

Geotourism in Volcanic and Geothermal Environments: Playing with Fire?

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Abstract Volcanic and geothermal landforms have unique features which make them attractive destinations for geotourism, ecotourism and adventure tourism. Vast numbers of volcanic environments worldwide combined with a special geodiversity offer an extensive range of outdoor activities including the opportunity for education about geoheritage as well as an insight into their significant value for regional culture, religion and history. The importance of volcanic and geothermal environments for the tourism sector has been recognised with the development of volcano-based National Parks and more recently, National and Global Geoparks where geomorphosites containing volcanoes which are currently active and volcanoes classed as active due to their past activity during the Holocene as well as geothermal landscapes are promoted as tourist attractions. Given the growing popularity of volcanic and geothermal destinations, it is paramount that management authorities make visits to active environments as safe as possible. To date, there is a paucity of publications in the academic literature on risk management in volcano and geothermal tourism. This article aims to contribute to closing this gap in the tourism literature.

Keywords Geological heritage · Geothermal environments · Geotourism · Risk management · Visitor safety · Volcano tourism

What is Volcano Tourism?

Travel and recreation today are frequently linked to destinations which include volcanic and geothermal land-

forms that are part of protected areas such as national parks, geoparks or world heritage sites. Volcano tourism is defined by Erfurt-Cooper and Cooper (2010) as follows:

‘Volcano tourism involves the exploration and study of active volcanic and geothermal landforms and processes. Volcano tourism also includes visits to dormant and extinct volcanic regions where remnants of activity attract visitors with an interest in geological heritage’.

With over 1,300 currently classed as active volcanoes worldwide and considerably more areas with dormant volcanic landforms, there is an abundance of volcanic destinations. Even if not all of them can be easily accessed, many areas are already developed for tourists. Volcano and geothermal tourism is an important segment of geotourism, which takes into account the geological heritage of unique landscape features (Dowling and Newsome 2006), but particularly the geodiversity of active volcanic and geothermal landforms. Growing numbers of tourists look for some form of adventure, and therefore, they plan their holidays close to active volcanoes (Brace 2000; Erfurt-Cooper and Cooper 2010).

Volcano Tourism in History

The volcanic and geothermal activity of such areas has attracted tourists for several centuries, and visits to active volcanoes are commonplace in Europe, especially in Italy and Iceland (Fisher et al 1997; Hróarsson and Jónsson 1992; Kilburn and McGuire 2001; Krafft 1991; Lopes 2005; Rosi et al 2004; Schmincke 2004; Sigurdsson and Lopes-Gautier 2000; Thordarson and Hoskuldsson 2002). Destinations such as Vesuvius and the nearby

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excavated cities of Pompeii and Herculaneum entombed by its earlier activity represented special attractions during the eighteenth century Grand Tour, which was a popular pastime of the more affluent members of European society. Geysers and other geothermal features based on volcanic activity have also traditionally been used widely to market destinations and to attract visitors to countries such as New Zealand, Italy, Turkey, USA, Japan and China, which all have a history of promoting their volcanic environments to increase visitor numbers. Destinations like North America's Yellowstone and Hawaii Volcanoes National Park for example attract millions of visitors every year; in New Zealand, the Tongariro National Park and in Japan, the Fuji-Hakone-Izu National Park represent major tourism destinations based on volcanic landforms and related geothermal features. It is very common for countries with active volcanic areas to use these geological 'power points' as special tourist attractions for marketing purposes. Table 1 below provides some examples of visitor numbers at popular volcanic and geothermal destinations.

This list alone adds up to approximately 134.5 million people visiting a volcanic environment on an annual basis, but does not include visitors to other active volcanic regions worldwide and is therefore a rather conservative estimate. The number of visitors to the Fuji-Hakone-Izu National Park may seem high in proportion to other destinations; however, for a location of significant interest (national, cultural, religious and historical values), this reflects a normal pattern among the domestic Japanese traveller (Erfurt-Cooper and Cooper 2010). To provide a general overview of well-known destinations which feature volcanoes, geothermal landforms or both, Fig. 1 points out a number of locations.

