Visions of Volcanoes

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Introduction

Since antiquity, volcanoes have been associated with fire, heat, and sulphur, or linked to fiery places — the burning hearth, the blacksmith's forge, or the underworld. Travellers returned from distant shores with tales of burning mountains, and the epithet stuck. In his dictionary of 1799, Samuel Johnson defined a volcano as 'a burning mountain that emits flames, stones, &c', and fire as 'that which has the power of burning, flame, light, lustre'.[1] 'Fire mountains' are found around the world, from Fogo (the Azores and Cape Verde Islands) to Fuego (Guatemala, Mexico, and the Canary Islands) and Gunung Api (multiple volcanoes in Indonesia).

Similar analogies with fire pervade the technical language of volcanology. Rocks associated with volcanoes are *igneous* rocks; the fragmental deposits of past volcanic eruptions are *pyroclastic* rocks; the dark gravel-sized fragments ejected during eruptions are often called cinders, and the finest grain sizes of ejecta are called ash. Specific styles of volcanic activity likewise attract fiery names: from the 'fire fountains' that light up the most vigorous eruptions of Kilauea, on Hawaii, to the *nuées ardentes* that laid waste to the town of St Pierre in Martinique in 1902. However, as became clear to nineteenth-century observers, the action of eruption is not usually associated with combustion: the materials ejected from volcanoes are not usually burning, but glow red or orange because they are hot, and it is this radiant heat that provides the illumination during eruptions.

The nineteenth century marked an important transition in the understanding of the nature of combustion and fire, and of volcanoes and the interior of the earth.[2] The early part of the century was also a period when

[1] Samuel Johnson, *Johnson's Dictionary of the English Language, in Miniature*, 11th edn (London: Longman and Rees, 1799), pp. 237, 86.

[2] See also Martin Rudwick, *Worlds Before Adam: The Reconstruction of Geohistory in the Age of Reform* (Chicago: University of Chicago Press, 2008); Haraldur Sigurdsson, *Melting the Earth: The History of Ideas on Volcanic Eruptions* (Oxford: Oxford University Press, 1999); Davis A. Young, *Mind over Magma: The Story of Igneous Petrology* (Princeton: Princeton University Press, 2003); selected papers in *Volcanoes and History*, ed. by Nicoletta Morello (Genoa: Brigati, 1998).

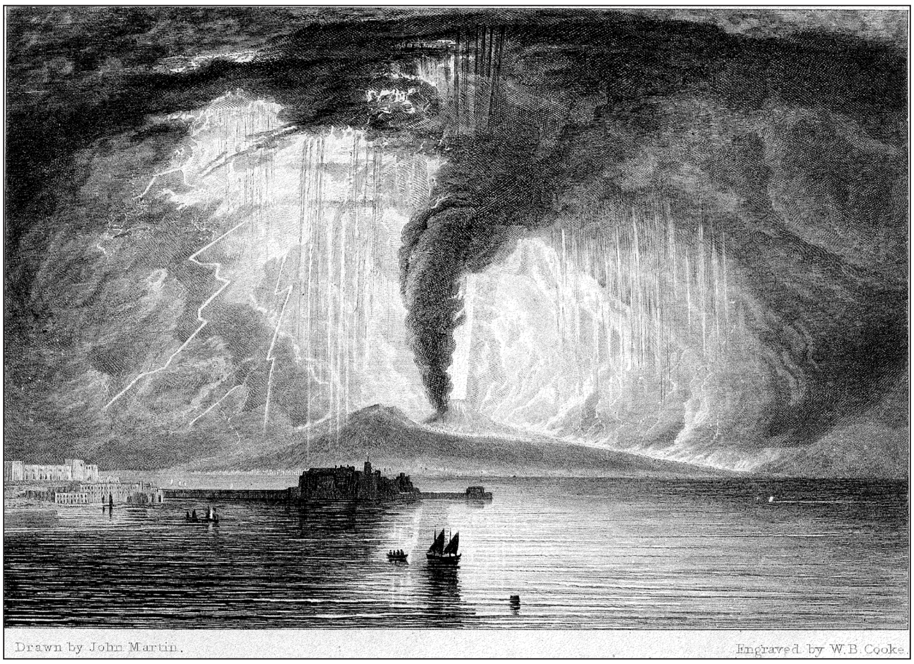

Fig. 1: John Martin, Eruption of Vesuvius from the sea, engraved by W. B. Cooke. *Pompeii, Illustrated with Picturesque Views*, 2 vols (London: Cooke, 1827), I, 25. This image of the violent 1822 eruption of Vesuvius was considered to capture the pine tree shape of the volcanic plume described in Pliny the Younger's letters of the AD 79 eruption.

dramatic eruptions of Vesuvius lit up the night skies of Naples on many occasions (*Fig. 1*). Like a beacon, Vesuvius drew eager travellers, inquisitive natural philosophers, and early geologists to visit and get up close to the glowing lavas of an active volcano. Vesuvius, the 'often-used volcano', was celebrated in literature and poetry,[3] and was a stimulus to generations of artists who had a ready market for vividly coloured images of an erupting volcano under a moonlit sky. By the end of the long nineteenth century, the scientific field of geology had become well established, and contemporary understanding of the behaviour of volcanoes and the nature of their products had moved away from the idea of combustion playing any role in the formation of volcanic rocks. Nonetheless, the use of fire as an analogy remained — and remains — deep-seated and pervades the formal and informal language of the science.

[3] Lord Byron, *Don Juan* (Halifax: Milner and Sowerby, 1837), XIII. 36. 286. Byron refers to 'the tired metaphor' of volcanoes (l. 285), but never visited Vesuvius.

This article explores written and visual representations of volcanoes and volcanic activity in the long nineteenth century, with the particular perspective of writers from the non-volcanic regions of northern Europe. I show how the language of fire was used in both first-hand and fictionalized accounts of people's interactions with volcanoes and experiences of volcanic phenomena, and how the routine and often implicit linkage of 'fire' with 'combustion', as an explanation for the deep forces at play within and beneath volcanoes, slowly changed as the formal scientific study of volcanoes developed. We will see how Vesuvius was used as a model volcano in science and literature and how, later, following devastating eruptions in Indonesia and the Caribbean, volcanoes took on a new dimension as contemporary agents of death and destruction.

Understanding volcanoes

There are no geologically young or active volcanoes within the British Isles, and the volcanic fields in France, Germany, and Spain have lain dormant for thousands of years.[4] But volcanoes and their nature would have been well known to northern European readers. Those familiar with the classical world of Italy would have heard tales of Etna and Vesuvius, and of the ancient cities of Pompeii and Herculaneum, entombed in volcanic debris in AD 79, and rediscovered in the mid-eighteenth century. On Sicily, the sprawling mountain of Etna loomed tall, but was off the beaten track. Its reputation was secured in 1669 when a 'torrent of fire' rolled past the walled city of Catania, 'pouring its flames into the ocean'.[5] In contrast, Vesuvius was in many respects a toy volcano, puny in comparison to the snow-capped volcanoes of the Andes, or the magnificent peaks of Tenerife or Hawaii. In Charles Daubeny's tableau of the 'burning mountains', the double-peaked Vesuvius lies in the foreground, dwarfed by most of the other active volcanoes of the world (*Fig. 2*). But Vesuvius was accessible, and produced the perfect eruptions for researchers and tourists alike, 'not so small as to be contemptible not so great as to be unapproachable'.[6] Here, for just a little effort, tourists could ascend the heights of these burning mountains, and share in the visions of the abyss.

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[4] See, for example, Charles Daubeny, *A Description of Active and Extinct Volcanos* (London: Phillips and Parker, 1826); Dougal Jerram, Alwyn Scarth, and Jean-Claude Tanguy, *Volcanoes of Europe,* 2nd edn (Harpenden: Terra, 2017).
[5] P. Brydone, *A Tour Through Sicily and Malta: In a Series of Letters to William Beckford, Esq. of Somerly in Suffolk*, 2 vols (London: Strahan and Cadell, 1773), I, 126.
[6] Humphry Davy to Michael Faraday, 10 December 1819, in *The Correspondence of Michael Faraday*, ed. by Frank A. J. L. James, 6 vols (London: IET, 1991–2011), I: *1811–1831* (1991), letter 108.

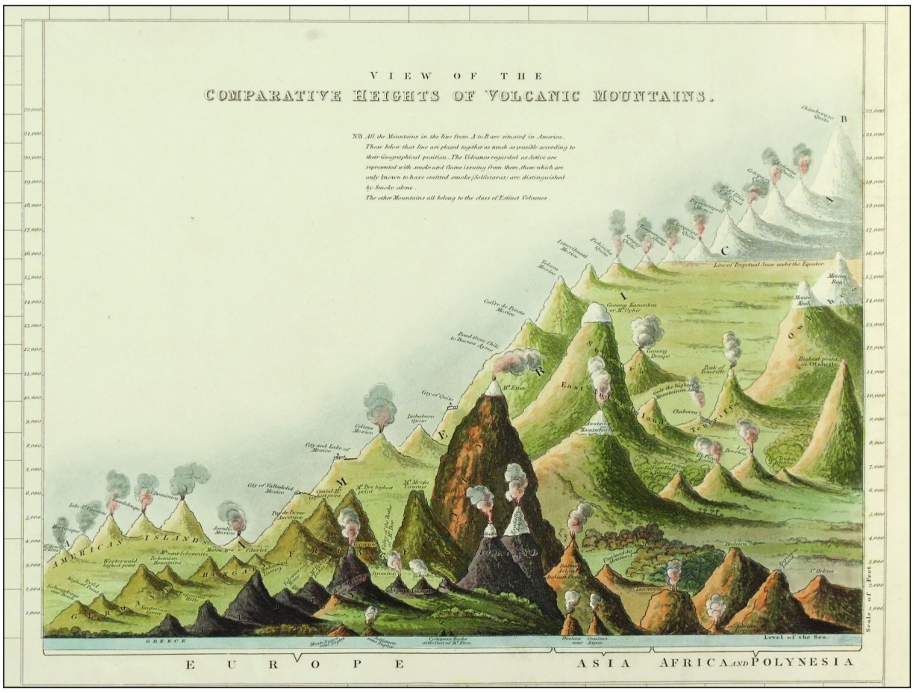

Fig. 2: View of the comparative heights of volcanic mountains, detail from Charles Daubeny, *Tabular View of Volcanic Phenomena* (London: [n. pub.], 1827). Oxford, Bodleian Library. (E) B1 (585). This shows the comparative heights of many of the world's known volcanoes, which are grouped geographically, and Daubeny distinguishes between those that were known to be active (with smoke and flames), steaming (with smoke), or extinct. Vesuvius is shown in the middle foreground.

