

If H be the circumcentre, O the orthocentre, I the in-centre, and I_1 the ex-centre opposite to the vertex A of the triangle ABC , then (1) if $IH = IO$ either A or B or C is 60° , and (2) if $I_1H = I_1O$ either A is 60° or B or C is 120°

(1.) The tripolar equation of a circle of radius ρ concentric with the in-circle is

$$aX + bY + cZ = (a + b + c)(2Rr + \rho^2).$$

If this passes through H , $X = Y = Z = R^2$; hence $2Rr + \rho^2 = R^2$, and the above equation becomes

$$aX + bY + cZ = 2R^2s.$$

If this circle passes through O , then $X = 4R^2 \cos^2 A$, $Y = 4R^2 \cos^2 B$, $Z = 4R^2 \cos^2 C$, and we obtain

$$a \cos^2 A + b \cos^2 B + c \cos^2 C = \frac{1}{2}s$$

$$4a(1 - \sin^2 A) + 4b(1 - \sin^2 B) + 4c(1 - \sin^2 C) = a + b + c$$

i.e., $\sin 3A + \sin 3B + \sin 3C = 0$

i.e., $\cos \frac{3A}{2} \cos \frac{3B}{2} \cos \frac{3C}{2} = 0$

whence A or B or C is 60° .

(2.) The tripolar equation of the circle of radius ρ concentric with the ex-circle opposite A is

$$-aX + bY + cZ = (b + c - a)(\rho^2 - 2Rr_1),$$

which, if it passes through H , reduces to

$$-aX + bY + cZ = 2(s - a)R^2.$$

Expressing that this circle passes through O we have

$$-a \cos^2 A + b \cos^2 B + c \cos^2 C = \frac{1}{2}(s - a)$$

whence $-\sin 3A + \sin 3B + \sin 3C = 0$

i.e., $\cos \frac{3A}{2} \sin \frac{3B}{2} \sin \frac{3C}{2} = 0,$

and therefore either A is 60° or B or C is 120° .

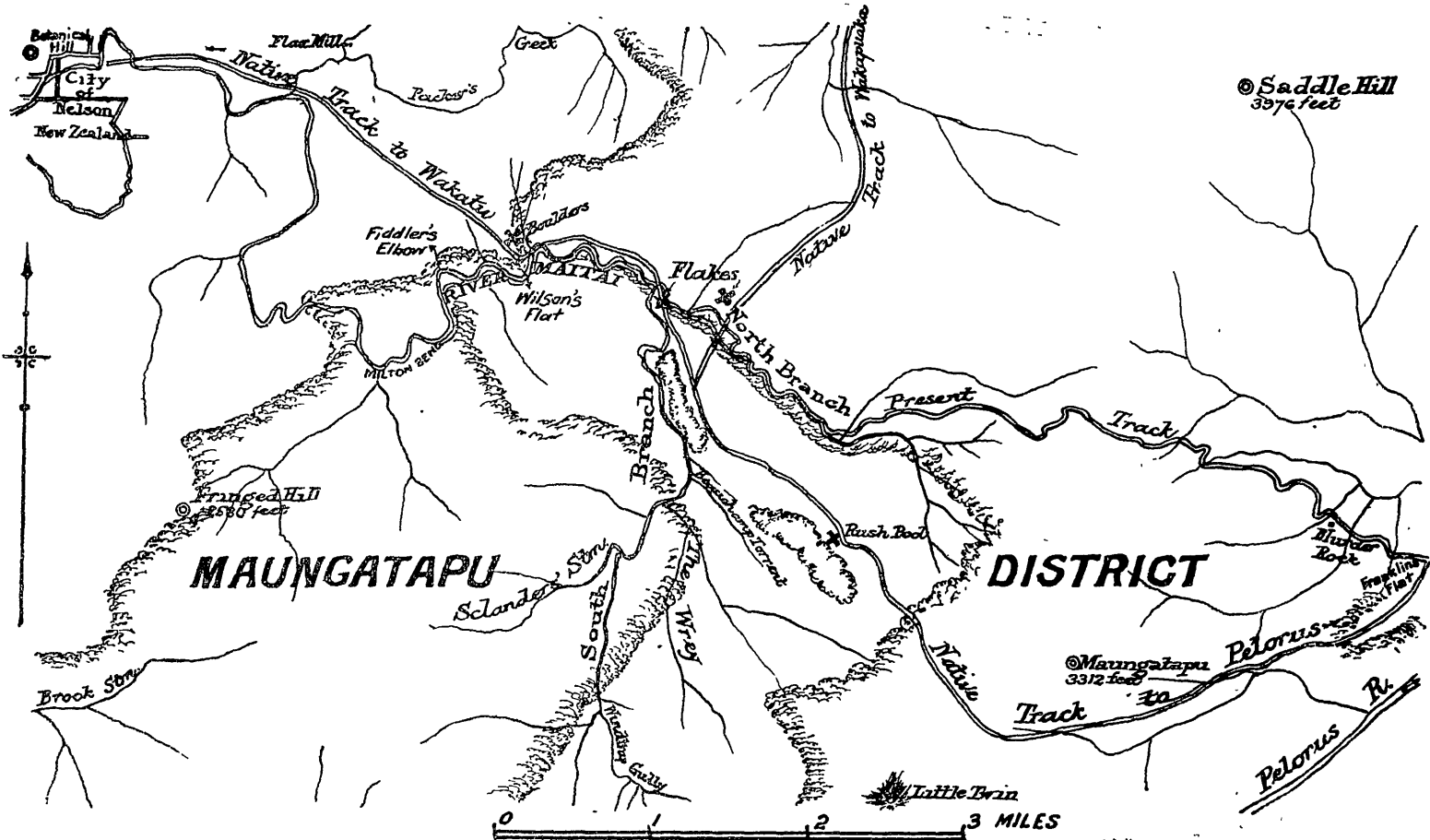
ART. XLIX.—*An Ancient Maori Stone-quarry.*

