A PRELIMINARY INVESTIGATION OF THE POHANGINA VALLEY RIVER TERRACES

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BY

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INTRODUCTION

The principal area of study in this dissertation is the Pohangina Catchment, an area about which little or no geomorphological work has been published. Whereas geomorphological literature on this area is lacking, work has been undertaken on the Geology of the Pohangina district (Carter, 1972). Recent work has also been carried out on the cover deposites on the Pohangina Terraces (Rijkse, 1972). Further work by the same author (1975) has resulted in the compilation of a soil map of the Pohangina County.

Adjacent areas, however, have received considerably more attention in the past. Suggate (1965) published an article on Pleistocene climatic changes which are of relevance throughout central New Zealand. Works on the Geology of the Manawatu were produced by Rich (1959) and Te Punga in the early 1960s. Cowie (1963) published articles on the Aokautere Ash and the loess deposits in the Manawatu.

Fair (1968) combined and related much of the work of previous writers and approached the study of the Manawatu from a more geomorphological viewpoint.

In very recent years the river basins adjacent to the Manawatu, in particular the Rangitikei, have received greater attention. The most important of these is the study undertaken by Milne (1973).

PREVIOUS WORKS

Conditions of terrace formation

The retreat of the of the sea from the western flanks of the Tararua-Ruahine Range during the Oturian produced what is locally known as the Tokomaru Marine Terrace (Fair, 1968). Furthermore, Fair (1968) concludes that the emergence of the Tokomaru Marine Terrace was primarily the result of uplift rather than due to eustatic changes.

Heerdegen (1972,8) states that:

> 'Research has been carried out in the Rangitikei, Oroua and Manawatu River Valleys, and the general conclusion reached is that fluctuations in climate during the waning phases of the Pleistocene stadials were of sufficient magnitude to induce changes in the regime of rivers that would allow for periodic aggradation and degradation on a scale large enough to produce terracing'.

During the glacials the climate would have been sufficiently cold to produce large quantities of debris in the Tararua and Ruahine Ranges through the operation of the process of frost shattering. Much of this debris so produced would quickly have found its way into the river channels due to the absence of vegetation. 'During the glacial episodes of the Pleistocene the snow line fell to between 3,600 and 3,900 feet and the tree-line fell to about present day sea level, or just below' (Stevens, 1974, 155).

In the case of the Manawatu and Pohangina River Terraces both the axial ranges and the flanking marine strata have been the source of the material which comprises them. In general 'the gravel sized particles are greywacke whereas the sand and silt sized particles are of marine origin'. (Rich, 1959,22).

The period of river aggradation during the glacials was then followed by a period of degradation during an interglacial. The decrease in the sediment supply accompanying the return to warmer conditions would firstly lead to an end of aggradation and then the commencement of river entrenchment which in the Manawatu Region was intensified by uplift (Fair, 1968). Initially the rivers entrenched themselves into their own deposits but eventually they cut into the underlying bedrock. (Heerdegen, 1972)

In this way the four major terraces of the Manawatu Valley identified by Fair (1968): the Forest Hill, the Milson, the Ashhurst , and the Raukawa were formed.

Subsequent to the formation of the Pleistocene terraces a series of minor terraces were created during the Holocene. These are of comparatively little importance as they are not associated with any climatic or sea level changes.

Terrace cover deposites in the Manawatu

The cover deposites associated with each of the major Manawatu terraces are distinctive and have been of use in the estimation of the ages of the terraces.

All the major terrace surfaces are mantled with loess. (Cowie, 1963). This loess accumulation was greatest during the cold phases of the Pleistocene when conditions were most favourable for its formation and accumulation. The cold phases were characterized by an abundance of rock debris, a lack of vegetation and the existence of strong anti-cyclonic winds around the glaciated areas. (Stevens, 1974).

The cover beds of the Forest Hill Terrace also include a relic soil immediately above the terrace gravels and below the loess. (Fair, 1968). The Aokautere Ash dated at 21,000 years B.P. ± 500 years (Cowie, 1963,) is also to be found in the Forest Hill profile embedded within the loess deposits.

