeting: Edgar Kausel (Chile- President), Ramon Cabre (Bolivia), ALBERTO Sarria (Colombia), Roberto Arellano (Ecuador), Jorge Alva (Peru), John Shepherd (Trinidad Tobago), Alberto Benavides (Uruguay), Andre Singer (Venezuela), Fernando Repetto (UNESCO), Oscar Gonzalez Ferran (PAIGH), Alberto Giesecke (Executive Director), Luis Fernandez (Associate Director), Observers were Isabel Santillan (Administrative Secretary - CERESIS), Patricia Anzola and Benjamin Fernandez (Colombia); Minard Hall (Ecuador), Alejandro Rodriguez (Nicaragua); Manuel Araneda and Sergio Barrientos (Chile), Bruno Podesta (Peru), J.A. Veloso (Brazil), Ramon Ortiz (Spain).

National Reports were presented by the national representatives of Member States.

The Director's report, for the period from October 1986 to September 1987 Included the following topics:

- **Brazil and Spain as Member States**

J. A. Veloso reported that the Ministry of Science and Technology and the Ministry of Foreign Affairs were preparing the documents required by the Brazilian Congress, to consider Brazil's membership in CERESIS.

The ambassador of Spain in Lima informed CERESIS that he was authorized by his government to sign the CERESIS multinational agreement.

- **SISRA 2 - US Geological Survey**

The proposal, prepared with the USGS, was presented to OFDA. The amount requested was U\$ 2,000,000 dollars for an 18 month period. It included tsunami inundation maps, strong motion catalogs, research on economic loss, volcanic hazard studies, graduate study and short term training, satellite-relay telemetric seismograph stations, updating catalogs, isoseismal maps and workshops.

- **The CERESIS Library**

The library in Lima files CERESIS documents - national reports, earthquake Reconnaissance mission reports, proposals, minutes of

meetings, trip reports, scientific journals, a few books, and provides reprints on request.

- **Post Earthquake Reconnaissance Missions**

As on previous occasions, UNESCO funded the reconnaissance missions. Two damaging earthquakes took place - the El Salvador, 10 October 1986 event which caused 1,500 victims, 10,000 injured and 100,000 left homeless. The government of Peru provided transportation from Lima to El Salvador for a seismologist, 2 structural engineers and a landslide expert from Colombia, Ecuador, Peru and Venezuela.

The Ecuador, 5 March 1987 event which caused 1,000 victims, severe damage to the country's principal pipeline for export of oil, and affected several historical monuments. The loss of spilled and unsold oil was estimated at 3,000 million dollars. The Mission included experts from Argentina, Chile, Mexico and Peru.

Mission reports for both events can be obtained from CERESIS

- **Nevado El Ruiz Volcano – Colombia**

The International Development Research Center of Canada granted CERESIS \$ CAN 166,410 to carry out a 15-month study of the scientific, technological, social, cultural and administrative aspects of the eruption and lahar that killed more than 23,000 persons at Armero and Chinchina in Colombia, on the 13th of November 1985. This event must be very seriously taken into account by every person interested in mitigation.

For more than a year, the El Ruiz volcano showed clear signs that it was again active. Fumarola, fume clouds, and tremors left no doubt that El Ruiz was flexing its muscles. The population clearly ignored the historical documents describing similar volcanic activity in 1595 and 1845 when El Ruiz erupted and produced a lahar which covered the whole area where present day Armero was situated. As months went by, dozens of volcanologists from many countries came to study the El Ruiz. Their reports, very fine scientific reports showing the increase in pH of the water trickling down from El Ruiz, and detailed analysis of the ash, and so on, found nothing relevant to prevention in those reports. President Betancourt of Colombia was told by the scientists that there was a 65% percent probability of an eruption in the next few months. Betancourt asked if he should evacuate Armero and other towns and for how long; the answer was "that is your responsibility, sir". The point is that not one scientist or civil defense officer advised the president that two simple actions should be taken. One, to implement a simple fail-proof alarm system that would tell the population that a lahar was on its way heading for Armero; the distance is 50 km and it takes a lahar about one hour to reach Armero from El Ruiz. The second action was to instruct the population on the facts: no scientist or politician could know and tell them when the volcano would erupt, but when it did erupt the

danger was not lava flow, pyroclastic rocks or ash - it was from the lahar which would take about one hour to reach them after the eruption. The population had to be well trained to evacuate their homes quickly. They had to choose and prepare the belongings they could easily carry to safe ground. There is no doubt that most of the 23,000 buried by the lahar would have saved their lives. High ground could be reached in 30 to 40 minutes. The lesson is that scientists and other experts must keep in mind that the ultimate aim of their expertise is to save the lives of people. Knowing the pH of the water is fine but unless that bit of knowledge could tell them when the eruption would occur, it was irrelevant to their safety.

- **International Seismological Center**

The CERESIS Director was the first member of the ISC Directive Council to visit ISC's new locale at Thatcham, Newbury in UK. He discussed with Director Anthony Hughes the possibility of having a CERESIS seismologist work at ISC for a two-year period.

- **British Geological Survey (BGS)**

The Director attended the symposium organized by the BGS, at Edinburgh, Scotland on "Extensive - Dilatancy Anisotropy : An Important New Tool for Earthquake Prediction". Dr. Stuart Crampin was convinced that the technique, to observe, analyze and interpret the polarization - shear wave splitting - of waves traveling through an active fault would lead to reliable earthquake prediction in the near future. In his opinion this is one of the most important contributions in the history of seismology.

- **Asociacion Peruana para Estudios de la Paz (APEP)**

APEP contributed \$ 1,000 to CERESIS to analyze and compare military and government budgets for prevention and mitigation of natural disasters in the Andean region, for the past 150 years. The idea is to convince the military that natural hazards are by far a more dangerous enemy than the countries on the other side of the borders. This project is on standby so far because of the difficulty of obtaining reliable statistics and information on military budgets of the Andean countries..

- **Third World Academy of Sciences (TWAS)**

CERESIS was invited to give a talk on the CERESIS organization and achievements at the TWAS Second General Conference held in Beijing, China, on September 1987.

- **Meetings and Courses:**

Seismic Risk. CERESIS co-sponsored a course on Seismic Risk in Bogota, Colombia, on 5-17 September 1987.

- **Special Advisory Commission for Prevention of Seismic Risk (CEAPRIS), Venezuela.**

CEAPRIS - Comision Especial de Asesoria para la Prevencion del Riesgo Sismico was created in the State of Merida in Venezuela in 1979. It is a very good example on how local governments and the population at large can contribute to disaster mitigation and prevention. Annual reports of CEAPRIS are available and should be widely distributed.

- **Change of Name.**

During the Meeting, Oscar Gonzalez Ferran proposed that CERESIS maintain its logo but change its name to Centro Regional de Sismologia y Volcanologia para America del Sur. There is no regional organization in South America for volcanology as there is for seismology; that the two disciplines are intimately related and CERESIS has occasionally been involved with volcanology; it would seem logical to consider this change. It is up to the national government representatives to discuss the matter in their respective countries. The change of name requires formal modification of the multinational agreement.

- **International Center for Physics (CIF)**

The Center is located in Bogotá, Colombia. It has expressed interest in organizing a course on seismology with the cooperation of Agustin Udias S.J. and Armando Cisternas. CIF proposed that a formal agreement with CERESIS be considered for future courses. .

- **Policy Concerning International Projects**

Many scientific expeditions come to south America to carry out an experiment or an investigation. They contact the proper national institution and a competent national counter, and receive information (data), guidance, and facilities such as help to bring in and take out equipment. This is certainly to be encouraged, but their offer of sharing data is generally forgotten. The CERESIS Council discussed this very common pattern and decided to discuss this matter at a future meeting. It would seem logical for institutions and government authorities (Foreign Relations) to adopt a uniform policy. For example, a minor point. they should insist that projects which finance foreign expeditions include in their budget the cost of having a national scientist participate actively in the observations, the data gathering , data reduction and interpretation phases.

- **International Decade for Natural Disaster Reduction (IDNDR)**

In the context of the forthcoming IDNDR, the Council proposed that countries include in their respective national budgets, contingency funds to use in case of disasters rather than relying solely on "humanitarian assistance" from friendly nations. CERESIS considers it is each

country's responsibility to do what it can to protect its own population, and then ask for help.

- **CERESIS Award 1987**

The Council decided that the 1987 CERESIS Award be presented to Enrique Silgado (Peru). Silgado was the first CERESIS president; he retired from CERESIS because of ill health, after 20 years. His outstanding work with historical seismicity, tsunamis and intensities is widely recognized.

4. EXTRAORDINARY MEETING OF THE CERESIS COUNCIL.

The meeting, held in **Bogotá Colombia, 9-13 December, 1988**, was called for a three day discussion of CERESIS activities and two days to discuss the Project Report on the 13 November 1985 "Armero" tragedy, and its presentation to government authorities and the IDRC Regional Office in Bogotá. The meeting was hosted by the Geographic Institute "Agustin Codazzi" - the CERESIS liaison Institution for Colombia.

Present were Council members Roberto Arellano (Ecuador - President), Mario Bufaliza (Argentina), Ramon Cabre (Bolivia), Alberto Sarria (Colombia), Edgar Kausel (Chile), Andre Singer (Venezuela), Fernando Repetto (UNESCO), Fernando Restrepo (PAIGH), Alberto Giesecke (Executive Director).

The Council expressed its deep sorrow for the death of E. M. Fournier d'Albe, for many years the Head of UNESCO's Earth Sciences Division. He was the principal promoter for the creation of CERESIS and a staunch supporter ever since. He died at the end of August 1988 in his home.

