IASPEI Task Group World Stress Map
Annual Report for 2005

Introduction

The World Stress Map (WSM) is a global compilation of contemporary tectonic stress information. The electronic access to the WSM database is free of charge (http://www.world-stress-map.org). The WSM project is a collaborative project of academia, industry and governmental organizations that aims to understand the state and sources of stress in the Earth's crust. The WSM project was initiated in 1986 under the auspices of the International Lithosphere Program as a global cooperative effort. Since 1995 the WSM has been a research project of the Heidelberg Academy of Sciences and Humanities. It is located at the Geophysical Institute of Karlsruhe University in Germany.

WSM 2005 database release

In December 2005 the WSM 2005 database release (Figure 1) was announced via the WSM newsletter amongst the WSM user. The WSM 2005 database release contains 15,969 stress datasets from a wide range of stress indicators. More than 12,000 datasets are assigned to A-C quality, i.e. they are considered to show the S_H orientation reliably within ±25°.

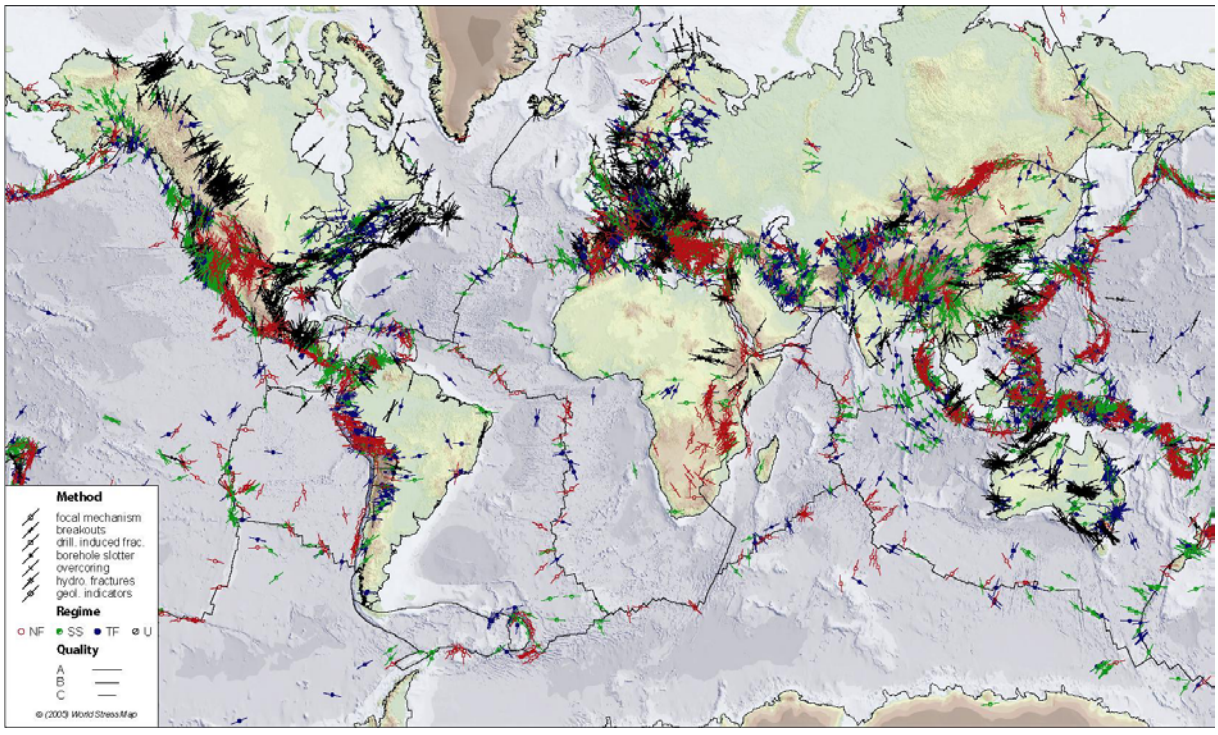

Figure 1. *Stress data with A-C quality from the WSM 2005 database release without the single focal mechanisms which are flagged as Possible Plate Boundary events. Lines represent the orientation of maximum horizontal stress (S_H), line length is proportional to quality. Colors indicate stress regimes with red for normal faulting (NF), green for strike-slip faulting (SS), blue for thrust faulting (TF), and black for unknown regime (U). Plate boundaries are taken from the global plate model PB2002 (Bird, 2003). Topography is based on the ETOPO2 data from the National Geophysical Data Center (NGDC) including bathymetry data from Smith and Sandwell (1997).*

Most of the stress data result from earthquake focal mechanisms (77%) and borehole breakouts (16%) (Figure 2). The majority of the stress data are deduced from single focal mechanisms and are taken from the Harvard CMT catalogue which is provided via the Harvard Seismology web site (http://www.seismology.harvard.edu). 17% of the A-C quality data have unknown stress regime, since this information has not be determined or cannot be provided for most of the borehole breakout and drilling induced fractures datasets.