The Milson profile is similar to the Forest Hill in that it also contains the Aokautere Ash. However, in this case the loess deposits are not so thick and no relic soil is apparent.

The profile of the cover deposits associated with the Ashhurst Terrace is totally different from those of the older two terraces. On the Ashhurst Terrace the terrace gravels are directly overlain by a thin veneer of loess within which the Aokautere Ash is not to be found. This means that the Ashhurst Terrace was either formed after or was being formed at the time that the Aokautere Ash was deposited. (Fair, 1968). Since the creation of the Ashhurst Terrace the accumulation of loess has decreased and had probably ceased at least

6,000 years B.P. (Cowie, 1963).

The estimated ages of the Manawatu, Rangitikei and Pohangina Terraces

Recent studies of the Rangitikei Terraces (Milne, 1973) are of importance to studies of both the Pohangina and Manawatu Terraces since river terraces are primarily formed by the aggredation and degradation of rivers in response to climatic changes and associated changes in sea level. As both climatic change and sea level change are phenomena that extend over large areas it is to be expected that an aggradational phase or a degradational phase in one river basin is likely to have its counterpart in neighbouring basins. Thus the dates of terraces in the Rangitikei should conform closely to those previously obtained for the Manawatu Terraces. Furthermore, an accurate dating of the Manawatu River terraces is of significance for any study of the Pohangina Valley as three of the major Manawatu Terraces identified by Fair (1968), that is : Forest Hill, Milson, Ashhurst, appear to be represented in the Pohangina Catchment.

Various researchers have estimated an approximate date of formation for all the major Manawatu River Terraces and the older Marine formation that is present in the region. Milne (1973) has recently concluded a detailed study of the terraces in the Rangitikei Basin, which includes an attempt to establish their ages. The combined results of all these researchers are summarized in Table 1.

TABLE 1.

The estimated ages of the terraces of the Manawatu and Rangitikei Basins

Terraces of the Manawatu	Age (000s yrs.B.P.)
Tokomaru Marine Terrace	45,000
Forest Hill	37,000-45,000
Milson	32,000-35,000
Ashhurst	18,000-21,000
Raukawa	14,000-14,400

Source: Suggate, 1965.

Terraces of the Rangitikei	Age (000s yrs.B.P.)
*Ngarino and Rapanui Marine Benches	80,000-120,000
*Porewa	70,000-80,000
Putorino	40,000-70,000
Rata	30,000-40,000
Vinegar Hill	25,000-30,000
*Ohakea	12,000-25,000
Bulls, Rewa, Onepuhi, Kakariki	0-12,000

Source: Milne, 1973.

1 A recent C^{14} dating of a log within terrace gravels beneath the lower Manawatu floodplain by Hesp and Shepherd (N.Z.3938) gave an age of 42,700 yrs.B.P. (corrected C^{14} years). The gravels are probably contemporaneous with the Milson Terrace gravels.

*Supported by absolute dating techniques.

An analysis of Table 1. indicates that some of the terrace ages correlate satisfactorily. Heerdegen (1972,9) states that 'the Ashhurst Terrace might be co-eval with the Ohakea Terrace on the Rangitikei River'. This proposition appears to be supported by the dates given in Table 1, however, it would ~~also~~ seem that the Lower Ohakean Terraces of the Rangitikei are also co-eval with the Raukawa Terrace of the Manawatu. Furthermore, Heerdegen (1972,9) states that 'it is probable that the Milson Terrace in the Manawatu Valley is co-eval with the St. Johns Terrace in Wanganui and the Rata Terrace in the Rangitikei Valley.' Again this proposition is supported by the estimated dates in Table 1. Assuming that these two terraces are in fact co-eval, then it is to be expected that the Forest Hill Terrace in the Manawatu Basin is equivalent to the Putorino Terrace in the Rangitikei. If this theory is correct then the Porewa Terrace in the Rangitikei Valley appears to have no counterpart in the Manawatu. The same also applies to the Vinegar Hill Terrace .

