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DIRECTION OF FAULTING IN SOME OF THE LARGER EARTHQUAKES OF 1954-1955

BY

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ABSTRACT

Fault plane solutions are presented for twenty-three of the larger earthquakes of 1954-1955.

INTRODUCTION

For several years this Observatory has been producing fault plane solutions by Byerly's method. Two recent papers marked the end of the initial stage of this program. The first of these papers (Hodgson, 1957) reviewed the method, summarized the 65 solutions produced to date, showed that these solutions were self-consistent and discussed their implications to tectonic theory. The second paper (Hodgson and Adams, in press) was a statistical examination of the data on which the first 65 solutions had been based. It was the conclusion of this study that the data from the direct phases P and PKP were reasonably accurate but that those from the reflected phases were not acceptable. This latter conclusion was based partly on the first 65 solutions, but more particularly on the solutions to be presented in the present paper. The conclusion to be drawn from the two review papers is that the techniques of the fault plane project have justified themselves sufficiently that the program should be continued, but without the use of the reflected phases.

The present paper is the first of this second series; it presents solutions for 23 earthquakes which occurred in the period from February, 1954, to July, 1955. The data on which the solutions are based were obtained by means of a questionnaire circulated in September, 1955. We are very much indebted to those seismologists who, by completing our questionnaire, have made this study possible.

In this series of solutions we have had, for the first time, data from all the stations of the U.S.S.R. This has made it possible to obtain well-defined solutions without the use of the reflected phases, and as a result to appraise their accuracy. The technique has been to base the solutions on data from P and PKP only; once the diagrams were established, data from the reflected phases were plotted and checked for consistency. They were found to be inconsistent about as often as they were consistent, indicating random data. The detailed results are shown for each solution and a summary is given in the paper mentioned earlier (Hodgson and Adams, in press). It should be stressed that the data from reflected phases have not influenced any of the solutions given in this paper.

PRESENTATION OF THE DATA

Table I lists the earthquakes for which solutions have been attempted. On three of the dates listed there were two earthquakes; in each case the earlier earthquake has been designated A, the later B. The earthquakes are listed in Table I in two sections, those for which solutions have been obtained and those for which no solution has been possible. In the latter case the reason for the failure has been indicated.

TABLE I

LIST OF THE EARTHQUAKES CONSIDERED

Date	H (G.M.T.)	Epicentre		Focal Depth	Magnitude	Remarks
		φ	λ			
Earthquakes for which solutions have not been obtained						
Feb. 1, 1954...	01:06:54	24½°N	143¾°E	0.00R	7¼	Conflict of Data
June 15, 1954...	13:29:59	5°S	77°W	0.01R	6¾	Conflict of Data
Sept. 17, 1954...	11:03:18	21½°S	177°W	0.03R	7	Conflict of Data
Jan. 5B, 1955...	23:42:03	16°S	167½°E	0.00R	6¾	Insufficient Data
April 5, 1955...	15:09:15	25°N	110°W	0.00R	7	Conflict of Data
May 31, 1955...	09:30:44	27°S	177½°W	0.01R	6¾	Insufficient Data
June 14, 1955...	06:11:18	20°N	107°W	0.00R	7	Insufficient Data
July 6, 1955...	01:54:17	51°N	158°E	0.00R	6½	Conflict of Data
Aug. 6, 1955...	08:31:25	21½°S	177½°W	0.05R	6¾	Insufficient Data
Earthquakes for which solutions have been obtained						
Feb. 19A, 1954...	19:07:48	30°S	177¾°W	0.00R	7	
Feb. 19B, 1954...	21:34:41	12½°N	87½°W	0.00R	6¾	
April 17, 1954...	20:10:37	51½°N	179°W	0.00R	6¾	
April 27, 1954...	10:06:24	6°N	82½°W	0.00R	7	
April 29A, 1954...	10:49:27	28½°N	113°W	0.00R	7¼	
April 29B, 1954...	11:34:34	28½°N	113°W	0.00R	7½	
April 30, 1954...	13:02:37	39°N	22°E	0.00R	7	
May 3, 1954...	15:29:40	51½°N	159½°E	0.00R	6¾	
May 14, 1954...	22:39:26	36°N	137°E	0.03R	7	
July 6, 1954...	08:04:42	46½°N	153½°E	0.01R	6¾	
Aug. 18, 1954...	04:42:20	21½°S	176°W	0.02R	7	
Sept. 13, 1954...	02:09:55	21°S	175½°W	0.02R	6¾	
Sept. 15, 1954...	17:56:08	18°S	178½°W	0.09R	7	
Oct. 3, 1954...	11:18:46	60½°N	151°W	0.01R	6¾	
Jan. 5A, 1955...	17:48:35	16°S	167½°E	0.00R	6¾	
Jan. 13, 1955...	02:03:43	53°N	167½°W	0.00R	6¾	
March 14, 1955...	13:12:04	52½°N	173½°W	0.01R	7	
April 17, 1955...	18:35:27	52°N	159¼°E	0.00R	6¾	
April 19, 1955...	20:24:05	30°S	72°W	0.00R	7	
May 30, 1955...	12:31:41	24½°N	142½°E	0.09R	7¼	
June 2, 1955...	00:18:56	51½°N	180°	0.00R	6¾	
June 20, 1955...	12:07:25	51½°N	180°	0.00R	6¾	
July 16, 1955...	07:07:08	37½°N	27°E	0.00R	6¾	

The data on which the solutions are based are shown in Table II. The notation used is that established in earlier papers of the series (*see* for example Hodgson, 1956, page 173).

ANALYSIS OF THE DATA

In this section solutions will be presented for each of the 23 earthquakes for which it has been possible to obtain them in the form that has been established in the earlier papers of the series. In each case the solution diagram will be given and a table will show the number of observations available and the number of these inconsistent. The reflected phases have not influenced the solutions, and these tables provide the material for the examination of their value.

Earthquake of 19:07:48, Feb. 19, 1954. $\phi = 30°S, \lambda = 177\frac{3}{4}°W$

We have found two possible solutions for this earthquake, differing quite radically from each other, which explain the direct data equally well. We present both solutions.

The first solution is shown in Figure 1. In this solution we have assumed that College is incorrect but that the P'_2 dilatations recorded at Alicante and at Cartuja, and the P_1 separation between Ottawa and Seven Falls, are correct and have obtained a solution accordingly. The score for this solution is shown in Table III.

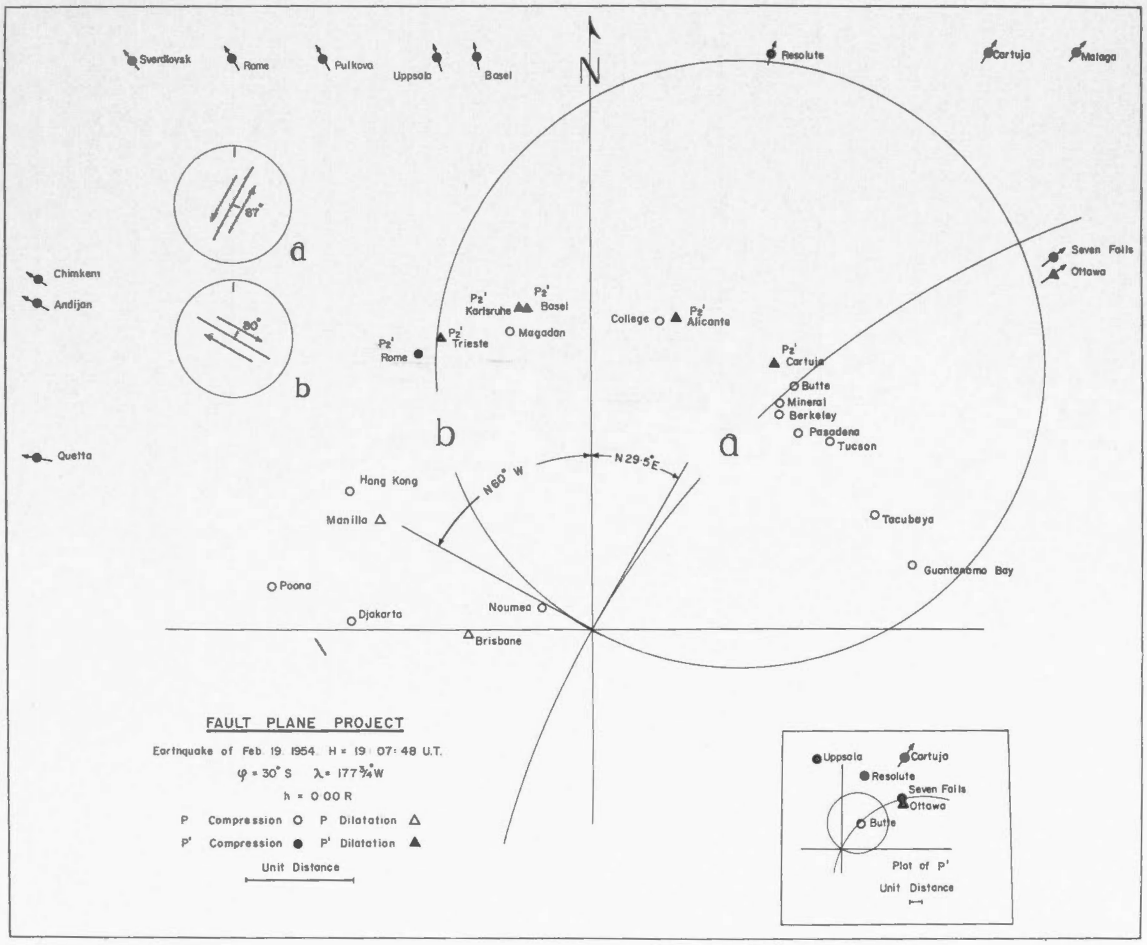

FIGURE 1.

TABLE II

Data on which the Solutions are Based

STATION	Feb. 19A, 1954	Feb. 19B, 1954	April 17, 1954	April 27, 1954	April 29A, 1954	April 29B, 1954	April 30, 1954	May 3, 1954	May 14, 1954	July 6, 1954
Aberdeen			C DD				D			(D)
Alicante	C_1' D_2'	C DD	D DD	(C) CC	(D)	C DD	C	D	C	(D)
Almeria										
Andijan	C_1' CCC						D			C
Apia							D_1'			
Ashkhabad			D					C	D	C
Astrida										
Athens								D	C	C
Balboa Heights		(D)		D						
Bandong								D	C cC	
Barcelona							C			
Barrett										
Basel	C_1' D_2'	C	C		C	(D)	D		D (cC)	C
Berkeley	C	D PcP=D	D CC (CCC) PcP=C	C DD	C	C	(C) CC	C	D dD	(C)
Besancon	(D_1')	(D)	(D)				D	D	D	
Bogota	(DD)	C	D	C		D	D	(CC)	CC	
Bologna										C
Bombay			D	(C_1')		DD	D	C	C	
Boulder City	C	C	D	C	D	D	D	C	D	C
Bozeman					D	D				D
Brisbane	(D)		(D)				(C_1')	D (PcP=C)	C	
Budapest										
Butte	C (CC)	C	(C)	C	D	D	D		D	(C)
Calcutta	DD		D			C_1'	D	D	C	(D)
Cartuja	C_1' D_2' CC dD_1' (dDD)	(D) DD	C (CC) (dDD)	(C) CC PcP=C	C DD (DDD)	C DD (DDD) PcP=C	(D) cC (DD)	D DD	C (DD) dD dDD	C (CC)
Chicago			D	C						
Chihuahua			D	C		(D)				
Chimkent	C_1'									C
Chinchina		D				D	D			
Christchurch							(C_1')		(D)	
Cleveland		C	D	C			D			C
Coimbra					(D)		C			(D) DD
College	(C) CC	C	C	C	C	C	D	C	(C)	D
Columbia		C		C	C	C	D			C
Copenhagen			(D)	D			D	C	D	C
Dehra Dun			D				(C)	(D)		(D)
Djakarta	C	(C_1') (C_2') CC (CCC)	D CC						C cC	C
Erevan			D				D	C	D	C
Fayetteville							D		D	
Fergana										
Frunse			D					C		C

TABLE II—*Continued*

Data on which the Solutions are Based—*Continued*

Aug. 18, 1954	Sept. 13, 1954	Sept. 15, 1954	Oct. 3, 1954	Jan. 5A, 1955	Jan. 13, 1955	March 14, 1955	April 17, 1955	April 19, 1955	May 30, 1955	June 2, 1955	June 20, 1955	July 16, 1955
(C_1') .... (C_1') (CC)	.... D_1' DD	.... D_1' (D_2')	(DD) DDD (C)	DD D_1' D_1'	 C	.... C C	D (D) (D)	C C C	D CC C (CC) cC	(D) C DD (D)	.... D CC	C DD (C) C C D
C D	....	(D) C	(dD) D	....	....	D	....	....	....	....	....	....
D_1'	....	C_1'	D	....	....	....	(D)	....	C_1' (CC) (cCC) (D)	....	....	....
D (DD) DD	D (cC)	C	.... D	D	....	....	....	....	cC D	....	....	D
D_1' cC_1'	D_1' cC_1'	C_1'	D	D_1'	C	C (dD)	C	....	C (dD) (CC)	(D)	D	D
C CC (dD)	D CC	C (PcP=C)	C	....	C	C PcP=D	....	C	D (DD) (cC)	D	D	C
D_1' D_1'	D_1' DD	C_1' D_1'	D D D	CC D_1'	C (D)	....	....	D	....	(D)	....	D
C D D cC	D C (C)	C D (D)	C C C	.... D	(D) D CC	C (D) D	C D	C	D (C) C (cC) (PcP=D	C (D) (C) PcP=D	D D D (DD) (PcP=C	D C (D_1')
D	....	(C_1') D	C	....	C	(D)	....	(D)	(C)	(D)	(C)	C
D D_1' (C_2') (CC) cC_1' dDD	D_1' (C_2') (CC) cC_1' (cC_2') (DDD)	D_1' C_2' (CC) (cCC) (CCC)	(C) (DD) DDD PcP=D	C_2' C_2' (CC)	(D) C CC (CCC)	(D) cC (cCC)	C (dD) CC PcP=C	C (CC) CCC	C (CC) (CCC) dDD	C DD cC (cCC) CCC	(C) (DD)	(C) (DD) DDD PcP=D
....	....	....	....	....	....	C	....	C	....	C	....	....
....	D	....	....	....	....	....	....	....	....	....	....	....
D_1' D	.... D	.... D	(C) C	DD C	C D	D C dD	 C	.... D D	D (C)	C C	D D	
(C_1')	D_2'	D_1'	D	....	....	....	....	C	....	C	D	D
(C_2')	DD (CCC)	(D_2') DD	....	....	....	....	....	....	....	....	....	(DD)
D (C_1') D_1'	C D_1'	C	D D D	C	D C D	C C	D C C	D_1'	D C DD (dD)	C C	(D) D	(D) D C
D (DD) dD	D (cC)	....	DD	D	C	dD	....	....	C	....	....	D
(C_1') D	.... (D)	.... D	D	....	....	(D)	....	....	....	....	D	....
....	D_1' DD	C_1'	D	....	C	....	C	....	C C	C	....	D

