How True to Nature are Julius Haast's Field Sketches and Paintings of Glaciers in the Southern Alps of New Zealand?

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A reproduction of Julius Haast's 1866 painting of the Lyell Glacier in the headwaters of the Rakaia River has recently been used on science news websites to illustrate the extent to which glaciers in Kā Tiritiri o te Moana (the Southern Alps) of New Zealand have retreated by comparing it with an aerial photograph. This raises the question of whether Haast's landscape paintings, and the field sketches on which they are based, are accurate environmental records of the extent and volume of those glaciers. There was little commentary on the veracity of Haast's sketches in the scientific or art-historical literature until the late twentieth century. In a more recent book on Haast's glaciological research, ecologist Colin Burrows included many field sketches by Haast, which he asserted are largely accurate based on his visits to many of Haast's sites, but little visual confirmation was provided.

In the research underpinning this paper, the fidelity to nature of Haast's illustrations was investigated by comparing a sample of Haast's field sketches, and the corresponding landscape paintings, with site photographs or virtual views generated by Google Earth Pro from, or close to, Haast's vantage points. The set of nine views selected were encountered on an expedition to investigate the headwaters of the Rakaia River in Canterbury and to document the glaciers that fed that braided river. For all of those views, Haast produced landscape paintings based on his field sketches, which were eventually reproduced in his official report as lithographs.

The fidelity analysis described here involves comparing enduring geographical, geomorphological and sometimes ecological features illustrated in his works with those recorded in contemporary site photographs or in virtually generated imagery. Faithfully rendered features and those modified for scientific or artistic reasons, are identified, leading to a significant conclusion about the reliability and value of Haast's glacial works as historical environmental records.

Finally, the findings of this research project on the fidelity to nature of a sample of Haast's works are compared with Burrows' judgement.

Keywords: fidelity to nature, field sketch, glacier, historical environmental record, Julius Haast, landscape painting, Rakaia River, roche moutonnée, Southern Alps, watercolour

Introduction

In recent years there have been a number of radio, newspaper, television and internet news items on the dramatic retreat of the glaciers of Kā Tiritiri o te Moana (Southern Alps) of New Zealand. One such internet article, on the *SciTechNews* website, is titled "New Zealand's Southern Alps glacier melt has doubled – up to 77% of Little Ice Age glacier volume already lost".[1] The item was based on research published by an international team of glaciologists led by the University of Leeds, working in conjunction with scientists at the National Institute of Water and Atmospheric Research (NIWA) in New Zealand (Carrivick et al. 2020). The article opened with a striking illustration, reproduced in Figure 1, which compares an 1866 landscape painting by Julius Haast (1822–1887) of the Lyell Glacier at the headwaters of the Rakaia River with a 2018 aerial photograph of that glacier by NIWA climate scientist Andrew Lorrey. Although the photograph was taken from a much higher vantage point, the aerial shot dramatically illustrates how far the ice has retreated in just over 150 years,

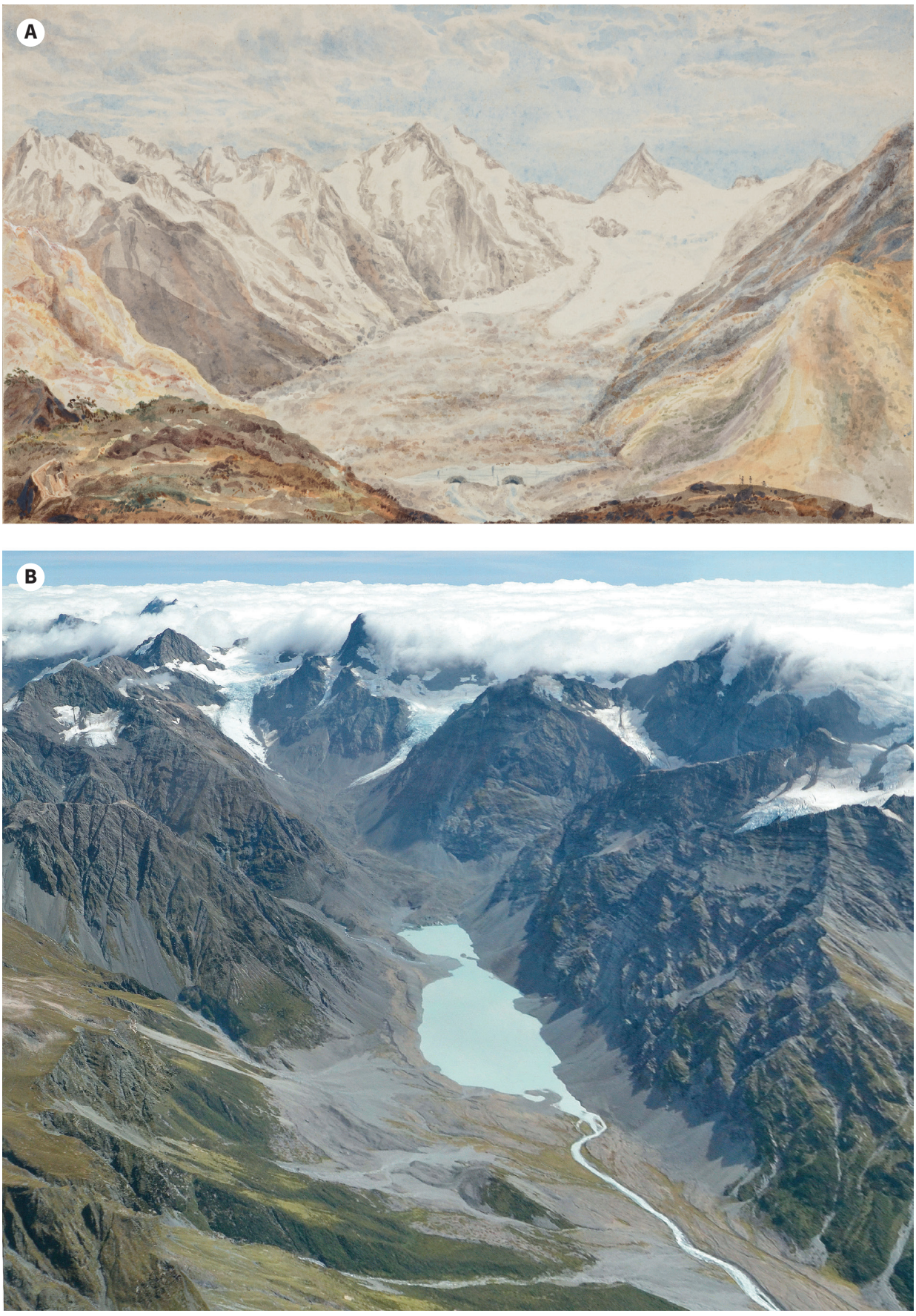

Figure 1. Comparison of a recent aerial photograph of the Lyell Glacier with a nineteenth-century painting. **A**, *View from Meins Knob looking West, the Southern Alps with the Lyell Glacier*, watercolour, 141 × 248 mm. Julius Haast, 1866. Alexander Turnbull Library A-149-003 **B**, *Upper Rakaia catchment looking west toward Lyell Glacier while flying over Meins Knob during the Southern Alps end-of-summer snowline survey in 2018*. Photograph by Andrew Lorrey, 2018

from a state in which the terminus of the glacier apparently filled most of the valley to its present position much further up the valley just beyond the more recently formed proglacial lake.[2] (Glacial terms are defined at the end of this article.)

Intriguing though the comparison is, it raises the question of the fidelity of Haast's landscape painting – is it an accurate historical environmental record? Was it true to nature at the time or did Haast use artistic licence to transform features of the glacier, rendering it a less reliable record?

In the 1860s, Haast explored and surveyed much of Kā Tiritiri o te Moana (the Southern Alps) lying within the mid-nineteenth-century boundaries of the Province of Canterbury in the British colony of New Zealand. In 2005, the ecologist Colin Burrows published a substantial book, titled *Julius Haast in the Southern Alps*, which focused on Haast's pioneering scientific research, particularly "his contributions to topographical and geological mapping, and his innovative studies of the glacial geology of the region" (Burrows 2005: back cover). Included in the book are 16 coloured sketches by Haast of glaciers or glacially formed features, all of which are in the Alexander Turnbull Library (ATL) collection. A search conducted through the website hosted by the National Library of New Zealand identified numerous other field sketches of views in Kā Tiritiri o te Moana (the Southern Alps) by Haast, as well as a limited number of finished landscape paintings based on some of those sketches,[3] one of which was used in the *SciTechNews* article.

Aware that I had recently completed extensive research into the issue of fidelity to nature in the Antipodean landscape paintings of the mid nineteenth-century colonial artist Eugene von Guérard (Hook 2022b), and of my interest in Haast's sketches, research librarian Sascha Nolden suggested that I might like to apply the techniques I had developed to assess whether Guérard's works are reliable environmental records to Haast's oeuvre. This appealed, as it would provide a further test of the validity and reliability of those methods.[4] The present study could not be completed on the same scale as the Guérard research, which had involved researching and visiting the sites of more than 100 of his landscapes, but a worthwhile assessment could be made of the fidelity of a sample of Haast's field sketches and paintings. This research could make a significant contribution to the literature on the recent history of New Zealand's glaciers, particularly as they are sensitive indicators of climatic changes, measurably expanding in volume and length as the climate cools and shrinking as the climate heats over interannual and longer time scales (Mackintosh et al. 2017; Baumann et al. 2020; Lorrey et al. 2022). Given that very few photographs were taken of New Zealand's glaciers until late in the nineteenth century, when it became more feasible to transport and set up bulky photographic equipment in remote alpine locations, Haast's sketches and paintings of glaciers, if accurate, are important sources of information about the maximum extent of Kā Tiritiri o te Moana (the Southern Alps) glaciers near the end of the Little Ice Age (Lorrey et al. 2014), before human-induced global warming began to influence the extent of glacial ice in New Zealand (Vargo et al. 2020).

Commentary on the Fidelity of Haast's Sketches and Paintings

In a 1911 chapter on the physiography and plant ecology of the Mt Arrowsmith district at the head of the Rakaia River, geologist Robert Speight acknowledged his "indebtedness to Julius von Haast on points so numerous that it is impossible to mention them in detail" (Speight et al. 1911: 317). However, he made no mention of the field sketches, most likely because he would not have seen them, as at that stage they were in the possession of Haast's widow Mary, stored in two metal trunks (Nathan 2022).

The first scientific article to comment specifically on the fidelity of some of Haast's field sketches of glaciers in Kā Tiritiri o te Moana (the Southern Alps), provocatively titled "The dwindling glaciers of

the Upper Rakaia Valley, Canterbury, New Zealand", was published by the geologist Maxwell Gage in 1951. Having visited the site in 1949, he wrote that Haast's sketch of the Lyell Glacier (Fig. 9B) "is a remarkably detailed and faithful representation of the *more permanent* features [emphasis added]" of the view (Gage 1951: 504).

In a 1974 article that mentioned the numerous field sketches made by Haast held in the Alexander Turnbull Library collection, art historian Janet Paul acknowledged that she was "struck by Haast's accurate eye and the speed of his work", with sometimes several "vast panoramic drawings" completed in a couple of days (Paul 1974: 6). Paul claimed that Haast limited the watercolour paints he used in the field to a cerulean blue wash for the sky and water, a scrubby grey for rocks and terre verte for vegetation.

The next scientists to specifically mention Haast's sketches of glaciers were Burrows and Brian Maunder (1975) in a paper on the recent moraines of the Ramsay and Lyell Glaciers in the Rakaia Valley. They noted that Haast had painted a watercolour of the Lyell Glacier from Meins Knob (Fig. 9C), the original of which was held in the Alexander Turnbull Library, "from which it could be seen that the terminus lay at the position of the M3 moraine". The researchers also commented that "Haast's painting from near the Louper [sic] Stream shows that the glacier terminus extended to the foot of Meins Knob in 1865 [sic]" (Burrows and Maunder 1975: 479, 482–483). In this instance, they were actually referring to a lithographic print in the back of Haast's report on the headwaters of the Rakaia River (Haast 1866: View No. 11). That print is based on a watercolour (Fig. 8C) that Haast produced back in Christchurch using his field sketch (Fig. 8B). As Burrows and Maunder did not question the visual information in Haast's sketch, painting or print, it can be assumed that they considered them to be accurate illustrations of the view, including the mid nineteenth-century glacial features. Their confidence would have been based on having reached some of Haast's vantage points and seen that enduring topographical features were accurately rendered.

