

**GEOSCIENTIFIC RECONNAISSANCE OF  
PERRY AGGREGATES QUARRY,  
RIVER ROAD, HOROTIU**

**Informal report prepared for David Jennings  
Opus International Consultants Ltd**

**by**

**Cam Nelson and David Lowe**

**Department of Earth Sciences  
University of Waikato**



**The  
University  
of Waikato  
*Te Whare Wānanga  
o Waikato***

**28 April 1997**

Nelson, C.S.; Lowe, D.J. 1997. Geoscientific reconnaissance of Perry Aggregates quarry, River Road, Horotiu. Report for Opus International Consultants Ltd. [per D. Jennings], University of Waikato, Hamilton. 7p

## INTRODUCTION

At the request of David Jennings, Opus International Consultants Ltd, Hamilton, we visited the Perry Aggregates quarry on River Road, Horotiu, on the morning of Wednesday 23 April 1997 to comment on the geoscientific context of the quarry. Our specific remarks relate only to observations made at the pit face at the present northwestern extremity of the quarry, which nevertheless are probably appropriate for the quarry as a whole. The quarry area inspected lies on a low terrace about 8 m above present-day river level (about 15 m a.s.l.) immediately adjacent to the Waikato River and covers an area of about 180 x 250 m centred on approximate grid reference S14 029885 (1:50 000 topographic map series NZMS 260).

Excluding the modern Waikato River deposits, the Horotiu site involves two geological units, an older **Hinuera Formation** unit and a younger **Taupo Pumice Alluvium** unit.

## HINUERA FORMATION

The Hinuera Formation comprises cross-bedded gravelly sands and sandy gravels, up to 90 m thick, deposited in shifting bars and channels in an ancestral braided Waikato river system during the Last Glaciation (Hume et al. 1975; Kear & Schofield 1978). Aggradation was in response to particularly active explosive volcanism in the Taupo Volcanic Zone at this time, coupled with a lowered global sea level and increased rates of erosion in the unforested hinterland under a chilly, windy and seasonally wet climate (Hume et al. 1975; McGlone et al. 1978; Green & Lowe 1985; Newnham et al. 1989). The composition of the Hinuera deposits reflects their ultimately volcanic heritage, and they comprise fragments of rhyolitic breccia, rhyolite, pumice, and ignimbrite in their coarser fraction, and quartz, plagioclase feldspar, pumice, glass shards, and heavy (dark) minerals in their finer fraction. Liquefaction structures are present locally, due to soft sediment deformation from loading and pore water escape during rapid sediment accumulation in the braided river setting. Occasional thin lenses of pumice silt can be interbedded with the coarse Hinuera sediments, and these represent preserved overbank deposits on the braided river floodplain, or in abandoned braid channels (Hume et al. 1975).

Radiocarbon dates from multiple sites in Hamilton Basin indicate that the Hinuera Formation alluvial deposits were formed here mainly between about 19,000 and 15,000 radiocarbon years BP (before present) (Hume et al. 1975; McGlone et al. 1978; Green &

Lowe 1985; Hogg et al. 1987; Lowe 1988; Selby & Lowe 1992), the most rapid accumulation of sediment occurring from about 19,000 to 17,000 years BP. Aggradation generally slowed from 17,000 to 15,000 years BP, if anything the sediment facies fined a little compared to the bulk of the underlying deposits, and the braidplain became stranded as an extensive flat to gently undulating surface across Hamilton Basin by around 15,000 years BP. This extensive 'upper terrace' braidplain is known as the Hinuera Surface (Schofield 1965; Kear & Schofield 1978).

The Hinuera Surface lies a few metres (about 4 - 7 m; not surveyed precisely) above the eastern (and northern) margin of the present quarry site, and is the surface upon which much of River Road is sited in the vicinity of the quarry, including at the main quarry entrance (about 20 m a.s.l.).

