Aerial Photography in New Zealand Archaeology

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Vertical aerial photographic coverage of New Zealand coastal districts (where most archaeological sites are found) was completed by the early 1950s. Systematic use of aerial photographs for archaeology, reconnaissance, as an aid in field survey, for mapping, illustration, analysis and for the measurement of rates of deterioration or destruction of archaeological sites, commenced in the late 1950s. Types of site for which the medium is useful include the Maori (Polynesian) earthwork fortifications of New Zealand, known as pa, horticultural plots demarcated by trenches or stone rows, and storage pits. Photographs relying on fine relief shadows are most commonly used. From the nineteenth century, there is potential to illustrate and analyse remains of early farming, industry, including gold-mining, and standing buildings shown in their wider setting.

Aerial photographs are most conspicuously of use in discovering or revealing patterns that are not readily seen in the ground view. It is not the purpose of this paper to analyse why that should be so. Generally, archaeologists use this capacity to reveal pattern in several ways: simply to illustrate, where the dramatic revelation of pattern first comes to be useful; to assist in fieldwork; to gather mapping data cheaply, efficiently and more powerfully, to further analyse the data and to consolidate it over wider areas than the single view; and finally, as an archive from which what has been lost in the field can be recovered, and to determine rates and causes of destruction. Basic techniques include the enhancing of the images of surface earthworks, crop and soil marks by the choice of time of day or season, camera viewpoint and the use of different filmstocks.[1]

New Zealand has been influenced by both American and English sources in the development of archaeological studies.[2]

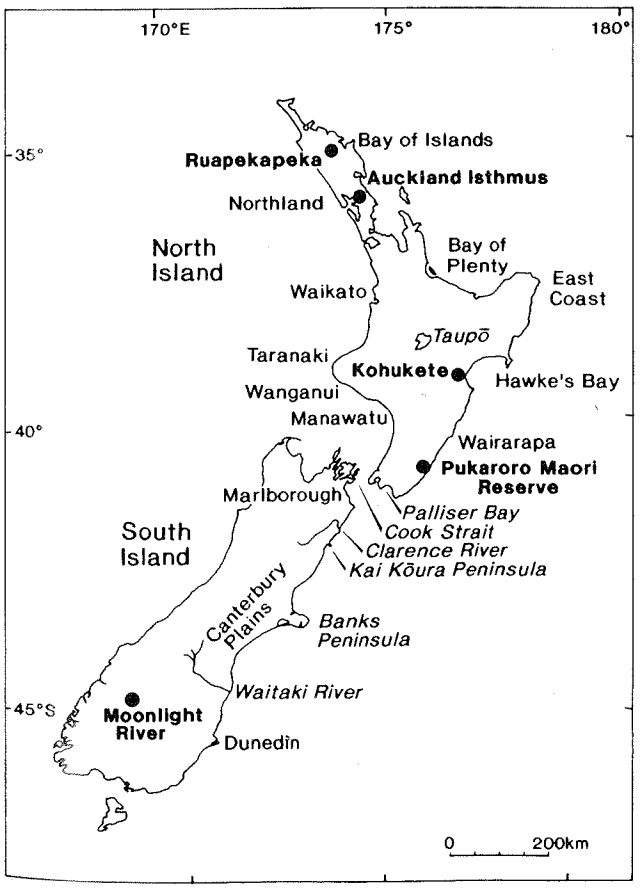

Fig. 1: Map of New Zealand showing places and regions mentioned in text.

However, soil and cropmarks feature relatively little in the New Zealand aerial photographic record. Although there are the usual textural and colour changes between generally dark topsoils and lighter-coloured subsoils, these contrasts are not as marked as they are, for example, in the chalk downlands or Pleistocene gravel terraces so much a feature of southern England. In the course of postgraduate student work on pa distribution in New Zealand, Ken Gorbey discussed the nature of New Zealand soils and the reasons why cropmarks are few. He concluded that this phenomenon resulted from the poor contrast between topsoils and subsoils, drawing the obvious lessons from the English experience of alluvial and chalk lowlands.[3] In New Zealand, such soils with extensive pre-European settlement are almost non-existent. The Pleistocene gravel alluvium of the South Island's Canterbury plains, New Zealand's principal grain-growing region, had relatively little settlement, although occasional soil marks of earth ovens are known.