The most recent scientific publication to include reference to the fidelity of Haast's field sketches and paintings of glaciers is the aforementioned book *Julius von Haast in the Southern Alps*. In that tome, Burrows included colour reproductions of 16 of Haast's sketches that illustrated alpine scenes with glaciers. Two of Haast's landscape paintings were also reproduced. Given the effort Burrows made to locate those specific images among the 200-plus sketches and paintings held in the Haast Family Collection in the Alexander Turnbull Library,[5] and then requesting colour scans, it is obvious that he had a great deal of confidence in the accuracy of the images. They informed significant sections of his analysis of the changes that particular glaciers have undergone in the intervening 140 years (relative to the time of publication of his book). Burrows commented that as his "own research career took me to many of the locations that Haast visited in the 1860s", he could only conclude that Haast "had not received due credit for his many acute observations on aspects of New Zealand glacial geology" (Burrows 2005: 14). Furthermore, Burrows wrote that "[one] special benefit of describing Haast's scientific investigations of the Southern Alps is that it provides an opportunity to present many of his drawings … to a wider audience". The ecologist noted that as Haast's exploration of the alps occurred before alpine photography became feasible, "his drawings and maps are valuable first-hand information on many natural phenomena, seen through European eyes for the first time". At no point in his substantial text did Burrows question the veracity of Haast's field sketches, although he did question the degree of accuracy of some. Clearly this confidence was based on the ecologist having reached many of Haast's sites on extended field trips after 1985,[6] and having compared reproductions of Haast's sketches with actual views. Despite his obvious familiarity with many sites, Burrows included few comparative photographs taken from or close to Haast's vantage points, and those photographs are located in a different insert of colour plates from that including reproductions of the field sketches. A striking exception

is the pairing of a sketch and a contemporary photograph of the Cameron Glacier (formerly the Hawker) at the headwaters of the Rangitata River, which illustrates the cover of the book and is reproduced in Figure 2. Burrows noted on the imprint page that "the glacier had receded by more than two kilometres".

Selecting a Sample with which to Assess Haast's Fidelity to Nature

A comprehensive assessment of the fidelity to nature of Haast's field sketches was beyond the scope of this research project, so I considered a sample of works instead. These could have been chosen randomly from the extensive collection here in New Zealand and in the more limited collection held overseas,[7] but this would have created some difficulties in investigating sites that would be in widely separated locations. I therefore decided to assess the fidelity to nature of the sketches that Haast completed on one particular excursion, that to the headwaters of the Rakaia River in Canterbury (see Figure 6).

Although there are at least 25 painted images connected to the 1866 Rakaia expedition in the Alexander Turnbull Library collection, not all were digitised. After viewing the digitised images it became apparent that there are two types of works, both executed in watercolours. Some are pencil and watercolour sketches and others are watercolour landscape paintings. The paintings reproduce views recorded in some of the sketches. Eventually it was established that there were nine paintings, each based on one of nine sketches. The library's metadata indicated that

Figure 2. Comparison of a field sketch of the Hawker Glacier (now known as the Cameron Glacier) with a contemporary photograph of the same view taken from close to Haast's vantage point **A**, *The Hawker Glacier, source of River Cameron from Mt Arrowsmith, 27 Feb. 1864*, pencil and watercolour, title in ink, 180 × 540 mm. Julius Haast, 1864. Alexander Turnbull Library C-097-040 **B**, *Arrowsmith Range, Canterbury*. Photograph by Callum Marshall, 2005

the landscape paintings were used as 'originals' to inform the lithographers who produced the illustrations found at the back of Haast's report on his survey of the topography and geology of the Rakaia catchment, published in the year of the expedition (Haast 1866). Therefore, for each of nine views Haast encountered in the Rakaia headwaters, there are three works – a coloured sketch, a landscape painting and a lithographic print.

Nine views would constitute an adequate sample for an exploratory investigation into the fidelity of both Haast's field sketches and landscape paintings, provided photographs of the same views could be obtained through site visits or other means. Although not randomly selected, the works have the advantages of relating to a fairly limited geographical region,[8] and of being completed when Haast was a well-established topographical and geological surveyor with well-developed draughting and artistic skills. Given that the prints were the lithographers' replication of Haast's landscape paintings, they do not form part of this fidelity analysis of Haast's works, although he would of course have had to approve them.

Haast's Alternative

Before assessing Haast's works, it is worth briefly considering the alternative approach that he contemplated. Two years prior to the Rakaia expedition, Haast commissioned the landscape painter John Gully (1819–1888) to produce 12 large watercolour paintings based on field sketches he supplied (e.g. Figs 3A and 3B). In 1864 Haast sent these artworks to the Royal Geographic Society in London to be used as visual aids when his paper was read to the society. The editor of the society's journal, in which Haast's paper was eventually published, described them as "well executed water-colour drawings" (Haast 1864: 92 footnote). In his published address, the society's president, Roderick Impey Murchison,[9] wrote that those paintings seemed to him "never to have been surpassed by any delineator of icy regions" (Murchison 1864: clxi first footnote).[10] The world-renowned botanist Joseph Hooker wrote to Haast from the Kew Gardens herbarium telling him that he was looking forward to seeing the "glacial views, which I hear are glorious" (Nolden et al. 2013: 65).[11]

Perhaps encouraged by the praise heaped on these watercolours, which established Gully's reputation, Haast came to appreciate the artist's abilities as a watercolourist despite his earlier reservations about his skills,[12] and invited Gully to accompany him on an expedition to survey the headwaters of the Rakaia. Given that Gully had not visited any of the glaciers he had painted for Haast (Paul 1974: 6), the scientist must have contemplated how much better illustrations of the glaciers would be if Gully could see the ice masses with his own eyes. This could have been another Antipodean example of an artist accompanying a scientific expedition, in order to paint the views encountered on the journey, such as Eugene von Guérard (Hook 2018) and Nicholas Chevalier (Gregg 2011: 92–116) joining the geophysicist Georg von Neumayer on some of his magnetic-survey expeditions across Victoria, Australia. Unfortunately, this never happened as Gully was "sorry to say that I cannot accept your offer much as I would like it. Our present Supert. [sic] would not listen for a moment to the proposition of two months leave of absence" (Gully 1984: 33).[13]

Despite this disappointment, Haast reconciled himself to painting the required 'original' images with his own brushes, based on the field sketches he would make. There is no information in the massive biography of Haast, written by his son Heinrich, about whether he received any formal artistic training, but judging by the landscapes produced following the Rakaia expedition, he was a talented amateur. In Burrows' opinion Haast's "ability with pen and watercolour was invaluable, although he was a careful accurate recorder of scenes, rather than an artist" (2005: 173). In Heinrich's opinion, his father's "skill with pencil and brush enabled him to record the striking scenes that had thrilled his being" (Haast 1948: 347).

Figure 3. Comparison of John Gully's painting of Macauley Glacier with Haast's field sketch **A**, *Sources of River Macaulay. 10 March 1862*, watercolour and pencil on paper, with ink annotations, 170 × 430 mm. Julius Haast, 1862. Alexander Turnbull Library C-097-083-1 **B**, *Macauley Glaciers, 4375 feet*, watercolour, 285 × 460 mm. John Gully, 1862. Alexander Turnbull Library C-096-007

Features of the Rakaia Field Sketches and Finished Landscape Paintings

Before assessing the fidelity to nature of Haast's illustrations of nine views in the Rakaia Valley, the general features of the field sketches and the finished landscape paintings are identified below. These observations are based on a viewing of the original works in the National Library of New Zealand, facilitated by curator Oliver Stead. The sketches are the middle images of Figures 7–15, and the landscape paintings are the bottom images, except in Figure 14 where the sketch and painting are in the middle rows.

The Field Sketches

The nine sketches were all made on thick sheets of paper of variable size, depending on the view being sketched and the pieces of paper available, often roughly cut or torn. Most sketches are approximately 180 mm in height, suggesting they may have been cut from a roll. Some sketches are panoramic in scope, while others are rectangles of the more typical landscape painting ratio of height to width of around 3:4. Two are framed within a pencilled rectangle. An outline of the gross topographical features of each scene was pencilled in initially, then watercolour paint applied to different areas. The limited colour range is discussed in the section titled View VII later in this paper. For some of the sketches the whole surface of the paper is covered in paint, but in others, parts of the foreground or the far sides of the scene are left unpainted. No staffage is included for estimating the size of natural features or their distance from the viewer. Most of the sketches have annotations in either pencil or ink, indicating the names of features (or code letters for them),[14] or giving brief descriptions of details, distances and sometimes compass directions. The title of the view is typically inked in and sometimes also the date on which it was sketched.

Most of the above characteristics of Haast's sketches are those generally associated with landscape sketches completed in the field in front of the subject (Hook 2022b: 147). It is highly likely that Haast completed the nine sketches largely in situ, particularly as it would have been challenging to recall the details of the topography and colouration on a later occasion, back at a campsite, hut, homestead or his office. Indeed, with reference to the field sketch of the Ramsay Glacier (Fig. 10B), Haast reported that, "For several hours I was occupied taking the necessary bearings and making a sketch of the glorious scenery before me" (Haast 1866: 19). This implies that he must have applied paint in front of his subject, as completing just the pencil outlines of the two sketches is unlikely to have occupied him for long. With regard to his sketch of the Lyell Glacier (Fig. 9B), Haast wrote that the "view towards the west [from Meins Knob] was magnificent" and that although the lower part of the glacier was covered in debris, higher up there were "many seracs [of] peculiar green and bluish hues", colours he attempted to capture on his sketch. Elsewhere in his report, Haast refers to "accompanying sketches, drawn carefully on the spot" (Haast 1886: 34).[15]

The Finished Landscape Paintings

The finished landscape paintings are all watercolour on paper but with a more extensive palette of colours used than in the corresponding field sketches. The features of each scene are more detailed than in the sketches, with the entire surface of the paper painted in, implying they are finished artworks. The foregrounds of the pictures are well developed and most have staffage to provide a sense of the scale of natural features. The paintings were executed on carefully cut rectangular sheets of paper in landscape orientation and two are panoramic in scope. Four of the works have identical dimensions, as do two other paintings. The other three are of variable dimensions. Each painting is mounted on a larger sheet of paper, which has an inked rectangle framing the work.

The mounts have neat handwritten titles and labels, as well as a number at the top. Given the completeness of these works, the carefully rendered detail using an extended set of colours, the regularity of the dimensions of the sheets and the pictorial depth apparent in each, Haast could not have painted them at a campsite or hut located in such rugged and often inhospitable environments. If Haast had been a professional painter, these would be considered studio works. In Burrows' opinion they were "more elaborate studio versions of the simpler field sketches" (2005: 173). Most likely they were painted when Haast had returned to Christchurch, either at home or in his office. It is clear, though, that they were produced primarily to act as the original finished artworks on which the lithographs inserted in the report would be based. Attractive though they are as works of art by an amateur artist, given their small size and variable dimensions it is unlikely

that Haast was contemplating using them as visual aids to accompany a paper that he would submit to an overseas scientific journal, as he had done previously. Furthermore, as art historian Mark Stocker asserted, "nor would he have considered them as 'art', fit to be exhibited".[16]

Techniques for Assessing the Fidelity to Nature of the Sketches and Paintings

When assessing the fidelity to nature of a landscape sketch or drawing, a variety of aspects of the view and of natural features recorded in the work are considered. Given that in his Rakaia sketches Haast recorded little detail of the rocks or trees he encountered, the focus of this study is primarily on enduring topographical and geomorphological features and, to a lesser extent, ecological aspects such as the distribution of vegetation. While it was not expected that the glaciers themselves would be the same after an interval of more than 150 years, some of the non-ice geomorphological features such as moraines, roches moutonnées and sugarloaf hills that Haast illustrated should still be in place if his field sketches are indeed accurate renditions of the views he beheld.

Typically, when assessing the fidelity to nature of a field sketch or landscape painting, the location of the site would need to be determined and then visited in order to compare a reproduction of the illustration with the view of nature visible from the artist's vantage point, which would then be recorded in a site photograph (Hook 2022b: 133–177). Knowledge of the natural history of the location would also be used when assessing the fidelity to nature. While it proved possible to identify locations and even to determine vantage points of some of Haast's Rakaia sketches without venturing into the field, actually reaching them would have been challenging given the very isolated mountainous regions in which they are located.[17] In this situation it was sometimes possible to make use of photographs taken from close to Haast's vantage points by experienced alpine trampers, some of whom are excellent photographers (Hook 2022a: 7, 11, 17, 21, 31, 35).

If no site photographs are available, then the topography illustrated in sketches or paintings can be compared with the view generated by a digital elevation model (DEM). One such model is that used by the mobile phone application PeakFinder (Hook 2022b: 161–163), whose topographical profiles are derived from the height data of Earth's surface recorded by the NASA space shuttles last century. The profiles are surprisingly accurate for middle- and far-distance features. The application also names and gives the elevations of most of the peaks visible from a particular spot on Earth's surface,[18] which can help to resolve issues relating to peaks being misidentified by Haast or renamed by later cartographers.

A better-known application, which uses the same data but supplemented by satellite and oblique aerial photography, is Google Earth Pro. Its DEM generates stunning pictorial views of alpine features from wherever the virtual observer is placed. While initially, with this project at least, I was doubtful about how reliable such views would be as compared to taking a photograph from the same spot, it was reassuring to see how realistic the renditions often are, as can be seen from the example illustrated in Figure 4.