The Council invited the **"El Ruiz - IDRC" team** that had produced the report on "Volcanic Risk, Revaluation and Mitigation in Latin America - Social, Institutional and Scientific Aspects". On December 12 and 13, the following persons met with the Council: Guillermo Thornberry (Head of the IDRC Regional Office in Bogota); Patricia Anzola (Sociologist - Colombia), Bruno Podesta (Sociologist - Peru), Benjamin Fernandez (Geodesist - Colombia), Oscar Gonzalez Ferran (Volcanologist - Chile), Minard Hall (Volcanologist - Ecuador), Alejandro Nadal (Volcanologist - Mexico), Alejandro Rodriguez (Geophysicist - Nicaragua), Alberto Giesecke (Team Leader) and with Etnos TV representatives - responsible for the video tape on the project.

The Council took note of suggested changes and corrections. It requested the Director and Bruno Podesta to incorporate these and to produce the revised version to be presented to IDRC in two formats: an Executive Summary (50-60 pages) and a complete report (300 pages). It was agreed that the work could be completed in 6 weeks. A public ceremony with the presence of Government and Civil Defense representatives took place the following day.

The **Director's report** covers the period October 1987-November 1988. It includes the following topics:

- **International Decade for Natural Disaster Reduction (IDNDR)**

The 1987 U.N. General Assembly , Session 42, adopted Resolution 42/169 which declares the period 1990-1999 as a United Nations International Decade to reduce on a global scale, by concerted actions, the number of victims and material and social loss caused by natural disasters such as earthquakes, wind storm, tsunamis, floods, volcanic eruptions, forest fires or locust infestation.

The Secretary General appointed a Steering Committee - the Heads of U.N. Agencies - and designated 25 experts to form the International Ad-hoc Group of Experts, - as individuals. The CERESIS Director was one of those designated..

The ad Hoc Group was chaired by Dr. Frank Press. It held its first meeting in Geneva, July 1988, and a second meeting in New York, December 1988. The Group would meet again in January 1989 in Morocco and in April in Tokyo. Its report to the U.N. Secretary General must be presented in May 1989 for discussion by ECOSOC and then by the U.N. 42nd General Assembly.

The CERESIS Director spent 3 weeks in September 1988 at UNDRO in Geneva. He was asked to work with Dr. V. Karnik on , UNDRO's IDNDR Progress Report to the U.N. Secretary General. Dr. Fournier had been working on the report when he died.

- **UNESCO's One page pamphlet.**

UNESCO published an excellent set of recommendations relevant to earthquake prevention. Originally it was prepared for business enterprises but CERESIS found it appropriate for everybody who lives in earthquake-prone regions person regardless of what he does or who he is. CERESIS translated the document to spanish, added a few suggestions (with UNESCO's authorization) and distributed several hundred pamphlets to countries in South America. A paragraph added at the end reminds us of the fact that human beings behave in a manner difficult to understand when it comes to seismic hazard. The person accepts a vaccine as a normal precaution to avoid illness; life insurance, long before he is agonizing; where it rains, he goes out with an umbrella under his arm. However, in a region where earthquakes occur frequently, where "earthquake season" is permanent, the person does not pay any attention nor does he or she dedicate any time at all, to think about and adopt prevention measures against a catastrophic event that is absolutely certain to occur, sooner or later.

- **Coordinating Committee-5; Data Centers and Data Exchange; International Lithosphere Program.**

The Director of CERESIS was invited to attend the meeting of the Committee. It took place on the occasion of the International Conference "Modern Technology of Geophysical Data Storage and New Scientific Applications", 17-21 November 1987, Suzdal, USSR. One of the projects proposed was "Neotectonic Regionalization of the Globe and Identification of Earthquake-Prone Areas" The attractive part of the project is the idea that by exploiting a great amount of existing data and advanced hardware and mathematical tools it could bring us to a swift and cheap identification of strong earthquake-prone areas around the world.

- **PAIGH "Seismic Risk" map for South America.**

PAIGH's proposal for a regional risk map, to be submitted to IDRC, was discussed at the PAIGH Symposium on Geophysics 1988 in Ottawa. The name "risk map" was changed to "hazard map": Dr. J. Tanner was to prepare the proposal in consultation with experts from CERESIS, CEPREDENAC, Mexico, the Caribbean and Canada. The Council expressed that though the project as such it was a good initiative, CERESIS had already done in South America much of the work PAIGH proposed.

- **International Symposium on Intraplate Seismicity in South America.**

The Symposium was organized by Marcelo Assumpção of the Institute for Astronomy and Geophysics of the University of Sao Paulo. CERESIS was asked to co-sponsor the meeting, to be held November 20-24, 1989 in Rio de Janeiro, Brazil..

- **Course on "Use of Information on Natural Risks in the Preparation of Investment Projects"**

CERESIS was asked by the Organization of American States (OAS) to Co-Organize the Course with the OAS Department of Regional Development. It will be held in Lima, Peru, probably the second semester of 1989.

ELEVENTH MEETING OF THE CERESIS DIRECTIVE COUNCIL

The meeting took place in **Santiago de Chile, on July 31 to August 4, 1989**, hosted by the Instituto de Investigaciones y Ensayo de Materiales (IDIEM) of the Universidad de Chile.

Council members present were: Roberto Arellano B. (Ecuador - President), Mario Bufaliza (Argentina), Ramon Cabre S.J. (Bolivia), Alberto

Veloso (Brazil), Edgar Kausel (Chile), Alberto Sarria (Colombia), Jorge Alva (Peru), Jose Martinez Solares (Spain), Keith Rowley (Trinidad Tobago), Alberto Benavides (Uruguay), Andre Singer (Venezuela), Fernando L. Repetto (UNESCO), Oscar Gonzalez-Ferran (PAIGH); and Alberto Giesecke (Executive Director). Invited Observers: S.T. Algermissen (USGS); Robert P. Masse (WDC A - Seismology); Leonidas Ocola (Peru); Angel Vega (Bolivia); Jesus Berocal (Brazil); Juan Carlos Castano (Argentina).

The Government of Trinidad-Tobago offered to regularize its status as Member State of CERESIS. The Government of Brazil expects it shall soon present the Multinational Agreement to its Congress for approval. The ambassador of Spain in Peru, was authorized by his Government to sign the CERESIS Mutinational Agreement; Brazil was therefor incorporated as a member State of CERESIS.

The Director's report covers the period from October 1987 to July 1989. The Council discussed the following topics:

- **Project SISRA and CERESIS Seismic Hazard Map**

SISRA ended. It was a very important project; and an example of a regional project successfully executed by national scientists and institutions; more than 200 south American professionals and technicians were involved. Dr. S.T. Algermissen is to be commended for his able guidance and efficient USGS-CERESIS coordination. The Auditing Office of the USGS has inspected and approved the project accounts.

Consideration of SISRA 2 was postponed indefinitely pending approval of USGS Project WWERM. Dr. Algermissen briefly explained Project WWERM - a five year program proposed by USGS. One-year WWERM pilot projects were executed in Chile and Indonesia. Similar pilot projects were scheduled for Peru and Morocco but were not yet funded.. The objective of WWERM is to demonstrate the feasibility, importance, and applicability of global earthquake hazard and risk assessments in three key geographical areas with different modes of earthquake occurrence, construction methods, types of construction materials and different national economies.

- Morocco: This country experienced significant damaging earthquakes all through its history. Morocco was at the time undergoing considerable economic development and construction and was a classic area for the assessment of earthquake hazard and risk.
- Peru-Chile: The western coast of south America is one of the world's most devastating earthquake zones. Data necessary for probabilistic ground motion assessment and the estimation of economic losses from earthquakes are available in both Peru and Chile.(Project :”Earthquake Hazard Mitigation in the Andean Region, OFDA/USGS–CERESIS). Peru-Chile is an area where a well-designed

demonstration study of earthquake loss potential would have great impact.

- Indonesia: The southern coastal areas of Indonesia have produced some of the world's great earthquakes which caused considerably damage throughout history. As in South America , a cooperative OFDA/USGS five year project entitled "Earthquake Hazard Mitigation Program in Southeast Asia" published seismological and geological data critical to the assessment of earthquake hazards in the countries comprising the Association of Southeast Asia Nations.

The significance of the research results is that they make available the necessary data for the quantitative assessment of seismic hazard and risk. Uniform catalogs of seismicity and seismotectonic maps are the basic materials required for any assessment of earthquake ground motion and geologic effects. The basic products will be produced for selected areas within each targeted country. They serve two important purposes: 1) to obtain political support for earthquake hazard mitigation in the country, and 2) to meet the needs of potential donors to WWERM. The products are: Probabilistic earthquake ground motion maps and quantification of the loss estimation model needed for probabilistic and deterministic estimates of earthquake losses.

The Council considered that CERESIS should proceed with the regional seismic hazard map as planned, with or without external financial aid. The Council took into account the USGS's offer of technical and material support, and the uncertainty of Project WWERM being funded. In any case, if Project WWERM were approved, so much the better. The Council appointed a Committee to coordinate the technical aspects of the project.

- **" Volcanic Risk, Evaluation and Mitigation in Latin America. Social, Institutional and Scientific Aspects".**

IDRC provided additional funds for a video tape and for the publication and distribution of the report (after approval by the Government of Colombia). CERESIS presented IDRC a proposal on "Natural Disasters in Latin America; Public Policies, Participation and Development", for a \$ 350,000 project to be executed in 30 months.

