UNITED STATES DEPARTMENT OF THE INTERIOR

GEOLOGICAL SURVEY

# INTERIM REPORT ON

# WORLDWIDE HISTORIC SURFACE FAULTING

by

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## Introduction

This interim report presents data on and interrelations between the parameters L (length of surface rupture), D (maximum surface displacement), and M (Richter magnitude of associated earthquake) for the main traces of historic surface faults that have been reported in the worldwide literature. Original descriptions of the individual fault-events published in English, French, German, or Spanish were used whenever possible, supplemented by translations of selected passages of reports published in Japanese and Chinese. For some events, original descriptions were not published in these languages and secondary sources were used. Although more than 100 fault-events have been reported in the literature, only those for which reliable data (in the judgement of the present writers) were available on at least two of the three parameters M, L, and D are included in this interim report and listed in table 1. Some fault-events have been omitted because the available reports contained significantly different data for the same event and the writers had insufficient basis for choosing between them.

This report was prepared to permit early release of part of the results of a more comprehensive study of historic surface faulting now under way, and to elicit suggestions and criticisms from users of the report. Comments are especially invited regarding the methods used in designating the fault type and in identifying the main fault.

The more comprehensive report will deal with subsidiary faults as well as main faults, will have detailed citations of the sources of information, and will discuss various additional aspects of faulting. It is anticipated that reliable data on a few more faults will be obtained, and it is hoped that comments from users of this interim report will permit improvement of the comprehensive report. Thus it is expected that the comprehensive report will contain modifications of the present data and will be of larger scope.

## Explanation of table 1

Some general comments on the table are given here; more specific comments are given in subsequent sections of the report.

The fault-events are listed geographically, and chronologically within geographic units. Faults numbered from 1 to 49 are in North America and those numbered 50 and greater are outside North America. (Each fault number also includes a letter indicating the fault type, which is explained in another section of the report.) The North American events are listed chronologically, oldest first. Faults outside North America are listed alphabetically by country and chronologically within each country. The data in the table apply to the main fault, as clarified in a following section of this report.

The column labelled "FAULT" gives the name of the fault, if known to the writers.

The date of the event is listed by year, followed by month and day.

The column headed "MAG" gives the Richter magnitude of the earthquake associated with the faulting. The intent was to include only instrumentally-determined magnitudes. If any non-instrumental, derived magnitudes are listed, the writers would appreciate being advised of this by users of the report.

Length of surface faulting and fault displacement are given in the columns headed "L-METERS" and "DISP-METERS" respectively. Length and displacement are included only if field measurements were reported; estimates based on aftershock area, dislocation theory, or other indirect methods are not listed. The apparent accuracy of some of the figures given is the result of computation, either of oblique slip from strike slip and dip slip components or of conversion from English to metric units by the computer. Field measurements of displacement are only rarely given as closely as 0.1 foot or 0.01 meter, and lengths are generally given only to the nearest mile or kilometer. The values given in table 1 for length and displacement must be multiplied by the power of ten that is given as a final digit in each of these columns, i.e., "06" indicates that the decimal point must be moved 6 places to the right, and "-01" requires shifting of the decimal point 1 place to the left. Other comments on fault displacement are given in a later section of this report.

Absence of data is indicated by "0.0" in the columns for magnitude, length, and displacement.

The column labeled "REFERENCES" indicates the principal sources of the data in the table. The two- or three-letter reference code is keyed to the alphabetical list of references at the end of this report.