The time depth of New Zealand history, generally believed to be little more than 800 years, means that there is less opportunity than in Europe for the successive patterns of occupation, accompanied by repeated cycles of destruction, to be revealed by cropmarks. The generally small pre-European population in New Zealand also contributes to this relative lack of complexity in the record of cropmarks. Shadow or relief marks of fortifications and horticultural sites have therefore been the stock in trade of aerial photographs in New Zealand archaeology. Particularly fine oblique aerial photographic surveys have been conducted by New Zealand Aerial Mapping, Ltd, in Hawke's Bay; Buist and Prickett (separately) in Taranaki; Edson and Sprenger in the Waikato and Smart in Wanganui.[4]

Aerial photographs have been used elsewhere in the Pacific, notably in the study of earthwork fortifications in Fiji, and general similarities of application to New Zealand can be seen. Aerial photography appears to have been relatively little used in Australia, partly because of the small area and relatively fine detail of most pre-European sites, an exception being the Victorian eel trapping complexes. In addition, it could have extensive application in the historical era.[5] Vertical aerial photographs taken at low altitudes (1 600 feet or less) will give scales on medium format negatives of about 1:6 000 and, enlarged to larger scales, could be of use for planning larger buildings or foundations and their environs.

Another constraint on the relevance of aerial photographs is the distribution of earthwork sites in relation to climatic, vegetation and land use factors in New Zealand (Fig. 1). Few pa appear south of the 'pa line', from the Manawatu across to the Wairarapa coast, at about 40°S. A total of 6 351 pa lie north of this latitude and 210 to the south.[6] This line reflects the

general southward reduction in population density late in pre-European history dictated by the marginal horticultural conditions south of about 42°S. In favoured coastal terrace lands to the south, however, pa occasionally do achieve the landscape prominence of their northern counterparts. A prime example is the complex of pa on the Kai Koura (Kaikoura) Peninsula in southern Marlborough.[7]

AERIAL SURVEYS

New Zealand coastal districts had conventional vertical aerial photographic coverage by the early 1950s. This body of work is a great asset in field survey since many sites were photographed that have been subsequently destroyed or truncated. There was a significant increase in government-sponsored forest and shrubland clearance in the 1930s. The 1950s were also pastoral boom years. Since then, occasional fiscal boosts to pastoralism notwithstanding, much land has gone back into bracken fern or shrubland and sites show poorly. Also, the earliest air photos were taken in slow aircraft which often flew all day over the survey scene at a relatively low altitude; all-season work was a feature and altitudes were low, negative scales of 1:12 000–15 000 are not uncommon (these were reduced in scale to prepare the draft inch-to-the-mile mapping series and there was a curtailed attempt at mapping at 1:25 000). As a result, both shadow definition of features and the size of features make for clear images. There are very few images available at scales on the contact print larger than 1:12 000.

These earlier vertical air photographs, then, used in stereo pair runs for areas up to 60 kilometres square, are valuable in reconnaissance for many reasons: to determine relict terrace landforms indicating old river courses and levels suitable for settlement; to indicate areas or zones worth searching by foot; as a record, and often the only record, of destroyed sites; as an aid to field sketches of the plans of sites, some of which could be large (1 000 metres or more long) and of very complex topography; and finally as an aid to identifying the exact position of a site and its extent where the mapped base at inch to the mile (100-foot contours) or the current 1:50 000 (20 metre contours) was inadequate.

AERIAL PHOTOGRAPHS AND SITE PROTECTION

Aerial photographs have long been recognised as a potential source of information on the lost archaeological landscape, to determine rate of loss, and to elucidate otherwise cryptic fragmentary remains. The earliest photographs are doubly important because they portray sites now destroyed by land development in the late 1970s. Earthwork sites have suffered terribly from urban encroachment. Extensive areas of the pa and horticultural stonefields of the Auckland Isthmus have been mapped from photographs or with the aid of photographs.[9] Elsewhere, farm livestock (especially dairy cows or beef cattle) and the construction of farm roads and fencelines also do great damage which would be difficult to monitor in the long term without photographic records. In sheep-grazing country, typical of land-use in the eastern North Island, sites can be subject to camping by sheep (which seem to like ridge crests for their warmth) but are generally in better condition. Aerial photographs repeated at regular time intervals to catch images of sites in good condition and to monitor degradation will be of benefit.[10]

With the passing of the *Historic Places Amendment Act* 1975, and its hard-won protective measures for archaeological sites, there was a surge in primary recording, both for development projects such as afforestation and more widely in area surveys. Aerial photographs, often commissioned by the development agency (e.g., the former New Zealand Forest Service), were widely used for survey and documentation of site location for land management purposes. Some purpose-flown vertical and oblique aerial photography was also carried out in the course of district surveys and archaeological site inspections for statutory protection, but these were shoe-string affairs.

