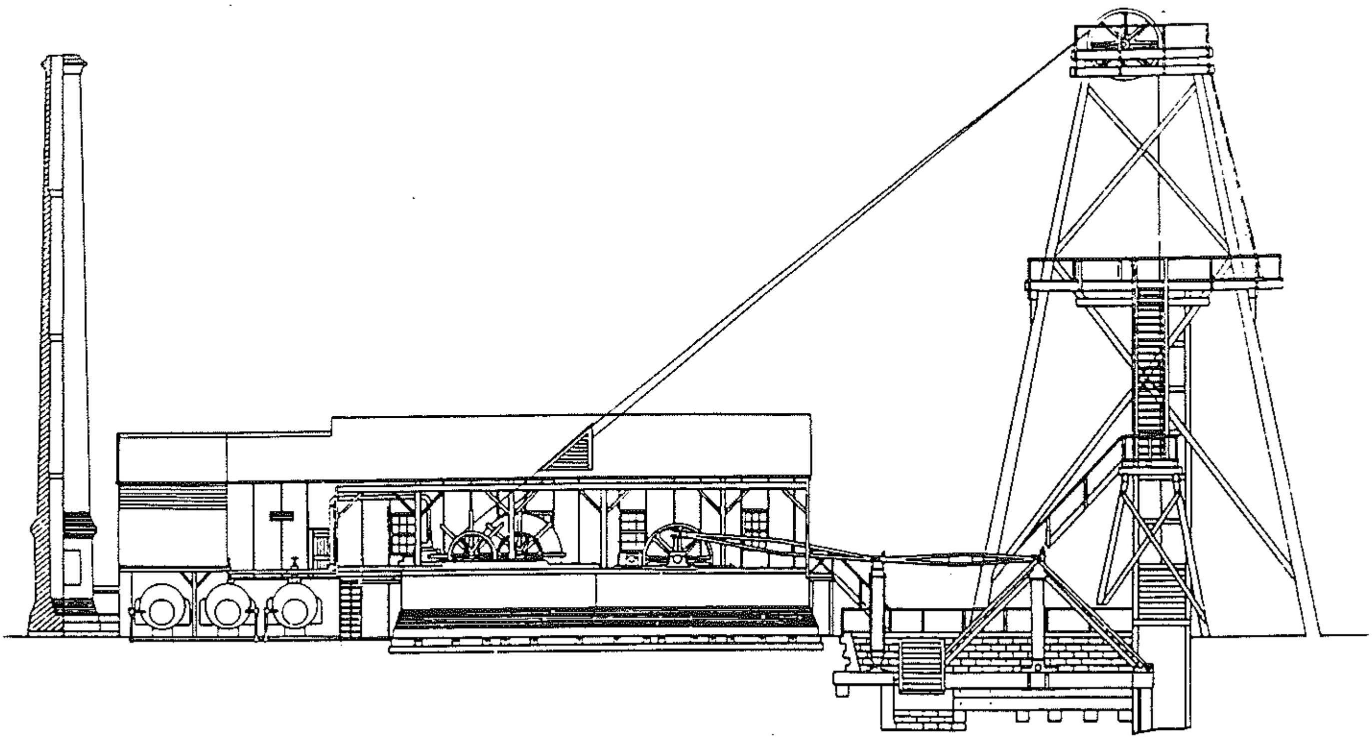
MINING HERITAGE PLACES

ASSESSMENT MANUAL



Michael Pearson and Barry McGowan

for

Australian Council of National Trusts

1998

MINING HERITAGE PLACES

ASSESSMENT MANUAL

CONTENTS

INDEX OF SUBJECTS IN GUIDELINES

Nomination to a heritage register			
nomination to heritage registers	-how to do it	3	
boundaries of mining places	-during survey -on nomination forms	1 3	4
describing mining places	-during survey -on nomination forms	1 3	 3
condition and integrity	-what to describe	3	5
assessment of significance	-during survey -on nomination forms	2 3	 6

INTRODUCTION

The *Mining Heritage Places Assessment Manual* is designed to assist in the recording, analysis, and heritage assessment of mining heritage places. It is aimed particularly at helping non-specialists in the heritage or mining fields to make basic decisions about heritage values, and aiding them to nominate mining heritage places to heritage registers. It is not about complex issues surrounding the conservation, continued mining or rehabilitation of mine sites, though a good understanding of a place's heritage significance is essential information in the resolution of these issues.

The development of the manual is consistent with the National Trust's *National policy and guidelines for the conservation of industrial heritage* (1997).

It is important to recognise that nomination of a place to a heritage register, following these guidelines, does not in itself guarantee that the place will be protected. Protection and conservation is a matter for the planning processes of the State or Territory concerned—documentation, assessment and nomination is only the first step in initiating that process.

The manual takes the form of a number of guidelines, each of which deals with either a step in the recording and assessment process, or provides basic help in researching and understanding mining heritage.

Recording and assessment guidelines:

Guideline 1. *A guide to the recording and analysis of mining places*, outlines the necessary background historical information and analysis needed to assess the heritage values of mining places, and gives assistance in the mapping and recording of mining places.

Guideline 2. *A guide to the assessment of mining heritage places*, shows how the heritage assessment criteria can be used to assess mining heritage places once they have been recorded and their history and remaining evidence analysed. These criteria are used by all Commonwealth, State and Territory heritage agencies as the basis for deciding whether a place warrants inclusion in a heritage register.

Guideline 3. *A guide to filling in heritage register forms*, works through the blocks of information required to nominate a place for a heritage register, and shows how the information already gathered is used in this process.

Supporting Guidelines and information:

Guideline 4. *A list of key contacts*, lists the heritage agencies, mines departments, National Trusts and archives authorities in each State and Territory. These contacts can provide either information and basic assistance in understanding the heritage system in each State and Territory, or assistance in locating historical information about mining places.

Guideline 5. *A guide to the sources*, outlines the various types of information relevant to researching mining heritage places, and where that information can be obtained. It includes a bibliography of key references within each State and Territory for each type of mineral, and has a list of useful internet resources.

Guideline 6. *A guide to common mining technology*, provides a glossary of mining terms that will enable mining processes and equipment to be more easily identified, and will help in understanding technical terms used in the historical documents dealing with mining.

The Appendix, *Model type profiles for mining places*, provides an outline of four types of mining, which can be used to provide a context for understanding particular mining places. The four mining types covered by the type profiles, coal mining, copper mining , and alluvial and reef gold mining, are provided as they cover possibly the most numerous types of mining heritage places. However, it is not at all to be assumed that these are the only types of mining deserving consideration for heritage listing, one of the hopes being that interested researchers and assessors will develop further type profiles in the course of their research on other mining types.

This manual is the outcome of the second stage of the *National Mining Heritage Research Project* initiated by the Australian Council of National Trusts to stimulate the identification, assessment and conservation of mining heritage places. The first stage of this project was the preparation of *A mining history of Australia* (Donovan and Associates 1995). The development of this Manual was undertaken by Dr Michael Pearson and Barry McGowan in 1998. The Project was commissioned by the Australian Council of National Trusts, and administered initially by Sarah Jane Brazil and subsequently by Dr. Susan Marsden. The project was guided by an Advisory Committee, the membership of which was:

- Dr Susan Marsden / Sarah Jane Brazil (up to May '98)
  Australian Council of National Trusts
- Mike Gregson
  representing Minerals Council of Australia
- Bill Jordan
  representing The Institution of Engineers, Australia
- Gerry MacGill
  Environmental Planning Branch, Ministry of Planning, Western Australia
- Leah McKenzie
  Heritage Victoria
- Richard Morrison
  Australian Heritage Commission
- Howard Pearce
  Cultural Heritage Branch, Department Of Environment, Queensland
- Professor Ray Whitmore
  Engineering and Heritage Consultant, Queensland

The *Mining Heritage Places Assessment Manual* project was carried out with the assistance of funds made available by the Commonwealth of Australia under the 1996/97 National Estate Grant Program. The views expressed in this Manual are those of the authors and do not necessarily represent the views or policies of the Australian Council of National Trusts or the Australian Heritage Commission.

MINING HERITAGE PLACES

ASSESSMENT MANUAL

GUIDELINE 1

A GUIDE TO THE RECORDING AND ANALYSIS OF MINING HERITAGE PLACES

GUIDELINE 1

A GUIDE TO THE RECORDING AND ANALYSIS OF MINING HERITAGE PLACES

This guideline, and indeed the whole manual of which it is a part, is intended to help in the **initial** identification and assessment of heritage places. It is not intended to create instant historical researchers and heritage experts, but to assist the non-specialist to come to grips with heritage assessment, and carry out recording and assessment to the degree necessary to make basic decisions about significance, and to nominate the place to a heritage register.

More in-depth research and investigations of a mining place might be required, for example in the context of management planning, and this is more appropriately the province of professional historians, archaeologists, geographers and technology specialists. Access to these specialists can be sought through the State or Territory heritage agency, listed in the *Contacts List* in this manual.

This guideline defines heritage significance and indicates the scope of places that might be regarded as being of mining heritage significance. It outlines how to gather basic information about a mining place, how to record the place, and how to analyse the place so that it can be assessed.

1. WHAT IS HERITAGE SIGNIFICANCE?

What is heritage significance and why do we try to define it? Heritage–those things we want to keep, enjoy or learn from, and pass on to the next generation–includes many aspects of our cultural environment, among them being mining places. A 'place' in this context is a site, area, building or other work, group of buildings or other works together with associated contents and surrounds[1]. However, our cultural environment contains a multitude of 'places', and all are not of such value to us that we wish to retain them and pass them on: they are not our heritage.

One way in which we separate places with heritage value (or 'cultural significance') from the rest is to assess whether they have strong and special meaning for a community or social group. A tool in this process is the use of a series of criteria which will help us identify any heritage values places may have (see *A Guide to the use of assessment criteria for mining places*).

The heritage significance of a mining place might be suggested, for example, by a general community recognition of its importance, or by a particular group (such as the local historical society or National Trust) identifying it as of value, or by independent research of mining history or local settlement history showing that the mine played a pivotal role in local, regional or state history. It is still useful, however, to subject even obviously-valued places to assessment against criteria, as defining the nature and level of the particular values

1 Australia ICOMOS 1992: 21.

of the place can help in deciding if and how the place should be managed it in order to protect those values.

Further reading: see information made available by most State and Territory heritage agencies on heritage assessment and listing processes (see the *Contact List* in this manual). For background, see the sources listed in the endnotes of this section[2].

2. WHAT ARE MINING HERITAGE PLACES?

The most obvious answer to the question "what are mining heritage places" is to say that they are the sites at which minerals and other materials of value were dug from the ground—they are mines. A moment's reflection and most of us would add that they include the batteries and mills in which the minerals were processed, then we might add the smelters or refineries where secondary processing occurred, the dams and water races that supplied water, the huts of the miners, and the tramways and roads built by the mine company.

It is very easy, however, to forget the broader context in which mining occurred, and that other places, including whole landscapes, might in themselves be of heritage significance because of mining. Mining sites very often gave rise to settlement sites, some of which went on to become towns while others were abandoned when mining ceased. There were associated transport routes and infrastructure, support industries such as timber milling, brick making and light and heavy engineering, and agricultural development such as market gardens to support the mine population. Native timber species were often extensively felled for fuel and mine props, exotic plant species were introduced, and other aspects of the landscape modified directly or indirectly by mining and related activities[3]. For example, the physical structure and course of rivers and streams can be changed substantially through dredging for gold and tin. If we just study, record and protect the mining sites themselves, we may end up with a very narrow representation of the heritage of mining in Australia.

While most of the practical advice in this manual is directed at more narrowly defined places of mineral production and processing, the principles of research, recording and assessment apply to all aspects of mining heritage. To take a broad view of mining heritage, it is necessary to consider the possible significance of following types of associated places as well as the mine itself:

- primary processing batteries and mills and secondary processing plant, such as smelters and refineries;
- miners' housing, villages and towns;
- roads and tramways associated with the movement of mining supplies and minerals
- infrastructure to support the mine, such as water supply, timber mills, smithies and foundries, brickworks, hydro-electric plant;
- aspects of settlement stimulated by mining—agriculture and market gardening, closer settlement, port development, railway extension;

---

2 background to heritage assessment: Pearson and Sullivan 1995

3 See, for example, McGowan 1992; Lamb 1989.

- landscape modification due to mining, such as deforestation, pollution induced barren areas, silted dams, open cuts, embankments and mounds, tailings dumps, dredged streams etc.

Ask yourself whether any of these types of places are associated with the mining site you are recording, whether they have been independently assessed for heritage value or warrant assessment, and include a description of the linkages with such places in your record of the mining heritage place.

A question often asked is "Is there a cut-off date for heritage values?". The answer is no; heritage is not just about things that are old, but things that are valued by the community for a range of characteristics they possess (see Guideline 2 for an elaboration of those values). So places that are currently being mined may have aspects of heritage significance. However, it becomes more difficult to assess heritage significance as the place becomes more recent, largely because it may not be possible to assess the features of the mine in an historical context. The perspective of time allows us to assess, for example, whether a mining technology has been influential, and whether a particular example of that technology was seminal, typical, rare or the last gasp. It may be difficult to make that assessment if the technology is new or still evolving.

The methods of recording and assessment outlined in this manual should be able to be applied to all mining places, regardless of their age. The examples used to illustrate these methods, however, are largely drawn from mining sites that are more than two or three decades old, because the perspective of time has enabled us to assess these places within the heritage assessment framework established by the various heritage agencies in Australia.

An added complication in recording and assessing mining sites is that they have often been mined at several periods of time, including in the present day. A range of mining remains a varying ages and technologies might therefore occur at a single site. The skills of identifying the sequencing of such places is based on a thorough knowledge of the technologies and processes of each phase involved, and a detailed study of the historical information from all periods of the mine's operations. In assessing such sites, the heritage value of all periods have to be identified and recorded, without undue emphasis being given to one earlier period. These skills can only be gained by experience, and until such experience is gained, it is recommended that the assistance of specialists in the mining field be sought to help assess and nominate complex multi-layered mining places.

3. HISTORICAL RESEARCH AND ANALYSIS

Before systematic assessment of heritage significance can proceed, the place has to be researched and recorded. This is because so much of the significance of a mining place is likely to be associated with the historical 'facts' of its past. An assessment of significance based on hearsay and oft-repeated myths is unlikely to result in the listing of the place on a heritage register, and is a bad basis for making decisions about a place's future.

The assessor has to know the background history of mining, and be able to place the mine in a local and regional historical context. This requires documentary research, starting with local histories, Mines Department reports and publications, maps and photographs, and other sources describing the particular mining processes found at the place. Sometimes the information about a particular mine might be hard to locate, or the information may be second or third hand, filtered through the interpretations of others. Always try and find out the basis for historical claims by going back to the original primary source, and in the case of oral information (a most useful source in the case of places operated in living memory) establish the informants association with the place and judge whether their information is based on personal experience or is repeating other oral or written sources. The most valuable skills of the historical researcher are an inquiring mind, lateral thinking, perseverance and a touch of scepticism.

CHECKLIST FOR RESEARCH AND RECORDING OF MINING HERITAGE PLACES

BACKGROUND RESEARCH

Gather historical information

- Start by studying local histories, and Mines Department reports, publications, maps and photos to get an outline of the history of the mining site. Try to find the original descriptions, rather than rely on later secondary histories. (see Guideline 5 for help with sources of information)
- Take photocopies of historical photos and plans you find, and photocopies or notes from the historical text.
- Interview local historians or ex-miners who may know the site and its stories.
- Check the Register of the National Estate and the State heritage register to see if the site is already recorded.

Understand the history of the place

- Identify and list key information about the mining place, such as when the mine was established and when major changes took place, and what those changes were (such as lists of new equipment introduced). Identify when the mine last operated.
- Use the checklists in this Guideline (section 3) to ask questions about the information you have gathered. Answer as many of the questions as you can with the information you have.

RECORDING THE SITE

Be careful

- Tell someone where you are going and when you intend to return—mining sites are dangerous places, so watch where your put your feet! If possible take someone else with you.

What to take with you

- Take the following with you to the mining site:
  - clip-board and a number of sheets of A4 paper
  - pencils and a ruler
  - magnetic compass, tape measure, and coloured tape for marking key features (optional)
  - food, water, hats, sunscreen
  - copies of any historical photographs, maps and plans from your research
  - topographical map of the area

Orient yourself in the site and plan the work

- Locate the site on a topographic map (1:25,000 is best, if it exists for your area), and record the map reference. Draw a sketch map of how you got to the site.

- Walk around and identify the extent of the site and the general location of its features, drawing a rough sketch plan as you go. Decide where the edges of the site are, and make these the boundaries of you survey, and start the detailed mapping working in from a chosen point on the boundary.

- Having familiarised yourself with the site, decide how long it will take to record it—will it take more than one day, and if so decide what areas should be recorded first? If you can only spend the one day at the site, decide what you recording you can achieve and concentrate on that.

Refer to historical photos and maps

- If you have historical photographs or plans of the site, compare these with what you can see now, and try to identify operational areas of the site and check what remains survive of the historical buildings and ground works. Keep the photos and plans with you and refer to them as you walk around the site.

Draw a map of the site

- Use any professional surveying help or aerial photography you are able to get access to, though this is not essential to producing a good map.

- Attach several, not just one, sheets of A 4 paper to a clipboard.

- Orient the board to the north and mark a north south line on the paper parallel with the edge of the board.

- Commence recording on the centre bottom of the page, the first reference point being a significant and visible feature on the southern boundary site, and work from that point to map the features of the site. Indicate north on every sheet you use.

- Mark all key features of the site on the plan, and indicate benches or major breaks in slope with a line along the top of the slope and short lines radiating down slope from it.

- Unless the site is small and manageable, do not attempt to draw a map precisely to scale, but leave this to the subsequent drafting stage. It may, however, be useful to have some broad scale in mind, say 1 mm being equivalent to two or five metres. When drawing the boundary of the site, the dimensions of a particular structure or fixing the bearing of a particular feature, both the compass bearing and the distance should be noted, perhaps as follows: 50m/60°

- While it is desirable to get as much of the site as possible on one page when recording, invariably several pages will be needed. The final overall site map will, however, need to be on one page. To avoid cluttering up the final map and to provide for the recording of sites which may need a different scale, say a battery site as opposed to the whole mine and processing complex, it may be useful to draw separate detail maps

- Where large distances, rugged terrain or thick bush are involved use of a tape measure will be impractical, although it may be useful for measuring certain specific features, such as batteries or building sites. In these cases pacing is much more time effective.

- Coloured tape can be particularly useful in highlighting certain features and obtaining and checking bearings. It is important to remove all flagging tape at the conclusion of the survey.

- If recording alluvial sites or open cuts, commence recording on the top of the face, not the floor of the diggings. Traversing is easier from the top of the face and many features are more in evidence there. Where the floor is relatively clear, say in open cuts or quarries, some recording of the floor may be useful as a cross check on the face recordings. There may also be some features on the floor which are not visible from the top of the face. If the area is extensive and crosses broken terrain do not attempt to use a tape measure, but use pacing. On such sites beware of the edge of the face, which may in some case be precarious, and watch out for snakes.

Record the main features of the site

- Describe the main features of the place, such as mine workings, mullock and tailings dumps, equipment and machinery sites, hut sites, roads and tramways, and dams and races.

- Look for the small things as well as the large—artefacts on the ground can provide valuable information.

- Look at features in relation to adjacent features, not just in isolation—for example a processing works needs a crushing works which needs a mine site to provide ore and a water supply to operate.

- Cross reference features to the plan by numbering both the descriptions and the mapped features.
- Make note of features shown in historical photographs and plans that can no longer be seen on site, and also make note of features found on site that are not referred to in the historical sources.

Photograph the site and its features

- Photograph the broad area of the mining place, showing as many associated features as can be seen in a single frame, and giving an impression of the environment of the site.
- Photograph individual features and objects that help in understanding the mining operation and the surviving evidence.
- Details of each photo should be recorded in sequence as each photo is taken. This is important in broken or heavily wooded sites, particularly those associated with alluvial mining where the features are often very subtle.

GATHERING HISTORICAL EVIDENCE

The *Guide to the Sources* in this manual describes the key types of information that are available, and provides a bibliography of key references to mining places divided by state and mineral type. It also has a series of internet addresses that have useful information that might make the searching for historical material easier. The *Contacts List* provides the locations of key providers of information and assistance.

There are a number of publications that can help in following through a systematic historical study. They are usually aimed at assisting local historians carry out local history, but the sources and techniques used to study mining places are largely the same. Some of these are listed in the bibliography and the endnote below[4].

The **Mines Department records** in each State are generally the most useful sources of information about particular mines and primary processing batteries and mills (be aware that the Mines Departments have all now changed their names—see the *Contact List* in this manual). They are of much less help when it comes to associated places not directly involved with the recovery and processing of minerals. The *Annual Reports* of the departments contain reports for each of the mining divisions or districts, and details of the operations of each mine in that period. It cannot, however, be guaranteed that a particular mine is reported on each year it was producing, so absence of reference to a mine in the *Annual Report* does not necessarily mean that the mine was not operating.

The Mines Departments also produced a number of other publications series, dealing with Geological Survey investigations of particular fields or mineral types. These draw on earlier published and unpublished department reports, and add new information, often including maps and plans. Some later field-based or mineral-based reports summarise and

4 Jack, I, 1983. 'Sources for industrial archaeology in Australia', in Birmingham, J., Jack, I, & Jeans, D. *Industrial Archaeology in Australia: Rural Industry*, Heinemann, Richmond Victoria. Royal Australian Historical Society, *Research Tools for Local and Family Historians*, Technical Information Service Bulletin No. 19, RAHS, Sydney.

re-interpreted original material, and it is always worthwhile going back through the earlier reports to extract the additional information.

Unpublished records dealing with individual mines or general 'commodities' are held by each of the Mines Departments, and are worthwhile investigating after the more readily accessible information has been gathered and the general historical outline of the mining operation is understood, or if no information on the mining place has been found.

Published **local histories** and the resources of the local historical society are a key resource. In some cases they will include information directly relating to the mining place, though more often they will give passing references only, but they will provide the context of the history of local European settlement within which the impact of the mining venture can be understood.

A worthwhile step is to check whether the place being studied has already been registered on a **heritage register**, or has been the subject of **earlier studies**. Register information can be obtained from the state or territory heritage agency and the Australian Heritage Commission (see *A Guide to the filling in of heritage register forms* for a list of such registers, and *Contact List* for the holders of registers), and information about reports and studies can be had from the respective heritage agency's library and the HERA Database (see *Guide to the sources* -internet addresses). Studies of similar types of mining places can be valuable sources of background information and help in assessing the significance of a particular place.

Maps and Plans and **aerial photographs** are a basis resource, and should be copied and studied carefully. The common sources of maps and plans is described in the *Guide to the Sources*. Similarly, historical **photographs, drawings and paintings** of the mining place are an invaluable aid to understanding the development of the place, and may provide primary information not accessible elsewhere. If original historical photographs are located, try to copy them and return the originals to the owners, or to a safe place such as the historical museum if that is agreed by the owner. Never send original photos with a nomination or report, and never glue them to a page. Take copies of historical photographs and plans with you to the place when you record it, as they are invaluable in understanding the surviving remains.

Interview with people associated with the history of the place can provide essential information not available from other sources, especially on small-scale sites actually worked by the persons being interviewed. Guides to carrying out this **oral history** work, and some of the caveats on its use, are provided in the *Guide to the Sources*.

The study of **Manuscripts and other original documents**, and of **newspapers and periodicals** can be central to the understanding of a place, but they are often more difficult to locate and study than other sources of information, and can absorb large amounts of time for small reward. Their study is essential in a full-blown heritage study, but for the purposes of describing a mining place to the level required to demonstrate significance for a heritage register the more readily accessible documentary sources may be sufficient.

ANALYSING THE HISTORICAL EVIDENCE

The gathering and presentation of masses of unsorted historical material is not the objective of this research. In preparing a nomination for a heritage register, say, the description of the history of the place must be succinct and focussed. Therefore the historical evidence has to be analysed and only key information has to be presented and interpreted in order to provide an accurate description of the place. There are a number of issues that commonly arise in mining places that should be considered, and if found to be relevant to the particular place, they should be addressed in the description.

The following is a list of questions that might be asked of the documentary evidence for mining places. This list might stimulate ideas about where such information might be obtained if it is not contained in the more obvious sources.

1. What is the local and regional context in which mining took place?

- What was the extent of mining for this mineral in the region (was this mine one of many, or unusual)?
- Are other mining places associated with the one being recorded—should they be referred to in the description?
- Are there huts sites, villages or towns directly associated with the mine?
- Did the mining activity influence or was it influenced by local settlement patterns?
- Did mining stimulate other industries or activities such as timber milling, foundries or smithies, market gardening, pastoralism etc?
- Did mining at this place influence transport routes or modes of transport in the district or on a wider scale?
- Did mining and related activities have a lasting impact on surrounding landscapes?

2. What does the historical evidence tell us about the mining place itself?

- What mineral was being exploited?
- Was the mine a producing mine or simply a prospect? Are production figures available?
- Is this an isolated mine, a part of a mining field together with other mines, or is it a whole mining field in itself?
- Is there clear evidence of how the mine operated? Were the processes up to date or old fashioned?
- Is the extent and form of the mine at its peak period identified? Are there good photos?
- Is there evidence of re-mining of the place or other later modification? What is the evidence of later mining activities?
- Are the associated water supply systems identified?
- Where did the miners live?
- What where the transport systems use to operate the place?
- What processing works existed, and where are they?
- What was the process of mineral treatment used?
- Do people survive who worked the mine? Have they been interviewed?
- Was any innovative mining or processing process invented, tested or modified at the place?
- Is there evidence for the evolution of mining processes or practices at the place?
- Did the place have any engineering feature of outstanding creativity or noteworthiness?
- Does historical information about similar mining places indicate that this place was in any way unusual, or is it was it highly typical of its type?

3. What are the historical associations of the place?

- Was the place associated with prominent named individuals or groups? What was the nature of any such association?
- Did any important events occur at the place? (eg. mining disaster)
- Did the place influence contemporary or later historical developments? (eg, was it subject of important legal proceedings; did it influence mining practices elsewhere; were any important labour issues raised or resolved there?)
- How important was the mining place in the overall context of the mining industry? (eg was it the largest mine of its type in the State; was it the principal mine of a major mining company; did it start a mining boom ?)
- Do communities survive who value the mining place because of past or current associations?

4. PHYSICAL RECORDING AND ANALYSIS OF THE PLACE

The historical research will, hopefully, provide a good picture of what the mining place was like in the past, and will indicate elements that should be looked for in the physical survey of the place. However, it is rare that a mining place will survive so completely intact that the historical plans can be instantly interpreted and all elements identified, so the place has to be surveyed to indicate what does survive. It is the combination of the historical and the physical evidence that will form the basis for the subsequent assessment of heritage values. It is important to recognise that identifying the historical associations of a place is, by itself, usually not a valid basis for assessing places for heritage listing or for conservation purposes. In addition the place has to be shown to have physical evidence which reflects or demonstrates that historical value.

SURVEYING A MINING PLACE

The level of surveying necessary for the initial recording, analysis and assessment of mining heritage places is relatively simple. As with the historical research, if more detailed information is later required as the basis for works planning and management decisions, more accurate survey will probably be needed, and this is best carried out by a professional surveyor.

If a professional survey of the site is able to be achieved, then by all means take advantage of it, and use the survey plan as a base-plan upon which to infill any detail not plotted by the surveyor. Similarly, if you can get aerial photography of the site undertaken, do so and use it in detailed mapping of the site. However, these advanced methods are not essential in order to draw a good map of a mining place adequate for a heritage recording.

Location

The first step in recording the place is to locate it accurately. In the case of mining places, this is usually best achieved by giving a standard Australian Map Grid (AMG) reference, using the largest scale topographic map available for the area (1:25,000 is ideal) as the base map. A Global Positioning System (GPS) can also be used to generate the map reference. The location should also be described in writing, referring to distance from a town or some mapped local feature, and normal access routes. A sketch map of the general location is always useful, especially if associated features such as village sites, dams, water races or processing plant are widely separated from the main mining place being recorded and surveyed. Where such associated places are considered an integral part of the mining place being recorded, they should also be given AMG references.

Drawing a plan

The simplest survey method is the use of magnetic compass and tape (or, less accurate, compass and pacing). This is a quick way to produce a reasonably accurate plan, though the accuracy will vary with such factors as the steepness and irregularity of the topography, in that vertical positioning of elements is far more difficult than their horizontal positioning.

Before starting to survey the place, first walk around it, identifying the extent of the remains, the edges of the mining area, and the location of elements within it. This will allow you to establish the boundary for the plan, and estimate how long it will take to survey it. Always try to map from the whole to the part, by defining the outer boundary of the place, plotting it on paper, then filling in the detail. If you work the other way around, from the detail outwards, you will invariably have to use more than one sheet to plot the place, cumulative errors mount up, and matching sheets at a later date is sometimes confusing and can lead to vital information going unplotted. If more than one sheet has to be used (for example on an extensive site), make sure the edge of one map match up with the edge of the next. Overlapping detail (by drawing the same 10 metre strip of the site on both sheets, for example) from one sheet to another helps. Add a north point at this stage (noting if it is magnetic or true north), to avoid any later confusion about the orientation of the plan. Be sure also to put a north point and a reference point related back to the main plan into any larger detail plans you make.

The plan drawn in the field does not have to be of a constant scale, so long as all measurements and angles are recorded on the plan (although it is ideal if time can be made plot the plan to scale on site, so accuracy can be double checked). A scale has to be decided, however, when the final plan is drawn up from the field notes, the best scale being one that allows the plan to be presented on one page, though multiple plans might be needed if a place is very complex, or covers a very large area. Always place a bar scale on the final plan—stating a scale ratio (eg 1:200) is useless if the plan is subsequently reduced or enlarged in scale, say for reproduction, or simply in photocopying.

On any field sketch or final plan, always include a title identifying the place, and note the date recorded and the name of the recorder in one corner of the plan. Also note some point that can be tied back to the topographic plan, such as giving the map reference of a plotted feature, or indicating the direction and distance to such a feature off the plan.

Plans can be made using a number of techniques using the most basic equipment[5]. A simple technique is called triangulation, where a base-line is measured out on the ground, and the distance and/or angle to particular features measured from each end of the base-line. Radiation is another method, where a central point is established and the distance and direction of each feature measured from it. Traversing can also be used, in which the distance and direction between one feature and the next is recorded in a sequence around the site. They are the basis for the surveying technique known as 'plane tabling', and if you know how to use this technique a very good map can be produced.

These three simple methods, used in combination, should enable the assessor to produce a plan of just about any site with a fair degree of accuracy in a relatively short time. The

5 See for example Pearson and Sullivan 1995.

methods described do not include the recording of height or slope, so if these are significant on the site they must be referred to on the plan in some way. One simple method is to draw lines marking the upper edge of benches or slopes, with short lines radiating down-slope from them marking the fall of the land. The relative difference in elevation between flat land at the top and bottom of the slope can be estimated and written on the plan.

It is very useful for future reference to number the photographs taken of the place, and indicate these with a corresponding number on the plan at the location of the photographer, with an arrow showing the direction of the view.

It is useful at the time of producing the plan to decide what the boundary of the place is, and how it can be recognised on the ground, by reference to roads, creek lines, ridges, fences, property boundaries etc. The boundary should encompass all elements of significance, and should be marked on the site plan, and in the case of a large site, on a photocopy of the topographic map.

RECORDING AND ANALYSING THE PHYSICAL EVIDENCE

The plan of the place should include all elements that form part of the place's significance. Separate notes should be taken describing each element, and if necessary a more detailed plan of each drawn at a larger scale than the overall site plan.

What elements of the place should be recorded?

Mining places can be complex, with many layers of evidence. All evidence relating to the understanding of the place should be described, including any evidence of:

- mining features shown on the historical maps and plans
- mine workings and operational areas from all periods of a mine's operation (sluicings, open cuts, pits, costeans, shafts, adits, headframes, winders, engines and boilers, mullock and tailings heaps, shower blocks, administration buildings etc)
- processing plant and operations from all periods of a mine's operation (batteries, mills, crushers, smelters, roasters, chimneys and flues etc)
- transportation and water systems (dams, races, tramways, roads, pathways, barrow ways, pipelines etc)
- miner's living sites (huts, barracks, tent sites, village sites and buildings, cemeteries etc)
- landscape modifications (blighted areas, silted dams, modified vegetation etc)

It is also important to note those elements of the place, identified in historical sources, that have now disappeared. This might include major pieces of machinery, buildings, and even landscape features such as open cuts that have been refilled and mullock dumps that have been re-processed. Any residual evidence of these features should be recorded and mapped. Similarly it is important to record features that are not referred to in the historical documentation, as these might show mining operations not recorded in the official records, or post-dating the assumed end of mining.

Some mines will have had recent mining activity, or might still be being mined. The modern mining evidence needs to be recorded and assessed, as it might be of heritage value in its own right. Where there are several periods of mining operations at the one site, it is important to record the evidence of each so that a sequence of operations might be determined, and the degree to which the historical significance of each period is demonstrated by surviving remains can be assessed. Detailed study of the documentary history is essential in unravelling the sequence of operations of such sites.

There is a range of features commonly found at many mining places of different mineral types that are simply described below. The model type profiles attached to this manual indicate in more detail the features that might be expected at particular types of mining sites, and individual elements of mining technology are described in Guideline 6.

Recognising ***hut sites*** is sometimes difficult, so take notice of discrete piles of stone (especially those with lots of mud between the stones), and squared stone features, which may be chimney bases. The chimney base and an adjacent levelled area may be all that remains above ground to indicate a timber hut or a tent site, though in some cases patterns of timber stumps are found. Sometimes garden plantings or stone or brick garden edgings can also indicate a domestic site.

Many mining places have ***tailings*** associated with them, ranging from simple low flat areas of sand located below processing works, to shallow silted tailings dams and complex systems of tailings on several levels and linked by posts indicating original tailings flumes. Tailings are usually able to be recognised by their fine sandy or muddy texture, they are often still clear of vegetation, and sometimes they are of an 'unnatural' colour due to the heating or chemical treatment of the sands.

Tailings can be a useful indicator of mine layout, as tailings are always below the processing works area, as they are almost invariably transported by water flowing under gravity. Similarly, the processing plant is almost always downslope of the battery or crushing plant, which is in turn downslope of the mine shaft or adit, again because ore and concentrates are usually transported with the aid of gravity.

Flues from ***boilers and furnaces*** invariably run in the opposite direction, up hill. Flues were commonly vaulted brick structures laid out along the ground, and often only survive as parallel lines of brick at ground level. Furnaces and boiler sites are often visible above ground as areas of burnt or clinkered brick, with perhaps fragments of low brick walls or lengths of iron rail used to reinforce the furnaces, and firebox bars. Chimneys may have collapsed, leaving large piles of brick. Sometimes the bricks have been scavenged for other local uses, and only a bench or flue line may remain to indicate the chimney location. Historical photos can be extremely useful in indicating the location of such features.

Machinery and equipment has been removed from the majority of heritage mining places. The former location of removed machinery is often indicated by stone, brick or concrete foundations and supporting blocks. A rectangular masonry structure with a semi-cylindrical depression running through it, for example, is likely to be a boiler mounting. Engine and machinery bases usually have iron bolts projecting from the top surface, onto which the machinery was bolted down. Engine blocks also may have a semi-circular slot on one side, indicating the location of the fly-wheel. Stamper battery sites are often indicated by heavy masonry or log stumps, with bolts projecting from them to hold down the battery. Stamper shoes and dies (circular or polygonal blocks of iron) and curved cam arms are often found near battery sites. Mining machinery was often re-used on a number of sites, and it cannot be assumed that the date of the machinery indicates the date of the mine. Similarly, machinery introduced at a later period of mining might occupy the same site as earlier machinery, so it cannot be assumed that the date of a mining feature is determined by the age of the more recent machinery associated with it.

Galvanised iron, timber or masonry ***tanks or vats*** are often found at processing sites. These might be cyanide vats (at gold mines) or chemical processing vats associated with chlorination or other mineral separation process at base metal mines. Tanks found at a higher elevation than the processing works are likely to be water storage tanks, and might be connected by a pipeline and pump site or a race to a dam somewhere near the mine. All of these tanks can be either above ground or partially or totally sunk into the ground.

Artefacts are important indicators of the age and operation of mining sites. Artefacts associated with mining might include components of machinery and equipment, assay crucibles, drill cores, chemical containers and the like that might indicate the layout of the mine operations and the identity of particular building remains. Machinery maker's plates can indicate the age and the sources of the equipment. Domestic artefacts can indicate habitation areas. Some, such as later beer bottles and marked pottery fragments, can be used to date the period of occupation. Toys and small shoes can indicate the presence of children. Tins and other containers can indicate elements of the diet of the miners. The description of the place should indicate the broad patterns of artefact scatters, and note any artefacts of particular use in adding to the history or interpretation of the site. However, avoid trying to photograph, draw or describe all artefacts—it is extremely time consuming and in the end not very helpful.

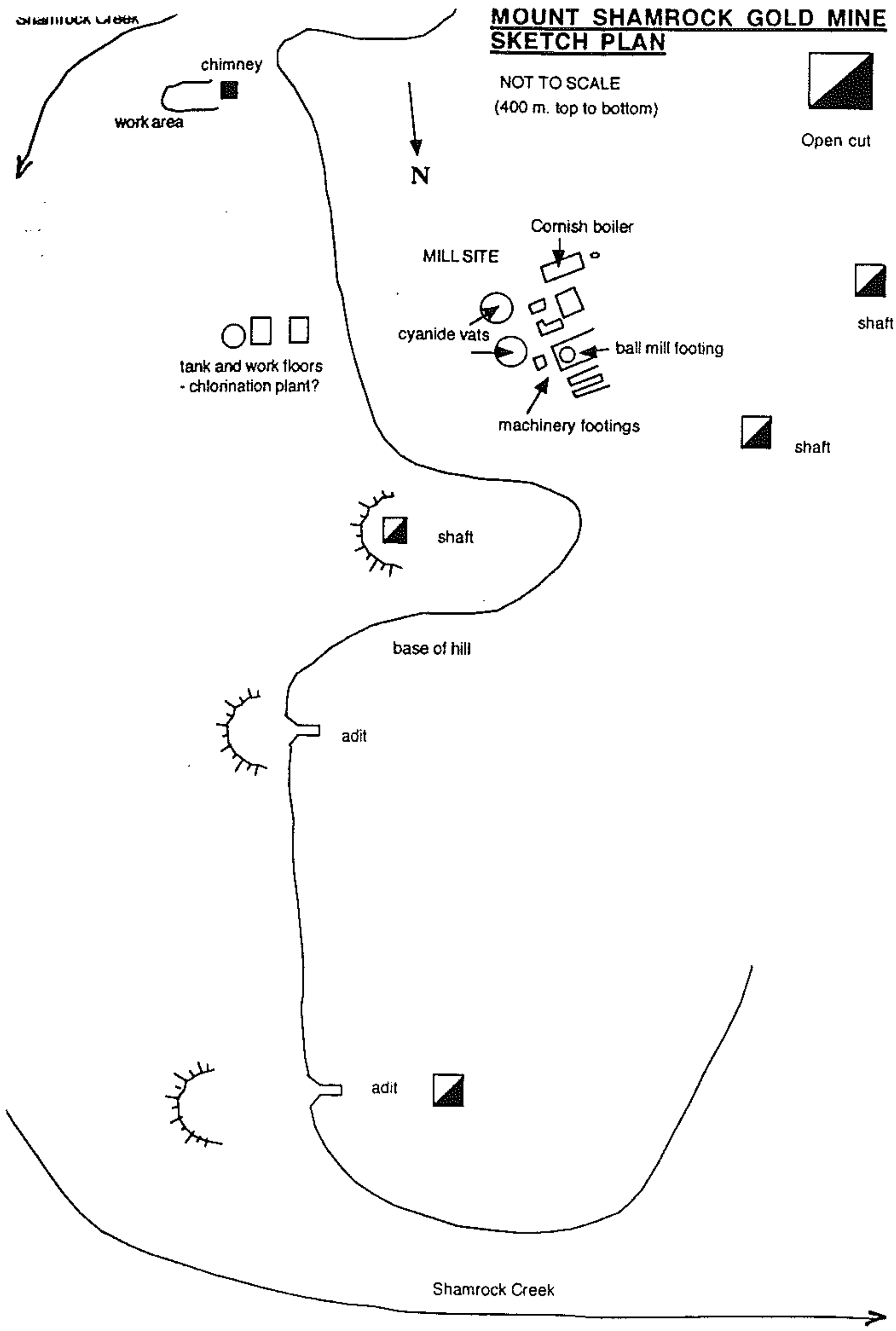
Photography is an important part of recording a place. Black-and-white photography is probably the best for place recording, and likely to survive much longer than colour prints or slides, but is very expensive these days. Taking both black and white and colour is best of all, but few of us arrive at a place with two cameras, or can afford doubling the processing costs. For the purposes of nominating a place for a heritage register, it is usually sufficient to provide colour slides or prints.

Overall views of a place, showing a number of features of the mining site and the environment in which the site sits are useful in setting the context for the place. Photographs of details (such as buildings, mine workings and machinery) should be taken, with a scale in the photograph where this will be useful (for example, detailed shots). A person often makes a good scale. Think through which features and objects are important in understanding this place, and photograph those, but avoid wasting film on irrelevant or non-diagnostic objects or features, such as a single bottle or each of 15 identical shallow pits scattered around the site.

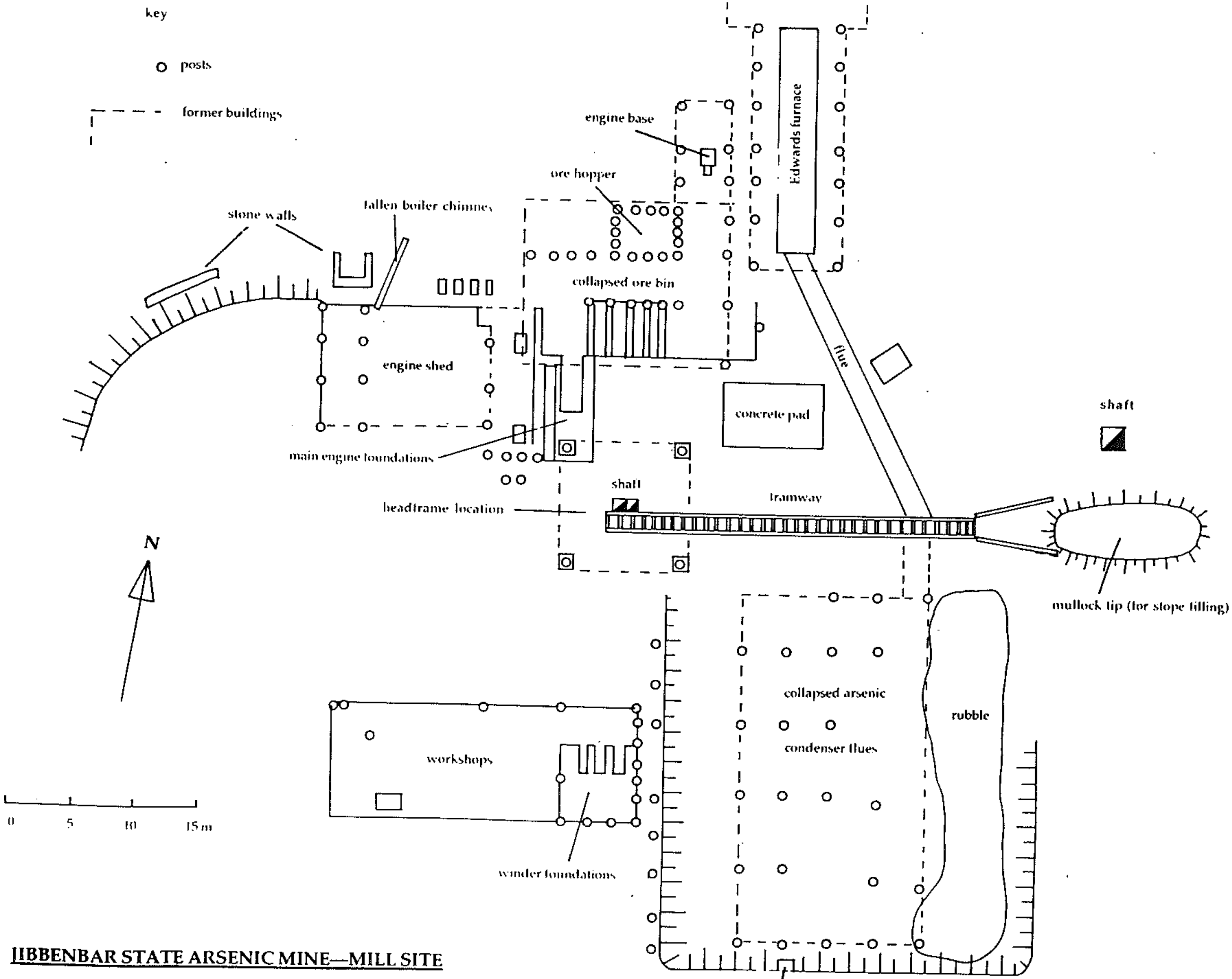
In taking photographs be careful to centre the main object of the photograph, and not to cut out important parts of the feature, and on the other hand do not focus on one part only without also including a photo of the whole feature or object. If the object of feature is closely associated with related features (such as a battery site and the tailings dump below it), try to get a photo showing both features, so their relationship can be seen.

If taking photographs in wooded country, be aware of the problem caused by the high contrast differences between sunlit and shaded areas. This is particularly a problem when using black and white film. Dull, overcast days are the best for photos in such country. Some features common to mining sites, such as open cut or sluiced areas, extensive tailings, or races, are often difficult to photograph, especially in wooded country or where the feature is shown only by subtle landform modifications. Photographs tend to 'flatten' the landscape, though sometimes this can be overcome by finding a raised view point, such as the opposite side of a valley, or using low sun in the morning or afternoon to highlight surface features by showing their shadows.

It is essential that all photographs are labelled as soon as possible with the description of what they show, where they were taken, the photographer's name, and the date of the photograph. If negatives are available, the negative number should also be noted, linked back to a film number, so that new photos can be developed if needed. It is also highly



Simple plan of a gold mine (Pearson 1994)



Plan of a ruined arsenic processing plant (Pearson 1994) desirable to include a sketch map with the photographs, showing the viewpoint from which each photo was taken of the place. This will be useful to subsequent researchers, managers and other users of the register.

SOME RECORDING CHALLENGES

Particular challenges can arise when recording mining places. For example, many mine sites have evidence from a succession of mining periods, which are at first quite difficult to separate. The features belonging to all periods of mining at a place need to be recorded and assessed. In some cases the contributions of various mining venture are retained at a site, and the site's heritage value is enhanced by the depth and variety of evidence it retains. In other case later mining activity may have disturbed or completely destroyed earlier mining features. Sorting out the sequencing of such a site can be complicated by the common habit of re-using equipment from other and older mine sites, or from earlier operations at the same site. The thorough study of the documentary history, photos and maps is an essential part of unravelling complex multi-layered mining places.

Some mining places are spread over a considerable area in rugged landscapes, and a degree of pre-mapping reconnaissance is necessary to locate all of the components. It is important for the recorder to ask, for example, where the processing plant, access road, water supply and miner accommodation are located, and try to identify these elements of the place and include them on the plan. It is important to think about the mining place as an operating system in order to ensure that all the essential elements of that system can be found and recorded.

Open cut workings and hydraulic or ground sluicing areas pose specific problems for mapping. The face of some alluvial workings, for example, can encompass several overlays of technologies and time periods extending over hundreds of metres, with no clear delineation between the technologies and periods. The floors of the workings can be a jumble of tailings and eroded gullies. The complexity of these sites can appear overwhelming.

In most instances the obvious choice of recording method will be traversing. However, an equally important choice is whether to record workings such as open cuts and sluiced areas from the floor of the workings or the top of the face, or both. The choice will determine the degree of difficulty and accuracy of the final plan.

The difficulty with recording from the floor is that it is often littered with waste heaps, tailings mounds and thick vegetation extending back to the face of the diggings or cut, making recording difficult, unpleasant and time consuming. The challenge with recording from the top of the face is that it can be very steep, up to 20 metres or more in height, and can entail a degree of risk. Generally, traversing is easier from the top of the face, and many features such as races, dams, hut sites, roads and drainage culverts are more in evidence from the top of the face and can be planned in using triangulation or radiation. Generally, the larger and more complex the site, the more likely that recording from the top of the face will be the most practical option for mapping the key features of the place.

The floors of open cuts and sluicings also contain important features that might not be visible or able to be mapped from the top of the face. These might include shafts, adits or crushing machinery (especially in open cuts), tail races, tailings mounds, tramways and barrow ways, and various levels of floor. The general outline of these features can be added to the plan by triangulation or radiation keyed to points established on the face by the earlier traverse. The complexity of the floor area, particularly in sluicing sites, can be daunting, and it is important to bear in mind that it is those elements that add substantially to understanding the place's significance that should be mapped. It is not necessary to plan in every single element of such places.

Dredging landscapes and alluvial diggings can extend over several kilometres along a river or stream system, and it is usually impractical to record all features over this area of land. The normal approach would be to map in the extent of the workings in relation to the river or valley, plan in particularly interesting features such as dredge ponds, pontoons, clusters of hut sites, clearly structured tailings mounds, races and the like, and perhaps plan in detail a sample area to illustrate the complexity of the whole.

MINING HERITAGE PLACES

ASSESSMENT MANUAL

GUIDELINE 2

A GUIDE TO THE ASSESSMENT OF MINING HERITAGE PLACES

GUIDELINE 2

A GUIDE TO THE ASSESSMENT OF MINING HERITAGE PLACES

This Guide discusses the use of heritage assessment criteria in the assessment of mining places. Heritage Assessment criteria are used by all Commonwealth, State and Territory heritage agencies as a basis for assessing places for heritage register listing, and it is necessary to be able to demonstrate the significance of a place in terms of the criteria in order to ensure that nomination to a register is justified. The guideline is based on earlier work by the Australian Heritage Commission, Heritage Office of NSW, Bell, Pearson and MacGill[6]. It is also consistent with the National Trust's *National policy and guidelines for the conservation of industrial heritage*[7].

1. THE CONTEXT FOR ASSESSMENT OF SIGNIFICANCE

The reason for recording and nominating a mining place to a heritage register is our belief that the place is in some way important to our society and important enough to pass on to future generations—it is our, and their, heritage. Not all mining places have such values. Some mining places are more important than others, and only some of them cross a threshold of importance that qualify them as 'heritage places' and hence worthy of listing in heritage registers.

Heritage assessment criteria have been developed by heritage agencies to help them assess the level of significance of places with some degree of rigour and consistency. The use of criteria require the reasons that a place is important to be spelled out. This both clarifies the analysis of significance, and provides a much better basis for making decisions about future management and conservation of the place.

The heritage values we ascribe to places are human constructs, not immutable qualities inherent in the place, and they may change over time as the contexts of knowledge and

---

6 Australian Heritage Commission 1990
Bell, P. 1993. 'Historic Minesites in Tasmania', unpublished report for the National Parks and Wildlife Division, Tasmanian Department of Environment and Land Management.
Heritage Office of NSW, 1996. *Heritage Assessments*, component of the *NSW Heritage Manual*, Heritage Office, Sydney.
MacGill, G. 1998. 'A policy and strategy for the conservation of mining heritage in Western Australia', Draft report for the Heritage Council of WA.
Pearson, M. 1997. ' "All that glisters...": Assessing the heritage significance of mining places', Australasian Historical Archaeology, 13 [1995]: 3-10;

7 Ginsberg Knight & Associates, 1997. *National policy and guidelines for the conservation of industrial heritage*, Australian Council of National Trusts, Canberra.

community association change[8]. For this reason alone anybody wanting to nominate a place for registration in the expectation that the place is worth conserving needs to be clear about why they want to ascribe cultural significance to a particular place, and within what framework they have assessed that significance. In the case of mining sites, some find it hard to accept that a place may have little or no heritage value when its significance is thoroughly analysed, and choose instead to base claims of heritage value on poorly explained and supported arguments. At one end of the assessment spectrum, as an example of an acceptable claim, might be that "the Acme Mine was the largest producer of wolfram in Australia, and has an exemplary array of intact original mining equipment"—at the other end of the spectrum, as an unacceptable claim, might be that "the Dismal Mine, despite the loss of all its equipment and the collapse of its only adit, is the only surviving mine of the Spectacular Goldfield, the seventeenth largest gold producer in the State's history".

Identifying the historical associations of a place is, by itself, usually not a valid basis for assessing places for listing or conservation purposes. The place has to be shown to have physical evidence which reflects or demonstrates that historical value. An example would be a gold mine shown by the historical reports to have pioneered the use of a new extraction process that was widely adopted. This would make the place important historically. However, if all evidence of the mining features associated with that innovative development have been destroyed by subsequent open cutting of the site, there will be no element of the place to demonstrate that association, and the place would probably be judged not to meet the heritage criteria.

Many mining places have experienced a succession of mining activities over a lengthy period of time. This has sometimes resulted in the presence on one site of mining features and equipment from more than one era of mining technology. Such sites can be complicated to record and assess, and a thorough knowledge of both the history of mining at the place and of the technology of each era is necessary to unravel the puzzle. The most recent mining episode, which might be ongoing, may well have heritage significance in its own right, and should be assessed along with all other periods. In some cases, the multi-layering and continuity of mining activity has given particular heritage values to a mining site. An example is the Ophir goldfield in NSW, the site of the first goldrush in Australia, which has experienced an almost unbroken history of small-scale mining to the present day, a period of over 140 years. The value of that continuity lies in the fact that the small-scale nature of the mining has meant that significance evidence of all periods of mining operations on the field have survived. Had larger-scale operations occurred it is likely that earlier evidence would have been obliterated.

One point which should be engraved on the mind of every would-be assessor of mining places, is that it is imperative to separate the process of significance assessment from that of management decision making. By management decisions is meant the decisions about the future conservation, re-mining, rehabilitation, flooding or any other action that might affect the place. Assessment of significance should be carried out independently from, and prior to, the making of management decision that might impact on important elements of the place, and management decisions should not be made in the absence of a knowledge of significance. The use of criteria as a framework for assessment maintains the focus on issues of significance, and should help the assessor be alert to situations in which management issues are raised in the guise of significance assessment.

It should also be remembered that when management decisions are made significance (though of great importance) is only one of the factors that has to be considered by the

8 For a fuller discussion of this issue, see Tainter and Lucas,1983.

manager, and by the government agencies that oversee mining, environmental and heritage issues. The establishment of significance does not in itself guarantee that management decisions must necessarily be made that will ensure the place is conserved and managed to protect that significance. The relationship between significance assessment and conservation/management decision making has been discussed elsewhere[9].

2. ASSESSING MINING PLACES USING CRITERIA

The heritage assessment criteria used by the States and Territories are, generally speaking, parallel to those originally devised and used by the Australian Heritage Commission for assessing places for the Register of the National Estate[10]. It is not necessary for a place to be important within each criteria, as significance within just one criterion might be sufficient to warrant listing. In most cases, however, a listed place is important under two or more criteria.

The criteria used to assess places for entry in the Register of the National Estate are as follows. Some of the criteria are generally more relevant to the assessment of mining places than others. The most commonly applicable criteria are criterion A to D below.

A. Its importance in the course, or pattern, of Australia's natural or cultural history.

The Australian Heritage Commission has adopted sub-criteria which help explain how a place might be important in the nations history. These are:

- Importance in exhibiting unusual richness or diversity of flora, fauna, landscapes or cultural features.
- Importance for associations with events, developments or cultural phases which have had a significant role in the human occupation and evolution of the nation, State, region or community.

<u>Guidelines for inclusion of a place under this criterion</u>

This criterion applies to many mining places, as mining has been a significant influence on Australian settlement patterns, economies, industrial development and population growth.

It is most often applied to successful mines which in some way shaped the history of the state or nation, or changed, say, production technology generally and made other mines more successful (also relevant to Criterion F). However, it can equally apply to unsuccessful mines, where they have had a major historical impact.

A place should be included under this criterion if it:

- shows evidence of a significant human occupation or activity
- is associated with a significant event or historical phase
- maintains or shows the continuity of a historical process or activity.

---

9 Kerr 1985; Australia ICOMOS 1992; Pearson & Sullivan 1995.

10 Australian Heritage Commission 1990

Examples:

- The Canoona gold field near Rockhampton in Queensland, the state's first gold rush (1857). The rush was not sustained, and the government was left with the task of 'saving' thousands of stranded diggers. The rush's influence on the pattern of history was to change the government's attitude to the control of goldfields in the future, and perhaps as importantly, the rush provided a 'seeding' population which assisted in the development of the tropical north.[11] Ironically, the ability of the Canoona field to reflect or symbolise this historical role is greatly diminished because of the limited nature of the mining remains that survive.
- The Mt Bischoff mine in Tasmania, which triggered the great era of west coast mining and settlement in 1871[12].
- The Geraldine Mine in Western Australia, the site of the first commercial mining operations in the state[13]
- The Wonthaggi State Coal Mine in Victoria had seminal impact in the state, as the Australia's first State-owned coal mine, one of the first with all-electrical operation, one of the largest mines of its era, and probably the best able to provide evidence of working conditions [14]
- The Arltunga mines in the Northern Territory were opened up in 1887 and were instrumental in opening up central Australia to European settlement, stimulating, for example, the development of the town of Stuart (Alice Springs)[15].

Guidelines for exclusion of a place under this criterion

The criterion applies only to places that are **important** in history, so places that are very common in the landscape, with no outstanding historical associations that had wider impact would not be included. Mining places of significance at the local level may be excluded if they had no significant influence on local or regional settlement or development, but may be significant under other criteria. Places believed to be associated with important events might be excluded if the association of place and event is not able to be demonstrated through documentary evidence, or where the place now possesses no physical evidence that can be associated with the event.

A place would be excluded under this criterion if it:

- has only incidental connections with historically important events, activities or processes
- is associated with events, activities or processes that are of dubious historical importance
- has been so altered that it can no longer provide evidence of a particular association.

Examples:

- Small alluvial diggings, prospect shafts and small 5-10 head gold battery sites are all commonplace and would not normally be considered significant under this criteria unless their substantial influence on local, regional or state history can be demonstrated.
- The North Lyell mine in Tasmania was the scene of the worst Tasmanian mining disaster in 1912. However, the event left no discernible trace, and there is nothing of cultural significance at that place.[16]

---

11 Pearson 1994a: 11, vol 2, 20.

12 Bell 1993: 59

13 MacGill 1998:2.2

14 Andrew C Ward and Associates 1994.

15 Holmes 1983.

- The Mount Chalmers Mine near Rockhampton was a significant mine in the development of central Queensland, but the vast majority of the site has been removed by a later open cut mine, so that no evidence remains of the significant mining remains[17].

B. Its possession of uncommon, rare or endangered aspects of Australia's natural or cultural history.

The Australian Heritage Commission has adopted sub-criteria which help explain how a place might be regarded as uncommon, rare or endangered:

- Importance in demonstrating a distinctive way of life, custom, process, land-use, function or design no longer practised, in danger of being lost, or of exceptional interest.

In a number of states the criteria for rarity is interpreted as qualifying other criteria, rather than as a criterion that is used in isolation. Thus a place might be significant, for example, if it is important in the course or pattern of history **and** is rare. Assessors should check the particular criteria of the state or territory in which they are nominating a mining place.

Problems in attributing rarity to mining places sometimes arise because the place has been assessed in the absence of comparative information— that is, surveys are incomplete and the place is only 'rare' until the next example or 'uncommon' until the next ten examples are identified. The attribution of rarity must be based on a reasonable understanding of the population of the type of place or particular aspect of significance. In the first instance the assessor should try to assess the place in the context of the available comparative information. However, the assessor must be aware that the heritage agency may have more information against which to assess rarity, and may come to a different conclusion.

Rarity is also relative to the particular contexts: some places may be rare globally, nationally, in a State or Territory, regionally or locally. It might be rare within the context of mining a particular mineral type, but relatively common in others. It might be rare for a particular period but common in subsequent periods. The consideration of these different contexts might help in the assessment of the relative heritage value of the place. For example, in most instances a place rare at the local level but common elsewhere would not be ranked highly on the basis of rarity in most heritage register assessments. On the other hand, a feature rare within its mineral type but common in others may still be of great importance in demonstrating the processing of that particular mineral, and assessed highly as a rare example for that reason.

Guidelines for inclusion of a place under this criterion

A mining place can be rare, endangered or uncommon if it:

- is a good example of a type that was few in number originally;
- is a good example of a type that is few in number due to subsequent destruction;
- is a good example of a type that is susceptible to rapid depletion due to changed practices or other threats; or
- is an outstanding example of an uncommon mining or related practice or activity.

---

16 Bell 1993: 59

17 Pearson 1994a: 11, vol 2, 64.

Examples:

- Ilfracombe, near Beaconsfield, is Tasmania's only surviving iron smelter. Nineteenth century ironworks (not strictly mining places, but closely associated) were few in number anywhere in Australia, and all such remains can be regarded as rare[18].
- The Eldorado Dredge in Victoria, represents a once common technology of which very few examples survive. Dredge pontoons, even without much of their superstructure and machinery, are uncommon. The rarity of these places is enhanced if associated with structural features such as tailings mounds, dredge ponds, channels and mooring posts.
- The gold ore roasting kilns at North British Mine, Maldon, Victoria, are uncommon, there being only seven known sites in Australia of this type (six of them in Victoria) , and are the most extensive example known in Victoria[19].
- The Jibbenbar State Arsenic Mine, near Stanthorpe, Queensland, is an uncommon example of government undertaking mining (other than coal) in its own right, in this case to provide cheaper poison to deal with prickly pear infestation. It is an example of a rare industry, the mining and processing of arsenic.[20]

Guidelines for exclusion of a place under this criterion

A place would be excluded under this criterion if it:
- is not rare
- is numerous but under threat
- is rare in a local context but numerous or abundant nearby.

Places significant under this criterion only at the local level would normally be excluded, as rarity at this level has little meaning. Absence of comparative information does not necessarily imply rarity, and if such information is not available and if a very strong prima facie case for rarity does not exist, the place should be excluded from this criterion. The criterion may not be appropriate if the rarity is only demonstrated by documentary sources, but not evident in any way in the remains at the place.

Examples:

- The only gold mining site in a local government area is not rare in any meaningful sense, though it may be significant under other criteria.
- The Rylance Colliery in Ipswich, Queensland, is uncommon historically, due to its long history of 113 years of mining, but rehabilitation of the site has left no distinctive evidence to demonstrate that history.

C. Its potential to yield information that will contribute to an understanding of Australia's natural or cultural history.

The research value of a place lies in the ability of the place itself to provide new information, not in the opportunity to learn more about the place from library research, nor in the place's ability to be used as an example of something, or to be used as an educational opportunity. The existence of good documentary evidence might add to the potential of a

18 See Jack & Cremin, 1994.

19 Davey 1986.

20 Pearson 1994a: vol 2

site to yield important information, but it is the site itself as an information source that is being assessed.

Some would include sites which have already contributed their information, and indeed the Australian Heritage Commission's own guidelines allow this interpretation[21]. There is a strong argument, however, that the criterion should only be used where the place has the potential to provide new, as yet untapped information. Places which no longer have research potential should, instead, be assessed under other criteria. The educational use and interpretative qualities of the place are not so much issues for assessment, but are very much attributes which might determine the nature of management of a place, after significance has been proven.

The important qualifying test in assessing places under this Criterion is the degree of confidence that can be placed in the claim that the place has research potential. This is particularly important at sites which are being assessed for their archaeological potential, especially in relation to sub-surface deposits. Bickford and Sullivan[22] have posed three simple questions which might help assessors make this judgement:

(i) Can the site contribute knowledge which no other resource can? ;

(ii) Can the site contribute knowledge no other site can?; and

(iii) Is the knowledge relevant to general questions about human history or other substantive problems relating to Australian history, or does it contribute to other major research questions?

In essence, can the assessor demonstrate that the information that might be obtained from the place is likely to be of research value, and can that information be obtained only from that place, and no other place or source.

Guidelines for inclusion of a place under this criterion

There must be a sound basis for assessing that the place has demonstrated or potential research value inherent in the fabric of the place itself, and that the information to be yielded by the place is likely to contribute significantly to our knowledge of the past.

Examples:

- The settlement site at Garibaldi, Tasmania, has the potential to provide information about Chinese tin mining and miners in the nineteenth century[23]. This site is likely to be able to satisfy all three questions posed above.
- In Queensland the Peak Downs copper smelter site, the earliest in Queensland (1865), has the potential to provide information on the genesis and early, apparently rapid, evolution of smelting practice in remote Australia, an aspect of mining history poorly recorded in the documentary evidence, and for which no other sites with the same antiquity and early length of operation exist in the state[24].
- The goldmining and associated settlements and transportation routes of the Jacqua Spring Creek Field on the Shoalhaven River and the Cowra Creek goldfield near Bredbo

21 Australian Heritage Commission 1990: 15.

22 Bickford and Sullivan 1984:23-24

23 Bell 1993: 60

24 Pearson 1994a: vol 2

in NSW have been shown to have a strong potential to yield important information about the relationship between mining and community dynamics over time[25] The latter field has substantial remains of both an 1890s and 1930s mining village.

- The goldmining sites along the Mongarlowe River and at Bombay crossing near Braidwood, NSW, have the potential to yield important information about Chinese gold mining and miners in the nineteenth century, there being little in the way of archival material to help with interpretation[26].

Guidelines for exclusion of a place under this criterion

The simple existence of archaeological deposits is not sufficient to satisfy this criterion. It must be demonstrated that the place has the potential to provide important information that addresses stated research questions. If the three questions presented above cannot be addressed, then the place should be excluded from the criterion.

Mining places which fail to satisfy other criteria are unlikely to satisfy this one. The research potential has to be targeted, so the place has to be shown to have evidence of, say, early or poorly documented mining, evidence of important technological advances reflected in surviving evidence, or associations with other industries or settlement patterns of particular interest and with surviving evidence. Absence of this sort of evidence should exclude a place from consideration under this criterion.

Examples:

- The Mount Chalmers Mine near Rockhampton, Queensland, is known to have experimented with new flotation systems invented at Broken Hill, but the potential of the place to provide new information this important historical issue has been lost with the removal of the physical evidence by open cut mining.
- The Currawong Copper Mine near Collector, NSW, was an early and substantial copper producer in the state for a number of years. However, much of the site has been rehabilitated, and any remaining heritage significance lies in the associated village site[27].
- A mining site of only local significance, and that is like many others of its type, is unlikely to have research potential unless it can be demonstrated that it has characteristics that are relevant to identified research questions of importance.

D. Its importance in demonstrating the principal characteristics of (I) A class of Australia's natural or cultural places; or (II) A class of Australia's natural or cultural environments.