At the beginning of the nineteenth century, much of what was known of volcanoes and their eruptions, at least in European circles, was derived from observations made on Vesuvius. By dint of its frequent eruptions and accessibility, Vesuvius was the example by which the world's volcanoes were interpreted, its conical shape exemplifying the 'most ordinary form of volcanoes'.[7] Natural historians like Alexander von Humboldt recognized that there were other landforms that were also volcanic: the craters and lava flows of the Azores; volcanic peaks which 'communicate with the atmosphere through permanent openings'; 'volcanes de agua y de fuego'

[7] Alexander von Humboldt, *Aspects of Nature, in Different Lands and Different Climates*, trans. by Mrs Sabine, 2nd edn, 2 vols (London: Murray, 1849), II, 219. For more on Humboldt, see Andrea Wulf, *The Invention of Nature: The Adventures of Alexander von Humboldt, the Lost Hero of Science* (London: Vintage, 2015). Kenneth L. Taylor argues that the focus on *particular* volcanoes rather reflected their accidental nature. See 'Before Volcanoes Became Ordinary', in *History of Geoscience*, ed. by W. Mayer and others (London: Geological Society, 2017), pp. 117–26.

(volcanoes of water and fire); and solfataras, emitting aqueous vapours, gases, and acids (II, 220, 219, 235). But at this time there was no agreed classification of volcano type or style of eruption. Scholarly treatments separated volcanoes into 'active and extinct' depending on whether they had erupted in known history or not (Daubeny, *A Description* (1826), p. 6). The links between the fiery products of erupting volcanoes and ancient crystalline rocks were not understood, and, above all, the nature and origin of light, heat, and fire, both in general and in volcanoes, was a puzzle. What were these phenomena, how did they relate, and could they explain the manifestations of volcanic activity?

Answers to some of these questions soon came from observations and experiments, and from the emerging fields of geology and chemistry. Writing in 1794, the Scottish geologist James Hutton commented that 'although the use of fire is brought to such perfection in the various arts of life, philosophers [...] have committed a mistake [...] in ascribing the appearances of burning to a cause or principle directly opposite to what is true'.[8] Hutton considered that the light released during burning was a form of matter that 'had subsisted in those bodies [...] as fixed light' (p. 229), while heat was the agent that 'may cause bodies to expand [...] lose their hardness and become fluid' (p. 10). Hutton regarded fire as one of the main agents of change on earth. In the Scottish Highlands, he saw crystalline rocks with fluidal textures, and inferred that they must once have been molten, due to 'an internal heat, a subterranean fire of a certain cause of fusion'.[9] Writing in 1802, John Playfair explained Hutton's view:

> The existence of subterraneous heat is [...] proved by phenomena [such as] hot-springs, volcanoes, and earthquakes. These [observations] leave no doubt of the existence of heat [...] in the bowels of the earth; [...] [but] at what depth [...], to what extent, and with what intensity, does it act?[10]

Earlier theories that the heat and flames in volcanoes were caused by combustion of coal, bitumen, or sulphur were hard to reconcile with the rocky nature of cooled lava.[11] Other ideas, for example that volcanoes were formed by reactions of iron, sulphur, and water inside the earth, made

[8] James Hutton, *A Dissertation upon the Philosophy of Light, Heat, and Fire* (Edinburgh: Cadell, 1794), p. 12.
[9] James Hutton, *Theory of the Earth*, 2 vols (London: Cadell and Davies, 1795), I, 239.
[10] John Playfair, *Illustrations of the Huttonian Theory of the Earth* (London: Cadell and Davies; Edinburgh: Creech, 1802), p. 91.
[11] W. E. Knowles Middleton, 'The 1669 Eruption of Mount Etna: Francesco d'Arezzo on the Vitreous Nature of Lava', *Archives of Natural History*, 11 (1982), 99–102.

good party tricks but held little credence.[12] Playfair dismissed combustion theories since they had 'no analogy to anything that is known' (p. 92).

New evidence for the intensity of the deep heat source emerged from experiments using furnaces to heat rocks.[13] Starting in 1790, the Scottish chemist James Hall began to systematically melt rocks to see what happened during cooling. He found that fast cooling produced glassy rocks, but that during slow cooling the melt would transform into a 'stony' crystalline mass, like the ancient rocks known as basalts.[14] These experiments illuminated Playfair's vision of earth's interior: the centre of the globe was a fluid melted mass, with vapour carrying heat to shallow subterranean reservoirs of 'whinstone and basaltes', or erupting as lava at the surface (Playfair, p. 95).

The distinctions between light, heat, and fire were emphasized in contemporary textbooks. In *Conversations on Chemistry* (1813), Jane Marcet explained that light was 'a real substance, immediately emanating from [...] luminous bodies', and showed how heat and light could be separated using a glass prism.[15] In Maria Hack's *Geological Sketches and Glimpses of the Ancient Earth* (1832), the protagonist Harry queries whether Hutton's 'subterraneous fire' was common to all volcanoes, or 'whether each volcano has an independent fire of its own?'. His mother replies firmly:

> I must request you not to use the word fire when you refer to Dr Hutton's theory: heat is a more correct expression. [...] Fire in the usual sense of that word, supposes fuel in the act of burning; but we have no reason for believing that there is a fire of this description in the centre of the earth.

The origin of heat was still so obscure 'that philosophers have not yet been able to ascertain the source of that produced by our parlour-fire', so how much more challenging must it be to explain what it is that 'melts the hardest rocks in the bosom of the earth?' (Hack, pp. 113–14).

[12] W. Milner, *The Young Man's Book of Amusement* (London: Milner, 1850), p. 85.
[13] Early experimentalists included Déodat de Dolomieu in France, Horace-Benedict de Saussure in Switzerland, and Lazzaro Spallanzani in Italy. See Young, pp. 46–49, 264–65; Sigurdsson, pp. 152–56.
[14] James Hall, 'Experiments on Whinstone and Lava', *Transactions of the Royal Society of Edinburgh*, 5 (1805), 43–75.
[15] Jane Marcet, *Conversations on Chemistry*, 4th edn (London: Longman, Hurst, Rees and Orme, 1813), pp. 26–27. Other authors of 'conversational' textbooks include Delvalle Varley, *Conversations on Mineralogy* (London: Longman, Hurst and Rees, 1822) and Maria Hack, *Geological Sketches and Glimpses of the Ancient Earth* (London: Harvey and Darton, 1832). For more on Marcet, see Barbara Gates, *Kindred Nature: Victorian and Edwardian Women Embrace the Living World* (Chicago: University of Chicago Press, 1998), p. 35.

Experimental chemistry soon provided another explanation for volcanic heat. In 1808 Humphry Davy discovered sodium, potassium, calcium, and magnesium. These highly reactive silvery metals were always found combined with oxygen at the earth's surface. Davy reasoned that if pure forms of these metals existed deep inside the earth, contact with air or water would cause reactions that would 'produce the effect of subterranean fire, and a product of earthy and stony matter analogous to lavas'.[16] Davy's discoveries were exciting and influential. He was well connected in emerging scientific circles in London, as a founding fellow of the Geological Society of London and secretary of the Royal Society.[17] As director of the chemical laboratory at the Royal Institution he impressed the evening crowds with a 'beautiful explanation of his theory' on volcanoes, using a volcano modelled from clay, packed with potassium metal. Adding water led to violent explosions, in which 'red-hot lava was seen flowing down its sides, from a crater in miniature — mimic lightnings played around: and [the tumult] of the audience might almost have been regarded as the shouts of the alarmed fugitives of Herculaneum or Pompeii'.[18]

Jane Marcet shared these discoveries and their wider implications with her readers. Potassium 'has so powerful an attraction for oxygen that it will absorb it [from] any body whatever that contains it'; indeed, it bursts into flame when thrown into water. If the interior of the planet 'is composed of a metallic mass, the surface of which only has been mineralised by the atmosphere', this provides an explanation for volcanic activity 'for if the bowels of the earth are the grand recesses of these new inflammable bodies, whenever water penetrates into them, combustions and explosions must take place' (Marcet, pp. 334, 342–43).

Davy had to wait some years to test his ideas on a live volcano. In May 1814 he first climbed Vesuvius with his young assistant Michael Faraday, and by the following year had made sufficient observations of the Italian volcanoes to be convinced 'in my guess as to the origin of Volcanoes from the action of Water on the metallic bases of the earth'.[19] Edward

[16] Humphry Davy, 'Electro-chemical Researches, on the Decomposition of the Earths; with Observations on the Metals Obtained from the Alkaline Earths, and on the Amalgam Procured from Ammonia', *Philosophical Transactions of the Royal Society, London*, 98 (1808), 333–70 (p. 369).
[17] David Knight, 'Chemists Get Down to Earth', in *The Making of the Geological Society of London*, ed. by C. L. E. Lewis and S. J. Knell (London: Geological Society, 2009), pp. 93–103.
[18] J. A. Paris, *The Life of Sir Humphry Davy* (London: Colburn and Bentley, 1831), p. 194; see also, Gillian Darley, *Vesuvius: The Most Famous Volcano in the World* (London: Profile, 2011), pp. 111–12. For Peter Wothers's recreation of this event, see 'Humphry Davy's Potassium Volcano', <http://thekidshouldseethis.com/post/humphry-davys-potassium-volcano> [accessed 26 October 2017].
[19] Humphry Davy to Rev. E. D. Clarke, 15 June 1815, <http://www.davy-letters.org.uk/> [accessed 26 October 2017].

