GOLD RUSH AND GOLD MINING: A TECHNOLOGICAL ANALYSIS OF GABRIEL'S GULLY AND THE BLUE SPUR, 1861-1891.

NICOL ALLAN MACARTHUR

Presented in Fulfilment of the Requirements for Admission to the Degree of Master of Arts in History

Otago University

February 2014
ABSTRACT

Philip Ross May stated in 1980 that well-informed studies of the technology of gold rushes and gold mining were long overdue but very little has been added to the historiography since then. As a result, various misconceptions and misunderstandings have entered into the New Zealand and wider gold rush historiography. A conflation of gold rushing with gold mining is sometimes evident and another misconception entrenches corporate structure with the level of capitalisation and mixes the mining of alluvial and quartz reef gold.

On May’s lines, this thesis argues that technology lies at the heart of all gold rushes and their gold mining, and seeks simply to demonstrate that the technology of gold rushes was different from the technology of gold mining. The thesis first completes a historical survey of gold rushes from sixteenth century Spanish America until Victoria in the 1850s. It then then closely evaluates the technology of the Gabriel’s Gully gold rush and its extension to mining the Blue Spur deposit, to deepen the findings of the global review, as a detailed case study of mining after a gold rush, and as local history.

All gold rushes were found to use a common suite of hand tools and simple manual methods of low productivity. This manual simplicity was diagnostic as was a slowdown in gold output and modifications in methods as the rich easy gold became exhausted. To continue required either hydraulic or mechanical methods, or large coordinated labour forces, along with capital expenditure. This signified mining, which typically comprised ground sluicing, hydraulicking, deep leading, or river mining.

Unlike other rushes, the Gabriel's Gully rush used hydraulic energy in long toms and box sluices, as well as manual cradling, to wash the paydirt. Whether due to this or not, a remarkable new finding is that in its first twenty-one months, the Tuapeka district produced more gold than the first twenty-one months of the Californian rush.

Regarding mining, Blue Spur proved to be an extremely large orebody, much of it heavily cemented and capable of high gold contents. Over its long fifty-year life, as different zones were reached, alluvial, quarrying, and underground mining and stamp
milling technologies were applied, and culminated in hydraulicking and the innovative hydraulic elevating developed in Gabriel's Gully. However, regardless of the mining technology in use, there was no structural change in the Blue Spur mining parties for twenty years, although each new technology required higher capitalisation. This supports Hearn’s work on the Tinkers goldfield.

This technological study has perhaps filled a gap in the local historiography, and historians of the Otago gold rushes and gold mining may be encouraged to pursue other lines of enquiry with the role of technology included in their perspective. This leads to a wider point that ongoing mining histories in New Zealand could look to the characteristics of local deposits and their required technology before generalising across different types of gold deposit nationally. The work shows also that Otago had a significant role in the global innovations in alluvial mining technology of the nineteenth century.
PREFACE

This thesis is an attempt to marry my experience as a mining engineer in alluvial gold and tin with the discipline of history, and the history of gold rushes in particular. My particular approach is to examine the role of mining as a successor to gold rushing. In this, Gabriel's Gully and the Blue Spur were an appropriate example to study as they were situated in my home region of Otago and the activities were well documented and archived. Notwithstanding the specific focus, I have also produced a body of wider information.

I am pleased to record the willing and friendly assistance of many people in my work for this thesis and I hope every one of you gains something from your assistance to me. If I have left anyone out, I greatly apologise. My gratitude goes to: the staff at Dunedin Regional Office of Archives New Zealand, namely, Peter Miller, and Aaron Braden, Amy Coleman, Andrew Crake, Vivienne Cuff, and Geordie Muir; to Thelma Fisher, Teresa La Rooy, Amber Marshall, Christine Brown, and many others in the University Central Library; to Judith Holloway, Ali Clarke, Karen Craw, Mary Lewis, Katherine Milburn, and Richard Munro at the Hocken Collections, University of Otago; to Malcolm Deans and other staff in the Heritage Room, Dunedin Public Library; to Jill Haley at Toitū Otago Settlers Museum; to Kate Murphy at Museum of New Zealand Te Papa Tongarewa; to Shar Briden of the Department of Conservation; to Ian Smith and the technical staff in the Anthropology Department, University of Otago University; and to seminar colleague Dan Davey. My particular appreciation goes also to Jamie Newman for graphics.

I would like to reserve special appreciation for Ernie McCraw and Matthew Sole who went out of their way to show me around the Tuapeka district, and to provide detailed information about the Blue Spur, respectively, and for Ralph Birrell for generously forwarding me a copy of his dissertation. I would also like to record my extra-special appreciation to Damien Hynes, who escorted me in a well-informed tour of the alluvial goldfields of Victoria and who chased up all possible connections between alluvial miners in Otago and those in Victoria, New South Wales, and Tasmania.
My kind thanks go also to Sue Lang, Peter Cadogan, and Gwen Slote, of the History Department, for assistance and departmental know-how, and to the postgraduate academic staff for their valuable seminars, workshops, and academic support and guidance over many years.

I also warmly thank supervisors Tony Ballantyne and Alexander Trapeznik, for their support, encouragement, belief in my project, and forbearance. Finally, my greatest thanks and appreciation go to my lead supervisor, Tom Brooking, for his unfailing patience, strong support, expert assistance, and wise guidance at all times.
# TABLE OF CONTENTS

ABSTRACT .................................................................................................................. ii  
PREFACE ..................................................................................................................... iv  
LIST OF FIGURES ....................................................................................................... ix  
LIST OF ABBREVIATIONS ......................................................................................... x  
INTRODUCTION .......................................................................................................... 1  

CHAPTER 1: GOLD RUSHES AND MINING FROM THE SIXTEENTH UNTIL THE MID-NINETEENTH CENTURY ................................................................. 12  
Colonial Spanish America ......................................................................................... 13  
  Arrival and Plunder .................................................................................................. 13  
  Internal Gold and Silver Rushes ............................................................................. 14  
  Hispanic Alluvial Technology ............................................................................... 16  
  Spanish Lode Mining and the Sistema del Rato .................................................... 18  
  Meanings of Gold Rushing and Gold Mining in Spanish Colonial America ............ 20  
Brazil .......................................................................................................................... 21  
  Early Self-regulation ............................................................................................ 22  
  Transition and Mining .......................................................................................... 23  
The Appalachian Goldfields ..................................................................................... 24  
  A Saprolite Gold Rush ......................................................................................... 25  
  Alluvial Innovations ............................................................................................ 28  
  A Pivotal Period in Alluvial Technology and Historiography ............................... 30  
Siberia ....................................................................................................................... 31  
  The Urals and Siberia ............................................................................................ 31  
  The Nature of a Siberian Gold Rush .................................................................... 32  
  Alluvial Mining ................................................................................................... 33  
  Technological Change in Siberia .......................................................................... 34  
Pacific Basin Rushes 1848 – 1864 .......................................................................... 35  
California ................................................................................................................ 35  
  Early Depletion and Transitions ......................................................................... 36  
  River Mining ......................................................................................................... 38  
  Ground Sluicing and Hydraulicking .................................................................... 40  
  Structural Change in California .......................................................................... 42  
  Gold Rush or Gold Mining in California ............................................................... 43  
Victoria ..................................................................................................................... 43  
  Surfacing Tools and Techniques in the Gold Rush ................................................. 45  
  Victorian Depletion and Transition ..................................................................... 46  
  Board Sluicing and Hydraulic Mining ............................................................... 47  
  Innovation for Deep Leads ................................................................................ 48
<table>
<thead>
<tr>
<th>Chapter</th>
<th>Title</th>
<th>Page</th>
</tr>
</thead>
<tbody>
<tr>
<td>2</td>
<td>THE TUAPeka GOLD RUSH AND ITS TECHNOLOGY</td>
<td>53</td>
</tr>
<tr>
<td></td>
<td>Spot Finds and Near Misses</td>
<td>53</td>
</tr>
<tr>
<td></td>
<td>Gabriel Read's Path to the Bonanza</td>
<td>56</td>
</tr>
<tr>
<td></td>
<td>Structuring the Rush</td>
<td>63</td>
</tr>
<tr>
<td></td>
<td>Peak Gold</td>
<td>69</td>
</tr>
<tr>
<td></td>
<td>The Technology of the Rush</td>
<td>73</td>
</tr>
<tr>
<td></td>
<td>Depletion and Transition in the Tuapeka Goldfield</td>
<td>78</td>
</tr>
<tr>
<td></td>
<td>Tuapeka Technology</td>
<td>82</td>
</tr>
<tr>
<td>3</td>
<td>MINING THE MULTI-CHARACTER BLUE SPUR DEPOSIT</td>
<td>84</td>
</tr>
<tr>
<td></td>
<td>The Uncharacteristic Characteristics of the Blue Spur Deposit</td>
<td>84</td>
</tr>
<tr>
<td></td>
<td>The Establishment of Water Races and Ground Sluicing</td>
<td>86</td>
</tr>
<tr>
<td></td>
<td>Was The Long Race Company at Waitahuna First?</td>
<td>86</td>
</tr>
<tr>
<td></td>
<td>Pioneers of the Blue Spur and Munro's Gully</td>
<td>88</td>
</tr>
<tr>
<td></td>
<td>The First Commercial Race</td>
<td>91</td>
</tr>
<tr>
<td></td>
<td>Races and Technology</td>
<td>91</td>
</tr>
<tr>
<td></td>
<td>Ground Sluicing in Action</td>
<td>93</td>
</tr>
<tr>
<td></td>
<td>Regulating Ground Sluicing</td>
<td>94</td>
</tr>
<tr>
<td></td>
<td>Quarrying the Spur - Chamber Blasting</td>
<td>100</td>
</tr>
<tr>
<td></td>
<td>Field Activity</td>
<td>100</td>
</tr>
<tr>
<td></td>
<td>Technological and Economic Aspects of Chamber Blasting</td>
<td>106</td>
</tr>
<tr>
<td></td>
<td>The Quarry Goes Underground</td>
<td>107</td>
</tr>
<tr>
<td></td>
<td>Morrison and Co.'s Stamp Mill</td>
<td>107</td>
</tr>
<tr>
<td></td>
<td>Gabriel's Gully Quartz Mining Company</td>
<td>108</td>
</tr>
<tr>
<td></td>
<td>The Nelson Co. Breaks New Ground Again</td>
<td>109</td>
</tr>
<tr>
<td></td>
<td>Other Parties Follow</td>
<td>111</td>
</tr>
<tr>
<td></td>
<td>Technological Review of Mining the Blue Spur</td>
<td>113</td>
</tr>
<tr>
<td></td>
<td>Depletion, Technology, and Tuapeka Society</td>
<td>116</td>
</tr>
<tr>
<td>4</td>
<td>HYDRAULIC ELEVATING, AN IMPORTANT INNOVATION</td>
<td>119</td>
</tr>
<tr>
<td></td>
<td>Innovation Driven by Tailings</td>
<td>119</td>
</tr>
<tr>
<td></td>
<td>Robert John Perry, Innovator</td>
<td>120</td>
</tr>
<tr>
<td></td>
<td>Engineering the Hydraulic Elevator</td>
<td>122</td>
</tr>
<tr>
<td></td>
<td>Implementation</td>
<td>125</td>
</tr>
<tr>
<td></td>
<td>Innovative Technology in Action</td>
<td>128</td>
</tr>
<tr>
<td></td>
<td>Wide and Structured Uptake</td>
<td>130</td>
</tr>
<tr>
<td></td>
<td>Initial Users After Perry</td>
<td>130</td>
</tr>
<tr>
<td></td>
<td>Corporate Uptake</td>
<td>132</td>
</tr>
<tr>
<td></td>
<td>The John Ewing Model</td>
<td>134</td>
</tr>
<tr>
<td></td>
<td>Mining Parties, Informal or Registered</td>
<td>135</td>
</tr>
<tr>
<td></td>
<td>Ongoing Operations on the Blue Spur</td>
<td>136</td>
</tr>
<tr>
<td></td>
<td>Dual Otago Emergence</td>
<td>137</td>
</tr>
</tbody>
</table>
Structural Change around the Blue Spur ................................................................. 140
Review of Hydraulic Elevating and the Blue Spur ....................................................... 142

CONCLUSION .................................................................................................................. 144

BIBLIOGRAPHY .............................................................................................................. 151
LIST OF FIGURES

Figure 1. Location of Historical Alluvial Goldfields ................................................................. 13
Figure 2. The Elements of a Cradle ................................................................. 29
Figure 3. A Long Tom with a Tapered “Jenny Lind” Section ................................................... 30
Figure 4. Chain Pump Driven by a Waterwheel ................................................................. 39
Figure 5. The Tuapeka Goldfield in October 1862 on 1871 topography .............................. 58
Figure 6. Gabriel’s Gully and the Tuapeka River ................................................................. 60
Figure 7. Ground sluicing in massive Blue Spur Conglomerate. Note miners for scale ....... 85
Figure 8. Mining Parties on the Blue Spur, 1887 ................................................................. 90
Figure 9. Original Blue Spur Village December 1864 .......................................................... 99
Figure 10. Tailings Flowing Through Blue Spur Village ca 1865 - A Kate Boyer Moment
(or year) [See Introduction] ................................................................................................. 99
Figure 11. Blue Spur Village Buried by Tailings ca 1870 ...................................................... 100
Figure 12. Rocky Blocky Cement, Looking North to Perseverance Battery ....................... 105
Figure 13. Rocky Blocky Cement in Brit. Am. Claim, Munro’s Gully. Note miners in lower
right quadrant. ......................................................................................................................... 105
Figure 14. Design of Perry’s Elevator ........................................................................................ 124
Figure 15. Field Layout of Elevator – Monitor System ........................................................ 126
Figure 16. Hydraulic Elevating in Gabriel’s Gully in the 1920s ............................................. 127
# LIST OF ABBREVIATIONS

<table>
<thead>
<tr>
<th>Abbreviation</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>AJHR</td>
<td>Appendices of the Journals of the House of Representatives</td>
</tr>
<tr>
<td>BH</td>
<td><em>Bruce Herald</em></td>
</tr>
<tr>
<td>c.</td>
<td>circa</td>
</tr>
<tr>
<td>CEHLA</td>
<td>Cambridge Economic History of Latin America</td>
</tr>
<tr>
<td>CHLA</td>
<td>Cambridge History of Latin America</td>
</tr>
<tr>
<td>cu.m.</td>
<td>cubic metre</td>
</tr>
<tr>
<td>cu.yd.</td>
<td>cubic yard</td>
</tr>
<tr>
<td>ft</td>
<td>foot</td>
</tr>
<tr>
<td>ha</td>
<td>hectare</td>
</tr>
<tr>
<td>km</td>
<td>kilometre</td>
</tr>
<tr>
<td>m</td>
<td>metre</td>
</tr>
<tr>
<td>mm</td>
<td>millimetre</td>
</tr>
<tr>
<td>NZGG</td>
<td>New Zealand Government Gazette</td>
</tr>
<tr>
<td><em>ODT</em></td>
<td><em>Otago Daily Times</em></td>
</tr>
<tr>
<td>OPGG</td>
<td>Otago Provincial Government Gazette</td>
</tr>
<tr>
<td>OW</td>
<td><em>Otago Witness</em></td>
</tr>
<tr>
<td>TT</td>
<td><em>Tuapeka Times</em></td>
</tr>
<tr>
<td>VPOPC</td>
<td>Votes and Proceedings of the Otago Provincial Council</td>
</tr>
</tbody>
</table>
INTRODUCTION

Gold rushes have been with us since the modest gold rushes of Hispanic America in the sixteenth century but the Brazilian Rush, ca 1695, was the first major gold rush. Following this, rushes of demographic or technical significance broke out in the Southern Appalachian Piedmont and in many parts of Siberia in the second decade of the nineteenth century, followed in mid-century by California and New South Wales-Victoria. The next transnationally significant gold rushes broke out in New Zealand, led by the Gabriel's Gully or Tuapeka gold rush in Otago in 1861. An alluvial diamond rush in South Africa in 1870 presaged a corporate scramble for quartz reefs, not a rush, on the discoveries of Barberton and the Witwatersrand in 1885. The nineteenth century concluded with rushes in the 1890s to Coolgardie-Kalgoorlie in Western Australia and the Klondike in the Yukon Territory of Canada.

These were frontier events which historians have tended to present as socially and culturally exceptional. As occurred in each and every gold rush in the study period starting with Brazil, though not detailed in this thesis, their onset generated a turbulent goldfield society and challenges to the existing precepts of society in the metropole.¹

The disruption need not be surprising: the characteristics of the alluvial gold deposits on which nearly all of the rushes were based, and the high value and ready saleability of gold in Western cultures, lent themselves to the relatively easy accumulation of wealth; wealth in a frontier setting of loose political and social controls easily led to noteworthy behaviour even if it was also one or more of being licentious, violent, and racist.²

However, I would argue that the perceived exceptionality was a function of

---

¹ Liquor-driven dissolute behaviour and commercial disorder also occurred in the first Spanish silver rush in the 1530s and prompted ordinances to control them, but the views of this in the metropole were not available for this thesis. Robert C. West, “Early Silver Mining in New Spain, 1531-1555,” in *In Quest of Mineral Wealth: Aboriginal and Colonial Mining and Metallurgy in Spanish America*, ed. Alan K. Craig and Robert C. West, (Baton Rouge, LA: Geoscience Publications, 1994), 130.

² Alluvial gold deposits comprise discrete gold particles that have been weathered from a reef and washed down to rivers, where they have been sorted and concentrated by river action. This creates gravel deposits that can be worked with hand tools, and due to its high density and occurrence as free particles, the gold can also be separated by hand methods. Alluvial deposits were perhaps the easiest to work of any type of mineral deposit, but considerable hard work in often difficult and dangerous conditions remained necessary. A further advantage of alluvial gold is that it represents one of the few types of
modernity on the Western frontier. First, gold rushes represented an emerging phenomenon in each of their separate periods of occurrence; second, they comprised individuals who possessed the individual freedom to move – neither church nor state bonds prevented them doing so; third, they were able to move due to transport technology that was itself continually modernising, and fourth they reached regions of the world that were entirely new to Western culture, a frontier. Finally, relative to the populations of their times, gold rushes were large enough mass movements of people to have constituted significant historical events.

Due to the social, demographic, economic, and political impacts of the mass movements and the generated wealth of gold rushes, not only in the frontier region but in also the metropole, historians have also, justifiably, written about gold rushes as being transformational events. These comprised dramatic immediate changes due to the initial wave of people and gold of a rush, and longer term changes that reached deeper into societies, economies and polities. However, without examining the technology of a rush or consequent mining, some historians have created something of a synecdoche in that a historiographically attractive but always transient (months to two or three years) gold rush is treated as being the same as, and representative of, the long term gold mining that followed. Hence, decades of gold mining have been historicised as a gold rush. This thesis seeks to provide a technological basis for identifying the break point between a rush and mining.

Historians in general have not tended to pay close attention to the technology of these activities although technology was the utterly fundamental means by which the wealth was gained. Some historians, such as Ronald Limbaugh, Rodman Paul, Randall Rohe, Clark Spence, and Otis E. Young in the United States, Ralph Birrell, Geoffrey Blainey, Chris Davey, and Peter McCarthy, in Australia, and Philip Ross May, James Forrest, J. H. M. Salmon, and W. R. Mayhew, in New Zealand, did have an appreciation of the role of technology and either they integrated technological factors into wider studies of gold rushes and gold mining, or wrote specialised papers on aspects of a particular technology. Environmental historians such as Tom Brooking, Terry Hearn, R. Hargreaves, Barry McGowan, and Graham Wynn also incorporate the mineral deposit that is formed at the earth’s surface, which ensures that the gold is accessible. Older buried and or cemented deposits also existed, nevertheless.
technology of gold mining in their analyses, since it caused environmental impacts. But there has been little significant change in the core/bulk of New Zealand historiography since as long ago as 1980, when Philip Ross May stated “… I’m concentrating heavily on the technology of the goldfields, which is of central importance yet badly neglected.” He added “… as Geoffrey Blainey has urged, he [the historian] must appreciate the importance of technology …”\(^3\) Brooking has emphasised this point in conference addresses since 2010.

Otherwise, there has been a range of confused or imprecise interpretations of the technology that was in use. Further, there are misconceived views of organisational structures that rely on two common assumptions. The first is that hard rock quartz mining automatically succeeds alluvial gold rushing and the second is that free ‘associative enterprises’ change automatically by a process of ‘structural change’ into monopolistic capitalistic corporate entities and again commence to mine quartz. As explained by Hearn, ‘associative enterprise’ refers to a group of miners or diggers that has banded together for gold rushing or mining, in some form of cooperative or partnership structure of their own choice. ‘Structural reform’ refers to a sequence in which individual diggers or gold rushers combined into parties when the alluvial going got tough, and when quartz mining or hydraulicking came along a capitalist, and likely monopolistic, registered company took over.\(^4\) As Hearn has shown, the progression of mining at Tinkers did not uphold the model of structural change.\(^5\) Nor, in Otago did quartz mining follow alluvial working because quartz mining was a minute part of total gold production: the production of alluvial gold totalled 8.0 million ounces whereas gold from quartz mining totalled 0.3 million ounces.\(^6\) Additionally productive technology in both alluvial and quartz mining unavoidably required more capital but


\(^5\) Hearn, Structural Change, 86-91.

there were many avenues for raising this. One can only paraphrase the sage words of David Cleary that capitalisation is not capitalism.\textsuperscript{7}

There are clearly gaps to fill in the general technological history of gold rushes and alluvial mining in Otago and the rest of the South Island, and in the particular question of structural change. There is little technological historiography on the working of Gabriel’s Gully, the Blue Spur and the local Tuapeka catchments. Yet this was the most significant alluvial activity in New Zealand and produced an estimated 1.5 million ounces of gold.\textsuperscript{8} Mayhew prepared an excellent history of the district for the Otago centennial and though he competently described the range of mining technologies, he was more descriptive than analytical, and since the work was published in 1949, a fresh and focused approach is warranted.\textsuperscript{9} One of the most recent major pieces of work, by Stevan Eldred-Grigg, contains considerable detail, but follows a simplistic model for technology that is decades old and maintains the conflation of technology and capitalism by ignoring the technological distinctions between mining alluvial gold and gold in quartz reefs.\textsuperscript{10}

Research into other historical aspects of the gold rushes in the South Island continues. But until a well-informed up to date evaluation of the technology of Gabriel’s Gully and the Blue Spur is completed, the misconceptions and oversimplifications will continue too, and the resulting interpretations will lack a depth of comprehension they could otherwise have. Deeper questions also await attention, for example the role of mining innovations in technological history, the transnational aspects of the alluvial technology around the Pacific Basin, in the emergence of resource management law in New Zealand, the role of long term mining projects in community formation in Otago after the gold rushes, and how a workforce and community survived in the face of a mining project that every few years changed its technology and numbers of employees. Otago historiography, let alone that of the Pacific Basin, would be much the richer for attention to these matters.

\textsuperscript{7} David Cleary, \textit{Anatomy of the Amazon Rush} (Iowa City: Iowa University Press, 1990), 7n4.
The proposition of this thesis is that technology lies at the heart of all gold rushes and the gold mining that followed, and further, that the technology of gold rushes was different from the technology of gold mining. If true, the seeming conflation between gold rushing and gold mining in much of the historiography might be resolved, and avoided in future, and allow better-informed histories to be written. In addition, an up to date historical analysis of the technology of these activities, separated into rushing and mining, can be expected to fill a gap in the historiography of gold rushes and reveal new meanings, and including Gabriel's Gully and the Blue Spur it will enhance the local historiography.

This thesis would not wish to ignore the scientific, social, or cultural relations of the technology in what was a transformative historical event in Otago. Rather, before performing any broader analysis, it is important to clarify the incompletely studied but potentially historiographically fruitful basic technology. In doing this, the thesis will take a productionist view of the activity and use gold production and productivity data as important evidence. Gold rushes occurred on the frontier and often created it, and productionism was the essence of a frontier, and further, productionism was part of the culture of the entire period of gold rushes from the Early Modern into the nineteenth century.

David Edgerton, an iconoclastic historian of technology, proposes a new form of technological history that he names as “technology-in-use.” (Noted cheekily as “use, mediation, and tinkering” by one of his peers). 11 It represents the opposite of innovation and deals with ongoing, often mundane, technologies. It can apply to a culture in any part of the world at any historical period. Edgerton recommends, “Stop thinking about technology but think about things.” 12

He argues that most of what has long passed as technological history has displayed a severe conflation of innovation with technology. What have been called histories of technology have been histories of inventions, of innovations, of the emergence of major technologies deemed to have transformed societies, and of technological change in general; and are usually about modern Western societies. These are not histories of

---

11 Ronald Kline, “Foundational Stories,” in Technology and Culture 54 no. 1, (January 2013), 120, 123.
technology as a modal component of society but of specific and usually eye-catching technologies.\textsuperscript{13} Histories of innovation are legitimate but as Edgerton states, “It is the conflation, not the focus on innovation or invention, … which is a crucial problem … if one is interested in the place of technology in history, or indeed the history of invention or innovation”\textsuperscript{14} Part of the problem of the conflation is high-flying rhetoric regarding the innovator or inventors as hero, and nationalist exceptionalism.\textsuperscript{15}

Edgerton also shows that invention and innovation rarely lead to use whereas, in a global perspective, old and basic technologies may persist, for example, steam locomotion remains widely used, though not necessarily in Western countries, in the twenty first century. Moreover, he points out, research and science are by no means the only drivers of improvement or innovation; there can be considerable innovation in the so-called smokestack industries, and it may arise from mundane activities such as teaching, routine testing, and maintenance, and even simply by doing and learning. Use in itself leads to innovation; not all the potential is locked in the designed or invented hardware.\textsuperscript{16}

This thesis will be a history of technology-in-use because doing so will force attention onto issues of innovation. Ongoing technologies are treated much as in any other form of history but given Edgerton's caveats, hydraulic elevating will require rigorous analysis. Amongst other factors, the structural “stages” will be evaluated in terms of technology, and not corporate development.

Before proceeding with the analysis, an outline of the meanings of technology, technique, work, and the difference between science and technology, is provided to avoid confusion. Technology constitutes a fundamental element of all cultures and comprises more than simply tools, machinery and material objects. Kate Boyer, a human geographer, shows the complexity of its position in society in the following statement:

\textsuperscript{14} Edgerton, quoted in Kline, 123.
\textsuperscript{15} Edgerton, “Innovation to Use,” 126-127; and Edgerton, Shock of the Old, xvii.
\textsuperscript{16} Edgerton, “Innovation to Use,” 123-124, 125.
Rather than existing in a separate realm from culture and society, technology is a constitutive part of social life, shaping, and being shaped by culture. Moreover, as a product of culture, understandings of technology are themselves situated and contingent. … the same technology will be viewed differently by different people, depending on one’s social location, cultural background, political inclinations, and historical context.\textsuperscript{17}

This is worth keeping in mind when the externalities of ground sluicing are considered but for general use, Webster’s College Dictionary suitably defines technology as “The application of knowledge for practical ends.”\textsuperscript{18} This captures the feature that technology is about applied knowledge with some practical use in mind, and is not concerned with the collection of knowledge for its own sake, which constitutes science. Edgerton paraphrases a prosaic working definition for technology from Singer et al., \textit{History of Technology}: “What is commonly done and made and how it is commonly done and made.”\textsuperscript{19} Also capturing practicality is “technology is the means by which we apply our understanding of the natural world to the solution of practical problems.”\textsuperscript{20}

All of these suit the direct technological investigation envisaged for this thesis.

Again, this thesis is not a philosophical treatise but the reader may find some distinctions between science and technology of use. Alexandre Koyré, the Russian philosopher of science and technology, argues that “The laws of science refer to nature and the laws of technology refer to human artifice. The function of technological rules is to provide a rational basis for design, not to enable man to understand the universe.”\textsuperscript{21} Science relates to the classical Greek \textit{epistēmē}, while technology relates to \textit{technē}.\textsuperscript{22}


\textsuperscript{21} This is an interpretation of Koyré’s work by Edwin T. Layton Jr. See Edwin T. Layton Jr., “Technology as Knowledge,” \textit{Technology and Culture} 15 no. 1, (January 1974), 35-36.

\textsuperscript{22} Layton, 40.
Thorstein Veblen, the Norwegian sociologist, bluntly distinguishes technological and scientific knowledge, respectively, as “workmanship and idle curiosity.”  

An associated term is technique: “… technique refers to the methods and procedures of material culture, especially in engineering and industry, while technology is concerned with the study of these activities, their principles.”  

Technology has come to describe the overall system of machines and processes, and can mean the study of such a system, whereas technique refers to a particular method or skill. Work constitutes the use of techniques and resources to produce a good, and significantly, it represents the hands-on production component of technology. Peter F. Drucker, a historian of technology as well as being a management specialist, sees the organisation of work as particularly important because it serves as a melting pot in which the various conflicting influences on a technology are mediated. Work “might provide one unifying concept which will enable us to understand technology both in itself and in its role, its impact on, and relationships with values and institutions, knowledge and beliefs, individual and society.”  

This can be related to those important questions about associative enterprise and structural change raised by Hearn.  

The arguments of this thesis are developed in chapters that are periodized by different types of technology. Chapter 1 deals with gold rushes from sixteenth century Hispanic America until Victoria in the mid-nineteenth century; Chapter 2 with the Gabriel's Gully gold rush of 1861; Chapter 3 with the mining of the Blue Spur from 1862 until 1880; and Chapter 4 with hydraulic elevating, an innovation from 1880 until 1891. The technological consequences of the depletion of gold deposits and the concept of a transition from gold rushing to gold mining are linking themes.  

Chapter 1 sets out the argument that on a technological analysis gold rushing and gold mining are distinctly different activities. The analysis is achieved through a review of the tools, techniques, and organisation of work of gold rushing and gold mining from the gold rushes in Early Modern Hispanic America to the mid nineteenth century. The phenomenon of depletion and its importance in driving changes in technology is  

24 Schatzburg, 488-489.  
introduced. The chapter also serves to establish descriptions of the tools and techniques used in the rushing and mining of their day.

The succeeding chapters concentrate on Gabriel's Gully and its extension, the Blue Spur deposit in the Tuapeka Goldfield in Otago. This close focus is intended first, to test whether the findings of Chapter 1 are validated when a rush is examined in some detail, and second, to use a technological approach to update and deepen the existing historiography for this important goldfield. This is the first technological analysis of this subject since Mayhew in 1949.

Chapter 2 documents the discovery of the Gabriel's Gully deposit, its gold rush, and its transition to mining. This allows a vigorous test of the proposal from Chapter 1, that mining is very different in technological terms from gold rushing. In addition, the unusual advantage of having two prospectors (Edwards Peters and Gabriel Read) who covered the same ground, is used to open the new historiographical proposal that prospecting should be studied as a form of technology. This chapter also shows the use of a productionist approach in identifying and assessing the unusually high output of the Tuapeka Goldfield and Gabriel’s Gully relative to California and monitors the subtle changes in gold rush tools and techniques as the rich easy ground became depleted. This chapter also shows how the focus on technology links with the role of the regulatory regime and extends the starting period for Hearn’s work on the emergence of resource management law in New Zealand to an earlier date. In these ways, the use of a technological approach in Chapter 2 uncovers new meanings, some of global significance.

Chapter 3 focuses on the technologies of mining the Blue Spur, to counterpose the characteristics of mining, including longevity, that distinguish it from rushing, whose characteristics were established in Chapters 1 and 2. By focusing on the technology of mining this chapter exposes the changes in mining techniques that were required as mining depleted the deposit. That these were more substantial than is portrayed in the present historiography would not have become evident without such attention to the technology. The technological approach is also used to bring out the organisation of work around the Blue Spur and appears to be the first detailed academic work on this topic since Hearn’s pioneering work in the 1980s noted above. The technological
assessment includes the supply of water to the Tuapeka goldfields, which was complementary technology to mining. Also explored as a facet of technology in the period up until the 1880s are the interactions between the regulatory regime and the diggings activity as the government sought to facilitate the benefits and mediate the adverse impacts of the technology. Finally, in this chapter, an analysis of the downstream impacts of tailings disposal, which were an externality of the mining technology, explores the relationship between technological history and environmental history.

Chapter 4 uses the innovation of the hydraulic elevator to test Edgerton's apparent view that innovation and technology-in-use should be kept separate. He is a highly perceptive historian and his view will not be absolute. That is as may be but in this chapter, the hydraulic elevator is brought together with earlier innovations in the Appalachian, Californian, and Victorian rushes, to propose that the alluvial gold mining in the nineteenth century was exceptional in relation to Edgerton's model of technological history. The exposition makes use of Burt’s model of mining macroinnovation as derived from Mokyr’s work and argues that innovation can be accommodated within a larger discourse of technology-in-use.27 The chapter goes further in using technological analysis to propose a relationship between the depletion of a deposit and innovation. Again, this is intended to show that a technological analysis of the history of gold extraction events can provide new, and this case, transnational meanings.

While this thesis focuses on tools and techniques it is important to note that the Blue Spur possessed unusual characteristics for alluvial gold – it was a giant deposit by any standards, the gold content was generally high though variable, and it was extensively cemented.

In this thesis, the term “Tuapeka Gold Rush” refers to the major gold rush that started in Gabriel's Gully and expanded to include the Wetherstons, Waitahuna, and Waipori diggings. General usage tends to apply “Gabriel's Gully Gold Rush” in this sense but

this thesis will keep terms that include “Gabriel's Gully” for that specific location. “Tuapeka Goldfield” is the formal name for the proclaimed goldfield and its extensions. However, “the Tuapeka” and “Tuapeka District” will refer only to the land around the Tuapeka River, Munro's Gully, Gabriel's Gully, and Wetherstons. This area had its own specific course of activities and characteristics and these did not apply to the Waitahuna, Waipori, or Woolshed districts. Another local name was the “Junction,” which was the camp and small diggings at the junction of the Wetherstons Creek and Gabriel’s or Black Creek. It became the surveyed town of Lawrence in 1862. The word “digger” is preferred to “miner” unless it is clear that the activity was mining. Digger is also used as an all-in term for the participant in gold rush digging or gold mining depending on the context, while “gold seeker” serves more or less as a synonym for “gold rusher” instead of digger, when it is clear that rushing, seeking, or early rich returns were the activity at hand.
CHAPTER 1: GOLD RUSHES AND MINING FROM THE SIXTEENTH UNTIL THE MID-NINETEENTH CENTURY

This chapter deals with the technology of gold rushes and their consequent mining, from Hispanic America in the Early Modern period until Victoria, Australia, in the 1850s. Figure 1 shows the goldfields where gold rushes occurred up till the end of the nineteenth century. It includes Coolgardie-Kalgoorlie, which represented a geologically different rush that soon became hard rock mining but is part of the Australian context. The Kimberley diamond rush in South Africa was valid but the gold reefs were essentially a corporate scramble, and together did not merit a larger map. Figure 1 also shows the crustal plate boundaries of the Circum-Pacific Tectonic Zone because this influenced the formation of many of the goldfields. Victoria was not the last great gold rush but the chapter ends there to set the stage for the next significant transnational gold rush, to Gabriel's Gully in Otago in 1861. In all these events an initial period of frantic activity and the winning of much gold, widely understood as a gold rush, settled down in the better diggings to steady extraction that sometimes lasted for decades; this constituted mining. I wish to examine the continuities in each form of activity and search for diagnostic differences between them. Evidence of the depletion of the gold deposits and any resulting changes in tools or techniques will be important.

By the approach of the Early Modern period in Europe, domestic gold deposits had become exhausted but rich alluvial gold deposits existed in many regions beyond Europe. Moreover, they would be easy to find, or as easy as any type of orebody ever is, because having been formed by rivers, they lay at the earth’s surface. In Australia and New Zealand and some other regions where gold held no value for the indigenous people, large rich goldfields lay completely untouched. In other regions, such as Mexico and Andean America, the inhabitants valued gold highly and extracted it from local deposits. However, they did so at their social rate of production because gold was

---

1 An alluvial deposit comprises unconsolidated sediments laid down by river action. Particle sizes can range from sand to boulders but river gravel is a typical form. Alluvial deposits are often bound by a matrix of silt and clay, which may coat or trap the gold particles. Working an alluvial deposit is much simpler than working a gold lode because alluvials can be excavated without drilling and blasting and because the gold exists as discrete pure particles separable by hand methods.
not a significant monetary commodity for them. This, too, left large rich gold deposits in their territories substantially untouched. Rushes were inevitable once Westerners found these deposits.

![Figure 1. Location of Historical Alluvial Goldfields](image)


**Colonial Spanish America**

**Arrival and Plunder**

When Christopher Columbus set sail in 1492, his aim was to prove that a direct route to Asia existed and would short-circuit the Portuguese sea route and the caravans though the Middle East. This proved a chimera but the indigenous peoples displayed gold ornaments and jewellery and made gifts of gold articles. Instead of trade as originally
anticipated, the economic objectives of Columbus and Spain became the extraction of gold, and settler enterprise in general.\textsuperscript{2}

The period until the 1520s was one of the Spanish requisitioning of gold by barter, looting, often via torture, tribute, forced labour, and enslavement. This extirpated most of the population of the Caribbean islands as well as purging most of their gold and the gold of the Panamanian mainland.\textsuperscript{3} This was very different from the harvesting of gold by the Indian natives in equilibrium with the communitarian needs of their society. Over the period from discovery until 1520, shipments of gold to Spain amounted to 803,000 fine ounces. This was a handsome harvest from the Spanish point of view, and the more so since their competitor, Portugal, traded the much lesser amount of around 450,000 ounces from its West African sources over the same period.\textsuperscript{4}

\textit{Internal Gold and Silver Rushes}

Gold rushes took place soon after conquest but they were never the major narrative of the Hispanic America project, which was based on silver.\textsuperscript{5} However, Morell notes that gold seekers “swarmed over from Española” to Cuba in 1513 but it was many years before the next recorded gold rush.\textsuperscript{6} After the dismantling of the Aztec empire in 1521, gold mining commenced directly without rushing in the Rio Balsas and other catchments on Mexico’s Pacific coast.\textsuperscript{7} It was the great silver discoveries of the early 1530s near Mexico City that created the first major rush - for silver. This was as unruly as any later gold rush and affected all levels of Mexican colonial society.\textsuperscript{8} Further silver discoveries followed as the Spanish frontier moved north, leading in 1552 to another silver stampede, to the lodes of Pachuca: “prospectors came in countless

\begin{thebibliography}{10}
\bibitem{2} J. H. Elliott, “The Spanish Conquest and the settlement of America,” in CHLA I, 159-162.
\bibitem{4} John J. TePaske, \textit{A New World of Gold and Silver}, ed. Kendall W. Brown (Leiden, Holland: Brill, 2010), Table 2.2, 56; and Pierre Vilar, \textit{A History of Gold and Money 1450 – 1920}, Trans. Judith White (London: NLB, 1976), 56, 104. The writer uses TePaske’s data because it covers both Hispanic and Portuguese America and it uses and reconciles multiple sources. Vilar, the next most up to date and comprehensive source, is used for gaps in TePaske.
\bibitem{5} Exports totalled 346 million fine ounces of silver in the sixteenth century alone. See TePaske, Table 3-1, 113.
\bibitem{6} Morell, 11; Bakewell, \textit{History of Latin America}, 112.
\bibitem{7} Bakewell, ibid; Morell 11-12; and Enrique Tandeter, “The Mining Industry,” in CEHLA I, 316.
\bibitem{8} West, “Early Silver Mining,” 130.
\end{thebibliography}
numbers and swarmed over arroyo, peak and ridge.” The last great Mexican rush was to San Luis Potosí (not the great Andean orebody) in ca. 1592.

In South America, (New Granada) after the progressive subjugation of the Indian peoples, exploration from 1536 led to the identification of both lode and alluvial goldfields, many of which had been worked by the indigenous people. Spanish expeditions opened mines in Colombia, the Andean highlands, central Chile, and along the Pacific drainages of the Andes. Then, in 1545, not far from traditional silver mines at Porco, in what is today’s Bolivian Andes, the Spanish discovered Cerro Rico de Potosí, (“the rich hill of Potosi”, often expressed as “Potosi”). This was the greatest silver orebody of all time and it provided nearly half of all the Spanish American silver. A silver rush broke out that attracted 14,000 Spaniards and their Indian labourers in eighteen months. The first gold rush only occurred much later, in 1581-82, at Zaragoza, near Antioquia in Colombia. This was sufficient to draw gold seekers and merchants from mines in distant Panama. In 1592, Spanish masters and their slaves flocked to Nueva Sevilla in Caribbean Colombia. One of the biggest gold rushes broke out in 1594 at Remedios on a tributary of the Rio Magdalena in Colombia, where 2,000 African slaves were working within two years, rather than the hundreds as in most other Colombian rushes. Overall, though, as Morell observes, “There was no great rush, rather a series of small ones, Spanish master and Indian servants moving on as the gold was worked out.”