By H. D. SKINNER.

[Read before the Otago Institute, 17th March, 1910.]

Plate XII.

ABOUT nine miles from the Town of Nelson, on the old Maungatapu Track that leads from the Maitai Forks into the valley of the Pelorus, is a well-known Maori tool-manufactory or quarry. The present road from Nelson follows the Maitai Valley to the Forks, where the old track strikes off up the spur between the north and the south branch. (See map.) On the spur, about a mile from the Forks, the track passes over a small hummock, beyond which there lies a curious hollow in the ridge. This basin encloses a shallow pool of water surrounded by a belt of rushes, from which the place takes its modern name—the Rush Pool. The shores,



SCALE.
LOCALITY MAP.

SKINNER.—An Ancient Maori Stone-quarry.

which, though low, rise steeply from the pool on three sides, are covered with stunted trees, manuka predominating. The north-eastern shore in one part rises barely a foot above the water, and then slopes down into a gully, a continuation of the hollow in which the pool lies. The existence of a pool in so unlikely a place—half-way up the summit-line of a steep spur—is due to a low causeway crossing the bed of a shallow gully. The head of the gully thus cut off forms the basin of the pool. From the north and south rims of the basin the sides of the spur fall steeply away to streams some hundreds of feet below. On the north-west side, behind the observer, the summit-line of the spur falls away, steep, rocky, and bare, to the Forks, about a mile distant. Eastward across the hollow the summit-line of the spur rises steeply to the main ridge, which forms the sky-line, more than a mile away. The spur's northward-facing slope is mineral country, stony and barren, but the southern slope has been invaded by beeches.

The spur is composed mainly of much-disturbed serpentines, and of rocks similar in appearance and composition to those of the Dun Mountain. The surface is covered with masses of these rocks, some of them of great size. For a short distance around the pool masses of argillite lie thickly scattered. This is the stone which the Maoris have quarried for adzes and other tools. When newly fractured it is black in colour, but it weathers rapidly to a light grey. The boulders are of all sizes, and have all, without exception, been tested as to quality either by fire or by the neolithic equivalent of a quartering-hammer.

