Rapid lateral changes in subduction style occur in the central North Island of New Zealand, with back-arc spreading in the Taupo Volcanic Zone in the north, and compression of the back-arc Wanganui basin in the south. Outstanding questions on the distribution of magmatism in the North Island include:

1. Why does magmatism terminate at the southwestern end of the Taupo Volcanic Zone, even though the subducted plate extends at least 350 km further to the southwest;

2. Why is the modern central Taupo Volcanic Zone the most frequently active and productive silicic volcanic system on Earth?

Why does magmatism terminate at Mt Ruapehu?

In the central Taupo Volcanic Zone the crust is c. 35 km thick, while southwest of Mt Ruapehu the crust thickens by c. 10 km. There is no significant low Vp or low Qp zone in the mantle wedge in this southwestern region, suggesting that this thicker crust has choked off mantle return flow. It is difficult to flux partial melt in the mantle wedge without return flow, hence we would not expect magmatism southwest of Mt Ruapehu, even though subduction continues much further southwest.

Why is the central Taupo Volcanic Zone so active?

The anomalous volcanic productivity of the central Taupo Volcanic Zone requires a mechanism that provides an anomalous concentration of melt in the mantle, and thus an anomalous concentration of fluid to flux this melt. Shear wave splitting results show a dramatic change in fast polarization direction from trench parallel southwest of Mt Ruapehu to trench perpendicular in the western Taupo Volcanic Zone. The trench parallel polarizations can be interpreted as fluid flow along strike in the southwest - we would expect the slower flow in the northeast to entrain fluid from the south. So the "edge effect" of the termination of magmatism is itself leading to an anomalous concentration of partial melt, as fluid from a large volume of mantle to the southwest is available to flux melt.

How is continental rifting achieved?

The southwestern termination of the Taupo Volcanic Zone is marked by a southwest-dipping band of earthquakes, which extend through the entire thickness of the crust. Vp/Vs and Qp contours also dip to the southwest, in concert with the seismicity. This linking of seismicity and material properties suggests that the earthquakes represent weakening of the crust by fluids exsolved from underlying magma, by means of increased fluid pore pressure on faults. The southern limit of the Taupo Volcanic Zone has been migrating southwestwards in time. Our seismicity and tomography results allow us to speculate that this may be a two stage process - initial ponding of melt at the base of the crust at the southwestern limit of the Taupo Volcanic Zone, followed by major weakening of the overlying crust by the large quantity of fluid exsolved from this melt.