Preface

Frontiers in Stress Research

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1. Introduction

Knowledge of the stress state and its link to deformation is important for a wide range of practical applications like the stability of underground openings, enhancing productivity from hydrocarbon and geothermal reservoirs and seismic hazard assessment. Stress information is also critical for resolving questions related to the driving forces of plate tectonics and intra-plate deformation. The systematic global compilation of in-situ stress information started in 1986 with the World Stress Map (WSM) project under the leadership of Mary Lou Zoback as a Task Force of the International Lithosphere Program (ILP). The ILP was established in 1980 by the International Council of Scientific Unions (ICSU) at the request of the International Union of Geological Sciences (IUGS) and the International Union of Geodesy and Geophysics (IUGG). First results of the WSM project were presented in 1992 in a special volume of the *Journal of Geophysical Research* (Zoback, 1992). The 1992 WSM data base release contained 7300 data records. From May 1995 to December 2008 the WSM continued as a research project of the Heidelberg Academy of Sciences and Humanities located at the Geophysical Institute of the Universität Karlsruhe, Germany. The current 2008 WSM database release contains 21,750 stress data records (*Heidbach et al.*, this issue).

This special issue on *Frontiers of Stress Research* is an assemblage of papers that have been presented at the 3rd World Stress Map conference in Potsdam, Germany, 15.-17. October 2008. The strategic aim of the conference was to announce the transition of the WSM as a research project of the Heidelberg Academy of Sciences and Humanities to the German Research Centre for Geosciences, GFZ Potsdam. Here, the future of the WSM project is secured as the GFZ Potsdam has agreed to incorporate the WSM project into its research structure and will provide resources for maintaining and developing it.

2. This volume

Following the three main objectives of the 3rd World Stress Map conference, the special issue aims to present modern concepts on stress and strain measurement techniques, data analysis as well as integrated regional studies including numerical modelling. Thus, the special issue is divided into three sections.

The first section focuses on stress and strain measurement, analysis and interpretation. It starts with the paper of Heidbach *et al.* on the revised quality ranking scheme of the WSM project, the new WSM database release 2008 (Figure 1) and a global statistical wave-length analysis of the contemporary crustal stress pattern. The following articles deal in detail with new ad-

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vancements in measurement techniques such as the methods for interpreting stress orientations from volcanic vent alignments (Paulsen and Wilson, this issue) and the measurement of present-day stress in the Taiwan Chelungpu-fault Drilling Project (Haimson *et al.*, this issue; Lin *et al.*, this issue).

The second section comprises a number of regional studies of the stress pattern in regions where stress information was either sparse or non-existent, such as the compilation of the first stress map of the Sunda plate in Southeast Asia (Tingay *et al.*, this issue). Figure 1 displays the location of these studies and the names of the authors. Most of the new stress data presented in these papers is included in the WSM database release 2008 except for the new data in Great Britain (Baptie, this issue) and Italy (Barba *et al.*, this issue) that will be added to the next WSM database release.

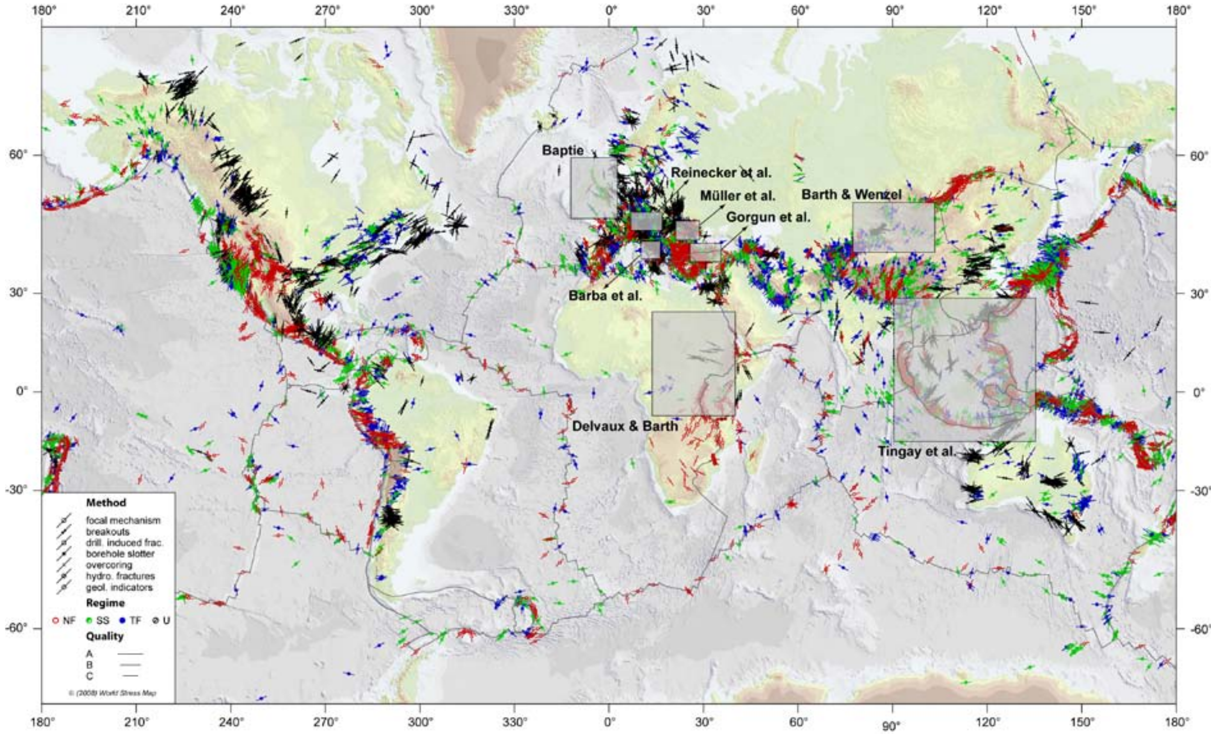

Figure 1. *Global stress map based on the WSM database release 2008 using the 11,346 stress data records with of A-C quality, but excluding all Possible plate Boundary Events (PBE) (Heidbach et al., this issue). Lines represent the orientation of maximum horizontal compressional stress S_H, line length is proportional to data quality. Colours of the symbols 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). Boxes indicate regional stress studies of this special issue.*

The third section is dedicated to numerical modeling of tectonic stresses. Modelling can provide an important tool for predicting the state of stress in regions of sparse geological data and near geological features. Furthermore, only numerical modelling can unravel the open question of the stress sources and the geodynamic processes that drive plate tectonics. However, the quality of the model results depends on the number and quality of model-independent constraints, such as stress and strain observations. Thus, one of the future challenges is to combine stress models with the rapidly increasing observations of Earth’s surface deformation through satellite geodetic techniques such as GPS, InSAR and Persistant Scatterer InSAR. In this sense this section presents the results from models that simulate the contemporary strain-rate and the crustal stress state and their changes on a wide range of spatial and temporal scales. For example, Flesch and Kreemer (this issue) present a model that links the gravitational potential energy to the stress observations of the World Stress Map and the strain derived from GPS velocities.

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