

# THE GEOLOGY OF THE TE AROHA MINING DISTRICT

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## THE GEOLOGY OF THE TE AROHA MINING DISTRICT

**Abstract:** *When gold was discovered on the slopes of Te Aroha mountain, its geology was unknown to geologists and miners alike. After initial hasty examinations, later investigations produced more reliable details, and by late in the twentieth century much more detailed and technical information was available. Originally, prospectors hoped to find alluvial gold, but instead discovered that, through volcanic action, the minerals permeated the quartz.*

*Despite intensive prospecting, payable ore was rarely found. At Waiorongomai, the large main lode was mostly a buck reef, the best patches of ore being found where it abutted side reefs. Hopes for a prosperous field soon faded because the various battery processes were unable to treat the ore profitably, a failure largely explained by its poverty and complexity. The output from the Te Aroha district proved to be one of the lowest of the Hauraki fields.*

### PUZZLING OVER THE ORE

According to the government geologist, Alexander McKay,<sup>1</sup>

On the discovery of gold at the Thames many who were not miners in any sense of the term had to engage in the active work of mining or necessarily abandon their holdings; but as usually an experienced miner formed one of the party, or the service of such might be engaged, under such conditions mining was carried on till definite registered companies directed by an experienced manager were formed. All in this manner became miners, some having experience of mining elsewhere, others experienced only in the field in which they were engaged. To all alike there was a necessity to speak of and distinguish between the lode-stuff and the rock within which this was enclosed, and as no one had before mined for gold in rocks of the same class there was a consequent difficulty in determining their nature and the names which should apply. To this the miner addressed himself without the aid of scientific advice, and where the rocks were moderately soft and friable they were called “sandstone,” where in a less-decomposed state they were called “bluestone” or “hard bars;” and there was a

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<sup>1</sup> See D.G. Bishop, *The Real McKay: The remarkable life of Alexander McKay, geologist* (Dunedin, 2008).

variety of terms common to most metal-miners, as “pug,” “mullock-bands,” and the like.

After the miner came the geologist, but the names which he applied to the rocks were unfamiliar, and sounded strange in the ears of those unaccustomed to them, and at most the more accurate terms were but slowly adopted; or, rather, for a time they were totally disregarded and the miner further developed his own nomenclature as suited his taste and requirements. He further distinguished as “kindly” or “barren” the nature of the country, and more specifically spoke of “flatheads,” “flinties,” and the like, and at this time was happily innocent of diorite, propylite, and other names terminating in “ite;” but, nevertheless, he won more gold under the old and vulgar name than he has done since the adoption of a classical and systematic nomenclature.<sup>2</sup>

At Te Aroha, as at elsewhere on the peninsula, alluvial gold was hoped for, but its absence meant it could never be a ‘poor man’s field’ because, as the gold permeated the quartz in minute particles, there were no nuggets. And by being mixed with other minerals the gold was not easily identifiable, and miners puzzled over the colours they found. Gold discovered at Te Aroha in 1880 was in ‘dark brown quartz’,<sup>3</sup> and that traced in the New Find at Waiorongomai was ‘contained in black bands running through the quartz’.<sup>4</sup> A geologist found that the gold in this reef occurred ‘in small black or blue veins which traverse the quartz in an irregular manner, and these veins do not appear to be continuous, but come in and die out in a very short distance, from a quarter of an inch to a foot or more’.<sup>5</sup> A Waiorongomai miner who later prospected in the Maratoto Valley found good ore in ‘blue bands, which is considered the richest indication for the existence of high-class bullion ores’.<sup>6</sup> Miners from Waitekauri were impressed with Werahiko and Waitoki ore because ‘that brown, soft, kindly looking rock, full of purple streaks, seems to remind them of palmy days’.<sup>7</sup> In one of his lectures on the Hauraki goldfields,<sup>8</sup> James Black explained

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<sup>2</sup> Alexander McKay, Introduction to W.J. Sollas, *The Rocks of Cape Colville Peninsula, Auckland, New Zealand* (Wellington, 1905), vol. 1, pp. 3-4.

<sup>3</sup> C.F. Mitchell to Premier, 1 November 1880, Mines Department, MD 1, 85/1006, ANZ-W.

<sup>4</sup> *Thames Advertiser*, 12 October 1881, p. 3.

<sup>5</sup> Cox, ‘Gold Fields of the Cape Colville Peninsula’, p. 38.

<sup>6</sup> *Thames Advertiser*, 11 September 1895, p. 2.

<sup>7</sup> *Te Aroha News*, 4 August 1883, p. 2.

<sup>8</sup> See paper on miners’ skills.

that ‘very fine gold was sometimes blue. Mentioning the wavy outline with blue vein so often seen in up-country quartz, the Professor gave it as his opinion that a bluish tint indicated excess of refined gold in a molecular state’.<sup>9</sup> All of which was confusing to amateurs. And because of lack of capital (a common Australasian problem), short cuts were taken and testing was often inadequate.<sup>10</sup>

## THE FIRST INVESTIGATIONS

In June 1881, S. Herbert Cox, who by the end of the decade was a lecturer in Geology, Mineralogy, and Mining at Sydney Technical College,<sup>11</sup> made the first, brief, geological exploration of the Te Aroha goldfield:

The character of the country in which the reefs occur is very similar to that of the Thames. It consists of a greenish-grey pyritous tufaceous rock, but undecomposed, and is traversed by flat-lying reefs, sometimes as much as 5 or 6 feet in thickness, as at the Prospectors’ Claim, which strike about N.N.W. These reefs have a curious brecciated character, and appear to consist of fragments of the country rock cemented or interlaced with thin strings and veins of quartz, which traverse the reef in all directions. These reefs have not, so far, proved to be auriferous, the gold having been found in thin leaders which have a general strike of N. 18° E.; and in this respect another point of resemblance between this and the Thames and Coromandel Gold Fields may be traced, at both of which places the large reefs are non-auriferous, and the gold has been obtained from the small leaders which drop into the reef.<sup>12</sup>

In February 1882, after spending six days investigating Waiorongomai, Cox produced a longer report. The mountain

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<sup>9</sup> *Thames Star*, 25 March 1896, p. 2.

<sup>10</sup> See Jan Wegner, ‘Underground Gold Prospecting Techniques on a late 19th – early 20th Century Queensland Goldfield’, *Journal of Australasian Mining History*, vol. 1 (September 2003), pp. 160-162, 164-165.

<sup>11</sup> *Report of the First Meeting of the Australasian Association for the Advancement of Science, held at Sydney, New South Wales, in August and September, 1888* (Sydney, 1889), p. 223.

<sup>12</sup> S. Herbert Cox, ‘On Certain Points Connected with the Geology of the Auckland District’ (30 June 1881), *Reports of Geological Explorations During 1881* (Wellington, 1882), pp. 96-97.

consists of a series of regularly stratified volcanic rocks, which are continuous through the mountain itself and the adjoining ranges, not differing in any way from those which have proved auriferous at the Thames and elsewhere. On the south-west side of Te Aroha range, near where the Waiorongomai River debouches on to the plain, a belt of soft country occurs, in which a little gold was formerly got. Above this, a belt of hard greenish rock, perhaps 100 feet thick, is seen dipping to the N.E. at an angle of about 20°; and, above this, a belt of banded country, some hard and some soft, crops out.... This belt would sweep round the hill to near the Te Aroha Township, a belt of hard brown rock, partially decomposed, overlying it; and in this belt the original prospectors' claim was opened. Above this belt again comes a bed of purple and green breccia.... The belts of country which overlie this are those which are met with in the new diggings; and the first of these is a soft belt ... passing through the lower part of the Arizona Claim and into the middle spur. Above this, a belt of hard blue rock occurs, which has not a very great thickness, but may still be seen at several points, notably in the gully between the Young Colonial and New Find Claims. Above this comes the belt of country in which the New Find, Eureka, Golden Crown, and Young Colonial, as well as several other claims, have got or expect to get their gold, and this belt consists of a rather hard, partially-decomposed, felspathic rock, in which a good deal of pyrites is present at times. It is a harder class of country than is generally considered favourable for gold at the Thames and elsewhere, but is, I think, the same rock, in which the filling of the reefs has not been attended by so much decomposition. A belt of hard blue rock (anamesite?) overlies this and caps the range about Peter Ferguson's Victoria Claim,<sup>13</sup> runs through the mountain at an elevation of about 2,000 feet, and caps the far ranges, dipping away towards the Waitawheta Valley; and on the summit of Te Aroha Mountain it is overlaid again by a softer class of country.<sup>14</sup>

The main Waiorongomai reef was

a hard white quartz which is traversed in various directions by veins of a white vughy quartz, which are all lying flat in the reef. It stands nearly vertical, but appears, if anything, to underlie slightly to the eastward. It rises as sheer cliffs, often 100 feet or more in height, from the spurs which it crosses, and is almost

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<sup>13</sup> See paper on Peter Ferguson and his New Era.

<sup>14</sup> Cox, 'Gold Fields of the Cape Colville Peninsula', *Reports of Geological Explorations During 1882* (Wellington, 1883), pp. 15-16, plus note on p. 5.

entirely denuded of the enclosing rock; at places it is as much as 20 feet in width or even more.

A large number of claims have been taken up along this line of reef, and also on certain branch reefs which generally follow a north-easterly course, and would junction with the main reef either on the hanging- or foot-wall side.... Where gold has been proved in the stone, the claims are situated either on one of the N.E. leads or on the main reef at the junction of one of these.<sup>15</sup>

#### MORE INTENSIVE INVESTIGATIONS DURING THE 1880s

In May 1884, Henry Andrew Gordon, the Inspecting Engineer of the Mines Department,<sup>16</sup> reported that

some of the lodes are very small, but the quartz is rich. The character of the gold is extremely fine, and averages about £2/16/- per ounce: it is diffused in bands through the stone, the same as though the gold had been ground to the finest flour, and peppered into the quartz when they were in a plastic state.<sup>17</sup>

By then, prospectors had found big differences in the value of the ore, depending on its location. 'In some mines east of the master reef the gold realizes £3 6s per ounce, whilst in those to the west of the same reef the gold is worth about £2 15s'.<sup>18</sup> In 1882, John Alexander Pond,<sup>19</sup> a government analyst based in Auckland, who invested in Te Aroha mining from the 1890s to the 1930s, detected traces of platinum.<sup>20</sup> Four years later, in his paper to the Auckland Institute about the minerals of the Hauraki Peninsula, he reported having found silver in the form of a telluride in the Moa reef, 'very unevenly distributed through the stone, and invariably accompanied by magnetic pyrites in minute grains and crystals, in the same manner as the free gold at Te Aroha'. The silver in the Champion lode at Tui was partly in the forms of tellurium and sulphide of antimony. There were several lead ores at Tui and Waiorongomai, the latter having

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<sup>15</sup> Cox, 'Gold Fields of the Cape Colville Peninsula', p. 37.

<sup>16</sup> See *Cyclopedia of New Zealand*, vol. 1 (Wellington, 1897), p. 173.

<sup>17</sup> H.A. Gordon to Minister of Mines, 20 May 1884, *AJHR*, 1884, H-9, p. 1.

<sup>18</sup> *Te Aroha News*, 30 August 1884, p. 2.

<sup>19</sup> *Auckland Weekly News*, 25 April 1891, p. 9.

<sup>20</sup> See paper on his life.

several compact well-defined veins carrying a fair sample of galena. At several places in this locality I have found lead in the shape of chromate in small quantities. The galena in these mines can only be worked to advantage when containing sufficient gold or silver to make it valuable on this account.

