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**THE LAST ROAST: ARCHAEOLOGY OF THE HISTORIC COPPER INDUSTRY
ON KAWAU ISLAND 1843-1855.
EXCAVATIONS 1991**

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The remains of the copper industry on Kawau, including the Smelting House (see cover), classified A by the Historic Places Trust, are now part of the DOC estate. DOC is currently preparing a management plan for all aspects of the estate including the historic resources. Archaeological investigations carried out jointly by the University of Auckland and the Department were initiated in response to the deteriorating condition of the Smelting House (Clough 1988), and continued in order to achieve a more complete understanding of the industry as a whole. During the first (1990) season the miners' settlement and mine were the focus of the investigation (Clough 1990a; 1990b), while the 1991 season concentrated on the smelting house complex, though including some further excavation at the miners' settlement (Clough and Sewell in prep.). This paper outlines the results of the 1991 excavations at Smelting House Bay.

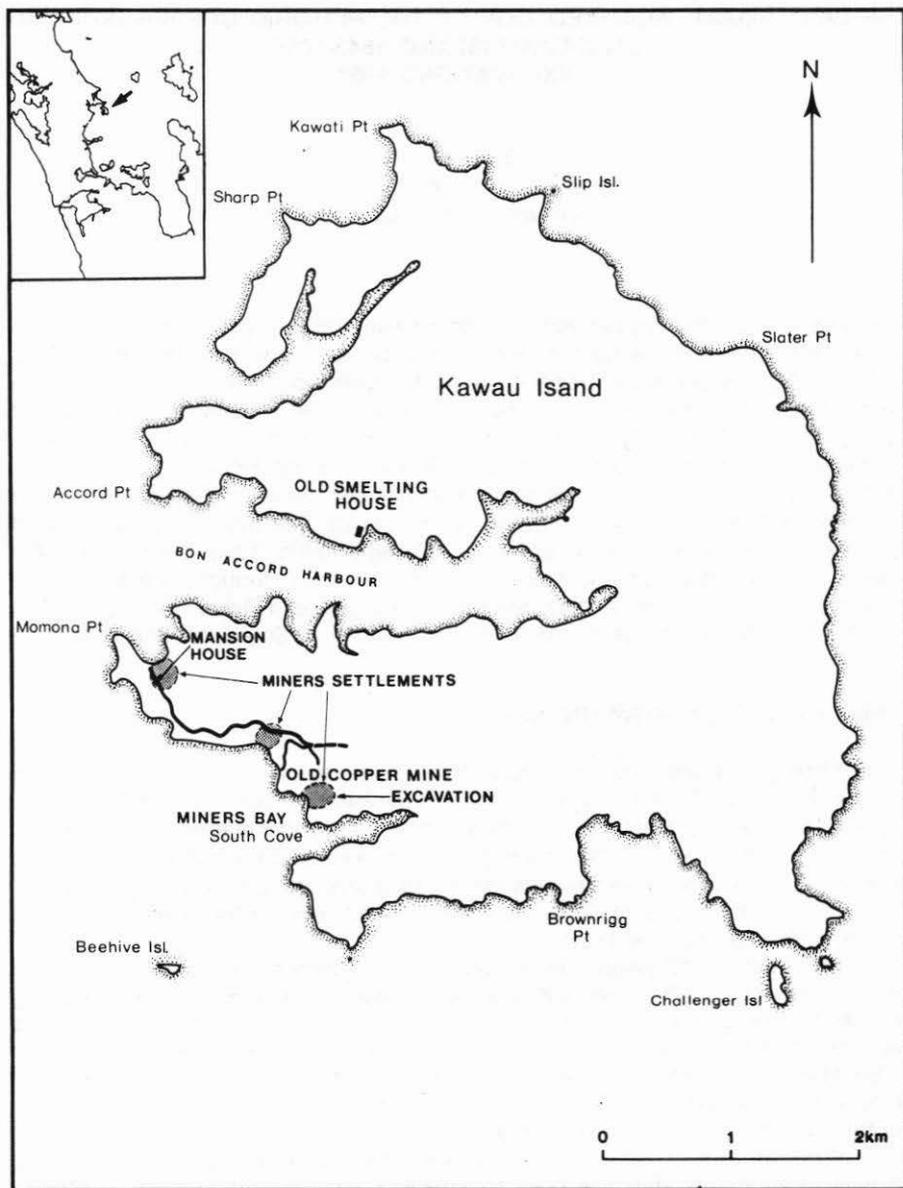
THE COPPER INDUSTRY ON KAWAU

Mining on Kawau began in early 1842 for manganese. Private prospecting by the miners, at this time, revealed the copper-bearing lode in South Cove (Fig. 1) and after assessment by Kingshorne (the then superintendent of the Great Barrier copper mine) in 1843, mining of the Kawau deposit began in 1844 and continued erratically under various mine managers for approximately 12 years. There were attempts to re-open the workings and dewater the mine c.1900, but these were even shorter lived.

During those 12 years, Kawau became the centre of one of New Zealand's earliest industries with over 200 people engaged in the mining and smelting operations or providing social and economic support. Remains of various aspects of the industry are still to be found at several locations on the island - Smelting House Bay, Blackwoods Bay, Miners Bay (South Cove), and Mansion House Bay - attesting to the significant role of the industry in the history of the Island and of New Zealand's industries.

From the outset the first of many problems to plague the venture surfaced. It was intended to ship the ores to smelting and casting facilities in Wales. However, this became complicated by the sulphidic nature of the ore, in that sulphides have a tendency towards spontaneous combustion - a problem in the hold of a ship (Hector 1869).

In July 1846 the *Mining Journal and Commercial Gazette of Australia*



S. Maingay, Regional Archaeology Unit, D.O.C., Auckland, 1988

