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MEMORANDUM FOR: Philip S. Justus, Acting Chief
Geotechnical Branch
Division of Waste Management

FROM: Michael E. Blackford
Geology/Geophysics Section
Geotechnical Branch, DWM

SUBJECT: 1986 AMERICAN GEOPHYSICAL UNION FALL MEETING

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I attended sessions of the Fall Meeting of the American Geophysical Union in San Francisco during the week of December 8-12, 1986. Most of the sessions I attended were under the auspices of either the Seismology Section or the Tectonophysics Section of the AGU, however I also attended some general Union talks, some Hydrology Section talks, and some Volcanology Section talks. I made a presentation on the feasibility of forecasting gauge heights of a tsunami based on an early determination of the earthquake magnitude. My talk was part of a session devoted to the Andreanof Islands earthquake of May 7,1986.

The session on the Andreanof Islands earthquake began with presentations by Bob Urhammer of UC Berkeley and Emile Okal of Northwestern describing determinations of the magnitude based on moment tensor analyses of broad band seismic data. Okal's determination was timely enough to avoid the need to call a tsunami warning in French Polynesia. I then presented my paper on tsunami forecasting. Okal's talk and my talk prompted some discussion of the need to determine the mechanism as well as the size of the earthquake in order to maintain a conservative stance in the issuance of tsunami warnings.

Dave Scholl of the USGS then made a presentation of the geologic setting of the earthquake source area based on seismic reflection data collected in the vicinity. The earthquake occurred in a segment of the Pacific and North American plate margin lying between Adak and Amlia Passages in the Aleutian Islands. The Pacific plate is being obliquely subducted beneath the North American plate in this vicinity. In addition to the subduction zone faulting some significant steeply dipping normal faults were found north of the plate margin. If the hypocenter location is correct, the earthquake appears to have been located in the plunging Pacific slab.

Following Scholl's talk a number of authors gave talks on the seismicity of the region and illustrated the nature of segmentation along the Aleutian arc. George Purcaru of Goethe University showed that as a result of this year's Andreanof earthquake, two new gaps now exist along the arc. The 1986 Andreanof earthquake ruptured a central portion of the zone activated during the 1957 great earthquake. The gap to the east of the latest rupture zone has a higher potential for rupture than the gap to the west according to Pucaru. Eric Engdahl of the USGS, using a recently refined crustal velocity model, relocated earthquakes of the region generally south of their original locations. The new locations are more compatible with the subsurface structure determined from seismic reflection surveys. Carl Kisslinger and Selena Billington made presentations of seismically-defined microstructures within the ruptured block based on their local network of stations on Adak and adjacent islands

Talks on the seismicity were followed by a series of talks on the mechanics of faulting during the event. Tom Boyd of Lamont, Goran Ekstrom of Harvard, and Doug Christensen of the University of Michigan each described mechanisms of bilateral faulting in two episodes of rupture running west and east from the hypocenter. Hwang of Cal Tech identified four distinct episodes in the rupture process. The final paper of the session, presented by Klaus Jacob of Lamont, discussed the first strong motion record to be triggered by a magnitude 8 earthquake. Uncorrected peak horizontal accelerations of 0.2g to 0.25g were recorded at ground level in a hanger on Adak at a distance of about 50 kilometers from the nearest point of rupture. Strong motion in excess of 0.1g lasted about 25 to 30 seconds.

On Monday afternoon I attended a session on personal computer applications in geophysics put on by the AGU Committee on Personal Computers. The main thrust of the session was to preview demonstrations planned for later in the week in the committee's booths in the exhibit area. Willie Lee of the USGS gave an overview of developments in PC's in recent years. He compared the rates of increase of instruction process time over the last two decades for main frames, minis, and PC's and demonstrated that rate of increase for the PC's is at least as great as that for the larger computers. New processors for the PC's available now can make these machines operate as fast as the minis of about 7 or 8 years ago. The committee held an open discussion to explore avenues of making AGU members aware of hardware and software specifically oriented to the solution of geophysical problems. The committee will be working with the AGU headquarters on the possibility of establishing a multidiscipline section devoted to PC's that could have a newsletter and collect section dues.