The Champion lode was of compact galena with ‘a good deal of iron-pyrites’; other lodes contained lead in the form of a carbonate and a sulphide but very little silver or gold. A small amount of mercury, in the form of cinnabar, was present, especially at Tui, but was ‘too small’ to be ‘of any practical value’.<sup>21</sup> When Professor James Black, of Otago University College,<sup>22</sup> examined the Champion, he ‘saw stone carrying gold, silver, mercury, copper, lead, iron, and zinc, the gold chiefly in the free state, the other metals being all combined with sulphur as sulphides, with part of the lead also as sulphate’.<sup>23</sup>

By 1887, more extensive prospecting had revealed that the main Waiorongomai reef had an average yield of from five to seven pennyweights of gold per ton, too poor to pay for working, but containing rich patches.<sup>24</sup> In one reef, the Silver King, ‘some of the quartz contains a considerable percentage of carbonate of copper, and it is from this class of stone the best results have been obtained’.<sup>25</sup> Professor Frederick Wollaston Hutton, who lectured in geology at Canterbury University College,<sup>26</sup> considered that the reefs had ‘much pyrites, but not much gold’, the bulk of the latter probably having been ‘deposited in the fissures which were feeding the buck-reef’.<sup>27</sup> Ten years later, after more thorough prospecting had been done, the future Professor James Park of Otago University College<sup>28</sup> described the mountain as consisting of ‘a great pile of agglomerate, breccia, and augite-andesite, with wide bands altered to propylite’. The Champion lode was ‘very complex and refractory, besides gold, containing lead, mercury, copper, iron, zinc, and silver, mostly in the form of sulphides, excepting at the surface, where

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<sup>21</sup> *AJHR*, 1887, C-5, pp. 56-59.

<sup>22</sup> See *Cyclopedia of New Zealand*, vol. 5 (Wellington, 1905), p. 154.

<sup>23</sup> *The Handbook of New Zealand Mines* (Wellington, 1887), p. 293.

<sup>24</sup> H.A. Gordon to Minister of Mines, 5 May 1887, *AJHR*, 1887, C-5, p. 30.

<sup>25</sup> *Te Aroha News*, 3 March 1888, p. 2.

<sup>26</sup> See paper on the Waitoa ‘find’.

<sup>27</sup> F.W. Hutton, ‘On the Rocks of the Hauraki Goldfields’, *First Meeting of the Australasian Association for the Advancement of Science*, pp. 267, 270.

<sup>28</sup> See *Cyclopedia of New Zealand*, vol. 2, p. 478; vol. 5, p. 155.

they are oxidized into oxides, carbonates or sulphates'. He summarized the Waiorongomai lodes:

The Big lode, generally spoken as the Buck Reef, runs nearly north and south, and can be traced along the flanks of the mountain for several miles. It stands nearly vertical, inclining only slightly to the east near the battery, and to the west some distance to the north. It varies from 10 feet to 85 feet in width, the greatest width being found at the Premier Blow.

It receives, or is crossed by, a number of large veins varying in size from 2 to 30 feet in width. The general course of these cross-lodes is N.N.E.- S.S.W. The best-known are as follows:-

- (1) Silver King Reef: 4 to 20 feet.
- (2) Werahiko Reef: 2 to 8 feet.
- (3) The Loyalty Reef varies from 2 to 9 feet in width....
- (4) The Welcome Reef varies from 10 to 20 feet in width, and like Nos. 1, 2 and 3, dips towards the big lode at an angle of 45°.
- (5) Goldsworthy's Reef: 3 to 6 feet.
- (6) Diamond Gully Reef is 18 inches wide, and enclosed in solid andesite. It yielded rich specimen stone resembling that found at the Thames.
- (7) New Find No. 2 varies from 4 to 20 feet in width. It passes through the big lode. Where it enters on the north side a large pay-shoot was found, locally known as No. 1 patch; and where it emerges a second pay-shoot occurred called No. 2 patch. From the ore obtained from these pay-shoots a 40-stamper battery was profitably employed for four years.
- (8) The Hero Reef averages about 8 feet. In the lowest level at which it was worked it opened out to 13 feet....
- (9) Premier Reef varies from 4 to 12 feet in width, being largest in the old Vulcan ground. It passes through the big lode in the Premier ground, and on both sides dips towards the big lode, which at the point of intersection varies from 80 to 85 feet in width.

The gold from the veins on the east side of the big lode was worth over £3 per ounce, excepting that from the Silver King, which contained a large proportion of silver.

In the Colonist section the big lode throws out a vein 3 feet wide, which returns to the mother lode in a distance of 270 feet. At both junctions rich ore was found.

The gold in the Waiorongomai ores is generally very fine, and often associated with iron and copper pyrites. Much of the ore is very similar to that in the Champion lode, but is not quite so refractory.<sup>29</sup>

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<sup>29</sup> James Park, *The Geology and Veins of the Hauraki Goldfields, New Zealand* (Auckland, 1897), pp. 82-84.



In 1905, the results of the tests made on ore sent, between 1900 and 1903, to William Johnson Sollas, an Oxford professor,<sup>30</sup> were published. He gave details of the geology of five sites at Cascade Creek near Te Aroha, somewhere in the Waiorongomai Stream, and Aroha Mines' low level tunnel,<sup>31</sup> but did not mention having found any bullion and did not comment on the possible profitability.<sup>32</sup>

## THE GEOLOGICAL SURVEY REPORT

The most detailed analysis, published in 1913 by the Geological Survey Branch of the Department of Mines, was made by John Henderson with the assistance of John Arthur Bartrum. Others who assisted were two mine managers, then working at Karangahake, John McCombie<sup>33</sup> and Henry John Hyde;<sup>34</sup> two Waiorongomai miners, Walter Greening<sup>35</sup> and John Tallentire;<sup>36</sup> and Francis H. Snow, an Adelaide mining investor interested in a metallurgical process 'which he considered applicable to Te Aroha ore'.<sup>37</sup> The report summarized the structure of the Waiorongomai field:

A north-east striking series of ore-bearing lodes cross obliquely a north-striking silicified zone. The lodes striking north-east are exceedingly numerous, and seem to belong to an extensive sheeted zone of country. The Waiorongomai flows southward parallel to and from 40 to 50 chains from the silicified zone, or Buck Reef. Army Creek, Diamond Gully, Canadian Gully, and Premier Creek cross the lode-bearing area of country, and produce series of exceedingly steep slopes and spurs, and it is where the north-east lodes cross these slopes that they carry ore. Thus the Silver King lode is the only one to cross the slope south of Army Creek....

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<sup>30</sup> See Sollas, vol. 1, p. 5.

<sup>31</sup> See paper on the New Zealand Exploration Company.

<sup>32</sup> Sollas, vol. 1, pp. 251-254; vol. 2, pp. 139-140.

<sup>33</sup> See *Ohinemuri Gazette*, 6 September 1926, p. 6.

<sup>34</sup> See Mines Department, MD 1, 11/260, ANZ-W; *Waikato Times*, 25 October 1926, p. 6.

<sup>35</sup> See paper on Hardy's Mines.

<sup>36</sup> See *Te Aroha News*, 27 May 1909, p. 2, 4 December 1909, p. 2, 9 December 1909, p. 2.

<sup>37</sup> P.G. Morgan (Director, Geological Survey), to Under-Secretary, Mines Department, 30 March 1914, Ministry of Commerce, AATJ 6090, 18/65, ANZ-W.

The rich shoots could not be traced beyond the steep slopes, while in the creek-beds the large reefs are nearly all represented by silicified country, or at most by a few stringers....

Te Aroha mining area has recently suffered considerable elevation. As far as the weathering of the rocks are concerned, the area may be considered “juvenile”.... The sulphide-enrichment zone has not yet migrated to the foot of the mountain-slopes; it is still to be found a considerable distance up the slopes.<sup>38</sup>

It described the lode fissures:

The lode fissures of the Te Aroha mining-area are exceedingly numerous. The largest lode of the ... Hauraki Peninsula - the Waiorongomai Buck Reef - has been traced a distance of 240 chains, and occupies a crush-zone striking nearly north-and-south.... The “reef” consists of a zone of crushed and silicified country of variable width, traversed by numerous longitudinal and obliquely transverse quartz stringers. The figures given below must be considered only approximate, since the silicified rock generally merges gradually into the country. On the other hand, in some places a pug band sharply marks the boundary. At the southern end this great zone is about 60ft in width; 35 chains from the southern end a crosscut shows a width of between 90ft and 100ft. At Diamond Gully it is about 140ft wide, while at the crossing of the Premier Stream it may be 30ft. At the northern end the silicification is not so intense, and the quartz stringers are rare. Its width here, in the head of the Mangakino, is uncertain, but must be considerable. Throughout the whole of its length, except on the saddle between the Premier and Mangakino streams, the lode is readily traceable. At many places along this line it stands up like a great wall, sometimes over 200ft high....

From time to time this great silicified zone has been thoroughly sampled, and has been proved to carry a little gold and silver, usually only in traces. It carries payable ore only where joined by some other reef.<sup>39</sup>

Hence its southern and most prominent portion was known as Buck Rock, a buck reef being a barren one. When Aroha Mines decided, in the mid-1890s, to drive a low level tunnel along its length to provide cheaper transport of ore to the battery and because it hoped the reef might be

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<sup>38</sup> John Henderson, assisted by John Arthur Bartrum, *The Geology of the Aroha Subdivision, Hauraki, New Zealand: Geological Survey Bulletin No. 16 (New Series)*, (Wellington, 1913), pp. 97-98, 109.

<sup>39</sup> *Geology of the Aroha Subdivision*, pp. 89-90.

payable at this depth, an Auckland mining engineer told the London *Mining Journal* there was no prospect of obtaining good ore:

It has been tried over and over again by English and American practical mining metallurgists, and in every case proved a dismal failure. I made numerous enquiries from experienced men who had worked portions of it, and had been prospecting the same for years, and who subjected the quartz to all kinds of treatment, and still failed. Many stated it would not go one dwt to the ton.<sup>40</sup>

Henderson noted that, like most of Hauraki lodes, Te Aroha ones did not 'live down' and were much reduced in size at depth. The reef in the low level tunnel was 'only 12ft thick, while on the hill above it averages at least 80ft of quartz and silicified country'.<sup>41</sup> He anticipated that 'future ore-bodies may be found at Te Aroha, but that they will not prove more profitable than those hitherto worked'.<sup>42</sup>

Others had found the same failure to live down even in the richest claims; the veins in the New Find, Colonist, and Premier 'shortened and pinched up in hard rock' at lower levels.<sup>43</sup> The greatest depth at which payable gold was found in these three mines was 300 feet.<sup>44</sup>

These features were not unique to the Te Aroha district. As a late nineteenth century English visitor, who understood geology, noted, the peninsula contained 'numberless small ore shoots scattered about the reefs which cross and re-cross in bewildering confusion'. Whilst these patches were 'rich enough to provide assays and excuses for promotion', they were 'not large enough to pay dividends'.<sup>45</sup>

## A GEOPHYSICAL SURVEY

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<sup>40</sup> *Thames Advertiser*, 24 December 1896, p. 1.

<sup>41</sup> *Geology of the Aroha Subdivision*, p. 93.

<sup>42</sup> *Geology of the Aroha Subdivision*, p. 119.

<sup>43</sup> F.C. Brown, 'Report on the Mining Property owned by Hardy's Mines, Ltd, and Situated at Waiorongomai, New Zealand', 1 March 1906, p. 3, Mines Department, MD 1, 23/4/54, ANZ-W.

<sup>44</sup> J.F. Downey, *Gold Mines of the Hauraki District, New Zealand* (Wellington, 1935), p. 261.

<sup>45</sup> Raymond Radclyffe, *Wealth and Wild Cats: Travels and researches in the gold-fields of Western Australia and New Zealand* (London, 1898), pp. 154-155.

A geophysical survey undertaken in late 1951 repeated that, as elsewhere in Hauraki apart from Waihi, the reefs normally decreased in thickness at depth. Waiorongomai's main reef shrank from a width of 40 to 120 feet, where it outcropped, to only 12 feet in the lowest drive to strike it.

Ore banding, from the surface downwards, is usually as follows: porous quartz with gold, silver and wad<sup>46</sup> at the surface. With increasing depth pyrite and oxidized lead, zinc, copper minerals occur, followed by heavy sulphides of the latter and argentite. Silver and copper decrease with depth, while lead and zinc increase.

At Te Aroha oxidation has not proceeded very far and sulphides outcrop. Zinc increases relative to galena with depth, and the cinnebar found at the surface disappears. Hence the succession mercury, silver, copper, lead, zinc is the order of occurrence downwards from the surface, and this is also the order of increasing solubility.

Ore is richest where veins, faults etc intersect. The Buck Reef is barren, except where joined by north-east striking veins.