Fig. 1. Location of sites related to the mining industry on Kawau (exact location of settlement in Bon Accord Harbour unknown).

reported spontaneous ignition of the Kawau ore on board the ships *British Sovereign* and *Regia* during passage to Sydney. Subsequently no ships could be found to transport such a dangerous cargo and it was necessary to reduce the sulphur content by partial smelting before shipping.

This, plus the costs of shipping, influenced the decision to construct a smelter on the island. As shipments of the ore were now in Australia, in 1847 the company decided to construct a smelting works there and engaged a party of smelters in Swansea. They arrived with construction materials in Port Jackson in December, where they were to remain for a year experimenting with the Kawau ore. These trials proved successful and in November 1848 the construction of a smelter on Kawau was put out to tender (*Southern Cross* 11 Nov. 1848: 3). In anticipation of the smelter, ore was being calcined (roasted) at the rate of 144 tons per week with 1000 tons waiting to be smelted (*London Mining Journal* July 1848). It is not clear from the archival evidence where the calcining was being carried out nor what process was being employed. However, in December 1848, the *May Queen* arrived with machinery and building material for the smelter and the works were operational by 1849. Newspaper entries from 1850 (*Southern Cross* and *New Zealander*) indicate that this was the most productive period of mining and smelting for the Kawau Company and the rival operations of the capitalists Whitaker and Heale, who had established a smelter on the neighbouring island of Motuketekete.

'KAWAU.- The mining and smelting operations on this island are being vigorously prosecuted at present. Recently the 'Susan', Captain Jones, shipped 105 tons of copper ore from Messrs Whitaker and Heale's mine for Sydney. The 'Esperanza' returned on Sunday last from the same mine with 110 tons of similar ore for Hobart Town. At the Kawau Company's works the same activity is going on. The barque 'Josephine' is at present discharging of her second cargo of coals for their smelting works; and is chartered to return with another. She takes 160 tons regulus of copper to Sydney. The 'Susan', Captain Grant, has also been taken up to deliver two cargoes of coals at the Company's works, and the first cargo of the 'Moa' will be one of copper from the Kawau mines to Sydney. We understand there is also a large shipment of bricks and other materials for the erection of three additional furnaces for the Kawau Company on board the brig 'Enterprise', shortly expected from London. (*Southern Cross* 9 Oct. 1849: 5 (1)).