There is no doubt that actual rushes took place in the sense of there being a sudden and rapid movement of significant numbers of people to a gold discovery. The question that arises is whether a gold rush can occur with forced labour, given that the Indian workforce operated under heavily enforced conscription, either encomienda in Mexico or mita in New Granada, while African slaves worked the gold bearing Andean

---


14 Morell, 14.
lowland river valleys. These workers had little agency and were mere factors of production along with the tools. It was their Spanish masters who possessed the freedom to rush and manifestly did so. These events can therefore still be seen as rushes.

**Hispanic Alluvial Technology**

The Spanish settlers were unfamiliar with alluvial technology and turned to the pre-existing manual Indian technology. The Indians, working under forced labour, would already have known the techniques; the main change by the Spanish was probably the introduction of metal-based digging tools. In shallow ground, the workers grubbed for nuggety gold with a dibble or hoe. In deeper ground, they worked in large pits known as “paddocks” in which they removed all the ground down to bottom. There was far more dirt to remove than from a shaft but the roomy paddock was easier working and did not risk losing the lead or having ground collapses as a shaft would. In creek beds and swamps, Indians used bowls to scrape up alluvium at seasonal low water. Rivers were worked by diving with a *batea*, sometimes behind groynes, also known as wing dams, which left calmer water in their lee. Coffer dams were sometimes used to isolate complete sections of a river. Different bowls were used for different gold winning purposes but the generic name was “*batea*.” Paydirt from all methods was panned in

---

15 *Encomienda* was in narrow terms a grant of labour, with wide powers of control, even if “in trust” to Christianize the subjects. *Repartimiento* was the grant of land to Spanish colonists. It came to include indigenous occupants of the said land as well. *Mita* was the name of the labour conscription system long used on a sustainable scale in the Inca Empire. The Spaniards expanded it exploitatively beyond its demographic sustainability, similarly to the extremes of *encomienda*. See Bakewell, *History of Latin America*, 244-248, 316-318, 322-328; William D. Phillips and Carla Rahn Phillips, *The Worlds of Christopher Columbus* (Cambridge: Cambridge University Press, 1992), 217-218, 223-224, 251-254; John M. Monteiro, “Labor Systems,” in *CEHLA* I, 190-191; and Charles Gibson, “Indian Societies under Spanish Rule,” in CHLA II, 399-404.

16 West, *Colonial Placer Mining*, 52. The “Catholic Kings” approved the inclusion of 20 “gold workers” for Columbus’ third voyage to the Caribbean because “neither the Europeans on the island nor the Indians knew the techniques of placer mining.” See Phillips and Phillips, 214, 216-217. The available archive is too sparse to show whether these miners arrived and if they did, how effective they were.


18 *Batea* was evidently a Carib word, the Caribs being one of the West Indies tribes. This implies that the *batea* was indigenous technology that predated the Spaniards. Nevertheless, “*batea*” might possibly represent “bandeja” the Spanish word for a bowl, allowing for some kind of New World Grimm’s Law. See West, *Colonial Placer Mining*, 72n4; and Phillips and Phillips, 214, 216-217.
a batea, aided, most unusually, by a mixture of frothy saps that selectively bubbled off waste minerals.\(^{19}\)

The South American Indians were long experienced in ground sluicing; for example, the Muisca people recovered emeralds by its use.\(^{20}\) In ground sluicing, water was channelled over a bench where operators had loosened the ground with crow bars, picks, or other tools. The water washed the loosened gravel to a trench termed a “ground sluice,” that had been cut in the floor of the workings and which had a rocky lined bottom that provided abundant trap sites for gold. The flowing water created turbulence and tumbled the dirt, which broke up lumps, sorted the dense gold from the less dense waste particles, and flushed them away as tailings. Operators helped to break up lumps, cleared blockages, and removed large stones. Periodically, the operators stopped the water, removed the floor stones, and recovered the gold bearing concentrate. The gold was recovered by panning in a batea. In a variant known as booming, a dam full of water was released, creating a rampant flow that was forceful enough to undercut and collapse a face of gravel.\(^{21}\) Networks of creek diversions with dams, water races, with masonry abutments where necessary, even bark conduits strung from trees, and head reservoirs, provided the necessary water. Since flowing water replaced much of the digging, washed the paydirt, and removed the tailings, ground sluicing was far more productive than panning with a batea. Such improvements over hand methods make this a form of mining. Ground sluicing required “fall” downstream so that the tailings flowed away and did not block up the workings but in spite of this, ground sluicing became the most used gold production method in Hispanic America.

Sometime before the 1550s, the Spaniards introduced board sluicing to South America.\(^{22}\) A board sluice (also known as a box sluice) was a wooden trough, three or four metres long and 0.6 to 0.9 metres wide with wooden blocks, or transverse cleats known as ripples or riffles, attached to its floor. The sluice was mounted in flowing water, and the washdirt dug and shoed in, whereupon the process followed the

---

\(^{19}\) West, *Colonial Placer Mining*, 60-62. The use of chemically treated bubbles to selectively remove specific minerals evolved in the late nineteenth century into the highly sophisticated process known as froth flotation.

\(^{20}\) Leo Estel, “The Mosca (Chibcha),” *The Ohio Journal of Science* 58 no. 4, (July 1958), 237-238. The Muisca were based near today’s Bogotá.

\(^{21}\) West, *Colonial Placer Mining*, 55-57.

action of a ground sluice. Sets of boxes were frequently joined end to end for increased
washing and effectiveness. Like ground sluicing, this also used the energy of flowing
water to replace manual effort in panning but the washdirt had to be dug and shovelled
into the sluice. Board sluicing was therefore less productive than ground sluicing and
not so widely used.

**Spanish Lode Mining and the Sistema del Rato**

The Spaniards, as had the Indians before them, also mined gold lodes, and all of the
silver came from lodes. Lodes were quartz reefs that plunged steeply into the ground
and if of any size, could only be worked by underground techniques. Hand working
was made easier by the fact that throughout both Mexico and South America the lodes
had been weathered to softer materials for depths of tens of metres or more.\(^{23}\) On the
other hand, the gold or silver itself commonly occurred within quartz, which had not
weathered, and required crushing. Moreover, the weathered zone reverted to hard
primary ore at the water table.

Following pre-Columbian Indian practice, the Spanish mining strategy was to start at
the outcrop with pits or trenches and then follow the lode down wherever it led. This
system was known as the *sistema del rato*, which meant an opportunistic or ad hoc
system.\(^{24}\) It provided rapid and cheap access to ore, but also created erratic layouts and
narrow twisting dangerous workings, so that its dog-English meaning of “rat-holing”
was entirely appropriate. On the whole, the Spanish mines reached deeper than the pre-
Columbian Indians did and the Spanish shafts were timbered. At the face, the
Spaniards replaced the Indian wooden and stone tools with metal crowbars, gads, and
sledge hammers, and around the mid seventeenth century brought in drilling and
gunpowder.\(^{25}\) Porters (*tenateros*) in large numbers carried broken ore through the

---

\(^{23}\) Potosí was weathered to as much as 300 metres deep but it was in the nature of a mountain peak. Bakewell, CHLA II, 109-110; and West, *Colonial Placer Mining*, 54, 65.

\(^{24}\) Otis E. Young Jr., “Black Legends and Silver Mountains: Spanish Mining in Colonial Spanish America Reconsidered,” in *In Quest of Mineral Wealth*, 113; and Bakewell, CHLA II, 110-112.

\(^{25}\) West, *Colonial Placer Mining*, 54; and Robert C. West, “Aboriginal Metallurgy and Metalworking in Spanish America: A Brief Overview”, in *In Quest of Mineral Wealth*, 13; and Izumi Shimada, “Pre-
Hispanic Metallurgy and Mining in the Andes: Recent Advances and Future Tasks, in *In Quest of Mineral Wealth*, 49-50. Regarding the introduction of gunpowder, Bakewell states that mines in Europe
first used blasting (with gunpowder) in 1627. It was possibly used at Huancavelica in the 1630s and
definitely was used around Potosí in the 1670s. See Bakewell, CHLA II, 112.
labyrinthine workings to the surface in sacks or baskets (*tenates*) that held tens of kilogrammes.\(^{26}\)

As time passed and the workings enlarged, difficulties with the *Sistema del rato* emerged. In the early nineteenth century, the great mining engineer, scientist, and explorer, Baron Alexander von Humboldt reported many inefficiencies from the lack of planning and coordination and likened *Sistema del rato* workings to "...*ill-construc*...*tions where, to pass from one adjoining room to another, we must go round the whole house.*"\(^{27}\) As well, the laborious porterage of ore was inefficient and dangerous. His recommendation was the European system of well-equipped shafts or adits that provided efficient ore removal and allowed systematic mine layouts. However, this strategy incurred significant time and capital outlays with no return until the accesses were completed. In comparison, the large squads of tenateros obviated the capital cost of shafts or adits. In addition, with their families, they created a critical mass of population that facilitated well serviced villages in the otherwise uninhabited regions where the mines occurred, which thereby lowered the net cost of the Spanish masters’ mines. Moreover, Humboldt’s one-stop implication of technological backwardness had ignored the fact that European-style mechanisation, water power, and underground support were problematic when iron, timber, and water were scarce, as they were in both Mexico and in the Andes. It was very much a case of Hispanic American mining agency working within the orebody constraints in a way that von Humboldt failed to appreciate.

Lode mining also necessitated significant surface processing and again, Spanish activity started with manual Indian technology to crush the quartz, recovering the gold with a *batea*.\(^{28}\) For their required higher production, the Spaniards roasted the rock in an open fire to oxidize gold or silver bearing sulphides and weaken the rock, and mechanised crushing with the edge mill and the *arrastra*, both of which were driven by horse or mule.\(^{29}\) The edge mill consisted of one or two broad stone wheels that were

\(^{26}\) Bakewell, CHLA II, 130; and Young, *Black Legends*, 112. Young refers to loads of 100 kg; this is close to a physical impossibility.

\(^{27}\) Humboldt, [1811], quoted in Young, *Black Legends*, 113.

\(^{28}\) West, *Colonial Placer Mining*, 54.

rotated on their rims around a circular stone floor, or later, in a metal pan or bowl. An *arrastre* consisted of a horizontal beam mounted on a vertical central shaft. One or more one large stone blocks hung from the beam and were dragged by one or more donkeys or horses around a level but slightly sloping stone floor on which the material to be ground was scattered.\textsuperscript{30} For higher production and for crushing primary quartz when mining reached the water table, the Spanish brought the stamp mill from Europe in the later sixteenth century. Its higher output was pre-concentrated in a sluice box on the same principles as board sluicing in the field. In this box, however, the riffles on its downstream half were replaced with a coarse woollen cloth or fleece to catch fine gold.\textsuperscript{31}

**Meanings of Gold Rushing and Gold Mining in Spanish Colonial America**

One conclusion that can be drawn from this Early Modern activity is that weathered rich silver lodes, being workable by simple hand methods and tools, could precipitate a rush as well as alluvial gold. The simplicity of the technology rather than the mineral precipitated a rush as long as the deposit was rich enough for the limited productivity of hand methods to produce enough wealth to be motivational. Another defining characteristic of the rushes was the stampede of people. The duration of these rushes is unclear, however, but the immediate use of coordinated mass labour, which ensured greater production, indicates mining. If so, mining commenced immediately on the arrival of the rushers and the only characteristic of a rush was a stampede. Ground sluicing represented a form of mining because of the mechanisation of work and the higher productivity obtained from water power, the significant time and capital expenditure to construct the water supply system, and the implied requirement to stay in one place to pay off the capital. These factors militated against the impetuousness of a rush and the simplicity of the methods. Lode working represented mining in utilising the work structure of coordinated mass labour, the mechanisation of crushing, the associated capital investment, and the resulting commitment to repay.

---

\begin{small}
\textsuperscript{30} Young, Jr., “The Spanish Tradition in Gold and Silver Mining,” *Arizona and the West*, 7 no. 4 (Winter 1965), 303-304; and West, *Colonial Placer Mining*, 65.

\textsuperscript{31} Young, *Western Mining*, 69-72; Young, *Black Legends*, 114; and Young, *Spanish Tradition*, sketch, 304-305. “Chilean” mill is a complete misnomer for an edge mill as it had no origins in Chile at all.

West, *Colonial Placer Mining*, 65-66; and Young, *Spanish Mining Tradition*, 305.
\end{small}
Brazil

After Portugal declared possession of Brazil in 1500 it took nearly two hundred years of struggling colonial development before worthwhile gold was discovered. In 1693-95, in a region north of Rio De Janiero and 350 rugged and jungle-covered kilometres from the coast, prospectors from the captaincy of São Paulo (“Paulistas”) struck rich alluvial goldfields in the catchments of the Serra do Espinhaço Mountains. The area became known as “Minas Gerais” or “General Mines” and the region was established as a captaincy in 1720. Lodes were found from the late seventeenth century onwards but were never a major gold producer in Portuguese colonial times.

The world’s first transnational rush broke out. Gold seekers of all races and classes poured into the diggings, from throughout Brazil, from Portugal’s Atlantic Islands, from Portugal, and inimically to Portugal, from other maritime countries. By 1697, 4,000 people were reported to be panning gold in the Caeté district, and this was just one of many diggings in the new goldfields. By 1710, around 50,000 people occupied the goldfields not including slaves. Great wealth was won; this is the essence of all rushes. Nuggets weighing up to eighty ounces were recovered and one gold seeker struck ground that returned him twelve ounces for each pan. Early Paulistas built up hoards of anything from 2,000 ounces to 20,000 ounces. An enterprising digger tried to buy the captaincy of São Vicente for the sum of 45,000 cruzados (6,800 ounces).

Gold output reached 23,000 ounces in 1699, more than doubled to 57,000 ounces in 1701, more than doubled again to 140,000 ounces in 1703, and doubled again to

---

32 For the first encounter, which secured possession under the Treaty of Tordesillas, see Bakewell, History of Latin America, 401-402.
290,000 ounces in 1704. Annual output peaked at 466,000 ounces in 1712 and estimated production for the period to 1720 was 3.0 million ounces.\(^{38}\)

**Early Self-regulation**

No rush is possible without a form of tenure that makes mineral rights widely accessible. To encourage gold production, the pre-Rush Brazilian mining code had authorised the finder of any gold deposit to mine it regardless of land ownership, subject to a royalty of one fifth of the gold, the “Quinto,” payable to the Crown.\(^ {39}\) Evidently, the first Minas Gerais diggers developed additional simple rules for the settlement of claim disputes.\(^ {40}\) This is significant because it indicates the possibility of digger self-regulation long before the California gold rush.\(^ {41}\) This was similar to long established modes of miner self-government in Europe and suggests that under any polity, gold seekers organised themselves to secure some degree of order on their diggings.\(^ {42}\) In 1702, the government introduced a standard claim of approximately 100 square metres per twelve slaves or around 10 feet square per slave. In addition, no person could obtain a second claim until the first one was worked out, and that a claim could be forfeited if not worked for forty days.\(^ {43}\) These provisions aimed to prevent ground from being land-banked or monopolised, in other words, to provide access as widely as possible. Similar stipulations appeared in many later rushes, not only in California, and seem to indicate a universal fair-minded diggings pragmatism.

The tools and methods used in the Brazilian gold rush were not significantly different from those of Spanish America two centuries earlier, including the unusual use of sap to facilitate panning.\(^ {44}\) African slaves carried out the heavy work of the diggings after having earlier replaced Indian slaves on the sugar plantations, but some Indian slaves

---

\(^{38}\) The dataset is gold imports into Lisbon, not the less reliable Brazilian mint or quint data. For the annual data see Boxer 59 and Vilar, 230. For the cumulative production see TePaske, Table 2.2, 56.

\(^{39}\) Boxer 51; Morell, 21-22; and Machado and Figueirôa, 11-12. Note: under the standard European “Regalian Right,” the king owned all gold regardless of land ownership.

\(^{40}\) Antonil, quoted in Boxer, 41.


\(^{42}\) Clay and Wright, 161.

\(^{43}\) Boxer 51-52; Russell-Wood, 357-358; and Morell, 21-22. Morell’s area projects to 62 feet square per slave whereas the other two historians provide 10 feet square. This thesis accepts the latter, being the majority opinion.

\(^{44}\) Morell, 22; and Machado and Figueirôa, 13.
were kept for domestic duties. West Africans were strongly preferred over Angolan slaves because of the West Africans’ capability from a long pre-European history of gold mining.\textsuperscript{45} Claim holders typically worked up with up to twelve slaves and large slave populations developed: there were 30,000 African slaves present in Minas Gerais in 1715, and 100,000 slaves of all origins, in 1735.\textsuperscript{46} Since panning with sap occurred only in the two rushes that used African slaves, it is possible that West African slaves introduced this, and if so, possibly other gold winning techniques to both regions. However, the possibility of common African origins is weakened by the fact that the Brazilian gold pan, known as a \textit{bateia}, which was introduced by African slaves, was a full cone, rather than a bowl as the Spanish \textit{batea} was.\textsuperscript{47}

\textbf{Transition and Mining}

Gold output peaked at 466,000 ounces in 1712 but there was a further peak of 800,000 ounces in 1720.\textsuperscript{48} Peaks indicate the progress of depletion and a transition from gold rushing to mining. However, these peaks can be explained by a series of rolling rushes as rich alluvial goldfields were discovered far outside Minas Gerais. From 1715 and continuing into the 1750s, Paulistas again were mostly responsible for discovering extensive new goldfields and prompting rushes elsewhere in Minas Gerais, and in the captaincies of Matto Grosso, Goiás, Espiritu Santo, and Bahia.\textsuperscript{49}

Details of mining technologies in Brazil are sparse but ground sluicing was dominant. With no pre-Portuguese mining in Brazil, the source of the expertise is unknown, but it might have been West African slaves. The technique must have been well established by 1720 because regulations issued that year contained clauses for the resolution of water disputes, which only hydraulic mining could have necessitated.\textsuperscript{50} In a local mode of ground sluicing a block of ground was cut into steps about 6-9 metres long and 1

\textsuperscript{45} A female Negro slave from Whydah was seen as an essential companion for a \textit{mineiro} for her prospecting skills and as a good luck charm. See Boxer, 165.
\textsuperscript{46} Boxer, 174, 175, 184; and Bakewell, \textit{History of Latin America}, 445.
\textsuperscript{47} Boxer, 38; Morell, 22-23; and Russell-Wood, 354. The \textit{bateia} was also known as a \textit{gamella}. See John Mawe in Boxer, 183; and Morell, 22.
\textsuperscript{48} Boxer, 59; and Vilar, 230.
\textsuperscript{49} Regarding the Paulistas, see the chapter titled “Paulistas and Emboabas” in Boxer, 61-83. Regarding the discoveries see Morell, 27-28; Boxer, 254-257, 267-268; and Russell-Wood, 321-322.
\textsuperscript{50} Morell, 27.
metre wide. Six to eight slaves on each step puddled the ground with shovels as the water flowed over it thus maximising both human and hydraulic energy.\footnote{51}

Other mining methods applied for other types of deposits. Some underground mining was carried out in thick river terraces but such gravels were generally weak and unsafe, and the work was not popular.\footnote{52} Riverbed mining was practised by damming the full channel and diverting the flow into an excavated channel or a flume. This exposed the full bed for working, and was an improvement on the coffer dams in Spanish America.\footnote{53} Another method was to drag the beds of deeper watercourses with a long handled iron scoop – a simple form of the spoon dredge that appeared later in Otago.\footnote{54}

Brazil was the world’s largest gold producer in the eighteenth century with total production until the end of the colonial period in 1810 of 32 million fine ounces.\footnote{55} After the output of the original and the rolling rushes there would have remained a large quantum of gold that supported the longevity of operations until well into the nineteenth century. While this reflects the great endowment of gold that Brazil possessed, such longevity is another characteristic of mining.

The Appalachian Goldfields

A rush broke out in the second quarter of the nineteenth century in the South Appalachian Piedmont of North Carolina and Georgia and their neighbouring states. Though yielding only a modest three to four million ounces of gold between 1803 and 1861, the rush and consequent mining activity were notable for the private ownership of the gold, the occurrence of saprolite lodes, the many innovations and inventions, and transnationalism.\footnote{56}

\footnote{52} Boxer 38 and 183-184.
\footnote{53} Prieto, figure facing 29. This shows riverbed mining for diamonds but the method was probably developed for riverbed gold because this commenced earlier and was more widespread.
\footnote{54} Morell 22-23.
\footnote{55} Vilar, 230; and TePaske, Table 2-2, 56.
\footnote{56} The following totals can be found in the literature: 2 M (million) oz (ounces) from all states, see Otis E. Young Jr., “The Southern Gold Rush,” *The Journal of Southern History* 48 no.3, (August 1982), 391; 3 M oz for North Carolina 1799-1860, see Fletcher Melvin Green, “Gold Mining: A Forgotten Industry of Ante-Bellum North Carolina,” *The North Carolina Historical Review* XIVa, no. 1, (January 1937), 3; 1 M oz from Georgia from 1828-1837, see Fletcher M. Green, “Georgia’s Forgotten Industry:
Gold activity commenced with fossicking in 1803 after a son found a “seventeen pound” nugget of gold on the farm of a Mr John Reed in Cabarrus County, North Carolina.\textsuperscript{57} John Reed and other, local landowner-farmers used their slaves to grub for nuggets in dry creek beds in autumn when the harvest was over, the same simple technique that Caribbean Indians had used. The slaves recovered gold from the fines by panning in a domestic bowl or pan, sometimes after using an early form of cradle.\textsuperscript{58} The crews also used mercury amalgamation.\textsuperscript{59} These operations could be rewarding and John Reed and his family recovered about 5,000 ounces of gold over twenty years.\textsuperscript{60}

\textbf{A Saprolite Gold Rush}

The fossicking ended in 1825 when Matthew Barringer, one of the seasonal gold farmers, tracked an alluvial lead out of a creek to a gold lode nearby. He picked out more than 60 ounces in the first day, when one pennyweight per day (1/20\textsuperscript{th} ounce)

---

\textsuperscript{57} John Reed was the Anglicised name of Johannes Reith who was previously a German mercenary soldier with the British defending Savannah. See Richard F. Knapp and Brent D. Glass, \textit{Gold Mining in North Carolina: A Bicentennial History} (Raleigh, NC: Office of Archives and History, North Carolina Department of Cultural Resources, 1999), 47-51.

\textsuperscript{58} Knapp and Glass, 8, 10, 18, 51; Young, \textit{Southern Gold Rush}, 377-378; and William Thornton, “Letter from William Thornton Esq. to the Members of the North Carolina Gold Mine Company”, \textit{The philosophical magazine} 27. (1806), 262, 263.

\textsuperscript{59} Mercury has the ability to sequester gold by alloying with it to form what is known as an amalgam. It is a type of physical absorption and does not involve any chemical reaction. It is used to recover alluvial gold from a pan concentrate or other material containing loose gold. The material is shaken up with mercury, which forms an amalgam with any gold present. The gold-rich amalgam is very dense like its mercury and gold, and is panned off, leaving all the waste minerals, usually iron sand, garnets, and silicates, behind. The gold is recovered from the amalgam by retorting it; the mercury volatilizes and can be recovered by condensing the vapour in water, while the gold is left behind in its original particles in the retort. These can then be melted to bullion. If a retort is not available, the amalgamated gold can be recovered by wrapping the amalgam in a chamois cloth and squeezing it tightly – the mercury passes through and leaves the gold particles behind. More crudely, gold can be recovered from an amalgam by it on a heating a metal plate, not uncommonly a shovel or spade, which again drives off the mercury as a vapour, but it then contaminates wherever it solidifies. Amalgamation was also applied in the field by adding mercury to sluice boxes or the riffle box in a long tom or cradle, as in North Carolina. Amalgamation it is a very simple, direct, and reliable process for recovering alluvial gold from concentrates but the mercury is highly toxic to humans and worse, it accumulates in whatever environment into which it might be discharged.

\textsuperscript{60} Knapp and Glass, 53. US$100,000 gold sales at the US Treasury price of US$ 20.67 per fine ounce indicates around 5,000 ounces.
after royalty was payable. Barringer had discovered a new kind of gold lode. Throughout the Appalachian goldfield, intense tropical weathering similar to that in Hispanic America to depths down to thirty metres had converted everything except the quartz and gold to a decomposed red-brown earthy, clayey material, known geologically as “saprolite.” The material could be dug with hand tools, and visible slugs could be hand-picked out. Finer gold could be liberated from the rotten rock by puddling, a process that entailed vigorously agitating a tub of saprolite slurry with a spade. The slimes were flushed off and the sands cradled and panned. Lumps of lode quartz and harder matrix that might occur were crushed by any of the many manual implements seen in Latin America, and the gold separated as before. Because of these simple techniques, saprolite was as “rushable” as alluvial gold, and if found, was much richer, as the Barringer strike showed.

Carrying on from the saprolite strikes, the gold seekers, none of whom had any experience of the work, utilised a sistema del rato approach of hand dug pits and shafts. The Capps deposit, opened in 1827 near Charlotte, NC., had eleven adjacent shafts and pits but when they reached the water table and hard primary reef, all extraction stopped, leaving much rich ore untouched. Fifty local gold seekers sank a large pit to follow the Barringer vein but their unsystematic disposal of the spoil led to the choking of the workings in heavy rain and closure. Nevertheless, they had recovered over 600 ounces of gold. Charles Rothe, a German mining engineer, considered that 90 percent of the work of these unsystematic inexperienced diggers had been wasted.

63 See for example Young, Southern Gold Rush, 379.
64 Knapp and Glass, 14-15. Sinking a shaft is one of the hardest tasks in mining.
65 Rothe, 216-217; and Knapp and Glass, 13.
66 Rothe, 216-217.
Wishing to continue their royalty income, since they owned the gold in their land, the farmer-proprietors engaged mining consultants, or they leased the mineral rights or sold the land outright to mineral investors. These included investor – mining engineer, Humphrey J. Bissell, and Count Vincent de Rivafinoli, an Italian mining engineer with Latin American experience and British financing. These people established fully equipped shafts or adits with pumps, ventilation, and planned layouts, drilling and blasting, proper haulage, and comprehensive surface batteries that utilised stamp mills, edge mills, and arrastras. These were complemented by staff and miners brought in from Latin America, Britain, and Europe. These mining and battery upgrades represented best practice from European hard rock mining coupled with economical Latin American crushing technology and transformed the sistema del rato of the Appalachian saprolite rush into productive quartz lode mining.

Saprolite-quartz mining revealed more differences from gold rushing than mechanisation alone. The handpicked, experienced, overseas operators and staff were the antithesis of the unskilled, self-directed, ad hoc gold seeker. The level of capital expenditure, which included mineral rights as well as mine development and machinery, could only have belonged to mining. The US$6,000 that Bissell paid for a share of the Barringer lode would have been well beyond the resources of a gold rush party but that was dwarfed by the US$150,000 that the United States Gold Mine Company paid for 450 acres of gold bearing land in Virginia in 1837. In comparison, the gold rushers paid their right to mine as a royalty to the landowner at the daily washup. Something like US$100,000 was required to set up a saprolite or quartz mining operation. For alluvial or saprolite rushing in 1829, a shovel cost US$1, a hand pump, US$2, and a cradle around US$15. Adding a hand-crushing device for the quartz in saprolite, and miscellaneous items and spares, the total expenditure for a gold rush party would hardly have exceeded US$50. Life span was another factor. Corporate charters typically had terms of twenty-five years in order to secure the

---

67 Knapp and Glass, 15-16, 19, 21, 24, 26; and Young, Southern Gold Rush, 381.
68 Knapp and Glass, 15-16, 21, 24, 26; and Young, Southern Gold Rush, 381.
69 Young, Southern Gold Rush, 380; and Green, Ante-Bellum North Carolina [a], 13, and [b], 135-136.
70 Franklin L. Smith, Letter, American Journal of Science and Arts XXXII, (July 1837), 130-133.
71 Knapp and Glass, 18-19, 23; Green, Ante-Bellum North Carolina [a], 13, [b], 145; and Green, Georgia's Forgotten Industry, II, 218.
72 Knapp and Glass, 23.
repayment of capital whereas alluvial gold rush claims were worked out in a few
weeks. Saprolite or underground quartz mining, therefore, differed from saprolite or
alluvial rushing not only in technology, but also in the nature of the work force, capital
items, and time scales.

Alluvial Innovations

In their alluvial activities, the Appalachian diggers were unusually innovative. Even in
the fossicking period, two important innovations arose. The first was an “eighteen-inch
frying pan docked of its handle,” or the gold pan, and was the essential flat-bottomed
frustum sided device used ever since by Western gold seekers, rather than its
predecessors, the kitchen bowl, round bottomed batea or apical bateia. The second
was a completely new device, an invention, that combined rocking and sieving, and
was known as a “cradle” or “rocker.” From a local parentage of a half barrel “drum
rocker” and a long hollowed out “log rocker,” the addition of a screen at its feed end
achieved the instant rejection of bulk coarse material and created the compact
“cradle.” This box-shaped device consisted of a removable screen onto which the
paydirt was shovelled, and under which a riffled sluice around one metre long trapped
the gold in the fines. Mounted on two rockers, the cradle was oscillated sideways by
hand while the operator added wash water from a dipper. See Figure 2, which shows a
modern cradle but all the traditional elements are present. While remaining a manual
device a cradle could process three or four times as much paydirt per day as a gold pan
while not requiring flowing water. It established itself as an essential implement for
gold seekers and for formal exploration drilling. Being entirely manual it is classed
here as gold rush technology.

In the gold rush period (1825 until 1828 or so) another major innovation, the long tom,
appeared. Unlike the riffle bottomed board sluice, the long tom was a smooth floored
wooden trough approximately 3-4 metres long and 0.6 metres wide, with an upwards

---

73 Knapp and Glass, 18.
75 “Rocker” was the preferred name in the United States but I will use “cradle” as it is the New Zealand usage.
sloping perforated plate or screen at the end. See Figure 3, in which the diagnostic features are the upward sloping screen that ends the tom section and the riffle box underneath. Flared long toms were often used, especially in Victoria, and were known as a “Jenny Lind.” A long tom was set up with a water flow and the paydirt shovelled in and puddled, and washed along the trough to the screen, which trapped oversize for washing and nugget picking, as in a cradle. The screened fines passed to a riffle section underneath, often on a coarsely woven material (“mats”), and sometimes with mercury.\(^{77}\) Its use of hydraulic energy to wash paydirt gave it around twice the productivity of a cradle, say 2-4 or more cubic yards (“yards”) per digger per day versus 1-2 yards by cradle, and placed it as transitional, not gold rush technology.\(^{78}\)

Figure 2. The Elements of a Cradle
(After W. F. Heinz, Prospecting for Gold, 2\(^{nd}\) ed. (Christchurch, NZ: Pegasus Press 1964), 20.)

\(^{77}\) Randall Rohe, “Origins and Diffusion of Traditional Placer Mining in the West,” \textit{Material Culture} 18, no.3 (Fall 1986), 134-137.

The long tom was arguably a local innovation because it emulated a cruder more laborious local hand screening process, and in addition was a robust “creek ready” version of a fragile looking trestle mounted device used in Georgia. Nevertheless, its concepts may have diffused from Europe from its similarity to many devices depicted in Georgius Agricola’s European handbook, *De Re Metallica*.

![Figure 3. A Long Tom with a Tapered “Jenny Lind” Section](image)

Figure 3. A Long Tom with a Tapered “Jenny Lind” Section

**A Pivotal Period in Alluvial Technology and Historiography**

Although largely ignored in mining historiography, the Southern Appalachian Rush and the mining that followed were pivotal. Brought together by the unusual saprolite lodes they represented the melding of the Latin American and European mining traditions, facilitated by the accessibility of North Carolina and Georgia to both Latin America and Europe. In this period, the cradle was a major alluvial invention and with the other Appalachian innovations, the gold pan and the long tom, formed the technological base for all gold rushes that followed. Such an innovatory spirit might have related to modernization or industrialization in the United States, the transnational diffusion of

---


expertise, or something else. This brings attention to Edgerton's call for care in dealing with innovation and his apparent preference for histories of innovation to be kept separate from histories of technology-in-use. Since the Appalachian innovations rapidly became core technology for all subsequent gold rushes, their historiographical separation from the mainstream of such histories would be problematic.

Siberia

The Urals and Siberia

In the mid nineteenth century Siberian alluvial gold succeeded Brazil in world prominence. This arose from the need for more state income than the state owned lode gold mines of the Urals could provide and emerged from a combination of legal and technical factors. In 1812, the Tsar relaxed his strict ownership of gold in Siberia by authorising private landowners to mine gold in their own land. In 1814, a mining engineer, Lev Brusnitsyn, discovered alluvial gold in the south-eastern Urals and equally importantly, showed that could be worked with a shovel, pan, and sluice box, and not the intricate machinery of the Ural quartz batteries. A major alluvial mining industry built up around the Urals but there was no gold rush, as the activity had arisen from systematic prospecting from the state’s quartz mines. With the diffusion of knowledge of alluvial technology, the communal memory of Scythian gold burial hoards across Southern Siberia and the additional demands of the exchequer after the Napoleonic and other wars, the Tsar offered further encouragement to Siberia. Between 1823 until 1826, he authorised private individuals to extract gold on Crown land in Siberia and enjoined regional governments to promote gold development.

83 Morell, 45; Kroupnik, 3; and Martin Aust, “Rossa Siberica: Russian-Siberian History Compared to Medieval Conquest and Modern Colonialism, Review (Fernand Braudel Centre) 27 no. 3, (2004), 185-186.
85 Morell, 45, 47; Kroupnik, 2, 3; Aust, 185-186; and Lincoln, 185-186.
In a wave of activity from 1828 until 1840, escaped serfs, clandestine prospectors, authorised prospectors, and government parties discovered four great alluvial gold bearing regions that extended for three quarters of the distance across the nearly ten million square kilometre vastness of Siberia. Starting 1,500 kilometres southwest of the Urals, these regions consisted of the Altai-Sayan-Salair fields on the upper Ob and Yenisei Rivers; a Krasnoyarsk group on the south western Lena and upper Tunguska rivers in central Siberia; a TransBaikal group within maybe 500 kilometres of Lake Baikal; and a Yakutsk group on the middle Lena in north east Siberia. The gold frontier reached the Sea of Japan in 1857 when a regional government party struck gold on the Maya River. Many other affluents of the Amur proved to be richly auriferous and a fifth great gold region emerged. Figure 1 shows the approximate location of the Amur gold region but the other Siberian goldfields were too far west to show meaningfully. A note of caution might be in order here because there is a risk of imprecision and overgeneralisation in treating such a widely distributed activity as the development of alluvial gold mining in Siberia as one monolithic event.

The Nature of a Siberian Gold Rush
A number of historians refer to the early mid-century wave of discoveries as a rush, especially Vladimir Kroupnik a Russian geologist and mining historian. Yet a heavy bureaucracy that required detailed plans, formal approvals, and fees before field activity could start reduced the spontaneity. Wealthy merchants or oligarchs far from the field, but with the funds and connections to secure approvals, often commissioned the field campaigns. The field participants were contractors hired for their bush craft or expedition management experience and were not free gold seekers. Regional governments themselves engaged in prospecting, and made some leading strikes. On present information, therefore, if the gold developments in Siberia constituted a gold rush, it was one peculiar to the authoritarian Russo-Siberian polity, and otherwise perhaps better seen as a widespread series of prospecting campaigns.

---

86 Aust, 186; Kroupnik, 3, 6; and Morell, 48-49, 59-60.
87 Kroupnik, 4; and Morell, 64.
88 It would be rather akin to treating the Appalachian, Californian, British Columbian, and Mountain States gold rushes as a single phenomenon.
89 Morell, 49; Aust, 186; Lincoln, 185-186; and Kroupnik, 3.
90 Morell, 49; and Lincoln, 186.
91 Morell, 47-50; and Kroupnik, 3, 6.
Alluvial Mining

Mining in Siberia was a large-scale proposition. After a successful strike and additional reports, approvals, and fees, concessions might be as large as 500 hectares or encompass complete valleys, and be granted for long and sometimes unlimited terms. These were undeniably intended for large-scale mining capitalistic organisations, commonly with oligarchic ownership, and not small parties or cooperatives.

The initial mining method was open pitting by hand digging. Once any permafrost had been thawed, the operators had to strip up to ten metres of overburden to reach the paydirt. Overburden and paydirt were carried away by wheelbarrow, and later, by horse and cart. In terms of mining criteria, these manual techniques were effective in extracting the given deposits while productivity or more accurately, production, was met by the mobilisation of mass labour on seasonal contracts. As many as 1,000 to 2,000 workers, who were mostly exiles, could be employed at one mine. In the deep leads of the Lensky goldfield, which lay at thirty-five to sixty metres deep, underground mining, again a manual technology, was employed. Alaska and the Yukon Territory faced the same environment five decades later. Their technological choices reflected a different techno-commercial polity in which small parties of independent miners used underground mining for rushing and mining. This was manual work as in Siberia but underground mining minimised the volume of permafrost to be thawed and waste material to be dug and removed, as in Siberian open pitting, and the diggers were motivated by self-reward.

Though sluices served as the workhorse for recovering the liberated gold, gold recovery tended to be more mechanised than mining. Mechanical equipment included the trommel, which was a rotating cylindrical screen, driven here by a water wheel, and a “disintegration bowl,” which possibly broke down frozen or clayey paydirt. Other

---

92 Morell, 50; and Cottrell, 60.
93 Water froze and prevented mining for six or more months of the year; the mining season closed on 10 September each year, by regulation. See Thomas Witlam Atkinson, Oriental and Western Siberia; a narrative of seven years’ explorations and adventures in Siberia, Mongolia, the Kirghis Steppes, Chinese Tartary, and part of Central Asia (New York: Harper, 1858), 327; Morell, 52, 62; and Lincoln, 186.
94 Kroupnik, 3, and photographs on pages 2, 4, 5; Morell, 60-61; Lincoln, 186; and Atkinson, 144.
95 Cottrell, 62; Union and Mining Magazine, 95, quoted in Blake, 39; Atkinson, 264; Morell, 51, 52, 53, 61, 66; and Lincoln, 187.
96 Kroupnik, 6.
mechanical devices contained multiple components that amongst other functions, screened the feed and raked the riffle concentrates to prevent blocking up. Their intricacy suggests origins in the Ural quartz batteries because such complexity was never applied for alluvials anywhere else, and no other alluvial goldfield started from quartz lode mining.

The manual strategy continued for decades. There was no steam power before 1860 and the first open cast railroad commenced in 1880, using horse-pulled wagons. Nevertheless, the gold production could be extremely high, which means that the leads were extremely rich. A Mr. Astachef’s mine in the Tomsk district produced 30,000 ounces in 1840 while a mine far north of Lake Baikal returned 65,000 ounces in a five-month season in the late 1850s. Profitability could be high too, based on a mine in the Yeniseisk district where a seasonal profit of £1,012 was made for the expenditure of merely £170, of which £145 was for wages.

**Technological Change in Siberia**

The environment of frozen below-valley deposits and work-hungry cheap exile labour virtually pre-determined the use of manual methods in Siberia, but slowly, over decades, horse, and then steam power found a place. Even this was not radical technology, but when a new and superior technology appeared in the 1890s, namely the Otago bucket ladder gold dredge, the Siberians sent technical missions to New Zealand and adopted it avidly. Indeed, there was a bucket ladder gold dredge operating in Siberia a year before the first one in the United States, which was at Bannack in Montana. This shows that innovation and mechanisation do not have to be forced.

---


99 Morell, 61, 67-68; Kroupnik, 4, 6.

100 Cottrell, 62; Major Collins, *Union and Mining Magazine X*, (1865?), 95, quoted in Blake, 39; and “The Gold Mines of Siberia,” see n97.


Siberian mining management used high technology as soon as the balance of capital, effectiveness, and productivity justified it.

**Pacific Basin Rushes 1848 – 1864**

In a twenty-year period in the middle of the nineteenth century, a set of rushes broke out on either side of the Pacific Ocean. California was first in 1848 and generated a cascade in which diggers with Californian experience seeded further rushes. These included rushes in New South Wales and Victoria in 1851, and then a series in the South Island of New Zealand that started in northwest Nelson in 1857. Before these, Charles Ring, reputedly an ex-Californian, had won a reward for finding gold in quartz float near Coromandel in 1852. This was a fizzer but was of significance as a pathfinder for the discovery of rich quartz lodes in the wider district and because it initiated tensions between Maori in possession of gold bearing lands and Pakeha gold seekers. In North America, rushes broke out in British Columbia and the Western mountain states of the United States from 1858 until 1863. These post-California North American events do not add significantly to this present technological review and so, the rest of this chapter is restricted to the Californian and Victorian rushes.

