

Supplementary Data

The Te Pungia Fault, Hauraki Plains: a new seismic source in the low seismicity northern region of New Zealand

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Contents

S1-Trench stratigraphy	2
Ryland – north wall.....	2
Detail of stratigraphy with tephras, Ryland - south wall.....	3
Arnold - north wall	4
S2-OxCal model code for Hinuera Surface age... ..	5
S3-Uncertainty associated with Te Pungia Fault slip rate.....	6
References.....	6

S1-Trench stratigraphy

Ryland – north wall

TS(*Ap) - 0-17 cm. Silty sand; dark brownish black; friable, weakly pedal, brittle peds; abundant roots; moderately allophanic (NaF test); distinct wavy boundary.

TS(*Bw) - 17-30 cm. Silt; yellowish brown; friable, apedal earthy; many roots, some large root channels; strongly allophanic; indistinct smooth boundary.

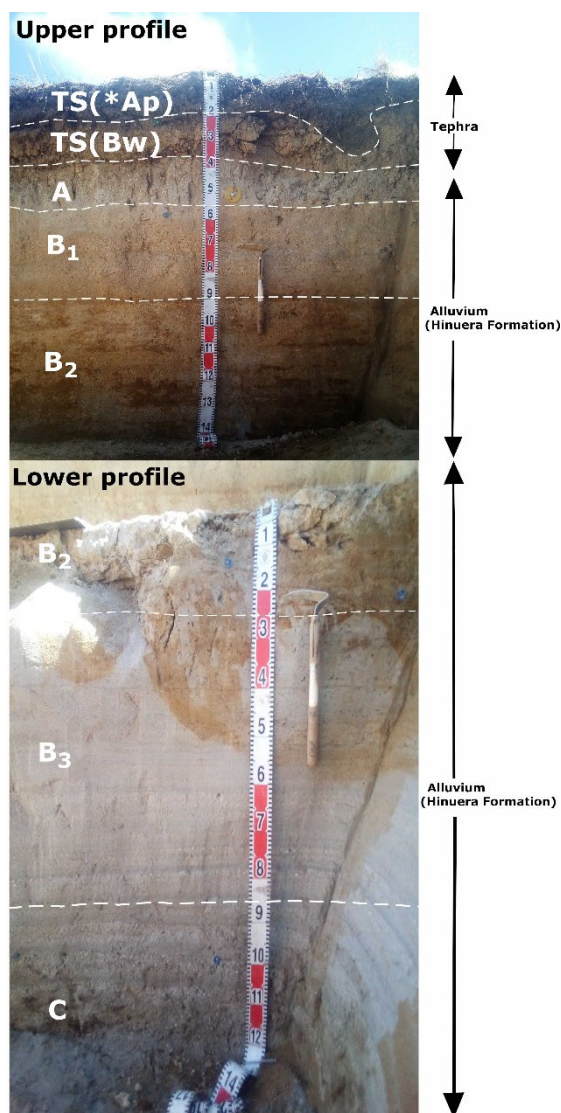
A - 30-58 cm. Fine to medium sand; blocky to prismatic; >90% low chroma colours, ~5% MnO₂ concretions; strong peds; few roots, few large root channels ~3 cm; smooth diffuse boundary.

B₁ - 58-90 cm. Fine to medium sand with some fine pumice lapilli; less coherent than A; a few deep root channels containing Ap horizon material; ~40% orange mottles, 60% low chroma colours; indistinct smooth boundary.

B₂ - 90-160 cm. Medium sand with coarse sand and medium pumice lapilli lenses; redox segregations, ~75% orange and ~25% low chroma, <5% MnO₂ concretions; strongly reduced (positive Childs' test); indistinct smooth boundary.

B₃ - 160-225 cm. Medium sand with coarse sand and lenses of medium pumice lapilli; thin horizontal heavy mineral (designated mafic hereafter) beds; 50% orange staining and 10% MnO₂ concretions in the upper 30 cm; strongly reduced; indistinct smooth boundary.