Table 1.-- SELECTED WORLDWIDE HISTORIC SURFACE FAULTING

| NO | LOCATION | FAULT | DATE | MAG | L - METERS | DISP - METERS | REFERENCES |
|---|---|---|---|---|---|---|---|
| 12 E | CALIFORNIA | SAN ANDREAS | 19060418 | 8.30 | 0.4345244D 06 | 0.6096012D 01 | LA,RC |
| 14 A | NEVADA,PLEASANT VALLEY | | 19151002 | 7.60 | 0.4828049D 05 | 0.4572009D 01 | JJ,PB |
| 15 C | NEVADA,CEDAR MOUNTAIN | | 19321220 | 7.30 | 0.6115529D 05 | 0.1219202D 01 | GC |
| 16 A | NEVADA,EXCELSIOR MTS. | | 19340130 | 6.50 | 0.1448415D 04 | 0.1219202D 00 | CG |
| 19 E | CALIFORNIA, EL CENTRO | IMPERIAL | 19400518 | 7.10 | 0.6437399D 05 | 0.5791211D 01 | RC,UF |
| 21 E | CALIFORNIA, MANIX | | 19470410 | 6.40 | 0.1609350D 04 | 0.7620015D-01 | AS,RC |
| 23 A | CALIFORNIA,FORT SAGE | | 19501214 | 5.60 | 0.8851422D 04 | 0.6096012D 00 | GV |
| 24 C | CALIF.,SUPERSTITION H. | | 19510123 | 5.60 | 0.3000000D 04 | 0.0 | AS,DT |
| 25 B | CALIFORNIA | WHITE WOLF | 19520721 | 7.70 | 0.5310854D 05 | 0.1219202D 01 | BS,DTS,RC,WC |
| 26 A | NEVADA,RAINBOW MTN. | | 19540706 | 6.60 | 0.1770285D 05 | 0.3048006D 00 | TD |
| 27 A | NEVADA,RAINBOW MTN. | | 19540823 | 6.80 | 0.3057764D 05 | 0.7620015D 00 | TD |
| 28 C | NEVADA,FAIRVIEW PEAK | | 19541216 | 7.10 | 0.4828049D 05 | 0.5699770D 01 | RCD,SD,SM |
| 29 A | NEVADA,DIXIE VALLEY | | 19541216 | 6.80 | 0.6115529D 05 | 0.2133604D 01 | RCD,SD,SM |
| 30 C | MEXICO,BAJA CALIFORNIA | SAN MIGUEL | 19560209 | 6.80 | 0.1931220D 05 | 0.9144018D 00 | SR |
| 31 E | ALASKA | FAIRWEATHER | 19580710 | 8.00 | 0.2000000D 06 | 0.6553213D 01 | TDF |
| 32 A | MONTANA,HEBGEN LAKE | | 19590817 | 7.10 | 0.2414025D 05 | 0.6096012D 01 | MH,WI |
| 33 B | ALASKA | PATTON BAY | 19640422 | 8.40 | 0.6276464D 05 | 0.7924816D 01 | PG ,PGM |
| 35 E | CALIFORNIA | IMPERIAL | 19660304 | 3.60 | 0.1000000D 05 | 0.9999998D-02 | BA |
| 36 E | CALIFORNIA,PARKFIELD | SAN ANDREAS | 19660600 | 5.50 | 0.3701504D 05 | 0.1767843D 00 | BV,WR |
| 37 E | CALIFORNIA,BORREGO MT. | COYOTE CREEK | 19680409 | 6.50 | 0.3300000D 05 | 0.3800000D 00 | AG |
| 52 B | ARGENTINA,SAN JUAN | | 19440115 | 7.80 | 0.7000000D 04 | 0.6000000D 00 | RC,HH,CA |
| 53 D | AUSTRALIA,MECKERING | | 19681014 | 7.00 | 0.3700000D 05 | 0.3030000D 01 | GE,EG |
| 55 A | BULGARIA,CHIRPAN | | 19280414 | 6.80 | 0.4700000D 05 | 0.5000000D 00 | RC,BB,KV |
| 56 A | BULGARIA,POPOVITSA | | 19280418 | 7.00 | 0.2900000D 05 | 0.3500000D 01 | RC,BB,KV |
| 64 A | GREECE,CORINTH | | 18611226 | 0.0 | 0.1300000D 05 | 0.2000000D 01 | SJ,RC,MF |
| 65 A | GREECE,LOCRIS | | 18940427 | 0.0 | 0.5900000D 05 | 0.2000000D 01 | ST,RC,MF |
| 69 A | INDIA,CUTCH | | 18190616 | 0.0 | 0.1287479D 06 | 0.9144018D 01 | LC,ORC,DC |
| 70 A | INDIA,ASSAM | CHEDRANG | 18970612 | 8.70 | 0.1931220D 05 | 0.1066802D 02 | OR,RC |
| 72 B | IRAN,BUYIN-ZARA | IPAK | 19620901 | 7.20 | 0.1029984D 06 | 0.7620015D 00 | ANB,ANI,ON |
| 73 E | IRAN,DASHT-E BAYAZ | | 19680831 | 7.30 | 0.6900000D 05 | 0.4500000D 01 | ATD,ATI |
| 74 B | JAPAN,ZENKOJI | | 18470508 | 0.0 | 0.3000000D 05 | 0.2400000D 01 | MM,IK |
| 75 C | JAPAN,MINO-OWARI | NEO-DANI | 18911028 | 0.0 | 0.1120000D 06 | 0.6000000D 01 | KB |
| 77 A | JAPAN,RIKU-U | SENYA | 18960813 | 0.0 | 0.6000000D 05 | 0.3000000D 01 | YN |
| 81 E | JAPAN,TANGO | GOMURA | 19270307 | 8.00 | 0.1800000D 05 | 0.3000000D 01 | YT,RC |
| 83 C | JAPAN,IDU | TANNA | 19301125 | 7.10 | 0.3000000D 05 | 0.3599999D 01 | KS,OY,II,GR |
| 84 E | JAPAN,TOTTORI | SHIKANO | 19430910 | 7.40 | 0.8000000D 04 | 0.1500000D 01 | DS,TH,RC,SMA |
| 86 B | JAPAN,MIKAWA | FUKOZU | 19450113 | 7.10 | 0.9000000D 04 | 0.2000000D 01 | THF,RC |
| 88 A | JAPAN,TESIKAGA | | 19590131 | 6.20 | 0.2000000D 04 | 0.9999996D-01 | MT |
| 89 A | JAPAN,NIIGATA | | 19640616 | 7.50 | 0.2000000D 05 | 0.5500000D 01 | KH,MI |
| 91 A | KENYA,SUBUKIA | | 19280106 | 7.10 | 0.2896830D 05 | 0.3352807D 01 | RC,WB,AT,MG |
| 92 A | MONGOLIA,GURBAN SAIKAN | | 19030000 | 0.0 | 0.1500000D 05 | 0.3000000D 01 | FS |
| 93 C | MONGOLIA | TSETSERLEG | 19050709 | 8.40 | 0.1150000D 06 | 0.0 | FS,RC |
| 94 E | MONGOLIA | KHANGAI | 19050723 | 8.70 | 0.3500000D 06 | 0.0 | FS,RC |
| 95 E | MONGOLIA,GOBI ALTAI | BOGDO | 19571204 | 8.30 | 0.2650000D 06 | 0.8849999D 01 | FS,DS |
| 97 C | NEW ZEALAND | AWATERE | 18481019 | 0.0 | 0.9656094D 05 | 0.6096012D 01 | MA,LC,LG |
| 98 A | NEW ZEALAND,WELLINGTON | WAIRARAPA | 18550123 | 0.0 | 0.1335760D 06 | 0.3048006D 01 | LC,OMW |
| 101 E | NEW ZEALAND,AMURI | HOPE | 18880901 | 0.0 | 0.2574960D 05 | 0.2590805D 01 | HJ,MAN |
| 104 B | NEW ZEALAND,W.NELSON | WHITE CREEK | 19290617 | 7.80 | 0.1126545D 05 | 0.4480569D 01 | HJN,BL,RC |
| 105 B | NEW ZEALAND,HAWKES BAY | | 19310203 | 7.90 | 0.9656098D 04 | 0.0 | HJH,RC |
| 106 C | NEW ZEALAND,WAIROA | | 19320916 | 6.80 | 0.0 | 0.1524003D 01 | OWH,RC |