**California**

The California gold rush was launched by an unplanned find of alluvial gold at Coloma in the catchment of the American River in January 1848. Gold output peaked at 3.9

---


104 Salmon, 26-30, 177-186.

105 Disappointed, exhausted, or satisfied gold seekers from California fomented rushes as follows: to the Fraser River in British Columbia in 1858, to Pike’s Peak, Colorado in 1858, to the Comstock silver lode of Nevada in 1859, to Boise, Idaho, in 1861, and to Bannack, Montana, in 1863; see Morell, 120-128, 137-143, 150-156, 165-170, and 177-183.

106 The gold was found in the excavation of a tail race for the waterwheel for a timber mill (“Sutter’s Mill”) that was under construction at Coloma. See Kenneth N. Owens, “Introduction,” in Owens, ed., 18-20; Kenneth N. Owens, “Gold-Rich Saints: Mormon Beginnings of the California Gold Rush”, in Owens, ibid., 35-36; and Paul, 16-17.
million ounces in 1852 by which time the non-Indian population had increased to 224,000 from 14,000 in mid-1848. From among the many possible topics of interest in this major historical event, the purpose of this chapter is to discuss the technological transition and touch on structural change from gold rush to gold mining. The gold rush was based on alluvial deposits though quartz mining became significant from 1850 onwards.

Californian gold rush technology comprised largely the manual equipment such as picks, shovels, cradles, and gold pans, and simple methods introduced by the early arrival of experienced Appalachian and Mexican alluvial miners. A tightly woven Indian flax bowl often stood early duty as a gold pan. Puddling was not needed but a butcher’s knife was essential for extracting gold from crevices in creek or river bottoms in their low season, and was a prominent and possibly the main method in 1848. Amalgamation was widely practised for the recovery of gold, based on a cheap supply guaranteed by the discovery of a large cinnabar deposit south of San Francisco. In the south, experienced Chilean and Mexican miners, favoured the batea over the flat-bottomed gold pan, and in the near-desert conditions, they used dry gold recovery techniques such as blanketing, winnowing, and dry blowing.

Early Depletion and Transitions

Extinction by depletion is the fate of all gold rushes. Early in a rush, the richest and easiest deposits to work are the target of frantic activity and are the soonest exhausted,

---


109 On 5 February 1848, Isaac Humphrey, a Georgian ex-miner who was already in California, had met Charles Bennett, who was carrying the news of the strike from John Sutter, the Coloma mill co-owner, to Colonel Richard B. Mason. See John Umbeck, “The California Gold Rush: A Study of Emerging Property Rights”, Explorations in Economic History 14 (1977), 209; Owens, “Introduction,” 20; and Morell, 78.


111 Cinnabar (mercury sulphide) is the main ore of mercury. Regarding the cinnabar deposit, see Paul, 272.

112 These techniques involved throwing the dry paydirt into the air from a blanket, batea, or gold pan, and letting a breeze waft the fines and light particles away. In blanketing, a series of shakes or lifts of a load of dirt on a blanket drew pebbles to the surface for removal by hand. For the smaller volume of a batea or gold pan the thrower blew the light particles away. See Rohe, Origins and Diffusion, 130; and Umbeck, “California Gold Rush,” 207.
while at the same time, the inrush of gold seekers is increasing, thus further increasing the rate of depletion. At some point, the best ground becomes completely worked out and only lower grade ground or ground not suitable for working by simple manual gold rush technology is left. Either the digger goes prospecting for new rich ground or uses different technology to continue in the existing diggings. In order to work lower grade ground the new technology must be more productive than gold rush methods, so that a digger can recover a liveable amount of gold for the same effort as in rushing. Or else, more effective technology is required, to work ground that might be rich but which simple manual gold rush methods could not work because of the new ground’s differing physical characteristics from the gold rush ground. Hydraulic washing, which comprised long tomming or board sluicing, was the usual technology for increased productivity. This used the hydraulic energy of flowing water to replace human effort in washing the paydirt and to some extent, in disposing of the tailings. As a result, long toms and board sluices washed two to six times more dirt than a cradle, as already noted. This new technology represented the start of a transition to mining and the end of a gold rush in technological terms.

After a rush had peaked, the remaining ground increasingly became either of too low grade to be profitable by the hand methods of the rush, or else, physically unable to be worked by those hand methods. This would include excessively wet ground, deep ground, cemented ground, and hard rock lodes. Low-grade ground required methods with lower costs, which meant higher productivity; this was achieved by mechanisation or mass manual activity with economies of scale. Unworkable ground required technology of greater effectiveness, that is, different methods altogether. Either approach required higher skills and tighter organisation than the hand methods of gold rushing and constituted the technological regime known as mining.

Depletion was exposed in California once the peak production of 3.9 million ounces was reached in fiscal 1852. Against a rising population, annual gold output dropped to 3.3 million ounces in 1853, rose a little to 3.4 million ounces in 1854, then decreased to

---

113 The terms “sluice,” and “board sluice,” refer to the same device. Operating a board sluice or a run of them end to end to recover gold in the field was known as sluicing, board sluicing, or box sluicing. A sluice box was a short board sluice that was used for washups of bulk concentrates from ground sluicing or board sluicing, or for prospecting instead of a cradle. Many varieties of sluice box appear in the pages of Agricola. See Agricola, 305-348.
2.8 million ounces in 1856, and continued decreasing thereafter.\textsuperscript{114} Other earlier indications had been the appearance of hydraulic washing by long toms in 1849, by board sluicing in 1850, and a noticeable increase in wages work in 1851, due to the scarcity of rich enough ground for self-support.\textsuperscript{115} The transition to hydraulic washing took place in Nevada County in the Northern Mines where many Appalachian miners long familiar with long toms and board sluices worked.\textsuperscript{116}

**River Mining**

Transitions to full mining were driven by the need to be effective in specific types of deposit. Mining was also more productive than hand methods due to economies of scale. Full river mining commenced very early, in mid-1849, on the American River.\textsuperscript{117} This is not surprising because the original rush was based on working creeks and riverbeds at the seasonal low, leading to the early depletion of beds accessible without diversion.

In river mining, the entire river was dammed and diverted into a wooden flume, leaving an exposed bed that was dewatered by waterwheel driven chain pumps then hand worked by pick, shovel, wheelbarrow and sluice. Figure 4 depicts a chain pump driven by a waterwheel. Its origins are revealed by its name in California as a Chinese pump whereas in Victoria and Otago it was known as a Californian pump. It consisted of a continuous belt that had wooden paddles attached. In the bottom section of the belt the paddles push water up and out because it is contained by the close fitting rectangular housing. In Figure 4 the paddles are seen in the upper, return section of the belt and travelled from upper left to lower right. Before river mining, hand rotated chain pumps were ubiquitous in gold rushes.

---

\textsuperscript{114} Paul, 345.


\textsuperscript{116} May, *Origins*, 36-37. Nevada County was well inside California and far to the west of the region that later became the state of Nevada.

In river mining, extensive preparatory construction of dams, flumes, waterwheels and pumps under tight schedules was necessary because of the tight low-river season of five months. Some ventures were highly capitalized, for example large installations on the Yuba River in the early to mid-1850s averaged a cost of around US$75,000 per kilometre of river, and 40 kilometres were mined. River mining usually operated under a corporate structure but Chinese miners also took it up enthusiastically and worked with cooperatives of tens to hundreds of members. With its requirement for skills, organisation, and preparatory construction, a large wages workforce, and capital expenditure, river mining can be accepted as mining and not rushing. Between 1852 and 1854, which were the peak years of Californian gold output from all sources, river mining produced the majority of the gold. This challenges much of the

---

118 Paul, 125.
119 Paul, 127.
121 Rohe, Origins and Diffusion, 141.
historiography of this seminal period and suggests that river mining should be written more strongly into California gold rush histories.

**Ground Sluicing and Hydraulicking**

The continuing use of hydraulic washing began to exhaust the entire resource of low-lying deposits along the floors of valleys. Obliged to look in other directions, diggers in Nevada County, found a new series of alluvial deposits that were perched on bedrock high above rivers or valleys. These consisted of unusually thick but relatively weak gravels overlying a rich bottom.\(^{122}\) Gold rush cradling, and transitional hydraulic washing, which relied on hand shovelling, were utterly impractical in such bulk, and while shafting or tunnelling could access the bottom, they often missed or lost the rich lead, and were expensive and unsafe.\(^{123}\) Ground sluicing was an automatic choice because the terrain was suitable, water was abundant, and timber for water race fluming was readily available.\(^{124}\) Led again by experienced Appalachian miners, ground sluicing commenced in the 1851-52 season. It proved both effective and productive in these thick gravels but it created dangerously high faces that collapsed and caused deaths and injuries.\(^{125}\)

In 1853, to meet this problem Edward E. Matteson invented the technology known as hydraulicking.\(^{126}\) This used a high-pressure jet of water to undercut a gravel washdirt face, which brought down the whole face, whereupon the now loose washdirt was flushed to a ground sluice in the floor of the workings. Additional ground sluicing water was usually necessary for flushing. For the occasional zones of cemented ground, tunnels were driven with chambers and the latter filled with explosives and detonated. Improvements in and strengthening of all components of the system over

---

\(^{122}\) These were old (80 million years) Early Tertiary river systems that cut across the present terrain because they predated the uplift of the Sierra Nevadas. See Paul, 147; and May, Origins, 32-34.

\(^{123}\) Paul, 148-151; May, Origins, 34-36; note especially the sketch facing 34; and Robert L. Kelley, “Forgotten Giant: The Hydraulic Gold Mining Industry in California,” Pacific Historical Review 23 no. 4, (November 1954), 344-345. This was known as “coyote mining” because it was widely practised on Coyote Hill, Nevada Co.

\(^{124}\) May, Origins, 23-25, and 37-49.

\(^{125}\) May, Origins, 36-38; and Rohe, “Origins and Diffusion,” 138.

\(^{126}\) May, Origins, 40-47. Paul refers to Antoine Chabot, and other writers refer to others as well. See Paul, 152-153 and May, ibid. However, May’s choice of Matteson is compelling. Note also that while Matteson is validly credited with the invention, he worked with a four-man party and they employed eight labourers in their ground sluicing claim at American Hill near Nevada City. See May, Origins, 45. As a further comment, hydraulicking was for a short time pronounced with a soft “c,” and was also known as piping or monitoring.
the next twenty or more years resulted in all-metal, universally jointed, water cannons
with trade names such as Monitor, Giant, or IntelliGiant. These were capable of
jetting around 1,000 litres per second of water at a head of over 1,400 kilopascals (200
psi) and flushing away enormous volumes of gravels.

The productivities of hydraulic mining (ground sluicing and hydraulicking) were
significantly higher than hydraulic washing (long tom and board sluicing), and far
ahead of cradling. In hydraulic washing, all material had to be dug and shovelled,
which human strength capped at around 4.5 cubic metres (6 yards) per digger per day.
In ground sluicing, the material only had to be picked, dug, or loosened into the flow of
water, and output related to the volume of water supplied. In these high lying
Californian alluvial deposits, the overburden was often so weak that ground sluicing
flushed it away, along with the forest cover, without needing digging at all.
Hydraulicking productivity depended on the pressure (static head) of water that could
be delivered. Quantifying this, one person could process approximately ½ a cubic yard
(“yard”) per day with a gold pan, ½ to 1 yards per day with a cradle, 2 to 4 yards per
day with a long tom and 3 to 6 yards with a board sluice. In California, ground sluicing
produced 25 to 50 yards per man per day and hydraulicking reached 50 to 100 yards per
man per day. High productivity meant low costs. A party using hydraulicking
could make money in ground with a gold content that was 1/25 of that for gold rush
cradling. This perhaps indicates the limited volume of ground that could support
gold rush technology. Further, the low costs of hydraulic washing enabled lower grade
resources to be mined, which enlarged the potential resource and the life of alluvial
mining. Environmentally, however, by 1884, because of its high productivity,
hydraulicking had discharged an estimated 1.2 billion cubic metres of gravels into the
Californian river system.

127 May, Origins, 49; Paul, 156-157 and 293-294; and Randall Rohe, “Hydraulicking in the American
no. 1, (Spring 2009), <http://www.sierracollege.edu/ejournals/jsnhb/v2n1/monitors.html> (23 January
2013).
129 The pan, cradle, and hydraulic washing data has been cited earlier. The Californian ground sluicing
and hydraulicking data arises from some rearranging of Browne, Report, 1862, quoted in Paul, 154.
130 These rates were based on a daily wage of US$4 per day. See Paul, 154.
131 Paul, 154-155; and Joseph J. Hagwood Jr., The California Debris Commission: A history of the
hydraulic mining industry in the western Sierra Nevada of California, and of the government agency
charged with its regulation (Sacramento, CA?: United States Army Corps of Engineers, Sacramento
In addition, hydraulicking required up 17 cubic metres of water for each cubic metre of gravel. New races at higher elevations were needed to supply the required higher volumes and higher heads. Following this, water supply changed from being delivered by local companies to being an industrial activity involving extensive civil engineering works and races hundreds of kilometres long. Race works cost an estimated US$13.6 million in aggregate to 1859.

Californian hydraulicking, with its high productivity, low breakevens, and ancillary race engineering made huge volumes of above-valley alluvial gold deposits mineable and brought about the industrialization of alluvial mining. Roger Burt, the Exeter University mining historian, classifies hydraulicking as one of seven “macroinnovations,” that transformed mining into a bulk industrial activity in the second half of the nineteenth century. Industry acceptance confirms this; as long as the spoil could be controlled hydraulicking proved the method of choice in all above-valley alluvial deposits for all minerals throughout the rest of the world from then on.

**Structural Change in California**

The organisation of work changed as gold extraction changed from gold rushing to hydraulic washing and on to full hydraulic mining. Mass egalitarian participation and self-regulation by miners’ committees in the gold rush period of 1848 until 1850 and later, is well known. However, as Philip Ross May argues, the accompanying external structural change to corporates was often nominal, as their members, style of work, and financing remained close those of the gold rush self-sufficient partnerships. According to May, serious corporatization became necessary only as late as the 1860s when

---

132 Kelley, 348.
134 Roger Burt, 324, 328-329. The other six macroinnovations comprised: the mechanisation of mining by steam, hydraulic and electric power, rock crushers, the mechanical rock drill, hydraulicking, the New Zealand gold dredge, froth flotation, and the cyanide process for gold. Burt’s model was based on the concepts of macroinvention and microinvention proposed by the technological historian Joel Mokyr, in which a macroinvention was a major new technology that broke existing technological bounds. See Joel Mokyr, *The Lever of Riches: Technological Creativity and Technological Progress* (New York: Oxford University Press, 1990), 9-13.
hydraulicking along with the race companies called for much higher capitalisation and legal formality.\textsuperscript{135} Nor, to repeat Cleary in the Introduction, does capitalisation equal capitalism. However, since hydraulicking largely only applied to the Northern Mines, structural change, if any, in the different geology and demography of the Southern Mines would have taken a different form.\textsuperscript{136}

\textit{Gold Rush or Gold Mining in California}

California continued the commonality from previous gold rushes of simple gold rush tools and techniques, albeit with the benefit of their recent modernization and some significant upgrading in the South Appalachians. It is clear that gold rush technology with hand methods and modest water usage was a different type and scale of activity from the hydraulic washing techniques forced by depletion.\textsuperscript{137} Further, the introduction of this transitional technology in 1849 within eighteen months of the Sutter’s Mill strike, and before the first wave of large scale immigration from the eastern states had reached California, shows how limited were the initial local rushes, although ongoing strikes in new areas continued the gold rush behaviour in the state as a whole. The establishment of the tightly scheduled and well capitalised river mining in 1849 signified the similar exhaustion of rich, easily extractable shallow creek and river bed deposits and could not be mistaken for gold rush activity. Nor could hydraulic mining, which used significantly more intensive technology than hydraulic washing, and necessitated large expensive tenure, high capital, complex on-site water reticulation, engineered equipment, and water supply networks with their own highly capitalised corporates. California stands as a well-documented example that gold rushing is transient and very different technologically from gold mining.

\textit{Victoria}

In 1851, three years after the outbreak of the California Rush, gold rushes broke out in New South Wales and Victoria. Victoria was a world class goldfield and produced 49

\begin{footnotes}
\footnote{May, Origins, 11-12.}
\footnote{The axial Californian river system subdivided the numerous diggings and goldfields into two main divisions: the “Northern Mines” lay on the tributaries of the Sacramento River, with the American River towards its southern limit; the “Southern Mines,” lay on tributaries of the San Joaquin.}
\footnote{That fact that these transitional techniques were introduced by experienced Appalachian and Latino miners implies that extra skills were necessary.}
\end{footnotes}
million fine ounces of alluvial gold up till 2004, while New South Wales produced 11
million ounces.138 Diggers from California were essential in both rushes and there was
a continuing interchange of technologies between Victoria and New South Wales
thereafter.139 The joint history is important but is not well documented and nor is that
of New South Wales gold rushes and mining. This chapter will be based on Victorian
activity.

The Victorian goldfields differed significantly from those in California because they
did not lie within the Circum-Pacific Tectonic Zone; they were significantly older,
deposits known as “deep leads” that were deeply buried below ground and river level
were prominent, the deposits were strongly clay-bound, and environmentally, water
was scarce. Consequently, Victoria faced different operational choices and constraints
from those of California. Major quartz lodes occurred too, especially the saddle reefs
of Bendigo, but were not significantly rushed and are not considered further.

The output of gold, number of diggers, and the total population of Victoria all rose
rapidly as the initial rush rolled on throughout the 1850s with repeated major rushes of
tens of thousands of gold seekers.140 Gold seekers made rich strikes as always but
nuggets were a Victorian bonus. Up until 1868, more than fifty nuggets that weighed
more than 15 kg (482 ounces) had been found. Siberia, also with ancient geology, was
next most fruitful.141 Victorian exports commenced at 145,000 ounces of gold for three
months in 1851 whereas California recorded 11,900 ounces in its first nine months.
Victorian exports exploded to 2.2 million ounces in 1852 and peaked at 3.0 million
ounces in 1856. Exports for the first ten years totalled 22.8 million fine ounces, against
California’s 24.3 million.142 As further confirmation of a large gold rush, the adult male
population on goldfields nearly doubled in one year, from 19,000 in 1851 to 34,000 the

138 Don Perkins generously passed on these data in September 2013.
Province,” Newsletter of the Society of Economic Geologists 56, (January 2004), 15; and Robert Brough
Smyth, The Gold Fields and Mineral Districts of Victoria: With Notes on the Modes of Occurrence of
Gold and Other Metals and Minerals (Reprint on demand [1869], Lavergne, TN: Nadu Public Domain,
2010), 361-366.
142 Smyth, Table No. 32, 536; and Paul, 345. Although 11,900 ounces is the best available figure for
California it seems anomalously low and does not reconcile with Bancroft’s assessment that gold seekers
were making one ounce per day.
next year, and continued increasing until a maximum of 147,000 in 1858. By then the rush had catalysed the state as a whole so that in 1861, when adult goldfields males had declined to 100,000, the full population of Victoria had grown from to 540,000, from 77,000 in 1851. Nevertheless, locally, this was transient activity as shown by Serle’s estimate that a gold rusher in 1851 averaged only around “six or seven weeks” on the diggings.

**Surfacing Tools and Techniques in the Gold Rush**

Although the deposits mostly occurred below creek or valley level, Victorian gold rush technology maintained the continuity of simple tools and hand techniques of past rushes. Working ground down to around ten metres deep was known as “surfacing,” in comparison to “deep leading.” Diggers undertook this by excavating paddocks or sinking shafts. To indicate timing, a three-person party of three once sank a shaft thirty metres deep in one week. However, given the subsurface occurrence of most of the gold, diggers called on mechanical or animal assistance for hoisting the hand-dug dirt. The simplest device, for the shallowest ground, was a “whip,” which was a vertical pole to which a long and counterweighted pole was pivoted. Pushing down the counterweight raised a bucket of dirt suspended on a rope at the other end of the pole. For deeper ground, a horse whip could be used, in which a horse walked back and forth along a straight track to raise and lower a bucket on a rope that passed over a sheave wheel at the top of the shaft. Strictly speaking, the use of horse energy would place this as a transitional method rather than rushing but it operated as part of the broader Victorian gold rush. For the deepest ground, the diggers used a windlass, which utilised the leverage of the handle, to raise and lower the buckets. Neither whips nor horses were prominent in California because it did not have similar ground.

---

143 Weston Bate, *The Victorian Gold Rushes* (Fitzroy, Victoria: McPhee Gribble Penguin), 27; and Smyth, Table No. 1, 511.
144 Serle, 24n.
146 “Alpha,” (Charles Bird, a journal writer), describes when his party of three decided to sink a 30 metre shaft as fast as possible, to lose weight! They lost over six kilogrammes each. See Alpha, pseud., *Reminiscences of the Goldfields in the Fifties and Sixties: Victoria, New Zealand, New South Wales. Part I, Victoria* (North Melbourne?: Gordon and Gotch, 1915), 105.
147 Smyth, 507-508; and Lock, 186-187.
In processing, the claybound Victorian paydirt was puddled in a tub before cradling, with the proviso that paydirt was commonly stockpiled until winter because many creeks ran dry in summer.\textsuperscript{148} The long tom also allowed some puddling and replaced the cradle in some districts. A version known as a “broad tom” or “Jenny Lind” was popular. This tapered outwards to as much as one metre wide at its discharge but was half the length of the standard American type. This provided space for a second broad tom that could be set at a different slope or have different riffles to recover gold that the first one had lost.\textsuperscript{149} The long tom represented transitional technology but, through its ubiquity in Victoria, could now perhaps be regarded as a gold rush tool rather than a sign of depletion. The final cleanup was by panning with or without amalgamation.

\textit{Victorian Depletion and Transition}

The sharp drop in output from 2.7 million ounces in 1853 to 2.2 million in 1854, reveals the onset of depletion of the originally rushed deposits, and more so since the number of adult males on the goldfields had increased in that time from 54,000 to 66,000. Confirming underlying depletion throughout Victoria by 1858, while the gold output had increased again by 18 per cent to 2.5 million ounces it had taken double the number of adult goldfields males, some 147,000 to recover it.\textsuperscript{150} Large volumes of poorer ground remained but a transition to mining was needed to exploit them.

The gold seekers found a solution in machine puddling which was a horse-driven technology. It worked on the principle of an \textit{arrastra} but used harrows instead of suspended rocks, and was carried out in a slurry in an annular pit, not on a dry stone pavement. Operating with a charge of up to thirty cubic metres of washdirt, the horse-drawn harrows broke down the clayey matrix, and released and cleaned the grains of gold. The resulting clay sludge was flushed out to a sludge channel and the residual solids were cradled or box sluiced. With a puddling machine costing around £200 to construct, capital of up to £80 per crew member was needed for a machine, horses, and dam for flushing water, but this was low enough to be afforded by a digger party.\textsuperscript{151}

\begin{flushright}
148 For example, see Alpha, 94.
149 Smyth, 127; and Christopher J. Davey, “The origins of Victorian mining technology, 1851-1900”, \textit{The Archefact} 19, (1996), 53.
150 Smyth, Table No. 1, 51, and Table 32, 536.
\end{flushright}
After their introduction in both Victoria and New South Wales in 1852, two thousand machines were reported to be operating in the Bendigo district in 1854.\footnote{For the first use, see Birrell, “Development of Mining Technology,” 50. He indicates a dual provenance, one being the pug mill for preparing clay for pottery, and the other being a processing device (a trommel?) used in the south-west of England. For the 1854 data, see, Davey, C. J. and P. L. McCarthy, “The Development of Victorian Gold Mining Technology,” \textit{Victorian Historical Journal} 73, no.1. (April 2002), 65.}

Machine puddling proved highly beneficial. Its main function was in effectiveness in that it mechanised and enhanced the liberation and cleaning of gold particles from the clay-bound matrix which increased gold recovery as a bonus. Even though it remained restricted by the rate of digging of six cubic yards per day per crew member, it provided economies of scale that delivered productivity six times that of cradling and hence reduced breakeven grades.\footnote{Birrell 95; Davey, \textit{Origins of Victorian Mining}, 53-54; and Serle 219.} These represented substantial improvements in both effectiveness and productivity over hand methods and led to its extension to the extraction of worked and abandoned ground. This growing category of resource comprised unworked parcels of ground interspersed with a mess of mullock dumps on top of unmined ground, and water or spoil filled paddocks. Here, it recovered previously lost or unmined gold, including the occasional rich lost lead. By 1857, 10,000 diggers with 5,000 horses were working 2,000 puddling machines in Bendigo alone.\footnote{Serle, 219.} What was essentially processing technology had become integrated into mining.

\textit{Board Sluicing and Hydraulic Mining}

Due to the dry climate and the predominance of below-valley deposits, the more productive transitional technique of board sluicing (rather than long tomming) was limited largely to the Beechworth Mining District, located on the northern forelands of the Great Divide. Important catchments included the Ovens River and an affluent, the Buckland, and main creeks, notably the Woolshed-Reedy, that drained granitic uplands around Beechworth. Even so, it was the wet, rich and increasingly deep leads below the creeks and plains that were of most interest after the 1852 gold rush. However, a transition to hydraulic methods occurred in the winter of 1853 when John Reilly, a Canadian via California, cut a race into the Nine-Mile diggings (from Beechworth) and began board sluicing. Based on first possession he also sold water to other parties, and
raised their hackles with his monopoly prices.\textsuperscript{155} Full mining by ground sluicing did not follow immediately, although it was more productive than board sluicing, because it used six times as much water, and initially, water was expensive. Once adequate race networks had been established and water prices had come down, ground sluicing and hydraulicking proved to be as productive and economical as in California.\textsuperscript{156} Cemented ground was not a major occurrence and when it occurred it was mined by chamber blasting as in California.\textsuperscript{157}

\textit{Innovation for Deep Leads}

A new type of below-valley deposit known as deep leads occurred around Ballarat. These were richly concentrated auriferous gravels in deeply buried palaeo-rivers. The overburden comprised tens of metres of weak and saturated lake sediments, with interspersed basalt flows.\textsuperscript{158} These were extremely challenging characteristics to deal with but persistence and expertise created a successful innovative mining method.

The development of the technology was a combination of incremental learning and specialised expertise from other branches of mining. Attempts started with shallow shafts in late 1852 and 1853 together with the novelty of blasting to penetrate a cemented false bottom. As shafts went deeper, diggers installed framing or “sets” made of saplings to support the walls, and then, to hold back wet loose ground, they lined the shaft with saplings packed vertically behind the sets. This was known as “slabbing.” To counter increasing ground pressure with depth, strong timber laths were later used instead of saplings or sheets of bark.\textsuperscript{159} Baling out water inflows was a never-ending task but the cooperative parties who carried out the early deep sinking projects utterly abjured steam powered pumping, which implied capital, monopoly, and the perceived serfdom of wages work.\textsuperscript{160} In the mid-1850s, with the never-ending baling, and rebaling after fall-ins, it was taking six or eight months to reach the leads.

\textsuperscript{156} Peter Wright, quoted in Smyth, 129; Smyth, 126-130; and Woods, 30. Note that the breakeven grade for hydraulicking was around a tenth of that for board sluicing.
\textsuperscript{157} Smyth, 352-354.
\textsuperscript{158} Hughes et al, 15; Blainey, \textit{The Rush}, 48-49.
\textsuperscript{159} Smythe, 448-450.
Parties increased to fifty or more members to bale out around the clock and share the costs of slow progress.\textsuperscript{161} It was these deep shafts that were at the centre of the Eureka conflict.

In 1857, a twelve-man party from Newcastle (assumed to be in New South Wales and not in England) found a comprehensive solution in working on the Frenchman’s Lead: they positioned their shaft to the side of the lead and deliberately sank through basalt, which required drilling and blasting but was stronger and drier than the lake sediments, and continued below the level of the lead into the hard rock basement, reaching 75 metres deep. From there they tunnelled out in the dry hard basement under the lead. Reaching this far took eighteen months.\textsuperscript{162} They then drilled drainage up-holes into the saturated gravel of the lead.\textsuperscript{163} With access achieved and water under control, the Newcastle Party adapted the bord and pillar method from coal mining to extract the paydirt, in the technique known as “blocking” or blocking out.”\textsuperscript{164} This was always dangerous work and required expert miners because apart from the inherent issues, variations in the nature of the lead changed the stability of the work place.\textsuperscript{165} Once the paydirt was dug out and hoisted to the surface, it was puddled and the gold recovered as for any other paydirt. For their efforts, the Newcastle Party earned a dividend of £4,125 for the expenditure of £450, excluding their own labour. Aggregate gold for all parties that worked the Frenchman’s Lead totalled £128,000 for the expenditure of £37,000, excluding labour.\textsuperscript{166}

Deep leading was undoubtedly mining and not rushing. Although the core tasks in shaft sinking and winning the wash were manual, with some chemical energy from gunpowder, hoisting, pumping, ventilation, and horse haulage along the bottom level were mechanised. Committing six months to two years of time to reach the lead, without an income, while consuming working capital was not in the opportunistic, low

\textsuperscript{161} Blainey, \textit{The Rush} 49-50; and Serle, 219.
\textsuperscript{162} Smyth, 495-497; and Davey and McCarthy, “Deep Lead Mining,” 17.
\textsuperscript{163} Later parties sometimes drove a secondary tunnel in the lead itself as a pre-emptive drainage “drift” above the main drive.
\textsuperscript{164} In blocking, parallel tunnels were driven at a spacing that depended on how far a miner could throw a shovel of paydirt – nominally five metres (16 ft) and how wide was a safe span of roof. Cross tunnels were also driven and “pillars” of ground left unmined and timber props and laths added, for ground support.
\textsuperscript{165} Davey and McCarthy, \textit{Deep Lead Mining}, 18-19; and Davey and McCarthy, \textit{Development of Victorian Mining}, 67.
\textsuperscript{166} Smyth, 497.
cost, go-anywhere style of rushing. Most of all, the skills for sinking the shafts and extracting the lead were the highest of any technology in Victorian alluvial mining, and totally uncharacteristic of a gold seeker. Looking also at longevity as a characteristic of mining, the Ballarat deep leads lasted for something like twenty years. The Chiltern deep leads in northern Beechworth Mining District commenced in the late 1850s and continued into the twentieth century.\textsuperscript{167} As in Brazil, longevity started with a generous national endowment of gold deposits but this cannot hide a substantive technological difference the two or three years noted in Victoria before depletion appeared in comparison with mine lives of twenty to fifty years.

\textit{Lessons from Victoria}

Goldfield regulations changed regularly in Victoria, and the changes were certainly advisable after Warden Doveton set the claim size at eight feet square in 1851 and change was greatly accelerated by the state violence of Eureka.\textsuperscript{168} In association with the regulatory and legislative change, Victorian independent diggers resisted attempts at corporatisation and its ancillary, monopolisation of tenure, more pointedly than their predecessors in California did. Much of this may have been because the wet and deep Victorian deposits were technologically more difficult than most Californian alluvials, and because Victorian capital-intensive reef gold was much more widespread than that in California and often even lay below rich alluvials. After approximately ten years, however, most of the deposits suitable for the independent diggers had been mined out and even their elected members on mining boards and in legislatures accepted legislation that supported corporate mining.

The Victorian rush confirmed the evidence of all previous rushes, that rich alluvial gold was easily extractable by simple manual methods. A question arises, however, whether the use of horse whips for hoisting and long toms for washing paydirt were variations due to the local characteristics of the deposits or a new trend of the mechanisation of a gold rush. The presence of diggers with recent Californian experience might at least partly explain long tomming. As in other goldfields too, distinctive technologies

\textsuperscript{167} Davey and McCarthy, \textit{Deep Lead Mining}, 18.
\textsuperscript{168} Doveton’s instructions had been to set the claim size according to the richness of the ground. See Birrell, \textit{Staking a Claim}, 14-15; and Serle, 20. In 1853, the size was increased to 12 feet square per crew member with a maximum of 24 feet square for four or more crew. See Birrell, 14, 22; and Serle, 73. For Eureka, see Blainey, \textit{The Rush}, 49-58; and for an excellent analysis of the regulatory changes in the Beechworth Mining district, see Woods, 42-48, 54-56, 92, 96-98, and 104-105.
evolved in Victoria, namely machine puddling and deep leading, in response to types of deposits not previously encountered. Again, innovation seems inherent in nineteenth century gold mining, notwithstanding the progression of rushes and their accumulated new technologies from one country to the next.

**Gold Rush or Gold Mine?**

The aim of this chapter was to investigate the differences between gold rushes and gold mining, and the influence of depletion on the selection of extraction technologies. In the dictionary’s terms, a gold rush was a stampede or impetuous movement of a mass of people to a discovery of rich gold. The usual historical understandings of a gold rush broaden this to incorporate the extraction of gold once a rusher arrived at the gold discovery.

The findings of this chapter are first that the extraction activity consisted of simple methods using hand tools that required little skill or experience, and which was self-funding. This activity was transient because the rich easy ground was exhausted relatively rapidly. Gold mining was the extraction activity that followed when gold rushing had been extinguished by depletion. Secondly, this chapter holds that to achieve this, mining had to have been more productive or more effective than gold rushing, or both. It met these requirements by either being mechanised, by being organised to capture economies of scale, or by the application of specialised skills, or by any of these in combination. In addition, the site of the mining activity was fixed and the activity operated with a long time horizon, or at least this was the intention when mining started.

These definitions might seem circular in that having a priori defined a rush as being characterised by manual technologies, the historical record was then reviewed and divided into activities using manual technologies and those using additional technologies. However, this is not circular because the two forms of activity are

---

separated, physically and temporally, by the physical reality of the depletion of the gold resource. This extinguishes the rush. Many major mining historians recognizes this. Moreover, the historical survey in this chapter shows that the two forms of activity were always sequential, as would be necessary if one depended on the extinction of the other. Also, there may have been some blurring in this chapter between hand methods and transitional methods such as hydraulic washing, and with the use of horses and long toms in Victoria, but there could never have been any blurring between gold rush hand methods, which at best worked two yards per day, and ground sluicing, hydraulicking, machine puddling, deep leading, which could treat anything from at least ten to hundreds of yards per digger per day.

In one form or another, gold panning, sluice boxes, and ground sluicing were stable technologies that were used for winning gold from ancient times. Conversely within the nineteenth century the innovations of the gold pan, the long tom, and deep leading, and the invention of the cradle and hydraulicking occurred. Once introduced these new technologies entrenched themselves in the corpus of alluvial mining technology. It does not seem possible, as Edgerton appears to advocate, to separate innovation from technologies-in-use as far as the gold rushes and nineteenth century alluvial mining are concerned.

---

170 For example, see Rohe, “Origins and Diffusion,” 155; Paul, 65-66; and Serle, 73.
CHAPTER 2: THE TUAPEKA GOLD RUSH AND ITS TECHNOLOGY

In this chapter, the Tuapeka Gold Rush of 1861 serves as a basis to investigate the role of technology in gold rushes in more detail than was possible in Chapter 1. As noted, the occurrence of the rushes in a global setting can be related to Western diffusion into new regions but a point not discussed was that prospecting expertise, though not essential, was often significant locally.¹ Before examining the technology of winning the gold, in this chapter I also investigate the role of prospecting as a form of technology in the Tuapeka Gold Rush. The role of depletion in the dynamics of a gold rush and its transition to mining is also studied.

Spot Finds and Near Misses

Due to New Zealand’s Circum-Pacific geological provenance, alluvial gravel beds that contained gold were widely distributed in Otago and Southland. The South Island Maori knew of this gold but attributed no value to it, because they did not need a monetary base, and because they mostly used the local jade, known as pounamu, for cultural production.² On the other hand, beginning in 1851, Europeans in the form of

---

¹ Invoking Western diffusion, J. McCarty’s argues compellingly that “deposits were discovered and exploited in order of their accessibility.” The writer agrees fully, since accessibility is a function of increasing Western diffusion across what, to the West, were frontier lands. McCarty also states that some kind of a popular expansionary spirit, even zeitgeist, was also a necessary condition. See J. McCarty, Suggestions for an Economic History of North American Mining in the Nineteenth Century,” in Pacific Circle, ed. Norman Harper, (St. Lucia, Queensland: University of Queensland Press, 1968), 94-100. Geoffrey Blainey makes a similar argument though he invokes specific economic conditions (a trough or recession) and low labour costs rather than an expansionary mood as an accompanying necessity to the diffusion of Western people. M. J. Morrissey and R. Burt challenge Blainey’s broad economics with intricate econometrics. Mel Davies uses details of the discovery of copper in South Australia to both support McCarty’s and Blainey’s thesis of Western penetration and rebut Blainey’s concept of low labour cost as an incentive. See Geoffrey Blainey, “A Theory of Mineral Discovery: Australia in the Nineteenth Century,” The Economic History Review, second series, XXIII., (1970), 298-313; R. J. Morrissey and R. A. Burt, “Theory of Mineral Discovery: A Note,” The Economic History Review, New Series, 26 no. 3, (1973), 497-505; Geoffrey Blainey, “A Rejoinder,” The Economic History Review, New Series 26, no. 3 (1973), 506-509; and Mel Davies, “Blainey Revisited: Mineral Discovery and the Business Cycle in South Australia,” The Economic History Review, New Series XXV, (1985), 112-128.

² VPOPC, Session XVI, 1862, Gold Fields Departmental Report, V. Pyke, 1 October 1862, 15.
untrained individuals, amateur scientists, government survey staff, and even so-called “experienced prospectors,” made a number of “spot” finds of gold in Otago and Southland.³ None of these finds demonstrated a payable goldfield though the survey traverses of J. T. Thomson and Alexander Garvie found gold in the Lindis, Tuapeka, Clutha, Waitahuna, and Manuherikia rivers, where goldfields were proven later.⁴ Nor did the posting of a reward of £500 by the Provincial Council in 1857 for finding an “available goldfield,” to counter the loss of the workforce to the North-west Nelson gold rush lead to success.⁵ Included in the claimants was Edwards Peters, who was a Hindu farm worker known at the time as “Black Peter.” In 1857, he had found gold on the west branch of the Tokomairiro River, soon to become known as the Woolshed diggings, but his claim for the reward in 1859 was refused.⁶ He also discovered gold in the Tuapeka River in 1857 for which he was again refused the reward. In 1860, a mining trial failed at Tuturau on the Mataura River where Ligar had found gold in 1856.⁷ Something more than these people had offered was needed to uncover a viable goldfield.

It took an experienced digger, Samuel McIntyre, to initiate Otago’s first rush. McIntyre had Californian experience and found gold in the Lindis River in March 1861 while working in a road gang in the northern Dunstan Ranges and prospecting after

---

³ Note: A “spot” or “grab” sample is a single sample of gold or gold bearing material, and is insufficient to establish the existence of a payable goldfield. Vincent Pyke, Secretary for the Gold Fields, summarised the spot finds in his first report in 1862. See VPOPC, Session XVI, 1862, Gold Fields Departmental Report, 1 October 1862, 15-17. For some of the individual announcements see VPOPC Session V, December 1856, Appendix, 32; “Educational Meeting,” OW, 24 October 1857, 5; “Local Intelligence. Gold,” OW, 4 April 1857, 4; and J. T. Thomson, “Lecture on the Province of Otago: Its Description, Resources, and Capabilities,” OW, 31 July 1858, 6.

⁴ Alex. Garvie, “Report on the Reconnaissance Survey of the South-Eastern Districts of the Province of Otago, executed during the months of October and November, also February, March, and part of April, 1857-1858,” OPGG III no. 91, 22 September 1859, 279. Pyke suggests that news of these important gold finds did not excite the public because it had been “buried in the pages of that respectable periodical [the OPGG] … - probably it was never seen beyond official circles.” See Pyke, Early Gold Discoveries, 17-18.

⁵ The petition that called for a reward was presented on 4 November 1857. It used the term “remunerative Gold Field,” which was standard wording, but when the sum of £500 was posted in the Provincial Council Appropriations, it used the uncommon term, “available Gold Field.” See VPOPC Session VI, 1857, Appendix, 42; and “Provincial Council,” OW, 7 November 1861, 2.

