FIELD RESEARCH AT THE STONE AXE QUARRIES OF WESTERN HIGHLANDS AND SIMBU PROVINCES, PAPUA NEW GUINEA

by John Burton

INTRODUCTION

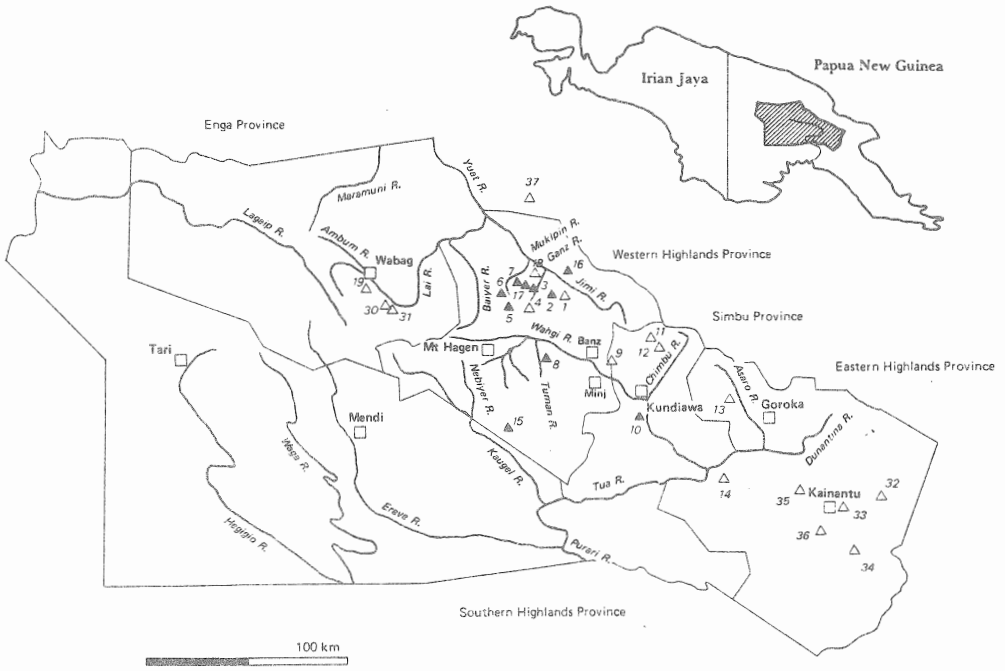
Stone axes, hafted with intricate canework and with quadrangular blades made from distinctively patterned, hornfelsed rocks, are among the most widely noted and easily recognised trade goods of the Papua New Guinea Highlands from the period before the Pacific War. However, published information about the technical and organisational skills of their manufacturers is extremely limited. The main aim of a PhD research project I carried out between 1980 and 1984 was to discover the nature of axe production in the Highlands and illustrate the methods used by the axe makers. Other problems addressed by my work have been the dating of the rise of the 'modern' axe quarries and the geochemical sourcing of axes found in artefact collections and archaeological sites in various parts of the Highlands (see Figure 1 for locations of major sites investigated).

PREVIOUS INQUIRIES AND MAJOR RESEARCH PROBLEMS

Early European visitors to those parts of the Highlands which include today's Western Highlands, Simbu and Madang Provinces made a point of the fact that especially fine stone axes were a prominent part of men's equipment and were carried everywhere (e.g. Chinnery 1934; Moyne and Haddon 1936; Ross 1936; Leahy and Crain 1937).

The early reports contain little specific information on either axe manufacture or trade and only one account can be rated as a serious piece of ethnography: that of Vial (1940) who visited the Dom gaima and Ganz River quarries. Vial observed the precise means by which the Dom quarrymen - or rather, miners - obtained their stone (1940:160-2). He saw a shaft about 10 m deep sunk through soft, weathered diorite. At the bottom of the shaft, which was lined with timber, Vial saw the miners working away at the axe rock with digging sticks. When suitable pieces were found, they were brought to the surface and put aside; spoil and useless rock was removed in baskets passed from hand to hand up the timber shoring set.