Table 1.--SELECTED WORLDWIDE HISTORIC SURFACE FAULTING - CONTINUED

| NO | LOCATION | FAULT | DATE | MAG | L - METERS | DISP - METERS | REFERENCES |
|---|---|---|---|---|---|---|---|
| 108 D | NEW ZEALAND,INANGAHUA | | 19680523 | 7.10 | 0.1000000D 04 | 0.41000000 00 | LS,AL |
| 110 A | PERU,ANCASH | QUICHES | 19461110 | 7.40 | 0.2000000D 05 | 0.3500000D 01 | SE,RC |
| 112 B | PERU,PARIAHUANCA | | 19690724 | 5.70 | 0.0 | 0.4000000D 00 | DEP,SSA,DE |
| 113 D | PERU,PARIAHUANCA | | 19691001 | 6.20 | 0.1600000D 05 | 0.1400000D 01 | DEP,SSA,DE |
| 120 E | SUDAN,JEBEL DUMBEIR | | 19661009 | 5.10 | 0.6000000D 04 | 0.0 | QS |
| 122 C | TAIWAN | MEITZUKENG | 19060317 | 7.10 | 0.1100000D 05 | 0.2712725D 01 | OF,IK,BC |
| 123 B | TAIWAN | CHIHHU | 19350421 | 0.0 | 0.1500000D 05 | 0.3000000D 01 | ER,RC,BC |
| 124 E | TAIWAN | TUNTZUCHIO | 19350421 | 0.0 | 0.1200000D 05 | 0.1500000D 01 | ER,RC,BC |
| 125 E | TAIWAN | SINHUA | 19461205 | 0.0 | 0.6000000D 04 | 0.2000000D 01 | CC |
| 126 D | TAIWAN | MEILUN | 19511022 | 7.10 | 0.7000000D 04 | 0.2299999D 01 | HT,HTL,GR,CK,BC |
| 127 D | TAIWAN | YULI | 19511125 | 7.30 | 0.4000000D 05 | 0.2080000D 01 | HT,HTL,BC |
| 130 E | TURKEY | ANATOLIA | 19391227 | 8.00 | 0.3400000D 06 | 0.3700000D 01 | PA,RC |
| 131 E | TURKEY | ANATOLIA | 19421220 | 7.30 | 0.5000000D 05 | 0.1750000D 01 | RC,BP,PH |
| 132 C | TURKEY | ANATOLIA | 19431126 | 7.60 | 0.2800000D 06 | 0.1500000D 01 | KIE,RC,KIA,KIT |
| 133 E | TURKEY | ANATOLIA | 19440201 | 7.60 | 0.1800000D 06 | 0.3500000D 01 | KIE,KR,KIT |
| 136 E | TURKEY,YENICE-GONEN | | 19530318 | 7.20 | 0.5800000D 05 | 0.4299999D 01 | KR,DH,PN,RC |
| 137 E | TURKEY,ABANT | ANATOLIA | 19570526 | 7.10 | 0.4000000D 05 | 0.1599999D 01 | KIA,AZ,ON |
| 139 E | TURKEY,MUDURNU VALLEY | ANATOLIA | 19670722 | 7.10 | 0.5400000D 05 | 0.1900000D 01 | AZ |

## Designation of the main fault

In most fault-events, one surface fault clearly predominates in terms of length, displacement, and continuity and can be designated the main fault without ambiguity (Bonilla, 1967, p. 5; 1970, p. 54-55). In some events however, many small faults of nearly equal importance occur, and in others two faults of similar importance may predominate over the other faults. When two faults of similar length, displacement, and continuity were reported in one event, the following criteria, in approximate order of decreasing importance, were used as guides in designating the main fault:

a) Rupture occurred on recognized (or recognizable) prequake fault

b) The greater $LxD^2$ (L, length; D, maximum displacement; both in same units)

c) Geodetic survey results, with consideration of age of surveys in relation to the faulting

d) Location of epicenter(s), with consideration of accuracy of location

e) Isoseismal lines

Criterion "a" was adopted because evaluation of the suitability of a reactor site with regard to seismic hazards generally involves an appraisal of the probable behavior of the most important recognizable fault in the vicinity of the site. The use of criterion "a" to help choose between two nearly-equal faults thus is intended to make the results of this study more applicable to the practical problem of evaluating seismic risk, especially from subsidiary faulting.

Criterion "b", following the usage of King and Knopoff (1968), was adopted early in the study as the best indication that can be obtained, from simple field measurements of fault displacement and length, of the magnitude of the associated earthquake and hence the "importance" of the fault. The data obtained as this study progressed confirmed the rather good correlation reported by King and Knopoff (1968) between magnitude and length times square of displacement (see table 3, fig. 4, and p. 17, this report).

Despite the use of the criteria listed above, a clear choice could not be made on designation of the main fault for the 1935 Taiwan event. The two prominent faults are both included so that their length-displacement data could be used, but the earthquake magnitude was omitted so that neither of these ruptures would be included in relations involving earthquake magnitude.

## Fault types

For the purposes of this report the faulting has been divided into 5 principal types, designated by letters A through E, based on the relative importance and sense of the strike-slip and dip-slip components of displacement. These 5 types are a grouping of the 12 fault types shown on figure 1. Figure 1 represents the plane of a fault dipping toward the observer. If a point originally at the center of the circle and on the far side of the fault is displaced by faulting to the rim of the circle, the indicated types of faults would be produced. The movement of the point generates a radial line that makes an angle (measured in the plane of the fault) with the horizontal line that represents the strike of the fault; this angle, called $\Phi$, can be measured on striations in the fault surface, or it can be calculated from the relative values of the strike slip (SS) and dip slip (DS): SS/DS = cotangent $\Phi$. The radii that mark the boundaries between fault types make angles of 30°, 60°, and 90° above or below the horizontal line (see fig. 1). The value of the contangent of $\Phi$ combined with the normal or reverse sense of displacement gives the 5 types of faults, as shown on table 2.

