# RECENCY OF FAULTING: A WIDELY APPLICABLE CRITERION FOR ASSESSING THE ACTIVITY OF FAULTS[I]

by

Joseph I. Ziony, Carl M. Wentworth, and Jane M. Buchanan[II]

## SYNOPSIS

The age of the most recent displacement of faults is commonly the best available criterion for estimating activity of faults in a region because data on recurrence intervals, seismicity, or strain accumulation are not uniformly available. Maps that summarize the stratigraphic and topographic evidence for the time of latest movement along individual faults provide a direct and consistent means of comparing the relative activity of faults and hence are valuable for engineering and land-use planning purposes.

## INTRODUCTION

The U.S. Geological Survey, on behalf of the U.S. Atomic Energy Commission, is preparing 1:250,000-scale maps of coastal California that systematically portray what is known about the recency of displacement along each mapped fault ([1],[2],[3]). Although primarily directed toward the safe siting of nuclear power reactors, the maps can be used for many types of land-use planning.

## SIGNIFICANCE OF RECENCY OF FAULTING

Few adequate geologic or geophysical criteria are available for a systematic appraisal of the potential for earthquakes or ground displacements along faults in a region. Recurrence intervals, for example, are known only crudely for a few faults in the world. Similarly, neither instrumentally determined strain accumulation nor a sufficiently long seismic record are available for most faults.

The age of latest displacement of a fault is an index of activity that, unlike these other criteria, can be applied consistently to a regional study of faults. Within the limits of the preserved geologic record, the recency of movement can be approximated for each fault from stratigraphic and/or topographic relations, and the ages of latest movement along individual faults compared. Those faults with the more recent displacements are more likely to be active and to have a higher rate or frequency of movement. Where available, data on strain accumulation or recurrence interval can be used to supplement age of latest displacement.

## DETERMINATION OF AGE OF LATEST FAULTING

The age of latest movement of a fault (other than historic offsets) must be inferred indirectly from geologic evidence that provides limits

---

[I] Publication authorized by the Director, United States Geological Survey

[II] Geologists, United States Geological Survey, Menlo Park, California

on the span of geologic time within which the movement occurred. This time span may range from hundreds to even millions of years, depending on the preserved geologic record of the region. Obviously, shorter time spans are the most useful for accurately determining recency of faulting.

Observed relations between a fault and adjacent rock (or sediment) units can be used to define maximum and minimum limits on the latest movement (Figure 1). The most recent displacement must postdate the youngest faulted rock along a fault and must predate the oldest unfaulted rock that is deposited across or is intruded along the fault. In many places, however, the preserved stratigraphic record, except for modern alluvium, provides no minimum limit on time of faulting. The presence of groundwater discontinuities within thick alluvium may be used to infer indirectly fault offset of at least the lower part of that alluvium. Fault-produced topographic features such as scarps and closed depressions are an additional means for determining the time of latest fault movement because the age of the most recent offset can be no older than the age of the fault-produced topography.

The length of the time interval that spans the latest displacement is a function of several factors: completeness of the existing geologic record along a fault, quality of age control for the limiting stratigraphic units or faulted topography, and the ability to discern critical geologic relations from natural or artificial exposures.

## NATURE OF MAPS SHOWING RECENCY OF FAULTING

Each fault on these maps is classed according to the time span containing its youngest known movement and is so designated by either color or letter codes. The geologic limits on the most recent movement are represented by color- or numeral-coded symbols (described in Figure 1) placed on the fault trace at the point of control. Figure 2 is an example of a map showing recency of faulting, annotated to indicate the kind of information that can be deduced from it.

The classification of time spans selected depends on the nature of the available geologic record and the probable usefulness of a class in assessing activity. In coastal southern California, faults are assigned to one of eight classes on the basis of the youngest <u>known</u> evidence of late Cenozoic faulting (Figure 3). Seven of the eight classes enclose progressively longer spans of time within which offset may have occurred. For example, the latest movement of a fault classed "P" (late Pliocene and Quaternary) could have occurred at any time within the last 5 million years if no younger unfaulted strata are preserved. The time span containing the latest displacement may be restricted further by unfaulted overlying deposits indicated on the map by minimum control symbols. Faults lacking evidence of late Cenozoic displacement are designated unknown unless positive evidence exists that they have not moved for at least 12 million years, in which case they are classed pre-late Cenozoic.

## APPLICATION OF MAPS

Faults of a region can be ranked according to likelihood of future movement on the assumption that those with the most recent displacements probably have relatively short recurrence intervals. Selection of those faults considered to be active, and thus requiring more detailed site investigations, must be influenced by the consequences of possible displacement on the engineering works involved. For example, all faults in the region with proved or likely movement during late Quaternary time (past 500,000 years) may be considered active for purposes of siting nuclear power reactors and other structures that require large safety factors, whereas many such faults might not be considered active for less critical land uses.