The mood was expansive, with two large calcining furnaces in operation 4 miles from the mine¹ and four flowing furnaces in the course of erection which were expected to be operational by August 1850 (*Southern Cross* 14 Sept. 1849: 4). In October 1849 a shipment of bricks (firebricks?) for the addition of three more furnaces arrived from London (*Southern Cross* 9 Oct. 1849: 5).

¹ This would suggest that this is a reference to the Whitaker installation on Motuketekete rather than Smelting House Bay, which is considerably less than 4 miles from the mine.

THE SMELTING COMPLEX

The journals of Peter McDonald (1865) are most informative of events on Kawau and provide some details as to the management and operations at Smelting House Bay. According to McDonald there was initially a 'Welsh' system with batteries of roasting furnaces. This system proved too costly on fuel and the labour required to break up the ore to fine particles, with parties of men employed night and day keeping up the fires and charging and discharging the furnaces. After a time, Mr Jones was dismissed and a German, Mr Berger, took charge of the works. He did away with the first set of furnaces and introduced a simpler technique based on a German system. Ore was not required to be broken up any finer than road metal. It was put in large heaps of 5-6 tons in the open air, mixed with a quantity of firewood, set to fire, then allowed to smoulder away for months until it went out of its own accord. This produced a beautiful regulus (see below, 'The industrial process') at much less expense to the company. The fumes were noxious and the village 'Swansea' in Bon Accord Harbour was not the most pleasant or healthiest place in the world.

The Smelting House in Bon Accord Harbour represents the Welsh aspect of the industry. Welsh smelters from Swansea arrived c.1849 to operate the smelting works, while the miners were largely Cornish. The Welsh/Cornish relationship in Great Britain can be seen in microcosm on Kawau, with similar geographic, economic and technological relationships. In Britain the Cornish mined the ore and shipped it across the Severn estuary to the Welsh smelting towns for processing. At Kawau the Cornish at Miners' Bay mined the ore and shipped it across Bon Accord Harbour to the Smelting House complex (Fig. 1). Even the place names ('Little Swansea') and the industrial pollution mirrored the situation at home.

THE ARCHAEOLOGY OF THE SMELTING HOUSE (R9/642)

Investigation of the industry was prompted by the deteriorating condition of the Smelting House itself. It had been constructed of a soft local (Mahurangi) sandstone which had weathered extensively resulting in partial collapse of the structure and concern about the safety of the remainder. As part of the preservation process it was necessary to excavate the areas which would be affected by the shoring, and in doing so to assess the potential for a more extensive excavation (Clough 1988).

Even from limited test squares the potential of further excavation was evident. A casting floor of fine sand was revealed, as were large slag blocks and pieces of matte (a sulphidic product of the smelting processes) (Clough 1988). Analysis of these will enable detailed reconstruction of the process and metallurgical evaluation of its efficacy. In addition, many of the bricks found at the smelter and mine were Australian imports and many of the firebricks, with the stamp of 'COWEN', were imported from England, and manufactured at Stourbridge (Gurke 1987), thus providing information about sources of

construction materials.

Subsequently, the decision was taken not to limit excavation to the smelting site, but to approach the industry as a whole and investigate all aspects: the smelter, mine (and associated technology), and mining village (about which the archival information is variable in its quality), and to integrate the archaeology with the documentary evidence to gain a more complete picture of the industry. The latter provided some conflicting and tantalising information which could be tested archaeologically.

In 1990 further investigation of the smelting installation in Smelting House Bay ('Little Swansea') was limited owing to problems of stability, and only minor test trenching on the landward side of the smelter was carried out. A 20-30 cm thick deposit of broken brick and burnt rubble (a destruction layer), solid brick floors and low walls were revealed. Many of the bricks indicated fire damage, which suggested that we were dealing with furnace installations, possibly those known to have gone out of use when Mr Berger introduced more efficient roasting techniques c.1851. The small area tested indicated that considerable detail of the roasting (?) installation and processes would be recovered by more extensive excavation, which was planned for the following season.