When using either PeakFinder or Google Earth Pro, the challenge is to locate the vantage point from which Haast made the sketch in the field. The title and labels on sketches (or paintings) often provide significant clues as to where they were made, as well as what the view was of, as do descriptions of sites in Haast's report. For example, titles indicate that two views were from atop Meins Knob, which is a steep rocky knoll towering about 350 m above the Rakaia riverbed (Fig. 4C), which Haast named (Burrows 2005: 180) and referred to as 'Mein Knob' (i.e. my knob). He described this "remarkable" geomorphological feature lying between two glaciers as a "true roche-moutonnée" with gigantic "erratic blocks perched in every possible position … deposited when the glacier retreated" and

Figure 4. A, *Above Meins Knob, Ramsay Glacier and Mt Whitcombe beyond Rakaia Valley Canterbury* (detail). Photograph by Shaun Barnett, 2013 **B**, Google Earth Pro virtual view dated 29 May 2020 from the same vantage point as the above photograph **C**, location of Meins Knob on the topographical map. Memory-Maps

Figure 5. The glacial valley occupied by the braided Rakaia River, as seen from Glenfalloch Station in December 2021. Photograph by George Hook

striations (Haast 1866: 12, 17–18). I had expected that he would have made both sketches from the highest point of the plateau (1,276 m), but this proved not to be the case. Given the foregrounds of the sketches, it was apparent that the two views must have been sketched from different locations on the summit, but that summit is as Haast noted "about half a mile broad, and covered with a succession of bosses, amongst which lie … several lagoons" (Haast 1866: 18). Finding the viewpoint of such sketches involves a time-consuming process of systematically moving the virtual observer of either application in large steps on a grid pattern, then progressively smaller steps until the view generated closely resembles that recorded in the field sketch. Occasionally it was possible to 'reach' a location with a closely matching virtual view, in which case the GPS spatial coordinates of Haast's vantage point were determined.[19] More often than not, I had to settle for a virtual view from a location that, at best, is close to Haast's vantage point. Regardless, such views with marginally different perspectives are usually adequate for assessing whether the topography of mountains, hills, gullies and riverbeds has been accurately rendered.

The Rakaia Expedition

The exploration of the headwaters of the Rakaia River was Haast's main expedition in 1866. Accompanied by A J Mathias, who assisted with the topographical survey, and Frederick Fuller, who acted as Haast's collector of bird skins, plant specimens and rock samples,[20] the party spent nearly seven weeks (from 2 March to 18 April) exploring the glacially sculpted Rakaia Valley and its braided-river system (Fig. 5), fed by a number of major tributaries such as the Cameron, Mathias, Wilberforce and Harper rivers. Early autumn would have been the ideal time of year to survey the extent of the glaciers as the snowfalls of the previous winter would have largely melted.

The route taken by the party is marked by a solid black line on the finely detailed and largely accurate map that Haast produced (Fig. 6), which attests to both his surveying and cartographical skills. That map eventually formed part of the published report.

Figure 6. *Topographical Map of the Head Waters of the Rakaia*, 1867 (Haast 1866). Lithographer: Ward & Reeves, Lyttelton. The map was completed after the report was submitted and Haast signed it on 3 January 1867. The approximate location of the vantage point and the direction of the view for each of Haast's sketches are indicated by the red labels and arrows.

After taking the dray road along the northern bank of the Rakaia River, the party crossed the Wilberforce River near its junction with the Rakaia, then followed a track leading to where the Mathias River joins the Rakaia, which they crossed, before continuing further up the Rakaia. After crisscrossing the braided river several times, they set up camp on 13 March some distance west of its junction with Whitcombe Pass Stream (now known as Lauper Stream).[21] From that confluence they could see Whitcombe Pass (Fig. 6, View I; Fig. 7B). On 14 March, Haast and Mathias ascended the stream to reach the pass. From that vantage point they were able to view the Whitcombe River, one of the principal sources of the Hokitika River on the West Coast. Three days later, on 17 March, Haast set off on horseback from their campsite to explore the glacial sources of the Rakaia headwaters, which he could see to the west (Fig. 6, View II; Fig. 8B), particularly a large glacier whose terminus projected across the valley floor. He found the route blocked, though, and could not make his way along the narrow gorge between the tip of the glacier and Meins Knob, through which a torrent of water flowed. The next day the party ascended Meins Knob along a very difficult route between gigantic boulders. On top of the knoll, spectacular views of Lyell Glacier (Fig. 6, View III; Fig. 9B) to the west and Ramsay Glacier (Fig. 6, View IV; Fig. 10B) to the north opened up.[22]

After returning to their Rakaia campsite, they travelled down the valley to the junction with the Mathias River. They then spent several days ascending the rugged gorge of the Mathias until they could see the glaciers that fed it on 22 March (Fig. 6, View V; Fig. 11B). After that excursion, they retraced their tracks to the Wilberforce River, where they stayed at the accommodation house by Goat Hill for several days. On 28 March, they followed the Wilberforce some distance northwards. From a steep slope on the Cascade Range they had an excellent view looking back towards Lake Coleridge (Fig. 6, View VI; Fig. 12B). The party continued up the Wilberforce for 2 days before sighting Nōti Raureka (Browning Pass) on 30 March (Fig. 6, View VII; Fig. 13B), which they ascended to the next morning along a very steep zigzag track to reach Whakarewa (Lake Browning) just beyond the pass (Fig. 6, View VIII; Fig. 14B). After descending some way along the Arahura River on the West Coast, they returned to Goat Hill, where they spent several days processing and packing their extensive collections of rocks, plants and bird skins.

On 4 April, they set out for the junction of the Harper and Avoca rivers, where the following day Haast sketched a view of some unusual glacial features (Fig. 6, View IX; Fig. 15B). Further excursions occurred, but Haast made no paintings of the views encountered. After the party returned to Christchurch, Haast spent several months processing the collection, writing his report and preparing topographical sections and the map (Haast 1879: 143), as well as painting those landscapes.

Evaluating the Fidelity to Nature of the Rakaia Sketches and Paintings

The field sketches and finished paintings associated with each of the nine views that Haast chose to illustrate in his report are considered in chronological order below. The approximate location of the vantage point and general direction of the view for each are indicated by red labels and red arrows added to Haast's map (Fig. 6).

View I: Looking towards Whitcombe Pass

Haast's sketch looking northwards from near the junction of Whitcombe Pass Stream and the Rakaia (Fig. 7B) accurately replicates the topography of the peak in the distance, which Haast named Mt Martius but which has no official name, and that of the mid-ground slopes, as generated in the Google Earth Pro view from 43°17'10.0"S, 170°56'44.0"E (Fig. 7A). However, the right peak of Martius appears slightly elevated. The bed of the stream is accurately rendered, as is the distribution of vegetation on either side, but Haast did not record the large scree slope above the stream as

Figure 7. View I: Looking towards Whitcombe Pass **A**, virtual view generated in Google Earth Pro from close to the vantage point of Haast's sketch of Whitcombe Pass **B**, *Whitcombe's Pass 3 miles from saddle, 14 March 1866*, watercolour and pencil on paper, title in ink, 180 × 280 mm. Julius Haast, 1866. Alexander Turnbull Library C-097-015 **C**, *View of Whitcombe's Pass from the banks of the Pass Stream*, watercolour on paper, 143 × 248 mm. Julius Haast, 1866. Alexander Turnbull Library A-149-013

the foreground is largely unsketched. In the left foreground Haast pencilled the annotation "Mt Whitcomb [sic] liegt hinter diesen Vorbergen verborgen" [Mt Whitcombe lies hidden behind these closer mountains].[23]

In the landscape painting (Fig. 7C), Mt Martius has been shifted dramatically to the right (east) relative to the mid-ground slopes and its peaks steepened further, particularly the right one. More significantly, a snow-covered peak has been inserted behind the left mid-ground mountain (Lauper Peak), which Haast named as Mt Whitcombe (Low 2010: 84). That mountain is actually 2 kilometres west of Lauper Peak, well outside the field of view of the sketch according to PeakFinder. Geographical features of the mid and foregrounds have been significantly elaborated or invented, and the green subalpine forest in the sketch has been changed to yellow, suggesting tussock rather than bush. The gently flowing sketched stream is transformed into painted rapids tumbling over rocks. Overall, Haast exercised a significant degree of artistic licence in producing this landscape painting.[24] He may have chosen to move Mt Whitcombe into his landscape painting as homage to John Henry Whitcombe, who with Jacob Lauper was the first European to survey Whitcombe Pass in 1863.[25] Whitcombe died in an accident when they reached the West Coast.

View II: Towards the sources of the Rakaia

Haast's sketch (Fig. 8B), made from close to where Whitcombe Pass Stream joins the Rakaia (Fig. 6), looks to the southwest. Meins Knob is the large green knoll just left of centre in the mid-ground, with a smaller knob just to its right. The terminus of Ramsay Glacier can be seen protruding from behind Jims Knob (the mid-ground green hill on the right), reaching across to the base of Meins Knob. When compared with the virtual view generated in Google Earth Pro from 43°16'6.9"S, 170°57'24.2"E (Fig. 8A), Haast's sketch accurately reproduces the topography of the peaks forming the horizon and the shape of Meins Knob, but that knoll has been shifted to the left (southeast) relative to the peaks behind it. Despite numerous movements of the virtual observer, it was not possible to obtain a view in which Meins Knob lined up below the peaks labelled B and C on the sketch. Nor was it possible to recreate the wide sketched gap between Meins and Jims knobs without other aspects of the view going out of alignment. It is therefore likely that Haast combined two views: one made from near the Lauper junction, which provided the back and foregrounds; and another made from further out on the bed of the Rakaia, which would have opened up the area between the two knobs, thus allowing more of the features of the glacier terminus to be seen, particularly the blue-grey ice cave out of which a glacial stream flows.

The landscape painting (Fig. 8C) largely reproduces the view recorded in the sketch but also introduces a much more dominant foreground slope that fills nearly a quarter of the work. The painting faithfully reproduces the sketched distribution of vegetation on the mid-ground slope and knobs. The colours of the two glaciers entering from the left have been intensified, bringing them to the notice of viewers. The ice cave out of which the glacial stream flows has also been made more distinctive. No staffage has been added to give an idea of scale.

Despite the mid-ground topographical liberties, both the sketch and the painting generally present a faithful view of the scenery at the location, albeit by combining views from two different vantage points. Haast exercised this artistic liberty for the sake of illustrating two unusual glacial features, primarily the terminus of a massive glacier pressing almost directly against a large rocky knoll, but also a glacial meltwater stream emerging from the side of the terminus. According to Gage, Haast observed that the glacier's "snout was thrust across the Rakaia trough to the foot of Meins Knob", almost blocking it (Gage 1951: 506). Haast estimated that the terminal face was about 45 m high, but that it was constantly being undermined by a "glacial torrent of considerable size" flowing through the narrow gorge between the terminus and Meins Knob, which came from

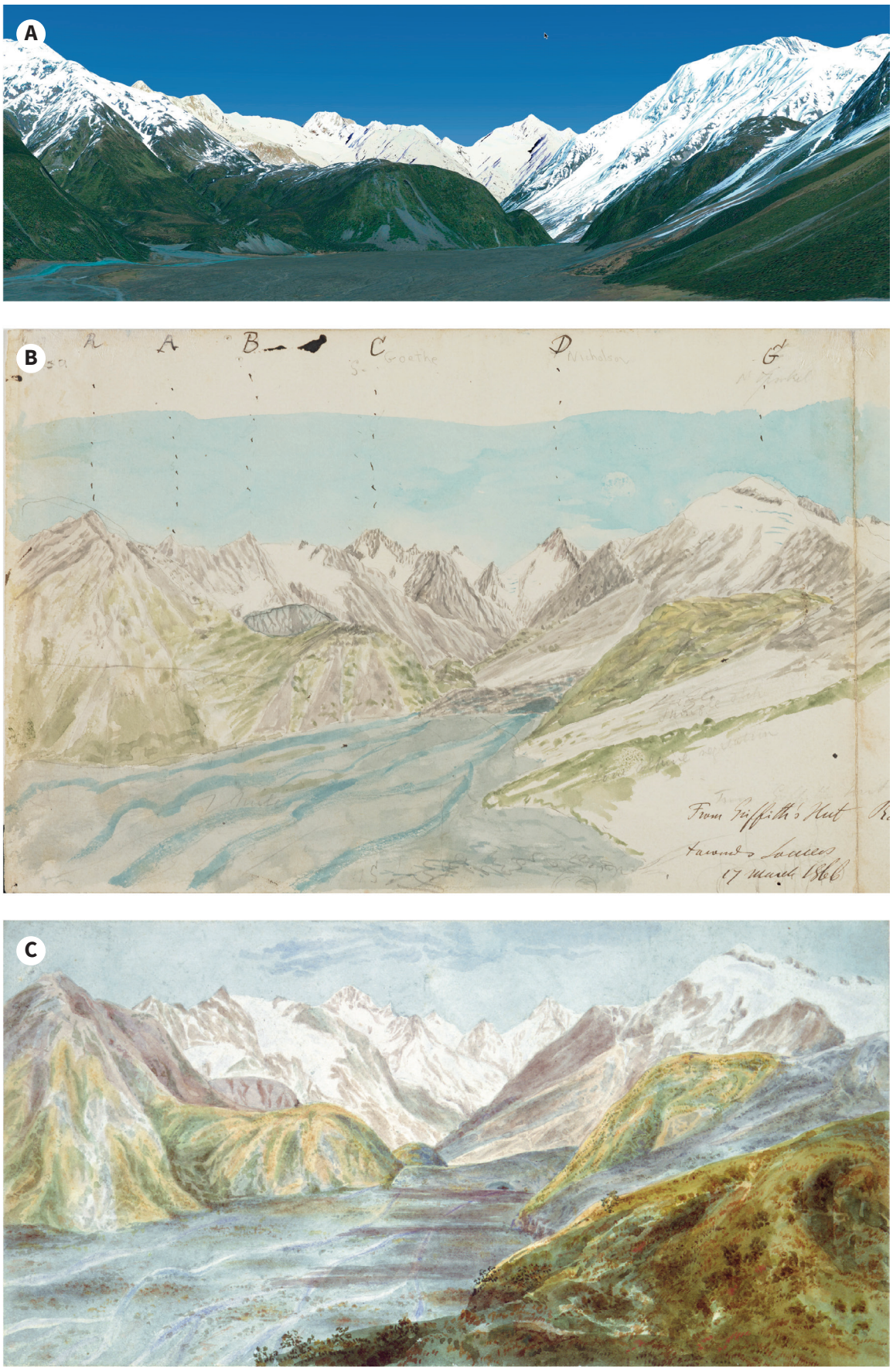

Figure 8. View II: Towards the sources of the Rakaia **A**, virtual view generated in Google Earth Pro from close to the vantage point of Haast's sketch of the Rakaia Valley **B**, *Towards sources of Rakaia and glaciers from Griffiths Hut, 17 March 1866* (detail), watercolour and pencil on paper, title in ink, 180 × 360 mm. Julius Haast, 1866. Alexander Turnbull Library C-097-042-1 **C**, *Towards sources of Rakaia and glaciers from Griffiths Hut*, watercolour on paper, 180 × 360 mm. Julius Haast, 1866. Alexander Turnbull Library A-149-001