C - 225-260 cm. Coarse sand with 3-5 cm thick fine to medium lapilli pumice beds; mafic mineral crossbeds (1-2 mm thick) present; strongly reduced.



Notes

* Ap and Bw are soil horizon designations from Clayden and Hewitt (1989); textural and other terms follow Milne et al. (1995). TS stands for Top Soil. Upper landscape soils at Arnold and Ryland sites are representatives of the Waihou and Te Punga series (Wilson 1980), respectively, and are Orthic or Impeded Allophanic Soils (Hewitt 2010); lower landscape soils are representatives of the Waitoa series (Wilson 1980) and are Orthic Gley Soils (Hewitt 2010).

Stratigraphy is based on field observations and Hume et al. (1975), Wilson (1980), Lowe (1988, 2023), Manville and Wilson (2004), Leonard et al. (2010), and Persaud et al. (2016).

Note that Unit 1 not on this stratigraphic section of the trench

Detail of stratigraphy with tephras, Ryland - south wall

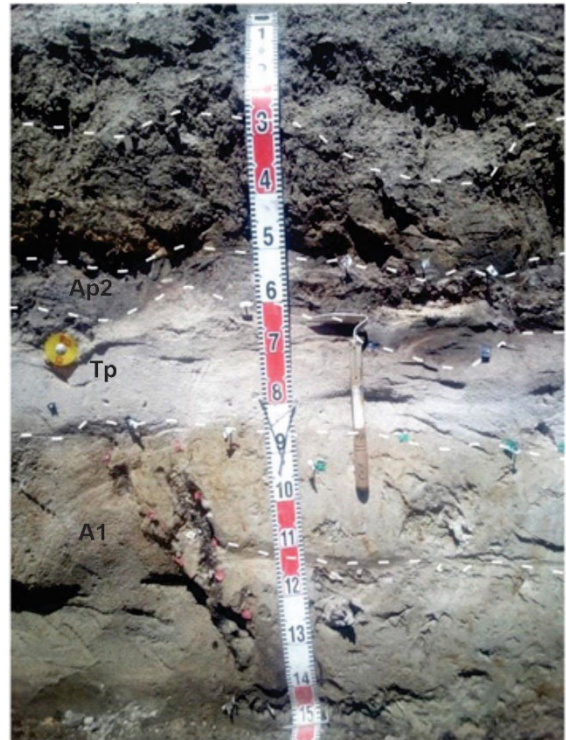
TS(Ap1) - 0-37 cm. Sandy loam; dark greyish brown; many strong polyhedral peds; common roots; indistinct wavy boundary. (S unit on log)

TS(Ap2) - 37-50 cm. Sandy loam; dark olive brown; Many strong polyhedral peds; common roots with brown mottles; below 46 cm, orange brown silty mottles occur; abrupt wavy boundary. (S unit on log)

1 (contains Kh/Tp) 50-61 cm. Medium sand; grey with brown mottles; intermittent orange-grey silt (Kaharoa tephra, Ka) overlying a white discontinuous pumice lapilli layer <5 mm thick (Taupo tephra, Tp); abrupt wavy boundary. (S unit on log)

A1 - 61-85 cm. Fine white sand with some fine pumice lapilli, fining upwards; 5% mafic minerals; distinct smooth boundary.

A2- 85-150 cm. Coarse sand with <5% fine pumice lapilli; <5% orange mottles; ~1 mm-thick beds of mafic minerals; coarse sand and pumice lapilli beds dipping steeply westward; thin peat layer at depth of 140 cm.



Arnold - north wall

TS(Ap) 0-30 cm. Silt loam; grey yellowish brown (10YR 4/2+); apedal, earthy; basal part mixed brownish-black, potentially from ploughing; weakly allophanic; distinct wavy boundary.

TS(Bw) 30-65 cm. Silty sand; yellowish brown, <5% orange mottles; friable; strongly allophanic; diffuse smooth boundary.

A1

A_{Sand} 65-85 cm and 95-107 cm. Coarse sand and pumice lapilli; yellowish brown, ~20% orange mottles; spatially variable – occurs as both a lens in profile and as a horizontal layer.