On Tuesday morning I split my time between a Seismology Section session on near-surface amplification and attenuation effects of local surface geology on seismic amplitudes and a session on contemporary tectonics of the southern San Andreas fault with emphasis on the 1986 North Palm Springs earthquake. In the session on seismic amplitudes Andrews of the USGS led off with a presentation of the results of a study comparing the ground motion at a depth of about 100 meters with surface ground motion at two boreholes in the Coalinga, California area. One borehole was located in an alluvium basin and the other was located at the basin margin with the downhole sensor situated in underlying sedimentary strata. The analysis compared spectral ratios of the uphole to downhole sensors and found that P-wave uphole spectra are about 3 times larger at both sites and S-wave uphole spectra are about 1.6 times larger at the basin margin site and about 3 times larger at site near the basin center. The seismic sources for this study ranged from 15 to 40 kilometers away.

Blakslee from UC Santa Barbara presented a similar paper using an array located in the Parkfield, California region. He observed that the uphole spectra are dominated by reverberations caused by waves becoming trapped in the upper strata. Downhole sensors, not as affected by the scattering, yield better spectra for determining source parameters.

Egill Hauksson of USC presented an interesting study of a deep vertical array of seismic sensors located in the Baldwin Hills of Los Angeles along the Newport-Inglewood fault. The sensors, situated at the surface, at a depth of 420 meters, and at a depth of 1500 meters recorded earthquakes nearly underneath the borehole at focal depths of 5-6 kilometers. There was some increase in spectral amplitudes between the 1500 and 420 depth sensors respectively but the greatest difference was observed between the 420 meter deep sensor and the surface instrument. Hauksson attributed this difference to P-wave conversions near the surface and wave trapping. He showed several examples of reflected, converted phases on the downhole sensor records. The following paper by John Orcutt of Scripps presented similar findings for an ocean bottom and ocean bottom borehole sensor array east of the Tonga Islands, with the added dimension of compressional wave energy in the water column affecting the ocean bottom instruments.

Following Orcutt's talk I moved to the session on the North Palm Springs earthquake where I heard three talks on coseismic or triggered phenomena. Fagerson from Cal Tech presented some observations of creep events along the San Andreas, however it was questionable whether some of these events were actually related to the North Palm Springs earthquake because alignment arrays between the epicenter and the creep instruments had no measurable offset. Steve Lund from USC then presented his observations of a change in water level in a well about 50 kilometers northwest of the epicenter. The water level dropped 10 centimeters starting at the time of the earthquake and had not returned to its pre-earthquake level. Mueller of the USGS reported on the first occurrence of a near-field coseismic magnetic event in 10 years of recording in the Palm Springs area. The observations were consistent with a right-lateral dislocation of 15 centimeters on a fault striking N70W and dipping 45 degrees to the north.

The last two talks of the session discussed the source parameters of the North Palm Springs, San Diego, and Chalfant Valley earthquakes of July, 1986 as determined from teleseismic instruments. Goran Ekstrom determined moments of 2.3 x 10**25, 2.0 x 10**25, and 2.4 x 10**25 dyne-centimeters respectively for the three earthquakes, using his single station method and data from the Harvard very broad-band instrument. The source geometries were not well-defined due mainly to uncertainties in the Green's functions for southern California. He proposed that a tripartite network consisting of the Harvard station and additional stations at College, Alaska and Honolulu, Hawaii would be sufficient to determine moments and source mechanisms for the west coast. The data from the remote stations could be available in real time using a dial-up telemetry system currently available for the Harvard station.

Javier Pacheco presented his analyses for the same earthquakes. For the North Palm Springs earthquake he determined a moment of 1 x 10**25 dyne-centimeters with a mechanism indicating about equal components of right-lateral and thrust motion on an east-west striking, north dipping fault. For the San Diego earthquake the moment was 1.5 x 10**25 dyne-centimeters and the mechanism was mostly thrust motion on a northwesterly trending fault that dips to the northeast. For the Chalfant Valley earthquake his moment determination was 2.0 x 10**25 dyne-centimeters. The mechanism for this earthquake was complicated by the occurrence of a second smaller episode of movement about 10 seconds after the main shock. Initial motion appeared to be right-lateral followed by strong thrust component for the second event.

I spent Tuesday afternoon viewing the AGU Committee on Personal Computers' demonstrations and the Volcanology Section's poster session on southwestern Nevada volcanic centers. The PCIPS - Personal Computer Image Processing System - of IBM and the PC TEX system for scientific typesetting of Personal TEX, Inc. demonstrated the availability of efficient PC systems that can produce photo-ready copy of journal quality.