TABLE II—*Continued*

Data on which the Solutions are Based—*Continued*

STATION	Feb. 19A, 1954	Feb. 19B, 1954	April 17, 1954	April 27, 1954	April 29A, 1954	April 29B, 1954	April 30, 1954	May 3, 1954	May 14, 1954	July 6, 1954
Galerazamba										
Gharm			D CC	DD				C	D (dD)	
Goris										
Grozny								C		
Guadalajara		C								
Guantanamo Bay	C		D CC DDD	D	(D) DD	(CC)	D (DD) DDD		CC	
Halifax								C	D	C
Helwan	(D_1')							D	C	
Hong Kong	C		D (DD)				D (CCC)	C	C	C
Honolulu			(D)						(C)	
Hungry Horse		C		C	D	(C)	D	C	D	
Hyderabad	(DDD)		D				D	C	C	C
Irkutsk			D				D	C	D CC	C
Jersey						C	C		C	
Jujhno-Sakhalinsk			(C)	C	(D)			C	C	
Kabansk			D				D	C	D	C
Kalocsa							C			
Karlsruhe	D_2'			D		(D)	(C)	C	D	C
Kew			C	D cC	C CC	C CC	D	(D)	D (DD) dD	C (CC)
Khorog										C
Kirkland Lake		C		C			D		D	C
Kiruna	C_1' (DD)		DD (DDD)	D (DD)	(D)	(D)		C	D DD	C
Kodaikanal			(C)					C	C	
Ksara	C_1' DD	(CC)		C					D cC	
Kulyab	C_1'		D				D	C	D	
Kurilsk								C		
Kyakhta			D				D	C (CC)	D	C CC
La Paz		(C) (DD)	(DD)	C (CC) (PcP=C)	CC	D (DD) (PcP=C)	D DD		D_1' (DD)	
Lembang	C (CC)	(C_1')	D CC		C_1'	C C_1'	D	D	C (CC) cC dDD PcP=C	C
Lincoln	DD									
Lisbon			C		D	D PcP=D	C			(D)
Logan										
Lwiro			D_1' CC (CCC)	C_1'	C_1' (CC)	C_1' (CC)	(D)			C_1'
Lwow	C_1'		(C)					D (PcP=C)	(C) (DD) dD	

TABLE II—*Continued*

Data on which the Solutions are Based—*Continued*

Aug. 18, 1954	Sept. 13, 1954	Sept. 15, 1954	Oct. 3, 1954	Jan. 5A, 1955	Jan. 13, 1955	March 14, 1955	April 17, 1955	April 19, 1955	May 30, 1955	June 2, 1955	June 20, 1955	July 16, 1955
(CC)	...	...	(C)	...	...	...	...	...	...	...	...	...
...	...	...	(C)	...	...	...	...	...	C	C	...	D
...	...	...	CC									
...	D_1'	(D_1')	...	...	C	...	...	...	C	C	D	
	D_2'	(D_2')	...	...	...	...	...	...	...	PcP=C		
...	...	...	...	...	...	...	...	...	...	...	...	...
C	...	...	...	...	...	...	...	...	...	...	...	...
CC	(CC)	...	D	...	...	...	...	...	CC	C	(C)	D
...	...	...	CCC	...	...	...	...	...	...	...	(CCC)	CC
...	...	(C_1')	(C)	...	D	...	...	...	...	...	...	...
(C_1')	...	(D_1')	(C)	...	...	...	(D)	...	(D)	(D)	(C)	
D	D	...	D	(C)	...	...	C	...	C	D		
...	...	...	...	(CC)								
C	C	D	(D)	...	D	...	...	...	(C)	...	D	...
(C)	D	C	(D)	(D)	C	C	C	C	D	C	C	C
D	...	C	D	CC	C	C	C	CC	C	C	(C)	(C)
D	D	C	...	D	C	C	...	...	C	C	...	D
...	...	...	...	...	DD	(dD)	...	...	cC			
...	...	...	D									
D	D	C	...		...	C	C	...	(D)	C	C	D
(cC)	...	(CC)										
D	D	C	D	D	C	...	C	...	C	C	C	D
...	...	...	...	...	...	...	...	...	...	...	...	...
cC_1'	D_1'	C_1'	D	D_1'	C	C	C	...	C	(D)	D	C
			dD	...	PcP=C	(dD)	...	...	cC	(PcP=D)	(PcP=C)	
C_1'	D_1'	C_1'	D	(CC)	D	(D)	(D)	(D)	(C)	C	(C)	D
C_2'	(dD_1')	...	...	CCC	...	DD	...	(CC)	CC	PcP=C	(PcP=C)	
...	...	...	...	...	...	(DDD)	...	...	cC			
									CCC			
...	...	...	...	...	...	...	...	...	...	...	...	...
...	...	...	D	...	D	C	...	D	(C)	C	D	D
									(cC)			
									cCC			
cC_1'	D_1'	C_1'	D	C_1'	D	C	C	(CC)	D	C	D	
...	DD	...	cCC	...	(PcP=D)	cC	...	...	(dD)			
	(dD_1')	...	...	...	...	PcP=C	...	...	cCC			
...	...	...	...	D	...	...	...	...	C	...	(C)	(C)
...	D_1'	C_1'	D	C_1'	C	...	C	DD	(D)	C	(C)	(C)
...	CC	DD	(DD)	DD								
	(cC_1')											
D_1'	...	...	D	...	C	C	C	...	C	...	...	D
			(DD)	...	...	...	...	...	...	...	...	(DD)
			DDD									
...	...	...	...	...	...	C	C	...	C	C	C	...
											dD	
D	D	C	D	D	C	C	...	...	C	C	C	D
C	C	...	CC	...	D	D_1'	D_1'	(C)	D_1'	C_1'	(DD)	(DD)
DD	(CC)	...	...	...	DD	DD	DD	(CC)	CC	(CC)		
cC	cC											
(cCC)	(cCC)											
D	D	C	(cCC)	D	...	(dD)	...	...	(D)	...	...	...
dD	(DD)	(CC)										
(DD)	(cC)	CCC										
...	...	...	...	...	...	...	...	...	...	...	...	...
D_1'	D_1'	C_1'	D	...	C	...	...	(D)	(C_1')	...	D	D
(CC)	...	DD										
					C	C	...	...	D	C		
						(cC)	...	...	(DD)			
									(cC)			
...	D_1'	(C_1')	...	D_1'	(D_1')	(C_1')	C_1'	...	...	C_1'	(C_1')	(D)
...	dD_1'	cC_1'	...	CC	(CC)	...	...	...	...	(CC)	(C_2')	(CC)
...	(DD)	...	...	...	...	...	...	...	...	...	CC	CCC
...	(C_1')	(D_1')	D	...	C	C	...	...	...	(D)	(C)	...
...	DD	(DD)	(DD)	...	(DD)	...	...	...	...	(CC)	CC	
					DDD	...	...	...	...	...	DDD	
											PcP=D	

TABLE II—*Continued*

Data on which the Solutions are Based—*Continued*

STATION	Feb. 19A, 1954	Feb. 19B, 1954	April 17, 1954	April 27, 1954	April 29A, 1954	April 29B, 1954	April 30, 1954	May 3, 1954	May 14, 1954	July 6, 1954
Magadan	(C)		D	(D)	(D)			(C)		
Makhach-Kala	C'_1		D	D'_1				C	D	C
Malaga	C'	C	(D)	(C)	D		(D)		C	
	(CC)									
Manilla	(D)		(C)				D	(D)	C	C
Manzanillo		(D)								
Melbourne							(DD)			
Merida				(D)						
Miami					(D)					CC
Mineral	C	C		C	D	D	D	C	D	D
							(DD)			
Moscow	C'							C	D	C
Mount Hamilton	C		D	C	C	D	D	D	D	D
							CC			
Myrgab										
Narin	C'_1		D				D	C	D	C
	CC									DD
Nelson	C	C	D	C	D	D	D	C	D	C
	DD	PcP=D					(DD)			
Neuchatel										
New Delhi			(C)				D	C	D	
Noumea	C		C					D	(D)	C
	CC		(CC)					(DD)	(dD)	CC
	(DDD)		(PcP=D)					(PcP=C)	CCC	dD
Oaxaca				C	(C)	D				
Obi-Gharm			D				D	C	D	C
							(CCC)		(PcP=D	
Ottawa	D'_1	C	C	C	C	C	D	(D)	D	(D)
Palisades		C	(D)	C	C		D	C	D	C
				DD	(CC)				CC	
									(cC)	
Palomar										
Paris										
Pasadena	C	C	D	C	D	D	D		D	D
							(DD)			
Pavia			D					(C)	D	C
Perth									C	C
Petropavlosk			(C)	C	(D)		D	(C)	D	
							(DD)		(cC)	
							DDD		DD	
Philadelphia		(D)								
Poona	C	(C'_1)	D	D'_1	C'_1	C'_1	(C)	C	C	C
Prato							C			
Puebla		C		C		C				
Pulkovo	C'_1		D					C	D	C
			DD					DDD	dD	
			CCC						DDD	
Quetta	C'_1	D'_1	(C)	D'_1		C'_1	D	C	(C)	C
										cC
Rapid City										
Rathfarnham			C	(C)	(C)	(C)	D		D	C
					(DD)	(DD)	(DD)		(cC)	
					PcP=C	(PcP=d)				
Reggio Calabria										

TABLE II—*Continued*

Data on which the Solutions are Based—*Continued*

Aug. 18, 1954	Sept. 13, 1954	Sept. 15, 1954	Oct. 3, 1954	Jan. 5A, 1955	Jan. 13, 1955	March 14, 1955	April 17, 1955	April 19, 1955	May 30, 1955	June 2, 1955	June 20, 1955	July 16, 1955
D	....	C	C	....	....	D	(C)	....	C	C	C	D
dD												
D'_1	....	....	....	....	....	....	....	....	....	....	....	....
D'	D'	(C')	....	(D')	....	(D)	(D)	(D)	....	C	D	D
DD	(CC)	(CC)										
D	....	C	....	D	(D)	(D)	....	....	C	D	D	....
....	....	....	....	....	....	....	....	....	....	....	....	....
D	C	D	....	....	....	....	....	....	C	....	....	....
....	....	....	....	....	(D)	C	....	....	....	....	D	....
(DD)	DD	....	....	....	(D)	....	....	....	....	C	(C)	D
(CCC)	....	....	....	....	(DDD)							
C	D	....	C	C	C	C	....	C	D	(D)	....	C
cC	cC											
D'_1	D'_1	C'_1	D	(DD)	C	C	....	....	C	C	D	C
	DD	DD	dD	....	....	CC						
	CCC											
	cCC											
C	D	C	C	C	(D)	C	C	C	D	D	D	(D)
....	....	(dD)	....	....	....	....	....	....	(cC)			
....	....	....	....	....	C	C	....	....	C	C	....	....
D'_1	D'_1	C'_1	D	....	....	....	....	....	....	....	....	....
....	(DD)											
C	D	C	C	C	C	C	C	C	D	C	D	D
....	....	....	D	....	....	....	....	....	....	....	....	D
....	....	....	D	....	C	C	C	CC	C	....	....	....
D	D	cC	(CC)	C	CC	D	CC	CC	D	D	D	(D'_1)
dD	....	....	CCC	(PcP=C)	DDD	dD	....	(CCC)	CC	(DD)	DD	CC
....	....	....	....	....	(PcP=C)	....	....	....	(cC)	(PcP=C)	cC	(CCC)
									(PcP=C)	....	cCCC	
											(PcP=C)	
C	....	....	D	....	D	....	....	....	....	....	D	....
CC												
D'_1	CC	C'_1	D	....	....	C	....	D'_1	C	....	(C)	....
D'_1	....	D'_1	D	C'_1	D	....	D	D	D	C	D	(C)
(C)	C	DD	D	(CC)	C	C	C	C	CC	C	D	D
(DD)	CC	....	(CC)	....	(cC)	cC	cC					
cC	....	....	dD									
(cCC)												
....	....	....	....	....	....	....	....	....	D	....	....	....
D'_1	D'_1	C'_1	D	D'_1	....	C	C	....	C	C	D	D
C	D	C	D	....	....	C	....	C	D	C	....	....
....	cC	....	....	....	....	....	....	....	(cC)			
D'_1	D'_1	....	D	D'_1	(D)	C	....	....	C	C	D	D
	(dD'_1)	....	....	....	....	cC						
D	....	....	....	D	C	....	D	....	....	....	D	....
					(CC)							
D	....	C	C	....	....	(D)	C	....	....	C	C	....
....	....	....	....	....	....	C						
....	D'_1	....	D	D	D	D	(D)	D'_1	(D)	(D)	....	D
....	....	C'_1	....	....	(D)	....	....	....	....	....	(C)	D
....	....	....	....	....	....	C	....	....	....	....	....	....
D'_1	....	....	D	....	C	C	....	....	C	....	....	....
CC	....	....	dD	....	....	....	....	....	(dD)			
....	....	....	DDD	....	....	....	....	....	(CC)			
....	(C'_1)	C'_1	D	(C)	C	D	(D)	D'_1	....	....	....	....
....	....	....	....	....	....	(dD)						
D	....	....	....	....	....	....	....	....	....	....	....	....
D'_1	....	C'_1	D	....	....	C	D	C	D	C	D	D
....	....	....	(DD)	....	....	cC	(PcP=D)	(CC)	CC	CCC		
....	....	....	dD	....	....	....	....	....	CCC	PcP=C		
			cCC	....	....	....	....	....	cCC			
			(PcP=C)									
....	....	....	....	D'_1	....	....	....	....	....	....	....	....