The Australian Heritage Commission has adopted sub-criteria which help explain how a place might be regarded as demonstrating the principal characteristics of its type:

- Importance in demonstrating the principal characteristics of the range of human activities in the Australian environment (including way of life, custom, process, landuse, function, design or technique).

This criterion distinguishes places which are a good example of a type. Because the place should be able to provide a good understanding of its type, the integrity of the significant

---

25 McGowan 1992.

26 McGowan 1996b.

27 McGowan 1996c.

element of the place should be relatively high. The criterion is very often incorrectly used in the case of mining places, with no reasons being given to explain why the place should be considered a good example. All places are, by definition, examples of their type, so the important questions in distinguishing the point at which this attribute takes on heritage significance are:

(a) how completely does the place represent all or key characteristics by which the type or class is defined?; and

(b) how important or unusual is it as an example of that class?

As an example, nearly all gold crushing battery sites will display key characteristics of such places. To apply this criterion to a gold battery, the assessor might wish to demonstrate, by reference to comparative information for other sites, that a particular place demonstrates a larger number of distinguishing features of the class than is common, or that the physical evidence demonstrating a range of characteristics is particularly intact and well preserved, compared with others of the class, or that the place has a large number of class characteristics but also possesses a wider range of physical remains representing changes in battery technology over time than other batteries (which might also qualify it under Criterion A.).

The assessor may also wish to consider whether the site may have enhanced significance as a consequence of its association with nearby cultural material, for example the remains of a mining village or hut sites. In these circumstances, however, it may be classified not primarily as a mining site, but as say a village, whichever is the more dominant. In some instances there may be associated burial sites, especially with the Chinese. These sites are invariably significant and should not be ignored. Clearly, however, they are not mining sites and should not be classified as such.

Some places might satisfy this criterion because they represent important regional variations in a class of place, or represent an important point in the history of the development of the class of place. Clearly, these assessments have to be based on a knowledge of the extent and nature of the class, so that comparative statements can be substantiated. The examples of mining type profiles included in this manual provide one context which might help in comparative assessment.

As with Criterion B this criterion is, in a number of states, interpreted as qualifying other criteria, rather than as a criterion that is used in isolation. Thus a place might be significant, for example, if it is important in the course or pattern of history **and** is a particularly good example of it type. Assessors should check the particular criteria of the state or territory in which they are nominating a mining place.

Guidelines for inclusion of a place under this criterion

Places included under this Criterion should retain a range of elements characteristic of their type or class, and with reasonably high integrity. Such a judgement must be based on sufficient comparative analysis to justify the assessment, and the documentary sources or some other basis for the comparative analysis should be referenced in the nomination.

A place should be included under this criterion if it:

- is a fine example of its type
- has attributes typical of a particular way of life, custom, process, landuse, function, design or technique

- is a significant variation to a class of items
- is part of a group which collectively illustrates a significant type

Examples:

- The Miclere battery and mining field, near Clermont in central Queensland, has a battery site which is largely intact and in a good state of preservation, and which characterises the various aspects of public battery operations on semi-arid gold fields. Surrounding the battery are mining remains, including surviving whims and whips, which are now rare (Criterion B), but which were key characteristics of mining in semi-arid environments in the nineteenth and early twentieth centuries. The very rarity of places with these key characteristics makes Miclere significant as an example of its class.
- The United Rise gold battery, near Monto, central Queensland, contains a stamper battery, several boilers including an in-situ Cornish boiler, a portable engine, Wheeler grinding pans, a small cyanide plant, and tailing dump, and the layout of the remains is easily related to an 1890s photograph of the site. Small battery sites with so many elements, once characteristic of such places, are now unusual in Queensland, and the site well-represents the range of features typical of its class[28].
- The State Battery at Coolgardie, WA, is an intact example of the many batteries constructed in the goldfields by the State government, and demonstrates the complete process of gold extraction[29]
- The Spa and Black Springs sites on the Shoalhaven River, NSW, are largely intact examples of hydraulic sluicing sites displaying features such as dams, races, tail races, tunnels, fluming and the interrelationship with older areas of ground sluicing[30].

Guidelines for exclusion of a place under this criterion

Places should not be included under this Criterion unless there is some substantial basis for assessing the place to be a good example of its type or class. Such a judgement should be based on comparative information showing the place to be a particularly good example, and the place should possess a sufficiently high degree of integrity to allow the typical characteristics to be well understood.

A place should be excluded under this criterion if it:

- is a poor example of its type;
- does not include or has lost a substantial number of elements typical of a class of place;
- cannot be demonstrated to be an important example of a type that is well represented by numerous surviving examples of similar completeness and integrity;
- does not represent well the characteristics that makes up a significant variation of a type.

Examples:

- The gold milling and roasting plant at Norton Goldfield near Calliope in central Queensland, while significant for other reasons, is not typical of its type because it utilised a roasting technology not commonly found on gold mining sites[31].

---

28 Pearson 1994a: vols 1 & 2
29 MacGill 1998: 2-4.
30 MacGowan 1992; 1996b:253-262.
31 Pearson 1994a: vols 2

- The Summerhill Copper Mine, near Bathurst NSW, while significant as a very early (1840s) smelting site would be excluded from this criterion because the elements making up the place are largely destroyed and difficult to distinguish, while other places in the same class in the same mining context have more clearly defined and better preserved elements.

E. Its importance in exhibiting particular aesthetic characteristics valued by the community or cultural group.

This criterion is usually difficult to apply to the majority of mining places. Aesthetic value is poorly elaborated generally in the conservation field, and has been seldom used in relation to mining sites, except, for example, in cases where associated buildings have high architectural merit, or associated village settlement has townscape qualities. Questions posed by Jim Kerr in relation to assessing aesthetic significance are relevant to the assessment of this value in relation to mining places:

(a) has the place a considerable degree of unity in its scale, form and materials?

(b) does the place have a relationship between its parts and the setting which reinforces the quality of both?[32]

<u>Guidelines for inclusion of a place under this criterion</u>

There are few examples of the use of this criterion on mining places. A place should be included under this criterion if it:

- is aesthetically distinctive;
- has landmark qualities;
- exemplifies a particular taste or style.

Examples:

- The engine house of the Tasmania Mine at Beaconsfield is included under this criterion because it is one of the finest examples of the architecture of the mining industry in Australia[33].
- The former Great Fingal Mine Office, Day Dawn, near Cue in Western Australia, is one of the finest extant examples of mining industrial architecture in the state[34].
- The Hill End mining village, NSW, has long been regarded as a highly evocative mining townscape, and has been the subject of many artist's works.

<u>Guidelines for exclusion of a place under this criterion</u>

Most mining places are excluded from this criterion.

32 Kerr 1985: 10

33 Bell 1993: 61

34 MacGill 1998: 2-2.

Example:

- The Mount Britton mining field inland from Mackay in Queensland is located in a stunningly beautiful landscape, but the beauty of the setting is not an outcome of the mining, and is not related to mining other than by accidental association. In Kerr's terms, neither the landscape nor the mines contribute significantly to the qualities of the other..[35]. In this example the landscape might be listed for its landscape qualities, but this would have nothing to do with the mine.

F. Its importance in demonstrating a high degree of creative or technical achievement at a particular period.

Guidelines for inclusion of a place under this criterion

This criterion applies only where the place has evidence of specific innovation or technical creativity or achievement particular to that place (eg the place had a seminal impact), or has a particularly good (and perhaps rare) example of an innovation or innovative application of existing technology which is also represented, but in a less important example, at another place.

A place should be included under this criterion if it:

- shows, or is associated with, an important creative or technical innovation or achievement;
- is the inspiration for an important creative or technical innovation or achievement.

Examples:

- The Great Australia Mine in Cloncurry, Queensland, has an early use of waterjacket smelters, one of which survives. The place requires more comparative research before the degree of innovation and technical achievement can be demonstrated, but a prima facie case exists for the use of this criterion at the site[36].
- In Tasmania, examples used have been the Mount Lyell smelters, which were the scene of Australia's first successful experiment in pyritic copper smelting (using components of the ore itself to fuel the smelting process) in 1902, and the Mount Cameron water race, which is a remarkable achievement of hydraulic engineering[37].
- The Mundaring to Kalgoorlie water pipeline and associated pumping stations, while not strictly a mining place, was critical to the operation of mines at Kalgoorlie. It was a major technological innovation and achievement in its day [38]
- The Yalwal mines near Nowra, NSW, have an extensive transport system of tramways, two of which are inclined and connected to large open cuts, the ore in one instance being conveyed to a tunnel through a network of drop shafts. The mining and movement of ore shows a considerable degree of technical innovation, though more comparative research would be needed to demonstrate the level of this significance[39].

---

35 Pearson 1994a: vol 2

36 Pearson 1994b

37 Bell 1993: 61

38 MacGill 1998: 2-3.

39 Andrews 1901

Guidelines for exclusion of a place under this criterion

The criterion does not apply in cases where the place is simply part of a general change in technology demonstrated at numerous other sites (such as the use of reverberatory copper smelters in the 1870s), or where the physical evidence of the technical innovation or achievement is poor or destroyed. The criterion would not be used unless the nature of any claimed technical or creative achievement could be demonstrated.

A place should be excluded under this criterion if it:

- has lost its design or technical integrity;
- it has only a loose association with a creative or technical achievement.

Examples:

- The Roasting Pits at Tambaroora, NSW, are important in demonstrating the range of technologies used on early Australian goldfields, but they drew on long existing technology, and did not show a high degree of technical achievement.
- Mount Chalmers (Great Fitzroy) copper mine, near Rockhampton in Queensland, undertook flotation separation experiments for copper concentrates at a time when Australia was leading the world in this technology. Unfortunately, there is no remaining physical evidence associated with this innovation or the mine where it occurred (due to later open-cutting), so it is excluded from the assessment of the fragmentary surviving remains[40].

G. Its strong or special associations with a particular community or cultural group for social, cultural or spiritual reasons.

This is a difficult criterion to apply in the absence of specific evidence that an association with an identifiable group exists. It is likely to be applied to only a small percentage of mining places. Too often a claim of significance is made under this criterion with no supporting evidence. If asked, representatives of a local community are likely to say that they think a mining place is important, but the demonstration of **'strong and special'** association goes beyond this level of normal feelings of regard for the past.

Guidelines for inclusion of a place under this criterion

The assessor has to demonstrate the existence of a high degree of regard for the place, usually over a sustained period of time, and the feeling of high regard has to be currently held by the community, otherwise it is an historical value only and should be assessed under other criteria. There are ways of addressing this aspect of significance[41], which involve the community itself in the assessment process. In the absence of other clear evidence to support the claim that the community has a strong and special association with a place, it might be necessary to undertake such a consultative process to demonstrate the existence of this value.

A place should be included under this criterion if it:

- is important to an identifiable group for its associations with that group;

40 Pearson 1994a: vol 2

41 see Blair 1993.

- is crucial to a community or identifiable group's sense of place.

Examples:

- The Zeehan School of Mines and Metallurgy in Tasmania, which was for many years the focus of educational and scientific training for Tasmania's mining industry[42].

Guidelines for exclusion of a place under this criterion

Places should not be assessed as meeting this criterion if the community association with them is not above that normal felt for old places, or is demonstrably of very recent origin (such as in response to an unpopular proposed land-use change). Generally, the criterion would not apply if the group valuing the place was very small, or had particular contemporary vested interests in the place (such as a local metal detecting group).

A place should be excluded under this criterion if it:
- is only important to the community for amenity reasons;
- cannot be shown to be crucial to a community or identifiable group's sense of place.

Example:

- In a survey of Queensland mining places a number of places were identified, such as Mount Morgan, Mount Perry, Mount Britton and Cracow mines, which gave rise to adjacent townships. It was believed that there may exist a strong feeling of regard for the mines within the communities of those townships (or among the descendants of former occupants of now-deserted townships), but there was no quantitative or substantial qualitative evidence to support this conjecture. Until such evidence is gathered, the criterion should not be used.

H. Its special association with the life or works of a person, or group of persons, of importance in Australia's natural or cultural history.

Guidelines for inclusion of a place under this criterion

This criterion is rarely used effectively in mining site assessments, as in few cases can 'special' associations between the mine and individuals or groups be demonstrated—every mine has associations with a mining company or manager, and a local mining community, but most are not 'special' associations. The assessment under this criterion should argue why the association between a person or group and the place is more significant that any other association the person or group may have had with any other place.

Places which either retain direct evidence of the association, or where it can be demonstrated that a person's association with the place has affected other notable aspects of the person's life's work, would generally be seen as being more significant under this criterion than places where such evidence did not exist.

A place should be included under this criterion if it can be demonstrated to have special associations with an important individual or group

[42] Bell 1993: 62

Examples:

- The mine manager's residence which was the home of distinguished metallurgist Robert Carl Sticht, general manager of Mount Lyell, Tasmania, from 1897 to 1922[43].
- The Galawa Mine near Rockhampton, Queensland, which was operated by Frederick Morgan, and helped establish the Morgan brothers in Queensland mining prior to their involvement with the opening up of the Mount Morgan deposits[44]. A number of other mining sites subsequently had a special association with the Mount Morgan Company, which held a special place in the history of the state.
- The Ipswich Mines Rescue Station, in Queensland, has been closely associated with the Mines Rescue Brigade, and more generally with the Ipswich coal miners, for over 70 years. The role of the Rescue Brigade in an inherently dangerous industry makes the association a special one, and the group and its functions are important in Queensland's mining history.

Guidelines for exclusion of a place under this criterion

Other than in exceptional cases, transitory association with notable individuals does not confer significance on a place[45]. Sometimes it is tempting to make too much of an interesting association, failing to recognise that, even though an association with a famous person may make for an interesting story in a public interpretation display, heritage assessment must be based on rigorous analysis of the evidence. Peter Bell and others have raised this in relation to the Sons of Gwalia Mine in Western Australia, where Herbert Hoover, later to be President of the United States of America, was mine manager. It was pointed out that 'it would be a mistake to attribute too much personal credit to a 23-year-old engineer backed by a highly competent mining enterprise, remembering also that Hoover was resident at the mine only from May to November 1898'[46]. More recent study of Hoover's influence at Gwalia and in WA generally seem to suggest that he may indeed have had a considerable influence on mining, and that a claim for significance under this criterion might be sustained[47]

A place should be excluded under this criterion if it:

- has incidental or insubstantial associations with an historically important person or group;
- provides evidence of people or groups that are of dubious historical importance;
- has been so altered that it can no longer provide evidence of a particular association.

BIBLIOGRAPHY

Andrew C Ward and Associates, 1994, 'Conservation analysis and management plan: State Coal Mine, Wonthaggi', report for the Historic Places Section, Department of Conservation and Natural Resources, Victoria.

43 Bell 1993: 62

44 Pearson 1994a: vol 2

45 see Kerr 1985: 10-11 for a discussion.

46 State Heritage Branch 1985: 21

47 Hartley, R. 1998. 'A history of technological change in Kalgoorlie Gold Metallurgy 1895-1915', unpublished PhD thesis, Murdoch University.

Andrews, E.C. 1901. *Report on the Yalwal Gold Field*, Geological Survey of NSW, Mineral Resources no. 9, Department of Mines, Sydney.

Australian Heritage Commission, 1990. *Criteria for the Register of the National Estate: Application Guidelines*, Australian Heritage Commission, Canberra.

Australia ICOMOS, 1992. *The Illustrated Burra Charter*, (P. Marquis-Kyle and M. Walker (eds)), Australia ICOMOS, Brisbane.

Bell, P. 1993. 'Historic Minesites in Tasmania', unpublished report for the National Parks and Wildlife Division, Tasmanian Department of Environment and Land Management.

Bickford, A., & Sullivan, S. 1984. 'Assessing the research significance of historic sites', in Sullivan, S. & Bowdler, S., (eds), *Site Surveys and Significance in Australian Archaeology*, Department of Prehistory, Research School of Pacific Studies, Australian National University, Canberra.

Blair, S. 1993. *People's places: Identifying and Assessing Social Value for Communities*, Technical Workshops Series No. 6, Australian Heritage Commission, Canberra.

Davey, C.J. 1986. 'The history and archaeology of the North British Mine site, Maldon, Victoria', in *Australian Journal of Historical Archaeology*, vol. 4, no. 51, p. 56.

Heritage Office of NSW, 1996. *Heritage Assessments*, component of the *NSW Heritage Manual*, Heritage Office, Sydney.

Holmes, K. 1983. 'Excavations at Arltunga, Northern Territory', *Australian Journal of Historical Archaeology*, vol 1; 78-87.

Jack, R. I., & Cremin, A. 1994. *Australia's age of iron: History and archaeology*, Oxford University Press and Sydney University Press, Melbourne.

Kerr, J. S. 1985. *The Conservation Plan*, National trust of Australia (NSW), Sydney.

MacGill, G. 1998. 'A policy and strategy for the conservation of mining heritage in Western Australia', Draft report for the Heritage Council of WA.

McGowan, B. 1992. Aspects of gold mining and mining communities in the Shoalhaven area of New South Wales: An archaeological and historical study', *Australasian Journal of Historical Archaeology*, 10: 43-54.

McGowan, B. 1996a. "The typology and techniques of alluvial mining; the example of the Shoalhaven and Mongarlowe goldfields in southern New South Wales", *Journal of Australasian Historical Archaeology*, Volume 14, 1996, pp 34-45

McGowan, B. 1996b. *Bungonia to Braidwood. An historical and archaeological account of the Shoalhaven and Mongarlowe goldfields*, the author, Canberra

McGowan, B. 1996c. *Lost Mines Revisited, Historic Mining Communities of the Monaro, Southern Tablelands and South West Slopes Districts*, the author, Canberra.

Pearson, M. 1994a. 'Mining Heritage Places Study: Southern and Central Queensland', unpublished report for the Queensland Department of Environment and Heritage.

Pearson, M. 1994b. 'Great Australia Mine and Smelter, Cloncurry: Cultural heritage study', unpublished report for Cloncurry Mining Company N.L.

Pearson, M. & Sullivan, S. 1995. *Looking After Heritage Places: The basics of heritage planning for managers, landowners and administrators*, Melbourne University Press, Melbourne.

State Heritage Branch, Department Of Environment And Planning, 1985, '"Sons Of Gwalia" Gold Mine: A report on the assessment of its heritage significance.' Unpublished report prepared for the Leonora/ Gwalia Historic Site Working Group, by the State Heritage Branch, Department of Environment and Planning, South Australia, Adelaide.

Tainter, J. A. & Lucas, G. J. 1983. 'Epistemology of the significance concept', *American Antiquity* 48 (4): 707-18.

MINING HERITAGE PLACES

ASSESSMENT MANUAL

GUIDELINE 3

A GUIDE TO FILLING IN HERITAGE REGISTER FORMS

GUIDELINE 3

A GUIDE TO FILLING IN HERITAGE REGISTER FORMS

INTRODUCTION

Each State and Territory, the Australian Heritage Commission, and most of the National Trusts develop and maintain registers of heritage places. Places considered for the registers might result from studies and surveys of a particular area or type of place, or they might be nominated by members of the public. In either case forms are used to structure the information for assessment, and to ensure that all relevant information about a place is before the body considering listing.

The register nomination forms differ considerably in their format and in the ordering of required information, but they all call for generally similar information to be provided. This guideline addresses the common blocks of information that have to be provided, and relate this to mining heritage places. The register nomination form appropriate to your needs is available from the relevant heritage agency, listed in the *List of Useful Contacts* in this manual. Each agency can also usually provide a guideline on how to fill in their form.

Be aware that in some states the nomination form is designed with urban properties particularly in mind, as these form a large bulk of many registers. Because of this some information relating to mining sites, especially those in isolated areas, might be more difficult to classify within a fields on a form, and some fields on the form might be irrelevant to the mining site (such as, for example, street address and block and lot number). Ignore what is not relevant, and attach additional important information if the form does not seem to provide an appropriate space for it.

1. NAMING THE PLACE

The place being nominated to a register has to have a name so it can be identified easily within the register. This might seem simple, but often the use of an inappropriate name can lead to considerable confusion at a later date. The name should be specific to the place, and should identify the place without confusion.

In the case of mining heritage places there are a number of approaches, some of them not very successful. A search of place names in the Register of the National Estate demonstrates these variations. The following table gives in column 1 examples of some of the types of names used in register records, and in column 2 a more appropriate name for the place.

Name given	More helpful name
House	Mine Manager's House, Acme Copper Mine
Engine House	Beam engine house at Acme Copper Mine

Mine	Acme Copper Mine
Copper mine chimney	Acme Copper Mine smelter chimney
Miner's Cottage	Miner's cottage, Acme Copper Mine
Acme Complex	Acme Copper Mine and associated sites
The Acme Group	Acme Copper Mine and associated sites

Think carefully about what is being nominated, and use the most straightforward and self-explanatory name. If a mine had two or more names at different times, use the name by which it is best known, or that which applied to the longest or most successful mining venture, but include the other names as additional information. Avoid using a broader term such as 'Acme Copper Field' when the place nominated is just one mine within that larger area.

If the place is formally protected by being reserved under State law, incorporate this status into the place name, such as 'Acme Copper Mine Historic Reserve', or 'State Recreation Reserve', 'Historic Site' etc.

2. LOCATION OF THE PLACE

2.1 Location

Most nomination forms have several ways in which the location of a place can be identified. These usually include;

- Address: Street address is not usually relevant for most mining places
- Map reference: Most useful for mining places. Use a recent topographic map of the largest scale available for the map reference (most desirably 1:25,000, but these are not available for many rural areas), and identify the map on the form. If a Global Positioning System (GPS) has been used to generate the map reference, state this on the form and indicate the known error margins and particular equipment used.
- Distance and direction from nearest town: Useful for mining places, which are usually isolated. Use a map to measure off the straight-line distance in kilometres from the nearest named town or village, and note the direction as N, NE, etc.

For mining places, which are often isolated and difficult to re-locate, it is often useful to provide additional information such as a written description of how to reach the place, with details of the distance and direction from prominent geographical points and the location of roads. While you are doing this, try to imagine yourself following your own directions to locate the place again.

A sketch map with distances and with as many recognisable fixed points as possible: roads (labelled), fencelines, natural landmarks, watercourses, and vegetation changes, for instance, can all help a future worker. Compass bearings can be useful.

2.2 Property information

The noting of property information such Lot and Deposited Plan Number is rarely relevant for mining places, though the rural property name and title description should be noted if relevant. Reference to county, parish and portion information from cadastral plans can be useful, especially where the only topographic maps are at 1:100,000 or 1: 250,000 scale. Cadastral information is available from the Lands departments and their local offices, and from most shire offices. Some editions of 1:25,000 topographic maps are also over-printed with cadastral information.

Some forms ask for ownership details. This might be difficult to identify for some mining places, but should be included where the owner's name is able to be found. Reference to the mine lease number, and whether the mine is on private or crown land can also be useful if it is known.

2.3 Boundaries

When identifying a place for nomination, the assessor should always define a boundary that encompasses the elements that make up the place's values. In the case of mining places this might be the lease boundary, or it might be a series of ridges and creek lines that encircle the mine workings, processing mill and living area. Sometimes the boundary might have to include two or more separate areas which have nothing between them of heritage importance. This might mean defining two separate boundaries, and stating clearly that the place has two or more discrete components.

An example might be a mine site and a water supply dam some distance away, linked only by a single race. The boundary might then be a circle that encompasses all the mine workings, and another boundary encompassing the dam , and a strip 10 metres wide along the length of the race.

The simplest way to define a boundary is to draw it on a map of the place, picking obvious alignments that can be recognised on the ground, such as creek lines, ridges, straight lines connecting prominent features, or simply a circle of a stated diameter from a defined central point.

3. DESCRIPTION OF THE PLACE

Some nomination forms include separate sections for historical information and physical description. Others have only one description field. In both case the description should be broken up into historical and physical description components.

3.1 History

A summary of the historical development of mining activities should be provided. This would be based on the historical documentation as outlined in Guideline 1, *A Guide to the recording and analysis of mining places*, and Guideline 5, *A Guide to the sources* in this manual. The history should include the key dates in the mining history, the historical evidence for the mining process and any mineral processing carried out at the site, and reference to associated historical events, persons, companies and closely associated places. The history should not be limited to the particular aspect of the site thought to be significant, but should also include information about prior and subsequent uses of the place (including Aboriginal occupation where this information is available).

Some forms require the nominated place to be set in a thematic historical context. There are several thematic approaches used, such as the *Principal Australian Historical Themes* developed by the Australian Heritage Commission, and the regional historical themes identified in NSW and SA. The thematic lists should be available from the relevant heritage agency to which the nomination is to be submitted.

Some forms have separate fields for 'year of construction' or 'activity period'. The period of mine operation or processing should be entered here, and this stated as being the period referred to.

3.2 Physical description

The physical description of the mining place should include:

- A clear description of what the place is, and its major features. For example, if it is a mining site, the number and nature of shafts, adits, open-cuts, mullock dumps and headframes, tramways, and associated processing works, building sites, dams, roads etc. Any surviving machinery and equipment should be identified and listed;
- The extent of the place; for example, the distance between elements if widely scattered, and the overall general dimensions of the place;
- A plan of the place and/or its main features. The inclusion of historical plans can help explain changes over time.
- A description of the place in relation to surrounding geography and environment; for example, a mine's relationship to timbered land, water courses, historical settlements etc.

This information should be backed up by a site plan and photographs (see below). Guideline 1, *A Guide for the recording and analysis of mining places* describes how to create site plans and gather the relevant information.

The description should concentrate in particular on those elements of the place that make it of heritage significance. Some forms have separate fields that seek information solely about significant fabric. The type profiles provided at the end of this Manual should be referred to, as provide useful comparative information that should help to identify physical features and assess there significance.

4. CONDITION AND INTEGRITY

Not all forms include a separate section to describe condition and integrity, and if there is none this information should be included in the physical description section.

'Condition' refers to the physical condition of the elements that make the place important. Note, for example, whether the headframe or buildings are in good condition or are in ruin, or whether the alluvial workings are eroded or clearly show mining faces.

'Integrity' refers to the degree of completeness of the elements that make the place significant. Note, for example, whether the crushing machinery, winding engine and headframe are intact or have been removed; or whether the ore body has been open-cut by subsequent operations, removing earlier important mining evidence, or mullock dumps have been removed for reprocessing; or whether any miner's huts or hut sites can be identified.

Loss of integrity, in particular, can substantially reduce a place's heritage significance (see *Guide to the assessment of mining heritage places* for examples).

5. OTHER HERITAGE LISTINGS

Most forms seek information about other listing in heritage registers or surveys. This is to check for useful information contained in other records, and to ensure some conformity of assessment processes. The assessor should check whether the place has been identified in any of the following registers:

- Register of the National Estate
- State or Territory heritage register
- State or Territory National Trust Register
- Local or regional planning scheme (where they exist)

Also indicate if the place is within land reserved by State or Territory law for environmental, recreation or historic protection, such as:

- National Park
- Nature Reserve
- Conservation Park
- Historic Site
- Historic Reserve
- Recreation Reserve

A *List of key contacts* is provided in this manual, and a list of internet sites that can assist in this search is provided in the *Guide to the Sources.*

6. STATEMENT OF SIGNIFICANCE

The statement of significance is the most important part of the nomination, in that it says exactly why the place is important, and why it should be listed in a heritage register. The important rule in writing statements of significance is to concentrate on those historical, social and physical elements of the place that have been assessed as making the place special when compared with other places. The statement should be short in length and very focussed, and their is a skill in writing them that has to be learnt.

The objective is to encapsulate **why** the place is important, **not** to restate the history or description of the place. As an example, the statement "The Acme Mine produced 100,000 tons of copper between 1884 and 1901" is simply a statement of fact, with no reference point to say whether that fact makes the place important or not. The statement "The Acme Mine, one of the largest producers of copper in Australia before federation and the only major copper mine in the state, is also one of the most intact mine sites in northern Australia" says why the place is important—it is historically important and it is rare because to its intactness. The first statement should be in the description part of the nomination, while the second should be part of the statement of significance.

The statement of significance should only include statements about those aspects of the place that are important. Information about aspects that are not significant should be excluded from this section, but included in the description section of the form. A mine might be important for a variety of reasons:

- the mine had an important influence on Australia's history;
- the mine is rare or uncommon (based on adequate comparative information), either because it was an unusual example of the method of exploitation of that mineral, say, or because it has survived where others of it type have not;
- the mine demonstrates to an unusual extent, through well preserved evidence of mining, the characteristics once common of that mining type;
- the mine site has evidence that, through archaeological or technological research, might provide important information not available in other sources;
- the mine site has elements that are valued for their aesthetic qualities, such as outstanding examples of mining architecture or landscape quality;
- the mine demonstrates in its surviving remains evidence of mining technology or processes of high technical or creative achievement, compared with other places;
- the mine has strong and special associations and is demonstrated to be highly valued by a particular group or community;
- the mine is directly associated with the work or life of important historical figures or groups.

All heritage listing agencies use criteria echoing the dot points above, to provide a context within which the significance of the place is assessed. Guideline 2, a *Guide to the assessment of mining heritage places* outlines how these criteria relate to the assessment of mining heritage places. Guideline 2 is a good starting point in understanding how to explain the significance of your site.

Some forms have one section for the writing of a statement of significance, while others have two sections, one for a brief statement of significance, and another for a more detailed statement against each of the assessment criteria used in that State or Territory. In all cases the statement of significance should state succinctly why the place is of heritage importance, and what are the specific aspects of the place that make it important. The information supporting the statement of significance should be included in part of the form outlining the historical and physical description of the place.

7. BIBLIOGRAPHY / REFERENCES

The sources for historical, physical and social description of the place and its assessment should be listed in the bibliography or references section of the form. The sources listed should be specifically relevant to the place, not simply of peripheral interest. Sources listed should include any of the historical documents referred to in the 'history' section; any reports or studies of the place carried out by the assessor, or others at an earlier time; the names of key oral informants interviewed for the recording of the place; and any historical photographs, drawings, paintings and plans providing original important evidence.

A standard format for references should be used, such as:

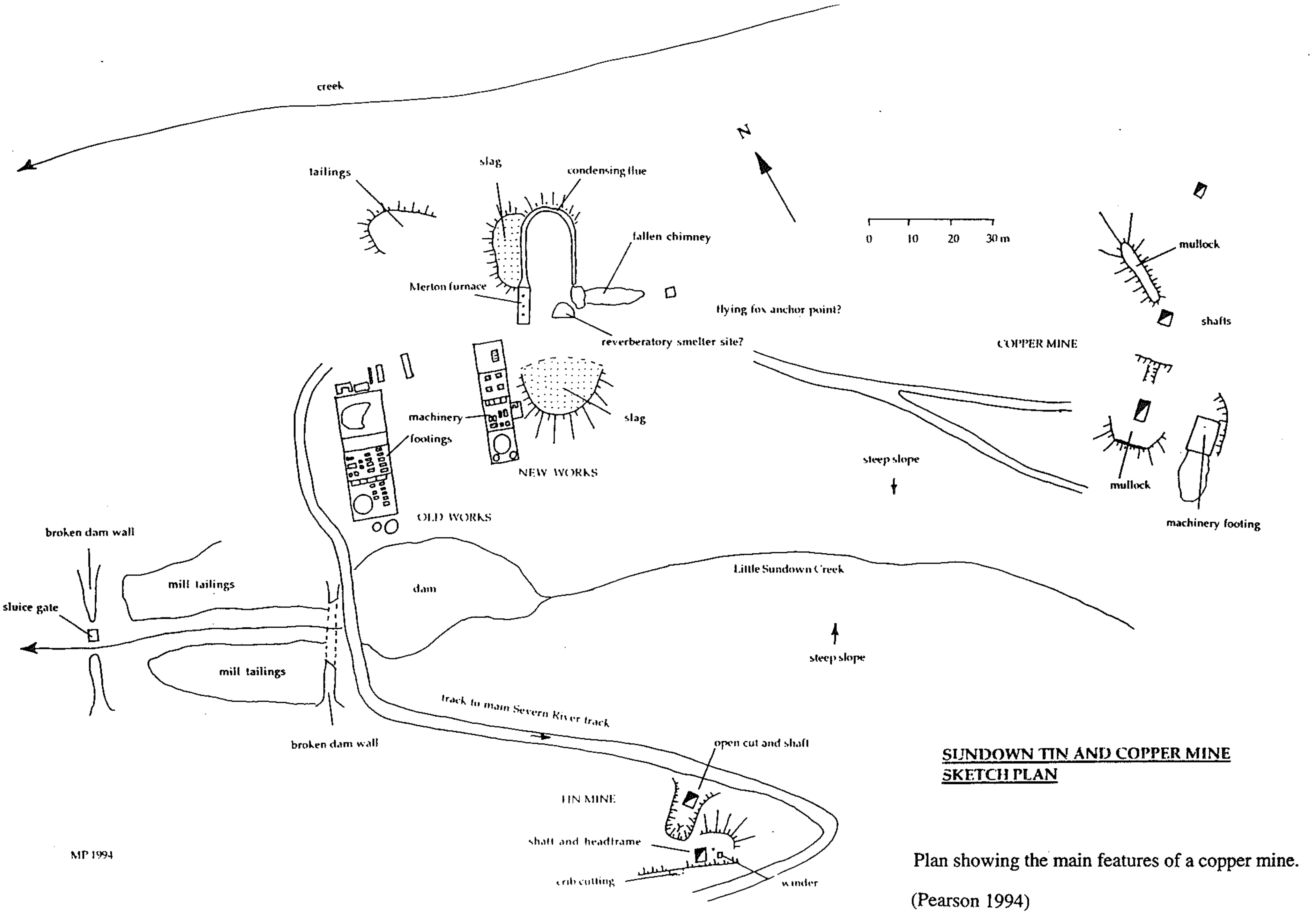
Blainey, G. 1954. *The Peaks of Lyell*, Melbourne University Press, Melbourne.

Reid, J. H. 1944. 'Peak Downs Copper Lode, Clermont', *Queensland Government Mining Journal*, Vol. 45, pp. 33-35.

8. MAPS AND PHOTOGRAPHS

The nomination should be accompanied by the site plan prepared as part of the place recording (see Guideline 1, *A Guide to the recording and analysis of mining places*), and any other plans or maps, historical or recent, that add to the understanding of the significance of the place. The set of the most informative photographs taken during the recording of the place should be included, and copies of any historical photos that are essential to the understanding of the place or changes to it over time.

An example of a site plan is attached at Figure 1.



Plan showing the main features of a copper mine.

(Pearson 1994)

MINING HERITAGE PLACES

ASSESSMENT MANUAL

GUIDELINE 4

A LIST OF KEY CONTACTS

GUIDELINE 4

A LIST OF KEY CONTACTS

HERITAGE AGENCIES	Address	Postal Address
Australian Heritage Commission	Administration Building King Edward Terrace PARKES, ACT ph. (02) 6274 1111	GPO Box 787 CANBERRA, ACT 2601 http://www.ahc.gov.au
ACT Heritage Council	Level 1 Homeworld Building TUGGERANONG ph. (02) 6207 2161	PO Box 1036 TUGGERANONG, ACT, 2901 http://www. act.gov.au/environ
NSW Heritage Office	Level 11 Signature Tower, 2-10 Wentworth St' PARRAMATTA ph. (02) 9635 6155	Locked Bag 5020 PARRAMATTA, NSW, 2124 http://www.heritage.nsw.gov.au/
Heritage Conservation Branch, Northern Territory	41 Smith St DARWIN ph. (08) 8924 4055	Department of Lands, Planning and Environment GPO Box 1680 DARWIN, NT, 0801 http://www.nt.gov.au/dlpe/
Cultural Heritage Branch, Queensland	160 Ann St BRISBANE ph. (07) 3227 7691	Department of Environment PO Box 155 BRISBANE ALBERT STREET, Qld, 4002 http://www.env.qld.gov.au/environment
Heritage South Australia	5th floor Australia House 77 Grenfell St ADELAIDE ph. (08) 8204 9299	Department of Environment, Heritage and Aboriginal Affairs GPO Box 1047 ADELAIDE, SA, 5001 http://www.dehaa.sa.gov.au/
Tasmanian Heritage Council	134 Macquarie St HOBART ph. (03) 6233 2037	GPO Box 618 HOBART, Tas, 7001

Heritage Victoria	Nauru House, Level 22 80 Collins Street MELBOURNE ph. (03) 9655 6519	Nauru House, Level 22 80 Collins Street MELBOURNE Vic, 3000 http://www.doi.vic.gov.au/
Heritage Council of Western Australia	108 Adelaide Terrace PERTH ph. (08) 9221 4177	PO Box 6004 EAST PERTH, WA, 6892 http://www.heritage.wa.gov.au/

MINES DEPARTMENTS	Address	Postal Address
Australian Geological Survey Organisation	Cnr Jerrabomberra Ave and Hindmarsh Drive Symonston, ACT ph. (02) 6249 9111	GPO Box 378 CANBERRA, ACT, 2601 http://www.agso.gov.au
New South Wales Department of Mineral Resources	29-57 Christie St St LEONARDS ph. (02) 9901 8888	PO Box 536 St LEONARDS NSW, 2065 http://www.slnsw.gov.au/ILANET/clients/mineral_resources/
Northern Territory Department of Mines and Energy	Centrepoint Building Smith Street Mall Darwin ph. (08) 89995511	GPO Box 2901 DARWIN NT 0801 http://www.dme.nt.gov.au/
Queensland Department of Mines and Energy	61 Mary Street, Brisbane ph. (07) 3237 1660	GPO Box 194 BRISBANE Qld, 4001 http://www.dme.qld.gov.au/
Mines and Energy Resources, South Australia	101 Grenfell St ADELAIDE ph. (08) 8226 0222	PO Box 2355 ADELAIDE SA 5001 http://www.mines.sa.gov.au/
Mineral Resources Tasmania	30 Gordons Hill Rd ROSNY PARK ph. (03) 6233 8333	PO Box 56, ROSNY PARK Tasmania, 7018 http://www.mrt.tas.gov.au/

Natural Resources and Environment, Victoria, Minerals and Petroleum Branch	Level 8 240 Victoria Parade EAST MELBOURNE ph. (03) 9412 5145	PO Box 500 EAST MELBOURNE Vic, 3002 http://www.nre.tas.gov.au/
Department of Minerals and Energy, Western Australia	Mineral House 100 Plain Street (cnr Adelaide Terrace) EAST PERTH (08) 9222 3333	Mineral House 100 Plain Street EAST PERTH WA 6004 http://www.dme.wa.gov.au/

NATIONAL TRUSTS	Address	Postal Address
Australian Council of National Trusts	14/71 Constitution Avenue CAMPBELL, ACT ph. (02) 6247 6766	PO Box 1002 CIVIC SQUARE ACT, 2608 http://www.austnattrust.com.au/
National Trust of Australia (ACT)	cnr Stuart and Light Sts GRIFFITH, ACT ph. (02) 6239 5222	PO Box 3173 MANUKA ACT, 2603
National Trust of Australia (NSW)	Observatory Hill SYDNEY ph. (02) 9258 0123	Observatory Hill SYDNEY NSW, 2001 http://www.tandem.aust.com/nationaltrust/
National Trust of Australia (NT)	Burnett House 4 Burnett Place MYILLY POINT (08) 8981 2848	GPO Box 3520 DARWIN NT 0801
National Trust of Queensland	Old Government House George St BRISBANE ph. (07) 3229-1788	GPO Box 9843 BRISBANE Qld, 4001
National Trust South Australia	452 Pulteney Street ADELAIDE (08) 8223 1655	452 Pulteney Street ADELAIDE SA, 5000

National Trust of Australia (Tasmania)	413 Hobart Road Franklin Village LAUNCESTON ph. (03) 6344 6233	PO Box 711 LAUNCESTON Tas, 7250 http://www.tased.edu.au/tasonline.nattrust/
National Trust of Australia (Victoria)	Tasma Terrace 4 Parliament Place EAST MELBOURNE ph. (03) 9654 4711	Tasma Terrace 4 Parliament Place EAST MELBOURNE Vic, 3002 http://www.vicnet.net.au/~nattrust
National Trust of Australia (WA)	The Old Observatory 4 Havelock Street WEST PERTH ph. (08) 9321 6088	The Old Observatory 4 Havelock Street WEST PERTH WA 6005

STATE LIBRARIES	Address	Postal Address
National Library of Australia	Parkes Place PARKES, ACT Ph. (02) 6262 1111	National Library of Australia CANBERRA ACT 2600 http://www.nla.gov.au/ (web catalogue access)
State Library of New South Wales (& Mitchell Library)	Macquarie Street SYDNEY ph. (02) 9273 1414	Macquarie Street SYDNEY NSW 2000 http://www.slnsw.gov.au/
Northern Territory Library	Parliament House DARWIN ph. (08) 8999 7177	Parliament House DARWIN NT, 0800 http://www.nt.gov.au/ntl/
State Library of Queensland (& John Oxley Library)	Cnr Peel & Stanley Streets SOUTH BRISBANE ph. (07) 3840 7881	Peel & Stanley Streets SOUTH BRISBANE Qld, 4101 http://www.slq.qld.gov.au/
State Library of South Australia (& Mortlock Library)	North Terrace ADELAIDE ph. (08) 8207 7200	North Terrace ADELAIDE SA, 5000 http://www.slsa.sa.gov.au/ (web catalogue access)

State Library of Tasmania	91 Murray Street HOBART ph. (03) 6233 7463	91 Murray Street HOBART Tas, 7000 http://www.tased.edu.au/library/library/htm
State Library of Victoria	328 Swanston Street MELBOURNE ph. (03)9669 9824	328 Swanston Street MELBOURNE Vic, 3000 http://www.slv.vic.gov.au/ (web catalogue access)
Library and Information Service of WA (Alexander Library)	Alexander Library Building Perth Cultural Centre PERTH ph. (08) 9427 3111	Alexander Library Building Perth Cultural Centre PERTH WA. 6000 http://www.liswa.wa.gov.au/ (web catalogue access)

GOVERNMENT ARCHIVES	Address	Postal Address
National Archives of Australia	Queen Victoria Terrace PARKES (Canberra) ph. (02) 6212 3600	PO Box 7425 CANBERRA MAIL CENTRE ACT, 2610 for State offices, see web site http://www.aa.gov.au
Registry Department of Public Administration (ACT Archives)	23 Mildura St FYSHWICK, ACT ph. (02) 6207 5921	GPO Box 158 CANBERRA ACT, 2601
Northern Territory Archives Service	25 Cavenagh Street DARWIN ph. (08) 8924 7677	GPO Box 874 DARWIN NT, 0801
Archives Authority of NSW	2 Globe Street The Rocks SYDNEY ph. (02) 9237 0254	2 Globe Street The Rocks SYDNEY NSW, 2000 http://www.records.nsw.gov.au
Queensland State Archives	435 Compton Road RUNCORN ph. (07) 3875 8755	PO Box 1397 SUNNYBANK HILLS Qld, 4109 http://www.archives.qld.gov.au

State Records, South Australia	Reading Room Netley Commercial Park Complex BLAIR ATHOL WEST ph. (08) 8226 800	PO Box 1056 BLAIR ATHOL WEST SA, 5084
Archives Office of Tasmania	77 Murray Street HOBART ph. 03 6233 7488	77 Murray Street HOBART Tas, 7000 http://www.tased.edu.au/archives/archives.htm
Public Record Office Victoria	Level 2, Casselden Place, 2 Lonsdale Street, MELBOURNE ph. (03) 9285 7999.	PO Box 1156 SOUTH MELBOURNE Vic, 3205 http://www.vicnet.net.au/~provic/
Public Records Office of WA	Alexander Library Building Perth Cultural Centre PERTH ph. (08) 9427 3360	Alexander Library Building Perth Cultural Centre PERTH WA. 6000 http://www.liswa.wa.gov.au/pro.html

MINING HERITAGE PLACES

ASSESSMENT MANUAL

GUIDELINE 5

A GUIDE TO THE SOURCES

GUIDELINE 5

A GUIDE TO MINING SOURCES

CONTENTS

1. DISCUSSION OF THE SOURCES

There are a number of key sources for information about mining heritage sites.

The **Department of Mines publications** for each State are particularly useful. These include their *Annual Reports* which list mining activities in each state by mining district, and surveys of mining fields and mineral types, which often appear in a *Geological Survey* Bulletin or report series. For example, in New South Wales the first Annual Report was published in 1875 and in South Australia six monthly reports commencing in 1905 were published under the heading *Review of Mining Operations for the State of South Australia.* In Victoria, *Quarterly Reports of the Mining Registrars* were also published. Also of use are Government journals such as the *Queensland Government Mining Journal.*, and in Victoria the *Mining and Geological Journal.* Mines Department publications are only represented in the Bibliography presented below by a few examples of key reports, as there are many dozen such reports covering the mineral fields and mineral types in each state, which have often been resurveyed at regular intervals. The Mines Department reports are kept in each State in the library of the respective mines department or its local equivalent.

They are also housed in the State Libraries in each State and Territory. In both cases you are likely to find an index system that helps search reports by mineral and mining field or individual mine. The library catalogue of the Australian Geological Survey Organisation (AGSO) is available on the internet, and is listed in Part 3 of the bibliography.

Many **Mines Department libraries**, which are usually located in the capital cities and sometimes have regional offices, also have a file system that contains information, including unpublished reports on individual mines. In some states (such as NSW) the older mining records have been transferred to the State Archives, and have to be accessed there. The Mines Department Librarian should be a good source of information on how to use the library, and where other information might be located.

The **local histories** for a district will often provide an overview of mining activities, and sometimes include a bibliography that can be helpful. Some local histories are listed in the Selected Bibliography below, but many thousands have been produced, and the best place to look for them is your local or regional library, and through the local historical society. Guides to local history collection have been published in a number of states, and can be accessed via local libraries. Some are included in this bibliography.

Local histories are often very good, but many repeat local myth and hearsay without providing any reference to original sources to back up dubious historical assertions. If reliable references for information are not provided, it is always wise to try to track down the primary source of the information, and if none exists to treat the information with caution.

Local historians, long term residents and former miners are usually a useful source of information, and often have strong associations with local mining sites. The local historical society is often a good starting point in identifying useful contacts. A list of historical societies and other contacts such as museums and collections are provided in *Into History: The Australian Historical Directory* compiled by Ralph and Amy Reid, listed in the general part of the Bibliography below.

Oral history information can be a most useful source, especially in the case of places which operated in living memory, but establish the informant's association with the place and judge whether their information is based on personal experience or is repeating other oral or written sources. If the latter is the case, the reliability of the information may be greatly reduced. Many field researchers have had their own published work quoted back to them as 'oral history'! However, very helpful guides (such as Robertson 1995, listed below) are available which outline how to approach oral history interviews, and avoid or recognise the potential traps, and good oral history is sometimes all the historical information that will be available for a mining place. Oral history also provides insights into how people were associated with mining, whereas most official reports of mining are dry stuff from the point of view of the human story.

The technology to be seen and recorded on mining sites is often complex and confusing. Understanding the technology is very much assisted by **old manuals and guidebooks** about mining equipment and techniques. A number of these are listed in the bibliography below. They are often hard to find in libraries, but it is worth trying to locate those relevant to the mining type you are recording if you are not familiar with the equipment and techniques being used. The *Australian Town and Country Journal* and *Australian Mining Standard* also gave particular attention to technical aspects of mining.

A range of **newspapers and periodicals** contain information about mining places. Runs of back copies, or microfiche copies of the local newspaper is sometimes held by the local historical society. If not, a useful listing of surviving newspapers in Australian libraries is the National Library of Australia's *Newspapers in Australian Libraries, a Union List, Part 2, Australian Newspapers* (Canberra 1975), which is held by many regional and all State libraries.

One of the most useful periodicals is the *Australian Town and Country Journal.* First published in 1870 this weekly journal ran until 1919, and had a section dedicated to mining developments and is often an invaluable source when others are silent. Other weekly illustrated journals included the *Queenslander* (1866-1939) and the *Illustrated Sydney News* (1853-1894). Also of use are the *Australian Mining Standard and Australian Mining* (originally published in 1908 as the *Australian Mining and Engineering Journal*) and the *Proceedings of the Australian Institute of Mining and Metallurgy*, and the *Australian Mining History Association*, the first proceedings of its first conference being published in 1998.

In Victoria and NSW the early mining records (especially before the creation of Mines Departments in 1874 and 1875 respectively), and Parliamentary inquiries on mining matters are incorporated into the **Parliamentary Papers** for each colony. Parliamentary papers can also be major sources in the other States, but they are usually a supplementary source rather than a starting point for site-based research. The Parliamentary Papers are found in the State Libraries and in some university libraries.

Maps and plans can be of great assistance in locating mining sites and understanding the landscape, transport routes, changes in mine layout and extent of development of an area at the time of mining. Again, local histories often contain old maps, and the local historical society, state lands or planning department offices, and local council chambers often hold relevant maps, including current and past topographic maps, cadastral maps, and many Mines Department reports contain site-specific maps and plans of mines and mills. Geological maps produced by the state departments of mines or lands identify not only mineral occurrences, but also many mine locations, and are usually accompanied by an explanatory booklet that contains more relevant information. **Aerial photographs** are also a valuable tool, and for some areas air photos exist taken as early as the 1930s and 40s. The National Library of Australia in Canberra, and the State Libraries and/or Lands Departments hold full runs of the air photos series.

There is a growing literature of **published and unpublished reports** on mining places, undertaken as part of environmental impact assessments and heritage surveys of various kinds. The State Heritage Council offices and their libraries can usually help in providing advice about past mining heritage assessments, assessment guidelines relevant to that State, and reports published by the Heritage and planning departments. They can also indicate what mining sites have already been listed on the State's **Heritage Registers**. The Australian Heritage Commission's Register of the National Estate and HERA bibliographic database are also good sources of information, and are listed below among the internet resources. The published and unpublished reports might relate to the mining place being recorded, or there might be studies of similar places, from which an overview of the mining or treatment process might be gained, or useful references obtained. Such comparative studies can also assist in judging the relative significance of a particular place.

Photographs are an often under-utilised source of valuable information about mining places. While historic photos are usually included in local histories, they are more often provided as simple illustration rather than being analysed for the information they contain. Photos are documents in the same way that written reports are, and they often show details that escape other forms of documentation. The local historical society usually has a photographic collection, as have the State Libraries and Mines Departments. Davis and Boyce's *Directory of Australian Pictorial Resources* (1981) is a guide to the location of collections, and Davies and Stanbury's *The Mechanical Eye in Australia* (1985) lists many hundreds of photographers operating in Australia in the nineteenth century. Other forms of pictorial representation, such as **paintings and drawings**, are much less common for mining places than photographs, but they should be sought and analysed if they exist. One source of drawings is the illustrated newspapers, described above, which contain engravings that can be extremely useful.

Manuscripts and other original documents can be useful in elaborating the history of a mining place, though the searching of archival collections is a far more difficult and at times frustrating task than other forms of library research. Local historical societies often hold original manuscripts, or copies of manuscripts held by State Libraries relevant to their area. State and Commonwealth Archives authorities hold the government archives, including in some cases the earlier mines department archives and records of defunct mining companies. Non-government archives, including some business archives of mining companies, are held by a number of repositories. A list of the government Archives offices is included in the *Contacts List* in this manual, and internet addresses for directories of archives and archive holdings, and non-government archives repositories, are to be found in Part 3 of this Guide.

2. SELECTIVE BIBLIOGRAPHY OF PUBLISHED SOURCES

This bibliography concentrates on key references, major or representative histories of mining fields, and sources that are more likely to be readily available. It is meant to be used as a starting point, rather than the sole source of information. Unpublished reports and conference papers have been kept to a minimum, as they are usually hard to get hold of. However, such sources often give the best information about a site, and summarise previous work, and so the key ones are included. Reports are also necessary for more intensive research, and more examples are to be found in the other bibliographies listed below. It should be noted, however, that the earlier publications are sometimes the most useful from the viewpoint of mining typologies and technologies.

In many cases we have cited the most comprehensive or most recent source of information for a particular mineral or area, and not the many earlier or sometimes less comprehensive sources. This is because the cited source usually has within it all the relevant references needed by a researcher to follow up the particular site or field of interest to them.

GENERAL REFERENCES

Mining bibliographies and research guides—Australia Wide

(see State-specific references under each State heading below)

Anderson, C. 1916, *Bibliography of Australian mineralogy*, Mineral Resource Bulletin No 22, Department of Mines, Sydney

Davies, M. 1997. *A bibliography of Australian mining history*, Australian Mining History Association, Department of Economics, University of Western Australia, Nedlands (Also available on the internet; see below for internet addresses)

Davies, A. & Stanbury, P. 1985. *The mechanical eye in Australia: 1841-1900*, Oxford University Press, Melbourne.

Davis, M. & Boyce, H. *Directory of Australian pictorial resources*, Centre for Environmental Studies, University of Melbourne, Melbourne.

Henning, G.R. 1987. 'Mines and mining', in Borchardt D.H. and Crittenden, V. (eds), *Australians: a guide to sources*, Fairfax, Syme and Weldon Associates, Sydney, pp. 261-70.

Jack, I, 1983. 'Sources for industrial archaeology in Australia', in Birmingham, J., Jack, I, & Jeans, D. *Industrial archaeology in Australia: rural industry*, Heinemann, Richmond Victoria.

National Library of Australia, 1997. *Australia's oral history collections: a national directory*, National Library of Australia, Canberra. (also available on the internet, at the National Library's home page listed later in this guide).

Reid, R. and A. 1996. *Into history: the Australian historical directory*, R.s and A. F. Reid, North Ryde. (available from the authors at 1 Ian Street, North Ryde, NSW, 2113)

Robertson, B. M. 1995. *Oral history handbook*, Oral History Association of Australia (South Australian Branch), Adelaide. (available from Oral History Association of Australia, South Australian Branch, c/o Beth Robertson, Institute Building, 122 Kintore Av. Adelaide, 5000)

White, O. Schwirtlich, A-M. and Nash, J. 1983. *Our heritage: a directory to archives and manuscript repositories in Australia*, Australian Society of Archivists, Canberra. (also available as an updated version on the internet; see below for internet address)

Australia-wide, and useful general mining references

Alexander, J. and Hattersley, R. 1981. *Australian mining, minerals and oil*, David Ell Press, Sydney.

Australasian Institute of Mining and Metallurgy, 1924. *An outline of mining and metallurgical practice in Australia*, Empire mining and Metallurgical Congress, London.

Blainey, G. 1981. *The rush that never ended*, Melbourne University Press, Carlton..

Clark, D. 1904. *Australian mining and metallurgy*, Critchley Parker, Melbourne.

Donovan and Associates, 1995. 'A mining history of Australia', Part 1 of the National Mining Heritage Research Project for Australian Council of National Trusts.

Fahey, C. and McCarty, J.W. 1987. 'Mining', in G. Davison, J. McCarty and A. McLeary (eds), *Australians: 1888*, Fairfax, Syme and Weldon Associates, Sydney, pp. 168-83.

Freeman, G.B. and F.C. Mathieson and Sons, 1896. *Australian mining manual*, Effingham Wilson, London.

Gaudin, A. M. 1932. *Flotation*, McGraw Hill.

Gordon, H.A. *Mining machinery and treatment of ores in Australian colonies*, New Zealand Government Printer, Wellington, 1889.

Gordon, H. 1894, *Mining and engineering and miners guide*, Govt Printer, Wellington.

Green, F. (ed.), 1953. *Extractive metallurgy in Australia: non-ferrous metallurgy*, Australasian Institute of Mining and Metallurgy, Parkville.

Hooper, R Pitman and Black, A.B. (eds.), *Mining methods in Australia and adjacent territories*, Australian Institute of Mining and Metallurgy, Melbourne, 1953.

Light Railways, Journal of the Light Railway Research Society of Australia—a good source for information about mining tramways and railways.

Lock, C. G. W. 1890. *Mining and ore-dressing machinery*, E & F. N. Spon, London.

McCulloch, G. and Campbell-Futers, T. 1912. *Winding engines and winding appliances*, Edward Arnold, London.

Milner, P. 'The identification of mining relics', in *Historic Environment*, vol. 7, no. 1, 1989, pp. 13-20.

Mouat, J. 'The development of the flotation process: technological change and the genesis of modern mining, 1898-1911', in *Australian Economic History Review*, vol. 36, no.1, March 1996, pp. 3-31

Norrie, A.W. (ed.), *Australian mining and metallurgy: miscellaneous features and practices*, Australian Institute of Mining and Metallurgy, Melbourne, 1953.

O'Hare, C.W. 1971. 'A history of mining law in Australia', in *Australian Law Journal*, vol. 45, June 1971, pp. 281-93.

Parbo, A. 1992. *Down under: mineral heritage in Australasia. An illustrated history of mining and metallurgy in Australia, New Zealand, Fiji and Papua New Guinea*, Australasian Institute of Mining and Metallurgy, Parkville.

Peele, R. (ed). 1918. *The mining engineers handbook*. John Willey and Son, New York, various editions.

Prider, R. T. 1979. *Mining in Western Australia*, University of Western Australia Press, Nedlands.

Prior, S. H. 1890. *Handbook of Australian mines*, Sydney .

Pulleine, F.A. *The Australasian mining directory* , F.A. Pulleine, Adelaide, 1888.

Ritchie, N.A. 1981. 'Archaeological interpretation of alluvial gold tailing sites', *New Zealand Journal of Archaeology*, 3: 51-70.

Ritchie, N. A. 1991. 'Is there an optimum system?: The recording and assessment of historic mining sites', *Australian Journal of Historical Archaeology*, 9: 37-44.

Ritchie, N. A. & Hooker, R. 1997. 'An archaeologist's guide to mining technology', *Australasian Historical Archaeology*, 15: 3-29.

Wilson, E. B. 1907. *Hydraulic and placer mining*, John Wiley and Sons, New York.

New South Wales and the Australian Capital Territory

Australian Mining Standard, *The mines and minerals of New South Wales*, Australian Mining Standard, Sydney, 1906.

Eslick, C.Hughes, J. and Jack, R. I. 1987. *Bibliography of New South Wales local history, & New South Wales Directories 1828-1950: a bibliography*, New South Wales University Press, Kensington.

McGowan, B. 1996. *Lost mines revisited, historic mining communities of the Monaro, Southern Tablelands and South West Slopes districts*, the author, Canberra.

Pittman, E. F. 1901. *The mineral resources of New South Wales*, Geological Survey of NSW, Department of Mines, Sydney.

Royal Australian Historical Society, *Research tools for local and family historians*, Technical Information Service Bulletin No. 19, RAHS, Sydney. (other Bulletins in this series address researching different sources)

Solomon, R.J. *The richest lode*, Hale & Iremonger, Sydney, 1988.

Trickett, G. 1919. *Bibliography of the economic minerals of New South Wales*, Mineral Resources No 28, Department of Mines, Sydney

Northern Territory

Donovan, P.F. 1981. *A land full of possibilities; A history of South Australia's Northern Territory*, University of Queensland Press, St Lucia.

Jones, T.G. 1987. *Pegging the Northern Territory: a history of mining in the Northern Territory, 1870-1946*, Department of Mines and Energy, Darwin.

Mills, C. M. 1977-83. *A bibliography of the Northern Territory: monographs*, Canberra College of Advanced Education Library, Canberra. 5 vols.

Queensland

Ball, L.C. 1915. *The Etheridge mineral field*, Geological Survey of Queensland, Publication No 245, Department of Mines, Brisbane.

Bell, P. 1984. *Timber and Iron - Houses in North Queensland mining settlements, 1861-1920*, University of Queensland Press, St Lucia.

Bolton, G. C. 1972. *A thousand miles away- A history of North Queensland to 1920*, Australian National University Press, Canberra.

Dunstan, B. 1913. *Queensland mineral index and guide*, Geological Survey of Queensland Publication No. 241, Department of Mines, Brisbane.

Jack, R.I. 1888. *The mineral wealth of Queensland*, Warwick Sapsford, Brisbane.

Jane Lennon and Associates, 1996. 'Mining heritage places study: northern and western Queensland: identification, assessment and documentation of cultural heritage significance', report for the Queensland Department of Environment. 5 vols.

Johnston, W. R. 1981. *A bibliography of Queensland history*, Library Board of Queensland, Brisbane.

Johnston, W.R. 1982. *The call of the land - a history of Queensland to the present day*, Jacaranda Press, Milton, Queensland.

Kennedy, K. (ed.), 1980-82. *Readings in North Queensland mining history*, Vols. 1 and 2, James Cook University, Townsville.

Kerr, R. S. 1979. *John Moffat's empire: a mining history of the Cairns hinterland 1880-1918*, J.D. and R.S. Kerr, St Lucia.

Kerr, R. S. 1992, 'Queensland historical mining sites study', Report for the Department of Environment and Heritage, Brisbane, 4 Vols.

MacLaren, J. M. 1901. *Queensland mining and milling practice*, Geological Survey of Queensland Publication No. 156, Brisbane.

Pearson, M. 1994. 'Mining heritage places study: Southern and Central Queensland', Report for the Queensland Department of Environment and Heritage. 2 vols.

Saint-Smith, E. C. 1914. *Geology and mineral resources of the Stanthorpe, Ballandean and Wallangarra districts, Southern Queensland*, Geological Survey of Queensland Publication No. 120. Brisbane.

Walker, M. I. 1975. *North Queensland towns and districts bibliography*, Libraries Board of Queensland, Brisbane.

South Australia

Austin, J.B. 1968. *The Mines of South Australia including also an account of the smelting works in that colony*, Advertiser and Chronicle Office, Adelaide, 1863. Libraries Board of South Australia, facsimile no. 48, (1968).

Brown, H.Y.L. *Record of the mines of South Australia*, Government Printer, Adelaide, 4 eds. 1887, 1890, 1899, 1908 and subsequent reprints.

Drew, G.J. 1987. *Australia's earliest mining era and its effect on land survey and settlement*, South Australian Department of Mines and Energy, Parkside.

Drew, G. J. & Connell, J. E. 1992. *Cornish beam engines in South Australian mines*, Special Publication No. 9, Department of Mines and Energy, South Australia.

Jack, R.L. 1916. *The Yundamutana mining field*, the Geological Survey of South Australia, Report No 3, Department of Mines, Adelaide

Johns, R.K. 1901. 'Mineral exploration and development in SA 1836-1991', in *Mineral Industry Quarterly*, No. 64, Sept, pp. 21-33.

O'Neil, B. 1982. *In search of mineral wealth: The South Australian Geological Survey and Department of Mines to 1944*, Special Publications No. 2, Department of Mines and Energy, Adelaide.

Selby, J. (ed.), 1987. *South Australia's mining heritage*, South Australian Department of Mines and Energy/Australasian Institute of Mining and Metallurgy, Special Publication No. 7, Adelaide.

Teesdale-Smith, E.N. 1959. *Bibliography of South Australian geology*, Department of Mines, Adelaide.

Tasmania

Bacon, C. 1989. *One hundred years of the Department of Mines*, Unpublished Reports of the Department of Mines No. 1989/09, Tasmania.

Bell, P. 1993. *Historic Minesites in Tasmania: a strategy to identify, assess and manage Tasmania's mining heritage*, Report for the National Parks and Wildlife Division of the Tasmanian Department of Environment and Land Management.

Dickens, G. 1995. *Mining in Tasmania - a brief history*, Tasmania Geological Survey Record 1995/11, Mineral Resources Tasmania, Hobart.

Gaughwin, D. 1992. 'Trade, capital and the development of the extractive industries of Northeast Tasmania', in *Australasian Historical Archaeology* 10, 1992 [published 1994], pp. 55-64.

Hills, L. 1914. *The Jukes-Darwin mining field*, Geological Survey Bulletin, No 16, Department of Mines, Hobart

Jennings, I.B. and Williams, E. 1967. *Geology and mineral resources of Tasmania*, Geological Survey Bulletin No. 50, Department of Mines, Hobart.

Jetson, T and Ely, R. 1995. *History of west and south-west Tasmania: a guide to printed sources*, Centre for Tasmanian Historical Studies, University of Tasmania, Hobart.

Nye, P. B. and Blake, F. 1938. *The geology and mineral deposits of Tasmania*, Geological Survey Bulletin No. 44, Department of Mines, Hobart.

Pearson, M. and Champion, S. 1996. 'Regional Forest Agreement: Cultural heritage identification and assessment: Study 3 Mining Sites', Report for the Tasmanian Environment and Heritage Technical Committee (Forestry Tasmania).

Pink, K. 1982. *The West Coast story: a history of Western Tasmania and its mining fields*, West Coast Pioneers' Memorial Museum, Zeehan.

Reid, A. M. 1918. *The North Pieman and Huskinsson and Sterling Valley mining fields*, Geological Survey Bulletin, no 28, Department of Mines, Hobart

Reid, A. M. 1919, *The Mount Pelion mineral district*, Geological Survey Bulletin No 30, Department of Mines, Hobart

Reid, A. M. 1925. *The Dundas mineral field*, Geological Survey Bulletin, No 36, Department of Mines, Hobart

Reid, A.M., Henderson, Q. J. 1929. *Avoca Mineral District*, Geological Survey Bulletin No 40, Department of Mines, Hobart

Townrow, K. 1986. 'An archaeological investigation of early mining in Tasmania: a preliminary assessment of resources', Report for the Tasmanian National Parks and Wildlife Service, Hobart.

Twelvetrees, W. K. 1915. *Catalogue of publications relating to the mines, minerals and geology of the State of Tasmania*, Geological Survey Bulletin No. 22. Department of Mines, Tasmania.

Twelvetrees, W.H. 1913, *The Middlesex and Mount Claude Mining Field*, Geological Survey Bulletin No 14, Department of Mines, Hobart

Twelvetrees, W.H. 1916, *The Gladstone Mineral District*, Geological Survey Bulletin No 25, Department of Mines, Hobart

Twelvetrees, W.H., and others. 1910. *The ore bodies of the Zeehan field*, Geological Survey Bulletin No 8, Department of Mines, Hobart

Vivian, H. 1985. 'Tasmania's Chinese Heritage: an historical record of Chinese sites in North East Tasmania', unpublished report to the Australian Heritage Commission and the Queen Victoria Museum

Ward, K. L, 1908. *The Mount Farrell Mining Field*, Geological Survey Bulletin No 3, Department of Mines, Hobart

Victoria

Beaumont, C. 1980. *Local history in Victoria: an annotated bibliography*, La Trobe University Library, Melbourne.

Milner, P. 1997. 'Beam pumping engines in Victoria', *Australasian Historical Archaeology*, 15: 40-54.

Milner, P. 1997. 'Databases for mining heritage in Victoria', *Australasian Historical Archaeology*, 15: 30-39.

Western Australia

Australian Archives, 1993. *Kalgoorlie-Boulder: A source analysis of records held by Australian Archives*, East Victoria Park, Western Australia: Australian Archives, WA Branch.

Blatchford, T. 1913. *Mineral resources of the North West Division. Investigations in 1912*, Geological Survey, Bulletin No 52, Department of Mines, Perth

Bridge, P.J. [1970]. *Combined index to the publications of the Geological Survey of Western Australia, 1910-1970*, Hesperian Press, Carlisle, WA.

Calvert, A.F. 1893. *The mineral resources of Western Australia*, George Philip and Son, London.