A_{Silt} 65-95 cm. Silty sand with rare pumice lapilli; 40% orange mottles, 30-40% low chroma colours; indistinct boundary to lower A_{Sand} layer (see photo).

A2

A_{Clay} 107-115 cm. Clayey silt; 80% low chroma colours; blocky; abrupt smooth boundary.

B_{1(liq)} 115-120 cm. White, fine sand-silt layer; possible liquefaction (liq) or sand blow; abrupt smooth boundary.

B₂ 120-186 cm. Medium to coarse sand with coarse sand and fine pumice lapilli beds; pale grey with ~5% orange staining; indistinct wavy boundary.

B₃ 186-197 cm. Medium sand with fine mafic mineral beds; pumice lapilli lenses <4 mm thick; grey with 10% orange staining and 20% MnO₂ concretions; smooth indistinct boundary.

B₄ 197-216 cm. Fine to medium sand with 30% mafic minerals; fine, rhyolitic sand lens pinching out; coarse grained interbeds; grey with 40% orange staining, distinct horizontal pattern; smooth indistinct boundary.

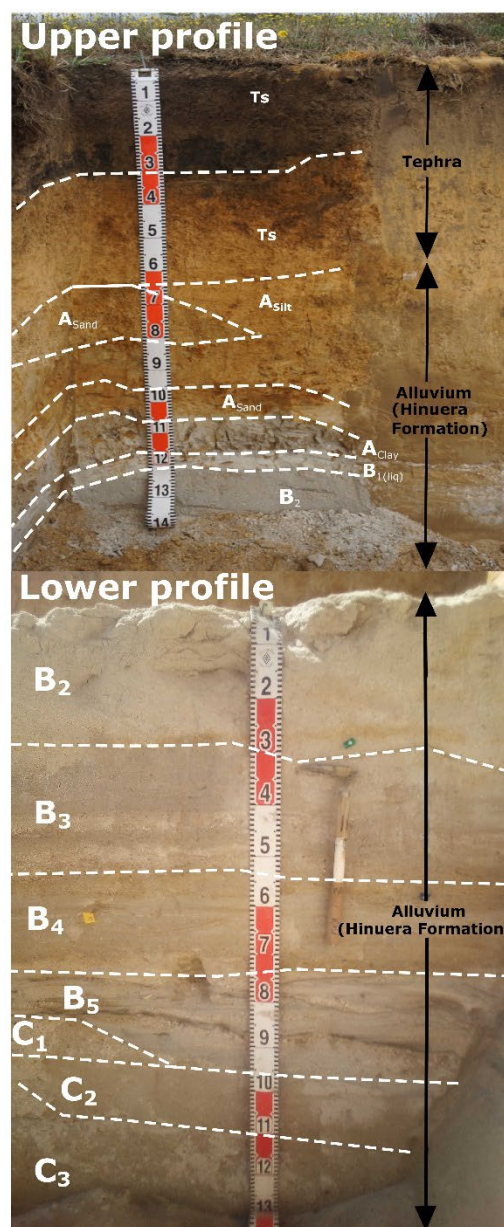
B₅ 216-236 cm. Fine sand with some pumice lapilli clasts (~3 mm) and fine mafic sand crossbedding; Medium pumice lapilli lenses; grey with <5% mottles; smooth distinct boundary.

C₁ Pinching out on left of photo. Coarse sand to gravel with medium pumice lapilli; grey; abrupt smooth boundary.

C₂ 236-250 cm. Coarse sand; dark grey; 30% mafic minerals; well sorted matrix with lenses of larger, medium pumice lapilli clasts; strongly reduced; distinct wavy boundary.

C₃ 250 cm. Fine to coarse sand, poorly sorted, contains fine to medium pumice lapilli; dark grey; variable mafic mineral concentrations; strongly reduced.

[†]Munsell colour notation



S2-OxCal model code for Hinuera Surface age...