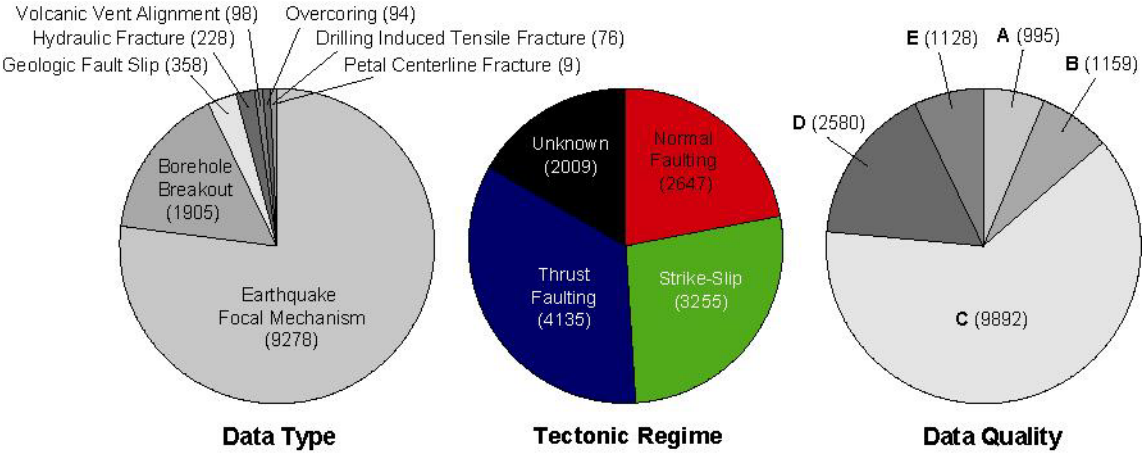

Figure 2. *Distribution of data type and tectonic regime for the 12,046 A-C quality stress data from the WSM 2005 database release. Data quality distribution of all 15,976 stress datasets indicate that ~76 % have A-C quality, i.e. the S_H orientation is regarded to be reliable within ±25°. In brackets numbers of each subset is given.*

For the WSM 2005 database release we also refined the detection criteria of a Possible Plate Boundary Event (PBE). The PBE flag marks the stress datasets which are deduced from single focal mechanisms near plate boundaries, where the orientation of the principal axes P-B-T of the moment tensor might predominately reflect the geometry and kinematics of the plate boundary and its shear strength, rather than the true regional stress field orientation. Thus, the orientation of the P-B-T axes might deviate considerably from the orientation of the principal axes of the regional stress field. By analyzing the single focal mechanisms data of the WSM 2005 database release we found a higher potential for large deviations when the following criteria are met by the single focal mechanisms: (1) The tectonic regime of single focal mechanisms reflects the plate boundary kinematics. (2) The deviation between the strike of the nodal plane and the strike of the plate boundary is smaller than 30°. (3) The event is located within a critical distance to the closest plate boundary. The critical distances depend on the types of plate boundaries. We estimated them by means of statistical analysis as being 45 km for continental transform faults, 80 km for oceanic transform faults, 70 km for oceanic spreading ridges, and 200 km for subduction zones. Applying these detection criteria to the 9864 data sets from single focal mechanisms, 3451 of these were marked by a PBE flag in the WSM 2005 database release. Even though the PBE flag does not imply a change in the quality assignment, users should be aware that these have the potential for a considerable deviation from the regional stress field.

We also added two more columns for each data set. The first new column gives for each data point the distance in kilometer to the nearest plate boundary segment. The second column gives the information on the plate boundary type whether it is an oceanic transform (OTF), continental transform (CTF), oceanic spreading center (OSR), continental rift boundary (CRB), continental collision boundary (CCB), oceanic collision boundary (OCB), or subduction (SUB). The used global plate model is PB2002 from Bird (2003).

WSM Perspectives for 2006

Data collection by the WSM project has accelerated over the past few years, and hence we provide new releases of the WSM database annually. These updates will be publicly available as usual on our web site (http://www.world-stress-map.org).

For the forthcoming 2006 release we will focus on three issues:

1. A refined quality assessment for focal mechanism solutions, borehole breakouts and hydro fractures. These changes are necessary due to technical improvements and new methodologies, which will be tested for their relevance as stress indicators by comparison with the other methods.
2. Continuation of the major worldwide initiative to improve WSM services for the petroleum industry, where most of the stress data are acquired in sedimentary basins. The impact of this initiative will result in a number of stress data in areas where no information was available (e.g., SE-Asia, Nile delta) (Tingay et al., 2005).
3. Inclusion of new stress orientations deduced from focal mechanism solutions using regional broadband data for waveform inversion. Focus of this work is on earthquakes with magnitudes below those used for the CMT Harvard catalogue located in intraplate areas where sparse or no stress information is currently available. In 2006 we will complete the semi-automatic procedure in order to establish a long-term cooperation with the operators of local seismic networks.

Since the success of the WSM strongly depends on the support of the scientific community we call for active participation for the next WSM database release.

Oliver Heidbach and the WSM Team[1]

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