Vial was told that the miners had been working for five months and, by the time of his visit, had reached the surface of the axe bearing seam. It is worth making the point that the Dom miners were definitely committed to full time work when sinking new shafts to obtain axe stone. Unlike axe quarries described in other ethnographies, few of the important sources in the Highlands could be exploited on a casual basis.



PAPUA NEW GUINEA HIGHLANDS known and suspected stone axe sources

▲ traditional source within study area
△ suspected or modern source, source outside study area

Figure 1. Location of Principal Sites Discussed in the Text.

2 Tsenga
3 Ganz
8 Tuman (Kunjin + Yesim + Ngumbamung)
10 Dom gaima

Vial also visited the Ganz River quarry (1940:159) which was a leading source of what have become known as 'Hagen' axes. (Another source later proved to be Tsenga, a quarry with different owners some 5 km to the east.) This kind of axe had a thin, rather flaring blade of very regular size and a distinctive hafting style. It was much sought after by men in the Central Melpa/Mt Hagen area as a dress, ceremonial and fighting axe. Vial described only parts of the manufacturing process, but, in conjunction with later accounts like that of Bell (1944/45) and Attenborough (1957; 1960), his report helps to create a picture in which the quarry owners seem to have worked more or less full time at axe making, turning out a standardised product in large quantities. In comparison to the handful of Dom brideprice axes held in ethnographic collections, many hundreds, if not thousands, of blades typical of the Ganz River style have been collected by anthropologists and others over the years.

Although the two axe 'types' or 'styles' already mentioned were the best known to patrol officers and anthropologists during the Australian colonial period, the greatest source of stone axes in pre-colonial times were the quarries adjacent to the Tuman River near Aviamp in Western Highlands Province. Ross (1936:347, 353) innaccurately stated that the Mogei, a large Hagen tribe, obtained work axes from the 'Pim' (i.e. Pin) River at Kuli. In fact the Tuman quarries are located further east in the next valley. I mention this vagueness because both the Pin and Tuman Rivers lay on the main patrol route to Mt Hagen, and European travellers passed in sight of the quarries for 17 years before their existence was noted officially (Timperley and Corrigan 1950/51).

Subsequently, attention was drawn to the Tuman quarries by Reay (1959:105) and shortly afterwards by Chappell (1966), who made the first thorough investigation of the Highlands quarries from a petrographic point of view. He succeeded in locating almost all the quarries of Western Highlands and Simbu Provinces, together with an important riverbed source, Kafetu, in Eastern Highlands. At about the same time, several anthropologists had assembled large collections of stone axes, both hafted and unhafted, and Chappell was able to attribute most of their blades to a subset of the sources he had found. These were the Ganz River, Tsenga and the Tuman quarries (1966:Table 2).

At around the same time, archaeologists began to excavate and find prehistoric pieces of ground stone axes at rockshelters in various parts of the Highlands. The earliest specimens of ground stone technology so far reported from the Highlands are two small (4 and 5 cm long) axes from Level 21 at Manim rockshelter, near Mt Hagen, dated to 5860 $\pm$ 130 BP (Christensen 1975:31) and a cutting edge fragment from Level IX at Kafiavana, which is nominally about 3000 years older, though its date is not so secure (White 1972:Fig. 18j).

Questions about the traditional use of stone axe quarries in the Highlands may be usefully divided between the synchronic and diachronic aspects of the subject. The important synchronic questions include the following selection. On what lines was axe making organised at each of the known quarries? Were there major differences among the axe making systems of different parts of the Highlands? What economic relations did the axe makers have with their neighbours? What characterised the trade in stone axes?

A basic list of the interesting diachronic questions is not hard to assemble. When did ground stone axes emerge as an important part of cultural equipment in the Highlands, what changes may be noted over time, and what socio-economic developments are reflected in the archaeological record? Much of the difficulty in making progress with these topics stems from the fact that large volumes of other stratified materials must be excavated from rockshelter deposits to produce small quantities of stratified axe stone. Thus, greater precision in the dating of early developments can be obtained only as quickly as archaeologists can start work on new sites with clearly defined stratigraphies.