TABLE II—*Continued*

Data on which the Solutions are Based—*Continued*

STATION	Feb. 19A, 1954	Feb. 19B, 1954	April 17, 1954	April 27, 1954	April 29A, 1954	April 29B, 1954	April 30, 1954	May 3, 1954	May 14, 1954	July 6, 1954
Resolute	C'_1	C	...	C	D	D	D	C	D	C
Reykjavik	...	...	...	D	D	D	C	(D)	(D)	C
Riverside	...	...	...	...	...	...	...	...	...	...
Riverview	...	...	C	...	...	...	(C'_1)	...	C	D
							CC	...	...	CC
							(CCC)	...	...	...
Rocca di Papa	...	...	...	...	...	...	...	...	D	...
Rome	C'_1	...	(C)	D	...	...	...	(C)	D	C
	C'_2	...	...	CC	...	...	...	...	...	...
	(DD)	...	...	...	...	...	...	...	...	...
Salo	...	...	...	...	...	...	C	D	...	(D)
								DD	...	DD
								DDD	...	...
Salt Lake City	...	...	...	...	D	D	...	...	D	D
San Juan	...	C	C	D	...	C	C	...	D'_1	...
Scoresby-Sund	...	...	...	C	...	...	D	C	C	C
Semipalatinsk	...	...	...	...	...	...	...	...	...	...
Seven Falls	C'_1	C	(D)	C	C	...	...	...	D	(D)
Shasta	...	...	D	C	D	(C)	(C)	C	D	D
							(DD)	DD	(cC)	(cC)
Shawinigan Falls	...	(D)	...	C	...	...	...	...	D	...
Shemakha	...	...	...	D'_1	...	...	D	C	D	...
Shillong	C'	...	C	...	...	...	D	C	(C)	C
Sitka	...	...	D	C	...	...	...	...	D	...
Stalinabad	C'_1	...	D	D'_1	...	...	D	...	D	...
									(PcP=D)	...
State College	...	C	C	C	...	C	(C)	...	D	C
							CC	...	(DD)	
							DDD			
Strasbourg	...	C	(D)	D	...	...	CC	C	D	C
								PcP=D	...	...
Stuttgart	...	...	C	...	...	...	...	C	D	C
			PcP=D	...	...	...	...	...	...	...
Sverdlovsk	C'_1	...	D	...	...	...	...	C	D	C
Swan Island	...	...	...	...	...	...	...	...	...	...
Szeged	...	...	...	...	...	...	C	...	...	...
Tacubaya	C	C	D	C	C	C	...	...	DD	...
Tananarive	...	...	D'_1	...	...	C'_1	D	...	...	(CC)
Tashkent	...	...	D	...	...	...	...	C	...	C
Tbilisi	C'_1	...	D	...	...	...	D	C	D	C
Tinemaha	...	...	...	...	...	...	...	...	...	...
Trieste	(D'_1)	...	(C)	...	(D)	(D)	C	(C)	D	...
	D'_2	...	...	...	(DD)	CC	...	...	...	...
	(DD)	...	...	...	...	...	...	...	...	...
	DDD	...	...	...	...	...	...	...	...	...
Tucson	C	D	(C)	C	D	...	(C)	...	D	C
Uccle	...	...	...	...	...	...	...	...	D	C
Uglegorsk	...	...	(C)	C	...	...	...	C	C	D
Ujhgorod	...	...	...	...	...	...	D	D	D	...
Uppsala	C'	(CC)	C	CC	C	C	D	C	D	C
					CC	...		cC	...	...
Uvira	...	...	...	...	...	...	...	...	C'_1	...
Vera Cruz	...	...	...	...	C	(D)	...	...	...	...
Victoria	...	C	D	C	D	...	...	...	D	...

TABLE II—*Continued*

Data on which the Solutions are Based—*Continued*

Aug. 18, 1954	Sept. 13, 1954	Sept. 15, 1954	Oct. 3, 1954	Jan. 5A, 1955	Jan. 13, 1955	March 14, 1955	April 17, 1955	April 19, 1955	May 30, 1955	June 2, 1955	June 20, 1955	July 16, 1955
...	...	...	D (DD) dD	...	(C)	...	...	...	...	...	...	...
(C_1') eC_1'	... ...	D_1' (dD_1')	D ...	... ...	... ...	... ...	... ...	... ...	(C) (cC)	(D) ...	(C) ...	C ...
... D (DD) (dD) (CCC)	... D (dD) CC	... D (cC) ...	... C (CC) ...	... D (cC) ...	D	... ...	... ...	... D (DD) ...	D (D) DD (dD)	D	D (DD) (dD)	...
... D_1' cC_1'	... D_1' DD cC_1'	... C_1' C_2' (CC)	(D) D ... D (DD) ...	... D_1' DD ... D_1' (DD) ...	C C CC cC (D) (DD) ...	... C (dD)	... C ... ... (D)	... D DD	... C DD (dD) (D) DD (dD)	... C	... D (DD) (dD) ...	... D ...
D ... (C_1') ... D_1' C CC (dD)	... ... (C_1') ... ... D	... D_1' ... ... (C) cC PcP=D	... D (C) ... ... C ...	... ... C_1' (D) ...	C C ... ... D C ...	(D) C (D) ... C C (CC)	(D) ... (C) ... D (D) ...	... C ... ... D C ...	(C) ... D C D D (cC)	(D) C (D) C ... C	C (C) ... D ... D	C D ... D (C) C
... D (DD) ...	... D_1' (DD) ...	... C_1' (CC) C	D ... (C)	... ... (C)	D ... C	... ... (D)	 C	... ...	... ...	 C	... ... D	... ... D
... D_1'	... D_1' CC (DD)	... C_1' ...	... D (C)	... ...	... (D) C	... C (D)	 C	... ... D	... C D	... (D) ...	... (C) ...	... ...
D_1' ...	D_1' (dDD)	C_1' C_2'	D dD	C_1' ...	... ...	C ...	C ...	(CC) ...	C (dD)	C ...	D (dD) DDD	D
D_1' ...	D_1' ...	C_1' C_2'	D dD	... ...	... ...	C ...	C ...	... ...	(D) (dD) DD	C ...	D (dD)	C
... (D) CC	D (D) CC	C_1' ...	D (C)	... ...	C ...	D ...	C ...	... ...	(D) ...	... ...	D (CCC)	(C) CC
... C D_1' DD D_1' (C_1')	... (D) (C_1') D_1' D_1'	... (C) (C_1') (D_1') ...	... D (C_1') D D	... ... D ...	... (D) ... C C (PcP=D)	... C ... C C ...	... ... C C PcP=C	... ...	... ... C C C	... ... C C C	... ... D_1' D ...	... ... (D) D (C)
... D_1'	... (C_1')	... ...	... D	... D_1' D_2' (DD) ...	... C (DD)	... C	... C	... C (C_1') (CC) CCC	D C	... C	... D	... D DD
C	C	C	D	C	C	C	...	C	D (DD)	C	D	...
... D (PcP=C) ...	... ...	... C ...	... C DD	... ...	... C ...	... ...	... C ...	... ...	... C ...	... C ...	... C dD	D D (DD) ...
DD ...	... ...	DD ...	D ...	... ...	D (DD)	C ...	C ...	... ...	D DD (dD) DDD	C	D CC PcP=D	C
... C C	... ...	 C	 C	... ...	... (D) ...	... ...	... ...	... ...	... (CCC) D	 C	 C	 C

TABLE II—*Concluded*

Data on which the Solutions are Based—*Concluded*

STATION	Feb. 19A, 1954	Feb. 19B, 1954	April 17, 1954	April 27, 1954	April 29A, 1954	April 29B, 1954	April 30, 1954	May 3, 1954	May 14, 1954	July 6, 1954
Vienna							D	D	(C)	(D)
Vladivostok				C			D			
Washington		C		C	C	C	D	(D)	(C)	
Wellington									C (CC)	
Woody										
Yalta										C
Zurich			D				D	C	D	C

TABLE II—*Concluded*

Data on which the Solutions are Based—*Concluded*

Aug. 18, 1954	Sept. 13, 1954	Sept. 15, 1954	Oct. 3, 1954	Jan. 5A, 1955	Jan. 13, 1955	March 14, 1955	April 17, 1955	April 19, 1955	May 30, 1955	June 2, 1955	June 20, 1955	July 16, 1955
(C'_1)	(C'_1)	(D'_1)	(C)	(C'_1)	C	....	(D)	....	(D)	....	D	(D)
					PcP=C	....	....	....	DD			
....	D	C	....	....	....	....	....	....	C	....	....	D
									dD			
....	(D)	....	D	....	....	....	C	C	....	C	....	D
D	D	D	....	C	....	....	....	(C)	D	....	....	....
....	....	....	....	....	....	....	....	....	D	C	D	....
....	....	....	....	....	....	....	....	....	....	....	....	....
....	....	C'_1	D	D'_1	C	C	C	....	C	C	D	D
		cC'_1	....	....	....	....	....	....	cC			

TABLE III

	Direct Phases				Reflected Phases					Grand Total
	P	P'_1	P'_2	Total	PP	pPP	pP'_1	PPP	Total	
Total Number of Observations	19	27	6	52	15	1	1	4	21	73
Number of Inconsistent Observations..................	5	3	0	8	7	1	0	2	10	18

The alternative solution is shown in Figure 2, and the score is given in Table IV. This solution supposes the field to be compressional, so that Ottawa is made inconsistent,

TABLE IV

	Direct Phases				Reflected Phases					Grand Total
	P	P'_1	P'_2	Total	PP	pPP	pP'_1	PPP	Total	
Total Number of Observations....	19	27	6	52	15	1	1	4	21	73
Number of Inconsistent Observations..................	2	4	2	8	5	1	0	1	7	15

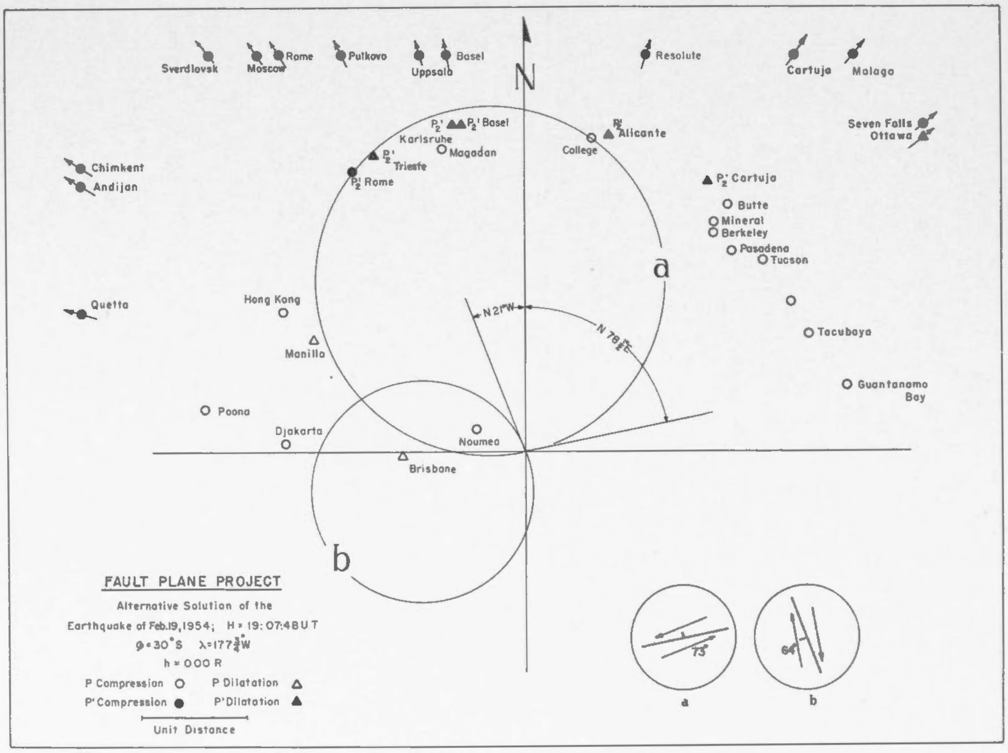

FIGURE 2.

and gives the solution in terms of a smaller pair of circles. As shown in Tables III and IV the score for the direct phases is the same in each case, whereas Figure 2 scores better on the reflected phases. Despite this better score we prefer the solution shown in Figure 1 because the null vector points in the direction we have come to anticipate. For this reason the inconsistencies listed in Table II are those associated with Figure 1.