At this point a number of discrepancies become apparent. Evidently there are more terraces present in the Rangitikei Valley than in the Manawatu Valley. No explanation for this has so far been presented in the literature.

In addition the youngest marine bench identified by Milne (1973), the Rapanui is dated by him at between

80,000-100,000 years B.P. which is more likely to be the correct age for the Tokomaru Marine Terrace estimated at 45,000 years B.P. by Suggate (1965).

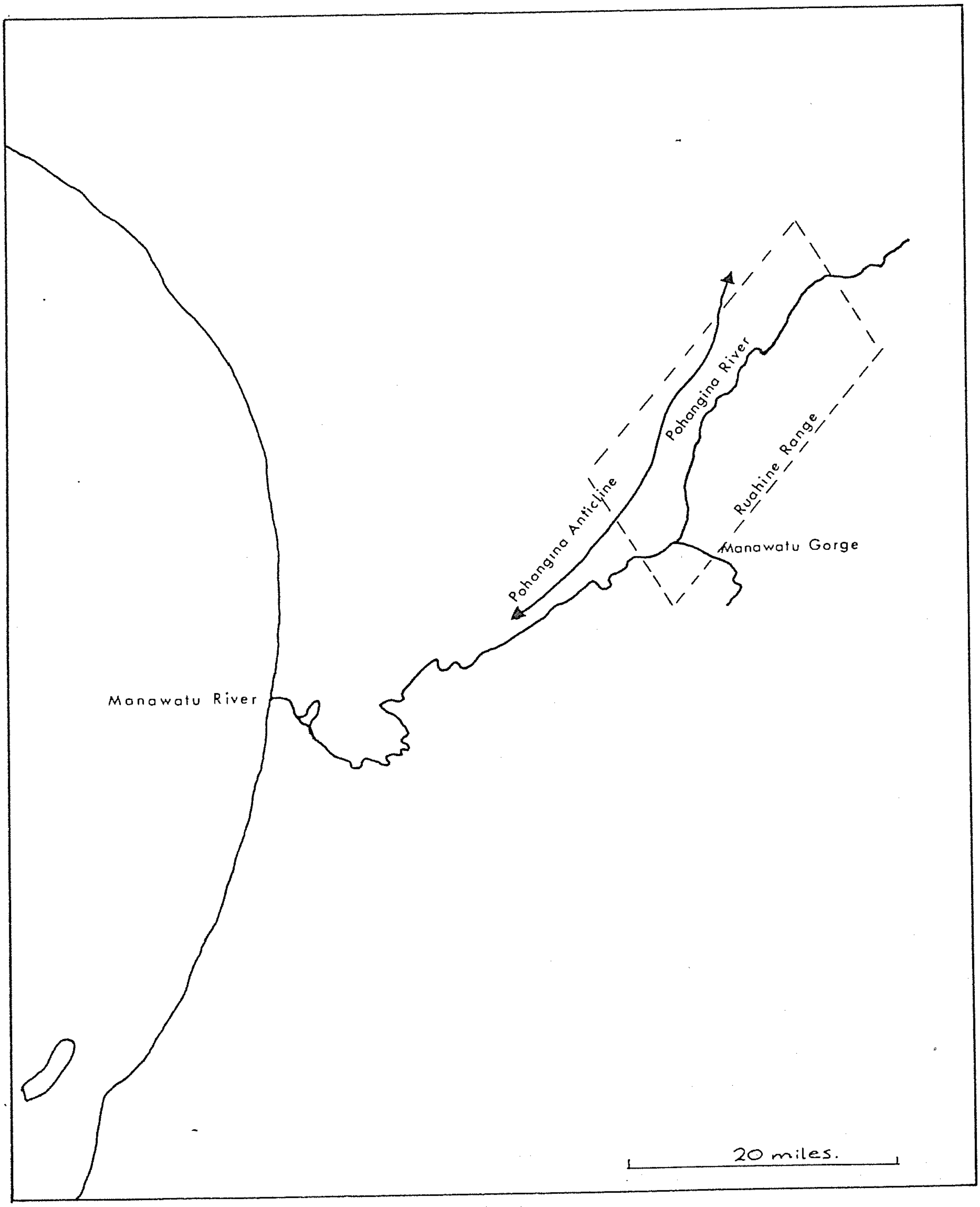

Figure 1 Research Area

THE POHANGINA RIVER TERRACES

Location

The Pohangina Catchment lies along the western margin of the Ruahine Range to the north of the Manawatu Gorge. The Pohangina Anticline, which generally runs parallel to the Ruahine Range, as its axis follows a southwesterly direction, forms both the western and northern boundary of the Pohangina River System. Together these two features of higher elevation combine to give the Pohangina Catchment a pronounced northeast to southwest orientation.

The area of study (Figure 1) extends twenty seven miles north from the township of Ashhurst, where the Pohangina and Manawatu Rivers combine, to the settlement of Umutoi. Further upstream beyond the twenty seven mile mark the Pohangina River is confined to the main Ruahine Range a region outside the area of study.

Field Techniques of Data Collection

In the field the heights of the various terraces were measured by means of a Paulin's Surveying Aneroid. All field measurements were tied into known spot heights located in the Pohangina Catchment. Such known heights include: Manawatu Catchment Board benchmarks that extend at half mile intervals twenty one miles up the Pohangina River Bed from Ashhurst, Survey Trigs located at co-ordinates 287-534 and 361-690 (N.Z.M.S. 1. N.144 Feilding); and bridge decking heights at Raumai, Totara Reserve, and Piripiri located at co-ordinates 269-529, 329-639 and 409-719 respectively (N.Z.M.S. 1. N 144 Feilding)

Problems of Data Collection and Interpretation

Changes in barometric pressure as well as changes in altitude affect the altitude readings given by Aneroid Barometers. In order to minimise the error attributable to changes in barometric pressure, field work was only undertaken on relatively stable days when an anticyclone covered the country.