Campbell, W. D. 1906. *Geology and mineral resources of the Norseman district*, Geological Survey, Bulletin No 21, Department of Mines, Perth

Clark, D. 1904. *West Australian mining and metallurgy*, Critchley Parker, Kalgoorlie, WA.

Crowley, F.K. 1949. *A guide to the principal documents and publications relating to the history of Western Australia*, University of Western Australia, Department of History, Perth, 1949.

Geological Survey of Western Australia, 1910. *Bibliography of government publications: geology & mining, to 1910*, Geological Survey, Bulletin, No. 60, Department of Mines, Perth.

Geological Survey of Western Australia, 1916. *General index to reports 1870-1910*, Geological Survey, Bulletin No 66, Department of Mines, Perth.

Geological Survey of Western Australia, 1990. *The geology and mineral resources of Western Australia*, Geological Survey of Western Australia, Memoir 3, Perth.

Maitland A. Gibb, 1898. *Bibliography of the geology of Western Australia*, Geological Survey, Bulletin No 1, Department of Mines, Perth

Maitland, A. Gibb, 1900. *The mineral wealth of Western Australia*, Geological Survey, Bulletin No 4, Department of Mines, Perth

Maitland. A. Gibb, 1906. 'History of mineral discoveries', in Western Australian Government, *Western Australian Year Book* 1902-1904, Government Printer, Perth.

Maitland, A. Gibb, and Jackson, C.F.V, 1904. *The mineral production of Western Australia up to the end of the year 1903*, Geological Survey, Bulletin No 16, Department of Mines, Perth

Maitland, A. Gibb, and Montgomery, A. *The geology and mineral wealth of Western Australia*, Geological Survey, Bulletin No. 50 of 1912 and No. 89 of 1924, Department of Mines, Perth

Prider, R.T. (ed.), 1979. *Mining in Western Australia*, University of Western Australia Press, Nedlands.

Spillman, K. 1993. *A rich endowment: Government and mining in Western Australia 1829-1994*, University of Western Australia Press, Nedlands.

Quartermain, M. K. and McGowan, E. 1979. 'A historical account of the development of mining in Western Australia', in Prider, R. T. (ed), *Mining in Western Australia*, UWA Press, Nedlands.

Woodward, H. P. 1894. *Mining handbook to the Colony of Western Australia*, Department of Mines, Perth.

MINERALS

COPPER

Australia-wide, and useful general references

Hofman, H. O. 1914. *Metallurgy of copper*, McGraw Hill New York.

Peters, E. D. 1907. *Modern copper smelting*, Hill Publishing Company, New York. (several editions)

Peters, E. D. 1907. *The principles of copper smelting*, Hill Publishing Company, New York.

Peters, E. D. 1911. *The practice of copper smelting*, McGraw Hill, New York.

Rickard, T. A. 1905. *Pyritic smelting*, Engineering and Mining Journal, New York.

Thomas, Fred, `Establishing Copper Smelting in Australia', *Journal of the Royal Historical Society of Queensland*, v. XV, no. 7, May 1994, pp. 313-328.

New South Wales and the Australian Capital Territory

Andrews, E.C, 1911. *Report on the Cobar Copper and Gold Field, Part I*, Mineral Resources No 17, Department of Mines, Sydney

Carne, J. E. 1908. *The copper-mining industry and the distribution of copper ores in New South Wales*, Mineral Resources No. 6, Geological Survey, Department of Mines, NSW, Sydney.

Kenny, E.J. 1923. *Copper*, Geological Survey, Bulletin No 3, Department of Mines, Sydney.

Queensland

Ball, L. C. 1908. *Cloncurry copper mining district*, 2 parts, Geological Survey of Queensland Publication No. 215, Department of Mines, Brisbane.

Blainey, G. 1960. *Mines in the spinifex: the story of the Mount Isa mines*, Angus and Robertson, Sydney.

Kennedy, K. H. 1978. 'The profits of boom: a short history of the Cloncurry copper field', in Dalton, B.J. (ed.), *Lectures in North Queensland History*, James Cook University of North Queensland, Townsville, Third Series, pp.1-34.

Kerr, J. 1982, *Mount Morgan: gold copper and oil*, JD and RS Kerr, St Lucia.

Lees, W. 1907. *The copper mines and minerals of Queensland*, Queensland Country Life, Brisbane.

Reid, J.H. 1944. 'Peak Downs copper lode, Clermont', *Queensland Government Mining Journal*, Vol. 45, pp.33-35.

South Australia

Auhl, I. 1986. *The Story of the 'Monster Mine': The Burra Burra mines and its townships 1845-1877*, District Council of Burra Burra.

Bannear, D. 1985. 'Archaeological Survey of the Wallaroo Copper Smelters', report for Department of Environment and Planning, Adelaide.

Bannear, D. and Annear, R. 1990. 'Burra smelting works: a survey of its history and archaeology', report for Burra District Council, Burra.

Cumming, D.A. 1986. 'Mining and smelting', in Walker, J. (ed.), *South Australia's heritage*, Government Printing Division, Adelaide.

Cumming, D. A. 1987. 'Copper smelting in South Australia: The first fifty years', in Selby, J. (ed), *South Australia's mining heritage*, Department of Mines and Energy & Australasian Institute of Mining and Metallurgy, Adelaide.

Gillingham Printers, 1980. *The Wallaroo and Moonta mines: their history, nature and methods together with an account of the concentrating and smelting operations*, Gillingham Printers, Adelaide.

Jack, R.L, 1917. *The Geology of the Moonta and Wallaroo Mining District*, Geological Survey of South Australia, Bulletin No 6, Department of Mines, Adelaide

Pryor, O. 1962. *Australia's little Cornwall*, Rigby, Adelaide.

Thomas, F, 1994. 'Establishing copper smelting in Australia', *Journal of the Royal Historical Society of Queensland*, v. XV, no. 7, pp. 313-328.

Tasmania

Blainey, G. 1954. *The Peaks of Lyell*, Melbourne University Press, Melbourne.

Godden Mackay Heritage Consultants, 1994. 'Mount Lyell Mining Lease cultural heritage assessment study', (2 vols), Unpublished report to Mineral Resources Tasmania and the Tasmanian Department of Environment and Land Management.

Victoria

Baragwanath, W. M, 1906. *The Walhalla or Thomson River Copper Mine*, Bulletin of the Geological Survey of Victoria, No 20, Department of Mines, Melbourne

Cochrane, G. W, 1982. *Copper, lead, zinc and barium deposits of Victoria*, Bulletin of the Geological Survey of Victoria, No 61, Department of Mines, Melbourne

Philipp, J. 1987. *A poor man's diggings: mining and community at Bethanga Victoria 1875-1912*, Hyland House, Melbourne.

Western Australia

Blockley, J. C. 1979. 'Copper, lead, zinc and tin', in Prider, R. T. (ed) *Mining in Western Australia*, University of Western Australia, Nedlands, pp. 39-56.

Low, G. H. 1963. *Copper deposits of Western Australia*, Geological Survey of Western Australia, Mineral Resources Bulletin No. 8, Perth.

Marston, R.J. 1979. Copper mineralisation in Western Australia, Geological Survey of Western Australia, Mineral Resources Bulletin No. 13, Perth.

Quartermain, M. K. 1987. *A history of mining at Ravensthorpe, Western Australia*, Ravensthorpe Shire Council.

Woodward, H. P, 1908. *A report upon the Mount Maledin Copper Mine, Eulaminna, Mount Margaret Goldfield*, Geological Survey of Western Australia, Bulletin No 32, Department of Mines, Sydney

GOLD

Australia-wide, and useful general references

Averill, C. V. 1946. *Placer mining for gold in California*, Bulletin 135, Division of Mines, San Francisco.

Eissler, M. 1896. *The metallurgy of gold*, New York

Idriess, I. 1931. *Prospecting for gold*, Angus and Robertson, Melbourne. (republished many times)

Lock, A. G. 1882. *Gold: its occurrence and extraction*, E & F. N. Spon, London.

Lock, C. G. W. 1889. *Practical gold-mining*, E & F. N. Spon, London.

Lougheed, Alan L. 1969. 'The discovery, development, and diffusion of new technology: the cyanide process for the extraction of gold, 1887/1914', in *Prometheus*, Vol. 7, No. 1, June 1989, pp. 61-74.

Lougheed, Alan L. 'The cyanide process and gold extraction in Australia and New Zealand 1888-1913', in *Australian Economic History Review*, Vol. 27, No. 1, March 1987, pp. 44-60.

Louis, H. 1902. *A handbook of gold milling*, Macmillan and Co, London.

MacFarren, H. W. 1912. *Text book of cyanide practice*, McGraw Hill, New York.

Rickard, T. A. 1898. *The stamp milling of gold ores*. New York: The Scientific Publishing Company,

Wilson, E. B. 1907. *Hydraulic and placer mining*, Wiley, New York.

New South Wales and the Australian Capital Territory

Andrews, E. C. 1901. *Report on the Yalwal Gold Field*, Geological Survey, Mineral Resources No 9, Department of Mines, Sydney

Andrews, E. C. 1901. *Report on the Drake Gold and Copper Fields*, Geological Survey, Mineral Resources, No 12, Department of Mines, Sydney

Belshaw, J. P. and Jackson, L. 1950. *Gold Mining around Armidale*, Regional Research Monographs No 1, New England University College

Belshaw, J. P. and Jackson. L. 1950. *Gold Mining around Walcha*, Regional Research Monographs No 3, New England University College

Belshaw, J. P. and Kerr, M. 1950. *Gold Mining around Glen Innes*, Regional Research Monographs No 5, New England University College

Blair, D. K. 1905. 'The career of the gold dredge in New South Wales', in *Transactions of the Australasian Institute of Mining Engineers*, v. 10, pp. 289-302.

Clarke, W. B. 1860. *Researches on the southern gold fields of New South Wales*, Reading and Wellbank, Sydney.

Clift, D. 1975. *Gold dredging in New South Wales*, Geological Survey, Mineral Resources No 41, Department of Mines, Sydney

Geological Survey of New South Wales, 1986. *Gold in New South Wales*, Geological Survey of New South Wales, Department of Mineral Resources, Sydney.

Harper, L. F. 1916. *The Adelong Goldfield*, Geological Survey, Mineral Resources No. 21, Department of Mines, Sydney

Higgins, M. 1990. *Gold and water: a history of Sofala and the Turon Goldfield*, Robstar Pty Ltd, Bathurst.

Jacquet, J. B, 1898. *Notes on gold dredging with reference to the introduction of the industry into New South Wales*, Geological Survey, Mineral Resources No. 3, Department of Mines, Sydney

Kenny, E. J. 1922. *Gold*, Geological Survey, Bulletin No. 7, Department of Mines, Sydney

McGowan, B. 1992. 'Aspects of gold mining and mining communities in the Shoalhaven area of New South Wales: An archaeological and historical study', *Australasian Journal of Historical Archaeology*, 10: 43-54.

McGowan, B. 1996. "The typology and techniques of alluvial mining; the example of the Shoalhaven and Mongarlowe goldfields in southern New South Wales", *Journal of Australasian Historical Archaeology*, Volume 14, 1996, pp 34-45

McGowan, B. 1996. *Bungonia to Braidwood. An historical and archaeological account of the Shoalhaven and Mongarlowe goldfields*, the author, Canberra

McGowan, B. 1998. 'Conservation and heritage overview of the Araluen catchment area, including the Araluen, Bell's Creek and Major's Creek goldfields', report to the Lower South Catchment Management Committee.

Moye, D. G. 1972. *Historic Kiandra: a guide to the history of the district* , Cooma-Monaro Historical Society, Sydney.

Willis, J.L. 1972. *Mining history of the Tumbarumba gold field*, Geological Survey of New South Wales, Bulletin No 23, Department of Mines, Sydney.

Northern Territory

Carment, D. 1991. *Australia's depression gold rush: Tennant Creek 1932-1936*, Faculty of Arts, Northern Territory University, Darwin.

Forrest, P. and the Northern Territory Department of Community Development, 1981. 'Arltunga Reserve historic gold field: a report on a study of historic sites and materials', report for the Department of Community Development, Darwin.

Holmes, K. 1989. 'Arltunga: a minor goldfield in arid Central Australia', in *Australian Journal of Historical Archaeology*, vol. 7, pp. 43-49.

McCarthy, J. and Associates, 1986. 'Pine Creek heritage zone: archaeological survey', report for the National Trust of Australia (Northern Territory), Darwin.

Mitchell, S. 1994. 'An archaeological and historical survey of selected mining sites in the Pine Creek district, Northern Territory', report for the National Trust of Australia (Northern Territory), Darwin.

Queensland

Bell, P. G. 1987. *Gold, iron and steam: The industrial archaeology of the Palmer Goldfield*, James Cook University of North Queensland, Department of History and Politics, Townsville.

Bell, P. G. 1992. 'Historic sites associated with mining and Chinese settlement in North Queensland', A report for the Australian Heritage Commission, Canberra.

Cameron, W.E. 1903. *Recent mining developments on the Ravenswood goldfield*, Geological Survey of Queensland, Publication No 183, Department of Mines, Brisbane

Cameron, W.E. 1909. *The Etheridge gold field (second report)*, Geological Survey of Queensland, Publication No. 219. Department of Mines, Brisbane

Colwell, L.J. 1974. 'The North Queensland Goldfields', in Dalton, B.J. (ed.), *Lectures on North Queensland History*, James Cook University of North Queensland, Townsville, pp. 73-82.

Comber, J. 1991. 'Palmer River heritage sites study (Stage 2)', report for the Queensland Department of Environment and Heritage, Brisbane.

de Havelland, D.W. 1987. *Gold and Ghosts: A prospectors guide to metal detecting and history of the Australian Goldfields - Volume 3 - Queensland Central and Southern Districts*. Hesperian Press, Western Australia.

de Havelland, D.W. 1989. *Gold and ghosts: A prospectors guide to metal detecting and history of the Australian goldfields - Volume 4 - Queensland Northern and Northwestern Districts.* Hesperian Press, Western Australia.

Dunstan, B. 1902. *The Clermont Goldfield,* Geological Survey of Queensland Publication No. 176, Brisbane.

Elmslie, C.T. 1904. *Mining in Queensland: A descriptive account of the principal gold mines of Queensland with survey plans of the principal goldfields,* London.

Grimwade, G. 1990. 'Palmer River Goldfields: cultural resources', Report for the Department of Environment and Heritage, Brisbane.

Ivimey, A. J. 1888. *Mining and separation in North Queensland,* Brisbane.

Jack R.L. 1891. *Report on Mount Morgan and other mines in the Crocodile gold field,* Geological Survey of Queensland, Publication No. 132, Department of Mines, Brisbane

Jack, R.L. 1896. *Report on the Hodgkinson gold field,* Geological Survey of Queensland, Publication No. 117, Department of Mines, Brisbane

Kerr, J. 1982, *Mount Morgan: gold copper and oil,* JD and RS Kerr, St Lucia.

Menghetti, D. 1982. 'The gold mines of Charters Towers', in Kennedy, K. H. (ed.), *Readings in North Queensland mining history,* James Cook University of North Queensland, Townsville, vol. 2, pp. 49-119.

Menghetti, D. 1982. 'Extraction practices and technologies on the Charters Towers Goldfield', *North Australia Research Bulletin,* No. 8, The Northern Australian Research Unit, Australian National University, Darwin. pp. 1-30.

Morton, C.C. 1934. 'Miclere diggings, Clermont District', *Queensland Government Mining Journal,* Vol 35, pp 225-230.

Rands, W.H. 1896. *Croydon gold field,* Geological Survey of Queensland, Publication No. 118, Department of Mines, Brisbane.

Reid, J.H. 1917. *The Charters Towers gold field,* Geological Survey of Queensland, Publication No. 256, Department of Mines, Brisbane.

Wegner, J. 1990. *The Etheridge,* Department of History and Politics, James Cook University, Townsville.

South Australia

Drew, G.J. 1993. *Goldfields of South Australia,* Department of Mines and Energy South Australia, Adelaide.

Horn, C.M. 1986. *Historical and geological review of the Teetulpa goldfield: geological survey,* South Australian Department of Mines and Energy, Adelaide.

Wells, R. 1980. *The Echunga goldfield,* Salisbury Education Centre, Salisbury East.

Tasmania

Broadhurst, E. 1935. *Lefroy and Back Creek Goldfields*, Geological Survey Bulletin No. 42, Department of Mines, Hobart

Coroneos, C. 1993. 'A poor man's diggings: an archaeological survey of the Lisle-Denison Goldfields - North-east Tasmania', unpublished report for the Forestry Commission, Tasmania, and the Queen Victoria Museum and Art Gallery.

Dickens, G. 1991. *The Lisle Goldfield - a brief history*, Division of Mines and Mineral resources Report 1991/17, Tasmania Department of Resources and Energy, Hobart.

Finucane, K. J. 1935. *Mathinna and Tower Hill Goldfields*, Geological Survey Bulletin No. 43, Department of Mines, Hobart

Julen, H. 1981. *A history of goldmining on the Tasmanian West Coast*, H. Julen, Launceston.

Kerrison, J. 1963. *Beaconsfield gold*, Beaconsfield Rotary Club, Beaconsfield.

Reid, A. M. 1926. *The Golconda Gold Mining District*, Geological Survey Bulletin No. 37, Department of Mines, Hobart

Victoria

Bannear, D & R. Annear, 1990. 'Assessment of historic mining sites in the Castlemaine - Chewton area', Report for the Historic Mining Sites Assessment Committee, Victoria.

Bannear, D. 1993a. 'Historic mining sites in the Dunolly Mining Division', report for North Central Goldfields Project, Victorian Department of Conservation and Natural Resources, North West Area, Bendigo.

Bannear, D. 1993b. 'Historic mining sites in the Heathcote (Waranga South) Mining Division', report for Department of Conservation and Natural Resources, North West Area, Bendigo.

Bannear, D. 1993c. 'Historic mining sites in the Maldon Mining Division', report for Department of Conservation and Natural Resources, North West Area, Bendigo.

Bannear, D. 1993d. 'Historic mining sites in the Rushworth (Waranga North) Mining Division', report for Department of Conservation and Natural Resources, North West Area, Bendigo.

Bannear, D. 1993e. 'Historic mining sites in the Sandhurst, Eaglehawk and Raywood Mining Divisions', report for Department of Conservation and Natural Resources, North West Area, Bendigo.

Bannear, D. 1993f. 'Historic mining sites in the Taradale Mining Divisions', report for Department of Conservation and Natural Resources, Melbourne.

Bannear, D. 1994a. 'Historic mining sites in the Maryborough and Avoca mining divisions', report for Department of Conservation and Natural Resources, Melbourne.

Bannear, D. 1994b. 'Historic mining sites in the Inglewood, Wedderburn and St Arnaud mining divisions', report for Department of Conservation and Natural Resources, Melbourne.

Bannear, D. 1995. 'Historic mining sites in the Stawell and Ararat Mining Divisions', report for the North Central Goldfields Project, North-west area, Department of Conservation and Natural Resources, Melbourne.

Baragwanath, W. M. 1903. *The Castlemaine Gold-field,* Memoirs of the Geological Survey of Victoria, No. 2, Department of Mines, Melbourne

Baragwanath, W. M. 1907. *The Berringa Gold-field,* Memoirs of the Geological Survey of Victoria, No. 5, Department of Mines, Melbourne

Baragwanath, W. M. 1923. *The Ballarat Gold-field,* Memoirs of the Geological Survey of Victoria, No. 14, Department of Mines, Melbourne

Bate, W. 1978. *Lucky City: the first generation at Ballarat: 1851-1901*, Melbourne University Press, Melbourne.

Bradford, W. M. 1903. *The Pyrenees Goldfield,* Bulletin of the Geological Survey of Victoria, No. 2, Department of Mines, Melbourne

Bradford, W. M. 1903. *The Stawell Goldfield,* Bulletin of the Geological Survey of Victoria, No. 7, Department of Mines, Melbourne

Bradford, W. M. 1903, *The Maldon Goldfield,* Bulletin of the Geological Survey of Victoria, No. 8, Department of Mines, Melbourne

Canavan. F. 1988. *Deep lead gold deposits in Victoria,* Bulletin of the Geological Survey of Victoria, No. 62, Department of Industry , Technology and Resources, Melbourne

Davey, C.J. 1985. 'Archaeological investigations of a mine site', in *Historic Environment,* vol. 4, no. 4, pp. 23-29

Davey, C.J. 1986. 'The history and archaeology of the North British Mine site, Maldon, Victoria', in *Australian Journal of Historical Archaeology*, vol. 4, no. 51, p. 56.

Davey, C. J. & McCarthy, P. L. 1988. 'Deep lead mining in Victoria', *Second Australian Institute of Mining and Metallurgy Mineral Heritage Seminar*, Sydney, July 1988, Australasian Institute of Mining and Metallurgy, Parkville, Victoria: 17-26.

Davey, C. J. 1996. 'The origins of Victorian mining technology, 1851-1900', *The Artefact*, vol 19: 52-62.

Fahey, C. 1986. 'The Berry Deep Leads: an historical assessment', report for Department of Conservation, Forests and Lands, Melbourne.

Flett, J. 1970. *The history of gold discovery in Victoria*, Hawthorn Press, Melbourne.

Griffiths, T. 1987. *Beechworth: an Australian country town and its past,* Greenhouse Publications, Melbourne.

Gregory, J. W. 1907. *The Ballarat East Goldfield,* Memoirs of the Geological Survey of Victoria, No 4, Department of Mines, Melbourne

Howitt, A. M. 1913. *The Maryborough Goldfield,* Memoirs of the Geological Survey of Victoria, Department of Mines, Melbourne

Hunter, S. B. 1903. *The Chiltern Goldfield,* Memoirs of the Geological Survey of Victoria, F.W. Niven, Melbourne

Hunter, S. B. 1909. *The Deep Leads of Victoria,* Memoirs of the Geological Survey of Victoria, No 7, Department of Mines, Melbourne

Howitt, W. 1855. *Land, labour and gold: or two years in Victoria: with visits to Sydney and Van Diemen's Land,* Longman, Brown, Green and Longman, London.

Milner, P.1989. 'The identification of mining relics', in *Historic Environment,* vol. 7, no. 1, pp. 13-20.

Serle, G. 1963. *The Golden Age: A History of the Colony of Victoria, 1851-1861,* Melbourne University Press, Melbourne.

Smyth, R. Brough, 1980. *The goldfields and mineral districts of Victoria,* Queensbury Hill Press, Carlton (reproduction of original edition).

Supple, R. 1992. 'Mining in the Victorian alps', in *Proceedings of the symposium on cultural heritage of the Australian alps, 1991, Jindabyne,* Australian Alps Liaison Committee, Canberra.

Tomlin, O. F. and others. 1979. *A Pictorial History of Gippsland's Jordan Goldfield,* Hill of Content, Melbourne

Whitelaw, O. A. L. 1905. *The Woods Point Gold-field,* Memoirs of the Geological Survey of Victoria, No. 2, Department of Mines, Melbourne

Whitelaw, O. A. L. 1911, *The Wedderburn Gold-field,* Memoirs of the Geological Survey of Victoria, Department of Mines, Melbourne

Western Australia

Blatchford, T. 1899. *The geology of the Coolgardie Goldfield,* Geological Survey , Bulletin No 3, Department of Mines, Perth.

Bridge, P. J. 1972. *Alphabetical index to the 1954 list of cancelled gold mining leases which have produced gold,* Hesperian Press, Carlisle, WA.

Feldtmann, F. R. 7 Farquharson, R. A. 1913. *The geology and ore deposits of Kalgoorlie, East Coolgardie Goldfield,* Part II, Geological Survey Bulletin No. 51, Department of Mines, Perth.

Gibson, C. G. 1906. *The Laverton, Burtville and Erlistown auriferous belt, Mount Margaret Goldfield,* Geological Survey, Bulletin No 24, Department of Mines, Perth.

Gibson, C. G. 1904. *The geology and mineral resources of a part of the Murchison Goldfield,* Geological Survey Bulletin No. 14, Department of Mines, Perth.

Hinde, J.L.(ed.), 1894. *Guide to the goldfields of Western Australia,* Fergusson & Mitchell, Melbourne.

Jackson, C. F. V. 1904. *Geology and auriferous deposits of Leonora, Mount Margaret Goldfield,* Geological Survey, Bulletin No 13, Department of Mines, Perth

McDonald, R. 1986. *Gold in the Gascoyne,* Hesperian, Carlisle, 1986.

Maitland, A. Gibb. 1903. *The geological features and mineral resources of Northampton*, Geological Survey Bulletin No. 9, Department of Mines, Perth

Maitland, A. Gibb. 1908. *The geological features and mineral resources of the Pilbara Goldfield*, reprint of Geological Survey Bulletins Nos 15, 20 & 23, Hudson & Kearns, London

Maitland, A. Gibb. 1909, *The Gascoyne, Ashburton and West Pilbara Goldfields*, Geological Survey Bulletin No. 33, Department of Mines, Perth

Maitland, A. Gibb, 1919. *The gold deposits of Western Australia*, in *The mining handbook*, Geological Survey Memoir No. 1, Department of Mines, Perth. (reprinted as a monograph , Hesperian Press, Carlisle, 1984.)

Western Australian School of Mines [Quartermain, M. K.] 1981. *Technological survey of the Golden Mile: A visual record of the machinery, structures and equipment used on the Golden Mile from 1893*, 2 Vols, National Estate Grants Report, WA School of Mines, Kalgoorlie.

Woodward, H. P. 1907. *A report upon the geology, together with a description of the productive mines, of the Cue and Day Dawn districts, Murchison Goldfield*, Geological Survey, Bulletin No 29. Department of Mines, Perth.

Woodward, H. P. 1911, *The geology and ore deposits of the West Pilbara Goldfields*, Geological Survey, Bulletin No. 41, Department of Mines, Perth.

IRON ORE

Australia-wide, and useful general references

Hughes, H. 1964. *The Australian iron and steel industry 1848-1962*, Melbourne University Press, Melbourne.

Jack, R. I. & Cremin, A. 1994. *Australia's age of iron: history and archaeology*, Oxford University Press and Sydney University Press, Melbourne.

New South Wales

Jacquet, J. B. 1901. *The iron ore deposits of New South Wales*, Geological Survey of New South Wales, Memoirs, No. 2, Department of Mines, Sydney

South Australia

Jack, R.L. 1922, *The iron ore resources of South Australia*, Department of Mines and Energy South Australia, Bulletin No. 9.

Tasmania

Twelvetrees, W. H. and Reid, A. 1919. *The iron ore deposits of Tasmania*, Geological Survey Mineral Resources No. 6. Department of Mines, Tasmania.

Western Australia

Connolly, R.R. 1959, *Iron ores in Western Australia*, Geological Survey of Western Australia, Bulletin No. 7, Department of Mines, Perth.

Fells, R. and Reid, S. 1991. '"Tons were the go": some recollections of work in the early days of the Pilbara iron ore industry', in *Papers in Labour History*, 8, pp. 1-16.

Trengrove, A. 1976. *Adventures in iron: Hamersley's first decade*, Stockwell Press, Mont Albert, Vic.

MINERAL SANDS

Australia-wide, and useful general references

Morley, I.W. 1981. *Black sands - A history of the mineral sand industry in Eastern Australia*, University of Queensland Press, St Lucia.

Queensland

Ball, L.C. 1905. *Gold, platinum, tinstone and monazite in the beach sands on the south coast*, Geological Survey of Queensland, Publication No 198, Department of Mines, Brisbane.

Carlson, O.J. 1950. 'The beach sands mineral industry of south east Queensland', in *Queensland Government Mining Journal*, vol. 51, no. 584, pp. 493-98.

SILVER AND LEAD

Australia-wide, and useful general references

Ingalls, W. R. (ed). 1906. *Lead smelting and refining with some notes on lead mining*, Engineering and Mining Journal, New York.

New South Wales and the Australian Capital Territory

Blainey, G. N. 1968. *The rise of Broken Hill*, Macmillan, Melbourne.

Dickinson, K.J. 1972. *Mining history of the silver, lead, zinc and copper mines of the Broken Hill district to 1939, excluding the main lode*, Geological Survey of New South Wales, Bulletin No. 21, Department of Mines, Sydney.

Harper, l. F. 1930. *The Yerranderie Silver Field*, Geological Survey, Mineral Resources No. 35, Department of Mines, Sydney

Kenny, E. J. 1923. *Silver, lead, zinc*, Geological Survey, Bulletin No. 7, Department of Mines, Sydney

Queensland

Ball, L.C. 1918. *Silver Spur Mine - recent developments and future prospecting*. Geological Survey of Queensland Publication No. 264.

Kennedy, K.H. Bell, P. G. and Edmondson, C. 1981. *Totley: A study of the silver mines at One Mile, Ravenswood district*, History Department, James Cook University of North Queensland, Townsville.

South Australia

Chilman, J. K. 1982. *Silver and a trace of gold*, South Australian Department of Mines and Energy, Adelaide.

Tasmania

Nye, P. B. 1923. *The silver lead deposits of the Waratah District*, Geological Survey Bulletin No. 33, Department of Mines, Hobart

Victoria

Shennan, M. R. 1985. *Silver threads and golden needles: the early history of Silver Creek*, Beechworth, M. Shennan, Noble Park.

Western Australia

Blockley, J.G. 1971. *The lead, zinc and silver deposits of Western Australia*, Geological Survey of Western Australia, Bulletin No. 9, Department of Mines, Perth

TIN

Australia-wide, and useful general references

Charlton, G. 1884. *Tin: mining, dressing and smelting*, E & F. N. Spon, London.

Herman, H. 1914. 'Australian tin lodes and tin mills', in *Australasian Institute of Mining Engineers Proceedings* VII, new series no. 14, 1914, pp. 278-402.

Kerr, R.S. 1989. 'The advent of tin dredges in Eastern Australia', in *Australian Journal of Historical Archaeology*, vol. 7, pp. 70-72.

Mantell, C. I. 1949. *Tin: its mining, production, technology and applications*, Reinhold Publishing Corporation, New York.

Thibault, P. J. 1908. *Metallurgy of tin*, Australian Mining Standard, Sydney.

New South Wales and the Australian Capital Territory

Carne, J. E. 1911. *The Tin-mining industry and the distribution of tin ores in NSW*, Mineral Resources series, Geological Survey of NSW, Sydney.

Edgeworth, D. 1887. *Vegetable Creek Tin Mining Field, New England district, New South Wales*, Geological Survey of New South Wales, Memoirs, No. 1, Department of Mines, Sydney

Harper, L.F. 1919. *The geology and mining development of the Ardelthan Tin Fields*, Geological Survey, Mineral Resources No. 29, Department of Mines, Sydney

Kenny. E.J. 1922. *Tin*, Geological Survey, Bulletin No. 1, Department of Mines, Sydney

Northern Territory

Walpole, B.P. 1958. *The Maranboy tinfield*, Australian Bureau of Mineral Resources, Bulletin No. 37, Canberra.

Queensland

Blake, D.H. 1970. 'Geology and mineral deposits of the Herberton tinfield North Queensland', in *Queensland Government Mining Journal*, vol. 71, October, p. 446-54.

Cameron, W.E.. 1904. *The Herberton tin field*, Geological Survey of Queensland, Publication No. 192, Department of Mines, Brisbane

Cameron, W.E. 1907. *The Annan River tin field*, Geological Survey of Queensland, Publication No. 210, Department of Mines, Brisbane

Jack, R.L. 1882. *Stanthorpe tin mining district*, Geological Survey of Queensland, Publication No. 12, Department of Mines, Brisbane.

Kerr, R. S. 1980. 'John Moffat and the North Queensland tinfields', in Kennedy, K. H. (ed.), *Readings in North Queensland Mining History*, James Cook University of North Queensland, Townsville, vol. 1, pp. 161-88.

Reid, J.H. 1916. 'Sundown tin and copper mine, Ballandean", *Queensland Government Mining Journal*_Vol. 17, pp 260-261.

Saint-Smith, E.C. 1916. *Geology and mineral resources of the Cooktown district tinfields*, Geological Survey of Queensland, Publication No 250 , Department of Mines, Brisbane

Sketchley, S.B.J. 1897. *Tin mines of Watsonville*, Geological Survey of Queensland, Publication No. 119, Department of Mines, Brisbane

Tasmania

Conder Hartwell. 1918. *The tin field of North Dundas*, Geological Survey Bulletin No. 26, Department of Mines, Hobart

Dickens, G. 1990. *The Mount Cameron water race - a century of operation*, Division of Mines and Mineral Resources Report 1990/15, Tasmania Department of Resources and Energy, Hobart.

Groves, D. I. et al. 1972. *A century of tin mining at Mount Bischoff 1871-1971*, Geological Survey Bulletin No. 54, Department of Mines, Hobart.

Jackman, G. 1996. 'Blue Tier mining heritage study: an archaeological survey of the Blue Tier Tin Field, Northeast Tasmania', report for Forestry Tasmania, Hobart.

Nye, P.B. 1925. *The sub-basaltic tin deposits of the Ringarooma valley*, Geological Survey Bulletin No. 35, Department of Mines, Hobart

Waterhouse, L. L. 1916. *The South Heemskirk Tin Field*. Geological Survey Bulletin No. 21, Department of Mines, Hobart

Waterhouse, L. L. 1914. *The Stanley River Tin Field,* Geological Survey Bulletin No. 15, Department of Mines, Hobart

Victoria

Cochrane, G.W. 1971. *Tin deposits of Victoria,* Bulletin of the Geological Survey of Victoria, No. 60, Department of Mines, Melbourne

Gregory, J.W. 1907. *The Mount Cudgewa Tinfield,* Bulletin of the Geological Survey of Victoria No. 22, Department of Mines, Melbourne

Western Australia

Hobson, R.A. & Matheson, R.S. 1949. *Greenbushes Mineral Field,* Geological Survey, Bulletin No. 102, Department of Mines, Perth

Woodward, H. P. 1908, *Notes on the geology of the Greenbushes Tinfield,* Geological Survey, Bulletin No. 32, Department of Mines, Perth

ENERGY SOURCES

COAL

Australia-wide, and useful general references

Hargraves, A.J. (ed), Kininmonth, R.J. Martin, C.H. and Saywell, S.M.C. 1993. *History of coal mining in Australia.* Monograph 21, Australasian Institute of Mining and Metallurgy, Parkville.

Power, F. Danvers, 1912. *Coalfields and collieries of Australia,* Melbourne.

Shaw, A.G.L. and Burns, G.R. 1947. *The Australian coal industry,* Melbourne University Press, Melbourne.

New South Wales and the Australian Capital Territory

Branagan, D. F. 1972. *Geology and coal mining in the Hunter Valley, 1791-1861,* Newcastle Public Library, Newcastle.

Edgeworth David. T.W. 1907, *The geology of the Hunter River coal measures,* Geological Survey of New South Wales, Memoirs No. 4, Department of Mines, Sydney

Ellis, M. 1969. *A saga of coal: the Newcastle Wallsend Coal Company's centenary volume,* Angus and Robertson, Sydney.

Fenwick, P. 1995. 'South Maitland coalfield heritage study', report for the National Trust of Australia (NSW), Sydney.

Harper, L.F. & Mingaye, J.C.H.. 1919. *The coke industry of New South Wales,* Geological Survey, Mineral Resources No. 23, Department of Mines, Sydney

New South Wales Department of Mines. (Pittman, E. F.)1925. *The coal resources of New South Wales,* Geological Survey of New South Wales, Bulletin No. 6, Department of Mines, Sydney

Turner, J.W. 1982. *Coal mining in Newcastle, 1801-1900*, Newcastle Region Public Library, Newcastle.

Queensland

Bell, P. G. 1980. 'The origins of the north Queensland coal industry', in Kennedy, K. H. (ed.), *Readings in North Queensland mining history*, James Cook University of North Queensland, Townsville, vol. 1, pp. 251-72.

Cameron, W.E. 1906. *West Moreton (Ipswich) coalfield with special reference to the Bundamba district*, (2nd report), Geological Survey of Queensland, Publication No. 204, Department of Mines, Brisbane

Hawthorne, W.L. 1960. *The Burrum Coalfield*, Geological Survey of Queensland Publication No. 296. Department of Mines, Brisbane

Hawthorne, W.L. 1971. *Coal resources - Darling Downs coalfield, Tannymorel - Killarney district*. Geological Survey of Queensland Record, 1971/15.

Jack R.L. 1879. *The Bowen River coalfield*, Geological Survey of Queensland, Publication No. 4, Department of Mines, Brisbane.

Whitmore, R.L. 1981. *Coal in Queensland: The first fifty years*. University of Queensland Press, St Lucia.

Whitmore, R.L. 1983. *Coke oven technology in the Ipswich area*. Department of Mining and Metallurgical Engineering, University of Queensland, National Estate Grant Report.

Whitmore, R.L. 1985. *Coal in Queensland: The late nineteenth century - 1875-1900*. University of Queensland Press, St Lucia.

Whitmore, R.L. 1991, *Coal in Queensland: federation to the twenties- 1900-1925*, University of Queensland Press, St Lucia.

South Australia

Parkin, L.W. and others, 1953. *The Leigh Creek Coalfield*, Geological Survey of South Australia, Bulletin No. 30, Department of Mines, Adelaide

Poole, G.G. 1946. *The Leigh Creek Coalfield: history and development*, Department of Mines, Adelaide.

Tasmania

Bacon, C. 1991. *The coal resources of Tasmania*, Geological Survey of Tasmania Bulletin No. 64, Hobart.

Bacon, C. A. and Banks, M. R. 1989. 'A history of discovery, study and exploitation of coal in Tasmania', in *Papers and Proceedings of the Royal Society of Tasmania*, vol. 123, pp. 137-89.

Bairstow, D and Davies M. 1987. *Coal Mines Historic Site survey: Preliminary report*, Occasional Paper 15, Tasmanian Department of Lands, Parks and Wildlife, Hobart.

Hills, L. 1913. *The Preolenna Coalfield and the geology of the Wynyard district*, Geological Survey, Bulletin No. 13, Department of Mines, Hobart

Twelvetrees, W.H. 1915. *The Catamaran and Strathblane Coalfields and coal and limestone at Ida Bay*, Geological Survey Bulletin No. 20, Department of Mines, Hobart

Victoria

Bain, A.D.N. 1951. 'Brown coal in Victoria', in *Mining and Geological Journal*, Mines Department of Victoria, Melbourne, September 1951, pp. 33-38.

Brown, G. 1948. 'Coal resources of Victoria', in *Mining and Geological Journal*, Mines Department of Victoria, Melbourne, September 1948, pp. 4-15.

Fahey, C. 1987. *Wonthaggi State Coal Mine: a short history of the State Coal Mine and its miners*, Conservation Forests and Lands and Wonthaggi Coal Mine Committee, Melbourne.

Knight, J.L. 1951. 'The story of black coal in Victoria', in *Mining and Geological Journal*, Mines Department of Victoria, Melbourne, September 1951, pp. 39-44.

Western Australia

Campbell, W.D.. 1910. *The Irwin River Coalfield and adjacent Districts from Arrino to Northampton*, Geological Survey Bulletin No. 38, Department of Mines, Perth

Lord, J.H. 1952. *Collie mineral field*, Geological Survey of Western Australia, Bulletin No. 105, Part I, Department of Mines, Perth.

Stedman, C. (ed). 1988. *100 years of Collie coal*, Curtin University of Technology, Perth.

OIL AND GAS

Australia-wide, and useful general references

Wilkinson, R.A. 1988. *A thirst for burning: the story of Australia's oil industry*, David Ell Press, Sydney.

Wilkinson, R.A. 1991. *Where god never trod: Australia's oil explorers across two centuries*, David Ell Press, Sydney.

New South Wales and the Australian Capital Territory

Burke, H. 1991. *Newnes shale oil complex: archaeological report.* report for NSW National Parks and Wildlife Service, Sydney.

Carne, J. E. 1903. *The Kerosene shale deposits of New South Wales*, Memoirs of Geological Survey of NSW, Geology 3, Department of Mines, Sydney.

Eardley, G. H. Stephens, E.M. 1974. *The shale railways of N.S.W.* Australian Railway Historical Society, Sydney.

Knapman, L. 1988. *Joadja Creek, the shale oil town and its people 1870-1911*, Hale & Iremonger, Sydney.

Lishmund, S. R. 1974. *Oil shale*, Geological Survey of NSW, Mineral Industry No. 30, Department of Mines, Sydney.

Queensland

Cameron, W.E. 1915. *Petroleum and natural gas prospects at Roma.* Geological Survey of Queensland Publication No. 247.

Kerr, J. 1982, *Mount Morgan: gold copper and oil,* JD and RS Kerr, St Lucia.

Mott, W.D. 1952. 'Oil in Queensland', *Queensland Government Mining Journal,* Vol. 53, pp 848 ff.

Wade, A. 1950. 'Fifty years searching for oil in Queensland', in *Queensland Government Mining Journal,* June, pp. 456-458, 460-468.

South Australia

Alexander, E.M.. (comp.), 1990. *Petroleum exploration and development in South Australia,* South Australian Department of Mines and Energy, Adelaide.

Donovan, P. Kirkman, N. 1986. *The unquenchable flame: the South Australian Gas Company 1861-1986,* Wakefield Press, Adelaide.

Tasmania

Reid, A. 1924. *Oil shale deposits in Tasmania,* Geological Survey Mineral Resources No. 8, Vol. 1, Department of Mines, Tasmania.

Victoria

Balfour, J.C.M. 1968. 'Petroleum in Victoria -- history and present status', in *A.P.E.A. Journal,* vol. 8, part 2, pp. 16-20.

Leigh, C.H. 1970. 'Oil and natural gas developments in the Bass Strait area', in *Geography,* vol. 55, pp. 221-23.

Western Australia

Boylen, L., Mcllwraith, J and Gladwell, D (eds). 1994. *Power for the people. a history of gas and electricity in Western Australia,* SECWA, Perth.

Murray, R. 1991. *From the edge of a timeless land: a history of the North West Shelf Gas Project,* Allen and Unwin, North Sydney.

URANIUM

Australia-wide, and useful general references

Australian Atomic Energy Commission, 1962. *Uranium in Australia: a collection of articles on the history and development of the uranium mining industry in Australia,* Australian Atomic Energy Commission, Sydney.

Cawte, A. 1992. *Atomic Australia 1944-1990,* New South Wales University Press, Kensington.

Northern Territory

Annabell, R. 1977. *The uranium hunters*, Rigby, Adelaide.

Barter, L. 1991. 'The 1950s uranium boom in the Northern Territory', in *Journal of Northern Territory History*, no. 2.

Shepherd, S. 1997. `Uranium mining at Sleisbeck', in *Journal of Northern Territory History*, no. 8, pp. 34-44.

Queensland

Harding, R. H. 1992. *Wholeheartedly and at once: a history of the first operation of Mary Kathleen Uranium Ltd*, CRA Ltd, Melbourne.

South Australia

Kakosche, K. 1991. *We were Radium Hill*, Radium Hill Community Association.

Western Australia

Carter, J. D. 1979. 'Mineral deposits of Western Australia: mineral fuels—iii. Uranium', in Prider, R. T. (ed), *Mining in Western Australia*, University of WA Press, Nedlands, WA. .

PRECIOUS STONES

Australia-wide, and useful general references

Croll, I.C.H. 1950. 'The opal industry in Australia', in Bureau of Australia Mineral Resources, *Geology and Geophysics Bulletin* No. 18, Melbourne, Department of Mines.

Gourlay, A.J. and Noakes, L.C. 1970. 'Developments in the Australian opal industry', in *Australian Mineral Industry*, vol. 23, September 1970, pp. 11-20.

New South Wales and the Australian Capital Territory

Barron, F.A. 1974. 'The history of White Cliffs opal field' in four parts. in *Australian Lapidary Magazine*, vol. 10, April, May, June and July 1974.

Belshaw, J.P. & Jackson, L. 1950. *Mining for diamonds, sapphires and emeralds in northern New South Wales*, Regional Research Monographs No. 2, New England University College

Campbell, E. G. 1968. 'Bengonaway, Boggy Camp and Copeton: a history of Inverell's diamond mine, 1872-1914', in *Armidale and District Historical Society. Journal and Proceedings*, no. 11, December 1968, pp. 20-25.

Queensland

Anon. 1950. '50 years of gem mining in Queensland', in *Queensland Government Mining Journal*, June, pp. 473-74.

Jackson, C. F. V. 1902. *The opal mining industry and the distribution of opal deposits in Queensland*, Geological Survey Report No. 177. Department of Mines, Brisbane.

South Australia

Barnes, L.C. and Townsend, I.C. 1982 (& 1992). *Opal: South Australia's gemstone*, South Australian Department of Mines and Energy, Adelaide, Handbook no. 5, Adelaide.

Brasse, L. and Sanders, M. 1994. 'Andamooka heritage survey', report for Department of Environment and Planning, Adelaide.

Crittenden, P.P. et al, 1979. 'The opal industry in South Australia', in *Mineral Resources Review*, no. 151, pp. 18-29.

OTHER MINERALS

Australia-wide, and useful general references

Hillier, G. 1976. 'Growth of the Australian nickel industry', in *Australian Mineral Industry Quarterly Review*, vol. 28, no. 4, 1976, pp. 99-113.

Owen, H.B. 1955. 'Bauxite in Australia', *Bulletin*: No. 24, Bureau of Mineral Resources, Geology and Geophysics, Canberra.

Pearson, M. 1990. 'The lime industry in Australia - an overview', *The Australian Journal of Historical Archaeology*, Vol 8, pp 28-35.

New South Wales

Andrews, E.C. 1916. *The molybdenum industry of New South Wales*, Geological Survey of New South Wales, Mineral Resources No. 24, Department of Mines, Sydney

Belshaw, J.P. 1950. *Mining for alum, antimony, arsenic and asbestos in Northern New South Wales*, Regional Research Monographs No. 4, New England University College

Carne, J. E. 1912. *The antimony-mining industry and the distribution of antimony ores in NSW*, Mineral Resources Series, Geological Survey of New South Wales, Department of Mines, Sydney.

Carne, J. E. 1912. *The tungsten-mining industry in NSW*, Mineral Resources No. 15, Geological Survey of New South Wales, Department of Mines, Sydney.

Carne, J. E. & Jones, C. J. 1919. *The limestone deposits of NSW*, Mineral Resources Report No. 25. Department of Mines, Sydney.

Harper, L.F. 1917. *Felspar in New South Wales*, Geological Survey of New South Wales, Mineral Resources No. 26, Department of Mines, Sydney

Jones, L.J. 1925. *The gypsum deposits of New South Wales*, Geological Survey of New South Wales, Mineral Resources No. 33, Department of Mines, Sydney

Kenny, E.J., 1924. *Antimony, arsenic, bismuth, molybdenum, tungsten*, Geological Survey of New South Wales, Bulletin No. 5, Department of Mines, Sydney.

Lichmund, S. R., Dawood, A. D. and Lang, W. V. 1986. *The limestone deposits of NSW*, Mineral Resources Report 25 (revised), Geological Survey of NSW, Department of Mines, Sydney.

Northern Territory

Travers, M. 1987. 'History of Hatches Creek and Wauchope wolfram mining', in *Trust News*, (Northern Territory), vol. 4, no. 4, November, pp. 1-5.

Sullivan, C.J. 1952. *Wauchope wolfram fields, Northern Territory*, Australian Bureau of Mineral Resources, Bulletin No. 4, Canberra.

Sullivan, C.J. and Opik, A.A. 1951. *Ochre deposits, Rumbalara, Northern Territory*, Bulletin no. 8: Bureau of Mineral Resources, Geology and Geophysics, Melbourne.

Queensland

Anon, 1969. 'Bauxite mining at Weipa', in *Australian Mining*, vol. 61, pp. 46-69.

Ball, L.C. 1915. *The wolfram mines of Mount Carbine, North Queensland*, Geological Survey of Queensland, Department of Mines, Brisbane.

Jensen, H.I. 1918. 'Arsenic and its occurrences in Southern Queensland' Part II, *Queensland Government Mining Journal*, Vol. 19, pp 503-8.

Rudd, R. 1978. *The veins of Carbine Hill: Mount Carbine 1895-1978*, Queensland Wolfram Limited, Mareeba.

South Australia

Jack, R.L. 1919. *The phosphate deposits of South Australia*, Geological Survey of South Australia, Department of Mines, Adelaide

Jack, R.L. 1921. *The salt and gypsum resources of South Australia*, Geological Survey of South Australia, Department of Mines, Adelaide

Tasmania

Bacon, C. A. 1992. *Notes on the history of mining and exploration at Adamsfield*, Report 1992/20, Mineral Resources Tasmania.

Hills, L. 1915. *Tungsten and molybdenum, Part 1, north-eastern and eastern Tasmania*, Geological Survey Mineral Resources No. 1, Department of Mines, Tasmania.

Hughes, T.D. 1957. *Limestone in Tasmania*, Geological Survey, Mineral Resources, No. 10. Department of Mines, Hobart

Taylor, Bl. L. 1955. *Asbestos in Tasmania*, Geological Survey Mineral Resources No. 9, Department of Mines, Hobart.

Twelvetrees. W.H. 1919, *Phosphate deposits in Tasmania*, Geological Survey, Mineral Resources No. 3, Department of Mines, Hobart.

Western Australia

Baxter, J.L. 1978. *Molybdenum, tungsten, vanadium and chromium in Western Australia*, Geological Survey of Western Australia, Bulletin No. 11, Department of Mines, Perth

De La Hunty, L.E. and Low, G. H. 1958. *The gypsum deposits of Western Australia*, Geological Survey of Western Australia, Bulletin No. 6, Department of Mines, Perth.

Foxall, J.S. 1942. *The blue asbestos deposits of the Hamersley Range and their economic importance*, Geological Survey, Bulletin No. 100, Part II, Department of Mines, Perth

Gresham, J.J. 1991. *Kambalda: history of a mining town*, Western Mining Corporation Limited, Melbourne. (nickel)

King, N. 1974. *Nickel country, gold country*, Rigby, Adelaide.

Matheson, R.S. 1944. *Mica*, Geological Survey of Western Australia, Bulletin No. 2, Department of Mines, Perth

Marston, R.J. 1984. *Nickel mineralization in Western Australia*, Geological Survey of Western Australia, Bulletin No. 14, Department of Mines, Perth

Pearson, M. 1985. Archaeological interpretation and ethnographic analogy: the lime industry in Western Australia, *Archaeology in Oceania*, 21: 94-102.

3. A LISTING OF USEFUL INTERNET SITES

There are many internet sites that contain useful information about aspects of mining, and provide comparative examples of mines elsewhere in the world. The Mining History Network site (see below) is a good way to access some of these sites.

The sites listed here are just the most relevant to assessment of mining sites in Australia. they include sites with site register, mining history, bibliographic and library and general heritage information. Use of the internet is a quick way of doing some initial research, especially if you don't have ready access to a major library catalogue. However, most of the material it provides references for is only available through libraries or archives.

The web addresses for heritage agencies, National Trusts, libraries and archives are included in Guideline *4 A list of key contacts.*

Australian Mining History Association

Web address: http://www.econs.ecel.uwa.edu.au/AMHA/amhamain.htm

A very useful listing of members of the Association in all states, a bibliography of mining sources divided by state and mineral type, and copies of the Association's newsletters. The bibliography is also available in hard copy form from the Association.

Mining History Network

Web address: http://www.ex.ac.uk/~RBurt/MinHistNet/

An international mining source, based in Britain. The site contains bibliographies for mining in Australia (by a link to the Australian Mining History Association bibliography), North America, Britain, and Ireland and for Coal. It also has very useful links to other mining web sites around the world, and directory of mining historians.

HERA Database—Australian Heritage Commission's Bibliographic database

Web address: http://www.ahc.gov.au

A bibliographic database of published material and unpublished reports and articles on heritage subjects, with about 30,000 entries. Searches on key words such as "mines and mining" or "goldfields' will give good results. The database can be searched by key words, locations, author and title. The AHC Library can provide inter-library loan access to the large number of books and reports it holds, that are also listed in HERA. This site also has the catalogue of the Australian Heritage Commission's own library, which contains many unpublished reports on mining sites.

Register of the National Estate on line

Web address: http://www.ahc.gov.au

The Register of the National Estate is accessible through the AHC home page (at the URL above). The database is able to be searched by place name or location. There is also a more advanced version that gives additional information and search functions, that is also accessible through the home page as the "Professional Users" version of the database. However, the general version is easier to use and gives most information you are likely to need in the first instance.

Australia's Cultural Network

Web address: http://www.acn.net.au/

This new site allows access to a wide range of heritage related areas such as museums and sites. Some of these are relevant to mining heritage. Its worth a look and a play to see what else it has in it, and some of the very useful links it contains.

NSW Department of Mineral Resources Minfinder Database

Web address: http://slim.slnsw.gov.au/minfinder-bin/search.cgi

A data base of 20,000 references to mining sites in NSW compiled from department records. This is useful if you have already got your basic historical information, and are chasing up mining ventures in detail. The sources referenced are in the main only available at the Department's library.

National Library of Australia

Web address: http://www.nla.gov.au/

This home page has useful links to a range of library resources and information about library holdings in the states, and an online copy of the Directory of Oral History Collections around Australia. A most useful component is the catalogue of the National Library itself, though this might be of limited usefulness if you can't get to Canberra, as the National Library does not provide inter-library loans.

Australian Libraries Gateway

Web address: http://enzo.nla.gov.au/products/alg/index.html

A one-stop reference system to Australian libraries, a part of the Australia's Cultural Network (see above). Provides easy access to information about local, state, university and national libraries in Australia.

Australian Geological Survey Organisation (AGSO) Library Catalogue

Web address: http://www.agso.gov.au/library/

Online catalogue of the library holdings of AGSO. Potentially of use in locating published materials for a given field or mine. The Library itself is in Canberra.

Directory of Archives in Australia

Web address: http://www.asap.unimelb.edu.au/asa/directory/

An update on the printed directory of archives (White, Schwirtlich, and Nash, 1983.), listing the archives collections and contents around Australia. Useful for detailed historical work.

Register of Australian Archives and Manuscripts

Web address: http://www.archivenet.gov.au/home4.html

A database containing records of non-government archives held in Australian archival repositories and libraries. It contains many items related to miners and mining companies. It is linked to the Directory of Archives, which provides details of the repositories.

National Archives of Australia Database

Web address: http://www.aa.gov.au/AAIndexpage.html

Provides access to the series held by National Archives, which has offices in each state, listed in the links at this site. Contains material on mining, where the Commonwealth has been involved.

History of mining in the Northern Territory

Web address: http://www.dme.nt.gov.au/library/mine_history.html

A copy of the Northern Territory chapter from Donovan & Associates "History of mining in Australia" 1995, by David Carment and Sue Harlow.

MINING HERITAGE PLACES

ASSESSMENT MANUAL

GUIDELINE 6

A GUIDE TO COMMON MINING TERMINOLOGY

GUIDELINE 6

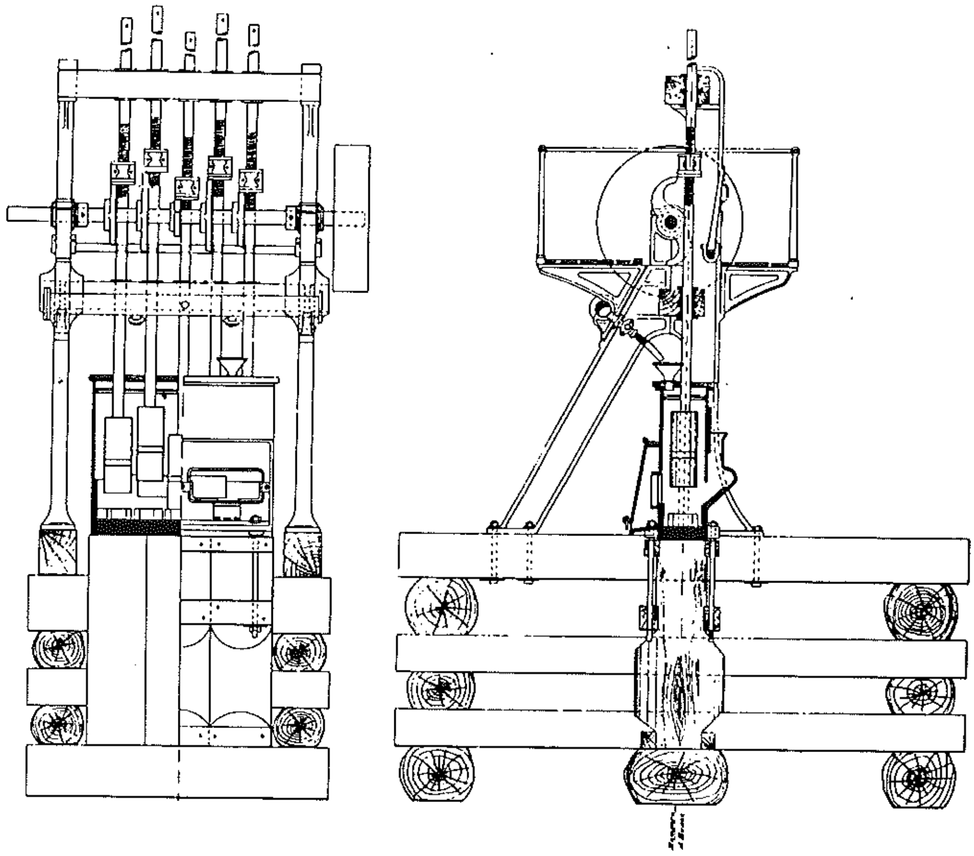
A GUIDE TO COMMON MINING TERMINOLOGY

The terms used here are based on Australian usage. The precise meaning of some terms varied from region to region, and between different mineral types.

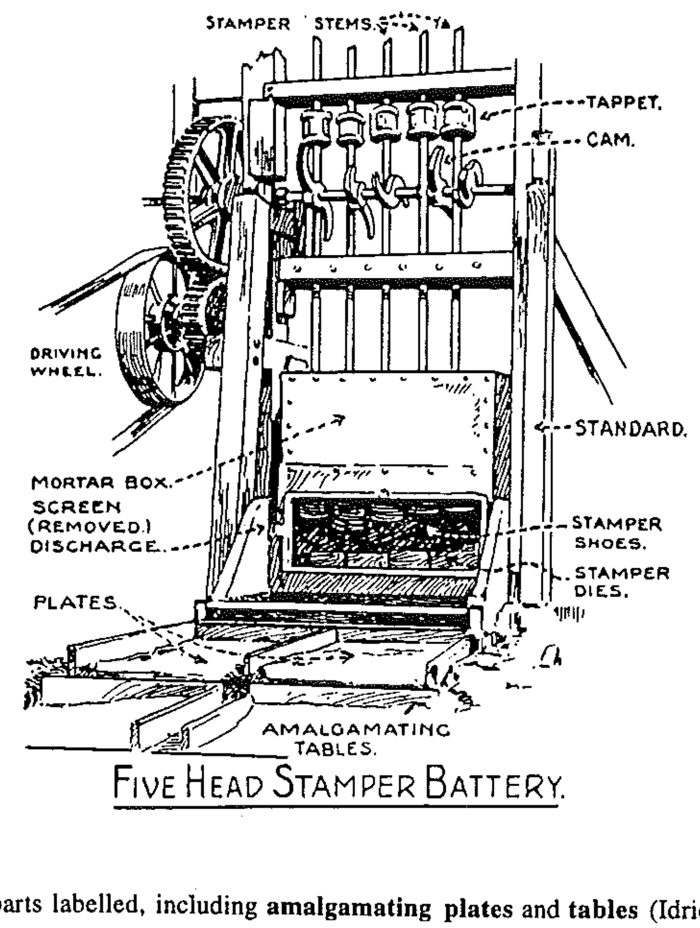
Terms defined elsewhere in the glossary are indicated in *italics*.

adit	A horizontal or gently inclined passage or opening from the surface into a hillside, for the purposes of exploring, accessing an ore deposit, removing mined material, drainage, or ventilation. Sometimes called *drive*.
aerial ropeway / flying fox	A system of transporting ore or fuel by means of ropes or cables suspended from towers or timber frames, the transported material being carried in steel buckets or *skips*, or on a flat platform. The ropeway could carry material over considerable distances, replacing road or tramway transport, or simply run from a high elevation to a lower one, or across a water course, in the latter cases being usually referred to as a 'flying fox'.
air receivers	A cylindrical riveted iron container, like a boiler shell but with no door access, both ends being riveted convex plates. Used to store compressed air under 90-100 psi pressure, for supply to machinery such as *rock drills*, loaders, *cutters* etc
air shaft	A *shaft* driven to connect with underground workings to provide ventilation. Sometimes with a *fan* at the surface to provide forced air. A chimney was sometimes built over an air shaft to increase draught and was called and 'air stack'.
alluvial gold, alluvial deposit	Gold removed from its parent rock by erosion and incorporated in water deposited alluvium (silt, sand, clay, gravel etc)
amalgamate, / amalgamating	The process by which gold combines with mercury to form an amalgam. Amalgamation can be undertaken both in a gold battery's *mortar box* and on the *tables* below the discharge of mortar box, where mercury-coated copper plates are placed (hence 'amalgamating tables'), It is also carried out in grinding *pans* such as *Berdan pans* and *Wheeler pans*. Gold and mercury were recovered from amalgam by *retorting*.
amalgamated claims	Adjoining claims that have been combined to allow more economical working. Often found where fields have been

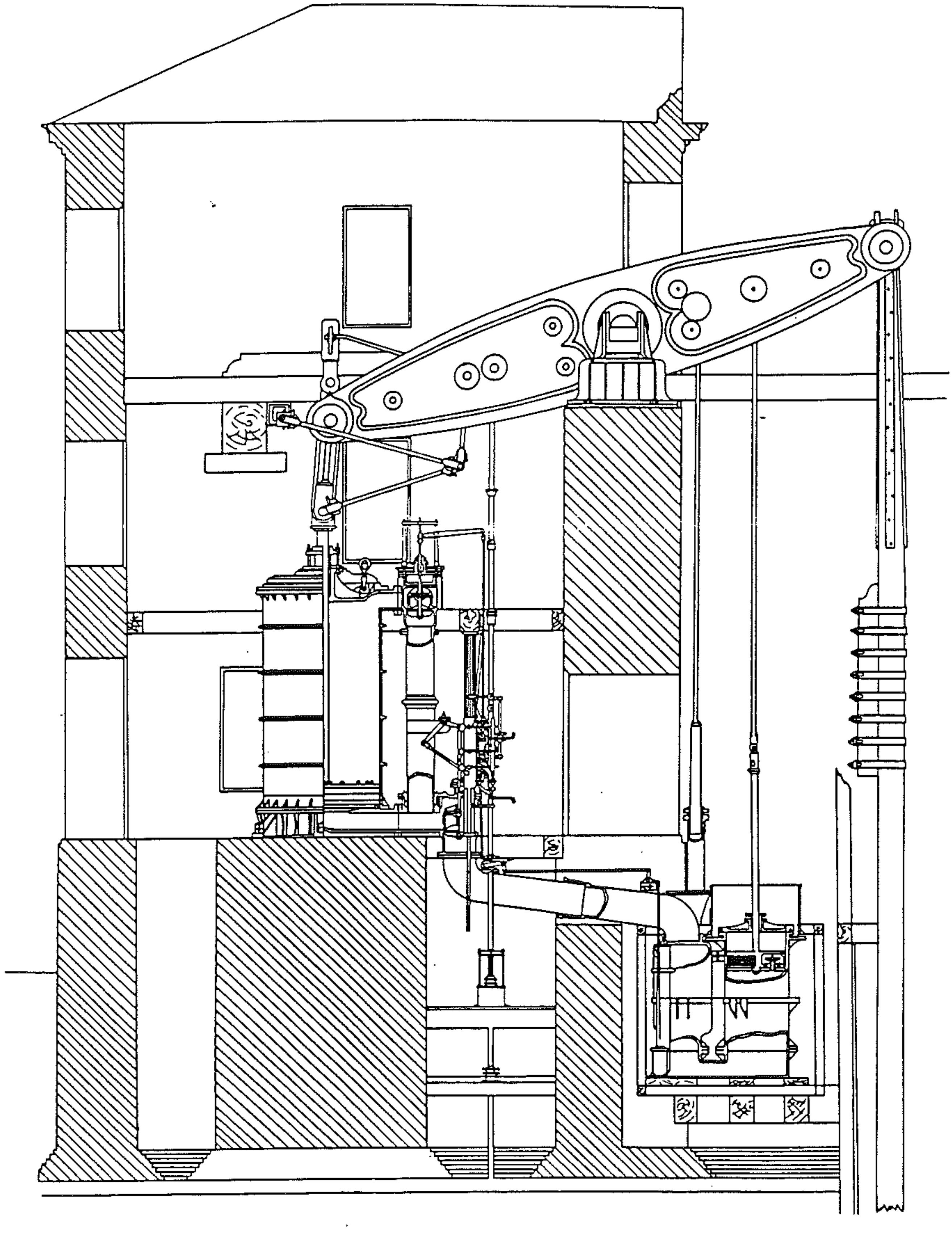
	rationalised after an initial rush.
argillaceous	Clay like deposit.
assay	The process of analysing an ore to determine the metal content. Usually applied to gold and silver assay. The process entailed crushing a small sample of ore, melting it with fluxes in a crucible furnace, then smelting it in a small furnace (a 'muffle - furnace') until the base metals are absorbed or vaporised, leaving gold and silver. The silver was separated using nitric acid, leaving pure gold. Assay occurred on many larger gold mining sites, and is sometimes indicated by broken vitrified ceramic cupels.
auriferous	Containing gold.
Babcock and Wilcox boiler	A sophisticated patent water tube *boiler*. The boiler consisted of a substantial masonry 'box' with a fire box at its base. A set of multiple water tubes is supported at an angle above the firebox, and a cylindrical boiler shell above the water tubes contains water and acts as a pressure vessel for the steam produced. The form of this boiler is very distinctive.
ball mill	A grinding machine in which ore or *concentrates* are fed into a rotating drum or cylinder and ground by the rolling action of steel balls.
banking level	Platform level within a large *headframe* structure at which the *cage* comes to rest. *Skips* are moved from and into the cage at this level. Also called the *brace*.
barrow ways	Cleared pathways, sometimes stone-lined, maintained through alluvial working areas to enable overburden or *washdirt* to be barrowed from the work face.
bath-house	An ablutions block, most commonly found at coal mines, but also present at some other mines, where miners showered after a shift, and where work clothing could be stored, in coal mines on drying racks that could be raised to the ceiling.
battery / stamper battery	A machine with sets of *stampers* that rise and fall onto metal bearing ore to crush and separate the components in the presence of water. The stamps operate in a *mortar box* with a metal screen regulating the size of the discharged material (*slimes*).
beam engine	A steam powered engine which transmits a reciprocal motion by way of a large beam. The beam is positioned above the engine, and is pivoted on a masonry wall on which it rocks. The beam end beyond the wall is attached to a connecting rod, attached to a machine or a pump within the mine. Beam engines are commonly housed in masonry multi-storey houses, deriving from Cornish practice. Most beam engine houses were in South Australia and Victoria, with a few examples in other states (see Drew & Connell 1992, and Milner 1997).