Earthquake of 21:34:41, Feb. 19, 1954. $\phi = 12\frac{1}{2}°N$, $\lambda = 87\frac{1}{2}°W$

The solution for this earthquake is shown in Figure 3 and the score is given in Table V. The earthquake is not large, and the percentage of inconsistencies is consequently higher

TABLE V

	Direct Phases				Reflected Phases				Grand Total
	P	P_1'	P_2'	Total	PP	PPP	PcP	Total	
Total Number of Observations..........	36	4	1	41	6	1	2	9	50
Number of Inconsistent Observations.....	7	3	1	11	3	1	0	4	15

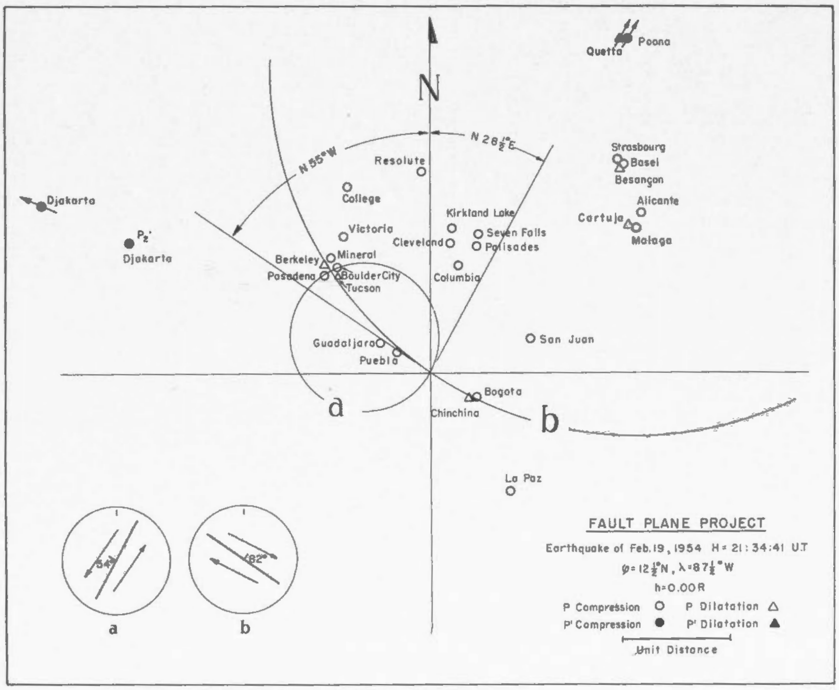

FIGURE 3.

than normal, but the solution must be approximately correct. The most serious criticism of the solution is the poor score shown for the PKP observations, 4 out of 5 having been made inconsistent. However all of these observations were described as weak, and it seems better to sacrifice them rather than some of the nearer observations.

Earthquake of 20:10:37, April 17, 1954. $\phi = 51\frac{1}{2}°N$, $\lambda = 179°W$

This earthquake is another with a magnitude of $6\frac{3}{4}$, a little too small for a satisfactory solution. As a result there is a good deal of ambiguity, and we have found two possible solutions, which explain the data about equally well.

The first solution is shown in Figure 4, and the score is given in Table VI. This solution has a slightly better score on the direct phases, and many of the observations made inconsistent in this solution have been described as doubtful by our collaborators.

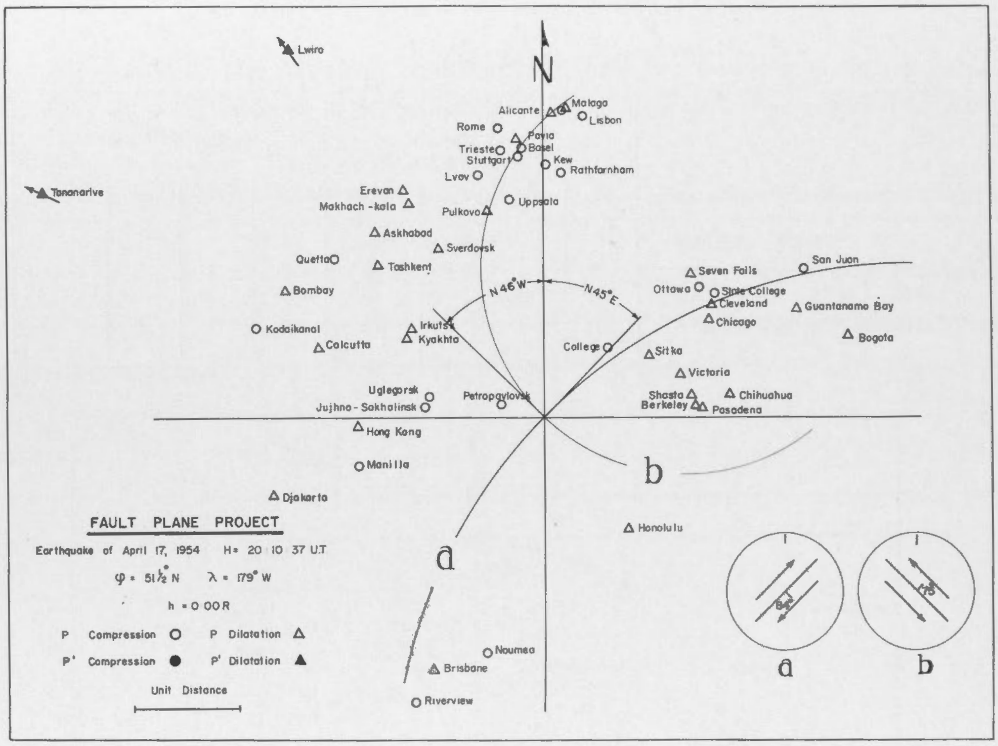

FIGURE 4.

TABLE VI

	Direct Phase			Reflected Phases					Grand Total
	P	P′	Total	PP	PPP	pPP	PcP	Total	
Total Number of Observations..........	77	2	79	14	5	1	3	23	102
Number of Inconsistent Observations.....	19	0	19	4	3	1	1	9	28

The alternative solution is shown in Figure 5, and the score is given in Table VII.

Because the solution shown in Figure 4 has the fewer inconsistencies, we have used it as the solution in marking the inconsistencies in Table II.

TABLE VII

	Direct Phases			Reflected Phases					Grand Total
	P	P_1'	Total	PP	PPP	pPP	PcP	Total	
Total Number of Observations..........	77	2	79	14	5	1	3	23	102
Number of Inconsistent Observations.....	22	0	22	7	5	0	2	14	36

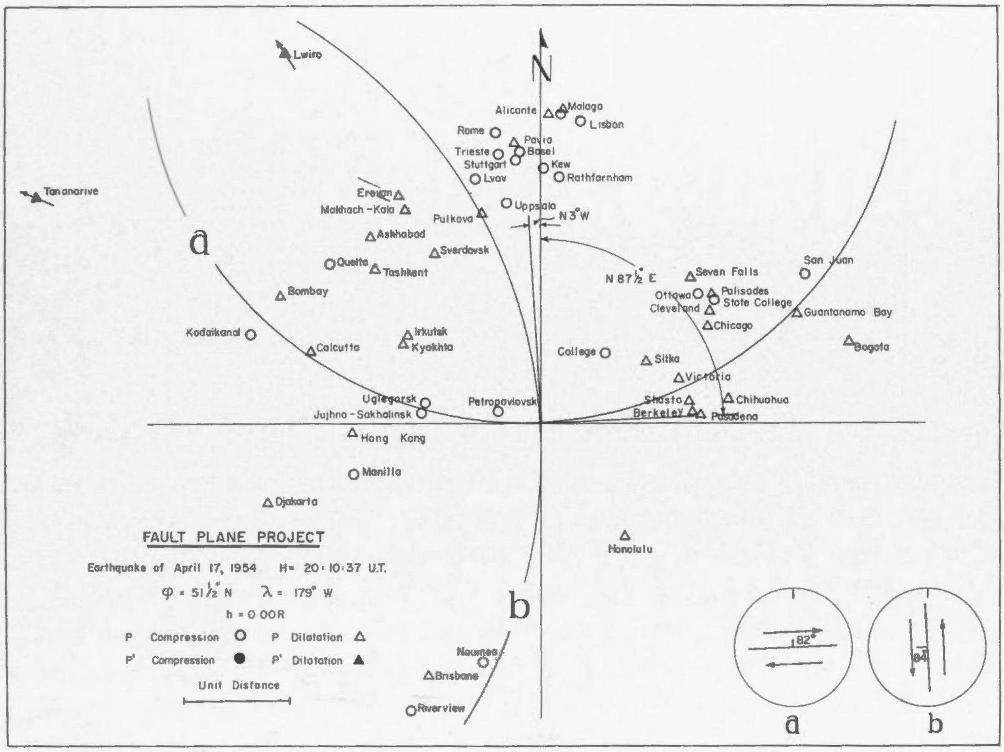

FIGURE 5.

Earthquake of 10:06:24, April 27, 1954. $\phi = 6°N$, $\lambda = 82\frac{1}{2}°W$

This earthquake presented no problems; the solution is shown in Figure 6 and the score is given in Table VIII. It will be noted that the score is remarkably good; this undoubtedly reflects the fact that almost all stations in North America received an unambiguous recording of the earthquake.

TABLE VIII

	Direct Phases			Reflected Phases				Grand Total
	P	P_1'	Total	PP	pP	PcP	Total	
Total Number of Observations............	52	7	59	9	1	2	12	71
Number of Inconsistent Observations......	6	1	7	4	0	1	5	12

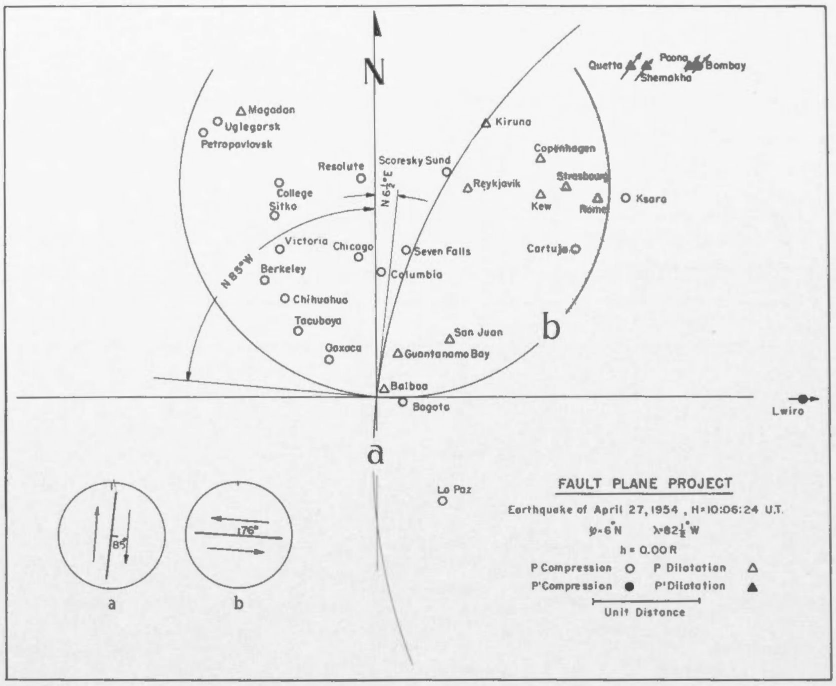

FIGURE 6.

Earthquakes of 10:49:27 and 11:34:34, April 29, 1954. $\phi = 28\frac{1}{2}$°N, $\lambda = 113$°W

These two earthquakes had the same epicentre, and their mechanisms were so nearly identical that a single solution suffices for the two. This is shown in Figure 7, the data plotted being those for the main shock. It will be noted that a good separation is obtained in California, between Berkeley and Mount Hamilton, and again in Mexico. There is however a good deal of confusion in Europe, and this has resulted in a high number of inconsistencies in the P observations. We have drawn circle *b* in a mean position; if we had drawn it smaller we might have made Rathfarnham correct, but at the expense of Tacubaya and Puebla. If we had made circle *b* larger the European dilatations could have been correct at the expense of the European compressions. Since most of the dilatations were called doubtful, and most of the compressions were not qualified the present solution seems the best compromise. We must admit an uncertainty in the dip of plane *b* of about $\pm 4°$.

The score for the foreshock is given in Table IX and that for the main shock in Table X.

TABLE IX

	Direct Phases			Reflected Phases				Grand Total
	P	P'₁	Total	PP	PPP	PcP	Total	
Total Number of Observations	40	3	43	9	1	1	11	54
Number of Inconsistent Observations	10	0	10	4	1	0	5	15

TABLE X

	Direct Phases			Reflected Phases				Grand Total
	P	P_1'	Total	PP	PPP	PcP	Total	
Total Number of Observations............	40	6	46	9	1	4	14	60
Number of Inconsistent Observations......	9	0	9	4	1	2	7	16

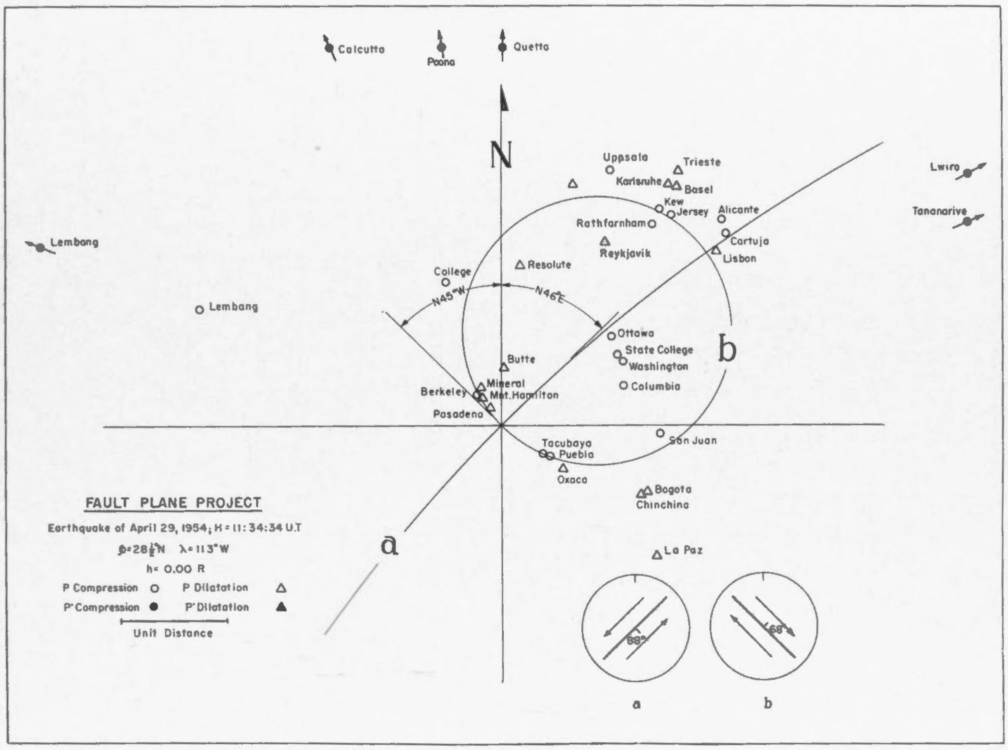

FIGURE 7.

