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Review

# Pareidolia in the Taupō volcanic zone: How misconstructed survey cartography condemned the white terrace, wonder of the world

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**Abstract:** Chaotic conditions prevailed after the 1886 Tarawera eruption, when the loss of the Pink and White Terraces, New Zealand's Eighth Wonder of the World, was rapidly declared. Four days after the eruption, surveyor Percy Smith approached about four kilometres from his supposed site of the White Terrace and mistakenly identified what he described as a "west-opening horseshoe bay" adjacent to a hill, concluding that the Terrace possibly lay within the newly formed crater. Pareidolia arises where ambiguous visual information intersects with cultural attachment and confirmation bias. This paper traces the subsequent life of Smith's claims through six parliamentary, government, and academic reports; two official audits; five survey maps; six contemporary artworks; Smith's later reminiscences; and a final interview. Forensic analysis of his survey maps shows that Smith altered the reported position of the White Terrace on two occasions and introduced topographic features during the period in which his work was being audited by sceptical government ministers. These early representations established an intellectual primacy that shaped official and academic understandings of the Terrace's fate into the twenty-first century. Indigenous Māori observers disputed Smith's conclusions at the time, but their testimony was disregarded under prevailing interracial conditions. This study extends the topography of the Rotomahana Basin through new altimetry, LiDAR mapping of the Kaiwaka Channel (also misidentified by Smith), reconstruction of his lost audit bearings, and derivation of an error ellipse for the White Terrace. The delineation of Smith's maps by Harding introduced cartographic pareidolia and confirmation bias. Taken together, the evidence indicates that Smith's successive claims for the White Terrace's location in the crater lake were unsupported by direct observation or by reliable survey control. This paper argues that the principal source of long-standing misinterpretation at Tarawera lies not only in the field surveys themselves, but in the later delineation process. Here, cartographic pattern completion transformed uncertain observations into apparently objective geometries that then guided subsequent perception and belief into the current century.

**Keywords:** White Terrace; Te Tarata; Lake Rotomahana; Tarawera eruption; Percy Smith; Kaiwaka Channel; Star Hill; pareidolia; surveying; Alpha Harding

## 1. Introduction

In the 140 years since the Tarawera eruption, the adjacent World Wonder, the Pink and White Terraces, continues to shine with international awareness across the public mind, tourism and the earth sciences. Though hidden from view, they retain an enduring fascination. The nineteenth-century belief that the Terraces were lost and Terrace fragments were scattered across the Rotomahana Basin owed less to observation and more to pareidolia, the cognitive bias that drives people to connect unrelated features into a coherent but illusory whole [1–3]. Percy Smith's (1840–1922) 1886 Tarawera eruption survey reports and sketches established a form of negative intellectual primacy, which later investigators, consciously or unconsciously,

projected onto ambiguous lake-bottom features, predisposing them to "see" what they hoped to find [4–7]. The pareidolia phenomenon is established in geography with, for example, the Martian canals and the 1976 "Face on Mars". At Rotomahana, the later lake-bottom Terrace claims were based on enhanced photographic and sonar imagery—not on direct observation. Further, no physical sample was produced, nor were any terrace coordinates published, so it is impossible to, e.g., scuba dive on the coordinates to physically check the lake bottom.

In c. 7,000 years BP, an underwater hot spring broke the surface in New Zealand [8]. The high spring and silica terrace commanded the region when Māori immigrants arrived in the fourteenth century [9,10]. They named it Te Tarata, the White Terrace(s). In 1886, the Tarawera eruption transformed the Rotomahana Basin, with the crater forming a lake surrounded by deep, ejected mud [11]. No geologist saw the eruption [12]. Surveyors' accounts were collected by the General Survey Office, which concluded that the terraces were likely blown into the air. Other voices, Māori and colonists, never accepted this. While there were early reports that siliceous sinter (sinter) lay around the crater, others failed to note any [2]. The Māori concluded that the White Terrace was buried in ash. No pieces are held by them today. There are no verified, post-eruption terrace sinter samples reported in New Zealand, suggesting the White Terrace was not blown up, but lies buried [2].

This paper examines the origins and legacy of the nineteenth and twentieth-century belief that the Pink and White Terraces were destroyed. The misinterpretation began on 14 June 1886 with Smith's claim that the terraces were destroyed [13]. Surprisingly, this claim has not been scrutinised. Later researchers took it at face value [6,14–16]. This research evaluates Smith, using the standards of 1886 terrestrial surveying to avoid presentism.

For six generations, the loss of the terraces was accepted by the public and some earth scientists; the evidence to support Smith's claims was never formally challenged due to the lack of survey coordinates for the terraces. The publication of Ferdinand Hochstetter's (1829–1884) 1859 survey over 2016–2023 and the landmark 2024 forensic examination of White Terrace claims using Kumete Ridge skyline geometry introduced a verification method for all claims for a Terrace location, including the new Hochstetter paradigm [1,17].

The historical record comprises four parliamentary reports: three by Smith and one by James Hector (1834–1907) of the Geological Survey of New Zealand, two by university staff, Smith's 1886 lecture, his reminiscences and final interview [13,14,18–23]. Hector effectively deferred to Smith in his sole report [18]. Smith published five maps and six artworks with locations for the White Terrace. The public record was collated by Ron Keam (1932–2019) to c. 1987, but without survey evidence, he was unable to proceed [15,16]. Smith's paradigm (after 1987, the Smith-Keam paradigm) came under challenge from 2016 with refutation of the claims that the terraces were destroyed [1,2,17,24].

This forensic geography paper reviews the surveying, error ellipses, cartography, altimetry and LiDAR of the north shore of Lake Rotomahana where the Smith-Keam and Hochstetter paradigms meet [1]. The competing claims provide White Terrace spring locations 500 m apart, yet this gap is the difference between a terrace destroyed and one buried and recoverable. The Rotomahana Basin received a Māori tapu (ban)

after the eruption. For traditional landowners, the loss of livelihood caused a diaspora. The White Terrace (even if damaged and non-functioning as is Pamukkale, Turkey) remains a tourism magnet.

## 2. Methods

This interdisciplinary research analyses survey and geospatial data, altimetry, LiDAR, photointerpretation, topography, seismic and forensic cartography. The analysis begins with the 1858–1916 claims by Smith. It focuses on his reports, maps, artwork, survey bearings, altimetry, lecturing, interviews and reminiscences. Keam's lay guides to the eruption assisted [15,16]. These summate the correspondence, politics and conflicts. A database of Australasian media was useful [2]. Smith's 1873 survey is reconstructed, an improved altimetry is given, and error ellipses are calculated for the White Terrace. Smith's delineator, Alpha Bennick [Bernie] Harding's (1856–1945) contribution to Smith's cartography is introduced into the historical record. LiDAR distinguishes the true Kaiwaka Channel from the lake overflow, which Smith mistakenly identified [25]. Smith's pareidolic legacy affected twenty-first-century interpretations.

### 2.1. Smith's first mistake. Star Hill for Steaming Ranges (aka Tarata Peninsula)

Smith's Rotorua activities, his reports, correspondence, maps and artwork are detailed from 1858 to 1894, with his reminiscences and final interview [26]. His first, pareidolic Star Hill claim on the White Terrace was altered in later reports.

### 2.2. Lost bearings on the White Terrace

Hochstetter's 1859 expedition provides the only survey bearings of the Pink and White Terraces. There were later bearings, but none survive. Smith's 1873 and 1887 audit set is reconstructed.

### 2.3. Altimetry and the Steaming Ranges datum

Altimetry is the key to relocating the White Terrace. Nineteenth-century altimetry was inaccurate. Colonists extrapolated the Lake Rotomahana elevation from that of Lake Tarawera. The author extends the first evidence-based altimetry for Lake Rotomahana to the Steaming Ranges (aka Tarata Peninsula, Pinnacle Ridge and Pinnacle Rocks), using photointerpretation and geometry [8]. This avoids reliance on changing lake levels. Refer to Figure 18.

### 2.4. Hochstetter's survey location for the White Terrace with LiDAR and error ellipses

Survey error ellipses are published for Hochstetter's survey stations [17]. Error ellipses for the White Terrace Spring coordinates are now calculated. LiDAR with reflectance colouring reveals the terrain and suggests subsoil features.

### 2.5. The true Kaiwaka Channel course

LiDAR from the Bay of Plenty Local Authority Shared Services (BOPLASS) reveals the upper true Kaiwaka Channel.

## 3. Results

### 3.1. Smith's Mistaken White Terrace locations

Smith developed ideas about the White Terrace via site sketches and maps. On his first 1858 visit, he sketched Lake Rotomahana, the Terraces and Rangipakaru Hill. In 1886, he failed to find Rangipakaru, leading to his first mistake [13,24].

**Table 1** lists 17 sources where Smith made claims about the White Terrace.

**Table 1.** Smith's 1858–1916 Reports and Maps with White Terrace Locations (Published reports).

| | **Smith's Reports and Maps with a White Terrace Location** | | | | |
|---|---|---|---|---|---|
| **Year** | **Month** | **Publication** | **Location** | **Figure** | **Notes** |
| 1858 | n/a | Sketch | North tip of lake | 1 | Pre-eruption. |
| 1873 | n/a | Notebook 40. | Lost | 15 | Reconstructed bearings. |
| 1886 | 13 June | Sketch | Unsighted | 2 | |
| 1886 | 14 June | Sketch | Star Hill | 3 | First location. |
| 1886 | 14 June | Lithograph | Star Hill | 4 | Included in main 1886 report. |
| 1886 | 14 June | Google Earth | Three sites | 5 | The 14 June locations on Google Earth. |
| 1886 | 19 June | Report | Star Hill | n/a | First parliamentary report. |
| 1886 | 12 July | Lecture | Star Hill | n/a | |
| 1886 | 12 August | Survey map | None | 7,9 | T cipher beside Steaming Ranges. |
| 1887 | March | Bearing audit | n/a | n/a | Smith defends with his 1873 bearings. |
| 1887 | July | Main report | Steaming Ranges | 10 | Second location is published. |
| 1887 | July | Main map | Unstated | 10 | An invented promontory but no terrace. |
| 1887 | August | Map Harding | Ranges | 11,12 | Introduced a lake/terrace caricature. |
| 1894 | n/a | Map Smith | Ranges | 13 | Repeats the second location. |
| 1894 | n/a | Lithograph | Ranges | 14 | Third location. |
| 1910 | March | Smith Interview | Ranges | n/a | First reference to terrace stream datum. |
| 1916 | n/a | Reminiscences | Second or third | 7 | "...my [1887]surmise was correct" |

In 1858, Smith was a teenage assistant surveyor and sketched **Figure 1**. He placed the White Terrace (Tarata) at the northern lake tip and labelled Rangipakaru Hill.

