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SEISMICITY AND EARTHQUAKE RISK AT THE NPP SITE OF LAGUNA VERDE, VERACRUZ

C. LOMNITZ*

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RESUMEN

Con base en una relocalización sistemática de los temblores con epicentro cercano a Laguna Verde, Veracruz, se llega a una estimación de a = 0.20 g para la aceleración máxima previsible (SSE), que debe utilizarse para el diseño de la planta nucleoeléctrica que funcionará en dicha localidad.

ABSTRACT

Forty earthquakes recorded near the nuclear power plant site of Laguna Verde, Veracruz, during 1920-1977 have been relocated. The Safe Shutdown Earthquake is estimated at a = 0.20 g.

* *Instituto de Investigaciones en Matemáticas Aplicadas y Sistemas, UNAM, México.*

INTRODUCTION

The site of Laguna Verde, location of the first Mexican nuclear power plant, is located in the Eastern abutment of the Mexican Volcanic Belt. It participates of the general features of seismicity which apply to the Mexican Volcanic Belt.

Earthquake locations in this area depend critically on the regional stations of Veracruz, Puebla, Tacubaya, Oaxaca and Mérida, established in or around 1911. Some of these stations have operated intermittently ;Puebla and Mérida are no longer in operation. The nearest station, Veracruz, features mechanical instruments recording on smoked paper, with generally unreliable timing.

No major earthquakes have affected the Laguna Verde site in historical times.

SEISMICITY

On the basis of all historical and instrumental records, Figueroa (1963) has postulated the "Zacamboxo Fault" which traverses the Mexican Volcanic Belt in an east-west direction through the epicenter of the Oxochoacan earthquake of 3 January 1920.

The "Zacamboxo Fault" is to be understood symbolically as a seismicity lineament, and not as an actual geological structure. It represents the axis of the general trend of shallow earthquakes which are associated with the volcanic belt. These earthquakes have been locally destructive, e.g. in Zapopan (1875), Acambay (1912) and Oxochoacán (1920); their historical magnitudes are of the order of 6, and may possibly have reached up to 7 in Acambay, 1912.

These shallow earthquakes are associated with surface faulting on recent tectonic structures. For this reason their prospective locations can be predicted with some confidence. The nearest major structure to Laguna Verde appears to be associated with the Cofre de Perote uplift, which produced the 1920 event, about 50 km due SW of the site.

Some offshore structures have been postulated but there is no indication that they are directly associated with recent seismic activity. Two or three scattered offshore epicenters, with magnitudes of the order of 4, represent the sort of negative evidence which tends to support the conclusion that intra-plate seismicity under the Gulf of Mexico is negligible. This conclusion applies probably to the entire Gulf Coast area, from Florida to Yucatán.

The largest earthquakes in Veracruz State correspond to intermediate-depth shocks associated with the Pacific Coast subduction zone. Magnitudes of these events may reach 7.5; they can cause widespread damage in an area which extends from the coast of Southern Veracruz to the sedimentary valleys in the (southern) Volcanic Belt. For example, the damage area of the 1973 event (M = 7.5) extended from Tierra Blanca, Veracruz to Ciudad Serdán, Puebla. One small intermediate-focus epicenters has been located just north of the city of Veracruz; none under the Volcanic Belt itself. They seem to occur mostly under the Southern Veracruz coastal plain, and towards the Oaxaca highlands.

RELOCATION OF INSTRUMENTAL EVENTS

In order to analyze the seismicity with a view towards determination of the design earthquake for the Laguna Verde NPP, it is necessary to proceed to relocate all shocks which have been detected and catalogued in the area. Table 1 lists all instrumental events with the corresponding references.

Table 1

(a) *Historical earthquakes*

1523		Veracruz, damage
1714		Córdoba, Veracruz (intermediate?)
1790	April 19	As in 1973 (intermediate?)
1838		Tidal wave (hurricane?)
1845	June 6	Veracruz, felt strongly
1854	May 5	Veracruz and Oaxaca, felt, damage (intermediate?)
1864	October 3	Casualties and damage in Puebla, some in Veracruz
1866	January 2	Damage in Puebla and part of Veracruz
1874	November 13	Jalapa
1879	May 17	Widely felt in Veracruz, Puebla and Guerrero
1911	February 3	Widely felt in Veracruz, Guerrero and Oaxaca

(b) *Earthquakes relocated in this study*

No.	Date	Origin Time	Lat.	Long.	Mag.	Comments
0	1920 Jan 4	04:21:58	19.30	97.17	5.8	Oxochoacan earthquake
1	1920 Apr 19	21:06:45.0	18.00	94.50	6.75	h = 110
2	1928 Oct 10	04:38:34.9	17.85	97.63	6.5	h = 100
3	1932 Mar 10	23:01:36.5	19.16	96.71		
4	1937 Jul 26	03:47:13	18.20	96.55	7.3	Maltrata, h = 85
5	1943 May 3	10:17:08.2	17.49	95.14	5.7	h = 150
6	1945 Jan 18	18:06:34.0	18.50	93.80		h = 40
7	1945 Oct 11	16:53:02.0	18.15	97.20		h = 95
7*	1946 Jan 11	18:42:09	18.2	94.3		Coatzacoalcos, felt
8	1946 Jun 30	04:59:32.0	18.00	94.30		h = 40
9	1946 Jul 11	04:46:40.4	17.24	94.33	5.5	h = 180, widely felt
10	1947 Feb 16	02:15:49.3	17.41	97.77		

(Table 1 - Cont.)

No.	Date	Origin Time	Lat.	Long.	Mag.	Comments
11	1948 Jan 6	17:25:56.9	16.70	98.87		
12	1948 Jan 6	18:00:14.2	16.83	98.81		
13	1948 Aug 11	10:36:19.5	18.04	95.22		
14	1949 Aug 1	08:03:52.1	19.43	96.23	5	
15	1949 Aug 6	18:53:26.7	18.10	95.64		
16	1950 Dec 14	14:15:39.3	15.61	98.12		
17	1950 Dec 17	01:08:01.4	16.25	98.93		
18	1954 Apr 7	05:35:47.6	17.49	97.32		
19	1954 Apr 8	19:32:01.1	19.10	95.80		
20	1954 May 28	08:01:32.9	18.35	99.38		
21	1958 Aug 19	01:48:15.5	18.59	97.66		
22	1959 Apr 6	07:25:52.5	19.14	97.96	5	h=200?
23	1959 May 5	01:30:49.5	19.14	97.96		
24	out of region					
25	1961 Dec 3	11:17:39.0	20.65	97.56		h=33
26	1963 Jun 4	20:28:46.0	18.10	95.94	4.3	h=127
27	1964 Jul 23	23:58:01.0	20.54	96.56	4.2	h=33
28	1965 Feb 3	21:25:33.1	18.72	97.49	4.0	h=100
29	1966 May 19	10:42:21.3	17.79	96.14	3.6	h=41
30	1966 Nov 28	20:10:43.3	18.29	96.06	4.4	h=67
31	1967 Feb 1	14:01:22.9	18.56	95.94	3.7	h=23
32	1967 Mar 11	14:45:02.0	18.99	95.94	5.3	h=47
33	1968 Mar 24	02:51:38.5	18.06	95.44	4.7	h=104
34	1970 May 5	18:22:21.6	18.14	95.31	4.6	h=94
35	1970 Nov 6	02:32:00.1	19.65	94.75	4.2	h=33, foreshock
36	1970 Nov 6	16:23:04.1	19.71	94.69	4.6	h=33
37	1973 Jan 31	12:32:27.2	18.16	96.95	4.7	h=50
38	1973 Aug 28	09:50:37.9	18.40	96.63	7.5	h=84, Cd. Serdán e'q
39	1974 Jul 25	09:53:35.6	19.34	96.31	4.5	h=76
40	1975 Jul 1	01:51:40.3	18.07	95.51	4.0	h=151
41	1977 Dec 26	07:27:45.6	18.12	97.35	4.7	h=67

The relocation procedure was as follows. First, all available readings were culled from the International Seismological Summary, the Bulletin of the International Seismological Center, the Tacubaya bulletins and other sources. Computer files were constructed with these data, and the 15 nearest stations were selected for the initial trial locations. These trial locations revealed serious discrepancies with earlier epicenters, particularly for events prior to 1940.

The second iteration included the selective elimination of stations wich showed high travel-time residuals or were otherwise unreliable. In the case of nearby stations the S-P intervals were used even when P-times were discarded.

Finally, only half a dozen doubtful locations remained. These events corresponded to earthquakes which occurred before 1930. They were relocated manually, and the manual solutions were run with the same epicenter program in order to obtain the travel-time residuals as before. The tabulated computer output for all solutions is given in Appendix I, and the solutions are displayed in Figure 1.