Stamper battery with inspection platform and bed-log foundations shown. (MacLaren 1901)

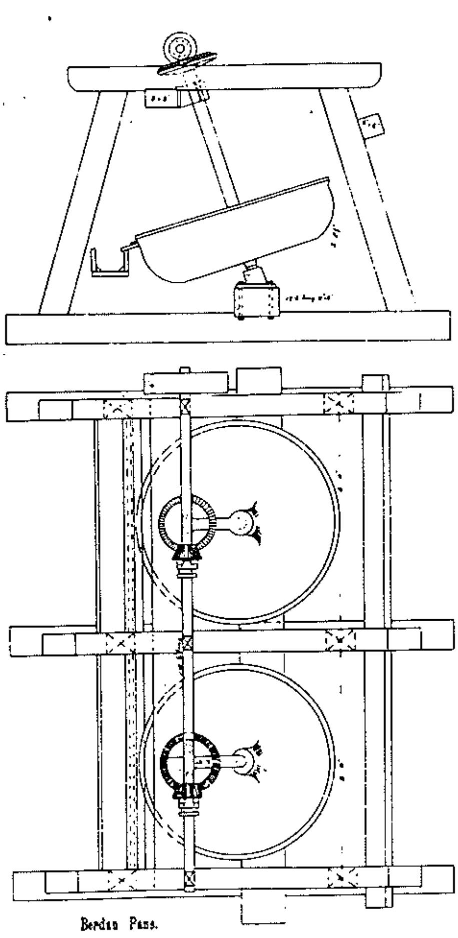


Stamper battery with parts labelled, including **amalgamating plates** and **tables** (Idriess 1931)



Cross section of a **beam enginehouse** and pumping engine, Berry Number One Mine, Victoria (deep lead). (Davey & McCarthy 1988: 20, after *Annual Report* 1884).

Berdan pans	A machine for crushing ore, patented in 1852. Consisted of a circular *pan* or bowl, set of an angle and rotated by a central shaft. Iron balls or blocks inside the pan crushed the ore by grinding it against the sides of the pan as it revolved. Lighter particles slopped over the side of the tilted pan. Usually used for the final regrinding of gold *concentrates* with mercury added to *amalgamate* released gold.
Blake crusher	see *rock breakers*
blanket tables	Tables covered with blanketing or corduroy material, to capture heavy metals (such as free gold) from the sands and slimes coming from a *stamper battery*. The blanket table was placed either directly beneath the *mortar box* of the battery, or more often below the *amalgamating* tables.
blast furnace	A metallurgical furnace in which a mixed charge of ore, flux and fuel is blown with a continuous blast of hot air, to stimulate the chemical reduction of metals to their metallic state. Most commonly used for the treatment of iron, copper and lead ores.
blow	An extensive surface outcrop of a reef or ore body. Usually worked by *open-cut* methods.
boilers	A common element of old mining sites, to provide steam for machinery. See *Cornish boiler, Lancashire boiler, Galloway boiler, Scotch boiler, firetube boiler, vertical boiler, Babcock and Wilcox boiler.*
bord and pillar	Mining method used for the extraction of coal. At the level of the coal seam, a normally rectangular grid pattern of wide drives (bords or stalls) are driven to extract coal, leaving *pillars* between them supporting the roof. The pillars are subsequently extracted allowing the roof to collapse. Also called 'pillar and stall', 'room and pillar' and 'stoop and room'.
brace	The landing platform on a headframe to which ore and mullock are raised. The brace is usually at the same level as the mullock dump and mill, and in coal mining is sometimes also used to refer to the attached coal handling structure (see *heapstead*). Also called the *banking level..*
brattice / brattice cloth	Heavy sacking or fire resistant fabric placed in mine passages and shafts to separate haulage ways and to direct air flow through the workings.
bucket dredge	A recovery plant mounted on a pontoon and equipped with digging, washing and concentrating apparatus, although some of this could be located on shore rather than on the dredge itself. The material was excavated by buckets on a continuous belt, the dredge moving under its own power and cutting its own channels and ponds.



Berdan pans (MacLaren 1901).

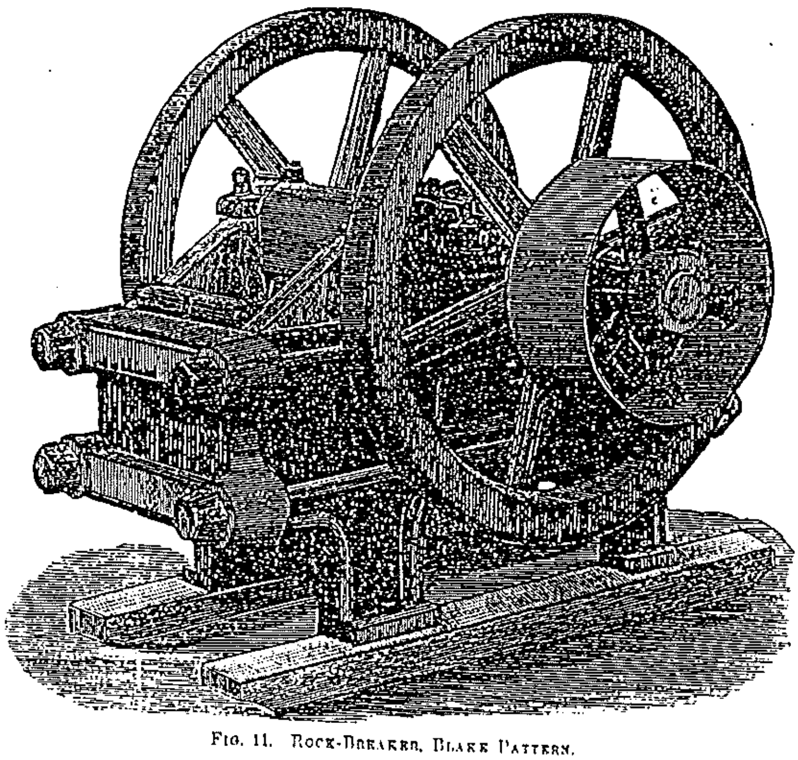
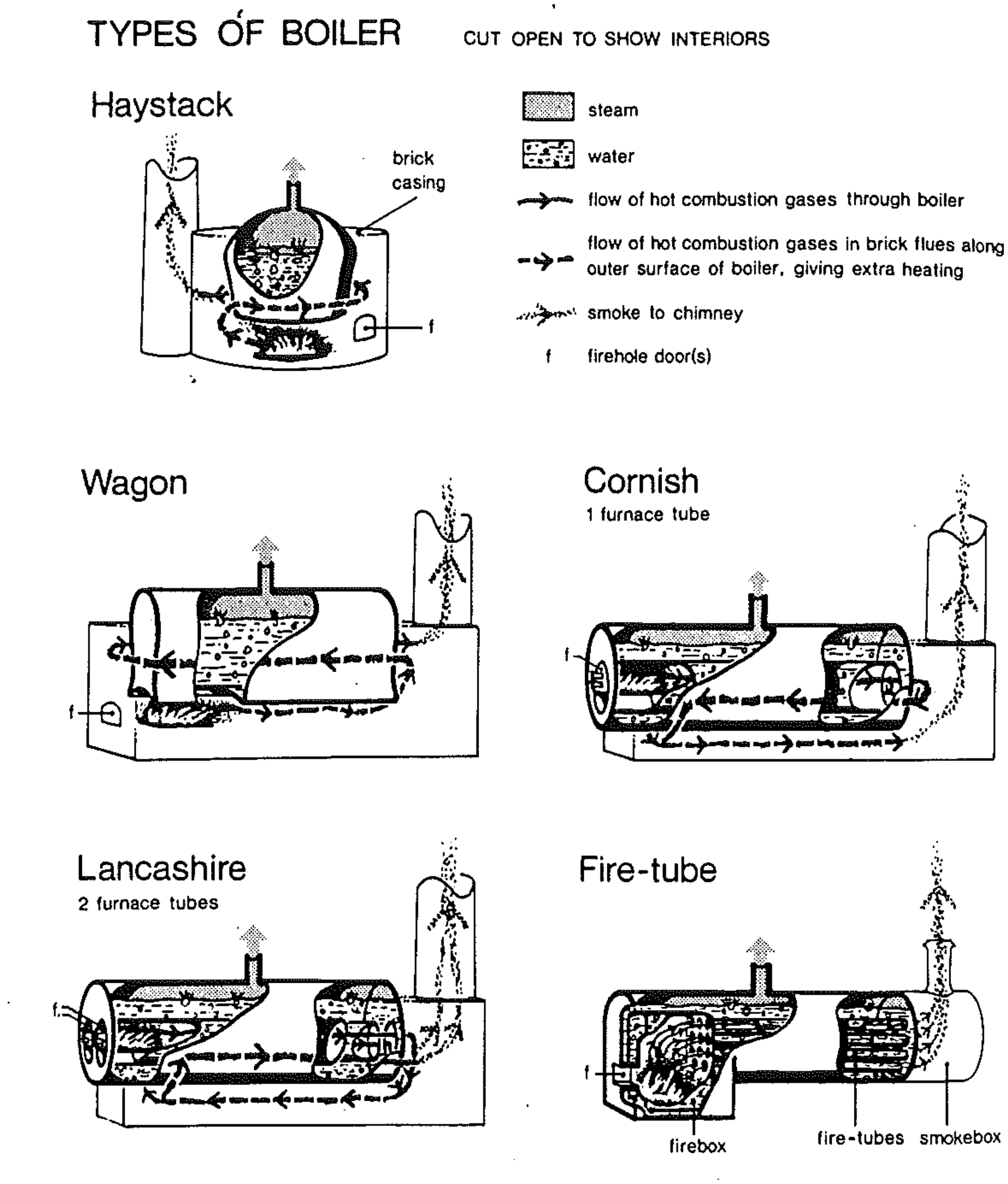
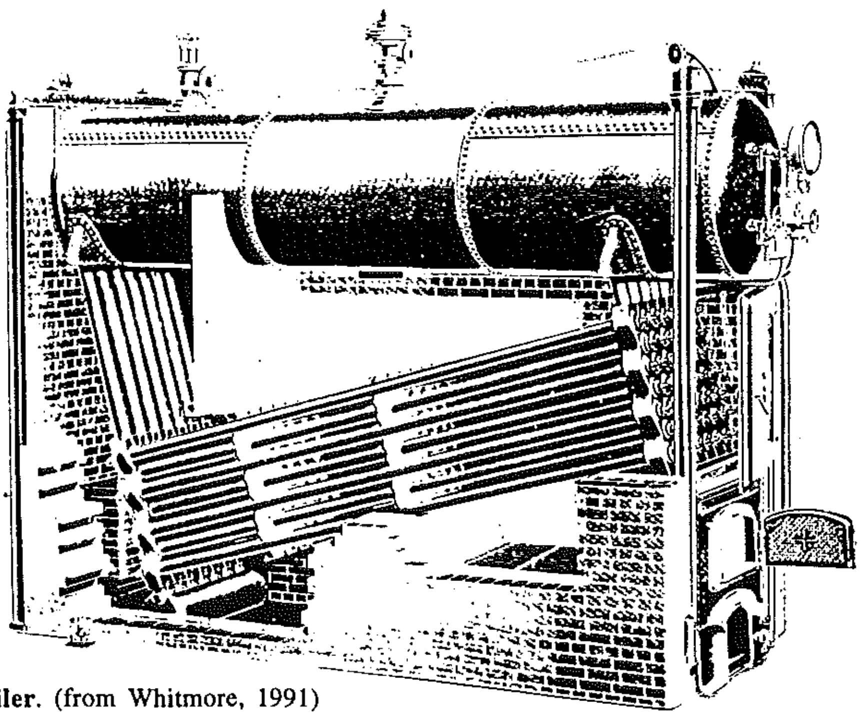


FIG. 11. ROCK-BREAKER, BLAKE PATTERN.

Blake rock breaker (Preston, 1895)



Cossons, 1993



Babcock and Wilcox boiler. (from Whitmore, 1991)

	The term 'dredger' is also used to describe large track-mounted cutting machines with bucket wheels or continuous bucket chains, used to cut brown coal. See also *dredge*.
buddles	Circular appliances used to separate and concentrate slurries of minerals or ores with the aid of flowing water and gravity. Buddles are large items, (c.9 m diam) either set in a circular pit, or above ground on a frame. The base of the buddle may be convex or concave, concentration being achieved by water flowing down the slope and the finely crushed ore being swept by water and rotating sweeps or brushes. Often used for reprocessing tailings from *batteries*.
cage	An enclosed platform attached to the winding rope and used to transport men and materials in a mine shaft.
calcining	Heat treatment designed to break down or drive off certain volatile constituents of an ore, such as pyrites, sulphur and arsenic. see *roasters*.
Californian pump	A simple hand or horse powered pump used to raise water short distances. It consisted of a timber trough or box, through which a continuous rope or belt passed, turned by a crank and roller at one end and running over a roller or wheels at the other. The pump operated on an angle, with the bottom end in a pool of water or a creek. A series of timber slats attached to the belt raised the water up the trough as the belt moved through it, discharging at the upper end. Based on the *Chinese pump* design.
cam	An iron fitting with a curved wing each side of a central hole, set onto a drive shaft and lifting and releasing the *stamper* stem within a stamper battery. Sometimes found discarded around a *battery* site.
caps	The heavy timber beam placed on top of vertical timbers (props) to support the roof of a *drive, adit or tunnel.*
centrifugal dredges	A centrifugal dredge (also called a suction dredge) was a pontoon-mounted centrifugal pump, together with washing and concentration apparatus. There were two main types: 1. The dredge floated in a pond in sandy or loose alluvium, the dredge extending the pond itself by undercutting the banks by suction. The centrifugal dredge in this case operated like a *bucket dredge*, the pump raising the material instead of buckets. This type was used for sand mining, and sometimes for gold mining. 2. The dredge sat on dry land and raised material washed into a sump adjacent to it, the dredge being moved from time to time by flooding the area and floating the dredge to a new location. Much of the washing plant for this type might be mounted on land near the dredge, the material often being raised to elevated sluice boxes by a *hydraulic* or pump *elevator*. The material was

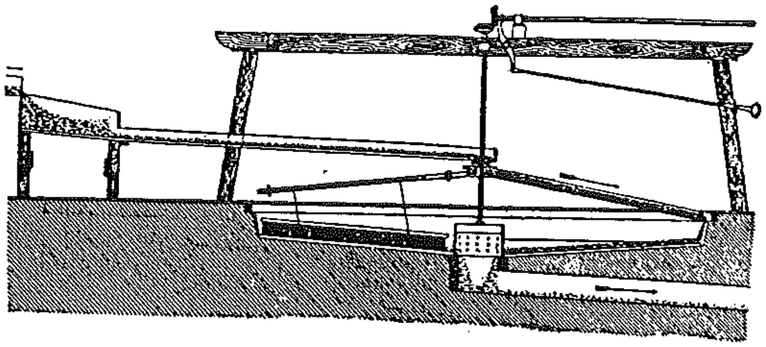
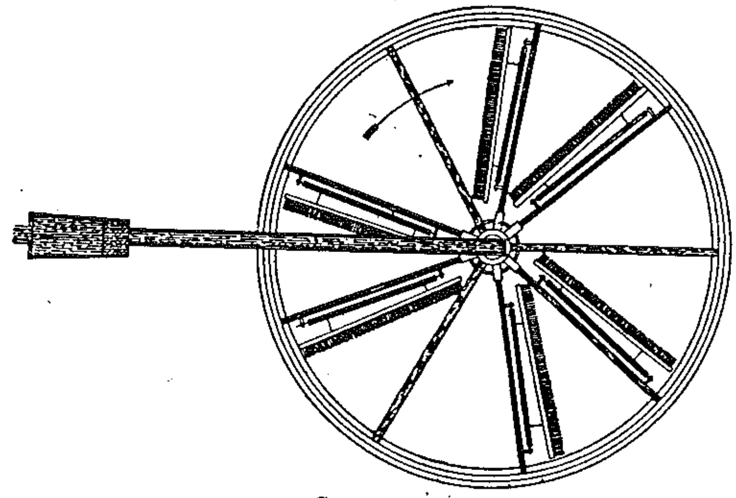


FIG. 587.



Concave Buddle.

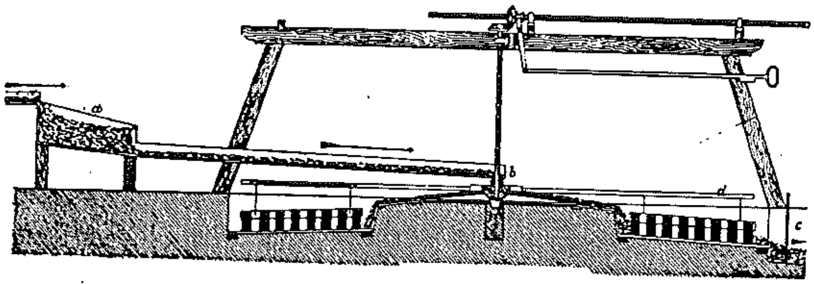
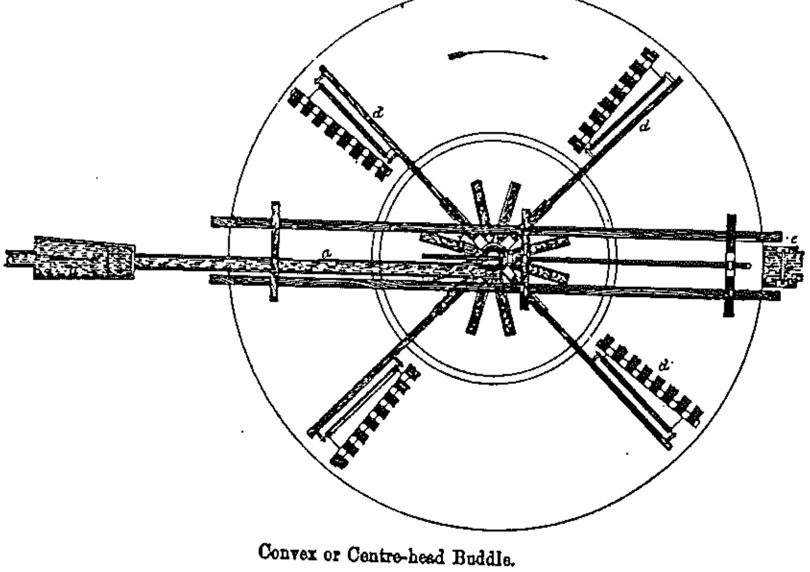


FIG. 535.



Convex or Centre-head Buddle.

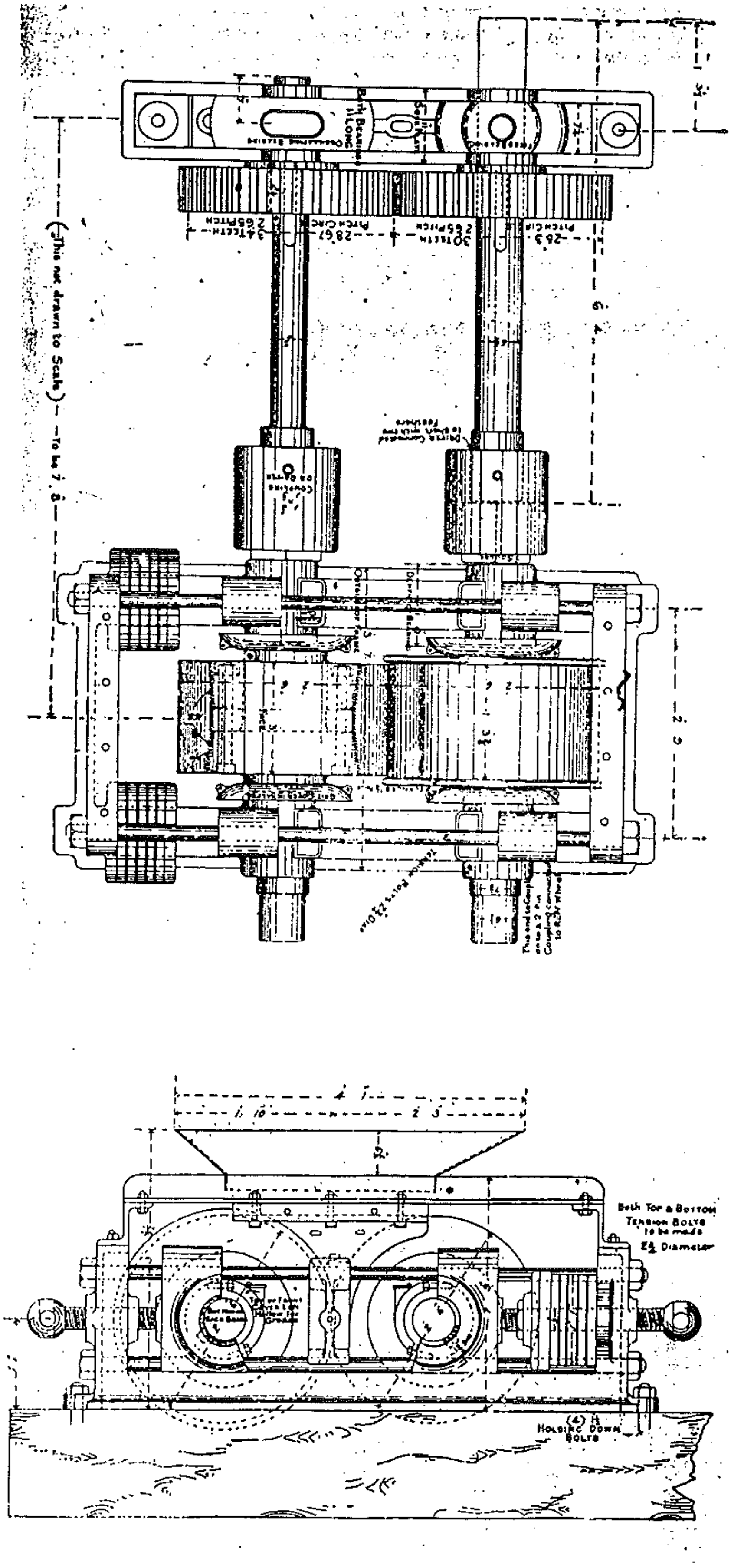
Concave and convex **buddles** (Lock 1890: 360-361).

washed into the sump for dredging by hydraulic sluicing of the surrounding alluvial deposits. The water pressure for the sluicing hoses was often provided by pumps mounted on the dredge, and the process was sometimes called 'pump hydraulicking' or 'centrifugal sluicing'.

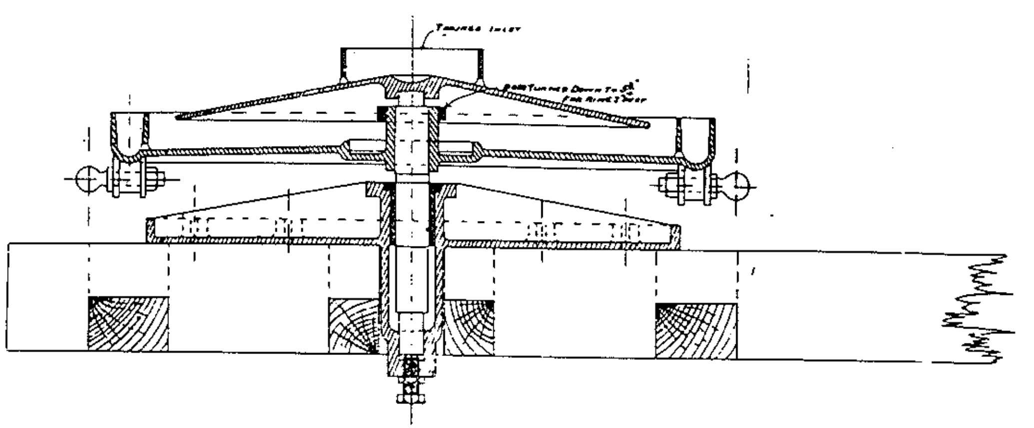
See also *dredge*.

Chilean mill	A circular trench in which two large stones with iron rims rotated around a central axis. The mill was horse powered, and used to crush ore. Modern steel versions are still used.
Chinese pump	Similar to the *Californian pump*, constructed entirely of wood.
chlorination	A method of capturing gold from ore, used most commonly in the 1880s and 90s but rapidly replaced by the *cyanide* process. The method involved roasting the ore, usually in *reverberatory furnaces*, then dissolving the material containing the gold in chlorine solution in wooden vats. The gold was precipitated from the gold chloride solution with ferrous sulphate, then filtered. It was much more expensive and not as effective as *cyanidation*.
claim	A portion of ground marked off in accordance with the mining by-laws and held by virtue of a licence or miner's right. Smaller, cheaper and less secure than a lease.
classifier	A separating machine which grades crushed material between steps in *concentrating* processes. '*Spitzkasten*' were one type of classifier, with an inverted pyramidal form, used on some Australian gold mining sites.
coal cutter	An electrical coal cutting machine generally consisting of a series of cutters fitted to an endless chain surrounding a cutting head that extended from the machine. Various forms of cutter were used. The first coal cutters were introduced into Australia in 1889, but even by 1946 only 36% of coal in NSW, for example, was cut by machine (Hargreaves 1993:113).
coke oven	A beehive shaped masonry oven, usually in banks of multiple ovens, for producing coke from coal by heating it in a controlled atmosphere, removing the gas and liquid components. Found near a number of coal fields. Coke was one of the fuels used in smelting.
collar	The timber, steel or masonry framework erected around the entrance to a *shaft* to prevent the ground surface collapsing into the shaft. The collar is sometimes extended part of the way up a *headframe* to prevent items falling into the shaft from the ground level.
colliery	A common name for a coal mine and its associated above ground buildings.

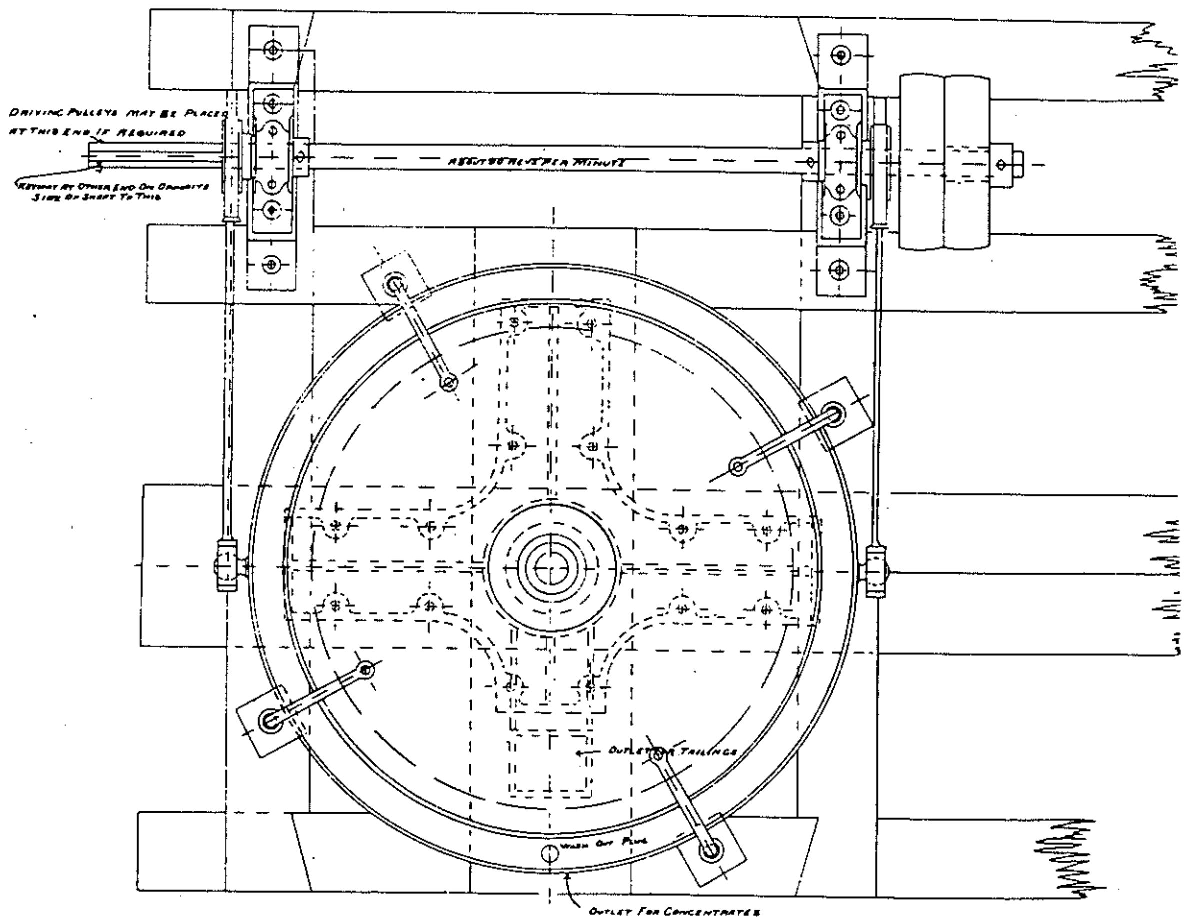
concentration	Elimination of the non-valuable lighter portions of a crushed ore and collection of the valuable heavy components.
concentrators	A variety of machines used to concentrate ore by removing non-valuable *gangue*. see *tables, vanner, jigs, buddle*. Convex concentrators, such as the Brown and Stanfield concentrator, were like small versions of *buddles*, and were used on some fields.
converters	Cylindrical steel vessels c 1.8 m in diameter and 2.4 m long, lined with refractory bricks, into which molten copper matter was poured and a blast of air passed through it to oxidise copper sulphide to copper metal. Present at a number of copper smelting sites.
Cornish boiler	A common type of boiler found on mining sites, used to produce steam for machinery. The Cornish boiler is cylindrical in external form, with a single circular flue running through it, with a fire grate accessed by a door in the 'front' face. See *boilers* for other types. Cornish boilers were set into a masonry bed, to conserve heat, support the boiler, and provide a smoke box and support for the chimney.
Cornish rolls	A heavy duty primary crusher, with opposing steel rollers. see *rolls*.
costean / prospect cut	A trench or slit cut into the ground to expose the geology. Used as a prospecting technique to identify the location of reefs or ore bodies.
country rock	The non-metalliferous rock in which a lode or reef is located.
cradle	A timber box, open at one end, resting on curved rockers. The box was fitted with two movable slides with *riffles*, and the base of the box also had riffles. *Washdirt* was placed in a removable hopper on top of the cradle, and the earth washed through the hopper's perforated base by ladling water into the hopper. , The dirt then washing over the riffle plates below as the cradle was rocked by hand.
creeper	An endless chain with hooks that engaged the axles of *skips*, moving them around an underground coal mine.
crevicing	The recovery of gold from crevices in bedrock or the hard base material beneath the *washdirt*.
crucible	A conical or cup-shaped vessel made of refractory clays used to heat ores in assaying, smelting and refining processes. Commonly found near assay offices on mining sites.
cut	A deep cutting into rock to cut an ore body or lode. Also used as shorthand to describe *costeans* and prospect cuts.
cyaniding / cyanidation	A process of extracting gold by treating the finely crushed ores



Cornish rolls (Clark 1904).

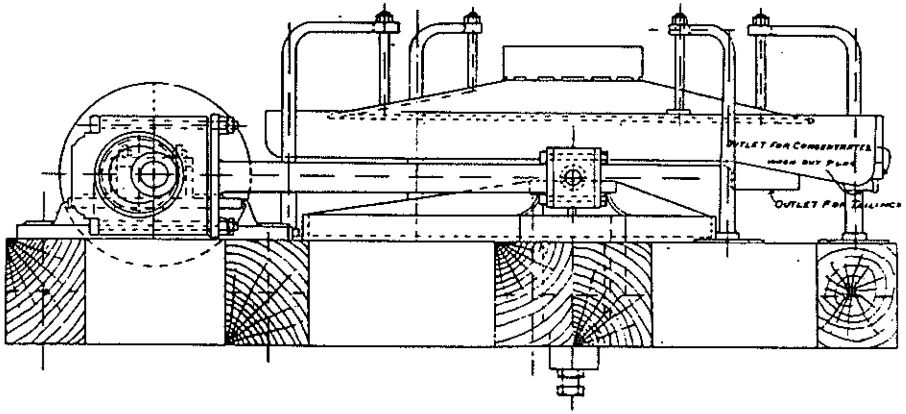


VERTICAL SECTION



PLAN

Brown and Stanfield Concentrator.
Scale : ¾ inch = 1 foot.



ELEVATION

MacLaren, 1901.

with a solution of potassium cyanide, sodium cyanide or calcium cyanide in large tanks or 'leaching vats', which are commonly found on gold mining sites. The gold was then recovered by filtration and the precipitation of gold on metallic zinc. Cyaniding came into use in Australia from 1892, and replaced the more expensive and less effective *chlorination* process. It greatly improved the efficiency of gold retrieval from low-grade ores.

Cyanide tailings are a distinctive bone-white colour

dams — A variety of dam types existed on mining fields. The dam wall could be of earth, concrete, stone, brick or timber, usually built across a creek line, though sometimes on relatively level land, especially above large alluvial workings. Dams could be fed by natural watercourses or by *races*, and delivered water to the workings or mill by race. pipe or *flume*.

deep lead — An auriferous or tin bearing alluvial deposit at a considerable depth from the surface in the old course of a buried stream, and entirely covered by basalt or by soil or weathered rocks.

derrick — A tall *headframe* usually associated with oil drilling and water boring.

dolly pot — A mortar and pestle used by prospectors to crush ore for *panning*.

dredge — A recovery plant mounted on a floating pontoon and equipped with digging, washing and concentrating apparatus. Used for the recovery of alluvial gold, tin and mineral sands. The mineral is raised from the stream or pond floor by continuous buckets or suction pipe, then passed through *screens*, *jigs*, *sluice boxes* and other apparatus, the residue being deposited behind the dredge.

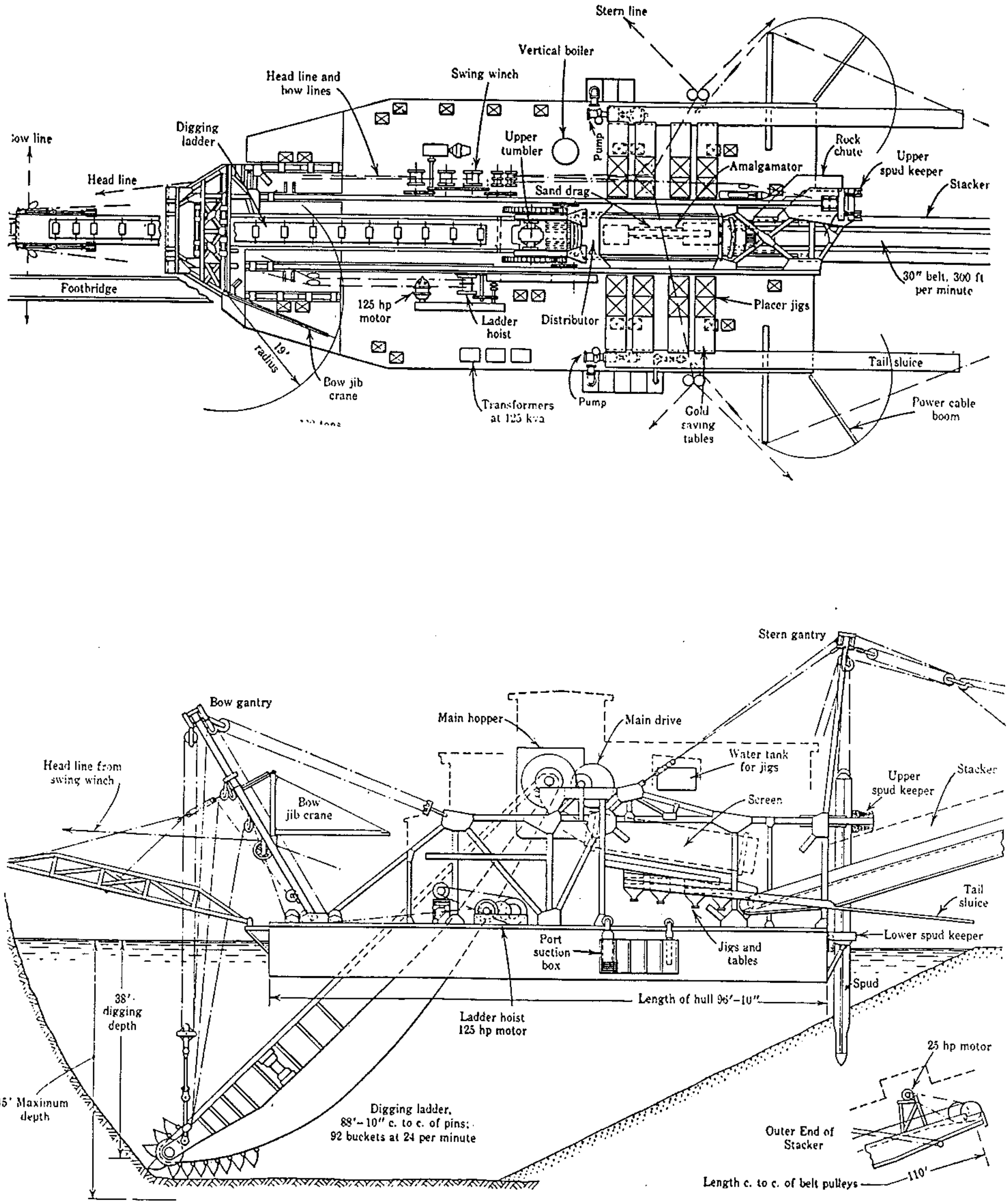
see also *bucket dredge* and *centrifugal dredge*.

dredge pond — The pond in which a *dredge* operated. The location of the pond changed as the dredge excavated one side and deposited tailings on the other. Dredge ponds often remain on river flats as a sign of dredging after the dredge itself has been removed.

drift shafts and tunnels — *Shafts* and *adits* dug to test or work auriferous alluvial deposits near the surface (as opposed to 'deep lead' workings). 'Drift' was also used to describe relatively loose alluvial material, and an inclined adit or shaft accessing an underground coal deposit.

drifter drill — A pneumatic drill used for driving in hard ground. It is mounted on a steel pole braced against the roof and floor of the *drive*.

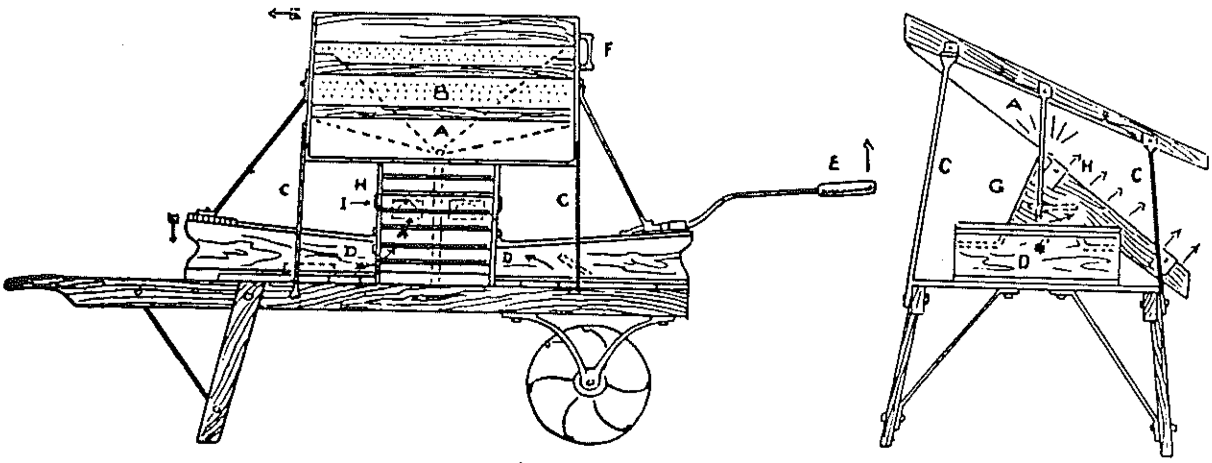
drive — A horizontal or gently inclined underground passage driven along the line of a lode, reef or structure within a mine, or connecting the shaft or the surface with the mining face. Sometimes used synonymously with *adit*, though some drives



Gold **dredge**—plan and sectional elevation (Peele 1941: 10-578)

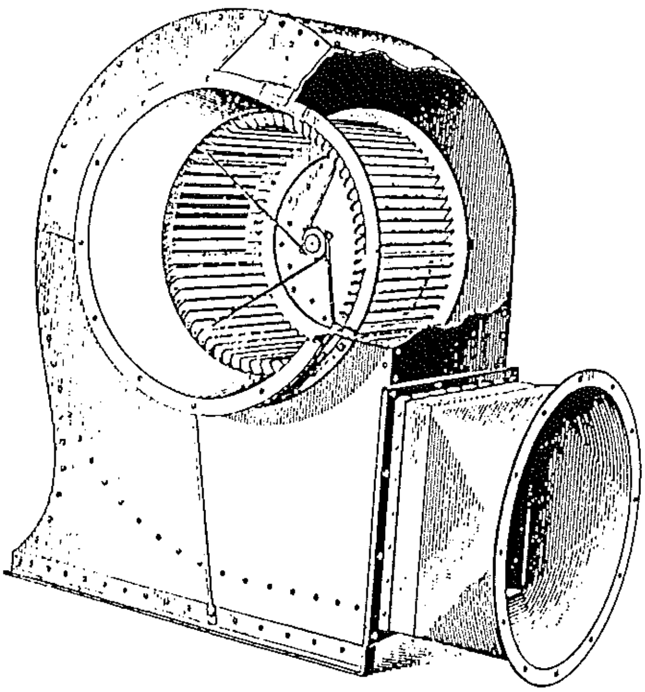
BUHRE'S DRY-BLOWER

Scale 0 1 2 3 FEET



A. Hopper. B. Screen and Riffles. C. Hinged Hopper Supports. D. Double Bellows, Top Movement. E. Handle for Right Hand. G. Wind Chest. H. Perforated Zinc Screen and Riffles. I. Flanges Keeping Zinc Screen in Position

Dry blower (Idriess 1931, after Dunstan 1902)

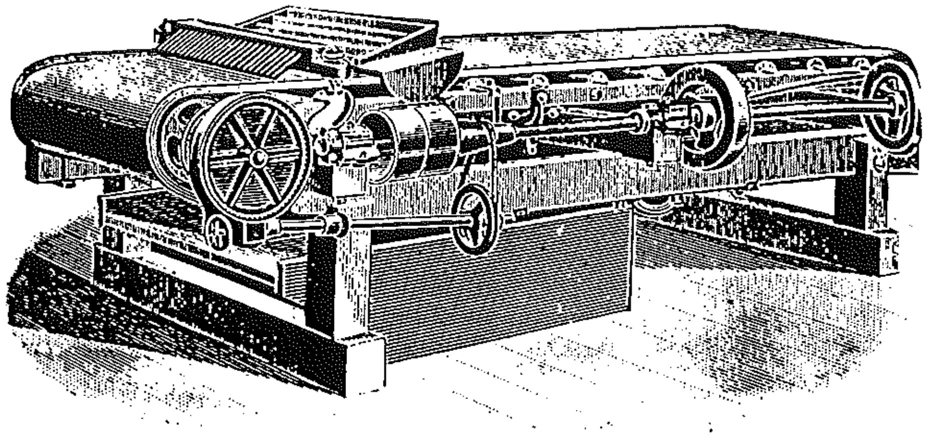


Single-entry Sirroco **fan** (Whitmore 1991)

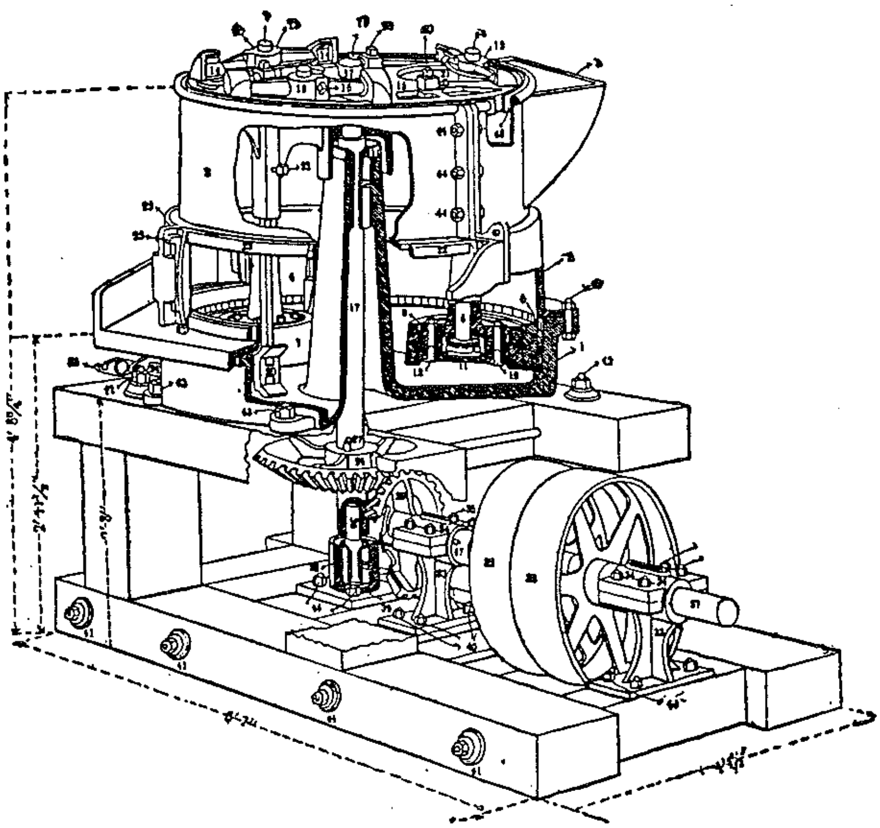
	are not adits in that they do not reach the surface.
dry-blowing	A way of separating particles of heavy mineral from sand or gravel when no water is available. Methods ranges from simple winnowing in the wind to the use of a dry-blower machine, which had a bellows which blew air through dirt loaded into the top of the machine, separating the lighter sand and gravel from the mineral.
face	The end of a *drive*, the area at which a seam or lode is worked, or the wall of a surface excavation. In *hydraulic sluicing* it was the area being actively worked, which could be up to 30 m high.
fan / fan-house	Feature of deep mines and especially coal mines, to provide artificial ventilation. Usually associated with a separate *air shaft* connecting with the underground workings, and consisting of a usually masonry structure housing a centrifugal fan, such as the 'Sirocco' fan. Before mechanical fans were introduced, generally from the 1880s onwards, coal mines used air shafts with furnaces at their foot to produce updraught by convection.
firedamp	Explosive gas such as methane released from coal, and producing the risk of explosion in coal mines. The risk led to the ventilation of coal mines by furnace and *fans*, the invention of the safety lamp, and the early introduction of compressed air and electrical equipment.
firebricks	Bricks made of refractory material and used to construct the inner skin of smelters, furnaces and kilns. Often imported and stamped with the maker's name, and commonly found at smelter sites.
firetube boiler	Sometimes called 'locomotive boilers'. Consisted of a circular boiler shell with a fire box at the 'front' face, from which numerous small fire tubes carried hot gas through the water-filled body of the boiler to vent through a smoke box and chimney at the other end. The most common type found on mining sites are in the form of portable engines with steam pistons located on top of the boiler (or sometimes beneath it—the 'undertype' engine), and wheels or axles for wheels to allow easier transportation.
flotation	A system of *concentration* in which the valuable component of the finely crushed ore is separated from the non-valuable part (the *gangue* etc) by means of gas or air bubbles blown through a liquid containing the ore. Various reagents (such as eucalyptus oil) were used at different times to improve the attractive power of the bubbles. Flotation was carried out in 'cells', being open boxes with associated piping to supply the air blown through the cells.
flue	A brick or masonry passage to carry fumes and smoke from a furnace, smelter or kiln to a chimney.

flume	A trough or launder usually mounted on trestles and used to carry water over a depression, a water course, or around the side of a cliff. Used in combination with *races* and pipes to carry water to or from workings and mills.
fluxes	Substances added to ore to lower its melting point and encourage chemical reaction in components of the ore during *smelting* or *converting*, or in assay refining. For different purposes, fluxes included ironstone, limestone, borax and sodium carbonate.
flying fox	see *aerial ropeway*
Galloway boiler	A boiler similar in external form to a Cornish boiler, but with a cluster of small firetubes running the length of the boiler from fire box to smoke box instead of the single tube of the Cornish type
gangue	The non-valuable matrix in which valuable metallic ore occurs.
gantry	An elevated tramway or conveyor belt leading from a *brace* or a *mill* to ore bins, processing plant or *mullock dumps*.
gossan	see *oxidized zone*.
goaf / gob	The area abandoned and left to collapse after the extraction of coal. see *bord and pillar*.
grizzly	A set of parallel bars or grating across which ore is passed, separating out the larger pieces for further primary crushing.
ground sluicing	The washing of shallow alluvial deposits with running water in a channel cut into the ground or bed rock, rather than in an elevated *sluice box*. The ground sluice was often lined with *riffles*, battens, wood blocks, or stones to prevent erosion of the floor and to increase the capture or ore. Ground sluicing required an adequate fall of land to allow sufficient flow of water through the sluice and for the water-born *tailings* to escape.
gully raking	The colloquial term for the following up of gullies and creek beds to win gold by *crevicing* and *panning* or small scale *sluicing*. Often used to describe the opportunistic re-mining of areas overlooked by earlier miners, and carried out without *claims* or leases being issued.
hammer and tap	A rock-drilling process in which one man holds a steel drill and rotates it while another hammers it with a sledge hammer.
haulage	Any system whereby *skips* are propelled along an inclined tramway by means of a rope. Particularly common in coal mines, where three systems were used; direct haulage by a drum winder, the skips returning by gravity alone; tail-rope, where a second rope was attached from a second winder drum to the end of a line of skips to reverse the direction of travel; and endless rope, where a rope ran around pulleys at in a continuous loop,

	skips being hooked on to travel around a circular track. The latter became the most common by the late 19th century. In the case of mines with inclined tunnel access, the haulage was usually extended to the surface, carrying the skips over a *tippler* where the coal emptied into bins or onto *screens* for sorting. (see Whitmore 1991 for a full description).
head / sluice head	A measure of water flow and volume. Used on those fields where water *races* were provided by companies other than those operating the particular mine drawing the water, in order to measure water usage and charge for it. A 'head' is usually given as one cubic foot of water per second. Races were sometimes referred to as carrying a certain number of sluice heads
headframe	The seat of wooden or steel legs and platform erected over a *shaft*, to enable materials to be raised and lowered safely. Also called a *poppet head.*
heapstead	The name sometimes given to the *pit-head* structures at the top of an inclined coal mine tunnel, housing the *tippler*, *screens* and *picking belt*.. At some coal fields the term *brace* seems to have been extended to this structure.
Huntington Mill	A machine for crushing ore in use from the 1890s. Operated as a centrifugal roller mill, with steel rollers rotating against the side of a cylindrical iron pan. Carried out the same functions as the stamper battery, and though by no means as common, is still found either complete or in pieces on some sites.
hydraulic elevator / jet elevator	An arrangement used to lift alluvial material and water to a higher level, so that gravity sluicing could be effectively utilised. Introduced from the 1880s. A sump was dug in the base of the alluvial area, and a vertical pipe with a constricted throat was placed in the sump. A hydraulic hose was led to the base of the pipe, and a nozzle directed up it. Any dirt and gravel washed into the sump was blown up the pipe onto sluices above.
hydraulic sluicing / hydraulicking	The sluicing of deeply buried and often poor deposits with the assistance of high-pressure water hoses. Required a reliable water source and a suitable fall of water to the sluice nozzle (monitor) to provide sufficient pressure to hose down the overburden and wash material. Resulted in large open workings cut into hillsides, with high steep faces. High pressure hydraulic sluicing was introduced into Australia from California in the 1870s, having been invented there in 1852. Hydraulic sluicing was sometimes used on ground previously worked by ground sluicing, and remnants of ground sluicing are often found adjacent to the hydraulic face.
incline	A inclined *shaft* or passage. An inclined shaft was sometimes called an *underlay.*
inclined tramway	A tramway linking a mine and/or mill located in the bottom of a gorge with the top, or linking a mine on a slope with a mill at a

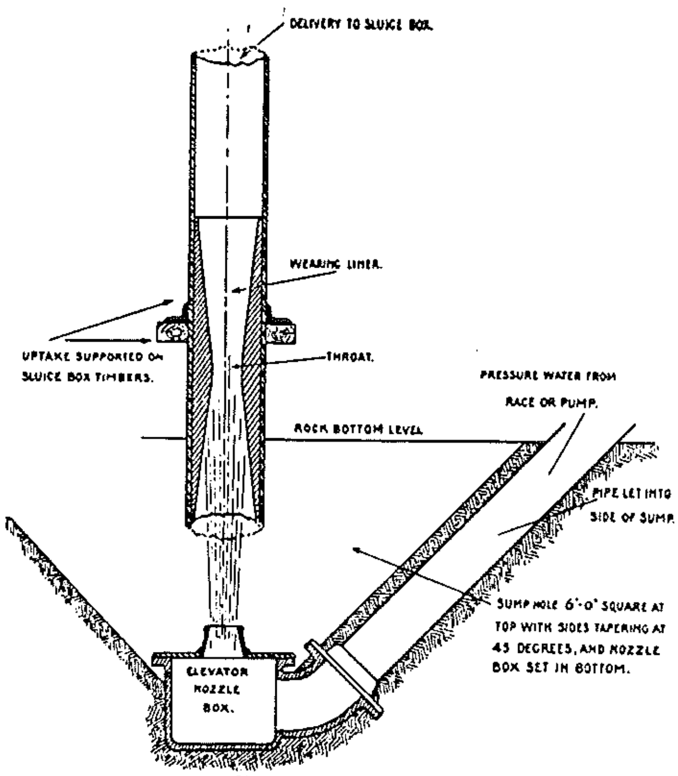


Frue vanner (Young 1978: 14)



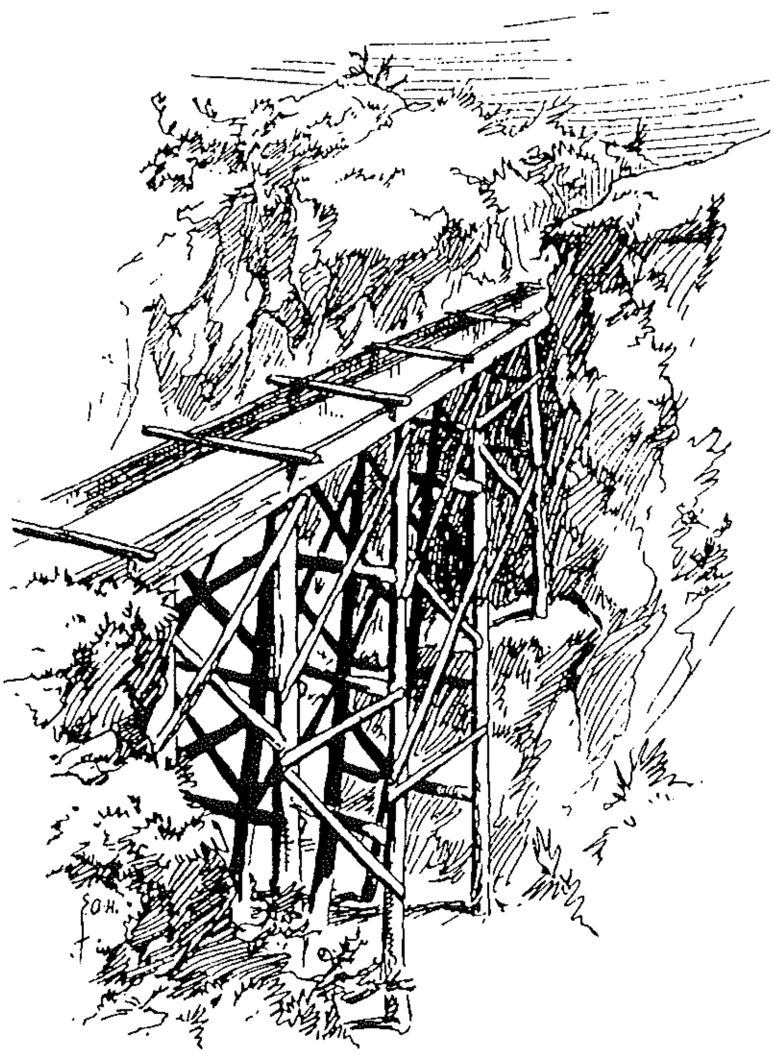
Huntington's Centrifugal Roller Mill.

Huntington Mill (Lock, 1890: 325)



THE ELEVATOR

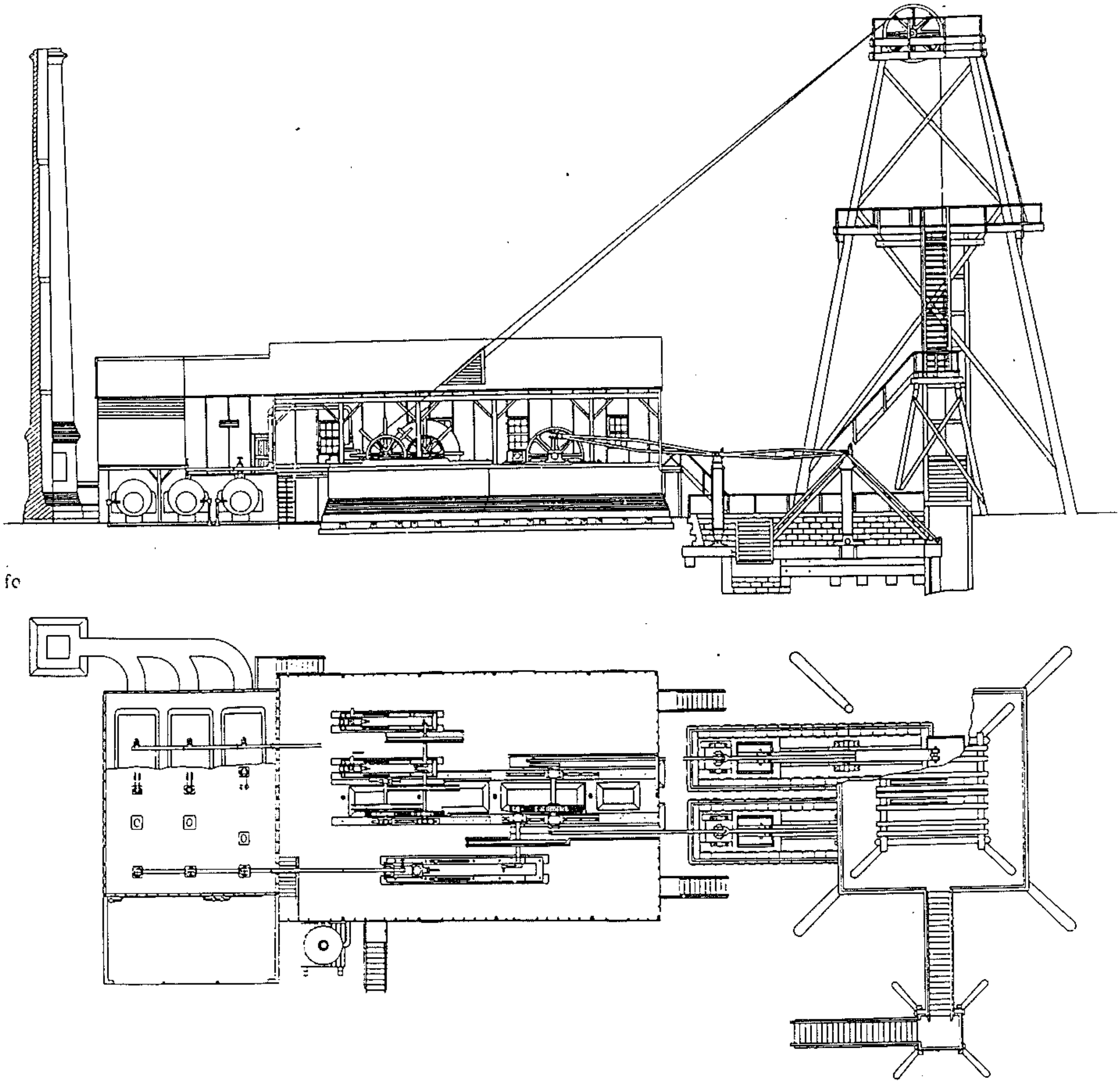
Hydraulic elevator (Idriess 1931)



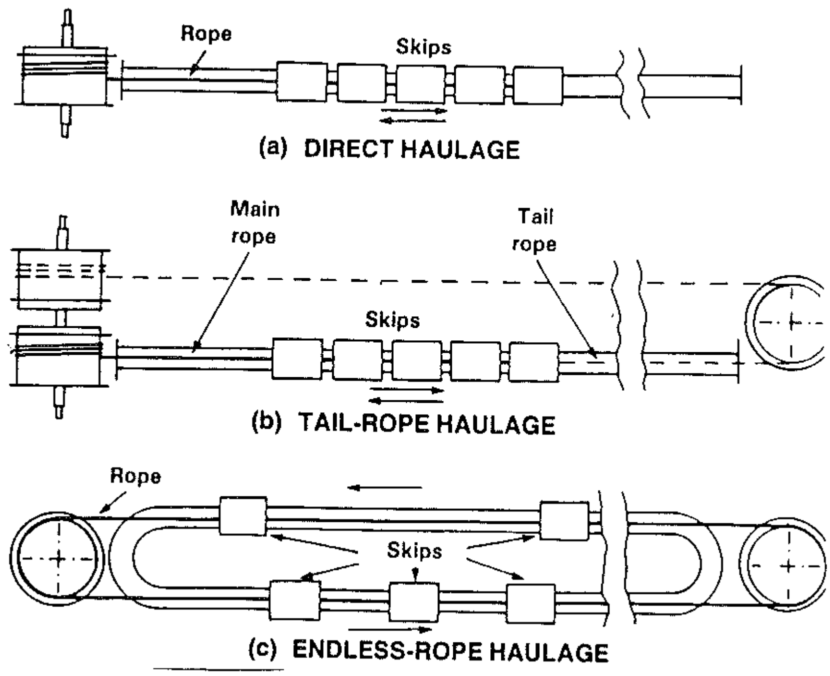
Flume (Idriess 1931)

FLUMING HEAD-RACE WATER ACROSS GORGE

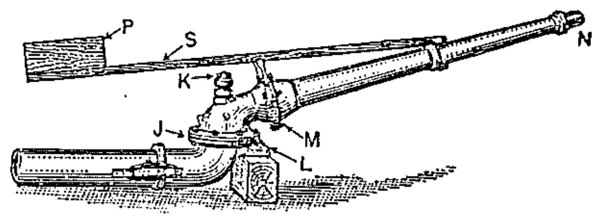
	lower level. Called a *self-acting incline* if the descending loaded trucks were used to pull up an empty truck on the other end of the cable. The tramway had a section of double track halfway up the incline so the trucks could pass each other. Some had three rails to simplify the cross over. Where the filled trucks had to be hauled up the incline, a *winding engine* was located at the top.
inverted syphon (siphon)	A pipe carrying water across a valley or depression by a syphon action. Introduced when wrought iron piping became readily available, the first syphon in NSW being built in 1887 (McGowan 1996a:218). An intake fed water from a race into a pipe laid down the side of the valley, the pipe then crossing the valley on a trestle, and rising up the other side to an outfall into a continuation of the race at a slightly lower level. The pipe was sometimes placed in a cutting or on an embankment to maintain a straight line of fall and rise, and these sometimes remain when the pipe has long gone. Syphons often replaced the more expensive high level flumes to carry a water race line across a gully.
jigs	An apparatus used to concentrate ore or separate large pieces (as in washing coal) on a screen submerged in water, either by a reciprocating motion of the screen or by the pulsation of water through it. A jig is also a *self-acting incline*, a term most commonly used in coal mining.
kibble	A barrel shaped bucket used to haul water or ore up a shaft. The steel frames of kibbles are often found at small mines.
kiln	A chamber in which ore was calcined or heated . Common forms of kiln included gold roasting kilns, coke ovens, and lime kilns.
lamp room	A room or building at a coal mine used to store and recharge cap-lamps.
Lancashire boiler	The Lancashire boiler is cylindrical in external form, with a two circular tubes running through it, with two fire grates accessed by two doors in the 'front' face. Heated gases passed through the tubes then returned along a flue beneath the boiler and passed again down the boiler sides of the boiler to the chimney. Lancashire boilers were set in a masonry bed. See 'boilers' for other types.
laths	Timber boards placed between the *sets* of *props* and *caps* in underground passages of all kinds, to support the side walls and roof and prevent or give warning of cave-ins.
level	An underground horizontal passage in a mine, driven to give access to ore bodies and to provide for truckways and tramways. Also used generally to indicate the different



Headframe, winding engine, boilers, and pumping engine with rocking beam, at the Berry Consols Mine (deep lead), Victoria. (Davey 1988, after *Annual Report* 1885)



Haulage systems (Whitmore 1991)

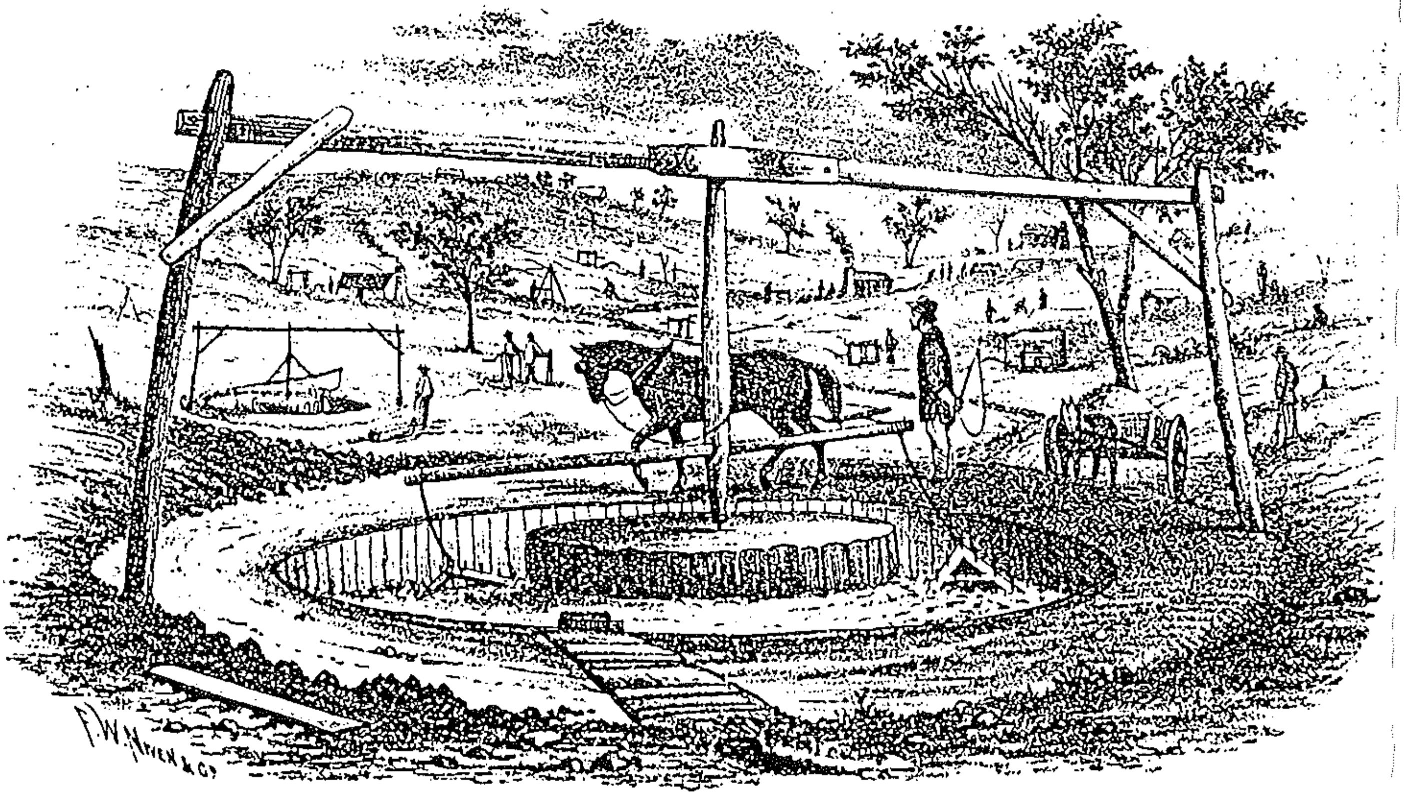


Hydrauliking **monitor** (Peele 1941:10-553)