Visitor Expectations

What are visitors to volcanic and geothermal environments looking for? One of the main objectives is to experience unique natural landscape features and possibly some eruptive activity. Determined volcano tourists are prepared to embark on excursions or expeditions to remote places such as the Aleutians, parts of Africa or the Russian Kamchatka Peninsula where the most impressive views are often only possible by flight-seeing either from a helicopter or a plane. Unfortunately, this can end fatally as was the case in 1979 when an Air New Zealand plane went on a flight-seeing trip from Auckland to McMurdo Sound in Antarctica. The plane crashed at the volcano Mount Erebus at low altitude leaving no survivors. Although Air New Zealand has not resumed flights to Antarctica, other

Table 1 Examples of annual visitor numbers from selected countries where volcano tourism is an integrated sector of the tourism industry

Country, location	Visitor numbers
Fuji-Hakone-Izu NP, Japan	103 million (2004)
Shikotsu-Toya NP, Japan	14.6 million (2005)
Daisetsuzan NP, Japan	6.1 million (2006)
Mt Teide National Park, Spain	3.5 million (2004)
Yellowstone National Park, USA	3 million (2008)
Hawaii Volcanoes NP, USA	1.2 million (2008)
Mt Rainier NP, USA	1.1 million (2008)
Tongariro NP, NZ	1 million (2004)
Vesuvius NP, Italy	1 million (2004)

Table compiled by author from several sources including Teide Parque Nacional 2006; Japan Atlas Nature 2010

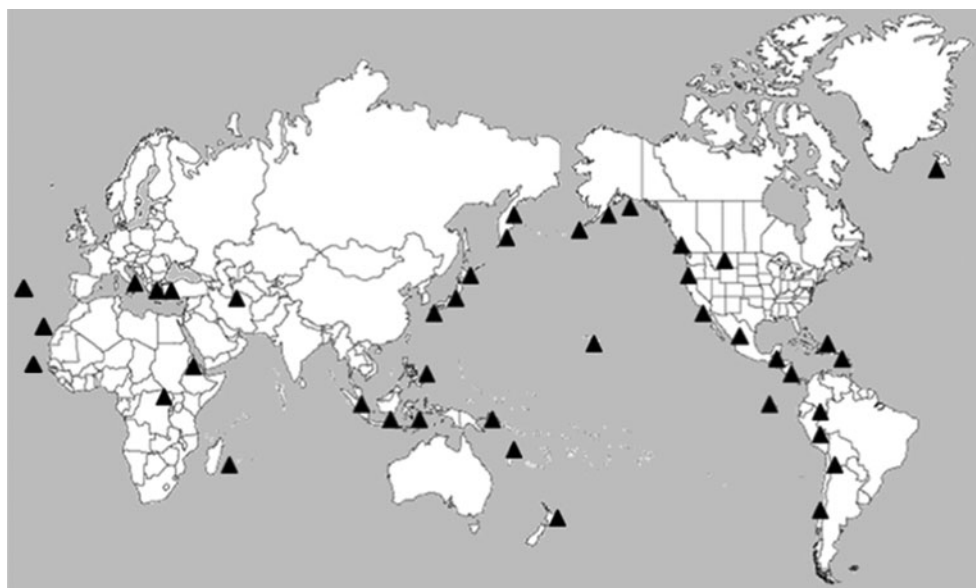
airlines offer flyovers on limited days at a substantial cost. The not insignificant cost factor (and risk factor) involved to any of the more remote destinations does not deter volcano tourists; participants of adventure tours or field trips do not mind being stationed at a base camp from which they embark to various points of geological interest. For many people, the visit to an active volcano is the 'dream of a lifetime' which is a comment repeatedly heard from volcano tourists. Additional reasons for visiting volcanic and geothermal environments have been identified (Table 2).