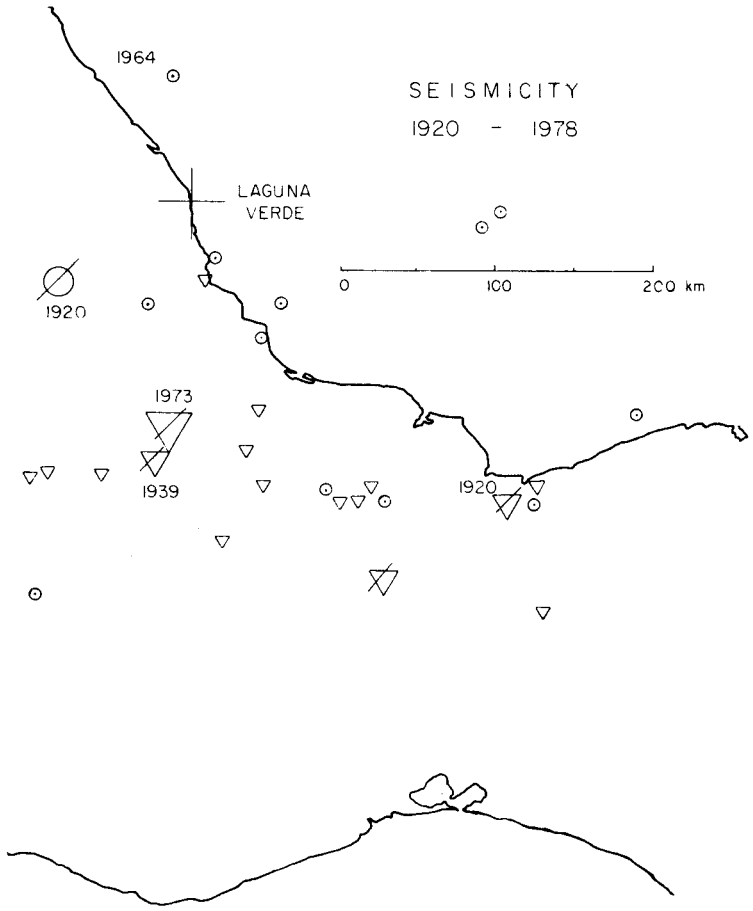

Fig. 1

The location for the Oxochoacán earthquake of 3 January 1920 was obtained from macroseismic evidence, since this important earthquake was not recorded at most foreign stations, and the times from local stations are unreliable.

The shock nearest to Laguna Verde is event No. 14 of 1 August 1949, relocated 41 km to the southeast of the plant. This earthquake occurred just offshore, some 30 km northwest of Veracruz. It is a shallow event. The magnitude has not been determined; but from the geographical extent of stations reporting I estimate a magnitude just below 5. No felt reports have been found for this event, though it should have been felt in Veracruz.

Two small events were relocated in deep waters, in the Gulf of Mexico. Relocation gives no support to the hypothesis of tectonic scarps off the Veracruz coast being seismically active, since all offshore epicenters relocate either on the continental shelf or below a water depth of more than 2,000 m.

The largest historical event in the Laguna Verde area may be assumed to be the great Veracruz-Puebla earthquake of 1973, which destroyed Ciudad Serdán and severely damaged Córdoba and Orizaba in the State of Veracruz. Similar but smaller events of the same kind (intermediate focus under the Veracruz-Alvarado coastal plain) occurred in 1714, 1864 and 1937.

THE OXOCHOACAN EARTHQUAKE

The event of 3 January 1920 was highly destructive in a radius of about 15 km (Figure 2). The Institute of Geology published an excellent memoir based on field studies carried out after the earthquake (Camacho, 1922). However, the shock was not reported by many foreign stations and was not located by the International Seismological Summary. Gutenberg attempted a location but gave up; his manuscript note on the event has been preserved at Pasadena. Since other Mexican earthquakes of magnitude 6 and above were well recorded at U. S. stations at the time, it seems likely that the magnitude of the Oxochoacán event was about $m_b = 6$ or less.

This assumption is consistent with the localized extent of the damage. This earthquake was a Managua-type event with shallow focus and concentrated damage. However, the local magnitude was somewhat below that of the Managua earthquake: probably around 5.5 to 5.8.

The evidence for surface faulting is about as clear as one might expect for a field investigation carried out in 1920. Near Xico there is a small foot bridge made of

steel girders which buckled because of shortening of the span by about one foot; this is still visible today.

The earthquake was unlikely to be felt at the Laguna Verde site.

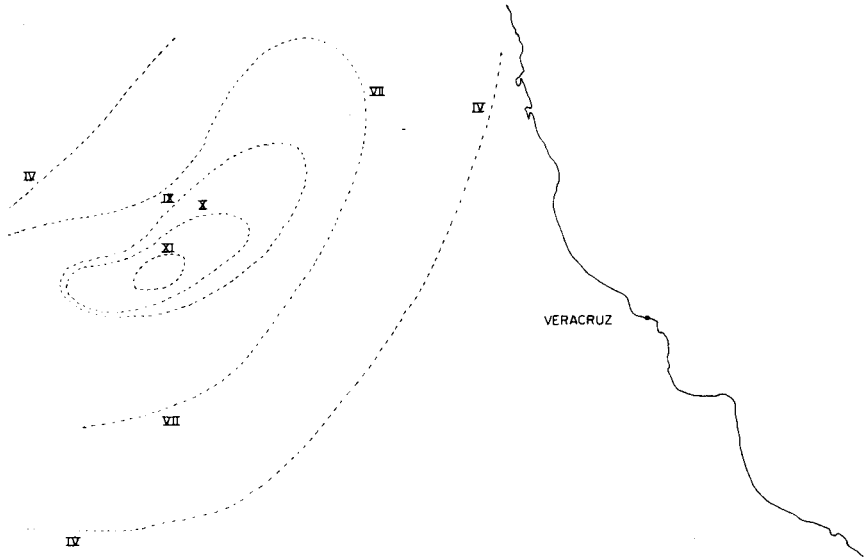

Fig. 2

THE CIUDAD SERDAN EARTHQUAKE

The intermediate-depth earthquake of 28 August 1973 was the most destructive Mexican earthquake of this century. It caused more than 500 deaths, according to official statistics. The area of maximum damage was elongated in the north-south direction and covered much of the State of Puebla and adjacent parts of the State of Veracruz. The epicenter was located near the southern edge of the meizoseismal area (Figure 3).

More than 200 colonial buildings, particularly church towers, were damaged. Destructive effects were almost entirely in adobe construction, with typical intensities of VI-VII on the Mercalli scale. In Ciudad Serdán, Pue., there was large-scale destruction of adobe houses located on valley sediments. In Orizaba, Ver., one older 4-story reinforced concrete building collapsed. The ground floor of this building was used as an automobile showroom and several structural columns had been removed by the owner for reasons of space.

The earthquake had a magnitude near 7 1/4 to 7 1/2 and a focal depth of 84 km, probably near the top of the subducted Cocos Plate. The distribution of intensities indicated that much of the energy was channelled along the top of the plate and then refracted upwards. However, the volcanic belt acted as a barrier and intensities north of the axis of the belt were uniformly low.

At Laguna Verde the intensity was around IV on the Modified Mercalli Scale. Unfortunately the accelerograph was out of order at the NPP site. Accelerations of up to 0.1g were recorded for this earthquake, e.g. at Minatitlán, Veracruz.

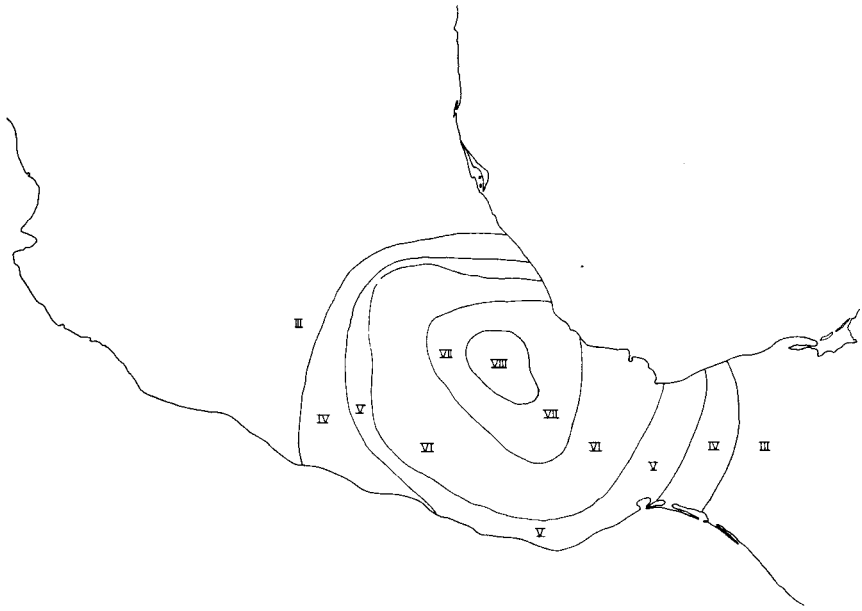

Fig. 3

The abrupt decrease of seismic intensities north of the axis of the volcanic belt ("Zacamboxo Fault") had been previously noticed by Figueroa (1963); it is a regular feature of all Southern Mexican earthquakes (Figure 3). It has been surmised that the volcanic belt acts as an absorption barrier against the propagation of seismic energy. More recently it has been shown that much of the energy in subduction earthquakes travels along the subducted Cocos Plate (Lomnitz, 1982). Thus, a discontinuity in the subducted plate under the volcanic axis would effectively prevent the channelled energy from spreading northwards.

Whatever the explanation, sites such as Laguna Verde are adequately protected against high seismic intensities from subduction earthquakes originating in the Co-

cos Plate. Because of its high magnitude and pronounced northward focusing of seismic energy, the 1973 Ciudad Serdán earthquake may be taken as the critical event in this category.

SUMMARY OF SEISMICITY AT LAGUNA VERDE

In conclusion, the following sources of seismic hazard at Laguna Verde have been identified:

a) *Seismicity associated with surface structures in the Mexican Volcanic Belt.* The prototype of these events is the Oxochoacán earthquake of 1920.

b) *Seismicity associated with the Cocos Plate Subduction zone.* The prototype of these events is the intermediate-focus earthquake of 28 August 1973, destructive in Ciudad Serdán and areas of the States of Puebla, Veracruz and Oaxaca.

c) *Other.* There is some indication of offshore rift structures parallel to the edge of the continental platform under the Gulf of Mexico. They are probably caused by gravity sliding of sediments.