About the base of every crag or boulder there lies a pile of flakes detached from the parent stone, and left as useless. Around some the earth appears to have been banked up so that the full heat of the fire might play into the surface of the rock. In every direction lie broken pieces that have probably been looked over and rejected. If the spur within a radius of 200 yards of the pool were thoroughly cleared it would probably be found that the whole surface is thickly covered with fractured argillite boulders, spalls, rejects, and flakes. The best stone appears to have been obtained from three special places. The first of these is along the northern slope of the spur, below the pool. The second is the argillite crag on the south-east of the pool, beside the terrace to be referred to later. The third, and probably the chief source, is the argillite cliff that forms the southern face of the hummock over which the track passes before reaching the pool. This part of the spur is covered by beech bush, and so seems to have been examined hardly at all by curio-hunters. In spite of the trees and the thick carpet of leaves that now conceals all minor features, this is the most interesting part of the manufactory at the present time.

When, in the "forties," the late J. W. Barnicoat passed the pool as he was following up the Native track into the Pelorus Valley he saw the ruins of Maori whares.* The spot on which they stood does not appear to have been recorded, but it can hardly have been elsewhere than on the terrace above the pool on its eastern side. The whole of this terrace, part of which is shown in fig. 1, Plate XII, is covered with a layer of flakes so thick that, after the passage of a century, vegetation has grown over it scarcely at all. On the slope from the terrace to the pool the flakes are also strewn thickly; but soil has been washed over them, and they are now overgrown by scrub.

* This information was obtained from Mr. R. J. Kingsley, who had it from Mr. Barnicoat. But no whares are marked on the map compiled from Barnicoat's traverse. One is shown farther up the spur.

The western boundary of the quarrying area is marked by a large group of boulders on the south slope below a point on the track some 500 yards from the pool. The lower parts of these rocks have been fractured by fire, but the quality of the stone is poor, and nothing further has been done. About 200 yards farther on the true area begins, and artificial flakes at once become plentiful. Beside the track is a small boulder which appears to have been superheated by fire. It has been split into white and powdery fragments. The stone-hewers naturally directed their efforts against the lower edges of boulders when attacking them by fire. In many places, notably at the crag by the flaking terrace, the earth appears to have been built up close to the rock-edges, so that the glowing embers might be close to the face of the stone. The use of fire in this way is the only possible explanation of the fractured surfaces in places where there is not room to swing a hammer-stone. Mr. Elsdon Best supplies me with the following note regarding the process: "A very good (Maori) authority tells me that a fierce fire was kept burning on the face of the rock until it became red with heat. Water was then thrown on it. This caused the surface to crack and split up into small, or comparatively small, pieces; but the rock underlying the shattered surface became not shattered, but merely cracked in fairly large pieces. The shattered surface was loosened and thrown away, then the underlying part was split open (*koara*) and suitable pieces selected (uncracked pieces) for *toki*, &c. Surface rock was always deemed inferior, and was not used. Interior stone was much better for tools. The best stone of all was obtained from below the surface of water." It will be noticed that fire is of no avail unless water is applied.

A second method of fracturing the rock is by means of a hammer-stone. This would be effective in the case of small-sized boulders. In the case of large masses of rock little could be done by hammers except surface-flaking, unless the rock had been opened up by fire and water as already described. But the large masses were sometimes attacked with hammer-stones and without the help of fire. On the cliff already mentioned, some 20 ft. up on the vertical face, and far beyond the reach of fire, some old-time stone-knapper has been at work with a pebble hammer. He has done nothing more, however, than remove the outer weathered coating.

These two are the only methods of obtaining stone of which there are any traces at the Rush Pool. No signs of cutting or sawing were observed in any part of the quarry.

