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Stress pattern in the southern termination of Nehbandan fault system from inversion of earthquake focal mechanism solutions: Rigan area

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Summery

Within the central and eastern parts of the Iranian plateau, active deformations follow the present-day NE-direction of compression. During 2010-2011, two earthquakes with the sinistral and dextral kinematics occurred in Rigan located at the southern edge of the Lut Block in eastern Iran. They were related to the activation of two strike-slip faults with no previous surface rupture. These two faults are NE-SW East Chah-Ghanbar and NW-SE South Chah-Ghanbar faults. Based on the dominant regional stress regime through eastern Iran, a reverse movement rather than sinistral kinematic is suggested along the NW-striking South Chah-Ghanbar fault. To investigate such an inconsistency, we studied the state of local stresses along the major fault systems surrounding the Lut Block, by the inversion of 99 focal mechanism solutions related to 74 earthquakes (1933 to 2018, Mw ≥ 4.8). The inversion results indicate a gradual deflection in the direction of the maximum horizontal compression (σ_1) along the Nehbandant fault system, from north to south that includes the Dasht-e-Bayaz: N044°E, the Nehbandan: N051°E, the Kahurak: N066°E, and the Rigan: N077°E. However, there is a sharp change between the state of stress within the Rigan area and that of the Sahdad – Bam area (N013-26°E) at its western part. Based on the obtained stress pattern, it seems that among different controllers on the deflection of the regional stress, the southern splays of the active deep-seated strike-slip Nehbandan fault system have a significant role. The obtained stress pattern suggests that the Rigan area is structurally part of the southern termination of the East Lut fault system. This study highlights the role of the deep-seated Nehbandan fault and its termination on the deflection of the regional stress and accommodation of deformation in eastern Iran.

Introduction

2010-2011 Rigan earthquakes occurred at the southern edge of the Lut Block. The sinistral kinematic and orientation of the second earthquake and its ~310°-striking causative fault are not in agreement with the stress regime throughout the eastern part of Iran (NE-trending horizontal σ1 axis). This study aims to investigate the factors that result in such an inconsistency in the seismic behavior of the active faults within the southern edge of the Lut Block. The results could shed light on the seismic behavior and accumulation of deformation within the region.

Methodology and Approaches

To investigate the states of local stresses, we applied the inversion method (FCALC – Geodyn-Soft) on 99 focal mechanisms related to 74 earthquakes (Mw ≥ 4.8). These events occurred around the Lut Block from 1933 to 2018. Depending on their locations, we divided them into six separated clusters including Rigan, Kahurak, Shahdad – Bam, Nayband – Kuhbanan, Nehbandan, and Tabas – Daht-e-Bayaz zones. The quality of the deduced stress states is marked by "A" and "B, directly based on the quantities of the used fault-slip data, Andersonian state of the retrieved stress axes, obtained stress ratio (R), and the misfit angle.

Results and Conclusions

The results reveal that both compressional/transpressional and strike-slip stress states dominate around the Lut Block. At the Shahdad – Bam (N013-026°E), Nayband – Kuhbanan (N010-013°E), and Tabas – Dasht-e-Bayaz (N044-048°E) zones, both compressional/transpressional and strike-slip stress states have been obtained. At the Rigan (N077°E) and Kahurak (N066°E) zones, strike-slip stress states have been derived while along the central part of the Nehbandan fault

system, a compressional/transpressional stress state (N051°E) has been achieved. Our results indicate that there are significant clockwise deflections in the orientation of the σ_1 stress axis southward along the Nehbandan fault.
In the concept of seismic hazard studies, deviation of the tectonic-scale stress field at regional and local scales occurs due to structural discontinuities, great magnitude earthquakes, rheology contrasts, and topography of mountainous environments. Among these controllers, the southern splays of the active deep-seated strike-slip East Lut fault system have a significant role.