Throughout the peninsula, payable ore ceased at depths of 400 to 800 feet below the surface.<sup>47</sup> Most metallic sulphides occurred in rich veins from six to 12 inches thick in reefs up to 30 feet thick. The widest sulphide band he had seen was three feet thick, but within 30 feet it had thinned to six inches. The mountain was 'literally riddled with reefs', especially at Waiorongomai, and high values were found where reefs joined, but its main reef was 'amazingly barren'. As many reefs joined a major one at depth, the number of reefs was greatest at the surface.<sup>48</sup> The survey noted 'the great abundance of reefs east of the Buck Reef as opposed to west of the Buck Reef'.<sup>49</sup>

## A VOLCANIC LEGACY

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<sup>46</sup> Either an impure mixture of manganese and other oxides, or hydrated oxides of manganese and other metals: *Glossary of Geology*, ed. Robert C. Bates and Julia A. Jackson, 3 ed. (Alexandria, Virginia, 1987), p. 729.

<sup>47</sup> J.B. Misz, 'Te Aroha Mountain Geophysical Survey' (typescript, 1952), p. 5, Mines Department, MD 1, 23/2/1218, Part 2, ANZ-W.

<sup>48</sup> Misz, p. 7.

<sup>49</sup> Misz, p. 8.

The ore had been produced by volcanic action. Park, in a book written to explain mining geology for miners and students, described the series of volcanic eruptions that had formed the Hauraki Peninsula:

In the expiring phases of both the andesitic and rhyolitic outbursts there was widespread hydrothermal activity, which resulted in the formation of the metalliferous veins and mushroom-shaped sinter deposits that are scattered throughout the peninsula....

It is possible that after the volcanic forces which originated these rocks had spent themselves, solfatara<sup>50</sup> action took place and continued in operation for a long time. In support of this we still have the thermal mineral springs at Te Aroha issuing from the same class of rocks.

The leaching action of thermal waters, doubtless accompanied by steam and acid vapours, would be more rapid and deep-reaching than the action of surface waters.

The former existence of solfatara action would satisfactorily explain the presence of the altered gold-bearing rocks at depths far below the reach of surface decomposition.<sup>51</sup>

## TRYING TO FIND THE RIGHT TREATMENT

As the main problem facing all goldfields before the use of cyanide became the norm was how to treat the ore successfully, various methods were used.<sup>52</sup> Quartz impregnated with gold was expected to be easily workable, despite the gold's fineness, if it was not combined with base metals. In 1883 an engineer who assisted in finding new processes for the Waiorongomai battery sent a colleague a sample of 'very fine but free' stone from 'the leading mine', the New Find.<sup>53</sup> Such 'free milling' ore, free from sulphides, was the most profitable because it could be treated relatively

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<sup>50</sup> 'A volcanic orifice which is in a dormant or decadent stage and from which gases (esp. sulphur dioxide) and volatile substances are emitted': *Chambers Dictionary of Science and Technology* (Edinburgh, 1999), p. 1070.

<sup>51</sup> James Park, *A Text-Book of Mining Geology for the Use of Mining Students and Miners*, 3 ed., rev. (London, 1911), pp. 93-95.

<sup>52</sup> See, for example, Ralph W. Birrell, 'The Extraction of Gold by Amalgamation and Chlorination', *Journal of Australasian Mining History*, vol. 2 (September 2004), pp. 18-31.

<sup>53</sup> W.T. Firth to R.R. La Valline, 23 March 1883, W.T. Firth Letterbook 1883-1900, MSC 19, Hamilton Public Library.

easily, unlike the ‘refractory’ ores making up most of the lodes. In 1906 Hardy’s Mines was told that its free-milling ore was

fairly hard white quartz carrying very fine free gold (worth about £2 10s per oz), and a small quantity of iron and copper pyrites (chalcopyrite), zinc blende, galena, and iron pyrites. The refractory ore carries very little free gold, but a fairly high percentage of iron and copper pyrites, zinc blende, galena, and iron pyrites.

The latter were in the form of sulphides.<sup>54</sup> In 1886, three Auckland journalists, one of whom, Henry Brett, invested in two Tui mines and was the second proprietor of the *Te Aroha News*,<sup>55</sup> described Waiorongomai gold as being ‘of a very fine quality, and the quartz containing it is heavily charge likewise with silver, galena, and other minerals’. Consequently, ‘the process of extraction is costly, in default of some cheap and effective means of dealing with refractory ores.... The processes tried so far have allowed too large a proportion of the gold to escape’.<sup>56</sup> Twelve years later, the same problem still existed, as a visiting overseas expert noted:

The reefs in the Te-Aroha group are in general moderately rich in gold, but as the ores often contain an intimate mixture of copper and iron pyrites, zinc blende and galena, they have not yet been worked at a profit for want of a satisfactory and economical method of concentration; this has retarded the further development of the reefs.<sup>57</sup>

One battery owner, Josiah Clifton Firth,<sup>58</sup> noted that, because the quartz was from 30 to 50 per cent harder than at Thames, his battery,

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<sup>54</sup> F.C. Brown, ‘Report on the Mining Property owned by Hardy’s Mines, Ltd., and Situated at Waiorongomai, New Zealand’, 1 March 1906, pp. 6, 7, Mines Department, MD 1, 23/4/54, ANZ-W.

<sup>55</sup> Te Aroha Warden’s Court, Register of Licensed Holdings 1881-1887, folio 185, BBAV 11500/9a; Licensed Holdings Grant Book 1882-1886, no. 185, BBAV 11549/1b; Rent Register 1881-1900, 4, 24/1887, 130/1888, BBAV 11501/1a; Plaintiff Book 1880-1898, 11/1889, BBAV 11547/1a; *Cyclopedia of New Zealand*, vol. 2, p. 828.

<sup>56</sup> H. Brett, T.W. Leys, and J.M. Geddis, ‘Descriptive Sketch of New Zealand’, in *Picturesque Atlas of Australasia*, ed. Andrew Garran (Sydney, 1886), vol. 3, p. 69.

<sup>57</sup> Karl Schmeisser, *The Gold-fields of Australasia* (London, 1898), p. 151.

<sup>58</sup> See paper on the Battery Company.

which at Thames had crushed 700 tons a week, at Waiorongomai never crushed more than 300.<sup>59</sup>

As the ore permeated the lode, there were no possibilities of bonanzas. Shareholders of Hardy's Mines were told in 1904 that the ore being extracted from the Premier could not be 'picked and selected as in the Thames and Coromandel mines'. All the ore was being treated because gold was 'distributed throughout the whole body'.<sup>60</sup>

### TRACING THE VALUES

On the basis of his 12 years of research in Hauraki, Park explained how the values of ore veins were influenced by the surrounding 'country rock':

- (a) The rock which has yielded the largest quantity of gold is a moderately hard yellowish-grey altered andesite, the "kindly sandstone" of the miners.
- (b) The most favourable country is not too soft, nor yet too hard, being shooting ground, requiring two or three shots to the shift.
- (c) In very hard country-rock, the veins are generally smaller than in soft rock; and when a vein passes into hard andesite, it invariably becomes smaller, and often thins out to a mere clay-parting or "clay head."
- (d) The veins in the hard rock have not proved so remunerative as those in the miner's "kindly sandstone," and this is due not so much to their leanness as to their smaller size and the greater cost of working them.
- (e) When a vein passes from altered andesite into a tuff or breccia, it invariably becomes barren, or too low grade to be profitable.<sup>61</sup>

'Rich masses of ore often occur in the oxidized portion of the ore-body', this 'secondary enrichment' being caused by

the migration of the valuable metallic contents from the higher portion of the vein to the lower portion of the oxidized zone by the agency of meteoric waters....

The veins in which secondary enrichment are most often seen are those of gold, silver, copper, lead, and zinc.

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<sup>59</sup> *Te Aroha News*, 30 May 1885, p. 2.

<sup>60</sup> *Auckland Weekly News*, 9 June 1904, p. 41.

<sup>61</sup> Park, *Test-Book of Mining Geology*, pp. 120-121.

Gold ores, in the *zone of weathering*, are often augmented in value by the long-continued disintegration of the vein and the enclosing rock, thus permitting the gold set free from its matrix to concentrate at the outcrop.<sup>62</sup>

Hence prospectors concentrated on finding outcrops, and the two best finds at Waiorongomai were the New Find and Premier 'blows'. Park explained that lower portions of ore bodies were impoverished because heat and pressure decreased near the surface, causing minerals to be precipitated:

Progressive poverty in depth below a certain depth must be the natural corollary of the general law governing the orderly distribution of ores in horizontal zones, through the agency of ascending waters.... When the values of secondary enrichment are added to ore already of a payable quality, the result is a rich shoot or bonanza; but when, as often happens, the secondary values are added to lean ore, then the net result is to render the lean ore just profitable. Below the zone of enrichment, the lean ore will be unprofitable.<sup>63</sup>

## HIGH HOPES

Optimists hoped Waiorongomai and Tui would be exceptions to these general rules. For example, while admitting that at Waiorongomai 'the lowest levels previously worked have proved to be poor,' the *Te Aroha News* in 1911 argued that, as this happened 'in most goldmines sooner or later', it did not prove the gold had 'gone altogether', and cited the Talisman at Karangahake as an instance of good ore being found at greater depth.<sup>64</sup> Enthusiastic amateur geologists traced what they imagined to be the valuable main reef across the countryside to Waihi in one direction and to

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<sup>62</sup> Park, *Text-Book of Mining Geology*, pp. 124-125.

<sup>63</sup> Park, *Test-Book of Mining Geology*, pp. 128-129; for more technical analyses of Waiorongomai and Tui ore, see Ronald H.A. Cochrane, *Geology of Tui Mine, Mt. Te Aroha*, (MSc thesis, Auckland University, 1969), A.J. Cartwright, *Geology of the Waiorongomai Valley, Te Aroha*, (MSc thesis, Auckland University, 1982), A.B. Christie, *Fluid Inclusions, Stable Isotopes and Geo-Chemistry of Porphyry Copper and Epithermal Vein Deposits of the Hauraki Gold-Silver Province, New Zealand*, (PhD thesis, Victoria University of Wellington, 1982).

<sup>64</sup> *Te Aroha News*, 14 February 1911, p. 3.



the King Country in the other. In 1882 A.L wrote that Te Aroha was ‘on a line with Waitekauri, Tairua, the Thames, Tapu, and Coromandel ... and, according to reliable report, the same line of reefs are traceable into the locked-up King Country’. He also believed its quartz to be ‘so free from base metal that, with fine screens, there will be no difficulty in saving the finer particles of gold’;<sup>65</sup> which was not a good prophecy. In 1888 a Waiorongomai correspondent cautiously reported that reputedly this reef had been traced ‘across the flats to the river, running in a westerly direction’.<sup>66</sup> Seven years later, Edwin Barnes Walker, who farmed near Cambridge,<sup>67</sup> and who speculated very modestly in Waiorongomai mining during the 1880s and 1890s,<sup>68</sup> believed he would find gold at Maungatautari because of ‘one side of the hill being in a direct line with some of the reefs of Te Aroha’.<sup>69</sup> In 1905 one old prospector claimed the Martha reef headed from Waihi to Te Aroha and could be picked up by ‘a few hundred feet of driving’ between the original prospectors’ claim at Te Aroha and Stoney Creek.<sup>70</sup> Even more enthusiastic was the last prospector of Waiorongomai, Malcolm Hardy,<sup>71</sup> who claimed that the main reef had been traced from the coast near Waihi to Te Aroha and on to Maungatautari, the Rangitoto-Tuhua Range, Puketutu, and across the King Country to meet the sea at Awakino, ‘thus bisecting the N[orth] Is[land] roughly from N to S’. He claimed to have examined specimens from this lode near Te Kuiti (presumably where his father farmed)<sup>72</sup> and at Awakino, the former being ‘almost identical with sulphides’ found at Waiorongomai.<sup>73</sup>

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<sup>65</sup> A.L., ‘The Te Aroha Goldfield’, *Auckland Weekly News*, 28 October 1882, p. 20.

<sup>66</sup> Waiorongomai Correspondent, *Waikato Times*, 29 November 1888, p. 2.

<sup>67</sup> See Eric Beer and Alwyn Gascoigne, *Plough of the Pakeha* (Cambridge, 1975), pp. 128-130, 152-158, 172, 273-279, 307-309.