The hammer-stones used at the quarry are, almost without exception, water-worn granite pebbles brought from Mackay's Bluff or from the Boulder Bank. They range in weight from a few ounces to half a hundred-weight. Many of them have traces of the brown oxidized surface that comes of exposure to salt water. The transport of the larger ones for many miles over streams, through bush, and across a high saddle must have presented great difficulties. By the cliff-foot they are especially numerous, and furnish the best proof of the long period over which the quarry must have been worked. It would, I believe, be possible to collect some hundreds of them.

Any other material than granite seems to have been rarely used. Only one hammer of quartz was observed. Rodingite, which is very similar in appearance and physical properties to gabbro, and which occurs in the bed of the Maitai, was not observed at all. This is singular, since gabbro was extensively used in the form of hammers by the primitive flint-workers of

Europe.* Rodingite is, however, a favourite material for the finishing-work called "pecking," and, in the form of small, almost spherical, boulders, is frequently found on village-sites around Tasman Bay.

On none of the hammer-stones examined was there any sign of hafting. In a cleft on the summit of one of the crags two much-battered hammers were found, placed in *cache* by some Maori that never returned. They were further concealed by a large piece of the surrounding rock being placed over the cleft.

Some of the finer flaking must, I think, have been done with a punch; but no specimens of this implement were found. Possibly they were made of wood, as in the case of the Aztec punches; possibly of bone. Some of the unfinished adzes found have been "pecked" as a step preliminary to polishing. In far the greatest number of cases the tools would be roughed out at the Rush Pool, and then carried away to some kainga on the coast, there to be finished at leisure. But there must have been a certain proportion finished at the pool itself, for on the terrace already mentioned a number of polishers were found.

When digging for water in the mud of the basin late in a dry summer, Dr. S. A. Gibbs discovered a finished adze.† I have not heard of finished tools being found in any other part of the quarrying area. For the most part, the roughed-out blocks must have been carried away. This is exemplified by a large unfinished gouge which was found on the saddle between the unnamed north branch of the North Maitai and the Teal. Through this saddle the old Native track to Whakapuaka passed. At the confluence of the unnamed tributary and the main stream a large pile of small chips marks a much-used camping-place on this track.

From the data gathered a fairly detailed picture may be drawn of the ancient Maori adze-maker at work. He comes to the Rush Pool one of a party laden with baskets of food and loads of pebbles from the Bluff. He stows the food in one of the whares on the terrace above the pool, and goes out equipped with a fire-plough and a large granite pebble. The smaller boulders of argillite which could be broken by a hammer without the intervention of fire have been used up long ago, so he removes, by tapping, a patch of the outer coating from one of the masses, finds the stone suitable, and builds a fire against its base. Next he fetches water from the pool and pours it on the red-hot stone. The surface splinters, and the interior cracks. When it has cooled he attacks it with his haftless quartering-hammer, breaking it into blocks of suitable size. These he takes up to the terrace, where, with smaller pebbles, and perhaps with punches, he reduces them to the rough shape. The flakes struck off go to swell the pile, part of which is shown in Plate XII, fig. 2. The work may occupy him for several days, and he may perhaps "peck" and polish one or two of the tools that satisfy him more than ordinarily well. But he will have rejected some of the blocks after the first examination, and others will be thrown aside on account of flaws or unexpected hardness in the stone. In the meantime half the party will have been away trapping kakapo and weka on the slopes of the Dun, for in those days the thick tussock of the mineral belt, untouched for centuries by fire, must have afforded shelter to teeming bird-life.‡ On the return of the hunters he hides the hammer-stones that

* *E.g.*, at Pfahlbauten, Switzerland (*vide* Dr. Keller, "Lake Dwellings," p. 36).

† It is probable enough that others would be found in the same place. The Nelson Philosophical Institute might consider the proper exploration of the basin.

‡ For this suggestion, together with information as to the Native track, I have to thank Mr. F. F. C. Huddleston.