Of particular interest was a sketch by Charles Heaphy, probably drawn in 1851 when Heaphy applied to survey Kawau Island (Fig. 2), which relates to the extant remains of the smelter and the surrounding area. It reveals not only the location of small cottages/offices, but also a large building of similar size to and immediately behind the Smelting House. There is no mention of such a structure in the documentary evidence, apart from the reference by McDonald to a battery of roasting furnaces (above, 'The smelting complex'). It is possible that it was used to house the furnaces and was demolished with them on the arrival of Mr Berger. The Heaphy sketch clearly indicated that today's lonely Smelting House was, in the middle of the 19th century, just part of a large industrial complex. For this reason, the 1991 season focussed the bulk of its efforts at this site, with investigation of Miners Bay continuing on a smaller scale.

Initially a 20 m by 2 m trench was opened up on a similar alignment to the remains of the Smelting House. Within the first day of excavation, during which a considerable volume of dirt and demolition rubble was removed, it became evident that we were uncovering the remains the 'battery of roasting furnaces', constructed in 1849 but 'demolished' by Berger c.1851 in favour of a more efficient process (McDonald 1865). We encountered low brick walls encompassing floors with evidence of considerable fire damage. On closer examination these floors proved to be constructed of firebricks, many impressed with the name of COWEN, a manufacturer of refractory bricks from Stourbridge (see above).

Over the next two weeks, the excavation was extended to expose an area some 20 m by 6 m, revealing a roughly symmetrical battery of eight roasting furnaces (one was left unexcavated) and associated storage structures. The floors of some of the roasting cells were covered with a thick purple pasty powder, which on analysis should prove to be the remains of the last ore

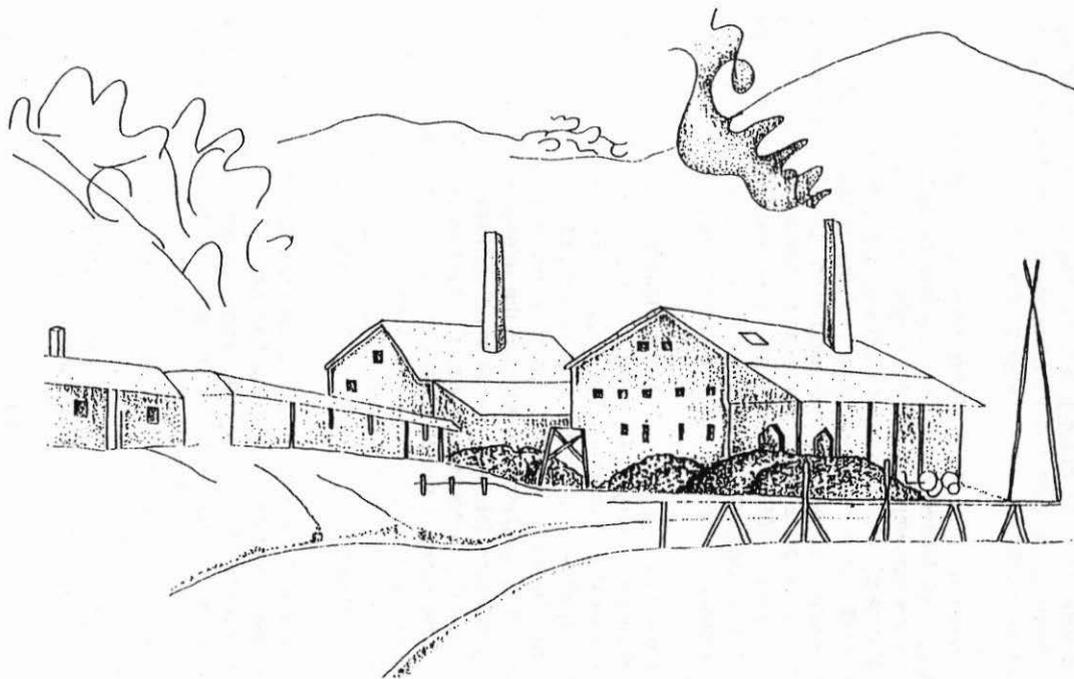


Fig. 2. Smelting House, Kawau, after Heaphy sketch of the 1850s (Heaphy Sketch Books, Auckland Institute and Museum).

roasted just prior to demolition. Two of the roasting cells were in a better state of preservation and had flues and part of the timber superstructure intact (Fig. 3, Plate 1). The roasting cells were in four blocks of two interconnecting furnaces, each member of the pair having a flue on the interior wall and being divided from the other by a half-wall. Each pair was back to back with another pair, though separated by two thick internal brick walls and a rubble-filled cavity. The two units of four roasters were separated from each other by a substantial sandstone block which undoubtedly formed the foundation for heavy plant, possibly crushing gear (Plate 2).