RECENT AERIAL PHOTOGRAPHY

Recent work in the medium of aerial photography has been funded by a grant from the Science Research Committee of the New Zealand Lotteries Board.[11] Lenses used were Mamiya TLR 120 mm square format cameras fitted with prism viewfinders with the 180 mm (telephoto) lens (most commonly used) and the 80 or 55 mm (wide angle). These are the 35 mm SLR camera equivalents of 100, 45 and 35 mm focal lengths. The rack and pinion mechanism is checked for focus and set at infinity by a plate lodged under it.

The wider angle work is with colour negative film, and the 180 mm in black and white. Film speeds are usually 100 ASA, with 400 ASA used on crop marks on hazy or overcast days. To avoid camera shake, 400 ASA is also desirable for use with the 180 mm lens. Typical exposures in summer with the 180 mm lens and 100 ASA would be f5.6 or f8 at 1/250th where no horizon is exposed. Recently, I have purchased a constant f-stop (f2.8) 28–70 mm Sigma zoom lens and a similar (f2.8) 70–200 mm Pentax zoom for the 35 mm cameras (Pentax P50s) to avoid the loss of shutter speed or wider apertures required by conventional zooms at their longer focal lengths. Exposure is aperture priority (say f8) with shutter speed set automatically at a stop less than that indicated by the meter. This improves shutter speed and compensates for over-exposure in predominantly green subjects.

In the air, practice is to fly between 800 and 1 200 feet, circling the subject to provide a 60° to 45° (above the horizontal) oblique view. (Lower oblique views do not make best use of the aerial platform although they might be used to snap subjects while cruising and a diversion closer towards the site is not worthwhile.) After this phase, if the subject warrants, altitude might be increased to about 2 000 feet and high-angle oblique (near-vertical) shots are taken with the plane in a hard bank. A Cessna 172 is the ideal aeroplane: it has a high wing, reasonable cruising speed, and the side window can be unlatched and flipped right up in the slipstream. The door can be taken off but this involves additional belts for security and other difficulties with film and document handling. Also voice-activated intercom with the pilot will be permanently on and transmitting slipstream noise in these circumstances (as it is when the window is open). Optimum speed is about 70–80 knots (stall is about 60 knots) throttled back from about 100–110 knots cruising. In 1996, I used a Cessna 185 fitted with a 15-inch floor opening to take vertical photographs with the Mamiya and the standard 80 mm lens. Simple time calculations allow the interval between shots to be determined so that each shot has a 60 percent overlap with the next. Ideally, a camera with motor drive connected to an intervalometer would be used, but I have found that an electronic metronome with LED and an earphone sound blip (the in-ear earphone is tucked under the intercom earphones), set at 0.5 seconds, can be used to set intervals from 2.5 seconds through to whatever interval might be needed at higher altitudes.

And finally, the weather: New Zealand, being in the zone of westerly cyclonic weather for much of its latitudinal range and remote from continental influences, seldom has stable weather. However, periods of up to two days without cloud are not uncommon as high pressure systems cross the country. Significant differences in cloud cover will occur between eastern and western districts in the course of the cycle of high pressure. Although a haze created by high humidity can be a

problem in northern districts, smoke or dust haze is uncommon; amongst landscape artists, New Zealand has long had a reputation for harshness or clarity of natural light.

Pre-European sites

Pa are the distinctive earthwork fortifications of New Zealand.[12] The term 'pa' is derived from a proto-Polynesian stem meaning 'fenced enclosure'.[13] Typical archaeological features are ditches and banks, sometimes multiple, in a wide range of landforms such as ridges, promontories, or terrace edges which were selected for ease of defence. On ridges or ridge ends, the defensive elements often comprise single or double (rarely, triple) transverse ditches and lateral ditches or steepened scarps (Fig. 2). 'Ring-ditch' forms, in which the ditch and scarp encircle a more or less rounded hill top or enclose a cliff edge, are common in some regions. On flat land, single or double ditches and banks, rectangular in plan, enclose the terrace scarp, or straight sections cut off points in alluvium. Occasionally, broad points are cut off by ditches and banks forming a dog leg in plan, drawn across the point and along the scarp line leading down to lower flood-prone terraces. Pa may range in area from 200 m^2 to 50 000 m^2. Measures of area are not really adequate when the sites lie on narrow ridges (Fig. 2); a single site could occupy up to two kilometres along a ridgeline. All these subjects lend themselves to photography depending on shadow-definition of relief features.