THE ORGANISATION OF WORK AT THE TUMAN QUARRIES

Perhaps the most important finding of my research was the fact that many of the former axe makers at the Tuman quarries, the focus of my study, were still alive. Indeed, so good was the survival rate (about one quarter of the men who quarried as grown men were alive in 1981, together with three quarters of those who were only boys), I was able to compile a workable census of the male membership of the Tungei, the quarry owning tribe at contact in 1933, as it would have been some 48 years previously. This task was greatly simplified by the fact that the first Australian census book to record the names of the Tungei, compiled in 1958, was still in existence and was relatively accurate.

From this starting point, it was a relatively simple matter to inquire which of the men listed were involved in quarrying. The many-times repeated answer was that they all were - but note that quarrying was restricted to men and youths only. It was also easy to find out who worked at each of the three main quarry complexes that were in use in 1933: Kunjin, Ngumbamung and Yesim.

The basic unit of quarry ownership was the clan, a unit consisting of anywhere between 15 and 45 men (the mean size was about 30 men). At Kunjin, four clans joined up to form a workforce of, by my count, 119 men and 27 boys; at Yesim, one clan of 37 men and 11 boys worked; at Ngumbamung, my figures are less secure, but around 49 men and boys from a pair of clans worked together. However, 'gangs' consisting of 'men's house groups' or subclans seem to have been the smallest useful work groups; these typically

consisted of about a dozen men.

I can confidently state that the organisational ground rules that may be seen in almost any group activity initiated today by the Tungei are sufficient to account for practically all the important features of their former work at the Tuman quarries. Men in the same subclan cooperate in their daily lives to dig new gardens and fence them off against pigs. They also feel safer fighting next to one another than next to men of other subclans. In quarrying, they joined forces to extract axe stone from a particular section of the quarry face which they marked off as their own. Equally, the various subclans of a clan today link up to exercise a collective defence of their usually contiguous territories, kill pigs together at the clan killing ground, and form the basic unit of exogamy. Clans were the owners of quarries and the maximal units of labour during quarrying.

An important function of the largest, but loosest, grouping of the Tungei - the tribe - was the scheduling of quarrying. The Tungei held strong mystical views about quarrying which closely resemble the Female Spirit cults of the Mt Hagen area (Strathern 1970). In particular they believed that the axe stone was guarded by two female spirits to whom sacrifices had to be made if an attempt to obtain the stone were to be successful. Like the Hagen cultists during cult performances, the quarrymen had to observe very strict isolation taboos for the several months of quarrying. The consequence was to formalise the process to the extent that all men from all the Tungei clans were obliged to quarry at once, setting up special bush camps behind ritual screens at the sites to do so. The tribal level of organisation was important in setting this up, as it was in declaring when a quarrying expedition was completed - sometimes the men at one of the quarries would have to wait for those at the others to catch up with them so that they could bring the expedition to a more dramatic finish at the given time.

The fact that quarrying expeditions were so formalised makes the job of quantifying the output of axes that much easier. Firstly, expeditions were clearcut events and, by tying them in with other markers in the life histories of individual informants, I was able to estimate that they took place once every 4-7 years during the present century. The last expedition took place in 1933 at the time of the first Australian patrol to Mt Hagen (the Taylor-Leahy patrol).

Other details, which I will not elaborate on here, suggest that individual quarrymen may have been able to procure anything between 10 and 50 axe roughouts on each expedition. Bearing in mind that there were about 200 quarrymen and that there were between 14 and 25 expeditions a century, the output of the Tuman quarries can be put at between 30,000 and 250,000 axes a century. The lower limit is very conservative and I think that 100,000-200,000 is a bracket of the correct order of magnitude.