Seismic effects from a possible volcanic eruption near the site are also to be considered.

The intensities at Laguna Verde from the prototype events in categories a) and b) probably did not exceed IV on the Modified Mercalli Scale. It is conceivable that the Oxochoacán Fault might generate earthquakes of higher magnitude than the 1920 event; perhaps a magnitude of 7, as in the 1912 Acambay earthquake, is not to be ruled out. In my view this is highly unlikely, because the Eastern volcanic belt contains no major structures such as the Acambay graben. Nevertheless, if such an event were to occur in the Oxochoacán region it could generate accelerations of up to 0.1 g at Laguna Verde.

Similarly, it is conceivable that an intermediate-focus event of a magnitude close to 8 could occur under the Veracruz coastal plain, at a focal depth of 80 - 100 km. Again, in this case accelerations of the order of 0.1 g would be expected at Laguna Verde, from an epicenter near Alvarado, Veracruz.

The most serious problem arises from source c), i.e. events of volcanic origin or from nearby unidentified structures. Though both possibilities have been separately discussed (Mooser, 1980), we believe that the question must be taken up again from a seismologist's point of view.

The possibility of a nearby unidentified focus, possibly connected with offshore rifting, is closely bound up with the general issue of intraplate seismicity. All one can reasonably say is that intraplate seismicity is minor and magnitudes tend to be low. The few scattered spicenters in the Gulf of Mexico are reassuring in this respect. In my opinion these epicenters cannot be attributed to any single structure known or unknown. If an intraplate event occurred directly under Laguna Verde, and if its magnitude were as high as 5 (an extreme upper bound, in my opinion), an acceleration of up to 0.20 g could perhaps be expected.

I would not hazard a guess as to the likelihood of such an occurrence: it is certainly very low. Yet it cannot be entirely ruled out, since the few scattered epicenters in the Gulf attest to the existence of intraplate seismicity.

As for the possibility of a nearby volcanic eruption, geological evidence indicates that the eruptive centers in the Laguna Verde area have been inactive for about 2 million years or more. In my judgement this makes the likelihood of a nearby volcanic eruption about comparable to, or even slightly higher than, the likelihood of an intraplate event under Laguna Verde. Therefore it must be taken into consideration, though we are speaking of extremely rare events even in terms of risk to nuclear power plants.

Some of the volcanic structures near Laguna Verde are extremely impressive, e.g. El Abra. An eruption at one of these structures could shower tons of pyroclastic materials over Laguna Verde; yet the seismic effects would be relatively minor. An eruption located at a distance of 15 km from Laguna Verde could generate accelerations of 0.10 - 0.20 g at the site.

ESTIMATION OF OPERATING BASIS EARTHQUAKE

This exhausts the possibilities of earthquake risk at the Laguna Verde site. Recurrence times in categories a) and b) are about once in a century, while recurrence times in category c) are of the order ot 10^6 years.

On the basis of the locations and magnitudes of earthquakes in the region, the events to which the NPP will be exposed during its period of operation will belong to categories a) and b), with epicenters in the Xalapa area (shallow), or under the Veracruz coastal plain (intermediate focal depth). In either case, the maximum probable acceleration will be 0.10 g; it is estimated that such an acceleration is to be expected about once in any 50-year period. It is true that such a high acceleration was never positively observed at Laguna Verde; but we cannot entirely exclude the possibility that a peak acceleration of 0.10 g might have been reached during the 1920 or 1973 events, since no accelerograph records are available for either.

In conclusion, we judge that a proposed OBE of 0.10 g is conservative and should be recommended in view of the numerous unknown factors involved in the estimation of seismicity at a relatively low-risk site such as Laguna Verde.

ESTIMATION OF SAFE SHUTDOWN EARTHQUAKE

The Safe Shutdown Earthquake is normally estimated on extremal considerations, and the Operating Basis Earthquake is then taken to be at half the SSE acceleration. I should like to explain briefly why I believe this to be an unsound procedure in the case of Laguna Verde.

The Laguna Verde site is an intraplate site located about 500 km inland from an active volcanic belt. Finally, monitoring of local seismic activity has been and is inadequate, in the sense that no reliable high-gain seismographic stations have been in operation within a radius of more than 200 km.

In such a case the uncertainties involved in the estimation of the SSE are very great indeed. Precisely because the risk is low, very few observations of earthquakes are on record. And the smaller the sample size, the greater is the variance. The current practice of estimating the SEE *before* the OBE leads therefore to castigating low-risk sites, such as Laguna Verde, more severely than high-risk sites where more seismic information is available. Obviously, the public interest is poorly served by this policy, since it leads to high-risk sites being preferred to low-risk sites.

On the other hand, the OBE can be estimated reasonably well from the seismicity record. In the case of Laguna Verde there can be little argument that an earthquake with an acceleration of 0.10 g represents a conservative estimate for the OBE. This is the highest earthquake the nuclear power plant will be subjected to in an average 50-year period.

What should be done about the SSE? According to current siting criteria as used for example in the United States, estimates of site acceleration are obtained from formulas or graphs as a function of magnitude and distance. Usually it is assumed that the largest "feasible" earthquake occurs at the point on the nearest active structure which is closest to the site.

In the case of Laguna Verde, no local scaling parameters for acceleration have been developed: because of the low seismicity no observations are available. For the same reason there are no known active faults or other active structures in the general area of the site. This is an extremely unfavorable situation from the traditional point of view, since the current siting criteria require the plant to be designed for a "floating" earthquake located *directly under the plant*! No wonder low-risk

sites are regularly overlooked in favor of sites located near known active structures (Lomnitz, 1981).

Such unrealistic siting procedures have contributed to a situation where plants built on needlessly risky sites are vainly battling for licensing, thus threatening the rational development of a safe nuclear industry.

On the other hand, the same siting regulations which prescribe unrealistic values of the SSE will blithely accept a design value of 50% of the SSE for the Operating Basis Earthquake, even though this value represents the kind of conditions most likely to be encountered during the lifetime of the plant! In other words, hypothetical extrapolations are given more weight than data based on field observations plus geological information.

In this paper I propose to follow the inverse procedure, namely to estimate the OBE and multiply the OBE value by 2 in order to obtain the SSE. This procedure is not only more rational and therefore safer, but it corresponds closely to the time-tested engineering concept of the *safety factor*. In other words, I propose a return to sound engineering criteria in nuclear safety, based on the idea that a low-seismicity site is preferable to a high-seismicity site, precisely because fewer local data are available.

Can we imagine any seismic event, or combination of circumstances leading to seismic shaking at Laguna Verde, under which a horizontal acceleration of 0.10 g will be exceeded during an average 30-year period? Note that this level of acceleration corresponds to a Mercalli intensity of VII, with generalized damage and collapse of adobe construction. No such event occurred during the past four centuries of Western occupancy. Accelerations of up to 0.10 g having nevertheless occurred elsewhere from subduction earthquakes which characteristically feature very large felt areas, we may accept this value as a conservative design value for the OBE.

A value of twice the OBE seems a reasonable upper bound for the SSE, even though no specific reasons exist for supposing that such a high value of the acceleration can ever be reached during an earthquake at Laguna Verde. Even an intraplate earthquake of magnitude 5 located directly under the plant would barely generate such accelerations: and there are no active geological structures in the Laguna Verde area which are capable of supporting a shallow local earthquake of this magnitude.

In conclusion, the design values for the Laguna Verde site are as follows:

OBE: 0.10 g

SSE: 0.20 g

```
  NO.  ANNO  OMES    DIA
   2. 1928.    2.   10.
(LAT,LONG)?: 17.85,97.63
HORA ORIGEN: (HORA,MIN,SEGS)? 4,38,34.9

ESTACIONES POR ELIMINAR:
PROFUNDIDAD? (KM): 84
```

EST	ARRIBOS P	ARRIBOS S	DIST	RESIDUOS P	RESIDUOS S
PUE	23.0	28.0	148.5	-15.5	0.0
OAX	52.0	0.0	122.7	15.9	******
TAC	43.0	0.0	122.6	1.6	******
VER	20.0	42.0	213.5	-26.4	0.0
GUA	76.0	152.0	694.7	-29.0	******
MAN	69.0	145.0	716.6	-38.6	******
CHH	220.0	367.0	1480.4	20.9	******
TUC	264.0	470.0	2079.6	-14.5	******
DEN	271.0	497.0	2535.9	12.2	******
CIN	322.0	575.0	2687.2	50.8	******
CHC	328.0	589.0	2820.8	-5.4	******
CHA	343.0	611.0	2919.2	21.5	******
GFO	356.0	627.0	3024.9	1.9	******
LIC	365.0	0.0	3188.4	1.7	******
TOK	385.0	660.0	3343.1	9.3	******

0 ITERACIONES

EPICENTRO		PROF.	HORA ORIGEN		
17.85	97.64	84 R	4	38	34.9

ELIPSE DE CONFIANZA
[illegible] KM
ANGULO DEL EJE MAYOR= 0.00 GRADOS

13 OBSERVACIONES ELIMINADAS

XI-CUADRADO= 3.6

```
  NO.  ANNO  OMES    DIA
   4. 1937.    7.   26.
(LAT,LONG)?: 18.2,96.55
HORA ORIGEN: (HORA,MIN,SEGS)? 3,47,13.0

ESTACIONES POR ELIMINAR:
PROFUNDIDAD? (KM): 85
```