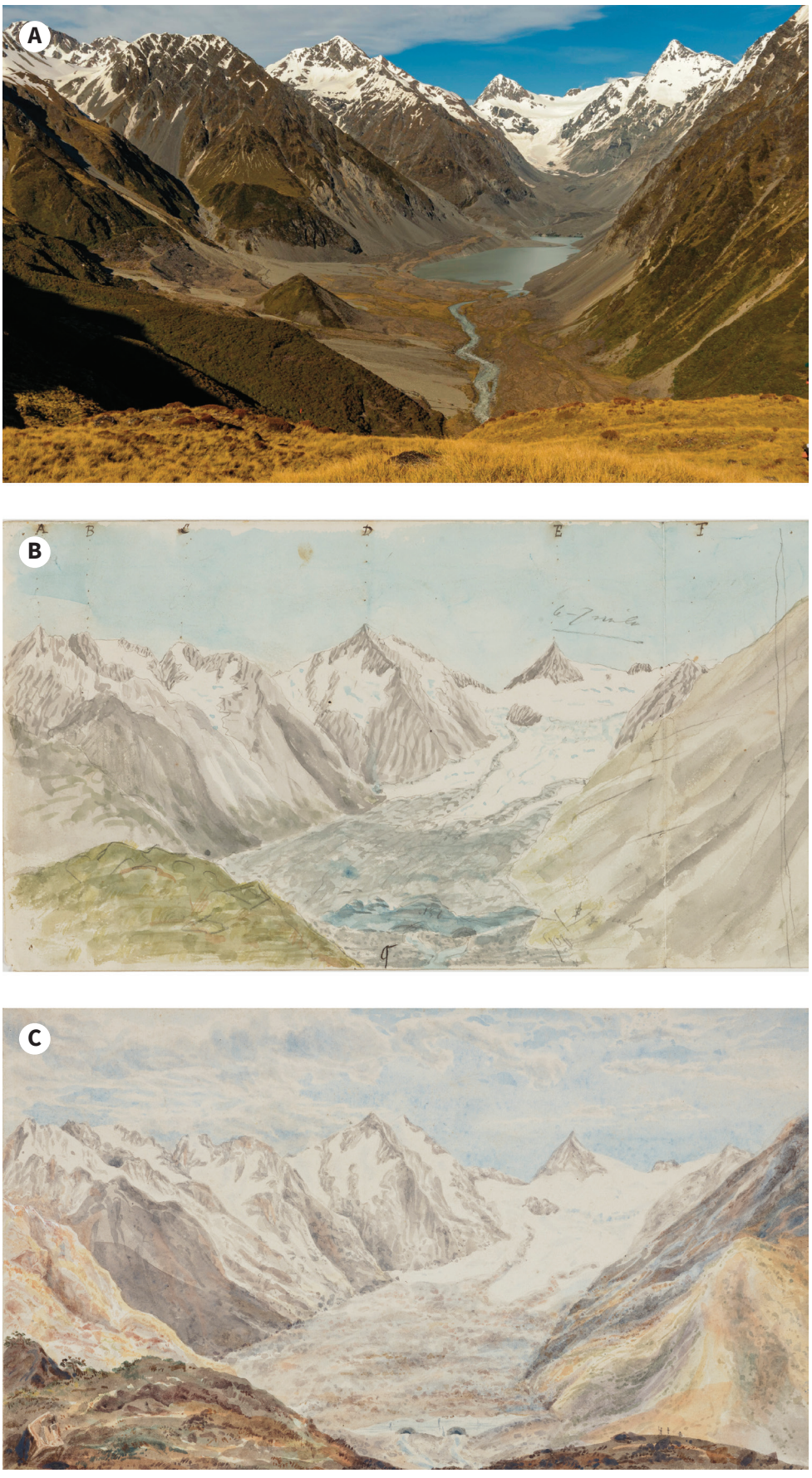

Figure 9. View III: Lyell Glacier from Meins Knob **A**, *Meins Knob with Lyell Valley beyond, Canterbury* (detail). Photograph by Shaun Barnett, 2013 **B**, *The Ramsay Glacier* [sic] *& Lyell Glacier from Mein's Knob, 18 March 1866* (detail), watercolour and pencil on paper, title in ink, 170 × 510 mm. Julius Haast, 1866. Alexander Turnbull Library C-097-084-1 **C**, *View from Meins Knob looking West, the Southern Alps with the Lyell Glacier*, watercolour on paper, 141 × 128 mm. Julius Haast, 1866. Alexander Turnbull Library A-149-003

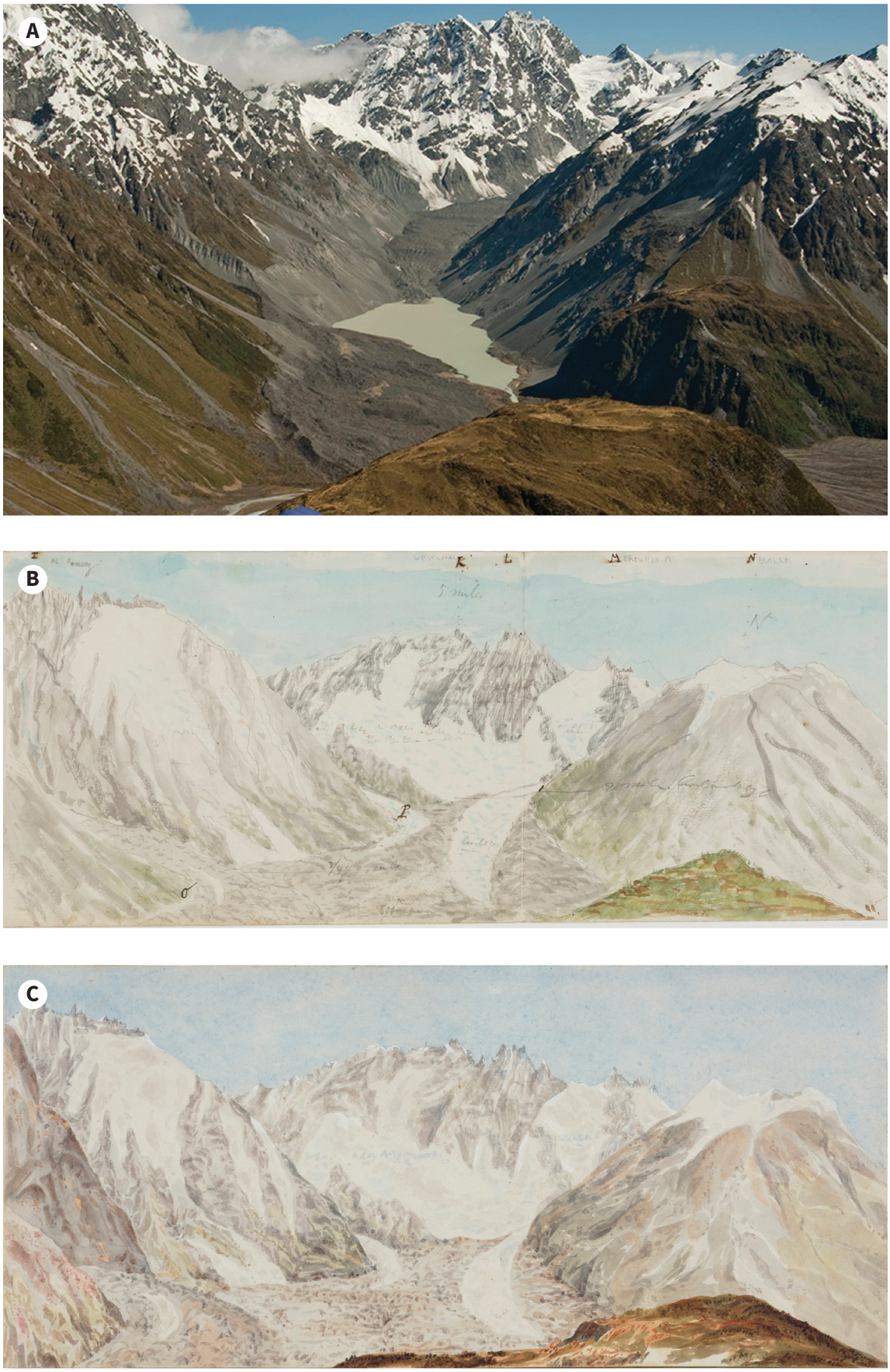

Figure 10. View IV: Ramsay Glacier from Meins Knob **A**, A*bove Meins Knob, Ramsay Glacier and Mt Whitcombe beyond Rakaia Valley Canterbury* (detail). Photograph by Shaun Barnett, 2013 **B**, *M* [sic] *Ramsay, Whitcombe, Erewhon Pk.*, Butler, watercolour and pencil on paper, title in ink, 180 × 360 mm. Julius Haast, 18 March 1866. Alexander Turnbull Library C-097-042 **C**, *View from Meins Knob looking North, with the Ramsay Glacier*, watercolour on paper, 126 × 275 mm. Julius Haast, 1866. Alexander Turnbull Library A-149-005

another glacier (Haast 1866: 16–17). This description clarifies what Haast was attempting to illustrate. Field research by Burrows and his colleagues in the 1970s established that a moraine exists close to the northern bank where the Rakaia flows tightly around Meins Knob (Burrows and Maunder 1975: 482–483), confirming that the terminus of a glacier crossing the Rakaia Valley nearly touched the face of Meins Knob. Further study of the age of terminal moraines in the Upper Rakaia Valley using lichenometry dating confirmed that in the late nineteenth century the snout of the Ramsay Glacier did indeed nearly reach Meins Knob (Burrows and Russell 1975: fig. 10).

View III: Lyell Glacier from Meins Knob

Haast described the view from Meins Knob of the mountains and Lyell Glacier to the west as "magnificent" (Haast 1866: 19). Fortuitously, Shaun Barnett took a photograph in 2013 (Fig. 9A) from close to the vantage point where Haast made his sketch (Fig. 9B). The photograph was taken from a short distance to the left (south) of Haast's vantage point, as an additional peak (Malcolm Peak) can be seen near the top right of the horizon. Haast accurately rendered the topography of the mountains, most of which have not been steepened except for Mt Nicholson, which is the peak with the annotation "6–7 miles" above it. The foreground section of Meins Knob in the sketch differs from that recorded in the photograph, suggesting that Haast's vantage point was further back than Barnett's, rather than Haast's sketching being inaccurate. Surprisingly, the rocky hill just to the left of the middle in the photograph does not appear in Haast's sketch. In the mid-nineteenth century that hill would have been a nunatak, an isolated rock outcrop protruding above the surface of the glacier. Either Haast chose to omit it or he could not see it from his position on Meins Knob, which is what Burrows and Maunder argued (1975: 486).

The landscape painting (Fig. 9C) largely reproduces the mid and backgrounds of the sketch, although a richer palette of colours is used. The foreground section of Meins Knob has been embellished and extended to the right (north), with tiny staffage figures inserted for scale. Distinctive cloud forms have been introduced, but as they are transient features they are not of interest when investigating fidelity to nature.

Given that the enduring features illustrated in the mid and backgrounds of the sketch have been accurately rendered when compared with the site photograph, it is reasonable to conclude that the glacial features are also accurately portrayed. The overall shape and features of Lyell Glacier are, therefore, faithfully rendered, showing the glacier largely filling the entire valley, with two glacial streams emerging from ice caves at the terminus of the glacier. Burrows and Maunder asserted that the dating of now exposed moraines in the valley confirms that during the second half of the nineteenth century the terminus did indeed extend to the position shown in Haast's sketch (1975: 479–480, fig. 2). However, by the first decade of the twenty-first century the terminus was 2.3 km further up the valley, a retreat that is clearly visible in the site photograph, where the terminus can be seen lying on the far side of the relatively recently formed proglacial lake. The terminus is grey-brown because of the immense amount of rocky debris on the surface of the glacier there and for several kilometres up the valley.