The poster session did not give me any information in addition to what I already knew from the EA's and their documentation. A poster by F.M. Byers of LANL showed relationships of the Silent Canyon, Timber Mountain, and Black Mountain calderas. The ages of activity of these major calderas are about 14 Ma, 11 Ma, and 8 Ma respectively. Work in the vicinity of Yucca Mountain reveals an additional caldera beneath Crater Flat and extending to Yucca Mountain. A poster by Virgil Frizzel of the USGS presented a new map of the geology of the Nevada Test Site, including Yucca Mountain, at a scale of 1:100,000. The map was based on a compilation of earlier maps produced at various scales including the 1:24,000 and 1:48,000 maps we have of the Yucca Mountain vicinity.

A poster by Wright and others on the central Death Valley volcanic field portrayed a rhombochasm between the Furnace Creek and Sheephead faults, encompassing the Black Mountains and the Greenwater Range, similar in nature to the rhombochasm between the Walker Lane and Las Vegas shear zone that encompasses the calderas within and adjacent to the Nevada Test Site. Volcanic activity appears to be coeval with the activity near Yucca Mountain and may represent a reasonably analogous study area. Nancy Walker displayed her study on the remote sensing analysis of the southern Walker Lane. She contends that the termination of large-scale volcanic activity in the southern Nevada region may be due to a reorientation of stresses driving the Paleozoic basement. These stresses are reflected in the lineament patterns observed through remote sensing.

On Wednesday morning I attended the Union session on the use of fractals in geophysics presented by a host of invited speakers including the mainforce in the development of fractal mathematics, Benoit Mandelbrot. Mandelbrot led off the session by explaining distinctions between self-similar shapes and self-affine surfaces. Self-similarity results in certain problems in dimensional analysis that can better be explained by self-affinity in which fractal dimensions are considered together to describe the fractal's local and global properties. The slope of the curve relating characteristics to their measure indicates the "smoothness" or "roughness" of the fractal.

Mandelbrot's generic introductory presentation was followed by more specific applications to various disciplines of the earth sciences. Chris Scholz of Lamont gave examples of the relations of geomorphological patterns to fractal dimensions. Don Turcotte of Cornell extended the concept of fractals to patterns of seismicity in both space and time. Sreenivasan from Yale discussed the role of fractals in describing turbulent flow on a large scale, using cloud formations as examples, while Thompson from Exxon spoke on fractal relationships, observed on an SEM scale, characterizing rock pore spaces. Chris Barton of the USGS described self-similar fractal relationships between the mapped fine fracture structure of the small patches exposed on Yucca Mountain to the detailed, but coarser, geologic mapping of the whole mountain and adjacent areas.

Wednesday afternoon Ben Page opened a Tectonics Section session on the northern San Andreas fault by giving an overview of the history of movement and extension of the San Andreas fault in northern California. A proto-San Andreas came into existence over eighty million years ago and by fifty-five million years ago it had displaced Salinian terrane by about 1700 kilometers. The San Andreas remained essentially dormant for about forty million years during consumption of the Farallones plate in central California, but it became active once more fifteen million years ago displacing terranes across the fault an additional 300 or so kilometers. Changes in plate motions about five million years ago has resulted in increased activity on fault strands to the east of the older through-going San Andreas as evidenced by recent seismicity patterns.

Art Lachenbruch discussed the implications of heat flow anomalies observed near the northern San Andreas fault. Heat flow builds southward from the Mendocino triple junction to a broad high about 200 kilometers south of the junction. Lachenbruch dismisses shear friction as a source of this anomaly and attributes it to the presence of asthenospheric conditions at the base of the seismogenic zone along the fault, possibly due to a buried spreading center.

Bob Cockerham of the USGS described the northern California seismicity based on the USGS network in the region. The USGS network has expanded gradually in northern California, mainly in response to the occurrence of moderate earthquakes beyond the limits of the network existing at the time of the earthquakes. A relatively dense network of stations in the northern Coast Ranges, the Shasta-Lassen area, and in the Sierran foothills east of the Sacramento Valley has existed since about 1980. Earthquakes located by the network have helped to define the subducted Gorda plate north of the Mendocino triple junction, two relatively active strike-slip fault zones that extend the Calaveras and Hayward fault zones to the Mendocino area, and a less well-defined zone of activity extending across the Sacramento Valley and up the Sierran foothills. The San Andreas, north of San Francisco appears to be essentially aseismic.