Earthquake of 13:02:37, April 30, 1954. $\phi = 39°N, \lambda = 22°E$

The solution for this earthquake, shown in Figure 8, is a very satisfactory one, although the exact position of circle *a* may be questioned. As shown in Table XI, the

TABLE XI

	Direct Phases			Reflected Phases				Grand Total
	P	P_1'	Total	PP	pP	PPP	Total	
Total Number of Observations............	76	4	80	15	1	6	22	102
Number of Inconsistent Observations......	10	3	13	9	0	3	12	25

score for the P phases is satisfactory, and although the P′ phases have a very poor score, most of these observations were described as doubtful by our collaborators. We might have made circle *b* smaller, to make San Juan inconsistent and Lwiro consistent; however the San Juan observation was described as an *i* while the direction observed at Lwiro was described as doubtful.

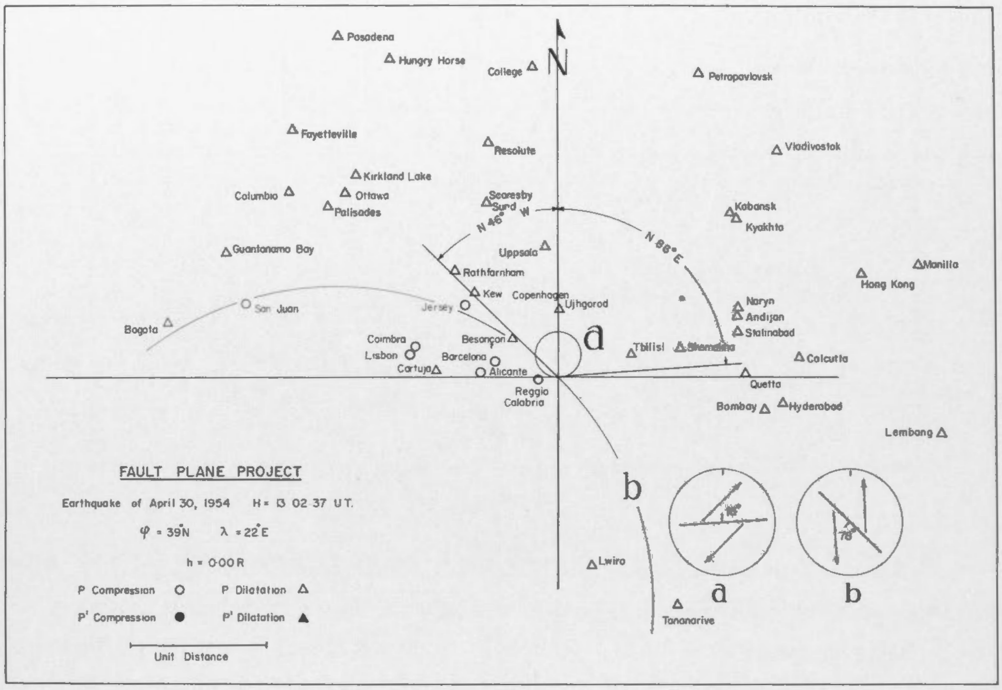

FIGURE 8.

The position of circle *a* appears to be very closely defined by the data but we must remember that the extended distances for short epicentral distance are not too reliable, so that the smaller circle may not be as closely defined as it appears to be. There seems little doubt however that the faulting is approximately normal.

Earthquake of 15:29:40, May 3, 1954. $\phi = 51\frac{1}{2}°N$, $\lambda = 159\frac{1}{2}°E$

The solution for this earthquake is shown in Figure 9, and the score is given in Table XII. The solution is straightforward except for some difficulties in Europe. A number of Italian stations (only Rome is shown in the diagram) recorded compressions. These

TABLE XII

	Direct Phases		Reflected Phases					Grand Total
	P	Total	PP	pP	PPP	PcP	Total	
Total Number of Observations............	74	74	6	1	2	4	13	87
Number of Inconsistent Observations......	11	11	3	0	0	3	6	17

could have been made consistent by increasing the radius of circle *b* slightly, but this would have made a number of other stations inconsistent, as shown in the figure. The present solution is a compromise which cannot be very far from correct.

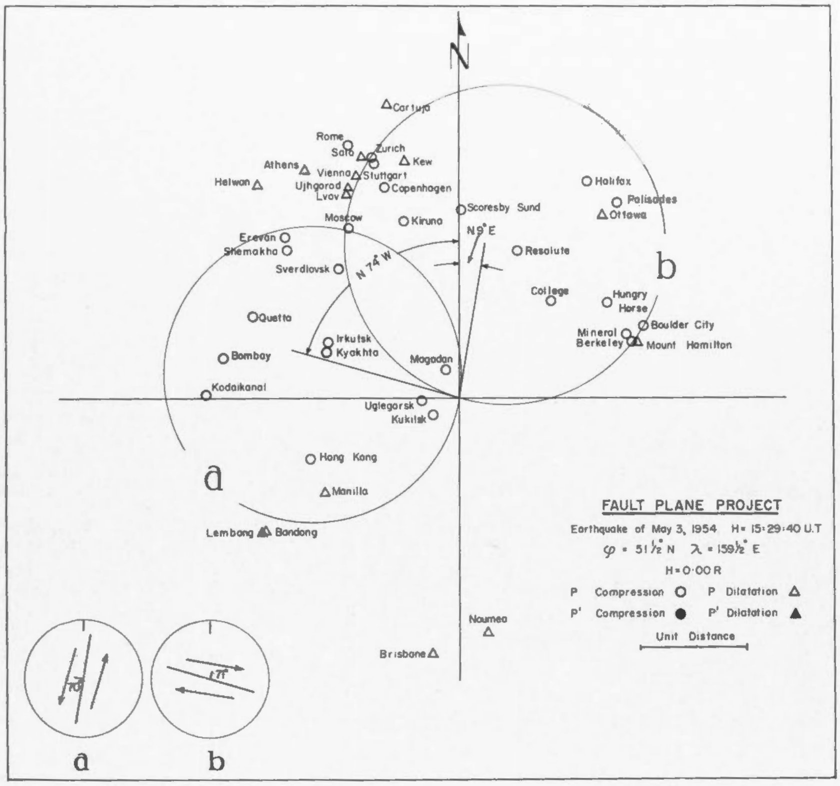

FIGURE 9.

Earthquake of 22:39:26, May 14, 1954. $\phi = 36°N$, $\lambda = 137°E$

The solution for this earthquake is shown in Figure 10 and the score is given in Table XIII. The solution is quite straightforward, and the number of inconsistencies in the direct observations is gratifyingly small.

TABLE XIII

	Direct Phases			Reflected Phases						Grand Total
	P	P′	Total	PP	pP	pPP	PPP	PcP	Total	
Total Number of Observations....	91	3	94	14	16	2	2	3	37	131
Number of Inconsistent Observations..................	10	0	10	7	7	0	0	2	16	26

Earthquake of 08:04:42, July 6, 1954. $\phi = 46\frac{1}{2}°N$, $\lambda = 153\frac{1}{2}°E$

We have not been able to obtain a unique solution for this earthquake; to illustrate the difficulty all the stations have been plotted on the diagram, although only a few of

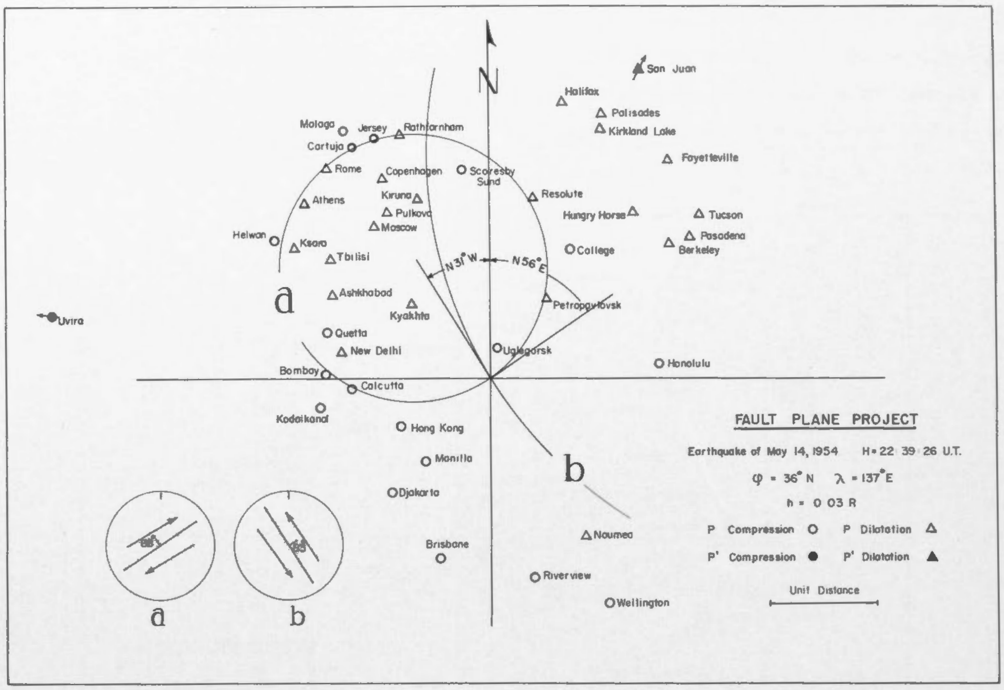

FIGURE 10.

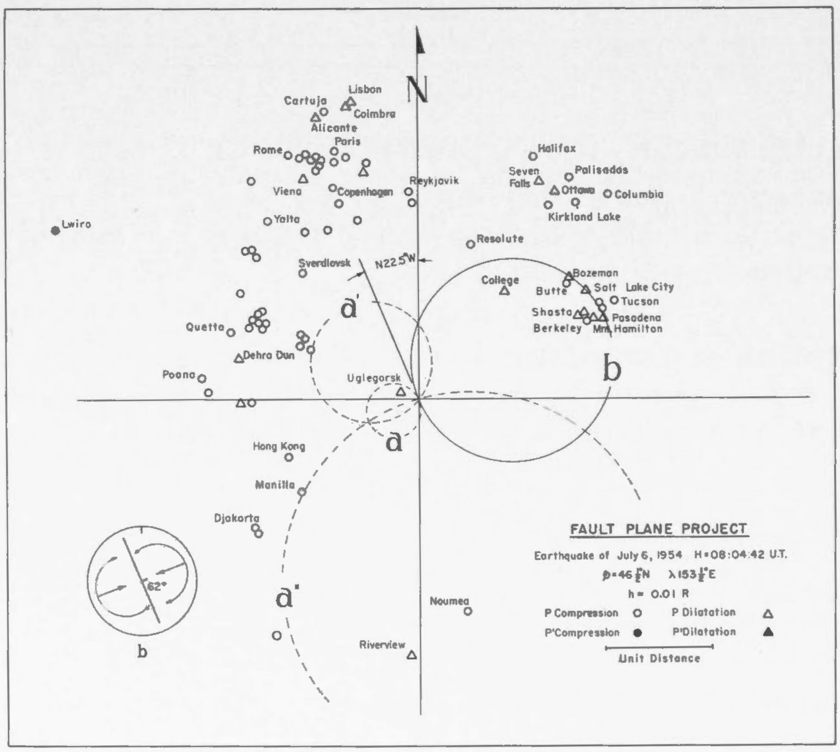

FIGURE 11.

them have been identified. As shown in Figure 11, circle *b* is well defined, but circle *a* may vary through wide limits. It has been shown in its extreme positions, and also in that position which would give pure thrust faulting. The insert diagram shows that anything between pure thrust faulting and almost pure strike-slip faulting would be consistent with the data. The score of the solution is given in Table XIV.

TABLE XIV

	Direct Phases			Reflected Phases			Grand Total
	P	P_1'	Total	PP	pP	Total	
Total Number of Observations	77	1	78	10	3	13	91
Number of Inconsistent Observations	12	0	12	3	1	4	16

Earthquake of 04:42:20, August 18, 1954. $\phi = 21\frac{1}{2}°S$, $\lambda = 176°W$

The solution, shown in Figure 12, is straightforward. The number of observations, and the number of these inconsistent, is shown in Table XV.

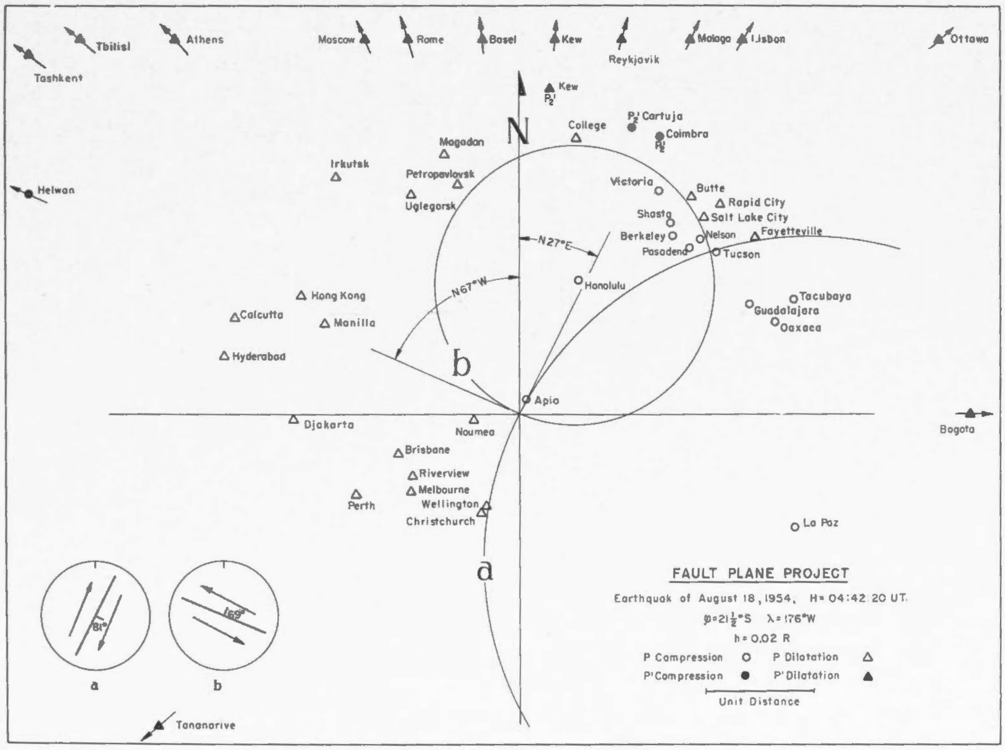

FIGURE 12.

