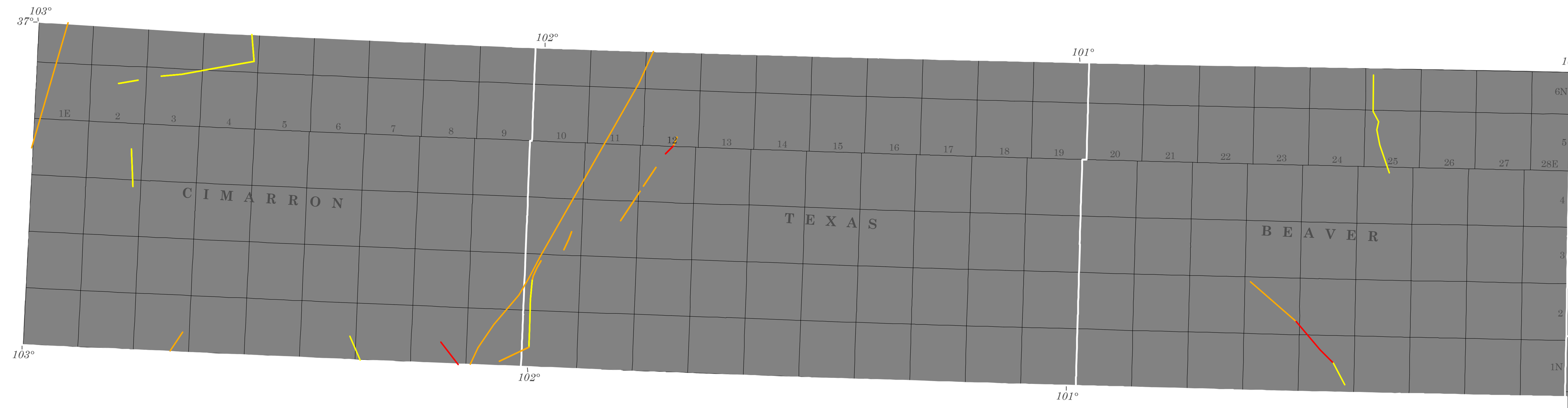

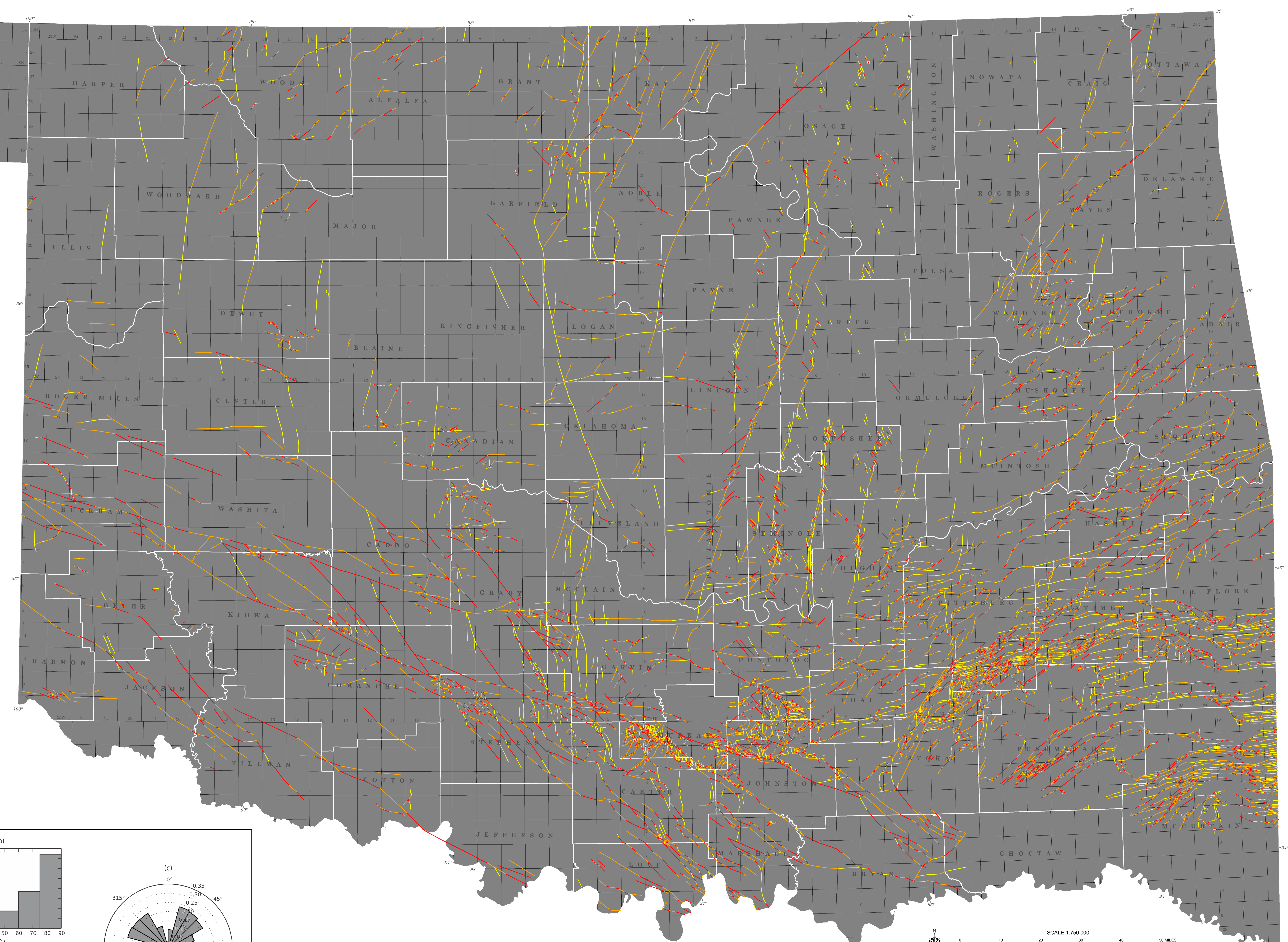

EXPLANATION

Fault Orientation (Azimuth):

- Optimal
  [45°–60°, 105°–120° and 135°–150°]
- Moderately Optimal
  [15°–45°, 60°–75°, 90°–105°, 120°–135°]
- Sub-Optimal
  [0°–15°, 75°–90° and 150°–180°]

Summary

This work is an extension of Holland (2013) and is considered preliminary as our focal mechanism database and fault database (Holland, 2015) continue to be updated as more information becomes available.

Six hundred and eighty-eight focal mechanisms were calculated between 2010 and 2015 and used to determine optimally oriented fault orientations within Oklahoma. Focal mechanisms characterize the direction of slip and the orientation of a fault and are calculated from seismic waveforms recorded on seismometers within and near Oklahoma. Identifying optimal fault orientations (those likely to have an earthquake within the contemporary stress field, N85°E) is important for determining the potential earthquake hazard of both naturally occurring and triggered seismicity.

The majority of the focal mechanism solutions used in this publication were computed using earthquakes occurring in central and north-central Oklahoma, a region where the greatest number of earthquakes has occurred. The focal mechanisms used in this compilation include Regional Moment Tensor solutions and first-motion focal mechanisms (Holland, 2013; Darold et al., 2015). First-motion focal mechanisms provide two possible fault plane solutions for every earthquake. These fault plane solutions are referred to as nodal planes. The probability density functions (PDFs) for fault azimuths were calculated with 15° bins for both possible nodal planes associated with the observed focal mechanisms.

The contemporary stress, maximum horizontal stress ($s_h$max) orientation of N85°E, was determined from the orientation of the Pressure-axis and Tension-axis (P- and T-axes) of the focal mechanisms used, following the method of Zoback (1992). Focal mechanisms represent the stress orientation at the hypocenter of the earthquake and the stress orientation governs the direction of slip on the fault. We determined a mean $s_h$max of 83.2° with a standard deviation of 21.3° azimuth. The median $s_h$max is 84.8° with 633 observations (Inset 1).