Polynesian horticulture in temperate New Zealand relied on root crops which had to mature in a short (compared with the tropics) growing season. A number of techniques, including site selection, shelter, mounding, and mulching with gravels, were used to improve soil and air temperatures through that growing season. In so far as these soils remain today, they may be able to be documented using thermal

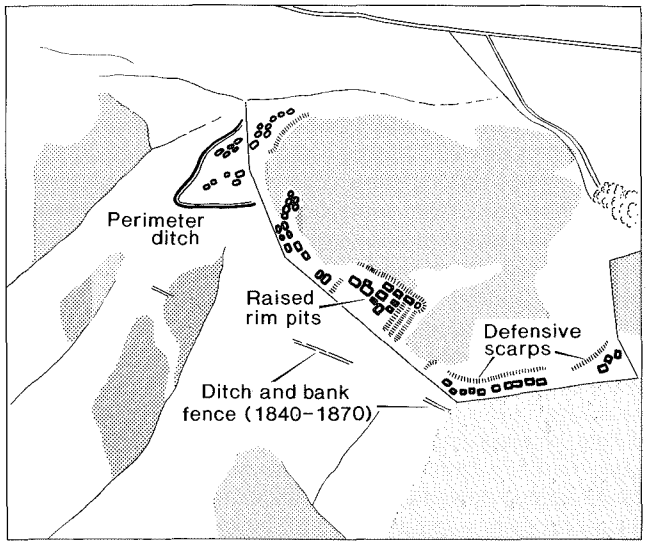

Fig. 2 interpretation

Fig. 2: Kohukete, one of the largest pa in the Hawke's Bay region, occupied during intertribal warfare in the 1830s. The crest of the hill (top left) is enclosed by a defensive ditch and bank which has been damaged to the right of the prominent fence line. At centre and on the near side of the fence, raised-rim pits have been ploughed out.

infrared techniques. However, as with pa, a pragmatic approach to recording surface features has been predominant. On the surface, horticultural sites take two general forms: stone constructions on stonefields on low coastal terraces with remnant boulder beaches (Fig. 3), or stonefields of volcanic origin; or trenches dug into colluvial slopes or alluvium. There is general agreement that the long linear heaps of stones, or stone rows (not unlike the reaves of the upland moors of England) were designed to demarcate plots and otherwise create pathways through plots that would be highly *tapu* (forbidden) at certain stages or for certain people.

Aerial photographs have been an essential cost-effective analytical tool for locating and detecting pattern, and measuring and making plans of a wide range of horticultural plots.[14] This has offered unparalleled insights into the function of the plots, choices of soil types, land tenure practice, and the relationship between plot locations and the wider settlement pattern.

Typically plots are long, narrow and aligned down slopes, suggesting that land was divided to give access up slopes from the sea or river (or some other boundary dictated by political or natural setting) and to distribute a reasonable proportion of the best toe-of-slope locations to the cultivator's work group.[15] 'Long plot' sizes are of the order of 150 metres by 10–15 metres across the slope, divided into smaller plots by transverse rows or terraces at 15–30 metre intervals. Ancillary functions of stone rows may have been windrowing (removing stones and other debris from land clearance and placing them in rows), lines of shelter (perhaps with a superstructure of brush), and places for the vines of the major dryland crops, yam (*Dioscorea alata*) and kumara (sweet potato, *Ipomoea batatas*). Gravel quarries (for adding gravel to the soils) and scatters of small numbers of house terraces and storage pits are occasionally found associated with areas of garden plots.[16]