Following cessation of Hinuera sedimentation at about 15,000 years BP, the Waikato River incised into the Hinuera Surface and its own sedimentary deposits to occupy more or less its present position flowing across Hamilton Basin from Cambridge to the vicinity of Taupiri Gorge. Downcutting coincided with climatic amelioration and reafforestation, global sea level rise, and a significant reduction in volcanic activity and sediment supply in the hinterland. A period of stillstand during downcutting enabled the Waikato River to cut in places a 'lower level' terrace within its valley confines prior to eventually reaching its presently deeply entrenched meandering position. Gullies draining laterally into the present-day Waikato River were also initiated during this period of entrenchment. The age of downcutting is not known precisely: sometime after 15,000 years BP but presumably well before deposition of Taupo Pumice Alluvium around 1850 years BP.

The Hinuera Surface is marked commonly by a complex pattern of low ridges and shallow swales of generally coarse and fine sediments, respectively, which reflect the original pattern of alluvial deposition by the ancestral Waikato river system. The modern soils form a general pattern of well drained to poorly drained soils relating to the ridge and swale microtopography: well drained soils of the Horotiu series occur typically on the ridges or levees, and are classed as Typic Orthic Allophanic Soils in the New Zealand Soil Classification of Hewitt (1992); poorly drained soils of the Te Kowhai or Ngaroto series (Typic/Acidic Orthic Gley Soils) occur in the swales; and moderately drained soils of the Bruntwood series (Typic Impeded Allophanic Soils) occur in intermediate positions (McCraw 1967; Bruce 1979; Singleton 1991; Bakker et al. 1996).

## TAUPO PUMICE ALLUVIUM

The Taupo Pumice Alluvium formed about 1850 years BP and was associated with the catastrophic release into the entrenched Waikato River of huge volumes of pumiceous gravel, sand and silt derived from the products of the Taupo Tephra eruption (which generated both pyroclastic fall and pyroclastic flow deposits) from Taupo volcano at Lake Taupo. Both the Taupo Tephra and the Taupo Pumice Alluvium are well radiocarbon dated at 1850 years BP, equivalent to around AD 200, from charcoal fragments, logs, and other material contained within the deposits: Taupo Tephra deposits have an error-weighted mean radiocarbon age of  $1850 \pm 10$  years BP ( $n = 41$ ; Froggatt & Lowe 1990); Taupo Pumice Alluvium has an identical error-weighted mean radiocarbon age of  $1881 \pm 19$  years BP ( $n = 10$ ; Table 1). The Taupo Pumice Alluvium in Hamilton Basin, which may be up to 30 m thick (Kear & Schofield 1978), typically consists of large-scale cross-bedded pumice sands and gravels with scattered charcoal fragments. This predominantly pumiceous facies has been named the Melville Pumice Member of the Taupo Pumice Alluvium by Kear & Schofield (1978).

**Table 1.** Radiocarbon ages on Taupo Pumice Alluvium in the Waikato region

Sample no.*	Material¶	Age (yr BP)†	Reference§
NZ37	C	$1780 \pm 60$	1, 2
NZ38	C	$1800 \pm 70$	1, 2
NZ162	C	$1830 \pm 70$	3
NZ165	SB, T, L	$1900 \pm 70$	3
NZ173	SB, T	$1750 \pm 50$	3
NZ174	SB, T	$1800 \pm 100$	3
WK424	W	$2040 \pm 50$	4
WK2974	C	$1870 \pm 60$	5
WK2975	C	$2000 \pm 70$	5
WK2976	C	$1950 \pm 50$	5

\* NZ = New Zealand Radiocarbon Dating Laboratory, Upper Hutt; WK = University of Waikato Radiocarbon Dating Laboratory, Hamilton.

¶ C, charcoal; SB, small branches; T, twigs; L, leaves; W, wood. Note that some samples are likely to have an inbuilt age and so the ages may be slightly overestimated, e.g. WK424.