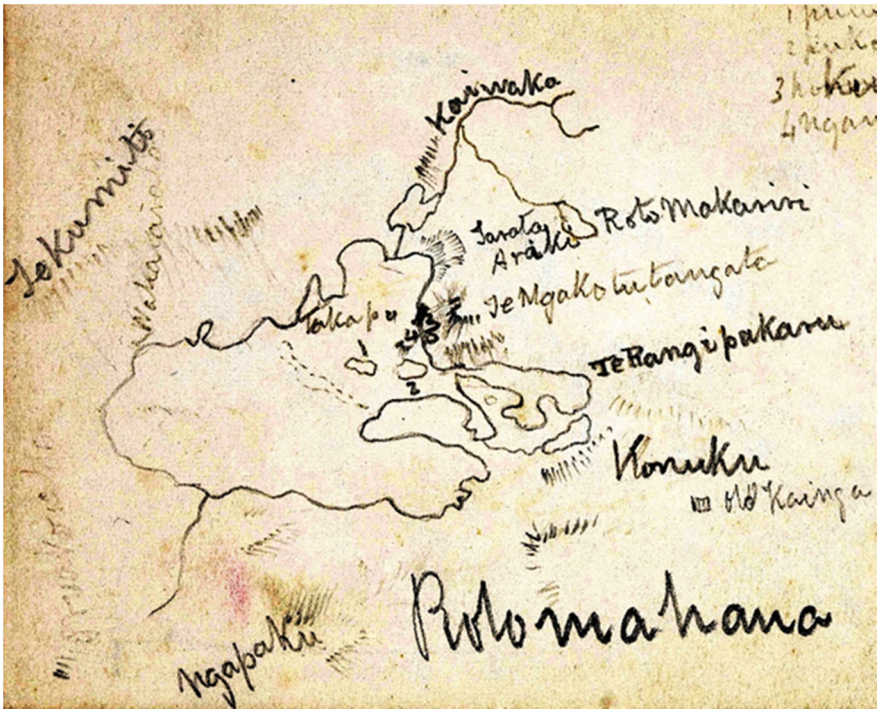


**Figure 1.** Sketch map of Lake Rotomahana, 1858 (Alexander Turnbull Library).

To follow his mistakes, we examine how he interpreted the landscape. Surveyors focus on high ground. From **Figure 1**, he knew Rangipakaru Hill lay across the lake, while the Steaming Ranges and White Terrace lay to its north. From Hape-o-toroa Hill (at 8 o'clock in **Figure 1**), he knew Mt Tarawera lay northeast and the White Terrace lay along that bearing [19]. Had he recognised Rangipakaru Hill, he would not have confused Star Hill with the Steaming Ranges. Instead, he would navigate to the Steaming Ranges where the White Terrace lay, outside the crater [24].

### 3.2. 13 June 1886 visit

On 13 June, Smith first approached the eruption. He sketched from Pareheru in **Figure 2** [13]. He guessed a White Terrace position, though Hape-o-toroa Hill blocked the intervisibility.

**Figure 2.** Sketch map of Lake Rotomahana, 13 June 1886 (Journals of the House of Representatives. 1886, session I. H-26).

### 3.3. 14 June 1886 visit

On 14 June, Smith neared the crater, sketching **Figure 3**. Seeking a hill with a west-opening horseshoe bay, he mistook the newly-formed Star Hill for the Steaming Ranges. This mistake was almost certainly pareidolic. He drew "D" as the *Former position of White Terrace.*

**Figure 3.** Sketch map of Lake Rotomahana, 14 June 1886 (Journals of the House of Representatives. 1886, session I. H-26).

Smith's Survey Office prepared a lithograph of **Figure 3** for their 1887 report. This is **Figure 4** and shows Smith's first Star Hill site and his second location. The difference between the red, yellow and white arrows decides whether the White Terrace was erupted or buried.

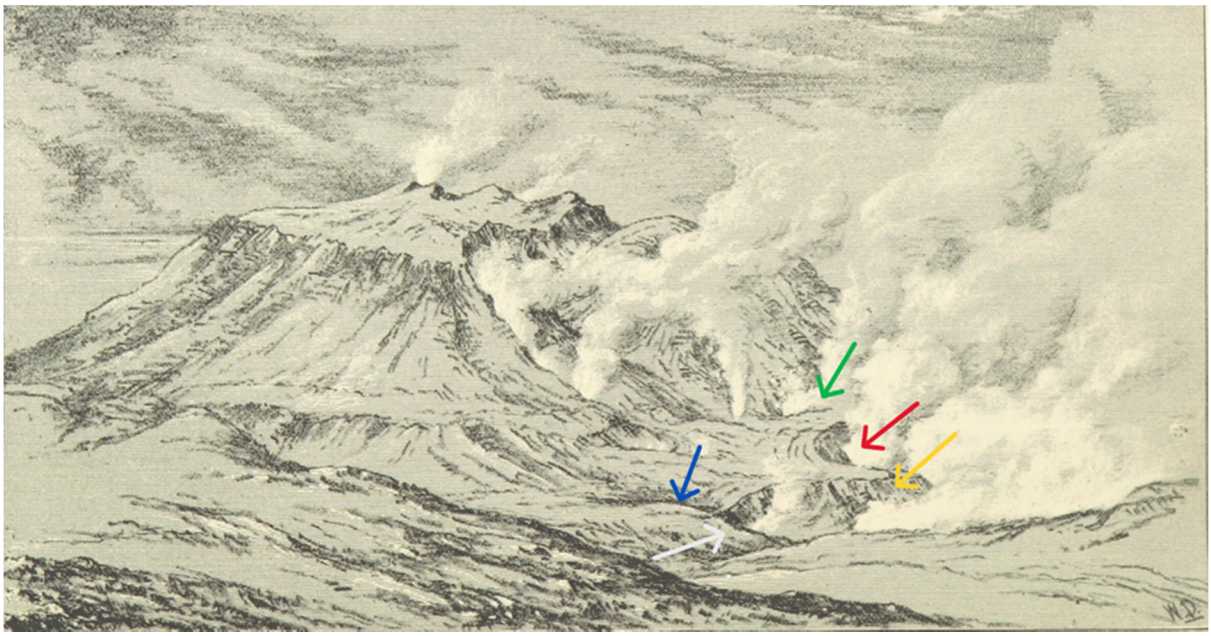

**Figure 4.** Lithograph of **Figure 3.** The red arrow is Smith's first location. The Yellow arrow is his second. The White arrow is Hochstetter's survey location. The blue arrow is the crater overflow. The green arrow is Lake Rotomakariri (General Survey Office).

**Figures 3 and 4** are the first evidence of Smith erring. His perspective is reproduced using a geographic navigation tool, Google Earth Pro™, in **Figure 5**. Here, the Chasm lies to the right of Ruawahia peak and beneath Tarawera peak, with Koa peak to its right. In **Figures 3 and 4**, Smith marks the White Terrace site 'D', behind a spur. Another spur projects into the crater behind 'D'. Smith marked E as the crater-lake overflow (**Figure 4**, blue arrow) and declared this was also the Kaiwaka Channel. He marked points "GI" as *en route* to Ariki inlet. This confused Keam, and recent research shows that Te Ariki was a term applied to multiple locales [3]. By 14 June, Smith identified four features along the north crater as pre-eruption. Five days later, these sketches were in his report to parliament:

> "The spot where once was situated the most beautiful object of its kind in the world, the White Terrace, is now, I believe, occupied by a crater forming a sort of horseshoe bay in the side of the greater crater of Rotomahana ... Should this horse-shoe crater hereafter prove to be not exactly where the White Terraces stood, it is, at any rate, quite close to it ... If not there then they are either buried deep under the stones and sand or have sunk into the main crater." [27].

His 19 June report engendered public grief. In **Figure 5**, Smith's observation position is reproduced. The horseshoe bay is below Star Hill.

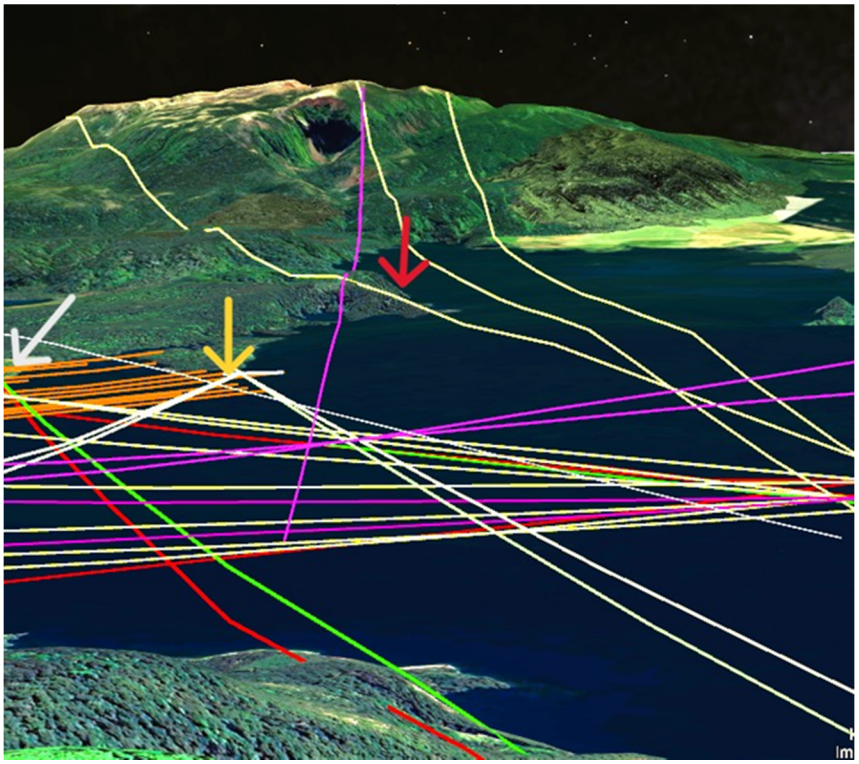

**Figure 5.** White Terrace locations—View from near Smith's 1886 site. The red arrow is his first Star Hill location. The yellow arrow is his second 1887 location. The white arrow is Hochstetter's survey location. Coloured rays are associated with survey bearings (Bunn & Nolden, 2023, Google Earth).

Rangipakaru Hill was out of shot in **Figures 3 and 4**, but it is in **Figure 5** (at two o'clock). Smith noted a new high ground he named Star Hill beside a horseshoe bay. The White Terrace spring was high on a hill and surrounded by a horseshoe embankment opening west in the Steaming Ranges [28]. Smith would recall the Ranges ended north of the terrace. This seemed to tally with what he saw. He concluded Star Hill was the northern Steaming Ranges. Instead, these lay buried in the foreground with the Terrace.

The Steaming Ranges and Star Hill, with its four spurs, are in later maps. These include Smith's 1886 watercolour map, his 1887 version, the 1887 versions by Harding for Algernon Thomas (1857–1937) and Smith's 1893–1894 versions. Despite their evidentiary significance, Smith failed to label the Ranges. The recent availability of his 1886 watercolour map enables the first analysis of Smith's errors as they developed over the five crater maps and six artworks between 1858 and 1894.

In **Figure 6**, Smith's **Figures 3 and 4** earthquake cracks extend west from Star Hill. These were sketched in **Figure 3** as "G".