Clarke, a mineralogist in Cambridge, was taken with this idea, declaring that Vesuvius 'as to its chemical nature, is, in all respects, a vast gas blow-pipe'.[20] But Davy still needed a full eruption to conduct the sternest test of his chemical theory. If lava was produced by the reactions of pure metals inside the earth, he should be able to find traces of unreacted metals in the lavas where they first erupted. In 1819 Vesuvius obliged:

> The event which I have so much longed to witness has occurred and Vesuvius has been for some days in a state of eruption. I have already made many [experiments] on the lava at the moment that it issues from the volcanoe [*sic*] and I should have completed them but for a severe indisposition owing to my having remained too long in that magnificent but dangerous situation [...] within 5 or six feet of a stream of red hot matter fluid as water [...] falling as a cataract of fire.[21]

In vain, Davy looked for evidence that the lavas might be reacting when they came into contact with air, but he found none. Eventually, he concluded that while the oxidation of metals could provide a chemical cause for volcanic fires, the evidence from mines and hot springs made it 'probable that the interior of the globe possesses a very high temperature', and the hypothesis that the centre of the globe was hot and fluid offered a simpler solution to the phenomena of volcanic fires.[22]

Alexander von Humboldt first reflected on the emerging theories of volcanoes in 1823. He had visited volcanoes in Europe and Latin America, and was interested in the large-scale workings of the earth. Humboldt was familiar with Davy's chemical theory, but was more impressed by observations that deep mines were warmer than the air outside, inferring that there must be a subterranean heat source. Humboldt saw volcanic phenomena as 'the result of a communication [...] between the interior and exterior of the globe', similar to Plato's view of 'volcanic fiery currents as streams flowing from the pyriphlegethon'.[23]

The vision of volcanoes arising from the movement of heat from earth's interior gradually became the consensus view, primarily due to the lack of evidence for the alternative.[24] However, arguments about the nature

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[20] 'The Gas Blow Pipe, or Art of Fusion', *Quarterly Review*, July 1820, pp. 466–73 (p. 470).
[21] *Correspondence of Michael Faraday*, ed. by James, I, letter 108.
[22] Humphry Davy, 'On the Phaenomena of Volcanoes', *Philosophical Transactions of the Royal Society of London*, 118 (1828), 241–50 (p. 250).
[23] Humboldt, II, 238. Humboldt's essay 'On the Structure and Mode of Action of Volcanos' was presented to the Academy of Berlin in 1823, and published in French in *Tableaux de la Nature* in 1828.
[24] Another proponent of the 'hot fluid nucleus' and the movements of hot rock and gas as a cause for volcanoes was George Poulett Scrope, *Considerations on*

of the earth's depths, and its heat, continued long after the end of the nineteenth century. The development of plate tectonic theory in the 1960s eventually set up a new framework for understanding the links between the convective motions of earth's cooling interior, deep circulation of seawater, and surface expressions of volcanism.[25]

Vesuvius, the fiery volcano

In Continental Europe, eruptions of Vesuvius formed a vivid backdrop for travellers, writers, and artists of the late eighteenth and early nineteenth centuries. In Britain, tales of modern and ancient eruptions of both Vesuvius and Etna were well known and celebrated in firework displays and theatrical extravaganzas.[26] William Hamilton's fabulously illustrated descriptions of the minutiae of eruptions of Vesuvius were published in 1776,[27] and vivid paintings representing or imagining eruptions of Vesuvius — inspired by contemporary ideas on the sublime — would have been familiar sights in country houses and galleries.[28]

Vesuvius was an accessible mountaintop, offering a commanding view of the Bay of Naples and an opportunity to peer into the abyss.[29] 'With what delight does the eye turn from the contemplation of the fearful and yawning crater, to dwell on the glowing picture seen from the summit

Volcanos (London: Phillips, 1825). Oxford chemist Charles Daubeny was a proponent of Davy's chemical theory, but had largely abandoned it by 1848 when he published the second edition of his treatise, *A Description of Active and Extinct Volcanos* (London: Taylor, 1848). Later textbooks regarded the chemical theory as largely unproven. See, for example, John W. Judd, *Volcanoes: What They Are and What They Teach* (London: Kegan, Paul, Trench, 1881).

[25] See, for example, Sigurdsson, pp. 221–29.

[26] Some examples: Giovanni Battista Torré's firework representations of Vesuvius and Etna in the Marylebone Pleasure Gardens; Charles Dibdin's smoking volcanoes at Sadler's Wells. See Simon Werrett, *Fireworks: Pyrotechnic Arts and Sciences in European History* (Chicago: University of Chicago Press, 2010), p. 215; Jane Moody, *Illegitimate Theatre in London, 1770–1840* (Cambridge: Cambridge University Press, 2000), p. 93.

[27] William Hamilton, *Campi Phlegraei: Observations on the Volcanoes of the Two Sicilies* (Naples: [n. pub.], 1776); William Hamilton, *Supplement to the Campi Phlegraei* (Naples: [n. pub.], 1779).

[28] Painters of Vesuvius included Pierre-Jacques Volaire, Jacob Philipp Hackert, Joseph Franque, Joseph Wright of Derby, Xavier della Gatta, and Giovanni Battista Lusieri. See James Hamilton, *Volcano* (London: Reaktion, 2012), pp. 69–104; Silvia Cassani, *In the Shadow of Vesuvius: Views of Naples from Baroque to Romanticism, 1631–1830* (Naples: Electa Napoli, 1990).

[29] Accessible in contrast with the Alps, for example. See Cian Duffy, *The Landscapes of the Sublime, 1700–1830: Classic Ground* (London: Palgrave Macmillan, 2013), p. 69.

of Vesuvius!'.[30] All that was required was 'a stout stick and a pair of boots'.[31] Consequently, the path to Vesuvius was well trodden, and captured in tales of breathless ascents to the summit plain, and the first-hand experiences of 'flame or smoke [and] red-hot lava'.[32]

After reawakening in 1631, Vesuvius erupted 'obligingly frequently',[33] and had the 'grand merit', compared to 'a hundred others of the same fiery family', of its position in 'the most showy spot of all Europe', standing 'like one of the fire palaces of the Arabian tales, in the midst of royal pomp and natural loveliness'.[34] As well its majestic profile, it was the only volcano that remained 'unextinguished upon the continent of Europe'.[35] The thrill of the 'horror of the scene' was the draw of the subterranean fires and the 'flames and conflagrations' of the latest eruption.[36] But although the 'frightful depth of the crater […] and the steep side of the Mountain' left many a visitor feeling in 'peril of our lives',[37] Vesuvius was, for the most part, an ideal attraction, often in eruption, but rarely threatening to life or property. It provided inspiration for writers, artists, and scientists: from tales of falling through a cavern of fire and sulphur into an underworld utopia,[38] to artistic depictions of the sublime power of eruptions, and from romanticized, illustrated tales of volcanic calamity to scientific treatises on volcanoes (*Fig. 3*).[39]

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[30] The Countess of Blessington, *The Idler in Italy*, 2nd edn, 2 vols (London: Colburn, 1839), II, 204 (written 1823).
[31] Mariana Starke, *Letters from Italy Between the Years 1792 and 1798, Containing a View of the Revolutions in That Country*, 2 vols (London: Phillips, 1800), II, 131.
[32] Jane Waldie, *Sketches Descriptive of Italy in the Years 1816 and 1817, with a Brief Account of Travels in Various Parts of France and Switzerland in the Same Years*, 4 vols (London: Murray, 1820), III, 166.
[33] Roy Porter, *The Making of Geology: Earth Science in Britain, 1660–1815* (Cambridge: Cambridge University Press, 1997), p. 123. For elegant discussions of the history of Vesuvius and its wider cultural influences, see Alwyn Scarth, *Vesuvius: A Biography* (Harpenden: Terra, 2009); Darley, *Vesuvius*; Sean Cocco, *Watching Vesuvius: A History of Science and Culture in Early Modern Italy* (Chicago: University of Chicago Press, 2013).
[34] Theodore Hook, 'Notes on Naples', *New Monthly Magazine and Humorist* (London: Colburn, 1838), pp. 279–81 (p. 280).
[35] H. W. B., 'Leaves from the Journal of Traveller', *Metropolitan Magazine*, October 1837, pp. 147–57 (p. 147).
[36] 'Mount Vesuvius', *The Times*, 18 October 1810, p. 3.
[37] Catherine Wilmot, *An Irish Peer on the Continent (1801–1803)*, ed. by Thomas U. Sadleir (London: Williams and Norgate, 1920), p. 150.
[38] *Bruce's Voyage to Naples, and Journey up Mount Vesuvius* (London: Fisher, 1802).
[39] An example of a romantic tale is Alcmaeon, 'Il Vesuviano: A Neapolitan Tale', *Friendship's Offering*, 1830, pp. 20–29. This featured an illustration of Vesuvius engraved by Jeavons, from a painting by J. M. W. Turner. As for scientific treatises, both George Poulett Scrope and Charles Daubeny were moved to write their books on volcanoes following visits to Vesuvius.

