WESTERN STATES SEISMIC POLICY COUNCIL
POLICY RECOMMENDATION 18-3

Definitions of Recency of Surface Faulting for the Basin and Range Province

Policy Recommendation 18-3

WSSPC recommends that each state in the Basin and Range physiographic province (BRP), through consultation with state and federal geological surveys and other earthquake-hazard experts, define scientifically and societally relevant categories for recency of surface faulting (generally earthquake magnitude ≥**M** 6.5).

WSSPC further recommends that in the absence of information to the contrary, all Quaternary faults be considered to have the recency of activity documented in the USGS Quaternary fault and fold database until more adequate data can be developed.

Executive Summary

Fault recency definitions are limited to the Quaternary because this period of geologic time is considered by the scientific community to be most relevant to paleoseismic studies of earthquake faults (Machette and others, 2004). The recency class of a fault is the youngest class based on the demonstrated age of most recent surface faulting. Latest Pleistocene-Holocene faults are included within the definition of late Quaternary faults, and both latest Pleistocene-Holocene and late Quaternary faults are included in Quaternary faults.

Establishment/definition of surface-faulting recency categories are based on the ways that faults are portrayed on geologic maps and on the availability of geologic data in the BRP. Policy makers (owners, regulators, governmental agencies) should consult with state and federal geological surveys and other earthquake-hazard experts in using these recency categories and additional geologic data in developing definitions of hazardous faults to be considered in planning for development or infrastructure projects.

Examples of categories that are applicable for much of the BRP include the following:

Latest Pleistocene-Holocene fault – a fault whose movement in the past 15 ka has been large enough to break the ground surface.

Late Quaternary fault – a fault whose movement in the past 130 ka has been large enough to break the ground surface.

Quaternary fault – a fault whose movement in the past 2.6 Ma (Cohen and Gibbard, 2010) has been large enough to break the ground surface.

Background

The BRP is a large extensional to transtensional tectonic domain that contains thousands of normal-slip and a lesser number of strike-slip Quaternary faults involved in geologically recent deformation. Large earthquakes in the BRP, especially those associated with surface rupture, have occurred on faults with a wide range of recurrence intervals (time between successive surface-faulting earthquakes) and times since their most recent surface-faulting earthquakes. Many of the historic surface-faulting earthquakes in the BRP have ruptured multiple, distributed strands at the surface, which in some cases had significantly different geologic histories.

The tectonic behavior of Quaternary faults in the BRP differs from the more localized, higher slip-rate, chiefly strike-slip tectonics typical of plate boundary systems. These differences may warrant different approaches within the WSSPC region when categorizing recency of surface faulting. The examples of fault recency categories in this policy recommendation are considered appropriate for much of the BRP within the WSSPC region, and depend on whether the fault offsets, or is covered by, geologic materials of different ages. The recency categories are described in more detail below.

A **latest Pleistocene-Holocene** criterion (≤15 ka) for recency of faulting is based upon recognition of faulting in deposits known to be ≤15 kyr old that are widespread over much of the BRP. These deposits are chiefly associated with the last glacial maximum, and with large, well-dated pluvial lakes such as Lake Bonneville and Lake Lahontan. The deposits possess distinctive stratigraphy and geomorphology that can be reliably recognized by geologists without recourse to costly dating techniques. The latest Pleistocene-Holocene criterion conforms to usage in the U.S. Geological Survey Quaternary Fault and Fold Database of the United States (*http://earthquake.usgs.gov/hazards/*). However, because major historical earthquakes have occurred in the BRP on faults that do not show surficial evidence of previous latest Pleistocene-Holocene activity, the latest Pleistocene-Holocene span of 15 kyr is too short to encompass the range of average earthquake recurrence intervals on faults in the BRP.

A **late Quaternary** criterion (≤130 ka) for recency of faulting uses the onset of the Sangamon interglacial period as a datum and spans many of the average fault recurrence intervals in the BRP. All but possibly one of the historical surface-faulting earthquakes in the BRP (1887 Sonoran earthquake; Bull and Pearthree, 1988; Suter and Contreras, 2002) occurred on faults that show evidence of late Quaternary activity.

The **Quaternary** criterion (≤2.6 Ma) for recency of faulting represents the onset of a major climatic change to the current cycle of glacial/interglacial intervals, during which most of the surficial deposits and much

of the present landscape formed in the BRP. All historical surface-faulting earthquakes in the BRP occurred on faults that show evidence of Quaternary surface faulting. The Quaternary recency of activity criterion encompasses the average recurrence interval for essentially all faults that might produce future surface-faulting earthquakes (≥**M** 6.5) in the BRP.

Recency of Faulting, Fault Activity, and Seismic Hazard

The examples of recency of faulting categories in this policy recommendation are intended to fulfill the needs of a broad spectrum of users involved in evaluating and regulating/mitigating earthquake hazards in the BRP. Categories based on recency of faulting use easily obtained observational data and, as such, represent a first step toward defining fault activity or seismic hazard associated with faults. Future large, surface-rupturing earthquakes in the BRP most likely will occur on faults that display evidence of prior surface faulting during the late Quaternary (≤130 ka), and almost certainly on faults that display evidence of prior faulting in the Quaternary (≤2.6 Ma). Evaluation of fault activity and seismic hazard should consider timing of the most recent surface-faulting earthquake, and a well-constrained average recurrence interval and/or slip rate spanning multiple paleoearthquake cycles (McCalpin, 2009). Whether a fault within a particular recency category constitutes a hazard or not depends on the time frame of concern, the elapsed time since the most recent event, and the size and frequency of future earthquakes.

Appropriate recency of faulting criterion allow policy makers to develop guidelines for identifying potential surface-rupture and ground-motion sources and evaluate the seismic hazards they present to specific communities and infrastructure. Elapsed time since the most recent large earthquake and average earthquake recurrence intervals are critical parameters when determining fault activity, but those data must be evaluated in conjunction with other considerations related to type of facility, societal constraints (level of acceptable risk); and goals, costs, and benefits of risk reduction (Lund and others, 2016) when assessing seismic hazard. It is then up to policy makers in each state to decide what recency category constitutes a hazardous or active fault and what level of seismic risk is acceptable.

References

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