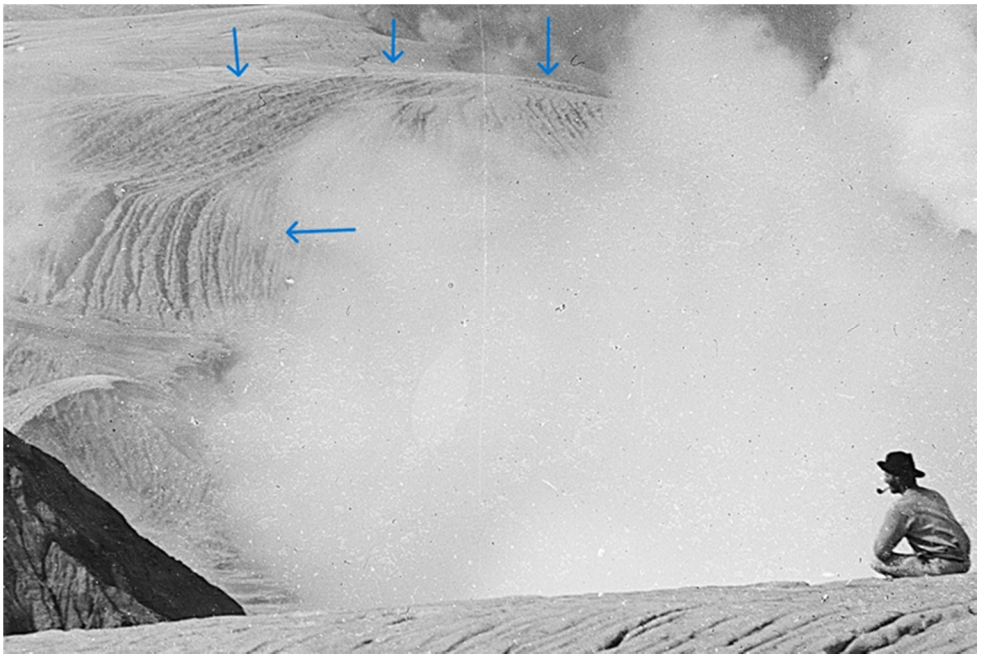

**Figure 6.** Smith's earthquake cracks (arrowed), (Te Papa Tongarewa C.010778).

Smith ceased fieldwork on 14 June. This seems odd for a crisis investigator reporting to parliament, as several parties approached the crater over 13–14 June through ground, which Smith declared impassable [13]. From 15–17 June, Smith stayed in his Rotorua hotel or at Kaiteriria or Te Wairoa [29]. He returned to Auckland on 18 June. His report is dated 19 June.

### 3.4. 19 June Preliminary Report to Parliament

Smith reported the crater was excavated south and west, leaving the country to the north intact save for ash: "[The eruption] has … eaten back southwards and westwards from the shore of the former lake … " [13]. This led him to locate the White Terrace in **Figures 3–5**. His mistaken report to parliament that Star Hill abutted the White Terrace was almost certainly pareidolic.

### 3.5. Lecture on 12 July at the Auckland Institute

From 14 June 1886 to July 1887, Smith spoke only of the incorrect Star Hill site. Three weeks after Smith's report, he and J. A. Pond (1846–1941) presented preliminary findings in a lecture. Smith reiterated that:

> "… the evidence … goes to show that the site of the terraces is now occupied by a horse-shoe shaped recess or bay … Nearer to us than this recess could be seen a gentle declivity … in which once ran the Kaiwaka Stream, the former outlet to Lake Rotomahana …" [30].

Recent seismic surveying found that this declivity was not the Kaiwaka Channel [25].

### 3.6 Watercolour survey map 12 August 1886 in Figures 7, 8 and 9

On 26 July, Smith returned to Rotomahana for 18 days of mapping. This map was the basis for his later published mapping. It was relocated when Keam's collection was auctioned in 2019. **Figure 7** is a detail.


**Figure 7.** Watercolour survey map detail of Rotomahana Basin, 26 July–12 August 1886. The spurs have yellow arrows. The Steaming Ranges have a blue arrow (Alexander Turnbull Library MapColl-r832.18cba/1886/Acc.57114).

The **Figure 7** map baseline runs from Oruakorako Hill, following the eruption rift bearing to Ruawahia [11]. Pencil lines are grid lines and/or bearings on Te Kumete and Tarawera massif.

In his reminiscences, Smith describes the survey [31]. He would identify key landmarks, e.g., Hape-o-toroa, Ruawahia, Chasm and Te Kumete. The surveyors, Smith, Eric Goldsmith (1848–1912) and Ernest Adams (1865–1957) would mark up a grid. Goldsmith and Adams's names did not appear on the published version. They were recognised in Harding's 1887 version. The survey party is in **Figure 8**, photographed by Hector's photographer Charles Spencer (1854–1933).

**Figure 8.** Smith's survey party on 27 July 1886, below the Chasm, Rear row, Eruiti and Charles Turner. Front row, Smith (fourth from left), Adams, Goldsmith, Blythe, Lundius and a dog (order unknown). Charles Spencer exposes the plate (Te Papa Tongarewa 0.048727).

They would triangulate features using bearings and distances. The crater would be estimated, paced and aligned with the grid. Shading and hachures were added, emphasising the altered topography. Elevations and placenames, e.g., The Pinnacles and Star Hill, were marked. The Pinnacles (the north Pinnacle was first named Cathedral Rock by Joseph Warbrick (1862–1903) on 13 June.

In **Figure 7**, there are fundamental changes from Smith's 14 June sketch map:

a) The horseshoe bay has Star Hill and a crater at its head.
b) The Pinnacles are shown. On 14 June, it was obscured by fog.
c) Star Hill is named.
d) The *Former course of the Kaiwaka* is pencilled in.
e) Four spurs project into the crater. The western pair are similar to the 14 June sketch. The largest descends from Star Hill (which remains a high point at 406 m a.s.l. [metres above sea level]). Beyond these spurs lay the pond named Rotomakariri New Lake. This agrees with the 14 June sketch.
f) In the 14 June sketch, the eastern branch of the horseshoe bay is higher. In bathymetry by iXSurvey™ Melbourne, this Star Hill spur remains conspicuous today. The Steaming Ranges are 50 m lower than Star Hill and are easily missed when navigating the lake today.
g) The White Terrace location is unnamed, a notable omission given its highlighting in earlier maps and with Smith's claim for it at Star Hill.

In **Figure 9**, Smith entered the letter "T" centrally amongst the hachures beside the Steaming Ranges. This is coincidentally where Harding first placed his White Terrace spring site in 1887. Following Admiralty symbology, there are "+" and "X"

marks on this map referring to vents and "O" marks for Conspicuous Objects, but this is the only known "T". The "T" is an Admiralty symbol for a lake bottom composed of tufa. Tufa forms from minerals precipitating out of water, while tuff forms from volcanic ash falling out of the air. At that time, tufa was often confused with tuff. Based on the toponym "THE PINNACLES" (in ~15-point typeface), the "T" is in 11-point typeface and indistinguishable unless one examines that spot. It forms a cipher. From Oruakorako, the Steaming Ranges presented Smith a more west-facing embayment than Star Hill. Today, this embayment opens southwest. In **Figure 18**, the greatest pre-eruption valley in the Ranges, the Ngāhutu Valley, also opened southwest of the White Terrace. Georeferencing shows the Ngāhutu Valley lies beneath today's embayment in **Figure 9** [20,24], which explains Smith's first error. In 2018, a PAWTL2 Project (Pink and White Terraces 2 Project) member repeated Smith's mistake, confusing the White Terrace embankment with the Ngāhutu Valley [32].

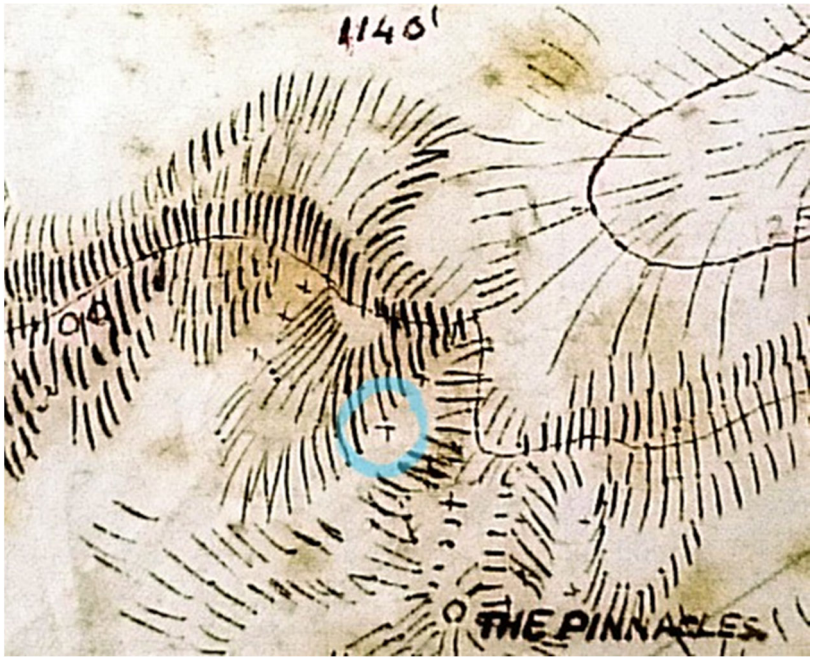


**Figure 9.** Detail of 12 August 1886 watercolour survey map of the Rotomahana crater showing the highlighted letter "T" (Alexander Turnbull Library MapColl-r832.18cba/1886/Acc.57114).

The "T" cipher is significant, given that Smith twice revised his White Terrace site. None of his sites is supported by Hochstetter's survey or by topographic or seismic research [1,13,24,25]. Smith, in effect, misled parliament on 19 June 1886 with his Star Hill claim and failed to acknowledge this in his later publications of **Table 1**.

### 3.7 Star Hill versus Steaming Ranges—the September evidence

From June to August 1886, Smith associated the White Terrace with Star Hill. In September, he reiterated: "the highest of these heaps of made ground … near the old site of the White Terrace. On this hill … Smith found the flag planted by the Star exploring expedition, and named it the Star Hill" [33]. The "T" cipher illustrates his

dilemma. At some point between September 1886 and July 1887, he segued from Star Hill to the Steaming Ranges.

### 3.8 Smith's 1887 official eruption report and map in Figure 10

In his official 1886 eruption report (published in July 1887), there is little evidence that Smith recognised key landforms—Te Rangipakaru Hill or the streams debouching into the crater [24]. He coined new names for the Hangapoua and Waiahinekahu streams. There is one innovation in his report: "immediately to the north of the central lake, there are some rugged pinnacles of black rock … These have a special interest as marking the site of some of the hills that formerly stood close to the White Terraces. The exact position of the [White] terraces cannot be identified, as the ground around where they formerly stood has been blown away; but **they were close to and north-west of the pinnacles**" [21] [my bold, ARB].

Smith's 1886 watercolour map was given three-colour printing in **Figure 10**. Of seven contributors, only Smith is credited. The northern crater is reworked. The Terraces are again omitted. The Pinnacle is renamed. This is misleading, for there were twin Pinnacles: north and south of the crater [24].

