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Relationship between normal faulting and volcanic activity in the Taranaki backarc basin, New Zealand

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Volcanoes and normal faults are, by definition, both present within volcanic rifts. Despite this association the causal relationships between volcanism and normal faulting can be unclear and are poorly understood. One of the principal challenges for investigations of the links between faulting and volcanic activity, is the definition of the detailed temporal relationships between these two processes. The northern Taranaki Basin, which benefits from excellent seismic (2D and 3D) and drillhole coverage, provides the basis for a detailed study of volcanism and faulting over the last ca 15 Myr. Most of the basin is characterised by sedimentation rates which exceed fault displacement rates, a condition which permits displacement backstripping of these syn-sedimentary growth faults. The timing of a suite of mostly andesitic submarine volcanoes has been constrained by interdigitation of the volcanic cones with basinal sedimentary rocks. Eleven dated horizons within the ca 15 Myr and younger stratigraphy together with mapping provide a means of examining the temporal and spatial links between fault and volcanic activity within the basin.

The northern Taranaki Basin has a multiphase deformation history, with extension during the Late Cretaceous to Mid Eocene (ca 80-45 Ma), followed by contraction in the Late Eocene to Early Miocene (ca 40-18 Ma) and then by Mid Miocene to recent back arc extension (ca 15-0 Ma). The youngest phase of extensional faulting initiated in the north and west of the basin and migrated to the southeast where present activity is focused. Volcanic activity also commenced in the north during the Mid Miocene and migrated towards the south and east. Volcanism and backarc extension are driven by subduction of the Pacific plate along the Hikurangi margin. The southward and eastward migration of both faulting and volcanic activity is attributed to the steepening and rotation of the subducting slab beneath the Taranaki Basin.

Despite the common origin of migration in faulting and volcanism, there are significant differences in its nature, with volcanic edifices showing a much more gradual migration than the distinctly punctuated, or step-wise, migration of fault activity. Indeed, detailed comparison of the location of faults and volcanoes in the basin suggest that there are no clear spatial or temporal relationships between individual faults and volcanoes. Our study suggests therefore that whilst the origin's of faulting and volcanism are generally linked on a basin scale, the interdependence of activity between individual volcanoes and faults is weak. Volcanic activity does not influence the location and the activity of tectonic normal faults which, in turn, do not exert a strong control on the locus and timing of volcanic activity in the basin.