- **Data Bank and Regional Digital Seismic Net (Project REDAS).**

The objectives of the proposal, presented by Jesus Berrocal (Brazil) and Robert Masse (NEIC-USGS), were to increase the number of hypocentral locations of earthquakes occurring in the region, by determining the hypocenters of events not included in ISC and NEIC bulletins, and to improve NEIC and ISC locations specially for earthquakes with $M_b < 5.0$. Another objective is to compile all existing data for earthquakes occurring in the region and disseminate the information among users inside the region to help and encourage

seismological research at local and regional levels. A Regional Digital Seismic Net for South America would enable CERESIS to report quick preliminary hypocentral locations of all potentially destructive earthquakes ($M_b > 5.5$) which occur in South America (about 4 per month), within the first hour after the occurrence of the event. New stations would be equipped with broad band, high dynamic range seismometers. Details of Project REDAS are available from CERESIS. There are many reasons and needs to justify support for the project. It was also necessary to improve performance of the existing regional net. Countries should be stimulated to installed dense local nets in specific active areas to obtain high location accuracy of local seismicity, specially of low magnitude events. The budget for the five-year project REDAS was estimated at \$ 5,700,000.

It was noted that the U.S. Government was sponsoring the installation of four GTNS in Paraguay, Argentina, Bolivia and Brazil; GEOSCOIPE had already installed a station in Surinam, a second station was being installed at the northern tip of the Antarctic Peninsula, and a third station was planned for Heredia, Costa Rica. IRIS was considering 3 or 4 stations in South America, for Project REDAS.

- **International Decade Natural Disaster Reduction - IDNDR and Cuban Academy of Sciences.**

The Tokyo Declaration (11 April 1989) of the ad-hoc Special International Group of Experts for the IDNDR was distributed to CERESIS member States. The Director recommended that CERESIS have an active role in supporting IDNDR activities in the region; CERESIS national representatives should establish close ties with the IDNDR National Committees. The Group of Experts stated that the IDNDR was "a moral imperative".

The Second International Congress on Natural Disasters took place in La Habana, Cuba, on July 3-7, 1989. In the framework of the Congress UNDRO organized an IDNDR preparatory meeting to examine disaster mitigation priorities in Latin America and the Caribbean. CERESIS cooperated by urging its member States to reply to the UNDRO Questionnaire, designed to find out each country's needs with regard to mitigation of disasters which could affect them. CERESIS processed the information received. The CERESIS Director was invited to present the results to the Congress. The president of the Academy of Sciences of Cuba, who attended the Congress, invited the CERESIS Director to visit the Academy and proposed that CERESIS and the Academy sign a Declaration of Intent. The ceremony took place at the Academy on July 8, 1989. A Declaration of Intent was signed by the Director of the Department of Geophysics and Astronomy of the Academy and Alberto Giesecke, as Director of CERESIS. It was hoped it would lead to closer and mutually beneficial ties, with exchange of information, and publications, and training, - for a better understanding of seismic processes,

- **IASPEI Commission on Earthquake Hazard and Prediction**

CERESIS Director was invited to be a member of the Commission's Working Group on Seismic Risk chaired by Karl V. Steinbrugge.

- **CERESIS Award 1989**

The Council elected Dr. S.T. Algermissen for the CERESIS 1989 Award. Dr. Algermissen's outstanding contributions to south american seismology and to CERESIS in particular, in the past 20 years, were beyond any doubt a key element for seismological progress in the region.

- **UNESCO sponsored activities**

No significant earthquakes occurred during the report period. UNESCO funded Dr. Berrocal's travel to prepare the proposal for Project REDAS and for the translation of EERI's book "Reducing Earthquake : Lessons Learned from Earthquakes" EERI offered to publish the spanish version, to which a Glossary of Terms, in spanish, was added by CERESIS.

- **Earth Physics Institute (EPI) - USSR**

Three EPI projects were of interest to CERESIS: Use of CD-ROMs, Global Neotectonic Regionalization and Identification of Earthquake-prone Areas, and Earthquake Prediction Theory Dr. A. D. Gvishiani advised CERESIS it would be invited to participate in these projects.

- **CEPREDENAC - Centro de Coordinación para la Prevención de Desastres Naturales en América Central.**

The idea of CEPREDENAC was inspired by CERESIS. SIDA, the Swedish International Agency for Aid and Development, offered to sponsor the creation of an inter-institutional Regional Center. Each of the six countries involved: Guatemala, Honduras, El Salvador, Nicaragua, Costa Rica and Panama would be represented by the Civil Defense or Emergency Organization and by the leading Geophysical Institutions, public or private. Two representatives from each country and a full time Director constituted the Directive Council. Sweden's financial commitment amounted to two million dollars for the first two years and an additional three million dollars for an additional three years. The institutions had no financial obligations to CEPREDENAC. CERESIS participated in the process.

- **Courses, Seminars and Symposia:**

- Workshop on Natural Hazards and Planning for Development. Scheduled for Lima, 1st semester of 1990, 10 participants.

- International Symposium on Intraplate Seismicity in South America.
The meeting was scheduled for 20-24 November 1989, in Rio de Janeiro. Organized by the Brazilian Society for Geophysics. CERESIS co-sponsored the meeting.
- Fourth Biennial Congress: Destiny and Hope for the Earth.
The event took place in Managua, Nicaragua, on 5-9, June 1989. The CERESIS Director was invited by the Local Organizing Committee. The purpose of the Congress is to search for ways and means to construct a viable and sustainable society, free of global threats of any kind, including environmental (earthquakes also) hazards. One of the sessions was on natural hazards and the IDNDR. One thousand persons participated in the Congress; 500 from Nicaragua and a similar number from outside Nicaragua.
- Third World Academy of Sciences (TWAS) General Conference.
To be held in Bogotá, Colombia, on 16-20 October 1989. The CERESIS Director was invited to organize an informal CERESIS workshop.
- **Donation.**

The Peruvian CERESIS Liaison Institution, the National Council for Science and Technology (CONCYTEC) donated two computers (worth \$13,000 dollars) to the CERESIS Library.

TWELFTH MEETING OF THE CERESIS DIRECTIVE COUNCIL

The meeting took place in **San Juan, Argentina on March 3 – 8, 1992**, hosted by INPRES. Council members present were Juan C. Castano (Argentina and PAIGH), Angel Vega (Bolivia), Alberto Sarria (Colombia), Edgar Kausel (Chile), Hugo Yepes (Ecuador), A.J.Martin Martin (Spain), Jorge Alva (Peru), Lloyd Lynch (Trinidad), Alberto Benavidez (President - Uruguay), Jorge Mendoza (Venezuela), Michio Hashizume (Head Earth Sciences Division, UNESCO), Alberto Giesecke (Executive Director). Observers: Mario Bufaliza (Argentina), Alberto Veloso (Brasil), Omar Dario Cardona, Andres Velasquez (Colombia), Jesus Berrocal (Invited Expert - Brazil). This was the first time that the official representatives of all 10 member States were present at a Council Meeting, as well as the delegate from Brazil, soon to become a member State.

The same week INPRES celebrated its XXth anniversary with a Seminar on May 4-5 on "Seismic Prevention, a Shared Responsibility" and on May 6-8 on "Criteria for Earthquake-Proof Design Spectra". The schedule for the CERESIS Council sessions permitted Council members to attend Seminar sessions of their interest.

The Director's Report covered the following topics, for the period August 1989 - April 1992:

- **CERESIS Seismic Hazard Map for South America**

Significant progress by the CERESIS member States, in fields pertinent to the preparation of seismic hazard and risk maps, - updated earthquake catalogs, historical seismicity, attenuation, definition of seismogenic zones, neotectonics, site response and surface geology had motivated the Council to approve the CERESIS seismic hazard map as a regional project. The map required a similar level of national know-how and data available, the use of uniform formats, norms and methodologies.

The first step was to update SISRA catalogs of Focal Parameters and Intensities, through December 1990. A visit to Lima by Dr. S.T. Algermissen, on 11-13 November 1991, to coordinate with CERESIS possible USGS support for the regional seismic hazard map. Algermissen described in detail the USGS-Chile project which produced probabilistic ground acceleration maps with a 90% probability of not being exceeded in 50 years, probabilistic intensity maps for MM VI - MM IX, for 50 years and 10% probability of being exceeded, specific site response maps associated with surface materials, and maps combining site response with intensities to determine the intensity of ground shaking for areas of particular interest. The maps produced for Chile are useful for disaster preparedness plans, mitigation, land use regulations and seismic risk studies and were relevant to the proposed CERESIS Seismic Hazard regional map. Dr. Algermissen offered to put the SISRA catalogs on diskettes, eliminating events of Magnitude less than 4.5 and Intensities less than MM V, CERESIS would include reliable data from local nets, focal parameters for historical events that might have been recalculated, data through December 1990 from ISC and NEIC. The USGS also offered in situ advice of Paul Tenhaus, the USGS expert on seismogenic zones, who would visit the countries as needed.

- **PAIGH Seismic Hazard Map for South America and the Caribbean**

The PAIGH Geophysics Commission obtained a \$ 467,000 dollars grant from Canada (International Development Research Center – IDRC), for a 5 year project to establish working relations between the principal regional centers and to execute a project with objectives similar to those of the CERESIS Seismic Hazard Map project for South America. CERESIS offered PAIGH the pertinent information for South America, in the context of CERESIS' policy of unrestricted dissemination and exchange of information. The offer included the SISRA maps, regional and national earthquake catalogs for focal parameters and intensities, historical seismicity, and the Seismic Hazard Map - when available. CERESIS requested that PAIGH acknowledge CERESIS's authorship, in all PAIGH project publications; PAIGH was to provide CERESIS with funds for specific tasks, as needed.