To aid in the correlation of the Pohangina River Terraces a Watts Telescopic Level was used in the field. The limiting factor here was that sightings, in order to be useful, had to be made at right angles to the strike of the terraces. Sightings where possible, were made at right angles to the present river bed in an attempt to ensure that this was the case. However, there can of course be no guarantee that when the major river terraces were formed the river flowed in precisely the same place as it does at present. Thus sightings made through the Watts Telescopic Level are only approximately at right angles to the strike of the terraces.

Further complications, associated with the use of the Watts Telescopic Level to correlate the terraces, arise out of the fact that the terraces on either side of the river appear to have been altered to different degrees by subsequent tectonism. Where the use of the Watts Telescopic Level appeared to be unsuitable correlations were made on the basis of Aneroid readings.

Descriptions of the Pohangina River Terraces

Throughout much of the Pohangina Valley the river terraces, especially the younger ones such as the Ashhurst and Milson, are well preserved. However, in several places all the major terraces are entirely absent.

On the east bank of the river the terraces have been completely removed between the junction with the Manawatu River to a point approximately five miles upstream from Ashhurst (appendix 1). All the major terraces are also absent on the east bank between Totara Reserve and Komako (Appendix 3) a distance of three miles. In both of these instances lateral erosion by the Pohangina River has been responsible for the removal of the major terraces, as in both of these places the present bed of the river is located close beside the western boundary of the Ruahine Range.

Sizeable areas on the west bank of the river are also devoid of major terrace remnants. From Totara Reserve to a point three miles south of the reserve the terraces have been removed by the actions of Coal Creek and Beehive Creek both major tributaries of the Pohangina River and which flow parallel to it (Appendix 3). Further upstream on the west bank lateral erosion by the Pohangina River has again been responsible for the removal of the terraces for a distance of four miles below Piripiri Bridge (Appendix 4). In this case the Pohangina River is at present eroding the eastern margin of the Pohangina Anticline.

ANALYSIS OF RESULTS OBTAINED IN THE POHANGINA VALLEY

The relationship between the Manawatu and Pohangina River Terraces

Because the Manawatu Gorge acts as a local base level for the Upper Manawatu Catchment, it is only possible to construct a long profile that is likely to resemble the so called graded profile of Davis, by combining the river and terrace profiles derived for the Manawatu and Pohangina river systems.