<sup>68</sup> Te Aroha Warden’s Court, *Plaint Book 1880-1898*, 7/1889, BBAV 11547/1a; *Mining Applications*, 16/1895, 112/1896, BBAV 11582/4a; *Letterbook 1883-1900*, p. 431, BBAV 11534/1a, ANZ-A.

<sup>69</sup> *Waikato Times*, 14 September 1895, p. 6.

<sup>70</sup> *Te Aroha News*, 20 July 1905, p. 2.

<sup>71</sup> See paper on his life.

<sup>72</sup> See chapter on Edwin Henry Hardy.

<sup>73</sup> Malcolm Hardy, *Report for South Pacific Mines*, 27 October 1955, pp. 3-4; for the dating of this report, see Alistair Isdale to Under-Secretary for Mines, 20 November 1962, *Inspector of Mines*, Box 16A, 13/11, vol. 1, held by Ministry of Commerce, Hamilton.

Before any ore was crushed, untrained observers predicted great returns from Waiorongomai, as, for example, *Brett's Auckland Almanac, Provincial Handbook, and Strangers' Vade Mecum for 1884*:

when impartially inspecting the various reefs, one cannot fail to be convinced that enormous quantities of payable quartz are to be obtained easily, while the large district over which the innumerable auriferous reefs extend is capable of supporting a very large mining population.... The gold appears to be well distributed through the reefs, and though fine, it is believed to be easily saved, and generally payable.... The country is chiefly block sandstone, very favourable for carrying gold, and similar to that met with on the eastern side of the Karangahake range, where the best gold was got.... The reef system seems to be traceable from Te Aroha through Karangahake and on to Waitekauri.<sup>74</sup>

Once again, ore bodies and future prospects were linked with more successful mining centres nearby.

## THE REALITY

A Thames newspaper, quoting a Cornish proverb that 'no one can see a foot in the ground', reminded its readers that it was 'never safe to prophecy in gold mining'.<sup>75</sup> Te Aroha mines were unprofitable for nearly all involved, despite employing competent mine managers and using the best technical processes available, as a 1933 summary of Waiorongomai mining made very clear:

Its whole mining history and experience shows emphatically that the payable gold bearing sections of the various lodes are only surface patches of enrichment and do not go down to depth. All the low prospecting and exploring done in more recent times since the original shallow deposits were worked out had led to disappointment, the reefs either not existing as reefs at all, being only fissures filled with country and silicified rock, or, if reefs, containing no values. The greatest depth at which quartz has been found containing gold but not in payable quantity is I

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[This report has now been lost, but Eric Coppard of Waihi had made a handwritten copy: Coppard Papers.]

<sup>74</sup> *Brett's Auckland Almanac, Provincial Handbook, and Strangers' Vade Mecum for 1884*, (Auckland, 1884), pp. 120-121.

<sup>75</sup> *Thames Advertiser*, 11 February 1884, p. 2.

believe 300 [feet] from the outcrop in the ridges, even in the hollows of the ravines where the lodes have been cut down a couple of hundred feet the formations have generally changed to mere vein filling.... Subsidiary lodes have shown patches of important enrichment in the vicinity of the Buck reef, never to any permanent depth nor to any considerable lateral distance from the main body. Some of these belts of enrichment run back to the main lode itself and even continue along the E. wall for short distances before they merge into the main body and lose all their identity and valuable content.<sup>76</sup>

At Tui, the most thorough geological investigations were made after the Second World War. In 1951, a report for the Auckland Smelting Company stated that the ore was found in 'more or less narrow fissure veins. The vein system appears to be extremely complex. The main gangue mineral is quartz and other minerals observed were galena, sphalerite, chalcopryite, covellite, argentite, malachite, pyrite and marcasite'.<sup>77</sup> When Norpac mined there from 1966 to 1972, it faced considerable problems with the class of ore. For a start, it was not one large ore body but consisted of 'veins and thin stringers of high value ore'.<sup>78</sup> In 1964, assays of 'ten samples taken over a width of 5ft' produced a value of \$30.78 per ton, but a geologist warned that this result would not be 'characteristic over the whole length of reef exposed along the drive'. There was a 'very lean gold content' in the oxidized ore.<sup>79</sup> The ore in the Ruakaka section was found at a shallow depth and in narrow veins, 'and grade and character vary very greatly'.<sup>80</sup> The lodes derived 'from hydrothermal solutions ascending normal faults' and

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<sup>76</sup> Unreadable name [a Waihi resident] to R.G. Milligan, 25 November 1933, Malcolm Hardy Papers, in possession of Eric Coppard, Waihi.

<sup>77</sup> J.M. Warrington, 'Report on Metalliferous Deposits at Te Aroha, North Island, New Zealand', (1951), Mines Department, MD 1, 23/2/1218, Part 1, ANZ-W.

<sup>78</sup> A.F. Downer to B.H. Swig, 11 June 1970, Norpac Papers, North American Partners File, later held by Mineral Resources at Union Hill, Waihi, but now destroyed; I am indebted to Eric Coppard of Waihi for giving me access to this material (hereafter Union Hill).

<sup>79</sup> B.J. Williams, 'Tertiary Propylitic Mineralization', in *Economic Geology of New Zealand*, ed. Williams (Melbourne 1965), p. 122 [reprinted unchanged in 1974].

<sup>80</sup> F.J. Handcock, Report 8/5 for period ending 8 August 1970, Norpac Papers, MSS and Archives, Vault 4, Box 6, NMC 19/5, University of Auckland Library (hereafter Norpac).

occupied 'open spaces (relatively) provided by such tensional rock-fracturing'.<sup>81</sup> The major veins, the Champion and Ruakaka,

crop out prominently in localities, and elsewhere are inconspicuous or their traces are represented by the end-product of propylitization, kaolinitic clays. With intensive weathering, the quartese parts of a vein disintegrate into an accumulation of quartz boulders and the less resistant parts are completely eroded. This accounts for the localized accumulation and distribution of mineralised quartz boulders from 15 [feet] or so diameter to smaller sizes.... Nowhere have boulders of one grade been noted.<sup>82</sup>

Scientists with varied skills continued to test the ore, which added to the general fund of knowledge without solving the problem of how to establish a long-term, profitable mine.<sup>83</sup>

In the 1980s, Mineral Resources (N.Z.) investigated both Tui and Waiorongomai, principally the latter. After summarizing both historic explorations and those done in the 1980s, Terry Bates, its exploration manager, claimed that 'the reefs collectively present an attractive exploration target capable of containing several ore bodies of complex base metal precious metal ore that probably have similar metallurgical

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<sup>81</sup> H.F. Fyfe, 'Summary Report - Tui Area', 1971, in Mines Department, MD 1, 23/2/1257, ANZ-W; also in Norpac Papers, Box 6, NMC 19/6, Norpac.

<sup>82</sup> H.F. Fyfe, 'Summary Report - Tui Area', 1971, Mines Department, MD 1, 23/2/1257, ANZ-W; also in Norpac Papers, Box 6, NMC 19/6, Norpac.

<sup>83</sup> See B.G. Weissberg and Antoni Wodzicki, 'Geochemistry of Hydrothermal Alteration and Origin of Sulphide Mineralization at the Tui Mine, Te Aroha, New Zealand', *New Zealand Journal of Science*, vol. 13 no. 1 (March 1970), pp. 36-59; Antoni Wodzicki and B.G. Weissberg, 'Structural Control of Base Metal Mineralisation at the Tui Mine, Te Aroha, New Zealand', *New Zealand Journal of Geology and Geophysics*, vol. 13 no. 3 (October 1970), pp. 610-630; D.J. Nicolas and R.R. Brooks, 'Biogeochemical Prospecting for Zinc and Lead in the Te Aroha Region of New Zealand', *Australasian Institute of Mining and Metallurgy, Proceedings*, no. 231 (1970), pp. 59-66; Brian W. Robinson, 'The Origin of Mineralization at the Tui Mine, Te Aroha, New Zealand, in the Light of Stable Isotope Studies', *Economic Geography*, vol. 69 no. 6 (October 1974), pp. 901-925; C.J.D. Adams, A Wodzincki, and G.G. Weissberg, 'K-Ar Dating of Hydrothermal Alteration at the Tui Mine, Te Aroha, New Zealand', *New Zealand Journal of Science*, vol. 17 no. 2 (1975), pp. 193-200.

characteristics'.<sup>84</sup> Much of the very detailed report on Waiorongomai produced for this company in 1986 by R.C.J. Walter was based on Malcolm Hardy's over-optimistic arguments, a very misleading starting point.<sup>85</sup> Walter claimed this area had 'not been adequately evaluated in the past with respect to low grade-high tonnage gold ore potential', estimated that the main reef 'probably contains over 13 million tones within 100 metres of surface', and proposed work programmes to evaluate this potential,<sup>86</sup> which were not acted upon, fortunately for both the shareholders and the environment.

## DIFFERENT TREATMENTS

Technical geological details were little understood by most early prospectors, who were usually self-taught. They learnt by trial and error to recognize likely prospects and to ignore 'fool's gold' and mica. Battery managers also had to learn the hard way how to treat the ore, for the early processes in particular often could not extract a payable return. Despite continual modifications and experimentation with new machinery and new processes, the refractory nature of the ore made it one of the least successful Hauraki field. The yield of bullion for Waiorongomai to the end of 1933, as given by Downey, was 68,961 ounces, valued at £115, 081; the Tui area produced 23 ounces valued at £133.<sup>87</sup> It has been claimed that 'by only totalling returns given to the Mines Department' Downey 'consistently downgraded production totals throughout the Hauraki Goldfields',<sup>88</sup> but even if additional returns could be traced and included it must be assumed that the relative proportions would remain the same.

Like the early prospectors, the early battery owners and managers were optimistic about how easily the ore could be treated. When visitors to

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<sup>84</sup> T. [Terry] E. Bates, 'Te Aroha Goldfield – Tui and Waiorongomai Gold/Silver/Base Metal Prospects', in *Mineral Deposits of New Zealand: The Gordon J. Williams Memorial Volume*, ed. David Kear (Australasian Institute of Mining and Metallurgy, Monograph 13, Melbourne, 1989), pp. 79-81.

<sup>85</sup> See paper on his life.

<sup>86</sup> R.C.J. Walter, 'Summary of Geological and Mining Information available on the Waiorongomai Area, PL 31-694', submitted to Ministry of Economic Development, Crown Minerals, Mineral Report Series MR522 (Wellington, 1986), pp. 2, 23-38.

<sup>87</sup> Downey, pp. 288-289; for details of all the main mines, see pp. 265-289.

<sup>88</sup> Walter, p. 27.

Waiorongomai in 1883 were dubious about how much of the fine gold would be saved, 'experienced miners' assured them 'there would be no difficulty' because of its density. An assayer who tested a parcel from the Welcome found that 'the total loss was little more than one and a half per cent of gold'. The *Te Aroha News* commented that 'no gold could have been saved more easily, it would be very hard to get a ton of quartz which would return almost forty ounces and show a smaller percentage of loss'.<sup>89</sup> The anticipation of 40 ounces of gold to the ton was quite unrealistic.

The first of several new processes that promised to save most of the ore was the LaMonte one, brought to Karangahake in 1885 and reported to have treated trial parcels of Waiorongomai ore and tailings in a 'very satisfactory' manner.<sup>90</sup> This process quickly proved to be a total failure, and the same newspaper that had hoped for so much from it commented, when the LaMonte furnace was sold for £29, that this was 'a kindly warning to speculators not to put their faith in every new process that is introduced'.<sup>91</sup> A warning it ignored itself, having just enthusiastically publicized another unsuccessful solution, Alexander Parkes' process.<sup>92</sup> A Waiorongomai correspondent with equal enthusiasm expected, in 1889, that 'in the near future' the new techniques introduced in the greatly enlarged battery<sup>93</sup> would solve the problem of 'treating successfully all descriptions of ores in our rich hills'.<sup>94</sup>

This was not to be. At this time all Hauraki mills failed to extract most of the bullion, and all struggled to find the best method of treatment. Despite the first Waiorongomai battery being, for its time, thoroughly up-to-date, because the gold was so fine and so diffused through the stone only about a third was saved.<sup>95</sup> Such losses were regretted but accepted as being unavoidable, as 'Obadiah', a mining columnist, complained:

Our doctrine has been and still is - never mind what has been lost  
- will the amount saved pay? - And in many instances it is not so,

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<sup>89</sup> *Te Aroha News*, 14 July 1883, p. 2.