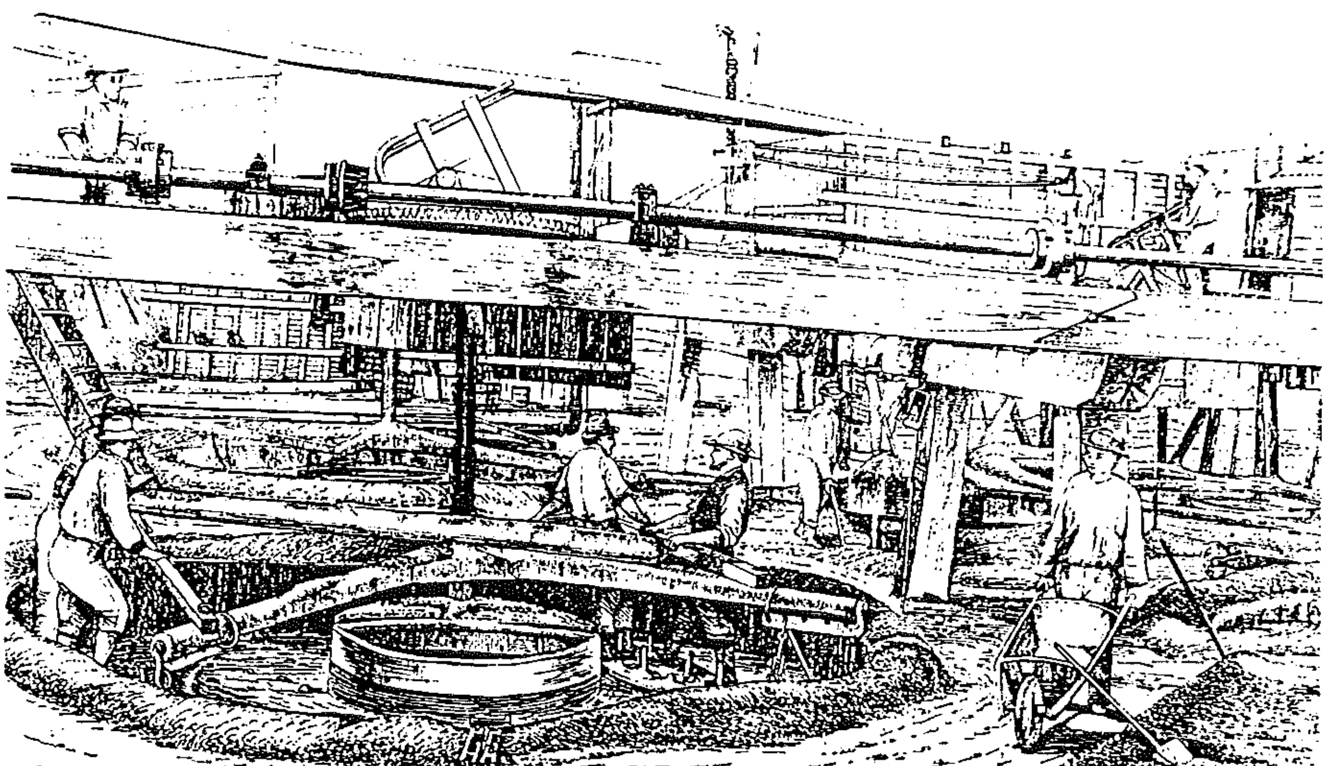
	workings at varying depths within a mine.
loaming	A method of prospecting in which dirt is washed from places chosen systematically around and up the slope of a hill, positive washings indicating the location of the mineral source.
lode	A mineral deposit in solid rock, as opposed to an alluvial deposit.
long tom	A type of *sluice box*, usually about 4 m long, used for continuous sluicing using running water. Comprised two inclined troughs or boxes placed one over the other. The upper box had a perforated or grated base near the lower end, through which the finer material fell onto the lower box which was fitted with riffles. Washdirt and water were fed into the top end of the tom, rocks being forked out from the perforated end of the top box.
longwall mining	Method of extracting coal on a continual working *face*. The space behind the wall, from which coal has been extracted, was in early forms of this method supported by stone packing, but later the roof was allowed to collapse behind the working area, where it was held up by steel beams and hydraulic rams. Traditional longwall operations occurred in Australian collieries from the turn of the century at least, though infrequently. Continuous mechanical longwall extraction is a relatively recent introduction in Australia, from the 1950s and 60s onwards.
matte	The metallic copper resulting from the *smelting* process. Matte was normally between 40% and 60% pure copper, and was further refined in *converters* or sent to centralised works for refinement by careful smelting or electrolysis.
mill	A collective title given to the concentrating equipment and grinding machinery used to treat and recover metals or minerals.
monitor	A large nozzle which directs a stream of water under high pressure on to alluvial ground. It was invented in 1870, had joints which allowed the nozzle to be swivelled to sweep the water jet across a face, and was used in *hydraulic sluicing*.
mortar box	An oblong cast-iron box in which the stampers of a *battery* work. Commonly a feed slot is located on one side of the box and an opening with a metal screen on the other to regulate the size of the crushed slimes leaving the box.
mullock	Waste, barren or uneconomic rock obtained in the course of mining. The Cornish name 'attle' is sometimes used in South Australia. Either deposited in *mullock dumps*, or used to backfill worked out *stopes*.
mullock dump	Deposited *mullock*, generally seen as the long heaps extending from an *adit* or surrounding a *shaft* or *pit*.

mundic	A Cornish-derived word for iron pyrites.
open cut	An excavation for the purpose of working an ore body or deposit which lies close to the surface. Sometimes called 'open cast'.
ore	Rock or mineral deposit containing particular metals or minerals in commercial quantities.
oxides	Compounds of oxygen with various other elements.
oxidized zone	The upper part of an ore body is sometimes oxidized, modifying the mineralisation of the ore. Commonly this zone is called *gossan*.
paddock / paddocking	A portion of an alluvial area being worked by *ground or box sluicing*, usually the latter Also an area for storing washdirt or ore, which was said to be 'at grass'. 'Paddocking' meant to systematically work a small claim on alluvial flats by a series of paddocks. The paddock was rectangular in shape and at the larger claims could measure 20 m x 20 m.
panel	The section of the mine (most common in coal mines) where production has or is taking place.
panning	The method of testing *washdirt* or finely crushed *lode* material for heavy minerals by washing a quantity of it in a dish so that the clay, sand, gravel etc are removed and the mineral allowed to concentrate in the rim of the dish. A common early method used for prospecting.
pans	Machines used to crush ore by a grinding action. See *Berdan pans* and *Wheeler pans*. Also the tin dish used for *panning*.
Pelton wheel	A patented water wheel operated by a high pressure jet of water hitting small hemispherical buckets with a central rib and propelling the buckets and the wheel to which they were attached at high speed. Invented in about 1870, Pelton wheels were small and reasonable portable, and were used extensively at mines where a suitable head of water could be provided, to drive machinery.
placer mining	The American synonym for *alluvial mining*.
picking belts / picking table	A conveyor belt at the pit top of a coal mine that transports broken coal and rock past a series of men and boys called 'pickers' removed any rock and break up large lumps of coal before the coal was loaded for dispatch. The process of picking was also used at some base metal mines, usually to sort out high quality ore for further processing. This might be done on a paved or cobbled picking floor.
pillar	Most commonly used in coal mines to describe a block of unmined coal.

pit	A depression, usually 2-3 metres in diameter, wider than it is deep. Commonly seen on alluvial fields where they are the remains of shallow *shafts* dug to access ore-bearing ground. Also known as 'potholes'. Also used generically to describe a coal mine.
pithead	The area of working at the top of a coal mine *shaft* or *haulage*. It includes the associated structures and machinery used in the retrieval and processing of coal.
poppet head	An iron, steel or timber structure of legs built over a *shaft*. It is equipped with pulleys over which the ropes or cables run which raise and lower the cages in the shaft. see also *headframe*.
portal	Surface entrance to an *adit* or *tunnel*.
prop	A wooden post or support used in a mine, such as to support the *caps* in a timbered drive.
puddlers / puddling machine	Circular holes 15-20 m. across in which dirt and water were mixed, and the contents thoroughly mixed and broken up by rakes attached to a long pole pivoted in the centre of the circle and pulled around by a horse walking around the outside of the puddler. This broke up intractable alluvium and clay, and allowed the heavy minerals to separate and fall to the bottom of the puddler, where it was cleaned up at intervals and final separation carried out by other means, such as panning and tomming. Puddlers used on gem fields were usually smaller (as little as 1.7 m diam.) and driven by machines.
pyritic smelting	A form of copper *smelting* that utilises the sulphur content of the ore as a fuel. The technique was perfected at the Mount Lyell smelters in Tasmania, but normally only partial pyritic smelting was practiced, with external fuel being added. The process was carried out in blast furnaces.
race	An open channel for conveying water. It can be a simple earth ditch, or lined with timber or metal, or a masonry structure, and often incorporated flumes (which see) to cross declivities and maintain a constant fall. Races ranged from short earthen ditches gathering storm water for opportunistic alluvial mining, to company-operated water supply channels many miles long and linked to supply and storage dams. A race supplying water to a workings or mill was a 'head race' while that removing water or tailings was a '*tail race*'. Referred to as 'ditches' in the US literature, and often as 'leats' in British usage.
reduction	The process for separating a mineral from *gangue*, in which oxygen is removed from the ore, the ore being physically reduced in size.

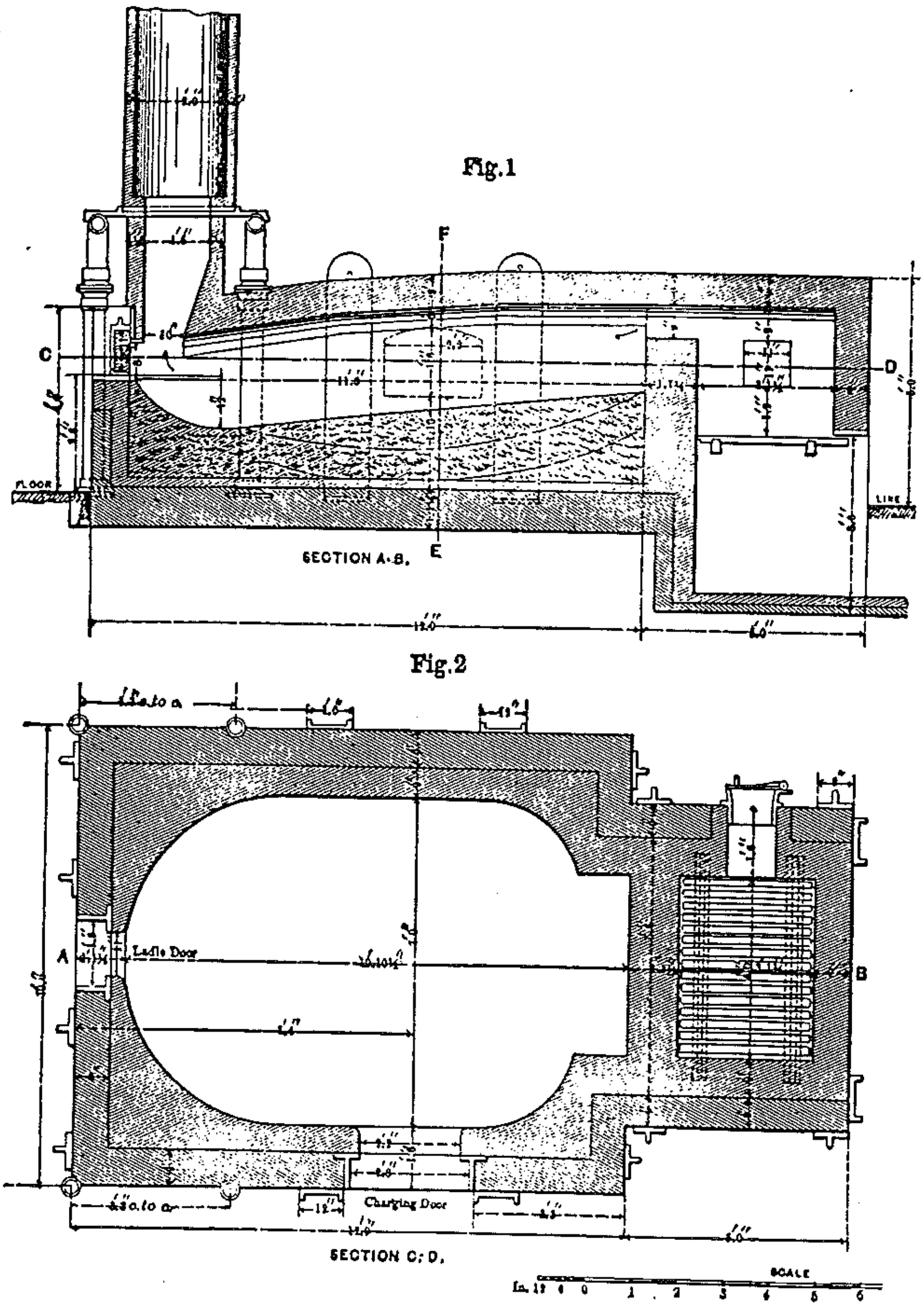


Horse **puddler** used to break up clayey gold bearing material. Pennyweight Flat, Ballarat, 1853. (Withers 1887: 200, in Davey 1996: 53)



Puddling machines at Ballarat Freehold Mine, 1868. (from *Dickers Mining Record*, Jan 14, 1868, in Davey and McCarthy 1988: 24).

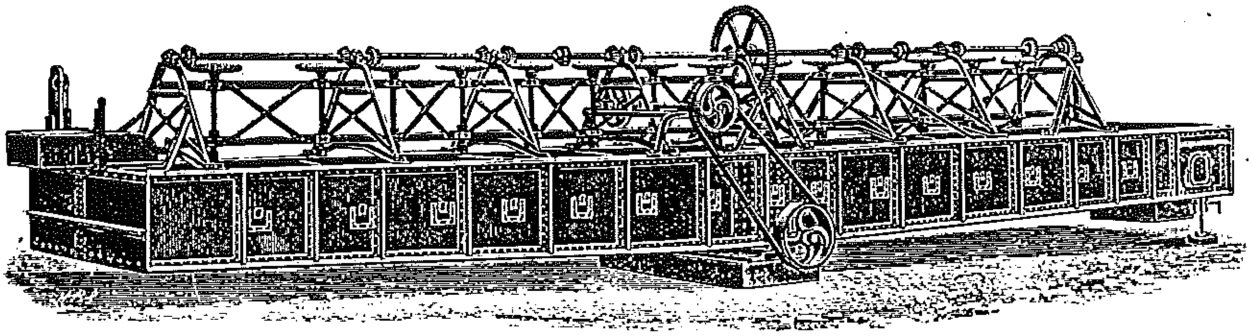
reef	A well-defined vein of mineralised ore.
retort	1. An apparatus for separating gold from mercury after *amalgamation*. An iron bowl is fitted with a lid with a pipe leading from it to a bowl of condensing water. The amalgam of gold and mercury is placed in the retort and heated to drive off the mercury as vapour. The mercury is condensed and saved for re-use, while the gold is left in the retort. 2. Ovens used to extract petroleum oils from kerosene shale.
reverberatory furnace	A brick furnace used for smelting *concentrates*. The crushed and concentrated ore and a flux is loaded into the furnace, and an intense fire maintained at one end in an external fire-box, the hot gasses passing over the ore and reverberating from the low ceiling of the furnace. Once molten, the metallic components separate from the lighter slag, and the metal and slag are drawn off separately.
riffles / ripples	A set of bars or slats placed in the bottom of a *sluice box*, in *long-toms* and *cradles*, or on separation *tables* to capture heavy minerals washed across them.
rise	A vertical *shaft* dug upwards from a lower passage.
roasting	The treatment of ore by heat and air in order to remove sulphur and arsenic, and, in early mining, to make ore more friable. The most simple form of roasting took place in kilns similar to lime kilns. Patent roasting furnaces included the 'Edwards' and 'Merton' roasters and the 'Huntington-Heberlein' and 'Dwight-Lloyd' blast roasters or sinterers.
rob	To remove coal from pillars (see *bord and pillar*).
rock-breaker	A machine for crushing large pieces of ore before more refined crushing occurred. Three types were built, one consisting of a fixed and a reciprocating jaw set on an angle so as to progressively reduce the rock to a smaller size (*Blake* type), the second type had rollers instead of jaws, and the third was conical with a gyrating conical muller inside it.. Also called 'stone breakers' and 'jaw crushers'.
rock drills	Term applied to all compressed air-driven drill used to bore holes for explosives. see *drifter drill.*
rolls	Sets of rolls were used at some early gold mining sites to crush ore, but were replaced by the stamper *battery*. Also used to refer to a rock-breaking machine with steel rollers to crush ore passed between them, sometimes used to crush material to be smelted. Also called 'roller crushers' and *Cornish rolls.*
rope-road	see *haulage.*
Scotch boiler	Sometimes called the 'economic boiler' and 'colonial boiler'. An internally fired return firetube type. It was of larger diameter



Section and elevation of a **reverberatory copper furnace** (Peters 1887: 329).

THE EDWARDS'

Mechanical Ore Roasting and Chloridising Furnace



NOW LARGELY IN USE IN THE PRINCIPAL MINES.

It is ECONOMICAL in FUEL and LABOR, and is Guaranteed to turn out an Absolutely Sweet Roasted Product, this assuring the Highest Possible Extraction of Gold.

Any further information may be obtained on application to—

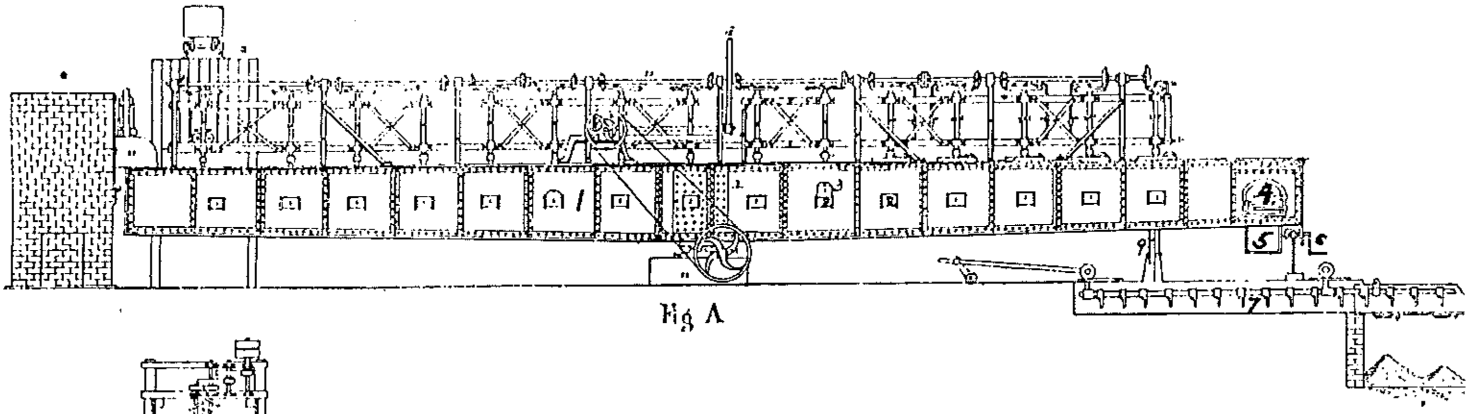


Fig A

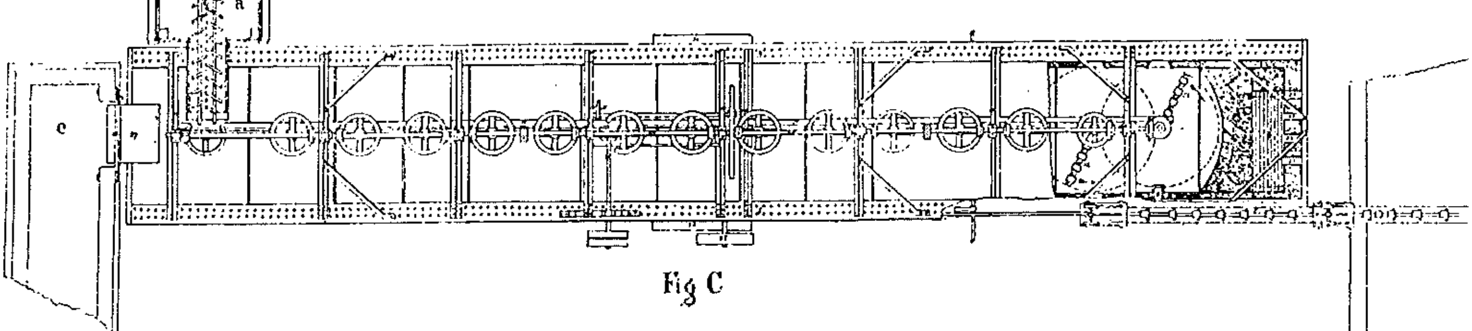


Fig C

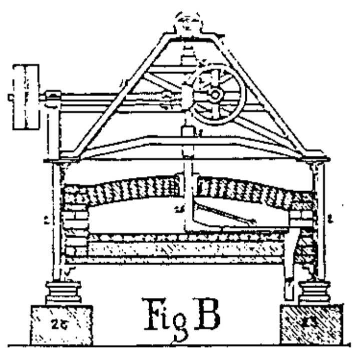
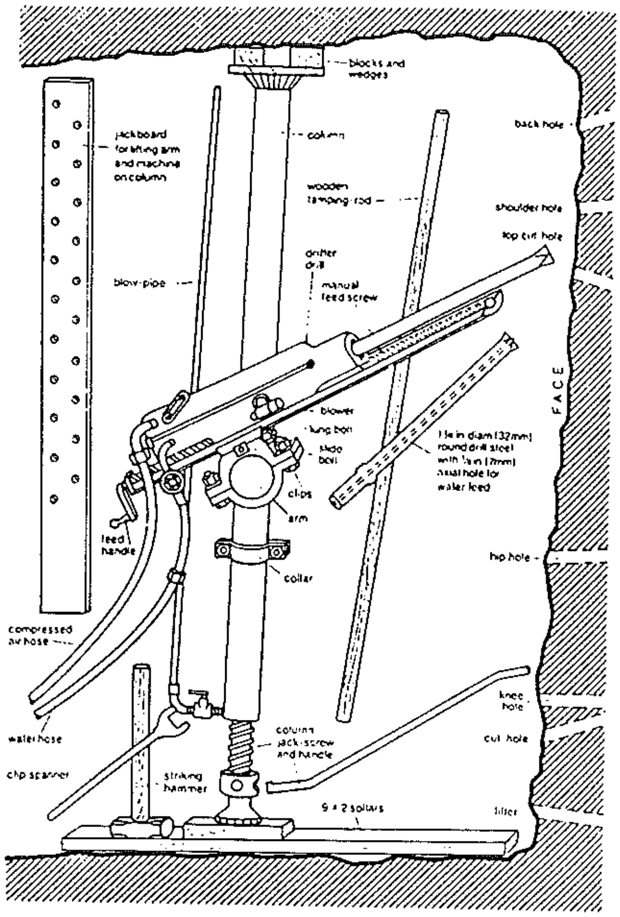


Fig B

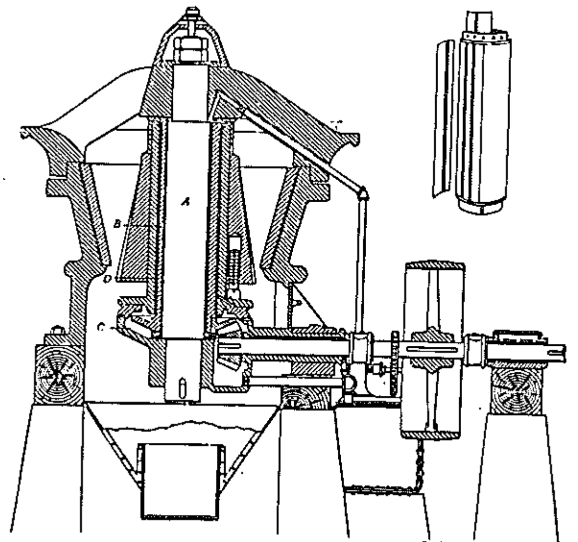
Edwards' Mechanical **Roasting** Furnace. Advertisement and elevation, plan and cross section. (Clark 1904).

	and shorter in length than most other boilers, and had one to four fire grates in its front face, feeding numerous fire tubes that ran to the end of the boiler then returned to vent through a smoke box and chimney extending from the top of the boiler above the fire hearths.
screens	see *jigs, grizzly, shaking screens, trommels.*
seam	A geological band of coal.
self-acting incline	see *inclined tramway*
sets	Timber frames used for propping the sides and roofs of *drives* , *drifts* and *stopes*. In the simplest form they consist of *props* , *cap* and *laths*.
shaking screen	A machine used to separate large from small pieces of ore, or in coal mining used to separate small coal before the larger coal moves on to the picking belt. Cylindrical screens are called *trommels.*
shaft	A hole that is deeper than its maximum dimension across at ground level. It may be vertical or inclined. Commonly seen on alluvial fields where they are dug to access *washdirt*, and in hard-rock country to access ore-bearing leads or coal seams. Usually equipped with a *windlass* or *poppet head.* Major shafts are commonly divided into two three sections, one or two being for raising and lowering *cages* , and the third for a ladderway and piping.
siphon	See *inverted syphon.*
sill	Timber beam set into the floor of a drive to hold apart the feet of the *props* where lateral pressure is applied to them.
skip	A rail mounted wagon or container used for hauling material at a mine. Either fitted with a door for easy unloading, or able to be tipped.
slack / slack coal	Small sized coal disposed of as a lesser grade of coal. Forms mounds found at many coal mines.
slag	A vitrified amalgam of silica, ferrous oxides and other elements, being the gangue component resulting from the smelting of an ore (such as copper or lead). Slag ranges from a dull to glassy dark rock-like substance, and is deposited in a number of forms, including cone shapes, lozenge shapes, granular form, poured molten spills, and as solid blocks poured in formwork. It is the most persistent evidence of smelter sites.
slimes	Finely-divided tailings resulting from the crushing process, which remain in suspension in water for a long period.
sluice	Washing alluvial material through a channel with *riffles* in its

sluicing sluice box	base for the capture of a heavy mineral released from its surrounding material. A sluice box is a wooden box for this purpose, while a *ground sluice* uses a channel cut into the ground.(see also *long tom, ground sluicing, hydraulic sluicing*)
sluice-head	A box fitted at the head of a water *race* to gauge or measure the quantity of water diverted from a river of stream. Came into use as by-laws were developed to control water use, and as companies built commercial races. Synonymous with *head.*
smelting	A method of extracting metals, usually base metals, from ore in a furnace in the presence of a flux. Smelting reduced the *gangue* to slag and freed the metal component. see also *reverberatory smelter, water jacket smelter, blast furnace.*
spitzkasten	see *classifier*
stamp / stamper	An iron rod, fitted with an iron or steel *stamper shoe*, and a tappet which is raised by a *cam*. The stamp and shoe fall onto *stamper dies* in the mortar box of a *battery*, so crushing the ore.
stamper battery / stamp-mill	see *battery*
stamper shoe	The heavy iron or steel foot of the *stamper* that crushes ore against a *die* inside the *mortar box* of a *battery.*
stamper die	An iron block, usually octagonal in shape, set into the base of the *mortar box*, onto which the *stamper shoe* falls to crush the ore. Worn stamper dies are sometimes found around battery sites.
stope	An underground excavation formed by the extraction of ore. Sometimes exposed at the surface by working an ore body upwards, or by later open cutting of the deposit (an 'open stope'). *Stulls* are inserted into the stope to support the roof and provide a working platform.
stulls	A *set* of wooden *props* placed across a *stope* to stabilise the sides or roof, and to provide a working platform and ore-holding area.
suction dredge	see *centrifugal dredge.*
surfacing	The removal of surface soil for treatment to extract gold.
tables	A machine with a table-like surface covered with *riffles* and used for the *concentration* of heavy minerals. It is given a horizontal shaking motion and the pulp which is passed over it is sorted according to weight. A common type is the *Wilfley table.* In a gold *battery* the tables were sloping shallow boxes set below the discharge of the *mortar box*, and consisting of *amalgamating* tables and *blanket tables.* Sometimes shaking tables were also included.

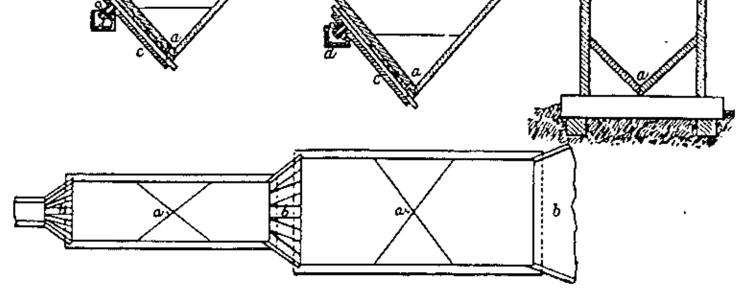


Drifter rock drill (Ritchie & Hooker 1997, after McAra 1988)



SECTIONAL ELEVATION OF THE SYMONS FIXED PILLAR CRUSHER.

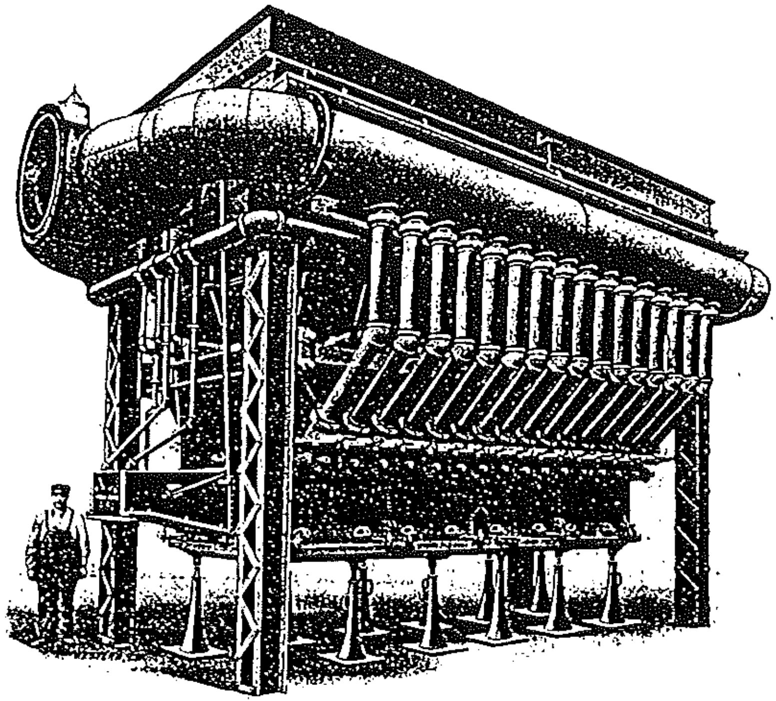
Symons pillar (conical) **rock breaker** (*Queensland Govt. Mining Journal* 1911: 219)



German Pyramidal Boxes, or Spitzkästen.

Spitzkasten classifier (Lock 1890: 346)

tailings	Rock, earth, gravel, sand etc that is the residue from the separation or other treatment of washdirt or ore by water. Different types of tailing can indicate different mining processes (see Ritchie 1981 and McGowan 1996b).
tailings wheel	A wheel with buckets around its rim used to raise *tailings* from a tail race up to a tailings dump at a higher level. Sometimes used at sites where the tailing dump grew higher than the tail race, and no alternate low-lying tailings dump site existed.
tail race	An artificial channel which drains a *sluicing* claim or conveys used water and tailings away from a *mill, battery* or other processing plant. Often a *sluice box* or *riffles* is placed at the head of the tail race to capture any residue mineral in the tailings.
tippler / tipple	A method of emptying *skips*, where the skip rails ran onto a framework that allowed the whole skip and rail section to be tipped or rotated over an ore storage bin or onto *screens*. Most commonly used in coal mines..
tom	see *long tom*
tribute / tributing	A contract under which a party of miners working on their own account ('tributers') gave the mine owner a proportion of all metal they mined. Often found in mines where the owner has ceased viable company operations, but where mineral can still be won.
trommel	A cylindrical screen or sieve used to separate ore or minerals from larger rocks. The trommel could operate dry or wet. The screen was placed at a slight angle, and rotated by a machine. material was loaded at the higher end, and the smaller mineral-bearing particles passed through the screen holes, while the larger material continued out the end of the trommel. Water could be sprayed through the material to assist in the separation process.
tunnel	A passage in a mine that is open to the air at both ends. (often used to in mining parlance to describe (inaccurately) an *adit*, which is only open at one end).
underlay	Also 'underlie'. An *inclined shaft* following the dip of an ore body.
vanner	A concentrating machine in which minerals are sorted according to weight by running the mineral in suspension onto an inclined continuous belt washed by streams of water. *Tables* largely replaced vanners in most fields. A common type was the 'Frue vanner'.
vertical boiler	Commonly called 'donkey boilers', these are self-contained and more portable and flexible in use than larger boilers needed to be set into masonry beds. The vertical boiler was cylindrical in



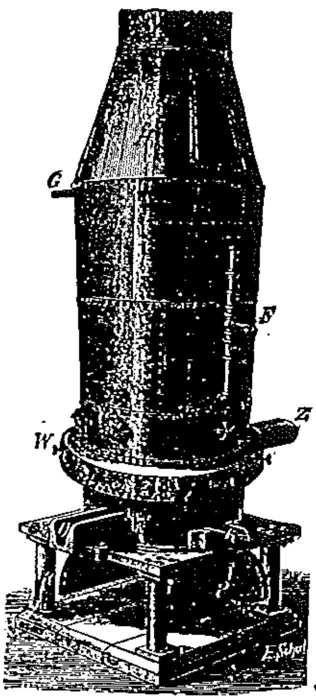


Fig. 29.

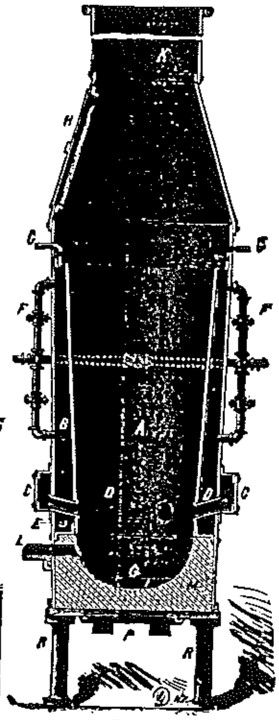


Fig. 30.

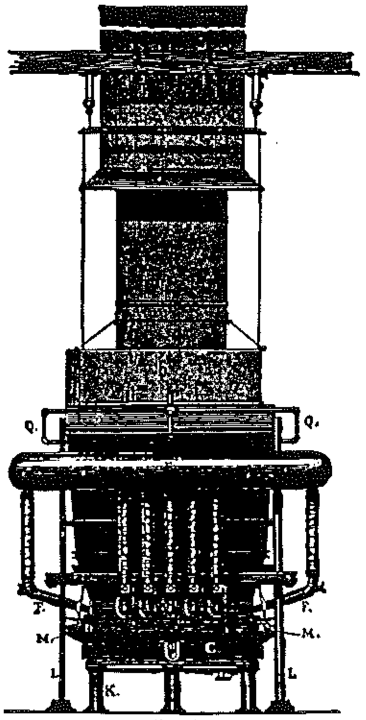


Fig. 34.

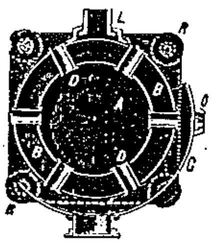


Fig. 31.

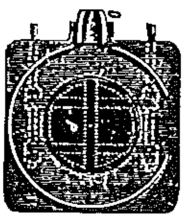
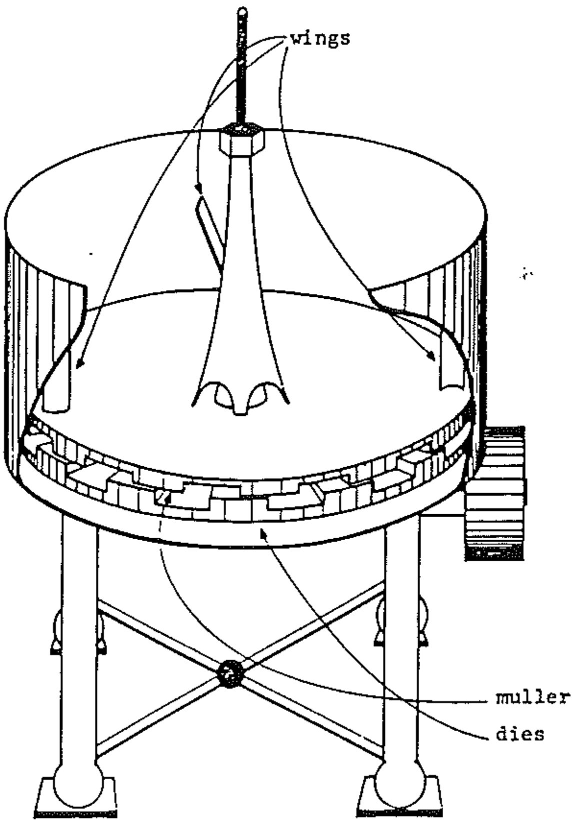
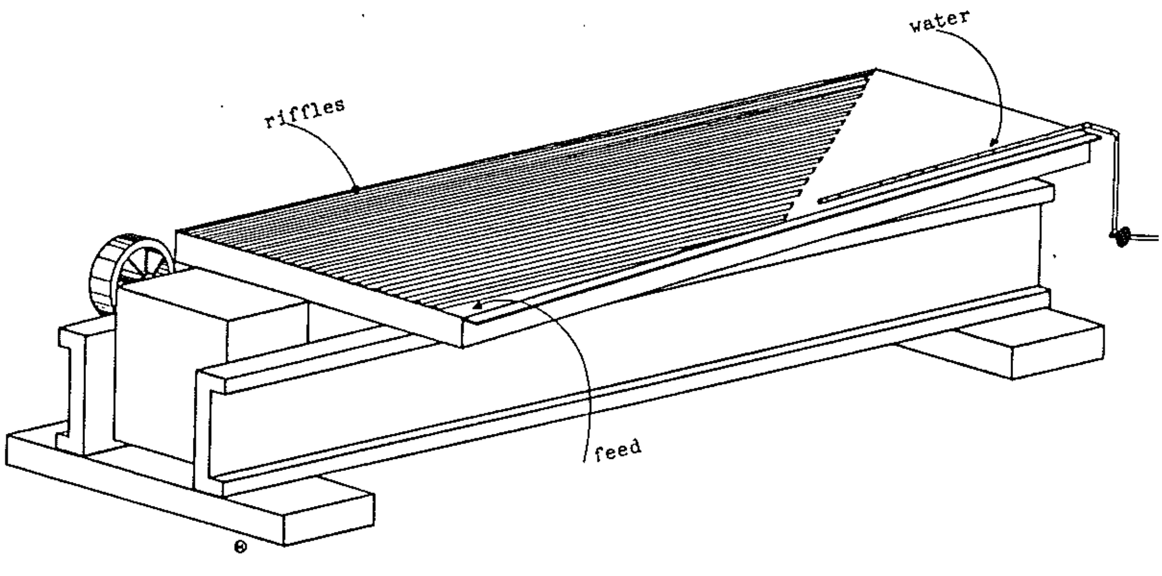


Fig. 32.

Various forms of **water-jacket blast furnaces** (Peters 1907: 267-269; Peter 1911: 152.)



Wheeler pan (Menghetti nd)



Wilfley table (Menghetti nd)

form, sitting on its circular base with a chimney at the top. It had a small fire grate at its base, and a smaller capacity for water and steam production than larger *boilers*.

washdirt — The auriferous gravel, sand, clay or cement in which the greatest proportion of gold is found.

washing up — The process of collecting and separating the targeted heavy mineral collected in the *riffles* of *sluice boxes*, *tail races* etc, usually done with a *pan*.

water-jacket smelter — A smelter in which the furnace is a double-skinned steel vessel with water circulating between the skins to help cool the structure and prevent it melting. see 'smelter'

water wheels — Generally over-shot or back-shot water wheels used to power machinery at some mines. Obviously limited in Australia to the better watered parts of the country. Some wheels in Victoria were over 20 m in diameter. Pelton wheels largely superseded water wheels in the late nineteenth century.

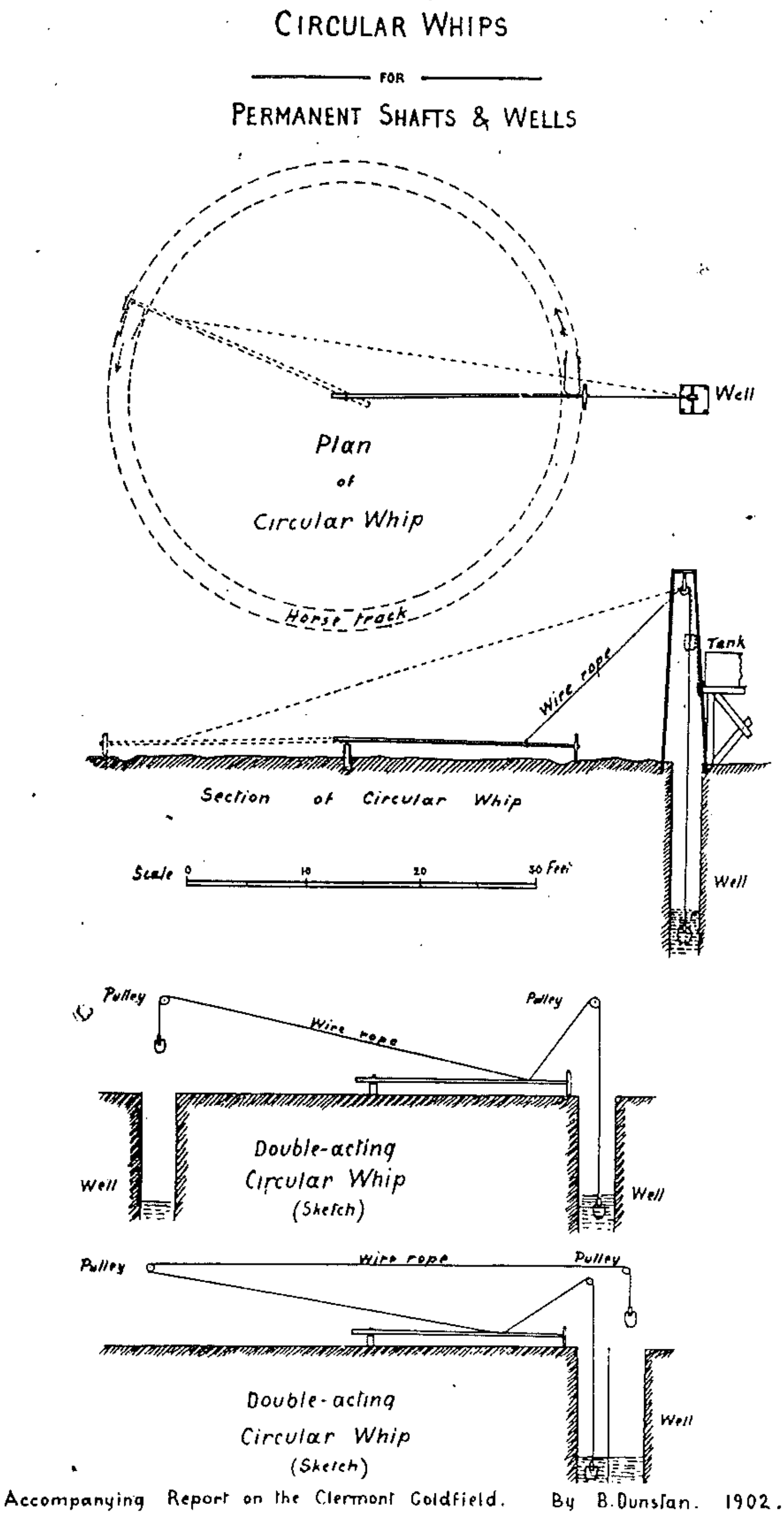
Wheeler pans — A machine for crushing ore. Consisted of a circular pan or bowl with a circular steel die set into its base, like the bottom stone of a flour mill. A circular steel muller rotated by a central shaft ground ore against the lower die. Usually used to regrind gold ores with mercury added to amalgamate released gold.

whim — A structure of strong timber supporting a large horizontal drum around which ropes are wrapped, being attached via a poppet head to buckets or *kibbles* in a *shaft*. The drum is attached to a long beam with a horse harness at its end. As the horse walks around the drum it turns and raises one end of the rope while lowering the other. Also referred to as 'horse whims' and 'whimsies'. Intact whims are only known to survive on a very few fields, but the iron components of whims such as horse yolk and the pin and gudgeon on which the whim pivoted are more often found.

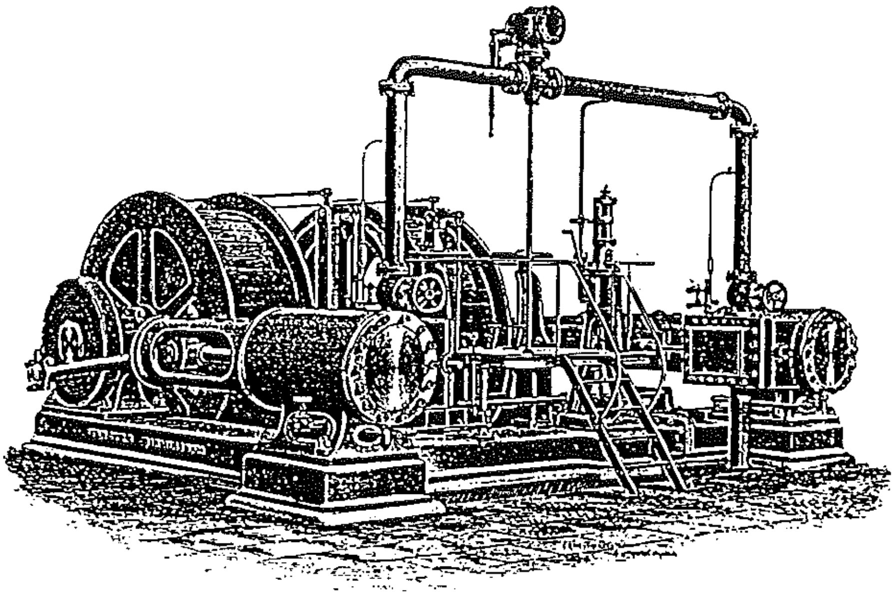
whip — A timber beam set at an acute angle above a shallow *shaft*. A rope passes over a pulley at the end of the beam, one end being attached to a bucket or *kibble* down the shaft, the other to a horse harness. The horse walks backwards and forwards raising an lowering the bucket.

A variation is the circular whip, where the horse walks in a circle drawing a pole pivoted in the centre of the circle. A rope attached to the pole runs over a pulley above the shaft, raising or lowering the bucket as the rope end travels around the circle.

Wilfley tables — Perhaps the most common form of *concentrating table* used at Australian gold mines. Wilfley tables, invented in 1844, had a slightly sloping table top, linoleum coated, with timber *riffles* of gradually reducing size attached to its length. The table was shaken and water and crushed ore poured down it, the fractions



Circular **whip** (Dunstan 1902)



From a Drawing of the 18 × 36 ins. size.

Tangyes **winding engine**, double drum. (Tangyes 1892: 216)

	of the mixture being sorted by weight as they travelled across the table.
winding engine / winder	Steam or electric machinery which hoists and lowers the *cages* in a mine shaft. Winders often have two drums around which the cable is wound, one letting out cable while the other takes it in, thus raising and lowering cages at the same time in adjacent compartments of the shaft. (see Wegner 1995 for examples)
windlass	A wooden roller with a crank handle at one or both ends, placed across the top of a shallow *shaft* and used to raise a *kibble*.
winze	A shaft that connects *levels* in underground working, but does not reach the surface. Winzes are excavated downwards, as opposed to *rises* which work upwards.
zinc-box	A box within which *cyanide*-treated gold is precipitated with shavings of metallic zinc.

Sources:

Axedale Mining Co Pty Ltd, 1978. 'A preliminary study of the Charlotte Spur Track, the Jirnkee Water race, the Mount Hepburn Treatment Works and the Orient Claims', report for the Shire of Omeo.

Clark, D. 1904. *Australian Mining and Metallurgy*, Critchley Parker, Melbourne.

Cossons, N. 1993. *The BP Book of Industrial Archaeology*, David & Charles, Newton Abbot.

Davey, C. J. & McCarthy, P. L. 1988. 'Deep Lead Mining in Victoria', *Second AusIMM Mineral Heritage Seminar*, Sydney, July 1988, Australasian Institute of Mining and Metallurgy, Parkville, Victoria: 17-26.

Davey, C. J. 1996. 'The origins of Victorian mining technology, 1851-1900', *The Artefact*, vol 19: 52-62.

de Havelland, D. W. 1987. *Ghosts and Gold: A prospectors guide to metal detecting and history of the Australian Goldfields. Volume 3: Queensland, Central and Southern Districts*. Hesperian Press, Carlisle, WA.

Drew, G. J. & Connell, J. E. 1992. *Cornish beam engines in South Australian mines*, Special Publication No. 9, Department of Mines and Energy, South Australia.

Fenwick, P. 1995. 'South Maitland Coalfield Heritage Study', report for the National Trust of Australia (NSW), Sydney.

Idriess, I. 1931. *Prospecting for gold*, Angus and Robertson, Melbourne. (republished many times)

Lock, C. G. W. 1890. *Mining and ore-dressing machinery*, E. & F.N. Spon, London.

McAra, J. B. 1988. *Gold mining at Waihi 1878-1952*, Martha Press, Doreen McLeod, Waihi, NZ.

McGowan, B. 1996a. *Bungonia to Braidwood: an historical and archaeological account of the Shoalhaven and Mongarlowe goldfields*. the author, Canberra.

McGowan, B. 1996b. 'The typology and techniques of alluvial mining; the example of the Shoalhaven and Mongarlowe goldfields in southern New South Wales', *Journal of Australasian Historical Archaeology*, Volume 14, 1996, pp 34-45

MacLaren, J. M. 1901. *Queensland Mining and Milling Practice*, Geological Survey of Queensland Publication No. 156, Brisbane.

Menghetti, D. 1982. 'Extraction practices and technologies on the Charters Towers Goldfield', *North Australia Research Bulletin*, No. 8, The Northern Australian Research Unit, Australian National University, Darwin. pp. 1-30.

Milner, P. 1997. 'Beam pumping engines in Victoria', *Australasian Historical Archaeology*, 15: 40-54.

Peele, R. 1941. *Mining Engineer's Handbook*, Wiley and Son, New York.

Peters, E. D. 1887. *Modern American Methods of Copper Smelting*, Scientific Publishing, New York.

Peters, E. D. 1907. *Modern Copper Smelting*, Hill Publishing Company, New York. (several editions)

Peters, E. D. 1911. *The Practice of copper smelting*, McGraw Hill, New York.

Preston, E. B. 1895. *California Gold Mill Practice*, Superintendent State Printing, Sacremento.

Ritchie, N.A. 1981. 'Archaeological interpretation of alluvial gold tailing sites', *New Zealand Journal of Archaeology*, 3: 51-70.

Ritchie, N. A. & Hooker, R. 1997. 'An archaeologist's guide to mining technology', *Australasian Historical Archaeology*, 15: 3-29.

Rose, T. K. 1902. *The Metallurgy of Gold*. Charles Griffin and Company, London.

Tangyes Limited 1892. *Tangyes Limited Catalogue: Edition 1891, Steam engines and boilers*, Cornwall Works, Birmingham, John Bellows, Gloucester.

Tracey, J. L. & Tracey, M. M. 1997. 'Glossary of 19th and early 20th century mining terminology', in Kerr, R. S. & tTacey, M. M. (eds) *Proceedings of the Australian Mining History Association 1996 conference*, Australian Mining History Association, Canberra. pp. 86-94.

Wegner, J. 1995. 'Winding engines on the Croydon goldfield: What the documents don't say', *Australasian Historical Archaeology*, 13: 11-17.

Whitmore, R.L. 1991, *Coal in Queensland: Federation to the Twenties- 1900-1925*, University of Queensland Press, St Lucia.

Young, O. E. 1978. *Western Mining*, University of Okalahoma Press, Norman.

MINING HERITAGE PLACES

ASSESSMENT MANUAL

APPENDIX

MODEL TYPE PROFILES FOR MINING PLACES

APPENDIX

MODEL TYPE PROFILES FOR MINING PLACES

1. What are type profiles?

Type profiles are a tool introduced by the Australian Heritage Commission in the 1980s to try to provide useful overview material that could help in the assessment of heritage places by putting them into the context of like places. The type profile is not supposed to replace good background research, but is to enable an initial understanding of:

- the chief characteristics of classes of place;
- the range of variation that exists in the geographical spread of the type, and;
- the geographical, temporal and technological variations known to exist.

Type profiles assist in the quick assessment of whether the place warrants more in-depth assessment. It is recognised that the concept of "type" could have a number of interpretations in terms of the scope and scale of each type identified. In the case of mining, for example, a 'type' might be defined as relating at the broadest scale to all mining sites, or at progressive levels of refinement to all underground mining, say, or to the mining of a specific mineral type, to each particular technological variation in the mining of a mineral, or at its most detailed to individual pieces of mining equipment or individual mining processes. There is debate about where, in a subdivision such as this, a clustering of like-places is a 'class' and where it is a 'type' or a variation of a type.

Clearly, the choice of the scope and scale of the type profile used will determine the number of type profiles that would have to be developed to cover any one industry. In the examples just given, the broadest 'type' definition would result in just one type profile, for 'mining sites'. The most particularistic definition would require many hundreds if not thousands of type profiles to describe the multitude of mining equipment and processes. It depends on whether 'clumping' or 'splitting' is the approach taken.

The approach taken with the four model type profiles presented here is to aim at describing in a general way the whole or a major aspect of one type of mineral extraction and processing The four type profiles are selected because they represent the majority of mining heritage places known to exist in Australia. They are:

- Model type profile 1. —Coal
- Model type profile 2. —Copper
- Model type profile 3. —Alluvial Gold
- Model type profile 4. —Reef Gold

MODEL TYPE PROFILE—COAL

1. DESCRIPTION OF THE TYPE

Coal mining, while utilising some technologies similar to those used in metal-mining, was generally distinctive because of the nature of coal itself. While metals were usually high-value, small volume products derived by varying degrees of technical processing from heavy ores, coal was a low-value, high volume product, which needed little processing before it was ready for market. The mining of coal seams with the related problems of subsidence and explosive and suffocating gas emissions, the high volume transport systems and the simple pit-head treatment of raw coal, clearly distinguish coal mines from other forms of mining. Many of the technical mining terms used in this type profile are defined in *A guide to common mining terminology* in this manual.

Outline history of coal mining:

- 1797—Coal officially discovered at the mouth of the Hunter River, NSW, followed by informal coal gathering by convicts, and various mining ventures from 1801. Coal also found at Coal Cliff in the Illawarra.
- 1801—First export of Australian coal from Newcastle to Bengal.
- 1831— The Australian Agricultural Company commenced mining in the Hunter, following the issue of a lease in 1828, and the guarantee of a monopoly over the coal trade till 1847.
- 1834—Coal mining commenced with convict labour at the Coal Mines on Tasman Peninsula, Tasmania's first successful coal mine.
- 1843—first coal mining in Queensland, at Goodna.
- 1847—End of Australian Agricultural Company's monopoly saw increasing coal operations in Newcastle region.
- 1857—Southern NSW Coalfield operations commenced at Mt Keira Colliery.
- 1850s—Queensland's West Moreton Coalfield developed.
- 1862—Brown coal being mined at Lal Lal, Victoria.
- 1863—Fingal coal field discovered, Tasmania.
- 1889—Mechanical coal cutters first introduced into Australia.
- 1883—First major coal find in WA, at Collie.
- 1909—Coal mining commenced at Wonthaggi, the first State-owned coal mine in Australia and to become Victoria's largest black coal producer.
- 1910—First Mine Rescue Brigade in Australia set up in Ipswich.
- 1924—Yallourn brown coal powering electricity supply to Melbourne.
- 1934—Black coal mining commenced by open-cut at Blair Athol, Queensland.
- 1935—First mechanical coal loaders introduced into Australia.
- 1943—Leigh Creek coalfield (brown coal) development began, SA.
- 1943—Open-cut mining begins at Collie, WA.
- 1950—First continuous mining machine introduced.
- 1955—Export of coal to Japan recommenced from NSW.

- 1961—Export of coal to Japan commenced from Queensland.

Description of the coal mining processes

The processes for mining coal were consistently suited to the extraction of coal from flat seams, a characteristic of coal measures not shared by most hard-rock mineral occurrences. The traditional way of cutting coal from a seam was by undercutting the coal face, at the base of the seam, with a pick, then the coal was picked and crow-bared down. The characteristics of early coal mines are described by Davies, based on the coal mines at Port Arthur[48]. Later nineteenth century practice was to hand-drill shot holes in the face above the cut, inserting explosives and blowing down the seam. The coal was then hand-shovelled into skips, with the miner's tally token attached, this being a leather tag identifying the miner and enabling a tally of his output to be maintained at the pit head. In very early mines it was common for sorting and sizing of the coal to occur at the coal face, with no subsequent treatment above ground—this was the case in Queensland until after 1900 (Whitmore 1981:160). As production increased, above ground screening, picking belts and, later, washing became normal. It was usual to expect each miner to cut, load and transport about two tons of coal in a shift. As will be seen below, mechanisation of this process was slow and incomplete until relatively recent time. Only in the last three decades has full mechanisation of underground operations become the norm.

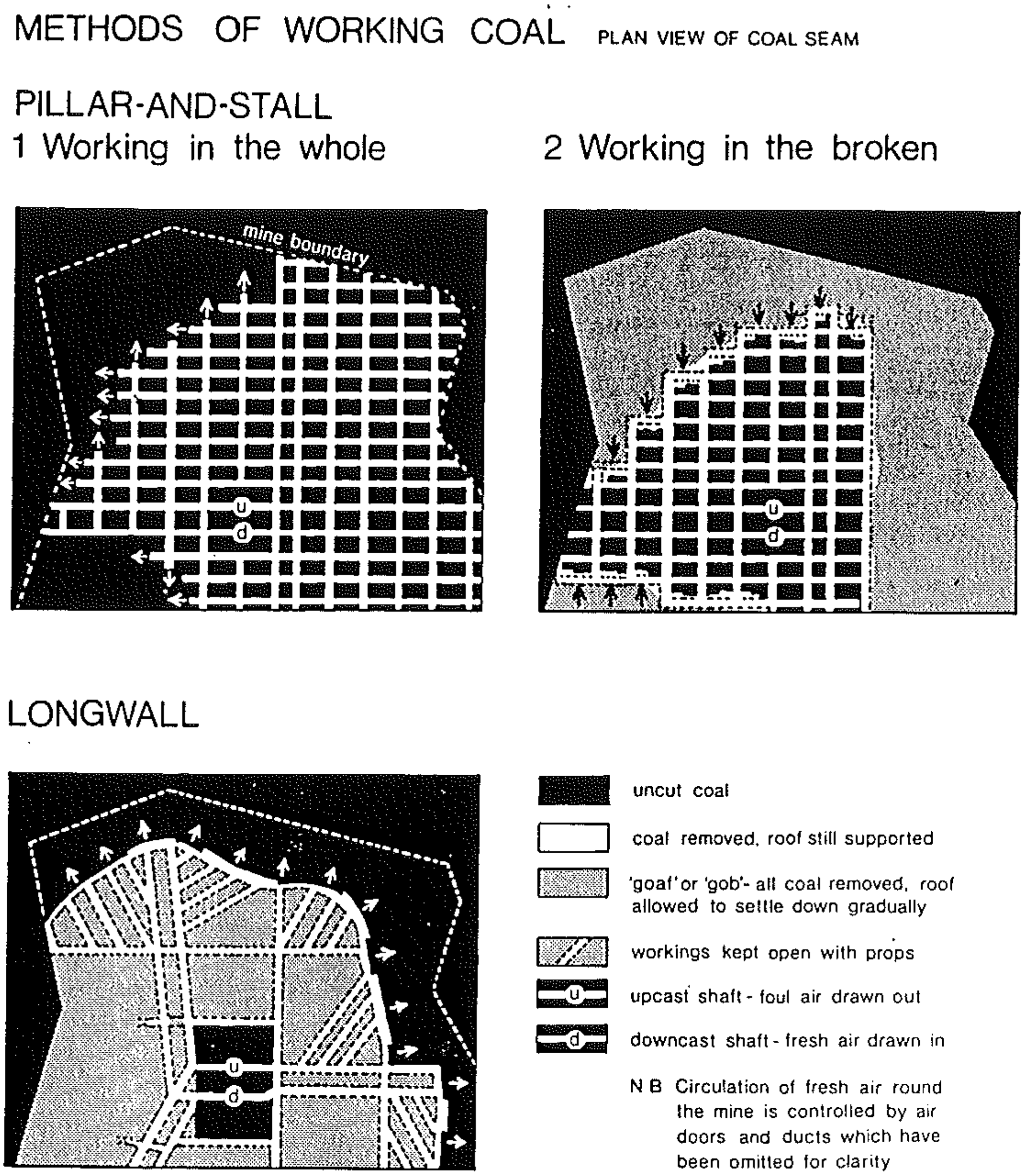
Coal seams were either accessed by way of a vertical shaft, or by an inclined tunnel or adit which facilitated the more ready removal of coal by rail systems. At the base of the shaft or inclined tunnel the seam was worked outwards in one of two ways.

Bord and Pillar mining was the traditional method used in Australian collieries. This method consisted of mining in broad compartment (bords) up to 9 m wide, leaving pillars between the bords to support the roof. The pillars were of equal or lesser thickness than the bords, and were often trimmed down to a minimum thickness after the basic pattern was established. Cross drives linked the bords (and removed coal from the pillars) at regular intervals, leaving a grid patterns of passage ways around pillars which supported the roof. Pillars were usually subsequently removed, at least in part, maximising coal retrieval and allowing the roof the slowly settle. Area where mining had been completed, and pillars removed, was called 'goaf' or 'gob'.

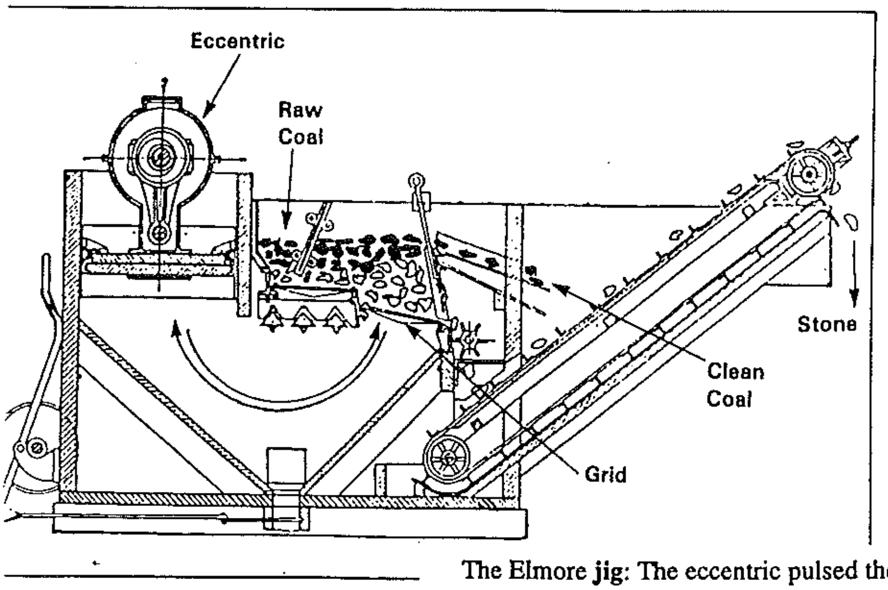
Longwall mining, the extraction of coal along a continuous face, with the roof supported behind the face by packwalls of rock, was used only infrequently in Australia. It was sometimes used where the coal seam narrowed to under 1 m thickness. Longwall extraction was being practiced, for example, at the Howard Colliery in Queensland as early as 1905, at Wonthaggi in Victoria from 1909, at two Newcastle collieries and at Mount Kembla in NSW by 1912, and in Tasmania the short or step long wall method was in use by 1914 at the Cornwall Colliery (Hargraves 1993:143; Jack 1979:111; Bacon 1991:27). This early use of longwall technique was not of the fully mechanised extensive longwall type used for total extraction, which came into use in some Australian collieries in the 1950s and 60s, and was not introduced into Queensland until 1986. By 1991 mechanical longwall methods accounted for 52% of underground operations in NSW, and 66% in Queensland.