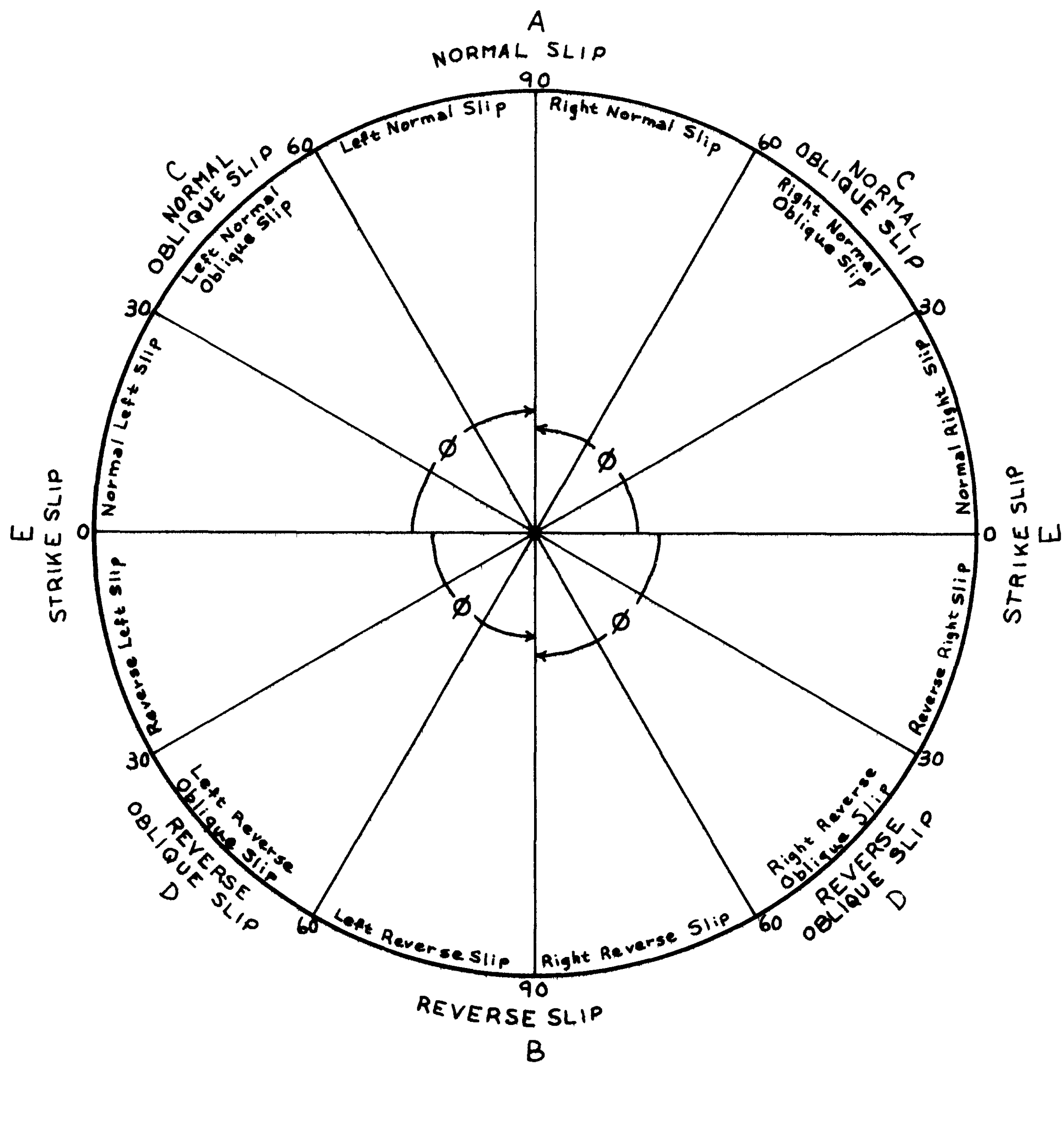


Figure 1. FAULT TYPES

Table 2. Classification of fault types used in this report

| | Fault type | Angle $\Phi$, degrees | Cotangent of $\Phi$ | Movement of hanging wall |
|---|---|---|---|---|
| A | Normal slip | 90 to 60 | 0 to 0.577 | Down* |
| B | Reverse slip | 90 to 60 | 0 to 0.577 | Up |
| C | Normal oblique slip | <60 to 30 | >0.577 to 1.732 | Down* |
| D | Reverse oblique slip | <60 to 30 | >0.577 to 1.732 | Up |
| E | Strike slip | <30 | >1.732 | - |

*If the fault surface was reported as vertical or nearly vertical, vertical slip was treated as normal slip unless strong evidence of compression was found, in which case it was treated as reverse slip.

The limits adopted give equal weight to all 12 fault types shown on figure 1. Whether the limits for oblique-slip faults shown on figure 1 and in table 2 fits the usage of others is not known to the writers, as they found no limits given in several text books that were consulted.

In applying the criteria for fault type, the predominant characteristics of the fault over most of its length were used, whenever possible, rather than the characteristics at one point. For example, a north-south fault on which the cotangent of $\Phi$ was 0.8 at one point but 1.8 at most other points, and the relatively downdropped side alternated from east to west along its length, would be classified as strike slip.

The fault types are designated by the letters A through E near the left side of table 1.

## Fault displacement

The displacement (abbreviated "DISP" on table 1) is the maximum reported for each event. For strike-slip, normal-slip, and reverse-slip faults the largest strike-slip or dip-slip component was used. For oblique-slip faults the largest resultant of the combined strike-slip and dip-slip components at a single point was used, if sufficient data were available; otherwise the largest strike-slip or dip-slip component was used.

## Relations between fault parameters

The relations between fault length and displacement and earthquake magnitude are plotted on figures 2 through 5, and equations for the best straight-line representation for these relations are given in table 3.

The fault numbers that identify the data points on figures 2 through 5 are the same as in table 1 and thus indicate the geographic location as well as the type of fault represented.

Table 3 lists 75 equations by giving the coefficients a and b in equations of the form $y = a+bx$ ; these were derived by the method of least squares. Length and displacement are in meters in all equations. The equations are given for groupings of various sets of faults, the first three sets being geographic and the remaining 12 being by fault type. The reliability of each of the equations can be judged by the number of data points in each set, by the standard deviation, and by the correlation coefficient (a measure of the goodness of fit of the least-square line), which are also given in table 3.

Table 3.--EQUATIONS FOR LINES OF BEST FIT

3.1 Magnitude vs Displacement: Log D = a+bM (see fig. 2)

| Fault set | Number in set | a | b | Standard deviation | Correlation coefficient |
|---|---|---|---|---|---|
| 1-49 | 19 | -4.211 | 0.616 | 0.413 | 0.848 |
| 50-140 | 31 | -3.123 | 0.471 | 0.317 | 0.655 |
| 1-140 | 50 | -3.916 | 0.578 | 0.362 | 0.799 |
| A | 14 | -4.660 | 0.689 | 0.408 | 0.761 |
| B | 7 | -2.703 | 0.389 | 0.310 | 0.705 |
| C | 7 | -0.167 | 0.066 | 0.261 | 0.065 |
| D | 5 | -0.111 | 0.042 | 0.304 | 0.053 |
| E | 17 | -4.334 | 0.633 | 0.305 | 0.918 |
| A+C | 21 | -4.399 | 0.655 | 0.378 | 0.715 |
| B+D | 12 | -2.003 | 0.302 | 0.327 | 0.538 |
| C+D+E | 29 | -4.049 | 0.600 | 0.323 | 0.854 |
| C+D | 12 | -0.427 | 0.097 | 0.285 | 0.110 |
| B+E | 24 | -4.021 | 0.582 | 0.329 | 0.879 |
| A+C+E | 38 | -4.310 | 0.637 | 0.350 | 0.845 |
| B+D+E | 29 | -3.847 | 0.562 | 0.341 | 0.847 |