† Age  $\pm 1$  sd on old half-life (Libby) basis. Error-weighted mean age ( $n = 10$ ) is  $1881 \pm 19$  yr BP; if WK424 is excluded, the mean age ( $n = 9$ ) is  $1853 \pm 21$  yr BP.

§ 1, Fergusson & Rafter (1957); 2, Kear & Schofield (1978); 3, Fergusson & Rafter (1959); 4, Hogg et al. (1987); 5, unpublished (D.J. Lowe, unpubl. data).

During emplacement and deposition, the Taupo Pumice Alluvium choked the Waikato River course and built up to flood over and bury to varying thicknesses the earlier low level terrace cut into the Hinuera Formation, as noted above. It was also deposited in low lying gullies and local stream channels draining into the Waikato River. This catastrophic event was associated with locally considerable river bank erosion and reworking of the antecedent Hinuera volcaniclastic sands and gravels, so that 'Hinuera-like' cross-bedded sands and gravels can be intimately associated with the purer pumice-rich deposits (Melville Pumice Member) of the Taupo Pumice Alluvium. Kear & Schofield (1978) used the name Hopuhopu Sand Member for these non- or only slightly pumiceous, cross-bedded volcaniclastic quartzofeldspathic sands and gravels of otherwise identical 'Taupo' age. Both members are mapped as a discontinuous low-level terrace up to 200 m wide and about 6 - 8 m above river level (McCraw 1967; Kear & Schofield 1978).

Distinction of deposits of the Hopuhopu Sand from the very similar looking Hinuera Formation is based primarily on the inclusion of characteristic charcoal fragments in the Hopuhopu Sand Member, which are not seen in the Hinuera deposits (Schofield 1965; Kear & Schofield 1978). A second, more subtle feature is that the Hopuhopu Sand deposits are easily dislodged into an assemblage of loose, single grains when disturbed whereas the Hinuera deposits are both more compact and coherent. The soils developed on the Taupo Pumice Alluvium, the Waikato series (McCraw 1967; Bruce 1979), are considerably less developed than those on the Hinuera Formation, having always only a thin 'weathered B' subsoil horizon at most (i.e. Bw or BC horizon; Clayden & Hewitt 1989). Soils developed on the pumiceous Melville Member are included in the Waikato series (Immature Orthic Pumice Soils or Typic Sandy Recent Soils); soils on the non-pumiceous Hopuhopu Sand are unnamed and are likely to be Typic Fluvial Recent Soils.

## PERRY'S AGGREGATE PIT

Our observations indicate that the sand and gravel extraction at Perry's River Road quarry is from the Taupo Pumice Alluvium, and that this involves a mix of Hopuhopu- (volcanic rock fragment-pumice-quartz-feldspar-heavy mineral sediment) and Melville- (pumice sediment) type facies. Many of the cross-bedded sands and gravels in the upper few metres of the quarried pit wall superficially resemble the Hinuera Formation sediments, but the ubiquitous presence of included charcoal, their very loose consistence when disturbed, their generally lesser degree of iron staining, their stratigraphic and topographic position, and their capping soil development (Waikato series), all indicate a Taupo Pumice Alluvium origin.

Consequently, the age of the deposit that has recently been, and is currently being, quarried is about 1850 years BP. It appears to form a cover unit at least about 3 - 4 m thick atop a low terrace that was cut into the Hinuera Formation during Waikato River entrenchment. It is very likely that the Hinuera Formation underlies the bulk of the quarried Taupo Pumice Alluvium unit, but this could not be confirmed during the site visit (deeper excavation or drilling would be needed). However, the Hinuera Fromation forms the riser along the eastern (and northern) margin of the quarry leading up onto the the Hinuera Surface proper. Indeed, in the northeast corner (far rightside looking downriver) of the present quarry, below some large gum trees, the quarry pit wall actually exposes a window of genuine Hinuera Formation deposits (more coherent cross-bedded volcaniclastic sands and gravels including some interbeds of tight pumice silt and iron-manganese pans, but containing no charcoal), and the onlapping relationship between the Taupo Pumice Alluvium (here mainly Hopuhopu facies) against the riser to the Hinuera Surface is evident.