---

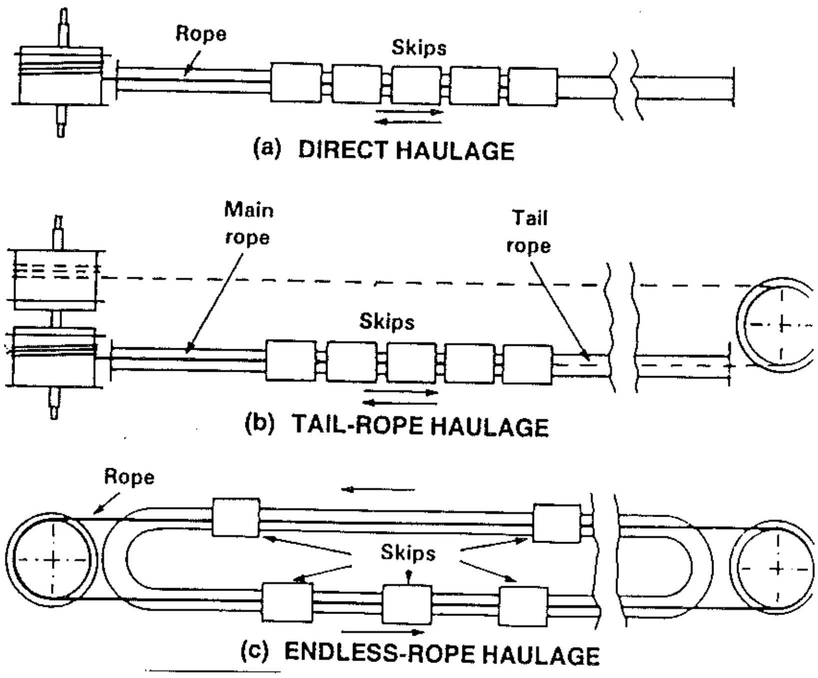
48 Bairstow, D and Davies M. 1987. *Coal Mines Historic Site survey: Preliminary report*, Occasional Paper 15, Tasmanian Department of Lands, Parks and Wildlife, Hobart.



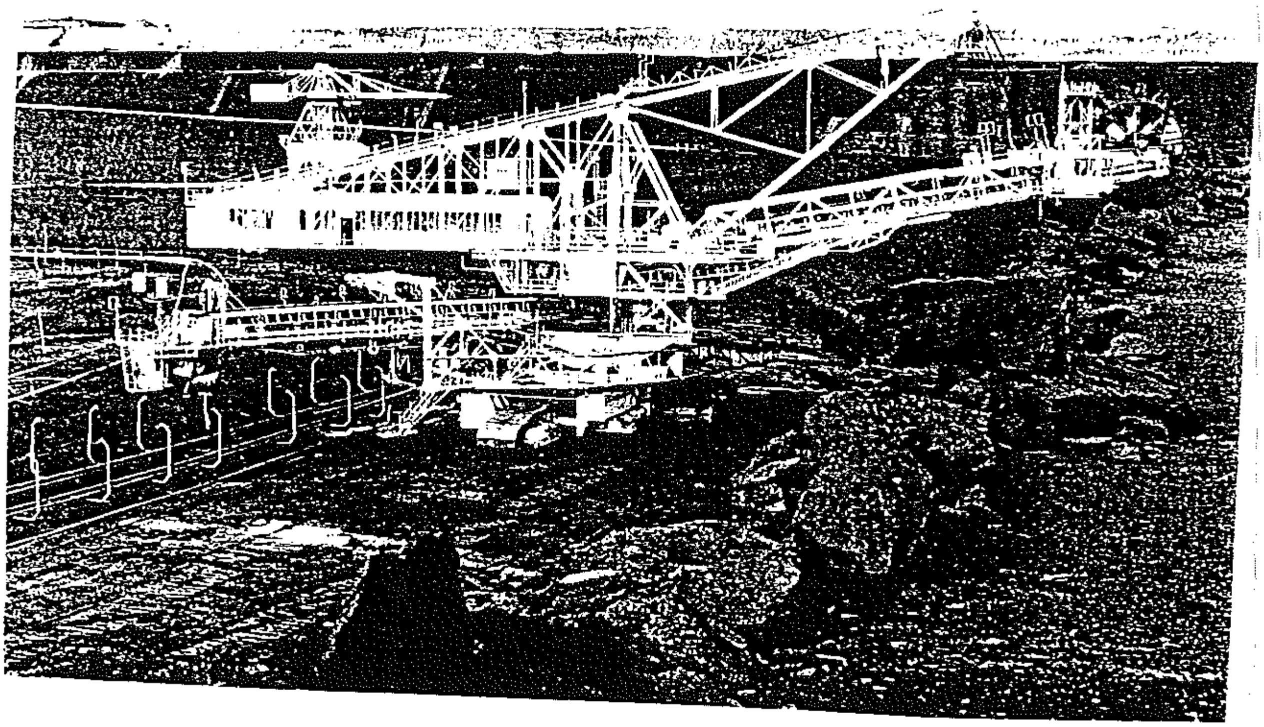
Cossons, 1993:73.



The Elmore **jig**: The eccentric pulsed the water through the bed of raw coal, separating the stone and clean coal. (from Whitmore, 1991).



Haulage systems (Whitmore 1991)



Brown coal bucket-wheel dredger operating at Yallourn in the Latrobe Valley, Victoria.
(Hargraves 1993)

Transport systems were central to coal mining operations, because of the high-bulk nature of the commodity. Remote coal deposits were often not exploited until the railway reached them, or special railways were built to transport the coal to market. Some collieries used long aerial cableways to transport coal from the mine to jetties or railway sidings for loading.

Within the mine the transporting of the coal from the face to the pit head, before mechanisation of the system, involved several steps. Once removed from the seam the coal was shovelled into skips by the miner, and the skips moved by 'wheelers' either pushing them, or pulling them with a horse, to a 'flat' where several drives from the work faces converged. Here the skips were arranged into short trains and pulled by a horse in the control of another 'wheeler' to the main haul road where an endless rope haulage system operated. At the main haulage the skips were attached to the rope or chain (the 'creeper) by 'clippers', and hauled to the shaft bottom for raising by cage, or hauled directly up through the inclined tunnel portal. Double track endless rope haulage ways could run 4-5 km from the shaft bottom to the furthest reach of the haulage road (Hargraves et al 1993).

After mechanisation transportation was by traditional endless rope or chain, conveyor belts, or by small diesel or electric locomotives hauling skip trains. When mechanical loaders were introduced slowly from the 1930s they delivered the coal directly from the face into skips, and starting from 1950 the later cutter-loaders did the entire cutting and loading process in one step.

At the base of the shaft skips would be moved onto a cage for hoisting to the brace. At the end of a haulage way up an inclined tunnel the skips were disconnected from the rope and run on into the pit head area by gravity. In both cases the skips were led over a weighbridge for weighing, and in contract system mines the token attached to the skip was removed to keep a tally of who cut the coal. From the weighbridge the skip ran onto a 'tippler' which tipped the load into a chute and onto screens and a picking belt where rock was removed and oversize coal was broken up with hammers. The picked coal then was sized by screens and loaded into rail trucks for shipment. As sorting and cleaning techniques improved, the picking belts were replaced by coal washers and/or jigs for sizing.

Open cut coal operations became common by WWII, and characterised the brown coal working in Victoria, the later Hunter Valley mines, and the large export mines in Queensland. The modern open cut is worked by large bucket draglines, 'dredgers' and other massive earth moving equipment.

Coal mining was overwhelmingly a hand operation for most of its history in Australia. The first **mechanical cutter** in NSW (and Australia) was a Gartsherrie cutter introduced for oil-shale cutting in 1881, and the first coal cutter was a Stanley Header installed at Greta Colliery in 1889, used to undercut the seam. Take-up of the new machines was slow, however, but acceptance of the benefits grew early in the new century, and by 1907 there were 104 coal cutters in NSW coal mines. In Queensland the first mechanical cutters were introduced in 1905, and by 1911 there were 24 coal cutting machines in the state. While mechanical aids for cutting and haulage increased after the standardisation of electrical power use in mines in NSW was legislated for in 1908, **mechanical loaders** were not introduced until 1935, and by 1946 still only 36% of coal in NSW, Australia's largest producer, was mechanically cut, and only 27% mechanically loaded (see Hargraves 1993 for a more detailed history). By that time, however, the use of **power borers** to drive shot holes was almost complete. An example of the slowness of mechanisation of coal mines is the continued use of horses for some haulage, at Wonthaggi up to its closure in 1968, at North Bulli No. 2 colliery in NSW until 1972, and at Stockrington Colliery west of Newcastle until its closure in 1982, even though diesel and electric locomotives had gradually been replacing horse haulage since before WWII. The first continuous miner, which cut and loaded in one operation, was introduced in 1950.

Before 1900 most mines were ventilated by furnaces placed at the base of an air shaft to induce convection, sometimes augmented by exhaust steam fed into the shaft. Some early (and usually quite short) adits were ventilated simply by digging a second, parallel, adit and joining the two by drives, inducing air flow[49] However, mechanical **ventilation** was introduced as mines became deeper and gassier. Furnace ventilation continued in the Lithgow area until at least 1912, and furnaces were finally prohibited in NSW from all but shallow mines in 1926. 'Brattice' cloth, a heavy sacking, was used to restrict passages and direct air flow through the workings.

The Courriers Colliery disaster in France in 1906, which was due to the explosion of coal dust, exerted a profound influence on **safe working** around the world, including Australia. From that date much attention was paid to ventilation, illumination, power supplies and the treatment of flammable gas and coal dust. Departments of Mines promoted the introduction of compressed air and electrical equipment such as cutting machines. Australia had, and was again to experience, its own mine explosions, such as that at Bulli in 1987 (81 men killed), at Dudley near Newcastle in 1898 (15 men killed), at Mount Kembla in 1902 (94 men killed), at Mount Mulligan in Queensland in 1921 (76 men killed), and at Bellbird in the Hunter in 1923 (21 men killed). An early safety measure, by no means universal for many years, was the locked flame safety lamp, which was first used as the sole lighting source in the Metropolitan Colliery in NSW in 1897. The Dudley disaster lead to the practice of the continuous ventilation of coal mines, whether they were being worked at the time or not, to avoid the accumulation of gas. The Bellbird disaster lead to the 1926 NSW *Mines Rescue Act* which required the setting up of rescue stations and the training of rescue personnel. The process of roof bolting (inserting long bolts to stabilise the roof of a mined area) was introduced after experiments starting in 1949, and greatly increased mine safety.

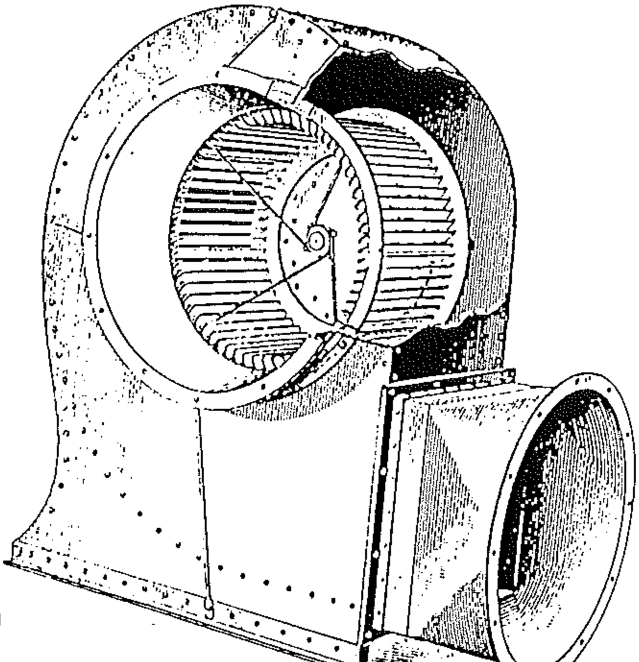
Electrical power had been slowly introduced into NSW mines from 1893, but really became the norm only after a Royal Commission in 1907-08 provided standard regulations for electrical power in mines. Electricity was used to drive pumps, lights, fans, stationary hauling engines as well as coal cutting and boring equipment. Electricity was first used in coal mines in Queensland in 1905 and was quite common by 1913, and electricity was the power source at Wonthaggi in Victoria by 1912. A number of coal mines were established with the 'captive' market of a power station built adjacent to them, powering both the mining operations and feeding into the State's power grid.

Working conditions for coal miners slowly improved as the safe working regulations were introduced, and as mechanical mining became more common. However, it was a slow change, with pit head features such as bath houses only becoming common by the late 1940s. The 'contract system' was the norm at most collieries until at least the end of WWII, with teams of miners being called out to cut coal or develop the mine on volume contracts when work was available. Working clothing was supplied by the miner, cloth hats being the normal headgear—miners protective helmets did not become compulsory in NSW until 1941. The gradual mechanisation of mining had the most profound impact on mine working conditions, though its introduction was from time-to-time resisted by the mining unions as threatening to reduce the amount of work available for miners. Cutting machines relieved miners of the backbreaking and dangerous process of undercutting the seam, and mechanical loaders reduced the manual handling of the coal.

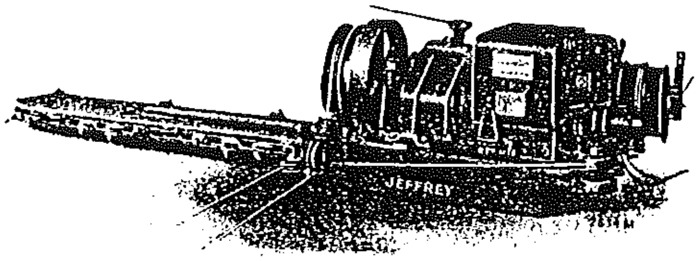
---

49 Bairstow & Davies 1987.

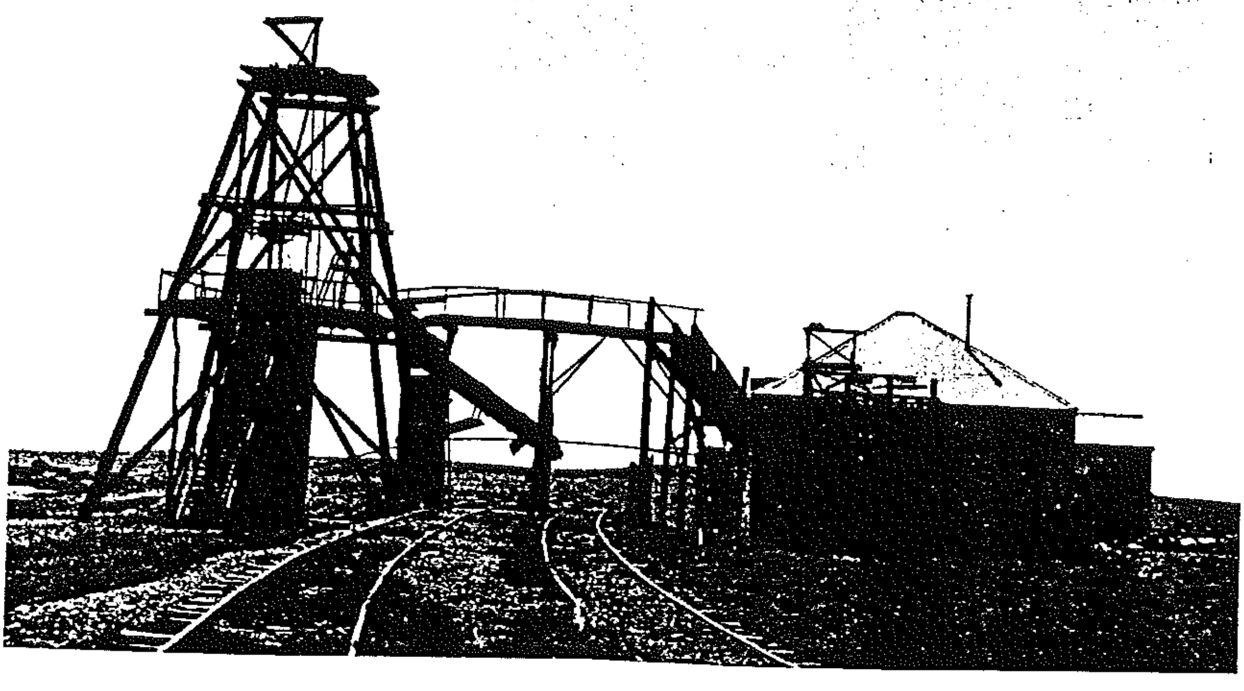
Ventilation fan house at Seaham Colliery, Hunter Valley. Engine house to left, then circular fan housing to left of the person on the roof, and air shaft and headframe to right. Inclined tramway in foreground. (NSW Mines Department *Annual Report* 1900)



Single-entry Sirroco **fan** (Whitmore 1991)



Jeffrey Shortwall Coal Cutter (Power, F. Danvers, 1912)



Leigh Creek Coal Mine (SA), in 1894 after it had been abandoned. The headframe and simple shute to load railway trucks is to the left, and a briquetting plant to convert low quality coal into solid briquettes is at the right. (Hargraves 1993)

Organised **mine rescue** teams slowly became active from the turn of the century. The first rescue brigade was established at Ipswich in Queensland in 1910, with a Rescue Station built in 1915. In NSW the Department of Mines and the mine owners agreed to share the cost of a mine rescue station and apparatus in the Hunter in 1912, but the system was ad hoc until the setting up of Rescue Stations was required by legislation in 1926. At Wonthaggi in Victoria a Rescue Station was established in 1928 following a mine explosion in 1924. Probably because Collie coal was relatively safe to work, being in shallow deposits and naturally wet (reducing dust and gas outbursts), there was no effective mine rescue system in place there until 1984 (Stedman 1988).

Coke production was an activity commonly associated with coal mines. Coke was used for smelting and foundry work, steel making, and as a fuel, and the market for it fluctuated with changing demands in these areas. The first coke ovens in NSW were built at Minmi near Newcastle in 1861, and coke manufacture started in the Illawarra coalfields in 1875. In Queensland the first coke ovens were built in 1869 to supply coke to the railways for fuel, and a series of coke ovens were in operation on the Ipswich coal fields up until 1958. (see Whitmore 1981 and Rogers 1988 for more on coke ovens).

Characteristic elements

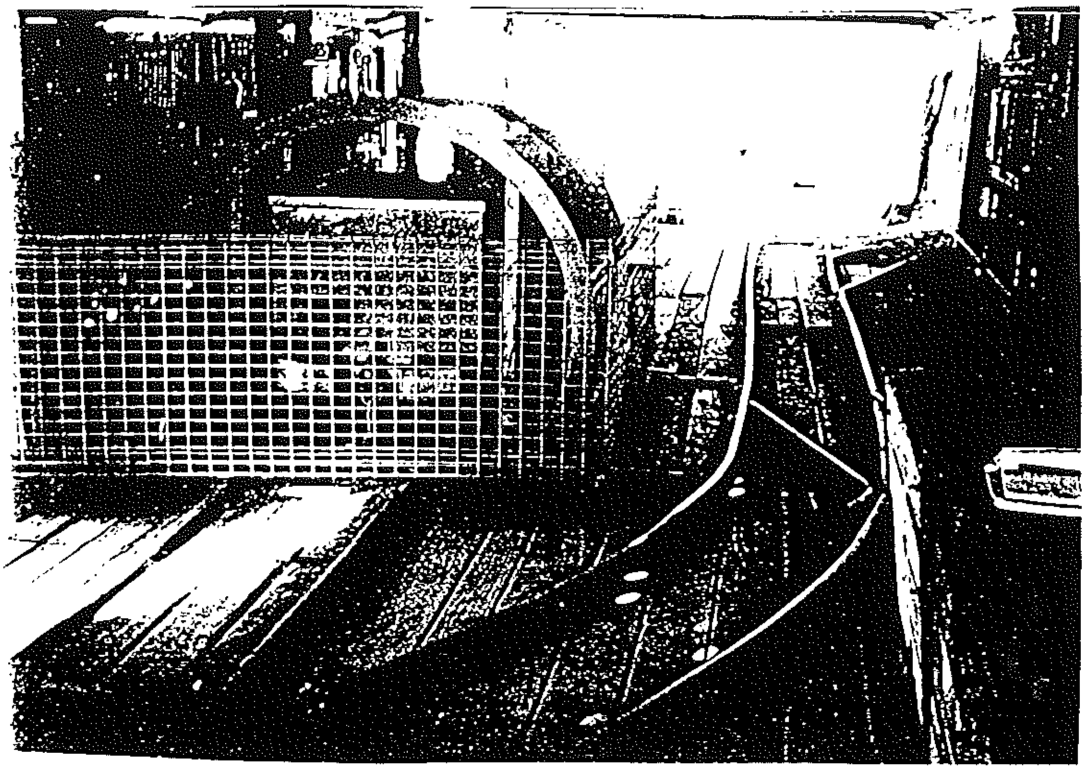
Pit head buildings—Until the turn of the century there were few pit head buildings and infrastructure at most Australian collieries, other than the **headframe** and brace building over the shaft or **heapstead** adjacent to the inclined tunnel, where the **winding engine** was located and rail truck loading took place. **Stables** for pit horses would be located nearby. The **portal** of the inclined tunnel, with the rails of the **haulage way**, is sometimes intact.

Depending on the coal field involved, by the end of the nineteenth or early twentieth century further pit head buildings began to appear. **Fan houses** to house ventilation fans were placed above an air shaft. **Weighbridges, tipplers, shaking screens, picking belts**, and eventually **jigs** and **washing plants** appeared to sort, clean and size coal before loading into rail trucks for shipment to users. **Power houses** and **switch rooms** were built as collieries became electrified. **Compressor houses** and air receivers were found at some mines. Loading **gantries** and **storage bins** were sometimes used for the holding and loading of coal at the **railway siding**, which could be quite extensive at large collieries. **Mine manager's houses** and **cottages** for other key staff were found at many collieries, and at isolated locations single miner's barracks and married miner's cottages were provided..

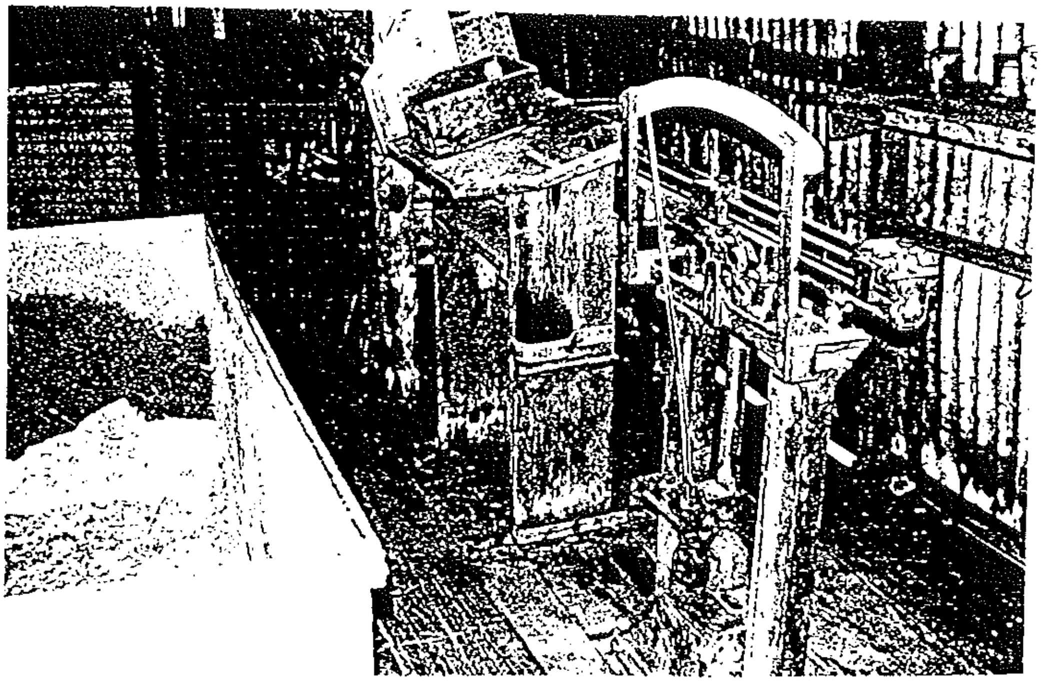
Lamp rooms became common for the refilling of acetylene lamps or the recharging of battery lamps. **Crib rooms** were provided for above-ground staff meals. **Bath houses** and **change rooms** appeared from the 1940s. Mine rescue equipment was stored in building near the shaft, and when formal **rescue stations** were introduced these were sometimes located at the colliery, or at a central point convenient to several mines.

Workshops for the repair of mining equipment and locomotives, **stores** for equipment and consumables, and **explosive magazines** were common features in this century. **Administration buildings** were common post-war. **Brickmaking plants** and **sawmills** were found at a few collieries.

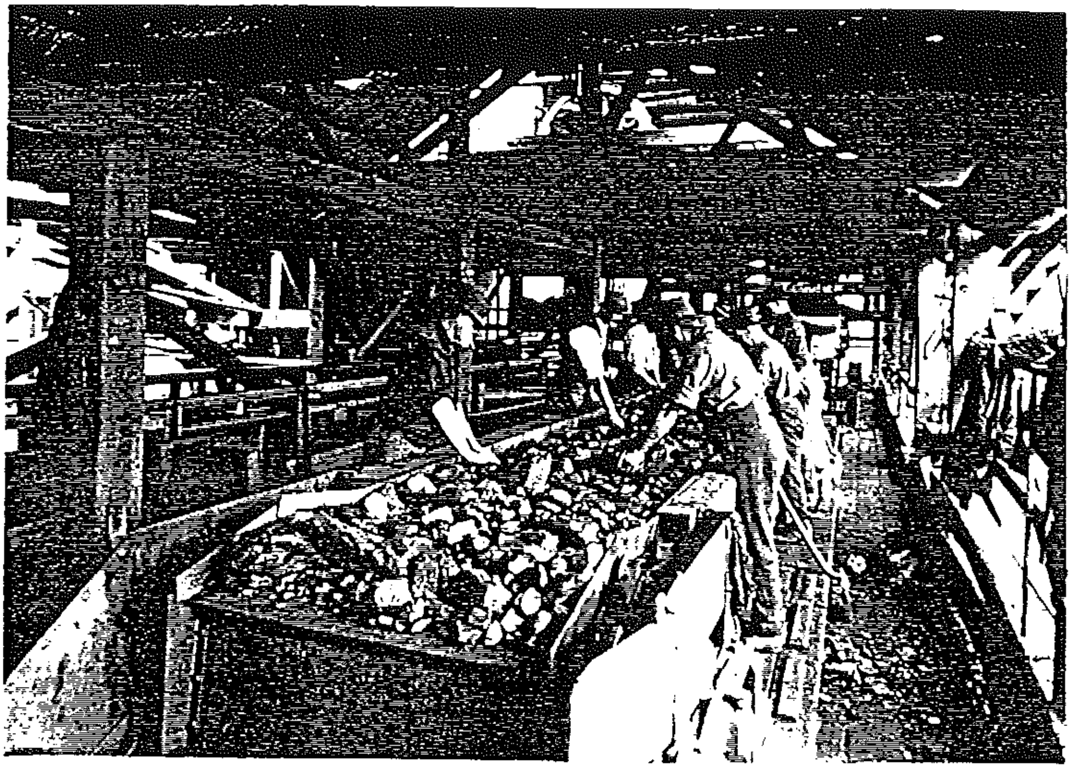
Slack dumps—The piles of slack, or fine coal, was common at mine sites before WWII, as were chitter dumps where rock sorted from the raised coal was discarded. Areas of



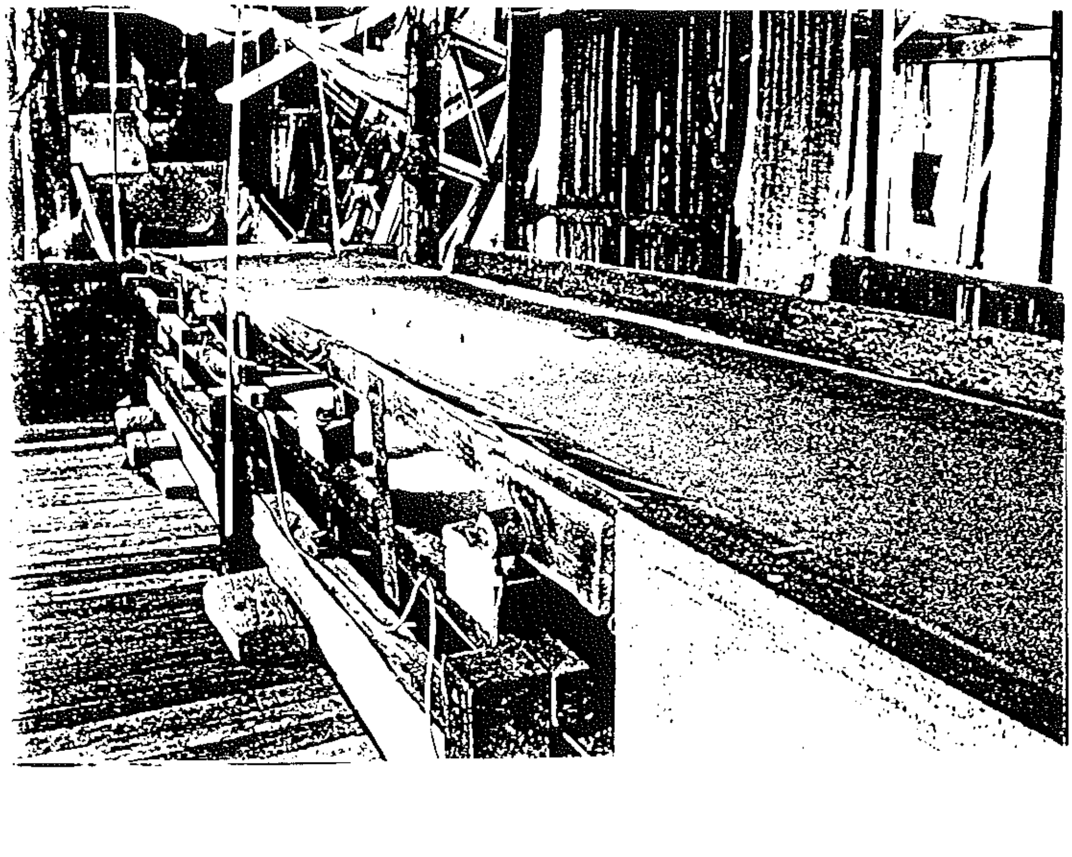
Tippler (with later safety fence around it), Acland Coal Mine, Queensland, 1994 (M. Pearson 1994)



Weighbridge at Acland Coal Mine, Queensland, 1994. Shows the skip on the scales at left, the scale mechanism, and the tally desk behind (M. Pearson 1994)



Picking belt at Ayrfield No. 3 Colliery, Hunter Valley, c. 1923 (Rothbury Estate Archives, University of Newcastle, in Fenwick 1995)



Picking belt at Acland Coal Mine, Queensland, 1994 (M. Pearson 1994) surface **subsidence**, where underground workings collapsed, were common around coal mines.

Coke ovens—Beehive ovens were used, consisting of a beehive-shaped brick oven with a circular plan 10 m in diameter, with a charging door at its base and a short flue at its apex to carry away waste gases (later collected at large oven batteries to produce by-product). The ovens were commonly set in parallel rows, two sets back to back with the spaces between them filled with earth to insulate the ovens, and a continuous brick or stone supporting wall running along the face of each set of ovens. Coke ovens are found at a number of coal mines around Australia.

Coal mines often were associated with the development of a **village or town** to service the mine. The major coal fields have numerous villages that owe their location and form to the nearby coal mine. Sometimes the village was initially owned and built by the mining company. These settlements might have heritage value in their own right, and should be referred to in recording and assessing the colliery itself.

2. DISTRIBUTION AND FREQUENCY OF THE TYPE

The relative distribution of coal mining activity can be seen to a large degree by the figure for coal production in the States, as shown in Figure 1. The largest coal deposits are in eastern NSW and eastern Queensland, with much smaller deposits in south-western Western Australia, southern Victoria, inland South Australia and eastern Tasmania.

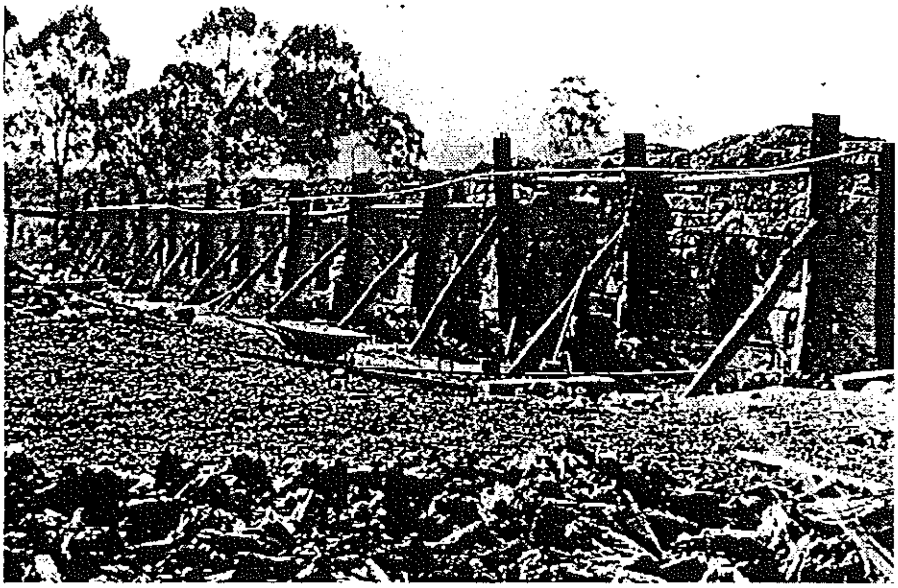
Figure 1.

Production of black coal in Australia to 1964.
(Source: Kalix, Fraser & Rawson 1966)

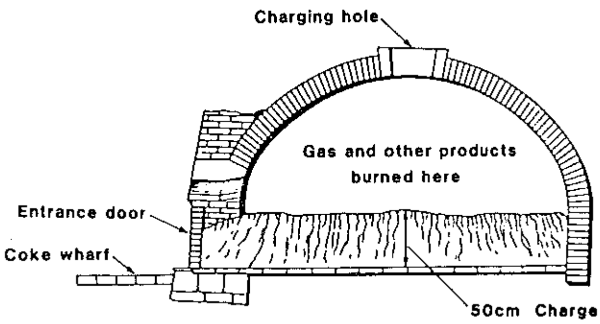
State	Tonnages
New South Wales	788,305,189
Queensland	99,912,814
Western Australia	33,851,311
Victoria	22,242,143
South Australia	12,645,515
Tasmania	9,556,321

Since 1964 the pattern of coal production has changed somewhat, the rate of extraction increasing greatly, most of it from open cut, which by 1991 represented over 90% of the production in Queensland, now the largest coal producer. In 1991 alone Queensland produced over 101 million tonnes, a figure exceeding total production in the State up to 1964. NSW production in the same year totalled over 97 million tonnes, 48% of it coming from open cut mines. Black coal production in Victoria ceased with the closure of the Wonthaggi State Coal Mine in 1968. However, the brown coal production in the Latrobe Valley has continued and by 1989 had totalled over 1,000 million tonnes. Western Australian production from Collie reached an aggregate of 100 million tons in 1991. (figures from Hargraves 1993).

Until recent times **New South Wales** was far and away Australia's largest producer of black coal. The main coalmining region was the Hunter Valley, where mining started in the 1790s, and booming after the proving of the South Maitland -Cessnock-Greta fields in the late nineteenth and early twentieth centuries. The other major fields were west of Sydney



Bench of 26 beehive coke ovens at rix's Creek near Singleton, NSW, c. 1916. (Rogers 1988)



Generalised cross-section of a beehive coke oven with a charge of coal (Roger 1988)

Coal in Australia

around Lithgow, and in the Illawarra around Wollongong. Coal markets included the railways and shipping lines, domestic and industrial use, electricity generation, and export to other colonies. The steel making enterprises at Lithgow, Newcastle, and Port Kembla were major markets for the adjacent coal fields (which had strongly influenced the location of the steel works in the first place).

In **Queensland** coal mining was carried out at a small scale from the time of the first commercial mining in the 1840s, but was slow to become a major industry, partly because the quality of the Ipswich (West Moreton) Coalfield could not match the quality of Newcastle coal for use by coastal steamers (see Whitmore 1981, 1985, 1991; Hargraves 1993 for history). By 1870 the Queensland coal output was just 17,000 tons, compared with three-quarters of a million tons produced in the Hunter. In 1870 the Queensland railways converted from wood firing to coal, and the thereafter expansion of the coal industry kept pace with railway expansion. Even so, imports of coal exceeded exports from the colony up until at least 1900.

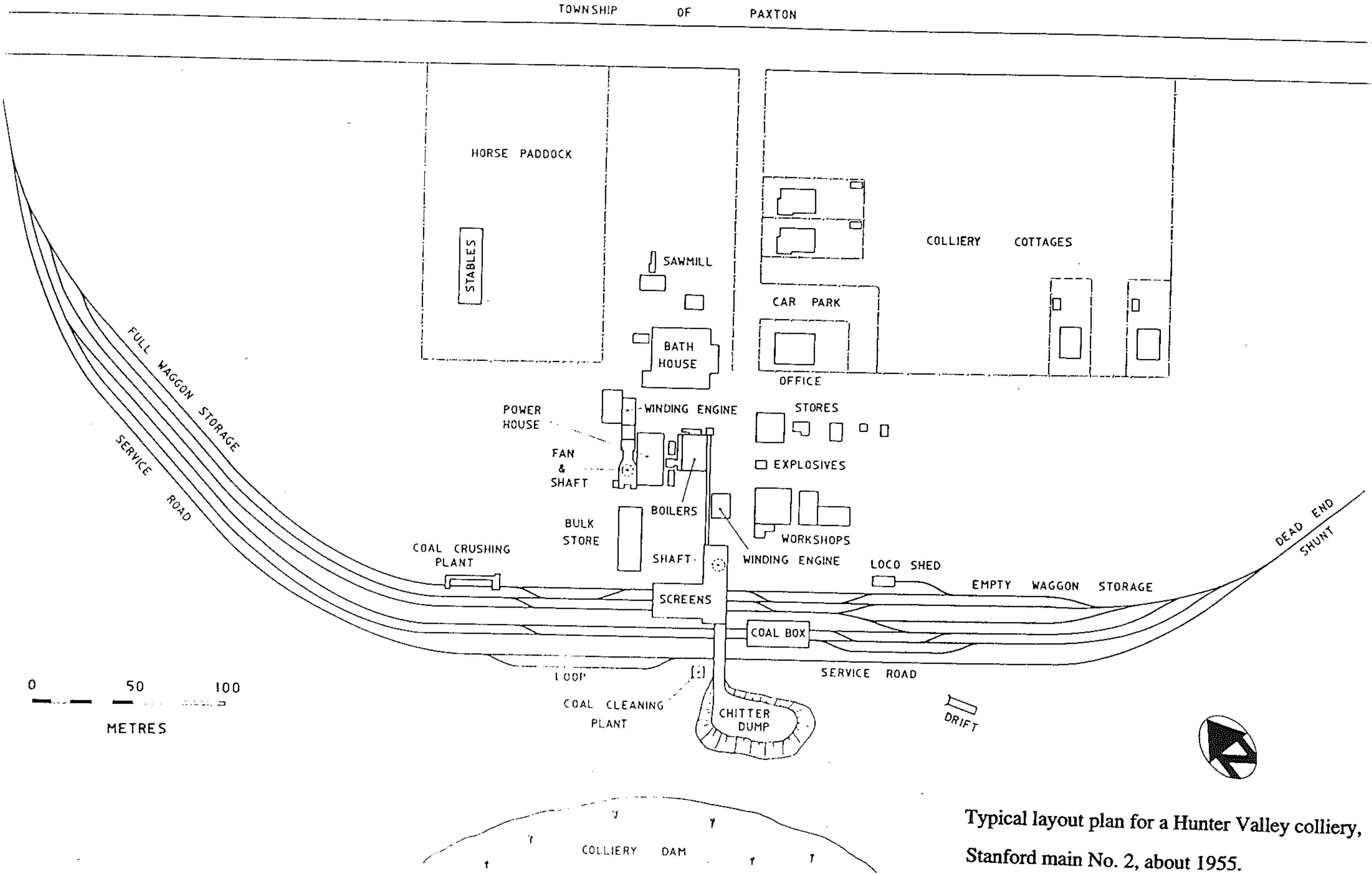
The primary producing areas at that time were at Ipswich, Burrum, the Darling Downs and Blair Athol in central Queensland. Mt Mulligan and Collinsville in the north of the State, and Baralaba, which supplied coal for Mount Morgan Mines, were other notable producers in this century. Local production remained healthy but not booming until the export of coal commenced in the late 1950s, with large open cuts being developed since then at Blair Athol, Moura, Callide and Blackwater. Queensland overtook NSW in annual coal production by 1990, to be the largest Australian producer. This has resulted from major development of the Central Bowen Basin reserves over the past three decades.

In **Victoria** black coal was mined at Wonthaggi (by far the largest producer), Outtrim, Korumburra, Jumbunna, Kilcunda, Woolamai, Mirboo and a number of other very minor producers (see Ward 1994 for figures). The supply of black coal was always only just sufficient to give some degree of independence from NSW coal suppliers for railway steaming coal. Low-grade brown coal deposits had been known since the 1860s, and brown coal was made into briquettes at Lal Lal and Morwell late in the century. Large scale open-cut brown coal mining started at Yallourn in 1924, replacing NSW coal in the local electricity supply systems. The Latrobe Valley brown coal deposits are now major sources of coal for power generation. (Hargraves 1993)

In **Western Australia** coal was discovered at Irwin River in 1846, but it was of low quality and remote. The only producing coalfield in the state was discovered near what is now Collie in 1882, and commercial operations began in 1898, when the railway reached Collie. Electric Jeffrey cutters were introduced in 1904. Up until 1940 miners were engaged on the contract system, and pit ponies were employed at some mines up to the 1950s. Before 1943 all mining was by underground workings, but open cut methods were added after that date, and became the predominant mining technique. Production reached 100 million tons by 1991 (Stedman 1988; Hargraves et al 1993).

In **South Australia** coal was discovered in 1847 in North Adelaide, but the first (and only) major mining was at Leigh Creek, discovered in 1888, which was utilised briefly for smelting fuel. Operations ceased in 1908. War demands renewed mining in 1943, when open cut methods were introduced at Leigh Creek and the Telford Basin, where it continues, mainly for power production in the State.

In **Tasmania** coal mining was restricted to black coal, which was distributed through a number of areas in the eastern part of the state. While many coal mines operated in the State, most operated for only a short period of time. The most successful mining area was in the Fingal-St Mary's-Mt Nicholas area (from 1886), while other coalfields, mainly with



Typical layout plan for a Hunter Valley colliery, Stanford main No. 2, about 1955.

(Fenwick 1995)

thin seams of coal, included the Mersey-Don, Denison Rivulet, Triabunna, Adventure Bay, Kaoota, Gordon, York Plains and Pateena, plus many other small mines (see Bacon 1991). While of relatively minor importance in the overall story of Australian coal production, the Tasmanian coal mines are of interest from a heritage viewpoint, because of the role of coal production in State development, and the fact that many mines were abandoned and evidence of their operations was not destroyed by later mining activity, as happened on the major coal fields in other states. Hence the only substantial evidence of convict coal mining is to be found there (as at the Coalmines Historic Site, Tasman Peninsula).

3. VARIATION OF THE TYPE

Variations in coal mining places relates mainly to the period of operation and the increasing sophistication of operations over time. The states had their own timeframes for the progression from simple to more complex colliery arrangements, with NSW and Victoria probably leading, but with other states such as Queensland showing the way in some aspects, such as rescue brigades and some other safety issues.

The simplest collieries were either early (up to 1900), or were later small operations unable to afford more advanced operating systems. These are characterised by pillar and bord mining, with minimal pit head facilities other than headframes and winding engines, coal loading facilities and some associated administrative and miner accommodation. From late in the nineteenth century pit head screening and picking installations, and more substantial buildings to house ventilation fans, lamp rooms and power houses became more the norm at larger collieries.

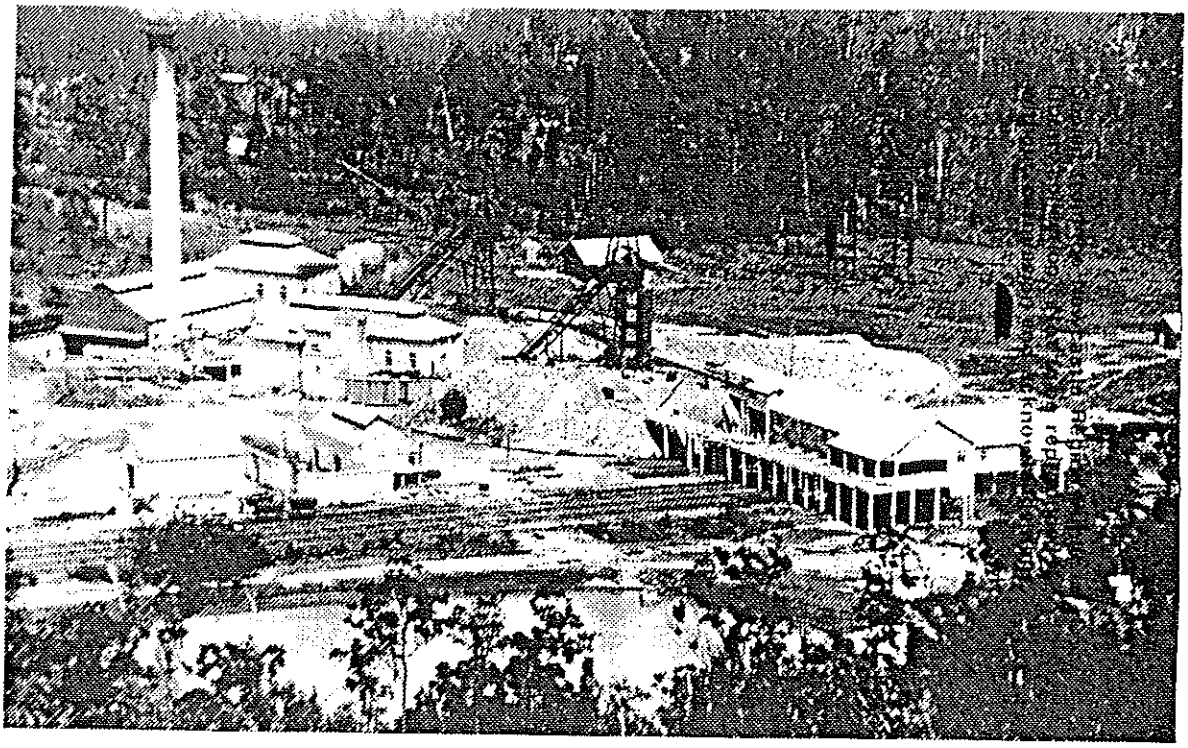
Small collieries (and some not so small) existed on some fields that were operated on an opportunistic basis by individuals or small groups of miners, especially in times of depression. Such mines often escaped the notice of the mines departments and do not appear in their records.

As the twentieth century progressed labour-related buildings became more common at collieries, buildings such as crib rooms, change rooms, bath houses, rescue stations, and sometimes miner accommodation. In larger collieries the administrative buildings became a focus of corporate image. As mechanisation increased workshops grew in size, to deal with steam, pneumatic, electrical and diesel machinery.

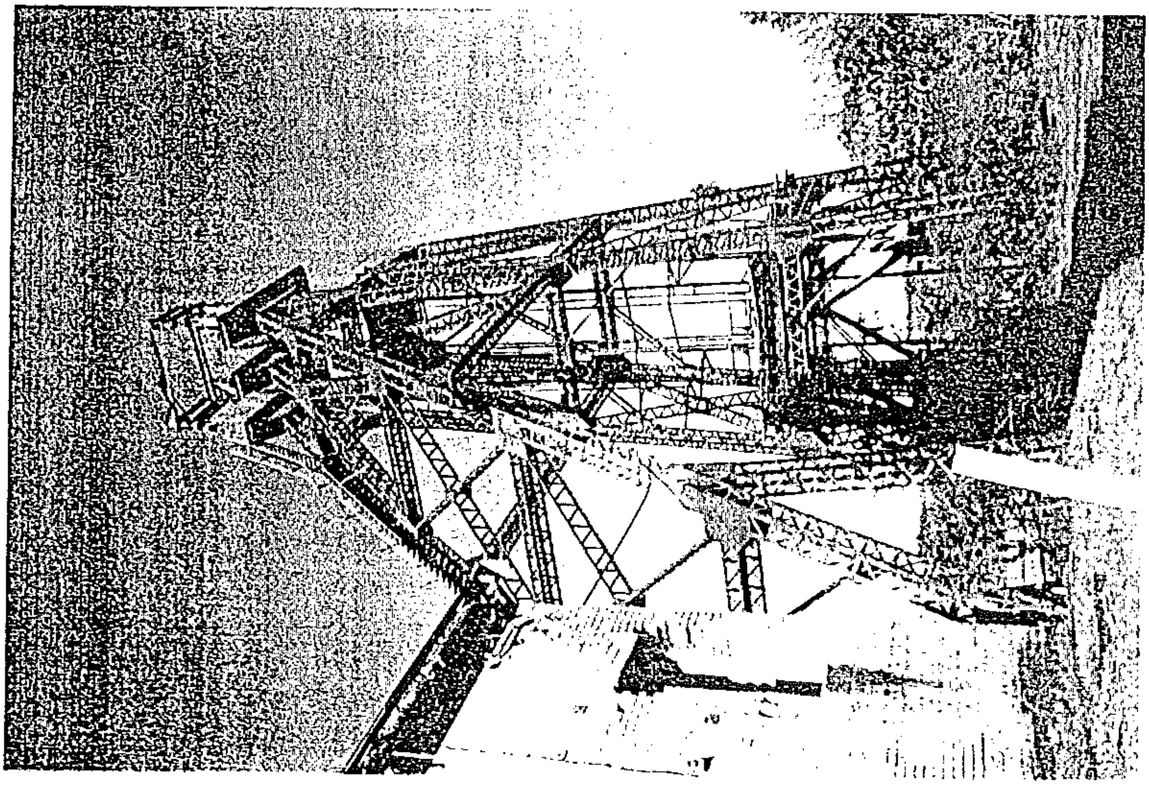
Gradually, from the 1920s onwards, open cut coal mining became a major factor in Australian coal production, and experienced a boom in the post-war recovery period and the development of export markets in Asia. Early open cut mines often re-worked deposits previously mined by underground methods, removing the coal left in pillars and uncut ground. Steam shovels and drags, and motor lorry tip-trucks were the normal means of working. From the 1950s the scale of these machines gradually increased, and modern open cuts have massive crane-mounted draglines, wheeled loaders and dump trucks. The Latrobe brown coal deposits were mined with giant 'dredgers', which consisted of bucket-wheel cutting heads or bucket chains on long gantry arms, with a conveyor belt carrying cut coal to be deposited behind the work area. The whole dredger is mounted on crawler tracks to move along the face of the open cut.

4. ATTRIBUTES PARTICULARLY WARRANTING HERITAGE REGISTRATION

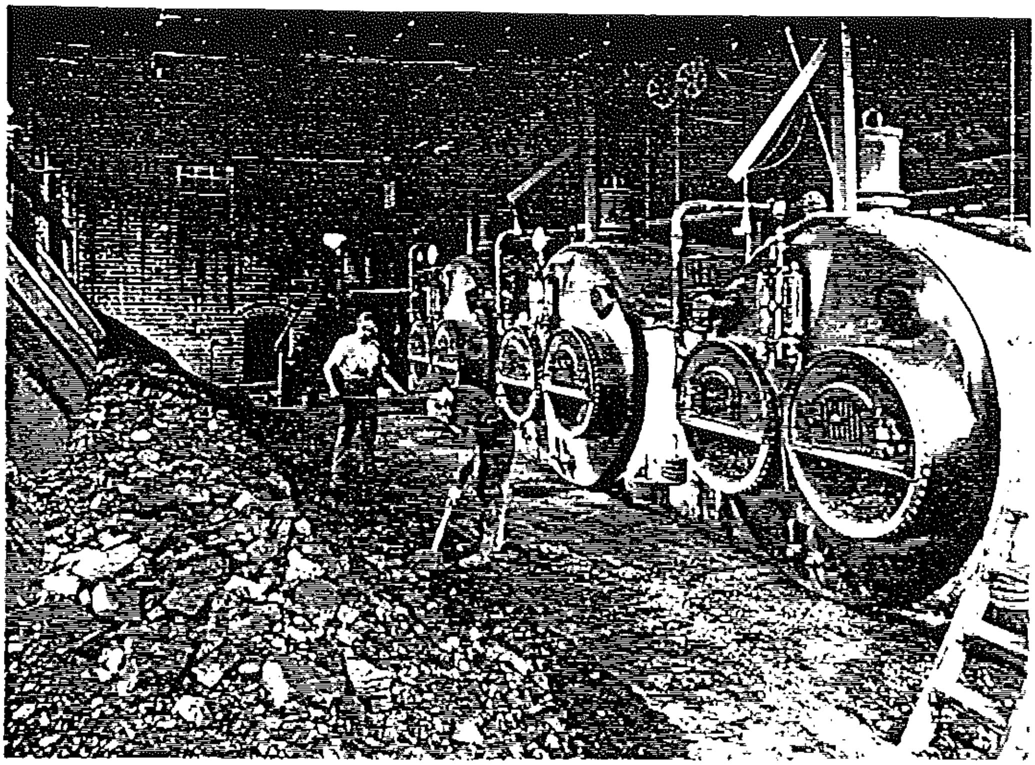
Attributes or combination of attributes of a coal mine that are likely to make it a good example are:



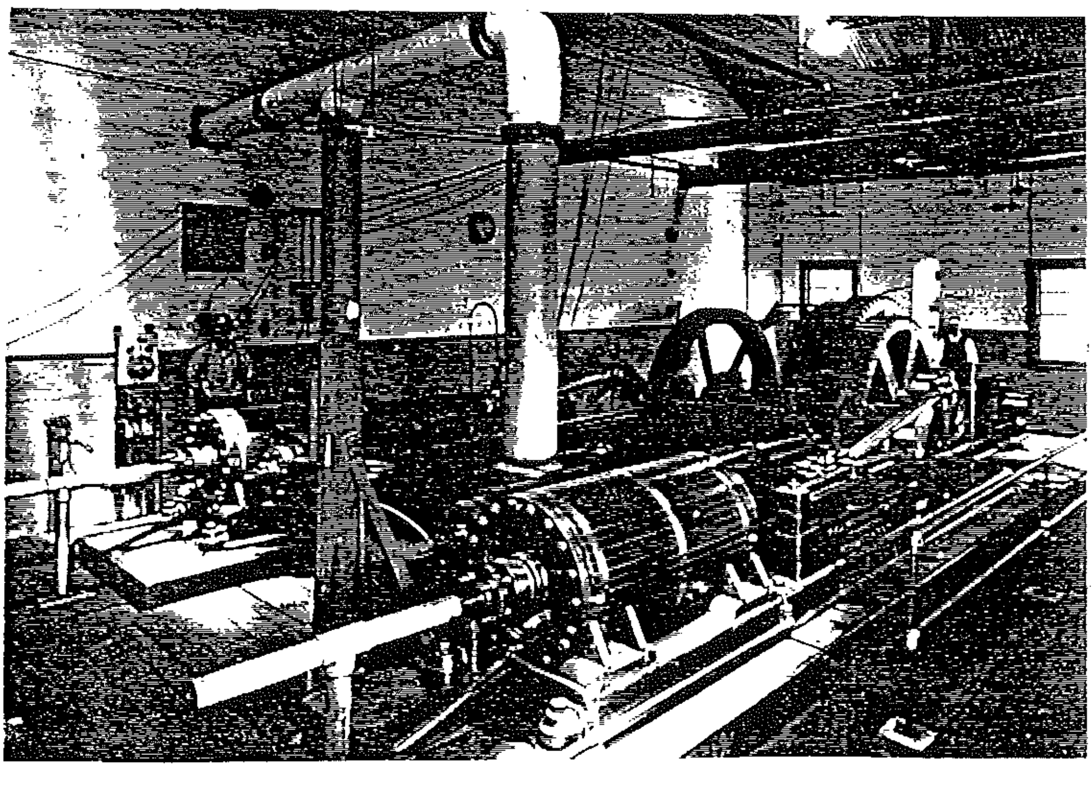
Hebburn No. 2 Colliery, Hunter Valley, about 1920, showing the complex and substantial above-ground development at a major coal mine. (Newcastle Regional Library, in Fenwick 1995)



Stanford Main No. 2 steel lattice headframe and winder building. Hunter Valley. (Fenwick 1995)



Lancashire boilers at Ayrshire No. 3 Colliery, Hunter Valley, about 1920 (Rothbury Estate Archives, University of Newcastle, in Fenwick 1995)



Twin cylinder steam engine driving haulage winder, Ayrshire No. 3 Colliery, Hunter Valley, about 1920 (Rothbury Estate Archives, University of Newcastle, in Fenwick 1995)

- clear evidence in combination of the various above-ground features appropriate to the colliery's age and location. As coal mines, especially early ones, are unlikely to have all buildings surviving, such evidence might include foundations, banking for structures, rail embankments, cutting and alignments, tunnel portals or shaft cappings etc. Evidence of recent collieries might be expected to have substantial intact structures to be regarded as good examples of their type.

Attributes or combination of attributes of a coal mining site that are likely to make it rare, uncommon or of particular interest include;

- Intact or unusually substantial examples of early coal mining technology, such as headframes, fans and/or fan houses, heapsteads or braces, picking belts.
- The combination intact or unusually substantial surviving feature that demonstrate clearly the range of operations typical of coal mines of its era.

The significance of mining features which satisfy or do not satisfy the above attributes might be enhanced by association with specific historical events (such as major mine disasters), technological innovations developed at the site, or strong or special meaning for a particular community or group (see *A Guide to the assessment of mining heritage places* in this manual).

5. KEY SOURCES USED IN THIS TYPE PROFILE;

Andrew C. Ward and Associates, 1994. 'Conservation Analysis and Management Strategy, State Coal Mine, Wonthaggi', report for Historic Places Section,

Bairstow, D and Davies M. 1987. *Coal Mines Historic Site survey: Preliminary report*, Occasional Paper 15, Tasmanian Department of Lands, Parks and Wildlife, Hobart.

Fahey, C. 1987. *Wonthaggi State coal mine: a short history of the State Coal Mine and its miners*, Conservation Forests and Lands and Wonthaggi Coal Mine Committee, Melbourne

Fenwick, P. 1995. 'South Maitland coalfield heritage study', report for the National Trust of Australia (NSW), Sydney.

Hargraves, A.J. (ed), Kininmonth, R.J. Martin, C.H. and Saywell, S.M.C. 1993. *History of Coal Mining in Australia*. Monograph 21, Australasian Institute of Mining and Metallurgy, Parkville.

Jack, I. 1979. 'Coal' in Birmingham, J., Jack, I. & Jeans, D. *Australian Pioneer Technology: sites and relics*, Heinemann Educational Australia Richmond: 99-118.

Kalix, Z. Fraser, L. M. & Rawson, R. J. 1966. *Australian mineral industry: production and trade 1842-1964*, Bulletin No. 81. Commonwealth of Australia, Department of National Development, Bureau of Mineral Resources, Geology and Geophysics, Canberra.

Rogers, B. 1988. 'The coke works at Flagstaff Point, Wollongong, 1875-1890', *Australian Journal of Historical Archaeology*, 6: 12-19.

Stedman, C. (ed). 1988. *100 years of Collie coal*, Curtin University of Technology, Perth.

Whitmore, R.L. 1981. *Coal in Queensland: The first fifty years*. University of Queensland Press, St Lucia.

Whitmore, R.L. 1985. *Coal in Queensland: The late Nineteenth Century - 1875-1900*. University of Queensland Press, St Lucia.

Whitmore, R.L. 1991, *Coal in Queensland: Federation to the Twenties- 1900-1925*, University of Queensland Press, St Lucia.

MODEL TYPE PROFILE—COPPER

MODEL TYPE PROFILE—COPPER

1. DESCRIPTION OF THE TYPE

Copper mines are very similar in form to a number of other hard-rock mining operations. The mining operation has much in common with that described in the type profile for Reef Gold Mining in this manual. Many copper mines have closely associated smelter sites, where the ore is converted into copper matte (low quality raw copper). The smelter sites are more diagnostic than the mining sites themselves. The *Guide to common mining terminology*, in this manual, provides definitions for many of the terms used in this type profile.

Outline history of copper mining

- 1844—Australia's first copper mine opened at Kapunda, SA, continuing to 1878.
- 1845—Copper mining commenced at Burra, SA, continuing to 1877.
- 1845—Copper mining commenced in NSW, at Copper Hill and Belubula, near Orange.
- 1859—Copper discovered at Wallaroo, SA, mining continuing to 1923.
- 1861—Copper discovered at Moonta, SA, mining continuing to 1923.
- 1862—Peak Downs copper deposits being mined, Queensland.
- 1865—Thompson River (Walhalla) copper mine opened in Victoria.
- 1871—Mount Perry copper deposits being mined, Queensland.
- 1870s—Numerous copper mines operating in central Queensland and central and northern NSW.
- 1878—Copper mining commenced at Cobar, NSW.
- 1883—First copper mining in Northern Territory at Daly River.
- 1885—first use of water-jacket smelters in Australia (Cloncurry)
- 1892—Deposits first worked at Mount Lyell, Tasmania.
- 1890s—Copper boom resulting in numerous small copper mines in Qld and NSW.
- 1903—Copper smelting began at Mount Morgan, Queensland.
- 1943—Copper smelting began at Mount Isa, Queensland.

Description of copper mining and smelting processes

In the first instance the best way to distinguish a copper mine from any other is by finding the documentary evidence that identifies the mine, though the green tones of weathered copper ores found around the top of the shaft and in the waste material around the mine is a common indicator of copper mining. Oral evidence can also be a good starting point.

Copper mines are more easily identified if they have smelters associated with them, though be aware that some other metals, such as silver and lead, can have similar smelting processes. With the exception of smelters, copper mines share characteristics with many other hard rock mines. The mine itself might consist of one or more shafts, adits and/or open cuts to access the ore body. In all but large copper mines the mining process was largely manual, mechanisation being evident only in a winder for the headframe, and sometimes a compressor and air receiver to power pneumatic drills. The larger mines and smelters are more likely to have steam engine railways for the transportation of ore and fuel, and sometimes for the disposal of slag, and may have rail haulage systems installed in the mine itself. In addition, rail links might be established to bring fuel (such as coal), and flux (such as limestone or iron stone) to the smelter.

It is the treatment of the ore that most clearly distinguishes copper mining sites from those associated with other minerals. Copper is often smelted at or near the mine, though other minerals such as lead and silver are also often associated with smelters. Smelters were sometimes built at copper mines at a very early stage, before the true production potential was established. Hence it is not unusual to find smelters associated with unsuccessful mines, and the use of the smelter might have been minimal, resulting in a correspondingly small slag dump.

The ore was often hand picked to reduce the amount of rock to be transported and treated. The simplest way of doing this was on picking or dressing floors. Before smelting the copper ore was sometimes roasted, to remove some of the sulphides which could complicate the smelting process. From early this century various processes were introduced to concentrate copper ores. The ore was crushed (often with jaw rock breakers), sometimes further reduced in ball mills, further concentrated on tables, and then perhaps treated by flotation or leaching processes.

For smelting, the concentrated copper ore was crushed and mixed with a flux (usually ironstone and limestone) to assist chemical reaction and lower the melting point of the ore. This mixture was placed in the hearth of the smelter (until early this century most often a reverberatory furnace or a water-jacket blast furnace) and heated, producing molten copper matte (up to 40 - 60% copper) and a slag of silica, ferrous oxides and other by-products. The matte is heavier than the slag, and the two were tapped off from the furnace separately. The slag can be treated in a number of ways (see below) to enable it to be moved to a heap or tip. The copper matte might be further refined on site in additional smelters or in converters (from the end of the 19th century), but from small mines was more commonly was sent off to a specialist refinery.

Complex ores were treated in a variety of chemical processes from the late 19th century, including acid leaching and chlorination (for ores also containing gold). Electrolytic plants simplified refining, and flotation treatment of ores was introduced, during the 20th century. Smelters improved though this century, first with electrical furnaces and converters, and then with flash smelters introduced for copper and nickel refining in the 1970s.

The mine and processing areas might be linked by road, rail or aerial cableways, and a road usually leads from the processing works towards the nearest town. Copper processing involved substantial masonry structures and amounts of iron reinforcing bars and other metal machinery, which often remains in a fragmentary form at copper mining sites. Slag is an extremely durable material, and was produced in large amounts from operating smelters. Unless the slag has been removed for later reprocessing, its presence is a good indicator of base-metal mines, including copper mines. Copper mines, and smelters in particular, required a resident labour force, and habitation sites ranging from a few huts to large towns are usually associated with copper mines.

Copper mines, especially small ones, are characterised by many breaks in the history of their operations. This is because copper, unlike gold, is subject to great fluctuations in world metal prices, and mine operation responded to these waves of profitability and bust.

Characteristic elements

Mine workings—Copper mines use similar technology to many other hard rock mines. They might have shafts, adits, open cuts, mullock heaps, head frames, winding engines, pumping equipment, compressors and pressure vessels, tramways and roads, dams and habitations.

Cornish beam engine houses—These are common at early mines in SA (1848-88) and occur less frequently elsewhere, in NSW (Cadia) and Victoria (at gold mines). They were most often used to raise water from underground workings.

Boilers and engines—Boilers were needed to provide power to engines for mining, drainage and smelting operations. Sites often have complete or fragmentary remains of boilers such as the cylindrical Cornish and Lancashire types, and firetube boilers including the complex Babcock and Wilcox type: The masonry beds for boilers sometimes survive even if the boiler has been removed. Steam engines occasionally survive, but more often just the engine bed and mounting bolts remain.

Dressing floors and concentrating works—Copper ore had to be crushed or reduced to be able to be smelted, and sometimes a cobbled or paved floor survives where this occurred (especially at early sites). The ore was reduced to from sand to fist size, depending on the smelter used, and was usually concentrated by removing rock without traces of ore. The machinery involved in concentration included rolls, jaw rock breakers and ball mills to reduce the ore, and jigs, buddles, shaker tables (such as Wilfley tables), classifiers (such as Frue vanners) and flotation cells to concentrate it.

Smelters— Copper ores were smelted to retrieve the copper they contained. It has been estimated that about 65 copper smelters were built in Australia between 1847 and 1897, and a further 65 in the boom period from 1897 to 1907, the number falling to only about 14 smelters in the next decade (Bell and McCarthy 1994).

The most common smelter during the 19th century was the Welsh **reverberatory** type. This consisted of a masonry hearth with a low arched roof. The copper ore was finely crushed, mixed with a flux and spread over the floor of the smelter. An intense fire was set in the fire box at one end, and the hot gases passed over the ore to exit through a flue and chimney at the opposite end of the smelter. The ore was heated directly by the hot gases, and by heat reflected from the roof, hence 'reverberatory'. The reverberatory furnace was tapped of its liquid slag and copper matte after each firing, and then reloaded.

Much experimentation occurred with reverberatory furnaces, both locally and internationally, to adapt the process to the peculiarities of the particular ore being mined. While excellent technical manuals existed (and are a great help in understanding the process), the local operations were very dependent on traditional rule-of-thumb practices, and influenced by often limited capital. As a result it is often difficult to get a close match between what is found on the ground and what is illustrated in the manuals.