Further interest in volcanoes has been generated through the group of Decade Volcanoes which represent 16 active systems selected by the International Association of Volcanology and Chemistry of the Earth's Interior for more in-depth studies (USGS 2010). These volcanoes subsequently became popular with those volcano tourists who expected heightened activity, and numbers of visitors to eruption centres increased (Fig. 2; Chester 2005). Included in the list of Decade Volcanoes are well-known mountains such as Vesuvius and Etna in Italy, Santorini in Greece, Unzen and Sakurajima in Japan, Mt. Rainier and Mauna Loa in the USA, and Merapi in Indonesia. All are closely monitored namely as a result of their destructive potential; however, all of them are also popular tourist destinations even if special safety guidelines for temporary visitors of active volcanoes are not available in all of them, but only for local residents.

Volcano Museums and Information Centres

Unique environments such as volcanic and geothermal landscapes are often found in protected areas such as national parks or geoparks as a method of controlling the environmental impact from (1) encroaching urban develop-

Fig. 1 Main active volcanic and geothermal tourist destinations are indicated by *triangles*: Azores, Cape Verde Islands, Canary Islands, Italy, Greece, Turkey, Iran, Ethiopia, DR Congo, Reunion, Indonesia, Bali, Philippines, PNG, Vanuatu, Solomon Islands, New Zealand, Japan, Kamchatka, Alaska, Cascades, Hawaii, Yellowstone, Mexico, Central America, Lesser Antilles, Galapagos/Ecuador, Colombia, Chile, Argentina, Iceland. Map modified by author



ment and (2) from excessive visitor pressure. Providing information about the range of attractions through interpretive or information centres is one way of explaining the key geophysical processes of interest and as case histories of, for example, past violent eruptions. In many volcanic national parks and geoparks and also within surrounding communities, volcano museums have been set up with exhibitions, illustrative material, movies and other powerful demonstrations of how volcanic activity can affect human society. Table 3 gives some examples of locations with interpretive centres and volcanic museums. The Toyako Visitor Center (Fig. 3) near the active volcano Mt. Usu on the Japanese island of Hokkaido is part of the learning experience when visiting this new UNESCO Global Geopark which includes the Toya Caldera and the Usu Volcano Geopark. Within this area, other educational and interpretive facilities can be visited, including the Mimatsu Masao Memorial Hall and the Lake Toya Eco-Museum, the latter being an open-air museum which contains the suburbs that were affected by the 2000 eruption.

Table 2 Individual motivations and specific reasons for visiting volcanic and geothermal areas

Recreation, tourism, adventure	Science, study, research
Sightseeing	Scientific interest
Photography	Field research
Curiosity, Ambition	Educational trips
Guided tours	Study tours
Documentaries	Collecting data
Collecting rocks (if permitted)	Collecting samples

Erfurt-Cooper 2008, 2009, 2010; Erfurt-Cooper and Cooper 2010

Volcano museums are a perfect option for visitors who either have no direct access or who do not want to go too close to a volcano with the potential to erupt, but are interested to find out more about the geological background of the area. Options may include looking into an active crater via webcam and the viewing of eruption footage from a distance and a relatively safe environment. Cultural and historical events are used as an opportunity for visitors to experience actual eruptions and the aftermath in 3-D theatres. For example, the museum of New Zealand (Te Papa, Wellington) has held an exhibition where ‘A Day in Pompeii’ offered a chance to view and experience the cataclysmic volcanic events that were the doom of Pompeii and Herculaneum in the year 79 AD (Te Papa 2010).



