Compressional Reactivation of E-W Basement Faults in the Region of the 2010-2011 Canterbury Earthquake Sequence: Questions of Inheritance

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The 2010-2011 Canterbury earthquake sequence involved the rupturing of blind, inherited discontinuities as well as new-formed immature faults, all previously unrecognised.

Re-interpretation of public domain exploration wells, seismic reflection lines and gravity surveys in the region between the Ashburton and Ashley Rivers allows reconstruction of the top-to-basement surface, with the imprint of an ENE-WSW to E-W fabric of former normal faults inherited from Late Cretaceous-Eocene rifting. The band of rupturing illuminated by seismicity lies along the southern boundary of the Late Cretaceous Pegasus-Rangiora basin, terminating against the Banks Peninsula structural high.

Structures revealed by a set of medium-to-good quality seismic lines in the Ashley River region (Surveys by Indo-Pacific Ltd, IP-256-99 and IP-256-00 tied to the Arcadia-1 well) form a good analogue to the Greendale Fault some 20 km to the south, where comparable information is not available. Interpretation of depth-converted seismic lines reveals compressional inversion of inherited, high-angle E-W blind faults with asymmetric folding and detachment of the Neogene cover sequence, and propagation of new faults through the Pliocene and Quaternary cover sequences. A component of strike-slip is suggested by "flower" geometry along some of the faults.

The largest rift-related normal faults within the inherited extensional fabric penetrate to at least mid-crustal levels within the Rakaia terrane. Such steep pre-existing E-W structures are favourably oriented for reactivation in the contemporary stress field where maximum compression (σ_1) is oriented 115°±5°.

However, the complexity of rupturing revealed by the distribution of seismicity and focal mechanisms cannot solely be ascribed to reactivation of inherited faults, and requires development of new fault segments linking older structures and branching from pre-existing discontinuities, as well as creation of NW-SE conjugate strike-slip faults that are not readily apparent in the inherited basement fabric.