The reverberatory smelter was a masonry rectangular structure ranging from under 4 m to 5 m wide and 5 m to over 11 m long. Few are found standing to their full height (the arched roofs have usually collapsed), but they were usually under 2 m in height. A fire box sits at one end, from 1 m to 2.5 m wide and 2 m to 3 m long. The hearth inside the rectangular structure is roughly oval in plan, with several draw-holes and rabble holes at the sides and end. A **flue** usually exits the smelter at the end opposite the fire box, and a is connected to a **chimney**. Both flue and chimney have often collapsed, and may have been scavenged for bricks. A series of relatively well-preserved smelters survive in central Queensland, but

Fig.1

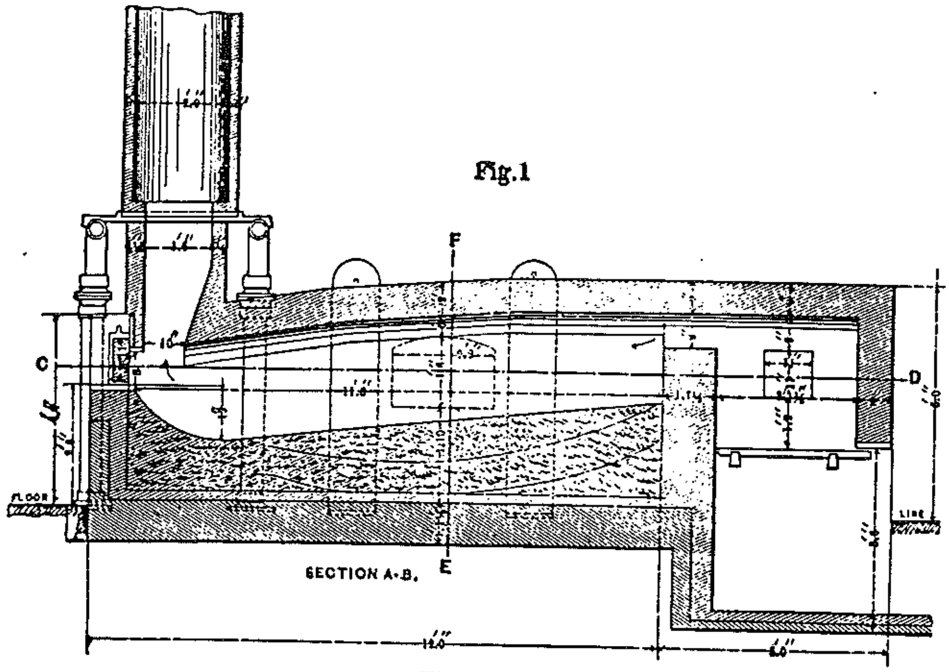
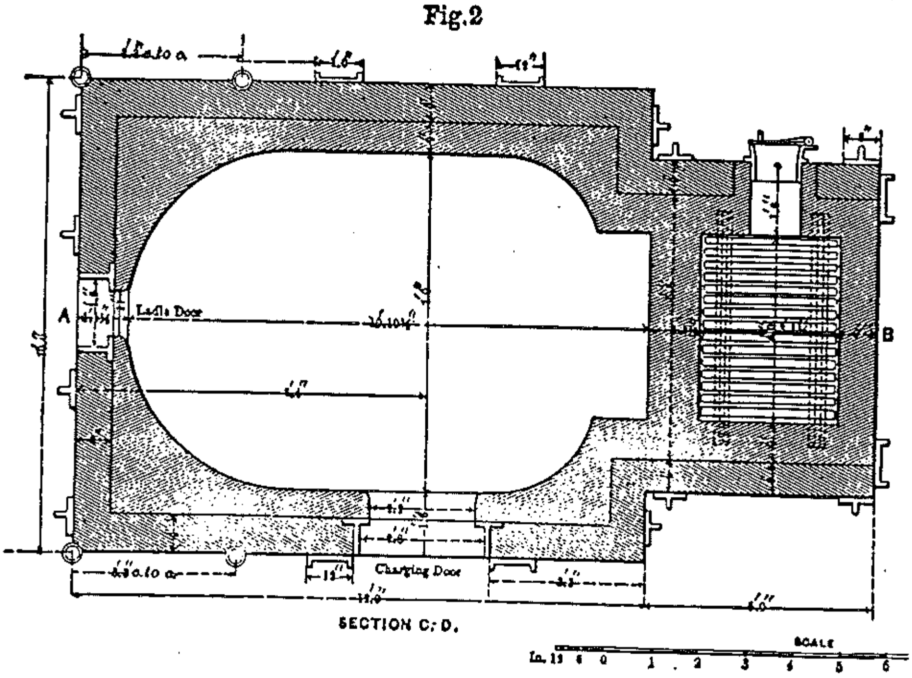
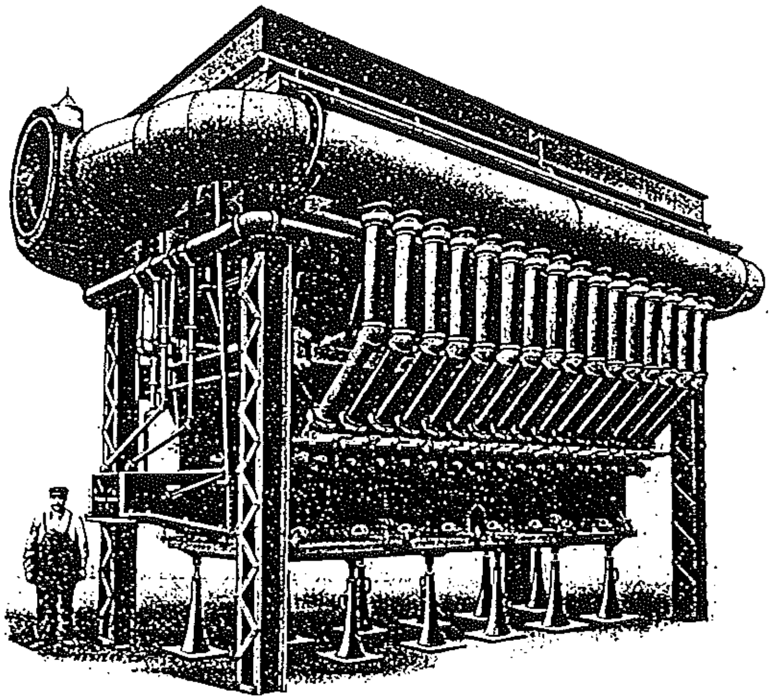


Fig.2



Section and elevation of a **reverberatory copper furnace** (Peters 1887: 329).



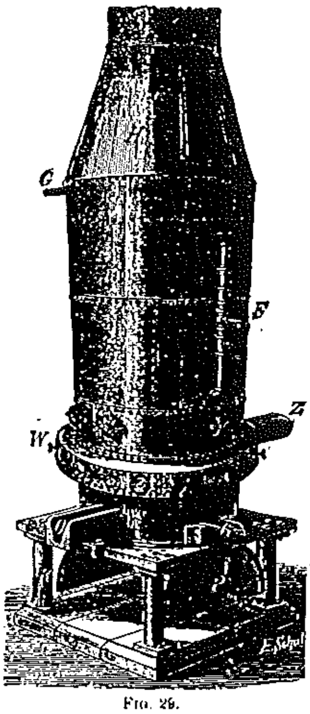


Fig. 29.

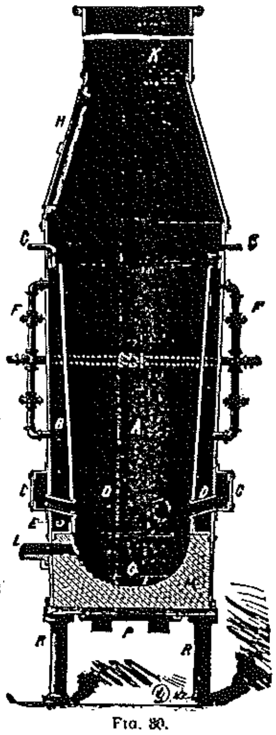


Fig. 30.

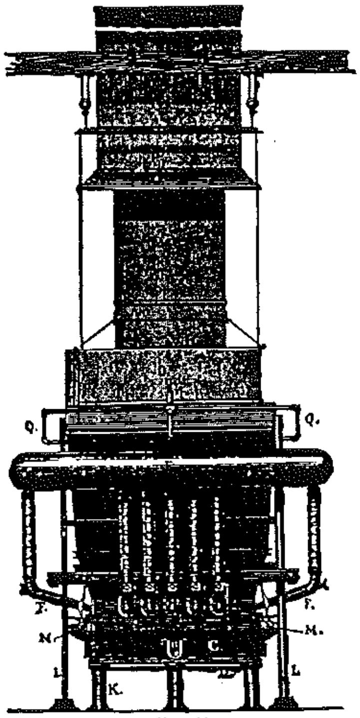


Fig. 34.

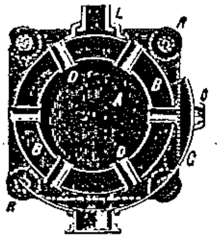


Fig. 31

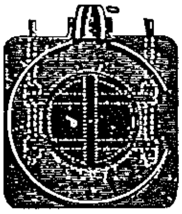


Fig. 32.

Various forms of **water-jacket blast furnaces** (Peters 1907: 267-269; Peter 1911: 152.)

on many sites the smelter is indicated only by a scatter of heat-eroded bricks with slag attached to them (often firebricks with maker's names stamped on them), iron reinforcing bands, and an adjacent slag heap.

German Cupola or brick blast furnaces were used at Cobar and Lake George in NSW in the 1880s, but were not very successful. From the mid-1880s (1885 at Cloncurry) a new American **water-jacket blast furnace** began to be used, and became very common after the turn of the century. This was a tapering iron cylindrical, oval or square-sectioned furnace with a double skin, through which water was passed to help cool the skin. A blast of air was provided through a series of pipes or 'tuyeres', to increase the internal heating, and the furnace was able to run continuously. The fuel used was coke, which was placed in the furnace in layers alternating with the ore. At some sites reverberatory and water-jacket furnaces operated concurrently. Some water-jacket furnaces had apparatus for collecting particles of copper from dust escaping up the flue.

Only a few water-jacket furnaces remain on sites in Australia (mainly in Queensland), and the technology is usually identified from the historical reports and the other on-site evidence, such as the absence of the masonry remains of a reverberatory furnace, or the presence of iron screw feet that supported the smelter, or sections of iron plating from the smelter itself.

Additional equipment was associated with the preparation of ore and the further refinement of the copper matte from the smelters. **Roasting furnaces** (such as Edwards roasters) occur on some fields, to roast the ore to remove sulphides before smelting. Steel cylindrical brick-lined **converters** to refine matte were found at several large sites after the turn of the century.

Coke heaps—Coke was used to fuel water-jacket furnaces, and at very least traces of coke are usually found at water-jacket smelter sites. Reverberatory smelters could utilise a variety of fuels (coke, coal, charcoal, firewood), so the linkage between fuel and this smelter type is not so diagnostic.

Slag heaps—A necessary feature of smelting sites is the **slag heap**, where the slag from the smelting process was deposited. Smelters produced 5 to 10 times as much slag as they did copper, and slag is an extremely durable marker of a smelter site. Slag could be run into sand moulds, giving lozenge-shaped pillows of slag (common at early or under-resources isolated smelters), or it could be poured into conical iron wheeled-buckets, giving cones of slag if it set (seen at both reverberatory and water-jacket sites), or poured in its molten state into formwork squares or simply poured over the tip face as a flowing mass, or quenched in water to give a granulated slag (the last three methods being more commonly associated with water-jacket smelters). Slag squares were often used to pave over the uneven top of the slag heap to allow easy access by wheeled buckets to the tipping edge. At some sites slag was caste into blocks and used as a massive building material for walls.

All of these types may be found at Australian smelter sites. The slag might be run out from the smelter in a series of long fingers, or deposited immediately adjacent to the smelter as a broad face working outwards from the smelter site. A few of the very large mines back-filled their underground workings with granulated slag, leaving surprisingly little above ground.

A careful survey of the slag tips can indicate the likely location of the smelter, and the type of slag can be an indication of the type of smelting carried out, and in the case of early sites, can help differentiate the remains of early from later operations.

Support buildings—Various support buildings might be associated with the copper mine. These might include stabling for horses, blacksmithies, workshops and garages for motor vehicles, steam engine houses, mine administration buildings, worker barracks and cottages, brickworks, water tanks and dams etc.

Habitation sites and villages—large copper mines, and particularly ones with smelters, required a reasonably sizeable workforce. Hut or cottage sites and sometimes small villages were associated with the mine and smelter, sometimes at some distance, especially where the mine was not in a well-watered location. In the case of large and successful mines, the village formed the nucleus for what is now a town (eg Cobar, Mount Morgan, Mount Perry, Burra, Queenstown), the layouts of which often owe their patterning to the needs of the mines, still evident even if the mine is now long closed. The habitations, villages and towns had road and rail systems that linked them to the mines and smelters and to the outside world, and often shared a water supply built for the mine.

2. DISTRIBUTION AND FREQUENCY OF THE TYPE

Economically viable copper deposits are few in number and widely scattered in Australia. The largest producer is Mount Isa, with an output of over 3.4 million tons of copper since operations commenced in 1943. Mount Lyell in Tasmania produced 1.3 million tons, and Moonta / Wallaroo, Mount Morgan and Cobar each produced over a third of a million tons. South Australia produced 53% of Australia's copper to 1907, New South Wales 19%, Tasmania 15% and Queensland 11%. At Mount Morgan and Cobar the deposits contained substantial proportions of both gold and copper, so the on-site evidence represents the processing of both minerals.

The best preserved copper mining sites are often the small and relatively isolated ones. Larger sites have often been re-worked over time, the machinery removed and the slag heaps sometimes re-processed.

In **New South Wales** a number of districts had copper mines operating in the 19th century and into the 20th century. The Cobar / Nymagee area had a number of mines, with the Great Cobar, the largest producer, commencing operations in 1871.

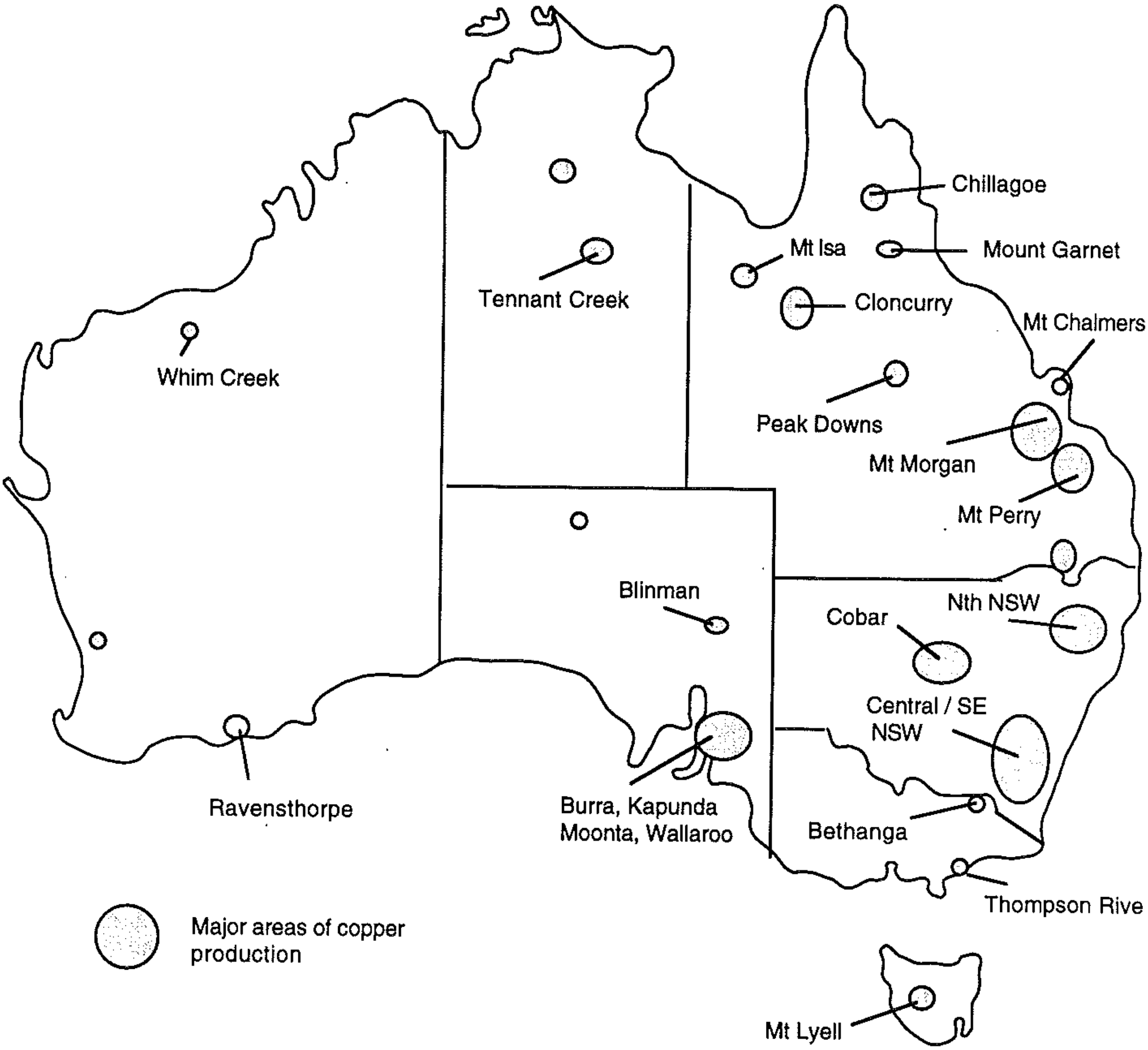
A large number of small copper mines operated in the Bathurst / Orange / Oberon / Carcoar area of central western NSW, from as early as 1845. These included very early mines at Copper Hill near Molong, Summerhill near Rockley, Icely near Carcoar and around Byng near Orange. The substantial Burraga mine worked from 1878, and the Cadia copper mine which has the only Cornish beam engine house in NSW, was built in the 1870s.

A number of small mines operated in the Northern Rivers and New England areas, the most notable being at Cangai on the Clarence River (from 1901). Similarly, the southern western tablelands and slopes had a number of small mines, among them being the Captain's Flat copper and lead mines, which operated blast furnaces, and the Lobb's Hole mine near Yarrangobilly.

Centralised copper smelters and electrolytic plants were built at Newcastle, Dapto, and Lithgow

In the **Northern Territory** the first copper discoveries were in the Pine Creek district in 1872, but mining didn't commence until 1883 at the Daly River. Marginal copper ventures later occurred in the Katherine area and other spot locations. Mining took place in the

Copper in Australia



Tennant Creek district after World War II, ceasing in the 1980s. The Territory was never a big copper producer.

In **Queensland** the first large mine (and smelters) in tropical Australia was established at the Peak Downs Copper Mine near Clermont in 1862, and the site was re-mined after the turn of the century. Other notable mines were at Mount Perry (1871) and Mount Chalmers (1869), and the largest of all at Mount Morgan (1903) and Mount Isa (1943). A number of small copper mines of the 1870s, several with remarkably well-preserved smelters, are scattered through central Queensland. In the north were the copper mines of the Cloncurry area (1880s) and Chillagoe, and Mount Garnet areas (1890s). This second wave in the 1890s saw new mines in central and southern Queensland, such as Sundown, Glassford Creek and Mount Cannindah.

In **South Australia** Moonta / Wallaroo was the overall largest production area, but the mines at Kapunda and Burra had high grade deposits and in combination they dominated Australian copper mining up until the turn of the century. Many other smaller and less successful mines operated in the state, in an area stretching north from Adelaide 450 km to Blinman and Bolla Bollana.

In **Tasmania** copper mining was dominated by the massive Mount Lyell deposits and associated outliers, which have been the subject of intensive heritage recording.

In **Victoria** there were only two copper mines of any note, the most notable being the Thompsons River (Walhalla) mine. The state was never a major copper producer.

In **Western Australia** early copper mining (1860s) took place in the Geraldton area. Substantial remains of the copper mines and smelter site (including converters) survive at Ravensthorpe. However, the state was never a major copper producer.

The attached map shows the primary regions where copper mining has occurred.

3. VARIATION OF THE TYPE

The main variations in copper mines over time, geographically and technologically include:

South Australian Cornish model— 1844-1888—Characterising the early South Australian copper mines, most recognisable by the stone beam engine houses.

Reverberatory smelter sites—Sites associated with reverberatory smelters and associated processing technology. Found in all states, and the most common smelter type before the 1890s, though still relatively common well into this century.

Masonry blast furnaces—Early blast furnace type, but used at times at later periods. Sites are rare, especially compared with the water-jacket type.

Water-jacket smelter sites—Sites associated with water-jacket blast furnace smelters and associated processing technology. Found in all states, and equally common with reverberatory smelters after the 1890s.

Centralised smelters—Large smelter sites separated from the copper sources they smelted. A number of such sites were built in NSW (Newcastle, Lithgow, Dapto), South Australia (Wallaroo) and Queensland (Mount Morgan, in part).

Large copper producing centres—There were a number of pre-eminent copper mining and smelting locations that dominated the industry. The most prominent were Mt Isa and Mt Morgan (Qld), Cobar (NSW), Mt Lyell (Tas) and Moonta / Wallaroo and Burra (SA). These sites were very extensive and long-lived, with complex remains.

Small self-contained copper mines—Small-scale copper mines, often with associated smelters, were scattered throughout the copper deposit regions of Queensland, NSW and SA, and to a lesser extent in NT and WA. These sites are usually much less well known that the large producing centres, but were of major importance in stimulating local economies. They often have well preserved remains, due to their short period of operation and the absence of later mining ventures at the site.

Ore roasting sites—A number of sites retain evidence of ore roasting furnaces where sulphide-rich ore was treated before smelting. The presence of such evidence is a variation on the basic smelter configuration.

Matte refining furnaces or converters—A number of sites retain evidence of smelters or converters used to further refine copper matte from the primary smelting process. The presence of such evidence is a variation on the basic smelter configuration.

4. ATTRIBUTES PARTICULARLY WARRANTING HERITAGE REGISTRATION

Attributes or combination of attributes of a copper mining site that are likely to make it a good example of its type include;

- Clear evidence of mine workings—A copper mining site with a substantial combination of surviving evidence (including ruined or partially disturbed elements) which might include: shaft or adit head equipment such as headframe, winding engine, air compressor; mullock heaps; ore crushing or concentration equipment; worker accommodation.
- Clear evidence of smelter activity—A smelter site with substantial evidence (which may include evidence in ruin) which might include: the smelter and chimney; ore roasting furnace; matte furnace or converter; ore dressing floor; concentration works; slag heap.
- A combination of well-preserved mine and smelter sites—especially where the association between mine and smelter is clearly shown.

Attributes or combination of attributes of a copper mining site that are likely to make it rare, uncommon or of particular interest include;

- Intact or unusually substantial surviving mine-head equipment— which might include: shaft or adit head equipment such as headframe, winding engine, air compressor; mullock heaps; ore crushing or concentration equipment; worker accommodation.
- Intact or unusually substantial evidence of smelters— which might include: the smelter and chimney; ore roasting furnace; matte furnace or converter; ore dressing floor; concentration works; slag heap, or more likely a combination of these.
- A combination of intact or unusually substantial surviving mine and smelter sites— where the association between mine and smelter is clearly shown, and both sites are substantially intact.

The significance of mining features which satisfy or do not satisfy the above attributes might be enhanced by association with specific historical events (such as major mine disasters), technological innovations developed at the site, or strong or special meaning for a particular community or group (see *A Guide to the assessment of mining heritage places* in this manual).

5. KEY SOURCES USED IN THIS TYPE PROFILE;

Allom Lovell Marquis-Kyle and Austral Archaeology, 1993. 'Chillagoe Smelter: Conservation plan', report for the Department of Environment and Heritage, Brisbane.

Bannear, D. and Annear, R. 1990. 'Burra smelting works: a survey of its history and archaeology', report for Burra District Council, Burra.

Bell, P. and McCarthy, J. 1994. 'The evolution of early copper smelting technology in Australia', unpublished paper at Third International Mining History Conference, Colorado School of Mines, golden, Colorado, 6 June 1994.

Blainey, G. 1954. *The Peaks of Lyell*, Melbourne University Press, Melbourne.

Carne, J. E. 1908. *The copper-mining industry and the distribution of copper ores in New South Wales*, Mineral Resources No. 6, Geological Survey, Department of Mines, NSW, Sydney.

Cumming, D. A. 1987. 'Copper smelting in South Australia: The first fifty years', in Selby, J. (ed), *South Australia's mining heritage*, Department of Mines and Energy & Australasian Institute of Mining and Metallurgy, Adelaide.

Donovan and Associates, 1995. 'A mining history of Australia', Part 1 of the National Mining Heritage Research Project for Australian Council of National Trusts.

Godden Mackay Heritage Consultants, 1994. 'Mount Lyell Mining Lease Cultural Heritage Assessment Study', (2 vols), unpublished report to Mineral Resources Tasmania and the Tasmanian Department of Environment and Land Management.

Halligan, R. 1994. 'Preliminary study of mining heritage in Western Australia', report for the National Trust of Western Australia, Perth.

Jane Lennon and Associates, 1996. 'Mining heritage places study: northern and western Queensland: identification, assessment and documentation of cultural heritage significance', report for the Queensland Department of Environment. 5 vols.

Pearson, M. 1994. 'Mining Heritage Places Study: Southern and Central Queensland', report for the Queensland Department of Environment and Heritage. 2 vols.

Pearson, M. 1994. 'Great Australia Mine and Smelter, Cloncurry: Cultural heritage study', report for Cloncurry Mining Company N. L.

Peters, E. D. 1907. *Modern Copper Smelting*, Hill Publishing Company, New York. (several editions)

MODEL TYPE PROFILE-ALLUVIAL GOLD

MODEL TYPE PROFILE-ALLUVIAL GOLD

1. DESCRIPTION OF THE TYPE

Outline history of alluvial mining

- 1851—gold discovered at Ophir, NSW in February, and later that year at the Turon, Araluen, Major's Creek and Bell's Creek
- 1851—gold found at Clunes in Victoria in July and in August at Buninyong, and later still that year at Mount Alexander (Castlemaine), Fryerstown and Bendigo.
- 1852 and 1853—gold discovered on the Ovens and Buckland and Mitta Mitta Rivers, Yackandandah, Rushworth, Heathcote, Daylesford, Creswick, Avoca, Maryborough and Wedderburn, to name but a few of the more significant Victorian fields. Numerous other fields were opened in subsequent years.
- 1855—alluvial gold found at Mangana, Tasmania
- 1858—first Queensland gold rush at Canoona.
- 1860—rushes to Kiandra and Lambing Flat, NSW.
- 1860's-1890's—gradual introduction of hydraulic sluicing and elevating across Australia
- 1872—alluvial gold found at Pine Creek, Northern Territory
- 1874—rushes to the Hodgkinson and Palmer Rivers, Queensland
- 1878—gold finds at Lisle-Denison and Golconda districts, Tasmania
- 1886—gold found at Croydon, Queensland and Kimberley gold fields, WA
- 1888—rush to the Pilbara and other nearby fields at Nullagine, Ashburton River and Marble Bar, WA
- 1891—alluvial gold found on the Murchison, WA
- 1894—rushes to Temora and Garangula NSW bring relief to thousands of unemployed
- Late 1890's, early 1900's—introduction of centrifugal and centrifugal dredges on major alluvial goldfields across Australia

Description of alluvial mining sites

The processes involved in alluvial mining for gold are very similar to those involved in other alluvial mining, for example, tin. With the exception of deep lead mines, alluvial mines are readily identifiable from their often structureless and widespread disturbance to the soil, in some cases of massive proportions. Unlike other minerals, including reef gold, many forms of alluvial mining cannot, however, be identified by reference to processing plant such as machinery or buildings, for there often was none of any consequence, and the equipment that was used was easily transportable and therefore removable.

Although alluvial deposits were typically found in and near streams and watercourses, they were also located in ancient or buried river beds. Where these deposits were overlain with basalt from volcanic eruptions they were referred to as deep leads. The method of working these deposits was similar to that employed in reef mining and is discussed under that type profile. Where the deposits were not so buried and were at a height above the current water courses they were often referred to as high level auriferous drifts. These drifts were readily identifiable to prospectors by the presence of river worn boulders and stones.

To identify the type of alluvial mining employed it is necessary to be familiar with the resultant landscapes, for they provide the clues to the technology used. On any one field a range of technologies could have been used, and on some sites evidence can be found of two or more technologies, one usually superimposed upon another, many goldfields being subject to continuous work over several decades.

Characteristic elements

Face—Typically diggings commenced at or near a river or stream and extended back into the older deposits, the working areas being referred to as the face. The height varied considerably, depending upon the technology used.

Races and dams—A reliable water supply was essential for alluvial mining, and where this was not available, water had to be brought on site. This applied particularly to workings in the high level auriferous drifts. Water races or channels resembling large open aqueducts were constructed for this purpose. Some races were of a considerable length, many kilometres long, others much smaller, only a few hundred metres in length. The races were earthen built with stone revetments used to support the races along the sides of the steeper hills. They followed the contours of the hills, using tunnels (some with ventilation shafts), culverts and metal or wooden fluming across gullies where necessary. Races terminated at the face of the diggings or below the diggings depending on whether sluicing was being used or whether the water was being used for washing with pan or cradle or other small scale appliance. They were also constructed to drain water from the diggings. These were known as tail races, and could be of a considerable length and depth.

For the larger races dams were often constructed near the head of the race and near the diggings to store water. In other instances there were no dams, the races being referred to as dry races, relying solely on seasonal water flows. The dams were usually earthen built, the water either flowing out through sluice gates or openings in or near the centre of the dam or from channels along the top side of the dam.

Creek and gully scourings —Where creek or gully beds were worked, there is little obvious evidence other than the beds having been cleaned out to bed-rock and the side of the banks washed away or otherwise worked. In the gullies this process was sometimes referred to as gully raking.

Hummocks of wash dirt or pot-hole tailings—These are closely grouped shallow shafts or rounded piles of wash dirt and soil. As stated by Ritchie (1981), these individual workings could be very small, but "...where a number of such workings were established in close proximity ...the aggregate was quite extensive." The hummocks were usually found in proximity to creek and gully scourings.

Diversionary channels and tunnels—Where a stream makes a horseshoe bend, it is often possible to drain the bend by making an open race-like cutting or a tunnel across the neck of the bend, thus diverting the water. Sometimes the diversion is assisted by the construction of diversionary dams in the stream. The diversion allows the stream bed to be worked.

Shallow surfacing—This feature occurs where high level auriferous drift has been stripped to bed rock at a very shallow depth, often only several centimetres. The area can be quite large and invariably adjoins other types of workings.

Paddocks—Paddocks resemble large open pits or quarries, square or rectangular in form, up to 40 metres by 40 metres in area, with a face of about two metres, though the size and height can vary. They are located primarily on the lower river and stream terraces where the wash is generally boulder free, but can also be found on high level auriferous drift.

Tailing mounds—Tailing mounds comprise elongated piles of river worn stone placed there after working of the face and floor of the diggings. They could be of considerable length and height. The mounds were arranged to facilitate draining and formed part of an overall drainage pattern, with the mounds and adjoining drainage channels feeding into each other and eventually into tail races. Their overall arrangement also owed much to the general fall of the land. The mounds and channels were also used to act either as rock sluices or to hold sluice boxes. They were also arranged to provide barrow ways or dams or to keep rainwater out of other areas of workings or to delineate leases.

There are two main types of tailing mounds. On some diggings the mounds will be characterised by neatly packed stone walls, the adjoining floor being completely clear of stones. The drainage channels are similarly aligned with packed stones. Often these diggings were relatively small in area, with very low tailing mounds well under a metre in height, the whole area having the appearance of having been intensively and meticulously worked. These structured mounds have been found in diggings known to have been worked by the Chinese and their occurrence can be taken as prima facie, but not necessarily conclusive, evidence of their presence.

Drift shafts—These shafts are characteristic of workings in high level auriferous drift. They are narrow and trench like in appearance and were dug not only at the claims to test the extent of the wash dirt but also along the line of race to test the drift in these areas as well. The shafts differ markedly from those associated with reef mining. They are narrower and as a rule shallower, and do not have large mullock heaps, for the drift was processed in a pan or cradle or otherwise washed away by the rain.

Drift tunnels—Drift tunnels occurred where it was impractical to get at the wash by any other means, particularly if it was very hard. They were dug into the face of the diggings, often where paddocking had occurred. Sometimes they had wooden roof supports, but more often they did not. Where drift tunnels and shafts have been dug in or near streams or gullies and have subsequently collapsed they form substantial and irregular areas of erosion.

Barrow ways—Both the overburden (also referred to as the stripping) and the wash dirt had to be removed from the site, the former being taken to a tip and the latter to a wash site. On the smaller sites the stripping and wash dirt were removed by wheel barrows. The barrow ways can be identified as well worn pathways, sometimes being stone lined. The paths often terminated at elongated stone packed mounds, from the top of which the stripping, and sometimes the wash dirt, was deposited. On the larger sites horses and drays were used and on others more mechanical means, including inclined tramways.

Puddlers—Puddlers or puddling machines were used where it was necessary to break up the wash. They consisted of large circular holes about 15 m to 20 m in circumference in which the dirt and water were mixed, with perhaps a small race conveying water into the puddler. In the centre of the puddler was a mound with a tall wooden pole acting as a pivot, to which was attached a wooden shaft extending over the hole and to which a horse was yoked.

Basic equipment: pan and cradle, toms and sluice boxes—The pan was a flat iron dish with a flat bottom and sloping side, usually with a groove near the rim. A cradle consisted of a box open at one end, fitted with rockers underneath, a moveable hopper or riddle with a perforated screen at the top and inside box one or two moveable slides with riffles beneath the hopper and two or three riffles on the bottom of the box to catch any gold that escaped the trays.

Sluice boxes were made of sawn boards usually 3.7 m in length, 40 to 50 cm wide and 25 to 30 cm deep. To prevent destruction of the bottom of the boxes from the pebbles and large stones and to assist in recovering gold, recourse was had to a false bottom, usually consisting of wooden bars or riffles. Where several boxes were used, the narrower end of one box fitted into the wide end of the other, with no other fastening required other than some stiff clay or rags.

The long tom was a type of sluice box and consisted of two inclined troughs or boxes placed one over the other. The upper box had a grating or screen in the bottom near the lower end and under this grate was placed the lower or ripple box.

In addition to tail races, a number of devices were used to drain claims. These included pumps powered by steam boilers, water-wheels and Californian pumps. The latter can be described as an endless belt passing over rollers and having buckets at intervals attached to it, the water being discharged from the top of the pump into a chute.

2. DISTRIBUTION AND FREQUENCY OF TYPE

Australia is one of the world's largest producers of gold, the gold rushes in Victoria in the early 1850's and WA in the 1890's being of international significance. Economically viable gold deposits are widely distributed throughout Australia. As measure of the relative importance of the various States, Territories and former Colonies, up to 1923 Victoria produced 49% of total gold production, Western Australia 24.8%, Queensland 13.8%, New South Wales 10.3%, Tasmania 1.4%, Northern Territory 0.4% and South Australia 0.3%.

Official figures on alluvial gold production, where they exist, are very unreliable. There are a number of reasons for this. Firstly, the early alluvial gold rushes in the early 1850's occurred at a time of enormous social change, the administrative interest in, and measures for, collecting reliable statistics, particularly on the output of individual fields, being almost nonexistent. Secondly, even when measures were in place, by its very nature reliable alluvial production statistics were always elusive. For example, gold escorts often did not differentiate between reef and alluvial gold although most of it was probably the former. Further, not all gold went by the escort. Some was sold privately to local gold buyers to avoid the escort fees and some was conveyed privately to the larger towns or cities where better prices could be obtained. Even more important, however, was the lack of any requirement to disclose returns, the widely scattered, numerous and for the most part, small scale nature of operations rendering the task of accurate measurement impossible even for the most diligent of officials.

Overall, alluvial gold production was accompanied by considerable secrecy. This was related to the general insecurity of tenure; claim jumping and pillaging, robbery and often violence, being a constant concern. These concerns were of particular importance to the Chinese. In any event, communication problems between Europeans and Chinese ensured that the output of the latter was little known, although occasionally details on yields were made available. Much of the output of the Chinese was personally conveyed back to China.

An additional complication with alluvial mining is the difficulty of differentiating between an alluvial and reef field. Many reef mining fields began as alluvial fields, and in some instances the reef mines may be superimposed over the alluvial mining landscapes. Many fields remained predominantly alluvial throughout their existence, but a good percentage underwent some metamorphosis.

Alluvial mining was generally confined to the better watered areas of the continent, a prerequisite for successful alluvial mining on any scale being adequate water supplies. The alluvial fields were also found in the drier areas of the continent, where techniques such as dry blowers were used. However, these fields never assumed any great significance. Techniques such as sluicing, and in particular, hydraulic sluicing, and dredging, required much larger and regular flows of water and were, therefore, even more confined in their distribution. Dredging also needed a particular type of stream and stream bottom, wide meandering streams such as Araluen and Jembaicumbene Creeks and the Macquarie River in NSW being particularly well suited to this activity.

The alluvial rushes in Victoria commenced in August 1851 in the Ballarat area and were of major national and international significance. Other important fields to open in the next few years included Creswick, Clunes, Castlemaine (Mount Alexander), Chewton, Maldon, Fryerstown, Anderson's Creek, Bendigo, the Ovens and Buckland Rivers, Woolshed Creek, Yackandandah, Omeo, Whroo, Rushworth, Kilmore, Heathcote, Maryborough, Avoca, Dunolly, Tarnagulla, Moliagul, Ararat, Stawell and St Arnaud. Subsequent alluvial gold finds were made in a wide number of districts in the central, north east and Gippsland areas. In some of these districts, for example, at Beechworth, Yackandandah and Mitta Mitta, hydraulic sluicing, centrifugal sluicing and dredging took place. These modes of working were confined to the better watered districts, being entirely unsuitable for the drier western and central districts.

In Western Australia, the first alluvial gold was found on river systems in the Kimberleys and in the Pilbara area in the 1880's, the earliest find of significance being at Hall's Creek in 1886. The actual returns may have been as much as ten times greater than the official returns, as the bulk was taken out secretly to avoid tax. The only WA field to be predominantly alluvial was the Ashburton (1890). A small amount of alluvial gold was obtained on other goldfields, for example, the Murchison, East Coolgardie, Coolgardie and Peak Hill. However, generally speaking, alluvial production accounted for only a small percentage of total gold production. There are no accounts of hydraulic sluicing or dredging being used in WA.

Alluvial gold in Queensland was first found at Canoona in 1858, followed by Clermont in 1861, Rockhampton and Mount Morgan in 1865 and Gympie in 1867, although these latter two became predominantly reef fields not long thereafter. The main alluvial gold field was the Palmer River, which was proclaimed in 1873, and attracted thousands of Chinese miners. Hydraulic sluicing was employed on some of the fields on the east coast. Bucket dredges were used to a limited extent on the Rockhampton, Cania and Clermont goldfields in the early 1900's but do not appear to have been particularly successful.

In New South Wales alluvial rushes commenced at Ophir in mid 1851 and quickly spread elsewhere to the Turon River area generally and Araluen, Major's Creek and Bell's Creek near Braidwood later that year. The next major alluvial rushes were at Adelong and the Tumut River in the late 1850's, and at Kiandra and Lambing Flat in the early 1860's.

Alluvial gold was also found in many other locations, particularly along the eastern seaboard. Hydraulic and centrifugal sluicing and dredging were used extensively on some fields, but particularly at the southern goldfields along the Shoalhaven River, Jembaicumbene Creek, Araluen Creek, Nerrigundah on the south coast and at Kiandra and the Turon. In the late 1880's alluvial gold was found at Tibooburra and Mount Browne in the far north west.

Alluvial gold was first found in Tasmania at Mangana in 1852, and later at Mathinna in 1855. The main area of alluvial workings was in the Lisle Denison-Golconda fields, discovered in 1872. Hydraulic sluicing (including centrifugal) was confined to the north east, and used extensively on the Lisle goldfield, commencing in the 1890's. Dredging was also used to a limited degree on the West Coast.

In the Northern Territory alluvial gold mining was confined almost wholly to the Top End. Alluvial gold was first found at Yam Creek in 1870, at Gandy's Gully and the Edith and Cullen Rivers in 1871, at Yam Creek again in 1872, then the Howly and Pine Creek, a gold rush commencing in 1873. Alluvial mining was almost solely confined to the Chinese, many of whom had been previously on the Palmer River goldfields.

Alluvial gold was found in South Australia at Echunga (1852), Forest Range (1854), the Barossa and Parra Wirra 1868) and Ulooloo and Mount Pleasant (1869). The largest alluvial field was opened at Teetulpa near Yunta in 1886.

3. VARIATION OF TYPE (TECHNOLOGY AND TECHNIQUES)

Pan and cradle

This was the most basic and common of alluvial mining techniques and was used on all gold fields in the early stages. In its most basic and primitive form alluvial mining consisted of washing river or stream dirt in a gold pan. As an advance on that, a cradle or long tom with a bucket to raise water or a short sluice was used. Pan and cradle techniques were used on all types of workings, particularly in the final clean up stage of common and hydraulic sluicing. The technique was most prevalent, however, on creek and gully scourings and where pot-hole tailings or hummocks of wash dirt prevailed, these diggings also being associated with the use of puddlers, and where structured tailing mounds are found. Races were also used occasionally to bring water on site for washing or for the puddlers. The presence of barrow ways for transporting wash dirt almost certainly indicates a pan and cradle diggings.

In the more arid areas dry blowers and wet jiggers were used instead of the cradle or long tom. The blowers separated the larger pebbles in the wash from the finer material by a series of perforated screens, a blast of air from a bellows then being applied to the wash, removing it and leaving the gold. Wet jiggers were used where coarse gold was involved. This equipment was in common use on the arid gold fields of WA, SA, NT, north west NSW and West Queensland.

Common (box and ground) sluicing

This was the next level of intensity, requiring larger and more regular quantities of water. There is considerable confusion in the nomenclature, the term sluicing often being used to apply loosely to all forms of working with sluice boxes. The terminology used here adopts that used by Brough Smyth, which distinguishes between the two main forms of sluicing, box sluicing and ground sluicing.

Box sluices were a series of inclined sluice boxes set on trestles, into which the earth was elevated or carried. They were used primarily where the bottom of the workings was below the adjacent creek bed and where, therefore, there was insufficient fall, to get rid of the water and tailings. Water was conveyed into the box sluice from a race or by hose, and the wash dirt was thrown in with shovels, any stones being removed by use of a sluicing fork.

Box sluicing was used extensively on paddocking claims, particularly those on the lower river terraces, where there was little or no fall. Originally the wash dirt was conveyed to the top of the face and deposited in the boxes by barrows, which were superseded by horse and drays and later still by steam powered tramways. As the diggings progressed boxes were gradually moved back into the face. Extensive tail races, often boarded and covered with tailings, were used to drain the claims. The process of removing the overburden was referred to as stripping.

Ground sluicing refers to sluices sunk in the bottom into which the excavated earth was conveyed by a stream of water. The ground sluices were often only channels cut down to bed-rock and paved with stones, the gold being caught under or behind the stones, but they were also built of sawn planks and boards. They were used only where the bottom was sufficiently high to provide the necessary fall and were the main method of working elevated ground. Instead of the wash dirt being shovelled out into barrows or carts, a stream of water was conveyed from a race or races over the face of the diggings, carrying both the top soil and the wash dirt into and down the sluice. This mode of working was used extensively on high level auriferous drifts where the fall was adequate. It was sometimes referred to as "flooding off".

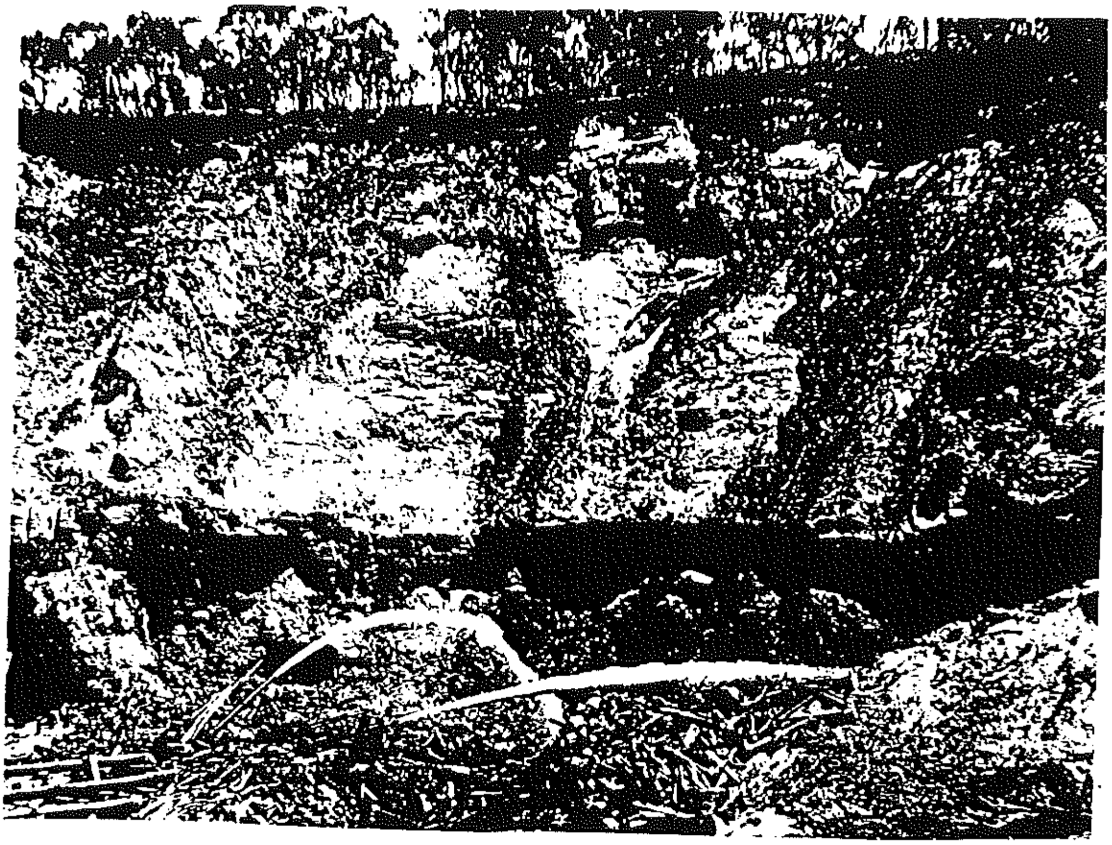
Two types of sluicing landscapes can be broadly distinguished. The paddocking claims associated with box sluicing have been described above. One obvious marker is a more or less vertical face. Ground sluicing claims, on the other hand, had a multiplicity of sluicing points (race entry points) and gentle debris slopes at and near the points, where the water has been run over the face. The floor was covered with tailing mounds arranged to facilitate the placement of sluices and allow drainage into one or more tail races. In both instances the height of the face was rarely more than five metres, but it varied considerably and was often much less.

Hydraulic sluicing

Hydraulic sluicing required even more regular and larger volumes of water than ground sluicing and was used primarily to work deposits where the drift and overburden were too deep and often too poor to be worked by any other method. In many cases these areas had been worked initially by drift tunnels and shafts, these methods proving impractical or uneconomic. Hydraulic sluicing involved the removal of the auriferous drift by the use of water conveyed under pressure to a hose, usually set up on a monitor, which would then be turned against the face of the workings, the aim being to wash the drift down to bed-rock, and thence into sluice boxes. By this method much larger areas could be processed in much less time than would be the case with ground sluicing, which relied on manual labour. Hydraulic sluicing was often a highly capital intensive process.

The wash dirt and overburden were reduced by the fall and further reduced by the monitor, which swept the disintegrated gravel towards the sluice boxes. Where the gravel was clay bound or contained lumps or streaks of clay it was swept back and forth across the pit bottom one or more times until free from the clay. Wing dams of timber, logs or boulders were built to guide the water and gravel into the head of the sluice. Where the size and

Hydraulic sluicing



Hydraulic sluicing, Kiandra NSW

Shallow sinking (pot hole tailings), the most basie form of alluvial mining, near Murrumburrah, NSW grade of sluices permitted it, all boulders that could be moved by the monitor were run through the boxes.

Hydraulic sluicing typically occurred on sites previously worked by ground sluicing and the former landscape is in these cases superimposed upon the latter, often with evidence of drift shafts along the perimeter. Often the landscapes associated with ground and hydraulic sluicing look similar, however, there are key distinguishing features. On the larger claims the face of the workings was often very high, up to 20 to 30 metres, though the height of the face could vary substantially, depending on the nature of the wash, a lower height being associated with low pressure hosing. There were almost always reservoirs near the workings and the tail races were generally deeper than those found on ground sluicing sites. The face was more vertical as well as being in some instance more irregular than in ground sluicing, areas of cemented drift resisting the force of water and giving rise to pinnacles, mesa tops and drift islands. In most hydraulically sluiced areas there was less in the way of tailing mounds rather than more, with the main floor being often very clear of stones, and presenting a barren appearance. A distinguishing feature is the presence of a second or upper floor or bench, representing the earlier areas of ground sluicing.

Hydraulic elevating

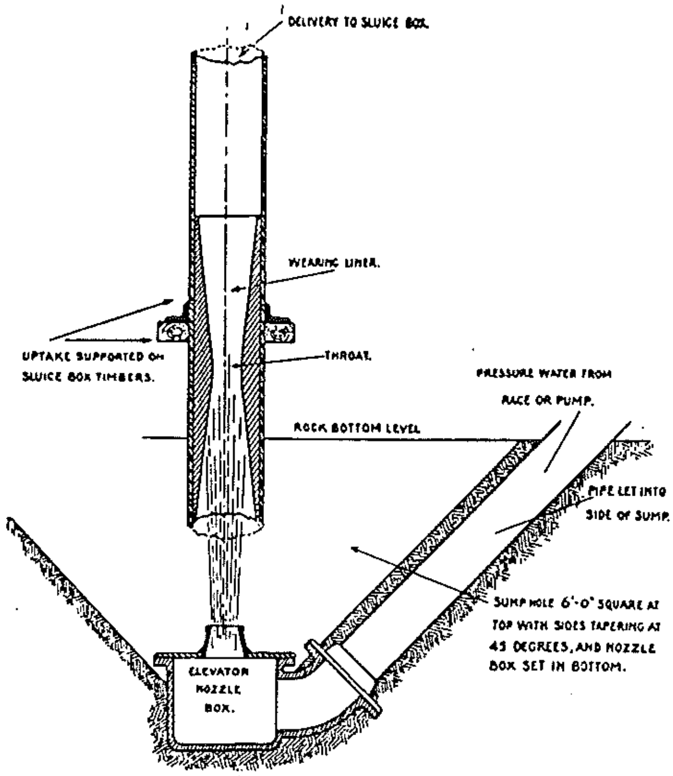
A variation on hydraulic sluicing was the use of a hydraulic elevator to raise gravel, sand and water out of workings into sluice boxes, the elevator consisting of a pipe with a constricted throat and a jet which provided a high velocity ascending column of water. A hole was sunk into a paddock with a race from the face leading into it. The overburden and wash dirt were hydraulically sluiced and washed into the hole from where they were blown up the elevator into the sluice boxes set on the face. The face of the workings is very similar to hydraulically sluiced sites, the main distinguishing characteristic being sump like areas resembling swamps or small lakes on the floor of the workings. The evidence of tailings above the face is less obvious, these often being very fine and easily dispersed over time. Elevating was often a highly capital intensive process.

Dredging

Dredging was a very capital intensive, last phase activity, usually signalling the end of most other forms of alluvial mining on the field, there being little prospect of reworking the ground profitably after dredging had ceased. and obliterating all signs of previous activity. It involved the removal of wash from rivers and stream beds, the aim being to exploit the lower stream gravels which could not be extracted by any other method.

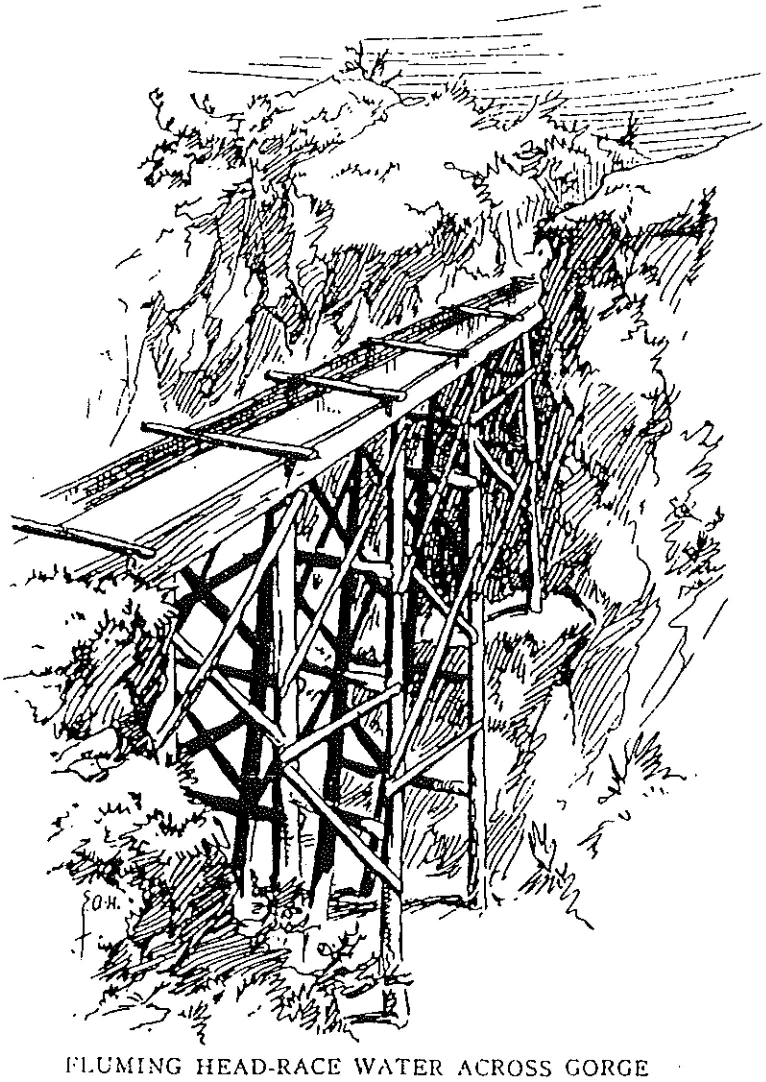
There were two main types of dredges, bucket and centrifugal, both types using pontoons and being built on site using imported timber, the machinery then being erected on the pontoon. The building and equipping of the dredge took many months to complete and can be regarded as a form of shipbuilding, for the vessel floated and was mobile, albeit often within a confined area. The bucket dredges were launched through channels or waterways excavated for this purpose. Sometimes they had to dredge their way to the area of workings. In other instances, particularly with centrifugal dredges, water was let into the excavation in which the dredge was resting.

The bucket dredges could be likened to large floating factories. For example, the Little River Company and the Shoalhaven River Company's dredges were commissioned in late 1900, the former being 21.3 m long and 7.3 m wide and the latter 27.4 m long and 9.4 m. They worked by cutting a passage for themselves by breaking down the gravel in front and stacking it behind after processing. For this purpose a tailings elevator was used to stop the tailings from finding their way back into the excavation made by the buckets. Thus the



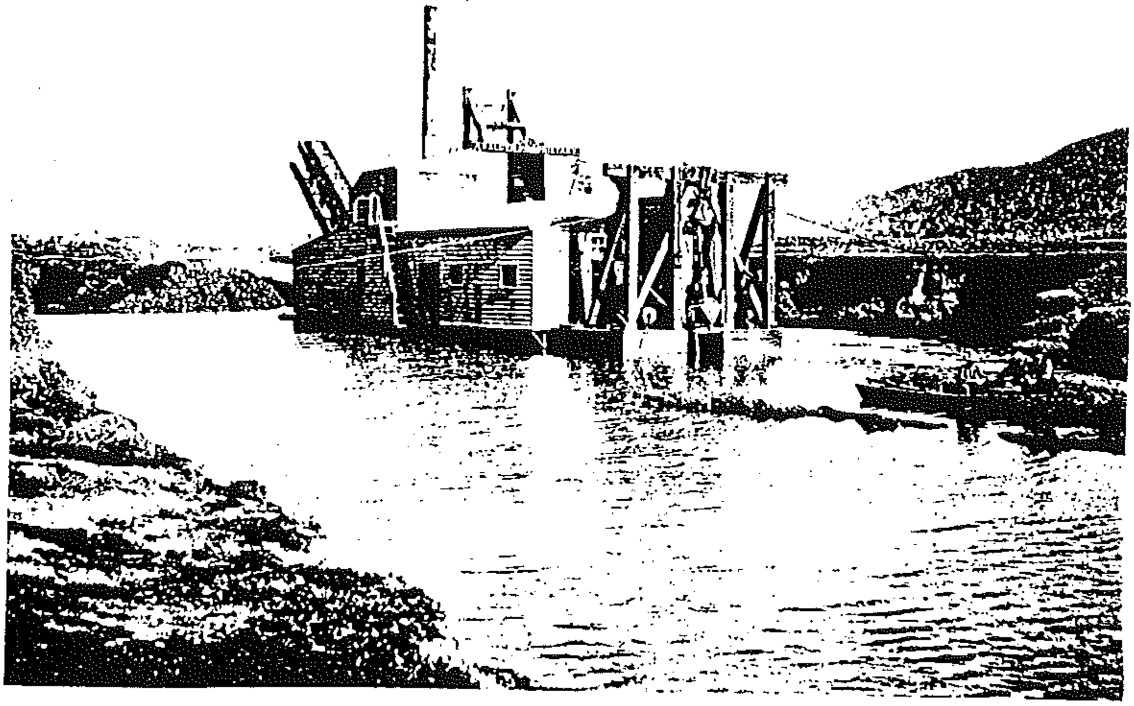
THE ELEVATOR

Hydraulic elevator (Idriess 1931)

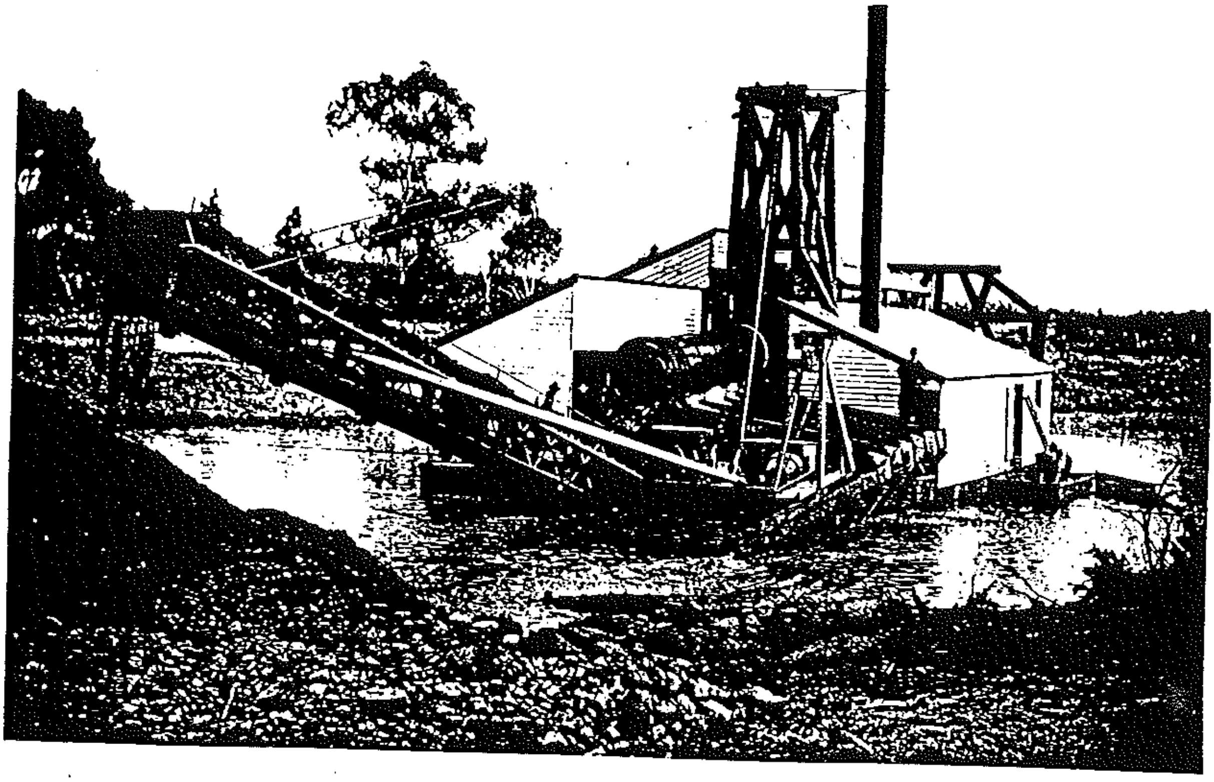


Flume (Idriess 1931)

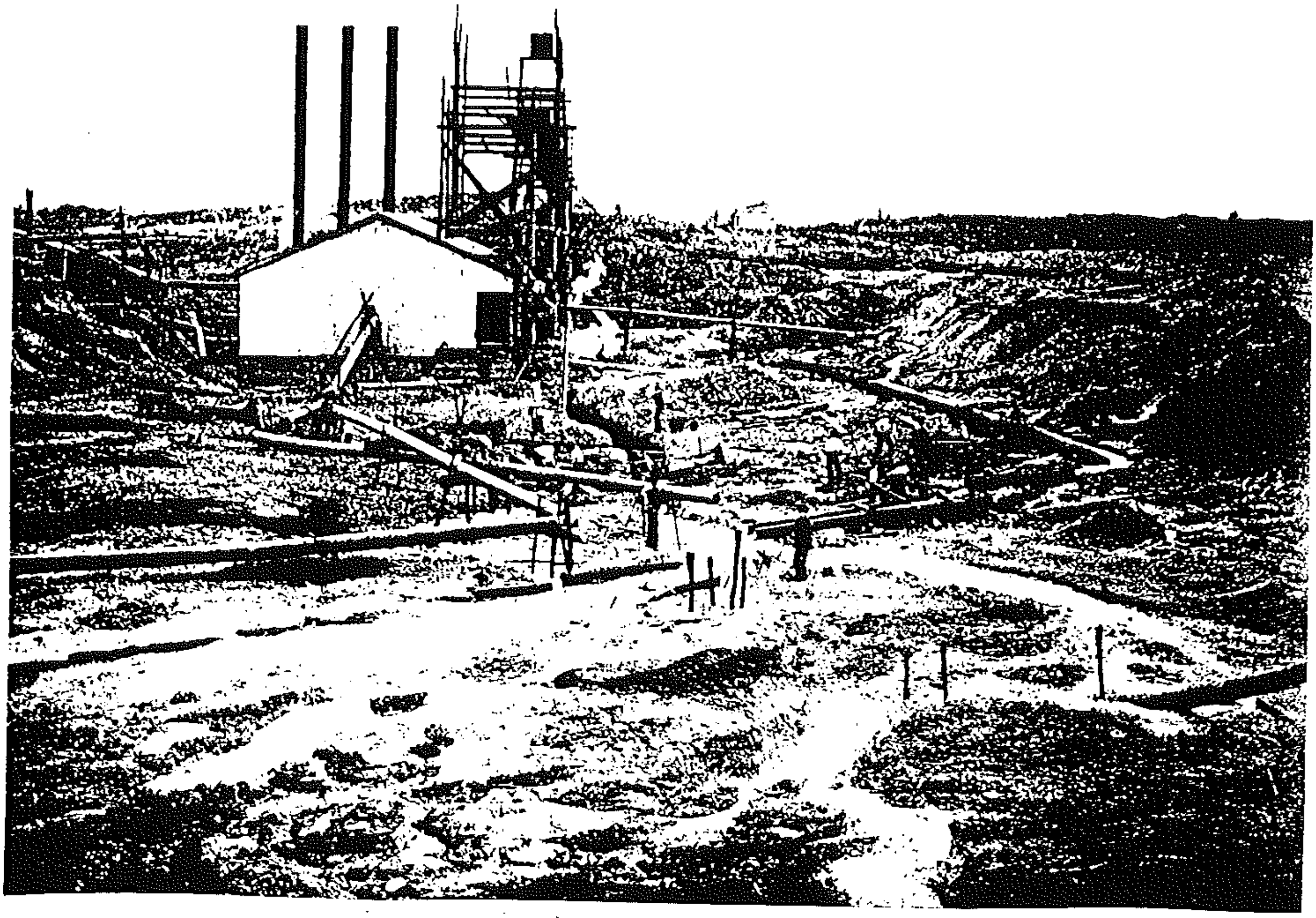
FLUMING HEAD-RACE WATER ACROSS GORGE



Bucket dredging, Araluen, NSW



Dredge, Mongarlowe River, NSW



Centrifugal dredging, Jembaicumbene, NSW tailings were lifted from the stern of the dredge by means of an elevator and deposited some distance away behind the pontoon. On some dredges the buckets discharged their contents by a chute into ordinary sluicing boxes. Other dredges had revolving screens.

Bucket dredges obliterated most stream bed vestiges of former alluvial operations and superimposed new landscape features, such as dredge ponds, tailing mounds, and entry re entry channels. The dredge ponds are broadly rectangular in shape and are usually surrounded on either side by tailing mounds deposited by the elevators. The mounds are oblong in shape and can fan out to about 20 m or more in width and length, the tallest part of the mound being near the point of exit from the tailing elevator. In some instances the mounds can reach several metres in height. In flood prone areas the lighter sand and soils have often been washed away by flood waters, leaving a low scatter of pebbles on a slightly raised area of ground. At the end of their working life the bucket dredges were dismantled in a dredge pond and it is in this area that pontoons and remains of heavy equipment can still be located. Buckets, cable and mooring posts and holes are usually found scattered along the length of the dredge workings.

Centrifugal dredges were of a similar size to bucket dredges, but were functionally different, usually relying on hydraulic sluicing to wash the dirt into a sump and thence by suction pumps into sluice boxes. Thus rather than buckets and elevator ladders, the centrifugal dredge had pumping machinery and extensive piping. The mode of working was very similar to hydraulic elevating, except that the machinery was erected on a pontoon, which rested on the floor of the workings, it being periodically floated to other locations. The workings left by the suction or centrifugal dredges resemble those left by hydraulic sluicing and hydraulic elevating, that is tall, near vertical faces, and small swamps or lakes over the sump areas.