In **Figure 10**, Smith invented a promontory between the Steaming Ranges and Star Hill. This does not exist in any other map or bathymetry. It formed two new bays, obscuring the shift in the White Terrace site between 1886 and 1887. The three eastern spurs are greyed out, and the elevation indicator is moved to obscure them. No White Terrace or "T" is marked. These changes were confusing, enabling Smith to control the Terrace narrative.

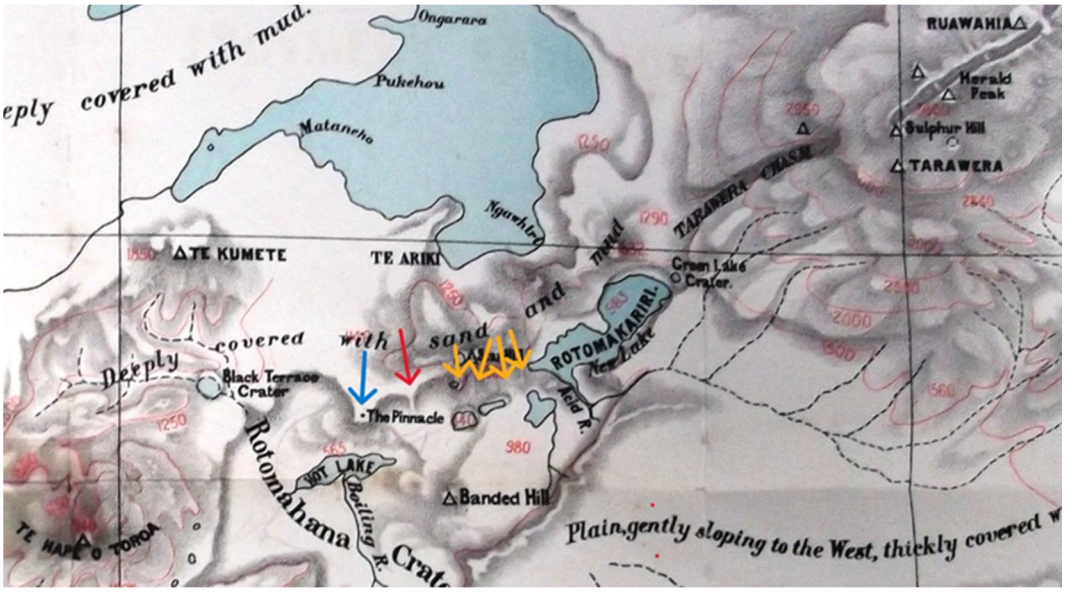


**Figure 10.** Detail of July 1887 survey map of the Rotomahana crater showing the Steaming Ranges (blue arrow), Smith's invented promontory (red arrow) and the four spurs (yellow arrows) (General Survey Office).

The **Figure 10** map assisted Smith's switch to the Terrace location in the 1887 report by avoiding a terrace location and by altering the topography. The White Terrace was shifted ~1,100 m west from Star Hill to lie northwest of the renamed Pinnacle in his report (but not on his map).

### 3.9. Harding's 1887 Plan No.3

Conflict between the Survey Office, academics and the government led to separate reporting, with the Survey Office holding all survey data. Thomas visited the region in 1886–1887, postponing his report till 1888. He accessed Smith's 1886 watercolour map and added findings with Harding. The hachures of **Figure 7** and the spurs return, but not Smith's invented promontory.

Smith's eruption report, including his **Figure 10** map, was published in July 1887, including Harding's Plan No. 3 (a survey working document). This Plan is the first depiction of a White Terrace location, in **Figure 11B**. Harding was a survey office delineator and did not accompany Smith's survey party in **Figure 8**. Harding also produced a monochrome version of **Figure 10** in August 1887, for Thomas's 1888 report in **Figure 12**. Harding's depiction of Smith's second White Terrace site has passed without scrutiny for a century. His restoration to the Terraces narrative is overdue and pivotal.

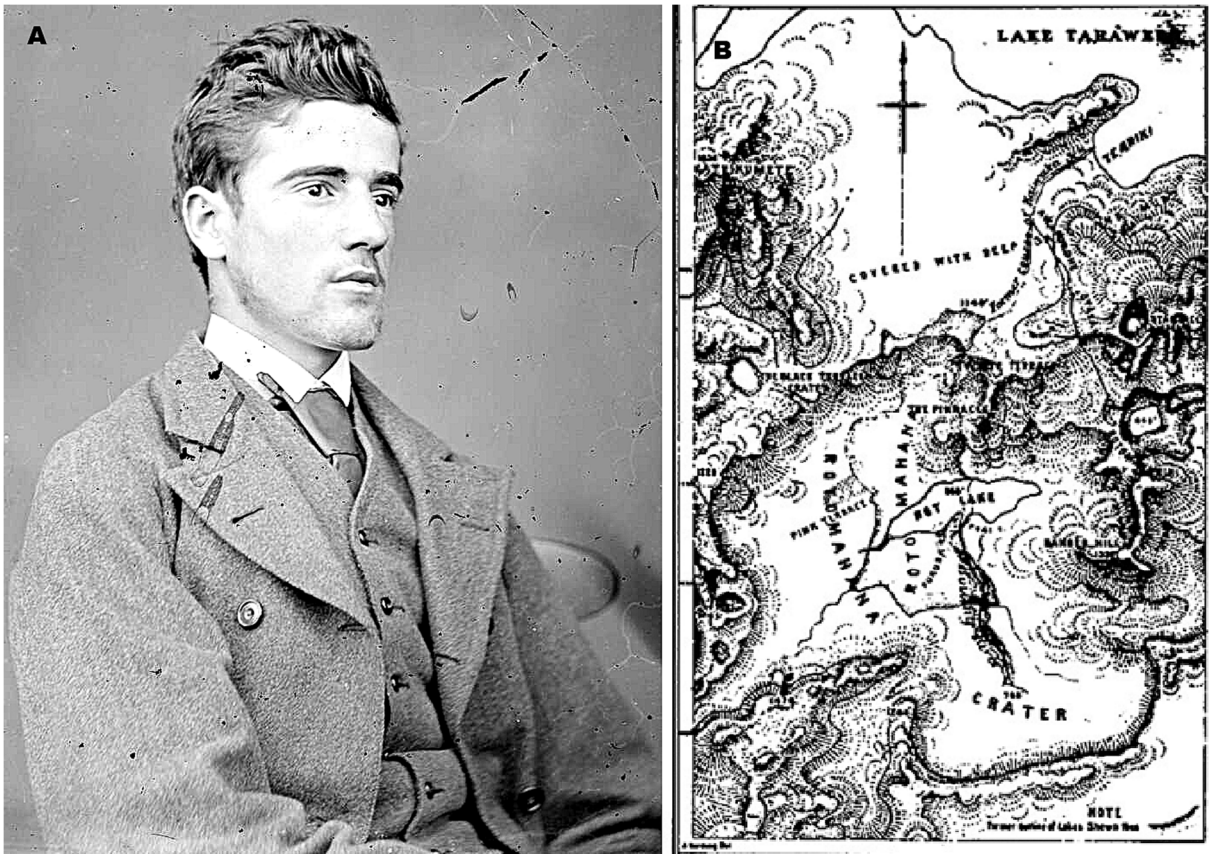


**Figure 11.** (**A**). Portrait of Alpha Bennick Harding, c. 1874. Photograph by William Harding. National Library of New Zealand, Wellington. Digital image, NDHA delivery ID IE3179606. Harding, the delineator credited on **Figure 12**, is shown in **Figure 11A**. He was a survey-office draftsman, not a surveyor at Rotomahana. (**B**). Harding's Plan No.3, a Survey Office draft plan, showing his invented Lake Rotomahana location (General Survey Office).

The delineation phase undertaken by Harding created the conditions under which pareidolia and confirmation bias could operate during the map plate production. Harding was not "seeing things" in the field; rather, he was compelled to impose cartographic coherence on methodologically disparate inputs supplied by Smith's field surveyors, whose observations were produced under different constraints and aims. In

this setting, pareidolia arises not as a visual illusion but as a pattern-completion mechanism intrinsic to cartographic production, operating where incomplete or non-congruent data are forced into a unified spatial representation.

When bearings, sketches, and narrative notes fail to align cleanly, the delineator must decide whether irregularities represent true discontinuities or merely observational noise. Late nineteenth-century cartographic practice favoured the latter. As a result, ambiguous gaps were "completed," misaligned features were gently coerced into coherence, and field hypotheses were stabilised into apparently objective linework. This can lead to pareidolia: the tendency to perceive meaningful spatial patterns where the underlying data are insufficiently determinate.

Downstream confirmation bias then enters. Once Harding's delineation was published under government authority, it acquired epistemic inertia. Later observers and researchers approached the landscape with the published map as a cognitive template, selectively interpreting terrain, deposits and alignments in ways that reinforced the map's implied structure. Contrary evidence, such as mismatched bearings, scale anomalies, or the absence of expected features, was more readily attributed to erosion, burial, or observational error than to artifacts from the original delineation process.

Importantly, this bias is recursive. The more Harding's map was treated as a faithful field record, the more confidently later interpretations conformed. In this way, a cartographic synthesis originally intended as an aid to understanding became a source of constraint, guiding perception rather than recording it. The phenomenon parallels classic cases of geographic pareidolia, where cultural expectations shape what observers believe they see on the ground, except here the "Martian face" is embedded in the authoritative geometry of an official map.

The long-standing misconstruction associated with the Pink and White Terraces is best understood not as individual errors of judgement, but as the cumulative effect of institutionalised pattern-completion and confirmation bias acting across generations of interpretation. Recognising Harding's plate delineation as an office-constructed artifact, rather than a direct proxy for field observation, is essential in disentangling what was seen, what was drawn, and what was later believed.

