Stress Map of the Mediterranean and Central Europe 2016

GFZ Helmholtz Centre POTSDAM

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Introduction

The World Stress Map (WSM) project provides a global compilation of information on the present day crustal stress field. It is a collaborative project between academia and industry that aims to characterize the stress pattern and to understand the stress sources. It commenced in 1986 as a project of the International Lithosphere Program under the leadership of Mary-Lou Zoback. From 1995-2008 it was a project of the Heidelberg Academy of Sciences and Humanities headed first by Karl Fuchs and then by Friedemann Wenzel. Since 2009 the WSM is maintained at the GFZ German Research Centre for Geosciences and since 2012 the WSM is a member of the ICSU World Data System. All stress information is analysed and compiled in a standardized format and quality-ranked for reliability and comparability on a global scale.

The stress map of the Mediterranean and Central Europe 2016 displays 5011 A-C quality data records of the WSM database release 2016 from the upper 40 km of the crust. Focal mechanism solutions labelled as possible plate boundary events in the database (for details see Heidbach et al., 2010) are not displayed. Further detailed information on the WSM quality ranking scheme, guidelines for the various stress indicators and software for stress map generation and the stress pattern analysis is available at www.world-stress-map.org.

Stress map displays the orientation of maximum horizontal compressional stress S_{Hmax}

Method		Quality		Stress Regime	
focal mechanism		A — S_{Hmax} is within ± 15°		○ Normal faulting	
borehole breakouts		B — S_{Hmax} is within ± 20°		● Strike-slip faulting	
drill. induced frac.		C — S_{Hmax} is within ± 25°		● Thrust faulting	
overcoring				● Unknown regime	
hydro. fractures					
geol. indicators					

Data depth range
0-40 km

normal faulting regime
$S_V > S_{Hmax} > S_{hmin}$

strike-slip regime
$S_{Hmax} > S_V > S_{hmin}$

thrust faulting regime
$S_{Hmax} > S_{hmin} > S_V$

Citation of this map

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Key references

Heidbach, O., Reinecker, J., Tingay, M., Müller, B., Sperner, B., Fuchs, K. & Wenzel, F. (2007): Plate boundary forces are not enough: Second- and third-order stress patterns highlighted in the World Stress Map database, Tectonics, 26, TC6014, doi:10.1029/2007TC002133.

Heidbach, O., Rajabi, M., Reiter, K., Ziegler, M. and the WSM Team (2016): World Stress Map Database Release 2016, GFZ Data Services, doi:10.5880/WSM.2016.001.

Heidbach, O., Tingay, M., Barth, A., Reinecker, J., Kurfeß, D. & Müller, B. (2010): Global crustal stress pattern based on the World Stress Map database release 2008, Tectonophysics 482, 3-15, doi:10.1016/j.tecto.2009.07.023.

Montone, P., and M.T. Mariucci (2016), The new release of the Italian contemporary stress map, Geophys. J. Int., 205, 1525-1531, doi: 10.1093/gji/ggw100.

Müller, B., M. L. Zoback, K. Fuchs, L. Mastin, S. Gregersen, N. Pavoni, O. Stephansson, and C. Ljunggren (1992), Regional Patterns of Tectonic Stress in Europe, J. Geophys. Res., 97, 11783-11803, doi:10.1029/91JB01096.

Reiter, K., O. Heidbach, J. Reinecker, B. Müller, and T. Röckl (2015), Spannungskarte Deutschland 2015, Erdöl Erdgas Kohle, 131(11), 437-442.

References of used data and software

This map contains a number of datasets: Plate boundaries are from the global plate model PB2002 (Bird, 2003), topography and bathymetry from Smith and Sandwell (1997). Stress maps are produced with CASMI (Heidbach and Höhne, 2008) which is based on GMT from Wessel and Smith (1998).

Bird, P. (2003): An updated digital model for plate boundaries, Geochem. Geophys. Geosyst., 4 (3), 1027, doi:10.1029/2001GC000252.

Heidbach, O., Höhne, J. (2008): CASMI - a tool for the visualization of the World Stress Map data base. Computers & Geosciences, 34, 783-791, doi:10.1016/j.cageo.2007.06.004.

Smith, W.H.F. and Sandwell, D.T. (1997): Global sea floor topography from satellite altimetry and ship depth soundings, Science, 277, 1956-1962, doi:10.1126/science.277.5334.1956.

Wessel, P., Smith, W.H.F. (1998): New, improved version of Generic Mapping Tools released, Eos Trans., 79 (47), 579, doi:10.1029/98EC00426.

Major contributors to the WSM database release 2016

Australasian Stress Map Project, Geofon Catalogue, The Global CMT Catalogue, European-Mediterranean Regional CMT Solutions Catalogue, Ikon Science Adelaide, DGMK, NAGRA, NECSA, PETROM, BP, Schlumberger, CHEVRON-Texaco, Fennoscandian Rock Stress Database, Wintershall, Shell, Karass, PTT, Eni, RWE-Dea, WEG, Dalexil Petroleum, Premier Oil

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