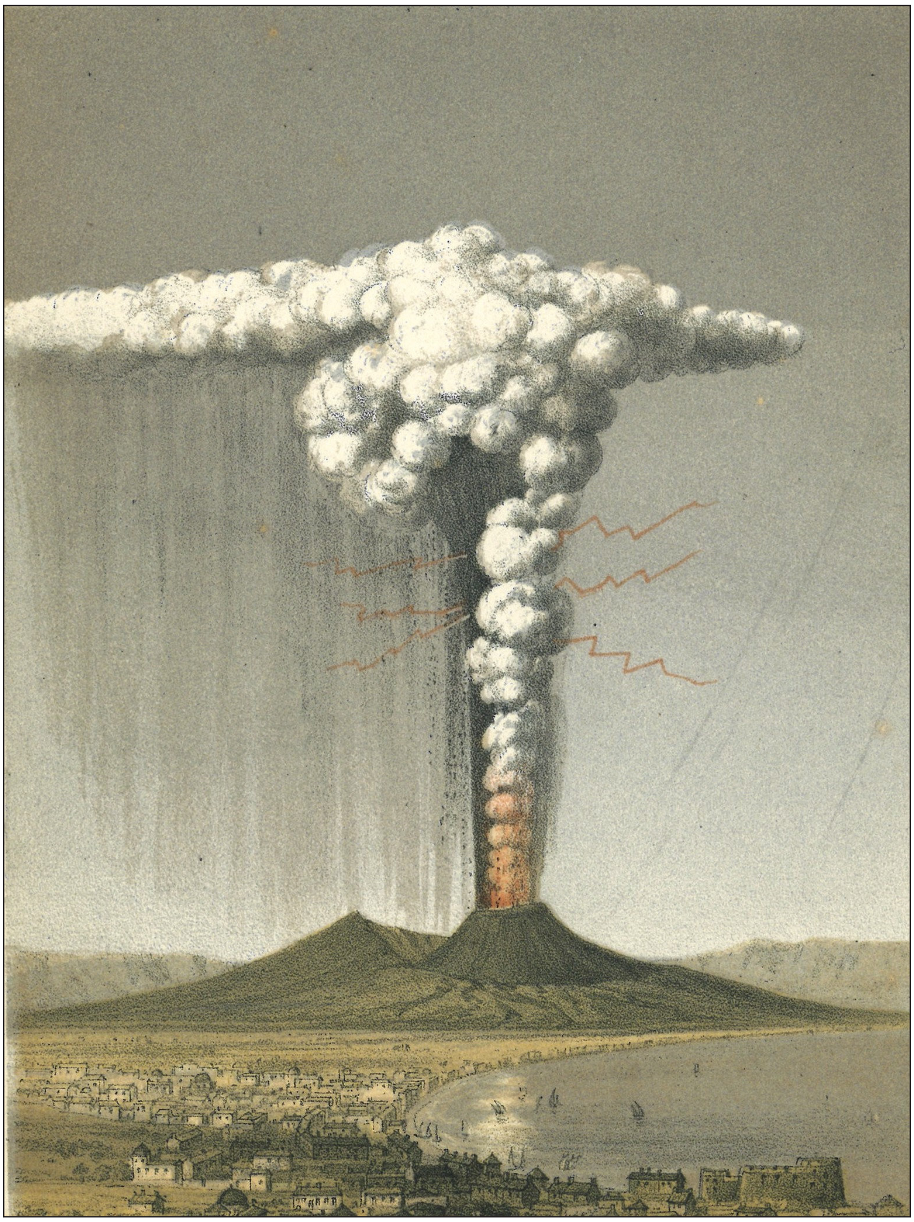

Fig. 3: Vesuvius in eruption, October 1822. George Poulett Scrope, *Considerations on Volcanoes*, 2nd edn (1864), frontispiece.

Few accounts, though, captured the effects of the most violent eruptions. One rare example that did was that of Mariana Starke. She visited Torre del Greco, at the foot of Vesuvius, in 1797. The town had been destroyed in the eruption of 1794, and her account was based on published eyewitness reports. Leading up to the eruption 'Vesuvius had for some time ceased to vomit fire and smoke as usual; a circumstance that generally presages mischief' (II, 131–32). This, and a series of earthquakes, gave sufficient warning for the town to be evacuated. At the climax of the eruption, a column of ash rose high

> into the shape of an immense pine [...] till at length it began to incline downwards, when, from the quantity of dense matter which composed the column [...] [it] fell to the ground. Torrents of flaming lava of an awefully portentous magnitude now poured down the mountain. (II, 133–34)

In common with many accounts of Vesuvius's explosive eruptions, Starke's description references Pliny the Younger's accounts of the pine tree-shaped eruption cloud in AD 79, while her account of the collapse of the ash column may be a description of a ground-hugging hot avalanche of ash.[40]

Some of the most evocative descriptions of an eruption of lava are found in Germaine de Staël's *Corinna*, published in 1807. This fictionalized narrative includes an account of an ascent to the summit crater by a melancholy British peer, Oswald, and a poet, Corinna.[41] The precision of the writing leaves little doubt that this description was born from first-hand experience:

> The lava itself has that dingy appearance which the poets assign to the rivers of the infernal regions; it rolls on slowly like a stream of sand, blackish by day and red by night. As it approaches you hear a kind of crackling sound, which occasions the greatest fear as it is indistinct. [...] Its resplendency is so intense, that for the first time the earth illuminates the sky, and gives it the appearance of continued lightning; the sky, in its turn reflects this lustre upon the water, and thus nature seems to be set in flames by this three-fold image of fire.[42]

Later writers struggled to add much that was new to the descriptions of the visual and sensory impacts of a visit to Vesuvius. Nonetheless many accounts capture a picture of the state of the volcano at the time of the visit, and a sense of the author's own perceptions and expectations of the wonder or horror that awaited them.

Vesuvius made a great impression on Percy Bysshe Shelley. In 1818 he took the usual route to the summit — by carriage and then mule to the Old

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[40] Pliny the Younger, *Letters, Volume 1: Books 1–7*, trans. by Betty Radice, Loeb Classical Library, 55 (Cambridge, MA: Harvard University Press, 1969), VI. 16. 427; David M. Pyle, *Volcanoes: Encounters through the Ages* (Oxford: Bodleian Publishing, 2017), pp. 77–79.

[41] Erik Simpson, 'On Corinne, or Italy', *BRANCH: Britain, Representation and Nineteenth-Century History*, ed. by Dino Franco Felluga <http://www.branchcollective.org/?ps_articles=erik-simpson-on-corinne-or-italy> [accessed 26 October 2017].

[42] Mad. de Stael Holstein, *Corinna; or, Italy*, 3 vols (London: Tipper, 1807), II, 299–300.

Hermitage; thence on foot. His reference point for the wonder of Vesuvius was the Alps. After the glaciers, the 'vast stream of hardened lava […] once a sea of liquid fire' was all in all the 'most impressive exhibition of the energies of nature I ever saw'. By night

> the effect of the fire became more beautiful. We were […] surrounded by streams and cataracts of the red and radiant fire; and in the midst, from the column of bituminous smoke shot up into the air, fell the vast masses of rock, white with the light of their intense heat, leaving behind them […] vapour trains of splendour.[43]

Vesuvius's frequent conflagrations often brought mention in the press, particularly in the illustrated newspapers that flourished in the middle of the nineteenth century.[44] The great eruption of October 1822 was still in the news when Byron began writing *The Age of Bronze* that December. He imagined the burning of Moscow during the Napoleonic wars as

> The Sublimest of Volcanoes! Etna's flame
> Pales before thine and quenchless Hecla's tame;
> Vesuvius shows his blaze, an usual sight
> For gaping tourists, from his hackneyed height.[45]

Letters capture the waxing and waning of the unsteady but continuing activity of Vesuvius through the mid-1800s. John Ruskin visited in the winter of 1841 when the volcano was 'practically in repose', but the lava of 1839 was still 'red hot to the eye in daytime', and able both to set wood on fire and roast eggs.[46] Charles Dickens recounted his struggle up the mountain in a letter to his friend Thomas Mitton in 1845. The vent inside the summit crater had grown 'a hundred feet higher' in just six weeks. Dickens and his entourage set off in the early evening, climbing through snow until they reached the cone from which 'fire was pouring out, reddening the night with flames, blackening it with smoke, and spotting it with red-hot stones and cinders'. Scrambling to the top, Dickens 'looked down into the flaming bowels of the mountain and came back again, alight in half-a-dozen places, and burnt from head to foot'.[47]

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[43] Percy Bysshe Shelley to Thomas Love Peacock, 22 December 1818, in *The Letters of Percy Bysshe Shelley*, ed. by Roger Ingpen, 2 vols (London: Pitman, 1909), II, 656–57.
[44] The *Illustrated London News*, the first weekly illustrated newspaper, launched in 1842 and featured many images of Vesuvius, Etna, and other volcanoes in eruption.
[45] Lord Byron, *The Age of Bronze; or, Carmen Seculare et Annus Haud Mirabilis* ([n.p.]: University of Adelaide, 2016), ll. 179–82. Ebook.
[46] John Ruskin, *Studies in Both Arts* (London: Allen, 1895), p. 42.
[47] Charles Dickens to Thomas Mitton, 17 February 1845, in *The Letters of Charles Dickens*, ed. by Mamie Dickens and Georgina Hogarth, 2nd edn, 2 vols (London: Chapman and Hall, 1880), I: *1833–1856*, 136–41 (pp. 139, 138, 139).

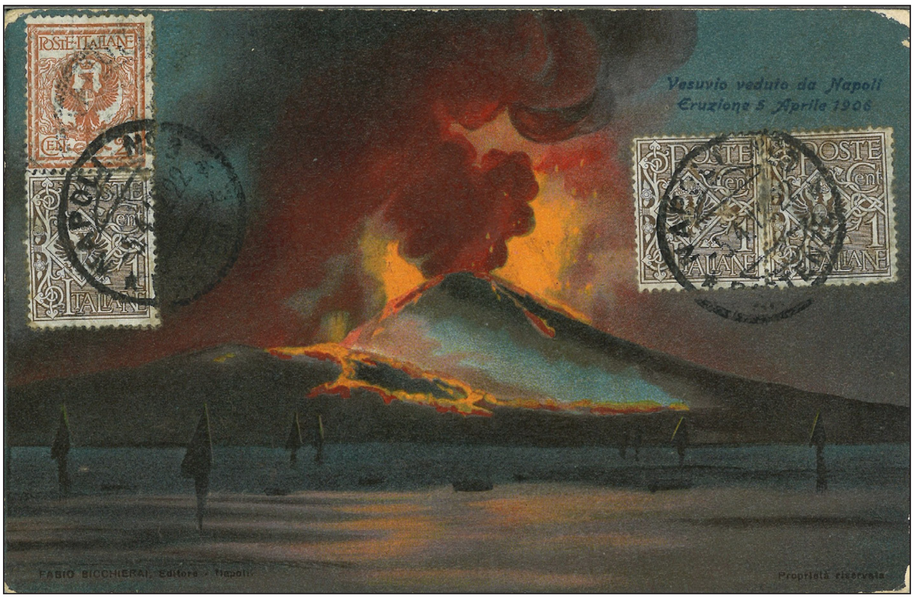

Fig. 4: Naples, illustrating the violent Vesuvius eruption of April 1906. Contemporary coloured postcard, Fabio Bicchierai.

One response of visitors to Vesuvius during periods of calm was to suppose that earlier reports had been exaggerated. Henry Armfield, vice principal of the Theological College in Salisbury, noted in 1868 that 'the old pictures in the scrapbooks that show Vesuvius represented by a triangle of black with an equal triangle of red nearly balanced on top of it, apex to apex, are [...] creations of the purest fiction'.[48] He too recommended arriving in the crater at nightfall to see it at its best, lit up with colour from 'the deep brick-red of the stones that have been under the action of fire, the brightest vermillion and every imaginable shade of orange and yellow' (Armfield, p. 18). Despite accounts that played down the spectacle of the fiery summit, the draw of Vesuvius for tourists led to the building of a railway up the volcano in 1880. This event was celebrated in the song 'Funiculì, Funiculà'. The railway was short-lived, however, and destroyed when the cycle of eruptive activity at Vesuvius reached another climax in 1906 (*Fig. 4*).