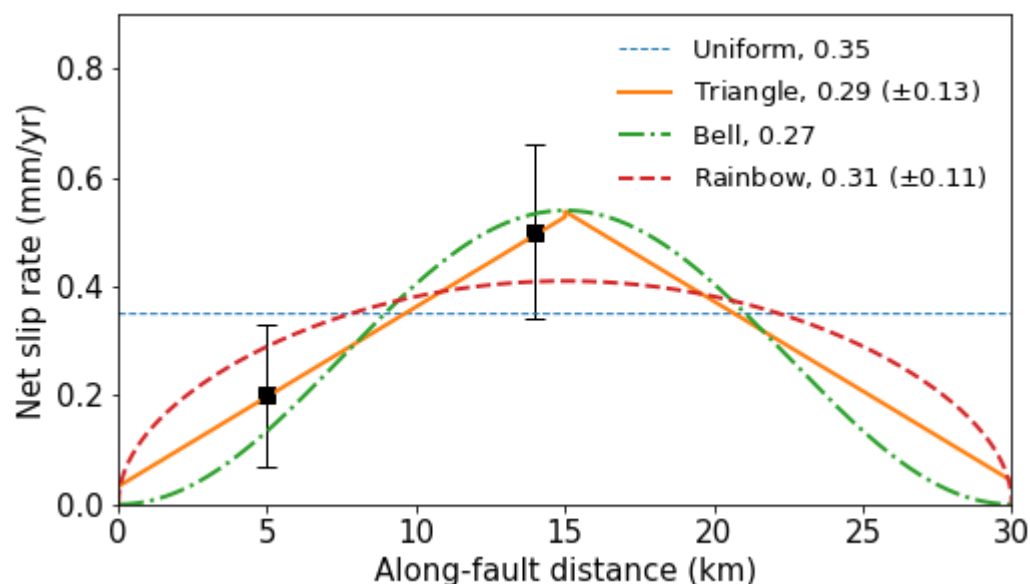
Oxcal code: Plot()

```
{
Curve("SHCal20","shcal20.14c");

Combine("Hinuera")
{
R_Date("Wk52552", 19773, 46);
R_Date("Wk52554", 19963, 47);
};
R_Date("Wk52555", 20705, 50);
};
Plot("x")
{
Sequence("x")
{
Boundary("base");
Phase("x")
{
Curve("SHCal20","shcal20.14c");
R_Date("Wk52552", 19773, 46);
R_Date("Wk52554", 19963, 47);
R_Date("Wk52555", 20705, 50);
};
Boundary("post-peat");
};
};
Plot("tau")
{
Sequence("x")
{
Tau_Boundary("base");
Phase("x")
{
Curve("SHCal20","shcal20.14c");
R_Date("Wk52552", 19773, 46);
R_Date("Wk52554", 19963, 47);
R_Date("Wk52555", 20705, 50);
};
Boundary("post-peat");
};
};
}
```


S3-Uncertainty associated with Te Punga Fault slip rate

To further assess uncertainty on the average net slip rate estimated along the Te Punga Fault presented in the main text, we have fitted the two data points to different models. These models are uniform (or mean of the estimated net slip rates), triangle (Manighetti et al. 2005), bell (or a raised cosine function; note this is different to the main text model, as in that one we forced the curve to fit the average values on those points), and rainbow-shaped (or sinesqrt) functions (Biasi and Weldon 2006; Thingbaijam et al. 2022). The average net slip rate estimates are annotated on the plot below (in the legend, the 2-sigma estimates are given in the brackets). All these models capture the data (square dots with error bars) within the error (2-sigma) bounds, the uniform model does not as it overestimates the net slip rate closer to the fault edge. Excluding the uniform model, there is reasonable agreement that the average net slip rate is < 0.3 mm/yr. The values of the main text of 0.25 mm/yr (95% CI limits of 0.15–0.37 mm/yr) are similar to the values estimated here. At this stage we regard the main slip rate value in the text as reasonable for this preliminary assessment until we can add more slip rate values along the fault to be able to properly assess what model better fits the Te Punga Fault slip rate.



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