Earthquake of 02:09:55, Sept. 13, 1954. $\phi = 21°S$, $\lambda = 175\frac{1}{2}°W$

There is some doubt about the proper position for circle *b*. As drawn (*see* Figure 13) it makes Tucson, Bozeman and Palisades correct, the Mexican stations, Swan Island,

TABLE XV

	Direct Phases				Reflected Phases							Grand Total
	P	P'_1	P'_2	Total	PP	PPP	pP	pP'_1	pPP	PcP	Total	
Total Number of Observations..	49	38	3	90	23	2	12	6	3	1	47	137
Number of Inconsistent Observations................	2	9	2	13	11	2	4	0	2	1	20	33

Fayetteville and a large number of reflected phases inconsistent. A better score would be obtained by drawing a larger circle. This has not been done because most of the dilatations have been called doubtful observations whereas most of the compressions have been called certain. In any event the difference would be very slight geologically.

The score is given in Table XVI.

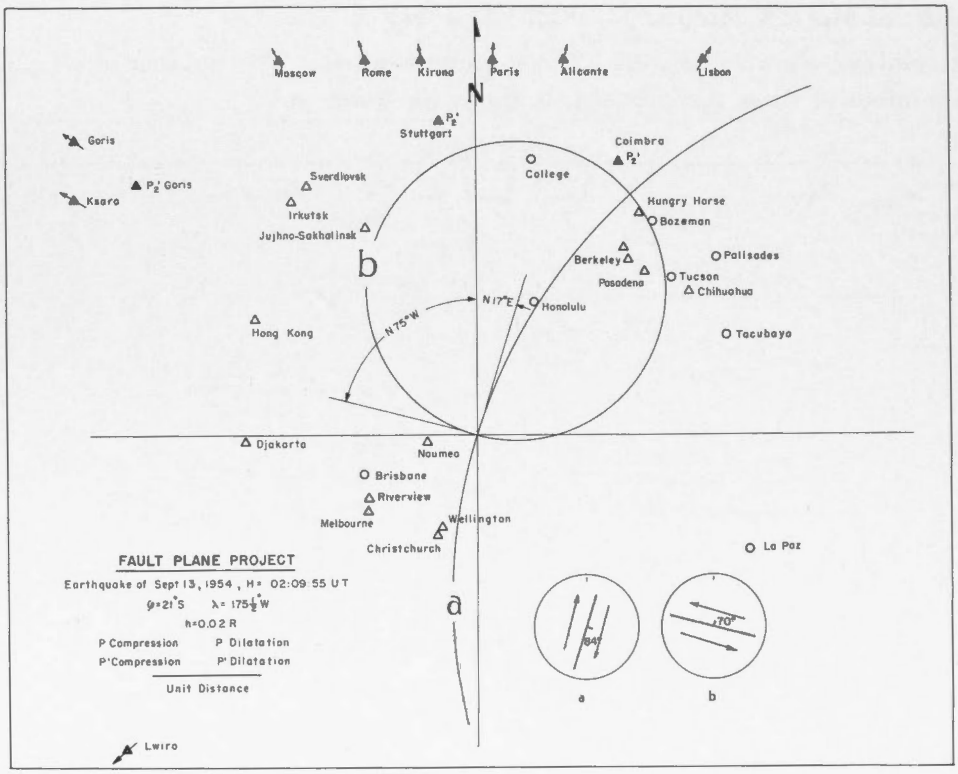

FIGURE 13.

Earthquake of 17:56:08, Sept. 15, 1954. $\phi = 18°S, \lambda = 178\frac{1}{2}°W$

As shown in Table XVII, there is a rather high percentage of inconsistencies among the PKP observations in this solution, but these inconsistent observations are so spread among consistent ones that no separation can be made, and they do not contribute a source of much doubt. There is some doubt about the exact position of circle *b* (*see* Figure 14); Tacubaya might have been made correct at the expense of Victoria. However the difference is slight.

TABLE XVI

	Direct Phases				Reflected Phases							Grand Total
	P	P'_1	P'_2	Total	PP	PPP	pP	pPP	pP'_1	pP'_2	Total	
Total Number of Observations..	35	33	3	71	25	3	7	3	8	1	47	118
Number of Inconsistent Observations................	5	5	1	11	9	2	4	2	4	1	22	33

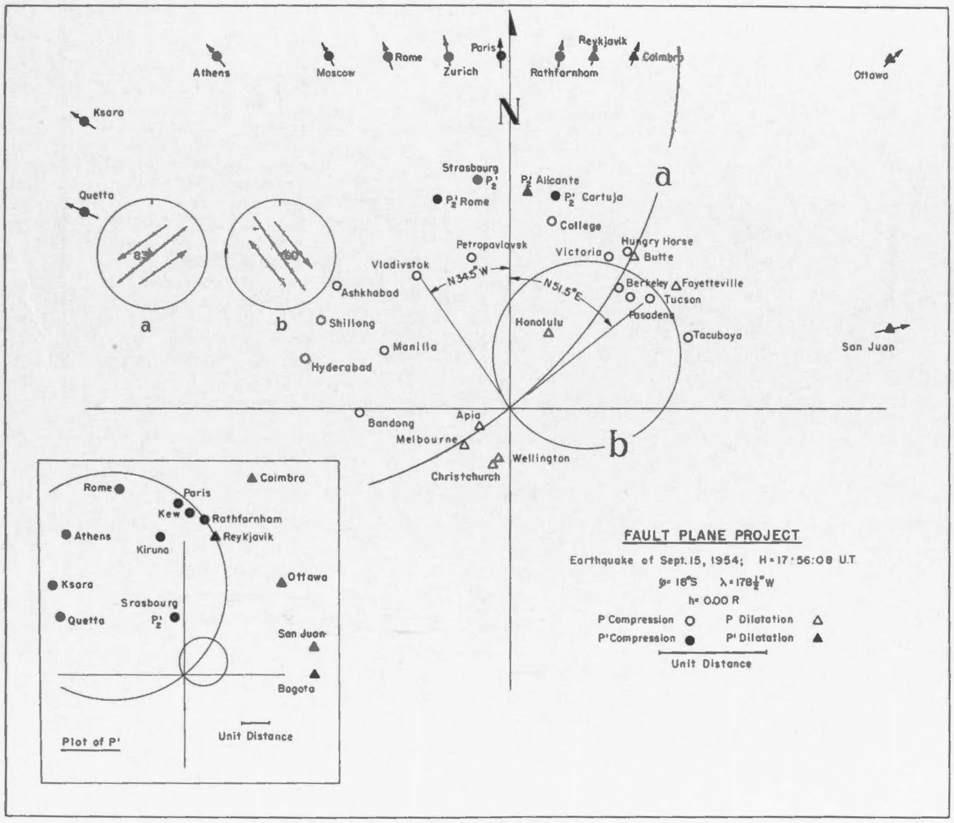

FIGURE 14.

TABLE XVII

	Direct Phases				Reflected Phases							Grand Total
	P	P'_1	P'_2	Total	PP	PPP	pP	pPP	pP'_1	PcP	Total	
Total Number of Observations..	34	41	7	82	13	2	4	1	3	2	25	107
Number of Inconsistent Observations................	4	10	3	17	6	1	2	1	1	1	12	29

Earthquake of 11:18:46, Oct. 3, 1954. $\phi = 60\frac{1}{2}°N$, $\lambda = 151°W$

The solution, shown in Figure 15, is perfectly straightforward, and the number of inconsistent observations shown in Table XVIII is about normal; note however the surprisingly good score of the pP and PPP phases and the very bad score for the PP.

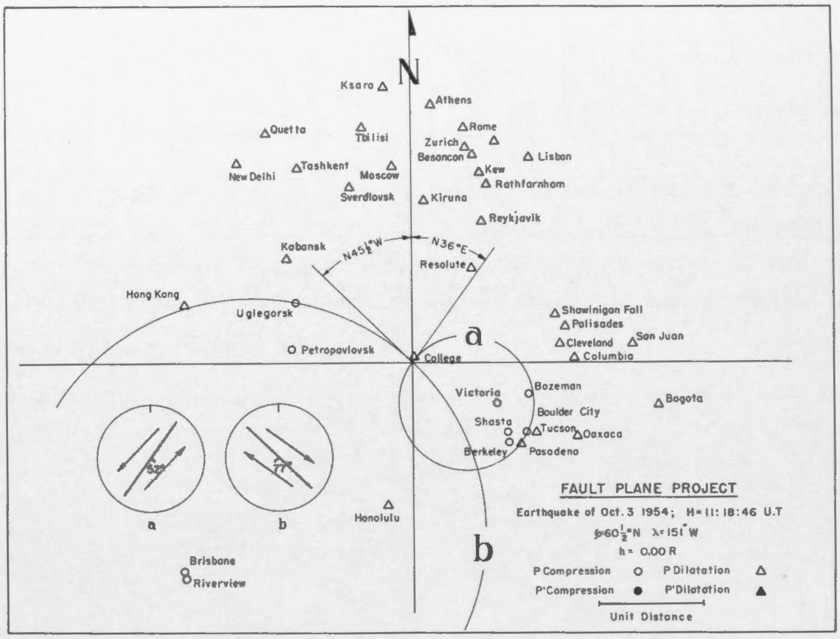

FIGURE 15.

TABLE XVIII

	Direct Phases			Reflected Phases						Grand Total
	P	P'_1	Total	PP	PPP	pP	pPP	PcP	Total	
Total Number of Observations....	90	1	91	15	6	9	3	2	35	126
Number of Inconsistent Observations..................	14	1	15	11	0	1	1	1	14	29

Earthquake of 17:48:35, Jan. 5, 1955. $\phi = 16°S$, $\lambda = 167\frac{1}{2}°E$

As shown in Table XIX, there are fewer observations than usual in this solution, but the percentage of inconsistencies is about normal. The solution is shown in Figure 16.

TABLE XIX

	Direct Phases				Reflected Phases					Grand Total
	P	P'_1	P'_2	Total	PP	PPP	pP	PcP	Total	
Total Number of Observations....	26	21	2	49	12	1	2	1	16	65
Number of Inconsistent Observations..................	4	2	0	6	6	0	2	1	9	15

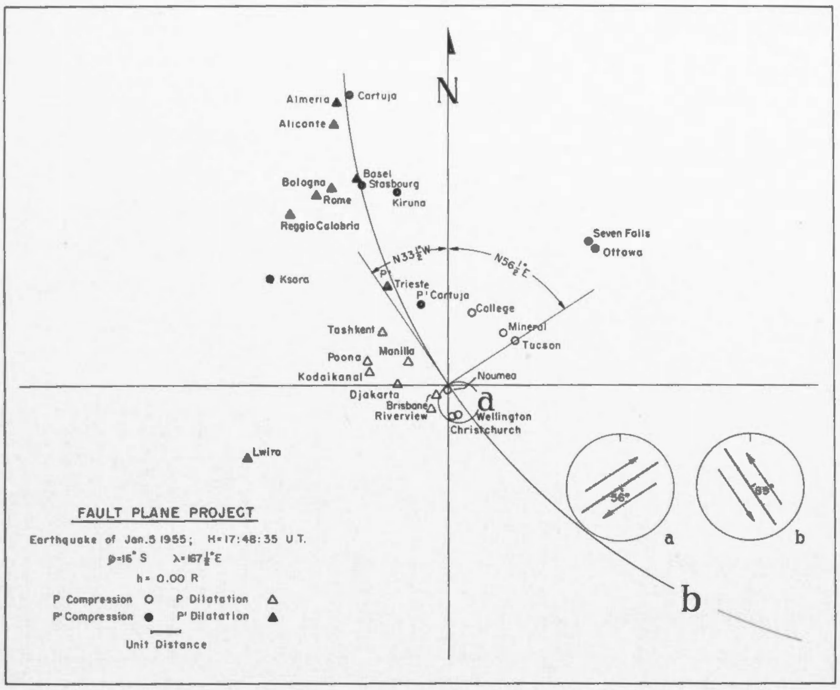

FIGURE 16.

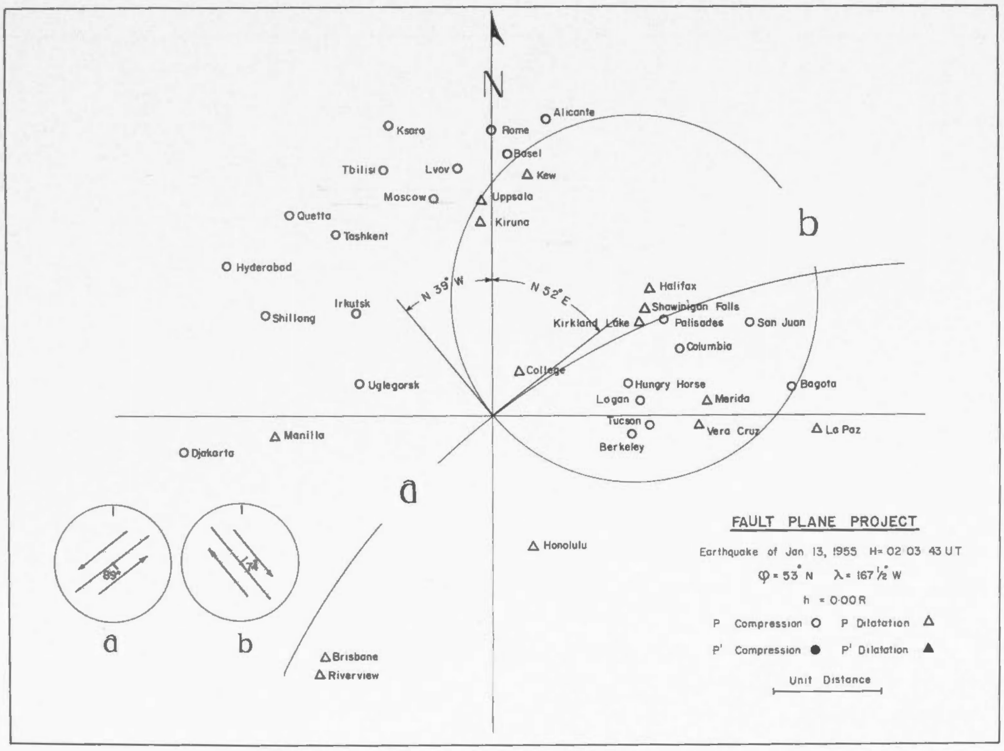

FIGURE 17.