The PDFs show the majority of focal mechanisms express slip on steeply dipping faults with dips greater than 75° (Inset 2a). The distribution of rake is consistent with these findings and shows that strike-slip motions are the primary source mechanisms (Inset 2b). The PDFs are determined by dividing the number of nodal plane orientations in each bin by the total number of nodal plane orientations and the number of degrees in each bin.

From the PDFs, it is possible to define orientations of optimal, moderately optimal and sub-optimal fault strikes (Inset 2c). The focal mechanism distribution is dominated by strike-slip motion on steeply dipping faults and thus fault strike is restricted to the range of 0° to 180° (Inset a). Optimal orientation ranges between 45°-60°, 105°-120° and 135°-150° and represent fault orientations most likely to have an earthquake. Moderately optimal orientation ranges between 15°-45°, 60°-75°, 90°-105° and 120°-135° and represent fault orientations moderately likely to have an earthquake. All other orientations of fault strike are sub-optimal orientation and have a low likelihood to have an earthquake. These results do not indicate that earthquakes cannot occur on sub-optimal fault strikes, but suggest that they are less likely.

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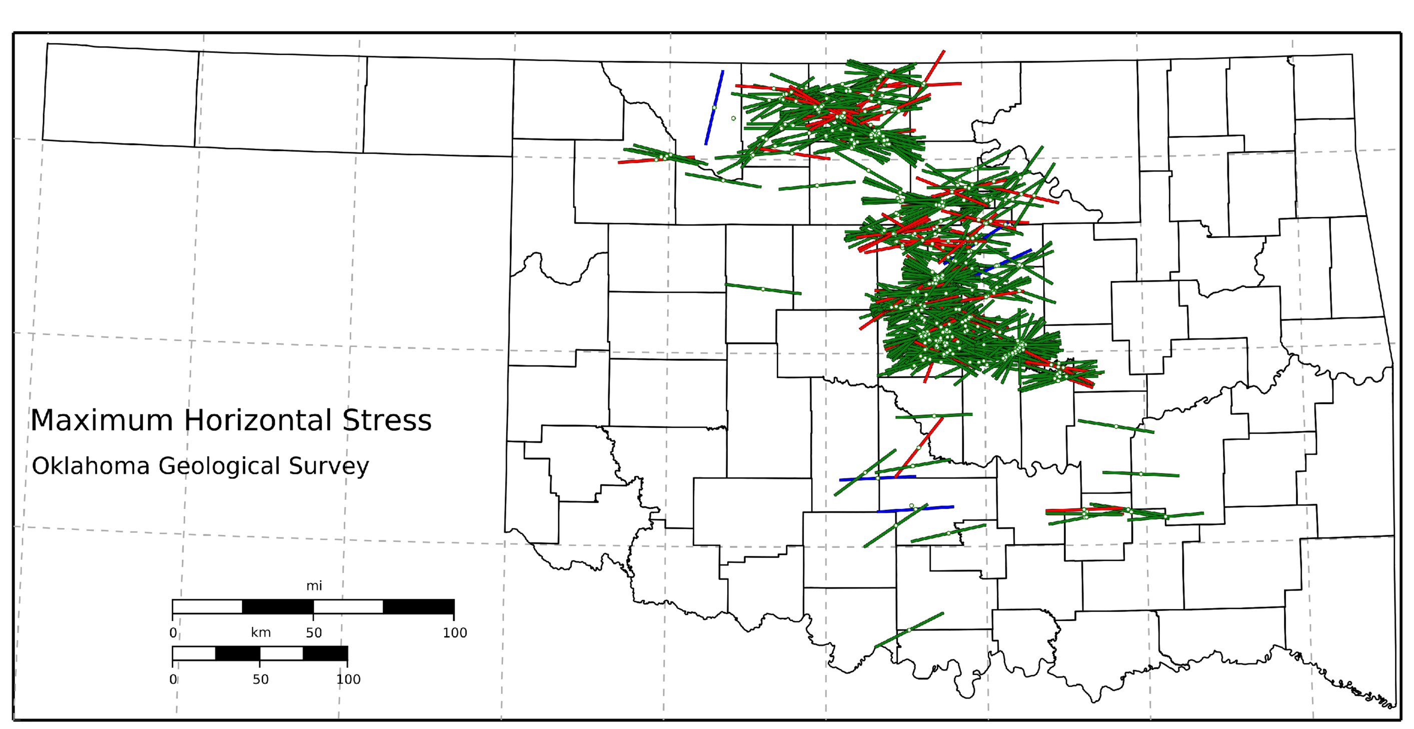
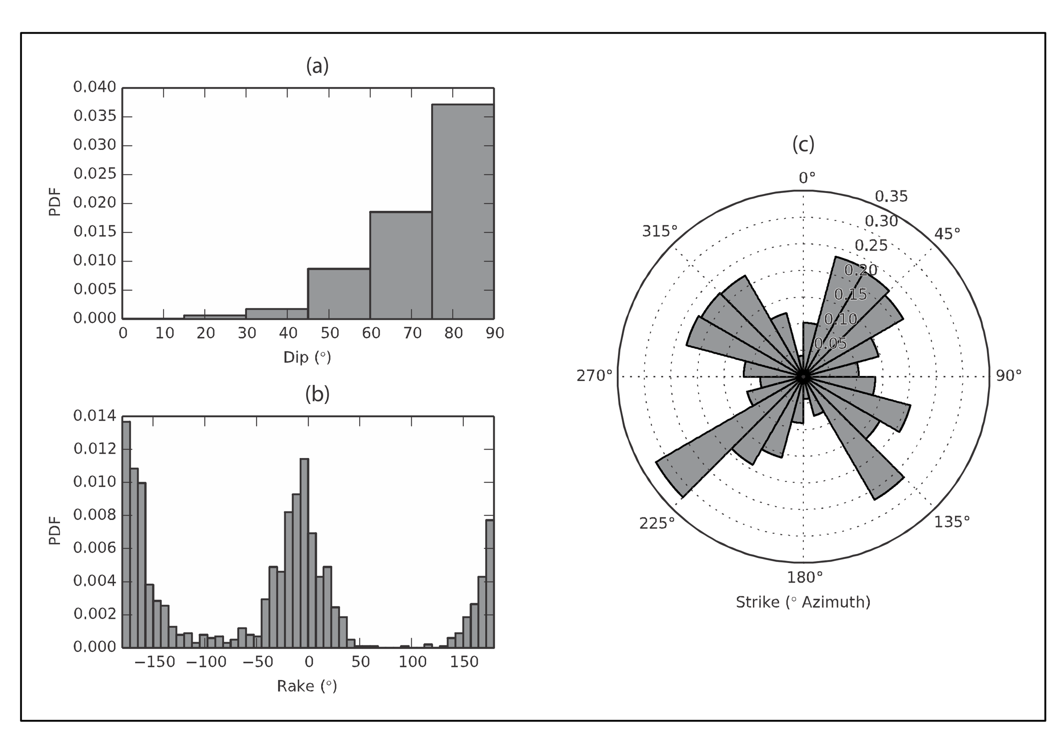


Inset 1: Maximum horizontal stress orientations determined from orientation of P- and T-axes of 633 focal mechanisms, following the convention of Zoback (1992); red, normal faulting; green, strike-slip faulting; blue, thrust faulting.



Inset 2: Probability density functions for fault orientations for 688 focal mechanisms within Oklahoma with 15° bin intervals and a total of 1,376 nodal planes; (a) PDF of fault dip, (b) PDF of fault rake, (c) PDF of fault strike.

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By
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2015