⁶ “Local Intelligence: Gold,” OW, 5 August 1859, 3.

hours.\textsuperscript{8} Thomson had publicly reported gold in the Lindis from his survey of 1858 but it was not his role to foment a rush. McIntyre reported to Superintendent Richardson that more than a dozen men were obtaining two to three ounces daily.\textsuperscript{9} A rush through Oamaru built up to two to four hundred on the diggings who included eight Maori and diggers from Victoria and produced perhaps something over 2,000 ounces of gold.\textsuperscript{10} However, the activity collapsed in the winter of 1861 due to the scanty gold resource, winter conditions in the high country, and competition by then from the Tuapeka Rush.\textsuperscript{11} The Provincial Council rejected McIntyre’s application for the £500 reward.\textsuperscript{12}

McIntyre, while skilled, located only a modest gold resource. This raises the question of how a goldfield was actually discovered and why Gabriel Read should have struck a bonanza when Edward Peters could not do so. In his Master’s thesis, A. P. F. Browne suggests that Blainey’s economic model may explain the occurrence of the Gabriel's Gully gold rush. Blainey holds that mineral discoveries arose in Australia when there was an increasing population on the frontier and when economic conditions made labour cheap and available. Browne shows that Otago went into recession in 1860 after relative prosperity in the late 1850s and indeed McIntyre’s road making was a public works programme for the unemployed.\textsuperscript{13} However, as others have shown, Blainey’s delineation of economic change points was imprecise, rendering questionable his correlations with discovery patterns, and that surplus or cheap labour was not essential.\textsuperscript{14} This leaves only McCarty-Blainey Western diffusion across mineralised frontiers as a valid factor. It is not necessary to consider econometric theory any further, in any case, because Edward Peters and Gabriel Read each prospected the same

\textsuperscript{8} For the discovery, see “Local Intelligence,” \textit{Lyttelton Times}, 20 March 1861, 4; and “Local Intelligence,” \textit{OW}, 6 April 1861, 5. Regarding McIntyre’s Californian experience see Edward McGlashan, “Lindis Gold Fields,” \textit{OW}, 4 May 1861, 5.

\textsuperscript{9} A. P. F. Browne, “The Otago Goldfields, 1861 – 1863: Administrative and Public Life” (MA diss., University of Canterbury, 1974), 7. If McIntyre’s claim were true such riches did not last long.

\textsuperscript{10} For general information see \textit{Lyttelton Times}, 20 March 1861, 4; \textit{OW}, 6 April 1861, 5; “Lindis Gold Fields,” \textit{OW}, 4 May 1861, 5; Robert B. Booth, \textit{Five Years in New Zealand (1859 to 1864)} (London: J. G. Hammond, 1912), 58, 68; and Pyke, \textit{Early Gold Discoveries}, 21-24. For reference to eight Maori see “The Lindis Gold Fields,” \textit{Lyttelton Times}, 26 June 1861, 2. No gold yields were officially recorded but based on say 1,000 gold seekers in total and 2 ounces on average recovered by each, (many of them got no gold at all and soon left), a very rough estimate of the yield is 2,000 ounces.


\textsuperscript{12} Pyke, \textit{Early Gold Discoveries}, 23; and Advertisements, \textit{OW}, 4 May 1861, 4.

\textsuperscript{13} Land sales, and wheat and wool exports were significantly reduced in 1860 from the late 1850s. See Browne, “The Otago Goldfields,” 2-7.

\textsuperscript{14} See discussion about McCarty and Blainey et al., 55n1.
ground. This reduces the question of the discovery of Gabriel’s Gully to one of personal capabilities.

**Gabriel Read’s Path to the Bonanza**

Born in Tasmania in 1825 into a successful Hobart business family, Gabriel Read held a degree from Cambridge University, and was a kindly and pious person. However, after suffering a serious head injury in his youth, he was subject to erratic behaviour. He gained alluvial experience as a Trans-Pacific “Forty-Niner” in the Californian gold rush and from time on the Victorian diggings, making some money but never a pile. Following the Eureka rebellion of late 1854 Read left the Victorian goldfields and settled down in the family bailiwick near Hobart where he farmed and lived a rural lifestyle. He died in 1894 after seven years in a psychiatric hospital.

Gabriel Read left two sets of correspondence that document his activities in New Zealand. The first set was a series of letters he wrote to Superintendent Richardson dealing with his discovery and prospecting campaigns in 1861 along with one or two later letters written to Richardson as a friend, and letters to Pyke. The second set comprises two long letters or memoirs written in 1887 that Vincent Pyke requested of him for the history of the Otago gold discoveries that he was writing. Read writes in an effusive and often indirect style and it is possible to take many meanings out of what

---

17 For letters to Superintendent Richardson see VPOPC Session XIII, 1861, Appendix, Reports and Correspondence Respecting the Discovery of Gold, and Subsequent Gold Prospecting Expeditions, xv-xxi; and Gabriel Read, letter of 15 April 1869, in A. W. Reed, ed., *Gabriel’s Gully and Dunedin in 1861* (Wellington: A. H. and A. W. Reed, 1957), 19-23. For citation of correspondence with Pyke in 1861 and 1862, see Browne, 242n5, 244n19 and n21.
18 For edited versions of these, see Pyke, *Early Gold Discoveries*, 121-132. For a full copy of the second letter see Gabriel Read, letter, “Discovery of Otago Goldfields,” 1887, McNab Collection, Dunedin Public Library. As Browne argues, and I agree, these appear to be written to justify the grant of the reward to Read by subtly downplaying the possible contributions of anyone else, for example John Gillies, who, Read hints, also thought he was entitled to the reward.
he has written. Some of his 1887 statements also conflict with his 1861 ones.\textsuperscript{19} We must therefore read his correspondence carefully.

In February 1861, according to his 1887 documents, he impetuously sailed to Port Chalmers, seeking the Mataura diggings which somehow he knew about.\textsuperscript{20} Further, while passing through the Tokomairiro district, he passed the time of day with Mr John Hardy, an Otago scheme settler, farmer, civil engineer, the local Member of the Otago Provincial Council (MPC), and a general booster.\textsuperscript{21} On explaining his mission and asking Hardy’s opinion, Hardy replied that, “Well, it is a singular thing, there appears to be gold all round, but nobody has been able to find anything to pay.”\textsuperscript{22} Somewhere past Balclutha, hearing only negative reports of gold Read turned back. (Refer to Figure 4 for local place names.)

Passing through Tokomairiro, he met Hardy again and told him that he was looking for work in Dunedin before returning to Tasmania. Hardy, who knew of Edward Peters’ activity and truly believed that there was a munificent goldfield somewhere in the district, saw in Read an expert capable of finding it. He offered Read work and accommodation to get the harvest in and Read accepted.\textsuperscript{23}

\textsuperscript{19} For example, in a letter to Superintendent Richardson in 1861 he states that he came to Otago to be a yeoman farmer, whereas in one of his letters to Pyke in 1887 he says that he came to Otago to try the Mataura diggings. See VPOPC Session XIII, 1861, Appendix, Reports and Correspondence Respecting the Discovery of Gold, and Subsequent Gold Prospecting Expeditions, Letter (4), xix; and Pyke, \textit{Early Gold Discoveries}, 122.

\textsuperscript{20} For Read’s arrival date, see Ernie McCraw, 4. The 1856 find was Ligar’s spot sample but Browne notes that Read was also aware of Roebuck and Blackmore’s 1860 trial mining campaign. See Browne, 242n5.


\textsuperscript{22} Pyke, \textit{Early Gold Discoveries}, 122.

\textsuperscript{23} Pyke, \textit{Early Gold Discoveries}, 122-123; and McCraw, 5.
In the Tokomairiro, Read regained his interest in gold when he attended a campaign meeting for the superintendency in early May 1861. Read used his detailed knowledge of Victoria to support a local man, John Lillie Gillies, to strongly rebut arguments about the Squatters’ Association in Victoria made by candidate McMaster. After the meeting, Gillies, who had been a digger in Victoria for over three years, thanked Read and told him that Edward Peters, the discoverer of the Woolshed diggings, had also struck gold in the Tuapeka River further inland. Gillies had panned some gold there with Peters earlier in the year and liked the prospect but considered that Peters was only “hen-scratching.” He planned to return and test the place properly at a convenient time. This sparked Read’s interest and as a competent prospector, he commenced accumulating information. He cannily made enquiries and confirmed Gillies’

---

24 “Advertisements,” OW, 4 May 611, 4; Pyke, Early Gold Discoveries, 39, 40.
25 Pyke, Early Gold Discoveries, 39.
comments about gold in the Tuapeka River; due to Hardy’s boosting a German named John Fischer, of the Woolshed diggings, visited Read and impressed him with “a nice sample” of gold; and Read prospected and found some gold in the North Branch of the Tokomairiro River.\textsuperscript{26} With every encouragement from Hardy, Read became even more enthused and left a note for Gillies that he was leaving for the Tuapeka River immediately. However, before departing, and showing his standing in the Tokomairiro district already, Read delivered the Tokomairiro papers from the 17 May election to the Superintendent-elect, J. L .C. Richardson, in Dunedin and took the opportunity to establish a relationship with the new Superintendent. After discussing his plans, Read, ever the professional, asked about prospecting rights. Richardson advised that there were no regulations, but Read should of course behave prudently on the runholders’ leases. Further, he offered his support to Read should any issue arise.\textsuperscript{27} From then on Read and Richardson regarded each other as friends.

Read’s prospecting expedition was systematic and concentrated. After leaving Hardy’s farm, Helensbrook, on 23 May, he found gold throughout four hours of panning in the Waitahuna River.\textsuperscript{28} He arrived at the Tuapeka River on Davy and Bowler’s Bellamy Station, (Run 137) the next afternoon. Bellamy Station and other localities in the Tuapeka District are shown on Figures 5 and 6. After setting up his camp, Read spent the remaining two hours of the day testing the Tuapeka River after a shepherd (Runs 53, 54, and 137 adjoined locally) had shown him where Peters had been working which was near Evans Flat.\textsuperscript{29} The results were unexciting and Read decided to return there only as a last resort.

\textsuperscript{26} For Fischer, and Read’s prospecting in the North Branch, see Pyke, \textit{Early Gold Discoveries}, 123, 125. For Read’s enquiries, see Butler in No Author, \textit{Gabriel’s Gully Jubilee, Reminiscences of the Early Gold Mining Days} (Dunedin, NZ: Gabriel’s Gully Jubilee Committee, 1911), 28.\textsuperscript{27} Pyke, \textit{History of Early Gold Discoveries}, 123-124.\textsuperscript{28} McCraw calculates the start date of 23 May after counting off Read’s activities since meeting Richardson on 19 May. See Ernie McCraw, 12-13.\textsuperscript{29} Two shepherds claimed to have shown Read the spot; one was William Cunningham, a young shepherd on Bellamy Station (Davy and Bowler’s Run 137), for whom Edward Peters had worked in 1857-57, and the other was George Munro, the head shepherd on Run 53, which followed the eastern boundary of Run 137. Read himself refers only to Munro, and in their separate letters to Pyke in 1887 both Read and Munro state that Read spent the night with George and his wife Helen in their dwelling in Munro’s Gully. For Munro’s statements see Pyke, \textit{Early Gold Discoveries}, 40-41 and for Read’s statements about Munro, see Ibid, 126-128. For Cunningham, see \textit{Gabriel’s Gully Jubilee}, 25-26. Peters had been fossicking along the Tuapeka River near where Evans Flat and the main road bridge are today.
With his practised eye, and most likely after some panning, he had already decided that the gully he had passed immediately before the Tuapeka River looked promising. Next day, Read started far upstream in the narrow forest-bound headwaters of this gully, which was known as Black Creek. Finding poor prospects in bouldery ground on a deep bottom, he tested his way downstream and struck gold opposite a distinctive spur. Continuing downstream, late in the day and about 1 ½ kilometres from the spur, he reached shallow ground where the valley pinched in. Here he made a rich strike of nearly two ounces of gold. In the following days, he tested the next flats eastward, (Wetherstons), the creek and banks joining the two catchments, and the district in general. On his last day, he returned to Black Creek to collect a quantum of gold to prove his find to officials and colleagues, again a thoroughly professional operator, and

---

31 According to local historian Jean Jackson, the gully was known before the gold rush as Glen Dhu, a Gaelic name that meant Black Glen. It was also known on Bellamy Station (Run 137) as Back Valley. See Jean Jackson, *The Blue Spur Bubble* (Dunedin, New Zealand: 1984), 2; and Cunningham, *Gabriel's Gully Jubilee*, 25.
32 Pyke, ibid, p128-129.
for gifts. For greater “production,” he puddled the gravel in his oilskin groundsheet before panning and recovered about seven ounces of gold.\(^\text{33}\)

Read returned to Hardy at Helensbrook on 2 June and wrote a letter of discovery dated of 4 June to Superintendent Richardson. This recorded that he had prospected the Waitahuna and Tuapeka catchments and had found many gold occurrences that would be payable with standard equipment, but above all, in one place, he had recovered some seven ounces of gold in ten hours. This was undeniably a bonanza. Without further verification, showing that he already trusted Read, the Superintendent passed the letter to the *Otago Witness*, which published it on 8 June 1861.\(^\text{34}\) After organising a dray load of supplies, to be brought up by “Brooks” one of Hardy’s farm hands and Edward Hardy, a son, Read left again for the Tuapeka on 5 June, taking John Hardy to witness the bonanza.\(^\text{35}\)

While Read was away in Milton, Helen Munro, the wife of George, made a rich strike in Munro's Gully. A passing traveller also told William Cunningham, a shepherd on Run 137, that Read had struck gold in Black Gully. William collected James White, his head shepherd, and together they found Read’s tent and started panning. "Being inexperienced, they “could only raise a colour.”\(^\text{36}\) In the middle of this, Read returned with John Hardy. Competent and adaptable Read made another contrivance, this time from manuka poles and bedding fabric, and washed out three ounces in front of them. While waiting at Bellamy Station for the dray, (see Figure 5) Read made them a cradle, and they won eight ounces on their first day.\(^\text{37}\) When Edward Hardy and Brooks arrived with the dray, Read formed a mining party with them and started serious digging.\(^\text{38}\)

The question of whether Edward Peters deserved the reward for discovering “an available goldfield” instead of Gabriel Read highlights the technology of prospecting.

\(^{33}\) Pyke, *Early Gold Discoveries*, 129-130; and “Tokomairiro Gold Fields - New Discoveries,” OW, 8 June 1861, 5.

\(^{34}\) Ernie McCraw, 15; Pyke, *Early Gold Discoveries*, p124; and “Tokomairiro Gold Fields – New Discoveries,” 5.

\(^{35}\) Read never indicated any Christian name for “Brooks,” who was a young labourer from Yorkshire on Hardy’s farm. Edward Hardy was a son of John. For the other information, see Ernie McCraw, 17; and Gabriel Read, Letter, 1887, 3.


\(^{37}\) Ibid.

\(^{38}\) Read, letter, 1887, 4.
Since both men had prospected the Tuapeka River and Gabriel's Gully, exogenous factors such as economic cycles and the various forms of “luck,” are virtually eliminated, leaving prospecting expertise as the difference between them. Read displayed high expertise. First, he scouted the entire Tuapeka River prospect in two hours and rated it poorly. Peters kept returning there but never struck it rich, and nor did anyone else in the rush period. Peters had tried the head of Gabriel's Gully with a partner Thomson, but found it too wet and deep and gave up, whereas Read also found this but methodically worked his way downstream until he struck the shallow rich bonanza. Second, by the end of little over a week of prospecting, Read had tested and correctly assessed all the main Tuapeka diggings, including Waitahuna. In comparison, Peters had discovered the Woolshed goldfield, gold on the Tuapeka River, and he claimed, gold at Waitahuna. Nevertheless, although he possessed sharp eyes and worked hard, he was not a skilled prospector, as Gillies had noted, and he completely missed the bonanza of Gabriel's Gully. Moreover, of his finds over a four year period only the Woolshed was worked. Third, in the voluntary prospecting campaigns that Read had completed in September 1861, his conclusions remained reliable even though he found little gold; the Waipori catchment proved reasonably remunerative as he implied it would be, while his traverse west of the Clutha around and beyond the Pomahaka catchment did not reveal much gold, and few made money there later. Read’s prospecting tools and methods were simple – a gold pan, a pick and shovel, and a butcher’s knife for gold in crevices, not to mention his groundsheet and ad hoc sluice. His use of these was manifestly skilful, and coupled with these were his deductive capabilities, enriched by experience, and his expert and systematic collection of information: by enquiry, by observation, and by sampling with the gold pan. He thus applied a combination of natural and other types of knowledge to a productive purpose; in other words, he used the form of technology known as

39 Pyke, Early Gold Discoveries, 37, 39, 40-41, 97-99.
40 Pyke, Early Gold Discoveries, 99, 128.
41 The area that he did not touch was Munro's Gully, possibly because he only traversed it while walking with George Munro to his cabin at the end of his day’s work on 24 May. Read’s rejection of Evans Flat was correct at the time as it only became workable at a later stage.
42 For Peters’ claim of a discovery at Waitahuna, see Pyke, Early Gold Discoveries, 38. Read had explicitly identified gold there in his first trip on his way to the Tuapeka. He returned in July taking John Cargill and Captain Baldwin of the Teviot station with him to prove his assessment. They did so, which led to Waitahuna becoming a viable diggings. See Pyke, Early Gold Discoveries, 31-34.
43 VPOPC Session XIII, 1861, Reports and Correspondence Respecting the Discovery of Gold and Subsequent Gold Prospecting Expeditions, Report dated 6th November 1861, xv; and Letter (4), 30 September 1861, xviii-xix.
prospecting. Peters’ knowledge of alluvials had apparently originated from a Californian in Balclutha who had told him simply that gold was often associated with white quartz.\textsuperscript{44}

**Structuring the Rush**

In spite of Read’s proficient delineation of a real goldfield with bonanza grades, the rush struggled to incubate. Read and the “Tocks” mounted a campaign of clarification.\textsuperscript{45} In late June, Read wrote again to the Superintendent confirming that he was recovering the same grades as his discovery.\textsuperscript{46} J. L. Gillies, finally with a party at the Tuapeka, also wrote to the Superintendent to say that Read’s party had recovered approximately 60 ounces of gold in seven days and added that, “in all my digging experience of three and a-half years in Victoria, I never saw a richer prospect.”\textsuperscript{47} John McIndoe, a brother in law of Gillies wrote to the *Otago Witness*, stating that they had witnessed Read’s party recovering four ounces of gold with a long tom, and that Cunningham and White, the two shepherds with Read’s cradle, were doing as well as Read, at an excellent three ounces each per day.\textsuperscript{48} Gillies and McIndoe also referred to increasing numbers heading for the Tuapeka from Tokomairiro and the need for a gold escort and an official to adjudicate disputes.\textsuperscript{49}

This information had its effect. The Superintendent took action by sending Message No. 11 to the Provincial Council on 28 June.\textsuperscript{50} In this, he vouched for Read’s assessment of the existence of a large, rich, and workable goldfield. In addition, no doubt mindful of the Californian and Victorian gold rushes, he asked for special powers

\textsuperscript{44} Pyke, *Early Gold Discoveries*, 41, 97-99.  
\textsuperscript{45} Read was rather dismissive of the local Tokomairiro people and referred to them as “Tocks.” See Read, letter, 1887, 1.  
\textsuperscript{46} “Latest from the Tokomairiro Gold Fields,” *OW*, 29 July 1861, 5.  
\textsuperscript{47} The members of the party were J. L. Gillies; J. T. [sic] Gillies, seemingly a mistake for Thomas Bannatyne Gillies, who was a brother of John; James McIndoe, married to J. L. Gillies’ sister Elizabeth; John Burnside was married to Janet, another sister of J. L. Gillies, and who lived in Dunedin; and a Mr Edward Martin, who may have been the Mr Martin from the Woolshed diggings. See “Original Correspondence, Tuapeka Gold Fields,” *OW*, 29 June 1861, 5; “Burnside, John Arthur (1857-1920),” in *Southern People*, ed. Jane Thomson (Dunedin, NZ: Longacre Press and Dunedin City Council, 1998), 71; and “Gillies, John (1871),” Ibid., 184. For John Gillies’ letter see ‘Latest from the Tokomairiro Gold Fields,’ *OW*, 29 June 1861, 5.  
\textsuperscript{48} James McIndoe, “Original Correspondence, Tuapeka Gold Fields,” *OW*, 29 June 1861, 5.  
\textsuperscript{49} John Gillies “Latest from the Tokomairiro Gold Fields,” Ibid.; and James McIndoe, Ibid.  
\textsuperscript{50} “Provincial Council. Friday, 28th June,” *OW*, 6 July 1861, 3.
to deal with any urgent action necessary to ensure civil order and security for the gold produced. He would also send Chief Surveyor Thomson to the goldfield for an official assessment.51 In the debate on the message, John Hardy added Read’s views that the gully would become the richest surface diggings in the world. Council approved the Superintendent’s requirements.52 This reliable official information prevailed over the scepticism and the rush broke out. On 6 July, a week after the Tokomairiro letters and Council debate, the Otago Witness displayed the famous words, written by proprietor, editor, and MPC, W. H. Cutten:

Gold, gold, gold, is the universal subject of conversation … The fever is running to such a height that if it continue, there will be scarcely a man left in town. … The public must not be surprised if they find an announcement on the door of the Witness Office of ‘No Paper this week – gone to the Diggings!’53

The detailed report of Chief Surveyor Thomson, a man of undoubted objectivity and competence, raised a further clamour a week later when published in a special late edition of the Otago Witness. There were 150 diggers in the field during Thomson’s visit and he expected that this would have doubled in the next week. He concluded that there was sufficient evidence of the occurrence of payable gold to justify the establishment of a goldfields police force, a Goldfield Commissioner, and a gold escort.54

Read did not end his prospecting at Gabriel’s Gully. In July, he took John Cargill and Captain William Baldwin, an energetic young run holder, as partners, to re-test Waitahuna 10 kilometres short of Gabriel’s Gully, where he had panned gold on his original journey to the Tuapeka. They confirmed workable gold.55 After finishing at Gabriel’s Gully he voluntarily prospected for the provincial council on an expenses paid

51 “Latest from the Tokomairiro Gold Fields,” 5. Enquiries regarding a senior police position must have started with the Lindis rush, because a Mr St. John Brannigan had already been contacted and had indicated his willingness. See “Provincial Council. Friday, 28th June,” OW, 6 July 1861, 3.
52 “Provincial Council,” Ibid.
53 Editorial, OW, 6 July 1861 , 4.
55 Pyke, Early Gold Discoveries, 33-34. John Cargill was a successful Gabriel’s digger and a fisherman-seaman from Waitati. He was not the son of Captain Cargill.
basis, in the Waipori and Waitahuna headwaters in September, and in the Pomahaka catchment and further south west in October. These campaigns were of mixed success as already noted.\textsuperscript{56} His letters show that Read genuinely wanted to help the authorities by finding new goldfields that would absorb the gold-ravenous “hordes” pouring out of Victoria.\textsuperscript{57} At the same time, as Browne points out, this work increased the obligation on the Council to pay Read the £500 reward, and indeed he resigned from prospecting the day after the Council awarded him the reward.\textsuperscript{58}

Before the rush there were probably only six permanent residents in the Tuapeka area but by early July, there were up to 300 diggers in Gabriel's Gully and Wetherstons.\textsuperscript{59} By July, people from outside the province were arriving by ship and one or two ships had discharged from Victoria.\textsuperscript{60} By the end of July, there were an estimated 2,000 diggers in the Tuapeka-Waitahuna district and by October, up to 8,000 diggers.\textsuperscript{61}

Whereas the Provincial Council was initially mostly interested in maintaining civic order in the face of the gold rush, the gold seekers sought fair play on the diggings. Early in a rush, fair play meant fair access to ground, for which the two largest challenges were land monopolisation and claim jumping. Claim jumping was the use of spurious arguments or force, or both, to dislodge a digger from a legitimately held claim. Regarding monopolising, there were no rules at the start and some of the earliest arrivals to the Tuapeka claimed entire flats or gullies. Gabriel Read recalled a Scottish claim-grabber who pegged 80 claims “for the rest of the clan.” Wearing official looking blue clothing, he attempted to use his intimidating size to hold onto them, but he did not succeed for long.\textsuperscript{62} Some kind of regulatory structure was called for.

A legal basis for gold mining in New Zealand had existed since the enactment of the Gold Fields Act 1858 (the “Act”) in response to the Northwest Nelson Rush. This provided authorisation to take the Crown’s gold by means of a Miner’s Right, but

\begin{footnotes}
\item[56] VPOPC Session XIII, 1861, Gabriel Read Report and Letters.
\item[57] Ibid.
\item[58] Browne, 242-243.
\item[59] The known six inhabitants were James Cunningham and John White on Bellamy Station, George and Helen Munro on Run 53 and Peter and Janet Robertson on Run 54. For the numbers in early July, see J. T. Thomson’s report in OPGG IV no. 148, 9 July 1861, “Official Report on the Tuapeka Gold Fields,” 228-229.
\item[60] “Local Intelligence. Goldfields,” OW, 20 July 1861, 5.
\item[61] “Latest From The Goldfields,” OW, 20 July 1861, 5; and “Summary,” 12 Oct 1861, 4.
\item[62] Henry Walton in Gabriel's Gully Jubilee, 12-13; and Read, 8.
\end{footnotes}
initially served largely only as a broad framework, and on-site regulatory management awaited provincial regulations.\textsuperscript{63} Behind this lay a legal mechanism in that only the Governor was entitled to exercise authority under the Act, but the Act also provided for the Governor to delegate authority. In the case of Otago, this delegation was implemented in stages, or piecemeal. There were three main sections, the authority to declare a goldfield and make regulations, the authority to institute Wardens’ Courts, and the authority to grant mining leases. The Miner’s Right entitled the holder to exclusive occupancy of a defined piece of ground, known as a “claim,” within which the holder could extract and take possession of the Crown’s gold.\textsuperscript{64} Importantly, it also provided a right of residence on land within a goldfield. Following Victorian law, a Miner’s Right cost one pound and was valid for one year. These entitlements constituted user rights, not property rights and therefore conferred no title.\textsuperscript{65} Most importantly, the Act and these rights applied solely to Crown land that had been proclaimed as a goldfield. In addition, on a proclaimed goldfield, gold extraction took priority over the rights of the holder of a depasturing licence, which was another user right. “Private land,” known as “freehold” land today, was different and the landowner owned the right of access to gold, which effectively meant ownership of any gold in the land. A landowner could refuse mining, or grant access onto the land by agreement with the miner.\textsuperscript{66}

The regulatory system was interlinked with technological issues. Apart from provisions for granting tenure and resolving disputes, rules relevant to technology were required for ensuring that activities on one claim did not prejudice activities on another. This was particularly important for races because they crossed tenements already being

\textsuperscript{63} Much of the Act was also concerned with the granting of mining leases and the setting up and operation of Warden’s Courts. These sections had little applicability until a transition to mining commenced.

\textsuperscript{64} As in most countries and most definitely in those with a British or European heritage, it was axiomatic that the crown owned all gold in its natural state. This was referred to as the Regalian Right.


\textsuperscript{66} Strictly, the freehold landowner owned only the right of access to any gold, but since the gold could not be extracted without access, the right of access was in practice equivalent to ownership. If access was granted it was usually on the basis of a royalty to the landowner, as in the Appalachian goldfield. Much of the Woolshed diggings occurred on Walter Miller’s privately owned Roxburgh Station, and he allowed gold mining by royalty.
mined or likely soon to be. Early in the transition to mining, the Otago regulations were revised to facilitate the working of lower grades or difficult ground. As mining proceeded, the emphasis changed to the prevention or moderation of externalities, that is, adverse impacts on third parties. Uncontrolled tailings dumping was the most aggravating of these, but the free taking of public water in races was widespread and was never properly dealt with. As the extraction technologies intensified the regulations tended to lag.

In spite of the delegation of the necessary powers to the Otago Superintendent in early June 1861, in response to the Lindis rush, and in spite of the detailed Victorian regulations available as a template, the Superintendent did not issue gold mining regulations until October 1861.67 Some 39,000 ounces had been escorted to Dunedin by then.68 However, as we have seen in Chapter 1, in the absence of governmental authority, diggers willingly established their own regulations through miners’ committees, and in New Zealand they had so done in the Northwest Nelson and Lindis rushes.69 Consequently, J. L. Gillies organised the formation of a Miners’ Committee for the Tuapeka diggings. The diggers elected Gabriel Read as chairperson, and John L. Gillies as adjudicator. The committee set the claim size at 24 feet square, the same as the Victorian alluvial standard, and among its rules, to counter wasted claims and ineffective working, stipulated that anyone arriving without provisions and tools could not peg a claim.70

For its part, in July the provincial government established other elements of a regulatory structure. The first was a gold escort, which delivered its first consignment to Dunedin on 12 July.71 On 17 July, the Superintendent made the foundational

---

67 For the delegation of powers see OPGG IV no. 149, 19 July, 1861, 231. The Governor reserved his power to issue leases and to institute Warden’s Courts. For the issue of the Regulations see OPGG IV no. 153, 16 October 1861, 255-256.
68 This is escorted gold from 12 July until 4 October inclusive. See for example “Monthly Summary,” OW, 23 November 1861, 9.
71 “The Gold Escort,” OW, 13 July 1861, 5. Modelled on Victoria, the escort comprised a troupe of uniformed and armed police who carried the gold in secure containers on one or more pack horses, and later, in a wagon. A miner, storekeeper, bank, or anyone else holding gold, deposited it with the Gold
proclamation of the Tuapeka Gold Field. This covered 21,000 hectares (51,000 acres) of land that comprised part of the catchment of the Tuapeka River, and the Gabriel's Gully, Munro's Gully, and Wetherstons diggings, but not Waitahuna. The Waitahuna and Waipori diggings and finally the Woolshed were included later. Figure 5 shows all of these in the full-sized proclaimed goldfield of October 1862. In this figure the southeastern boundary is the North Branch of the Tokomairiro River and it continues as the southern boundary along the main road from Milton to Lovells Creek. These sections are not shown because they would overprint the topographical data.

In a significant milestone, Superintendent Richardson appointed a Commissioner on 21 July and on 24 July, he appointed a Gold Receiver and an Assistant Gold Receiver. All took office in the Tuapeka around 19 August. The appointment of Commissioner Mr A. C. Strode, a longstanding magistrate in Otago, was timely, as claim disputes were becoming more demanding than the Miners' Committee could deal with. Even so, a Commissioner was a lower level official than a Warden, who sat in a Warden’s Court, and whose legal training and authority were comparable with those of a District Court judge. In civil matters Commissioner Strode functioned at the level of a Resident Magistrate. The Gold Receivers, Mr T. W. Parker and Mr John McKay, occupied multiple roles: as well as receiving gold for the escort, they issued miner’s rights and business licences, registered goldfield claim transfers and agreements, and received land rentals and all other governmental payments. On 28 August, Mr St John Brannigan from Melbourne took office in Dunedin as Commissioner and Inspector of Police for Otago.

Receiver in the government offices in the goldfield and received a receipt. The depositor could then either redeem the gold in person in Dunedin by presenting the receipt, or he or she could direct the gold to be deposited in a bank. This was a free service funded from the gold export duty of 2/6d per ounce. Nevertheless, at least initially, a number of diggers preferred to carry their gold personally to Dunedin. Using the official data on escorted gold, exported gold and bank gold stocks, private gold transfer averaged around 12 – 15 percent of the gold exported over time.

72 OPGG IV, 149, 19 July 1861, “Proclamation,” 231.
73 This date was why the first issues of Miners’ Rights, and there was a large number of them, occurred on 19 August 1861. See Register of issue of miners’ rights and business licences in the Tuapeka gold fields, 19 August-1 November 1861, Tuapeka Magistrate's Office, qMS-2045, Alexander Turnbull Library. For the appointments, see “Monthly Summary”, OW, 31 August 1861, p4; and OPGG IV no.150, 20 September 1861, 234.
74 For A. C. Strode’s background, see “Strode, Alfred Rowland Chetham (1823-1890),” in Southern People, 487.
75 OPGG IV no. 150, 20 September 1861, 234.
Peak Gold

From July to November 1861, we can see the consolidation of the rush. Yields continued at the same rich levels as those at the start of July and the inrush of gold seekers increased. In August and September, many of the original parties were still obtaining gold prolifically: John Cargill and Party won 43 ounces in one day in August; in the 2½ months since the start of the rush Peter Lindsay’s party of three, one of the most successful, had recovered around 250 ounces each, worth nearly £1,000 per member; and in mid-August Gabriel Read’s party was still getting nearly 3 ounces daily per member. Other excellent returns included Johnson’s five man party who won 4 ½ oz. per digger-day for eight days and £5,000 worth of gold up till early September, and Miller’s party of five (possibly Wattie Miller, proprietor of Roxburgh station), at 162 ounces (5 kg) in three days in early September and “close on £5, 000,” or around 1,300 ounces since start up in June. Munro's Gully began to show out too with Wilson and Party winning 39 ounces in a few days, an unnamed two-man party gaining 60 ounces each in a week, and others reputedly “turning out a pound weight a day.” It was results such as these that lodged in the communal memory, rather than the unrelenting grind of the work, or the hard luck stories.

The pulling power of these returns reached Victoria, where by 1861, wages work or tributing in deep lead or quartz mines was the main form of employment. Incomes were poor as shown by the annual yield for a miner in Victoria in 1861 of £69, whereas it was £229 for that year in Otago. In addition, the Victorian economy was in poor shape. Serle draws attention to a crisis that had emerged in 1857 with “extensive unemployment and distress…,” and notes that “The years 1854 to 1861 were a time of rapid deflation…” He further refers to “The economic crisis of the later gold-rush

---

80 VPOPC Session XVI, 1862, Departmental Reports: Gold Fields, 19-20.
81 Serle, 239.
period from 1857 to the early sixties …”\(^82\) This partly motivated Read’s volunteer prospecting campaigns. In a letter to the Superintendent, he commented, “This Victorian invasion [of Otago] is more the result of the distress prevailing in the other Colony,” [namely Victoria] and “the 250,000 who are barely existing on their goldfields.”\(^83\) Victorian diggers thus faced strong push as well as strong pull factors. Extensive immigration from Australia began in August, when fifteen ships booked passengers for Otago. In one week in September, 3,297 persons departed from Melbourne for Otago.\(^84\) These people brought wide experience of gold mining technology that was important in the further development of the Tuapeka goldfields.

By September, many of the Gabriel’s Gully originals had left or soon would do, having worked out their claims or having made enough money for a new life. One commentator went so far as to say that most of the departees had cleared between £150 and £700, and were keen to buy land, or invest in horse or bullock teams.\(^85\) On the other hand, Chief Surveyor Thomson could see the underlying exhaustion of the best ground when he noted that, “Many of the first diggers are leaving the field, being satisfied with what they have made, and doubtful of further great success.”\(^86\) Gabriel Read and his two co-workers had pulled out in mid-August, because Read had promised the Superintendent two months earlier that he would “do my best to make room for the large number of people who might be expected” by prospecting for a new bonanza.\(^87\) Their claim was not exhausted, because their successors recovered 80 to 90 ounces by early September.\(^88\) Serle’s estimate, noted above, of a seven-week average stay in the Victorian rush indicates similar timing of around two months for initial gold rushers.

\(^{82}\) Serle, 246.
\(^{83}\) VPOPC Session XIII, 1861, Reports and Correspondence, T. Gabriel Read, Letter (2) and Letter (3) dated Tuapeka 16\(^{th}\) September 1861, xvii-xviii.
\(^{84}\) Editorial, OW, 14 September 1861, 5; and “Melbourne,” OW, 28 September 1861, 6. For the impact in Victoria see for example, “The New Zealand Gold Fields,” OW, 14 September 1861, 3.
\(^{86}\) OPGG IV no. 151, “The Tuapeka Gold Field,” 26 September 1861, 237-238.
\(^{87}\) VPOPC Session XIII, 1861, Reports and Correspondence, T. Gabriel Read, Letter (2) dated Tuapeka 16\(^{th}\) September 1861, xvii. This may have meant that he would simply exit his claim in Gabriel’s Gully but it may also mean that he would go prospecting in order to find new ground that would accommodate a rush of Australian diggers. Read did then carry out prospecting from September until mid-November.
\(^{88}\) “The Gold Fields,” OW, 7 September 1861, 5.
October finally saw the appearance of the official “Rules and Regulations of the Tuapeka Gold Fields” and Major Edward Croker replaced A. C. Strode as Commissioner. The Regulations continued to honour the longstanding culture of mass access. The Miners’ Committee standard claim of 24 feet square was retained; this originally derived from the Victorian miners’ egalitarian philosophy of giving every person a chance, regardless of their station in life. No one could hold more than one claim at a time, and subject to reasonable exceptions, a claim was liable to forfeiture if left unworked for more than 24 hours.\textsuperscript{89} A claim could be bought and sold, even though it remained a user right.\textsuperscript{90} The Regulations also granted the holder of a Miner’s Right entitlement to the electoral franchise.\textsuperscript{91} This had been an important step in the democratisation of the Victorian goldfields after the Eureka rebellion, and may have reflected Chartist thinking in the Otago government.

A number of provisions in the Regulations reflected the state of technology on the diggings. The fact that long toms and sluice boxes were in use and required more water than cradling was recognised in provisions for creek diversions, water races, and tailraces. Following techniques seen in the Brazilian and Appalachian goldfields, there was provision for turning a river in order to work the bed.\textsuperscript{92} A considerable area of ground must have been worked out already and depletion becoming obvious because a double claim was made available for “worked ground.”\textsuperscript{93}

\textsuperscript{89} OPGG IV no. 153, Rules 3, 4, and 15, 255-256. In addition, Rule 6 stipulated that claims were to be marked by solidly buried pegs that extended at least 2 feet above the ground but this was not strictly followed. As one reporter noted: “Boundary pegs, … are of the most fragile description: a bullock’s horn, an empty bottle stuck with the mouth downwards, or occasionally a battered salmon tin are made to do duty.” See “The Gold-Fields,” OW, 15 February 1862, 5.
\textsuperscript{90} OPGG IV no. 153, Rule 25, 256.
\textsuperscript{91} OPGG IV no. 153, Rule 1, 255.
\textsuperscript{92} OPGG IV no. 153, Rules 9, 10, and 16-18, 255-256.
\textsuperscript{93} OPGG IV no. 153, Rule 3, 255.
### Table 1. Tuapeka Monthly Gold Returns, July 1861- September 1862

<table>
<thead>
<tr>
<th>Period</th>
<th>Escort Gold Oz Tuapeka Goldfield$^{94}$</th>
<th>Number Of Diggers</th>
</tr>
</thead>
<tbody>
<tr>
<td>July 1861</td>
<td>(2,500)$^{95}$</td>
<td></td>
</tr>
<tr>
<td>August 1861</td>
<td>5,056</td>
<td></td>
</tr>
<tr>
<td>September 1861</td>
<td>19,040</td>
<td>6,000$^{96}$</td>
</tr>
<tr>
<td>October 1861</td>
<td>46,613</td>
<td></td>
</tr>
<tr>
<td>November 1861</td>
<td>73,904</td>
<td>15,000$^{97}$</td>
</tr>
<tr>
<td>December 1861</td>
<td>58,870</td>
<td>14,000$^{98}$</td>
</tr>
<tr>
<td>January 1862</td>
<td>47,391</td>
<td></td>
</tr>
<tr>
<td>February 1862</td>
<td>42,473</td>
<td></td>
</tr>
<tr>
<td>March 1862</td>
<td>32,202</td>
<td>12,000$^{99}$</td>
</tr>
<tr>
<td>April 1862</td>
<td>22,863</td>
<td></td>
</tr>
<tr>
<td>May 1862</td>
<td>22,944</td>
<td>6,000$^{100}$</td>
</tr>
<tr>
<td>June 1862</td>
<td>12,877</td>
<td>5,000$^{101}$</td>
</tr>
<tr>
<td>July 1862</td>
<td>10,376</td>
<td>5,000 or fewer$^{102}$</td>
</tr>
<tr>
<td>August 1862</td>
<td>14,186</td>
<td>Includes some gold from the Dunstan Rush that was brought down for the Tuapeka escort.</td>
</tr>
<tr>
<td>September 1862</td>
<td>12,619</td>
<td></td>
</tr>
</tbody>
</table>

$^{94}$ Except for July 1861, the escort data comes from VPOPC Session XX, 1865, Report XIV, Return showing the Total and Comparative Amount of Gold ..., 63.

$^{95}$ The July and 1 August escort total is as reported by the *Otago Witness*, but the official VPOPC tables do not show this gold, possibly because the Gold Receivers did not arrive in the Tuapeka until 19 August. For the escort values see “The Gold Escort,” *OW*, 13 July 1861, 5; and “Summary,” *OW*, 12 October 1861, 4.

$^{96}$ Thomson estimates 3,000 working in Gabriel's Gully alone and “not less than 6,000 people on the diggings.” 6,000 diggers is my round up to include the other Tuapeka diggings. See “Local Intelligence, Our Gold Fields,” *OW*, 21 September 1861.

$^{97}$ “What Our Goldfields Really Are,” *OW*, 16 November 1861, 4.

