UNITED STATES DEPARTMENT OF THE INTERIOR

GEOLOGICAL SURVEY

PRELIMINARY SLIP-RATE TABLE AND MAP OF LATE-QUATERNARY FAULTS OF CALIFORNIA

by

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Open-File Report 84-106

Foreword

This preliminary table and map summarize late-Quaternary slip rates for faults of California. Although we concentrate on slip during the last 100,000 years or less, we include older slip rates for some faults where no reliable younger rates have been measured. We exclude current creep rates in this edition because our initial focus is on geologic, rather than geodetic, data.

Our intent is to be both informative and judgmental. We have tried to supply original data, crucial assumptions, and our evaluations of uncertainty. Individual compilers, identified by initials, are responsible for their entries in this table. They have studied, interpreted, and evaluated the original data for their entries. Users of this table should recognize and take into account both the large variations in quality of original data and the wide range in emphasis and style between different compilers of this first edition.

Users of this table must recognize its limitations. Many of the rates given here are provisional. Some will be changed as better or more representative measurements are made. Other faults with known Holocene displacement or historic faulting (for example, Hayward, Calaveras, Maacama, Mannix) do not appear in this table because no late-Quaternary slip rates have yet been measured.

We have included several sites in the Mojave Desert that show topographic evidence of late-Quaternary displacement (scarps in alluvium, depressions), but for which the only measured offsets are older than 2 m.y. The resulting rates for these sites are accurate for late-Quaternary time only if slip rates have been uniform over a much longer time, which is an untested assumption.

We intend this report to evolve by successive editions as new data and interpretations accumulate and as we discover overlooked or incorrect information. Although we intend to keep the individual viewpoint of identified compilers as part of this table in future editions, we also will strive for more consistent and uniform treatment of entries in the table than is evident in this edition. We urge users to send us new information, corrections, and omissions.

The following paragraphs explain the columns used in the table.

The first two columns of the table, Map Location and Fault refer to site locations shown on the accompanying map, which has been divided into broad physiographic provinces with locally arbitrary boundaries drawn for convenience. The provinces are listed alphabetically in the table by two-letter code (see map). Within provinces, faults are listed alphabetically by three-letter code, with a different two-digit number for each slip-rate site, north to south, along that fault. For example site designations NC FRJ 01 through 05 refer to North Coast Ranges province (NC), Frijoles fault (FRJ), sites 01 through 05. So far, the San Andreas is the only fault with slip-rate sites in more than one province. Many fault names are informal; some faults are unnamed.

Location refers to a place name at or near the slip-rate site. Latitude/Longitude are given for the site; for sites that have large horizontal offset, latitude/longitude are centered in the offset. Fault strike is average for the vicinity of the site.

We designate the Style (where possible) of each fault (strike-slip, dip-slip or oblique-slip) as defined in the footnotes on each page of the table. Right-vertical (RV) and left-vertical (LV) faults are vertical faults with significant and consistent components of both vertical and horizontal slip. We also recognize that many strike-slip faults have a minor and generally variable vertical component of slip. For some faults our assignment to one or the other of these categories is tentative, and may change with more information.

The horizontal and vertical components of dip-slip, D, (H_d and V), and of total slip, T, (H_d, H_s, and V), are defined in the block diagram in the footnotes to the table. We give all available reported and calculated values; however, for some sites, not all components have been measured. At these places, reported slip rates are incomplete and may be less than the true slip rate.

Slip and Age of Offset are reported or estimated by us from original data as minimum, mn, and maximum, mx, values, wherever possible. These minima and maxima represent our estimates of reasonable limits, and we think they yield the most realistic range of slip rates for a site. We derived them in various ways from original data and site descriptions, both published and unpublished. Although we have tried to apply uniform criteria to this task, accuracy of these tabulated limits may vary greatly from site to site.

Where original data are insufficient to estimate minima and maxima, we report qualified best values according to the following scheme: E, either our best estimate or the measured value; ranges not available. P, published value, ranges not given. S, minimum and maximum within the accuracy of the given value, assumed to be ± about one significant figure in the reported value (for example, ST IMP 01 has a reported horizontal component of slip of 6.0 m, which we assume to mean 6.0 ± .1 m). U, the minimum or maximum value is unknown.

Slip and Age of offset refer to total displacement and time elapsed from some time in the past up to the present, except where age entries are marked with a star(*). Starred values of age indicate that age, slip, and rate for that site apply to a period that ends before the present. For example at site NC SAN 90, Age of offset of a stream channel is given as "*.94-1.2," which means that it took more than 940 years and less than 1200 years for the reported slip to accumulate during some period in the past (at this site, roughly from 1100 yrs. B.P. to 1906).

The extreme values of slip and age of offset feature are combined to give the probable range of Slip rate for a site, presented as minimum, mn, and maximum, mx. In addition, we may give a preferred value, pf, of Slip rate, which represents the informed judgment of the individual compiler for that entry in the table, unless identified as the preferred value of the quoted source.

Slip rates based on the last few thousand years and which include historic or prehistoric earthquakes of large displacement are unusually sensitive to assumptions and errors related to dates. Hence for our estimates of minimum and maximum slip we assume that a dated feature that marks the beginning of such a slip-rate period may have formed either immediately before or after a large earthquake. When we assume such a feature formed before a large earthquake, we subtract slip associated with the latest earthquake from the total slip for that period, in order to start and stop the period at the same point on an assumed strain-release cycle. In both cases we eliminate time after the last large earthquake (for example, after 1857 on the San Andreas fault; see SAN 45 and 46), because subsequently accumulated strain may not have been released as slip. Our objective with these tactics is to increase the probability that we will bracket both the range of true short-term slip rates and the average late-Quaternary slip rate. (An alternative method used in some publications cited in this table is to include the slip of the latest event and add an average recurrence interval to the date of the last event).

Feature offset includes a wide range of geologic, biologic, and cultural features whose displacement by faulting can be measured or estimated and dated.

Method of age estimation lists the principal technique or techniques used for each entry, whether by direct determination of age of offset, or by correlation of a layer or rock unit associated with the offset to a dated feature elsewhere.

Each compiler has made a qualitative, subjective evaluation of uncertainty in the slip (U_s) and age (U_a) estimates. This evaluation ranges from A (small uncertainty, widely accepted values, sound assumptions) to D (major uncertainty, controversial values, speculative or tenuous assumptions), as explained in the footnotes to the table. The boundaries between these categories are obviously fuzzy. We also recognize that each compiler brings different biases to these evaluations, yet one of the most important elements of this table is the informed opinion of reliability that we assign to the rate.

Note that enlarging the range between minimum and maximum values will reduce the uncertainty (for example, change C to B) that we have bracketed the true value. Hence some entries have A or B uncertainties merely because the estimated minimum and maximum are very far apart. Furthermore, users should recognize that compilers conservatively assign greater uncertainties to measurements that are poorly documented or unfamiliar to them.

References and Comments are designed to allow users to evaluate the original data from which the rates are derived, and the methods by which we or the quoted source arrived at the slip rates. Our intent is to supply enough information here so users can find out how we got the rates and estimated their uncertainties.

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