View IV: Ramsay Glacier from Meins Knob

Haast claimed that this panoramic view to the north, with its "diversity of scenery and its wild alpine character", was "second to none in New Zealand" (Haast 1866: 19), and he was in a position to pass judgement given he had seen so much of Kā Tiritiri o te Moana (the Southern Alps). When comparing the view in Haast's sketch (Fig. 10B) with another 2013 photograph by Shaun Barnett (Fig. 10A),[26] it is clear that the photographer was close to Haast's vantage point. However, Haast must have been lower down on Meins Knob as Jims Knob on the opposite side of the Rakaia River (Fig. 4C) is obscured by the northern end of the summit of Meins Knob. The profile of Mt Whitcombe

in the centre, the topography of the other mountains and the scree slopes have all been accurately rendered by Haast. He described Mt Whitcombe in the centre of the view as a "stupendous, rugged mass with turrets, pinnacles and even minarets" (Haast 1866: 19). The inclination of the rock faces on Mt Whitcombe also appear to be faithfully portrayed. In contrast, though, the topmost features of Mt Butler on the right have been simplified. Although it is difficult to visually reconcile the pointed shape of the far end of Meins Knob in the sketch with the squarer end of that summit in the photograph, that may just be a consequence of different perspectives.

In the landscape painting (Fig. 10C), Haast mostly reproduces the topographical and geomorphological features visible in the field sketch, particularly those of the Ramsay Glacier, which largely fills the valley. He effectively uses a more extensive colour palette to distinguish ice from the rocky debris covering the glacier in the area now occupied by the proglacial lake. The St James Glacier on the left (labelled "O" on the sketch), which merges with the Ramsay, is highlighted and given more of a sweeping curve. The lower slopes just above the glaciers appear to have been steepened slightly. The sketched foreground, however, is significantly transformed in the landscape painting, both in its extent and its appearance, creating a dramatic contrast with the mid and backgrounds of the picture. There is no sign of staffage.

Given that the enduring features visible in Haast's field sketch are generally faithful to the view he beheld atop Meins Knob, we may assume that the extent to which the glacier filled the valley in the 1866 sketch is also accurately recorded. Haast's 1866 report supports this contention, as he described the Ramsay Glacier as "striving, but ineffectually, to bar the way of the torrent" coming from the Lyell Glacier as it rushed around the base of Meins Knob, "the waters continually undermining and destroying the ice" (Haast 1866: 19). Fieldwork by Burrows and Maunder in the 1970s confirmed that the Ramsay Glacier filled all of the valley floor visible from atop Meins Knob in the second half of the nineteenth century, as the lichenometry-dated terminal moraines lie beneath the vertical field of view of Haast's sketch (1975: 482–483).[27] It is clear from the 2013 site photograph that the Ramsay Glacier has retreated a significant distance up the valley, with the valley floor, which was previously covered by the glacier, now largely submerged beneath the proglacial lake. The grey debris-covered terminus of the Ramsay Glacier can be seen on the far side of the lake, while the St James Glacier has retreated beyond the field of view.

View V: The headwaters of the Mathias River

Haast went on to explore the headwaters of the Mathias River to see if a "practicable pass exists there to the western side" (Haast 1866: 23). This possibility did not eventuate, but near the upper reaches of the river "two very prominent peaks rose conspicuously above" the party. These were Mt Tancred (now Shafto Peak) and Mt Carus (now Mt Bryce) (Burrows 2005: 68). Haast was taken with the view and completed a detailed sketch in pencil and watercolours (Fig. 11B) looking northwest from a steep slope on the western side of the North Mathias River. This view emphasised the dramatic glacier descending the slopes of Mt Tancred. While no photographs of the headwaters of the Mathias could be located on the internet, it is possible to generate a view in Google Earth Pro from 43°5'54.5"S, 171°9'22.9"E that shows similar profiles of the distant mountains and of the slopes of the mid-ground peaks (Fig. 11A). However, the two principal peaks appear to be heightened and their slopes steepened in the sketch.

In the landscape painting (Fig. 11C), Haast makes those peaks even pointier. The mid-ground slopes are illustrated in stronger colours and an elaborate foreground is invented, which frames both sides of the work. In that foreground, unidentifiable rocks and plants are inserted, and the icy stream emerging from the 'Tancred' glacier is highlighted in blue tones, while the gorge through which it flows towards the viewer is widened. Even though these transformations are typical of

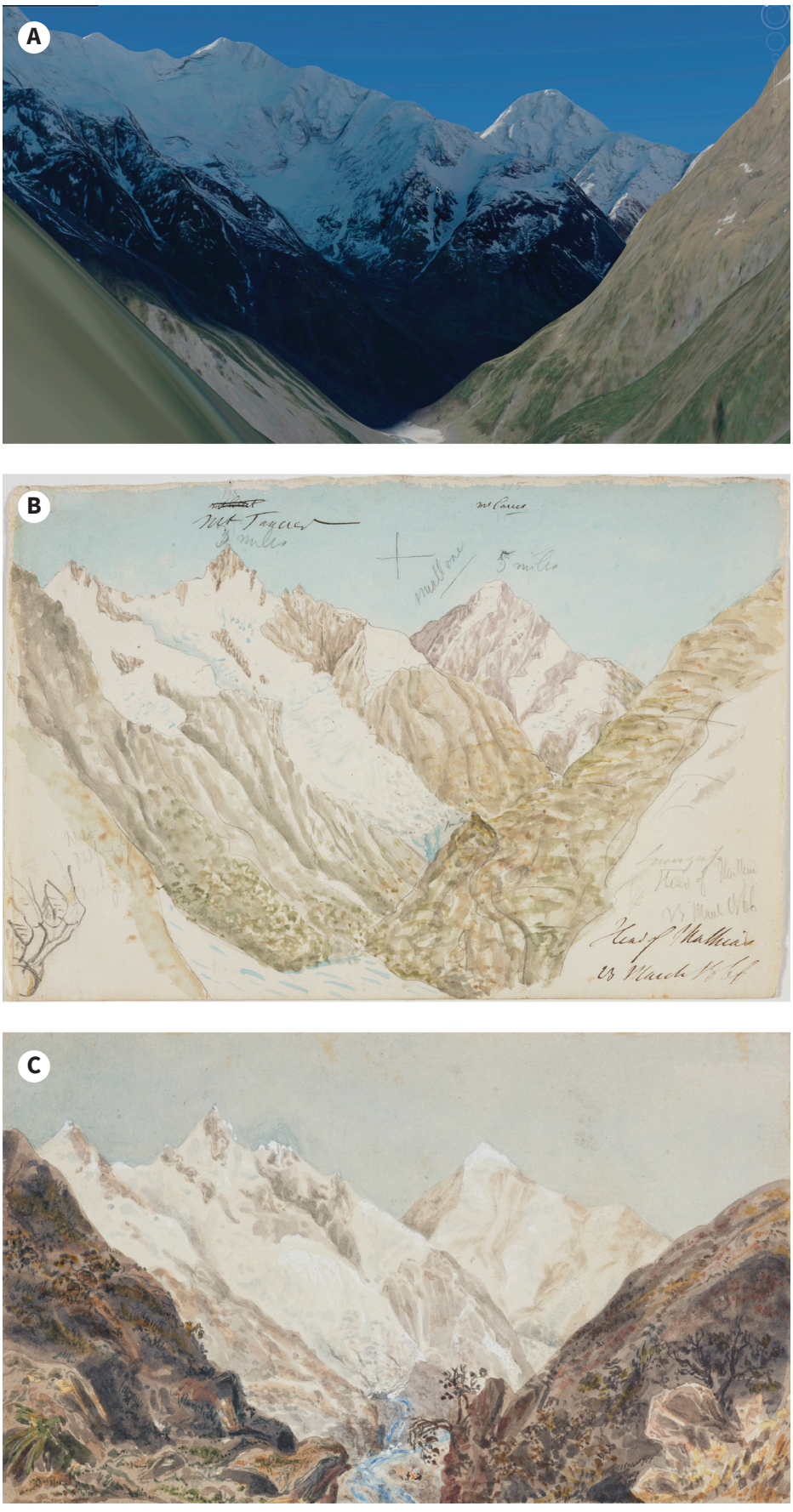

Figure 11. View V: The headwaters of the Mathias River **A**, virtual view generated in Google Earth Pro from close to the vantage point of Haast's sketch of the headwaters of the Mathias River **B**, *Head of the Mathias, 23 March 1866*, watercolour and pencil on paper, title in ink, 180 × 265 mm. Julius Haast, 1866. Alexander Turnbull Library C-097-018 **C**, *View of the Head waters of the Mathias a branch of the Rakaia*, watercolour on paper, 89 × 148 mm. Julius Haast, 1866. Alexander Turnbull Library A-149-008

Figure 12. View VI: Towards Lake Coleridge **A**, virtual view generated in Google Earth Pro from close to the vantage point of Haast's sketch looking towards Lake Coleridge **B**, [View of Lake Coleridge from the valley of the Wilberforce near Cascade Peak], watercolour and pencil on paper, 90 × 145 mm. Julius Haast, 28 March 1866. Alexander Turnbull Library C-097-129 **C**, *View of Lake Coleridge from the Valley of the Wilberforce near Cascade Peak*, watercolour on paper, 88 × 148 mm. Julius Haast, 1866. Alexander Turnbull Library A-149-009

the liberties that mid-nineteenth-century colonial landscape painters often took (Hook 2022b: 435–437), they do not affect the fidelity of the view of the more distant alps.

There is no independent evidence to confirm the extent of the 'Tancred' glacier other than Haast's own report, but it is clear from the Google Earth Pro view that this glacier, which was pristine along its length in the 1860s (Haast 1866: 23), has retreated a significant distance up the mountain.

View VI: Towards Lake Coleridge

On 28 March Haast sketched a view (Fig. 12B) looking southeast towards Lake Coleridge from relatively high up on the steep slopes of the Cascade Range on the west side of the Wilberforce River, which flows into the Rakaia from the northwest (see Figure 5). As a number of the topographical features visible in the Google Earth Pro view of the landscape from 43°6'22.9"S, 171°19'4.0"E (Fig. 12A) align well with much of the sketched horizon, I was confident that the virtual view was close to Haast's vantage point. Although the framing slopes and the shape of Mt Oakden (right horizon peak) in the sketch match the virtual view, Haast made the four mid-ground hills (Little Knuckles, Goldney Hill, Mt Hennah and Mt Cotton) on the left pointier and exaggerated their heights when compared with the virtual view and a drone photograph viewable on the internet.[28]

In his report, Haast described Mt Oakden as one of two "roches-moutonnées of very remarkable form" (Haast 1866: 47). Roches moutonnées are rounded, asymmetrical bedrock hills, which were sculpted by the glaciers that overrode them. They are usually elongate parallel to the direction of the flow of the glacier. Typically, the upstream end is smooth and gently inclined, while the downstream end is rough and steeply inclined. Judging from the topographical map, two of the other above-named hills are also roches moutonnées, but the much smaller Mt Hennah is a round-topped sugarloaf. The distribution of the "magnificent [beech] forest [that] clothes the lower slopes" of the Cascade Range (Haast 1866: 25) in the right foreground is accurately reproduced in the sketch.

In his watercolour (Fig. 12C), Haast faithfully reproduced the overall topography illustrated in the sketch, although the shapes of the roches moutonnées are further exaggerated and the framing hills are more rounded. While Haast used his extended colour palette to clarify details of the scene, his recolouration of the beech forest on the slopes of the Cascade Range is less authentic than the colour of the forest in the sketch.

As to the reason why Haast exaggerated the shapes of the roches moutonnées, they were a significant part of the evidence he put forward to support his assertion that the whole of the Rakaia Valley and its tributaries had been filled with a massive glacier during the Ice Ages (Haast 1866: 40–42, 44, 46–47). This conjecture can be seen more clearly on the map illustrated in Figure 16. Perhaps, understandably, Haast likely wanted to make the roches moutonnées near Lake Coleridge appear more dramatic when they were later reproduced in his report as a lithograph based on his watercolour, although he did not identify them as such on the labelling of his finished watercolour.