The nature of the rubble filling the cavity between the pairs of furnaces was interesting and threw some light on the sequence of construction of the smelting complex. It comprised layers of mortar and large flakes of Mahurangi sandstone of the type used in the construction of the Smelting House. The flakes must derive from masons' debris from shaping the large blocks used in the construction of the Smelting House, as no sandstone was used in the construction of the roasting complex. This suggests that the construction of the roaster was more or less contemporary with that of the Smelting House, and therefore that this was not the roaster used for calcining the ores in 1848 (see above, 'The copper industry').

The floors of each cell were laid with firebricks and in two of the cells these were arch bricks laid on edge (alternatively up and down to form a flat and interlocking surface). In the other cells the bricks were standard refractories laid flat, using fewer bricks though providing a weaker floor. It is not clear why two different techniques were used in the construction of the cell floors, and the use of more costly arch bricks which are predominantly used in the construction of smelting furnaces seems extravagant. Possibly they were at the time excess to requirements, and since the source was 12000 miles away there would be a tendency to use whatever was available. Some of the cell floors and walls had been removed during the demolition process, presumably for other uses around the site, but the rest of the structure was backfilled.

A further structure with solid metre deep brick walls and a brick floor was attached to the roasting installation, but had no sign of fire damage, nor were the bricks refractory (Fig. 3). It was, however, full of fused firebricks, which undoubtedly represented the remains of one of the smelting furnaces rather than the roasting installation, as temperatures required in the roasting process are much lower and would not result in the degree of fusion observed. In smelting processes it is customary to dismantle furnaces at intervals and reconstruct them, replacing the more damaged bricks and relining the remainder. Underneath this furnace debris was a thick deposit of fine white quartz sand, the lower levels of which had been stained orange by iron objects corroding in the pit. The structure had no doorway, and had obviously been used for sand storage, with access to the pit being from above. Probing suggested that the walls of this storage structure continued under the baulk and it is possible that a similar cell or cells remain to be excavated.

Fine quartz sand would have found many uses in the industrial process: for a refractory mortar and lining when rebuilding the furnaces; as a moulding floor (the Smelting House has a layer of such sand in front of the furnace