In England, people could also enjoy the celebrated views of Vesuvius. In Leicester Square, Robert Burford created a rotunda, within which he painted a panorama of the moonlit Bay of Naples with an eruption of

[48] Henry Armfield, *At the Crater of Vesuvius in Eruption: A Word-Picture* (Salisbury: Brown, 1872), p. 5.

Mount Vesuvius, forming an immersive spectacle. The *Spectator* declared it to be magnificent Christmas entertainment and an extraordinary *coup d'œil*. 'The sky is dark, the stars shine brightly [...] and the Castel dell' Uovo reflects a glare in which moonlight and the lurid brilliancy of fire are blended.' The source of the fire is, of course, Vesuvius, illuminating 'the heavens with coruscations of flame and jets of red-hot stones'.[49]

While Vesuvius was important, it was not the only volcanic destination for travellers. In the second half of the nineteenth century, postal steamers helped to open routes for intrepid travellers eager to visit the volcanoes of Hawaii, including Kilauea, one of the most active volcanoes on earth. Kilauea was familiar from the accounts of earlier expeditions,[50] with lurid descriptions of its fiery summit crater 'surpassing in beauty and sublimity all that the ingenuity of art ever devised', incandescent flows of lava 'rolling in splendid coruscation among the labouring craters' and a magnificent lava lake.[51] In the 1870s Isabella Bird and Constance Gordon Cumming each visited Hawaii, and recorded their experiences in letters and sketches, which were gathered later for publication. In 1873 Bird described the activity of the summit crater of Halemaumau as the 'conflagration of a metropolis'.[52] In 1879 Gordon Cumming wrote that at night she could see a 'glowing cloud rising from the fire-lake [...] like red hot cinders', but after crossing a 'billowy ocean' of 'lava-waves' she reached the lake of fire to find that 'THERE WAS NONE'.[53] A later ascent eventually rewarded her with a dramatic view of 'a perfect network of rivers of molten rock [...] meandering at their own wild will over the bed of the great crater' (I, 190) (*Fig. 5*).

By the end of the nineteenth century, smouldering volcanoes around the world were magnets for tourists and travellers and the backdrop for tales of adventure, from the volcanic islands of the Lesser Antilles to the great volcanoes of the Andes, or the remote volcanoes of Asia.[54] This travel writing celebrated the landscapes, landforms, and stories of

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49 'Christmas Entertainments', *Littell's Living Age*, January–March 1845, pp. 402–03 (p. 402); cf. Robert Burford, *Description of a View of the City and Bay of Naples, by Moonlight, with an Eruption of Mount Vesuvius* (London: Brettell, 1845).

50 Maria Graham, *Voyage of HMS Blonde to the Sandwich Islands in the Years 1824–1825* (London: Murray, 1826).

51 C. S. Stewart, *Journal of a Residence in the Sandwich Islands, During the Years 1823, 1824, and 1825* (London: Fisher and Jackson, 1828), p. 377.

52 Isabella Bird, *Six Months among the Palm Groves, Coral Reefs, and Volcanoes of the Sandwich Islands*, 3rd edn (London: Murray, 1880), pp. 251–57.

53 C. F. Gordon Cumming, *Fire Fountains: The Kingdom of Hawaii, Its Volcanoes, and the History of Its Missions*, 2 vols (Edinburgh: Blackwood, 1883), I, 143, 156, 157, 165.

54 Some examples: Edward Whymper, *Travels amongst the Great Andes of the Equator* (London: Murray, 1892); Charles Kingsley, *At Last: A Christmas in the West Indies* (London: Macmillan, 1872); Henry E. M. James, *The Long White Mountain; or, A Journey in Manchuria* (London: Longmans, Green, 1888).

Fig. 5: Constance Gordon Cumming, painting of the 'overflow of the new lake of fire in the crater of Kilauea', based on sketches made in the field. Constance Gordon Cumming, *Fire Fountains*, 2 vols (Edinburgh: Blackwood, 1883), frontispiece.

these journeys. The systematic treatment of volcanoes was now the domain of the professional, whose public writings included measured 'exposition[s] of the present condition of our knowledge' of the 'living volcano'.[55]

Vesuvius as a centre for volcanology

Throughout the nineteenth century, Vesuvius was an outdoor laboratory for natural scientists. Visits to the erupting volcano and its extraordinarily varied mineral occurrences provided formative experiences for many, and fed such a quantity of books and papers that by 1903 the bibliography filled a report 'of 340 quarto pages'.[56] Vesuvius also provided a rare opportunity in the search for flames. Geologist Leopoldo Pilla was intrigued by the

[55] Judd, *Volcanoes*, p. vii; Thomas G. Bonney, *Volcanoes: Their Structure and Significance* (London: Murray, 1899), p. v. Bonney was professor of geology at University College London.

[56] Tempest Anderson, *Volcanic Studies in Many Lands* (London: Murray, 1903), p. x. Albert Pelloux, 'The Minerals of Vesuvius', *American Mineralogist*, 12 (1927), 14–21, lists over 150 minerals discovered on or around Vesuvius; many formed by the interaction of volcanic heat, gas, and magma with 'country rocks' in the subsurface.

possible existence of volcanic flames.[57] In June 1833 he was in the crater of Vesuvius at night, and saw a sequence of explosions that were accompanied by 'violet-red' flames with the 'faint smell of hydrogen gas' (p. 234). On another occasion, he witnessed green flames 'produced by the chloride of copper accompanying the gaseous substances', and the smell of hydrochloric acid (p. 235). These showed that some components of volcanic gases might indeed be combustible and burn in eruptions. Pilla's work came to an untimely end when he was killed in battle at Curtatone in 1848.

Vesuvius's value as a centre for the emerging study of volcanoes grew after 1841, with the founding of the world's first volcano observatory by King Ferdinand. The second director of the observatory was Luigi Palmieri, a physicist with interests in atmospheric electricity and earthquakes. He took charge just in time for the *incendio* of 1855. That Sunday evening, as he records,

> all the country around [...] had assembled to look at the river of fire, and perhaps as much at the living stream of human beings flowing in from Naples. [The lava] was pent within the deep banks of a wide bed, and was flowing down, not like a fluid [...] but like a mountain of coke, or at times like highly gaseous coal. It split, and crackled, and sparkled, and smoked and flamed up and ever moved on in one vast compact body. Pieces detaching themselves rolled down, leaving behind a glare so fierce that I could have imagined myself at the mouth of an iron furnace; and as every mass fell down with the noise of thunder [...] the trees flamed up, and the crowds uttered shouts of admiration and regret.[58]

Other onlookers likened the dazzling cascade of lava to a 'glowing, flaming Niagara'.[59]

The British geologist John Phillips had a long-standing interest in volcanoes, and made a first visit to Naples in 1868, aiming to write an 'authentic history' of Vesuvius, illuminated with his own sketches.[60] While there, 'Vesuvius rekindled his watch-fires, and began to blaze at intervals much like an iron-furnace' (p. 122). Phillips watched carefully using a telescope — one evening from the terrace on the top of the Hotel de Russie,

[57] Leopold Pilla, 'On the Production of Flames in Volcanoes, and the Consequences that May Be Drawn Therefrom', *Edinburgh New Philosophical Journal*, 36 (1843–44), 231–36.

[58] 'Foreign Correspondence', *Athenaeum*, 2 June 1855, pp. 645–46 (p. 646). A technical account of the eruption was later published by Giovanni Guarini, Luigi Palmieri, and Arcangelo Scacchi, *Memoria sullo incendio Vesuviano del mese di maggio 1855* (Naples: Nobile, 1855).

[59] 'Vesuvius', *Crayon*, 4 July 1855, p. 10.

[60] John Phillips, *Vesuvius* (London: Macmillan, 1869), p. ix.

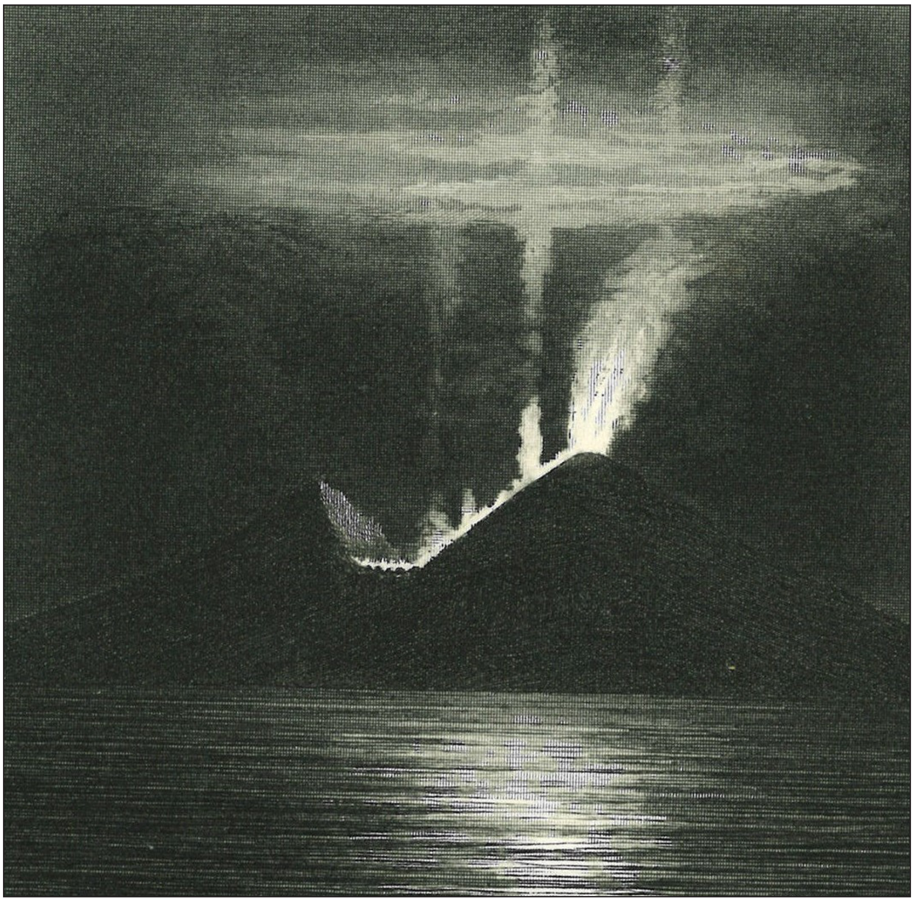

Fig. 6: John Phillips, Eruption of Vesuvius at night, March 1868. John Phillips, *Vesuvius* (London: Macmillan, 1869), plate V.