## REFERENCES


1. Wentworth, C. M., Ziony, J. I., and Buchanan, J. M., 1970, Preliminary geologic environmental map of the greater Los Angeles area, California: U.S. Geol. Survey TID-25363, 41 p., table, 1:250,000 scale map; issued by U.S. Atomic Energy Comm.
2. Ziony, J. I., and Buchanan, J. M., 1972, Preliminary report on recency of faulting in the greater San Diego area, California: U.S. Geol. Survey Open File Report, 16 p.
3. Ziony, J. I., Wentworth, C. M., Buchanan, J. M., and Wagner, H. C., 1973, Preliminary map showing recency of faulting in coastal southern California, U.S. Geol. Survey Misc. Field Studies map (in press).


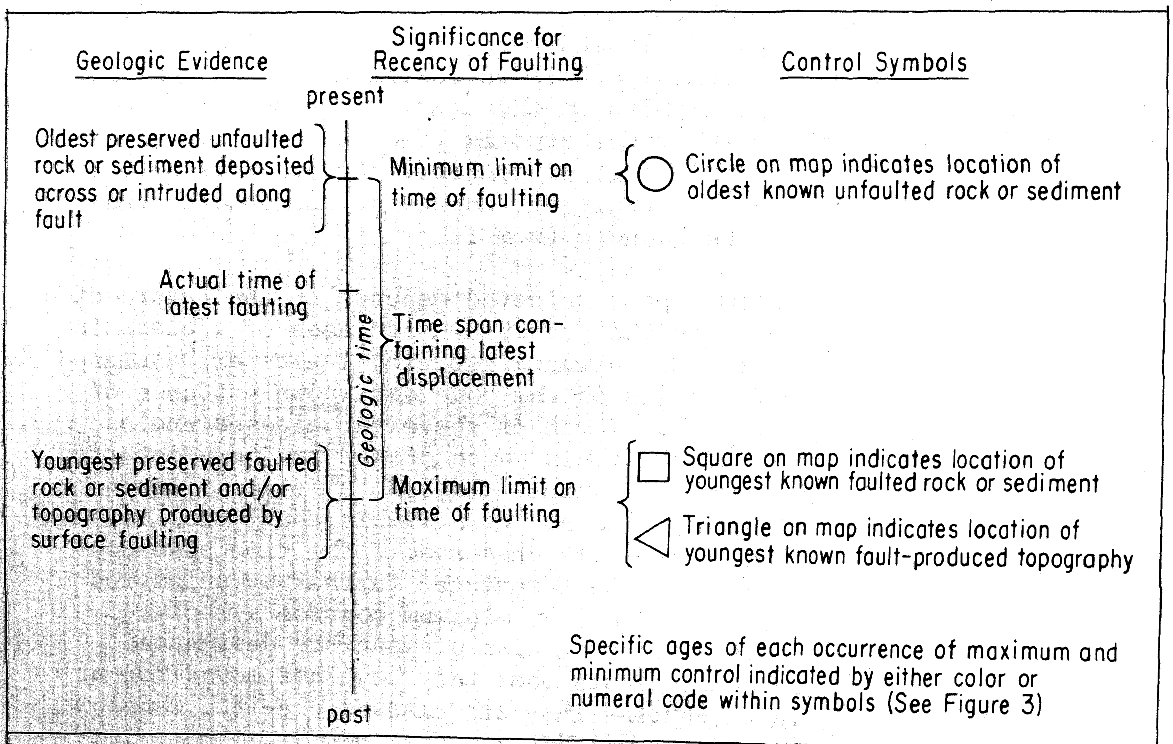


FIGURE 1 - Basis for determination of recency of faulting: available geologic limits on time of latest displacement of a fault, and symbols used to show that control on a map.