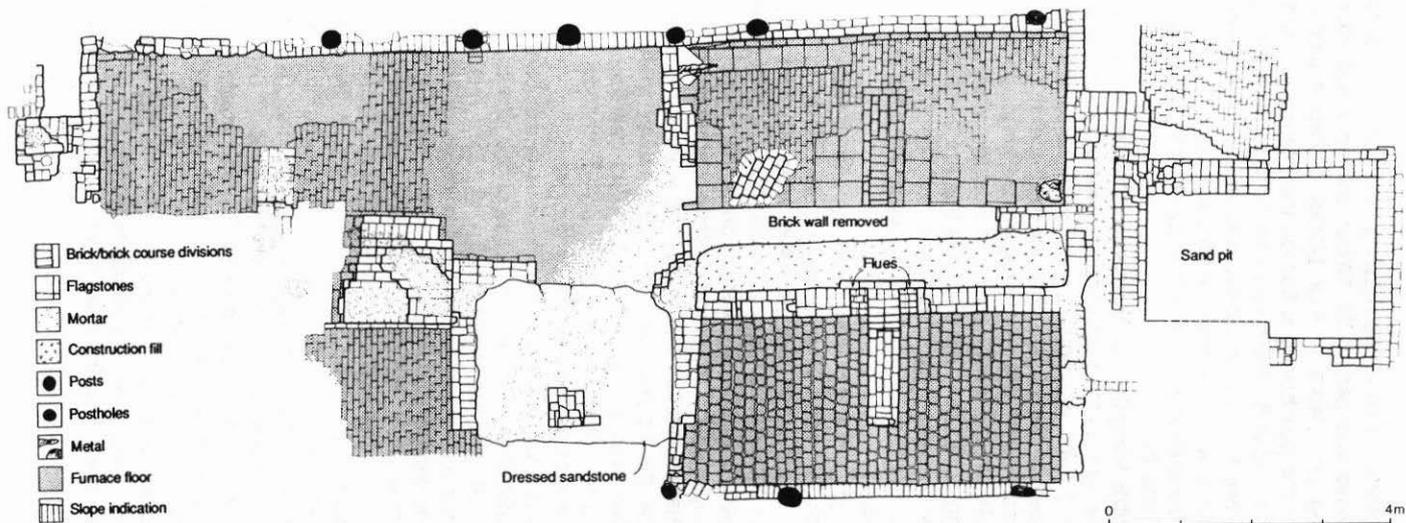


Fig. 3. Plan of the remains of the roasting installation excavated in 1991 (north at right).



Plate 1. A pair of roasting cells (shown in Fig. 3, lower right), viewed from the north. Note the two flues either side of the partial dividing wall.



Plate 2. Partially demolished cells (right) and sandstone (crushing?) floor (top left), viewed from the west.

bases (Clough 1988)), possibly for the casting of the large slag blocks found both in the smelter and as foundations for the wharf at Mansion House; and for blending into the melt to react with the excess iron known to be in the ore body, but undesirable in the copper.

The peripheral wall of the battery of roasting kilns (constructed of non-refractory red brick) was interrupted by a series of large postholes 20-25 cm in diameter and over a metre deep, with fragmentary remains of posts (tentatively identified as *puriri* or *pohutukawa*) *in situ*. These obviously represented the remains of a superstructure, but the presence of large iron spikes in the centre of four of them made it unlikely that they extended from floor to ceiling. It was postulated that they acted as piles (jack studs) supporting horizontal beams. This hypothesis was later confirmed during the excavation of the last roasting cell, where one intact post (stud) and a horizontal beam (bearer) running along the outer side of the wall were secured in place with a large iron spike. It is not known what materials was used for the superstructure. Timber and sheet iron might be a possibility (although subject to rapid deterioration in the corrosive sulphidic atmosphere).

The refractory bricks were largely unmarked, but of those that were, COWEN was the most common stamp, with RUFFORD STOURBRIDGE and HICKMAN & CO STOURBRIDGE represented on whole, arch, half and other types of brick common in furnace construction. All of these manufacturers were commercially active in the Staffordshire region in the middle of the 19th century (Gurke 1987). It is unlikely that the Kawau Company ordered directly from the brickworks: bricks were probably supplied through a London agent and loads of mixed origin may have been common under this system.

The remains of a small assay crucible were recovered, similar to a complete specimen displayed in the Warkworth and District Museum and labelled 'from the Smelting House'. This is of some interest, for although we know of two assay houses over the 12 years in Mansion House Bay, there is no mention of assay facilities at the smelting complex, although it would be a logical place for them.

THE INDUSTRIAL PROCESS AT KAWAU

The production of copper from sulphidic ores, such as those from Kawau, can be broken down into several distinct stages:

1. Mining brings the ore to the surface where it is then processed.
2. Beneficiation, or enrichment of the ore, is usually carried out by a process of mechanical or hand breaking followed by hand selection of the richer pieces. This is facilitated by the colour difference between the copper-rich as opposed to the iron-rich sulphides. There is good evidence for this sorting and breaking process adjacent to the mine at Kawau. Preparation floors were located on the artificial embankment between the mine and the miners' settlement on a map of 1848 by Captain Ninnis (Fig. 4). The ore was then transported by sea to the smelting installation (by lighter barge),