and another from Mary Somerville's apartment on the Riviera. As the sky grew dark 'the old mountain of Somma was lighted up by the fires of its younger rival, down whose side flowed, bright and red, one long straight line of liquid fire' (p. 125) (*Fig. 6*). Mary Somerville, 'the queen of science', took a keen interest in Vesuvius.[61] She speculated that the new craters which erupted in 'bursts of red-hot lapilli and red smoke' and fed a 'great stream of lava' could be linked to the 'unusually great' fall of rain during that autumn.[62] In 1872 Somerville watched as Vesuvius erupted in one of its largest outbursts of the century, an event that was captured for the first time in short exposure photographs and became a favourite repre-

[61] Obituary, *Morning Post*, 2 December 1872, p. 6; cf. Elizabeth C. Patterson, 'Mary Somerville', *British Journal for the History of Science*, 4 (1969), 311–39 (p. 311).
[62] Martha Somerville, *Personal Recollections from Early Life to Old Age of Mary Somerville* (London: Murray, 1874), pp. 340–42.

sentation of eruptions for the next thirty years.[63] From the observatory, Palmieri watched as Vesuvius 'sweated fire': 'The cone [...] seemed completely perforated, and the lava oozed as it were through its whole surface.'[64] By this time, the geologists' view of flames and fire was settled. John Phillips was clear that

> in the majority of cases it can be clearly seen that the light emanates from incandescent, but not flaming bodies. It is the light of the glowing lava [...] which makes the great column of seeming flame rushing up from Vesuvius. (p. 153)

A decade later, John Judd, professor of geology in the Royal School of Mines, and author of the textbook *Volcanoes: What They Are and What They Teach* (1881), dismissed the popular idea that 'a volcano is a burning mountain [...] which issue[s] smoke and flames' (p. 1). In his view, every element of the statement was untrue: there is no combustion, volcanoes need not be mountains, the 'smoke' is condensing steam or vapour, and the 'raging "flames" are nothing more than the glowing light of a mass of molten material reflected from these vapour clouds' (p. 2).

Now that Vesuvius lies dormant, as it has since 1944, it is perhaps difficult to fully appreciate the significance that this single mountain holds for the natural history and science of volcanoes. But in the nineteenth century Vesuvius was the most accessible erupting volcano in the world, and became a crucible for the emerging science of volcanology. The 'imprisoned energy of Fire' inspired many; and even though the flames proved to be largely illusory, the quest to understand the origins of volcanic heat, and of the forces that drive eruptions, greatly enriched our knowledge of volcanoes.[65]

Volcanoes as agents of disaster

In the early nineteenth century volcanoes were usually represented in writing and images as examples of the sublime forces of nature. Large eruptions of both Vesuvius (in 1631, 1779, and 1794) and Etna (1669) had been dramatic, though not on the scale of eruption that had buried Pompeii under metres

[63] Pyle, 77–79. The photograph of this eruption featured in textbooks by Judd (1881), Bonney (1899), and Edward Hull, *Volcanoes: Past and Present* (London: Scott, 1892).
[64] Luigi Palmieri, *The Eruption of Vesuvius in 1872* (London: Asher, 1873), p. 90.
[65] Phillips, p. x. Books or monographs on the nineteenth-century activity of Vesuvius include those by Teodoro Monticelli (1822), John Auldjo (1832), Arcangelo Scacchi (1844), Giovanni Guarini (1855), Charles Sainte-Claire Deville (1855), Charles Justus Roth (1857), James Lobley (1868), John Phillips (1869), Luigi Palmieri (1873), and Henry Johnston-Lavis (1891).

of ash in AD 79. There were no recent or contemporary reference points of great volcanic disasters to match the imagined horrors of the eruptions of classical antiquity that continued to be celebrated in graphic style in paintings and novels.[66] Indeed, it was this tension between the destroyer and the destroyed, picturesque and awful, that attracted attention and interest — as well as the human stories that survived, frozen in volcanic mud.[67]

News stories of deadly eruptions arrived in Britain in letters many weeks after the event, often warranting just a few lines in foreign news. The violent eruption of St Vincent in April 1812 made *The Times* leader column in June of that year and inspired a painting by Turner.[68] It was, however, primarily reported as an economic disaster that affected British landowners' interests, rather than in terms of the impact on the lives and livelihoods of the people who occupied those lands.[69] By the end of the nineteenth century, the global network of submarine telegraph cables opened up the era of instant news, conveyed quickly from the far-flung reaches of the world. The stories of survivors of volcanic disasters at Krakatoa, Indonesia in 1883 and on the Caribbean islands of St Vincent and Martinique in 1902, painted a sombre picture of the ravages of volcanic activity. These events also provoked the recognition of a new style of eruption, the *nuée ardente*, or burning avalanche of volcanic ash.

Edward Bulwer-Lytton's *Last Days of Pompeii* (1834) culminates with the eruption of Vesuvius and the destruction of Pompeii and Herculaneum. He took care to represent the event 'very little assisted by invention [...] and not less accurate for its appearance in a Romance', but struggled to match Pliny's descriptions of the darkness of the descending clouds that enveloped Pompeii with the lurid expectations of fire portrayed in paintings.[70] His solution was to invoke lightning, as documented by Hamilton during earlier eruptions of Vesuvius (Hamilton, *Supplement*, p. 10). As the blackness grew so 'the lightnings around Vesuvius increase[d]

[66] For example, Karl Briullov, *The Last Days of Pompeii*, 1833, oil on canvas, State Russian Museum, St Petersburg; Edward Bulwer-Lytton, *The Last Days of Pompeii* (London: Bentley, 1834). See also, David E. Alexander, 'The Portrayal of Disaster in Western Fine Art', *Environmental Hazards*, 15 (2016), 209–26.

[67] Meilee D. Bridges, '"Thou Thing of Years Departed": (En)gendering Posthumous Sublimity in Felicia Hemans's "The Image in Lava"', *Women's Studies*, 40 (2011), 429–47.

[68] Joseph Mallord William Turner, *The Eruption of the Souffrier Mountains, in the Island of St. Vincent, at Midnight, on the 30th of April, 1812, from a Sketch Taken at the Time by Hugh P. Keane, Esq*, 1815, oil on canvas, University of Liverpool Art Gallery. This was first exhibited at the Royal Academy in 1815.

[69] *Report from Committee on Petition of Persons Interested in Estates in the Island of Saint Vincent*, Parliamentary Papers of the House of Commons, Printed by Command, Cd. 182 (London: HMSO, 1813).

[70] Edward Bulwer-Lytton, *The Last Days of Pompeii* (London: Bentley, 1839), p. 419.

in their vivid and scorching glare', lighting up the whole city in colours from 'brightly blue as the most azure depth' to 'livid and snakelike green' and 'a lurid and intolerable crimson' (Bulwer-Lytton, p. 396). Towards the end of the eruption the cone split apart, bringing events to a dreadful conclusion.

Bulwer-Lytton's interpretations of the sequence of events were based on sound reasoning. The contemporary interpretation was that the cemented deposits at Pompeii had been laid down by mudflows, and Bulwer-Lytton invoked fire or hot lava to explain the charring of the papyrus scrolls recovered from Herculaneum.[71] Modern interpretations of these deposits, however, are that they were indeed searingly hot, and formed by a hot ash avalanche that spilled off the mountain at the climax of the eruption.[72]

Two extraordinary eruptions that became known to European readers of the early nineteenth century were at Tambora, Indonesia in April 1815 and Asama, Japan in 1783. The great eruption of Tambora, one of the largest of the last five hundred years, caused widespread damage and tens of thousands of deaths — facts that were only established many years later. Stamford Raffles, then governor of Java, dispatched a team to distribute emergency supplies and to find out what had happened.[73] At the culmination of the eruption, the Rajah of Saugar described how 'columns of flame burst forth' before the mountain appeared like 'a body of liquid fire extending itself in every direction'.[74] This was the moment that a hot avalanche of pumice and ash collapsed down the sides of the volcano, engulfing villages and leaving a crater in place of the mountaintop. Similar phenomena — later called *nuées ardentes* — have been responsible for many of the worst volcanic calamities known, including the burial of Pompeii and the destruction of the city of St Pierre, Martinique in 1902. Brief news of the Tambora eruption was reported in *The Times* seven months later, but it was not until

[71] Davy had earlier carried out some experiments on these scrolls, but thought they had not been burned: Humphry Davy, 'Some Observations and Experiments on the Papyri Found in the Ruins of Herculaneum', *Philosophical Transactions of the Royal Society of London*, 111 (1821), 191–208.
[72] Haraldur Sigurdsson, Stanford Cashdollar, and Stephen R. J. Sparks, 'The Eruption of Vesuvius in A.D. 79: Reconstruction from Historical and Volcanological Evidence', *American Journal of Archaeology*, 86 (1982), 39–51.
[73] For fuller accounts, see Clive Oppenheimer, *Eruptions that Shook the World* (Cambridge: Cambridge University Press, 2011); Gillen D'Arcy Wood, *Tambora*: *The Eruption that Changed the World* (Princeton: Princeton University Press, 2014).
[74] Sophia Raffles, *Memoir of the Life and Public Services of Sir Thomas Stamford Raffles* (London: Murray, 1830), p. 249.

decades later that its global impacts became apparent: this was the eruption that led to the 'year without a summer' of 1816.[75]

The dramatic tale of the devastating eruption of Asama volcano in 1783 first became known outside Japan in 1822 with the posthumous publication of Isaac Titsingh's *Illustrations of Japan*.[76] Titsingh was head of the Dutch East India Company in Japan from 1779 to 1784. While posted there he gathered information on customs, costumes, and current affairs, including the violent, explosive eruption of Asama in August 1783. Reports described how the volcano awoke with a tremendous noise as 'flames burst forth […] from the summit of the mountain, followed by a tremendous eruption of sand and stones […] every thing was enveloped in profound darkness, through which the flames alone threw at times a lurid light' (p. 97). Boulders and hot clouds of ash cascaded off the mountain, reaching villages up to ten kilometres from the volcano, reducing them to ashes by the 'ignited matter which it projected' (p. 98), and leaving a terrible human toll. The striking coloured image of the aftermath of this eruption, created by Joseph Constantine Stadler many years later, represents both the hot avalanche of ash descending from the mountainside and the conflagrations triggered by this searing ash cloud (*Fig. 7*). At Tambora and Asama the fire is both literal and figurative, combining the wood burned by the heat of the volcanic debris and the incandescence of the ejecta themselves.