<sup>90</sup> *Te Aroha News*, 23 May 1885, p. 2, 6 June 1885, p. 2.

<sup>91</sup> *Te Aroha News*, 9 January 1889, p. 2.

<sup>92</sup> *Te Aroha News*, 11 February 1888, p. 2, 4 April 1888, p. 2, 7 November 1888, p. 2.

<sup>93</sup> See paper on the Te Aroha Silver and Gold Company.

<sup>94</sup> *Waikato Times*, 26 February 1889, p. 3.

<sup>95</sup> *Auckland Weekly News*, 11 April 1885, p. 20; Te Aroha Correspondent, *Waikato Times*, 28 May 1885, p. 2.

and the mines have been shut down as unprofitable, when, with careful manipulation and a better system of saving our bullion, more satisfactory results would be obtained.<sup>96</sup>

This was what happened at Waiorongomai, for the 'better system' was hard to find, and the more refractory the ore the harder it was for even the best system to succeed. And what worked in the laboratory with test samples normally did not work when treating large amounts in the battery. A few months after the Waiorongomai battery started, with disappointing results, the *Te Aroha News* warned that tests of small samples tended 'to mislead those who have them made' and were 'of little or no practical use', for invariably they gave 'much larger returns than can possibly be obtained, even with the most careful manipulation, under the ordinary process of treatment'.<sup>97</sup>

By 1886, it was regarded as 'a recognized fact' that the Waiorongomai reefs could not be profitably worked unless there was 'some process of treating the ores different from any of the systems that have been yet tried' on other fields. In what was to be a regular occurrence when mining was in difficulty, the government was expected to provide funds to help find a new process. Backed by the Brokers' Association and the Auckland Chamber of Commerce, Hauraki miners petitioned it to send an experienced battery manager ('not merely a theorist') to America, England, and Germany to investigate the best methods.<sup>98</sup> The government declined. But even the best methods might not work with Waiorongomai ore, for reasons explained in the *Te Aroha News* in 1885:

Its extreme fineness is where the difficulty comes in, the common mode of treatment by stamper and berdans, etc, being found utterly ineffectual to save more than a small proportion of it owing to this peculiarity. If at a moderate cost seventy five per cent to ninety five per cent of the gold can be secured, even when fine, as against twenty five per cent to thirty five per cent saved in the appliances now in vogue, what a reaction would quickly set in, where now the mining industry is at such a very low ebb.<sup>99</sup>

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<sup>96</sup> 'Obadiah', 'Shares and Mining', *Observer*, 15 April 1893, p. 12.

<sup>97</sup> *Te Aroha News*, 28 June 1884, p. 2.

<sup>98</sup> *Te Aroha Correspondent*, *Waikato Times*, 7 August 1886, p. 3.

<sup>99</sup> *Te Aroha News*, 16 May 1885, p. 2.

Despite another 12 years of experimentation, in 1897 not more than 40 per cent of the gold was being saved.<sup>100</sup>

The first Waiorongomai battery was erected for Josiah Clifton Firth and James McCosh Clark.<sup>101</sup> Immediately it started crushing, in November 1883, it was found that the ore was far more difficult to treat than anticipated. One of Firth's sons, who assisted to make technical improvements, noted in February 1884 that the ore was 'of such a rebellious nature' that the ordinary process lost both gold and silver.<sup>102</sup> In April 1884, the warden wrote that the reason was assumed to be 'the fineness of the gold and, possibly, the presence of base metals' causing 'an unusually large percentage' of gold to end up in the tailings, which were being saved for further treatment. 'A careful test of some tons shows that from 1oz to 1 1/2oz of gold may be saved from the ton of tailings; even then leaving a large quantity of gold to be accounted for; this, with the gold-saving appliances at present in use at the Aroha, it is to be feared must be considered as lost'.<sup>103</sup>

One year later, the warden explained mining's decline by the loss of gold:

The extreme fineness of the gold, coupled with the difficulty experienced in separating it from the silver and baser minerals, ensures a loss of from 40 to 60 per cent of the gold by the present treatment. I have no hesitation in saying that at Te Aroha, as also in many parts of the Thames Goldfield, not more than one-third of the gold is saved. This has been demonstrated by careful and numerous tests of the stone taken from different portions of the reef, as also from the stone passing through the battery. The tests have been made at the banks, both in New Zealand and Sydney, and privately, by experts. Stone that at the battery was giving, after the tailings had been passed through the berdans, an average of 1oz to the ton, was found to contain from 3oz to 5oz. Stone that would not give more than 1/2oz to the ton was found to contain from 1 1/2oz to 3oz. Of this latter quality, tens of thousands of tons are now lying untouched in the various mines. As the present method of treatment will not pay the expense of

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<sup>100</sup> *Auckland Weekly News*, 7 August 1897, p. 13.

<sup>101</sup> See paper on the Firth and Clark battery.

<sup>102</sup> W.T. Firth to Hugh Craig, 1 February 1884, W.T. Firth Letterbook 1883-1900, MSC 19, Hamilton Public Library.

<sup>103</sup> Harry Kenrick to Under-Secretary for Gold Fields, 19 April 1884, *AJHR*, 1884, H-9, p. 19.



raising and crushing, of course, when saying that 1/2oz of gold to the ton will not pay working expenses, the inferior value of the gold must not be forgotten. The average value of Te Aroha gold would probably be about £2 16s per oz.<sup>104</sup>

In 1888, Gordon, who argued that many mines would be profitable once there was a plant 'capable of treating the ore properly' instead of losing half or more of the bullion, explained some of the geological difficulties:

The gold on this field is extremely fine, and it occurs in bands in the stone being disseminated through these bands in very minute atoms. Not only is it always found in finely divided particles among the quartz, but it is also associated with silver and other minerals, some of which occur in such a form as to be very refractory to treat. Indeed, there is very little free-milling ore to be found on the field.

To show the value of some of the ore from this field, when the New Find Company first commenced to work their mine the quartz gave 2oz of gold to the ton by the ordinary battery process. The tailings were afterwards treated in berdans, and yielded almost a similar amount. They were ultimately treated in berdans a second time, and still paid for working. It will therefore be seen that a very small percentage of the bullion in the stone was obtained in the first process by the ordinary stamping-battery.<sup>105</sup>

It was clear that this battery 'was not capable of properly treating' ore containing 'gold, silver, copper, zinc-blende, and galena. It was only suitable for free-gold ores'. The miners only looked for gold, having 'no idea of silver being in the lodes in payable quantities. The combination of sulphur, arsenic, galena, and zinc-blende with the gold sickened the mercury used in the battery treatment'.<sup>106</sup>

Park was certain that the normal process could not extract silver because the ore contained too much sulphur, chlorine, and, probably,

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<sup>104</sup> Harry Kenrick to Under-Secretary for Gold Fields, 20 April 1885, *AJHR*, 1885, C-2, p. 29.

<sup>105</sup> H.A. Gordon to Under-Secretary, Mines Department, 1 May 1888, *AJHR*, 1888, C-5, p. 28.

<sup>106</sup> H.A. Gordon to Under-Secretary, Mines Department, 8 June 1889, *AJHR*, 1889, C-2, p. 44.

tellorium.<sup>107</sup> The company, therefore, sent its battery manager, Henry Hopper Adams,<sup>108</sup> to America in 1886 to investigate the gold-saving appliances currently in vogue, taking samples of ore from several mines for testing.<sup>109</sup> The result was that a revolving furnace was erected to roast the tailings, hoping thereby to save an additional ten per cent of the bullion.<sup>110</sup> By roasting the tailings with salt and lime, more than double the yield was obtained compared with treating the raw ore in berdans; in some cases up to 95 per cent of the assay value was achieved. In reporting this result, Gordon commented that, to achieve the best result, it would be necessary to remove the sulphur and arsenic before roasting.<sup>111</sup> Experiments to find the best ways of using the furnace were incomplete when the battery was sold to William Robert Wilson of Australia, whose Te Aroha Silver and Gold Mining Company employed the American metallurgist John Howell to thoroughly reconstruct it to incorporate new methods.<sup>112</sup> Howell decided to use a wet-jacket smelting furnace, and, to ascertain which fluxes were needed, quartz from two mines was treated at the Adelaide smelting works.<sup>113</sup> At the tailings plant, one simple change made a significant improvement:

Formerly, as soon as the tailings came from the roaster, they were cooled by a spray of water before being treated in the berdans. Now the sand, after leaving the roaster, is spread on the concrete floor, there allowed to cool naturally, thus getting rid of sulphur and any other noxious gases that are considered so deleterious in the matter of gold-saving.<sup>114</sup>

The new process put the crushed ore through concentrators and then a reverberatory furnace, to be finally smelted with fluxes in furnaces. As only

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<sup>107</sup> James Park to Minister of Mines, 27 December 1886, Mines Department, MD 1, 87/794, ANZ-W.

<sup>108</sup> See paper on his life.

<sup>109</sup> *Te Aroha News*, 18 September 1886, p. 2.

<sup>110</sup> *Te Aroha News*, 23 April 1887, p. 2.

<sup>111</sup> H.A. Gordon to Under-Secretary, Mines Department, 1 May 1888, *AJHR*, 1888, C-5, p. 29.

<sup>112</sup> See paper on this company.

<sup>113</sup> George Wilson to Under-Secretary, Mines Department, 4 April 1888, *AJHR*, 1888, C-6, p. 12.

<sup>114</sup> *Waikato Times*, 7 June 1888, p. 2.

the concentrates were to be smelted, the 'essential portion of the ore will be retained, and the troublesome portion, silica, will be allowed to run off'.<sup>115</sup> The concentrators separated all the 'base sulphides from the valueless gangue' and enabled the complex ores to be worked successfully. In the opinion of the warden, concentration was the solution to treating all the base ore of Hauraki.<sup>116</sup> With these and other changes, Waiorongomai had 'the most complete reduction-works in the whole of the Australasian Colonies', one expected to be able to cope with all varieties of ore. 'The large quantity of silica the ore contains renders it unsuitable for the smelting process, and this plant copes with this difficulty by getting clear of most of the silica on the concentrating-tables, and only dealing with a small percentage of it in the material that goes into the smelting-furnace'.<sup>117</sup>

Gordon reported that 'about 60 per cent' of the gold and silver was 'associated with base-metal sulphides' which formed 'about 3 per cent of the weight of the crude ore'. Analysis of the concentrates revealed them to contain 8.44% sulphide of lead, 3.35% sulphide of copper, 12.80% sulphide of zinc, 48.50% bisulphide of iron, 0.17% tersulphide of arsenic, and 26.05% silica and silicates.<sup>118</sup> And there were the usual optimistic prophecies that the battery would 'be able to profitably treat ore, now considered almost valueless, and cast aside'.<sup>119</sup> There were the usual statements that the machinery was working splendidly, Howell saying he had 'never' seen 'a furnace that has given so little trouble, or done better and cleaner work'.<sup>120</sup> According to the chairman of directors, their battery produced 'over 99% of the assay value of the crude concentrates and ore smelted. Nearly the whole of the gold and silver contained in the bullion had been obtained from ores with the most refractory character which by ordinary methods of treatment would have been lost'.<sup>121</sup> He was referring to Waiorongomai ore: only 46 per cent of the assay value of the Champion lode was extracted, being 'the most complex and refractory' ore in New Zealand, and no European plants had

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<sup>115</sup> *Waikato Times*, 7 July 1888, p. 2.

<sup>116</sup> H.W. Northcroft to Under-Secretary, Mines Department, 26 April 1890, *AJHR*, 1890, C-3, Appendix 1, pp. 137-138.

<sup>117</sup> H.A. Gordon to Under-Secretary, Mines Department, 8 June 1889, *AJHR*, 1889, C-2, pp. 43, 44.

<sup>118</sup> H.A. Gordon to Minister of Mines, 1 June 1890, *AJHR*, 1890, C-3, p. 44.