EST	ARRIBOS P	ARRIBOS S	DIST	RESIDUOS P	RESIDUOS S
VER	53.0	0.0	118.9	22.7	******
OAX	64.0	64.0	134.7	31.9	0.0
PUE	42.0	0.0	194.0	2.9	******
TAC	60.0	0.0	306.1	6.5	******
GUA	119.0	0.0	761.1	11.0	******
MAN	126.0	0.0	826.3	10.2	******
MAZ	169.0	0.0	1171.4	11.9	******
CHH	212.0	0.0	1514.2	4.7	******
TUC	269.0	481.0	2112.3	-8.2	******
COL	281.0	508.0	2322.0	36.7	******
STL	284.0	504.0	2341.5	38.9	******
FLO	286.0	514.0	2363.7	39.8	******
POR	302.0	547.0	2560.0	44.9	******
DEN	304.0	548.0	2515.0	49.5	******
LAJ	318.0	572.0	2623.9	57.0	******

EPICENTRO		PROF.	HORA ORIGEN		
18.20	-96.55	85 R	3	47	13.0

ELIPSE DE CONFIANZA
0.00 0.00 KM
ANGULO DEL EJE MAYOR= -49.75 GRADOS

13 OBSERVACIONES ELIMINADAS

XI-CUADRADO= 15.2

```
  NO.  ANNO  OMES    DIA
   3. 1932.    3.   10.

ESTACIONES POR ELIMINAR:2

CUALES ESTACIONES:2,7
PROFUNDIDAD FIJA=? (DEFAULT=LIBRE; *,G*=GLOBAL): 1
```

EST	ARRIBOS P	ARRIBOS S	DIST	RESIDUOS P	RESIDUOS S
LIT	229.0	415.0	1793.8	1.0	******
STL	277.0	500.0	2252.9	-0.6	******
FLO	278.0	509.0	2275.1	-1.2	******
MOU	319.0	0.0	2693.4	-1.3	******
PAS	320.0	0.0	2693.4	-0.3	******
TIN	338.0	886.0	2895.1	2.4	******

5 ITERACIONES

EPICENTRO		PROF.	HORA ORIGEN		
19.16	-96.69	1 R	23	1	36.5

ELIPSE DE CONFIANZA
11.47 8.59 KM
ANGULO DEL EJE MAYOR= -70.95 GRADOS

0 OBSERVACIONES ELIMINADAS

XI-CUADRADO= 1.7

```
  NO.  ANNO  OMES    DIA
   5. 1943.    5.    3.

ESTACIONES POR ELIMINAR:4

CUALES ESTACIONES:1,2,3,5
PROFUNDIDAD FIJA=? (DEFAULT=LIBRE; *,G*=GLOBAL): 1
```

EST	ARRIBOS P	ARRIBOS S	DIST	RESIDUOS P	RESIDUOS S
CAP	276.0	494.0	2268.9	-0.4	******
STL	286.0	512.0	2391.7	-0.3	******
FLO	288.0	514.0	2402.8	0.7	******
BOG	318.0	0.0	2693.6	0.0	******
LAJ	326.0	0.0	2810.6	-0.3	******
RIV	331.0	0.0	2868.9	-0.1	******
MOV	337.0	0.0	2935.6	0.4	******
PAS	338.0	0.0	2946.7	0.5	******
LOG	352.0	632.0	3127.8	-0.3	******
TIN	353.0	0.0	3139.2	-0.2	******

3 ITERACIONES

EPICENTRO		PROF.	HORA ORIGEN		
17.49	-95.13	1 R	10	17	8.2

ELIPSE DE CONFIANZA
2.80 2.30 KM
ANGULO DEL EJE MAYOR= -65.57 GRADOS

0 OBSERVACIONES ELIMINADAS

XI-CUADRADO= 0.1

```
  NO.  ANNO  QMES    DIA
    6. 1945.    1.   18.
(LAT,LONG)?: 18.5,93.8
HORA ORIGEN: (HORA,MIN,SEGS)? 18,6,34

ESTACIONES POR ELIMINAR:
PROFUNDIDAD? (KM): 40
```

EST	ARRIBOS P	ARRIBOS S	DIST	RESIDUOS P	RESIDUOS S
VER	46.0	72.0	261.8	-7.6	0.0
PUE	69.0	121.0	468.8	-10.5	******
TAC	82.0	0.0	577.3	-10.9	******
MER	88.0	140.0	509.4	3.5	******
TUC	288.0	546.0	2285.3	5.2	******
STL	290.0	528.0	2254.3	9.4	******
FLO	290.0	528.0	2276.6	7.9	******
PIE	332.0	0.0	2781.9	-4.7	******
PAL	335.0	0.0	2818.1	-4.7	******
LAJ	335.0	0.0	2832.8	-5.9	******
BOU	334.0	0.0	2828.0	-6.5	******
RIV	341.0	0.0	2894.0	-4.9	******
SAN	341.0	631.0	2914.9	-6.7	******
MOV	347.0	0.0	2960.7	-4.4	******
PAS	347.0	0.0	2971.8	-5.3	******

```
     0 ITERACIONES

        EPICENTRO        PROF.     HORA ORIGEN

    18.50     -93.80       40 R      18  6  34.0

 ELIPSE DE CONFIANZA
    16.60      16.55 KM
ANGULO DEL EJE  MAYOR=     -42.79 GRADOS

  10 OBSERVACIONES ELIMINADAS

 XI-CUADRADO=       20.1
```

```
  NO.  ANNO  QMES    DIA
    7. 1945.   10.   11.
(LAT,LONG)?: 18.15,97.2
HORA ORIGEN: (HORA,MIN,SEGS)? 16,53,2.0

ESTACIONES POR ELIMINAR:
PROFUNDIDAD? (KM): 40
```

EST	ARRIBOS P	ARRIBOS S	DIST	RESIDUOS P	RESIDUOS S
PUE	15.0	31.0	140.9	-6.7	0.0
TAC	26.0	43.0	255.3	-9.8	0.0
GUA	82.0	0.0	701.2	-9.1	******
TUC	248.0	456.0	2073.6	-11.7	******
BAL	266.0	0.0	2156.5	-2.6	******
CAP	269.0	495.0	2248.5	5.8	******
STL	279.0	514.0	2373.2	6.7	******
COL	277.0	525.0	2377.4	4.3	******
LAJ	296.0	0.0	2577.1	6.0	******
PIE	296.0	0.0	2584.2	5.3	******
BOU	300.0	477.0	2629.1	4.9	******
RIV	302.0	543.0	2665.4	3.3	******
MOU	308.0	545.0	2732.1	2.2	******
PAS	309.0	545.0	2732.1	3.2	******
CHH	316.0	574.0	2772.6	5.8	******

```
     0 ITERACIONES

        EPICENTRO        PROF.     HORA ORIGEN

    18.15     -97.20       40 R      16 53   2.0

 ELIPSE DE CONFIANZA
    19.97      19.35 KM
ANGULO DEL EJE  MAYOR=     -55.45 GRADOS

  9 OBSERVACIONES ELIMINADAS

 XI CUADRADO=       12.7
```

```
  NO.  ANNO  QMES    DIA
 45. 1946.    1.   11.

ESTACIONES POR ELIMINAR:1

CUALES ESTACIONES:4
PROFUNDIDAD FIJA=? (DEFAULT=LIBRE; *,G'=GLOBAL): 1
```

EST	ARRIBOS P	ARRIBOS S	DIST	RESIDUOS P	RESIDUOS S
VER	48.0	0.0	111.5	0.8	******
PUE	72.0	121.0	323.3	-3.5	******
TAC	88.0	152.0	430.4	3.2	******
CAP	282.0	0.0	2058.2	-0.6	******
TUC	292.0	0.0	2119.3	2.8	******
STL	296.0	535.0	2181.5	0.3	******
FLO	297.0	0.0	2192.6	0.1	******
PIE	337.0	0.0	2615.1	1.1	******
LAJ	338.0	0.0	2654.9	-2.5	******
PAL	340.0	0.0	2652.7	-0.2	******
BOU	342.0	0.0	2662.3	0.6	******
OVE	343.0	0.0	2670.7	0.6	******
RIV	347.0	0.0	2728.4	-2.5	******
MOU	352.0	0.0	2795.1	-0.2	******

```
     8 ITERACIONES

        EPICENTRO        PROF.     HORA ORIGEN

    19.40     -95.08        1 R      18 41  56.3

 ELIPSE DE CONFIANZA
     2.38       2.09 KM
ANGULO DEL EJE  MAYOR=     -28.14 GRADOS

  0 OBSERVACIONES ELIMINADAS

 XI-CUADRADO=        3.3
```

```
  NO.  ANNO  QMES    DIA
   8. 1946.    6.   30.
(LAT,LONG)?: 18.00,94.3
HORA ORIGEN: (HORA,MIN,SEGS)? 4,59,32.

ESTACIONES POR ELIMINAR:
PROFUNDIDAD? (KM): 40
```