Unfortunately, a similar combination of profiles incorporating the Manawatu and Oroua Catchments is not possible. Although the Oroua River is the only other major tributary of the Manawatu that joins it west of the Gorge, the terraces associated with the two rivers are not present at the point of juncture in the Kairanga Basin, which is an area of fluvial deposition.

From Figure 2 it is at once apparent that there is a reasonable degree of continuity between the present Manawatu and Pohangina Rivers and the terraces associated with them.

Figure 2 also appears to suggest a certain cyclic pattern in terms of the nature of the junction between the two river systems. The Forest Hill profile is obviously unusual and confused at this point, and the sag in its long profile is difficult to explain. The Milson Right Bank profile would, however, seem to indicate that the two rivers had during the period of its formation attained a highly graded condition and were in a state of harmony with each other, as is evident from the uniformity of the terrace profile at the point of intersection.

The point of inflection in the Ashurst Terrace profile and the present river profile would tend to suggest that since the formation of the Milson Terrace the discontinuity between the two river systems has increased. Such discontinuity may be the result of one of the rivers moving towards a new state of grade. Such a movement may have been made necessary by tectonic activity altering the Pohangina Catchment. Alternatively, changes in the grade of the Manawatu River may be responsible for the development of these points of inflection. The recorded downstream migration of gravels which tend to suggest that the Manawatu River may be aggrading, coupled with the fact that the Pohangina terrace profiles are surprisingly lacking in tectonic deformation (Figure 3) would tend to support this notion.

It is perhaps sigificant, and worth mentioning at this point, that the Raukawa Terrace which is fairly extensive in the Manawatu Valley (Heerdegen, 1972,10) does not appear to be present in the Pohangina Valley. If it is in fact present in the Pohangina Valley it can only occur in the lower catchment close to the existing river channel. This being the case it must be of very low relief since it is not readily distinguishable from the Holocene terraces. The noticeable lack of any minor terraces below the Ashhurst terrace in the upper catchment (Appendix 4) would suggest that the Raukawa Terrace is definately not present further up the valley.

Terrace Gradients

Figure 2 and Table 2 indicate that in general the average gradients of the Pohangina Terraces are greater than those of the corresponding Manawatu Terraces.

In addition Table 1 illustrates that the older the terrace, the steeper ~~will be~~ is its average gradient. Hence with the exception of the East Bank Milson Terrace the Pohangina Terraces diverge to the north and converge towards the Gorge in the south. This distinctive characteristic would tend to suggest that greater tectonic uplift has or is occurring to the north in the upper Pohangina Catchment.

Subsequent deformation of the Pohangina River Terraces

Although the Pohangina Terrace profiles generally show a surprising lack of deformation due to tectonism (Figure 3), there are several irregularities that are most likely explained by subsequent tectonic activity.

The greatest irregularity evident involves the lower sections of the East Bank Ashhurst Terrace, which is markedly deformed. At the point where the greatest deformation occurs the side ridges from the Ruahine Range extend down very close to the existing river channel; consequently terraces older than the Ashhurst

TABLE 2

Average terrace gradients

Manawatu Terraces	Gradient (fall per mile in feet)
Manawatu River	6·0
Ashhurst	11·6
Milson Left Bank	13·2
Milson Right Bank	19·3
Forest Hill	22·1

Source: Fair, 1968,72

Pohangina Terraces	
Pohangina River	26·6
Ashhurst East Bank	26·0
Ashhurst West Bank	32·7
Milson East Bank	38·4
Milson West Bank	37·7
Forest Hill	50·0

Source: Field survey, September 1976.