$^{98}$ *Statistics of New Zealand for 1861, Including the results of a Census of the Colony Taken on the 16th December in that Year*, Table 1 and Table 11, 1862. Table11 shows 10,830 miners in Otago, while Table 1 states that an estimated additional 3,000 diggers had been uncounted because they were working in isolated locations or in transit on census day. The resulting total of 13,380 diggers has been rounded to 14,000 for this thesis.

$^{99}$ “Prospects of the Otago Gold Fields”, *OW*, 15 March 1862, 3. This took a total population of 16,000 on the diggings estimated by a journalist and applied a factor of 75 percent to represent active diggers.

$^{100}$ “Gold Fields,” *ODT*, 17 May 1862, 4. This is based on a journalist’s estimate of total goldfields population of 9,000 reduced by 2/3 (Pyke’s ratio) to derive the number of active diggers.

$^{101}$ “Narrative of Current Events for Transmission to Melbourne”, *ODT*, 7 August 1862, 5. It have reduced an estimate of total goldfields population of 7,630, made by the staff of the Goldfields Department, to 67 percent, Pyke’s standard ratio for the number of active diggers. The journalist reduced the total population number to only 52 percent, surely an unreasonably low ratio but one that produced a better yield of gold per miner than 67 percent.

$^{102}$ VPOPC Session XVI, October 1862, Reports, Gold Fields, 18, 20. On page 18, Pyke indicates “about” 7,000 total in July from staff counts, and suggests that 66.7 percent, or 4,669 of these, were diggers, while on page 20 he states an average of 6,000 diggers for May to July. The writer here stays with the page 18 version, and rounds it to the nearest 1,000, with reservations since the ongoing winter might well have seen fewer diggers in July than May.
No sooner was the full regulatory regime in place than the Tuapeka Rush peaked. After 46,600 escort ounces in October, escort returns reached 73,900 ounces in November, and was followed by the lesser amounts of 58,900 ounces in December, and 47,391 ounces in January 1862. See Table 1: Tuapeka Monthly Gold Returns, July 1861 to September 1862.

The goldfields population also peaked around November 1861, although the data is imprecise due to the large floating population. Referring to Table 1: in September 1861, Thomson estimated 3,000 diggers and 6,000 people of all categories in the Tuapeka goldfield; a November newspaper estimate, probably the most imprecise of all, gave 15,000 diggers; and most precisely, the December 1861 census assessed 13,380 diggers including those in isolated locations and in transit on census day. On the basis of another rather imprecise newspaper estimate, this had declined to 12,000 in March 1862.

The Technology of the Rush

While core gold rush technology remained manually based over centuries there were different emphases of techniques depending on the local characteristics of the deposits coupled with increasing innovation through the nineteenth century. What applied in the Tuapeka Rush?

The Tuapeka deposits were alluvial but not clayey or deeply buried as were those in Victoria. The gold occurred in alluvial deposits without strongly defined leads in valley or gully floors or above the valleys. In Gabriel's Gully, the paydirt lay at less than a metre deep where Gabriel Read made his strike, and increased to around four metres at the head. The gold lay within a thin layer (50 – 500 mm thick) of gravel on a weathered schist bottom (known locally as ‘slate’) and the gold had penetrated into crevices or cleavages within the schist. Inexperienced gold seekers could easily miss

---

103 VPOPC Session XVIII, 1864, Report XIII, Gold Fields’ [sic] Department, Table Showing the Total and Comparative Amount of Gold … Escort, 136.
this paydirt. On the other hand, one careful party in Munro's Gully collected 50 ounces of gold from crevices with a spoon. In Munro's Gully, the entire deposit was perched up from the valley floor in blind gullies in the continuation of the Blue Spur Conglomerate through the ridge from Gabriel's Gully. At Wetherstons, gold could occur from the tussock roots down.

Extraction utilised the same manual digging with pick and shovel or spade as in previous gold rushes. Paddocking was ideal for the Tuapeka shallow wash in valley and gully floors and in any case, the looseness and wetness of the ground made shafting undesirable due to the expensive timbering required. Thomas Gillies noted that the dimensions of paddocks were, “12 to 20 feet or upwards in length, by from 4 to 8 feet in width.” Effective dewatering was important because most of the ground was saturated and saturated sidewalls tended to collapse. Wetherstons’ flats were particularly wet and many like John Watmuff’s party found it extremely frustrating to have to abandon promising paddocks because they could not keep the water down, and find that another party had made a pile there later when the flat had been drained by the extent of later workings. Collapses of the sides were a dangerous hazard as well. Baling out by bucket was the simplest technique, but hand operated chain pumps, known as Californian pumps in Otago and Australia, though of Chinese origin, were much used. Figure 4 depicts a waterwheel driven type. For raising the dirt below a shovel throw depth, whips were common in paddocking, while windlasses were used for sinking shafts. The crew members dumped all the waste material (“mullock” or overburden) lying above the paydirt, around the collar of the paddock or shaft. If the claim did not front onto a creek, the diggers transported the washdirt to the nearest water by wheelbarrow, passing between claims on walls left in accordance with the

---

105 Read’s letter to Major Richardson, OW, 8 June 1861 p5; OW, 20 July 1861, 5; and Allan Houston, “The Goldfields of Otago, A.H.’s Jottings 1865, with Lithographic Illustrations …”; first two pages, (unnumbered), Misc-MS-1413, Hocken Collections, University of Otago.
106 “News of the Week,” OW, 24 May 1862.
107 A blind gully was a local gully that was too short to have a permanent creek.
110 See Chapter 1 for a description. For considerable numbers in Gabriel's Gully see “Our Gold Fields,” OW, 24 August 1861, 5.
111 In a rush the more intricate and expensive horse whims were never justified. Any later shaft mines in Otago used the more effective steam or water turbine powered winding engines.
regulations. In parts of Wetherstons and Waitahuna where creeks were more distant, horse drawn drays carried the wash to water. Other than these, extraction was executed manually with standard digging tools.

The processing of Gabriel's Gully paydirt was different from all previous practice in that hydraulic washing was applied from the start. We have seen that Read made a cradle for the two Bellamy shepherds but he used a long tom himself. Thomson’s July report identified sluices (meaning sluice boxes), and long toms in use as well as cradles. Later in July, Thomas Gillies stated that “Long-toms do not appear to be great favourites,” and that sluices were more numerous than cradles. He thought that cradles would replace sluices because they recovered more fine gold. However, poor operating technique or inexperience rather than any inherent metallurgical weakness was more likely to cause loss of gold in sluices. Henry Walton’s party did extremely well with a sluice: “With our sluice box, we had the laugh. We could, five of us, sink and clean a paddock a day, getting 50 oz and 60 oz. a paddock.” Field concentrates from sluice box, long tom or cradle were cleaned up by panning. Once panned down, there would usually remain some black sand and other heavy mineral particles. The digger would dry the product in his tent at night, and carefully pan and remove the contaminants, possibly using a special flat bottomed, straight sided pan made for the purpose, with an open flat snout off one side. This allowed the dry contaminants to be puffed out to leave clean alluvial gold in the pan. Amalgamation was not much reported in the Tuapeka.

Hydraulic washing was more productive than cradling but its immediate use in a gold rush requires some explanation. Unlike Victoria, adequate water for tomming or sluicing was readily available on most of the diggings all year round. In addition, the skill base had already diffused to New Zealand and did not have to be built up as in California. Many Otago settlers had not arrived directly from the United Kingdom but had been diggers in Australia, and when the rushes faded in the mid to later 1850s, or

---

112 See Rule 4, in “Rules and Regulations of the Tuapeka Gold Fields,” OPGG IV no 153, 16 October 1861, 255.
113 VPOPC Session XVI, 1862, Departmental Reports: Gold Fields, 23.
114 McIndoe, Original Correspondence, OW, 29 June 1861, 5. Needs more.
115 “Provincial Council, Saturday, July 6,” OW, 13 July 1861, 3. See also OPGG IV no. 148, 9 July 1861, 228-229, for the formal presentation.
117 Walton, Gabriel's Gully Jubilee, 12, 13.
for other reasons, they had moved to New Zealand, where their expertise had been lying dormant. These included J. L. Gillies, Walter Miller, and Henry Walton. Another category was H. L. (“Holy Joe”) Gilbert, who was familiar with the technology from having been a miner in Cornwall before migrating to Otago in 1860. Hydraulic washing had also been practised in Northwest Nelson goldfield and in the Lindis before the Tuapeka rush and some of these practitioners, for example, Thomas Henry Cullen and Gersham Curtis, were early gold seekers in Gabriel’s Gully. Close at hand, too, one of the parties at the Woolshed used a long tom. Another contributing factor in the early use of hydraulic washing in the Tuapeka was that the Otago paydirt was relatively clay-free and did not need puddling, thus improving the gold recovery from hydraulic washing.

The work structure, or organisation of the work, is also part of a particular technology. In line with the simple tools and methods, the work style for alluvial gold mining seen in previous rushes continued in the Tuapeka rush. This consisted largely of cooperative parties of mostly previously unskilled individuals. Incorporated companies were rare, if they appeared at all, during the rush. Casual wages work was also acceptable as a route for poorly funded or poorly equipped inexperienced gold seekers to learn the techniques and build up a stake. A pound a day was not unusual for a good worker, though this settled down over time to ten or eleven shillings daily. However, wages work was not always a free choice, because, as noted, the Miners’ Committee prohibited gold seekers with no supplies or equipment from staking a claim. Another dynamic that lay behind the working of claims was the endemic need to find the next claim. When eight weeks, very broadly, was the working life of a paddock on the flats somewhere, and less if a wall collapsed or it was too wet to reach the bottom, gold

---

118 Walton’s experience was shown by the fact that he took the planks for a sluice box with him from Dunedin when he joined the rush. He also commented that he responded to the news of the rush like an old war-horse responding to a bugle. See Walton, ibid. For Miller as a “Victorian” see Pyke, Early Gold Discoveries, 39.


120 The rules of the Northwest Nelson Miner’s Committee provide for sluice box and tomming. See “Rules and Regulations Agreed Upon . . . ,” Nelson Examiner and NZ Chronicle, 18 March 1857, 2. See also Editorial, The Nelson Examiner and New Zealand Chronicle, 11 April 1857, 2; and The Nelson Gold Fields,” The Nelson Examiner and New Zealand Chronicle, 13 June 1857, 3. The origin of Curtis and Cullen in the Nelson diggings was the reason for the name of the “Nelson Company” on the Blue Spur. They were one of the first ground sluicing parties in the Tuapeka. For the Lindis field, see Booth, 65; and “The Lindis Gold Fields,” Lyttelton Times, 26 July 1861, 2.


seekers spent considerable time and energy finding the next claim. The search represented a form of prospecting and local gold rushes were another, regardless of how irrational they seemed too many commentators.

What then of Gabriel Read’s expectation that the Tuapeka would be the richest surface diggings in the world? The most reliable data for the California gold rush indicates a total of 12,000 ounces in its first nine months, whereas the first nine months of the Gabriel’s Gully rush saw 188,000 ounces of gold exported, let alone produced. In an attempt to smooth out possibly gross under-reporting in 1848, looking at the first twenty-one months of Californian output shows 503,000 ounces. On escort gold for the Tuapeka goldfield, and allowing ten percent extra for gold moved privately, the total from July 1861 until the end of April 1863 was 550,000 ounces. On this data, the Tuapeka goldfield was more productive than California over their first twenty-one months. Hydraulic washing was twice or more productive than cradling, and as discussed in Chapter 1, hydraulic washing by long tom began to replace cradling in California approximately a year into the rush in 1849, and the more productive box sluicing a year later. It is quite possible that technology in the form of experienced diggers and hydraulic washing contributed to the high production of the Tuapeka goldfield in comparison with the mostly inexperienced gold seekers who flooded into California in 1848 and 1849. A close check of California production data might clarify that anomaly but without detailing gold grades, Read’s judgement was sound; the Tuapeka and Gabriel’s Gully proved exceptionally productive.

123 See J. Hardy in “Provincial Council,” OW, 6 July 1861, 4.
124 Paul, California Gold, 345. This shows gold value for United States fiscal years, which end in September. The discovery strike was at Sutter’s Mill in January 1848, which means that the data for fiscal 1848 arose from the first nine months of the rush. Converting the given gold value of US$ 245,301 at the Treasury gold price of US$20.67 per fine ounce derives 11,867 fine ounces for fiscal 1848. The disparity between California and the Tuapeka is so great that considerable Californian gold must have escaped any record keeping. It should also be remembered that gold output in California increased exponentially in the next few years after 1848. For Otago see AJHR C2, 1895, Table No. 3, 24.
125 Paul, California Gold, 345. Note that twenty-one months of the gold rush represents the first two fiscal years.
127 Paul, 60-65; Rohe, Origins and Diffusion, 134-136, 138-139; and May, Origins, 36, 37.
Depletion and Transition in the Tuapeka Goldfield

After November 1861, notwithstanding yet more rich individual results even in the original Gabriel’s Gully site, and full rushes to Wetherstons and Waipori, the escort returns showed a different picture.128 This was a sharp and persistent decline from the peak of 74,000 ounces in November to 42,500 ounces in February 1862 as seen in Table 1. Sparse estimates for February imply around 15,000 persons on the goldfields in that month, which was not much smaller than the peak. Since a similar number of diggers had produced significantly less gold, the grades of gold in the ground had dropped. The richest grades were becoming exhausted and this was a fundamental turning point in the rush.

The diggers were forced into more difficult parts of the diggings. With most of the floor of Gabriel’s Gully turned over, diggers moved to the valley sides or the hills and ridges between the main valleys, or to abandoned ground. Experienced Victorians probably led the move to sink shafts on the hills (“hill sinking”) that divided Munro’s Gully, Gabriel’s Gully and Wetherstons, which revealed the rich top horizons of the Blue Spur.129 Other diggers moved 1½ kilometres up Gabriel’s Gully from the zone of the original strike to the head. This ground was deeper and wetter than downstream, and though it meant a challenging six to eight metres of sinking it could be even richer.130 In addition, this area lay at the foot of, and drew diggers onto, the Blue Spur.

Due to gold left in tailings by unskilled early operators, or in good ground foregone due to poor testing, or false bottoms, some diggers found it profitable to rework abandoned ground.131 This existed as a chequerboard of untouched ground beside or buried under

---

128 For the Wetherstons rush and 900 ounces in one claim, see ‘Arrival of the Escort with 19,700 ounces’, OW, 2 November 1861, 5; “The Gold Fields,” OW, 30 November 1861, 4; “Summary,” OW, 14 December 1861, 2; and “The Gold-Fields,” OW, 15 February 1862, 6. For Waipori see “Reported New Gold Field at the Waipori,” OW, 21 December 1861, 2; “The Waipori Diggings,” OW, 28 December 1861, 7; and “Rambles Through the Gold Fields,” OW, 8 February 1862, 3. For Gabriel’s Gully, see “The Goldfields”, OW, 18 January 1862, 5; and Ibid., 15 February 1862, 6. The volume of a mining bucket was not given but was probably greater than a large farm/household bucket, which contains 20 litres. A 25 l bucket would hold 45 kg of material and be close to a working limit.

129 Original Correspondence, OW, 7 September 1861, 5; “The Gold Fields”, OW, 7 September 1861, 5; Ibid., 30 November 1861, 4; and Ibid., 18 January 1862, 5.

130 “Our Gold Fields,” OW, 31 August 1861, 5.

131 A false bottom is a barren horizon that the washdirt lies on that a digger mistakes for true bottom because of its differences in colour, hardness, and sedimentology from the auriferous horizon deposited on it. Below a false bottom there is a true bottom somewhere deeper down that is often extremely rich. See “Monthly Summary,” OW, 31 August 1861, 4; and “Summary” OW, 12 October, 1861, 4.
mullock (waste) heaps and collapsed and water-filled paddocks or shafts. Such ground had to be pumped out and the sloppy mullock removed to reach the unmined ground. On the other hand, at Wetherstons, the original paddocking, often deserted because of water problems, had opened up so much wet ground that it had drained itself over time, thereby making much early abandoned ground workable.

These remaining types of ground usually required more unpaying time to reach the wash. This emphasised the need for more productive or more effective methods. Sinking to as much as twenty metres deep was necessary in hill claims, and with slabbing for shafts and propping for underground extraction, it required more skill and was more costly than paddocking. 132 Parties pooled capital and labour for riverbed mining: twenty-three Victorians from Ballarat committed £1,200 for a long diversion of the Waipori River that required extensive rock blasting and fluming, while twenty-one men in three parties combined to divert the Waitahuna River. 133 The techniques remained manual but these were hardly gold rush activities.

While there was no additional difficulty in processing the washdirt, the capacity of long toms and box sluices was limited. Parties in Wetherstons tried puddling, which had been highly effective in Victoria. 134 In May 1862 seventeen puddling machines were operating there, for an aggregate capital of £6,000, and the claims were paying well. However, the Tuapeka deposits proved to be more gravelly than clayey, and the operating costs of puddling machines, due to the horses, outpaced any extra gold recovery as gold grades continued to decline. Puddling was abandoned in the Tuapeka. 135

Another option to new technology in the Tuapeka was prospecting. The willingness to chase rumours in bogus rushes such as the Sam Perkins affair indicates the desperation

---

132 Editorial, OW, 2 November 2, 1861, 5, and “Summary,” OW, 16 November 1861, 4. A Victorian pointed out that the Otago ground was so much weaker than Victorian (“such rotten ground”), that he considered underground mining too dangerous, given the lack of timber for ground support. He therefore advocated hydraulic mining as in California. See “Snowy River” (pseud.), “The Gold Fields. Tuapeka,” ODT, 16 December 1861, 4; and “Tuapeka,” ODT, 14 June 1862, 5.

133 “The Gold Fields,” OW, 1 February 1862, 3; Ibid., 25 January 1862, 7; and “The Gold-Fields,” ODT, 1 April 1862, 5.

134 For example, see “The Gold-Fields,” ODT, 3 March 1862, 2; “Goldfields,” ODT, 15 April 1862, 5; “The Gold Fields,” OW, 10 May 1862, 6; and “Tuapeka” OW, 24 May 1862, 2.

135 “The Gold-Fields,” OW, 3 May 1862, 7; Ibid., 10 May 1862, 6; “The Gold Fields -Tuapeka,” OW, 24 May 1862, 2; and “News of the Week,” OW. 27 September 1862, 5. Puddling was later found beneficial in parts of Waitahuna and at Hamiltons in the Maniototo.
to find new ground. Read’s government-supported campaigns foreshadowed the Waipori goldfield. The estimated 3,000 unenumerated persons in the December 1861 census show the scale of prospectors and fossickers dispersed across Otago. Another official prospecting expedition led by Mr W. McCrae, into Northern and Central Otago in October-November 1861 reported colours in many places but found nothing compelling. Through 1862, though, there were some successes. A promising area revealed in February was Dunstan Creek in the upper Manuherikia valley. This became the large deep St. Bathans goldfield. In April 1862, 1,500 people rushed the lower Tuapeka River five kilometres downstream of the Junction and this provided a living for many for a few years. In May there was a rush to Mount Highlay in the catchment of the Taieri River and the district yielded modestly for decades. However, none of these diggings compensated for the decline in the core Tuapeka diggings.

One simple change used in California and Victoria to counter depletion was to increase claim sizes so that the revenue from the greater volume would recoup working capital expended in sinking shafts, pumping out, mucking out, and so on. Under the term “Extended Claims,” this became a mantra in Otago. In early 1862, the Superintendent commissioned John Hardy, now the Provincial Secretary, to advise improvements in the regulations in view of the changing modes of operation. The revised regulations appeared on 26 February 1862 and as expected, they provided larger claims for deeper paddocks and shafts; for “worked and abandoned ground;” for extracting the bed of a river; and for wet ground and envisaging steam pumps, additional claims for wet ground were to be granted pro rata on pump horsepower.

---

136 For example see Pyke, *Early Gold Discoveries*, 47-49.
137 VPOPC Session XVI, 1862, Reports and Correspondence Respecting the Discovery of Gold and Subsequent Prospecting Expeditions, Report by Mr. W. M’Crae, 11 November 1861, xvi – xvii.
141 Examples of the clamour for Extended Claims include: “Waitahuna,” *OW*, 14 December 1861, 2; “Snowy River,” supra; “Tokomairiro”, *ODT*, 9 January 1862, 2; and Unnamed, *ODT*, 29 January 1862, 2.
142 OPGG IV no. 165, 5 March 1862, 309 – 310.
Indicating prospects of permanence, a claim was introduced for quartz mining but there was no recognition of mining leases. 143

The need for regulations that recognised the increasing difficulties of working the deposits and offered support for working capital, signified a transition to alluvial gold mining. The February 1862 Regulations therefore confirmed the trend of the escort results that the gold rush was ending.

Another sign of a transition was an emerging social dimension. With gold rush civil disruption evidently under control, the provincial government was looking beyond the dying gold rush to long-term settlement in the goldfields. Hardy’s brief on regulatory matters included instructions to investigate social services and “how we may manage to offer sufficient inducements to the fine body of men who have come to our shores to settle permanently among us.” 144 Hardy recommended enhanced funding for a hospital and the establishment of residence leases to supplant the loose right of occupancy of a Miner’s Right. As a civil engineer-surveyor he also fixed sites for townships, to be known as Lawrence (at the “Junction”), and Havelock (at Waitahuna), recommended that the Council upgrade local roading, and that local lignite be mined and made available at cost for the comfort of goldfields inhabitants over winter. 145 The provincial government had implemented most recommendations by early February, and introduced residence leases in August. The first sections in the new townships were advertised in September. 146

Gold output continued to decline throughout 1862 and amounted to 10,376 ounces in July as shown in Table 1. Output was severely hindered by a ferocious winter in which races froze and workings were often snowed in and made unworkable for up to a week at a time. 147 This only worsened the existing downward trend. As a result of the extremely unpleasant conditions the goldfields population also plunged and many diggers returned to their wives and families in Australia. As a result the peak of

143 OPGG, Ibid.; and Editorial, OW, 1 February 1862, 5.
144 OPGG IV no.162, 5 February 1862, 297-298.
145 Ibid.
146 For the residence leases, see OPGG V no.199, 4 August 1862, 34-35. For the first sale of sections in the new townships, see Advertisements, ODT., 27 September 1862, 3.
approximately 15,000 diggers on the goldfields in November – December 1861 more than halved to approximately 5,000 in July 1862. (Table 1). The Tuapeka Rush was over but the outbreak of the Dunstan Rush in August 1862 completely extinguished any vestige of gold rushing in the Tuapeka goldfield. However, by then mining by ground sluicing had become established on the Blue Spur.

**Tuapeka Technology**

This chapter aimed to show the use of technology as a new framework of analysis for the Tuapeka gold rush. It also aimed to examine issues from previous rushes in greater detail than was possible in Chapter 1. These largely derived from the impacts of depletion. Depletion drove the course of the Tuapeka gold rush, as it did for all other rushes, but technology provided some solutions to the difficulties that arose.

In looking at the technology of a gold rush in this chapter, the first item that is highlighted is that prospecting is a form of technology. Prospecting represents the collection and interpretation of sharply observed geological field information and sampling by gold pan to provide the material good of a rich gold deposit. Many gold rushes have been prompted without it, for example the Californian Rush but Gabriel's Gully provided a case study of expert prospecting by Gabriel Read.

As far as the Tuapeka Gold Rush itself is concerned, the same simple tools and manual techniques sufficed to extract the paydirt as in all three major gold rush regions of the mid nineteenth century. There were no innovations. However, unusually, the diggers in the Tuapeka used full hydraulic washing as well as cradling to wash their paydirt. This may well have delivered a higher rate of production of gold in the Tuapeka rush than previously realised because the data shows that Tuapeka goldfield produced more gold in its first twenty-one months than the first twenty-one months in all of California. Even if the Californian data is so unexpectedly low as to remain suspect, Tuapeka’s apparent superiority over California might be real and if so, the greater efficiency of hydraulic washing in the Tuapeka over cradling in California would be at least part of the reason. The Tuapeka diggers had the additional advantage of a pool of experience.
in New Zealand before the rush and large numbers of experienced Victorian diggers as the rush progressed.

Depletion of the richest and easiest to work ground is the unavoidable reality of the extraction of all mineral deposits. In the Tuapeka Rush, it is shown clearly in the monthly escort gold data, which peaked in November 1861. The diggers moved to lower grade and deeper, wetter, or messier ground and adopted more specialised techniques than the simpler gold rush techniques. Lower gold output still resulted and showed that more productive or effective technology was still needed.

Taking over from the diggers the Otago Provincial Council instituted a regulatory structure to support the use of effective technology. The changed techniques forced by depletion also necessitated changes in the mining regulations to support the resulting more costly and specialised extraction techniques and the reworking of abandoned ground. The revised regulations of February 1862, which took specific account of these changes, can be taken to indicate the end of the rush.

Contrarily, the fact that in February 1862 the Provincial Council also took action to facilitate long-term settlement is evidence of a social aspect of the transition, from the transience of a gold rush to the longer-term stability of gold mining. While this thesis focuses, on technology, it accepts that social and many other areas of endeavour were part of a gold rush too.

The depletion-driven moves to shaft sinking in the ridges between Gabriel's Gully and Munro's Gully and to the valley floor at the head of Gabriel's Gully did not restore gold production to its previous levels but had sown a seed. The material that formed the spur proved to be auriferous and called in the technologies of mining and of these, ground sluicing had been brought into realisation by mid-1862. These technologies are assessed in Chapter 3.
CHAPTER 3. MINING THE MULTI-CHARACTER BLUE SPUR DEPOSIT

Following the inability of hand methods and hydraulic washing to deal with the impacts of depletion, this chapter reviews the application of hydraulic mining and then hard rock methods to mine the Blue Spur deposit. This will show that the technology of gold mining was very different from gold rush in this deposit. It will also reveal that the Blue Spur was an unorthodox alluvial deposit. Given the longer time scale of the activity, this chapter also takes the opportunity to briefly review some aspects of the organisation of the work in terms of Hearn’s comments on associative enterprise and structural change.

The Uncharacteristic Characteristics of the Blue Spur Deposit

Of primary significance in emergence of gold mining in the Gabriel's Gully diggings was the realisation from early 1862 that an entire spur of bluish coloured material, henceforth known as the Blue Spur, contained rich gold. The hill sinking, the rich claims at the head of Gabriel's Gully, and the profitable results of Holy Joe Gilbert and others who had worked high tributary gullies on the Munro's Gully side during the gold rush all showed this.¹ The Blue Spur deposit extended from the upper slopes of Munro's Gully, under the saddle and down into the head of Gabriel's Gully. Figure 6 shows its location schematically and Figure 7 indicates the massiveness and thickness of the deposit. All ground depicted in this view contained gold.

The deposit proved to be thick and extensive in area and was composed of multiple horizons of auriferous gravels with occasional barren clays and with significant thicknesses cemented by silica. The deposit tilted southeast down into the head of Gabriel’s Gully from its exposure high on the sides of Munro’s Gully and it dipped (tilted) to the north east, into the hill upstream of the diggings, where under the land surface it was truncated against a major regional fault known as the Tuapeka Fault. Geologically it was defined as the Blue Spur Conglomerate. In 1864, Mining Surveyor John Drummond estimated a volume of twenty two million cubic metres based on a thickness of thirty metres for this material.

In comparison with other alluvial gold deposits the Blue Spur was unusual because of its bulk, its multiple contiguous gold bearing horizons, and its extensive cementation. Alluvial gold deposits elsewhere typically consisted of two auriferous horizons at the

---


3 VPOPC, Session XIX, 1864, Reports of the Mining Surveyors, 3.
most, the upper one of which would usually be of marginal gold content, would have barren overburden lying on top, and be un-cemented. The deep leads of Victoria reached for kilometres as a single horizon but were deeply buried and required extensive mine development, while the Nevada County placers in California were bulky but most of the bulk was overburden or of poor gold content. The Ross goldfield in Westland was similar to the Blue Spur in being large, coherent, and multi-layered but only a few of the layers were richly gold bearing and much of the deposit lay below ground level which prevented it from being mined in bulk.

The Establishment of Water Races and Ground Sluicing

*Was The Long Race Company at Waitahuna First?*

Without giving a date, J. R. Gascoigne, an important digger, race maker, and businessman, states that the first race “made in Otago for gold-mining purposes” was cut in Waitahuna by John Edie and his Long Race Company. The historians Pyke, Mayhew, Salmon, and Eldred-Grigg repeat Gascoigne’s statement, without attribution, sometimes in Gascoigne’s words. There are many reasons to doubt Gascoigne. While he kept a journal throughout his life and his statement of the sequence of races and ground sluicing around the Blue Spur is accurate, other of his timings are unreliable. The dates he gives for the starting and ending the construction of his water race into Wetherstons and its duration of construction differ by up to a month or more between his journal and a letter he wrote to Vincent Pyke for his 1887 history, and the dates he gives for his arrival in Dunedin in 1861 in these two documents differ by two months. It is also questionable whether The Long Race Co. was “mining.” In a memoir, Eric Skinner considers that a photo of the party at work shows box sluicing, and the writer would agree. As this thesis has been at pains to argue, box sluicing is limited to being

---

4 Gascoigne, 70th and 71st pages.
5 Pyke, *Early Gold Discoveries*, 100; Mayhew, 40; Salmon, 65; and Eldred-Grigg, 184-186. Mayhew indicates it was box sluicing.
6 J. R. Gascoigne left three records of his activities. See Pyke, *Early Gold Discoveries*, 99-101; *Gabriel’s Gully Jubilee*, 21-22; and his full journal, Gascoigne, 70th – 71st page. Although most of his information is comparable across these texts, he provides two start dates and two finish dates for the race. To avoid constant counter-referencing and have one coherent source, the writer uses the data from Gascoigne’s journal.
a transitional technology by its dependence on shovelling. In this case box sluicing was in progress in Munro's Gully in January 1862. For Waitahuna to be first in mining it would have to have commenced ground sluicing before early June 1862, when ground sluicing from Meehan’s race to the Blue Spur commenced. Races had been cut in the Waitahuna goldfield in January 1862 but the context suggests that these were small diversion channels for the extraction of creek beds, which was transitional extraction and not mining. The earliest significant recorded race in the Waitahuna Register of Water Rights was Waitahuna Race No. 6 which was registered in August 1862. This was a long race, no doubt, at eighteen kilometres (eleven miles) long. Warden’s Court records for this race show the date of registration and include the names of John Edie and John Norman, who Skinner names as members of the Long Race Co. The records provide other names earlier then Edie’s and tie together the eighteen kilometre long Race No. 6, Dam No. 9, and the Long Race. Co. Such a length would have taken around six months to complete and even allowing for a month of operating before the registration was lodged, this race and its so-called mining appears later than those on the Blue Spur. Also, a news item dated 12 July 1862 stated that a party in Maori Gully at Waitahuna was “now sluicing” (whether ground or board is not stated) with a race that was nominally fifteen kilometre (nine miles) long. This places the Maori Gully activity, which appears to be the Long Race Co., as starting one month later than the

8 [sic, now known as Toitū Otago Settlers Museum] were J. Edie, J. Bulfin, Jos. Ferris, Baird, T. Burnett, J. Norman, R. J. Johnstone, J. Wilson, and A. McDonald.
9 <http://www.kaelewis.com/database/gold/autopopups/Popup35505.html> accessed 11 February 2014; registration of Dam 9 in Tucker Gully by John Brett, John Norman, and Martin O’Hara on 21 August 1862, <Ibid./Popup35535.html> accessed 11 February 2014; an extended sluicing claim at Maori Gully for Robert Gibson and three others in November 1862, AENX/D583/54, No.4, Application for an extended sluicing claim, 7 November 1862, [Archives New Zealand, Te Rua Mahara o te Kāwanatanga, Dunedin Regional Office]; the transfer of Frederick Jessup’s share in Race No. 6 and dam to James H. Sutter in May 1863, <http://www.kaelewis.com/database/gold/Popup38498.html> accessed 24 November 2013; the transfer of John Brett’s share in Dam No. 9 to John Edie [this is Edie’s first appearance], in May 1863, <Ibid./Popup38500.html> accessed 11 February 2014; registration of the “Code of Rules” of the Long Race Company on 21 September 1863, under the names of Robert Gibson, John Edie, John Norman, and James H. Sutter, <Ibid./Popup37882.html> accessed 11 February 2014; transfer of Robert Gibson’s share in the Long Race Co., Water Race No. 6 and Dam No. 9 to William Ferris; Water Race No. 6 and extensions were noted as being eleven miles long; <Ibid./Popup37628.html>, <Ibid./Popup37633.html> and <Ibid./Popup37635.html> accessed 11 February 2014; the transfer of one seventh share in Race No. 6 from Ferris and Sutter to Robert Johnson and John Bulfin on 25 July 1864, [this is the first mention of Johnson and Bulfin, whom Skinner names in the historic photograph], <Ibid./Popup40640.html> accessed 7 February 2014 ; and the transfer of a one seventh share in the Long Race Company “including Dam, races, etc. etc.” from William Ferris to Joseph Ferris (named by Skinner in photograph), on 22 October 1864, <Ibid./Popup41059.html> accessed 24 November 2013.
10 “Rambles Through the Gold Fields IV,” OW, 12 July 1862, 8.
Blue Spur ground sluicing. Additional data confirms 1863 as the first year that John Edie appears in Waitahuna.\(^{11}\) Other members of the Long Race Co. were present on the Tuapeka goldfield from 1861 onwards, but the company seems only formed in September 1863. So John Edie was probably not in the Tuapeka in mid-1862 and the Long Race was not the first race for mining by ground sluicing.

**Pioneers of the Blue Spur and Munro's Gully**

There was no mystery about ground sluicing as a possible method to replace hand methods in the Tuapeka goldfield. By the peak of the rush there were diggers present with Californian hydraulic mining experience. In December 1861, a writer to the *Otago Daily Times* had advised that Otago was more similar to California than Victoria and ideal for hydraulic mining.\(^{12}\) The Tuapeka alluvials were more gravelly and crumbly than the clay-bound types in Victoria and would sluice more readily. Abundant water was available due to the temperate climate, and the hilly terrain provided both elevation for high heads and also fall for disposal of the tailings. This was important because ground sluicing needed larger races than hydraulic washing because it consumed more water.

James Meehan, an experienced Californian race cutter, initiated the first significant race. Unknown to the pundits, he had approached Commissioner Croker for authorisation in November 1861 to tap into the head of Gabriel's Creek for ground sluicing on the Blue Spur.\(^{13}\) After receiving approval in February 1862 the race was completed and ground sluicing commenced on the Blue Spur in early June 1862.\(^{14}\) With partners Thomas White and James Bryan the group was known as White and Party and later as the Otago Company.\(^{15}\) Meehan sold out of the party in 1863 taking

\(^{11}\) “Edie, John (1853-1918),” in *Southern People*, 144-145. In addition, *Victoria Outwards* shipping records show a John Edie, a miner aged 27 years, leaving Melbourne for Port Chalmers on 29 January 1863.

\(^{12}\) “Snowy River” (pseud.), Letter, *ODT*, 16 December 1861, 4; and Editorial, Ibid.

\(^{13}\) “Early Gold Discoveries – A Correction,” *OW*, 25 March 1887, 14; “The Goldfields Story,” *OW*, 7 April, 1887, 18; and “The Originator of the Blue Spur Water-Races,” *OW*, 22 April 1887, 12.

\(^{14}\) “Early Gold Discoveries – A Correction,” *OW*.

\(^{15}\) Pyke, *Early Gold Discoveries*, 100. Many mining parties designated themselves as “Companies” but few of them were formally registered. They therefore remained legally as partnerships.
£90 for his 1/9 share, which was a reasonable sum, but he had “turned his back on a fortune” because the race reputedly became the most profitable on the Blue Spur.  

By now, many mining parties on the Spur were known as “Companies,” although they were not formally registered. In terms of associative enterprise, they might have been operating with more formality than a gold rush “party” but will be referred to in this thesis as “Co.” Registered companies, which included the Great Extended Sluicing Company (Regd.), the Perseverance Sluicing Company (Regd.), and the Blue Spur Sluicing Company (Regd.), will be shown as “Company.”

Other parties had followed Meehan’s lead in race-cutting. By the end of June or soon after, the Nelson Co., whose two leaders, Thomas Henry Cullen and Gersham Curtis, had worked on the Northwest Nelson diggings, and Hales and Hinde, had also completed races and were ground sluicing on the Blue Spur.  

The Nelson Co. and White and Party were sited on the east and bottom end of the Blue Spur with Nelson operating the southern side, White and Party on the northern, and Hales and Hinde in a sliver between them that widened out uphill and west as shown on Figure 8. These locations would have had minimum overburden and short tailraces, which may have contributed to their parties’ long mine lives: the Otago and Nelson companies continued mining until the great consolidation of 1888 while Hales and Hinde operated until Hinde died in 1883. The Great Extended Sluicing Company bought the claim and carried on mining until 1888.

---

16 “The Goldfields Story,” OW, 7 April 1887, 18; AENX/D583/36 – 82 Sale of share in water race and claims on Blue Spur 18 March 1863 [Archives New Zealand, Te Rua Mahara o te Kāwanatanga, Dunedin Regional Office]. Indicating the value of this race, a 1/8 share sold for £200 in 1862. See “News of the Week”, OW, 4 October 1862, 5.

17 For the Nelson Company see “Early Gold Discoveries – A Correction,” OW; and Pyke, Early Gold Discoveries, 100. For Hales and Hinde, see Mayhew, 38; and “Lawrence,” OW, 1 September 1883, 18.

18 For the death of Hinde and the sale of the claim see “Lawrence,” OW, 1 September 1883, 18. For the sale of Great Extended into the consolidation in 1888 see “The Great Extended Sluicing Company (Registered),” TT, 21 April 1888, 2; and “The Blue Spur and Gabriel's Gully Consolidated Gold Co.,” TT, 21 July 1888, 3.
The first ground sluicing in Munro's Gully also commenced in June 1862, with a race cut by James Graham, another Californian, and well-known around the diggings as “Californian Jim” or “Californian Jem.” Working in Holy Joe’s Gully his party obtained over 120 ounces in a few weeks. Since “Holy Joe” had already made a rich harvest in this ground in the gold rush, this was an excellent advertisement for ground sluicing. Graham went on to specialise in long races from the headwaters of both the Tuapeka and Waipori Rivers.

---

19 For “Californian Jim’s,” activities, see Pyke, *Early Gold Discoveries*, 137; J. R. Gascoigne quoted in Pyke, *Early Gold Discoveries*, 101; and “The Gold-fields, Tuapeka”, *ODT*, 13 August 1862, 5. “Holy Joe” was a Cornish lay preacher whose success in the early gold rush gave the gully its name. After the rush he moved to Port Chalmers and set up a mission for seamen, and provided services for the Presbyterian Church for the rest of his life. See “Obituary. H. L. Gilbert, Missionary, Aged 69,” *OW*, 5 December 1895, 28.

20 See, for example, “The Gold-fields Tuapeka,” *ODT*, 13 August 1862; and “The Originator of the Blue Spur Water-Races,” *OW*, 22 April 1887, 12
The First Commercial Race

J. R. Gascoigne’s proper significance is that whereas all previous parties had cut races for working their own claims, his party cut the first race in the Tuapeka for the commercial sale of water to miners. When working on a claim at Wetherstons, he found that diggers were obliged to pay five to ten shillings per cubic yard to have their paydirt carted by horse and dray to Wetherstons Creek for washing. Having experience as a digger and race company manager in the Mokelumne district in California, Gascoigne could see the opportunity for a water race to supply the miners directly.\(^{21}\) He formed a party of eight and completed a seven kilometre long race into Wetherstons plus a reservoir, in thirteen weeks, finishing in early July 1862.\(^{22}\) By charging the equivalent of one shilling per yard of washdirt the race was an immediate success and put the carters out of business. Operating as the registered Weatherstons Water Race Company the company’s rates differentiated between box sluicing, long toms, and puddling machines, and it provided dam top ups. As standard practice, successive parties were charged for the use of the race water discharged by the preceding one.\(^{23}\)

Races and Technology

Water races exemplify technology in being the means by which skill and knowledge were combined to provide water to satisfy essential physical human needs. Races were also essential for ground sluicing, which was practised for many minerals in many countries as least as early as the time of the Roman Empire. Race construction was equally as old as antiquity. For the Blue Spur, although the technology was long established, it remained a challenge to keep any race on grade while minimising aqueducts, rock cuttings and tunnels, in the often rocky and steep Tuapeka terrain. A typical grade was 1 in 1584, or in field terms, three feet four inches in a mile but it varied to up to fifteen to thirty feet per mile.\(^{24}\) Using long derived techniques the race cutting crew set this with a large wooden A-frame device on which the horizontal cross tie was marked off to correspond to given gradients. The grade was read by checking a plumb line suspended from the apex of the frame (held upwards) against the marks on

\(^{21}\) Gascoigne, 36\(^{th}\), and 40\(^{th}\) – 43rd pages.