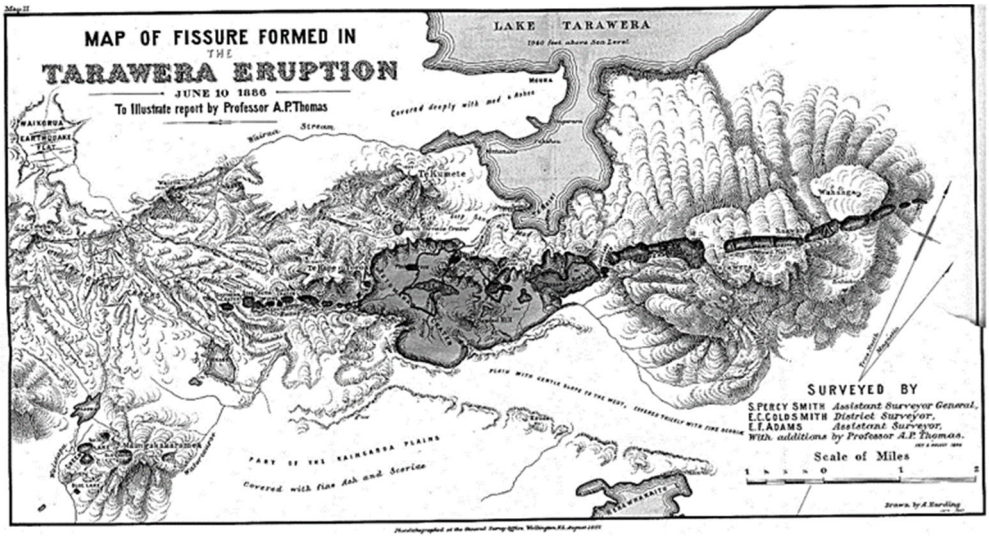


**Figure 12.** Harding's map of the Tarawera eruption, August 1887 (General Survey Office).

**Figure 13** is a detail of Harding's **Figure 12** map. Key points:

a) One Pinnacle is named and included.
b) Black Terrace Crater is shown (Black Terrace lies northwest).
c) The invented promontory is removed.
d) The four spurs in Figures 7 and 9 are reinstated (yellow arrows).
e) The Steaming Ranges are unnamed (blue arrow).
f) The overflow and Awaporohe Stream are pencilled in.
g) Harding's outline of Lake Rotomahana overlays the crater. The terrace locations are incorrect—the Pink Terrace is tipped north, and the White Terrace is displaced south. The lake shape may derive from an 1869 sketch by John Kinder (1819–1903) in the Hocken Collection. It also resembles a sketch by Edward Weller (1819–1884) [34]. Kinder's map was a sketch of August Petermann's (1822–1878) map [35].
h) Harding's northerly position for the White Terrace contradicts Smith's 1887 report claim that the White Terrace lay northwest of the Pinnacle. Research in 2023 showed the White Terrace lies northwest, but outside the crater [27,24,25]. In **Figure 13**, the true White Terrace site is ~1,200 m from Smith's Star Hill site.


**Figure 13.** Detail of Harding's **Figure 12**. showing the Steaming Ranges (blue arrow) and four spurs (yellow arrows), (General Survey Office).

### 3.10. The Thomas report, 1888

The **Figure 13** lake outline covered Smith's "T", preventing Thomas from including a terrace site. In Thomas's report, he demurred on the Pink and White Terraces, though among the sceptics [36]:

> "The sites of the Pink and White Terraces… have been identified with sufficient closeness by the surveys of Mr. Percy Smith, … Fragments of the sinter of which they were composed have been found amongst the débris around. The White Terrace was situated a little to the north of some bold, jagged rocks … the name of Pinnacle Rocks …" [37]. This is the fourth name given to the Pinnacles. Given the politics, Thomas avoided criticising Smith:
>
> " … in many important respects the conclusions arrived at in the present report differ from those expressed [by] other writers in papers published …. As these, however, with the exception of … Mr. Percy Smith, profess to have the character of preliminary reports, … it has not been thought desirable, … to make special reference to their divergent views." [37].

### 3.11. The 1893 Rotomahana Basin map, Figure 14

In 1893, Smith returned to Rotomahana as Surveyor-General. He gave his third report to Parliament in 1894 [22]. This included his fifth map and fourth artwork of Rotomahana. The fifth map is derived from his 1886 watercolour map (and Harding's) with a modified legend, e.g., it has a single Pinnacle and the 1893 waterline. Printed in three colours, it includes Harding's old-lake sketch and orients north. The "T" location is shown. In **Figure 14**, the White Terrace (white arrow) lies north of the Pinnacle, contradicting Smith's 1887 eruption report. In 1893, the Pinnacle lay in shallow water. This had a perhaps unintended consequence.

Harding's lake sketch shows that Smith's second White Terrace spring site now lies buried on land between the waterline and the crater rim. Smith gives a rim elevation of 1,140 feet (347.47 m). The crater base elevation nearby lay between 840 feet (256.03 m) and 980 feet (298.70 m). The first evidence-based altimetry of the old lake established that the White Terrace base lay at 301–303 m a.s.l. and the spring lay at 326–333 m on eruption eve [8]. The White Spring site now lies buried on the shore.

In **Figure 14**, the four spurs are reinstated (yellow arrows). Smith's promontory is removed. In **Figures 6, 12 and 14**, Smith's "earthquake cracks" extend from Star Hill. Misplacing the White Terrace is one of several errors. The Pukura and Puai Island names are transposed. The scale legend is incorrect. Oddly, the monochrome version has a different aspect ratio.

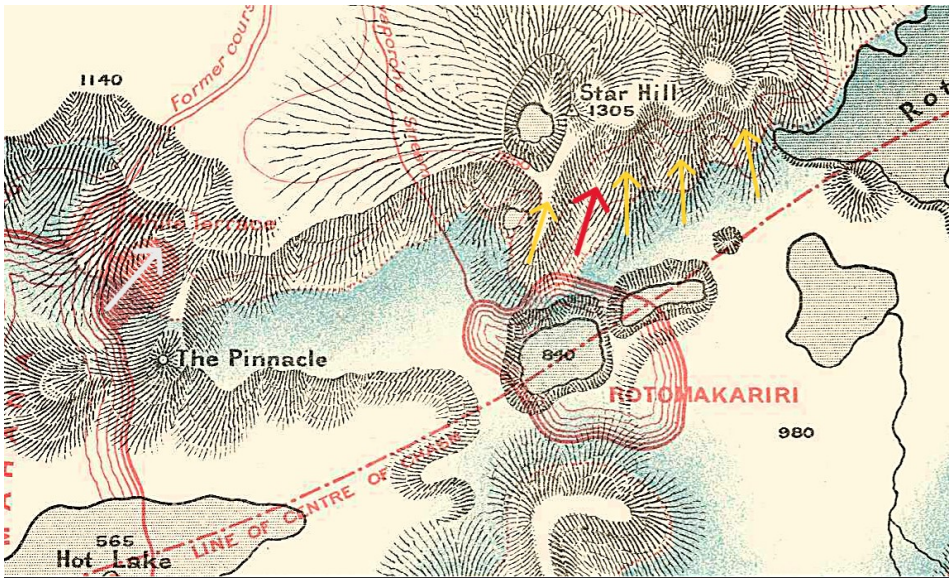


**Figure 14.** Detail of Smith's 1893 crater map showing his first (red arrow) and second (white arrow) White Terrace locations and the spurs (yellow arrows), (Alexander Turnbull Library).

## 3.12 Smith's final 1994 Rotomahana artwork

**Figure 15** is a lithograph by George Neville Sturtevant (1858–1937) from a photograph by Frank Smith (1846–1922). This was an aerial oblique view; hence, it is impossible to assess the terrace spring coordinates. To this point, Smith pursued terrace locations on hills with "west-facing" bays. In 1894, he abandoned this.

In **Figure 15**, Smith formed his third, final location for White Terrace via an intersection. He advised, "At a point very close to the letter D on the picture was situated the famed White Terraces" [22]. D is midway between the Pinnacle and the southern tip of the Steaming Ranges. From c. 1887–2016, investigators accepted Smith's third location until it was rebutted [1,17,38–41].

In **Figure 15**, Smith included a "C" intersection for the Kaiwaka Channel. "C" and "D" contradict his 1887 report that the Kaiwaka descended one statute mile [24]. Smith's Kaiwaka from "D" is a third longer. Star Hill dominates the shoreline. The Steaming Ranges merge into the shore, explaining Smith's June 14 mistake and the

"T" cipher. Smith failed to give primary evidence for the second and third locations until 1910.

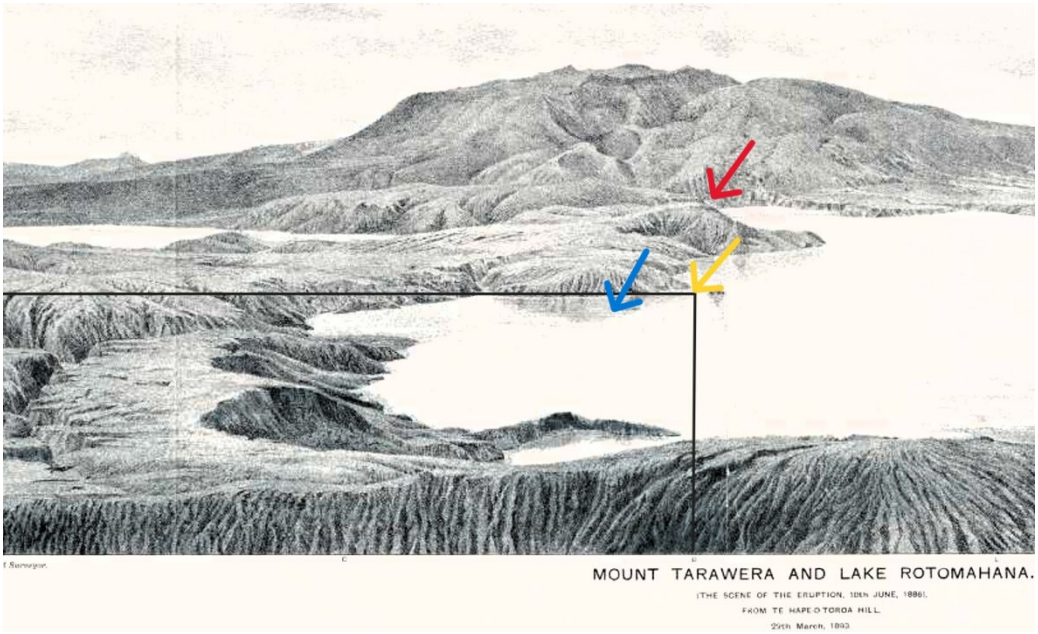


**Figure 15.** 1893 lithograph of the Rotomahana crater showing Star Hill above Smith's first White Terrace site (red arrow), the second (blue arrow) and third (yellow arrow) locations. (Sturtevant & Smith). The author includes Smith's "D" intersection. (Journals of the House of Representatives, Report for 1893–94. Wellington: Department of Lands and Survey).

**Figure 16** is a panorama from the author's 2016 PAWTL Project scuba dives, showing how Star Hill still dominates the lakeshore and skyline, and so misled Smith.

**Figure 16.** 2016 Star Hill panorama on azimuth 59° (courtesy Ingrid Fisher).

### 3.13. Smith's 1910 interview

In 1910, Smith told a reporter that the only evidence he had for the White Terrace location was a small stream in the crater. He did not mention this stream for 24 years. This is a serious omission that undermines his claims on the White Terrace. Alfred Warbrick prompted this 1910 disclosure, as he lobbied for government action to drain the lake. In reply, Smith gave his final interview. In the Brisbane Telegraph, he referred to his 1886 survey:

" …their sites were not covered by water as at present but dry land. To the best of our belief, **we located the site of the white terraces, as then marked by a little stream, which was rising from the dry bed of the crater** …" [26], [ARB Bold].

This stream was Smith's only primary evidence: "… it was absolutely impossible to define exactly the original position of the terraces…"—yet he marked the "T" cipher in 1886 and published this stream evidence 24 years later [26]. The stream appears on no map. It may have been backflow draining from Lake Tarawera into the crater [3].

In 2023, the author conducted the first hydrological overview of pre- and post-eruption streams in the Rotomahana Basin, with data from Hochstetter, Smith and the New Zealand River Pilot [24]. No streams now enter or leave the lake along the north shore. On his 1886 watercolour map, Smith sketched six crater streams entering from the south. One he named Acid River. In his 1887 report, Boiling River and Black Terrace Stream were sketched [42]. The latter and the Haumi were omitted from his 1886 survey. Others, e.g., the Hangapoua and Waiahinekahu, remained innominate.