1 All average gradients are derived from the altitudes of the terraces at the eight and twenty one mile marks except the Forest Hill. In the case of the latter the altitudes of the two and twenty one mile marks were used.

are non existent at this point which means that they can not be examined to see whether they also exhibit a similar pattern of deformation. However, immediately upstream from the area of maximum deformation, which lies between ~~the~~ 5·5 and 8·5 miles upstream from Ashhurst, the east bank Milson Terrace is present and at this point displays a very regular uniform profile. This would tend to suggest that the tectonism responsible for the warping was centred close to the present river bed. This notion is further supported by the fact that at the corresponding point the West Bank Ashhurst Terrace also displays some slight deformation (Figure 3).

Between 11·5 and 15 miles above the township of Ashhurst there is evidence to suggest the presence of a fault running in an east west direction from the Ruahine Range to the present river bed. Both the Ashhurst East Bank and the Milson East Bank at this point display an identical irregularity in their profiles (Figure 3). From the nature of the irregularity it would appear that the area to the north of the suspected fault line has been downthrown relative to the south side.

Similarily at approximately the 12 mile mark both the Ashhurst and Milson west bank terraces exhibit parallel changes in their gradients (Figure 3). This also may indicate the presence of an east west fault or fold, again with the northern side apparently downthrown relative to the south side.

An examination of the differences in altitude between the various terraces reveal that the major faulting in the area probably has a northeast southwest orientation and thus runs parallel to the terraces along the present river bed. Indeed such a fault running northeast from Raumai is marked on the geological map for the area. (N.Z. Geological Survey Sheet 11 Dannevirke). This proposition is further supported by the fact that generally the terraces on the east bank are higher than their equivalents on the west bank, except where probable east west folding or faulting has complicated the situation. (Figure 3).

In summary the fault or fold pattern of the Pohangina Catchment would appear to be one where the principal fault runs in a northeast southwest direction approximately along the river bed. Upon this basic pattern, it appears, is then superimposed a series of smaller faults or folds running in an east west direction.

Terrace cover deposites in the Pohangina Valley

The cover deposit profiles on the Forest Hill and Milson Terraces in the Pohangina Valley seem to be very similar to those observed in the Manawatu Valley.

The thickness of the loess cover on the Ashhurst

Terrace makes it readily identifiable in the Pohangina Valley; more so than in the Manawatu Valley. In the lower Pohangina Catchment the loess layer covering the Ashhurst Terrace is relatively thin, generally about three feet thick. However, in the upper reaches of the Pohangina Valley the loess cover on the Ashhurst Terrace is virtually non-existent and the terrace gravels protrude at the surface. The fact that in the upper reaches of the Pohangina River the present river channel is narrow and deeply incised, and is thus relatively sheltered from the prevailing northwest wind could account for this low level of loess accumulation.

As the prevailing wind in the Pohangina Valley is from a northwesterly quarter it is to be expected that loess accumulation will be greater on the eastern side of the river. Field observations suggest that this may be the case on the Ashhurst Terrace, although it is difficult to draw any conclusions regarding this matter for the Milson and Forest Hill Terraces. Differences in the rate of loess accumulation between the two river banks may also be a ~~contributary~~ factor that helps to explain the apparent differences in altitude between corresponding east and west bank terraces.

CONCLUSION

This study should be regarded as a preliminary investigation of the Pohangina Catchment in the expectation that more work will be undertaken in the area. The literature on neighbouring river basins, especially the Manawatu, in association with my field observations have enabled several contraversial points to be discussed, although much more field work is necessary before any definate conclucions can be reached.

From the results obtained it would appear that the terraces found in the Manawatu Valley extend up the Pohangina Valley to the point where the river issues forth from the Ruahine Range. Field evidence indicates that all of the Pohangina Terraces have a mantle of loess on them. This mantle varies markedly from place to place, especially on the Ashhurst Terrace.

Before any field work was carried out the literature on the Manawatu Region seemed to indicate that I would find the Pohangina Catchment very complicated in terms of denudation chronology and geomorphology. It was expected that subsequent tectonism, landslides and eroision by tributaries would have deformed, obscured and removed the river terraces. Perhaps the most significant result to emerge from this study is that the river terraces appear to be remarkably unaltered. This suggests that the past history of the Pohangina Valley is not as complicated as was first thought.

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