\(^{22}\) Gascoigne, 71\(^{st}\) page; and “The Gold Fields Tuapeka,” OW, 12 July 1862, 3.

\(^{23}\) Gascoigne, 71\(^{st}\)-72\(^{nd}\) pages.

\(^{24}\) To negotiate unavoidable difficult sections, the grade could vary considerably for limited lengths. If the grade was too steep the race scoured and if too flat, the required volume would not flow.
the cross-tie. Mining Surveyor Drummond was only called on for setting out and checking the feasibility of long or difficult races, such as when he surveyed the route of Graham’s fifty kilometre long race to the headwaters of the Waipori River.

The excavation (“cutting”) of races required significant time and capital expenditure. The early races to Munro's Gully and Blue Spur took from around three to six months to complete and cost from around £200 to £1,500 or more, depending on the length and capacity of the race and the difficulty of the terrain. Contract or wages workers were employed on the longer races, such as the fifteen to twenty workers engaged by James Graham (California Jim) for his twenty-five kilometre long Race No. 70 from the Tuapeka headwaters to the Blue Spur. The Fenton and Morrison Party, of which Graham was at the time a member, applied for this race in May 1862, to deliver eight heads or 225 litres per second for ground sluicing. One aqueduct was 550 m long and nearly twenty metres above the ground. By November the cost had risen from £1,200 to around £2,000. Such capital expenditure and the duration of construction without an income exclude such activity from being considered as gold rushing.

By 1865 three trunk races had been established over long distances from the Tuapeka, Waipori and Waitahuna catchments. The first completed belonged to Fenton and Morrison as above. This embodied community hopes and anxieties about the very future of the goldfields. The public expectation was that the race’s huge volume of water would be able to single-handedly ensure the future of alluvial gold mining in Otago. The second was Keppel and Co.’s thirty-eight kilometre Hibernian Race from Reidy Creek in the upper Waitahuna River. The third trunk race was the James

---


26 “John Drummond, “The Originator of the Blue Spur Water-Races,” OW.

27 “The Gold Fields, Tuapeka,” ODT, 13 August 1862; “The Gold Fields, Tuapeka,” OW, 2 August 62; Ibid., 9 August 1862. For Gascoigne’s timing see Gascoigne, Gabriel’s Gully Jubilee, 22, and Adventures, 69-71; and Mayhew 38-39. The capacity of the races was typically between two and four heads, or 55 – 110 litres per second.

28 AENX/D583/36-70/Item70 Application for a water race, 5 May 1862 [Archives New Zealand, Te Rua Mahara o te Kāwanatanga, Dunedin Regional Office]. The party comprised James Graham, Thomas Fenton, William D. Morrison, and Francis Nicoll.

29 “The Goldfields, Tuapeka,” OW, 31 July 1862, 5; and Ibid., 4 December 1862, 6.

30 See for example, “Gold Fields. Tuapeka,” ODT, 21 May 1862, 5. The writer wryly noted that with this and all the many other races in progress there would soon be enough water “to wash Tuapeka into the sea.”
Graham and Waipori Water Company epic fifty-five kilometre race for ten heads (282 litres per second) from the upper Waipori River, completed after many adversities in October 1865. The future of alluvial gold mining in Otago was now secure with some 470 kilometres of races delivered water to and around the Gabriel's Gully district.

**Ground Sluicing in Action**

Ground sluicing generated good returns immediately. Most parties in Munro's, at that stage the leading diggings, made good wages at £5-8 per week through July and August. Doyle and Co., who had been earning up to £20 weekly per member per week already, took out nearly 180 ounces, or £700 worth, over five weeks till mid-August. However, box sluicing on the Munro’s Flat could also go well as shown by Chapple and Party whose members had each been winning up to £15 weekly for some time. By August, with many other satisfactory results to hand around the Tuapeka goldfield, the *Otago Witness* noted that sluicing had been found as the best means of extracting the gold from the soil. As Commissioner Pyke’s first report of the Gold Fields Department also observed, “Sluicing is the favourite system.”

Ground sluicing was not only productive but highly effective for the extraction of the thick material that constituted the Blue Spur deposit. The thought of hand shovelling and box sluicing the ground shown in Figure 7 is comical. Ground sluicing also ensured the maximum recovery of the gold since it recovered any lost or unsuspected rich leads along with the rest of the bulk. It was also an effective method for abandoned ground because it flushed all material out without requiring dewatering or the separate removal of mullock.

In addition to its effectiveness, the operating costs of ground sluicing were low because no machinery or heavy maintenance was necessary and the modest costs of labour, at 11 shillings per day, and water, say at £6 –£12 weekly, were distributed over a large

---

31 Mayhew, 38; and “News of the Week,” *OW*, 14 October 1865, 11.
32 VPOPC, Session XXI, 1865, Gold Fields Department Report, 42A
36 VPOPC, Session XIV 1862, Gold Fields Department, 23.
volume. This combination of higher productivity and lower cost meant that ground sluicing could work on much lower gold grades than hand methods. In the Beechworth field in Victoria the breakeven grade for ground sluicing was around 10 per cent of that for box sluicing and 2 per cent of that for cradling. This generated a geometrically greater volume of profitable alluvial ground. This in turn offered the potential for longer working lives and permanent settlement, which was the antithesis of the short stays and tent camps of a gold rush.

Hence, to emphasise arguments in Chapter 1, ground sluicing represented mining and was not a form of gold rushing. Technologically, ground sluicing represented a change from a manual activity applied to small rich and erratic alluvial leads or patches, to a hydraulically mechanised activity applied to lower grade alluvials in bulk. This indicated that alluvial mining could throw off its usual meanings of unpredictable and short lived riches coupled with wild swings in populations and become a permanent industry and engender the same politico-cultural support as quartz mining. This was transformational.

Water races represented an essential component of the technology. A sluicing party that had cut its own race had to stay in place long enough to amortise its capital. A sluicing party could avoid this by buying their water from a race company, but then the race company instead had to pay off the capital. This created a symbiotic relationship between commercial race entities and ground sluicing parties which relied on and therefore encouraged long term activity whoever actually constructed the race. In practice race companies outlasted the mining parties that they serviced, and provided permanent and long-term employment to their race men for the upkeep of the works and managing the distribution of the water.

Regulating Ground Sluicing

Ground sluicing was highly productive but equally so was its generation of sloppy tailings. As a change from hand methods ground sluicing was always likely to have some adverse effects on parties who did not benefit from the advantages, and some

37 Derived from data provided by Peter Wright, quoted in Smyth, 132. Equivalent data is not available for the Tuapeka goldfield.
38 It is a common geological occurrence that the volumes of lower grade ground increase proportionately more than the decrease in grade.
social effects outside the domain of the technology, in other words, externalities. It was not long before they appeared. There was immediate and considerable disquiet that Gascoigne’s party could cut a race and take public water to sell for profit. A more practical issue was the swamping of downstream claims and creeks with tailings. This threw attention onto the regulatory system for the goldfields.

An important administrative appointment consolidated the regulatory system. In May 1862, Mr Vincent Pyke of Victoria took up the newly created position of Commissioner of Gold Fields in the Otago Provincial Council, where he was to organise and lead an Otago Gold Fields Department. Pyke brought to Otago considerable experience, having been a Victorian miner, goldfields storekeeper, writer, member of a Mining Board, magistrate, a member representing diggers first in the Legislative Council and then in the Legislative Assembly, one-time Commissioner of Trade and Customs, and President of the Board of Land and Works. Amongst other achievements he had been responsible for a major and enduring revision of the law for Victorian mining companies.

In June 1862, Pyke brought down a new set of gold mining regulations that were facilitative in the face of continuing depletion and more detailed in relation to the newly appeared technology of ground sluicing. He increased the size of the ordinary claim to thirty feet square and the sizes of special claims for working in difficult conditions. He also clarified water race priorities and added protection for creeks and bridges. He did not directly address the right to take the water but downstream users and third parties were protected to some extent by a right to object to an application for

---

42 Birrell, Staking a Claim, 39, 59, 68.
43 OPGG IV, 193, 28 June 1862, 479–485. Pyke was rather proud of this work (and dismissive of previous versions) and considered that it served as the base for mining regulations throughout New Zealand for the next twenty-five years. See Pyke, Early Gold Discoveries, 66-67 A subtle change was the removal of the right of any holder of a Miner’s Right to challenge anyone else to show theirs on pain of forfeiture of privileges. This power was left solely with authorised officials. See Ibid., Section I, 2, 479.
a water race, by limiting the volume of take in proportion to the size of the applicant party, and the by requirement that sufficient water must always be left for public purposes. Pyke took care to include a definition of a head of water and to prescribe a standard gauge box for its measurement. The design depended on an expert knowledge of the fluid mechanics but their operation was straightforward. In addition, Pyke formalised general administration by strengthening the requirements around the registration of claims, agreements, and transfers. There were no regulations for the direct control of sluicing or its tailings. The impacts of the tailings from ground sluicing around the Blue Spur were probably greater than the Pyke could have envisaged. The scale of “hill sluicing” as it was known and its location above creek workings was not something commonly found in the Victorian goldfields, or at least not until gravel pump mining emerged in the 1890s.

The problem of sluicing tailings came to a head in August 1862 when twenty summonses were taken out in one week against hill sluicers by miners on the creek flats in Munro's Gully. The plaintiffs argued that the hill sluicers’ tailings had blocked Munro’s Creek, which caused it to overflow in floods and swamp their claims with sludge. The cases were heard in the Court of Petty Sessions before Commissioner Croker as resident magistrate. Croker found against all of the hill sluicers except for two large prominent parties, namely Doyle and Co., and Livingstone and Co., for whom the evidence against was deemed inadequate. The penalised defendants appealed on the grounds that the Court was ultra vires. This was part of a broader problem with the regulatory regime. At the personal level Commissioner Croker was criticised for being inconsistent and that when water was concerned, he was said to

44 OPGG IV, No 193, 28 June 1862, Section IV, Nos. 1, 11, and 17, 481-482.
45 Pyke, Early Gold Discoveries, 139; and OPGG IV 193, 481. Pyke defined a head of water as; “A stream of water running for twelve hours each day to be guaged [sic] by a box, 6 feet long, and 20 inches wide, with an opening of a uniform depth of 2 inches across the bottom. The box shall be fixed level in the race, the lower edge of which shall be level with the edges of the box.” Ibid., Section IV, no. 10. This defined a volume of water. Confusion may arise because the term “head” was also used under local definitions as a flow rate, usually around 1 cubic foot of water per second (cusec) and as a unit of pressure head; for example a 300 ft head meant the pressure from a column of water 300 feet high.
46 For the stronger provisions for the registration of tenements, transactions, and agreements, see OPGG IV, No 193, 28 June 1862, 481, Section IX, 483-484. From this provision commenced the main Wardens Court records of mining privileges that historians and genealogist find so valuable.
48 “Tuapeka”, OW, 16 August 1862, 5.
work on the basis of “might is right” and “those that have, shall keep.”\textsuperscript{50} Watmuff called him, “an old woman, an old Scotch captain, who knows nothing about mining or anything,” and this probably reflected the opinion of many diggers.\textsuperscript{51} At a structural level, Commissioner Croker also often mediated disputes by acting \textit{ultra vires}, because the prevailing regulations did not provide adequate authority for him to deal with partnership disputes, compensation for damage, amongst other matters. Nevertheless, most parties accepted his declarations as they meant a resolution of sorts. The core issue was that although the Gold Fields Act 1858 stipulated explicitly that gold mining suits were to be heard in a Wardens Court, the Otago authorities had not constituted these courts.\textsuperscript{52} Recourse to the civil courts on a diggings conflict, as in the suit just described, was always going be \textit{ultra vires}. Governor Grey had empowered Superintendent Richardson to constitute Wardens’ Courts in January 1862, but he had refused to act, notwithstanding many well justified calls to do so.\textsuperscript{53} Only in October 1862 did he establish Wardens’ Courts and appoint Major Edward Croker as Warden of the Tuapeka Gold Field.\textsuperscript{54} Reasons for the delay are not obvious.

Meanwhile Pyke had had upgraded the June regulations twice by October.\textsuperscript{55} Additions in August introduced a transferable residence right for an area of up to half of an acre, thus finalising one of Hardy’s recommendations from February, and empowered the Commissioner to impose conditions for the “restoration of the soil.”\textsuperscript{56} This does not appear to have had much impact. The large October revision included tighter controls on water use, introduced formal Extended Claims, and gave the Commissioner discretion to grant double or treble sized claims for sluicing and for categories of disadvantaged ground.\textsuperscript{57} These had little effect, as shown by a well-justified complaint in November about the first two ground sluicing parties on the Blue Spur (White and

\textsuperscript{50} “Damage to Mining Claims”, letter, \textit{ODT}, 21 June 1862, 5; and “The Gold Fields. Tuapeka,” \textit{ODT}, 2 August 1862, 5. Doyle and Livingstone in the previous paragraph seem to be an example.

\textsuperscript{51} Watmuff, 27 April 1862.

\textsuperscript{52} New Zealand, The Gold Fields Act 1858, Sections 15-27 in general, and specifically Sections 16 and 19.

\textsuperscript{53} For empowerment, see NZGG 8 January 1862, quoted in OPGG IV 168, 12 March 1862, 323-324; for calls for Wardens’ Courts see Editorial, \textit{ODT}, 18 December 1861, 4; “The Gold Fields, Tuapeka,” \textit{OW}, 5 July 1862, 3; and “The Gold Fields,” \textit{OW}, 12 July 1862, 3.

\textsuperscript{54} OPGG V 211, 15 October 1862, 136-143.

\textsuperscript{55} The amendments to the regulations are shown in OPGG V 199, 4 August 1862, 34-35, and V 211, 15 October 1862, 133-136.

\textsuperscript{56} OPGG V 199, 4 August 1862, 34-35.

\textsuperscript{57} OPGG V 211, 15 October 1862, 133-136.
Co. including James Meehan, and Curtis and Party (the Nelson Co.). Their races were pre-empting water from diggers still working on the Gabriel's Gully flats below, and the two plaintiff parties were discharging their tailings onto the claims below. The diggers on the flats carried on working what ground they could on sufferance, or they became totally buried by hill sluicers’ tailings.

Nor was there any resolution of the diverting of natural water without payment and selling it for profit. It was implicit in all regulations that a mining party could take water for its own sluicing but they were silent on commercial races, which of course the commercial race parties took as assent. To resolve this and other problems, in November 1862 the combined race proprietors presented a memorial to the Superintendent requesting legal security for their races and the removal of a restriction on sluicing that limited them to twelve hours per day. They desired security for the large investments in their races and argued that the success of the gold mining industry was now based on ground sluicing, and that this depended on their races. The Superintendent deferred a decision though he imposed a moratorium on new race rights. A vigorous debate ensued between the Hill Sluicers and Race Parties, and the Gully and Creek Miners, but this was a high volume - high stakes conflict and a zero-sum game, for which there was no immediate solution.

Ground sluicing was a powerful and destructive earth-moving technology and the tension between the technology and the regulatory system intensified in succeeding years as mining progressed deeper into the Blue Spur. As time passed the issues carried to the courts because the regulations alone were insufficient to constrain the field activity. Aspects of this issue as it appeared in the 1870s are discussed in Chapter 4. In respect to the issue of the disposal of tailings, Figures 9, 10, and 11 show the progressive burial of the original Blue Spur village at the foot of the Blue Spur between 1864 and 1870.

58 Jno Boring, “Original Correspondence,” OW, 8 November 1862, 5.
60 See the third last paragraph of: Frederick Bower, Letter, “The Hill Sluicer’s Deputation,” ODT, 8 December 1862, 5.
Figure 9. Original Blue Spur Village December 1864  
(Houston image, Hocken Collections te Uara Taoka o Häkena, E5848-11)

Figure 10. Tailings Flowing Through Blue Spur Village ca 1865 - A Kate Boyer Moment (or year) [See Introduction]  
(Hocken Collections Te Uara Taoka o Häkena, E988-40)
Quarrying the Spur - Chamber Blasting

Field Activity
Towards the end of 1862, a ground sluicer noticed that the bottom his party was working to was not schist rock but cemented gravel, and on breaking it up with a hammer, it had released finely sized gold in payable quantities. In other words they had been working to a false bottom. The material consisted of a conglomerate of rounded quartz pebbles and schist fragments cemented with silica, which imparted a translucent bluish colour. The term “cement” was used from then on. A year later two parties found cement in the Munro's Gully workings, which indicated an extensive occurrence. This prompted the first change of technology for the Blue Spur.

Dealing effectively with the cement became the main technological challenge for the next thirty years. Its hard cemented nature meant that it would require blasting, as in quarrying, and possibly crushing, as in quartz mining. Some claim holders had already started breaking it out with gunpowder. Without mechanised drills there were two options: plaster blasting, when a pad of blasting powder was placed on a hollow or

---

plane of weakness on the cement surface and detonated, or pop blasting when a hole was drilled manually into the cement, filled with blasting powder, and detonated. In this technique one miner held a short drill steel while another hit it with a sledge hammer. The holder would then rotate the steel ready for another hit. This technique was known at the time as “single” or “double handed drilling,” depending whether one or two men hammered the drill steel. The term “hammer and tap” only came into use in the twentieth century later. See Jan Wegner, “Blasting Out: Explosives Practices in Queensland Metalliferous Mines, 1870-1920,” *Australian Economic History Review* 50 no. 2, (July 2010), 195, 198.

Hughes and Party, otherwise known as the Nelson Co., indicated that they would install a stamp battery if they could get “protection.” In the event, the battery was never built.

The additional volume of the cement was promising but the Nelson Co. revealed a whole new future for the Blue Spur in early 1863 when they sank a shaft through the cement to the true basement. Under 2.5 metres of surface overburden of soils and clay lay 14.5 metres of gravels and cements of which only 1 metre was not auriferous. “Too much importance cannot be attached to this discovery,” declared the *Otago Witness*, and rightly so, because it implied an order of magnitude increase in the volume of payable alluvials on the Blue Spur. The Tuapeka Mining Surveyor, John Drummond, quantified the volume in late 1864, with an estimate of some 22 million cubic metres of gold bearing material.

After three years of what must have been awkward surface popping of the cement, Morrison and Co. introduced chamber blasting in July 1865. In this method, a tunnel was driven into the cement mass, chambers were excavated along and at the end of the tunnel, which were then filled with blasting powder and the powder detonated. As an alternative to multiple drill holes, this fractured the rock mass rather than intensely fragmenting it. It also loosened the un-cemented overlying gravels, which could be quite tight, and this greatly facilitated their sluicing. For this first blast, contractors drove a tunnel thirty metres into the cement. After filling each chamber with kegs of blasting powder and gunpowder were virtually identical but gunpowder contained a component that minimised the residue in a gun barrel.

---

63 In this technique one miner held a short drill steel while another hit it with a sledge hammer. The holder would then rotate the steel ready for another hit. This technique was known at the time as “single” or “double handed drilling,” depending whether one or two men hammered the drill steel. The term “hammer and tap” only came into use in the twentieth century later. See Jan Wegner, “Blasting Out: Explosives Practices in Queensland Metalliferous Mines, 1870-1920,” *Australian Economic History Review* 50 no. 2, (July 2010), 195, 198.

64 “The Gold Fields. Tuapeka.,” *ODT*, 18 November 1862, 6. The requested “protection” was a waiver from work requirements while the battery was being installed.


67 “The Gold Fields. Tuapeka.,” *ODT*, 18 November, 1864, 9. This was based on a thickness of 30 metres, which Drummond considered was conservative.

68 “Mining Intelligence,” *ODT*, 28 June 1865, 6; and “Great Blast at the Blue Spur”, *OW*. 5 August 1865, 4. Note: blasting powder and gunpowder were virtually identical but gunpowder contained a component that minimised the residue in a gun barrel.

69 “News of the Week”, *OW*, 17 November 1865, 11. For cracking to fifty feet back see Untitled, *ODT*, 12 December 1865, 4.
blasting powder they were blocked with large rocks and sealed with clay. The explosive was detonated by an electric battery and wires. The procedure took nearly five weeks and cost an estimated £300.70

At the recommendation of the Provincial Council, Morrison and Co. called in a Mr David McIntosh to superintend the operation, since as the manager of Dunedin harbour reclamation he managed the quarrying of Bell Hill.71 His presence indicates that chamber blasting was a specialised matter and not something familiar to alluvial gold miners. McIntosh increased the amount of powder from one to three tonnes, making it one of the largest gold mining blasts in Australasia.72 It released an estimated six months’ worth of sluicing and was seen as the start of a new era of efficiency and science in gold mining.73 The blasted cement and accompanying overlying gravel was “washed off” in ground sluices on either side of the heap at over 1,000 tons per week. When completed after four months and not the expected six months it was rather chillingly found that, in spite of McIntosh’s supervision, two tonnes of the three tonnes of gunpowder had not exploded.74 This was the first of many misfires from this technique and again confirmed that chamber blasting required more expertise than ground sluicing, which itself was more specialised than the hand digging and cradling of a gold rush.

The blast yielded 400 ounces of gold at 23 ounces per week. For the four member party this was nearly as good as gold rush days. Equally significant was productivity: ground sluicing the same volume would have taken anything from eighteen months to two years to complete.75 Not dissuaded by the misfire, Morrison and Co. continued with large blasts. In one run of six months they recovered 850 ounces from a blast of 1.7

---

70 “Great Blast at the Blue Spur.”
71 “Great Blast at the Blue Spur.” McIntosh went on to join W. D. Morrison in his Blue Spur ventures and in 1875 was appointed Legal Manager of the Great Extended Sluicing Co. Regd. Re the latter see CBAT/D480/1q-32 Great Extended Sluicing Company Registered, 1866 [Archives New Zealand, Te Rua Mahara o te Kāwanatanga, Dunedin Regional Office].
72 A 400 pound blast on Bell Hill the year before had been regarded as being “of unusual power.” See Untitled items, ODT, 23 January 1864, 4.
73 “Great Blast at the Blue Spur”; and “Blasting Operations in Otago,” Nelson Examiner and New Zealand Chronicle, 10 August 1865, 4.
74 “News of the Week,” OW, 24 November 1865, 11.
75 “Untitled,” ODT, 3 October 1865, 4.
tonnes of powder. Later large blasts included 1.4 tonnes in December 1868 and two tonnes in August 1869.\textsuperscript{76}

By the end of 1865, all parties on the Blue Spur had adopted chamber blasting as their core mining technique. Blasts ranged from 150 kilogrammes of powder to more than 1.5 tonnes. In November 1865, Spiers and Co. designed and executed their own 0.9 tonne blast. Not only did it fragment an estimated 20,000 tonnes of cement but it also loosened 26,000 tonnes of overlying material. This represented over a year’s worth of ground sluicing. In addition, the cost of a two-man crew tunnelling for three weeks plus explosives and fuses was £120, which less than 20 per cent of the cost of sluicing the same volume.\textsuperscript{77} Indicating a learning curve, in December 1865, Strong and Co., less confident than Spiers, had asked \textit{Otago Witness} to find out whether the same weight of powder in one chamber would have same effect as split up into two chambers. An “expert” advised that two chambers were generally much preferred but possible weak planes and changes in the strata should always be kept in mind. Their blast successfully used 1½ tonnes of powder to produce around 10,000 tonnes. Moreover, the ground was cracked for fifteen metres back from the face, which made sluicing easier, and weakened the cement for the next blast.\textsuperscript{78} In all cases, lumps too large for sluicing were broken up by pop blasting and sledge hammers before washing off. The mining parties built up wages workforces of tens of employees for this.\textsuperscript{79}

Over the next six years, much experience was gained in the application of chamber blasting. The bulk nature of the deposit meant that the workings were set up as a quarry, and at least one party was able to develop two separate panels so that tunnelling and chambering could proceed in one panel while production continued, by washing off the previous blast in the other panel. There was much to learn about the specialised and hazardous technology of explosives, and further, the response of the cement to blasting as well as gold content varied throughout the deposit.\textsuperscript{80} Inadequate fragmentation of

\textsuperscript{76} “Tuapeka Mining News,” \textit{Bruce Herald} 2 December 1868, 5; and “Measures Not Men,” \textit{Tuapeka Times} 7 August 1869, 2.


\textsuperscript{78} Untitled, \textit{ODT}, 12 December 1865, 11; and “News of the Week, \textit{OW}, 16 December 1865, 11.

\textsuperscript{79} “Blue Spur Mining News,” \textit{Tuapeka Times}, 20 March 1969, 3; ibid., 22 May 1969, 3; and “Blue Spur,” \textit{Bruce Herald}, 30 June 1969, 3.

\textsuperscript{80} Variations were inevitable given that the deposit could reach over 80 metres in thickness and occupied an area of around sixty hectares from Munro's to Gabriel's Gullies.
hard cement was a continuing difficulty, as unbroken lumps of cement locked up good gold. It was preferable to use more powder and over-blast, rather than pinch pennies and under-blast, and be left with a blocky mess of boulders that cost more in re-blasting and manual spalling than the money saved by under-loading. As with the famous first blast of Morrison and Co., misfires were not uncommon. The risk of serious injury such as burns, blinding, or lost hands or fingers was a new workplace hazard though not many fatalities were reported.\footnote{See for example, “Blue Spur,” \textit{OW}, 17 July 1869, 11; “Mining, Lawrence,” \textit{OW}, 26 February 1870, 10; and “Country News, Lawrence,” \textit{OW}, 12 June 1875, 17.} These injuries were additional to the litany of serious injuries and deaths in alluvial mining that were caused mainly by collapses of ground, but rocky overhangs added a new hazard from chamber blasting.\footnote{See, for example, “Fatal Accident on the Diggings,” \textit{OW}, 1 March 1862, 5; “Blue SpurMgg News,” \textit{Bruce Herald}, 2 December 1868, 5; “Lawrence,” \textit{OW}, 3 February 1865, 21; Local and General,” \textit{Tuapeka Times}, 26 May 1870, 4; Ibid., 13 October 1870, 4; and Ibid., 3 November 1870, 5. For safety while ground sluicing, Morrison and Co. employed a lookout on the top of their face while sluicing, for the danger of collapse was high. Many diggers on pit floors lost their lives or were badly injured by being caught this way. In one large fall, the floor crew managed to escape by running for their lives when the lookout gave a warning – but in their flight, they left their boots, shirts, and tools behind in and these were buried. See “The Blue Spur District,” \textit{OW}, 10 April 1869, 11.} Figures 12 and 13 show the rocky blocky nature of the cement in chamber blasting workings on the Gabriel’s Gully and Munro’s Gully sides of the deposit, respectively.

In a sense, the chemical energy of the blasting powder was a form of mechanisation and chamber blasting proved to be both effective and also productive. Its comprehensive uptake by the Blue Spur parties stands as proof of this although the alternatives of using popping, or brute force with sledgehammers, were never going to be practical. Chamber blasting also enhanced the productivity of ground sluicing by reducing everything, including the tight uncemented gravels to a loose heap highly amenable to ground sluicing. This shortening of the time to sluice a given volume of cement or gravel then increased the rate of revenue and profit.
Figure 12. Rocky Blocky Cement, Looking North to Perseverance Battery
(Burton Brothers, Photograph of Blue Spur, c. 1870s-1880s, Museum of New Zealand Te Papa Tongarewa, O.026498)

Figure 13. Rocky Blocky Cement in British American Claim, Munro's Gully. Note miners in lower right quadrant.
(Hocken Collections Te Uara Taoka o Hākena, E3513-1)
Technological and Economic Aspects of Chamber Blasting

Alluvial mines in California and Victoria and beach leads in the Addison’s Flat and Charleston districts on the West Coast also encountered cemented material, but not on the scale of the Blue Spur.\(^8^3\) As such, chamber blasting at the Blue Spur brought hard rock mining technology into alluvial mining to an unusual degree. Among the new factors that this involved was considerable consumption of blasting powder.\(^8^4\) Even in 1865, when chamber blasting was in its infancy, 50 tonnes were used whereas annualised imports for all of Otago only totalled approximately 15 tonnes in 1862, and this was already a time of increased usage in civil works for the expanded gold rush population.\(^8^5\) In 1869, four parties used more than four tonnes in one week though when annualised, six month total for October 1869 amounted to 56 tonnes.\(^8^6\) In addition, the combination of heavy blasting and the congested nature of the claims led to cross-boundary slope failures, lost working time, and extensive litigation, all of which increased as chamber blasting continued.\(^8^7\)

Another techno-economic aspect of chamber blasting was that the blasting powder was an imported commodity and added market characteristics to the Blue Spur *chaine opératoire*. Availability, price, and customs duty all influenced good cheer on the Blue Spur, and could be influenced by events on the other side of the world. During the Franco-Prussian War of 1870, prices in the Tuapeka reached twelve pence per pound, from the usual seven to eight but the disappearance of supply was a bigger problem. Speculators had cornered the stocks in Dunedin and attempts to obtain powder from Melbourne proved fruitless as it was under the same international squeeze.\(^8^8\) The American Civil War had never caused a shortage of American hickory handled picks.


\(^{8^4}\) Blasting powder was used exclusively for many years although Nobel patented “Dynamite” in the mid-1860s. It was far stronger than blasting powder but more sensitive and “terrible loss of life” resulted from its use. See Untitled, *ODT*, 22 November 1865, 4; and “Blasting at the Blue Spur,” *Tuapeka Times* 6 March 1869, 5.

\(^{8^5}\) For Otago in 1862 the estimate is based one month of imports, namely 2,750 lb from London and 223 lb from Clyde in the month from September 12 to October 12, 1862. See “Statement of Exports,” *ODT*, 29 December 1862, 4.

\(^{8^6}\) “Blasting at the Blue Spur,” *Tuapeka Times* 6 March 1869, 5; “Mining on the Blue Spur,” 13 March 1869, 3; and “Blue Spur Mining Notes,” 23 October 1869, 3.

\(^{8^7}\) *OW*, 17 June 1869, 11.

\(^{8^8}\) *Tuapeka Times* 28 September 1870, 6; and *Bruce Herald* 26 October 1870, 6.
and shovels and other tools that were essential during the gold rush period. Another factor for miners was that the customs duty on gunpowder varied from nil to 3 pence per pound, which was a large proportion of something that sold for around 8 pence.\textsuperscript{89} Only in the 1870s did the Blue Spur miners arrange direct importing from Melbourne.\textsuperscript{90}

The introduction of blasting methods fostered major changes in water use. The cyclic nature of tunnelling, blasting, and “washing off” reduced the use of sluicing water and the blasted material sluiced more easily. In 1869 water was only really scarce in the driest periods of summer and dams and reservoirs tended to overflow at other times.\textsuperscript{91} This situation of adequate supply did not change much until the general adoption of hydraulicking and hydraulic elevating in the 1880s. In 1874, reduced demand led the Waipori and Tuapeka Water Race Company to reduce its longstanding charge of £7 per head of water per week to £6 per head.\textsuperscript{92} Over this period the race parties actively improved the efficiency of their existing works. They cut spur races to nearby creeks or over saddles into the adjoining catchment, enlarged races, excavated larger reservoirs or new ones, and they extended races to new diggings.\textsuperscript{93} Complementary tactics by the miners included the greater use of branch races that were freer of snow than others in winter, increased washups in summer, and using some reservoirs or dams while topping up others.\textsuperscript{94}

The Quarry Goes Underground

\textit{Morrison and Co.’s Stamp Mill.}

The problem of gold losses in lumps left by inadequate blasting necessitated the continued use of a labour crew with sledge hammers. Once again, Morrison and Co. was the innovator in erecting a stamp battery to crush the lumps. Their claim

\textsuperscript{89} For example, see “Tariff of New Zealand,” \textit{ODT}, 6 September 1862, 4.
\textsuperscript{90} “Blue Spur,” \textit{Bruce Herald}, 15 February 1871, 3.
\textsuperscript{91} “Blue Spur,” \textit{Bruce Herald}, 30 June 1869, 3; “Blue Spur Mining Notes,” \textit{Tuapeka Times}, 23 October 1869, 3.
\textsuperscript{92} “Local Intelligence,” \textit{Tuapeka Times}, 10 January 1874, 2.
\textsuperscript{94} “Blue Spur,” \textit{Bruce Herald}, 30 June 1869, 3; “Measures Not Men,” \textit{Tuapeka Times}, 7 August 1869, 2; and “Blue Spur Mining Notes,” \textit{Tuapeka Times}, 23 October 1869, 3.
presumably had suitable terrain, which argues that environmental conditions in individual claims might have been determinative, otherwise other parties would have done the same. In February 1871, Morrison and Co. bedded in a seven stamp crusher driven by an overshot waterwheel mounted in the tailrace. The system was designed and built by Mr John Lawson, an enterprising millwright of Tokomairiro who also established the first flour mill in Tuapeka. After working satisfactorily the party encountered low grade cement that did not pay costs, and then, ironically after six years of blasting, came cement that was too soft to need crushing. The mill does not seem to have operated after July 1871.

**Gabriel's Gully Quartz Mining Company**

The range of technology for gold mining in the Tuapeka widened in 1872 following the discovery of a quartz reef on the east (Wetherstons) side of Gabriel's Gully. This was in Wick’s Gully (or Walsh’s) a few hundred yards upstream of Read’s original strike and might well have contributed to it. Clark and Party, the discoverers, commissioned a ten stamp mill battery powered by a water turbine, and associated gold recovery equipment in November 1872. A water turbine, known also as a “hurdy-gurdy,” was a small iron water wheel enclosed in an iron casing. Water at a high head (pressure) was directed through a nozzle at the blades of the runner, causing them to move and rotate their axial shaft. Or, in a reaction turbine, water was discharged from tubes mounted radially on a shaft, and submerged jet types also existed. Turbines operated at low volume, high head, and high speed, for example 400 revolution per minute, and represented the technological obverse of a water wheel, which operated at a slow revolutions, low head, and high volume. Turbines were compact unlike a water wheel

---

95 “Blue Spur,” *Bruce Herald*, 24 August 1870, 6; "Local and General," *Tuapeka Times* 13 October 1870, 4; “Blue Spur,” *Bruce Herald*, 21 December 1870, 5; and Ibid., 15 February 1871, 3;


97 “Country News,” *OW*, 27 May 1871, 9; and “Blue Spur Mining Notes,” *Tuapeka Times*, 20 July 1871, 5.

and matched the low volume high head races round Gabriel's Gully admirably. The Gabriel's Gully turbine generated a nominal 30 horsepower and the full works needed only one head of water.\textsuperscript{99} Kincaid, McQueen and Co., the well-known proprietor of the Vulcan Foundry in Dunedin provided the machinery and equipment.\textsuperscript{100} The breakeven cost for the operation was three pennyweights per ton.\textsuperscript{101} This was low for a hard rock mine because of low capital and the extremely low operating cost of turbine power as against steam. After returning grades up to 8 dwt per ton and paying dividends, the reef was mined out by March 1874 despite extensive tunnelling to find an extension. Total production was gold worth £4,028 from 4,000 tonnes of quartz at an average grade of 5 dwt per ton.\textsuperscript{102} This quartz mine served an important role for the Blue Spur in that it made hard rock gold recovery technology available locally.\textsuperscript{103}

Such a mill was considerably more sophisticated than the sluice boxes and cradles of the gold rush. Most critically, before any wash was processed, metallurgical and mechanical engineering design was needed, followed by heavy engineering capabilities to fabricate the heavy iron machinery and turbine. As well as engineering expertise, capital was required. John Hughes indicated a capital cost of £600 to £700 for the mill he envisaged in 1862 but by 1875 a twenty head mill for combined gravel and cement for Hales and Hinde was projected at £2,000 to £3,000.\textsuperscript{104}

\textbf{The Nelson Co. Breaks New Ground Again}

The Nelson Co. again made a geological breakthrough. By 1874, as much as 30 metres had been stripped off the Blue Spur deposit in places. Parties in the thinner ground at the edges, especially on the uphill Munro's Gully side, were running out of ground and closing down or amalgamating. There was intense congestion at the land surface as high head-slopes from adjoining claims intersected, causing rich ground from one mining lease to slump into an adjoining one after a blast. Leaky or broken races flushed good ground away or barren ground in and removed ground that supported

\textsuperscript{99} “The Gabriel's Gully Quartz Mine.”
\textsuperscript{101} “Gabriel's Gully Quartz Mining Company,” \textit{Tuapeka Times}, 2 January 1873, 7.
\textsuperscript{103} “Local Intelligence,” \textit{Tuapeka Times}, 28 October 1874, 2.
services in other claims. Law suits multiplied of which the most famous was the case of Clayton and others (the Perseverance Mining Company) v. Morrison and others (Morrison and Co.) in 1873 for encroachment, that is, the burial of ground in one claim due to its collapse from the neighbouring one.\textsuperscript{105} Parties were mining to lower elevations and having increasing trouble maintaining fall as the base of sluicing moved lower while at the same time the level of the discharged tailings was rising. Costs were rising as well, there were complaints about the price of race water and dividends had fallen for the past two years.\textsuperscript{106} The future did not look easy.

The Nelson Co. made their breakthrough in early 1874, when it sank a shaft from the top of the cement to plumb the lower levels of its deposit and found bottom a distant fifteen metres down and richer than any other layer. A bulk sample of this material crushed in the now idle Gabriel's Gully Quartz battery returned a grade of 1 ounce 5 dwt. gold per tonne (25 dwt. per tonne), which was remarkable against a breakeven of 3 dwt per tonne.\textsuperscript{107} Since their volume of sluiceable gravel was approaching exhaustion the Nelsons decided to focus on the cement, which required underground mining, and leave the remaining uncemented gravels untouched on top. The cement also required quartz battery technology and in June 1874, the Nelsons engaged Kincaid, McQueen to supply and erect a stamp battery and gold recovery plant.\textsuperscript{108}

The Nelson Co. used the Victorian deep lead technique of “blocking out” for underground extraction of the cement. This method used manual labour, and it was dangerous since large areas of the back (that is the roof of an underground working) were left unsupported. Hence it required a high level of expertise and a larger labour force than ground sluicing. Drilling and blasting normally broke out the cement though pickaxing and barring out would have been used where possible. The broken out cement was shovel-thrown to a rail track up to five metres away and loaded into mine tubs. There were hauled up the inclined shaft to the battery by a rope haulage.

\textsuperscript{105} After taking the dispute through all the lower courts and achieving a neutral decision in the Supreme Court, for the expenditure of more than £5,000, the two main protagonists Henry Clayton and William D. Morrison settled their differences personally by mutual agreement. For the start of the Supreme Court hearing see “The Courts, The Supreme Court Lawrence,” Tuapeka Times, 11 February 1873, 5.

\textsuperscript{106} “Local Intelligence,” Tuapeka Times, 10 January 1874, 2, and Ibid., 11 March 1874, 2.

\textsuperscript{107} “Local Intelligence,” Tuapeka Times, 11 March 1874, 2.

\textsuperscript{108} Untitled, ODT, 24 June 1874, 2.
Similarly, a stamp mill was much more complex for processing alluvial gold than a sluice box, but the Nelson Co. engaged Mr Murphy, who had been manager of the Gabriel’s Gully quartz battery. The Nelson battery package was much the same as at the Gabriel’s Gully quartz mine but required in addition a winch and rope haulage system for the underground workings. This was driven off the turbine as well as the mill but at thirteen kilowatt power it was much smaller than the twenty-two kilowatt turbine of the quartz company.

The battery started in October 1874 and with some reservations gave good results. The grades were “very profitable” but not as high as the bulk sample, and the recovery was down because of unexpectedly fine gold sizing. Further, around 500 metres of undersized water delivery pipe had to be replaced. More serious was the slowness of the haulage winch, which shared power with the stamp mill. This made the mine the bottleneck and necessitated three haulage shifts. Several days were also required to bail out flooding after a breakthrough from the workings of the adjoining Otago Co.

With these difficulties out of the way the Nelson Co. carried on with underground cement mining and stamp milling as its main method for the next decade.

**Other Parties Follow**

The increase in mine life and income that the rich deep cement offered was clear to all parties. The Otago Co. on the Gabriel’s side and the North of Ireland Co., on the Munro’s side were the next closest parties to bottom, although when they sank to it they found it was twice the depth of the Nelson lease. In July 1874, the Otago Co. had a twenty tonne parcel of cement put through the Gabriel's Gully Quartz Company’s battery. On the (unannounced) results of this they decided to convert to underground...