EST	ARRIBOS P	ARRIBOS S	DIST	RESIDUOS P	RESIDUOS S
OAX	48.0	0.0	288.6	0.1	******
PUE	64.0	0.0	434.0	-2.2	******
TAC	78.0	0.0	533.8	-0.5	******
MER	115.0	175.0	586.0	30.0	******
MOB	201.0	359.0	1536.4	-4.1	******
COL	286.0	493.0	2204.8	4.3	******
TUC	274.0	493.0	2292.4	-0.3	******
STL	283.0	508.0	2316.2	7.0	******
FLO	283.0	509.0	2338.4	5.3	******
BOG	328.0	542.0	2647.2	23.1	******
CHC	318.0	606.0	2718.1	5.8	******
PIE	319.0	0.0	2788.9	-9.3	******
PAL	321.0	0.0	2821.6	-10.0	******
BOU	323.0	0.0	2835.8	-9.2	******
OVE	324.0	0.0	2845.7	-9.0	******

```
     0 ITERACIONES

        EPICENTRO        PROF.     HORA ORIGEN

    18.00     -94.29       40 R       4 59  32.0

 ELIPSE DE CONFIANZA
    10.47       9.70 KM
ANGULO DEL EJE  MAYOR=      58.02 GRADOS

  9 OBSERVACIONES ELIMINADAS

 XI-CUADRADO=        6.8
```

```
  NO.  ANNO  OMES    DIA
   9. 1946.    7.   11.

ESTACIONES POR ELIMINAR:3

CUALES ESTACIONES:4,6,10
PROFUNDIDAD FIJA=? (DEFAULT=LIBRE; *,G*=GLOBAL): 20

EST       ARRIBOS            DIST          RESIDUOS

          P         S                       P         S
OAX      58.0      64.0       267.3       -1.0       -5.3
VER      44.0      78.0       290.3        2.1        3.6
PUE      61.0     107.0       464.4       -1.1       -3.4
MER      82.0     152.0       641.8       -2.2      ******
MAN     132.0     245.0      1082.2        0.5      ******
MOR     202.0     358.0      1619.1       -4.2      ******
CHH     225.0     405.0      1747.2        3.4      ******
COL     271.0     479.0      2279.8       -2.6      ******
TUC     283.0     514.0      2358.6        3.2      ******
STL     284.0     518.0      2404.2        0.3      ******
FLO     285.0     520.0      2426.4       -0.6      ******
BOG     306.0     550.0      2604.8        2.9      ******

     3 ITERACIONES

          EPICENTRO          PROF.      HORA ORIGEN

     17.20      94.30         20 N        4 44  40.1

 ELIPSE DE CONFIANZA
     5.69       5.32 KM
ANGULO DEL EJE  MAYOR=      -70.22 GRADOS

   0 OBSERVACIONES ELIMINADAS

 XI CUADRADO=        5.6
```

```
  NO.  ANNO  OMES    DIA
  10. 1947.    2.   16.

ESTACIONES POR ELIMINAR:2

CUALES ESTACIONES:1,5
PROFUNDIDAD FIJA=? (DEFAULT=LIBRE; *,G*=GLOBAL): 1

EST       ARRIBOS            DIST          RESIDUOS

          P         S                       P         S
STL     299.0     543.0      2167.1        1.4      ******
FLO     301.0     544.0      2178.2        0.4      ******
PAL     318.0       0.0      2329.7       -2.8      ******
BOU     322.0       0.0      2357.8        1.2      ******
OVE     324.0       0.0      2379.1        0.7      ******
RTV     324.0       0.0      2387.5        0.4      ******
ADU     330.0       0.0      2443.1       -1.3      ******
PAS     330.0       0.0      2454.2       -2.7      ******
BOG     344.0     612.0      2544.1        0.4      ******
MAT     340.0       0.0      2570.1        1.5      ******
CHC     340.0     605.0      2567.5        1.8      ******
TIN     348.0       0.0      3094.5       -1.4      ******

     3 ITERACIONES

          EPICENTRO          PROF.      HORA ORIGEN

     17.11      97.23         1 P         2 15  42.3

 ELIPSE DE CONFIANZA
103124.18   8.287.64 KM
ANGULO DEL EJE  MAYOR=      -0.00 GRADOS

   0 OBSERVACIONES ELIMINADAS

 XI-CUADRADO=        2.4
```

```
  NO.  ANNO  QMES    DIA
  11. 1948.    1.    6.

ESTACIONES POR ELIMINAR:3

CUALES ESTACIONES:1,2,14
PROFUNDIDAD FIJA=? (DEFAULT=LIBRE; *,G*=GLOBAL): 1
```

EST	ARRIBOS P	ARRIBOS S	DIST	RESIDUOS P	RESIDUOS S
BAL	284.0	0.0	2259.7	0.6	******
TUC	270.0	0.0	2099.3	1.4	******
COL	317.0	587.0	2614.4	0.4	******
LAJ	314.0	0.0	2567.9	1.3	******
PAL	313.0	0.0	2570.7	-0.4	******
PIE	320.0	0.0	2621.2	1.8	******
BOU	323.0	609.0	2655.3	0.9	******
RIV	323.0	0.0	2667.4	-0.6	******
MOV	329.0	0.0	2723.0	1.4	******
PAS	328.0	0.0	2734.1	-3.8	******
HAI	341.0	0.0	2867.0	1.3	******
TIN	347.0	0.0	2955.8	-0.0	******

```
     3 ITERACIONES

        EPICENTRO        PROF.     HORA ORIGEN

    16.70    -98.09       1 R      17 25  56.9

 ELIPSE DE CONFIANZA
     3.49       3.26 KM
ANGULO DEL EJE  MAYOR=     -60.28 GRADOS

   0 OBSERVACIONES ELIMINADAS

 XI-CUADRADO=        2.3
```

```
  NO.  ANNO  QMES    DIA
  12. 1948.    1.    6.

ESTACIONES POR ELIMINAR:4

CUALES ESTACIONES:2,7,9,13
PROFUNDIDAD FIJA=? (DEFAULT=LIBRE; *,G*=GLOBAL):
```

EST	ARRIBOS P	ARRIBOS S	DIST	RESIDUOS P	RESIDUOS S
OAX	48.0	0.0	223.3	1.4	******
TAC	61.0	0.0	290.8	3.2	******
VER	67.0	0.0	380.5	0.5	******
MAN	100.0	158.0	630.7	2.2	******
GUA	100.0	156.0	630.3	1.2	******
BAL	290.0	0.0	2261.4	0.8	******
LAJ	317.0	0.0	2559.7	1.3	******
PAL	317.0	0.0	2570.4	0.2	******
PIE	320.0	0.0	2611.9	-1.3	******
RIV	324.0	0.0	2658.9	-2.4	******
MOV	329.0	0.0	2714.5	-3.2	******

```
     9 ITERACIONES

        EPICENTRO        PROF.     HORA ORIGEN

    16.83    -98.83       12       18  0  14.2

 ELIPSE DE CONFIANZA
 67684.64  57054.32 KM
ANGULO DEL EJE  MAYOR=      -0.00 GRADOS

   0 OBSERVACIONES ELIMINADAS

 XI-CUADRADO=        4.3
```

```
  NO.  ANNO  QMES    DIA
  13. 1948.    8.   11.

ESTACIONES POR ELIMINAR:6

CUALES ESTACIONES:2,5,6,8,11,13
PROFUNDIDAD FIJA=? (DEFAULT=LIBRE; *,G*=GLOBAL): 20
```

EST	ARRIBOS P	ARRIBOS S	DIST	RESIDUOS P	RESIDUOS S
OAX	33.0	0.0	203.4	0.6	******
PUE	48.0	0.0	325.6	0.5	******
TAC	63.0	0.0	447.5	1.8	******
MAN	125.0	0.0	967.5	-0.7	******
TUC	272.0	488.0	2214.4	-2.7	******
STL	283.0	516.0	2332.6	4.1	******
BOG	318.0	582.0	2736.1	-1.2	******
CHC	318.0	575.0	2733.1	-0.8	******
LAJ	318.0	0.0	2739.8	-1.7	******

```
     3 ITERACIONES

        EPICENTRO        PROF.     HORA ORIGEN

    18.04    -95.20       20 R      10 36  19.5

 ELIPSE DE CONFIANZA
     8.69       5.60 KM
ANGULO DEL EJE  MAYOR=     -84.11 GRADOS

   0 OBSERVACIONES ELIMINADAS

 XI-CUADRADO=        3.7
```

```
  NO.  ANNO  QMES    DIA
  14. 1949.    8.    1.

ESTACIONES POR ELIMINAR:4

CUALES ESTACIONES:5,13,14,15
PROFUNDIDAD FIJA=? (DEFAULT=LIBRE; *,G*=GLOBAL): 1
```