The eruption changed the surface and bottom elevations of Lakes Tarawera and Rotomahana. With the Great Crater at ~182 m a.s.l. and the lake floor in Rapatu Bay at 250–260 m a.s.l., backflow would commence. The Kaiwaka Channel formed a rubble drain at the low point. This drainage occurred for a time during 1887–1893, until the Rotomahana level exceeded that of Tarawera and drainage into Tarawera resumed [8,43,44].

### 3.14 Smith's reminiscences

In 1916, Smith wrote his reminiscences, and these were published in 2011 [31]. He reiterated that he believed the terrace had been blown into the air. Yet, in 1886, he admitted to Warbrick that the Terraces may have escaped destruction [36].

### 3.15 Smith's lost bearings on the White Terrace

One of Smith's surveys has long puzzled researchers. In 1873, he recorded two bearings on the White Terrace in his notebook no. 40. Ron Keam saw the notebook entry, knew of the stations and discussed them in his opus [16]. He did not share these stations or bearings. While Smith's notebooks are held by the Turnbull Library, no. 40 is missing.

When Smith faced the 1887 audit, he relied on these bearings. They were taken from points west and southwest of Hape-o-toroa Hill. [16]. Keam left clues to locate Smith's stations. They were near the ejecta boundary and were neither on Hape-o-toroa Hill nor Rainbow Mountain.

In the audit, Smith took check bearings from the stations en route to Rainbow Mountain with Surveyor-General James McKerrow (1834–1919) and the civil servants auditing Smith. This audit was ordered by Minister (later Premier) John Balance (1839–1893), who disagreed with Smith. Balance had visited with pre- and post-eruption photographs by George Valentine (1852–1890) and believed the White Terrace survived, hence the audit [16]. This was two weeks after Thomas, Edward Payton (1859–1944), and Warbrick met at the White Terrace site and also disagreed with Smith [36,45].

Smith survived the audit, but the matter simmered until 1910 with a fresh investigation ordered by Minister Thomas Mackenzie (1853–1930), who stated: "I have never been satisfied that the terraces were destroyed... I requested the departmental officers in the district to report . . . I deemed it advisable to widen the scope of the investigation ..." [46]. The matter was still debated in the press in 1922, when Smith died [47].

To reconstruct the 1887 audit, the reports and Keam's clues narrow the 1873 stations to the Rotorua-Taupō road in **Figure 17**. Only two road sections are intervisible with the White Terrace locale. The only western sightline is between Kumete Ridge and Hape-o-toroa–Oruakorako Hills. The only intervisible peak is Tuminui Hill at 671 m, which became a tourist observation point for the eruption [1]. Pareheru is on this line.

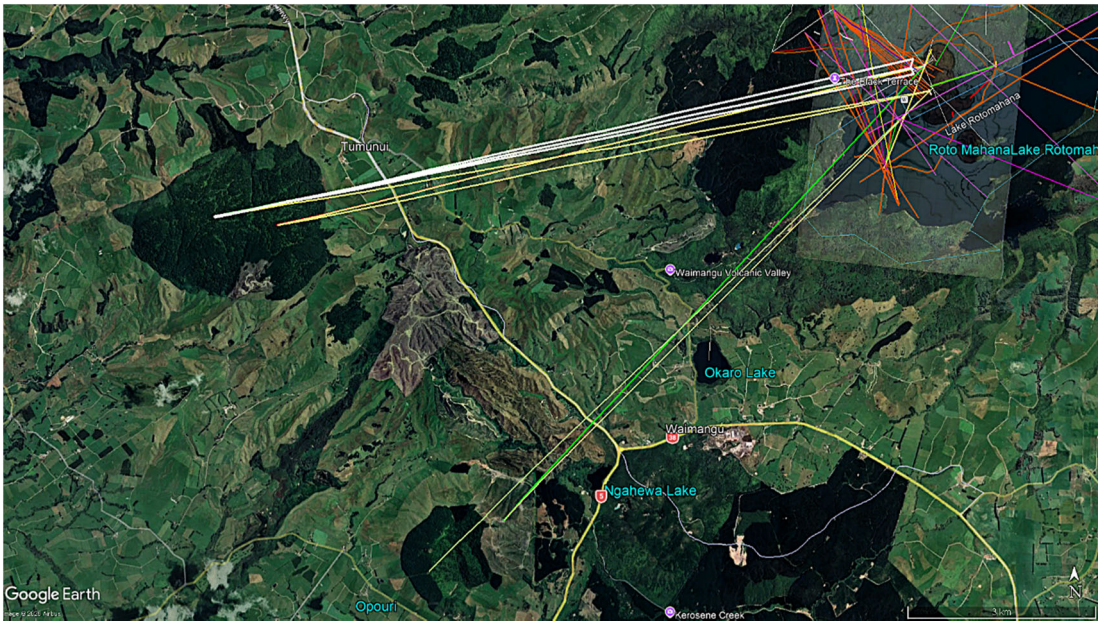


**Figure 17.** Rebuilding Smith's 1872 and 1887 bearings from Tuminui and Maungaongaonga to White Terrace, the white, yellow and green rays. Other coloured rays are close-in survey bearings (Google Earth & Bunn).

After elevation profiling, the only southwest sightline is from Maungaongaonga with its twin peaks, to Smith's and Hochstetter's terrace locations. The bearing passes Hape-o-toroa and crosses the crater as McKerrow noted [16]. Given government angst and with the Survey Office management ordered into the field audit, both peaks would be checked. The bearings traverse 10 km. The White Terrace was close to the crater. Hochstetter's survey places it ~100 m [24]. The auditors saw into the crater, and Smith's depth is consistent with today's bathymetry. McKerrow decided Smith was right. It is hard to imagine another conclusion. Smith was relieved, for his claimed accuracy was ±50 m [16]. This was optimistic given the stations' acute included angle of 33–35° in **Figure 17**, giving an inaccurate two-bearing intersection for the Terrace. The difference between these peaks and Smith's first Star Hill and second Steaming Ranges positions is 2–3°. From Hochstetter's Terrace location, it is 3–4°. Thus, Smith narrowly passed the audit. It seemed odd to Keam (and to this author) that Smith never mentioned the audit or these check bearings.

### 3.16 The Lake Rotomahana altitude

One difficulty after the eruption was Rotomahana's altitude. Without it, there was no way to measure the depth of buried features and thus the excavation cost. Geologists estimated the Lake Rotomahana elevation from estimates of Lake Tarawera. This required the Tarawera elevation and the fall between the lakes. For the fall, geologists opted for a guess by Keam: one without evidence [8]. How deeply the terraces lay buried was unknown [48]. Changes in the Lake Rotomahana elevation would also need to be guessed.

To redress this, we take the pre-eruption lakes' data, trace the eruption changes and the 1886–2024 attempts to calculate the White Terrace altitude and depth. Next, we transfer the lake elevation datum onto land. Māori records are unhelpful because they did not quantify altitude. In their navigation system, elevations were relative to landmarks, their shape or spiritual significance.

The first formal altimetry (for the topographic map height above sea level) was by Hochstetter using a Kapeller aneroid barometer. He measured Lake Rotomahana at 1,088 ft (331.6 m.) and Lake Tarawera at 1,040 ft (317 m a.s.l). Early aneroid barometers had considerable error. The second attempt was probably made by surveyors A. C. Turner (*fl.* 1877) and Henry Mitchell (*fl.* 1877) in c. 1877, but no records exist [31]. The third was during 1886–1887 by Smith at 1,080 ft (329.2 m.). Smith and eyewitnesses recorded the descent of the Kaiwaka Stream as 40 ft (12.2 m), comparable to Hochstetter's (14.6 m) and today's altimetry. In 1894, Smith reduced his altitude to 1,010 ft (307.8 m.) [22].

The fourth estimate was by Jean Malfroy (1839–1897). James Healy OBE (1910–1994) reports Malfroy's 1891 estimate was 10 ft (3 m) above Tarawera, i.e., 965.5 ft (291.5 m). Malfroy arrived in Rotorua two days after the 1886 eruption and so could not make a pre-eruption altimetry [49]. Healy supported Smith over Malfroy [50]. The author found no support for Malfroy.

The fifth estimate was made in 1975 by Healy, of 307.7 m [50]. This was probably derived from Smith's 1894 figure. Later, Healy published the sixth attempt, i.e., a corrected figure of 300.7 m, derived from graphical curve-fitting and incorporating Smith's inter-lake gap of 12.2 m and a Tarawera elevation of 956.5 ft (288.5 m), [50].

In the seventh attempt in 1988, Keam considered Smith's data for Lakes Tarawera and Rotomahana, i.e., 1,040 ft and 1,080 ft. He pointed out that, as the pre-eruption and 1971 Tarawera elevations did not differ by 60 ft, then most/all of Smith's 1887 data may be erroneous [16]. He failed to note that Smith's final 1894 altitude for the lake was 1,010 ft and less 40 ft for the Kaiwaka, then Tarawera pre-eruption would be ~ 970 ft (295.7 m). This is realistic as over the past century, Tarawera has had a range of 297.9–298.5 m. For most of 1971, Tarawera had an elevation of 298.2 m; hence, Smith's data are reasonable [16].

Keam's estimate was an admitted guess of a one-to-two-metre inter-lake gap, with 291–292 m for Lake Rotomahana [16]. Keam and Malfroy are outliers from the consensus 40–48 ft (12.2–14.6 m) difference in inter-lake elevation. Keam acknowledged neither Malfroy nor Healy. Philip Andrews in Healy's obituary

provides a possible reason*:* "A few geologists from a later generation tended to undervalue Healy, a methodical and cautious scientist, slow to publish." [49].

In 2022, the author published the ninth attempt, the first this century, with empirical evidence. The 1858–1886 Lake Rotomahana elevation was 303 m a.s.l. with a rise and fall of ±1−2 m [8]. Healy's final attempt of 986.5 ft (300.7 m) is within this error margin. All surveys have errors and at Rotomahana, the causes include the eruption, landform change, erosion, deformation, uplift and subsidence. While there is regional subsidence, there is no significant ground deformation specific to Tarawera-Rotomahana (pers. comm. Brad Scott, December 2025). A fixed datum was required.

Herein, a more stable landform datum is developed, based upon a landmark with multiple measurements—the White Terrace spring. Its height above the lake was estimated over time at 25–30 m. Taking the length at 240 m and the angle as 9°, the sine function gives a height of 37.5 m. As the terrace grew, the angle decreased. Next, we measure the embankment height. Records fail to show how this was measured. Were the spring platform and the apron included? A chain and a clinometer were likely tools. **Figure 18** is the author's panorama of the Steaming Ranges. The angle of view is ~60°, the maximum for a natural appearance. The plumes of Ngāhutu and Ngahapu occupy the valley, which survives as the horseshoe bay on the Tarata Peninsula.

**Figure 18.** Steaming Ranges two plates by Burton in 1885–1886, probably using twin cameras. The seam is unfeathered for verité. (C.010654, C.010659 Te Papa Tongarewa, Bunn).