<sup>119</sup> *Te Aroha News*, 27 April 1889, p. 2.

<sup>120</sup> *Te Aroha News*, 9 October 1889, p. 2.

<sup>121</sup> *Te Aroha News*, 21 December 1889, p. 2.

been able to treat it satisfactorily 'owing to the large quantity of zinc-blende'.<sup>122</sup>

Within a month of the chairman's statement, the battery was closed once all the ore on hand was treated,<sup>123</sup> and the smelting and roasting furnaces along with the concentrating plant were removed to Australia. It had been assumed that Champion ore could be used as a flux in the smelting process, but it was unsuitable because of containing as much zinc as lead.<sup>124</sup> The process was too costly, and there was insufficient ore of a suitable grade; it was estimated that the plant was from 25 to 50 per cent more expensive than necessary and could not save the gold.<sup>125</sup> Gordon wrote that Howell's process was not suitable to deal with this class of ore, which was 'quite different from any the American experts had been accustomed to treat, and they were as much at sea in reference to the proper method of treatment as our mill-men would be with American ores'.<sup>126</sup> The intention had been to concentrate the ore before smelting, but the gold was so fine it would not concentrate.<sup>127</sup> An English observer noted that the 'extremely complex nature of many of the ores' made treatment 'very difficult', the 'ordinary crushing battery and amalgamation processes' being 'practically useless'. Before the tailings were retained for later treatment, the lowest estimate of the annual loss was £20,000.<sup>128</sup>

Adams took over what remained of the battery, and appointed a leading metallurgist, James Napier,<sup>129</sup> to find a successful treatment. Soon

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<sup>122</sup> H.A. Gordon to Minister of Mines, 1 June 1890, *AJHR*, 1890, C-3, p. 46.

<sup>123</sup> H.W. Northcroft to Under-Secretary, Mines Department, 26 April 1890, *AJHR*, 1890, C-3, Appendix 1, p. 136.

<sup>124</sup> *Geology of the Aroha Subdivision*, p. 14.

<sup>125</sup> Editorial, *Te Aroha News*, 20 July 1895, p. 2; H.A. Gordon to Minister of Mines, 1 June 1890, *AJHR*, 1890, C-3, p. 42; H.A. Gordon to Minister of Mines, 24 July 1895, *AJHR*, 1895, C-3, p. 66; *Brett's Auckland Almanac, Provincial Handbook, and Strangers' Vade Mecum for 1896* (Auckland, 1896), p. 142; Downey, p. 257.

<sup>126</sup> H.A. Gordon to Minister of Mines, 8 June 1893, *AJHR*, 1893, C-3, p. 72.

<sup>127</sup> *Auckland Weekly News*, 7 August 1897, p. 13.

<sup>128</sup> George J. Binns, 'Mining in New Zealand', *Transactions of the Federated Mining Engineers*, vol. 3 (1891-1892), p. 646.

<sup>129</sup> See *Cyclopedia of New Zealand*, vol. 2, pp. 492-493; *Thames Advertiser*, 5 May 1888, p. 2, Waiorongomai Correspondent, 27 May 1891, p. 2, 1 June 1891, p. 2, 10 July 1891, p. 2, 27 July 1891, p. 2, 25 April 1892, p. 2, 20 December 1892, p. 2, 17 April 1894, p. 2; *Te*

reports of successful experiments were published: 'Quartz highly impregnated with copper and other minerals hitherto thrown over the tip, or used to fill in the stopes', could now be treated profitably.<sup>130</sup> From the 'complex ores' of the New Find, Hero, and Colonist, payable amounts of gold, silver, and copper were being obtained by his method of smelting.<sup>131</sup> But it was soon revealed that these experiments lost money. Dry crushing was tried, with the pulverized stone being treated with cyanide (the new Cassel process), but after two months it was found that the ore contained too much copper for this to be economical. Accordingly, wet crushing was used again, gold being saved using the previous method, only tailings being treated with cyanide.<sup>132</sup> The problem might really be, one cynical observer suggested, that 'a little more bullion in the rock would ... lead to better results'.<sup>133</sup>

When Adams started experimented with cyanide, he found the percentage of bullion saved varied 'considerably'; he could not explain this, but believed insufficient care had been taken. Gordon commented that this process was 'yet in its infancy' and would be 'considerably improved' in time.<sup>134</sup> Some believed that cyanide was not suitable for Waiorongomai ore; others, noting an excessive amount of cyanide was being used, thought the process was not properly understood.<sup>135</sup> Because the copper, galena, and zinc-blende made it difficult to extract the bullion, to find a solution 'some ore of this description was sent to Maryborough, in Queensland, for treatment, which gave good results; but it was found that, after deducting all expenses in connection with the transit and smelting, it would not leave sufficient to work the lodes at a profit'.<sup>136</sup> By reverting to the mercury

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*Aroha News*, 4 December 1889, p. 2; *Auckland Weekly News*, 9 March 1895, p. 10, 10 March 1904, p. 41, 1 October 1908, p. 23.

<sup>130</sup> Waiorongomai Correspondent, *Waikato Times*, 30 May 1891, p. 2.

<sup>131</sup> *Thames Advertiser*, 10 July 1891, p. 2.

<sup>132</sup> H.A. Gordon to Minister of Mines, 24 July 1894, *AJHR*, 1894, C-3, p. 48.

<sup>133</sup> 'Obadiah', 'Shares and Mining', *Observer*, 2 September 1893, p. 7; see also *Observer*, 10 June 1893, p. 18.

<sup>134</sup> H.A. Gordon to Minister of Mines, 8 June 1893, *AJHR*, 1893, C-3, pp. 72-73.

<sup>135</sup> H.W. Northcroft to Under-Secretary, Mines Department, 19 May 1893, *AJHR*, 1893, C-3, Appendix 1, p. v; *The New Zealand Mining Handbook* (Wellington, 1906), p. 27.

<sup>136</sup> H.A. Gordon to Minister of Mines, 24 July 1894, *AJHR*, 1894, C-3, p. 48; see also *AJHR*, 1893, C-2, p. 6.

process, far more gold was lost than if the cyanide process had been made to work.<sup>137</sup>

The introduction of English capital meant another reconstruction of the battery in the mid-1890s, when Aroha Mines decided to dry the ore in a kiln to desulphurise it before crushing it and using cyanide. 'The experiment will be watched with interest', wrote a visitor, but soon critics stated that this process was inappropriate for the type of ore.<sup>138</sup> An 1899 survey of Hauraki mining noted that cyanide had failed at Waiorongomai, and although 'several attempts have been made, and thousands expended on experimenting', the right process had not been found.<sup>139</sup>

When Edwin Henry Hardy<sup>140</sup> took over the battery and most mines at the end of the century, he experimented to find the right process. In December 1903 he claimed that his alterations would enable him to extract over 86 per cent of the bullion. 'Cyanide treatment has been entirely discarded as quite unsuitable to the class of ore milled'.<sup>141</sup> His battery did succeed in saving a high percentage of the values, and the concentrates were sent to Dapto, New South Wales, for smelting.<sup>142</sup> Over ten per cent of the ore comprised sulphides, which were treated in vanners specially imported from America.<sup>143</sup> But a sudden drop in the value of the ore meant this battery closed also.<sup>144</sup>

Other batteries were no more successful. When Peter Ferguson<sup>145</sup> began building his New Era Battery in 1884 he confidently promised to lose a 'much smaller percentage of gold'.<sup>146</sup> Black shared his optimism, because it was 'a really splendid plant, which should prove a great acquisition to the

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<sup>137</sup> See complaints from those using the battery: *Te Aroha News*, 8 June 1895, p. 2, 12 June 1895, p. 2, 15 June 1895, p. 2.

<sup>138</sup> *Thames Advertiser*, 10 August 1896, p. 2, 16 February 1897, p. 4.

<sup>139</sup> Thomas William Rhodes, *The History and Resources of the Auckland Goldfields* (Coromandel, 1899), p. 14.

<sup>140</sup> See paper on his life.

<sup>141</sup> *New Zealand Herald*, 1 December 1903, p. 6.

<sup>142</sup> James Coutts (Inspector of Mines) to Under-Secretary, Mines Department, 18 February 1905, *AJHR*, 1905, C-3, p. 36.

<sup>143</sup> E.H. Hardy to Directors, Hardy's Mines, 31 March 1905, Company Files, BADZ 5181, box 165 no. 1208, ANZ-A.

<sup>144</sup> See paper on Hardy's Mines.

<sup>145</sup> See chapter on Peter Ferguson and his New Era.

<sup>146</sup> *Te Aroha News*, 28 June 1884, p. 2; *AJHR*, 1886, C-4, p. 2.

district, as it would be capable of saving the silver', for similar plants in Nevada had treated similar ore 'with great success'.<sup>147</sup> At the end of June 1886 the furnace for calcining the ore was lit and reportedly worked 'admirably'.<sup>148</sup> Within a week, 'several important alterations' were made and more were planned to make the plant 'much more suitable for the class of stone likely to be received'.<sup>149</sup> In a flurry of letters between the supporters of the rival batteries about which had saved the most ore most cheaply, George Fraser,<sup>150</sup> who had provided some of the machinery for the new battery, defended its disappointing start by claiming that it was treating inferior ore.<sup>151</sup> A visiting expert suggested that the crushed ore should be 'furnaced to get rid of the sulphur and other base metals before amalgamation'.<sup>152</sup> Park, who had seen the plant being built and who claimed to be familiar with the ore, thought this process should work. Ferguson had shown him 'some small cakes of Waiorongomai bullion got on a small scale in Auckland by the Fraser and Ferguson pan process', and the results were 'very satisfactory'.<sup>153</sup> This was another example of a successful laboratory process not working in the battery, which was closed for over two years while more capital was raised to bring in new machinery for a new process that had been tested on ore sent to Scotland.<sup>154</sup> Despite adding the cyanide process, bringing in specialists from Scotland to supervise this and other new processes, and promises to save over 90 per cent of the assay value, the reconstructed plant was a complete failure, and by 1892 had been sold and removed.<sup>155</sup>

An experimental plant, built in 1898 high in Diamond Gully for the Great Western Company, featured a Chilean mill, which, after being quickly

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<sup>147</sup> *Waikato Times*, 15 December 1885, p. 2.

<sup>148</sup> *Te Aroha News*, 3 July 1886, p. 3.

<sup>149</sup> *Te Aroha News*, 10 July 1886, p. 2, 24 July 1886, p. 2.

<sup>150</sup> See paper on Peter Ferguson and his New Era.

<sup>151</sup> *New Zealand Herald*, 30 August 1886, p. 3.

<sup>152</sup> *Te Aroha News*, 13 November 1886, p. 2.

<sup>153</sup> James Park to Minister of Mines, 27 December 1886, Mines Department, MD 1, 87/794, ANZ-A.

<sup>154</sup> *Te Aroha News*, 14 July 1888, p. 2, 1 December 1888, p. 2.

<sup>155</sup> Waiorongomai Correspondent, *Waikato Times*, 26 March 1889, p. 2; *AJHR*, 1889, C-2, p. 95; *Te Aroha News*, 1 May 1889, p. 2, 26 March 1890, p. 2, 5 April 1890, p. 2; H.A. Gordon to Minister of Mines, 1 June 1890, *AJHR*, 1890, C-3, p. 47; *AJHR*, 1892, C-3A, p. 15; note H.A. Gordon to Minister of Mines, 24 July 1895, *AJHR*, 1895, C-3, p. 66.

worn out by the ‘somewhat ... flinty nature’ of the quartz, was shut down and sold after a trial run of only a couple of months.<sup>156</sup>

The most loudly self-promoted technique was Joseph Campbell’s Thermo-Hyperphoric Process,<sup>157</sup> which he claimed would extract ‘95 per cent of the gold-assay value of any ore’ at a fraction of the usual cost.<sup>158</sup> Although a trial run of his plant near Te Aroha was reportedly a ‘marked success’,<sup>159</sup> his process failed, although he blamed the ore not the process.<sup>160</sup>

The Bendigo Battery, opened in 1911,<sup>161</sup> used cyanide and was described as ‘equal to anything in the country ... in its capacity to save gold’. Although it was expected to recover 80 per cent of the bullion, only a small percentage was saved.<sup>162</sup> The reason for this, according to Pond, who took over the abandoned plant, was the amount of copper salts in the ore. Pond, by his own account,

decided then to treat the crushed ore by the oil flotation method and on the small tests this proved a remarkable success, and a plant capable to dealing with several tons a day was built, which was later increased in size and about six or eight tons of concentrates obtained assaying from £40 to £50 a ton.<sup>163</sup>

Despite this claim to have succeeded where others failed, Pond abandoned the battery. The last plant at Waiorongomai, erected in 1933 by

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<sup>156</sup> *Te Aroha News*, 5 February 1898, p. 2, 12 February 1898, p. 2, 23 June 1898, p. 2; *Thames Star*, 2 March 1898, p. 4; *Ohinemuri Gazette*, 5 March 1898, Supplement, p. 1; *Thames Advertiser*, 8 April 1898, p. 4, 4 September 1899, p. 3.