EST	ARRIBOS P	ARRIBOS S	DIST	RESIDUOS P	RESIDUOS S
VER	11.0	0.0	24.9	0.2	******
PUE	38.0	0.0	209.3	-1.2	******
TAC	53.0	0.0	311.8	1.1	******
TUC	259.0	478.0	2041.4	0.4	******
CHC	314.0	556.0	2609.0	1.0	******
PAL	311.0	0.0	2571.2	2.2	******
BOU	312.0	0.0	2587.7	1.4	******
OVE	313.0	0.0	2600.4	1.0	******
RIV	317.0	0.0	2649.8	-0.7	******
PAS	322.0	0.0	2716.5	-3.8	******
CLE	330.0	599.0	2815.6	-1.7	******

```
     3 ITERACIONES

        EPICENTRO        PROF.     HORA ORIGEN

    19.43    -96.23       1 R       8  3  52.1

 ELIPSE DE CONFIANZA
167441.23 105672.41 KM
ANGULO DEL EJE  MAYOR=      -0.00 GRADOS

   0 OBSERVACIONES ELIMINADAS

 XI-CUADRADO=        2.7
```

```
  NO.  ANNO  QMES    DIA
  15. 1949.    8.    6.

ESTACIONES POR ELIMINAR:3

CUALES ESTACIONES:1,3,4
PROFUNDIDAD FIJA=? (DEFAULT=LIBRE; *,G*=GLOBAL): 1

EST      ARRIBOS          DIST          RESIDUOS
        P        S                      P        S
OAX    29.0     0.0         169.4      -0.7   ******
MER    92.0     0.0         703.5      -0.5   ******
TUC   270.0   484.0        2188.9       0.1   ******
PIE   317.0     0.0        2691.4      -1.2   ******
PAL   320.0     0.0        2707.3      -0.2   ******
BOU   322.0     0.0        2734.4      -1.6   ******
RIV   322.0     0.0        2785.8       2.2   ******
PAS   332.0     0.0        2863.6       0.8   ******
CHN   337.0     0.0        2921.2       1.1   ******

     3 ITERACIONES

        EPICENTRO        PROF.      HORA ORIGEN

    18.10     -95.64        1 R      18 53  26.7

 ELIPSE DE CONFIANZA
127166.17 162626.11 KM
ANGULO DEL EJE  MAYOR=     -90.00 GRADOS

   0 OBSERVACIONES ELIMINADAS

 XI CUADRADO=          1.3


  NO.  ANNO  QMES    DIA
  16. 1950.   12.   14.

ESTACIONES POR ELIMINAR:3

CUALES ESTACIONES:6,10,15
PROFUNDIDAD FIJA=? (DEFAULT=LIBRE; *,G*=GLOBAL): 1

EST      ARRIBOS          DIST          RESIDUOS
        P        S                      P        S
OAX    30.0     0.0         213.1      -0.8   ******
PUE    48.0     0.0         384.5       0.1   ******
TAC    54.0     0.0         429.8       0.3   ******
VER    57.0     0.0         447.6       1.1   ******
GUA   101.0     0.0         789.8       2.1   ******
CHH   207.0   371.0        1658.5       1.2   ******
LIT   264.0   494.0        2195.4      -2.1   ******
TUC   271.0   467.0        2248.1      -0.0   ******
STL   309.0   579.0        2662.3      -1.3   ******
LAJ   316.0     0.0        2714.1      -0.6   ******
COL   313.0   571.0        2667.4       2.1   ******
PAL   316.0     0.0        2725.9      -2.1   ******

     4 ITERACIONES

        EPICENTRO        PROF.      HORA ORIGEN

    15.61     -98.11        1 R      14 15  39.3

 ELIPSE DE CONFIANZA
     3.61       3.18 KM
ANGULO DEL EJE  MAYOR=     -82.72 GRADOS

   0 OBSERVACIONES ELIMINADAS

 XI CUADRADO=          1.9


  NO.  ANNO  QMES    DIA
  17. 1950.   12.   17.

ESTACIONES POR ELIMINAR:3

CUALES ESTACIONES:1,10,15
PROFUNDIDAD FIJA=? (DEFAULT=LIBRE; *,G*=GLOBAL): 1

EST      ARRIBOS          DIST          RESIDUOS
        P        S                      P        S
PUE    49.0    91.0         323.6      -2.5      1.9
TAC    52.0     0.0         345.6       1.9   ******
VER    61.0     0.0         439.2      -1.0   ******
TUC   269.0     0.0        2142.7       1.3   ******
PAL   314.0     0.0        2616.8       1.9   ******
PIE   318.0     0.0        2654.1       1.6   ******
BOU   321.0     0.0        2686.9       0.4   ******
RIV   321.0     0.0        2694.6      -0.3   ******
OVE   323.0     0.0        2720.0       1.5   ******
PAS   326.0   608.0        2761.3      -3.7   ******
CHA   332.0   677.0        2833.6       0.6   ******
CHN   333.0     0.0        2851.4       0.1   ******

     3 ITERACIONES

        EPICENTRO        PROF.      HORA ORIGEN

    16.25     -98.96        1 R       1  8   1.1

 ELIPSE DE CONFIANZA
     2.53       2.18 KM
ANGULO DEL EJE  MAYOR=     -62.18 GRADOS

   0 OBSERVACIONES ELIMINADAS

 XI-CUADRADO=          3.0


  NO.  ANNO  QMES    DIA
  18. 1954.    4.    7.

ESTACIONES POR ELIMINAR:
PROFUNDIDAD FIJA=? (DEFAULT=LIBRE; *,G*=GLOBAL): 1

EST      ARRIBOS          DIST          RESIDUOS
        P        S                      P        S
OAX    14.0     0.0          78.5      -0.0   ******
PUE    31.0     0.0         193.9      -0.7   ******
VER    36.0     0.0         226.9       0.2   ******
TAC    44.0     0.0         288.6       0.6   ******

     4 ITERACIONES

        EPICENTRO        PROF.      HORA ORIGEN

    17.48     -97.32        1 R       5 35  47.6
```

```
 NO.  ANNO  QMES    DIA
 20. 1954.    5.   28.

ESTACIONES POR ELIMINAR:
PROFUNDIDAD FIJA=? (DEFAULT=LIBRE; '*'=GLOBAL): 1

EST       ARRIBOS              DIST          RESIDUOS
        P          S                          P          S
TAC    21.0       38.0        117.9         0.2        0.8
PUE    25.0       45.0        146.7        -0.6       -0.6
OAX    46.0       86.0        315.2        -1.0        2.2

     3 ITERACIONES

          EPICENTRO          PROF.      HORA ORIGEN

     18.35     -99.36          1 R       8  1  32.9

 ELIPSE DE CONFIANZA
    16.61      13.56 KM
ANGULO DEL EJE  MAYOR=     -73.45 GRADOS

    0 OBSERVACIONES ELIMINADAS

 XI-CUADRADO=          0.5
```

```
 NO.  ANNO  QMES    DIA
 22. 1959.    4.    6.

ESTACIONES POR ELIMINAR:1

CUALES ESTACIONES:5
PROFUNDIDAD FIJA=? (DEFAULT=LIBRE; '*'=GLOBAL): 1

EST       ARRIBOS              DIST          RESIDUOS
        P          S                          P          S
PUE     7.0       12.0         30.2        -1.0       -1.1
TAC    26.0       45.0        136.1         0.6        1.0
VER    33.0       56.0        188.3         0.1       -1.5
OAX    43.0       75.0        264.2         0.7        0.9

     5 ITERACIONES

          EPICENTRO          PROF.      HORA ORIGEN

     19.14     -97.96          1 R       7 25  52.5

 ELIPSE DE CONFIANZA
    10.42       9.11 KM
ANGULO DEL EJE  MAYOR=     -76.41 GRADOS

    0 OBSERVACIONES ELIMINADAS

 XI-CUADRADO=          0.5
```

```
 NO.  ANNO  QMES    DIA
 21. 1958.    8.   19.

ESTACIONES POR ELIMINAR:1

CUALES ESTACIONES:4
PROFUNDIDAD FIJA=? (DEFAULT=LIBRE; '*'=GLOBAL): 1

EST       ARRIBOS              DIST          RESIDUOS
        P          S                          P          S
TAC    25.0       50.0        183.5        -0.3        0.4
VER    25.0       47.0        175.5         0.7        0.6
OAX    26.0       54.0        198.2        -1.1        1.4

     3 ITERACIONES

          EPICENTRO          PROF.      HORA ORIGEN

     18.59     -97.67          1 R       1 48  15.5
```

```
 NO.  ANNO  QMES    DIA
 25. 1961.   12.    3.

ESTACIONES POR ELIMINAR:3

CUALES ESTACIONES:1,5,6
PROFUNDIDAD FIJA=? (DEFAULT=LIBRE; '*'=GLOBAL): 1

EST       ARRIBOS              DIST          RESIDUOS
        P          S                          P          S
PUE    35.0        0.0        190.7         0.1   ******
TAC    44.0       77.0        267.5        -0.4        0.5
OAX    58.0        0.0        409.9        -0.0   ******

     5 ITERACIONES

          EPICENTRO          PROF.      HORA ORIGEN

     20.64     -97.60          1 R      11 17  39.1
```

```
  NO.  ANNO  QMES    DIA
  26. 1963.    6.    4.

ESTACIONES POR ELIMINAR:0
PROFUNDIDAD FIJA=? (DEFAULT=LIBRE; *,G*=GLOBAL): 10

EST       ARRIBOS            DIST          RESIDUOS

          P         S                       P         S
VER     22.0      36.0        122.7         0.4      -2.4
OAX     26.0      42.0        149.4         0.9      -2.7
TAC     52.0       0.0        374.8         1.6    ******

     24 ITERACIONES

          EPICENTRO        PROF.      HORA ORIGEN

     18.10     -95.92        10 R       20 28  45.9

 ELIPSE DE CONFIANZA
    35.68      23.82 KM
ANGULO DEL EJE  MAYOR=     -88.49 GRADOS

    0 OBSERVACIONES ELIMINADAS

 XI-CUADRADO=         1.2
```

```
  NO.  ANNO  QMES    DIA
  28. 1965.    2.    3.

ESTACIONES POR ELIMINAR:5

CUALES ESTACIONES:1,3,4,10,13
PROFUNDIDAD FIJA=? (DEFAULT=LIBRE; *,G*=GLOBAL): 1

EST       ARRIBOS            DIST          RESIDUOS

          P         S                       P         S
VER     21.0      47.0        233.0         1.9      -0.9
LUB     218.0      0.0       1862.9         2.4    ******
WIC     222.0      0.0       1933.0        -1.6    ******
TUL     239.0      0.0       2063.6         1.0    ******
ATL     251.0      0.0       2195.0        -1.0    ******
ALB     246.0      0.0       2160.8        -2.4    ******
COM     262.0      0.0       2324.3        -0.6    ******
TON     263.0      0.0       2349.1        -1.6    ******
PUG     320.0      0.0       2952.0         0.1    ******
EUR     331.0      0.0       3059.0         2.4    ******

     3 ITERACIONES

          EPICENTRO        PROF.      HORA ORIGEN

     18.72     -97.52         1 R       21 25  33.1

 ELIPSE DE CONFIANZA
     4.95       3.15 KM
ANGULO DEL EJE  MAYOR=     -73.69 GRADOS

    0 OBSERVACIONES ELIMINADAS

 XI-CUADRADO=         2.8
```

```
  NO.  ANNO  QMES    DIA
  46. 1964.    7.   23.

ESTACIONES POR ELIMINAR:3

CUALES ESTACIONES:4,6,11
PROFUNDIDAD FIJA=? (DEFAULT=LIBRE; *,G*=GLOBAL): 1

EST       ARRIBOS            DIST          RESIDUOS

          P         S                       P         S
TAC     44.0      29.0        252.6         2.6       1.8
OAX     53.0      91.0        349.8         0.2       2.2
NCS     132.0     222.0       771.0         0.9    ******
ALO     238.0      0.0       1845.1         1.8    ******
TEO     265.0      0.0       2092.0        -0.1    ******
GCA     288.0      0.0       2322.1         1.1    ******
RLA     295.0      0.0       2407.7        -0.3    ******
UBO     305.0      0.0       2515.6         1.2    ******

     3 ITERACIONES

          EPICENTRO        PROF.      HORA ORIGEN

     20.54     -96.54         1 R       23 58   1.0

 ELIPSE DE CONFIANZA
     4.68       3.79 KM
ANGULO DEL EJE  MAYOR=     -66.21 GRADOS

    0 OBSERVACIONES ELIMINADAS

 XI-CUADRADO=         1.4
```

```
  NO.  ANNO  QMES    DIA
  29. 1966.    5.   19.

ESTACIONES POR ELIMINAR:2

CUALES ESTACIONES:8,9
PROFUNDIDAD FIJA=? (DEFAULT=LIBRE; *,G*=GLOBAL): 1

EST       ARRIBOS            DIST          RESIDUOS

          P         S                       P         S
VIS     16.0       0.0         88.8         0.5    ******
OAX     17.0       0.0        103.9        -1.0    ******
JUA     34.0      52.0        188.9         3.2      -3.4
WIC     234.0      0.0       1878.1        -0.5    ******
CUM     273.0      0.0       2232.1         0.1    ******
TON     283.0      0.0       2344.3         1.6    ******
UIN     322.0      0.0       2791.4        -1.9    ******

     3 ITERACIONES

          EPICENTRO        PROF.      HORA ORIGEN

     17.79     -96.14         1 R       10 42  21.3

 ELIPSE DE CONFIANZA
461529.69 227208.28 KM
ANGULO DEL EJE  MAYOR=      -0.00 GRADOS

    0 OBSERVACIONES ELIMINADAS

 XI-CUADRADO=         2.5
```

```
 NO.  ANNO  QMES    DIA
 30. 1966.   11.   28.

ESTACIONES POR ELIMINAR:7

CUALES ESTACIONES:1,4,5,7,9,12,14
PROFUNDIDAD FIJA=? (DEFAULT=LIBRE; ',G'=GLOBAL): 1
```