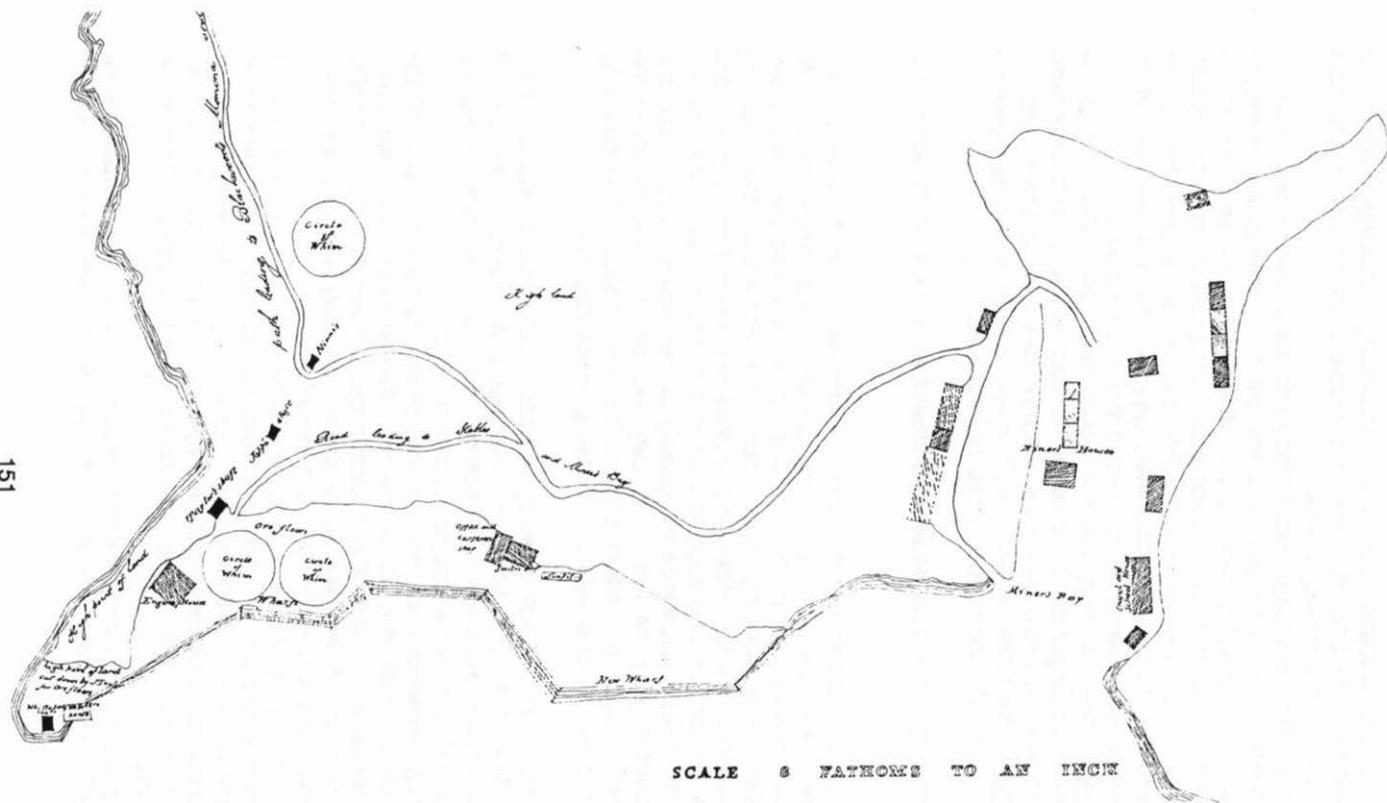


Fig. 4. The mine (left) and miners settlement (right) in South Cove in 1848. Detail from a map by Captain Ninnis (mine manager 1846-1851), National Archives.

where it was unloaded for further processing, including comminution (referred to by McDonald). This was probably carried out on the hard stone floor in the roasting house.

3. Roasting. The next stage was loading into the roasting furnaces which, once ignited, burned for days with the ore being manipulated at regular intervals. The roasting process was designed to remove much of the sulphur from the ore, as sulphide was undesirable in the end product. The sulphurous fumes given off at this stage were the inspiration for the unaffectionate name 'Little Swansea', given to the area because of its unfortunate resemblance to its polluted Welsh counterpart.
4. Smelting. After roasting, the ore would have been raked out of the roasters and charged into the smelting furnaces, where it would have been reduced eventually to a black porous substance known as 'blister copper'.
5. Refining. The blister copper would then undergo a refining operation where ingots of pure copper would be produced.