Earthquake of 02:03:43, Jan. 13, 1955. $\phi = 53°N$, $\lambda = 167\frac{1}{2}°W$

The solution for this earthquake, shown in Figure 17, should be approximately correct, but there is some doubt about the exact position of circle *b*. As drawn it makes the Mexican stations inconsistent, and the stations at San Juan and Bogota consistent. If the circle were to be reduced in radius to reverse this, it would make Kiruna, Uppsala and Kew inconsistent. However something might be accomplished by swinging the circle around, and the fact that a number of Italian stations reported doubtful dilatations (not shown) might support this. There would be no geological significance in the change. The inconsistencies in Italy and Mexico contribute most of those shown in Table XX.

TABLE XX

	Direct Phases			Reflected Phases					Grand Total
	P	P_1'	Total	PP	pP	PPP	PcP	Total	
Total Number of Observations..........	77	1	78	12	2	4	5	23	101
Number of Inconsistent Observations.....	14	1	15	6	1	1	2	9	25

Earthquake of 13:12:04, March 14, 1955. $\phi = 52\frac{1}{2}°N$, $\lambda = 173\frac{1}{2}°W$

The solution is shown in Figure 18 and the score is given in Table XXI. The solution requires no comment.

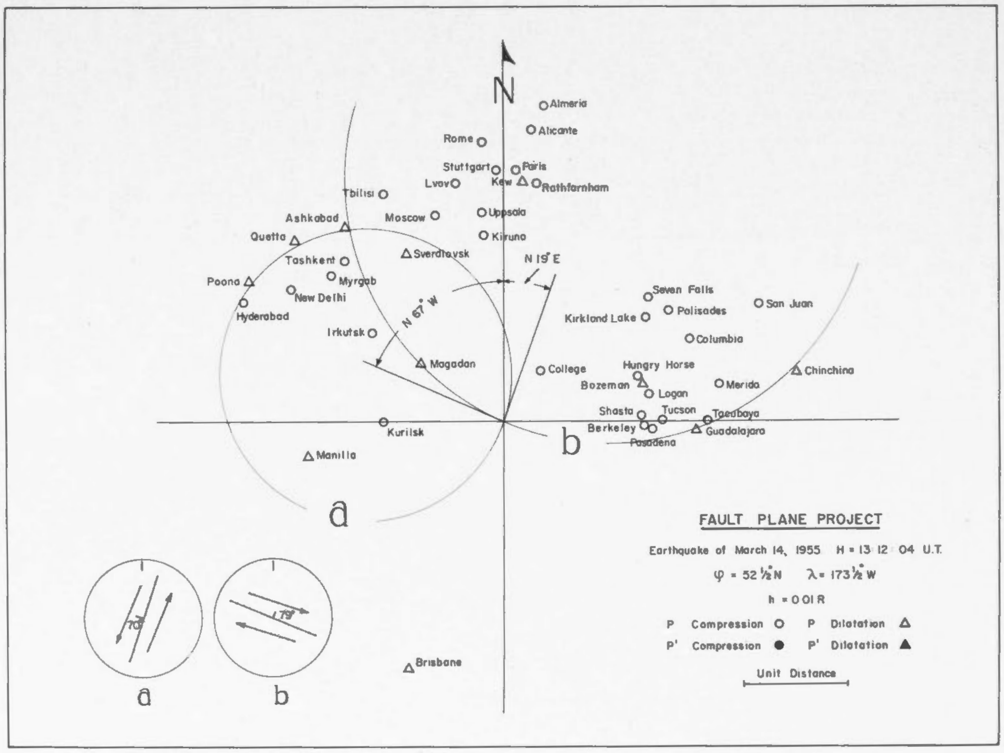

FIGURE 18.

TABLE XXI

	Direct Phases			Reflected Phases						Grand Total
	P	P_1'	Total	PP	PPP	pP	pPP	PcP	Total	
Total Number of Observations....	71	2	73	4	1	15	1	2	23	95
Number of Inconsistent Observations..................	12	1	13	1	1	7	1	0	10	23

Earthquake of 18:35:27, April 17, 1955. $\phi = 52°N$, $\lambda = 159\frac{1}{4}°E$

In the solution, shown in Figure 19, the position of circle *a* is clear, but circle *b* cannot be fixed exactly. As drawn, it makes Kiruna, Uppsala, Copenhagen and Paris correct,

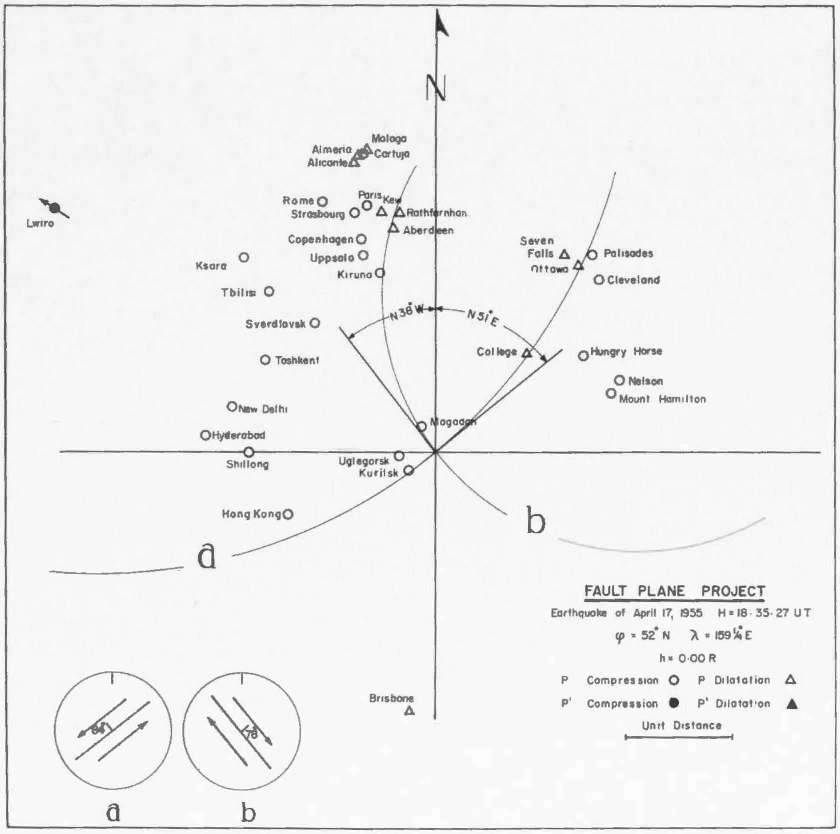

FIGURE 19.

Kew, Alicante, Almeria and Malaga inconsistent. These could have been reversed by increasing the radius of the circle to correspond to a dip of 82°; the difference is of no geological consequence, but the uncertainty is reflected in the high percentage of errors in the P observations, as shown in Table XXII.

TABLE XXII

	Direct Phases			Reflected Phases				Grand Total
	P	P_1'	Total	PP	pP	PcP	Total	
Total Number of Observations............	56	2	58	3	2	3	8	66
Number of Inconsistent Observations......	13	0	13	0	1	1	2	15

Earthquake of 20:24:05, April 19, 1955. $\phi = 30°S$, $\lambda = 72°W$

There are relatively few data for this earthquake, but the solution shown in Figure 20 accounts for these so well that publication seems justified. The percentage of inconsistent observations in the directest phases is gratifyingly low, as shown in Table XXIII.

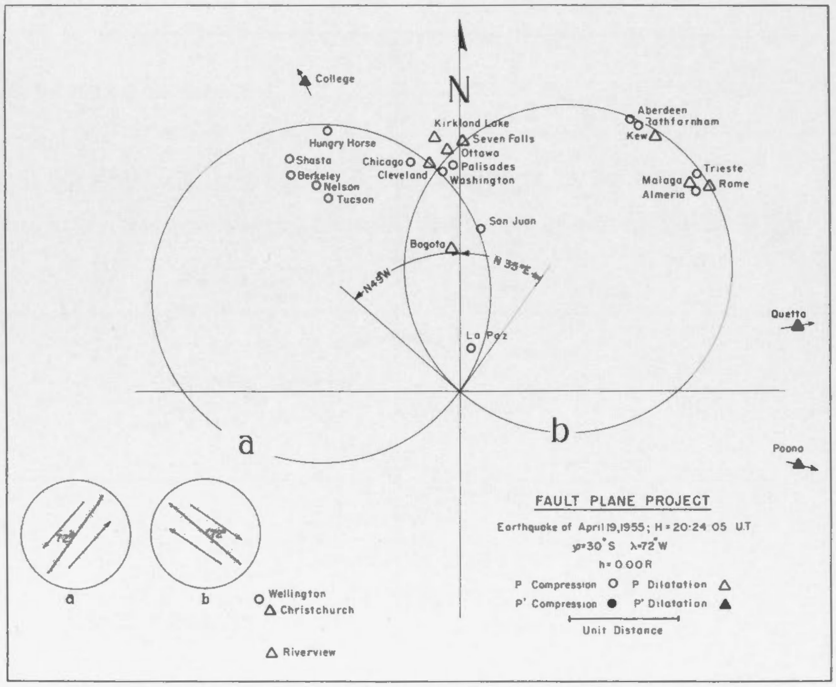

FIGURE 20.

TABLE XXIII

	Direct Phases			Reflected Phases			Grand Total
	P	P_1'	Total	PP	PPP	Total	
Total Number of Observations...............	34	5	39	13	3	16	55
Number of Inconsistent Observations.........	4	1	5	8	1	9	14

Earthquake of 12:31:41, May 30, 1955. $\phi = 24\frac{1}{2}°N$, $\lambda = 142\frac{1}{2}°E$

There were so many inconsistent observations in the direct phases in this solution (*see* Figure 21 and Table XXIV) that we seriously considered withholding its publication, particularly since many of these inconsistent observations came from stations which are normally dependable. However most of these observations were surrounded by consistent ones so that the solution has a reasonable degree of probability.

The very high percentage of inconsistencies in pP is worthy of note.

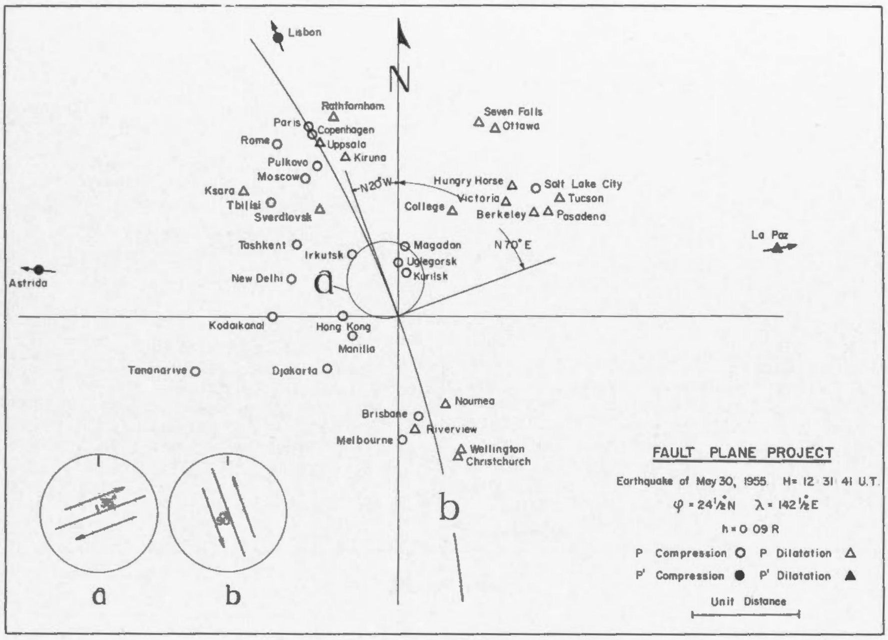

FIGURE 21.