---

109 “Blue Spur Mining Notes,” *Tuapeka Times*, 3 October 1874, 2.
110 “Blue Spur Mining Notes,” Ibid.
111 After the rich bulk sample the Nelson Co. never again advised their gold results in public.
112 “Blue Spur Mining Notes,” Ibid.; “Local Intelligence,” *Tuapeka Times*, 28 October 1874, 2; “Local Intelligence,” *Tuapeka Times*, 7 November 1874, 2; and “Mining News,” *ODT*, 24 November, 1874, 3.
113 *Tuapeka Times* 24 June 1874, 2 and 27 June 1874, 2.
114 One sample returned 14 dwt “to the “bucket.” Assuming say 30 l to a bucket (i.e. 45 kg), this gives 18oz per cu.yd or 12oz per ton. See “Local Intelligence,” *Tuapeka Times* 24 June 1874, 2. The next sample was even richer, with 19 dwt in a bucketful. See “Deep Sinking at the Blue Spur,” *Tuapeka Times*, 27 June 1874, 2. The 20 ton parcel put through the Gabriel's Gully Quartz Co. battery was of great local interest. A bookmaker was in attendance taking bets on a range of outturns from 1½ oz to 2½ oz per cu. yd. However, the result of the trial was not published. See “Local Intelligence,” *Tuapeka Times*, 8 July 1874, 2.
mining and ordered a ten stamp battery from Kincaid, McQueen. They were followed in August by the North of Ireland Co. who obtained 15 dwt. per tonne. They stole a march on the Otagos by buying the Gabriel's Gully quartz battery and commissioning Kincaid, McQueen to re-erect it, thereby avoiding the delay of fabricating a new one in Dunedin. Learning from the Nelson Co. they specified a separate turbine for the haulage way, and, following the advice of Mr Ulrich FGS, the eminent Victorian gold mining consultant who had recently toured the Otago goldfields, upgraded the quartz mill's gravity separation circuit. This battery commenced work in January 1875, whereupon Kincaid, McQueen completed the Otago Co. mill, which was commissioned in April 1875.

As their workings approached bottom, most of the other parties similarly stopped sluicing or chamber blasting and took up underground cement mining. Hales and Hinde were a late conversion because their ground contained the gutter of the original river and was the deepest part of the entire deposit, and for the same reason, also reputedly the richest. They only sank to it in October 1875, whereupon they found visible gold in the basal layer, a sure sign of a bonanza. They decided to quarry or opencast their entire thickness of cement rather than use the more difficult underground method to selectively work only the basal, and richest, section as the other parties were doing. Hales and Hinde commissioned Kincaid, McQueen to supply a twenty head battery, to handle their bulk cement approach, and with sufficient power to expand to forty.

The capital investment for these projects was significant but there was no structural reform, that is greater organizational formalisation or incorporation as a corporation, as implied in Hearn’s interpretation of McLintock or Eldred-Grigg, with which the writer agrees. The tunnelling cost would not have been excessive, probably a few hundred pounds judging from chamber blasting. However, the stamp battery, mine haulage and turbine cost in the order of £1,000 to £3,000. Calls on the shareholders or partners in a party and the offloading of formal or informal shares in the mining partnerships or

---

115 Ibid., 19 August 1874, 2; and “Blue Spur Mining Notes,” Tuaepka Times, 12 September 1874, 2.
116 “Blue Spur Mining Notes,” Tuaepka Times, 12 September 1874, 2; “Local Intelligence,” Tuaepka Times, 16 January 1875, 2; “Warden’s Report,” Tuaepka Times, 31 March 1874, 2; and Untitled, ODT, 10 April 1875, 2.
117 “Local Intelligence,” ODT, 20 October 1875, 2; Ibid., 17 November 1875, 2; and “The Mining Interest,” Tuaepka Times, 20 November 1875, 3.
companies were two avenues for funding. A capital injection for a share in the operation was another. Robert Grieve, a publican and businessperson of Blue Spur, practised this by advancing mortgages for capital expenditure and was also the founding manager of the Great Extended Company. Archibald McKinlay, a successful Lawrence businessperson whose activities included a partnership in the merchant Herbert and Co. which held the highly lucrative agency for blasting powder was another such “grubstaker.” Banks then or later also advanced mortgages, with the mining plant, as specific as down to the water pipes, as security, as revealed in the great consolidation of 1888 when the Great Extended Company revealed that it was heavily mortgaged to the Bank of New Zealand. Raising capital, then, may have partly changed the ownership but did not change the structure.

Technological Review of Mining the Blue Spur

By the mid-1870s the progress of mining had exposed most of the characteristics of the Blue Spur deposit. Due to its great thickness and volume, multiple auriferous beds, some of which were very rich, and its extensive cementation, it stood revealed as a most unusual alluvial deposit. There has possibly been none other like it in the other great alluvial goldfields. There were thick voluminous deposits in the Northern Mines in California but these consisted of thick barren or low grade gravels lying on a single rich lead on the bottom and were not pervasively cemented. Victoria's deep leads were also single layers and mined as such but what might have been found in Siberia is quite unknown. The Ross goldfield on the West Coast consisted of a large volume of uncemented gravels in which multiple rich layers were separated by barren horizons. It would nearly have been equivalent to the Blue Spur though it was a buried deposit and not amenable to bulk surface techniques. The characteristics of the Blue Spur supported not only the normal alluvial mining methods but necessitated what amounted to quarrying, underground hard rock mining, and quartz milling technologies. Yet hydraulicking, which was the most productive hydraulic method elsewhere in the

119 “Herbert, Edward (c 1834-1909),” in Southern People, 222; and “McKinlay, Archibald (1826-1910),” Ibid., 315.
120 Jean Jackson, 26, 49.
Otago goldfields, had found little place on the Spur. Motive power had turned in many directions too. The path moved from manual effort in hand digging and hand cradling, to using the energy of flowing water to extract and wash the gravels in ground sluicing, then back to manual effort to tunnel the hard cement by drilling plus the energy of blasting powder, followed by the manual loading of the rock into mine tubs. Hydraulic energy via turbines hauled the rock out of the mines and drove the stamp mills. In fact apart from the short-lived stamper of Morrison and Co. in 1871 which was powered by a waterwheel, all machinery around the Spur, which included the haulage systems, the stamp mills, equipment in workshops, and dynamos that generated electricity for lighting, was driven by water turbines.

Rather than being inventions or innovations, these were existing technologies that were brought to the Blue Spur by diffusion. This is a transfer of technology by people who possess the knowledge and skills. Most were techniques used in Victorian deep lead alluvials or quartz mines. Noting as above that at the peak, up to 80 percent of the diggers during the rush came from Victoria, these people were without doubt the vector of diffusion of most of the technological changes on the Blue Spur. Chamber blasting was a quarrying technique and perhaps well used around New Zealand. David McIntosh, the manager of the removal of Bell Hill, who acted as a consultant on the first chamber blast of Morrison and Co. and others, looks likely to have been the vector. The bulk of Victorians were not familiar with hydraulic mining and it is notable that experienced race men from California established first two ground sluicing operations on the Blue Spur. In addition, Gascoigne, another person with Californian experience, whose party cut the first commercial water race, had also promoted ground sluicing in 1862 in a letter to the Otago Daily Times under the pseudonym of “Progress.”

People like T. H. Cullen and G. Curtis who were the founders of the Nelson Co. must also have been vectors of diffusion coming as they did from the Northwest Nelson goldfield where ground sluicing was practised.

---

121 Hydraulicking in the Tuapeka goldfield was rarely discussed. Its absence can be inferred by the absence of the term “hydraulic hose,” (the governmental term for hydraulicking), in the early reports of equipment in use on the goldfields. See VOPPC Session XIX, 1864, Reports of Mining Surveyors, John Drummond, 16 July 1864, 3, and Table of Machinery and Races, 6. Unusually, this particular text notes “working with the hydraulic hose (or by hydraulic pressure)” for Gabriel’s Gully. In the later session of 1865, Pyke’s consolidated tables record nil miners using the hydraulic hose and nil for hydraulic hose in the counts of mining devices. See VOPPC Session XXI, 1865, Report of Secretary V. Pyke, 15 November 1865, 39A – 42A.

122 “Progress,” (pseud.), Letter, ODT, 1 April 1862, 3.
The level of mechanisation introduced by cement mining and milling represented a form of industrialization. It called for specialised skills, not only in on-site operations, but also in Dunedin and further afield. The greater range of equipment and machinery, methods and techniques that were brought to bear for mining the cement, coupled with the offsite design and fabrication in ironworks in Dunedin, constituted industrialization both of the goldfields and also of Dunedin. At the same time this demonstrates another way in which the activity on the Blue Spur was far different from the application of hand tools and wooden equipment in a gold rush.

One of the factors in the entrenchment of mining was adequate tenure. The Extended Claim of Pyke’s August 1862 regulations served as an intermediate step but properly adequate tenure for mining took the form of the mining lease. A mining lease (“ML”) was granted for a term of up fifteen years, was not subject to the risk of forfeiture for non-working, was defined by survey, and formed a registered interest in the land. As such it conferred secure legal long-term tenure appropriate for systematic long term mining and capital investment. One disadvantage was that the procedure required many interdepartmental approvals, registration with the District Land Registrar, and final signature by the Governor. This could take years and as was pointed out some applications had been mined out before the Mining Lease (ML) had been granted.123

The Blue Spur was taken up in mining leases from an early date but intermittently, as existing Extended Claims had to be finished. In November 1862, evidently seeing a long life ahead, the Nelson Co. made the first application. Other applicants who became long-lived miners included Samuel Hales and Thomas Hinde in May 1863, W. Fenton, W. J. Morrison, Frank Nicolls, and H. C. Clayton in June 1864, and eight applicants making up the Otago Gold Mining Co. in February 1865.124 At some point, Henry Clayton left the Fenton and Morrison group, which settled down to become known as Morrison and Co. Clayton, who with six others had applied as Clayton and Co. for their own ML in March 1864, was integral in the Perseverance Company, and later, the Amalgamated.125 Other parties took up leases on the Munro's side but some

123 “Redtapism,” OW, 25 August 1866, 1.
124 DAAK/9378/D450/313- Record 2, Applications 1, 6, 51, and 97, 1862-1865, Register of Mining and Agricultural Leases [Archives New Zealand /Te Rua Mahara o te Kāwanatanga, Dunedin Regional Office].
125 DAAK/9378/D450/313-Record 2, Application 47, 1864, Ibid.
of these were in the thinnest part of the Blue Spur Conglomerate and were soonest worked out.

Changes occurred in the membership of the various parties but usually there were core members who stayed in and gave the party its identity. Some parties, by negotiation, amalgamation, or further applications also built up a package of adjoining leases that were best worked as one. This was not an attempt at a monopoly and it appears that it was usually based on the geography of the terrain, in that the lie of the deposit, access for water races and runs for tailraces would always favour working from one particular direction that the boundaries of a lease might not allow. In these circumstances, and bearing in mind that the parcels were usually awkward corners or small zones of adjoining ground, one party sometimes came to an agreement to mine the adjoining ground for the payment of a royalty or share of the gold, to avoid the bureaucracy of formal tenure.

By 1875, when cement mining had become well-established, the parties actively working the Spur had consolidated to eight. On the Gabriel’s side these comprised the Otago Co., Hales and Hinde, the Nelson Co., the Great Extended Company, Morrison and Co., and the Perseverance Company; and White and Co. (later known as the North of Ireland Co. and Livingstone and Co. (later the Fidelity Co.) on the Munro's side. There were no Chinese leaseholders because all ground had been taken up by February 1866 when the first Chinese miners arrived in Lawrence. 126 Otherwise, Chinese parties periodically held claims along the sides of Gabriel's Gully. Except for the changes of names these holdings remained essentially stable through to 1888. Figure 8 shows these parties in 1887 and includes a new name, Amalgamated, which was likely the result of a formal amalgamation of patches of boundary ground rather than a less formal royalty arrangement.

**Depletion, Technology, and Tuapeka Society**

Employment levels in mining on the Blue Spur by the 1870s were very different from the days of the gold rush. There were only eight parties amounting to between 85 and

---

126 Mayhew, 89.
95 people not counting the race men engaged in mining on the Blue Spur.\textsuperscript{127} This small number probably reflects high productivity for the chamber blasting and sluicing in still in use. However, underground cement mining required a large labour force. In 1875 the three parties with underground operations employed a total of sixty four miners whereas the other five operating parties on chamber blasting and ground sluicing employed thirty-one.\textsuperscript{128} Other forms of labour included contractors who tunnelled for the chamber blasts and who cut races, and tributers, such as the Peterson Party who worked on the claim of the Blue Spur Sluicing Company in Munro's Gully.\textsuperscript{129} More broadly, the Warden’s count for all miners in the Tuapeka Gold field in 1875 was around 1,000. Since fewer than one hundred of these occupied the Blue Spur operations, the remainder comprised small miners, of who around 50 per cent were Chinese, still working the flats and lower slopes. It also included a party of Cornish miners operating a well-planned large scale mine working from one side of the valley to the other in the floor of Munro's Gully.\textsuperscript{130} The total population of the goldfield was around 5,000. Since only 1,000 of these were diggers, important demographic changes had occurred in the life of the goldfields.\textsuperscript{131}

As mining progressed or in other words, depletion, it revealed that the Blue Spur orebody comprised a large, variably cemented alluvial orebody with variable but in places extremely rich gold grades. As its physical character varied from gravels to hard cemented conglomerate gravels so too did the extraction technologies which became akin to quarrying and then quartz mining. The techniques diffused into the Tuapeka district without difficulty except for something of a learning curve for chamber blasting. As mining technologies, they were characterised by more difficult techniques and a more hazardous work place than a gold rush diggings, mechanisation including pervasive use of hydraulic turbines, highly skilled miners, increasing levels of capital expenditure, and stability. Already in 1875, thirteen years of mining had passed, and

\textsuperscript{127} “Mining at Lawrence,” \textit{ODT}, 22 May 1874, 2.
\textsuperscript{128} “Mining at the Blue Spur,” \textit{ODT}, 20 April 1875, 2.
\textsuperscript{129} In tributing, the holder of a claim leased it out to a working party to mine it, for the payment of a percentage of the gold. It allowed a less competent claim owner to pass responsibility for mining to an experienced crew who could work the ground efficiently and did not have the overheads of the claim owner. It often occurred in poor ground where the claim owner had lost money. Tributing enabled both parties to make a modicum of money at least, where otherwise the owner made none and the tribute party had no work.
\textsuperscript{130} Mayhew, 44-45.
\textsuperscript{131} “Warden’s Report,” Tuapeka Times 31 March 1875, 3.
had been founded on the secure tenure of mining leases. The mining parties themselves were highly stable too, though the use of loan finance arguably avoided the structural change of becoming fully corporatized and publicly listed. Productivity varied between very high, accompanied by smaller workforces, for the hydraulically supported chamber blasting, to lower productivity and higher employee numbers in underground cement mining. However, the latter possessed great effectiveness, because the cement being mined on the bottom was the richest seen in the deposit and carried the high capital and labour costs. Now, too, time frames can now be compared. The Gabriel's Gully rush peaked in five months in November 1861 and was over in twelve, in June 1862, when the first ground sluicing commenced. In comparison, mining the Blue Spur had not stopped by 1875 after thirteen years of activity. None of this activity could be compared, and nor should it be confused, with the simple, self-funded, short-term technology of gold rushing.

However, the application of the mining technology in the given deposit also embodied conflict and instability. The regulatory structure could not prevent activities that caused collapses of ground into or out of neighbouring ground and burst water races, and suits in the Warden’s or higher courts proliferated. Injunctions around these often stopped work for at least one of the parties for periods up to two or three months. The productionist culture saw acceptance of the burial of the original Blue Spur village and the tailings went on to create drainage problems as far away as Lawrence. The regulatory system found difficulty in the early years of ground sluicing in resolving the conflict between downstream landowners and miners and the Blue Spur hill sluicers. The labour force for underground mining was three times that for chamber blasting and ground sluicing, and was affected by shuts downs under the lawsuits. Labour was contingent on the technology.

An important innovation emerged in 1880 which changed the work arrangements again and in addition there was a consolidation of the mining parties. This is examined in Chapter 4.
CHAPTER 4: HYDRAULIC ELEVATING, AN IMPORTANT INNOVATION

The aim of this chapter is to examine an example of innovation (hydraulic elevating) within the larger discourse of a history of technology-in-use in the mining of the Blue Spur deposits. This also throws light on Hearn’s questions of “associative enterprise” and “structural reform” in early Otago gold mining. The chapter also examines the place of the history of innovation as discussed by historians like Edgerton within the context of the history of technology in mining.

Innovation Driven by Tailings

As mining on Blue Spur proceeded through the 1870s, the use of Gabriel’s Gully as a sludge channel increasingly raised problems. Either the tailings gravel or the ponded tailings water swamped residential properties and alluvial operations downstream. The “beautiful garden” of Mr Hales’ of Hales and Hinde was wholly under water by April 1871 and he was considering action against Morrison and Co. for damages.¹ In June 1871, Warden Simpson found for each of three plaintiffs against Elliot and the North of Ireland Co. for damage that its tailings or water had caused. The house of one plaintiff, Mr Livingstone, who was a leading miner on the Munro’s side, had been rendered uninhabitable.² A senior member of the Nelson Co., Edward Lawson, and his wife, who had also built a model garden, had recently been forced out because the tailings water had reached their doorstep. Their property is a showpiece in one of the Hocken Collections’ photographs.³ Lawson had sued Morrison and Co. for damages in May but little good had it done.

Infrastructure was equally at risk from water or tailings. The business premises shown in earlier in the original Blue Spur village at the foot of the Blue Spur were abandoned in the mid-1860s and buried under tailings. Not only that, but tailings washed down

¹ “Local and General,” Tuapeka Times, 6 April 1871, 4.
² “Warden’s Court,” Tuapeka Times, 29 June 1871, 5.
Gabriel's Gully Creek, and dammed Wetherstons [sic] Creek beside Lawrence causing water to back up into nearby business premises. This led to a petition of complaint to the Lawrence Town Council in May 1873.4 The road down Gabriel's Gully was similarly flooded by water backing up or was eroded out when the Gabriel's Gully creek changed course when tailings swamped its bed.

In August 1873, the Provincial Engineer, Mr. D. L. Simpson, reported on three options for the effective discharge of the Blue Spur tailings. These comprised a tunnel from Gabriel's Gully into Munro's Gully, a longer tunnel to discharge lower down directly into the Tuapeka River, and an engineered creek and drainage channel through the tailings down Gabriel's Gully. Simpson recommended the last as there was a risk of the tunnels blocking, and flat gradients at the discharges of the tunnels.5 In the absence of any implementation eight months later W. D. Morrison, the leader of Morrison and Co. the party that had caused many of the complaints of the upper Gully residents, proposed that government funds be used to carry out the works for whatever option was chosen. He argued that this would allow the reworking of the tailings (4,000 ounces lost in mining over seven years) and the untouched ground underneath (50,000 ounces) and that the economic benefit from this would balance the cost of the proposed sludge channel. However, the proposal did not survive the General Assembly in September 1874.6

Robert John Perry, Innovator

Supporting Morrison’s proposal, in mid-1878 a group of influential Blue Spur miners and business-persons applied for a large (ten hectare, twenty-four acre) special mining lease over the tailings at the head of Gabriel's Gully.7 Horace Bastings, MHR and chair of the Tuapeka County Council was the leader and two senior members of Morrison and Co. and Robert Grieve were included.8 This raised concerted opposition from the seven operating parties on the Blue Spur side, who saw a threat to their freedom to dispose their tailings into Gabriel's Gully, and the appropriation of gold they had

---

4 “Local and General,” Tuapeka Times, 23 April 1873, 5; and “Lawrence Town Council,” Tuapeka Times, 1 May 1873, 5.
5 “Blue Spur Tailings,” Tuapeka Times, 7 August 1873, 6.
7 AJHR, H17, 1881, Wardens’ Reports, 34.
8 Advertisements, Tuapeka Times, 7 August 1878, 2.
already lost in their tailings but now suddenly wished to reclaim. However, with support in the General Assembly from H. Bastings and the other local MHR, J. C. Brown, the lease was executed in 1879. In anticipation, the applicants had advertised a competition with a prize of £100 for the best machinery to work the tailings. A remarkable person, Robert John Perry, won the competition with a proposal based on a continuous chain of buckets that would dig and elevate the tailings to a series of sluice boxes, equivalent to the bucket ladder in a gold dredge.

Perry was a mechanical and hydraulic engineer and mining entrepreneur from Oxford, England, and held an Oxford MA. After early participation in the Gabriel's Gully gold rush under the first batch of Miner’s Rights, holding No. 177, he followed quartz mining for many years, firstly at Skippers in the Shotover River and then from the late 1860s until the early 1880s in Thames, New Zealand. Here he owned and operated a quartz tailings retreatment battery and was a manager, director, and shareholder of a number of quartz mining and transport companies. However, he specialised in designing water turbines and quartz battery machinery. Among his achievements was the design, construction, and installation of the first water turbine in Thames, which replaced a steam boiler and engine for the Queen of Beauty battery and achieved a

---


10 “Public Notices,” ODT, 1 February 1879, 3. The notice was also posted in Melbourne and Ballarat, and had a closing date of 31 March 1879.


12 Regarding Perry’s Oxford MA., see Jean Jackson, 32. Declaring himself as an engineer, at the opening ceremony in Thames (New Zealand) for an important mine pump and turbine that he had designed and commissioned he noted that he was familiar with the principals of hydraulics used by the most eminent French and English engineers; see “Starting of the Queen of Beauty Pump,” Thames Star, 27 May 1880, 2.

13 For Perry’s life details see New South Wales Death Certificate 1901/016116, kindly passed to me by Damien Hynes; Register of issue of miners’ rights and business licences in the Tuapeka gold fields, 19 August-1 November 1861, Tuapeka Magistrate’s Office, qMS-2045, Alexander Turnbull Library; and “A Loss to the Mining Industry,” ODT, 21 December 1901, 10. For the Skippers mines see for example, the application to register British American Quartz Mining Company Registered on 13 June 1866, in CBAT/D480/11-24, British American Company Registered [Archives New Zealand, Te Rua Mahara o te Kāwanatanga, Dunedin Regional Office]; “The Wakatipu District,” ODT, 3 May 1866, 5; and “Quartz Mining in the Lake District,” ODT, 4 September 1867, 5. For Thames, see for example, “Shortland,” Daily Southern Cross, 24 October 1868, 4; “Mining Matters at the Thames,” Daily Southern Cross, 11 March 1870, 4; and “Prospectus,” Auckland Star, 3 June 1876, 3.

14 See, for example, “Shortland,” Daily Southern Cross, 24 October 1868, 4; “Mining Matters – The Long Drive Specimens,” Daily Southern Cross, 11 May 1869, 5; “Telegraphic,” Daily Southern Cross, 16 October 1874, 3; “Black Angel, Queen of Beauty Battery,” Thames Star, 29 May 1877, 2; and “The Evening Star,” Thames Star, 18 April 1877, 2. “The Evening Star” is a special section of the Thames Star that may only be published on Wednesdays.
substantial reduction in costs. He visited Otago in the early 1880s for the Gabriel's Gully tailings reclamation project. After the consolidation of the Blue Spur mining parties in 1888, Perry floated some public gold mining companies for hydraulic elevating elsewhere in Otago and after that he took up gold dredging. He was the pioneer in the Waikaka field in Southland, with the profitable Perry’s Reward dredge but he failed with a hydraulic suction dredge at Waitahuna. In the mid1880s he took up interests and designed machinery for alluvial tin mining in New South Wales. In 1899-1900 Perry was one of the New Zealand operators who took bucket ladder gold dredging to Australia, on the Araluen River in New South Wales. He died in Sydney on 20 November 1901 aged 69. Whether in alluvial or quartz gold Perry was a pioneer and innovator. On his death in 1901, his obituary stated, “Mr Perry was a genius in many respects. He was a singularly clever mechanic, he was of a scientific turn of mind, and he had a vast fund of general knowledge …”

He was also an entrepreneur and deal-maker. When the Lawrence based tailings syndicate came to incorporate the project in a registered company in October 1879, four of the original applicants had disappeared, but there was Perry with a controlling 58 percent of the shares.

**Engineering the Hydraulic Elevator**

Working in Thames, Perry changed his prize-winning design completely, and replaced the mechanical bucket system with a hydraulic device based on the principle of a venturi water pump. Tests with a small prototype at Thames threw sand, stones six or seven metres into the air, and proved that the idea could work. Of significance in relation to who devised the concept or designed the equipment, Perry pointed out that while he had suggested the principle, all the rest had been carried out by his superintendent, John Brown who was a well-respected mine and battery manager in

---

15 It also probably had one of the few opening ceremonies in New Zealand complete with speeches and toasts, for a water turbine and pump. See “Queen of Beauty Battery.” *Thames Star*, 29 March 1877, 2.


18 “A Loss to the Mining Industry,” *ODT*, 21 December 1901, 10.

19 Named as The Blue Spur and Gabriel's Gully Sluicing Company (Limited), the nominal capital was £30,000 in £1 shares of which 27,852 were issued, and paid to 5/- each. See NZGG 115, 13 November 1879, 1605-6.
Thames and a fellow shareholder in the project. Was Perry being modest or was Brown really the “inventor”? Another hint of its origins was that in Otago in April the device was referred to as an adaptation of an American machine.21

Whoever it was that devised it, the device became known as a hydraulic elevator. This was in effect a pump for gravel that was powered by high-pressure water. As such, it could raise auriferous gravel to a height suitable for the disposal of tailings where there was not enough natural fall or, as at Gabriel's Gully, where the natural fall had been blocked by earlier tailings. These capabilities conquered the age-old limitation of sluicing methods of needing fall for the disposal of tailings and would allow the hydraulic elevator to work the thick deep Gabriel's Gully tailings. The hydraulic elevator was not, however, a device for mining gravel per se and hydraulicking or ground sluicing remained necessary to break out the in situ gravel and present it as a slurry in a sump for the elevator.

The design of Perry’s elevator is shown in Figure 14. In operation, water under the high pressure of ninety metres of static head (294 ft., 850 MPa, or 123 psi pressure) in the high pressure water pipe was jetted into the tapered throat of the liner inside the bottom section of the gravel discharge pipe.22 The nozzle converted the high-pressure inflow into a high velocity jet of water. In fluid mechanics, it was well proven that the pressure in a contained fluid system was inversely proportional to its flow velocity a high velocity created a low pressure. The high velocity from the nozzle created a very low pressure, tending to a vacuum, in the tapered throat. This sucked the gravel slurry in the sump into the gravel intake pipe, which was designed to plumb into the throat near the nozzle with the minimum of sharp bends and obstructions.23 The velocity of the jet, the suction of the vacuum, and momentum carried the gravel slurry up the gravel discharge pipe. At the required height, the gravel discharged against a thick cast iron splash plate in an iron lined discharge box, which dissipated the flow and broke up cement lumps. The gravel slurry passed from the discharge box to a line of sluices mounted on trestles, which, due to the effectiveness of the elevator could be set as high

20 Untitled, Thames Star, 11 March 1880, 2; and “The Evening Star,” in Thames Star, 12 March 1880, 2.
21 “Interprovincial,” OW, 3 April, 1880, 10; and “News of the Week,” OW, 3 April 1880, 16.
23 W. E. Thorne and A. W. Hooke, Mining of Alluvial Deposits by Dredging and Hydraulicking (London: Mining Publications Ltd, 1929), 82, Figure 69A on 85, and Figure 70 on 86.
above the ground level as necessary to provide fall onto or past the existing tailings. The twin parallel pipelines (high-pressure water down and gravel slurry up) angled down to the sump, the trapezoidal discharge box, and the run of sluice boxes on trestles above existing tailings, are a characteristic structure that identifies a hydraulic elevator in many historical mining photographs of Otago.

Figure 14. Design of Perry’s Elevator

H. A. Gordon, the Inspecting Engineer of the Mines Department, was familiar with American technology and talks about Perry's elevator as moving the gravel by blowing whereas the American Cranston elevator which appeared two or three years earlier sucked the material into the inlet throat.24 The vacuum principle is the same and any difference is a one of local design and not technologically very significant; the ratio of water head to height lifted was the same for the 1878-79 Cranstons as for Perry, at 6 -

---

7:1. However, later American elevators tended towards Perry’s throat design and positioning, a compliment to his engineering capability.

Implementation

Perry commenced the necessary extensive preparatory site works in Gabriel's Gully early in 1880. Water lines were established from separate sources to provide high and very high heads, for hydraulicking and hydraulic elevating respectively. In addition, a large diameter (685 mm diameter) drain pipe was buried under the tailings to bypass the creek from upstream and receive tailings water. Later on, this required continual deepening and clearing and was a constant difficulty in the system. The elevator and a turbine for workshop power were made to Perry’s designs in Judd’s Foundry in Thames. Revolving buckets to extract tailings and feed the elevator were also to be made at Judd’s. All told, the project incorporated activity and expenditure well beyond what would have been needed to set up a stamp mill for the cement, something between £1,000 and £2,000. However, the paid up capital or around £7,000 looks adequate and included the scope for calls if need be. After over a year of construction, fabrication, excavation, and trials, the elevator system was operating by April 1881. A hydraulic monitor had replaced the bucket excavator line to extract the tailings and made more sense as a simpler proven device. The installation of a mechanical bucket elevator, grizzly, (bar screen) and chain conveyor for the feeding the hydraulic elevator and screening out and disposing of coarse stones that would block the gravel inlet pipe, remained for completion. By late 1882 a looped and toothed chain conveyor had been erected and was dragging material from the sluice face along a channel to the elevator sump. However, this device cannot have been of any advantage because it was never reported in use again. If hydraulicking could not adequately flush paydirt to a sump then nothing mechanical would. The other function of Perry’s device, to sort and

25 Lock, 351-353.
26 “Local and General Intelligence,” Tuaeka Times, 10 January 1880, 2.
27 “Blue Spur and Gabriel's Gully Sluicing Company,” Tuaeka Times, 7 April 1880, 3; Ibid., 28 August, 1880, 2.
29 “Gabriel's Gully Tailings Company,” Tuaeka Times, 27 April 1881, 2; and AJHR H17, 1881, Wardens’ Reports, 34.
reject oversize, was handled in mines elsewhere by bars over pipe inlets and the hand
stacking of the oversize stone, sometimes assisted a crane or winch. 

The working layout as in 1883 is shown schematically in Figure 15.

![Figure 15. Field Layout of Elevator – Monitor System](image)


As commented above there are two separate pressure pipelines and unusually, the
elevator water pipe in this layout, entered from the front end of the pit. In most other
set-ups, this line was installed beside the gravel up-pipe under the sluice trestling,
giving rise to the characteristic twin pipeline seen in many photographs. The elevator
unit was submerged in a sump in the deepest part of the pit and was fed by a ground
sluice that was fed with gravel brought down by the monitor. The jet nozzle was of 90
mm diameter (3½ inches). At Gabriel's Gully, where the static head was 90 metres
(294 feet), the elevator lifted the material around 13 metres, or 45 feet. The monitor
and the elevator used fifteen to twenty heads of water which was much more than any
ground sluicing on the Blue Spur. The estimated capacity of the elevator was two

---

30 “Local and General Intelligence,” Tuapeka Times, 16 September 1882, 2.
32 “The Mines Department,” ODT, 3 August 1885, 3.
33 AJHR 1883, H5, Report on Gold Fields etc, Visited, and Works in Progress, 3-4.
tonnes of solids per minute or around sixty cubic metres of slurry per hour.\textsuperscript{34} This was high productivity but a hydraulic elevator was a transfer device and did not increase mining productivity, which was the role of the hydraulic monitor. Instead, the elevator’s great benefit was in its effectiveness, in allowing gold to be won from sluiceable ground that lay below the level of fall.

Figure 16 depicts hydraulic elevating at the head of Gabriel’s Gully in the 1920s, which was no different from the original system. The white arc in the lower left is a jet of monitor water removing a slice of washdirt on the bottom of the pit and flushing it to the elevator. This is not visible but its position is marked by the two pipes at centre left, for high pressure water down and for elevated gravel up, respectively and the latter leads to the distinctively shaped discharge box. This leads to a run of sluice boxes. On the far right is a secondary elevator that raises the primary elevator tailings high enough to have fall for discharge over old tailings. The view also shows that there was much more space in a working paddock than the sketch of the layout in Figure 15 implies.\textsuperscript{35}

\begin{figure}[h]
\centering
\includegraphics[width=\textwidth]{figure16.jpg}
\caption{Hydraulic Elevating in Gabriel’s Gully in the 1920s}
\textit{(Hocken Collections Te Uare Taoka Hākena, 1309_01_018A)}
\end{figure}

\textsuperscript{34} “Lawrence,” \textit{ODT}, 3 May 1882, 3.
\textsuperscript{35} The Tailings Company’s paddock in 1885 was approximately 120 metres long by 70 metres wide and 20 metres (65 feet) deep. See “Important Mining Inquiry,” \textit{OW}, 19 September 1885, 3.
As a footnote to the Gabriel's Gully sludge channel issue, the Minister of Mines, Mr W. J. M. Larnach, visited the district in July 1885 and was pleased to see the completed Lawrence – Gabriel's Gully drainage scheme of 1882.\(^{36}\)

**Innovative Technology in Action**

The hydraulic elevator proved to be highly successful technology. Along with the monitor and sluice boxes, Perry system had no difficulty in working the tailings and lumps of cement and extracting their gold. After thus exhuming the unmined wash under the tailings, the sluicing monitor could rip through the washdirt and into the weathered schist bottom, and flush the gold out of cracks and crevices. Even though this ground had been worked over by Chinese miners after the Europeans, it contributed most of the gold recovered by the Perry technology.\(^{37}\) The hydraulic and hydraulic elevating system was efficient in cost terms as well because and used nine men where otherwise thirty to forty would be used in a cement claim.\(^{38}\) This shows again how contingent on the technology, work at the Blue Spur was.

In spite of its production effectiveness, the tailings project was not greatly profitable. A 10 ½ month period in 1884-85, when output was 804 ounces, or say 900 ounces annualised was one near-annual result but according to the Warden, no dividend was paid that year.\(^ {39}\) In aggregate, the Mines Department reported that by 1887 the operation had recovered over 3,000 ounces of gold, at a breakeven of nine ounces per week.\(^ {40}\) Over six years the average annual output would have been 500 ounces and the average weekly output, 9.6 ounces, which would have left very little margin over the breakeven. An 1887 Statement of Affairs for the Tailings Company, which reported that no dividends had been paid also indicated poor profitability.\(^ {41}\) Even the higher aggregate value of £15,000 worth of gold, or 4,000 ounces, over a life of seven years,

---

\(^{36}\) He also noted that the House had voted £2,000 for it. See “Our Mines,” *ODT*, 27 July 1885, 4.

\(^{37}\) AJHR, 1882, H19, Wardens’ Reports, 34.

\(^{38}\) AJHR 1885, C2, Wardens’ Reports, 46.

\(^{39}\) Own Correspondent, *New Zealand Tablet*, 13 February 1885, 18; and AJHR 1884, H9, Wardens’ Reports, 39.


\(^{41}\) “Statement of Affairs of a Company,” *Tuapeka Times*, 5 March 1887, 3.
for a weekly average of 11 ounces, that emerged from the Consolidated Company takeover of the Tailings Company, was hardly more indicative of profitability.\textsuperscript{42}

The problem lay in the lean overall grade of the material processed. It soon became clear that there was not much gold in the tailings, nor in the cement lumps.\textsuperscript{43} In addition, the operation had started a significant distance down the gully, away from the known rich ground at the head. Clearly, the basal unmined paydirt at the starting position was low grade and it returned little gold no matter how well hydraulicking scoured the schist bottom. Perry moved the installation up the valley as fast as practicable including the considerable work of extending the ever-deepening through drain.\textsuperscript{44} The deepest issue in the lack of financial success may simply have been the incessant additional costs of bedding in the new technology. Perry was continually making changes; as well as moving the operation upstream; there were new races, dams, and pipelines, the discarded chain conveyor device, enlargements of the sluice boxes for higher elevator output, any of which incurred shutdowns as well as expenditure. The costs and lost production from these issues could well have absorbed any gains from the low operating cost of the system.

The environmental benefits that had prompted the project did not eventuate and could not. The tailings scheme used its ability to create its own fall to avoid having to do anything about the valley itself but it was never a whole-of-valley scheme nor depended on an engineered sludge channel. Ironically, the deeply buried pipe through-drain, which was the equivalent of Gabriel’s Creek, was the greatest source of difficulty in the entire elevating project. In September 1882, therefore, an updated report on tunnels and flood damage in Lawrence appeared. This again ruled out any tunnels on risks of blockage and flat gradients inside and out. Instead, it recommended works to separate the outflows of the Wetherstons’ and Gabriel's Gully creeks by providing

\textsuperscript{42} This was after Mr F. M. Byrne, a Blue Spur school teacher, had pointed out the company’s gross misrepresentation of claiming that the amount had been recovered in one year. See “British and Foreign News,” \textit{Tuapeka Times}, 21 July 1868, 4; and “The Blue Spur Mines,” \textit{OW}, 9 May 1889, 11.

\textsuperscript{43} “Gabriel's Gully Tailings Company,” \textit{ODT}, 13 October 1882, 3.

\textsuperscript{44} “Gabriel's Gully Tailings Company,” \textit{Tuapeka Times}, 27 April 1881, 2; and “Local and General Intelligence,” \textit{Tuapeka Times}, 18 May 1881, 2.
through drainage from the other creeks in Lawrence in a new flood-safe channel. The only attention to Gabriel's Gully was to straighten the creek at the bottom.\textsuperscript{45}

**Wide and Structured Uptake**

*Initial Users After Perry*

Although Perry developed it for tailings, the combined system of hydraulicking and hydraulic elevating applied to unmined ground. In this case, it was known as “hydraulic sluicing” and it was recognized that due to the capital costs of the elevator, its additional high head water supply network, and the operating cost of the water, costs were higher than for ground sluicing and hydraulicking. However, elevating’s unique capability was its effectiveness in enabling rich below grade deposits to be worked. The unprofitability of the Tailings Company did not obscure the capability of the technology and new users soon appeared.\textsuperscript{46}

In 1883, the Mountain Race Company set up a hydraulic elevator at Tinkers in the Manuherikia Valley. The Undaunted Company followed the Mountain Race Company with a hydraulic elevator in 1885.\textsuperscript{47} John Ewing, who had developed the technology for mining at St. Bathans at the head of the Manuherikia Valley before Perry had done so at the Blue Spur, might have assisted them. In 1884, Roche and Party set up a hydraulic elevator on the Nelson Creek deep lead on the West Coast after visiting Perry’s operation at Gabriel's Gully. However, the following year another party somehow claimed their ground for the disposal of tailings and their elevator venture died.\textsuperscript{48}

In 1885, Great Extended initiated the application of hydraulic elevating to raw alluvials on the Blue Spur. Rather bravely, they had decided to rely on the force of a monitor jet to break out the cement. If it worked, it stood to be more productive and have lower

\textsuperscript{45} “Lawrence Sludge Channel,” *Tuapeka Times*, 16 September 1882, 3. The scheme was designed by Mr Ussher the District Engineer.

\textsuperscript{46} This was the generally used name for Perry’s Company.


\textsuperscript{48} AJHR 1884, H9, Report on Gold Fields, Etc, Visited, and Works in Progress On Gold Fields, 8-9; and AJHR 1885, C2, Ibid., 9-10.
costs than underground mining or chamber blasting because of their laborious manual drilling and tunnelling. As Perry had shown, heads of 90 to 120 metres were feasible as against 60 to 90 metres in the 1860s and 1870s, and this higher pressure would generate more powerful jets. For the inevitable lumps of cement too large to elevate, Great Extended planned to use hand sledge-hammering until they had solved the logistical issues of using their idle battery on the far east end of the Hales and Hinde claim. Great Extended planned to use hand sledge-hammering until they had solved the logistical issues of using their idle battery on the far east end of the Hales and Hinde claim. They had bought the claim and its assets in 1883 on the death of Thomas Hinde. However, the unused battery burned down in July 1885, but had not been used for over a year, anyway, while the company was converting to hydraulicking. The depth of the working face also necessitated the innovation of two elevators working in series to achieve the required twenty five metres of vertical lift, the first one lifting eleven metres and second one fourteen metres.