The smelting process on Kawau was described by Peter McDonald (1865) as follows:

'The works consisted of a number of furnaces all on the reverberation principle. The first part was a long row of furnaces where the ore was exposed to a strong heat for a number of hours; it was then withdrawn and taken to the smelting house proper. This was a large stone building with furnaces attached where the roasted ore was submitted to a mass of intense heat which brought the ore into a molten state. The copper, being the heavier substance fell naturally to the bottom of the furnace, the slag swimming to the top. The slag was drawn to the mouth of the furnace by long iron instruments and run into moulds. The cool slag formed a very hard substance containing about 75% iron.'

The initial effect of the smelting process, apart from driving off more sulphur, would be the production of a molten mass, separating, on the basis of density, into three components: slag floating on the surface, matte or regulus beneath that, with the dense copper layer at the base.

The slag, essentially an iron silicate, served to remove many of the impurities from the melt, in particular the iron. As mentioned, quartz sand may have been added if the ratio of iron:silica in the ore was too high. At some point near the end of the process at Kawau, the slag was cast into large blocks, which made a durable building material.

As the process continued and more sulphur was removed, a regulus or matte, which is a sulphide enriched in copper, was formed. It is believed that on Kawau the process ended here, with regulus being the desired end product (it was probably this which was observed by McDonald rather than copper), as it was stable relative to the ore and therefore unlikely to cause problems in the holds of ships.

If the process had been allowed to continue it would have resulted in the production of blister copper, and small amounts would have been produced in

the Kawau smelters even if regulus was the required end product. After enrichment had progressed as far as it could, the slag would be tapped off leaving the molten matte, at which stage green poles (branches) would have been plunged into the molten mass creating a violent oxidising reaction driving off the last of the sulphur and forming the blister copper. Only small test squares have been sunk in the Smelting House and hence it is unclear how far the process was taken. However, the small pieces of dense, silvery regulus recovered and the several references to the shipping of regulus to Sydney (e.g. *Southern Cross* 9 Oct. 1849: 3), indicate that regulus was the desired end product.

The symmetrical design of the Kawau roasters suggests a cycle of events enabling a continuous process of loading, firing, cooling and unloading occurring in each pair of cells at any one time. Even with this seemingly efficient design, the process was too labour intensive and replaced with a simple method of roasting on open pyres.

CONCLUSIONS

The excavation in 1991 concentrated on the industrial complex in Smelting House Bay, with a small team completing work on the miners' settlement at Miners Bay. Excavation of the smelting complex enabled us to locate and confirm the existence of the 'battery of roasting furnaces' briefly referred to by McDonald (1865) and confirmed the function of the building observed behind the Smelting House in Heaphy's faint pencil sketch of the 1850s (Fig. 2). In addition, it has provided many details not available from textual evidence regarding the construction, use and demolition of the site, as well as information on the type and origin of materials used in both the construction and the process (firebricks from Staffordshire, bricks and coal from Australia). From these details it has been possible to reconstruct the process of roasting (prior to the introduction of a simpler method), and we have in fact recovered physical evidence of the last roast.

It is hoped that the remains of the roasting installation exposed by excavation (Fig. 3) can be consolidated and preserved for display to the public. This would considerably enhance the value of the Smelting House as a historic and educational resource.

The copper industry on Kawau was beset with many problems from its inception, and within 12 years these had brought about its demise. Part of the problem initially was the attempt to establish an industry in a region devoid of the necessary backup facilities – in this case smelting and refining technology – thus incurring prohibitive transport costs and problems such as combustion of the ore in the holds of ships. Establishing roasting and smelting facilities on the Island was an attempt to resolve the latter problem and to reduce the transport costs. In achieving this end it was one of the more successful aspects of the industry (although not without technological problems) and could perhaps be seen as prolonging its life when a host of problems threatened to swamp it. Among these were legal wrangles over ownership (Wright 1984),

watering of the mine, and loss of labour to the goldfields of Australia and California. Even remote events such as the changing of shipping laws in Britain all played a part in condemning this industrial venture in the remotest of colonies.

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