3.2 Magnitude vs length: Log L = a+bM (see fig. 3)

| Fault set | Number in set | a | b | Standard deviation | Correlation coefficient |
|---|---|---|---|---|---|
| 1-49 | 20 | 2.092 | 0.344 | 0.485 | 0.609 |
| 50-140 | 33 | 1.513 | 0.401 | 0.533 | 0.465 |
| 1-140 | 53 | 2.036 | 0.338 | 0.523 | 0.506 |
| A | 14 | 2.308 | 0.277 | 0.420 | 0.418 |
| B | 7 | 3.900 | 0.056 | 0.448 | 0.051 |
| C | 7 | 0.196 | 0.611 | 0.323 | 0.677 |
| D | 5 | 4.849 | -0.116 | 0.588 | -0.075 |
| E | 20 | 1.915 | 0.389 | 0.492 | 0.695 |
| A+C | 21 | 1.545 | 0.401 | 0.423 | 0.528 |
| B+D | 12 | 2.905 | 0.177 | 0.524 | 0.181 |
| C+D+E | 32 | 1.765 | 0.395 | 0.527 | 0.606 |
| C+D | 12 | 0.208 | 0.586 | 0.524 | 0.479 |
| B+E | 27 | 2.290 | 0.316 | 0.541 | 0.546 |
| A+C+E | 41 | 1.799 | 0.384 | 0.480 | 0.616 |
| B+D+E | 32 | 2.192 | 0.320 | 0.575 | 0.501 |

Table 3. (Continued)

3.3 Magnitude vs Length times Displacement: Log LD = a+bM

| Fault set | Number in set | a | b | Standard deviation | Correlation coefficient |
|---|---|---|---|---|---|
| 1-49 | 19 | -1.882 | 0.930 | 0.779 | 0.788 |
| 50-140 | 29 | -1.681 | 0.880 | 0.724 | 0.534 |
| 1-140 | 48 | -1.695 | 0.890 | 0.750 | 0.699 |
| A | 14 | -2.352 | 0.967 | 0.742 | 0.672 |
| B | 6 | -5.183 | 0.675 | 0.560 | 0.461 |
| C | 6 | -5.855 | 1.507 | 0.322 | 0.750 |
| D | 5 | 4.738 | -0.073 | 0.868 | -0.032 |
| E | 17 | -1.871 | 0.950 | 0.719 | 0.828 |
| A+C | 20 | -2.705 | 1.033 | 0.670 | 0.681 |
| B+D | 11 | 0.975 | 0.475 | 0.735 | 0.333 |
| C+D+E | 28 | -1.898 | 0.941 | 0.733 | 0.755 |
| C+D | 11 | -0.706 | 0.754 | 0.733 | 0.324 |
| B+E | 23 | -1.405 | 0.858 | 0.752 | 0.758 |
| A+C+E | 37 | -2.191 | 0.976 | 0.704 | 0.773 |
| B+D+E | 28 | -1.386 | 0.848 | 0.799 | 0.708 |

3.4 Magnitude vs Length times square of Displacement: Log $LD^2$ = abM (see fig. 4)

| Fault set | Number in set | a | b | Standard deviation | Correlation coefficient |
|---|---|---|---|---|---|
| 1-49 | 19 | -6.094 | 1.546 | 1.152 | 0.821 |
| 50-140 | 29 | -4.912 | 1.366 | 0.985 | 0.585 |
| 1-140 | 48 | -5.701 | 1.479 | 1.057 | 0.755 |
| A | 14 | -7.013 | 1.656 | 1.122 | 0.717 |
| B | 6 | -4.410 | 1.218 | 0.796 | 0.550 |
| C | 6 | -5.236 | 1.466 | 0.552 | 0.541 |
| D | 5 | 4.626 | -0.030 | 1.161 | -0.010 |
| E | 17 | -6.206 | 1.583 | 0.984 | 0.874 |
| A+C | 20 | -7.140 | 1.692 | 1.005 | 0.713 |
| B+D | 11 | -0.577 | 0.718 | 1.010 | 0.362 |
| C+D+E | 28 | -5.966 | 1.544 | 0.994 | 0.812 |
| C+D | 11 | -1.054 | 0.840 | 0.977 | 0.275 |
| B+E | 23 | -5.580 | 1.461 | 1.033 | 0.821 |
| A+C+E | 37 | -6.517 | 1.614 | 1.000 | 0.818 |
| B+D+E | 28 | -5.347 | 1.425 | 1.085 | 0.778 |

Table 3. (Continued)

3.5 Displacement vs Length: Log D = a+bLog L (see fig. 5)

| Fault set | Number in set | a | b | Standard deviation | Correlation coefficient |
|---|---|---|---|---|---|
| 1-49 | 19 | -4.264 | 0.951 | 0.545 | 0.715 |
| 50-140 | 42 | -1.190 | 0.350 | 0.319 | 0.510 |
| 1-140 | 61 | -2.239 | 0.558 | 0.469 | 0.552 |
| A | 20 | -3.136 | 0.774 | 0.420 | 0.668 |
| B | 8 | 0.151 | 0.035 | 0.355 | 0.040 |
| C | 7 | 0.197 | 0.041 | 0.300 | 0.060 |
| D | 5 | -1.640 | 0.451 | 0.149 | 0.872 |
| E | 21 | -3.266 | 0.751 | 0.545 | 0.641 |
| A+C | 27 | -2.391 | 0.601 | 0.418 | 0.578 |
| B+D | 13 | -0.936 | 0.281 | 0.310 | 0.420 |
| C+D+E | 33 | -2.288 | 0.556 | 0.494 | 0.567 |
| C+D | 12 | -0.966 | 0.287 | 0.269 | 0.536 |
| B+E | 29 | -2.528 | 0.606 | 0.531 | 0.544 |
| A+C+E | 48 | -2.709 | 0.654 | 0.489 | 0.594 |
| B+D+E | 34 | -2.181 | 0.537 | 0.502 | 0.541 |

## Magnitude related to displacement

The plot of the relation between maximum surface displacement and earthquake magnitude (figure 2) shows less scatter of the data points than any of the other graphs. This is evident from visual comparison of the graphs and is supported by the correlation coefficients, listed in table 3.1, which are generally higher for this relation than for the others. The correlation between displacement and magnitude is especially good for strike-slip faults and the correlation coefficient for them is the highest of the 75 listed in table 3. Chinnery (1969) also found a high correlation between displacement and magnitude for strike-slip faulting.