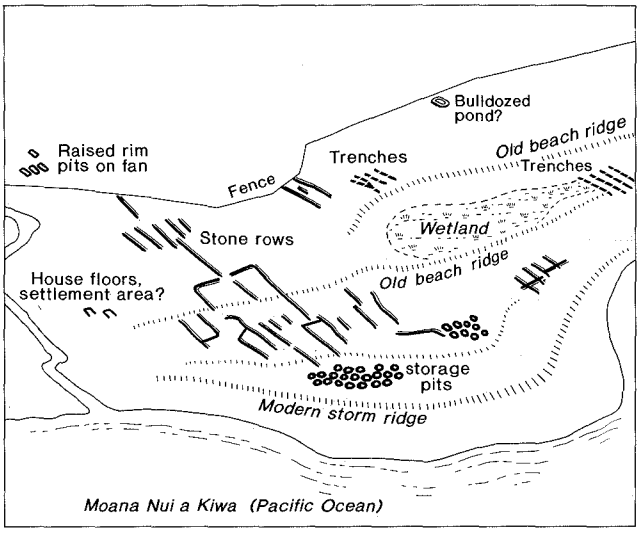

Fig. 3 interpretation

Fig. 3: Horticultural land division, Pukaroro Maori Reserve, eastern Wairarapa, at the foot of steep hill country. Several phases of tectonic uplift have exposed some 3–4 old beaches and beach ridges above High Water Mark. Stone row plot divisions have been made across the coastal strip using the beach ridges as cross boundaries. Storage pits form an array of regular depressions on the foreshore. Other details include sand quarries and raised-rim storage pits.

Trenches, on the other hand, come into their own in the consideration of taro (the root crop, *Colocosia esculenta*) cultivation. Their distribution is more or less co-extensive with regions in which taro was grown — i.e., north of 39°S, or somewhat to the north of the latitudinal tolerance of sweet potato. Trenches, like stone rows, are aligned down slope for up to 150 metres, with average spacings across the slope as close as six metres in the extreme case. A spacing of 15 metres is more typical. Trenches are generally regarded as plot boundaries and drains.[17] The overall impression of such gardens would have been of finely managed inter-cropping of the various species, with taro also grown in the trenches themselves.[18]

Storage pits are also a common feature of the archaeological landscape. They are in two forms: semi-subterranean, rectangular forms with or without raised-rims (originally an earth bulwark under the eaves of the roof); and fully subterranean with a bell-shaped section and a narrow, usually vertical entrance way.

Nineteenth-century sites

Sites include those related to warfare, both intertribal and as response to colonisation, as well as pastoral, agricultural, industrial and mining activities. Of the last, gold-mining is perhaps the most spectacular.

Earthwork fortifications fall into four broad periods: (1) the musket wars of c.1810–1835, when intertribal warfare flourished, with muskets more readily available to northern tribes,[19] allowing them a strategic advantage in the settling of ancient rivalries; (2) the Northland phase of the New Zealand Wars in 1845–1846 when British marines and troops engaged in two failed attacks in the inland Bay of Islands and one successful attack at Ruapekapeka; (3) the main Taranaki and Waikato phase of the New Zealand Wars in 1860–1864; and (4) the last phases of the New Zealand Wars in which, under the 'self-reliant' policy, New Zealand-financed Armed Constabulary fought for and occupied ground in regions outside the Waikato and northern Taranaki theatres (mainly south Taranaki, Bay of Plenty and the East Coast) in 1865–1870.[20] The best preserved of the known earliest Maori forms of earthwork fortification is Ruapekapeka in the Bay of Islands (Fig. 4).

From 1870–1880, fortifications were maintained as part of military settlements on the 'frontier' (more like the Roman *limes*), especially in the Waikato and Taranaki, but there was little concerted fighting.[21] Because they are only 120–130 years old, and some were taken into Police (now historic) reserves, many fortifications of the later phases of the New Zealand Wars still survive. Typically, they are small redoubts or stockades with blockhouses or 'flanking angles' (extensions of the bank and ditch out from the corners of the redoubt to offer enfilading fire into the ditch). Few Maori fortifications survive from this period.