Hardly had Great Extended started its operation, in late July, when it was stopped by an injunction and a claim for damages from the Tailings Company. The Tailings Company had mined out the Great Extended tailrace, which admittedly had been idle during many years of stamp milling, so Great Extended had returned the favour by channelling its tailings into the Tailings Company’s working paddock. The case turned on whether the long unused tailrace was current, or legally abandoned. Warden Revell decided for the Tailings Company and awarded moderate damages. However, the Blue Spur miners petitioned the Governor, who commissioned an enquiry by E. H. Carew, the previous Warden. This showed twenty years of extensive use of a number of races that the Tailings Company had mined through, at which it compromised considerably and agreed to replace the Great Extended and the other races. It was mid-November before the Great Extended party was back in full swing with its new hydraulicking and hydraulic elevating system and required only three men to reduce cement lumps with a sledge hammer in the absence of a stamp mill. Twenty to thirty employees in the previous underground mining and stamp milling mode had not put

49 “Local and General Intelligence,” Tuapeka Times, 25 February 1885, 2; and “Mining at the Blue Spur,” ODT, 28 May 1885, 2.
50 “Local and General Intelligence,” Tuapeka Times, 22 July 1885, 2.
51 “Mining at the Blue Spur,” ODT, 28 May 1885, 2; and Patrick Galvin, ed., The Handbook of New Zealand Mines (Wellington, NZ: Government Printer, 1887), 18.
52 “Warden’s Court,” Tuapeka Times, 5 August 1885, 5.
53 “Mining Dispute,” Tuapeka Times, 16 September 1885, 5. Two other important parties whose races had been mined through were the Otago Co. and the Nelson Co.
through as much cement. Great Extended had proven that “hydraulic sluicing” the Blue Spur cement to be feasible and productive. The other parties starting with the Otago Company followed as their ground called for it.

**Corporate Uptake**

Wider uptake of the hydraulic sluicing technology followed and can be expressed in terms of three organisational types: large corporates, many with London connections; the John Ewing model, which used bank funding to stay independent; and local groups who fitted hydraulic sluicing into their existing workings without much apparent disruption, for example Great Extended.

Perry was involved in the formation of many public companies. In August 1888, he formed the United Hercules Hydraulic Sluicing Company Ltd to use hydraulicking and hydraulic elevating to mine on Hercules Flat beside the Clutha River downstream of Roxburgh. Authorised capital was £12,000 of which Perry held 78 percent initially. After much site work, production began in July 1889. He floated the Roxburgh Amalgamated Mining and Sluicing Company Ltd in early 1889 with Vincent Pyke, long out of goldfields management, as chairperson and himself as managing director. The company operated with four elevators and enjoyed a long-life. Unconnected to Perry, and floated in London, the Island Block Gold Company Ltd moved into production in July 1889 on an old back channel of the Clutha River downstream of Millers Flat. The Hercules No. 2 Gold Mining Company was incorporated in Dunedin on 25 March 1890 to mine thirty acres of gold bearing land that included part of the Special Claim of United Hercules Hydraulic Sluicing Ltd. Sir Robert Stout was a director along with Perry, but he was not a shareholder.

---

54 “Local and General Intelligence,” Tuapeka Times, 18 November 1885, 2.
55 “Blue Spur Mining Notes,” Tuapeka Times, 31 December 1885, 5.
56 DAAB/D91/9055/18j-169, The United Hercules Hydraulic Sluicing Company Limited 188801898 [Archives New Zealand, Te Rua Mahara o te Kāwanatanga, Dunedin Regional Office].
57 “United Hercules Hydraulic Sluicing Company Limited,” OW, 29 August 1889, 12.
58 “Miscellaneous,” OW, 28 March 1889, 12.
59 “Island Block Gold Company, A description…,” Tuapeka Times, 30 January 1889, 3; and “United Hercules Hydraulic Sluicing Company Limited,” OW, 29 August 1889, 12.
60 DAAB/D91/9055/23f -216, The Hercules No. 2 Gold Mining Company Limited 1890-1890 [Archives New Zealand, Te Rua Mahara o te Kāwanatanga, Dunedin Regional Office].
Perry was also the promoter and one of three New Zealand directors of the Pactolus Syndicate Company which was floated in London in 1891-92. It initially proposed to use a centrifugal pump and not a hydraulic elevator to raise monitored paydirt from its ground in the upper Nevis Valley. Using a gravel pump would have been radical but when they began mining in November 1893, it was with a low head high volume mode of hydraulic elevating that was unusual nevertheless. The operation closed down in late 1896 for unspecified reasons but evidently not technical failure because the plant was transferred to a mining lease in the Round Hill goldfield.

A real corporate was the Blue Spur and Gabriel's Gully Consolidated Gold Company Limited (“Blue Spur Consolidated”). This was floated in London in 1888 with a nominal capital of £130,000 with the object of amalgamating the claims on the Blue Spur, including the Tailings Company, and applying monitoring and hydraulic elevating to work them systematically. It swamped the other hydraulic elevating floats but it was of the same organisational type. It is discussed further below.

A separate venture, the Round Hill Syndicate Limited was floated in London in 1891 by George M. Evans, a technologically astute entrepreneur of English origins who gained familiarity with the goldfield by working as a shopkeeper and miner at Round Hill. Nominal capital was £50,000 and the Hon W. J. M. Larnach as well as Sir Robert Stout were directors of the local board. The Round Hill Gold Mining Company Limited commenced elevating in November 1891 and operated successfully for decades. Evans invented an elevator with multiple gravel inlet pipes that allowed an easy restart after a blockage, and made other improvements. After bedding down the Round Hill operation he moved to the United States where his invention was widely promoted, while he managed a large hydraulic elevating mining in Colorado.

---

61 Vincent County Mining Notes,” OW, 15 December 1892, 14.
64 The Round Hill goldfield, which lies between Colac Bay and Orepuki in Southland, was the largest Chinese diggings in New Zealand. In building a package of mining and water rights to float in London, Evans have taken over or obtained by forceful means the water rights of the Chinese miners. James Ng interprets Evan as a racist who worked to remove all Chinese miners per se.
65 AJHR C3, 1892, 95; and AJHR 1898, C3, (Robert Wilson), 124.
66 For details of Round Hill see AJHR 1898, C3, Inspecting Engineer’s Report ,124; and .AJHR 1892, C3, Inspecting Engineer’s Report, 96.
The John Ewing Model

Within Central Otago, John Ewing was as entrepreneurial as Perry. More than any other miner, he used funding by bank loans to establish large ambitious projects. He claimed to have invented hydraulic elevating but there were practitioners in the United States at least as early as he was in Otago. His first recorded elevating operation was about nine months earlier than Perry in Gabriel's Gully, as discussed further in “Unclear Origins” below. Regardless of first use, he was an expert in the technology and continued to develop it in use whereas Perry moved onto new projects.

Ewing’s technology was driven by the whether the bottom of his hydraulicking operation at Kildare Hill in St. Bathans was above or below the St. Bathans sludge channel, which was periodically deepened. His floor must have reached its limit of fall in 1880 because that was his first reported use of an elevator. The Otago Witness, reported rather mildly that it was “something of an innovation in mining.” In 1886 as he approached the level of the tailrace again, he recommenced elevating, with a lift of six metres. However, this was a Perry elevator because he had found it superior to his own model. In 1889, he set out to increase the lift to over fifteen metres by using a newly patented Robertson air-bleed nozzle. In two years, this proved susceptible to breakages and did not deliver the promised 30 percent greater performance over the Perry type. Once again, Ewing designed and installed his own new unit, which incorporated, amongst other improvements, cast steel wear parts. This proved an admirable device and from then on, learning from use, which Edgerton advocates as a fruitful source of innovations, Ewing continued the improvements. The relationships between the nozzle and throat diameters and the spacing between the nozzle and the throat were of particular importance, leading to elevators of increasing capability and efficiency. This culminated in a double lift system for 33 metres height in November 1894 of which 28 metres was a single lift.

Ewing proceeded with new projects and incorporated hydraulic elevating as needed. In 1887, he and a partner William McConnochie bought an unworked claim in the Tinkers

68 John McCraw, The Gold Baron: John Ewing, Central Otago's mining entrepreneur (Alexandra, NZ: Central Stories Museum and Art Gallery, c. 2009), 27-29; and “Notes from St. Bathans,” OW, 29 November 1894, 17. Note: the many authors who describe this as a single lift are mistaken. As the newspaper reported, Ewing and his staff had replaced a triple lift system with a double lift, notwithstanding that the upper lift of 28 metres was still an impressive technical achievement.
diggings but after spending £9,000 on water rights, cutting a water race, water pipes, hydraulicking equipment, and innovative wide riffle tables, it was October 1890 before he commenced mining. Elevating was only necessary in 1902 when Ewing and McConnachie amalgamated their claims and water rights with those of the Sugar Pot Party to form the Tinkers Gold Mining Company. From a detailed analysis of this and other property transactions in the Tinkers diggings Hearn has concluded that associative enterprise modes persisted through much apparent structural change. In late 1892, John Ewing bought the hydraulic plant and claims of the liquidated Hercules No 2 Company for £1,800. Continuing mining more efficiently than the failed Hercules Company went on to buy the adjoining United Hercules property, which also went into liquidation in 1895. In 1892, Ewing lent £4,000 to the Bald Hill Sluicing Company at Fruitlands but this project only brought him years of entanglements due to poor gold grades, inadequate water supply, and land conflicts. However, he managed to continue mining here with some elevating until closure in 1906. His home base of mines at Vinegar Hill and Cambrians mines, near St. Bathans used hydraulicking without needing elevating. Structurally John Ewing’s bank funding mechanisms gave him the freedom to execute his projects as he saw fit based on his considerable technical and operating expertise, without the impositions of an absentee and uninformed board of directors. This enabled him to apply and develop hydraulic elevating to its peak capabilities and provide guidance for others. These included George Evans at Round Hill.

In 1906, in the official New Zealand Mining Handbook, the expert and hugely experienced John Ewing pointed out that most of the alluvial mining throughout the South Island was now carried out with hydraulic elevators, reaching depths of as much as 50 metres. He concluded that “but for its invention, alluvial mining in Otago would be almost a thing of the past.” This was a very successful innovation.

**Mining Parties, Informal or Registered**

The Mountain Race Mining Company and Great Extended had shown that local registered companies could handle hydraulic elevating technology. Many associative

---

69 John McCraw, 72-74.
70 Hearn, Structural Change, 86-91.
71 John McCraw, 76-82.
72 John Ewing, ‘Hydraulic Mining,’ in Galvin 209.
enterprises around the Blue Spur also fitted hydraulic elevating and hydraulicking into their mine plans, found the funds, and proceeded without any great disturbance and showed that incorporation was unnecessary. Kitto and Party, “The Cornishmen” who were mining the entire width of Munro's Gully as a cooperative, built hydraulic elevating into their operation. The Local Industry Company, a party of around local five miners, commenced mining the downstream and eastern side (Wetherstons) side of the Gabriel's Gully tailings in 1892 using exactly the same hydraulic technology as the Tailings Company. Mills and Party commenced hydraulicking and hydraulic elevating at the junction of Munro's Creek and the Tuapeka River in early 1895. The cost of their equipment and site preparations was merely £800. Similarly, the Fidelity Co., the successor of Livingstone and Party on the Munro's Gully side of the Blue Spur and a party which did not join the 1888 consolidation, was working a deep face of cement by chamber blasting and using an elevator to bring it out. They had invested £900 in plant. In all examples, neither the cost of the hydraulic technology nor the organisational structure had any obvious influence on the uptake of the technology.

**Ongoing Operations on the Blue Spur**

A feature of the ongoing operations of the Blue Spur mining parties was increased complexity of production techniques as the parties exhausted their richest material. The ability of the upgraded technology of higher pressure monitoring to break out cement was clear and added flexibility, but technological reversions also occurred. The Nelson Co. had stopped underground mining and had laid up their stamp mill because the grades of the bottom cement were now not paying. They had gone back to chamber blasting and ground sluicing in other parts of their leases. Regarding flexibility, Great Extended were monitoring in Gabriel's Gully while utilising ground sluicing on the Munro's Gully side of their claim. At other times in the latter 1880s, they also tributed out an underground section of their property and operated a ground sluicing joint venture along their northern boundary with the North of Ireland Co.

---

76 “The Otago Gold Fields, Their Past History…,” OW, 23 April 1896, 16.
However, lumps of cement still required hand sledge-hammering for ground sluicing or elevating. This encouraged a search for a cheaper means of crushing than a stamp battery. In November 1886, Great Extended commissioned a Marsden stone crusher that had cost a very reasonable £350 for their Blue Spur claim. Further, indicating a reduction in costs, it could be attended to by a “boy.” In December, Kincaid, McQueen delivered a new and patented roller mill to the Nelson Co. These were in the vanguard of their field as Charles McQueen had designed and patented his device and the Marsden machine was a patented upgrade of the original Blake jaw crusher technology. All parties held great hopes for these new machines as local experience had shown that stamp batteries were costly and inefficient, but shutting them down had cost people their jobs and had shortened the life of mining.

**Dual Otago Emergence**

The exact origins of this important device are unclear. Ewing had an elevator working industrially around nine months before Perry, even if the written record is not as clear as desirable. More interestingly, they worked completely independently of each other, their prototypes arising in the widely separated St. Bathans and Thames and the bigger question is whether for each of them it was their own idea or came from elsewhere. The principles themselves were ancient as the Carthaginians used an equivalent tool for “dredging waterways.”

Many similar devices reported in New Zealand in the 1870s could have established a precedent. Both Perry and Ewing might have known of a device known as water pump for dewatering unusual spaces. This was based on a two pipes joined in a tee or acutely angled junction pointing in the direction of flow. Flowing water entered the straight-through pipe that formed the top of the tee and induced suction in the suction pipe, which was the stem of the tee, and whose open end was placed in the water to be pumped. This water was thus sucked into the pipe. It flowed past the join and out, along with the driving water, through the other limb of the tee. Such a device was

77 “Local and General Intelligence,” *Tuapeka Times*, 6 October 1886, 2; and “Mining Notes,” *Tuapeka Times*, 6 November 1886, 3.
78 “Local and General Intelligence,” *Tuapeka Times*, 18 December 1886, 2.
reported in the Otago goldfields in 1871, and had been used “on a large scale” for improvements on the Yarra River in Melbourne.\textsuperscript{80} A similar device in 1873 was reported in a gasworks to remove water from sumps where a mechanically driven piston pump would not fit.\textsuperscript{81} Most unusually, because the information seems to have been soon forgotten, in 1872 a Mr Acton exhibited a model of such a device for the extraction of gravel by flowing water. Not only that but this was in Lawrence and Acton specifically stated its use for the reworking of tailings. However, the \textit{Tuapeka Times} reporter without seeing the device scornfully wrote, “It appears to be nothing new – merely an ordinary hydraulic pump.”\textsuperscript{82}

Diffusion from the United States is another possibility. In 1872, the United States Patent Office granted Patent No. 122,657 for a device “for raising tailings in mines” to W. A. Rogers. This was a crude looking device in which the discharge pipe was made of four planks of wood bolted together and which was fed under simple atmospheric conditions by a wooden flume.\textsuperscript{83} This must have been horribly inefficient but a later device, the Cranston elevator, was all-metal and better engineered and became the American industry standard in the late 1870s, notwithstanding that the industry of hydraulic elevating was not significant in the Californian alluvial scene.\textsuperscript{84} Information about its successful application in California reached New Zealand in articles in the \textit{Otago Witness} in 1877 and 1878. Both Ewing and Perry were technically astute and presumably technically alert, and were quite probably aware of these articles.\textsuperscript{85} Another indicator of diffusion from the United States is the report noted above from a northern paper and published in the \textit{Otago Witness}, in which John Brown’s test work was referred as being “an adaptation of an American machine.”\textsuperscript{86} Mr H. A. Gordon the knowledgeable Inspecting Engineer also refers to Perry’s elevator in the same terms.

\textsuperscript{80} “Mining,” \textit{ODT}, 8 January 1871, 7, quoted in John McCraw, 26.
\textsuperscript{82} “Local and General,” \textit{Tuapeka Times}, 9 May 1872, 7.
\textsuperscript{84} Lock, 351.
\textsuperscript{86} “News of the Week,” \textit{OW}, 3 April 1880, 16.
The American information was more specific and close to the time of Otago emergence and might well have been the originating factor.

There is a deeper issue than the technical origins of the Otago designs and that is that innovation by hydraulic elevating was another case of responding to the changing characteristics of the orebody under depletion by mining. Issues like this will always arise in mining because all extraction activity is a process of depletion; this, as this thesis shows, forces mining to into more difficult material that needs different technology for its working. Hence, mining is a more dynamic technology than is perhaps normally recognized in the historiography. I therefore argue that innovation is always going to be a part of mining, and should be taken by historians of mining and technology as normal and not as an Edgertonian nuisance.

Hydraulic elevating was never a macroinnovation, as hydraulicking was, but it was the last major innovation for land based alluvial deposits after hydraulicking. Although it can be said to have been invented in the United States, hydraulic elevating was not widely used there, and the banning of mega-hydraulicking in 1884 must have had an influence. In the South Island alluvial goldfields of a different disposition to California the use of hydraulic elevating was de rigeur. Because of this wide use, two important improvements were made in this region that exemplify the improvements possible from technology-in-use. These were the full engineering and accurate design of the device and the incorporation of air infusion after Robertson, even if Ewing found it unhelpful. George Evans’s multiple inlet design that was much advertised in the United States may also have been developed while he managed the Round Hill mine in Southland; but if not then important elements of it were.

---

87 The introduction of jigs for processing alluvial paydirt was extremely valuable in mineral processing.
88 Hagwood, 26.
89 For George Evans’ work in the United States, see Jonathon C. Horn, “Snake River Ditch (Oro Grande Canal No. 1),” Historic American Engineering Record HAER CO-82, 1994, 10-12. For his general work at Round Hill refer to the reports in AJHR, C3, 1890-1898.
Structural Change around the Blue Spur

In April 1888, in accordance with its contracts with the Blue Spur mining parties as vendors, recently floated London based Blue Spur and Gabriel's Gully Consolidated Gold Company Ltd. (“Blue Spur Consolidated” or “the Consolidated Company”) commenced to take over the properties.\(^9^0\) The parties, which included two valuable race companies, consisted of the following: the Blue Duck, (an unworked claim under tailings to the east of Perseverance but workable by elevating, Fidelity, Great Extended, Morrison and Co., Nelson Co., North of Ireland, Otago, Perseverance, and the Tailings Company; and the Waipori and Tuapeka Water race companies.\(^9^1\) Except for the Blue Duck, the mining claims are those shown in Figure 8. However, this grand package of properties did not survive for long. In May 1889, the Great Extended, Nelson and Perseverance parties withdrew from the arrangement due to the Consolidated Company’s non-payment of the final quantum of cash, and in June the Company abandoned the Blue Duck, Fidelity, and North of Ireland properties, the latter two of which were in Munro's Gully and not of immediate use.\(^9^2\) This left the consolidated package with only the ground of the Tailings Company as its core, along with the Otago and Morrison claims and the essential race companies. However, except for the two Munro's Gully parties, these parties had rejoined the consolidation by 1890, indicating that the Blue Spur Consolidated must have built up the funds to pay them fully.\(^9^3\) The Blue Spur Consolidated worked tailings until the end of November 1891 with much more success than the Tailings Company, perhaps because the rich ground at the head of the Spur had finally been reached. After approximately one year, it had recovered around 1,600 ounces of gold and was employing twenty-nine men including a race crew of five.\(^9^4\) Mining of the Blue Spur proper was based on hydraulic monitoring or quarrying with blasting but did not contemplate underground methods.

\(^9^0\) “The Blue Spur and Gabriel's Gully Consolidated Gold Company (Limited),” *Tuapeka Times*, 31 March 1888, 3.
\(^9^1\) “The Blue Spur and Gabriel's Gully Consolidated Gold Company (Limited),” *Tuapeka Times*, 31 March 1868, 3.
\(^9^2\) “Assays of Tailings,” *ODT*, 20 May 1889, 2; and “The Blue Spur and Gabriel's Gully Consolidated Gold Co.,” *Tuapeka Times*, 8 June 1889, 3.
\(^9^3\) This was indicated by the attendance of their representatives at a formal meeting of shareholder in the Blue Spur Consolidated. See “Blue Spur and Gabriel's Gully Consolidated Gold Co.,” *Tuapeka Times*, 23 April 1890, 5.
\(^9^4\) For the end date of November 1891 see “The Tuapeka Goldfields,” *Tuapeka Times*, 21 September 1892, 3. For the other information see AJHR 1889, C2, Goldfields Water Races and Other Works in Connection with Mining, 68-69.
Production was achieved by working in two panels, or working blocks. Each panel was serviced by a monitor, with blasting as necessary, and two hydraulic elevators and their associated runs of sluice boxes. The two elevators in series allowed the new tailings to traverse the uncoordinated previous workings and their tailings dumps and dispose of the new tailings far out of the way. This allowed the systematic and most efficient extraction of the remaining resource.  

Over the next many years, the operations of the Blue Spur Consolidated carried on under the highly competent management of Mr Howard Jackson, a professional engineer. In the interests of the effective working of the deposit he compiled technical data to measure the efficiency of his machinery, especially the hydraulic elevators. Some of this data found its way into handbooks and textbooks on hydraulic mining around the world. Crushing the lumps of cement continued to pose difficulties as the Marsden and Kincaid, McQueen machines, and any others tried, did not prove adequate. In 1893, Mr Jackson advised Mr Gordon that he found it best to blast the cement thoroughly to minimise large blocks and use hammers and picks under manual labour to reduce the remaining lumps small enough to suit the elevators.

The Company closed down in 1912 after recovering 51,000 ounces of gold. The suitability of the hydraulic elevator technology can be deduced from its two decades of application around the Blue Spur since its introduction by Perry. Such longevity in one alluvial digging with one suite of technology indicates a robust innovation.

This was a major structural change into a fully corporate structure. After considerable initial instability when the local operation was refused working capital by its London board and the board was sued for fraud by a shareholder, in both cases due to excessive payments to vendors, many of whom themselves withdrew for a period due to lack of full payment, economic efficiencies emerged from the restructuring. After these

---

95 AJHR 1896, C3, 134.
97 Some of the data was collected in conjunction with the Inspecting Engineer of the Mines Department, Mr H. A. Gordon. See Thorne and Hooke, 78-80.
99 Mayhew, 47.
controversial events had been dealt with, the structural change proved to be appropriate for the long-term exploitation of what was a massive unique deposit.

**Review of Hydraulic Elevating and the Blue Spur**

Hydraulic elevating and its co-technology, hydraulicking, was an innovation that secured another thirty years of life and the production of 60,000 ounces of gold from the Blue Spur deposit. Adding the preceding period of simpler mining technologies, the life of the deposit was fifty years. Such a long life allowed time for the miners to develop or adopt innovative technology as the orebody became depleted and mining became more difficult. This is the antithesis of the simple unvarying methods and transience of a gold rush, and is not to be conflated with gold rushing. Nor are the increasing sophistication and the necessary higher capital of more complex technologies to be conflated with capitalism.

Unlike other forms of technology where a steady-state world of mundane Edgertonian activities may be envisaged, mining technology in the nineteenth century was particularly dynamic as the Western frontier moved into lands with large rich deposits of gold and other minerals, while at the same time the West was on-industrializing. As Burt points out, in the mining sector seven technologies in this period transformed mining into a bulk industry. This chapter argues that the Edgertonian model of stability and incrementalism is unsuitable for this period. Further, since depletion is an inherent characteristic of mining and will always force innovation, mining may be perennially exceptional against Edgerton's model. On the other hand, Edgerton is focused on the twentieth century where industrialization could be said to have consolidated the innovations of the nineteenth century.

As the case of hydraulic elevating around the Blue Spur shows, in the face of the exigencies of depletion, the extraction of the large varied Blue Spur deposit required dynamic technological responses. Innovation, or at least adoption by diffusion, was

---

100 This includes the 51,000 ounces from the Blue Spur Consolidated from 1888-1912, plus an allowance for the Tailings Company and the Blue Spur companies from 1880 onwards and for the other two companies who retreated tailings in Gabriel's Gully after the Blue Spur Consolidated.

101 Roger Burt, 324, 328-329. Refer also to n27 in the Introduction and n134 in Chapter 2.
therefore the operating technological mode for the first thirty years’ life of mining of this deposit. Based on this, it follows that innovation should be incorporated in any technological history of a given mining operation.

An examination of the question of “structural change” revealed some interesting points. None of the Blue Spur mining parties had any difficulty in accommodating the quite demanding technology of the new hydraulicking-hydraulic elevating systems, which required much enhanced water supply systems and the intensive heavy equipment of monitoring as well as the elevator network. In wider Otago, the same no-change pattern was seen in equivalent associative enterprises whether cooperative or registered. The model should perhaps be named as “structural stability.” The appearance of Perry’s Tailings Company and its always-challenged monopolistic rights over land-in-common definitely created tension but this was adequately resolved. The Blue Spur and Gabriel’s Gully Consolidated Gold Company Ltd introduced a quantum structural change on the Blue Spur. After an initial two years of contentious events that were due not to any monopoly, which it was, but to virtual economic incompetence, it adapted blasting, hydraulicking, and hydraulic elevating to provide twenty more years of mining. The lost economic benefits to the mining parties by not being able to continue were in fact capitalised in the price they received for vending into the consolidation.

R. J. Perry was the key figure in the development of the particular innovation on which this chapter is based and was a particularly dynamic person himself. As a hitherto ignored but important figure in New Zealand mining history he merits more attention. George Evans took an improved version of the technology to the United States and is also important.
CONCLUSION

The proposition of this thesis is that technology lies at the heart of all gold rushes and the gold mining that followed, and further, that the technology of gold rushes was different from the technology of gold mining.

The first half of the proposition is almost a truism. The gold in a rush or mining was won by the exercise of geological knowledge, combined with the knowledge of tools and the techniques for using them, in the activity known as work. This form of endeavour constitutes “technology” as has been defined in the Introduction, especially in the sense of being “the means by which we apply our understanding of the natural world to the solution of practical problems.” The fact that only the application of technology and no other component of a culture, such as religion, science, or politics, could have extracted the gold, represents a truism; even so it places technology at the heart of the rush or mining. This, then, addresses the first part of the proposition.

The next part of the proposition was to show that the technology of gold rushing was different from the technology of gold mining. It is axiomatic that a rush involved the sudden and rapid movement of a large number of people to a new discovery of gold. What they did when they got there was equally as fundamental, and it was an exercise of technology. In terms of technology, in spite of the widely varied geographies, geologies, and political systems in which rushes broke out, gold seekers in all rushes chose from the same suite of basic tools, namely pick, shovel, spade, dibble, crowbar, and bowl or pan. These cost little or were easy to make, and needed only simple manual methods requiring little skill. Some experience was helpful but the techniques could be readily learned. From the Appalachian rushes onwards, the cradle, which was another low cost and manually operated device, was added to the suite. The simplicity and low cost of gold rush technology made it accessible to large numbers, which made rushes possible but the technology was of low productivity. The maximum for a cradle was around one to two cubic metres daily per person. A gold rush ended when these

1 Li-Hua, 18-22.
simple manual techniques no longer made money, because their limited productivity in reduced grades could not produce enough gold to cover daily expenses.

Mining was characterised by technology of a higher productivity or greater effectiveness than achievable with the manual methods and low cost tools of a rush. The workforce was smaller than for a rush because of its higher productivity, or else it was fixed in place and could not go rushing, because it was tied into wages or contract employment due to the nature of the technology and also because there was little ground worth rushing for. Productivity was achieved by mechanisation by hydraulic or mechanical means. Unlike the more or less universal rush technology, mining technologies varied according to the characteristics of each deposit and terrain. The techniques that were available included hydraulic mining (ground sluicing or hydraulicking), river mining, deep leading, and, if productivity was not achievable by mechanisation, the use of coordinated mass labour, as in Hispanic America and Siberia, and to a lesser degree, in river mining in California. Mining required higher skills and experience was highly valuable. Capital expenditure, for securing tenure, cutting water races, diverting rivers, developing and equipping mine access, building surface plant, and for purchasing any other machinery, was diagnostic. A further difference was that gold rushing was transient or short-term, whereas mining took a long-term perspective. This was possible because the higher productivity in hydraulic mining made large lower grade deposits profitable, while in other types of deposits, more effective but capital-intensive technologies could exploit large but difficult deposits that gold rush technology could not contemplate, but which were rich enough to stand capital expenditure unavailable to the gold seeker. Deep leads and river mining offer examples.

In alluvial deposits that occurred near creeks or had fall for tailings disposal, there was usually a transition period to mining at the end of a rush when hydraulic washing was used. In this phase, the richest ground had been exhausted but what was left remained diggable with hand tools. Hydraulic washing by long tom or board sluice, which provided up to six times the productivity of a cradle, replaced human effort by using the energy of flowing water.
This thesis contends that a gold rush ended on any particular diggings when hydraulic washing replaced cradling. This is considered the break point because deposits that supported simple manual technology made a gold rush possible. Hydraulic washing as just stated, utilised hydraulic energy. It might be argued that in the same material, a rush ended when full mining started, that is, at the end of any transitional hydraulic washing period rather than the start. This would have weight in Otago because hydraulic washing was used from the start of the Gabriel's Gully rush. In underground leads and riverbeds, hydraulic washing or hydraulic mining were never a possibility, and the start of mechanisation and capital expenditure signalled the end of a rush. The writer prefers the start of hydraulic washing to signal the end of a rush because, as given, it means the end of the purely manual techniques that became almost symbolic. However, a more important issue is that the fundamental technological differences between rushing and mining often go unrecognized or are ignored.

Given the differentiation of gold rushing from gold mining and applying it to the Gabriel's Gully gold rush and the mining of its extension, the Blue Spur deposit, along with the following analysis in the rest of the thesis, we now have a coherent technological history of gold extraction in Gabriel's Gully and the Blue Spur. This includes a fresh look at prospecting and the origins of the Gabriel's Gully gold rush. After the gold rush, mining commenced when two experienced Californian race-cutters established ground sluicing operations on the Blue Spur Conglomerate in Munro's Gully and on the Blue Spur side respectively in mid-1862. No evidence was found to support the much repeated claim that it was a party from the Ovens in Victoria, who established the first race for mining in the Waitahuna diggings, and accordingly must have been the first alluvial miners in the Tuapeka goldfield. In 1865, following new geological knowledge, ground sluicing was supplanted by tunnelling and chamber blasting, which was a quarrying technique. In 1874, full underground mining, and crushing with stamp batteries commenced. All machinery and lighting systems where necessary throughout this period were powered by water turbines except for the short-lived stamp mill of Morrison and Co., of 1871, which had an overshot waterwheel. In 1881, R. J. Perry, a dynamic and entrepreneurial engineer, commissioned an important innovation. This was the hydraulic elevator, which raised material, in this case Blue Spur tailings, from below ground level to well above, so that they could be reprocessed.
for gold and disposed of with adequate fall. The tailings were first extracted from their dump by a hydraulic monitor. This also was new technology for Gabriel's Gully despite having been invented in 1853 and widely used. In 1885, the Great Extended Company made a further important innovation when they applied hydraulicking and hydraulic elevating to mining the cement. With a new high-pressure water supply, the monitor proved able to rip out the cemented Blue Spur Conglomerate that had required blasting methods for the previous twenty or more years. This powerful combination of hydraulic elevating and hydraulicking (termed “hydraulic sluicing”) was avidly taken up in the rest of Otago and revived a declining alluvial mining industry. In 1888, the Blue Spur and Gabriel's Gully Consolidated Gold Company Ltd. bought out the Blue Spur mining parties and continued mining with “hydraulic sluicing” and some blasting until 1912. That ended fifty years of mining on the Blue Spur since the commencement of ground sluicing.

This long life indicates the size of the Blue Spur deposit while the range of technologies borrowed from quarrying and quartz mining indicate its unusual characteristics. There does not appear to have been any other alluvial deposit like this anywhere else in the world of alluvial mining. However, the many changes of technology had accompanying increases and decreases in employment, which must have influenced the community outside the mines. Knowing the timing and the reasons for the changes will allow a sharper focus for any future histories in these topics.

The analysis has established depletion as a fundamental factor in the extraction of a gold deposit. Equally fundamental in determining the technologies and their rates of change were the characteristics of any given deposit. However, depletion could not be directly be quantified from the data that was available. Instead, the use of productionist data in the form of monthly escort gold and the productivities of the different extraction technologies proved very useful in indicating the course of depletion, comparing alluvial techniques and explaining changes in the technology.

This work has revealed important new production information. Gabriel's Gully repeated the simple technology of gold rush extraction of the washdirt by hand tools as in every gold rush back to those in Hispanic America but in a significant departure, the Gabriel's Gully gold seekers used hydraulic washing as well as cradling. Gabriel Read
himself used a long tom before the rush began. Whether due to this more highly productive washing technology or not, as shown in Chapter 2, the Tuapeka goldfield produced significantly more gold than California in the respective first nine and twenty-one months of activity of each goldfield.

The regulation of mining is also part of the technology of mining in that it represents the means by which government situates the role of mining in society. Including three months of Miners’ Committee adjudication, the Otago regulatory system was supportive and responsive to technological changes through the rush and into the transition to mining. However, when the highly productive ground sluicing technique took over in mid-1862, the impacts of its tailing were beyond any scale of regulation, and recourse to the Warden's Court was not effective either. In the end, productionist values saw the tailings prevail over everything in their path. These problems link mining on the Blue Spur to environmental history. Specifically, by close attention to the Mining Regulations of 1861 and 1862 this thesis provides new meanings regarding the foundations of resource management law in New Zealand. These imply an earlier start to statutory thinking than does the work of Hearn and others who used the Gold Mining Acts and tailings disruption from the 1870s onwards as their information base.

What was evident in this thesis regarding associative enterprise and structural change supported Hearn’s findings from the Tinkers goldfield. Apart from the major structural change when the London based Blue Spur and Gabriel's Gully Consolidated Gold Company Ltd. bought the Blue Spur parties in 1888, associative enterprises stayed as they had started for the preceding twenty-six years as did the registered companies. Tenure under fifteen year mining leases was no doubt one reason for this stability. There was no difference apparent in the technological behaviour or performance of these groups although the membership of both types changed over time.

As far as the structural issues of monopoly and capitalism are concerned, the Blue Spur organisations were no more capitalistic or monopolistic than their tenure allowed. What does monopoly mean when each form of mineral tenure - from a 24-foot square claim to a 10-acre mining lease - entitled the holder to exclusive occupancy, and ownership of any gold extracted? The most aggrandizing miner was probably John Ewing, whose strategy was to accumulate large areas that tended to hold low grade
Another accumulator of tenement holdings was the Blue Spur and Gabriel's Gully Consolidated Gold Company Ltd but its early revealed behaviour was anything but monopolistic. Of the nine mining parties it originally contracted to buy, within a year, due to financial strictures, it held only three. It regained three more but two of the remaining three continued successfully; this was not a full monopoly. Quartz mines, the source of much confusion when their far different technology is combined in a misinformed generalisation with alluvial mines, were usually more heavily capitalised, but there were none of significance in the study area. Further, given that quartz reef gold was a much lesser part of Otago gold production than alluvial, a writer would be unwise to lump them together. The existence of monopolies and capitalistic hegemony on the Tuapeka goldfield is not borne out in this thesis.

Of wider historiographical significance is the finding that innovations in alluvial rushing and mining continued throughout the nineteenth century from the cradle, long tom, and gold pan of North Carolina and Georgia, to the hydraulic elevator of Otago. Indeed, although it lies outside the scope of this thesis, the development of the bucket ladder gold dredge in Otago in the second half of the century was another significant innovation, rated as a macroinnovation. All of these innovations were rapidly incorporated into mainstream alluvial mining technology. The pattern was noted by Edgerton, of innovations quietly failing when the publicity of emergence was over, did not occur in alluvial mining in the nineteenth century, although the board sluice enjoyed a strong preference over the long tom in most situations. The pattern of innovation in alluvial technology may justify a re-examination of Edgerton's separation of histories of innovation and technology. This thesis suggests that mining is inherently exceptional in regard to Edgerton's model of technology-in-use because it must continually respond to the depletion of any given deposit and innovate. Burt's model of macroinnovations for nineteenth century mining matches the characteristics of mining and more closely than that of Edgerton.

Some further work might prove worthwhile in some areas. Somehow, the Californian gold production data should be reconciled with that of the Tuapeka but the anomalies lie at the California end. Rodman Paul considers that he reached the limits of official Californian data so I suggest an approach based on normative field production on the
lines of Bancroft’s widely quoted figure of one ounce per digger per day.\textsuperscript{2} Further study on the nature and structure of work in Tuapeka goldfields would have application throughout the Otago goldfields. There is much information in the archives, and the evolution of water rights around the Blue Spur is not the intricate matter that it was at Tinkers. Since the technology and its timing is now evident more attention could be given to social matters outside the mines. The role of long-term mining projects in community formation in Otago after the gold rushes, and how a work force and community survived in the face of employment changes driven by technology would much enhance the Otago historiography. Perry the Innovator could be studied. He was a pioneer not only in hydraulic elevating, not forgetting John Ewing, but also in gold dredging and hydraulic mining machinery in general, and not only in Otago but previously in Thames and latterly in New South Wales.

With a technological base now established for alluvial mining around the Blue Spur, a gap in the local historiography may have been filled. Historians may be encouraged to pursue other lines of enquiry relating to the Otago gold rushes or gold mining with the role of technology included in their perspective. Further, the seeming conflation between gold rushing and gold mining in the historiography might be resolved, and allow more meaning to be derived from the existing historiography.

\textsuperscript{2} Bancroft, noted in Morell, 79.
BIBLIOGRAPHY

Primary – Government Sources

Unpublished Manuscripts, Records, and Maps

Archives New Zealand/ Te Rua Mahara o te Kāwanatanga, Dunedin Regional Office

Magistrates/Warden’s Court, Lawrence - Mining Applications No. 1 – 201, (AENX/D583); [Archives New Zealand, Te Rua Mahara o te Kāwanatanga, Dunedin Regional Office].

Ministry of Economic Development, Southern Business Centre – Defunct Mining Company files, (CBAT/D480); [Archives New Zealand, Te Rua Mahara o te Kāwanatanga, Dunedin Regional Office].

Lands and Deeds Registry Office, Dunedin, Defunct Company and Incorporated Society files, (DAAB/D91/9055): [Archives New Zealand, Te Rua Mahara o te Kāwanatanga, Dunedin Regional Office].

Department of Lands and Survey, Dunedin Survey Office, Otago Goldfields Mining and Agricultural Lease Application Registers, (DAAK/9378); [Archives New Zealand, Te Rua Mahara o te Kāwanatanga, Dunedin Regional Office].

Alexander Turnbull Library

Tuapeka Magistrate’s Office, Register of issue of miners' rights and business licences in the Tuapeka gold fields, 19 August-1 November 1861, qMS-2045.

Hocken Collections, University of Otago


United States Patent and Trademark Office


Published Material - Records

Appendices of the Journals of the House of Representatives

Selected items from 1881, H17, - 1898, C3.

New Zealand Government Gazette, 1879 no. 115.
Otago Provincial Government Gazette


Votes and Proceedings of the Otago Provincial Council

Selected items from Session V, 1856, Session VI, 1857, and Session XIII 1861 – Session XXVII, 1870.

Published Material – Books and Articles


Primary – Private Sources

Unpublished – Manuscripts


Unpublished – Photographs

Photographs from the Blue Spur, Gabriel's Gully, and Gold Mining Methods sections, Hocken Collections, University of Otago.

Photograph of Blue Spur, Museum of New Zealand Te Papa Tongarewa

Published Material

Newspapers

Bruce Herald

Daily Southern Cross

Lyttelton Times

Mount Ida Chronicle

Nelson Examiner and Daily Chronicle

Otago Daily Times

Otago Witness

Thames Advertiser

Thames Star

Tuapeka Times

West Coast Times

Books and Articles

Atkinson Thomas Witlam. Oriental and Western Siberia; a narrative of seven years’ explorations and adventures in Siberia, Mongolia, the Kirghis Steppes, Chinese Tartary, and part of Central Asia. New York, Harper, 1858.


Secondary Sources

Unpublished

Theses


Published


Bakewell, Peter. “Mining in Colonial Spanish America”. In CHLA II, 105-151.


Bray, Heather, ed. *Pick and Shovel, Cradle and Pan: 150 Years of Gold Discovery in Otago, Southland and on the West Coast; Stories of Our Gold Mining Ancestors*. Dunedin, NZ: Heather Bray and Dunedin Family History Group, 2011.


____________, “Innovation, Technology, or History: What is the History of Technology About.” Technology and Culture 51 no. 3, (July 2010), 680-697.


Green, Fletcher M. “Georgia’s Forgotten Industry: Gold Mining.” Pt. I. *The Georgia Historical Quarterly* 19 no. 2, (June 1935), 93-111.

__________, “Georgia’s Forgotten Industry: Gold Mining”. Pt.II. *The Georgia Historical Quarterly* 19 no. 3, (September 1935), 210-228.


__________. “Origins and Diffusion of Traditional Placer Mining in the West.” *Material Culture* 18, no.3 (Fall 1986), 127-166.