For the historic faulting included in this report, the lines of best fit for strike-slip faults, normal-slip faults, all fault types in North America (set 1-49), and all fault types in the world (set 1-140) are very similar, as can be seen on figure 2. The line for reverse-slip faults is conspicuously different from the others, perhaps because of the small number of examples (7) in the set.

## Magnitude related to length

The relation between length of surface rupture and magnitude of the associated earthquake is shown in table 3.2 and on figure 3. The correlation is a poor one as shown by the scatter of points and the low correlation coefficients, the highest of which is less than 0.7. These low correlation coefficients indicate that only 49 percent (0.7x0.7x100) or less of the variation in logarithm of fault length may be accounted for by the variation in the earthquake magnitude (Freund and Williams, 1958, p. 315).

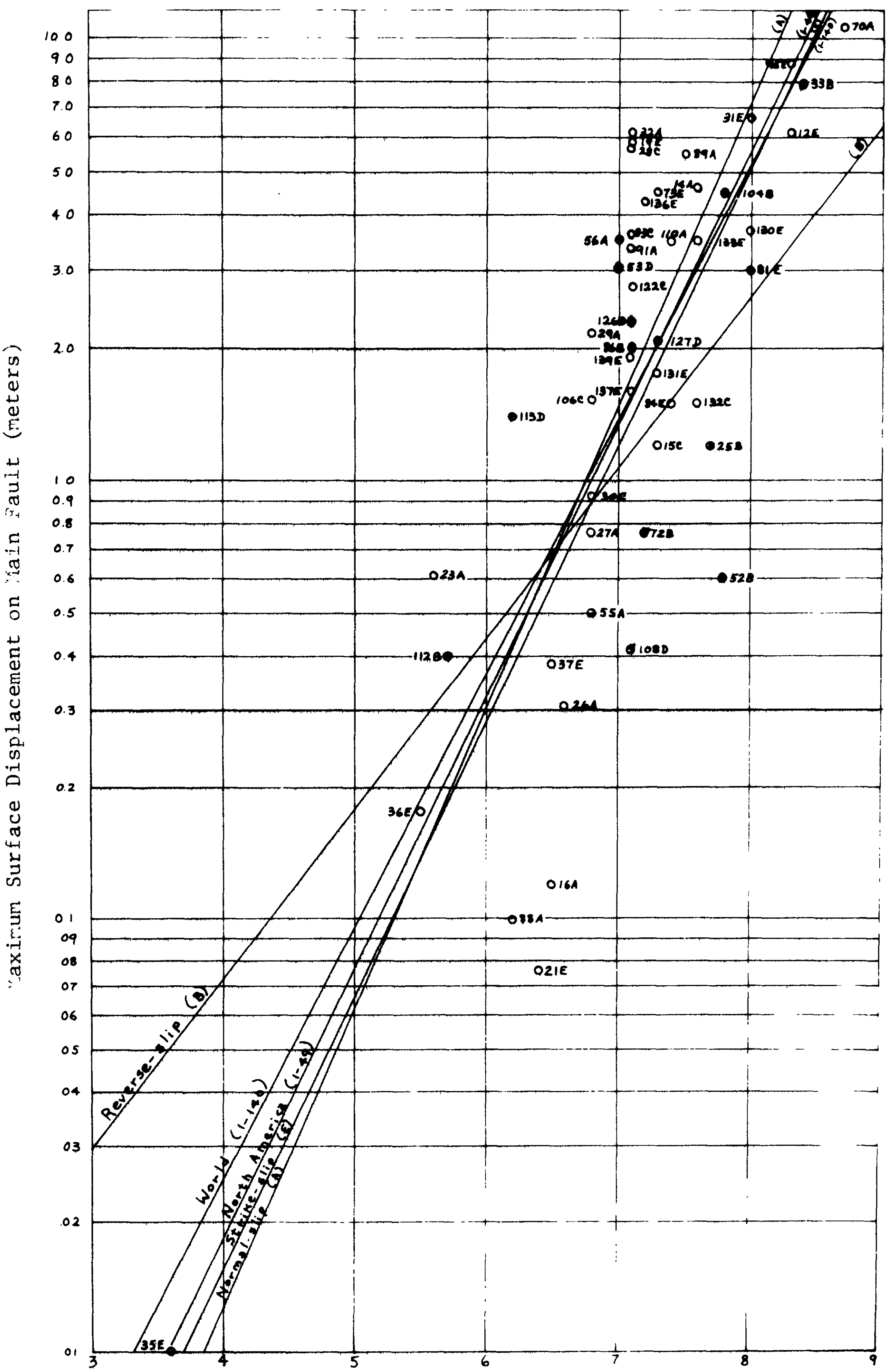


Figure 2. MAXIMUM SURFACE DISPLACEMENT ON MAIN FAULT AS RELATED TO EARTHQUAKE MAGNITUDE

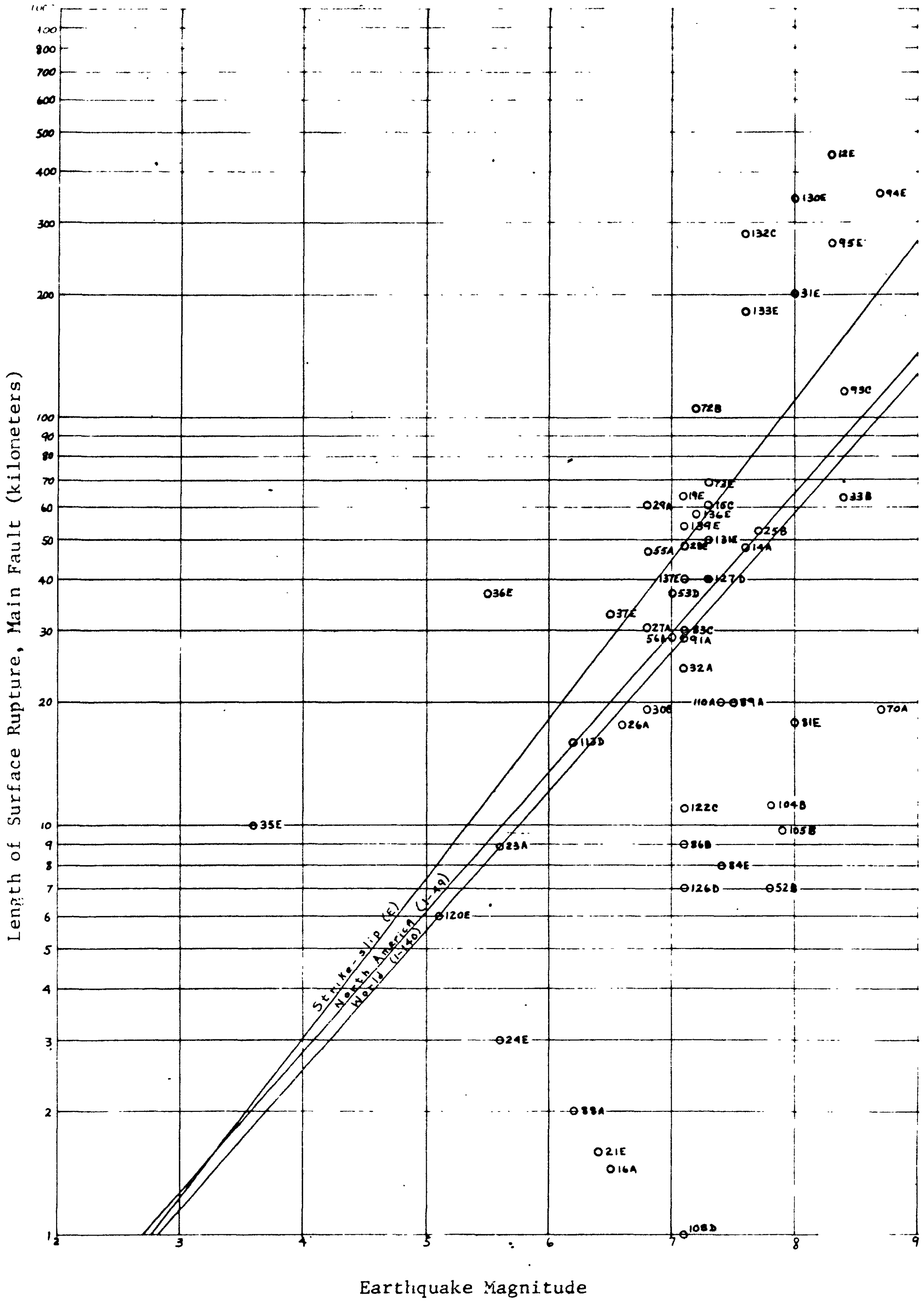


Figure 3. LENGTH OF SURFACE RUPTURE ON MAIN FAULT AS RELATED TO EARTHQUAKE MAGNITUDE

## Magnitude related to $LD^2$

The relation of magnitude to the product of length and the square of displacement, recently studied by King and Knopff (1968), is given in table 3.4 and shown on figure 4. The correlation coefficients generally are moderately high, approaching those obtained for the relation between magnitude and displacement. Although the line for reverse-slip faults is drawn on figure 4, it must be used with caution inasmuch as the correlation coefficient is only 0.55.

## Displacement related to length

A poor correlation exists between the maximum surface displacement and the length of surface rupture. This is illustrated by the scatter of points on figure 5, and is indicated by the generally low correlation coefficients listed in table 3.5. Of the lines drawn on figure 5, only that representing North America has a correlation coefficient greater than 0.7. The wide scatter of points should be kept in mind if any of these lines are used.