- **Global Seismic Hazard Assessment Program (GSHAP).**

GSHAP was launched by the International Program of the Lithosphere (ILP) as a contribution to the IDNDR. It began with a meeting in Rome, June 1992. The purpose of the meeting was to discuss the state of seismic hazard assessment around the globe, the elements of modern seismic hazard assessment, earthquake catalogs and databases, recent scientific developments for seismic hazard developments, seismotectonics, earthquake source zones, strong motion, hazard computations, the establishment of a Coordinating Center and Regional Centers, regional meetings and a Steering Committee. GSHAP considered that regional centers were the key for the entire Program. The project, its philosophy and goals coincided so closely with CERESIS and its activities during the past several years, that the CERESIS Council felt gratified. CERESIS could be proud of its accomplishments, and continue to have an important role in developing South American seismology. The Council took note of GSHAP's invitation and asked the Director to attend the June, 1992 Rome meeting

- **Project WWERM (USGS-OFDA)**

One of Project WWERM's objectives is to evaluate seismic hazard and risk. The initial phase of the project considers 3 pilot areas: Indonesia, Peru-Chile, and Morocco. The Chile part had already been executed by Chile-USGS. Peru prepared its proposal to WWERM (\$350,000), patterned after the USGS-Chile, and presented it to the USAID Lima, in the framework of the CERESIS regional seismic hazard map.

- **Reconnaissance Missions**

During the report period, three missions visited affected areas. Two of the earthquakes occurred in the same general area in north central Peru. The first, an Mb 6.0 event, on 29 May, 1990, and the second one, a Mb 6.2 shock on 5 April, M1991. The 1990 event destroyed 14,000 homes; 34 persons died. The small number of victims can be attributed to the time of day when the earthquake occurred, the simple one story houses with light roofs, from which it was easy to escape and the rural environment. The second mission had the opportunity of applying epidemiological methods to correlate deaths, injuries and material damage, and to observe in great detail the pattern of damage to adobe housing. The mission included two doctors (M.D.) from the Oficina Panamericana de Salud (WHO-OPS-PAHO) in Lima. It was the first time medical doctors and geophysicists worked together.

The third mission, organized at the request of the University of Costa Rica, studied the Limon (Costa Rica) / Bocas del Toro (Panama) area, was coordinated by Jose Grases of Venezuela and included experts on strong motion records, soils, and structural engineering, from Venezuela, Costa Rica and Panama.

The Missions were funded by UNESCO's Regional Office in Montevideo CERESIS published the respective reports.

- **Intermediate Term Earthquake Prediction Project**

On December 1991 the CERESIS Director, Professors G. Panza and V.I. Keilis-Borok, met in Trieste at ICTP to discuss a four-year project: "Intermediate-Term Earthquake Prediction in Peru and Adjacent Regions", to be presented to the European Community; it was endorsed by ICSU and the IDNDR. The cost: Euros 1,113,000.

- **Seismological Database and Digital Seismic Network in South America**

At the request of CERESIS, Jesus Berrocal (Brazil) visited most of the South American countries to present to inform the leading seismological institutions, of the main aspects of the project to establish a regional seismological database and to seek their support for its operation.

The ISC catalog listed over 200 south-American stations presumably in operation; however, most of the stations do not regularly send data to international centers. There is a large amount of unassociated seismicity data in relation to NEIC hypocentral determinations; in addition, there are a number of events each month which are considered too poorly located to be useful, not enough stations report the events, there is insufficient azimuth control and the computed location is far from where the true epicenter should be as deduced from the residuals of S-phases. From a detailed analysis of the situation, it was seen that the present south-American seismic network actually comprises a relatively small number of stations, around 60, that regularly report to ISC and NEIC and that only a few areas are adequately covered by a reasonable number of stations. Seismicity and seismotectonic studies rely mainly on the number and quality of hypocentral determinations. By using frequency-magnitude relations it is possible to infer the expected number of seismic events that should be observed in the Andean region in particular. It appears that less than 20 per cent of earthquakes with $M_b = 4.0$ that can be expected to have occurred, are found in ISC catalogs. An immediate result of a CERESIS proposal would be to reach a threshold of $M_b = 4.5$. Some objectives of the project are to install three new digital broad-band stations at key locations, upgrade short period analog networks, to be able to report quick preliminary hypocentral locations of all potentially destructive earthquakes ($M_b = 5.5$), and if possible, with the solution of the focal mechanism and focal parameters. The proposed research will contribute to fundamental science - a more reliable description of seismicity patterns and seismotectonic relationships, removal of many uncertainties concerning stress. Teleseismic waveforms contain information in a frequency band of interest to structural engineers; temporal variations in seismic risk is another problem that can be addressed. The Council considered Berrocal's report a very important

document, and urged the member States to analyze it and to consider their own possibilities of improving national nets and procedures of reporting data to international centers.

- **VIIth CERESIS Course for Seismic Station Operators.**

The course was held in Quito, Ecuador at the Escuela Politecnica Nacional (ESPONA), on march 4 - 22, 1991, under the direction of Minard L. Hall of Ecuador, ESPONA's Technical Director. 19 students from nine countries participated. This was the first CERESIS course to include volcanic activity in addition to operation, maintenance and repair of seismic stations, interpretations of seismograms, location of epicenters, data processing and the utilization of digital data. An introduction to volcanology, the monitoring of volcanic activity and excursions to Cotapaxi volcano were new in the context of CERESIS courses. At Cotapaxi, students were able to observe a System for Volcanic Vigilance.

A preliminary Agreement with the USGS considered the possibility of developing joint NEIC-CERESIS courses "Understanding Earthquakes and Mitigating their Effects"/"Cursos para Operadores de Estaciones Sismicas", in spanish, for Latin Americans .

Dr. Pierre Usselmann, Head of France's Regional Office for Cooperation, offered to sponsor travel costs within South America, of participants to regional scientific meetings in the CERESIS region.

- **XXVI UNESCO General Conference. October 1991**

The Conference, considering that CERESIS had made a significant contribution to seismology and the mitigation of damage caused by earthquakes, that efficient regional and international cooperation is a basic condition to attain good results and its financial difficulties, resolved to invite the Director General of UNESCO to urge the member States of CERESIS to comply with their commitment to support CERESIS and also invited the Director General to urge potential country donors and international funding agencies to provide voluntary contributions that would allow CERESIS to continue and expand its regional and international contributions to seismology and earthquake risk reduction. The Director General recognized the important role that CERESIS has; in his opinion the IDNDR Secretariat and the STC should take note of the situation.

- **International Decade For Natural Disaster Reduction - IDNDR.**

In 1987 the U.N. General Assembly approved a United Nations Decade for the nations of the world to work together to reduce the number of victims and material losses caused by natural phenomena. The Decade would begin on 1 January 1990 and end December 31, 1999. 20 Experts from different countries and regions of the world, were invited by the

U.N. Secretary General to serve as members of a U.N. Special Working Group for two years (1988-89). The Group, under Dr. Frank Press, as Chairman, would produce guide-lines and a framework for the Decade. CERESIS Director Alberto Giesecke was invited. The Group produced a document which was submitted to the U.N. General Assembly in 1989 for approval. IDNDR was officially launched. Funds were allocated for the Decade Secretariat in Geneva. The Group recommended the appointment of a Scientific and Technical Committee (STC) for the Decade (similar to the pre-Decade "Special Working Group".) The CERESIS Director was invited to be an STC member; members were appointed for one or two three-year terms. The STC met once a year in different parts of the world. One of IDNDR's activities was to widely publicize "IDNDR Demonstration Projects" that donor countries and/or international funding agencies might be willing to sponsor. Proposals for such projects were evaluated by STC; those considered practical and potentially useful were selected as IDNDR demonstration projects. Hopefully they would show threatened populations how to protect their lives and reduce their material losses. The IDNDR itself did not fund the projects; the "accepted" proposals would be endorsed by IDNDR and presented to donor countries and funding agencies. Toward the end of the Decade, demonstration projects would be evaluated and officially recognized as successful Decade Projects or not.

CERESIS prepared five proposals for the IDNDR which it presented to the STC at its Second Meeting in 1992, in Guatemala. These were:

1. Volcanic Risk – CAVOL
2. Natural Disasters in South America – Information for reduction of vulnerability.
3. Seismic Reinforcement of Existing Adobe Houses in the Andean Region
4. Medium- Term Prediction of Earthquakes
5. Seismological Data Bank and Digital Seismic Net for South America

The Scientific and Technical Committee (STC) approved the second proposal: Seismic: - Seismic Reinforcement of Existing Adobe Housing in the Andean Region:

Approximately forty million persons live in the Andes - a very active seismic region - in highly vulnerable, and traditional non-engineered adobe houses. The inhabitants of the Andean region are very poor. It is inconceivable that they themselves would reduce their structural vulnerability by relocating or rebuilding their homes with better materials. Neither is it realistic to suppose that governments, NGOs or international funding agencies, are able and willing to lend (donate) money for such a purpose. CERESIS proposed an alternative solution that would focus on protecting the lives of the people and not on saving their homes. Alive, they themselves could build their new home The idea was first discussed by a CERESIS working group which met in Lima in 1987 and 1988. The

group drafted a proposal to discuss simple reinforcement techniques, bearing in mind the cost, availability of reinforcing materials, and how much protection was acceptable. The idea was to prolong the amount of time the existing house could withstand strong shaking before it collapsed. A proposal was presented by CERESIS to the IDNDR STC in Guatemala. It was accepted as an IDNDR Demonstration Project. The goal was to produce a technique that would give the house an additional ten or fifteen seconds of "life". The Catholic University of Lima has a large horizontal shaking table on which large scale models of existing adobe houses can be built and tested; the table is activated by a computer that simulates earthquake shaking. The extra seconds gained through reinforcement makes it possible for people to escape from their house before collapse. The Council authorized the Director to contact potential donors to fund the project.

