The Nature and Tectonic Significance of Fault Zone Weakening

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The Nature and Tectonic Significance of Fault Zone Weakening

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Preface

Many faults appear to form persistent zones of weakness that fundamentally influence the distribution, architecture and kinematic patterns of crustal-scale deformation and associated geological processes in both continental and oceanic regions. To date, however, our understanding of the mechanisms that lead to changes in fault zone rheology, their many geological consequences and the larger-scale implications that they may have for lithosphere dynamics are still poorly understood. This publication contains 18 papers written by an international group of Earth Scientists based around a central theme of the causes and consequences of fault zone weakening in both continental and oceanic regions.

The opening paper (**Rutter *et al.***) presents a basic review and overview of the causes and consequences of fault zone weakness during crustal deformation. The papers that follow are grouped into four sections. In the first section, *Insights from Neotectonic Settings, Deformation Experiments and Modelling Studies*, the issues of fault strength and rheology are explored using earthquake focal mechanisms (**Townend & Zoback**), direct analysis of fault core from an active low-angle detachment (**Kopf**), experimental deformation studies (**Main *et al.***) and numerical modelling (**Furlong *et al.***).

In the second section, *Insights from Natural Fault Rocks,* the nature and significance of clay-mineral transformations are examined (**Warr & Cox, Yan *et al.***), together with detailed case studies illustrating the use of microfractures in the analysis of reactivated fault zones (**Mitra & Ismat**) and metamorphic/microstructural evidence for episodic weakening and hardening in a deep crustal shear zone (**Steffen *et al.***).

In the third section, *Geometric Controls and Fault System Evolution*, the fundamental influence of factors such as fault size, connectivity, position and orientation upon strain localization and fault growth is examined (**Walsh *et al.***). The following papers are concerned with the nature and origin of asymmetric arrays of shear surfaces in natural fault zones (**Wojtal**) and a quantitative study of the way in which pre-existing basement heterogeneities influence brittle fracture zone development during reactivation (**Beacom *et al.***).

The final section, *Insights from Lithosphere-to Crustal-Scale Fault Zones*, presents a series of case studies in which issues related to long-term reactivation of faults/shear zones and weakening are examined on various scales. Examples are drawn from: Idaho, USA (**Tikoff *et al.***); Central Argentina (**Simpson *et al.***); the Southern Appalachians, USA (**Hatcher**); the Apennine–Maghrebide system, Italy (**Tavarnelli *et al.***); and Sweden (**Talbot**). The final paper in the volume (**Handy *et al.***) presents a synthesis and review of the relationships between fault zones and melting in the continental crust, and how the presence of molten material and its subsequent crystallization may lead to profound changes in crustal strength.

The volume derives from a conference held in March 2000 at Burlington House, London under the joint auspices of the Tectonic Studies Group (Geological Society of London, UK), the Structural Geology & Tectonics Division (Geological Society of America) and InterRidge.

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Bob Holdsworth would like to dedicate this volume to his son Ronan who passed away 23 November 2000.