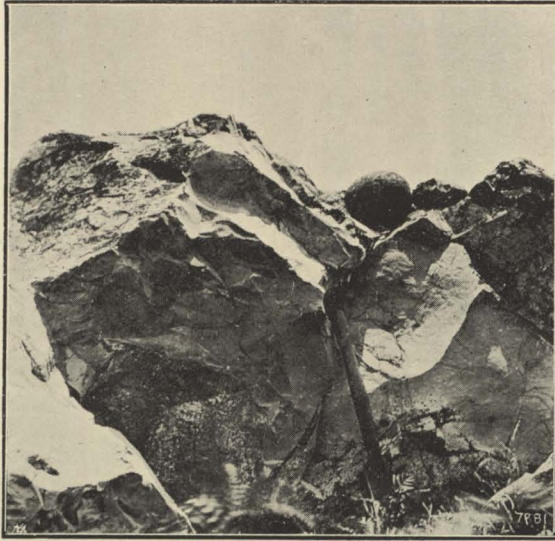


FIG. 1.—STONE-QUARRY, RUSH POOL, NEAR NELSON.



FIG. 2.—STONE-WORKERS' "WORKSHOP" AT RUSH POOL QUARRY.

are still unbroken, carefully packs his roughed-out tools, and turns his face down the spur to his home by the sea.

We have no record of the tribe that first quarried the stone about the Rush Pool, but we may feel fairly confident that it was used by Ngati-tu-mata-kokiri, and by their conquerors, Ngati-apa-ki-te-ra-to. Ngati-apa were the ruling tribe when D'Urville sailed by Mackay's Bluff in January, 1827, and, though they then knew the effects of firearms, they knew little about iron or iron implements.* I think we may fairly conclude that they were the last tribe to use the quarry extensively, and probably the last to use it at all, for in 1828 the Taranaki tribes swept down on Tasman Bay, conquering Ngati-apa, and afterwards settling over the whole land. They were armed with muskets, and were well acquainted with iron implements, which must have come to them in increasing quantities from Kapiti and Cloudy Bay. What tribe discovered and first made use of the stone will most probably never be known, but we may feel confident that the quarry was used over a long period of time. The granite boulders lying scattered over the surface could scarcely have been carried there in less than a century, and very probably indicate a much longer period. The great mass of flakes beside the pool is of itself no proof that the workings were long in existence, for a single Brandon flint-knapper can make between fifteen and sixteen thousand gun-flints in a week.† The ancient Maori, though not so quick a worker as that, could doubtless strike off a good many flakes in a short time.

Although we may be fairly sure that such whares as existed were on the flaking terrace overlooking the pool, there is no trace of their foundations. Neither is there any trace of shell or refuse heaps. On the northern slope, about 100 ft. below the track, there is a curious pit, probably of Maori origin. When cleared of the earth and stones that had fallen into it, it measured 5 ft. by 3 ft. by 4 ft. It may possibly have been a store-pit for fern-root.

The pool itself appears to be artificial. A low bank appears to have been thrown across the upper part of a gully, the pool in the basin thus cut off being fed by surface water. The advantage of a plentiful supply of water in the middle of the quarry area when quarrying is carried out by the use of fire and water must have presented themselves at once.

The Native tracks to and from the Rush Pool are indicated in the accompanying map. One of them, beginning at the present site of Nelson, follows the Maitai as far as the confluence of Sharland's Creek. Here it strikes up the spur between the creek and the river,‡ follows the bare ridge for a mile or two, and then, dropping down to the Maitai at Wilson's Flat, follows the valley again to the Forks. From this point onwards as far as Franklin's Flat it follows the line of Barnicoat's track—the "Old Mokitap." At Wilson's Flat a small patch of argillite boulders has been worked, while at the flat by the Forks granite boulders and argillite flakes indicate either a small quarry or a much-used camping-place.

A second track led up the stream by the present sawmill, over the saddle, into the Teal Valley, and thence to the coast. A large gouge, 18 in. long, was found on the saddle. The flakes that mark a camping-place at the commencement of this track have been mentioned already.

* McNab, "Murihiku," p. 369.

† Evand, "Ancient Stone Implements," 2nd ed., p. 21.

‡ The narrowness of the Maitai Valley for some miles below Wilson's Flat rendered it almost impassable.