- **IASPEI Regional Assembly in South America**

Dr. Jesus Berrocal, Brazil, early in 1992, discussed with IASPEI Secretary-General Dr. E.R.Engdahl the possibility of holding a IASPEI Regional Seismological Assembly in South America (probably Brazil). It appeared possible for 1994. On the other hand the majority of the CERESIS Council members were interested in a I Regional Meeting to review what CERESIS had accomplished in 25 years, how to improve its performance and discuss the future. The Council instructed the Director to pursue the possibilities for a IASPEI Meeting, a CERESIS Assembly or a combination of both.

- **International Course on the Use of Information on Natural Hazards and Risks in the Preparation of Investment Projects**

The Course, scheduled for September - October 1992, in Lima, Peru, was financed and co-organized by the Department of Regional Development and Environment of the Organization of American States (Dr. S. Bender), the Peru-Japan Center for Seismological Research and Disaster Mitigation (CISMID) and CERESIS. The purpose of the Course was to train persons responsible for taking decisions relevant to the mitigation of natural disasters at the planning stage and during the process of formulating specific projects.

5. EXTRAORDINARY MEETING OF THE CERESIS COUNCIL.

The Council met in **St. Augustine, Trinidad and Tobago on 10 – 16 October 1993**. The meeting was hosted by the Seismic Research Unit of the University of West Indies. The government of Trinidad and Tobago invited the CERESIS Council to meet in T.T. and to participate actively in the Caribbean Conference on Natural Hazards, scheduled for the week of October 10. The Government of T.T. paid its debt to CERESIS for over-due annual quotas. The

French Regional Cooperation Program offered air-fare for CERESIS participants from the Andean countries.

Council members present were Juan C. Castano (Argentina, President), Lawrence Drake (Bolivia), J.Alberto Veloso (Brazil), Fernando Muñoz (Colombia), Edgar Kausel (Chile), Fabian Bonuilla (Ecuador), Julio Mezcuca (Spain), Leonidas Ocola (Peru), Lloyd Lynch (Trinidad) Alberto Benavides (Uruguay), Jorge Mendoza (Venezuela), Alberto Giesecke (Executive Director) Observers: S.T.Algermissen (USGS), Jose Grases (Venezuela).

The Director's Report covered the period from May, 1992 to September 1993. National Reports were presented.

- **Brazil, Spain and Paraguay - CERESIS Member States**

The governments of Brazil, Spain and Paraguay signed the CERESIS Multinational Agreement. In most countries it was required that the Agreement (Treaty) had to be ratified by Congress. Brazil and Spain ratified the Agreement recognizing CERESIS as an International Autonomous Regional Organization and the Regional Center for Seismology for South America.

- **IDNDR Demonstration Project - To Reinforce Adobe Housing**

The German Agency for Development - GTZ - agreed to provide CERESIS DM 600,000 over a three year period to carry out the proposed project to reinforce existing adobe houses in the Andean region against earthquakes. Administrative procedures were complicated by the fact that CERESIS is a Multinational Organization; it was a first experience for GTZ. The project was expected to start not later than 1994.

- **CAVOL - Andean Volcanological Center**

"Partners of America" invited CERESIS to a Meeting held in Quito, Ecuador, on 29 and 30 June, 1992 to analyze the possibility of creating the "Andean Volcanological Center" - CAVOL - as a Special CERESIS Program, hosted by the Escuela Politecnica Nacional in Quito. POA were willing to donate \$14,000 - seed money for the project.

- **Agreement with PAIGH (Geophysics Commission) on the Production of the Seismic Hazard Map.**

PAIGH considered it necessary that an Agreement be signed with CERESIS to make sure that CERESIS would provide the information relevant to the PAIGH Seismic Hazard Map for Latin America and Caribbean. PAIGH offered to pay CERESIS up to \$62,500, for expenses as needed. The amount represents approximately 13.5% of PAIGH project funds. 86.5% was assigned to Central America, the Caribbean and administration.

- **Global Seismic Hazard Assessment Program (GSHAP)**

The Director attended the Rome GSHAP Technical Planning Meeting held in Rome, June 1-3, 1992. Alberto Giesecke presented the situation of seismic hazard assessment in South America and CERESIS activities. Catalogs and data bases, recent scientific development for seismic hazard assessment, seismotectonics, source zones and hazard computations were discussed. A Coordinating Center and six Regional Centers were announced, and a preliminary delineation of regions and locations. Regional Working Groups were formed to discuss how to implement GSHAP. CERESIS was recognized as an already existing Regional Center for GSHAP Region 5 - South America.

GSHAP's five-year program budget allocated \$2,480,000 dollars for the first operational phase and \$2,760,000 for the second phase - A total of \$5,240,000. The first 2-year budget for each Regional Center allocated \$40,000 for regional meetings, \$80,000 for hardware and set-up costs, and \$240,000 for operations, - a total 2-year budget for each Center of \$ 360,000 dollars. The 2-year second phase budget for each Regional Center allocated \$60,000 for regional meetings and \$320,000 for operations, a total of \$320,000 for each Regional Center!. GSHAP appeared to be a golden opportunity for CERESIS to function at its maximum potential, without the permanent handicap of severe financial constraints..

Dr. Domenico Giardini was appointed Project Coordinator and chief of the Coordinating Center prior to the meeting. Alberto Giesecke was invited to be a member of the Scientific Steering Committee.

- **Caribbean Conference on Natural Hazards: Volcanoes, Earthquakes, Winds Storms and Floods.**

The Conference was held in Port of Spain, Trinidad and Tobago, on October 11-15, 1993. Council members and observers present were: Juan Carlos Castano (Argentina - President), L. Drake (Bolivia), J.A.Veloso (Brazil), F. Muñoz (Colombia), Edgar Kausel (Chile), Fabian Bonilla (Ecuador), Julio Mezcuca (Spain), Leonidas Ocola (Peru), Lloyd Lynch (Trinidad), Alberto Benavides (Uruguay), Jorge Mendoza (Venezuela), Alberto Giesecke (Executive Director). Observers: S.T. Algermissen (USGS), Jose Grases (Venezuela).

- **Regional IDNDR Conference.**

The meeting was scheduled for Cartagena, Colombia, march 21-24, 1994, to discuss "National Experiences on the Reduction of Disasters". CERESIS would co-sponsor the meeting. It was an opportunity to present progress on the CERESIS Seismic Hazard Map for South America, the Adobe Reinforcement Project and Project REDAS: Establishment of a Digital Seismic Network and a Seismological Data

Base for South America". Alberto Giesecke would participate in the Meeting as CERESIS Representative and member of the IDNDR STC.

- **Project SNAPP - South America - Nazca Plate Motion Project.**

The project, launched by NASA with other institutions, aimed at GPS Geodetic Monitoring of the South America-Nazca Plate Convergence to study the dynamics of the solid earth. Scientists from Argentina, Chile, Peru, United States, Germany and France participated in the project. CERESIS cooperated with SNAPP in Peru.

- **CERESIS Regional Seismic Hazard Map.**

The countries reported on their updated catalogs: They were revised and integrated by CERESIS. The following time-table was agreed:

- 1) Dec. 5-11, 1993 Installation of state of the art equipment and software at INPRES, for probabilistic evaluation of seismic hazard. The equipment and sophisticated software (developed by USGS at a cost of about one million dollars) were transferred at no cost to CERESIS. INPRES personnel was trained in situ by USGS experts, with regard to both the hardware and the software.
- 2) March 4-10, 1994. CERESIS Workshop at INPRES to review the information received from the member States - seismogenic zones, catalogs, attenuation laws.
- 3) March 21-24, 1994. Presentation of a preliminary version of the CERESIS Seismic Hazard Map, and other CERESIS products at the IDNDR Conference in Cartagena, Colombia - if possible.
- 4) June 30 - Dead-line for the revision of the Map by the member States.
- 5) Not certain. Corrections, additions or modifications by the member States, to be incorporated by INPRES, as soon as ALL of the member States provided the information. Only then would the map be considered a "finished" product, to be published and widely distributed, including to PAIGH and GSHAP.

- **Regional Digital Seismic Net for South America - Project REDAS**

CERESIS' objectives are to promote efficient links between seismological institutions of the region and between these and international geophysical centers, to create a system to integrate, process and distribute regional earthquake information or related to the region, and in the case of destructive earthquakes and/or tsunamis, to be able to quickly provide preliminary focal parameters.

CERESIS, spent much time and effort putting together a well fundamented and viable proposal. Key contributors were Jesus Berrocal, CERESIS Council members, Robert P. Masse (USGS), Michio Hashizume, (UNESCO), and Julio Mezcua (Spain) who contacted

Domenico Giardini (Inst. Nazionale Geofisica, Italy), Bernard Dost (ORFEUS, Holland) and Winfried Hanka (GEOFONE, Germany), all of whom expressed their willingness to participate in the project. Berrocal had the opportunity of meeting with them at the Paris, September 1992, Symposium "Ten Years of GEOSCOPE".

Early in 1992, CERESIS presented the proposal to the European Community (EC) in Brussels: "Establishment of a Digital Seismic Network and a Seismological Data Base for South America" requesting 600,000 ECU for a three year project: 1992 - 1995. The proposal was not accepted because the EC arbitrarily did not recognize CERESIS as a bonafide International Organization for South America; it only recognized the Andean Pact (a sub-regional group: Venezuela, Colombia, Ecuador, Peru and Bolivia, created essentially for commercial integration and also to promote cultural ties). The Andean Pact does not include Chile, Argentina, nor the rest of the CERESIS countries. Efforts to reverse EC's decision did not succeed.