A defining moment of nineteenth-century volcanology was August 1883, which saw the culmination of the eruption of Krakatoa in the Sunda Straits. The volcano came to life in May 1883, after a long repose, and reached a dramatic conclusion in late August in an explosive eruption that destroyed much of the island of Krakatoa, and killed tens of thousands of people along the coasts of Java and Sumatra. Early phases of the eruption were captured in a photograph, later redrawn and coloured, and published in the Royal Society report of the event (*Fig. 8*).[77] The Krakatoa eruption became celebrated in part because this was the first such catastrophe that played out in the news many thousands of kilometres away; and its effects — sea waves and atmospheric disturbances — were detected around the world.[78]

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[75] Henry Stommel and Elizabeth Stommel, *Volcano Weather: The Story of 1816, the Year Without a Summer* (Newport, RI: Seven Seas Press, 1983); William K. Klingaman and Nicholas P. Klingaman, *The Year Without Summer: 1816 and the Volcano that Darkened the World and Changed History* (New York: St Martin's Press, 2013).
[76] M. Titsingh, *Illustrations of Japan; Consisting of Private Memoirs and Anecdotes of the Djogouns*, trans. by Frederic Shoberl (London: Ackermann, 1822).
[77] *The Eruption of Krakatoa and Subsequent Phenomena*, ed. by G. J. Symons (London: Trübner, 1888).
[78] See, for example, Tom Simkin and Richard S. Fiske, *Krakatau 1883: The Volcanic Eruption and Its Effects* (Washington DC: Smithsonian Institution Press, 1983).

Fig. 7: The earthquake and eruption of Asamayama, August 1783, engraved by Joseph Constantine Stadler, a German artist based in London. [Isaac] Titsingh, *Illustrations of Japan* (London: Ackermann, 1822), plate 2. Oxford, Bodleian Library. Douce T subt. 7.

One survivor whose story became well known was Johanna Beyerinck, a Dutch colonist. She lived on the coast of Sumatra, thirty kilometres from Krakatoa, and was badly burned during the eruption. Having escaped the tsunami that accompanied the opening stages of the eruption, she took shelter in a hut on a nearby hill. It was subsequently engulfed by hot currents of ash that had travelled across the sea from the collapsing volcano:

> What I saw then! Thousands of tongues of fire lit up the surroundings. On tops of the trees I saw flames. I heard a crack, and saw a sheet of fire right next to me. The sea was not to be seen. Everything was covered in ash. I could not see my hand before me.

A few hours later, there was another eruption, and another ash cloud:

> Suddenly it was pitch dark. The last thing I saw was the ash being pushed up through the cracks in the floor boards, like a fountain. I felt a heavy pressure, throwing me to the ground. Then it seemed as if the air was being sucked away and I could not breathe. (Simkin and Fiske, p. 84)

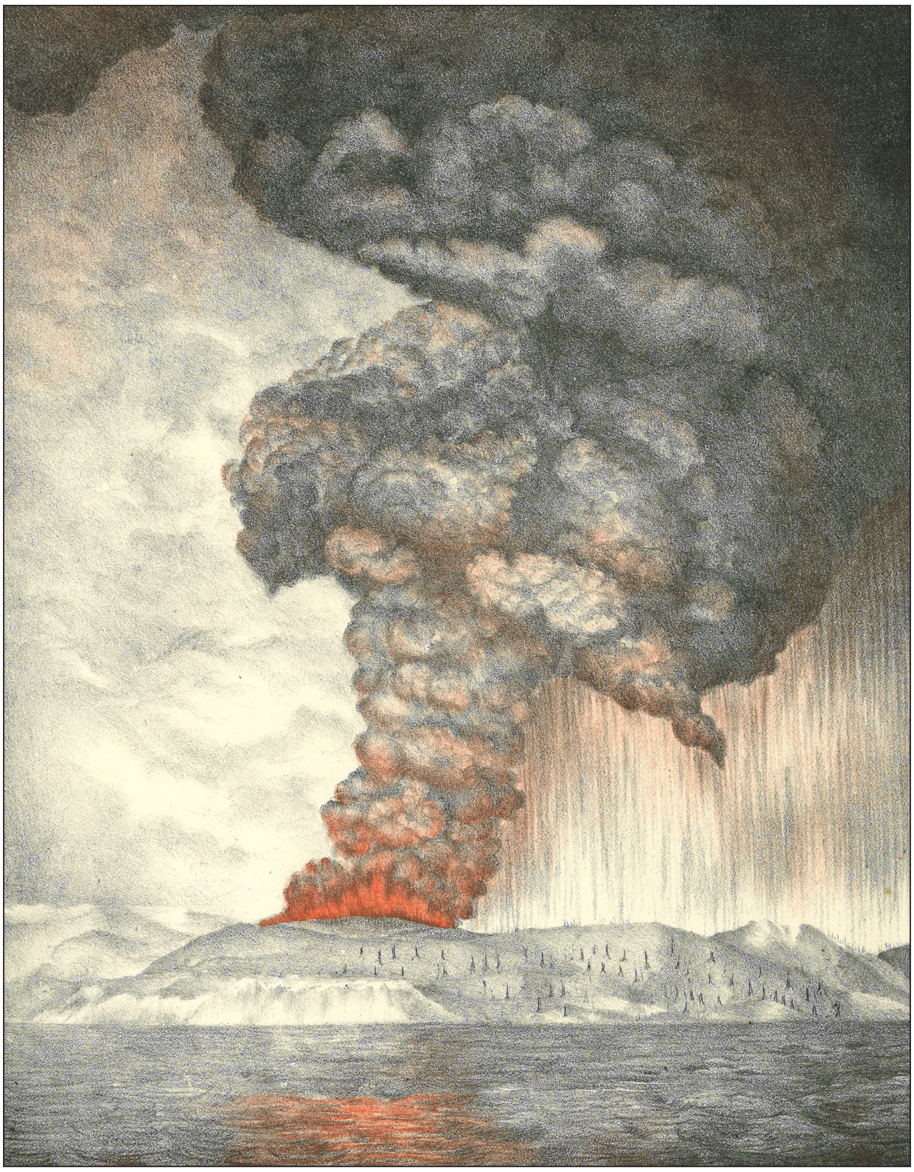

Fig. 8: View of Krakatoa during the early stages of the eruption, 27 May 1883, drawn from a photograph. Chromolithograph by Parker and Coward. *The Eruption of Krakatoa and Subsequent Phenomena*, ed. by G. J. Symons (London: Trübner, 1888), plate 1.

Out to sea, Captain Watson, on the British merchant ship *Charles Bal*, had a clear view of the climax of the eruption, in the mid-afternoon of 26 August:

> We heard above us and about the island a strange sound, as a mighty crackling fire, or the discharge of heavy artillery at one or two second intervals. At five, the roaring noise continued, darkness spread over the sky and a hail of pumice stone fell on us, or which many pieces were of considerable size and quite warm.
>
> That night was one of blackness — from the continuing fall of ash — broken by incessant flashes of lightning, both in the sky, and around the island. (Simkin and Fiske, pp. 102–03)

Through the night he saw 'chains of fire' rising and falling in the distance, forming a 'continual roll of balls of white fire', phenomena caused by the movement of the electrically charged ash particles. The air was 'hot and choking, sulphurous, with a smell as of burning cinders [...]. The mast-heads and yard arms were studded with corposants and a peculiar pink flame came from fleecy clouds' around.[79] These eyewitness accounts provided the inspiration for dramatic reconstructions and accounts of the eruption, which was soon regarded as one of the largest in history.[80]

News of the horror of the destruction of Krakatoa was soon followed by a sequence of remarkable sunsets, witnessed around the world. On Chelsea embankment, William Ascroft captured the lurid glow that was seen at dusk through the autumn of 1883 (*Fig. 9*). Writing in *Nature*, Gerard Manley Hopkins provided irresistible descriptions of the intense afterglow that 'prolonged the daylight and optically changed the season', filled the whole sky, and was 'mistaken for the reflection of a great fire'.[81] Alfred Lord Tennyson's experiences framed the opening lines of his poem, 'St Telemachus':

> Had the fierce ashes of some fiery peak
> Been hurl'd so high they ranged about the globe?
> For day by day, thro' many a blood-red eve,
> [...]
> The wrathful sunset glared.[82]

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[79] J. W. Judd, 'On the Volcanic Phenomena of the Eruption', in *Eruption of Krakatoa*, ed. by Symons, p. 20. These descriptions are of ball lightning and St Elmo's fire.
[80] For example, Robert Ballantyne, *Blown to Bits* (London: Nisbet, 1889); Camille Flammarion, *L'Eruption du Krakatoa et les tremblements de terre* (Paris: Girard and Boitte, [n.d.]).
[81] Gerard Hopkins, 'The Remarkable Sunsets', *Nature*, 29 (1884), 222–23 (p. 222).
[82] Alfred Lord Tennyson, 'St Telemachus', in *The Death of Oenone, Akbar's Dream, and Other Poems* (London: Macmillan, 1892), pp. 15–22 (p. 17). See also Richard D. Altick, 'Four Victorian Poets and an Exploding Island', *Victorian Studies*, 3 (1960), 249–60.