A final point is that the Tungei only sharpened some of the roughouts themselves. They did the preliminary knapping for most if not all of the roughouts, but they traded many of them to their immediate neighbours. By the time these 'secondary axe makers' had worked on their share of the total, almost all the output would have taken the form of finished axe blades. It is in this manner that we can speak of a Tuman style of axe blade, because a core of perhaps 2000 men within a 15 km radius of the sites - the Tungei and their neighbours - were responsible for grinding and shaping the finished products. Hafting was carried out by skilled men within the same groups and in a distinctively Tuman style also.

The other quarries of which I was able to investigate were the Ganz River and Dom quarries. Some quite remarkable differences in geology and socio-political organisation led to quite different circumstances of exploitation there. Briefly, the Dom miners were faced with a thin seam of axe stone, buried at a relatively great depth. Instead of following the cult-based expedition system, they worked in much smaller groups of men for much longer periods of time. Vial (1940:160) was told by the party of eight men that he saw in action that they had been at work for five months before reaching the axe stone. My inquiries lead me to believe that this is a gross underestimate and that one to two years was the absolute minimum if work was continuous.

The main goal of the Dom miners was to obtain flat slabs of stone as large as possible in size. At the Tuman quarries, the largest axes, shaped initially by percussion flaking, attained only 30-35 cm in length. Dom gaima axes could be much larger that this due to the laminar nature of the stone and the method used to obtain it. The Dom miners built a fire on the shaft base, retreated to a position of safety outside the shaft and poured water on the heated rock below, which then exploded. Large flat slabs could then be prised off the shaft base and sawn - not knapped - into shape. The axes had great value in the wealth economy and as brideprice axes, but no use at all for work. Work axes were made from the scraps left over or were obtained from the Tuman quarries in trade.

The Ganz River system of production, together with other quarries in the Jimi Valley, was different again, though my opportunities for ethnographic inquiry were more limited there. One of the main problems was the much poorer life expectancy of Jimi populations compared to those of the Wahgi Valley, where both the Dom and Tuman quarries are situated. I found few informants old enough to be able to tell me about axe making.

Enough is known of the Jimi factories through patrol reports to show that production has continued on and off until the present day. After the Pacific War, Ganz River men say they switched from the traditional sources to alternative sources of softer rock, realising that steel had destroyed the demand for functional tools

and weapons of stone. Nonetheless they continued to produce axes for cash sale. This was probably due to a production system based more on smaller groups of men and laying more emphasis on the grinding and hafting stages of manufacture than than elsewhere. This may be contrasted with the Tuman system, in which nothing could be done unless over 200 men could be mobilised at once, and where, scaled down or modified production was not even attempted after 1933.

Considerations such as these show that many categories of problems in material culture studies can be solved long after a given way of life or productive industry has fallen into disuse. Fortunately, those aspects of Tuman quarrying operations which I found most amenable to retrospective methods of study with the help of aged informants and ethnographic and oral historical inquiries are among those which prove most interesting from an archaeological point of view.

Aspects which I have not covered are the technical methods employed by the quarrymen to extract the axe stone, knap and grind it into shape. Suffice it to say that these tasks can easily be explored experimentally, as I was able to show by asking a skilled haft maker to mount an axe blade in the traditional fashion and copying the work under his guidance. Haft making was apparently the specialty of one or two men in each clan - informants named those of their contemporaries who did this work - and it is reasonable to think that there was one haft maker to approximately every 10-15 unskilled men among the quarry-owning and neighbouring tribes.

GEOCHEMICAL SOURCING AND PREHISTORIC CHRONOLOGY

I was able to collect axe rock samples from the major quarries I have mentioned and from a dozen or so minor sources in the Highlands (cf. Chappell 1966; Hughes 1977). Chappell succeeded in characterising most varieties of Highlands axe stone using optical petrology and a suite of distinctive traits (1966:Table 1), but I found that the very small grainsize - typically from 10-20 microns - made identification very difficult. At the suggestion of A. Watchman I carried out a program of identification with infrared spectroscopy. Powdered samples were prepared from drill plugs taken from the rocks and from axes collected in the Manim Valley by O. Christensen and at Kuk Agricultural Research Station, near Mt Hagen, by J. Golson, P. Gorecki and others. This proved to be only partly successful. Some quarries had very distinctive spectra, notably the minor sources of Puki and Dabiri, but others were dominated by common minerals like quartz.