- **Regional Seismological Assembly in South America**

It was decided that the Assembly be held in Brasilia, August 2-26, 1994. The First Announcement and Posters were sent out from Brasilia. It had not yet been definitely decided if the Assembly was to be a Regional IASPEI event or a CERESIS regional meeting. The Local Organizing Committee had not been appointed. Scientific topics proposed by CERESIS, in the case of a CERESIS Regional Meeting, were: 1) local and regional seismicity studies; 2) crust and mantle structure including seismic tomography; 3) distribution of stress in the lithosphere, focal mechanisms and source parameters; 4) seismology of strong shocks; 5) recent large earthquakes; 6) evaluation of seismic hazard and risk; 7) seismological studies associated with volcanic processes; and 8) geothermal research. Drs. K. Aki, H. Kanamori, R. Madarriaga, and A. Udias would be invited to be Conveners.

CERESIS considered the following courses to be offered during the Assembly: 1) quantitative seismology, 2) training in interactive analysis of digital seismic data (ISOP) and 3) application of IASPEI software for acquisition and data processing.

The Council proposed the following persons as members of the CERESIS Scientific Committee: M. Assumpção, a. Benavides, J. Berrocal, L. Drake, E. Kausel, J. Mendoza and L. Ocola.

Funding possibilities included IASPEI - IUGG - TWAS - ILP - CERESIS. - UNESCO, - OAS, and Registration Fees. The Council noted that \$80,000 would be an optimistic estimate. By the end of August, it would be possible to estimate the budget for travel grants to south American participants.

- **Geophysical Atlas for South America.**

Julio Mezcua (Spain) proposed that CERESIS produce a regional Geophysical Map. The Instituto Geografico Nacional in Madrid would publish it. They will also publish a wall-version of the CERESIS Regional Seismic Hazard Map, on a scale of 1:5,000,000.

- **Sub Regional Technical Meetings**

With UNESCO funds and co-sponsored by CERESIS, three meetings took place to reinforce the process of data exchange, coordination and planning, in the context of the IDNDR and the CERESIS Seismic Hazard Map project:

- Asuncion, Paraguay, 26 - 30 September 1992. - IDNDR, UNESCO and WMO- Delegates from Argentina, Brazil, Panama, Paraguay and Uruguay.
- Santiago, Chile, 6-10 December 1992. -USGS- Delegates from Argentina, Bolivia, Chile and Peru.
- Caracas, Venezuela, 14-16 March 1993.- FUNVISIS-. Delegates from Argentina, Colombia, Ecuador y Venezuela.

6. EXTRAORDINARY MEETING OF THE CERESIS COUNCIL.

The Meeting took place on **22-25 November, 1995, in San Juan, Argentina.**

Council members present were Juan Carlos Castano (Argentina - President), Alberto Veloso (Brasil), Edgar Kausel (Chile), Julian Escallon (Colombia), Hugo Yopez (Ecuador), Julio Mezcua (España), Juan Carlos Velazquez (Paraguay), Jorge Alva (Peru), Alberto Benavides (Uruguay), Herbert Rendon(Venezuela), Juan Carlos Castano (PAIGH), Alberto Giesecke (Executive Director). Hosted by Instituto Nacional de Prediccion Sismica (INPRES). Observers: Klaus Bataille (Chile), Leandro Rodriguez (Peru).

The president informed that the meeting had been called in view of the fact that the Regional Workshop of GSETT-3, in the framework of the U.N. Disarmament Conference, took place in San Juan on 20-22 November, under the auspices of the group of scientific experts. Ten CERESIS Council members attended the GSETT-3 Workshop.

The Director's report covered the period from October 1993 to October 1995:

- **Financial Situation**

The total amount of unpaid annual quotas of the member States including the quota for 1996, totals \$ 235,155 dollars. Of this amount ,

\$ 103,800 dollars will be paid by Peru very soon. CERESIS has been able to function because of the contracts with PAIGH, GTZ, and timely annual quotas paid by Argentina, Chile and Spain. No less important was CERESIS' policy of avoiding all but strictly necessary expenditures.

- **Legal Aspects**

The Director recommended that the Statutes be revised and modified as necessary. Members were invited to send proposals by Internet. The Council postponed discussion of this subject until its next council meeting.

- **Seismic Reinforcement of Existing Adobe housing in the Andean Countries.**

GTZ- German Agency for Development awarded CERESIS a four-year Grant. CERESIS signed an agreement with the Catholic University of Peru (PUCP) for a three year laboratory research and testing program to be carried out with use of a large shaking table. Members of the University's Department of Civil Engineering, with many years of experience in the use of adobe for constructions, accepted the responsibility of executing the laboratory program and to obtain the best possible technical low-cost simple solution. The fragile behavior of adobe houses is due to the lack of a structural element that controls the size of the cracks generated by the poor behavior of the adobe. The first laboratory results indicate that unreinforced adobe houses collapse several seconds before those houses reinforced with planks or rope tied around the perimeter of the house. Results of initial tests using wire netting were promising.

- **Global Program for Seismic Hazard Evaluation (GSHAP)**

Although CERESIS was recognized as the GSHAP Regional Center for South America, and GSHAP funds were budgeted for the regional centers, CERESIS did not receive any financial or technical support from GSHAP. The periodic reports of the GSHAP Coordinator systematically ignored CERESIS. The CERESIS Director was unable to attend the GSHAP directive committees because GSHAP did not provide travel money. CERESIS's Director, by mail, brought this anomalous situation to the attention of the president of the Steering Committee.

- **International Decade for Natural Disaster Reduction (IDNDR)**

CERESIS Director reported that after seven years as a member of the IDNDR Group of Experts and STC, he had retired from official IDNDR activities. The IDNDR Secretariat suggested that after IDNDR, CERESIS consider being the leading institution in south America for natural disaster mitigation activities.

- **Project "Piloto"**

With the refusal of the European Community to accept CERESIS as a regional international organization, Dr. Domenico Giardini, who was aware of the situation, offered to contact the CEE in Brussels, an organization with which he was very familiar. His suggestion was that the five Andean countries - Bolivia, Colombia, Ecuador, Peru and Venezuela, member States of CERESIS, each present the same national proposal separately, with the sponsorship of Germany, Spain, Netherlands and Italy. Although the proposals were prepared by CERESIS the documents presented to Brussels were in no way similar to Project REDAS. Brussels approved the individual proposals from the five countries for a project identified as Piloto. The objectives of Piloto were to improve the monitoring capacity and capability of estimating the seismic hazard, optimize access to and use of advanced technology for monitoring and research, to develop efficient procedures for the location and magnitude estimation of regional earthquakes and to implement fast systems for seismic alerts, to initiate a data exchange system amongst the participating countries, to implement a regional parametric and digital data bank, to complete the compilation of instrumental and historical earthquakes and to produce a comparative study on methods to evaluate seismic hazards between the Andean and European countries. The project would terminate in July 1997. Project Coordinator was Domenico Giardini; the Scientific Committee members were the representatives from the five Andean and the four European countries. A decision was taken that no external scientists would attend the Piloto Scientific Committee meetings. Each Andean country received from Piloto a \$ 50,000 dollar grant; PILOTO Project funds were disbursed by Coordinator Domenico Giardini. CERESIS as such was not invited to any of Piloto's meetings although Piloto made use of the CERESIS Catalogs, Maps and CERESIS information and Piloto's scientists were CERESIS's Council members. Information from project Piloto to CERESIS was almost inexistent. Most of the work done under Piloto repeated what CERESIS had done or was doing.

- **Project SALSA - Scientific Alliance for South America**

SALSA was an initiative of the Carnegie Institute of Washington and IRIS. It was hosted by the Department of Geophysics of the University of Chile.. The purpose of SALSA was to coordinate South American efforts related to seismic hazard. The immediate task was to improve the precision of seismic locations in south America. A target for this effort were the temporary experiments with portable equipment by visiting scientists who prefer to keep their data for themselves, months or years, until they publish their research results. Klaus Bataille was in charge of the SALSA Center in Chile; he worked very closely with CERESIS and established a mutually beneficial link between SALSA and CERESIS.

- **Evaluation of Seismic Hazard and Risk of Urban Areas**

CERESIS with OAS and EQE International approached the Inter American Development Bank to explore the possibility of financing a project to evaluate the seismic hazard and risk in urban areas of Latin America and the development of profiles of disaster vulnerability. The application of methodologies adopted for the preparation of profiles permits the use of the information to formulate policies for economic development, the preparation of investment projects and the application of preparatory measures. If the IDB shows interest a formal proposal will be prepared and submitted to the Council for consideration.

- **AUTODRM : A System for the Exchange of Seismic Information in Spain**

The delegate from Spain presented the System used in Spain for the exchange of seismic information in quasi-real time. The generalization of automatic detection systems and electronic communication nets had made possible to automatically implement exchange systems between countries and regions. The system used in Spain has been adopted by the Euro-Mediterranean Seismological Center (EMSC) since early 1994. Three nodes - IGN Madrid, ING Rome and LDG Paris - administer the system. Its purpose is the quick determination of epicenters of M 5.5 or higher events. The system transfers the data received from 32 participating stations in 21 countries to the three nodal Centers. Dr. Mezcuca offered the interested CERESIS member States the pertinent software.

- **Regional Catalog CERESIS 91.H**

The SISRA Catalogs for South America, hypocenters and focal parameters have been updated through 31 December 1991 by INPRES and the CERESIS Office in Lima. The focal parameter Catalogs was 95% finished; work on the Intensity Catalog was at its initial stage.

- **CERESIS Regional Seismic Hazard Map.**

The preliminary version of the Seismic Hazard Map, prepared at INPRES by J.C. Castano and M. H. Millan, was presented to the Council for approval. Ecuador and Peru pointed out discrepancies between the regional map and their respective national hazard maps. Both countries were to submit a detailed report describing discrepancies in order to modify the regional map. The Council's approval of the map was conditioned to the above revision. The revised map and the corresponding manual were to be immediately delivered to PAIGH and GSHAP.