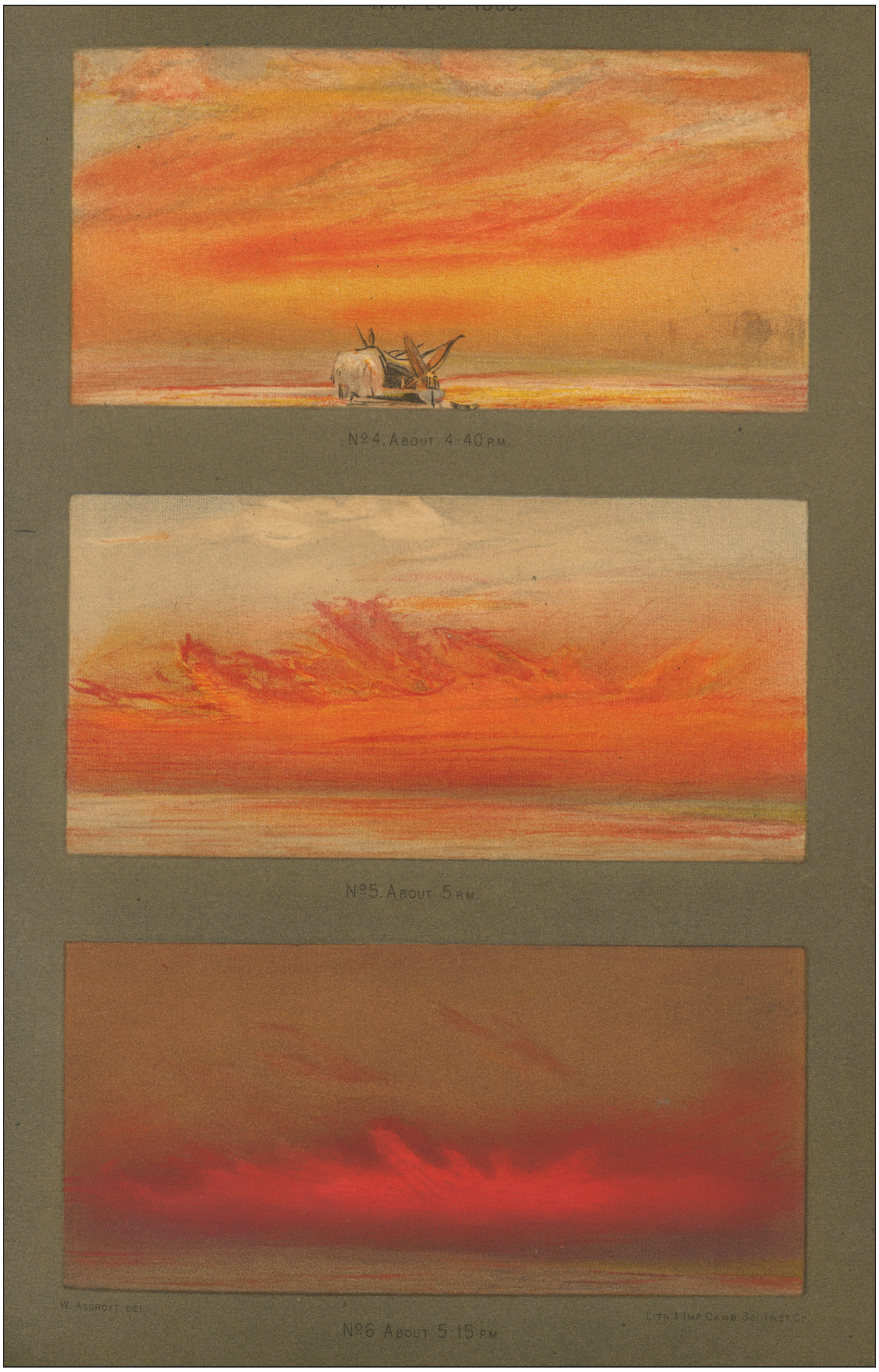

Fig. 9: Sequence of crayon sketches of the afterglow visible from Chelsea embankment on 26 November 1883, following the eruption of Krakatoa. Through the autumn and winter of 1883–1884 William Ascroft painted over 500 images; many, like these, in quick succession. *The Eruption of Krakatoa and Subsequent Phenomena*, ed. by Symons, frontispiece.

The eruption of Krakatoa presented a contemporary vision of both the destructive nature and global reach of explosive volcanic eruptions and became a byword for disaster. However, apart from the words of the survivors and some dramatic photographs of the destruction on Java and Sumatra caused by the tsunamis, there is no visual record of the eruption itself. Just a few years later, the catalogue of volcanic disasters grew with the near simultaneous eruptions of two Caribbean volcanoes: the Soufrière of St Vincent and Mont Pelée, Martinique. These eruptions immediately attracted attention, and left a rich legacy of eyewitness accounts and imagery (Pyle, pp. 174–85).

On St Vincent, the Soufrière volcano burst back to life on 6 May 1902, after ninety years of quiet. The eruption escalated rapidly, reaching a climax the next afternoon with the descent of the 'great black cloud [...] charged with immense quantities of red-hot dust. [...] It resembled a curtain hanging in folds, black, dense, solid, and well-defined.' Eyewitnesses, caught up as this cloud ran across the sea, survived by plunging underwater: 'It came over the water with a strong ripple and a hissing sound, due to the hot sand falling into the sea and making it steam. In a moment it was pitch dark and intensely hot and stifling.'[83] One day later, Mont Pelée erupted violently. Searing clouds of ash descended rapidly from the mountain, laying waste to the seaside town of St Pierre. A French traveller, Comte de Fitz-James, was crossing the bay in a rowing boat when he was caught in the eruption:

> The breath of fire swept down upon the city and water front with all of the force that could have been given to it by [...] a cannon. [...] Cinders were shot into our face with stinging effect. The air was filled with flame. Involuntarily we raised our hands to protect our faces. I noticed the same gesture when I saw the bodies of the victims on shore.[84]

These calamitous eruptions provoked a rapid humanitarian response. Relief ships were sent from as far away as New York, and emergency funds were remitted from around the world: from colonial governments, from the Lord Mayors of London and Liverpool, and from appeals and collections organized by newspapers, churches, and groups of concerned citizens.[85] Among those who were the first to travel to the scene were scientists from the Academies in France, Britain, and the United States. The Royal

[83] Tempest Anderson and John S. Flett, 'Report on the Eruptions of the Soufrière, in St Vincent, in 1902, and on a Visit to Montagne Pelée, in Martinique. Part I', *Philosophical Transactions of the Royal Society London*, 200 (1903), 392–93.
[84] Charles Morris, *The Volcano's Deadly Work* (Washington DC: Scull, 1902), p. 158.
[85] *Correspondence Relating to the Volcanic Eruptions in St Vincent and Martinique in May 1902*, Parliamentary Papers of the House of Commons, Printed by Command, Cd. 1201 (London: HMSO, 1902); Pyle, p. 177.

Fig. 10: Mont Pelée, Martinique: the 'black cloud' of 16 December 1902 as it reached the sea, photographed by Alfred Lacroix. Angelo Heilprin, *The Eruption of Pelée* (Philadelphia: Lippincott, 1907), plate XXVI.

Society dispatched Tempest Anderson, an ophthalmologist from Yorkshire and pioneering volcano photographer, and John Flett, a Scottish geologist. Their accounts of the eruption include harrowing stories of survivors of the hot avalanche of ash. On Martinique, few survived the 'whirlwind of fire'.[86] However, as the eruptions continued, Alfred Lacroix and others saw for themselves the 'hot tornadic blasts' and the incandescent ash clouds that continued to descend from Pelée (*Fig. 10*).[87] Lacroix coined the term '*nuées ardentes*' to describe this phenomenon, and the parallels in eruption style between the descending 'dark black clouds' at the climax of the AD 79 eruption of Vesuvius, and the searing, hot ash clouds of St Vincent and Pelée were soon recognized.[88]

These observations opened new avenues in the understanding of volcanic eruption processes, with the recognition of new styles of volcanic deposit: the landscape-altering blankets of scoria, ash, or pumice, emplaced as 'flow[s] of incandescent sand'.[89] By the 1930s geologists had formalized the scientific nomenclature of these deposits, calling the fragmental products of explosive eruptions 'pyroclastic' rocks, and the deposits of ash and pumice avalanches 'ignimbrite'.[90]

Concluding remarks

During the long nineteenth century, volcanoes and their activity became familiar to new audiences in the non-volcanic lands of northern Europe. From depictions of the wonder of volcanoes in children's books, to lurid accounts of the latest conflagrations of Vesuvius and Etna in the daily and weekly newspapers, descriptions of volcanoes used the familiar analogy of fire to bring these stories to life. Writers on natural philosophy and geology who were pondering the nature and origins of volcanoes used the same fiery analogies in their descriptions of volcanic phenomena, but came to develop new ideas on the deep causes of volcanic fire. By the end of the nineteenth century, the scientific consensus was that the earth's interior was hot, and that the fire associated with volcanoes was both

[86] Angelo Heilprin, *Mont Pelée and the Tragedy of Martinique* (Philadelphia: Lippincott, 1903), p. 97.
[87] Alfred Lacroix, *La Montagne Pelée et ses eruptions* (Paris: Masson, 1904); Heilprin, p. 272.
[88] Heilprin, p. 121; Anderson and Flett, p. 452. See also, Marjorie Hooker, 'The Origin of the Volcanological Concept *Nuée Ardente*', *Isis*, 56 (1965), 401–07.
[89] Robert Griggs, *The Valley of Ten Thousand Smokes* (Washington DC: National Geographic Society, 1922), p. 1.
[90] 'Pyr', from the Greek, and 'ignis', from the Latin, are words for fire. See Jim Cole and others, 'Pyroclastic Nomenclature in New Zealand', *New Zealand Journal of Geology and Geophysics*, 15 (1972), 686–92; Richard V. Fisher and Hans-Ulrich Schmincke, *Pyroclastic Rocks* (Berlin: Springer, 1984), pp. 187–92.

radiant — incandescent — and electrical. Nonetheless, the convenience of the analogy of fire as a description of volcanic phenomena meant that the use of terms synonymous with fire persisted in both popular and technical writings on volcanoes. The need to add colour to the greyscale visual representations of volcanoes in mass circulation newspapers, magazines, and books also ensured that, whenever the chance arose, these too would be tinted with oranges and reds. But the spectres of Krakatoa — the eruption that destroyed an island and then painted the world's skies red — and, later, of Pelée — the eruption that destroyed a city in an instant — reminded the world of the violence of volcanic eruptions. In contrast to the tame fury of Vesuvius's dazzling lava flows, these glowing avalanches of ash could wreak havoc in moments. The recognition of *nuées ardentes* explained the burial of Pompeii and Herculaneum, as well as the burning ash currents of Tambora and Krakatoa, and paved the way for studies of pyroclastic rocks — the fragmental products of explosive eruptions.