TABLE XXIV

	Direct Phases			Reflected Phases						Grand Total
	P	P'_1	Total	PP	PPP	pP	pPP	PcP	Total	
Total Number of Observations....	88	3	91	22	5	26	5	2	60	151
Number of Inconsistant Observations..................	19	1	20	8	2	18	1	2	31	51

Earthquake of 00:18:56, June 2, 1955. $\phi = 51\frac{1}{2}°N$ $\lambda = 180°$

In this earthquake, which occurs at the junction of the two sections of the Aleutian arc, a line striking N86°E separates most of the compressions, lying to the north, from most of the dilatations, lying to the south. To show how well this has been accomplished all the points have been drawn in Figure 22 although only some of them have been identified. As drawn, the line passes through Hong Kong, Kurilsk, Berkeley and Mount Hamilton, and they may be regarded as correct. The only serious problem arises in the stations of western North America. Six of the stations—Hungry Horse, Victoria, Shasta, Boulder City, Tucson and Woody—recorded compressions, eight of them—Butte, Bozeman, Salt Lake City, Mineral, Nelson, Berkeley and Mount Hamilton—recorded

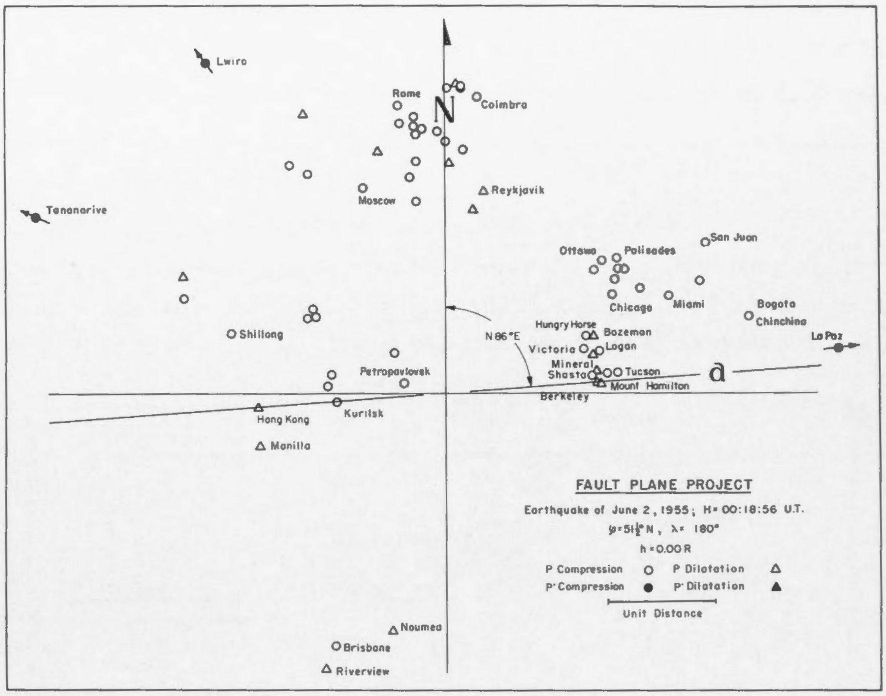

FIGURE 22.

dilatations. If no second circle is drawn through the area the six compressions and the dilatations at Berkeley and Mount Hamilton are consistent, against six inconsistent dilatations. If we draw a circle to include the dilatations at Bozeman and Nelson all the dilatations become consistent but all the compressions inconsistent. Clearly there is no statistical justification for drawing a second circle through the area. Hence the second circle could be any small circle drawn on the line *a* as centre—in particular the circle of zero radius drawn at the centre and representing a horizontal plane through the focus would be justified. In any case the direction of the null vector, but not its dip, is known. The data are summarized in Table XXV.

TABLE XXV

	Direct Phases			Reflected Phases						Grand Total
	P	P'_1	Total	PP	PPP	pP	pPP	PcP	Total	
Total Number of Observations....	78	3	81	6	2	1	1	4	14	95
Number of Inconsistent Observations..................	16	0	16	4	0	0	1	2	7	23

Earthquake of 12:07:25 June 20, 1955. $\phi = 51\frac{1}{2}°N$, $\lambda = 180°$

This earthquake has the same epicentre as that just discussed, but the solution, shown in Figure 23 is completely different. The percentage of inconsistent direct observations is again rather high, and it seems probable that both these solutions should be accepted

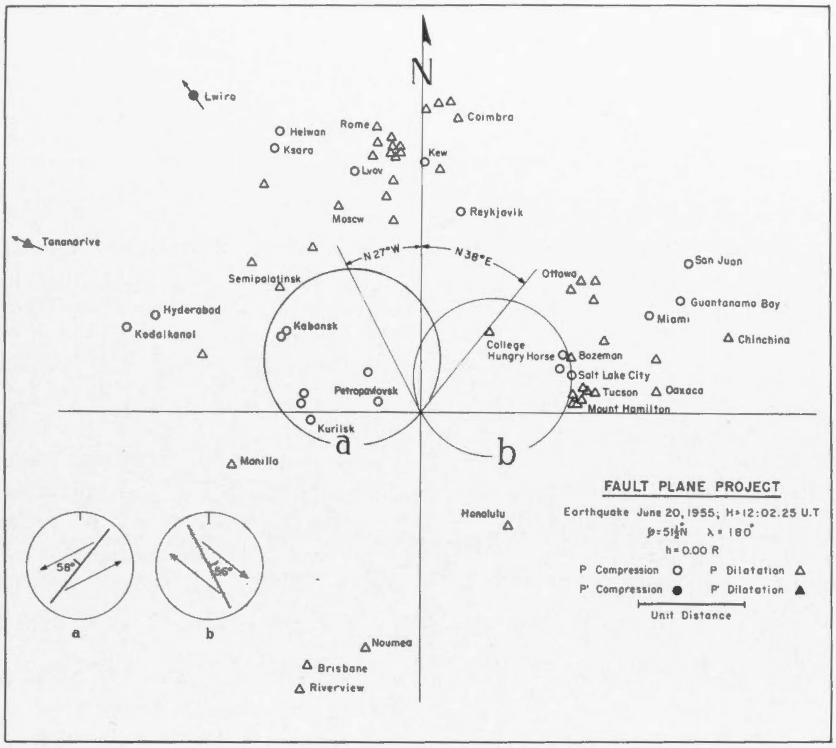

FIGURE 23.

with reservations. Most of the inconsistent observations derive from compressional observations at the greater distances, such for example as San Juan, Lwiro, Kodaikanal and the like. These are persistent enough to suggest the possibility of another mechanism. The score is given in Table XXVI.

TABLE XXVI

	Direct Phases				Reflected Phases						Grand Total
	P	P_1'	P_2'	Total	PP	PPP	pP	PcP	pPPP	Total	
Total Number of Observations....	71	2	1	74	10	4	7	6	1	28	102
Number of Inconsistent Observations..................	16	1	1	18	5	2	4	4	0	15	33

Earthquake of 07:07:08, July 16, 1955. $\phi = 37\frac{1}{2}°N$, $\lambda = 27°E$

The solution is shown in Figure 24. Circle *b* is extremely well defined by the separation in Europe and in the western United States, but circle *a* is not so well limited. It might, for example, be made larger to make Sverdlovsk correct and Magadan incorrect, or it might be made much smaller. The score is given in Table XXVII.

TABLE XXVII

	Direct Phases			Reflected Phases				Grand Total
	P	P'_1	Total	PP	PPP	PcP	Total	
Total Number of Observations............	71	2	73	12	3	1	16	89
Number of Inconsistent Observations......	14	2	16	6	1	0	7	23

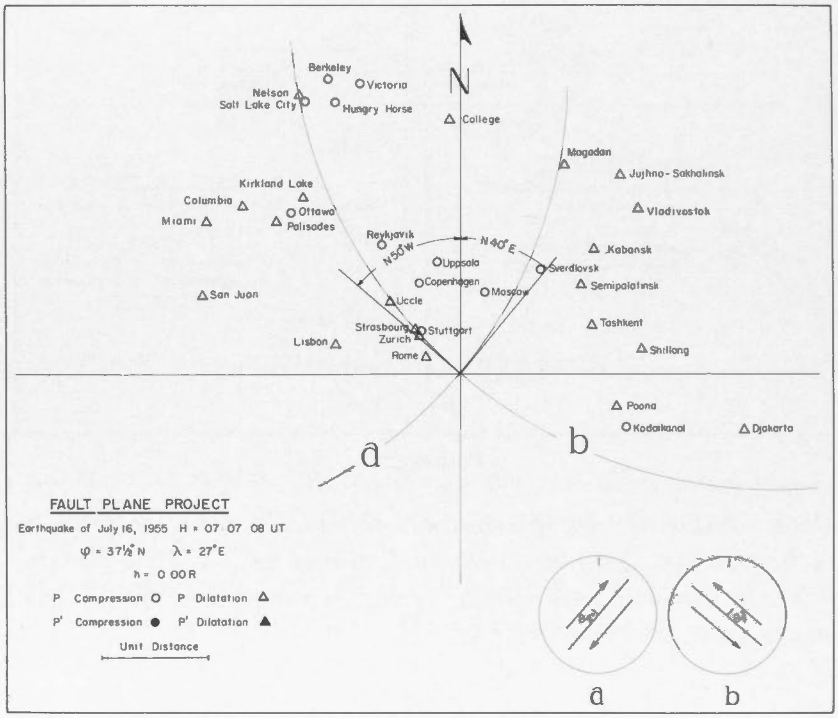

FIGURE 24.

SUMMARY

It was mentioned in the Introduction that this is the first in a second series of papers giving fault plane solutions. Until more solutions have been completed in this new series there is little to add to the discussion given in the recent paper (Hodgson, 1957) which reviewed the solutions of the first series. For that reason we simply provide the summary shown in Table XXVIII; the form of this table and the order in which the material is arranged is the same as that used in the review paper.

Throughout the present paper the solutions have been based on P and PKP alone, and the reflected phases have been tested for accuracy with reference to these solutions. The score for the reflected phases has been given with each solution, but the results for

TABLE XXVIII

EARTHQUAKE				PLANE a					PLANE b					NULL VECTOR		DEXTRAL Solution	SINISTRAL Solution
Date	φ	λ	Focal Depth-km.	Strike Direction	Dip Direction	Dip	Strike Component	Dip Component	Strike Direction	Dip Direction	Dip	Strike Component	Dip Component	Trend	Plunge		
New Zealand - Kermadecs - Tongas - Fiji																	
February 19A, 1954	30°S	177.7°W	Normal	N29.5°E	S60.5°E	87°	.985	+.175	N60°W	N30°E	80°	.999	+.053	N48°E	79.5°	b	a
- Alternative Solution -				N78.5°E	N11.5°W	73°	.889	+.459	N21°W	S69°W	64°	.946	+.325	N72°W	58°	b	a
August 18, 1954	21.5°S	176°W	150	N27°E	S63°E	81°	.932	-.363	N67°W	N23°E	69°	.986	-.168	N50°E	66.8°	a	b
September 13, 1954	21°S	175.5°W	150	N17°E	S73°E	84°	.939	-.345	N75°W	N15°E	70°	.994	-.112	N32°E	69.6°	a	b
September 15, 1954	18°S	178.5°W	600	N51.5°E	N38.5°W	83°	.864	-.504	N34.5°W	N55.5°E	60°	.990	-.141	N39.5°E	59.4°	b	a
New Hebrides																	
January 5A, 1955	16°S	167.5°E	Normal	N56.5°E	S33.5°E	56°	.999	-.022	N33.5°W	N56.5°E	89°	.820	-.572	S35.5°E	55.9°	a	b
Bonins - Japan - Sakhalins - Kuriles - Kamchatka																	
May 30, 1955	24.5°N	142.5°E	600	N70°E	N20°W	35°	1.000	-.000	N20°W	S70°W	90°	.574	-.819	N21°W	35.4°	a	b
May 14, 1954	36°N	137°E	250	N56°E	N34°W	68°	.991	+.132	N31°W	N59°E	83°	.926	+.378	N14.5°W	66.9°	a	b
July 6, 1954	46.5°N	153.5°E	100	← Not defined				+ →	N22.5°W	N67.5°E	62°	←	+	Not defined			→
May 3, 1954	51.5°N	159.5°E	Normal	N9°E	N81°W	70°	.938	-.346	N74°W	N16°E	71°	.932	-.362	N34°W	62.2°	b	a
April 17, 1955	52°N	159.2°E	Normal	N51°E	N39°W	84°	.978	-.210	N38°W	N52°E	78°	.994	-.107	N25°E	76.9°	b	a
Aleutians - Alaska																	
June 2, 1955	51.5°N	180°	Normal	N86°E	←	90°				Not defined				N86°E			→
June 20, 1955	51.5°N	180°	Normal	N38°E	N52°W	58°	.752	-.660	N27°W	N63°E	56°	.769	-.639	N7.5°E	39.7°	b	a
April 17, 1954	51.5°N	179°W	Normal	N87.5°E	N2.5°W	82°	.994	-.106	N3°W	S87°W	84°	.990	-.140	N40°W	80.0°	a	b
- Alternative Solution -				N45°E	S45°E	84°	.965	-.261	N46°W	N44°E	75°	.994	-.108	N66°E	74.3°	a	b
March 14, 1955	52.5°N	173.5°W	100	N19°E	N71°W	70°	.979	-.203	N67°W	N23°E	79°	.938	-.348	N39°W	66.3°	b	a
January 13, 1955	53°N	167.5°W	Normal	N52°E	S38°E	89°	.961	+.275	N39°W	N51°E	74°	.999	+.018	N66°E	73.3°	b	a
October 3, 1954	60.5°N	151°W	100	N36°E	S54°E	52°	.958	-.285	N45.5°W	S44.5°W	77°	.775	-.632	S31°E	49.3°	b	a
Pacific Coast of North America																	
April 29A, 1954	28.5°N	113°W	Normal	N46°E	S44°E	88°	.925	+.379	N45°W	N45°E	68°	.999	+.038	N50°E	68°	b	a
April 29B, 1954	28.5°N	113°W	Normal	N46°E	S44°E	88°	.925	+.379	N45°W	N45°E	68°	.999	+.038	N50°E	68°	b	a
February 19B, 1954	12.5°N	87.5°W	Normal	N28.5°E	N61.5°W	55°	.985	-.170	N55°W	N35°E	82°	.815	-.579	N44°W	53.3°	b	a
South America																	
April 27, 1954	6°N	82.5°W	Normal	N6.5°E	S83.5°E	85°	.970	-.243	N85°W	N5°E	76°	.996	-.090	N27°E	75.2°	a	b
April 19, 1955	30°S	72°W	Normal	N35°E	N55°W	72°	.946	-.325	N49°W	N41°E	72°	.946	-.325	N6°W	64.4°	b	a
Mediterranean																	
July 16, 1955	37.5°N	27°E	Normal	N40°E	N50°W	84°	.995	+.105	N50°W	N40°E	84°	.995	+.105	N5.5°W	81°	a	b
April 30, 1954	39°N	22°E	Normal	N86°E	N4°W	18°	.998	-.069	N46°W	S44°W	78°	.954	-.301	N48.5°W	13°	a	b

TABLE XXIX

	PHASE					
	PP	PPP	pP	pP′	pPP	PcP
Number of Observations................	277	58	109	19	21	48
Number of Inconsistencies...............	128	25	52	6	10	25
Percentage of Inconsistencies............	46.2	43.1	47.7	31.6	47.6	52.1

all the solutions are summarized in Table XXIX. This table will be discussed in more detail in another paper (Hodgson and Adams, in press), but it is clear that the reflected phases are producing random observations and should not be used.

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