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The state of stress in the shallow crust of the Hikurangi Subduction Margin hangingwall, New Zealand

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Knowledge of in situ stress fields is critical for a better understanding of deformation, faulting regime, and earthquake processes in seismically active margins such as the Hikurangi Subduction Margin (HSM), North Island, New Zealand. In this study, we utilize Leak-off Test (LOTs) data, borehole breakout widths measured from borehole image logs, and rock unconfined compressive strengths (UCS) derived from empirical P-wave velocity log relationships to estimate vertical (S_v), minimum (S_{hmin}), and maximum horizontal stress magnitudes (S_{hmax}) and interpret the likely faulting regime experienced in four boreholes (Kauhauroa-2, Kauhauroa-5, Titihaoa-1, and Tawatawa-1). Using the standard Anderson's stress regime classification, relative stress magnitudes in Kauhauroa-5 at 1200-1700 m depth and Kauhauroa-2 at 1800-2100 m and indicate that the stress state in the shallow crust of the central and northern part of HSM is predominantly strike-slip ($S_{hmax} \geq S_v \geq S_{hmin}$) and normal $S_v \geq S_{hmax} > S_{hmin}$ respectively. Moving to the offshore, southern HSM a dominant compressional stress regime ($S_{hmax} > S_{hmin} > S_v$), with some possible strike slip stress states are observed in Titihaoa-1 from 2240-2660 m and Tawatawa-1 from 750-1350 m. The observed normal/strike-slip stress state in Kauhauroa-2 and Kauhauroa-5 is consistent with the average S_{hmax} orientation of $64^\circ \pm 18^\circ$ (NE-SW) determined from borehole breakouts and dominantly NE-SW striking normal faults interpreted from seismic reflection data. The normal/ strike-slip regime in this area suggests that the stress regime here is probably influenced by the effect of the clockwise rotation of the HSM hangingwall associated with oblique Pacific-Australia plate convergence (ENE-WSW). Alternatively, these stress states could be the result of gravitational collapse due to rapid uplift of the subducting plate during the mid-Miocene. The compressional stress regime in the southern HSM in Titihaoa-1 and Tawatawa-1 is in agreement with the S_{hmax} orientations of $148^\circ \pm 14^\circ$ (NW-SE) and $102^\circ \pm 16^\circ$ (WNW-ESE) obtained from image logs and mapped NE-SW striking reverse faults in this region. This observation suggests that the tectonics here are strongly linked to the subduction of Hikurangi plateau under Australian Plate (NW-SE) or active frontal thrusts in the overriding plate.