Fig. 2 Mt. Unzen is one of the ‘Decade Volcanoes’ with its last eruption period from 1990 to 1996. Volcano tourists are using a viewing platform at the Nita Pass to catch a glimpse of this mountain. Car parks, picnic facilities, souvenir shops and restaurants cater to visitors. Photo source: Patricia Erfurt-Cooper

Table 3 Examples of volcano museums and visitor information centres from a number of countries to indicate the significance of these information sources for the volcano tourist as well as the general sightseeing visitor to the region

Examples of volcanic museums and interpretation centres

Te Papa, Wellington, New Zealand	Mt. St. Helens Volcanic Monument, USA
Mt. Aso Volcano Museum, Japan	Lava Butte Visitor Centre, Oregon
Unzen Memorial Hall, Japan	Penshurst Volcanoes Discovery Centre, Australia
Sakurajima Visitor Centre, Japan	Volcano Art Centre, Hawaii
Volcano Science Museum, Mt. Usu, Japan (Fig. 1)	Jaggar Museum, Hawaii
Volcano Museum, Aurillac, France	La Maison de Volcan, Reunion
Eifel Volcanic Museum, Daun, Germany	Buried Village, Rotorua, New Zealand
Batur Volcano Museum, Indonesia	St Pierre Volcano Museum, Martinique
Masaya Volcano Museum, Nicaragua	Merapi Volcano Museum, Indonesia
San Venanzo Volcano Museum, Italy	Red Rock Cinema - Reykjavik, Iceland
Asama Volcano Museum, Japan	Museum of Nature and Man, Tenerife
Santorini Museums, Greece	Volcanic Museum, Nicolosi, Sicily
Eldfjallasafn Volcano Museum, Iceland	

Table compiled by author

The history and culture associated with events caused by volcanic activity at places like Pompeii (Italy), Martinique (West Indies), Heimaey (Iceland), Unzen (Japan) or Taupo (New Zealand) are significant factors adding further interest in tourist attractions which already include unique geological formations in extreme environments, and thus, highlight the social perspective. Disasters and tragedies which have occurred in volcanic areas also show some close linkage to Dark Tourism or Disaster Tourism, although the degree of horror seems to vary with the time that has elapsed since the actual event (Erfurt-Cooper and Cooper 2010). Volcano museums are therefore a powerful medium to introduce visitors to the destructive forces of volcanic eruptions or earthquakes via virtual reality while at the same time keeping them away from potential danger. Standing in front of a big screen and feeling surrounded by a pyroclastic flow (minus the heat) complete with sound effects and ground tremors leaves quite an impression. The educational value of these facilities is generally paired with retail opportunities such



Fig. 3 One of the many volcano museums in Japan where visitors can have close-up experiences with simulated volcanic activity. Photo source: Patricia Erfurt-Cooper

as souvenir shops, book shops as well as cafés and restaurants. In the same way, World Heritage listed sites (Table 4) often include additional attractions related to the local culture, history, religion and architecture, e.g. the Borobudur Temple near Mt. Merapi in Indonesia. But generally, volcanic World Heritage properties have been identified according to their geomorphology or volcanic geology and include volcanic landforms that have developed through varying combinations of endogenetic or exogenetic processes. Thirty-four properties on the World Heritage List and 28 potential sites contain volcanoes either classed as currently active or having been active throughout the Holocene (Joyce 2009; Wood 2009).

Finally, volcanic and geothermal landforms, which occur worldwide, include many unique features and attractions (Table 5) and are commonly linked to ongoing volcanic activity. However, geothermal springs can also be found in non-volcanic and dormant volcanic environments and are a tourist attraction in their own right, while including remnant volcanic landscapes for additional recreational activities such as hiking and climbing (Erfurt-Cooper and Cooper 2009).

Risk, Danger and Adventure

Unique environments such as active volcanic and geothermal areas are potentially dangerous and two decades ago Perry and Lindell (1990) argued that “...volcanic risks are intimately related to the beauty and recreational quality of the area...”. Active forms of tourism such as geotourism, ecotourism and adventure tourism can help raise awareness about the potential hazards of such environments; however, the task of risk assessment and risk management is extremely challenging due to the varying degrees of danger

Table 4 Examples of World Heritage listed areas with volcanic and geothermal landforms—the list currently includes 34 volcanic sites