The latter part of Wednesday afternoon was spent viewing exhibits and demonstrations. Russ Needham of the USGS's National Earthquake Information Center has compiled six volumes of fault plane solutions for earthquakes since 1981 that were over magnitude 5. I was able to acquire four of the six volumes; supplies of the other two had been exhausted. Joseph Steim demonstrated the Harvard Very-Broad-Band On-Line Data Retrieval System as part of the AGU Committee on Personal Computers' general show and tell. The system holds much promise for increasing the amount of data that can be available to the seismologic community in real time. An organization with a limited data network, using a PC, can augment the information available for studying the parameters of an earthquake with this system. The system allows you to either capture the raw data directly or to set up filters to obtain a response of interest.

On Thursday morning I divided my time between a tectonics session on the earthquake potential of folds and fold belts and a seismology session on teleseismic source parameters. Jay Namson gave a presentation of his estimate of the recurrence interval for the May 2, 1983 Coalinga earthquake using a fault-bend-fold model. The model consists of a blind thrust extending from about six to about four kilometers below the surface. Deformation beyond the thrust apparently occurs aseismically, however in the vicinity of the thrust seismic events are accompanied by anticlinal folding. During the Coalinga earthquake the Coalinga anticline was uplifted 25 to 45 centimeters which corresponds to a displacement of 70 to 125 centimeters on the thrust. Given a total displacement of 7.2 kilometers and uplift of 2.2 kilometers over a period of 2.2 million years, the recurrence interval determined for the Coalinga anticline is 53 to 95 years.

In the teleseismic source parameter session I listened to a series of three papers describing techniques for dealing with complex sources of earthquakes using time dependent moment tensor inversion or multipole expansion of the seismic radiation. These techniques, presented by Junkyoung Kim and Jeff Slevin of the University of Arizona and Y.Y. Kagan of UCLA, yield synthetic seismograms which resemble the real seismograms remarkably well. These papers were followed by a description of an improved broad-band seismometer developed by Bill Nugent of UC San Diego. Nugent replaced the analog feedback system of a Streckeisen instrument with a digital feedback system that yielded an instrument with a much broader dynamic range. Recordings made with the modified Steckeisen seismograph and a LaCoste-Romberg seismograph, with the seismometers located on the same pier appear to be nearly identical.

The final presentation I listened to at the teleseismic source parameter session was by Doug Wiens of Washington University on the effects of bathymetry on teleseismic P-waveforms. His thesis is that complexities in the P-waveform are due to the large impedance contrast at the water-crust interface and the slope of the seafloor for certain earthquakes originating beneath the oceans. To demonstrate this dependence he generated synthetic seismograms that took these effects into account and matched the observed seismograms. There was some question from the audience concerning the degree of the impedance contrast since the seafloor sediments immediately below the water are loosely consolidated and thoroughly saturated. His examples were taken from ridge crest earthquakes, however, where one would not expect to see very thick sediments that could affect the impedance contrast. I spent the remainder of Thursday morning discussing ray tracing and synthetic seismogram programs for PC's with Dave Crossley of McGill and interactive graphics processing of seismograms on PC's with Bob Urhammer of UC Berkeley at the AGU Committee on Personal Computers' PC demonstrations.

Thursday afternoon I attended three presentations at the Hydrology Section's first session on flow and transport through unsaturated fractured rock. The first presentation I listened to was by Karsten Preuss of LBL, UC Berkeley on modeling isothermal and non-isothermal flow in unsaturated rock. His paper, which was actually a review, discussed the problems involved in accounting for the thermal effects of emplaced HLW on a groundwater system. The temperatures involved give rise to boiling and condensation conditions which require consideration of two-phase (liquid, gas), two-component (air, water) fluid flow as well as the heat flow. He stated that considerable effort must be extended in order to develop experiments that can reliably test the validity of models of groundwater flow under these conditions.

Todd Rasmussen described his PC-based modeling program for three dimensional flow and transport in variably-saturated fractured rock. His program involves a three-step process that generates a fracture network, assigns boundary conditions and calculates hydraulic potentials at the fracture intersections, and finally calculates flow patterns at the intersections. Input for his model was based on observations of the diffusion of helium in a typical media at a site in Arizona.

Billaux of the French Bureau of Geological and Mining Research, currently at LBL, UC Berkeley, gave a presentation on a procedure used to model observed fracture patterns at the Fanay-Augeres mine in France. The method entails the generation of three dimensional disk-shaped fractures, with the capability to control the density and orientation of the fractures according to observed data. The generation of the fracture pattern utilizes a cause-and-effect relationship that allows the fracture pattern to grow with time.