The Steaming Ranges were aligned north-south [17]. They were ~1,600 m long and 574 m wide, narrowing to 400 m behind the White Terrace where they peaked. Hochstetter estimated they were 200 ft (61 m) high. Keam suggested 50–60 m. The entrance peaks above the spring provide a datum. Applying the similar triangles method, in **Figure 18**, Lucy's Isle (Ruihi's Isle) is 4 mm high. The south peak is 42 mm. The embankment is around 38.4 m. Adding 25–30 m for terrace height, the embankment was 63–68 m above the lake. The photointerpretation is consistent with Hochstetter and Keam and delivers an elevation datum for buried ground.

In **Figure 18**, the lake was ~301 m a.s.l. The embankment would be 364.4–369.4 m a.s.l. on eruption eve. Today's elevations in the area are 340–360–370 m a.s.l. Smith's 1886 altimetry nearby was 347.47 m. This implies some loss of embankment during the eruption. Late pre-eruption photography shows it was fretting. Given

eruption surges, the embankment was unlikely to survive intact, though it shielded the terrace.

### 3.17 Hochstetter's White Terrace survey error ellipse

Nolden and Bunn resected Hochstetter's observation stations (Station 21 and Puai Station) through six iterations [17,40,41]. The bearing datasets gave reciprocal bearings, which established the stations' loci and error ellipses. Hochstetter's bearing to the White Terrace was projected from Station 21 and intersected with the Spring on Hochstetter's georeferenced 1859 map.

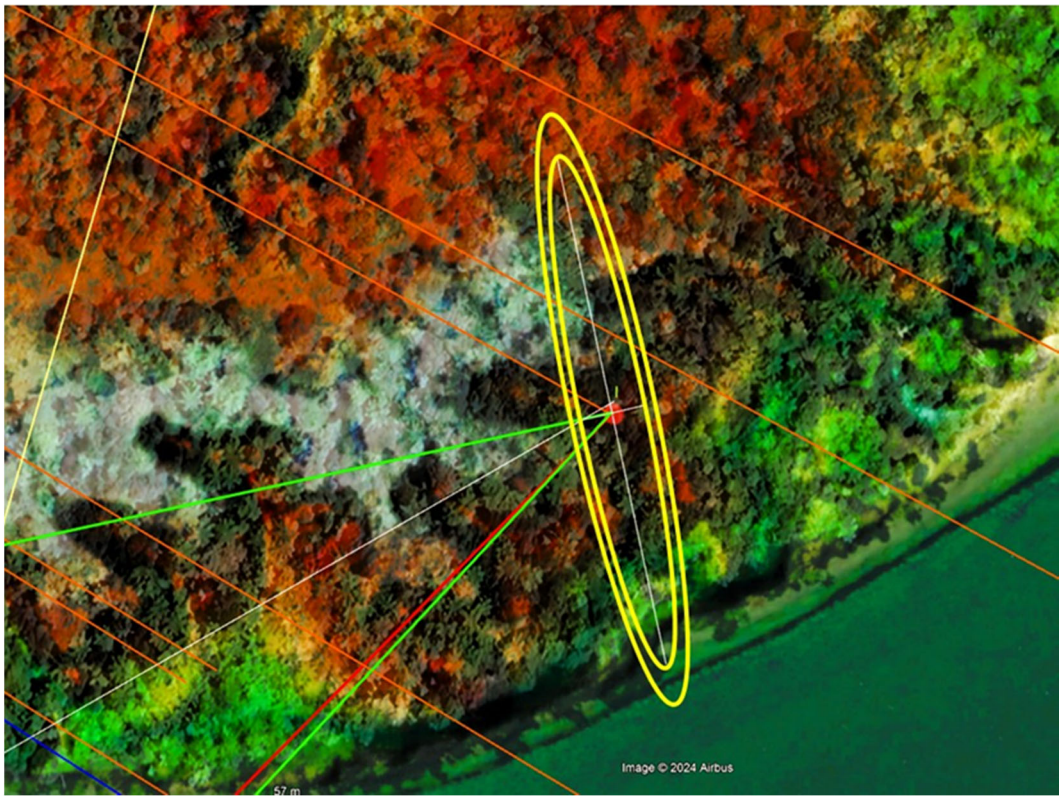


**Figure 19.** Error ellipses for Hochstetter's survey location of White Terrace. Inner ellipse for his two-minute compass. Outer ellipse for his 10-min compass. Coloured rays are survey bearings. (LiDAR courtesy of Adam Richardson at BOPLASS, Bunn).

The error ellipse for the spring centre was initially calculated interactively, using ChatGPT (GPT-5, OpenAI, October 2024) for numerical propagation and trigonometric analysis, and a simplified distance-scaled error propagation method. This result was validated interactively, using Gemini (Google Large Language Model, October 2025), applying standard geodetic covariance matrix propagation, utilising the Law of Error Propagation (LEP) via covariance matrix summation [51]. The validation produced a similar major-axis error and orientation with a slight minor-axis difference. The White Terrace ellipse has a major axis of ±52.9 m at azimuth 346.6°. The minor axis is ±6.9 m at azimuth 76.6° [51]. In Figure 19, the base image is Google Earth. The middle layer is LiDAR (laser-based mapping) from the Bay of Plenty Local Authority Shared Services (BOPLASS). The error ellipses are the top layer.

From the altimetry, the terrace embankment is shallowly buried, and the surface may indicate what lies beneath. For example, at ten o'clock on the ellipses lies a high point with both north and south drainage. This may correspond to one of the entrance peaks. The white high ground, high-reflectance region covers potentially significant, low-density vegetation extending west from the ellipse. This follows the terrace orientation and length. It may indicate low-soil cover and/or shallow rock or sinter. The terrace location may also be below the water table. These findings will direct any further seismic testing [25].

### 3.18. The true Kaiwaka Channel

Smith's second White Terrace location led him to declare that a low section of the crater rim was the Kaiwaka Channel. Seismic research shows no evidence of a channel [25]. This mistake created a hazardous legacy. Given the high-risk eruption dam on the isthmus, attention has focused on this section, not on the true Kaiwaka course in **Figure 20**.

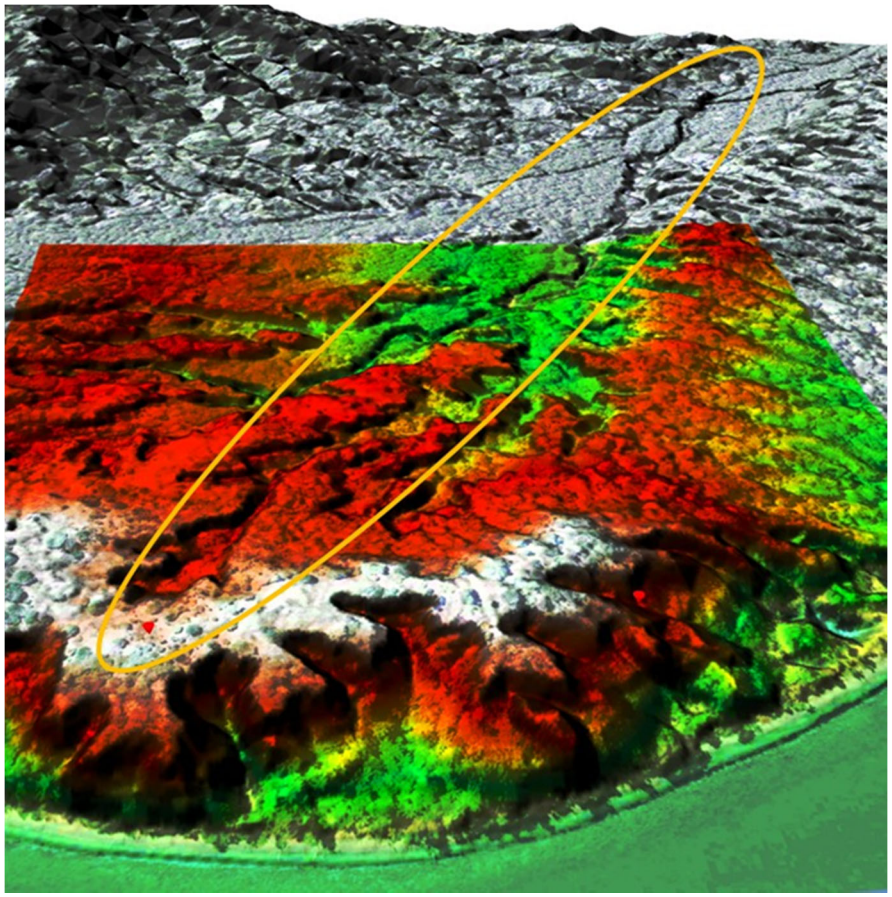

**Figure 20.** LiDAR of the Rotomahana shore. White shading shows high-ground, high-reflectance areas. The true Kaiwaka Channel course is outlined in yellow. The left red dot shows the White Terrace-Kaiwaka junction. (LiDAR courtesy of Adam Richardson at BOPLASS; Bunn).

In **Figure 20**, deep drainage channels are descending from the red dot (the survey White Terrace-Kaiwaka Channel intersection). These watercourses along the upper Kaiwaka are deeper and wider than those below Smith's lake overflow, reflecting

greater surface and sub-surface water flow. These upper channels connect with the lower Kaiwaka Channel, still on its pre-eruption course. Heavy vegetation along this watercourse indicates the presence of sub-surface water flow. Reviewing the ecosystem may show a preference for phreatophytes.

The LiDAR z-scale was increased to enhance detail on each site. The true Kaiwaka entry is superimposed on the Haroharo caldera. These each curve east to Pukekiore Hill before the Kaiwaka again overtops the caldera at Lake Tarawera. The Kaiwaka Channel is the lowest point in the dam, forming a drain. Since 1886, this will have eroded piping under the isthmus, increasing the risk of dam failure for Lake Tarawera residents who would receive little warning of a tsunami raising the lake by seven metres. It poses a diving risk from currents and entanglement. The high, coloured flow observed by Ken Raureti in 2023 persists and shows that the Kaiwaka continues to erode ash. This may eventually weaken the structure. Another 1886 eruption dam on the Tarawera River failed in 1904 with great downstream loss. The LiDAR, seismic, altimetry and topography triangulate Smith's mistake at the Kaiwaka Channel.

### 3.19. Twenty-first-century pareidolia at Lake Rotomahana

Smith's legacy at Rotomahana persisted until 2016, when the first, pre-eruption survey was published [17,40,41]. In 2011, a joint American-New Zealand project visited Lake Rotomahana and quickly claimed they had found the Pink and later the White Terraces on the lake floor [5–7].

They did not follow the Ingelfinger Rule and three days later held a press conference. Their excitement was palpable: "... 'lo and behold, this 'hook' jumped out of the map. It was like, 'bingo!' ... It was 'bingo!' again when ... In exactly the right place were curved structures that looked like the scalloped front edge of a terrace ... Their excitement building, Fornari downloaded photos from the same area taken by his underwater camera — and there they were, the buttresses of several terraces, complete with the 'candle wax' texture on their outer faces. They were even pink ... 'The terraces were never destroyed', he [de Ronde] said. 'They never went anywhere. What happened to them is that they got completely and utterly covered in up to 10 metres of thick mud, which was all excavated out of the old lake.' " [7].