## Variations of fault parameters by type of fault

One of the aims of this study is to learn whether the relations among fault length, displacement, and associated earthquake magnitude differ according to the type of faulting that occurs. Although an analysis of this aspect of the data is still very incomplete, a few contrasts and similarities were noted and are given below without attempting, at present, to evaluate their significance or possible causes.

For 4 of the 5 relations listed in table 3, the strike-slip faults (set E) display the most consistent groupings, as judged by the correlation coefficient. The one exception is for the relation between displacement and length, in which the reverse-oblique slip faults (set D) have the highest correlation coefficient. The line for strike-slip faults has a steeper slope (constant "b") and a lower value of the constant "a" than the line for all faults (set 1-140) on all of the graphs.

The normal-slip faults (set A) have a moderate to low correlation coefficient on all plots, with values ranging from 0.761 to 0.418. The slope of the line for normal-slip faults is greater than, and the "a" values are less than, the line for all faults (set 1-140) on all plots except figure 3 (magnitude related to length).

Owing to the small number of examples and the scatter of the points for reverse slip (set B), normal oblique slip (set C), and reverse oblique slip (set D) faults, little can be said about them. Most of the correlation coefficients are very low and some of the lines of best fit for set D even have a negative slope, indicating an inverse correlation. Nevertheless, the slope of the line for reverse faults (set B) is consistently lower than for all faults (set 1-140), and the "a" values, with one exception, are greater than for all faults; these relations are opposite to those for normal faults.