Also on Thursday afternoon I attended three presentations at the Seismology Section's session on source mechanics and strong ground motion. Edoardo del Pezzo gave the results of a study of swarm earthquakes associated with an uplift of the Campi Fiegrei caldera during 1984. Using an array of three component digital seismographs within about four kilometers of the swarm activity, del Pezzo and his associates were able to determine source parameters for many of the swarm earthquakes in the magnitude range of about 0.0 to about 3.3. The events were typically double-couple events with normal faulting mechanisms and stress drops of about five bars. Little or no attenuation was observed at these close ranges to the earthquake sources.

Eric Chael of Sandia described a high frequency digital seismic system recently installed at the NORESS array in Norway. The digital system allowed him to use different filtering techniques to enhance the signal-to-noise ratio to the point where the system is capable of discerning events of less than magnitude 2.0 at a distance of 400 kilometers. Spectral ratio studies agree with an omega-squared source law and f-max for the smallest events was not observed.

The last presentation I heard in this session was given by Jim Bicknell of the USGS. He described a series of studies of mine-induced earthquakes in South Africa for the purpose of comparing the parameters of relatively small and relatively large earthquakes as well as the depth- and frequency-dependence of seismic attenuation. An array of seismographs capable of recording high frequencies was installed both at the surface and at various depths in the mine workings down to depths of about four kilometers. The results of the studies indicate that for events greater than about magnitude 3 the parameters determined by the surface instruments agree well with those expected from the instruments underground. For events less than magnitude 3 the surface instruments record lower amplitude ground motions than those recorded by the underground instruments.

Friday morning I attended a Seismology Section session on subduction zone earthquakes. I listened to three papers devoted to interplate seismicity in Mexico and Costa Rica and a fourth paper discussing intraplate seimicity in Mexico. Karen McNally of UC Santa Cruz led of the session with a description of the patterns of seismicity associated with the subduction zone beneath southwestern Mexico. Earthquakes with thrust mechanisms are confined to a shallow Benioff zone dipping down to depths of about 25 kilometers as much as 270 kilometers from the Middle America trench. Beyond this depth the subducted plate appears to break up in a series of normal faults as evidenced by a few scattered events with normal mechanisms. The more detailed determination of the seismicity was achieved through the use of a more realistic model of the crustal structure described in a later paper by Christian Stolte. The new model incorporates a crustal layer, whose velocity increases linearly with depth, overlying a constant velocity half-space that dips about 10 degrees to the northeast in a direction similar to the subducted plate.

Gerardo Suarez of the Geophysical Institute of the National University of Mexico described the patterns of seismicity associated with the Trans Mexico Volcanic Belt and a region in the southwestern portion of the Gulf of Mexico near the Isthmus of Tehuantepec. Normal mechanisms were generally found for those events along the volcanic belt, which is consistent with the observations made by McNally. The mechanisms for the activity along the gulf coast were not well determined but the data seem to indicate stress orientations related to the Cocos-North American relative plate motion. The gulf coast seismicity dies out abruptly north of the volcanic belt.

F. Guendel of the Costa Rica National University, currently working at UC Santa Cruz, described the nature of the subduction of the southeastern portion of the Cocos plate under Nicaragua and Costa Rica. Seismicity patterns show that the plate is subducting at a shallow angle beneath Nicaragua. This angle is a bit steeper than observed under Mexico. The plate plunges progressively steeper from Nicaragua to Costa Rica becoming almost vertical near Panama.

I spent the remainder of Friday morning examining the Tectonics Section posters on the Decade of North American Geology transects. Of particular interest was the map of Great Basin seismicity, including focal mechanisms, by Al Rogers of the USGS. In contrast to his earlier maps of the southern Nevada seismic zone, which showed almost all strike-slip mechanisms, this new map includes many more normal mechanisms. A plot of the poles of the compressional and tensional axes of the mechanisms shows a nearly uniform band compressional axes trending NE-SW. This can indicate the uniform presence of mechanisms ranging from pure dip-slip to pure strike-slip on north-trending faults.