EST	ARRIBOS P	ARRIBOS S	DIST	RESIDUOS P	RESIDUOS S
VIS	24.0	0.0	125.2	0.6	******
OAX	26.0	45.0	140.6	0.1	-0.2
AHU	108.0	0.0	824.9	-0.3	******
WIC	234.0	0.0	1847.6	1.0	******
AIB	263.0	0.0	2117.5	0.1	******
TUC	266.0	0.0	2142.2	0.5	******
TON	284.0	0.0	2329.5	1.8	******
CHN	329.0	0.0	2873.9	-3.6	******

```
     3 ITERACIONES

        EPICENTRO        PROF.     HORA ORIGEN

    18.29    -96.05        1 R      20 10  43.3

 ELIPSE DE CONFIANZA
     4.64       3.87 KM
ANGULO DEL EJE  MAYOR=     -64.41 GRADOS

   0 OBSERVACIONES ELIMINADAS

 XI-CUADRADO=        2.3
```

```
 NO.  ANNO  QMES    DIA
 31. 1967.    2.    1.

ESTACIONES POR ELIMINAR:2

CUALES ESTACIONES:2,6
PROFUNDIDAD FIJA=? (DEFAULT=LIBRE; ',G'=GLOBAL): 10
```

EST	ARRIBOS P	ARRIBOS S	DIST	RESIDUOS P	RESIDUOS S
VIS	30.0	0.0	173.7	-0.2	******
WIC	230.0	0.0	1808.7	0.3	******
ALB	262.0	0.0	2090.0	0.8	******
TUC	266.0	0.0	2126.2	0.9	******
UIN	322.0	0.0	2741.5	-1.8	******

```
     4 ITERACIONES

        EPICENTRO        PROF.     HORA ORIGEN

    18.56    -95.95       10 R      14  1  22.9

 ELIPSE DE CONFIANZA
391083.22 257753.02 KM
ANGULO DEL EJE  MAYOR=      -0.00 GRADOS

   0 OBSERVACIONES ELIMINADAS

 XI-CUADRADO=        1.0
```

```
 NO.  ANNO  QMES    DIA
 32. 1967.    3.   11.

ESTACIONES POR ELIMINAR:4

CUALES ESTACIONES:2,3,14,15
PROFUNDIDAD FIJA=? (DEFAULT=LIBRE; ',G'=GLOBAL): 1
```

EST	ARRIBOS P	ARRIBOS S	DIST	RESIDUOS P	RESIDUOS S
VER	6.0	0.0	35.1	-2.4	******
TAC	47.0	87.0	357.5	-2.3	0.1
COM	67.0	123.0	503.2	-0.7	3.3
LEO	89.0	0.0	650.6	2.7	******
MER	89.0	0.0	675.3	-0.4	******
GUA	105.0	0.0	806.1	-0.7	******
AHU	114.0	0.0	857.5	1.9	******
LAP	113.0	0.0	887.3	-2.8	******
MAN	119.0	0.0	897.3	1.9	******
SAN	120.0	0.0	927.9	-0.9	******
MAZ	155.0	0.0	1188.3	2.0	******

```
    10 ITERACIONES

        EPICENTRO        PROF.     HORA ORIGEN

    19.03    -95.92        1 R      14 45   2.1

 ELIPSE DE CONFIANZA
     2.83       2.79 KM
ANGULO DEL EJE  MAYOR=     -38.33 GRADOS

   0 OBSERVACIONES ELIMINADAS

 XI-CUADRADO=        3.6
```

```
 NO.  ANNO  QMES    DIA
 33. 1968.    3.   24.

ESTACIONES POR ELIMINAR:4

CUALES ESTACIONES:1,2,8,5
PROFUNDIDAD FIJA=? (DEFAULT=LIBRE; ',G'=GLOBAL): 1
```

EST	ARRIBOS P	ARRIBOS S	DIST	RESIDUOS P	RESIDUOS S
JUA	26.0	45.0	169.8	-0.6	-4.3
OAX	30.0	49.0	184.2	1.5	-3.6
PHM	36.0	59.0	204.1	5.0	2.0
MEX	57.0	103.0	432.3	1.7	2.7
TAC	59.0	106.0	436.6	3.1	4.7
WIC	232.0	0.0	1882.0	-1.3	******
TUL	244.0	0.0	1986.5	-1.0	******
FAY	249.0	0.0	2009.8	1.4	******
ALB	262.0	0.0	2177.9	-3.6	******
CUM	263.0	0.0	2176.6	-2.5	******
TUC	265.0	0.0	2217.2	-4.7	******

```
     2 ITERACIONES

        EPICENTRO        PROF.     HORA ORIGEN

    18.05    -95.33        1 R       2 51  38.6

 ELIPSE DE CONFIANZA
     4.42       4.40 KM
ANGULO DEL EJE  MAYOR=     -48.38 GRADOS

   0 OBSERVACIONES ELIMINADAS

 XI-CUADRADO=        7.9
```

NO. ANNO QMES DIA
34. 1970. 5. 5.

ESTACIONES POR ELIMINAR:5

CUALES ESTACIONES:7,9,12,13,15
PROFUNDIDAD FIJA=? (DEFAULT=LIBRE; 'G'=GLOBAL): 33

EST	ARRIBOS P	ARRIBOS S	DIST	RESIDUOS P	RESIDUOS S
VIS	21.0	0.0	176.0	-1.9	******
JUA	25.0	43.0	178.4	1.8	-0.9
POP	45.0	0.0	362.8	-0.9	******
TEP	52.0	0.0	405.2	0.8	******
MEX	54.0	0.0	428.1	-0.0	******
TAC	55.0	0.0	431.8	0.5	******
OXT	61.0	0.0	477.7	0.8	******
TUL	245.0	435.0	1979.0	-0.4	******
FAL	249.0	0.0	2005.0	0.7	******
CUM	265.0	0.0	2169.8	-1.1	******

3 ITERACIONES

EPICENTRO		PROF.	HORA ORIGEN
18.14	-95.31	33 R	18 22 21.6

ELIPSE DE CONFIANZA
3.62 3.45 KM
ANGULO DEL EJE MAYOR= 63.53 GRADOS

0 OBSERVACIONES ELIMINADAS

XI-CUADRADO= 1.1

NO. ANNO QMES DIA
36. 1970. 11. 6.