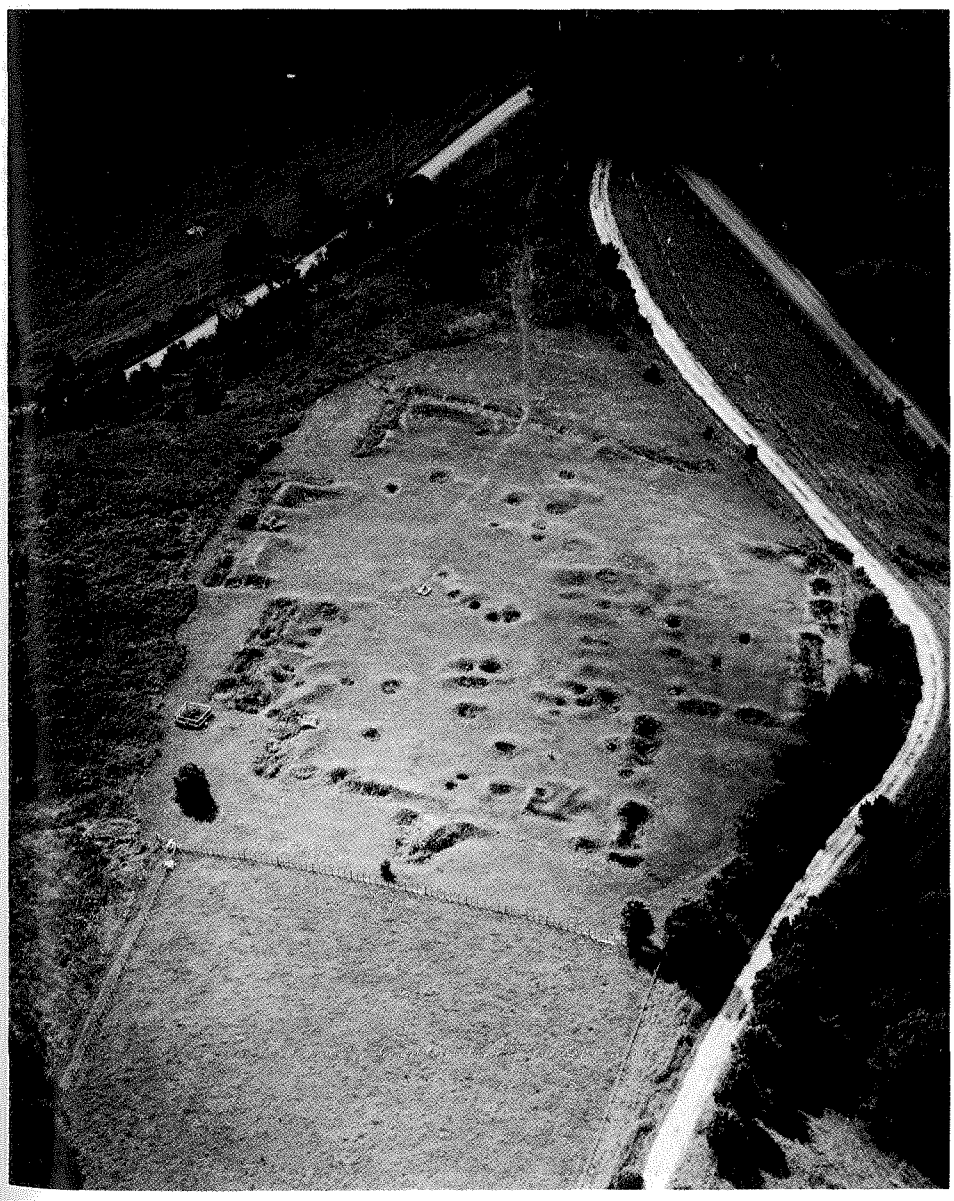

Fig. 4: Ruapekapeka, inland Bay of Islands. British troops defeated Kawiti and Hone Heke, of the Nga Puhi tribal confederation, here in mid-summer 1845–1846. The pa expresses the culmination of three decades of Maori experience in gunfighting. It had a double palisade or stockade in hardwood (marked by the perimeter trench) to defend against ball, and hardwood and earth-roofed pits to defend against shell and rocket fire.

The development of pre-European styles of Maori fortification to accommodate the demands of the musket and, later, the rifle and artillery has attracted much attention, some of it in an attempt to posit a post-modern, or at least revisionary, view of the morality of the colonial encounter. In this view Maori are given superior skills in earthwork fortification, developed from their traditions, and win all the battles of a primarily defensive (from the Maori viewpoint) campaign, providing the model for the successful use of defensive earthworks that so marked World War I in the modern era.[22]

Paradoxically, although the battles are won, the war is lost. If there is a similarity between Maori tactics in the 1840s or 1860 to 1865 and the trench warfare of 1914–1918, it arises because of what anthropologists term 'convergent evolution'. The ease of defence from trenches against massed ground attack had widespread import from the middle of the nineteenth century. With rapid mass movement of troops in flanking manoeuvres, earthworks also came to have offensive potential; the aggressor could force defenders to attack the aggressor's fortifications on the defender's supply lines. Maori were simply participants in a broad mid-nineteenth-century revolution in ground warfare which began with the use of accurate long-range rifle fire by regular infantry in the Crimean War and reached its peak with the shocking casualties of the American Civil War. Aerial photographs are the quickest source for tracing the development of fortifications from the pre-European period, through the intertribal wars from 1820, to the New Zealand Wars.[23]