- **CERESIS Homepage**

The Council was informed that a CERESIS Homepage was being preparing for Internet. The member States were urged to provide information for inclusion in this Homepage. Amongst other things it was intended that the updated Catalogs and the probabilistic Regional Seismic Hazard Maps would be presented in the Homepage.

- **CERESIS Anniversary**

The Council recalled that in 1996 CERESIS would celebrate 30 years since it was created as a UNESCO-Peru Regional Center and 25 Years as a Regional Independent Intergovernmental Organization. The Council members were urged to propose scientific events to be held in Lima for these celebrations.

7. EXTRAORDINARY MEETING OF THE CERESIS COUNCIL.

This Extraordinary meeting was held on **June 30, 1996, in Lima, Peru.** Council members present were Edgar Kausel (Chile, president a.i.), Ramon Cabre (Bolivia), Jorge Alva (Peru) and Juan Jose Rueda (Spain), Alberto Giesecke (Executive Director). The meeting was held at CERESIS headquarters in Lima.

The Director's report for the period from December 1995 through June 1996. Included the following topics:

- **Amendment of CERESIS Statutes**

The main purpose of the meeting was to continue the discussion of the Statutes. It was urgent to modify the clause which referred to voting rights of the member States. The following modification was proposed:

To insert a second paragraph in Article IV - 6, as follows:

"If one half of the member States have lost their right to vote because they have not paid their annual quota to CERESIS in the past three years, the absolute majority of the members representing member States who have the right to vote, can authorize voting privileges, in that particular session, for member States who have lost their right to vote. This authoritative decision must be included in the minutes of the session and is only valid for that specific opportunity".

The purpose of this modification is to avoid punishing member States who may only temporarily be in arrears of paying their quotas.

The council resolved to approve the proposed Amendment to the Statutes.

- **Seminar on Seismic Topography**

Delegates at a Project Piloto Workshop, held in Lima on the same dates, proposed that CERESIS consider a regional project for seismic tomography. The Council approved the initiative and tentatively scheduled the Seminar for Lima for January 1997..

- **Retirement of the Executive Director**

The Council took note that the Director had expressed his intention to retire from CERESIS as soon as possible. The Council decided to take the necessary steps select a new Director. The Council had to be able to guarantee availability of fund to pay the Director's salary.

THIRTEENTH MEETING OF THE CERESIS DIRECTIVE COUNCIL

The meeting took place in **Lima, Peru on December 10-12, 1997**. The first day's session was held at the Peru-Japan Center for Seismic Investigation and Mitigation of Disasters – CISMID (Universidad Nacional de Ingenieria), and the following sessions at CERESIS.

Council members present were: J. C. Castano (Argentina-President), Angel Vega (Bolivia), Edgar Kausel (Chile), Jose Antonio Canas (Spain), Jorge Alva (Peru), Alberto Benavidez, (Uruguay), Mateo Casaverde (PAIGH). Alberto Giesecke (Executive Director). Observers: Jose Ignacio Badal (Spain) and Leandro Rodriguez (CERESIS).

The ambassador of Paraguay informed the Council that the Government of Paraguay has designated the University of Asuncion, the National Liaison Organization for CERESIS in Paraguay, and that the amount of their annual quota would be \$ 1,000 dollars.

The Director's reported on activities during the period from July 1996 to December 1997.

- **Financial Situation**

The debt of member States increased to \$ 280,598 dollars. The two major debtors were Argentina \$109,279, and Peru \$ 93,800. Both countries had officially informed CERESIS that they would pay their debt before Christmas.

It is a permanent worry for the Council that the member States do not pay their quotas punctually; CERSIS must solve this problem.

- **CERESIS Anniversary**

The Ministry of Foreign Affairs of Peru organized a ceremony to commemorate CERESIS's 25th anniversary as an Independent regional international organization, and the 30th anniversary of CERESIS as a UNESCO-Peru organization. The ceremony was held at the Palacio de Torre Tagle , on July 1, 1996. The ambassadors and national representatives of the member States, the UNESCO and OAS representative sand members of Peru's scientific community were present. Dr. Ramon Cabre S.J. , CERESIS's first Director, addresses the gathering.

- **CERESIS Award**

At the Anniversary Ceremony, the 1996 CERESIS Award was presented to Director Alberto Giesecke, for his outstanding contribution to the development of seismology in south America.

- **Post-Earthquake Reconnaissance Mission**

On November 12, 1996 an Mb 6.5 earthquake struck the city of Nazca, Peru and surrounding areas. The mission focused principally on three aspects: aftershocks, analysis of the impact on adobe constructions and study of soils identified with MM Intensity of VI or higher.

- **Preliminary Neotectonic Map of Peru**

The preliminary neotectonic map produced by the Geophysical Institute of Peru in 1991 was updated by Jose Machare with CERESIS support, a contribution to the Neotectonic Regional Map for South America and to GSHAP. The map is being digitalized for publication and distribution..

- **Historical Seismicity in South America in the XVI, XVII, XVIII and XIX Centuries**

A monograph on this subject, by Enrique Silgado F. was published by CERESIS

- **Regional Seismological Assembly in South America**

The Assembly was actually a IASPEI Regional Assembly. Funds and Meetings were IASPEI's responsibility. The Local Organizing Committee was Brazil's responsibility. CERESIS helped identify south American and other Latin American participants and provided administrative support; CERESIS also cooperated with LOC in the organization of some of the sessions and courses. Neither the President of the CERESIS Council nor the Director were able to attend. A CERESIS Regional Meeting could not be funded by IASPEI so the idea of a CERESIS Regional Meeting was abandoned. With the funds generously provided by IASPEI, IUGG,

ILP, UNESCO and TWAS it was possible for about 60 scientists from Latin America to participate in the meeting. As is always the case the IASPEI meeting was excellent and offered many of the younger earth scientists from the south and central American regions to attend a first class scientific meeting. 86 papers were presented and more than 100 scientists participated.

A small informal group discussed CERESIS, but without proper orientation and leadership the session was unproductive.

- **ICLA Conference in Amsterdam**

At the 2nd ICLA International Conference (Local Authorities Confronting Disaster Emergencies - LACDE), held in Amsterdam from 22 - 24 , April 1996, CERESIS was invited to present a talk on the project " Seismic Reinforcement of Existing Adobe Houses in the Andean Region". The number of participants was 547 from 87 countries.

- **Bechtel International Inc.**

CERESIS, under contract, cooperated with Bechtel to develop a "broad" ground motion shaking hazard estimate pertinent to the 650 km gas line from Camisea in eastern Peru, across the Andes to the Pacific coast.

- **Meeting on Seismic Tomography and Subduction in South America**

The meeting, sponsored by CERESIS, and UNESCO, was held in Lima, Peru, on 20-23 January 1997, hosted by IGP

Fourteen Seismologists from ten countries attended the Meeting. A Meeting Report is available from CERESIS. The main conclusions were: (1) It is important that the countries contribute data to a Data Bank sponsored by CERESIS as a regular practice; (2) it is necessary to identify true personal and institutional interest in tomographic studies; (3) it is necessary to eliminate isolation of individuals and institutions from a regional project in tomography by fluid communication, distribution of information, exchange of software, methodologies and formats for data, and coordination between active groups; and (4) to participate in a pilot project with available information.

A Special Session on Seismicity and Seismotectonics in Latin America, organized by William Spence, was held at the December AGU meeting in San Francisco continued the Seismic Tomography and Subduction discussion at the Lima meeting.

FOURTEENTH MEETING OF THE DIRECTIVE COUNCIL AND THE LAST THREE YEARS

The fourteen meeting took place in **Lima, Peru on January 20-22, 1999**, hosted by CONCYTEC (Consejo Nacional de Ciencia y Tecnologia). Council members present were: Edgar Kausel (Chile – President), Lawrence Drake S.J. (Bolivia), Jeannette Fernandez (Ecuador), Jose A. Canas (Spain), Javier Pique del Pozo (Peru), Alberto Benavidez (Uruguay), Alberto Giesecke (Executive Director). Observers: Michael Schmitz (Venezuela), Francisco Vidal (Spain), Leonidas Ocola (IPGH), Hernan Montes (IGP).

This report covers the period from January 1998 through January 1999, and some relevant activities in the last three years.

- Memorandum of Understanding with the U.S. Geological Survey

A Memorandum of Understanding, entered into by CERESIS and the United States Geological Survey, November 1998. The MOU favors cooperative activities in Earth Sciences, with special emphasis on the reduction of seismic risk. Specific areas for cooperation include a) a more efficient exchange of seismic data to characterize the location of the event, its size and type of rupture; b) exchange of data needed by the tsunami early warning system in the Pacific; c) exchange of technology - instruments to study principal landslide zones and seismically active regions; d) participation in the Volcanic Disasters Program (VDAP); e) evaluation of seismic risk, f) rapid response to a disastrous geological event, g) methodology to evaluate seismic risk in urban areas, h) distribution of information, i) training, facilities for visiting scientists and post-doctoral studies, j) participation in international and regional meetings.