<sup>157</sup> See paper on Joseph Campbell.

<sup>158</sup> Joseph Campbell, ‘The Gold-Fields of the Hauraki Peninsula, New Zealand’, *Transactions of the Institute of Mining Engineers*, vol. 12 (1896), p. 480; *AJHR*, 1897, C-3, p. 99.

<sup>159</sup> *Thames Advertiser*, 27 April 1898, p. 3, 2 May 1898, p. 3, 7 May 1898, p. 4, 6 July 1898, p. 3, 13 July 1898, p. 4; *Waikato Argus*, 26 May 1898, p. 4; *Te Aroha News*, 9 July 1898, p. 2; *Auckland Weekly News*, 4 November 1898, p. 19; for full details, see chapter on Joseph Campbell

<sup>160</sup> *Thames Star*, 23 February 1900, p. 4; *Auckland Weekly News*, 6 July 1900, p. 40.

<sup>161</sup> See paper on the Bendigo Battery.

<sup>162</sup> *Te Aroha News*, 31 August 1911, p. 3; J.A. Pond to Secretary, Waiorongomai Gold Mines, 21 August 1933, Company Files, BADZ 5181, box 695 no. 4544, ANZ-A.

<sup>163</sup> J.A. Pond to Secretary, Waiorongomai Gold Mines, 21 August 1933, BADZ 5181, box 695 no. 4544, ANZ-A.



Malcolm Hardy, was modelled on his father's one.<sup>164</sup> Despite his claims for its being 'somewhat unique', it was like all the others: unable to treat the ore adequately, and three years later he told the Minister of Mines that his losses on the plant were 'enormous. He really needed a proper amalgamating outfit'.<sup>165</sup>

When, in the late 1940s, the Auckland Smelting Company revived mining in the Tui district, its sales pitch to potential shareholders included several dubious claims.<sup>166</sup> 'Certain sound Mining Geologists have stated that Te Aroha is the "Gold Field of the future." This is more than likely now it is known beyond doubt that the Refractory or Complex Ore located there exists in massive formation'. A new crosscut was expected to prove there would be sufficient ore to keep a mill treating '100 tons or more per day for say a minimum of 20 years'.<sup>167</sup> The company was using modern laboratory methods to determine how to treat the 'substantial bodies' of sulphide ores to extract the lead, copper zinc, gold, and silver.<sup>168</sup> Unknown to investors, the mining inspector and the Mines Department's Inspecting Engineer of Metalliferous Mines reported, much more cautiously, that although 'the possibilities' were 'sufficiently attractive to justify a prospecting programme', their venture was 'highly speculative'.<sup>169</sup> To tempt the investing public, encouraging reports were released periodically. In July 1952, for instance, the first New Zealand discovery of the 'valuable and rare element Germanium' was announced; it could be used for making transistors.<sup>170</sup> The annual general meeting for that year was assured that the company was obtaining the 'utmost co-operation and encouragement'

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<sup>164</sup> See paper on Malcolm Hardy.

<sup>165</sup> *Auckland Star*, 3 June 1933, p. 4; Malcolm Hardy to Minister of Mines, 31 July 1934; Malcolm Hardy to Under-Secretary, Mines Department, 8 August 1934, 6 October 1934; Minutes of meeting between Malcolm Hardy and P.C. Webb (Minister of Mines), 9 March 1936, Mines Department, MD 1, 23/4/54, ANZ-W.

<sup>166</sup> See paper on this company.

<sup>167</sup> 'Auckland Smelting Company Limited, Te Aroha Mine 1951', p. 1, copy in Mines Department, MD 1, 23/2/1218, Part 1, ANZ-W.

<sup>168</sup> Auckland Smelting Company, 'Base Metals Mine at Te Aroha', n.d. [c. 1950], copy provided by J.B. McAra of Waihi in 1986.

<sup>169</sup> E.J. Scoble and R.F. Landrath to Under-Secretary of Mines, 'Application for Financial Assistance by Auckland Smelting Co. Ltd.', n.d. [11 February 1952], Mines Department, MD 1, 23/2/1218, Part 2, ANZ-W.

<sup>170</sup> *Te Aroha News*, 11 July 1952, p. 5.

from geologists and other experts.<sup>171</sup> In June, it had accepted the offer of Gordon Williams, Director of the Otago School of Mines, to help find the best treatment methods.<sup>172</sup> On the basis of one afternoon's visit to the mine, he doubted there was enough ore available. He did not expect a larger or richer lode at depth, anticipated it would vary in thickness, and warned that 'however attractive individual exposures may be, they have no commercial value' unless there was sufficient ore to provide 1,000 tons for milling per month. Unless 150,000 tons of good ore were available, there was 'little hope' of financial success.<sup>173</sup> As the crosscut had failed to hit the reef there was insufficient tonnage to be treated, and there was in any case 'no market for complex ores containing lead, zinc and copper'.<sup>174</sup> In June 1953, mining was 'temporarily discontinued';<sup>175</sup> in practice, this company ceased working.

In 1953 a Japanese firm, the Mitsui Mining and Smelting Company, tested Tui ore. Although considering it to be of 'very good quality', as it could not be treated by their process the company would only purchase it as a concentrate.<sup>176</sup> This was provided in the late 1960s by Norpac, which traced and opened up the lodes more successfully than the previous company. However its mill had constant difficulties in treating the complex ores, despite all the advice received from overseas experts. For instance, in August 1969 the general manager wrote that

from the time the ore is broken in the stopes to when it is drawn and treated at the mill, the growth of copper sulphide coatings on sphalerite causes premature activation of zinc in the lead copper circuit, and creates a serious milling problem, which is added to where the oxidised products are also used.<sup>177</sup>

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<sup>171</sup> *Te Aroha News*, 8 August 1952, p. 5.

<sup>172</sup> *Te Aroha News*, 20 June 1952, p. 5.

<sup>173</sup> Report by Gordon Williams on Tui Mine, 1952, Inspector of Mines, BBDO A902, box 58, file 4, ANZ-A.

<sup>174</sup> B.J. Dunsheath to Minister of Mines, 23 March 1953; Minister of Mines to B.J. Dunsheath, 7 April 1953; R.F. Landreth to Under-Secretary, Mines Department, 29 June 1953, Mines Department, MD 1, 23/2/1218, Part 2, ANZ-W.

<sup>175</sup> *AJHR*, 1954, C-2, p. 41.

<sup>176</sup> Douglas Kendrick (NZ) Ltd to B.J. Dunsheath, 21 September 1953, Mines Department, MD 1, 23/2/1218, Part 2, ANZ-W.

<sup>177</sup> F.J. Handcock to Alister Griffith (of Daniel Griffiths and Co Ltd, London), 1 August 1969, Norpac Papers, File 4 (Office File), Norpac Papers, Union Hill.

In December that year he reported that ‘after two periods of reasonably good metallurgy’ it was ‘disappointing to have much poorer results’. The nature of the ore made it ‘inevitable’ that milling would never be a ‘piece of cake’ and there would be ‘ups and downs’.<sup>178</sup> A particular problem was that narrow veins meant the ore was diluted with adjacent stone. As a geologist (and director) explained, ‘extreme fluctuations’ in the quality of the ore were ‘very difficult to avoid in a low-tonnage operation working on narrow veins, the grade of which may change very greatly in a short distance’. The ore in one part of the mine was predominantly lead and zinc but in another was predominantly copper, increasing the problems in the mill as the ore coming over the feed belt changed in composition. As the mill staff had ‘no way of knowing about the change ahead of time’, until the types of ore were separated so that they could be treated at different times the mill would have to make constant ‘radical changes’.<sup>179</sup> After receiving low quality concentrate, Mitsui threatened to cease buying it.<sup>180</sup> Difficulties experienced in the mine meant that during the last year of mining there was a shortfall in ore production, which, the directors noted, ‘must be compensated for by higher grade’ ore.<sup>181</sup> As this was not achieved and nor were all the milling difficulties overcome, the Japanese refusal to buy concentrates containing an unacceptable level of mercury meant mining at Tui ended, permanently.<sup>182</sup>

## CONCLUSION

In brief, the geology of the Te Aroha district was far more complicated than early miners had anticipated, and the impurities and base metals combined with a low bullion content made all treatment difficult, expensive, and, except for patches of richer ore, usually unprofitable. Alleged experts

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<sup>178</sup> F.J. Handcock, Report 12/4 for period ending 29 November 1969, Norpac Papers, Box 5, NMC 19/4, Norpac.

<sup>179</sup> A.G. Pentland to President, South Pacific Mines Ltd., 12 July 1971, Norpac Papers, File 4 (Office Files), Union Hill.

<sup>180</sup> E.K. Haddy (Secretary, Norpac Mining Company) to F.J. Handcock, 22 September 1971, Norpac Papers, File 4 (Office File), Union Hill.

<sup>181</sup> Minutes of 39th Meeting of Directors held on 29 February 1972, Norpac Papers, Box 9, Norpac.

<sup>182</sup> See paper on Norpac and pollution.

continued to claim to have the solution, thereby encouraging attempts to revive mining. In 1930, one 'old prospector' stated that 'twenty years ago he showed some of the mineral deposits to a German mining man, who remarked, "If we had these in Germany we should treat them all"'.<sup>183</sup> Successfully?

In conclusion, in the words of an old Cornish saying periodically cited in goldfields newspapers, 'Where it be, well, there it be!'.<sup>184</sup> And there was no alluvial gold, despite the 1906 claim that 'excellent alluvial prospects' had been found at Waiorongomai.<sup>185</sup> The ore was not extensive, and the average yield per ton was the lowest, narrowly, of all the main goldfields during the 1880s: Coromandel produced 3oz 6dwt 8gr, Ohinemuri 1oz 7dwt 4gr, Thames 1oz 3dwt 15gr, and Te Aroha 1oz 3dwt 11gr. Nevertheless, this was regarded as 'extremely rich' compared with other parts of the world. 'In Victoria, for instance, during the years 1884-85, the average yield from all the quartz-reefing districts was less than 10dwt to the ton'.<sup>186</sup> Official figures of production up to 31 December 1933 revealed that Waiorongomai's 50,850 tons had produced 68,961 ounces, valued at £115,081.<sup>187</sup> That compared with:

247,266 tons from the Coromandel County producing 531,250 ounces, value in 1933 £1,454,231;

1,691,623 tons from Thames County producing 2,515,637 ounces, value £6,241,990;

63,479 tons from Tauranga County (Muir's Reefs near Te Puke and the Eliza mine behind Katikati) for 54,177 ounces, value £164,198;

14 tons from Wharekiraupunga producing 19 ounces, value £25;

17,055 tons yielding 41,640 ounces worth £37,145 on Great Barrier Island;

Owharoa producing 72,580 ounces worth £141,279 from 39,356 tons;

Waitekauri producing 430,369 ounces from 190,467 tons, value £471,683;

202,795 tons from Komata producing 534,852 ounces, value £457,048;

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<sup>183</sup> *Te Aroha and the Fortunate Valley: Pioneering in the Thames Valley 1867-1930*, ed. F.W. Wild (Te Aroha, 1930), p. 279.

<sup>184</sup> *Thames Star*, 23 June 1903, reprinted in *New Zealand Mines Record*, 16 June 1903, p. 508.

<sup>185</sup> *Thames Star*, 12 March 1906, p. 2.

<sup>186</sup> Binns, p. 648.

<sup>187</sup> Downey, pp. 278-279.