The beneficiaries of the New Zealand Wars were the pastoralists and agriculturalists. The roots of this industry go back to the 'improving' endeavours of the Church Missionary Society which established a model farm at Te Waimate, inland Bay of Islands district, in 1831. Other less wealthy missions also established farms to support themselves. From this era up until the rationalisation of title in the 1870s, and the introduction of barbed-wire fencing, many historical landscapes are marked by ditch and bank fences (sometimes of great extent) or enclosures.[24] Ploughing also produces useful patterns that can be analytically distinguished from pre-European horticultural features, and potentially dated.[25]

Finally, aerial photographs can be of use in the illustration of industrial archaeology, most notably gold-mining. Gold was discovered on the Coromandel Peninsula in 1852, in Nelson in 1857, in Otago in 1861, and on the West Coast in 1864.[26] Hard rock quartz mining was predominant on the Coromandel and in parts of the other regions. Much of the evidence today is covered in forest. In the semi-arid Central Otago region gold-mining remains are readily available to the aerial photographer. Here alluvial mining, sometimes on terrace country, was predominant. There were probably some innovations in cruder forms of alluvial exploitation using water from races, notably 'blowing down'. In this practice, the water is flooded over broad sloping terraces and the surface broken up by picks. The gravels are borne away by the water to a tail race and riffle or settling box. Later the California sluice monitor was in widespread use, allowing a much deeper working face. This required prospecting at depth of terrace deposits (by digging shafts into likely deposits) and painstaking stacking of boulders (sluiced out of the face) into tailings which also guided water into the settling boxes. Aerial photographs enable close mapping of the features of such sites, and a clear depiction of their systemic features such as integrated supply, head and tail races, water storage dams, the last working faces, and the tailings stacks (Fig. 5). Because of their extent, location on terrace lands suited to intensive use, and, fatally, the ability to re-utilise the older gold-mining infrastructure for irrigation water-supply, many such sites have been destroyed by farming activity.

DISCUSSION AND CONCLUSIONS

Most aerial photography in New Zealand has concentrated on upstanding earthwork fortifications. Compared with elsewhere in Polynesia, these fortifications exist in great numbers in New Zealand, and it is not surprising that they have been, and continue to be, the subject of most attention. The other field of interest where aerial photography has made a real analytical contribution is horticulture, again based on archaeological sites with relief features, although cropmarks and even thermal infrared methods may have potential value. The condition of the surface detail of many New Zealand sites can on occasion be quite fine, and often represents a single phase of occupation. New Zealand archaeologists are probably too little conscious of the volume and the relatively recent age of their earthwork fortifications.

Surprisingly little work has concentrated on within-settlement analyses of pattern. This may be because the required detail does not exist because of nineteenth-century ploughing, but some examples of sites with well-preserved interiors do occur (e.g. Fig. 3–4). Wider patterns of contemporaneous occupation in the landscape have also been ignored. The assumed shortness of the time scale has led to a straining for unwarranted and unachievable precision in establishing contemporaneity instead of simply modelling in some allowance for span of occupation.

Very little work has been possible on cropmarks, probably because physical soil conditions, climatic factors and contemporary agricultural practices do not allow for any significant degree of visibility. This stands in remarkable contrast to the lowland European situation where many eras can be layered on to the landscape and indeed into single sites. The New Zealand situation is more akin to that of two broad situations in the United Kingdom: the uplands which, from the late Bronze Age, were occupied at a time of pastoral land pressure and probably in a climatic optimum; and the lowland landscapes of the Medieval period, where whole settlements were abandoned in the plagues and never re-occupied.[27] Both landscapes exhibit features which are more or less synchronous and rich in detail to the same degree as New Zealand. Both the New Zealand Polynesian and the British landscape have been changed from the time of the eighteenth and nineteenth century by enclosure, brought to New Zealand simply as the predominant ideology of individual ownership of land.