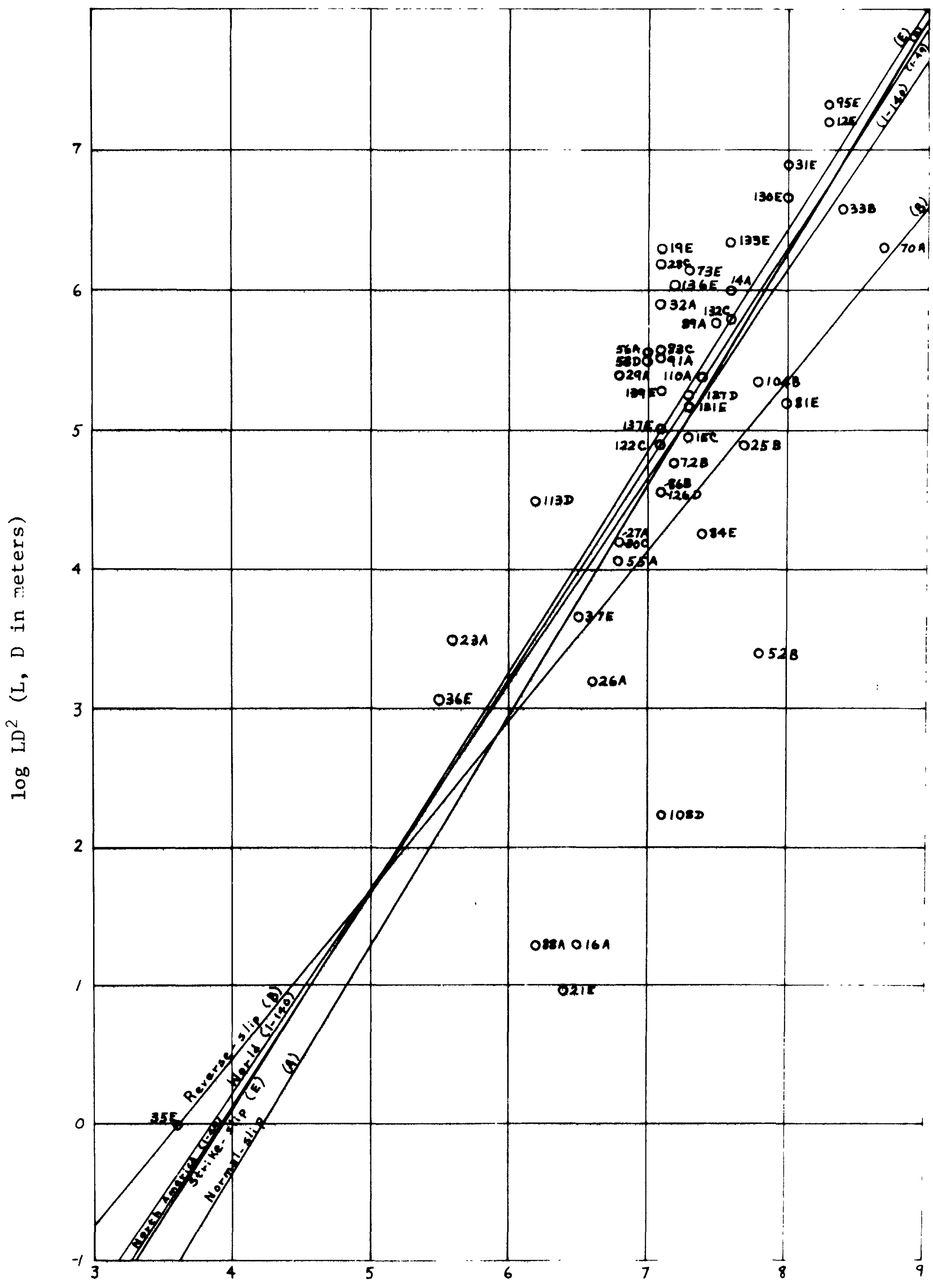


Figure 4. RELATION OF EARTHQUAKE MAGNITUDE TO SURFACE LENGTH TIMES SQUARE OF SURFACE DISPLACEMENT

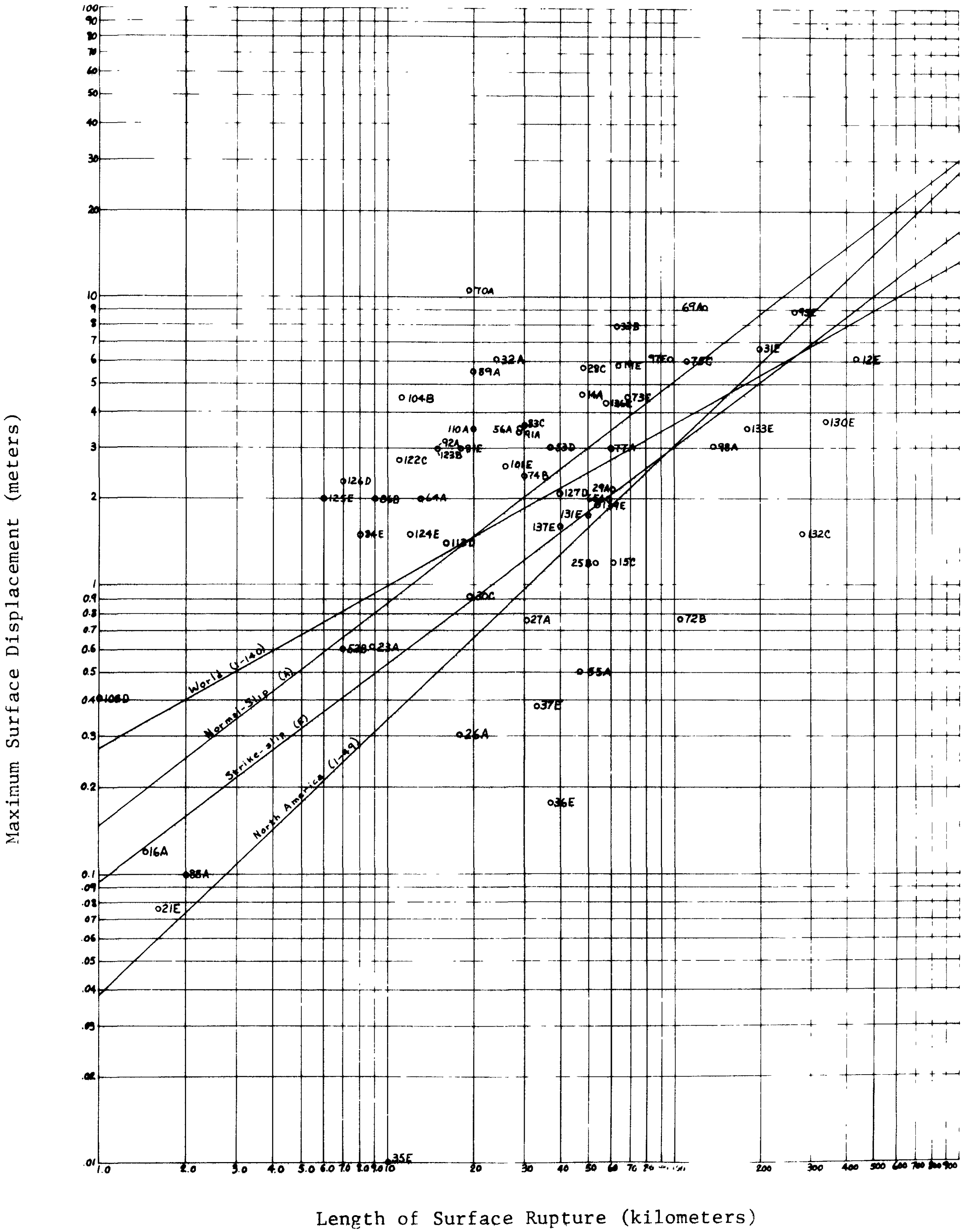


Figure 5. MAXIMUM SURFACE DISPLACEMENT AS RELATED TO LENGTH OF SURFACE RUPTURE ON MAIN FAULT

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