## REFERENCES

- Bakker, L.; Lowe, D.J.; Jongmans, A.G. 1996. A micromorphological study of pedogenic processes in an evolutionary soil sequence formed on Late Quaternary rhyolitic tephra deposits, North Island, New Zealand. *Quaternary International* 34-36, 249-261.
- Bruce, J.G. 1979. Soils of Hamilton City, North Island, New Zealand. *New Zealand Soil Survey Report* 31.
- Clayden, B.; Hewitt, A.E. 1989. Horizon notation for New Zealand soils. *DSIR Land and Soil Sciences Scientific Report* 1.
- Fergusson, G.J.; Rafter, T.A. 1957. New Zealand  $^{14}\text{C}$  age measurements — 3. *New Zealand Journal of Science and Technology* B38, 732-749.
- Fergusson, G.J.; Rafter, T.A. 1959. New Zealand  $^{14}\text{C}$  age measurements — 4. *New Zealand Journal of Geology and Geophysics* 2, 732-749.
- Froggatt, P.C.; Lowe, D.J. 1990. A review of late Quaternary silicic and some other tephra formations from New Zealand: their stratigraphy, nomenclature, distribution, volume, and age. *New Zealand Journal of Geology and Geophysics* 33, 89-109.
- Green, J.D.; Lowe, D.J. 1985. Stratigraphy and development of c. 17 000 year old Lake Maratoto, North Island, New Zealand, with some inferences about postglacial climatic change. *New Zealand Journal of Geology and Geophysics* 28, 675-699.
- Hewitt, A.E. 1992. "New Zealand Soil Classification". *DSIR Land Resources Scientific Report* 19.
- Hogg, A.G.; Lowe, D.J.; Hendy, C.H. 1987. University of Waikato radiocarbon dates I. *Radiocarbon* 29, 263-301.

- Hume, T.M.; Sherwood, A.M.; Nelson, C.S. 1975. Alluvial sedimentology of the Upper Pleistocene Hinuera Formation, Hamilton Basin, New Zealand. *Journal of the Royal Society of New Zealand* 5, 421-462.
- Kear, D.S.; Schofield, J.C. 1978. Geology of the Ngaruawahia Subdivision. *New Zealand Geological Survey Bulletin* 88.
- Lowe, D.J. 1988. Stratigraphy, age, composition, and correlation of late Quaternary tephras interbedded with organic sediments in Waikato lakes, North Island, New Zealand. *New Zealand Journal of Geology and Geophysics* 31, 125-165.
- McCraw, J.D. 1967. The surface features and soil pattern of the Hamilton Basin. *Earth Science Journal* 1, 59-74.
- McGlone, M.S.; Nelson, C.S.; Hume, T.M. 1978. Palynology, age, and environmental significance of some peat beds in the Upper Pleistocene Hinuera Formation, South Auckland, New Zealand. *Journal of the Royal Society of New Zealand* 8, 385-393.
- Newnham, R.M.; Lowe, D.J.; Green, J.D. 1989. Palynology, vegetation and climate of the Waikato lowlands, North Island, New Zealand, since c. 18,000 years ago. *Journal of the Royal Society of New Zealand* 19, 127-150.
- Schofield, J.C. 1965. The Hinuera Formation and associated Quaternary events. *New Zealand Journal of Geology and Geophysics* 8, 772-791.
- Selby, M.J.; Lowe, D.J. 1992. The Middle Waikato Basin and hills. In: Soons, J.M.; Selby, M.J. (eds) *Landforms of New Zealand* Second edition. Longman Paul, Auckland: 233-255.
- Singleton, P.L. 1991. Soils of Ruakura — a window on the Waikato. *DSIR Land Resources Scientific Report* 5.