In a much smaller test, the measurement of minor or trace elements with X-ray fluorescence showed itself to be a promising means of discriminating between axe types with similar compositions, as demonstrated by infrared analysis. The two techniques are complementary in many respects; infrared spectroscopy identifies

compounds and crystalline substances, while XRF picks out elements.

CONCLUDING REMARKS

Naturally, many more issues may be raised than I have so far indicated and important technical methodologies, which I have barely touched upon, can be applied to several of the topics I have outlined. For example, the sourcing of axes in ethnographic and archaeological collections could be turned into a major research effort by itself, though the ultimate goal is to quantify trade. Equally, the excavation, using archaeological methods, of one or more of the quarry sites might be attempted (I found the task too large in scale) in order to answer certain questions about the methods and organisation of quarrying.

Many - but not all - of the questions of organisation would best have been answered closer to the time when the quarries were still in use. Economic changes, including the introduction of steel and huge quantities of shell wealth, ensured that no traditionally used source of axe stone remained in use beyond the Pacific War. Blackwood's (1950) ethnographic work in what is now part of Eastern Highlands Province is almost the sole instance of a material culture study carried out in such conditions in the study area. Consequently, archaeologists and others interested in the subject have probably assumed that nothing further could be learnt of the disused technology of quarrying and axe manufacture. As I have attempted to show, this is far from the case.

Another subject is prehistoric change in the use of stone axes. In an early review of the prehistoric finds, Bulmer (1964) made the broad observation that two basic kinds of axes are found in excavations. The first kind, indeed the only kind found in stratigraphically early positions, have a lens-shaped cross-section whereas the second kind, found exclusively in later stratigraphic positions, have a rectangular cross-section and flat sides. She termed these two broad types 'lenticular' and 'planilateral' axes and suggested, then as on subsequent occasions (1964:267; 1975:45), that the replacement of a toolkit containing lenticular axes by one containing planilateral axes was an important cultural watershed involving movements of people from Southeast Asia to Papua New Guinea. The dating of this alleged change is vague but is placed somewhere between 4000-2000 BP.

I found that there is no evidence to support such broad changes in prehistoric populations. On the contrary, the difference between the two types of axes seems to me to be between locally made axes, that is to say axes made from streambed and other informal sources of raw material, and axes made made from quarried stone. All the 'modern' quarries in Western Highlands and Simbu Provinces produced planilateral axes and in my view this was a function of the type of raw materials found there and the formalised styles of axe

that had gained acceptance in the same region. If this view is accepted, then the 'change' in axe types simply reflects the rise of the modern quarries. This may be dated by the appearance and increase over time of formally quarried materials in archaeological sites. I have made an analysis of the Manim Valley rockshelter finds, and my results suggest that production at the Tuman and Jimi Valley quarries, at least, commenced somewhere between 2500 and 1000 BP. Closer dating awaits future excavations in the same areas.

ACKNOWLEDGEMENTS

I would like to thank Prof. J. Golson for his help with all aspects of this work, Dr J. Allen for his additional supervision in Canberra and A. Watchman for advice with geochemical sourcing. I am extremely grateful for the help given to me by many people, both in Papua New Guinea and in Canberra. I must single out the residents of Tun, near Tuman River, Western Highlands Province and Aulabol, near Gaima, Simbu Province, who unconditionally offered me their hospitality. This work was given financial support by the Research School of Pacific Studies, Australian National University, and proceeded with the kind permission of the Institute of Papua New Guinea Studies, The National Museum, the Department of Anthropology and Sociology, University of Papua New Guinea, and the Western Highlands and Simbu Provincial Governments.

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