- Project ADOBE (Seismic Reinforcement of Existing Adobe Houses in the Andean Region)

The CERESIS project considered a very important IDNDR contribution to seismic prevention and mitigation, is the seismic reinforcement of existing adobe (mud brick) houses in the Andean countries. The countries have a combined population of about 150 million. Approximately 25% (35-40 million people) live in adobe houses which are vulnerable to earthquakes. Many millions in other regions of the world live in the same condition. In Peru alone, the estimated number of earthquake victims in the past 35 years is 60,000, the majority of which lived in adobe houses. A strong enough earthquake, MM Intensity VII or higher, destroys an adobe house in about six seconds, and will kill and bury the people inside when the house collapses. The CERESIS project focused on retarding the collapse of the house. The extra seconds, with the house still upright, give the people the chance to escape to safety and watch the house collapse from the outside. The four and a half year program (1994-1999) financed by the German Government (GTZ) was

executed by CERESIS and the Structures Laboratory of the Catholic University in Lima (PUCP).

The result was a simple, thoroughly shaking-table tested, reinforcement procedure, using low-cost available materials (about US\$ 400 per house). The project reinforced 40 adobe houses in earthquake-prone areas in Venezuela, Ecuador, Peru, Bolivia and Chile, for demonstration purposes and also to be tested by a real earthquake.

Five localities were chosen in Peru; one of these, Moquegua, was struck on 23 June 2001, by an offshore shallow MW 8.4 event which destroyed over 3000 adobe houses in the area. The three houses reinforced by CERESIS/PUCP in Moquegua withstood the strong shaking very satisfactorily, in contrast to near-by adobe houses which suffered severe damage and many collapsed. No doubt, CERESIS has produced a viable, "do it yourself", reliable and low cost technique, to protect people living in adobe houses, applicable not only in the Andes but probably in many other parts of the world. However, most of the Andean people are at or below the poverty level and do not have the money to purchase the materials needed. A solution to this problem is under consideration. Reconstruction by the Peruvian government of the Moquegua area has made extensive use of the CERESIS/PUCP technique.

An official publication to commemorate IDNDR: "Natural Disaster Management" - (Jon Ingleton, Tudor Rose 1999), describes the CERESIS adobe project.

- **International Seminar in Cusco, Peru**

The results of the Project: Seismic Reinforcement of Existing Adobe Houses in the Andean Region were presented On 23 – 24 January 1999, during the International Seminar held in Cusco. Present were approximately 70 persons. Among there were: members of Peruvian institutions (SENCICO, INFES, INDECI, UNSAAC, IGP), DIRDN–NNUU, AAIS, PAIGH; Non Governmental Organizations; delegates from Venezuela, Colombia, Ecuador, Bolivia, Chile, Uruguay and Spain; Students and teachers from the UNSAAC (National University San Antonio Abad from Cusco); local authorities of surrounding towns.

A field trip to Huasao and Andahuaylillas took place to let a group of 30 participants, observe in situ, the reinforcement labor done, and the labor in progress.

- **GSHAP - General Comments**

Three projects had created expectations in the sense that CERESIS would be making an important contribution to a global program, gain recognition and, at the same time, hoped to improve its economic situation. GSHAP and PAIGH disappointed CERESIS. CERESIS received nothing at all - technically or financially - nor recognition, from

GSHAP and a small amount of PAIGH's project funds. CERESIS delivered its Seismic Hazard Map for South America and the Regional Catalogs to both GSHAP and PAIGH. The GSHAP Coordinator recognized PAIGH as the "Cooperating Project for Central America, the Caribbean and South America", and ignored CERESIS even though GSHAP publications list CERESIS as the GSHP Regional Center and the CERESIS Director as a member of GSHAP's Steering Committee.

Cristina Dimate et al wrote the report on Project PILOTO (identified as a GSHAP Test Area), published in the GSHAP Summary Volume of *Annali di Geofisica*. It is the one GSHAP document that gives credit to the role and contributions of CERESIS to a GSHAP activity. CERESIS had the satisfaction of supporting Bolivia, Colombia, Ecuador, Peru and Venezuela.

- **Post-earthquake Reconnaissance Missions:**

- Cariaco, Venezuela, 9 July 1997.

The Mission included structural engineers and seismologists from the University of Chile and from FUNVISIS. They compared damage from this event with that caused by the shallow 6.6 earthquakes, MMI VIII, which damaged Caracas on 30 July 1967, thirty years before.

- Aiquile and Totorá, Bolivia, 22 May 1998

Severe damage to small communities in the region surrounding Aiquile and Totorá and damage to historical monuments in those two cities. A UNESCO-Peru Mission visited the area at the request of the government of Bolivia.

- Bahía de Caraquez, Ecuador, 4 August 1998

The Ms 7.1, h= 30km, earthquake occurred on the coast, in the same general area where the 1906 Ms 8.7, the 1942 Ms 7.9 , the 1979 Ms 7.7 and other large events have occurred. The CERESIS Mission included structural engineers, seismologists, and soil mechanics experts from Argentina, Peru, Venezuela and Ecuador. The mission held public scientific and technical conferences, in Quito and Ecuador, to discuss and report on their conclusions.

- El Salvador: January 13th and February 13th , 2001.

Two important earthquakes occurred in El Salvador. The first one, with magnitude of 7.6 Mw and subduction origin at 60 kms depth, caused geological effects and damage to the infrastructure of most of the country. The second earthquake with magnitude of 5.3Mw had a superficial origin. It caused geological effects and damage in

the infrastructure localized in the central part of the country, next to the epicenter of the earthquake. UNDP (El Salvador) requested CERESIS to send a reconnaissance mission.

- **Seismological and Tectonic Deformation Studies in the Central Andes and Seismic Hazard Evaluation in the Peru-Chile Border Region.**

Jesus Berrocal, drafted a proposal entitled "Seismological and Tectonic Deformation Studies in the Central Andes and Seismic Hazard Evaluation in the Peru-Chile Border Region". The objective of the five-year project is to determine the seismotectonic structure and seismicity patterns of the region between 13°S-26°S and 60°W-80°W, in order to pin down the basis for future earthquake prediction research in the Central Andes, mainly in the Arica bight region - the area comprises southern Peru, northern Chile, Bolivia, north-western Paraguay, western Brazil and northern Argentina. CERESIS colleagues in Peru and Chile have contributed to the proposal, which has received encouraging reviews from respected scientists in Europe and the United States. It was discussed at the Conference held in Santiago on "Modern Systems for Preparedness and Response to Seismic, Volcanic and Tsunami Risks" in Santiago, Chile, in April 1998. It was also to be discussed at a special session during the 31st International Geological Congress.

- **Regional Seismological Assembly in South America (Central Andes Seismicity and Seismotectonics)**

In the framework of the 31st International Geologic Congress held at Rio de Janeiro, August 2000, CERESIS organized General Symposium 17-1 with a Poster Session which presented 24 papers from Bolivia, Chile, Cuba, Costa Rica, Peru, Venezuela, Norway and Rusia. The Minutes are available from CERESIS, on CD. An open special session was held on "Central Andes Seismicity and Seismotectonics" - specifically a discussion of the CERESIS - Berrocal project. It is an ambitious project well worthwhile pursuing in view of its goals, but it needs to be revised, especially in view of technological advances such as the use of GPS for deformation studies. A recording GPS was operating in Southern Peru when the 23 June 2001 earthquake occurred. An average of 0.47m horizontal displacement caused by the earthquake was clearly recorded at the Misti Station in Arequipa at the moment the main shock occurred.

- **Crowding the Rim Summit**

In August 2001, the CERESIS Director participated in the Crowding the Rim Summit, an initiative sponsored by the Circum Pacific Council, American Red Cross, Stanford University and the U.S. Geological Survey to address the question "How at risk are we to a regional disaster in the Pacific Rim?". 180 participants from all countries on the Pacific Rim, examined the societal and economic risks associated with natural disasters in the Pacific to gain a better understanding of how natural

hazards may result in regional disasters and to introduce scientific tools and technology that support effective risk-reduction decisions. Contacts with Circum-Pacific Council members and others were very encouraging for future CERESIS activities.

- **Historical Seismicity**

Many publications in South America focus on cultural, religious, social and economic aspects of earthquakes. Whatever their nature they all contribute something to the geo-scientist's perspective. CERESIS has encouraged research in the field of historical seismicity; one of the SISRA Volumes presents Enrique Silgado's 300-page report on Destructive Earthquakes of South America, 1530-1894, and the author's estimates of corresponding MM Intensities. A CERESIS Working Group on Historical Seismicity is planned. CERESIS representatives will be participants of the forthcoming Workshop "Investigating the records of past earthquakes", sponsored by the Instituto Nazionale di Geofisica e Vulcanologia, to be held 1-7 July 2002, Erice (Sicily)

V. FINAL COMMENTS

After 36 years, CERESIS must revitalize its leadership, modernize its activities, restructure its administrative and financial base, strengthen its scientific credibility and justify its existence and role as a regional organization. These are topics that need to be discussed at a high level Conference with the active participation of (a) representatives of governments of the CERESIS member States, the CERESIS National Representatives and Directors of the National Liaison Institutions; (b) representatives of relevant International Organizations, for example IASPEI, USGS, UNESCO, OAS/PAIGH, CIRCUM-PACIFIC COUNCIL, (c) a small but representative group of today's new generation of top south American seismologists, geophysicists, volcanologists, earthquake engineers and (d) a selected group of "CERESIS old-timers" - e.g. Edgar Kausel, Alberto Benavides, Alejandro Giuliano, Julio Mezcuca, Alberto Sarria, Lloyd Lynch, John Shepherd, Mario Bufaliza, Hugo Yepes, Jose Grases, Andre Singer, Jorge Alva, Angel Vega, Estela Minaya, Roberto Arellano, Oscar Gonzales Ferran, Alberto Giesecke and "senior friends" S.T.Algermmissen, Cinna Lomnitz, Gerardo Suarez, ...). Let us hope that as a result of such a meeting, CERESIS will be able to look forward to another 35 years before it again needs to charge its batteries.

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<http://www.ceresis.org>