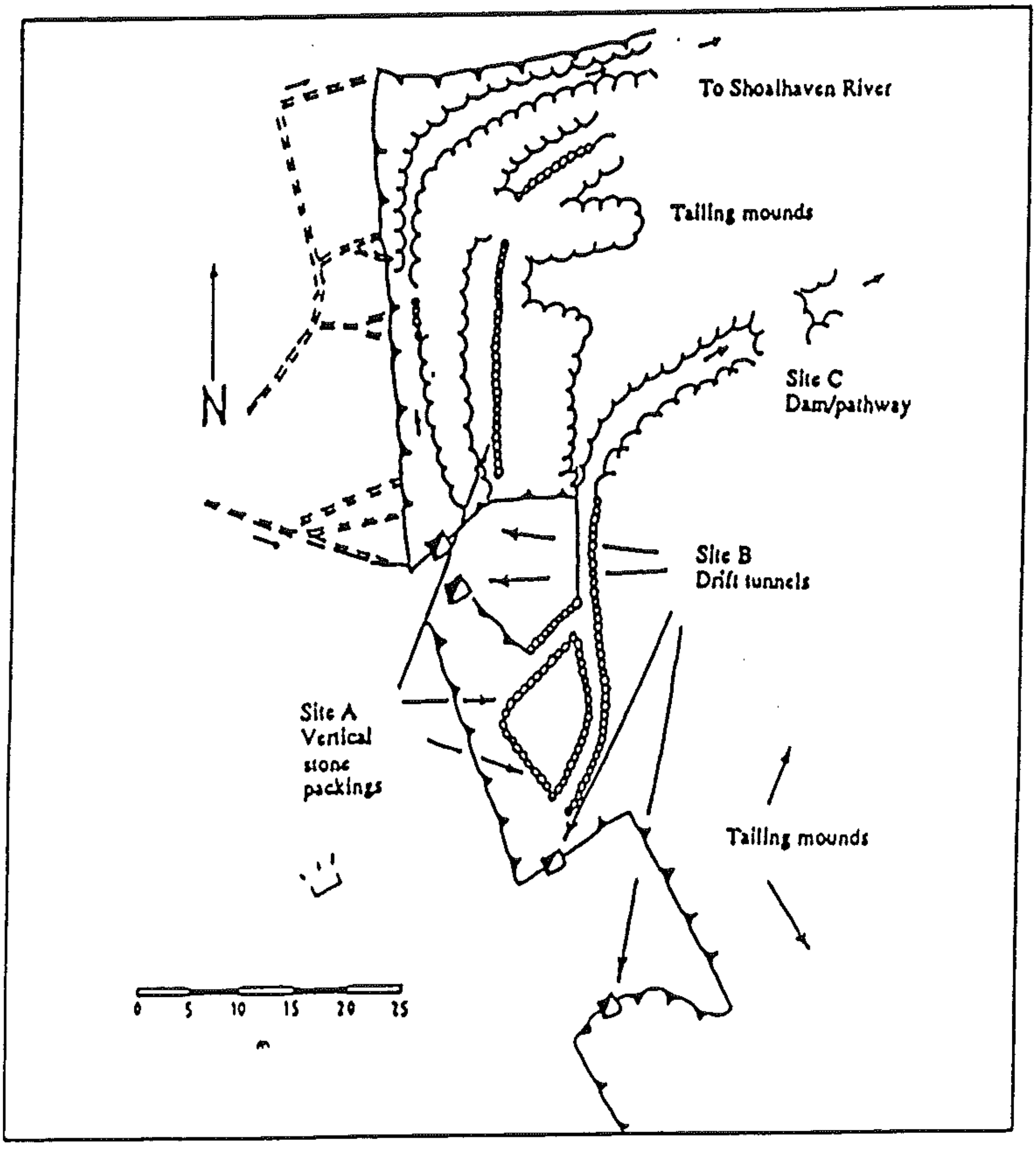
4. ATTRIBUTES PARTICULARLY WARRANTING HERITAGE REGISTRATION

Attributes or combination of attributes of an alluvial site that are likely to make it a good example of its type include:.

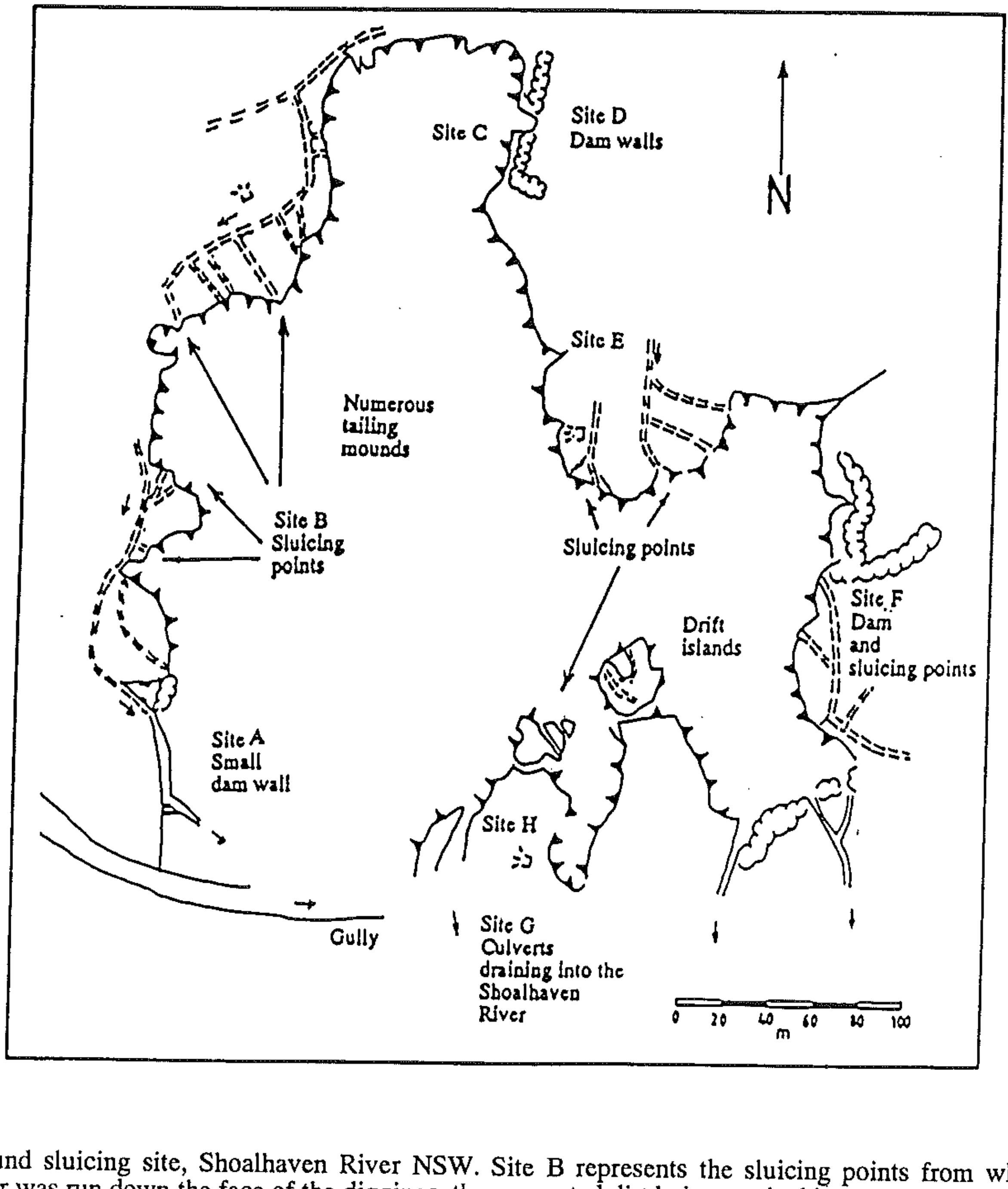
- Clear evidence of mine workings—a riverine or lower river terrace area of undisturbed alluvial workings is often difficult to find where dredging, extensive cultivation or roadworks has occurred. Ground and hydraulic sluicing sites are less likely to be disturbed where they are located in high level auriferous drift. Dredging was usually the last mining imposition on the landscape and is also less likely to be disturbed. Even where they are undisturbed, however, this attribute is not necessarily enough in itself to warrant registration. This is because of the widespread distribution of these sites across Australia.

- Clear evidence of machinery and equipment—as a generalisation alluvial mining sites are characterised by an absence of equipment and machinery, most of it being very portable. Picks and shovels are usually the only material evidence left on site, and are not by themselves significant. The exception relates to dredges. While the machinery was often removed, the pontoons and broken machinery were left in or near a dredge pond. Where the pontoons have been submerged or partly submerged for any length of time they are often very well preserved.

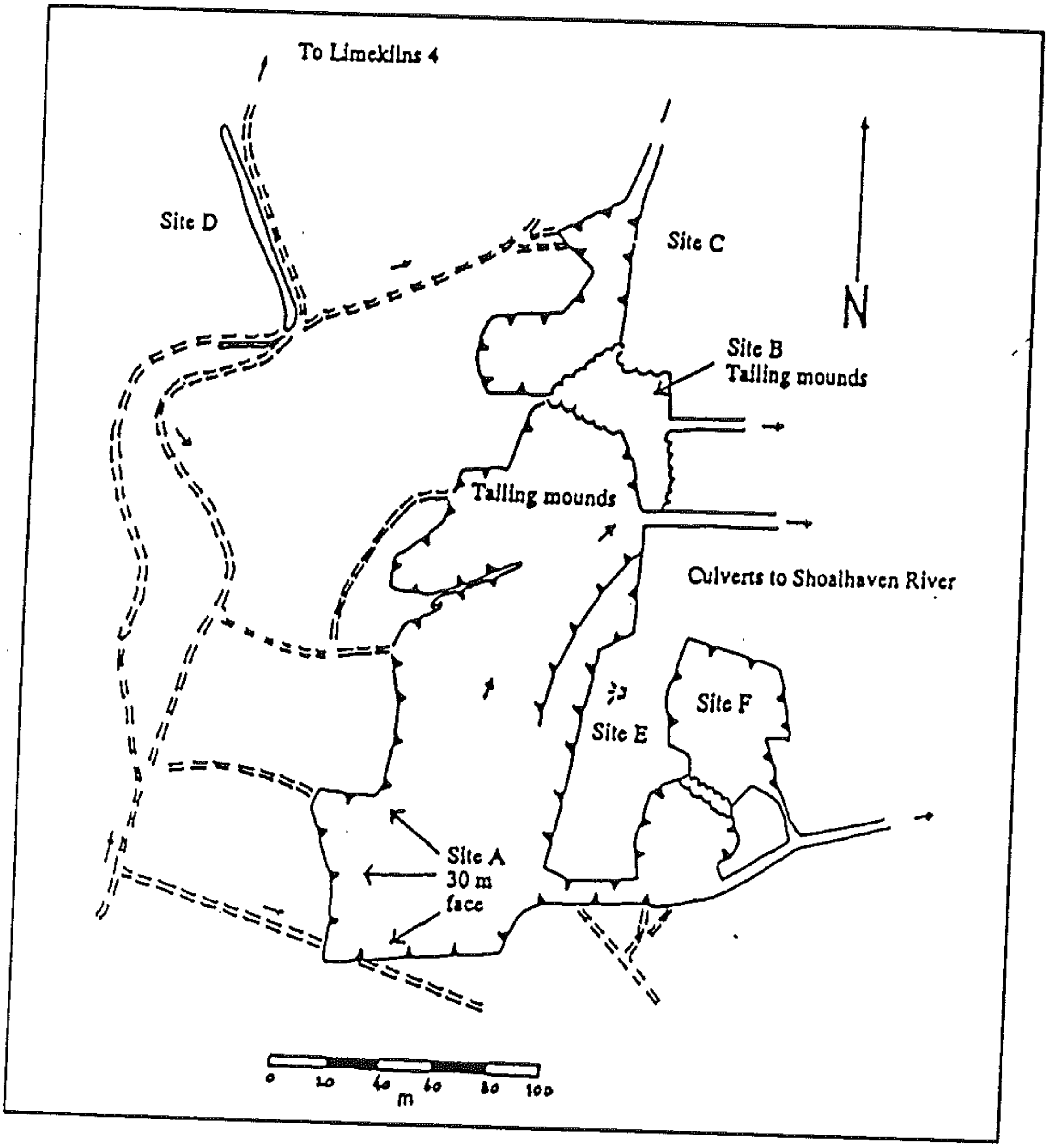
- Clear evidence of settlement—The most obvious evidence is the presence of hut sites, which may occur singly or in clusters. They are indicated by the remaining structures, some of which will be very evident, such as stone walls and chimneys and other much less so, there being only a small rectangular arrangement of stones open at one end



Pan and cradle site, Shoalhaven River NSW. Although there are a number of sluicing points along the face, the face is vertical, the confined nature of the workings suggesting that they were worked by pan and cradle techniques or at best by a short sluice. A key feature is the presence of vertically stacked tailing mounds arranged to facilitate drainage, a feature characteristic of sites worked by Chinese miners.



Ground sluicing site, Shoalhaven River NSW. Site B represents the sluicing points from where water was run down the face of the diggings, the excavated dirt being washed into ground sluices or sluice boxes set between the tailing mounds. The face is characterised by gentle debris slopes., and is for the most part about five metres high.



Hydraulic sluicing site, Shoalhaven River NSW. Site A is the main area of hydraulic sluicing, the face being 30 metres high. Site B is an upper level bench characteristic of earlier ground sluicing and shallow surfacing workings.

where the chimney or fireplace once stood. Other evidence includes artefacts such as crockery, glass and metal.

- Evidence of ethnicity—The most obvious evidence for the presence of the Chinese is the presence of structured tailing mounds. On sluicing sites (both box and ground) reliance, however, may need to be placed on other evidence as these forms of mining were used by both Europeans and Chinese. This evidence may include dwelling sites and artefacts. The former is possibly the most obvious for indications are that the Chinese lived in small closely grouped and irregularly arranged hut sites, often very close to the diggings or actually in the diggings. As a generalisation the Chinese were not involved in large scale hydraulic sluicing or elevating operations or in dredging.

Attributes or combination of attributes of an alluvial mining site that are likely to make it rare, uncommon or of particular interest include:

- Largely intact workings—However, further tests of significance need to be applied, as generally there is nothing rare in either lower river terrace or creek bed workings associated with pan and cradle activity or the generality of box and ground sluicing sites.

- Size and scale of the workings, their historical significance, if that can be determined, and the evidence for settlement and ethnicity—Where workings are intact and significant as measured against one or more of these criteria then registration may be considered. Most Chinese and hydraulic sluicing and elevating sites will be significant against several of these criteria. Dredge workings are not by themselves rare, however, occasionally there is a combination of undisturbed dredge ponds, tailing mounds, cuttings, entry and re entry points that provides a good example of a dredging landscape, particularly if combined with some equipment scatter. Substantially intact dredge pontoons are rare.

Key sources used in this type profile

Australian Town and Country Journal, 1871 , 1874. articles 17 June 1871 and 28 March 1874

Averill, C. V. 1946. Placer Mining for Gold in California, Bulletin 135, Division of Mines, San Francisco

Coroneos, C. 1993. A poor man's diggings: An archaeological survey of the Lisle-Denison Goldfields - North-east Tasmania, unpublished report for the Forestry Commission, Tasmania. and the Queen Victoria Museum and Art Gallery

Cronise, T. F. 1868. The Natural Wealth of California, H H Bancroft and Company, San Francisco

Department of Mines, Victoria, undated. Prospectors Guide

Dunstan, B. 1902, The Clermont Goldfield, Geological Survey of Queensland, Publication No.176, Department of Mines, Brisbane

Dunstan, B. 1913. Queensland mineral index and guide, Geological Survey of Queensland, Publication No 241, Department of Mines, Brisbane.

Gordon, H. 1894. Mining and Engineering and Miner's Guide, Government Printer, Wellington,

Herman, H. 1914. Economic geology and mineral resources of Victoria, Geological Survey of Victoria, Bulletin No 34, Melbourne

Idriess, I. 1934. Prospecting for Gold, Angus and Robertson, Melbourne

Jennings, I.B. and others, 1967. Geology and mineral resources of Tasmania, Geological Survey Bulletin, No 50, Department of Mines, Hobart

Kenny, E.J. 1922. Gold, Geological Survey of New South Wales, Bulletin No 7, Department of Mines, Sydney

Maitland, A Gibb, 1919, The gold deposits of Western Australia, in the Mining Handbook, Geological Survey Memoir, No 1, Department of Mines, Perth, (reprinted as a monograph, Hesperian Press, Victoria Park, 1984).

McGowan, B. 1992. "Aspects of Gold Mining and Mining communities in the Shoalhaven Area of New South Wales: An archaeological and Historical Study." Australasian Historical Archaeology, Vol. 10, pp 43-54

McGowan, B. 1996. "The typology and techniques of alluvial mining: the example of the Shoalhaven and Mongarlowe goldfields in southern New South Wales." Australasian Historical Archaeology, Vol. 14, pp 34-45

McGowan, B. 1996. Bungonia to Braidwood, an historical and archaeological account of the Shoalhaven and Mongarlowe goldfields, Canberra

McGowan, B. 1998. 'Conservation and heritage overview of the Araluen catchment area, including the Araluen, Bell's Creek and Major's Creek goldfields', report to the Lower South Catchment Management Committee.

New South Wales Agriculturist and Grazier, 9 July and 6 August 1881

Pittman, E. F. The mineral resources of New South Wales, Geological Survey of New South Wales, NSW Department of Mines, Sydney, 1901

Ritchie, N. "Archaeological interpretation of alluvial gold tailing sites, Central Otago, New Zealand", New Zealand Journal of Archaeology, 1981, vol 3, pp 51-69

Ritchie, N. and Booker, R. "An archaeologist's guide to mining terminology", Australasian Historical Archaeology, vol. 15, 1997, pp 3-29

Searle, G. 1977. The Golden Age. A history of the colony of Victoria 1851-1861, Melbourne University Press, 1977

Selby, J. (ed) 1987. South Australia's mining heritage, South Australian Department of Mines and Energy/Australasian Institute of Mining and Metallurgy, Special Publication No.7, Adelaide.

Smyth, R.B. 1869. The Goldfields and Mineral Districts of Victoria, Facsimile Edition, Carlton

Vivian, H. 1985. Tasmania's Chinese heritage, an historical record of Chinese sites in north east Tasmania, Australian Heritage Commission and Queen Victoria Museum, 1985

Woods, C. 1985. Beechworth: A Titan's Field, United Shire of Beechworth in conjunction with Hargreen Publishing Company, Melbourne

MODEL TYPE PROFILE-REEF GOLD

MODEL TYPE PROFILE-REEF GOLD

1. DESCRIPTION OF THE TYPE

Introduction

The nature of alluvial and reef gold deposits is very different, the former being the consequence of stream deposition, the other occurring as a mineral in an ore body sometimes in combination with other minerals such as silver, lead, copper or iron pyrites. The processes involved in reef gold mining are, therefore, with the exception of deep lead mining, substantially different from most forms of alluvial mining. They are, however, very similar to those involved in other hard rock mining, for example, copper.

Deep lead mining involved the extraction of alluvium from ancient buried stream beds or gutters, the deposits sometimes occurring at a very considerable depth. The method of extraction was basically similar to reef gold mining. For this reason deep lead mining, although strictly alluvial mining, is considered under the type profile for reef gold.

While different, alluvial and reef deposits did, however, often occur in close proximity, for the former was a derivative of the latter as a consequence of prolonged erosion and weathering of the gold bearing ore deposits. This factor was well known to most prospectors, for if colours were found in streams or rivers, the wash would be followed upstream, the coarser the finds the closer the gold bearing reefs (often referred to as the mother lode).

This phenomenon does lead to an important identification and classification issue, for care is needed in describing goldfields as either alluvial or reef. Some clearly were, but many displayed both types of mining. Sometimes the reef and alluvial mining occurred simultaneously at other times separately, that is, a field could be predominantly or solely alluvial at one point in time and predominantly reef at another.

Outline history of reef and deep lead gold mining

- Early 1850's-deep lead mining and later reef gold at Ballarat, Victoria.
- Early to late 1850's-reef and deep lead gold found throughout central, western and north east Victoria, for example, Ararat, Bendigo, Castlemaine, Chewton, Chiltern, Clunes, Creswick, Maldon, Maryborough and Stawell
- Early 1860s-reef gold found at Woods Point and Walhalla, Victoria
- Mid to late 1860's-gold found at Forbes (deep lead-1861), Grenfell (1866) and Gulgong (1868), NSW
- Late 1860's-gold found at Gympie (1867), Ravenswood (1868) and Charters Towers, Queensland
- 1872-Holtemann nugget found at Hill End, NSW
- 1873-rush to Pine Creek field, Northern Territory
- 1874-gold found at Parkes, NSW
- 1877-gold found at Beaconsfield, Tasmania's largest gold mine
- 1881-gold found at Lucknow, NSW

- 1882-gold found at Mount Morgan, Queensland
- 1887-gold found at Arltunga, central Australia, helps open up central Australia to settlement
- 1887-gold found in Yilgarn and Pilbara districts, WA
- Early 1890's-gold finds at Coolgardie (1892) and Kalgoorlie (1893) lead to gold rushes attracting tens of thousands from the depression plagued eastern seaboard. Other eastern goldfields discoveries follow soon after.
- 1896 on-discoveries at Gwalia and Wiluna (1896), Peak Hill and Kanowna (1897), Phillips River (1900) and Bullfinch (1909), WA.
- 1932-gold found at Tennant Creek, Northern Territory.

Description of mining and processing techniques

Mining

The reefs were identified by outcrops of quartz or other gold bearing ore which were then dollyed up (that is, pieces were broken up and crushed in a dolly pot and then washed). If the results warranted it then the surface deposits would be worked and shafts dug. If the reef could not be found or was subsequently lost, then exploratory trenches, known as costeans (or 'costains'), would be dug to pick up traces of quartz. It should be noted that gold was not only found in quartz, but also in less obvious material, in particular, ironstone and granite. Deep lead deposits were found in buried river systems and surface indications were not obvious.

A shaft was a vertical opening either on or near the vein or outside it, if the lode had a dip, but intersecting it at depth. An incline was a sloping shaft. The shafts were often shored up with timber collars to prevent collapse, these collars sometimes extending to the top of the shaft. Some ore deposits were accessed by tunnels or adits. Where tunnels were a substantial length, ventilation shafts were used. Most reef sites of any consequence were worked by a combination of shafts and tunnels.

The internal workings of many reef mines, particularly the more productive ones, were often very complex. For example, a winze connected the interior workings, it being either vertical or inclined. Drives were run from the shafts as they deepened, sometimes several being put in at the one level to test the ground in a number of directions. The ground from which the ore was taken between the different levels was called a stope, and the process of excavation was known as stoping. Stopes were usually above or below a drive or level.

To raise the gold ore from the shafts and to assist with drainage, a windlass, post and pulley arrangement, tripod hoisting apparatus or horse driven whim were used. With depth, more elaborate and expensive winding and pumping equipment and machinery powered by steam driven boilers was needed, particularly where heavy water flows were encountered. For example, large wooden or metal poppet heads or head frames were built to assist with the winding. Also important on some sites, particularly deep lead mines, was the use of beam pumping engines. Powder magazines were sheds for the storage of explosives.

If deemed payable the extracted stone was taken to a processing site. Otherwise it was deposited near the mouth of the shaft or tunnel. These deposits were referred to as mullock heaps. Loading bays or ramps were located near the mouth of the shafts or tunnels, often in the form of rectangular raised areas, shored up by stone packed embankments. This is an indication that payable ore had been extracted and transported to a processing site.

Processing

The basic processing plant was a battery consisting of between one and ten stamps (though the larger plants could consist of 20 or even 40 stamps) for crushing the ore, and often referred to as a crushing plant or stamp mill. The stamps can be best described as iron rods with heavy cylindrical stamper shoes on the bottom, the stamps being raised and dropped by a series of cams on a shaft. The stamper shoes fell on stamper dies, the ore being fed into the back of the battery mortar box and crushed between the stamper shoes and dies. Most batteries were driven by wood fired boilers and steam engines, although water powered (using water wheels or pelton wheels) and even wind powered (using windmills) batteries were sometimes used. On some sites ore feeders were used, whereby a regulated amount of ore was fed into the battery. Mercury was used, both in the mortar box and on the copper plates below the battery. Stamper batteries were particularly popular because of their portability, being able to be broken down the manageable component parts, and their ability to handle a wide range of ores from hard rock to clayey materials.

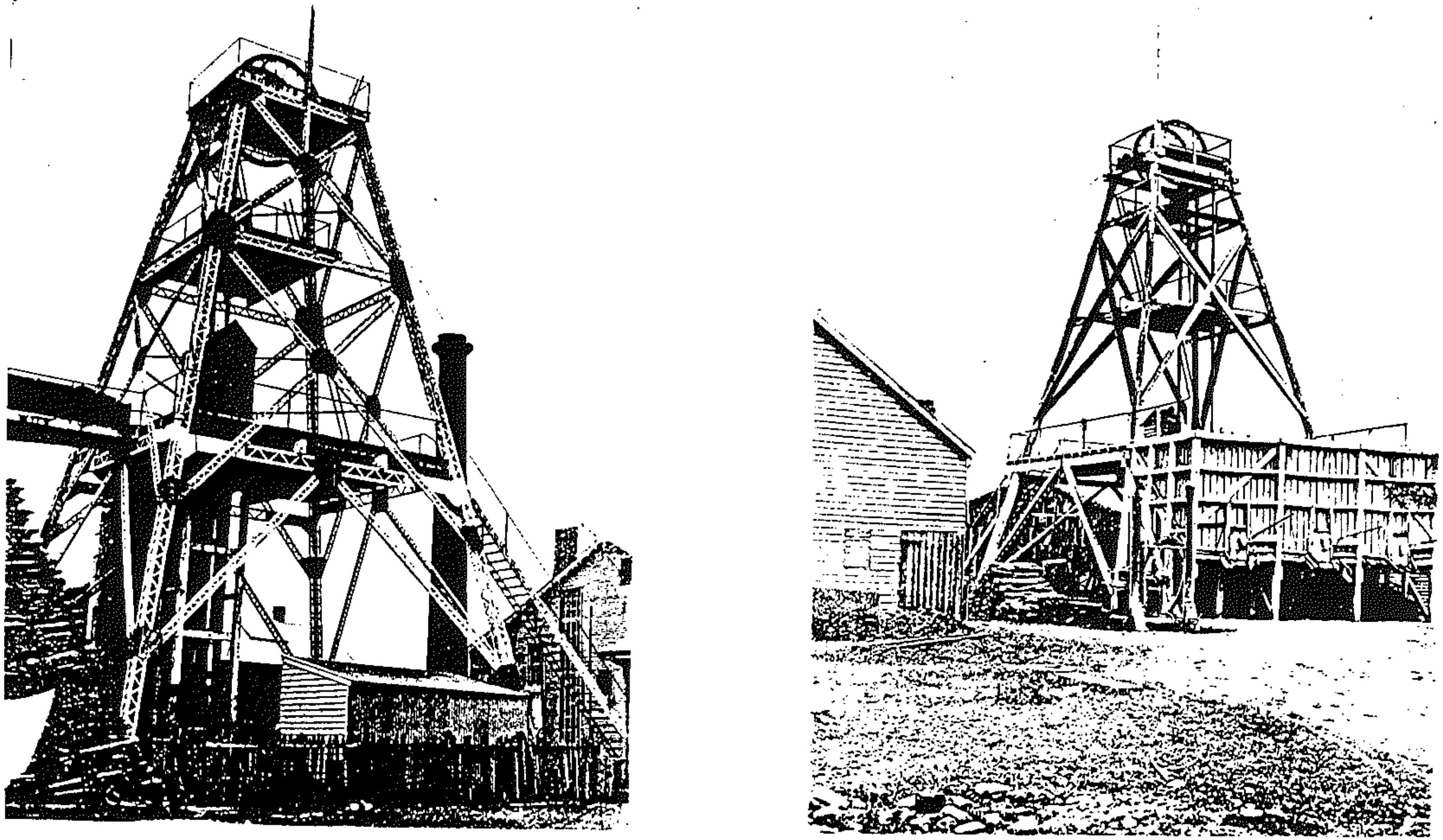
Sometimes an ore breaker or jaw crusher was attached to the batteries, but this was a more common practice with the Huntington mill. These mills were cheaper than stamp mills, but like other roller mills it was essential that they have an ore breaker attached to them. Instead of stampers falling perpendicularly and crushing the stone by their own weight, they achieved the same result by a grinding process. The mill was a stationary iron cylinder having a number of vertically mounted rollers suspended on a cross arm and shaft. When in motion, the ore was crushed between the rollers and a steel ring on the inside of the cylinder.

Cornish rolls and ball mills were sometimes used for crushing, but they too needed additional equipment such as rock breakers. On the plus side the roller mills used less power and had a far greater crushing capacity than any other crushing machine, one set of rollers having a crushing capacity equal to five heads of stamps. Chilean mills were also used. They consisted of a circular trench around which a large steel capped wheel was pulled by a horse, the ore being crushed in the trough.

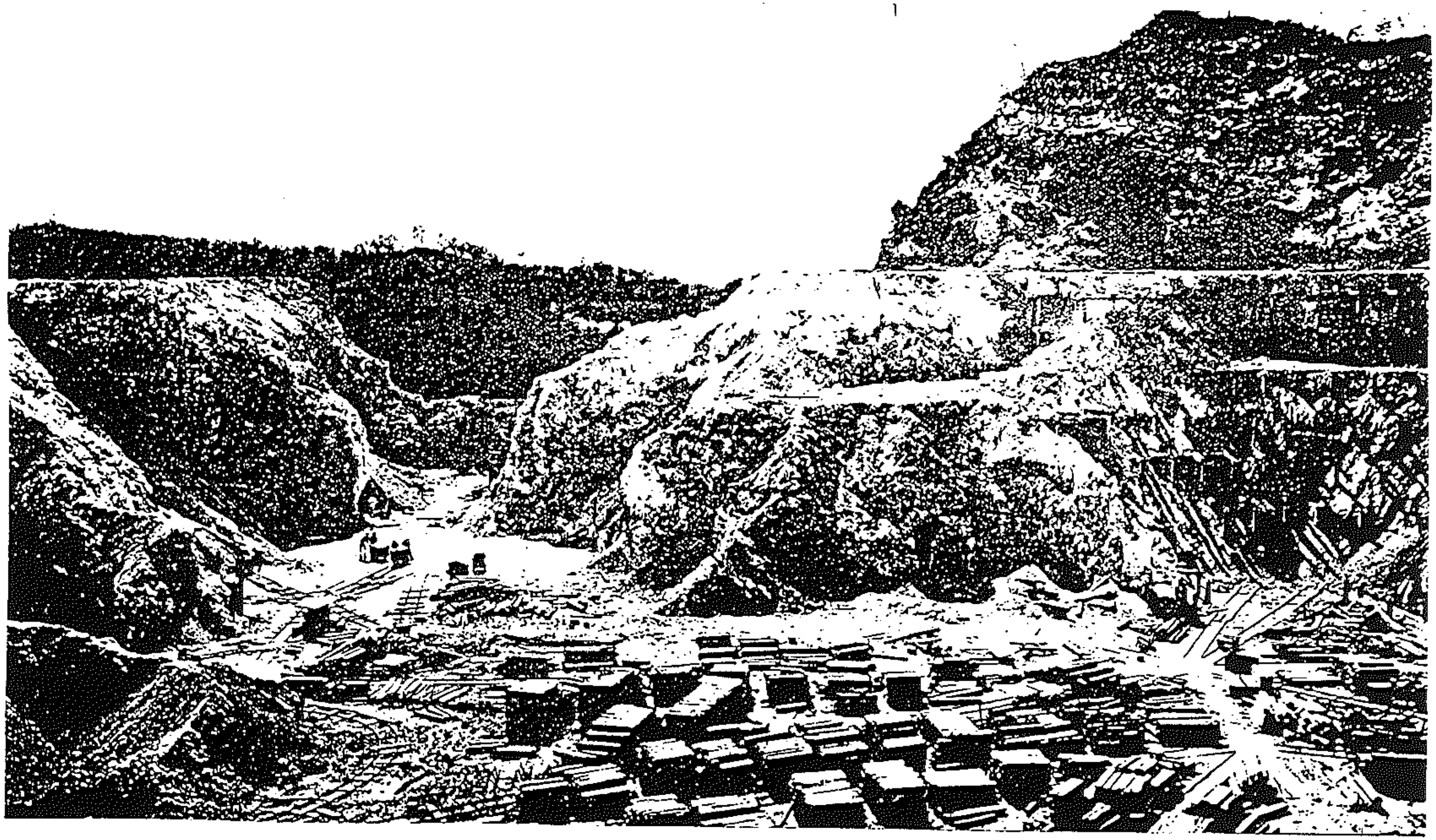
The crushed ore slurry was washed over copper plates dressed with mercury which absorbed the gold (the amalgamation process). When the mercury on the plates had amalgamated with as much gold as it could absorb, the plates were cleaned down and the amalgam retorted to separate the mercury from the gold. Where the gold was in a very fine state and in combination with sulphides of various metals (known as mundic or refractory ore), mercury would have no effect, and other processing techniques, such as smelting and chlorination had to be used.

The crushed ore was often concentrated before being processed in this way, the most basic concentration technique being the use of blanket tables which were simply a continuation of the mercury tables, but covered with strips of coarse blanket intended to arrest the heavier metallic particles. A disadvantage of this method was that the blankets often clogged up. Percussion or shaker tables (the Wilfley table was the best known) were an improvement on this method whereby a jerking motion was given against the flow of water and pulp, resulting in a concentration of the heavier minerals towards the upper part of the table. Jiggers were another form of concentrator.

Refractory ore was often transported to a central processing facility. In other instances chlorination plants were erected on site. The ore was processed by rock breaking plants before being put through roller mills or batteries, the concentrates being roasted as a preliminary to chlorination. The furnaces were similar to reverberatory furnaces (see



Poppet heads, Bendigo, Victoria



Open cut workings, Mount Morgan, Queensland copper type profile). The gold was leached out of the ore in a chlorine solution, often containing bleach and acid. The solution was then run off into a filtering vat and finally into a precipitating vat and then to an incinerating furnace.

An alternative to chlorination was the cyanide process. The tailings were placed in large vats and treated with solutions of potassium, sodium or bromo-cyanide of varying strengths. The solutions dissolved the gold, which was eventually precipitated by zinc shavings or other precipitants. As a further refinement tube mills were used to fine grind the ore into slimes, the slimes then passing into agitators where they were treated with solutions of cyanide. The sludge was then filter pressed, the gold being precipitated from the resultant solution by the use of zinc shavings. This procedure was known as the Diehl process.

Characteristic elements

Mining

While reef mining areas can have a scattered appearance, they usually follow a line of reef and can be traced through a series of consecutive costeans and shafts. The most obvious evidence of reef mining is the presence of shafts, adits, tunnels and costeans, mullock heaps loading bays and ramps. An indication of the significance of the mining activity, though not necessarily of its productivity, is the presence of large mullock heaps. The internal workings of many reef mines, particularly the more productive ones, were often very complex and deep, and for reasons of time and safety examination of them is not regarded as necessary for determination of significance.

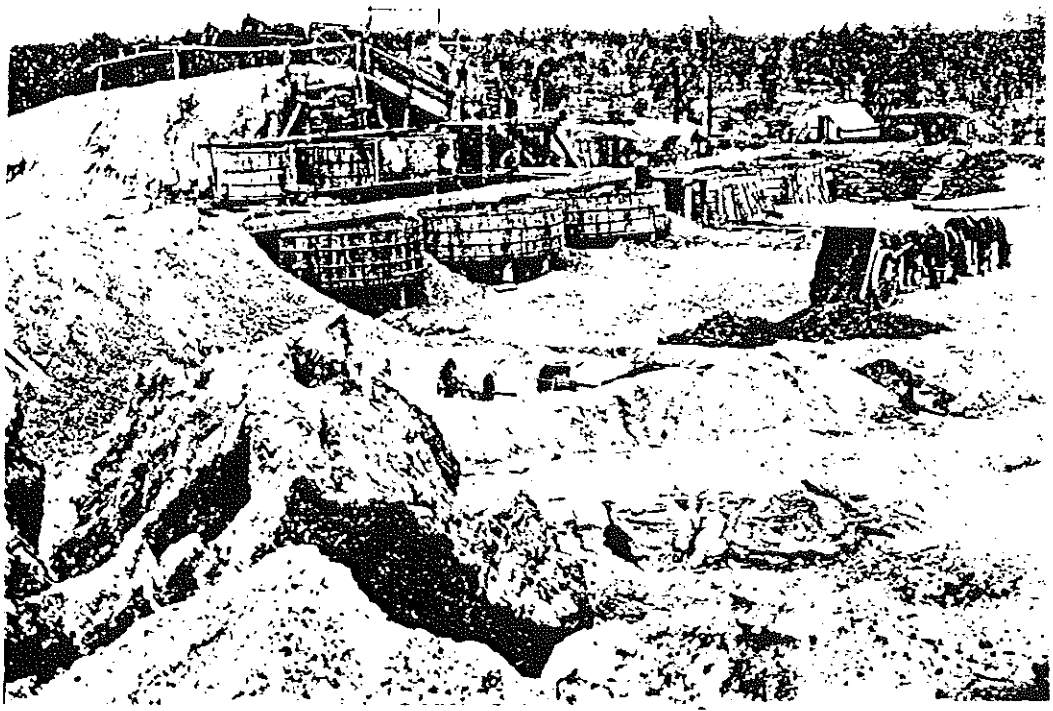
On many mines remains of the poppet heads can still be found. However, windlasses, whims, whips, hauling and winding machinery have often been removed. Evidence of the latter can be identified by the presence of concrete or wooden footings, with protruding iron bolts, bricks or pieces of boiler plates. Sometimes, buckets and other hauling equipment can be found nearby. Powder magazines could be substantial buildings of stone or brick, or of a much lesser construction, usually some distance from the mines and set into a cutting for safety reasons. At the mouth of tunnels evidence may be seen of tramway lines.

Beam pumping engines were relatively rare on the gold fields. They were, however, often housed in substantial stone and brick buildings and the remains can be impressive. At the very least they comprise remnants of the walls and masonry rubble.

Processing

The absence or otherwise of a processing plant can be an indication of the significance or otherwise of a gold mining field, though in some instances, especially where refractory ore was concerned, quite sizeable and profitable mining fields were worked without a plant. Similarly, the significance of a processing site can to a degree be gauged by the size of the tailings, though often these mounds can be washed away.

In the older sites, particularly on the eastern seaboard, the most important determination of the location of a processing plant was a reliable supply of water. Water was critical for washing the plates, generating steam in the boilers and processing the tailings. A processing plant was, therefore, always located near a source of water, which may mean that it was located some considerable distance, perhaps several kilometres, from the mines. Where small streams or gullies were involved, dams were constructed in very close proximity, usually downstream from the processing plant. The dams were built of earth,



Cyanide plants, Etheridge field, Queensland stone, logs or concrete or a combination of these materials. The water was pumped to the battery through pipes or by a combination of small water races and pipes.

In the more arid mining areas, for example, in WA, there were no regular supplies of surface water, and water for both domestic and processing uses had to be procured from wells or mine shafts. For example, on the Murchison goldfield at the turn of the century water was found at Meekatharra at a depth of from 130 to 150 m and elsewhere from 60 to 90 m. In these instances there were no dams on gullies other than to catch occasional showers, and there may be few water storage facilities on the field, the water being conveyed directly from the wells and shafts to the processing sites. Where the water was saline, condensers were erected.

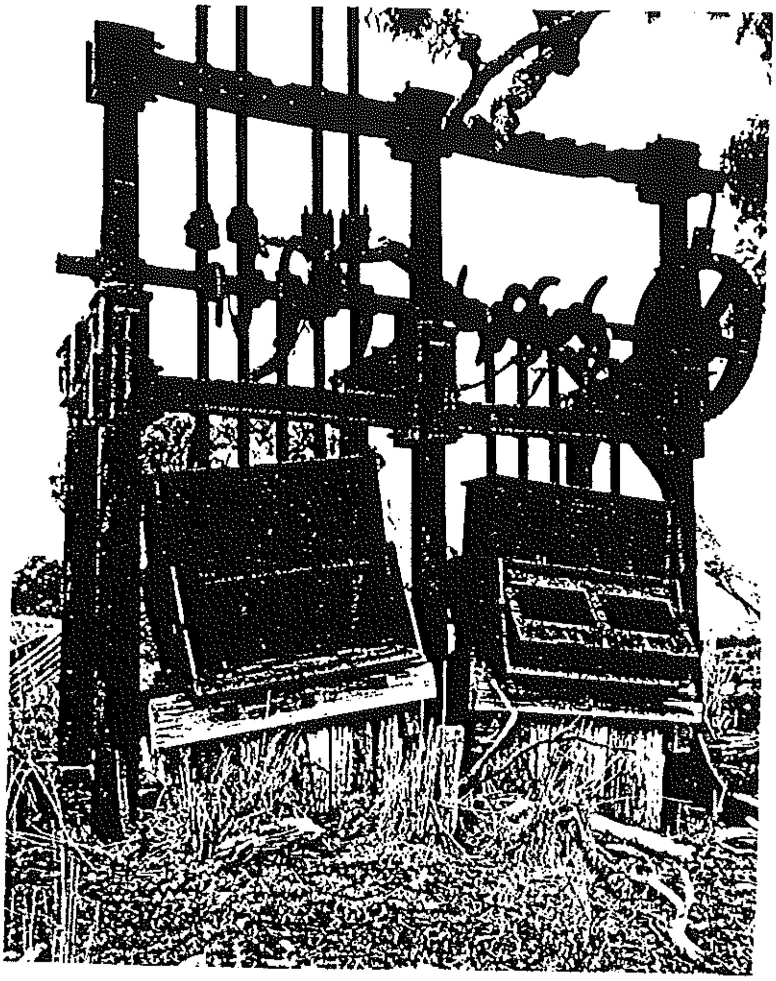
Where electricity was used dependence upon water supplies for power generation was eliminated. In these instances water could be pumped from more distant sources, and the location of the plant in proximity to water was not as essential. In some instances power stations fuelled by wood or oil were located on the field.

Where practical, processing plants, whether batteries or mills, were built on a number of levels, almost always on a slope, to allow the ore to be fed directly into the back of the battery. The plants were, therefore, located in a rectangular shaped cutting set into the slope. Where jaw crushers were used, the feeding area was located above it rather than the battery, the crushed ore being then fed from the latter into the plant. This added another level to the site. The engine and boilers were located in close proximity to the processing plant, but sometimes at different levels. In the absence of any meaningful machinery remains a rectangular shaped cutting is the clearest indication of the presence of a processing plant. On some fields, particularly in WA, where the terrain was often very flat, the plant could not be built on different levels. The same order of usage of plant and equipment prevailed, however.

The two most obvious physical remains to look for on the processing sites are the batteries, mills or jaw crushers and, on the older sites, the boilers. In most instances, however, much of this equipment has long since been removed, and other evidence must be looked for. The evidence consists of remains such as concrete footings and heavy upright squared off wooden logs for holding the battery and other machinery in place. Often these have heavy iron bolts still embedded. Other typical artefacts include pieces of boiler plates, bricks for housing the boiler, pieces of stamper shoes and dies, cam shafts, wheels and the like. Rarely are stamps still standing on site, though this does sometimes occur. The Huntington mills did not require the degree of stabilisation that batteries did and the squared off wooden logs are therefore absent, as are battery remains such as stamper shoes, dies and cam shafts. Other concrete footings may also indicate where the engines, pumps or power plants were located.

Typically the cyanide plants were located below the level of the processing plant, and are characterised by cyanide vats and large areas of fine white coloured sands. The former are circular in shape and either of wooden or galvanised iron construction. If the latter, they have metal bindings to hold the wood in place. On older sites the metal bindings are often all that remain. Sometimes there are no remains of the vats at all and only the cyanided sands remain. These can be quite extensive in area.

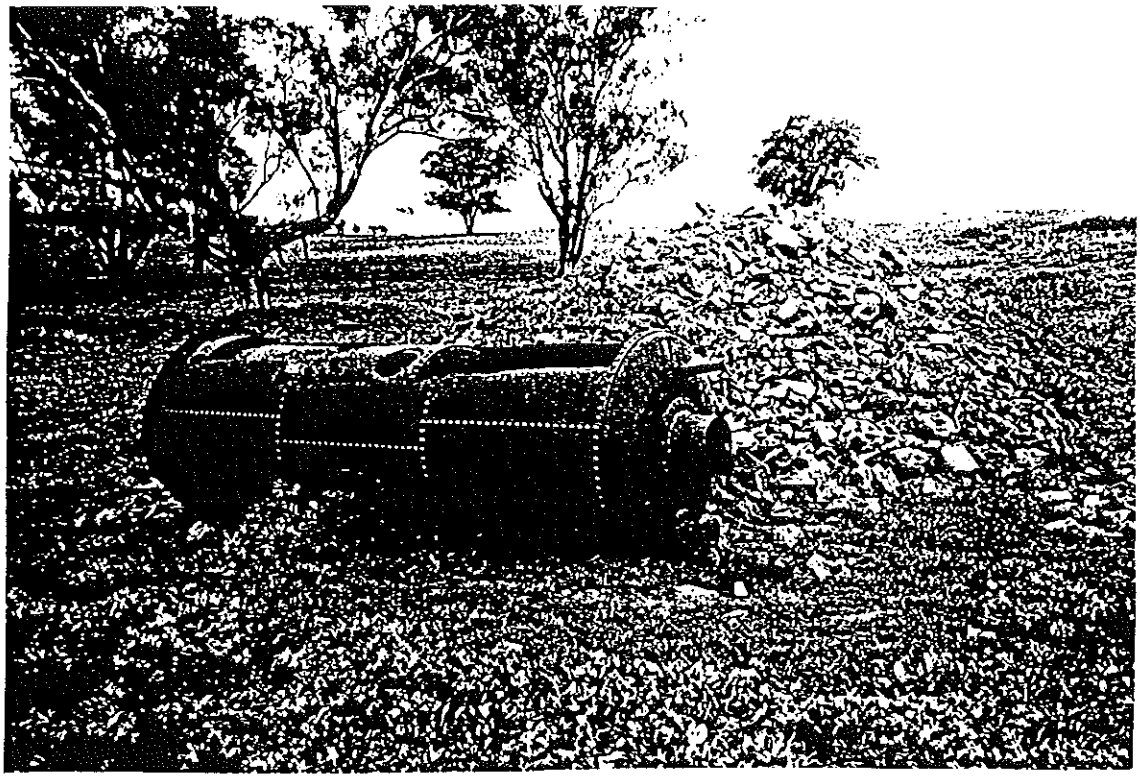
Remains of brick structures such as kilns and refractory furnaces are the best visual indications of the presence of a smelting or chlorination process. These structures are often in proximity, usually downhill, from processing plants such as jaw crushers, batteries or Huntington mills, though sometimes the two sets of processes are in separate locations. The smelting and chlorination sites were often plundered for their supplies of bricks for



10 head stamp, Cullinga, NSW

Boilers for stamper, Cullinga, NSW

Cam shaft for 15 head stamp, Cullinga, NSW



Boiler for hauling equipment, Cullinga, NSW local building purposes, and often very little remains of the structures other than their basic outline. There are some sites, relatively rare, where no crushing took place at all, the ore being fed directly into furnaces for preliminary roasting prior to smelting.

An important feature of both mine and processing sites is the presence of tracks, pathways and tramways, both aerial or ground, connecting the different areas of the processing plant, and linking the mines to the processing areas. Often some degree of ingenuity was involved and remnants will include embankments and sometimes sleepers and rail lines. The internal transport arrangements for some sites were complex and are an important feature.

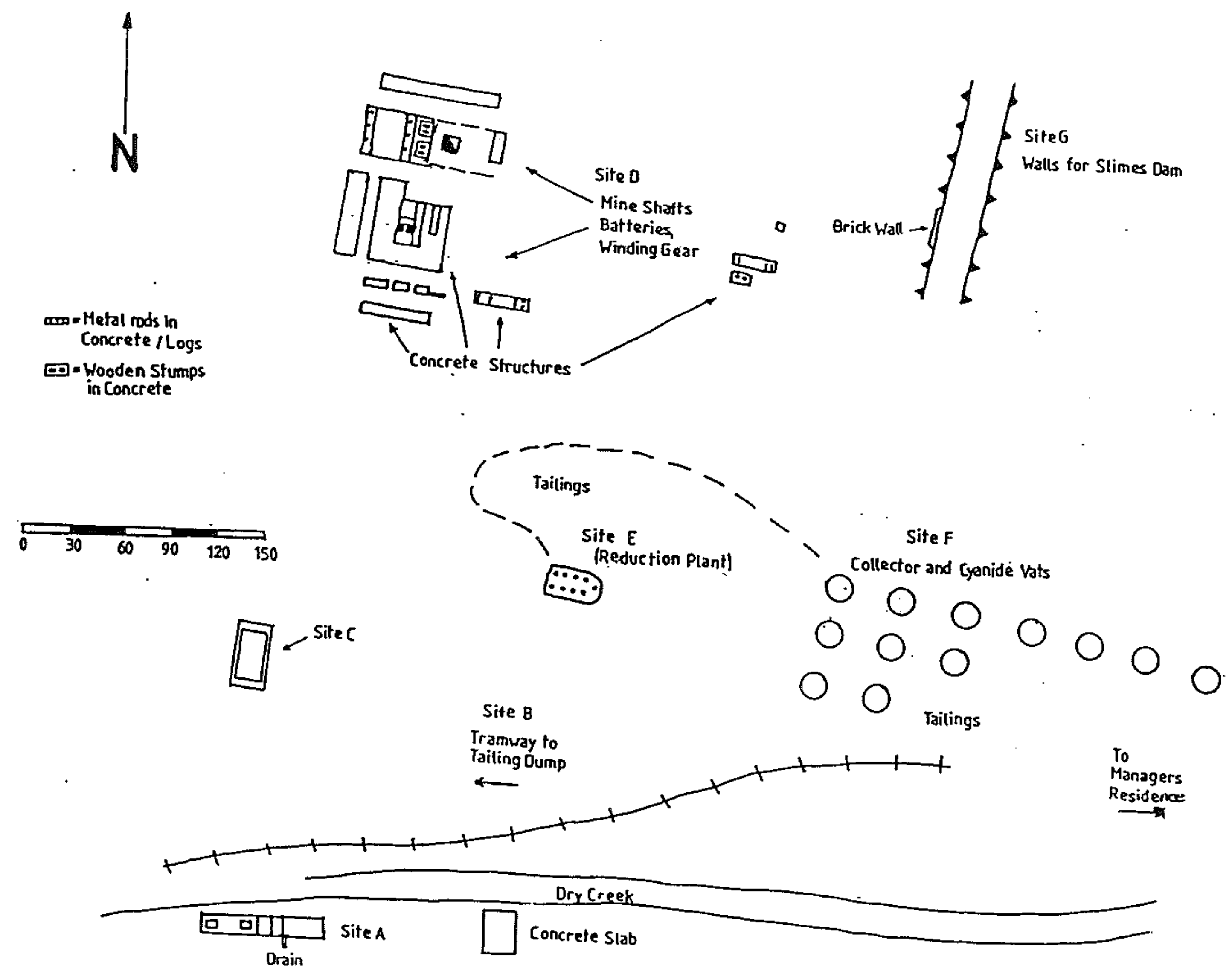
2. DISTRIBUTION AND FREQUENCY OF TYPE

Australia is one of the world's largest producers of gold, the gold rushes in the early 1850's being of international significance. Economically viable gold deposits are widely distributed throughout Australia. Up to 1923 Victoria produced 49% of total gold production, Western Australia 24.8%, Queensland 13.8%, New South Wales 10.3%, Tasmania 1.4%, Northern Territory 0.4% and South Australia 0.3%. Unlike most alluvial production, statistics on reef output are more reliable, because the operations were more centralised and throughput more easily measured. Most companies of any size were listed on the Stock Exchanges and their returns were readily available. The production figures cited below are of both alluvial and reef production, the former, however, constituting only a relatively small part of total output.

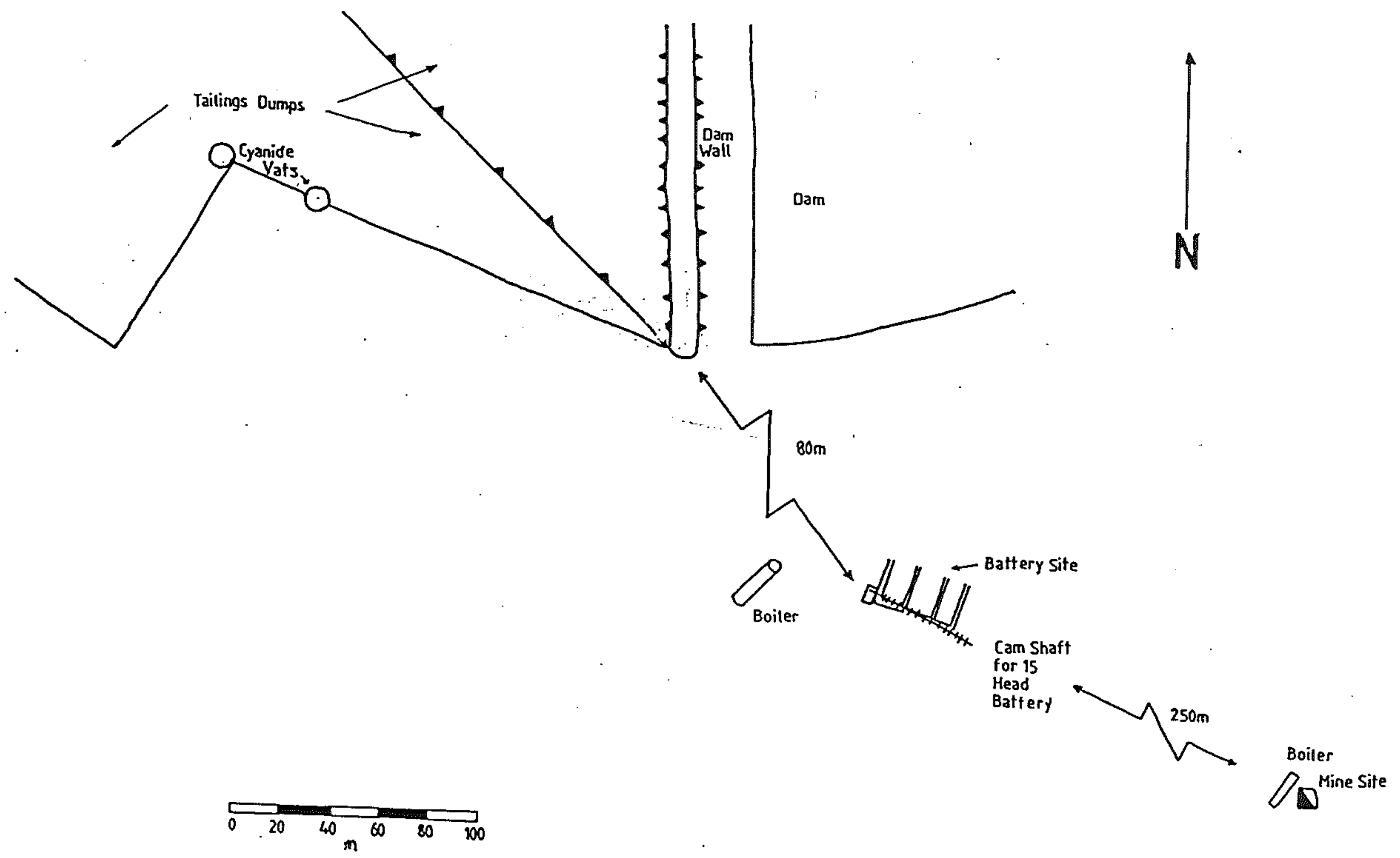
In Victoria, the main reef and deep lead finds followed closely behind the early alluvial rushes, the earliest reef and deep lead mining being at Clunes, Ballarat, Castlemaine and Bendigo. Reef and deep lead finds followed elsewhere, the latter being located primarily within the watershed of the Great Dividing Range. To 1913 the main producer by far was Bendigo with 19.7 million oz. Other large fields to that date were Clunes, 1,338,882 oz, Walhalla (Cohen's Line alone) 1,477,094, Ballarat, about 1,430,000 and Stawell 600,000.

Reef gold was discovered in Western Australia in 1885 at Hall's Creek in the Kimberleys, the significance of this find being more historical than economic. The next main discovery was at Yilgarn in 1887, 906,977 oz being produced up until 1918. The main discoveries were not until the early 1890's, several of them paling all else into relative insignificance. For example, the East Coolgardie goldfield centres (1894) of Boulder and Kalgoorlie produced 16.1 and 17 million oz respectively up to 1918, the field accounting for 66% of Western Australia's total production to that date. Other major fields in order of significance were Mount Margaret (1897), including Leonora and Laverton, 2,820,624 oz, East Murchison (1895) including Lawlers, Sandstone and Youanne, 1,715,869 oz, Coolgardie (1892), including Coolgardie and Burbanks, 1,150,980 oz, North Coolgardie (1895), including Menzies and Kookynie, 956,481, Dundas (1893), 594,823, the main centre being Norseman, and Broad Arrow (1896) 467,855, the main centre being Siberia. The main deep lead mine was at Kanowna on the North East Coolgardie field (1896), 713,767 oz. Almost all reef fields of any significance are located in the area generally known as the Eastern goldfields.

The first reef find in Queensland was at Hector Reef on the Rockhampton, Mount Morgan field in 1866 and the largest gold producing field in Queensland to 1912 was Charters Towers. This field was proclaimed in 1872 and produced 6,359,225 oz, or 36% of Queensland's total production. Next in significance was the Rockhampton, Mount Morgan field. This field produced 4,023,364 oz, accounting for 22.7 % of Queensland's production to 1912. The next largest was Gympie, proclaimed in 1867 and producing 2,653,293 oz or 15% of Queensland's total production to 1912. Other reef fields in order



Reef mine and processing plant, Harden, NSW



Reef mine and processing plant, Cullinga, NSW of significance were Ravenswood, (1870) 822,275 oz, Croydon (1886) 744,703 oz, the Etheridge (1872), 569,248 oz and Hodgkinson (1876), 234,298 oz. All up these seven fields accounted for over 85 % of Queensland's total gold production. They are located in a broad band running from the far north of Queensland down the eastern seaboard to central Queensland.

Reef gold in New South Wales has been found primarily in the far north west, north east, and central and south east regions. The first reef gold was probably discovered on the Hill End and Tambaroora goldfields in central NSW in 1851. The most successful mining on this field was at Hawkins Hill between 1870 and 1872, 688,722 oz being extracted to 1923. Another significant producer in the central area was Lucknow, near Orange, which was worked extensively from 1862 to 1867, yielding 504,474 oz to 1923. To the west, the Mt Boppy mine (1896) near Candalego yielded 432,816 oz, the Wyalong field (1893), 445,700 and the Tomingley Peak Hill (1883 and 1889) field 231,599. Further west still the Cobar mines (1870) yielded 628,563 oz from 1887 to 1923, returns prior to that date not being available. The Adelong field (1857) was the most significant reef producer in the southern area and in the north east Hillgrove (1881) with 520,000 oz was the largest producer. Deep leads were found primarily at Forbes (1862) and Grenfell (1866), 300,000 oz being won at the former in the first two years.

In Tasmania the most important reef deposits were in the Beaconsfield and Lefroy districts and in a 90 km belt from Mangana through Mathinna to Lyndhurst in the north east. The first reef deposits were discovered at Mangana in the 1850's, the first battery being built in 1859, the Back Creek, Lefroy and Mathinna fields following on from this. At Beaconsfield the first reef was discovered in 1877, this field producing 854,600 oz between 1877 and 1914. On the West Coast most of the main sulphide ore bodies were originally worked for gold before becoming predominantly base metal mines.

In the Northern Territory the first main area of reef mining was at Union Reefs, near Pine Creek, commencing in 1873. Reef mining subsequently commenced at Arltunga in 1887. New gold finds were made at nearby White Range in 1897 and 1898 and at Winnecke in 1903. Gold was found at Tanami in 1900 and again in the 1930's. Mining commenced at Tennant Creek in 1932, production rising from 64 tons in 1934 to 25,129 tons in 1942.

In South Australia payable reef gold was first found at Jupiter Creek on the Echunga field in 1869 followed by Forest Range and Sandy Creek on the Barossa field, Birdwood, Mount Pleasant, Mount Torrens in 1870 and Parra Wirra in 1871, all these mines being in the Adelaide Hills and Mount Lofty Ranges area. The largest reef mine was at Waukaringa in the east near Yunta, the main mine the Alma-Victoria which yielded over 40,000 oz from 1873 until 1894. Other reef mines were at Woodside (1879) and Wadnaminga (1888).

3. VARIATION OF THE TYPE

Basic components of reef mining were established almost from the outset, there being a gradual progression to the use of whims, pumps and boilers if necessary. Where gold was to be processed on site, stamp batteries or mills were established not long thereafter, either to process ore from specific mines or for the public, or both. The basic processing plant consisted of a mill or a 5 or 10 head battery and amalgamating tables. This equipment was used from the very earliest days of reef mining in Australia, there being very little change in design thereafter. Because of their portability, many mills and batteries were recycled for use on other fields many years, often decades later. No matter what subsequent processing techniques were used, however, the site always had a battery or mill.

Reef gold and deep leads locations

The inadequacy of crushing and amalgamation techniques for the treatment of refractory ore led to the development of other processing techniques, for example, smelting and chlorination. The earliest examples of chlorination plants were at McMahon's Reef near Harden, NSW, and Ravenswood, Queensland, both established in 1885. A chlorination plant was also established subsequently at Charters Towers. These plants were expensive to build and operate as the ore needed to be crushed and roasted in furnaces before chlorination. They were not particularly successful and were not widely used.

Chlorination was generally superseded by the cyanide process. The first cyanide plant was built at Ravenswood in 1887. However, their introduction across Australia was relatively slow, it not being until 1897 that output of gold from this process rose rapidly. The immediate aim of cyanide operators was the processing of tailings that had accumulated over many years, thus the process was used initially on many abandoned fields. Often these plants were very small.

Not all fields used the cyanide process. For example, in Queensland up until 1914, the bulk of cyanided ore came from Charters Towers, there being very little cyanidation at other major fields such as Gympie and Mount Morgan. The difficulties with extracting gold from concentrates, mainly the length of time the cyanide vats were engaged in this process, and the introduction of Wilfley concentrators, led many companies to send increasing quantities of concentrates to smelters, some of the better known being at Maryborough Queensland, and Dapto and Cockle Creek in New South Wales. Nevertheless, the cyanide plants were relatively cheap to construct and are as a consequence widely distributed throughout Australia.

In WA cyanidation was used more extensively than elsewhere in Australia, there being 10 plants in 1896 and 79 the following year. The process needed modifying at Kalgoorlie and led to the development of the Diehl process involving tube mills, agitators and filter presses. Subsequently, for cost considerations, the Diehl process lost much of its appeal and modifications were used, with others subjecting all the concentrates to roasting and cyaniding. At some mills dilute cyanide solutions were introduced during the crushing process.

4. ATTRIBUTES PARTICULARLY WARRANTING HERITAGE REGISTRATION

Attributes or combination of attributes of a reef gold mining site that are likely to make it a good example of its type include:

- Clear evidence of mine workings-a mining site with a substantial combination of surviving evidence (including ruined or partially disturbed elements) which might include: shaft or adit head equipment such as a poppet head, rail lines, collaring and either the machinery for or concrete footings for winding machinery, pumps or air compressors.

- Clear evidence of a processing site—substantial evidence (including evidence in ruin) which might include batteries, boilers, mills, dams, cyanide vats, tailing heaps, or in the case of more complex sites, kilns and furnaces.

- Clear evidence of habitation.-these may be isolated huts or groups of huts or in the case of larger fields, villages or even small towns. The sites may only be visible as rectangular areas four metres by six metres or less, with only an outline of stones where the chimney stood. Ovens or forges are located separately and measure about one metre square.

Attributes or combination of attributes of a reef mining site that are likely to make it rare, uncommon or of particular interest include:

- Intact or unusually substantial surviving mine head equipment which might include shaft or adit equipment such as poppet heads, winding or pumping engines, air compressors mullock heaps and powder magazines.

- Intact or unusually substantial evidence of processing plants such as batteries, mills, boilers, furnaces and cyanide vats. Much of the equipment used in the mining and processing was highly portable and only occasionally are batteries, mills, boilers and engines found intact. Often the evidence is more subtle.

- Intact or unusually substantial evidence of habitation sites. Sometimes there are substantial remains of huts, including whole walls or chimneys, and sometimes there are significant artefact scatters. These serve to enhance the value of such sites, even where the number of huts may be limited.

5. KEY SOURCES USED IN THIS TYPE PROFILE

Dunstan, B. 1902. *The Clermont Goldfield*, Geological Survey of Queensland, Publication No.176, Department of Mines, Brisbane

Dunstan, B. 1913. *Queensland mineral index and guide*, Geological Survey of Queensland, Publication No 241, Department of Mines, Brisbane.

Feldtmann, F.R. & Farquharson, R A. 1913. *The geology & ore deposits of Kalgoorlie, East Coolgardie Goldfield, Part 11*, Geological Survey, Bulletin No. 51, Department of Mines, Perth

Gibson, C.G. 1904. *The geology and mineral resources of a part of the Murchison goldfield*, Geological Survey, Bulletin No. 14, Department of Mines, Perth

Gordon, H. 1894. *Mining and Engineering and Miner's Guide*, Government Printer, Wellington,

Herman, H. 1914. *Economic geology and mineral resources of Victoria*, Geological Survey of Victoria, Bulletin No. 34, Melbourne

Jennings, I.B. and others, 1967. *Geology and mineral resources of Tasmania*, Geological Survey Bulletin, No. 50, Department of Mines, Hobart

Kenny, E.J. 1922. *Gold*, Geological Survey of New South Wales, Bulletin No. 7, Department of Mines, Sydney

Lougheed, A. L. 'The cyanide process and gold extraction in Australia and New Zealand 1888-1913', *Australian Economic History Review*, Vol 27, No. 1 March 1987, pp 44-60

Maitland, A Gibb, 1919, 'The gold deposits of Western Australia', in the *Mining Handbook*, Geological Survey Memoir, No. 1, Department of Mines, Perth, (reprinted as a monograph, Hesperian Press, Victoria Park, 1984).

Milner, P. "Beam pumping engines in Victoria", *Australasian Historical Archaeology*, vol 15, 1997, pp 40-54

Pittman, E. F. *The mineral resources of New South Wales*, Geological Survey of New South Wales, NSW Department of Mines, Sydney, 1901

Ritchie, N. and Booker, R. "An Archaeologist's guide to mining terminology", *Australasian Historical Archaeology*, vol. 15. 1997, pp 3-29

Searle, G. 1977. *The Golden Age. A history of the colony of Victoria 1851-1861*, Melbourne University Press, 1977

Selby, J. (ed) 1987. *South Australia's mining heritage*, South Australian Department of Mines and Energy/Australasian Institute of Mining and Metallurgy, Special publication No.7, Adelaide.