ESTACIONES POR ELIMINAR:6

CUALES ESTACIONES:1,5,7,14,15
PROFUNDIDAD FIJA=? (DEFAULT=LIBRE; 'G'=GLOBAL): 1

EST	ARRIBOS P	ARRIBOS S	DIST	RESIDUOS P	RESIDUOS S
COM	61.0	106.0	447.0	0.5	-0.9
TEP	62.0	0.0	466.7	-0.9	******
TAC	65.0	0.0	476.8	0.8	******
JUN	169.0	0.0	1322.7	-0.3	******
FAY	231.0	0.0	1843.1	-1.1	******
ATL	233.0	0.0	1852.7	-0.1	******
OAK	260.0	453.0	2084.7	1.0	******
TUC	266.0	0.0	2146.0	0.5	******
FLO	269.0	0.0	2179.7	-0.0	******

2 ITERACIONES

EPICENTRO		PROF.	HORA ORIGEN
19.68	-94.67	1 R	16 23 3.9

ELIPSE DE CONFIANZA
7.04 4.64 KM
ANGULO DEL EJE MAYOR= -1.45 GRADOS

0 OBSERVACIONES ELIMINADAS

XI-CUADRADO= 0.5

NO. ANNO QMES DIA
35. 1970. 11. 6.

ESTACIONES POR ELIMINAR:2

CUALES ESTACIONES:2,6
PROFUNDIDAD FIJA=? (DEFAULT=LIBRE; 'G'=GLOBAL): 33

EST	ARRIBOS P	ARRIBOS S	DIST	RESIDUOS P	RESIDUOS S
VER	23.0	41.0	158.8	-1.2	2.0
COM	62.0	107.0	455.2	1.2	-1.2
TEP	62.0	0.0	465.6	0.0	******
TAC	65.0	111.0	474.2	1.2	-1.4
TUL	229.0	335.0	1812.3	-0.7	******
FAY	232.0	0.0	1833.3	-0.1	******
ATL	233.0	0.0	1846.3	-0.6	******
CUM	248.0	433.0	1987.0	-1.6	******
AIB	260.0	0.0	2059.1	2.5	******
OAK	261.0	456.0	2077.2	1.5	******
TUC	267.0	0.0	2137.1	1.1	******
FLO	268.0	0.0	2170.0	1.4	******
MAN	270.0	0.0	2182.7	-0.7	******

2 ITERACIONES

EPICENTRO		PROF.	HORA ORIGEN
19.62	-94.81	33 R	2 31 59.9

ELIPSE DE CONFIANZA
108805.29 65804.29 KM
ANGULO DEL EJE MAYOR= -90.00 GRADOS

0 OBSERVACIONES ELIMINADAS

XI-CUADRADO= 1.7

NO. ANNO QMES DIA
37. 1973. 1. 31.

ESTACIONES POR ELIMINAR:2

CUALES ESTACIONES:10,12
PROFUNDIDAD FIJA=? (DEFAULT=LIBRE; 'G'=GLOBAL): 1

EST	ARRIBOS P	ARRIBOS S	DIST	RESIDUOS P	RESIDUOS S
LAP	125.0	0.0	949.5	1.3	******
TUL	246.0	0.0	1951.9	1.2	******
FAY	250.0	0.0	1991.5	0.8	******
ALB	258.0	282.0	2064.7	0.8	******
TUC	258.0	0.0	2074.0	-0.2	******
CUM	272.0	0.0	2220.9	-1.7	******
ROL	274.0	0.0	2228.0	-0.5	******
OAK	282.0	0.0	2317.4	0.8	******
GLA	291.0	0.0	2412.1	1.8	******
LEE	312.0	0.0	2635.5	-0.1	******
DUG	330.0	0.0	2858.8	-1.4	******
EUR	339.0	0.0	2972.4	-1.7	******
MED	341.0	0.0	2992.5	-1.3	******

2 ITERACIONES

EPICENTRO		PROF.	HORA ORIGEN
18.16	-96.95	1 R	12 32 27.2

ELIPSE DE CONFIANZA
57954.14 38127.11 KM
ANGULO DEL EJE MAYOR= -90.00 GRADOS

0 OBSERVACIONES ELIMINADAS

XI-CUADRADO= 1.4

NO. ANNO QMES DIA
38. 1973. 8. 28.

ESTACIONES POR ELIMINAR:2

CUALES ESTACIONES:1,7
PROFUNDIDAD FIJA=? (DEFAULT=LIBRE; *,G*=GLOBAL): 1

EST	ARRIBOS P	ARRIBOS S	DIST	RESIDUOS P	RESIDUOS S
MEX	43.0	0.0	290.7	1.0	******
TAC	44.0	66.0	295.1	1.4	-11.4
GUA	100.0	177.0	749.1	4.5	******
LAP	114.0	0.0	913.1	-1.9	******
SAN	120.0	213.0	945.8	0.0	******
HOC	163.0	0.0	1286.2	1.1	******
JUN	176.0	0.0	1381.2	2.5	******
TUL	241.0	440.0	1946.7	0.1	******
FAY	244.0	0.0	1982.5	-0.9	******
TUC	257.0	464.0	2098.0	-0.5	******
CUM	265.0	480.0	2198.3	-3.1	******
TRI	271.0	0.0	2234.0	-0.7	******
TON	276.0	0.0	2253.5	2.9	******

3 ITERACIONES

EPICENTRO		PROF.	HORA ORIGEN
18.39	-96.65	1 R	9 50 37.9

ELIPSE DE CONFIANZA
4.09 3.36 KM
ANGULO DEL EJE MAYOR= -15.09 GRADOS

0 OBSERVACIONES ELIMINADAS

XI-CUADRADO= 4.2

NO. ANNO QMES DIA
39. 1974. 7. 25.

ESTACIONES POR ELIMINAR:0
PROFUNDIDAD FIJA=? (DEFAULT=LIBRE; *,G*=GLOBAL): 1

EST	ARRIBOS P	ARRIBOS S	DIST	RESIDUOS P	RESIDUOS S
MEX	41.0	78.0	309.7	-2.0	-1.2
TAC	44.0	78.0	312.0	0.7	-1.8
JUA	47.0	0.0	327.5	1.8	******
OXT	48.0	0.0	363.0	2.5	******
COM	67.0	0.0	549.1	-2.0	******
WIT	228.0	0.0	1841.3	0.4	******
TUL	227.0	0.0	1840.6	-0.5	******
GRA	246.0	0.0	1995.0	1.1	******
ALB	247.0	0.0	2004.7	1.0	******
ROM	250.0	0.0	2033.5	0.8	******
GRE	252.0	0.0	2048.0	1.3	******
TUC	251.0	0.0	2046.2	0.5	******
DON	253.0	0.0	2074.8	-0.6	******
ELC	257.0	0.0	2109.4	-0.4	******
TYS	264.0	0.0	2199.0	-2.8	******

2 ITERACIONES

EPICENTRO		PROF.	HORA ORIGEN
19.34	-96.34	1 R	9 53 35.6

ELIPSE DE CONFIANZA
28743.89 22532.44 KM
ANGULO DEL EJE MAYOR= -90.00 GRADOS

0 OBSERVACIONES ELIMINADAS

XI-CUADRADO= 2.1

NO. ANNO QMES DIA
40. 1975. 7. 1.

ESTACIONES POR ELIMINAR:2

CUALES ESTACIONES:5,6
PROFUNDIDAD FIJA=? (DEFAULT=LIBRE; *,G*=GLOBAL): 1

EST	ARRIBOS P	ARRIBOS S	DIST	RESIDUOS P	RESIDUOS S
COM	37.0	0.0	336.8	0.1	******
TAC	56.0	0.0	488.5	-0.1	******
TUL	247.0	0.0	2036.0	2.8	******
FAY	244.0	0.0	2059.7	-2.8	******

3 ITERACIONES

EPICENTRO		PROF.	HORA ORIGEN
18.07	-95.51	1 R	1 51 40.3

ELIPSE DE CONFIANZA
24.19 20.39 KM
ANGULO DEL EJE MAYOR= -1.80 GRADOS

0 OBSERVACIONES ELIMINADAS

XI-CUADRADO= 3.9

NO. ANNO QMES DIA
41. 1977. 12. 26.

ESTACIONES POR ELIMINAR:2

CUALES ESTACIONES:1,5
PROFUNDIDAD FIJA=? (DEFAULT=LIBRE; *,G*=GLOBAL): 1

EST	ARRIBOS P	ARRIBOS S	DIST	RESIDUOS P	RESIDUOS S
MEX*	36.0	0.0	234.8	1.1	******
OXT	41.0	69.0	277.2	0.9	-4.2
COM	77.0	135.0	593.8	1.4	******
HOC	166.0	0.0	1322.7	-0.0	******
DAL	208.0	0.0	1635.3	3.7	******
ESC	210.0	0.0	1695.8	-1.5	******
LUB	220.0	0.0	1773.4	-0.7	******
FAV	246.0	0.0	2021.7	-2.9	******
ALB	254.0	0.0	2071.7	-0.4	******
ELC	272.0	0.0	2271.4	-2.0	******
FRE	276.0	0.0	2305.7	-0.6	******
GLA	287.0	0.0	2404.1	2.1	******
GOL	296.0	0.0	2515.1	0.6	******

2 ITERACIONES

EPICENTRO		PROF.	HORA ORIGEN
18.12	-97.35	1 R	7 27 45.6

ELIPSE DE CONFIANZA
14741.55 12422.50 KM
ANGULO DEL EJE MAYOR= -90.00 GRADOS

0 OBSERVACIONES ELIMINADAS

XI-CUADRADO= 3.0

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