In historical archaeology, the relationship between a few surviving buildings and their surrounds has been little explored. Indicated by cropmarks, the outlines of former buildings, fences, yards, dams, drains, ploughing patterns, etc., should all be readily documented and provide readily appreciated context for the surviving buildings. In low-contrast (light overcast) conditions standing ruins and buildings could also be documented by low-level oblique photographs.

The contribution of aerial photography could be considerable in area-wide analyses and the construction of area histories. Fowler has regularly lamented the inability to ascend 'from a brilliant technique to a discipline which asks and answers questions by its own terms of reference'.[28] This is an interesting comment which itself deserves a closer examination, and possibly rebuttal, than is warranted here. The density of existing site recording and its availability as readily mappable data probably means that aerial photography will and should always be utilised simply as an ancillary to the New Zealand Archaeological Association site recording scheme.

Nevertheless, since it offers a form of data that may be entered directly into systems such as G.I.S., it might be argued that aerial photographs could stand on their own terms of reference. Computer systems sometimes appear to offer a

suitable system of mapping but they have not been widely used in New Zealand. The principal computer-based mapping is from a grid reference and controlled subject code index to the New Zealand Archaeological Association central file. There are other possible avenues of computer usage; for example, computer capture, compilation and enhancement of poor or fragmentary images is not practised, but probably should be if we are to extract maximum value from the older photographic record.

Finally, aerial photography has so far not been closely examined in the process of Maori nationalist revival in New Zealand. A typical feature of the revival is a position on the ethics of how knowledge is gathered and imparted and to whom according to *tikanga* (customary method). The material in museums and rockshelter art has been closely examined and tribal claims asserted over a form of 'copyright interest' in rock art. Could such a claim be made on the images of past settlement? Is aerial photography an intrusion on privacy? What implications would this have for the study of aerial photographs in settlement pattern or other studies?

The ethnic nationalist revival can be juxtaposed against a liberal ideal of openness of information and its dissemination.[29] Scientific method and liberal democracy are built on freely available information, and the right to gather and impart information is conveyed to all citizens in the New Zealand Bill of Rights (section 14, *New Zealand Bill of Rights Act*, 1990). By the same token, executive agencies or academia may be oppressive in their sheer capacity to gather information that minorities may wish to retain, even if solely for partisan historical and ultimately political reasons. Equally likely is that indigenous minorities may feel shamed by the existence of 'external' knowledge which challenges, or may appear to challenge, the locally held traditional knowledge. At a minimum there should be engagement with local communities to the extent that, where not known from recorded mapping, the naming of places is possible.[30] From there, the aerial photograph as heuristic medium can be taken into ethnic communities for community development purposes.

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Fig. 5: Gold-mining complex, upper Moonlight River, near Queenstown, Central Otago. Supply races feed in the dam created by the curved bank enclosure. From the dam, head races run to the sluice faces at the edge of the terrace. The larger rectangular enclosure is probably a stockyard; the smaller is probably a house floor with a perimeter drain.

NOTES

1 Crawford 1924; Crawford and Keiller 1928; Wilson 1982.

2 Blake-Palmer 1947; Duff 1968; Green 1995.

3 Gorbey 1967; 1970.

4 Buist 1964; e.g., Prickett 1980; 1982; others unpublished.

5 Parry 1977; Connah and Jones 1983a; Connah and Jones 1983b.

6 Walton 1995, pers. comm.

7 Brailsford 1981; Jones 1994:220–221.

8 H.M. Leach 1976; 1979.

9 Brown 1961, 1962; Sullivan 1972:153.

10 Prickett 1985; Jones and Simpson 1995; Walton and Jones in press.

11 Jones 1994.

12 Best 1927; Buist 1964; Prickett 1980, 1982.

13 Green 1967.

14 Leach 1976, 1979; McFadgen 1980a, 1980b.

15 Leach 1976, 1979; McFadgen 1980a, 1980b.

16 Leach and Leach 1979; Walton and Cassels 1992; Cassels and Walton 1992.

17 Barber 1989.

18 Jones 1994:66–70.

19 Smith 1910.

20 Cowan 1983; Belich, 1985.

21 Prickett 1994.

22 Belich 1986:291–297.

23 Jones 1994:83–96.

24 Smart 1966; Jones 1994:250–251.

25 Nichol 1983; Walton 1982.

26 Williams 1974.

27 Butler 1991.

28 Fowler 1983:11–12.

29 Ward 1992.

30 E.g., Davis and Wilson, 1990.

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