**Figure 21** is one of the photographs claimed to show the Pink Terrace. In 2020, the author reviewed this photograph, finding: ". . . no sign of any shelf, terrace basin, regular surface or stalactites . . . only mud-covered rock" [38].

**Figure 21.** Image 2011_01_30_23_54_05- Image of the Pink Terraces underwater, with kaumātua Anaru Rangiheuea. (Used with permission, Stuff / Dominion Post. GNS Science 2011 press briefing on the rediscovery of the Pink Terraces.

This GNS Science 2011 interpretation was most likely a case of pareidolia, where the mind sees a pattern in ambiguous, random things. In 2011, there existed three characteristics of pareidolia: ambiguous visual data, a strong emotional, cultural attachment and confirmation bias, the desire to find what is hoped to exist: "Finding the terraces was never part of the official plan ... 'If you go to a government funding agency and say, We're going to look for something that 99.9 percent of people thought was gone, you would have no chance of getting the money', de Ronde said. ... "But secretly, at the same time, I said to myself, 'We've got this state-of-the-art gear to go have a look, and maybe we can figure out what happened to the terraces.' " [7]. Their claims were not published in a peer-reviewed journal until 2016 and then largely retracted [6,52].

Their second enhanced photograph (file name 2011_01_30_23_53_55-enhanced), also claimed over 2011–2016 to be of the Pink Terrace, was in 2016 instead suggested to be the Giant Buttress of the White Terrace (see **Figure 12C** in de Ronde 2016 and [4]). The terraces were 1,200 m apart, so one or both of these interpretations was fallacious. There was no public correction of the prior attribution, nor of the migration of the inferred terrace locations between 2011 and 2016. This migration disconnected their 2011–2014 photography and sonar evidence from their later claims [38]. In **Figure 21**, the Tūhourangi kaumātua (Māori elder) Anaru Rangiheuea initially endorsed de Ronde's interpretation but later withdrew his endorsement [53].

In 2025, the author made an Official Information Act (OIA) enquiry to Earth Sciences New Zealand (ESNZ, formerly GNS Science), requesting metadata from the two photographs, and from sonar mosaics which were the chief evidence for the 2011 White Terrace claim. According to ESNZ, "the only [sonar] processing that was done was to remove the water-column gap underneath the tow-fish (AUV), which improved

the georeferencing of the features in the mosaics shown in de Ronde et al." (Earth Sciences New Zealand, OIA response to the author, 23 October 2025, copy on file).

The removal of the water column, performed months later in the USA, would introduce operator subjectivity. This probably required manual adjustment, at the time when the world media was focused on the discovery claims and, in the absence of photography for the White Terrace, expectations of sonar evidence to support this claim. In any event, the White Terrace basins were imperforate and so could not emit gas. Any basin-like forms beneath bubble plumes cannot be said to represent the White Terrace.

## 4. Discussion

One difficulty in this research is the cartographic record. We have no Māori maps. The first map of Lake Rotomahana was Smith's in 1858. In 1859, we have Hochstetter's three watercolour survey maps and a flawed version from Petermann. An 1869 map by John Kinder (1819–1903) is a tracing of Petermann [54]. Between 1859 and 1886, there were no new large-scale maps. After 1859, there was photography. While this offers advantages, e.g., photogrammetric optics and photointerpretation, it introduces fresh error from, e.g., pareidolia, misinterpretation and the removal of avian life and thermal fog.

There was also a dynamic environment. In 1841, Ernst Dieffenbach (1811–1855) found Rotomahana, "a deep lake of a blue colour, surrounded by verdant hills … the lake covered with waterfowl … which feed upon a small fish that abounds in the lake" [55]. In 1859, Hochstetter found it a small, dirty-green lake, with its marshy shores, and the desolate and dreary-looking, treeless hills about it, and the fish had fled. During that time, Te Whakataratara, the solfatara beside the Pink Terrace, burst its embankment, a putative reason for the poor water quality and the flight of finned fish.

Also, the terraces were developing, especially the White Terrace, which, unlike the Pink, was not confined to a gully. By 1886, the White Terrace extended south, and its extension was called the Red Terrace. Final pre-eruption photography shows the ridge separating the White Terrace from Ngāhutu spring was fretting, and had the 1886 eruption not occurred, Ngāhutu and White Terrace may have become a binary attraction.

Drawing on Smith and Harding's report data, cartography, photography and eyewitnesses, this study shows how pareidolia (perceptual bias) fused with institutional authority to create a durable orthodoxy. Strikingly, the official 1886 reports were not prepared by volcanologists, nor even by geologists in any formal sense, but by a surveyor, assisted by a chemist.

The 2011–2014 Woods Hole Oceanographic Institute (WHOI)-GNS investigations treated the Pink and White Terraces as a marine detection problem, led by oceanographers using seabed-imaging tools, rather than as a historical survey and geomorphological problem, resulting in a technically impressive but epistemically misframed and publicly funded exercise.

Scientific vision, once anchored, can become blind to contradiction. By contrast, the Hochstetter paradigm, from 2016, was constructed on the only pre-eruption

terrestrial survey, strengthened with LiDAR, seismic, altimetric and topographic analysis; spatial and photogrammetric optic analyses and mātauranga Māori [17].

## 5. Conclusions

Of the five maps Smith produced between 1858 and 1894, the most important omitted the White Terrace. His preliminary 1886 report has a different location from Harding's 1887 map, which in turn contradicts Smith's 1887 report. In 1894, Smith's third location misdirected later investigators. His 1910 stream disclosure is impossible to verify, as the crater lake submerged the stream. Smith almost certainly erred due to pareidolia. Why he failed to report his mistakes is unclear. It is relevant that his later work is challenged for fabrication [56]. Smith's possible motive was that he realised the tourism trade had ended (whether or not the Terraces survived), and announced their loss to move tourists to other geothermal features at Orakei Kōrako.

Despite Smith sketching Lake Rotomahana in 1858, his 13 June 1886 location for the White Terrace was speculative. His 14 June claim was specific. He clearly mistook the new high ground at Star Hill for the Steaming Ranges. This was probably due to sighting the western pair of Star Hill spurs. He assumed the White Terrace lay between them. When he returned, he realised his error and hid it. Perhaps, he wished to avoid being sanctioned by parliament, although he had to defend this accusation in 1887.

Smith established the negative primacy of his account through his parliamentary reports. This not only misled decision-makers at the time but also shaped the historiography of the Pink and White Terraces, embedding misconceptions that persisted in scholarly and public understanding for over a century. Twenty-first-century marine investigators with an undeclared agenda to find the Terraces in the lake quickly photographed the rocky lake bottom and declared an enhanced image to be the Pink Terrace [5,6]. A White Terrace claim followed, based upon enhanced sonar. No samples or coordinates were produced.

A mystery is solved by the "T" cipher in Smith's 1886 watercolour map. Harding placed his White Terrace spring on it. This is unlikely to be a coincidence. The "T" is a letter, not an unfinished hachure or a plus sign. "T" is an Admiralty symbol for a lake bottom composed of tufa. At that time, tufa was confused with tuff. It represented siliceous sinter. Smith very likely used the "T" symbol for the sinter deposit of the White Terrace. It could also be Smith's shorthand for Terrace or Tarata. All of the above—signposts that, by August 1886, Smith was no longer confident he had located the Terrace at Star Hill. The "T" was unknown before this research. It suggests the "T" was a cipher. It bridges his June 1886 Star Hill location for the White Terrace spring with his July 1887 migration of it to the Steaming Ranges. It is unlikely to represent the stream Smith disclosed in 1910 as his only evidence for the White Terrace location. Oddly, he never marked that stream on a map. The "T" helps explain how Smith migrated his Tarata Spring, creating confusion perhaps to avoid scrutiny.

In 1887, when he tendered his main report to parliament, he knew ministers were sceptical and that Hutton, Brown and Thomas were preparing reports. Brown resigned, and Hutton and Thomas reported separately. Smith was aware that Payton was publishing a book and would, along with Warbrick, be sceptical. He was probably

aware they lobbied Thomas at Rotomahana, and Thomas sympathised with their view [1]. However, Thomas depended on the Survey Office for maps and data and was compromised. Smith was open to assisting the academics, while McKerrow was not [16]. This politicking impacted the 1886–1893 map-making. It explains the Survey Office authorship of Harding's maps, emphasising that the map was not by Thomas; four Survey Office authors are named "with additions by Professor A. P. Thomas". It helps explain the insertion of Harding's lake sketch, which prevented Thomas from inserting Warbrick's location. Thomas avoided this in his report. In 1894, Smith developed a third location for the White Terrace. None of the three agrees with Hochstetter's survey location.

Smith omitted photography, which would have enhanced his reports. Instead, he drew sketches, though photographer Spencer was at the crater. Smith's 1887 report included many inferior sketches that his office initially rejected. In 1893, he returned to Rotomahana, and his brother Frank exposed "a splendid view of the scene ... " [31].

Today, we can have little confidence in Smith's three White Terrace locations. Until 2016, when the first pre-eruption Rotomahana survey was published, workers relied on him under the Smith-Keam paradigm [25]. Today, that paradigm is untenable [1,2,24]. No investigator supports Smith's Star Hill position. Some public sector researchers followed his third position into a spurious correlation [1,5,6,24]. Smith wrote the official record as if he had one evidence-based location for the White Terrace rather than three guesses.

From the "T" cipher, the various claims, Harding's role and the negative evidence in the blue 1886 map and the stream evidence, we may conclude that Smith misrepresented his claim of the White Terrace at Star Hill over August 1886–June 1887. His second location was covert, and his third lacked evidence. Smith's stream enters the record not as science, but as reminiscence — too late to test, too vague to verify.

No new Terrace surveying has been published since 2024 [1–3,25,57]. Hochstetter's survey places the White Terrace under the isthmus, not beneath the lake. LiDAR shows high ground there with low vegetation and high reflectance, consistent with shallow ash cover over a terrace. LiDAR accentuates deep drainage channels over the true Kaiwaka entry, connecting into the lower Kaiwaka Channel on its pre-eruption course. The new lake overflow, confused by Smith with the Kaiwaka, is a shallow rill with no underlying channel [25].

Pareidolia can afflict any investigator seeking a lost wonder of the world. The best defence is forensic triangulation of terrestrial survey, cartographic, photographic and geomorphological evidence, to prove a reproducible consilience, with independent datasets converging on a single spatial solution for the White Terrace site. Hochstetter's survey is the *sine qua non* of consilience. It remains of vital public interest that this lost "Wonder of the World" be properly understood: that Smith and Harding's pareidolia be recognised, that the primacy of Smith's accounts be set aside, and that topographic research be finalised so that any imaging, drilling, or excavation may be considered under the tino rangatiratanga of the traditional landowners.

This paper argues that the principal source of long-standing misinterpretation at the Rotomahana Basin lies not only in the field surveys themselves, but in the later delineation process, where cartographic pattern completion transformed uncertain

observations into apparently objective geometries that then guided subsequent perception and belief through confirmation bias.

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