Friday afternoon I sat in on the second part of the Seismology Section's session on teleseismic source parameters. The session opened with two papers by Jeff Barker of Woodward-Clyde and Hiroo Kanamori of Cal Tech on the unusual earthquake that occurred near Tori Shima, Japan on June 13, 1984. The event, which a magnitude of 5.5, generated a small tsunami that was visually observed with an amplitude of about 140 centimeters on Hachijo Island, 150 kilometers from the source, and recorded on the Japanese mainland with an amplitude of about ten centimeters, nearly 500 kilometers from Tori Shima. Both Barker and Kanamori determined the source mechanism to be mainly of the compensated linear vector dipole (CLVD) type, which Kanamori had previously identified for the Mount St. Helens earthquake that triggered the catastrophic 1980 eruption. Barker's study indicated that the depth of event was limited to less than three kilometers beneath the seafloor. Kanamori proposed that the event was caused by a form of natural hydrofracturing driven by super-critically pressurized water generated by magma injected into the saturated crust just beneath the seafloor. This type of deformation is more efficient for tsunami generation than faulting with the same scalar moment.

These papers were followed by a series of three presentations discussing various aspects of shallow earthquakes in a plate collision environment. Jiajun Zhang described an inversion process which yielded estimates of the extent of faulting independent of estimates based on the aftershock area. She repeated the inversion at different periods to obtain the best match between the original seismograms and generated synthetics and thus minimize the inversion error. Paul Lundgren of Northwestern presented a technique to deal with complexities in the earthquake process involving an iterative scheme that moves a window of pulses through the time domain. This method eliminates undesirable offsets caused by the influence of earlier pulses and produces better synthetics. He applied this technique to the December 6, 1978 Kuriles earthquake, a slab-tearing event on a near vertical fault. Vincente Cagnetti of the ENEA of Italy described an aftershock study of the magnitude 6.9 earthquake that occurred in southern Italy on November 23, 1980. The study indicated that two fault planes were activated, one oriented parallel to the trend of the Appenines and another perpendicular to the trend.

Six papers were presented in this session that discussed the relationship of deep earthquakes to the subducted slab. Giardini of Harvard, Willemann of LANL, and Apperson of UT Austin described studies of the temporal and spatial relationships of the seismicity to the Wadati-Benioff zone geometry. Giardini, using methods of fractal geometry, found that in contrast to the relatively uniform fractal dimension determined for the b-values of shallow events associated with subducting plates world-wide, there was a wide range of fractal dimensions for deep earthquakes. Willemann demonstrated that aftershocks of deep earthquakes do not necessarily occur on the nodal planes defined by the main shock but seem to occur on planes parallel to main shock fault plane. Although more events seem to occur up-normal to the Wadati-Benioff zone, larger events occur down-normal to the zone. Denise Apperson reported that her study showed that for deep earthquakes compressional axes determined from focal mechanism solutions were mainly oriented subparallel to the plane of the Wadati-Benioff zone with a slightly steeper dip than the plane. The evidence was not overwhelming, however, with a significant number of other axis orientations being observed, indicating a complex fracture structure present in the lower subducted plate.

Xinping Liu of UC Santa Cruz presented a paper describing the relationship of the location of the neutral surface within a subducted slab to the environment of the subduction zone. The neutral surface is a boundary between tensional and compressional regimes within the subducted slab. In strongly coupled subduction zones, with strong regional compressive stresses such as Peru, the neutral surface appears to be elevated to depths less than ten kilometers. In weakly coupled subduction zones where regional stresses are only weakly compressive or even tensional, the neutral surface may be depressed to as much as sixty kilometers as in the Sunda trench.

Two papers in the session, given by Cliff Frolich and Scott Davis of UT Austin, described and gave an application example of the single-link analysis technique for evaluating seismicity data. The technique involves the build up of chains of events starting with the linking of the closest events and continuing with the linking of these events to their next closest neighbors. Using distance as a metric, it is possible to objectively define subsets of the seismicity data by eliminating links greater than a particular distance. The technique could be used as a tool to define tectonic provinces of various sizes, seismic gaps, and the degree of clustering or isolation of seismic events. If time is also taken into consideration, aftershock sequences may be defined. Davis applied this technique to the the ISC earthquake catalog and was able to define the major seismic belts which mark the plate margins around the world. He also showed how the technique was able to identify the seismic gap that was filled by the last major earthquake in Mexico.

The final paper of the meeting I listened to was presented by Barbara Romanowicz of the Paris Institute of the Physics of the Globe. She presented her preliminary investigations of the magnitude 6.9 Romanian earthquake of August 30, 1986. The earthquake appears to have occurred on a reverse fault at a depth of about 150 kilometers in the Vrancea seismic region. The event had a seismic moment of about 2 x 10**27 dyne-centimeters and a time source duration of about 18 seconds. The event appears to have occurred as three distinct episodes of dislocation.

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