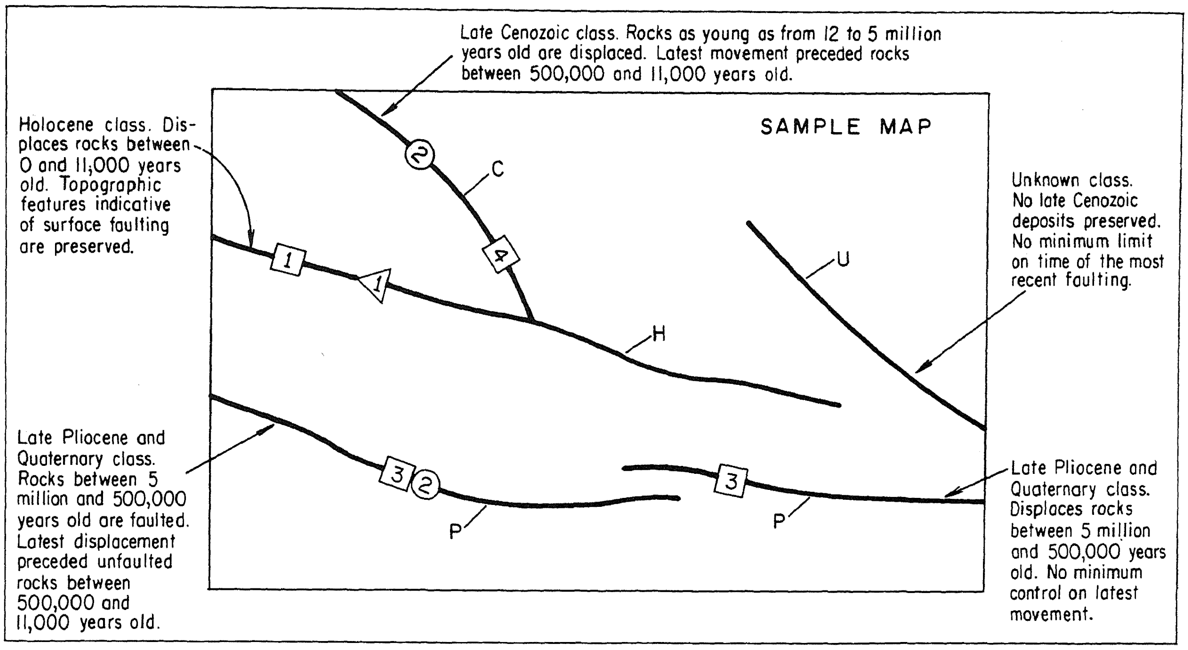


FIGURE 2 - Example of map showing recency of faulting. Letter and numeral symbols keyed to Figure 3.

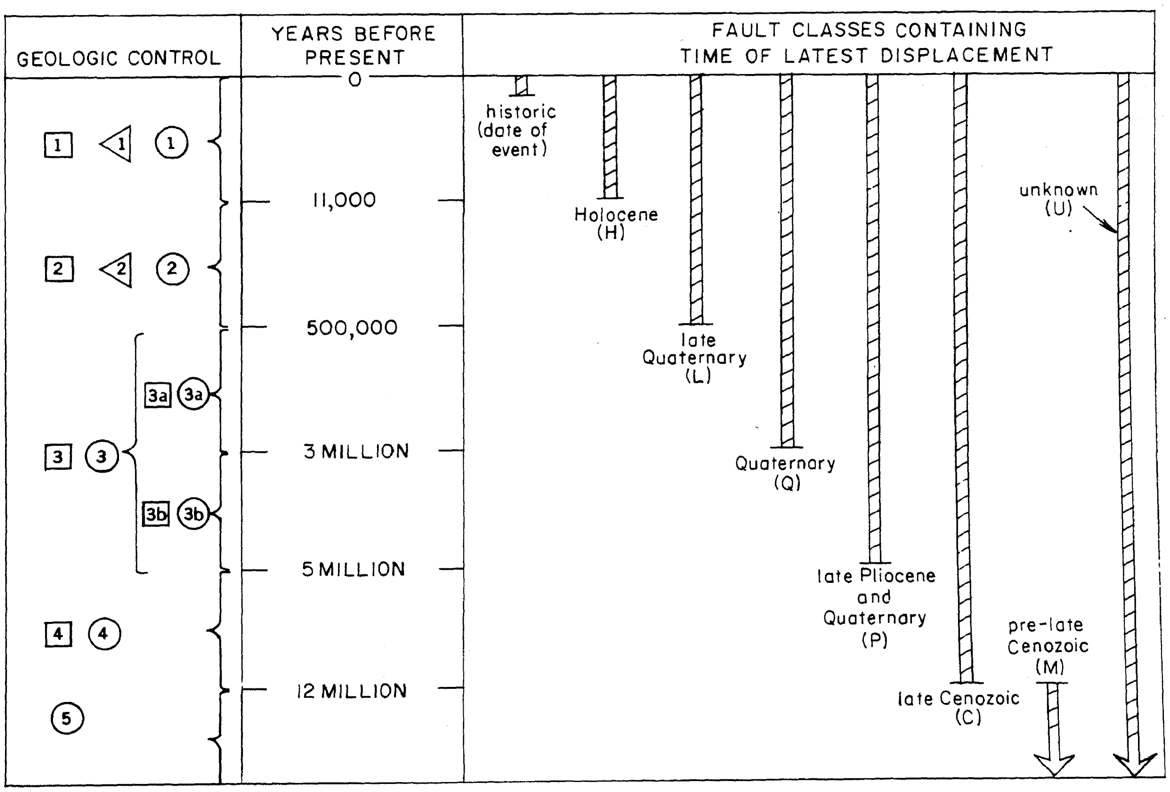


FIGURE 3 - Chart showing age ranges of geologic control and of recency-of-faulting classes for coastal southern California. Ages in years approximate. Column not to scale.