View VII: Looking up at Browning Pass from the Wilberforce Valley

After ascending the Wilberforce Valley for several days, on the evening of 30 March Haast's party reached Greenlaw's Hut, "situated a mile below the southern foot of Browning Pass" (Haast 1866: 27). The pass, originally known as Nōti Raureka, had been discovered by Māori several centuries earlier and was used for transporting pounamu (greenstone) from the West Coast.[29] The following morning Haast sketched a view from close to the hut looking northwards up to the pass (Fig. 13B), which is marked by the "2½ miles" label. This drawing well illustrates how Haast would have sketched in the field. The relatively small, roughly torn sheet of paper would have been pinned

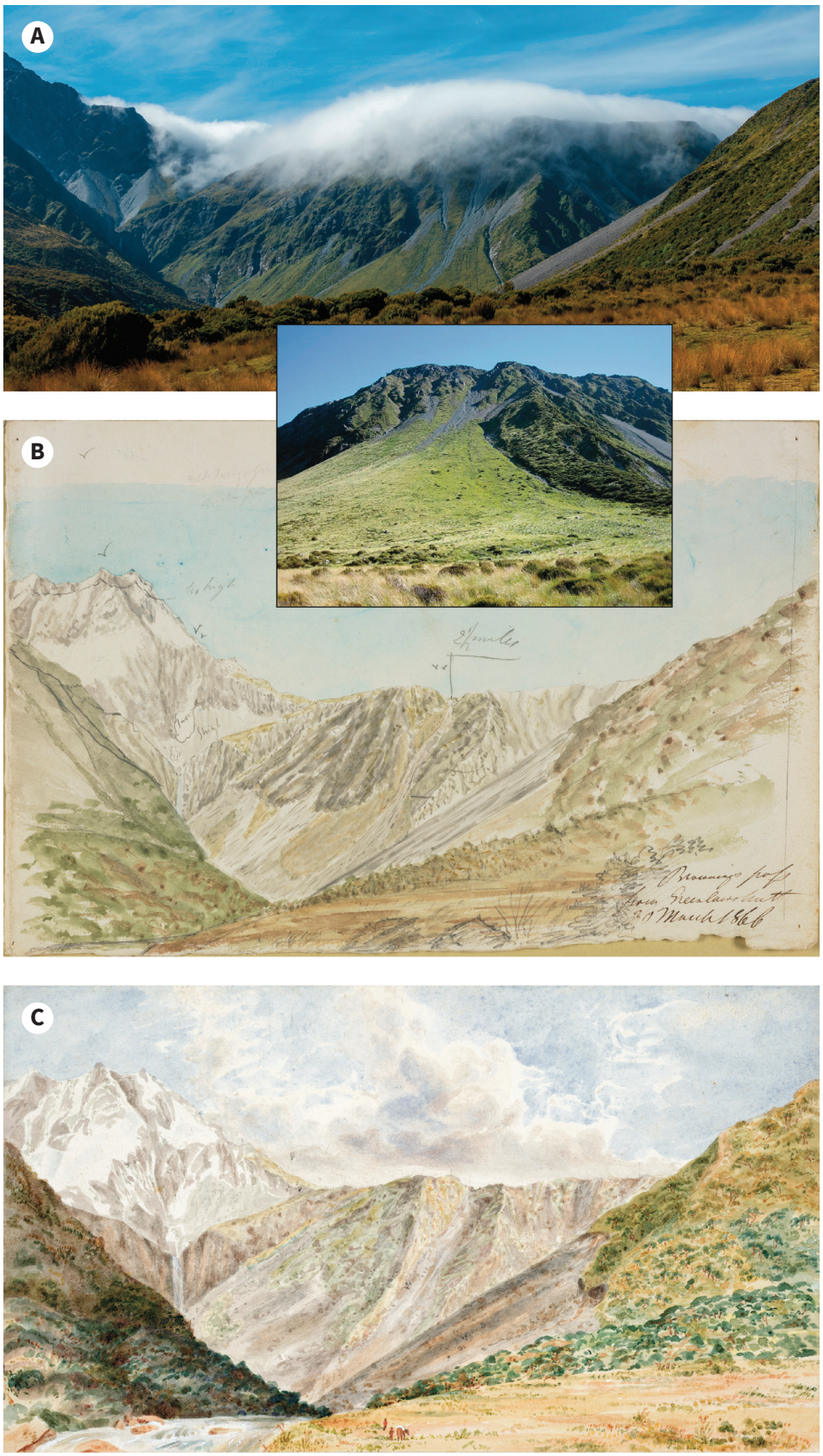

Figure 13. View VII: Looking up at Browning Pass from the Wilberforce Valley **A**, *Browning Pass, photo taken from Three Passes Track, New Zealand* (detail). Photograph by Michael Klajban, 2021. Wikimedia Commons. Inset: *Browning Pass zigzag*. Photograph by Ian George, 2011. New Zealand Tramper website **B**, *Brownings Pass from Greenlaw's hut, 30 March 1866*, watercolour and pencil on paper, 180 × 265 mm. Julius Haast, 1866. Alexander Turnbull Library C-097-033. **C**, *View of Brownings Pass from the Valley of the Wilberforce*, watercolour on paper, 88 × 148 mm. Julius Haast, 1866. Alexander Turnbull Library A-149-006

onto a stiff board, as evidenced by the holes in the corners. Most likely Haast sat with the board on his knees and his watercolours nearby. Outlines of the main geographical features, such as peaks, glaciers, scree slopes, falls, hills and gullies, were then pencilled in, before paint was applied in wide or narrow brushstrokes as appropriate. According to two experienced watercolourists, Saskia von Voorn and Miles Fairburn, at least five paints were used – cerulean blue, terre verte, a light grey, yellow ochre and burnt sienna,[30] which increased the number proposed by Paul. These paints are transparent, so Haast's pencil outlines can still be seen. The zigzag path up to Nōti Raureka (Browning Pass) is indicated only by a sinusoidal pencil line. Interestingly, Haast added a pencil line below the profile of the Twin Peaks on the left horizon, with an annotation indicating that the peaks were too high. In a manner atypical of his sketches, Haast painted in nearly all of the foreground, except for the pencilled outlines of a few rocks and plants.

Haast's field sketch can be compared with a very useful site photograph (Fig. 13A) taken by Michael Klajban from very close to Haast's vantage point at approximately 42°57'50"S, 171°20'35"E,[31] which captures much of the same field of view, except for Twin Peaks. Unfortunately, cloud covers the top of the pass, so a photograph by Ian George, which shows more of the detail of the pass, albeit from a different vantage point, has been inset. On the whole, the topography of the scene has been accurately rendered by Haast, that of Twin Peaks being confirmed by the virtual view generated by Google Earth Pro. The details of the shingle screes on the left, and Hamer Falls beneath them, closely align with those features in Klajban's photograph. The distribution of vegetation in the foreground and on the hillsides framing the mid-ground closely matches that shown in the photograph, as does the colour of the tussock, suggesting that the scene was viewed by both the painter and the photographer during late summer. When the middle section of Haast's sketch is compared with George's photograph, taken in midwinter, when the tussock is greener, it is clear that Haast did not show that the track zigzags up to the pass across a massive scree slope, as in the sketch it appears to cross back and forth across an ascending ridgeline.

The landscape Haast painted (Fig. 13C) faithfully reproduces the topography of the fore, mid and backgrounds illustrated in the sketch, although the ice fields and screes on the Twin Peaks are slightly enlarged in size. Haast used the wider range of watercolours available to him back in Christchurch to create greater contrast between features, which effectively highlights Hamer Falls and distinguishes screes from alpine vegetation on the steeper slopes. The headwaters of the Wilberforce are made much more prominent in size, emphasised by the size of the nearby inserted staffage.

View VIII: Lake Browning

Having reached Nōti Raureka (Browning Pass) after ascending the zigzag track on the morning of 31 March, Haast wrote that:

> *a picturesque lake lay at our feet, surrounded by hills mostly covered with a deep green alpine turf, thickly studded with flowers. Over them rose the majestically rugged forms of Mt Harman and Twin Peaks with their snow-fields and ice-masses glistening in the morning sun* (Haast 1866: 28).

Whakarewa (Lake Browning) lies in a depression atop the Main Divide, which separates eastern and western catchments. Haast's sketch (Fig. 14B) takes in a panoramic, northward-facing view of the tarn and its surrounding hills and mountains from a rise just west of the highest point of the pass at 42°56'59.4"S, 171°20'32.5"E.[32]

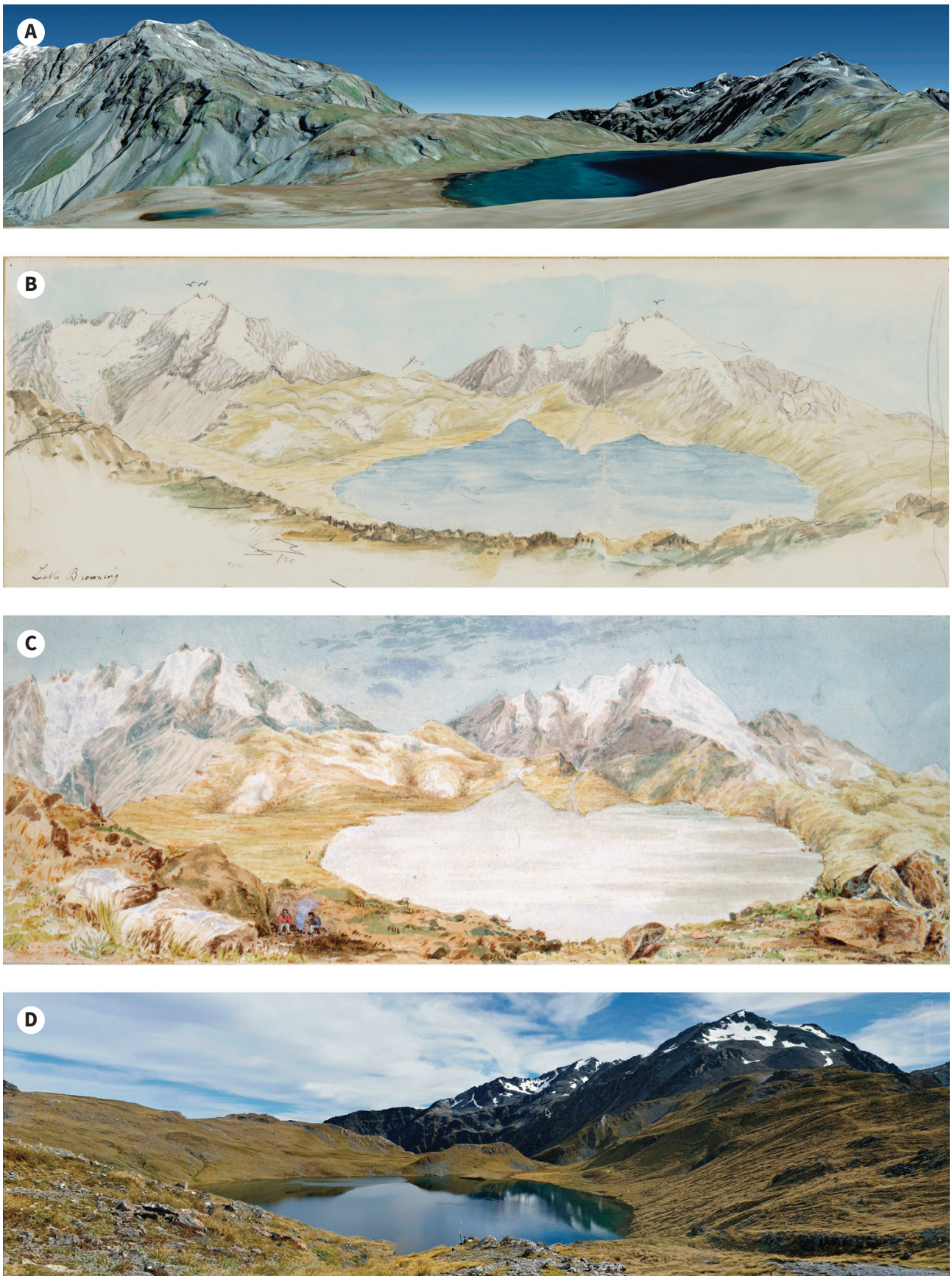

Figure 14. View VIII: Lake Browning **A**, virtual view generated in Google Earth Pro from close to the vantage point of Haast's sketch of Nōti Raureka (Lake Browning) **B**, *Lake Browning, 31 March 1866* (detail), watercolour and pencil on paper, 170 × 507 mm. Julius Haast, 1866. Alexander Turnbull Library C-097-035 **C**, *View of Brownings Pass from the Gap looking North*, watercolour on paper, 100 × 275 mm. Julius Haast, 1866. Alexander Turnbull Library A-149-007 **D**, View from the pass itself. Photograph by Sergey Kamch, 2020. Google Earth Pro

When Haast's sketch is compared with either the Google Earth Pro virtual view (Fig. 14A) or the site photograph taken by Sergey Kamch (Fig. 14D), it is apparent that while the features and topography of Twin Peaks and Kaniere (Mt Harman) are accurately portrayed, there is an issue with the almost 180-degree field of view being compacted horizontally. This is particularly obvious when considering the gap between the right flank of Twin Peaks and the left flank of Kaniere (Mt Harman), which is much compressed in the sketch. It is not possible to find a virtual vantage point from which that gap closes up to the extent sketched while still maintaining the vertical alignment of mid-ground hills with background mountains. Perhaps Haast shortened the distance between the two mountainsides to accommodate his panorama within a more standard-sized field of view. The small hills on the opposite side of the lake have also been inaccurately rendered. Regardless, the distribution of the carpet of vegetation around the lake is accurately rendered and coloured.

Haast's watercolour (Fig. 14C) diligently reproduces the mid and backgrounds of the field sketch, although the peaks have been made slightly higher and steeper. The whole sweep of the lively foreground is invented, with Haast inserting plants, rocks and people. This is the only painting with such clearly delineated rocks, yet it is still not possible to identify the rock type. Haast's decision to insert such rocks may have been because he had now reached schist country (Nathan et al. 2002).[33] It must be conceded, though, that it would be difficult for even a professional landscapist to paint an identifiable rock type on the scale of his painting, which measures only 100 mm by 275 mm. His treatment of the far side of the lake reveals the limits of his artistic ability, as slopes are not well enough differentiated from flat areas, resulting in an ambiguous perspective.