12,628 tons at Maratoto producing 21,903 ounces, value £18,999;

1,125,589 tons from Karangahake producing 4,011,471 ounces, value £3,941,016;

and best of all, Waihi producing 29,249,968 ounces from 9,298,575 tons, worth £20,793,926.<sup>188</sup>

Compared with the South Island, all Hauraki ore was of lower quality, an 1868 guide giving an average assay of 18.65 carats compared to 22 carats and above in the former.<sup>189</sup> Downey argued, in 1935, that the estimates he cited of the value of Hauraki gold were too high because the low quality had been ignored, and suggested £2 13s per ounce was more accurate than the usual approximation of £3.<sup>190</sup> As for the Te Aroha district, he concluded that its mining history could ‘scarcely be described as other than one long chapter of disaster for the many companies that ventured their capital in it’,<sup>191</sup> an outcome that must be blamed on the complexity and poverty of most of the ore.

### *Appendix*

*Figure 1:* Alexander McKay, Geological Map of the Coromandel Peninsula, *AJHR*, 1897, Session 2, C-9, redrawn by Max Oulton, University of Waikato, and published in Waitangi Tribunal, *The Hauraki Report: Wai 686* (Wellington, 2006), vol. 1, p. 269; used with permission.

*Figure 2:* ‘ “Sketch Map of the Hauraki Gold-Mining District, New Zealand”, to illustrate the Revd Joseph Campbell’s Paper on “The Gold-fields of the Hauraki Peninsula, New Zealand” ’, *Transactions of the Federated Institution of Mining Engineers*, vol. 12, 1896, p. 483.

*Figure 3:* G.E. Harris, ‘Diagram of Lode Fissures, Te Aroha Mining Area’, in John Henderson, assisted by John Arthur Bartrum, *The Geology of the Aroha Subdivision, Hauraki, Auckland: Geological Survey Bulletin no. 16* (Wellington, 1913), facing p. 89.

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<sup>188</sup> Downey, pp. 265-279.

<sup>189</sup> *The Thames Miner’s Guide* (Auckland, 1868), p. 48.

<sup>190</sup> Downey, pp. viii-ix.

<sup>191</sup> Downey, p. 261.

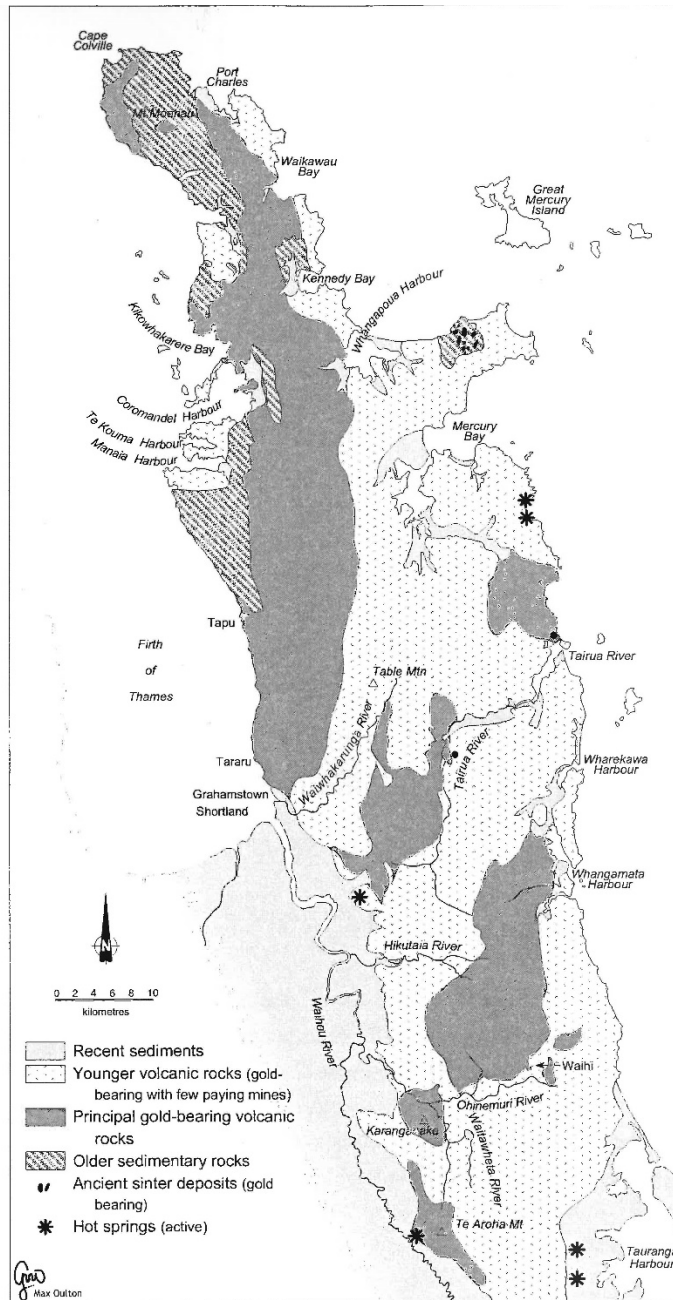


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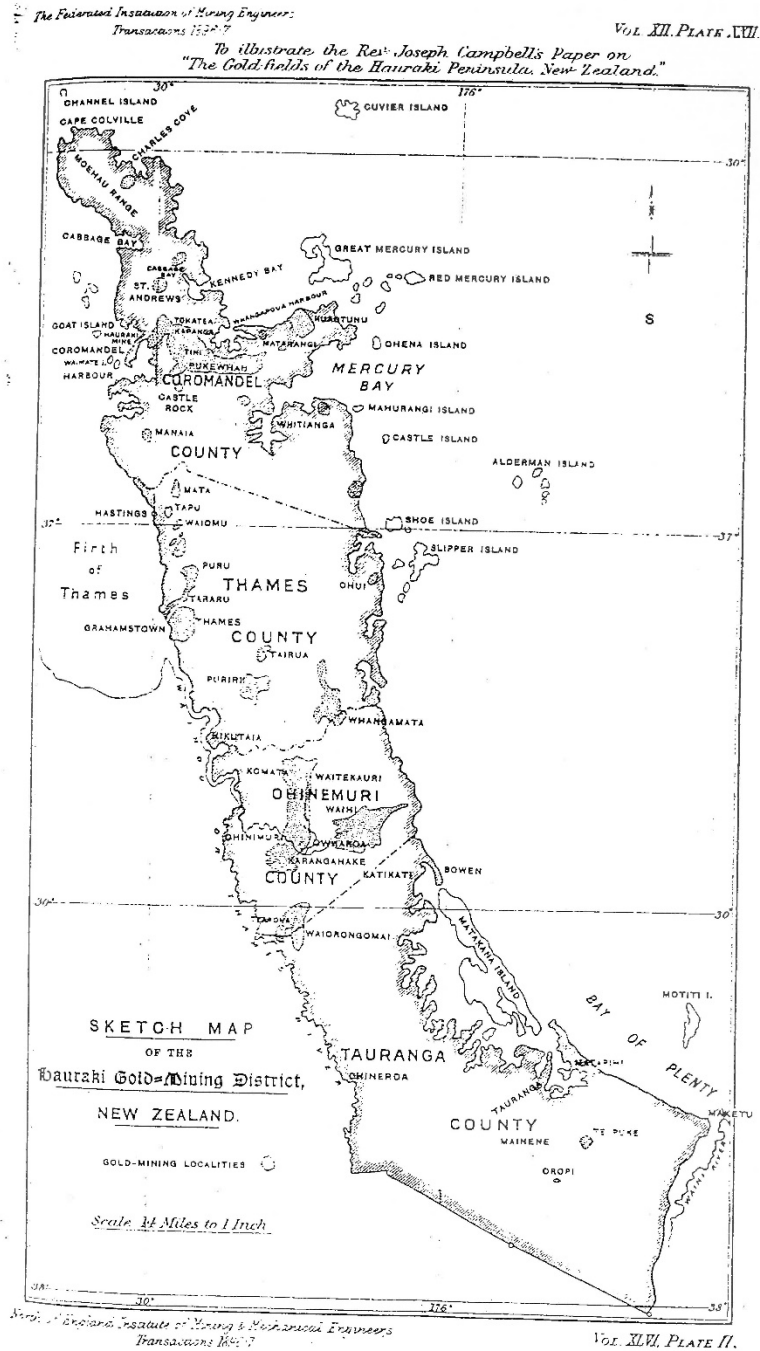


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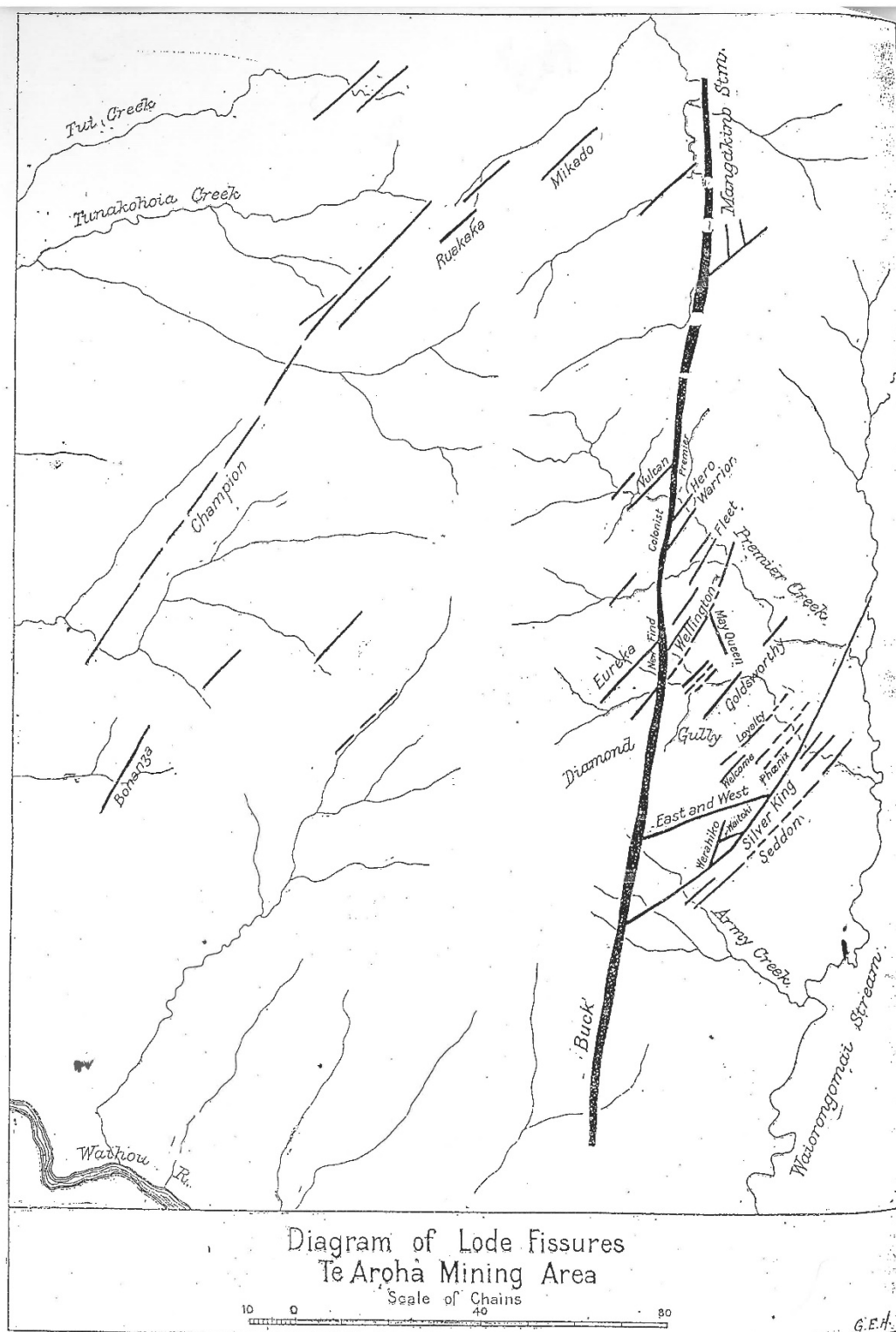


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