View IX: Roches moutonnées seen from the junction of the Harper and Avoca

On 4 April Haast set out to explore the "sources of the main branch of the Harper River" (Haast 1866: 35), another tributary of the Rakaia. When he reached the junction of the Avoca River with the Harper, to the southeast Haast saw "a large opening … leading along the western slopes of the Craigieburn Range towards the Canterbury Plains" (Haast 1866: 41–42), which was filled with a number of what he called "huge roches-moutonnées". However, earlier in his report, Haast noted the "peculiar form" of some of the mountains and hills in this location, which were "commonly called sugarloaves" (1866: 40). Several were "perfect cones, rounded on all sides", which he attributed to "the effect of several glacier branches coming from different directions", laterally eroding them. Glaciologist Stefan Winkler concurred, stating that "the 'sugarloafs' are laterally shaped by ice streams when they acted as obstacles forcing the ice to separate into different channels".[34] In his summary of Haast's original ideas on glacial geology, Burrows asserted that the geologist recognised that a "distinctive landform type" found in Kā Tiritiri o te Moana (the Southern Alps), the 'sugarloaf', was evidence of the "Great Glaciation" (Burrows 2005: 135). This was despite Haast erroneously classifying it as a "kind of roche moutonnée".[35]

Haast was impressed by these cones, some of which he described as being "so perfect in form that they have been mistaken for volcanic craters by the settlers" (Haast 1866: 35). He made a small sketch (Fig. 15B) that included one of these cones in the left mid-ground, which he labelled Sugar Loaf Hill but which is now an unnamed hill close to a geographical feature called The Redoubt. He also sketched the outlines of a number of other glacially sculpted hills using pencil and painted in the whole of the framed area. However, when the sketch is compared with the Google Earth Pro view (Fig. 15A) from the same vantage point on the flank of Mt Fitzwilliam on the western side of the Avoca at 43°9'42"S, 171°32'3"E, or a photograph (Fig. 15A inset) by John Johns, taken from a high spot on the eastern side of the river, it is apparent that Haast significantly modified the shapes, heights and possibly the positions of the five orange-yellow peaks, known from left to right as Sugar Loaf Hill, Goldney Hill, Little Knuckles, Laings Hill and Mt Hennah (Burrows 2005: plate 37). The profile of the Craigieburn Range has also been exaggerated, with the major ridge descending in the wrong direction.

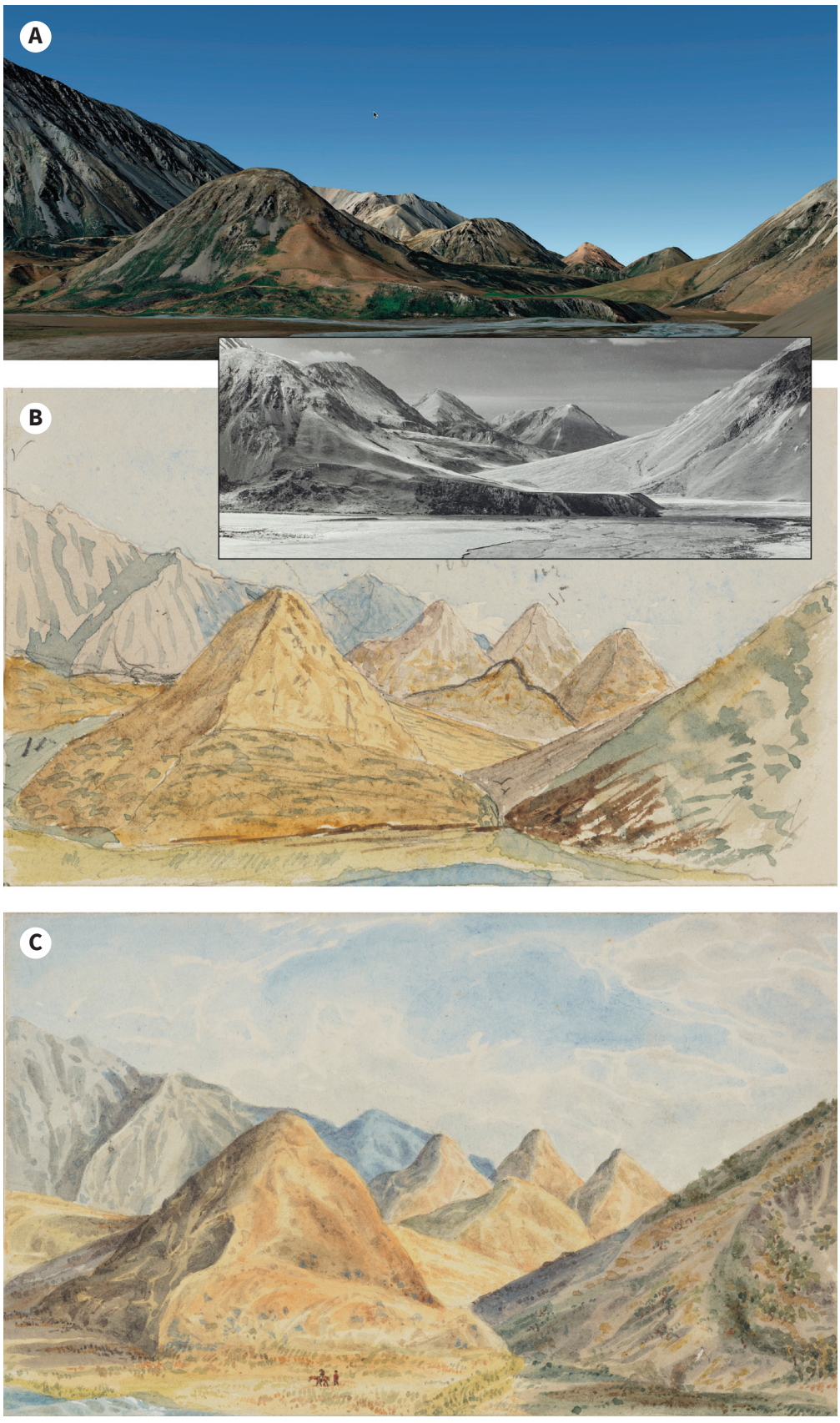

Figure 15. View IX: Roches moutonnées seen from the junction of the Harper and Avoca **A**, virtual view generated in Google Earth Pro from close to the vantage point of Haast's sketch of the sugarloaf hills. Inset: *Confluence of the Harper and Avoca Rivers* (detail). John Johns, date unknown. Museum of New Zealand Te Papa Tongarewa 0.041983 **B**, *View of the roches moutonnees from the junction of the Harper with the Avoca*, watercolour and pencil on paper, 90 × 150 mm. Julius Haast, 5 April 1866. Alexander Turnbull Library C-097-130 **C**, *View of the roches moutonnées from the junction of the Harper with the Avoca, looking S.E.*, watercolour on paper, 89 × 148 mm. Julius Haast, 1866. Alexander Turnbull Library A-149-010

The landscape painting (Fig. 15C) reproduces the inaccuracies of the field sketch, but does illustrate more realistically details of the Harper River sweeping past Sugar Loaf Hill. The left (northeastern) flank of that hill has been made to look roughly scoured when compared with the sketch. Haast titled his painting *View of the roches moutonnees from the junction of the Harper with the Avoca*, even though the dominant mid-ground hill does not have the definitive shape of a roche moutonnée,[36] being a sugarloaf.

Why Haast would take such geomorphological liberties with the landforms he viewed from beside the Avoca is, as previously asserted, presumably due to his wish to give these particular features highly distinctive forms, so that they would be readily identified as glacially sculpted hills by informed readers of his report, and possibly also of a scientific paper he intended to write on the glaciation of the Rakaia Valley.[37]

Summary

The aim of this article is to establish the extent to which Haast's field sketches of glaciers in Kā Tiritiri o te Moana (the Southern Alps) are reliable historical environmental records from the 1860s, particularly whether they accurately indicate the former extent of those glaciers.

Investigating the extent to which Haast's field sketches accurately record the state of particular glaciers in the alps in the mid-nineteenth century involved assessing how true to nature they are by comparing enduring features illustrated in the sketches with site photographs or virtual imagery. Enduring features included topographical, geomorphological and, sometimes, ecological aspects. With respect to the elapsed time involved, the extent of glacial ice could not be considered to be an enduring feature, but the position of terminal moraines could be used to indicate the extent of those glaciers. Given the limited illustration of rocks and trees in the field sketches, neither geological nor botanical features were considered when assessing the fidelity of the sketches.

As it was not practicable to assess the fidelity of every glacial sketch made by Haast, the research project involved an exploratory study of the veracity of the Rakaia scenes that later illustrated his official report in the form of lithographs derived from landscape paintings based on the field sketches. This involved assessing nine field sketches and the corresponding paintings. The former enabled the accuracy of Haast's field sketches to be considered, and the latter, the extent to which transforming field studies into finished works of art involved exercising artistic licence. All of the nine views include either glaciers or glacially formed features such as roches moutonnées or sugar loaves.

Three of the views were compared with only recent site photographs taken from close to Haast's vantage points. Four views were compared with only virtual views generated in Google Earth Pro, also from close to Haast's vantage points. The remaining two views were compared with both site photographs and virtual views.

In most of the field sketches, the topography of landforms such as mountains, hills, valleys, gullies and riverbeds is accurately rendered, although peaks are sometimes steepened and/or elevated. In one sketch the mid-ground topography is modified to better expose glacial features and in another sketch the field of view is horizontally compressed to fit the landscape onto the paper. In two other sketches, non-ice glacial features are significantly modified to make them more dramatic in appearance. On the whole, enduring features are faithful to nature except for when Haast had a different agenda, such as inserting a peak to acknowledge an earlier explorer, drawing attention to particular glacially-formed landforms, or when he encountered a practical constraint, such as fitting a very wide panorama onto a sheet of paper.

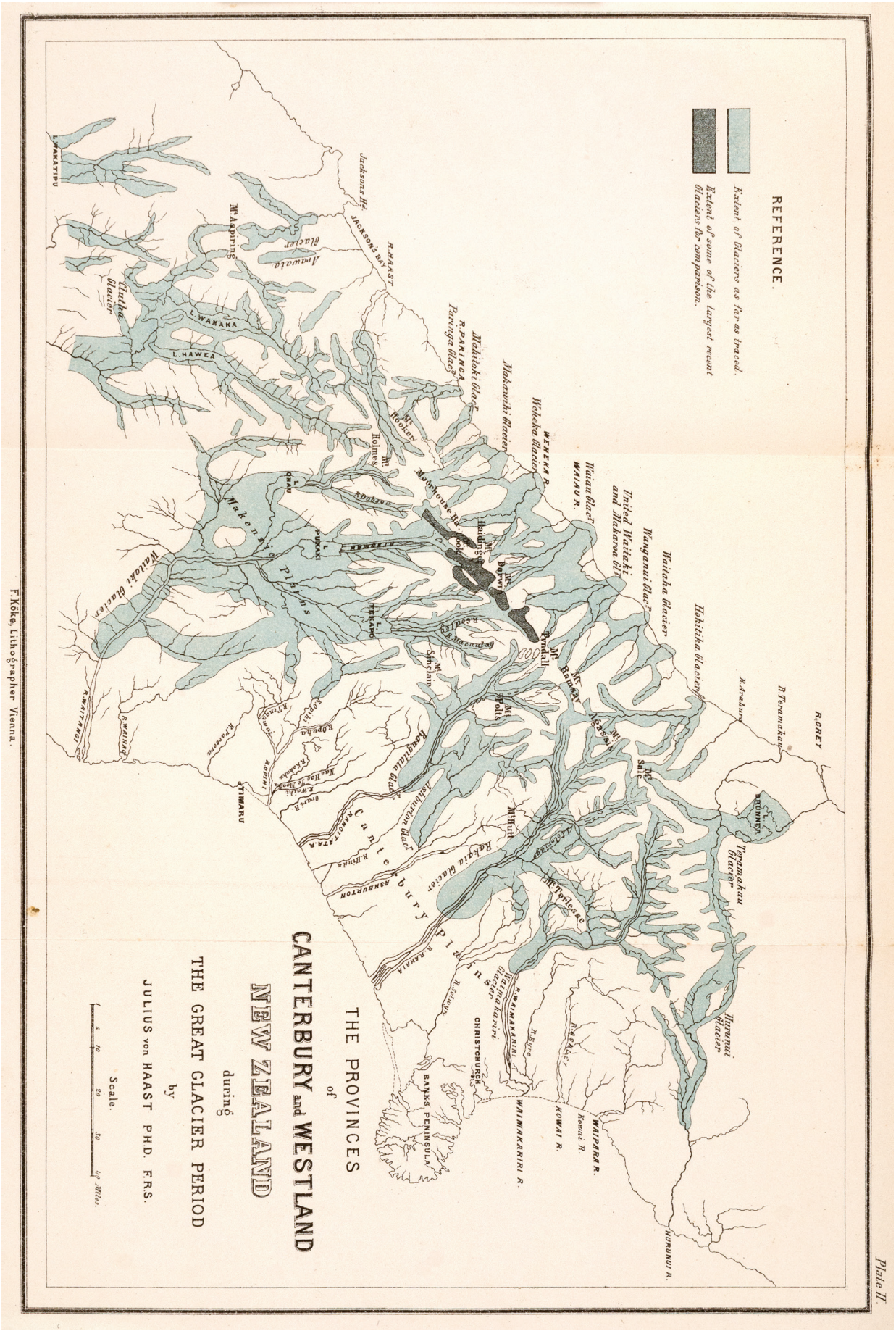

Figure 16. *The Provinces of Canterbury and Westland during the Great Glacier Period*, map included in Julius von Haast, *Geology of the Provinces of Canterbury and Westland* (1879: map II), inserted after p. 370. Lithographer: F. Köke, Vienna

With regard to the landscape paintings, Haast generally faithfully reproduced the accurately sketched mid and background topographical features. His use of a more extensive colour palette enabled him to emphasise important geographical and geomorphological features. However, Haast also reproduced sketched features that he would have known had not been accurately rendered, such as a compressed horizontal field of view to close up the middle horizon, the shifting of mid-ground features relative to the background topography to better expose the terminus of a massive glacier, and the exaggerated forms of roches moutonnées and sugarloaves. In most of the landscapes studied, Haast painted an invented foreground, which helped to frame the view and added staffage to give the viewer a sense of the magnitude of the views.

Discussion

Excluding Haast's portrayals of roches moutonnées and the sugarloaf hills, the general accuracy of his illustrations of enduring features in the sample provides a degree of confidence that the extents of the Rakaia glaciers, as shown in his 1866 sketches, are also accurately illustrated. This inference was confirmed in part by the research of Burrows and his collaborators in the 1970s, who presented evidence, such as the locations of age-dated terminal moraines, that Haast's portrayal of the extents of the two major Rakaia glaciers is indeed reliable.

Although the sample size in this study is small, the total population of alpine sketches is not large. There is, therefore, no reason to assume that other field sketches Haast made throughout Kā Tiritiri o te Moana (the Southern Alps) would not also be reliable environmental records. This would be particularly true of the sketches that show the extent of glaciers, as Haast wished to document their mid-nineteenth-century extent in comparison with the much more extensive glaciation that he believed occurred in earlier times, which he illustrated on the map reproduced in Figure 16, titled *The Provinces of Canterbury and Westland during the Great Glacier Period* (Haast 1879: map II).[38]

Based on the findings of this research project, the field sketches should, therefore, prove to be reliable environmental history records for climate scientists currently seeking to corroborate the physical extent of formerly significantly larger glaciers during the nineteenth-century using geomorphological features, such as moraines, whose embedded boulders can be objectively dated by measuring the residual concentration of certain isotopes in the sample (Schaefer et al. 2009; Putnam et al. 2012; Dowling et al. 2021).[39] These isotopes were originally produced when the boulders were exposed to high-energy cosmic rays on the surface of moraines.

With regard to the landscape paintings, the kinds of enhancements that Haast included are similar to those that nineteenth-century landscape painters typically used to create a more visually engaging scene that led the viewer's eyes towards the principal subject of the work. As an informed observer of "pictorial art" (Haast 1948: 836),[40] Haast would have known something about the liberties landscape artists took while still seeking to be true to nature. However, shifting a whole mountain several kilometres in order to include it in a view would have been beyond the typical liberties taken by most other landscapists.[41] It should be noted, though, that as far as the actual details of the glaciers go, Haast did not significantly embellish those aspects in his paintings. Regardless, the finished landscape paintings often better reveal the extent, volume and other features of the glaciers than the sketches do, by establishing spatial depth and through the use of more distinctive colour contrasts.

This research project proved to be both a robust and a successful test of the applicability of the spatial techniques that I had developed while investigating the fidelity to nature of Guérard's Antipodean landscape paintings, and locating the original sites of the Pink and White Terraces before they were either destroyed or submerged following the eruption of Mt Tarawera (Hook and Carey 2019). The project also confirmed the value of geospatial applications as research tools, such as PeakFinder and Google Earth Pro for locating the vantage points of field sketches, and PeakFinder for identifying painted peaks. Furthermore, the accuracy with which Google Earth Pro generated images that closely matched alpine photographs, provides a high degree of confidence that Haast's vantage points can be established, enabling the fidelity of his sketches and paintings to be assessed. It is likely that the approach utilised in this project will lead to interdisciplinary collaboration with glaciologists or climate scientists interested in what else Haast's glacial iconography will reveal.

Further work remains to be done by the author, in terms of a more extensive survey of the fidelity to nature of Haast's glacial sketches made in other catchments of Kā Tiritiri o te Moana (the Southern Alps), particularly those that illustrate the extent of those glaciers in the mid-nineteenth century. Determining Haast's vantage point in each case will be the key.

Conclusion

On the basis of his extensive field experience in the alps, Colin Burrows concluded that paintings based on Haast's field sketches are "fair guides to the terminal positions and the general magnitude of various glaciers, but Haast's original drawings must be regarded as the most accurate" (2005: 81).[42] The findings of this research project into the fidelity to nature of Haast's visual records, based on comparing sketches and the corresponding paintings with contemporary site photographs or virtual views of the landscape, largely confirm Burrows' assertion.

Glacial Glossary

erratic boulder – a large rock transported from its source by a glacier and deposited when the glacial ice melted.
lateral moraine – a large ridge of loose rocky rubble deposited on or near the sides of an alpine glacier.
Little Ice Age – an interval of atmospheric cooling between the fourteenth and nineteenth centuries.
moraine – a large ridge of relatively unconsolidated rocky rubble deposited at the terminus or sides of a glacier.
nunatak – an isolated rocky peak protruding above the surface of a glacier.
Ōtiran Glaciation – New Zealand term for the most recent major glacial period, which occurred between 75,000 and 14,500 years ago.
proglacial lake – body of water just downstream from the terminus of a glacier.
Quaternary – the current geological period, which commenced about 2.58 million years ago.
roche moutonnée – a rounded, exposed asymmetrical bedrock hill that was sculpted by an overriding glacier. The hill is usually elongate parallel to the direction of the original glacial flow. Typically the upstream end is smooth and gently inclined, whereas the downstream end is rough and steeply inclined.
serac – a tower or pinnacle of ice located on the surface of a glacier.
striations – grooves or scratches in rock caused by boulders at the base of the glacier grinding that rock as they pass.
sugarloaf – a round-topped hill formed by the action of glacial streams surrounding and overriding it.
terminal moraine – a mound of rocky rubble deposited at the terminus of a glacier.
terminus – the downstream end of a glacier.

Acknowledgements

I would like to thank Sascha Nolden for encouraging me to undertake this research project and for archival advice; Mark Stocker for peer-reviewing this article; Andrew Lorrey for providing climate science feedback, references and an aerial photograph; Stephan Winkler for providing glaciological advice; Stephen Carey for providing geological feedback; Oliver Stead for facilitating a viewing of Haast's artworks and peer reviewing this article; Claire Viskobc and Llewelyn Jones for providing excellent quality scans; the National Library of New Zealand for discounting the price of scans; Saskia van Voorn and Miles Fairburn for sharing their watercolour expertise; Susi Bailey for her meticulous copy editing; Phil Skewes for his technical editing; Shaun Barnett for the use of two photographs; Simon Nathan for his editorial suggestions; Daniel Smith for scanning Haast's maps; Callum Marshall for the use of a photograph; Michael Klajban for uploading a photograph to Wikimedia Commons; Sergey Kamch for placing a 360° photograph on Google Earth Pro; and Ian George for the use of a photograph.

Endnotes

1 The article, which was published on *SciTechDaily* on 16 August 2020, is available from https://scitechdaily.com/new-zealands-southern-alps-glacier-melt-has-doubled-up-to-77-of-little-ice-age-glacier-volume-already-lost [accessed 16 July 2022].

2 The proglacial lake developed early in the 1970s (Burrows 2005: 85).

3 Not all of the landscape paintings were by Haast himself; some were done by John Gully, based on Haast's sketches.

4 The methodology was also applied to interrogating panoramic photographs of Lake Rotomahana in order to determine the original locations of the Pink and White Terraces, which were either destroyed or submerged in the 1886 eruption of Mt Tarawera (Hook and Carey 2019).

5 Sascha Nolden, email communication with author, 3 May 2022.

6 Burrows did not read Haast's original reports until 1985.

7 Haast sketches are also held in two European collections: 19 sketches and three manuscript maps from the Dr Albert Schedl Collection, Vienna, were brought to New Zealand on exhibition loan by Sascha Nolden and shown in Auckland in 2008 (Nolden 2008: exhibits 88–93, 138–153); two panoramic watercolours of Kā Tiritiri o te Moana (the Southern Alps) are held in the Hochstetter Collection, Basel (Nolden and Nolden 2011: 23–25 [HCB 1.3.1 and 1.3.2]; Nolden 2016: figs 18 and 19).

8 The Upper Rakaia catchment actually covers an area of 2,900 km^2, most of which is located in Kā Tiritiri o te Moana (the Southern Alps).

9 Haast named a mountain and a river in the Tasman region of the South Island after Murchison (Tee 2007: 4).

10 The 12 watercolours were repatriated in 1974 at a cost of £5,000 (Paul 1974: 4, 10). They are now part of the collection of the Alexander Turnbull Library.

11 Letter from Hooker to Haast, 18 February 1864, reproduced in Nolden et al. 2013: 65. Haast named a mountain, a glacier and a river after Joseph Hooker and the latter's father William (Tee 2007: 4–7).

12 Biography of John Gully, Collections Online – Museum of Te Papa Tongarewa. Available from https://collections.tepapa.govt.nz/topic/942 [accessed 16 June 2022].

13 Quote in Gully (1984: 33) from a letter sent by Gully to Haast on 23 January 1866 (Alexander Turnbull Library, Haast Family Collection MS-Papers-0037-068). At the time, Gully was employed as a draughtsman in the Lands and Survey office of Nelson Province.

14 The names of peaks indicated by code letters would have been recorded by Haast in his field books. None of Haast's Canterbury field books have been located (Sascha Nolden, email communication with author, 27 June 2022).

15 Although technically he was referring to lithographs derived from the watercolours that were based on his field sketches.

16 Comment in one of the peer reviews of this article.

17 A planned helicopter trip to Meins Knob, where several of Haast's works could have been compared with site views, did not eventuate as the service was no longer operating.

18 The names are sourced from *Geonames* website, supplemented with identifications by members of the New Zealand Alpine Club.

19 For most of the Rakaia sketches it took several hours to locate a closely matching virtual view.

20 Haast wrote that: "[o]wing to the indefatigable zeal of my collector", 160 bird skins, numerous geological and palaeontological samples and several thousand specimens of dried plants were brought back to Christchurch (Burrows 2005: 81).

21 Whitcombe Pass Stream is now known as Lauper Stream, although Burrows incorrectly claimed that it should be Louper Stream.

22 Haast named these glaciers after the Scottish geologists Charles Lyell (1797–1875) and Andrew Ramsay (1814–1891) (Tee 2007: 4, 7), both of whom he was in correspondence with.

23 Transcription and translation by Sascha Nolden (email communication with author, 23 June 2022).

24 Transporting peaks to different locations would have been considered an unusual practice in nineteenth-century colonial art, although Eugene von Guérard did so on occasion (Hook 2017: 1036–1038).

25 The first European to discover the pass was the Erewhon runholder and satirical novelist Samuel Butler (Low 2010: 24).

26 Only that section of the sketch and the photograph corresponding with the field of view of the painting have been reproduced in Figure 10.

27 The moraines were dated by determining the age of the lichens on the surface of each moraine, which would have begun growing only once the moraine was exposed to the atmosphere.

28 See *Dronescape* website, Lake Coleridge Survey. Available from https://www.dronescape.co.nz/uncategorized/lake-coleridge-survey [accessed 24 June 2022].

29 The history of the discovery and naming of the pass by Māori is described in Wikipedia, Browning Pass / Nōti Raureka. Available from https://en.wikipedia.org/wiki/Browning_Pass_/_Nōti_Raureka [accessed 20 June 2022].

30 Saskia von Voorn, email communications with author, 20, 21 and 25 June 2022; Miles Fairburn, email communication with author, 24 June 2022.

31 As established using both PeakFinder and Google Earth Pro.

32 Only that section of the sketch corresponding with the field of view of the painting has been reproduced in Figure 14.

33 Schist is a metamorphic rock type that has a foliated appearance and is particularly apparent around Lake Wakatipu.

34 Stefan Winkler, email communication with author, 21 July, 2022.

35 Haast was, however, clearly aware of the commonly accepted geological definition of a roche moutonnée (Haast 1866: 53).

36 I am indebted to geologist Stephen Carey for pointing this out.

37 No such published article has been identified, nor any such manuscript located.

38 Burrows asserted that Haast's "glacier limits were too extensive in Canterbury and not extensive enough in Westland" (Burrows 2005: 130). The limits were too extensive on the Canterbury Plains because Haast had mistaken some alluvial deposits for eroded moraines.

39 In a review of this article, dated 30 June 2022, Andrew Lorrey commented that "Burrows' lichenometry work … cannot be reproduced; the state-of-the-art methods use 10-Beryllium cosmogenic dating on boulders embedded in moraines".

40 In 1879 von Haast delivered a series of six lectures on the history of pictorial art from Giotto to the van Eycks (Haast 1948: 836–837).

41 Although this strategy was not beyond the pale for Eugene von Guérard (Hook 2017: 1031–1038).

42 Burrows was referring more specifically to the paintings by Gully based on Haast's sketches but the same comment would have been applied to Haast's finished landscape paintings.

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