Country	World Heritage area
Indonesia	Merapi and Borobodur Temple
New Zealand	Tongariro National Park
USA	Hawaii Volcanoes National Park
USA	Yellowstone National Park
Russia	Kamchatka
Ecuador	Galapagos Islands
Spain	Teide National Park
Ireland	Giants Causeway
Kenya	Kilimanjaro National Park
Korea	Jeju Volcanic Island
Ecuador	Sangay National Park
Italy	Aeolian Islands (Stromboli, Vulcano)
Democratic Republic of Congo	Virunga National Park

Table after Wood (2009)

from active volcanoes which can generate different types of emergencies. Remoteness, difficult terrain and adverse climate conditions often present additional complications in a disaster situation (Buckley 2007; Erfurt-Cooper and Cooper 2010). Moreover, health and safety issues play a key role in volcano and geothermal tourism with several potential dangers identified (Table 6). These potential dangers in volcanic mountain environments are compounded when combined with common hazards such as exposure at higher altitudes, lack of water, and getting lost in bad weather. Unexpected eruptions, lava flows, lahars, toxic gases or other volcanic hazards increase the potential for disaster in volcanic environments. Potential hazards common in non-volcanic environments (Table 6) can create additional problems in emergencies, making rescue attempts even more difficult (Erfurt-Cooper 2010).

Risk Management Related to Volcano and Geothermal Tourism

As we have seen, volcano tourism occurs worldwide with a conservative estimate of between 150 and 200 million people visiting volcanic and geothermal environments on an annual basis, and with many volcano tourists becoming repeat visitors to popular active and dormant volcanic

Table 5 Active volcanic and geothermal attractions

Strombolian eruptions	Boiling ponds
Active lava flows	Fumaroles and vents
Geysers and hot springs	Boiling mud pools
Lava lakes	Hot rivers and streams
Crater lakes	Sinter terraces

Table compiled by author

landscapes. Visitors attracted by volcanic and geothermal activity often have a keen interest in geology and plan their travelling to suit their interest. Heightened activity appears to attract more visitors (Sigurdsson and Lopes-Gautier 2000; Morella 2007), whose expectancy is to have the experience of a lifetime (Erfurt-Cooper and Cooper 2010).

While health and safety aspects are usually an important factor when it comes to choosing a holiday destination, visitors to active volcanic and geothermal environments, especially of currently active volcanoes, are knowingly approaching potentially dangerous areas. These possible dangers highlight the need for responsible risk prevention programs to be put in place with a focus on every volcanic and geothermal tourist destination worldwide. Visiting active volcanoes with unique geothermal manifestations such as hot crater lakes or geothermal landscapes with highly active features poses a significant risk factor which is often underestimated.

There is a distinct lack of safety guidelines for volcano tourists at most sites, which is compounded by language problems in many areas as the majority of signage is usually in one language only. However, while countries like Japan are setting an example by offering up to four different translations for international visitors at many volcanic destinations (Fig. 4), at the majority of active volcanic tourist destinations worldwide, this is not yet the case. Interpretive signage and signs that contain warnings must be in more than one language, and/or contain symbols or pictograms for easy visual recognition. Safety recommendations for the conduct of temporary visitors in active volcanic and geothermal environments in existing guidelines for local residents need to be modified to include tourists as well (Erfurt-Cooper and Cooper 2010).

A strong focus on the relatively new tourism sector of geotourism and its educational values including geo-trails, guided tours and multi-lingual interpretive and warning

Table 6 Potential hazards in volcanic and non-volcanic environments

Volcanic environments	Non-volcanic environments
Unexpected eruptions	Hiking accidents
Pyroclastic flows	Sudden weather changes, fog, etc.
Lava flows	Avalanches—snow, rocks
Tephra fall (e.g. volcanic bombs, lapilli and ash)	Getting lost
Toxic fumes or gas emissions	Landslides
Thermal burns from hot springs or lava flows	Rock falls
Lahars, mudflows	Hypothermia
Earthquakes and tsunamis	Altitude sickness

Table compiled by author

signs could become the ideal tool to raise awareness about potentially dangerous environments without decreasing visitor numbers. In particular, visitors who are not familiar with the local terrain would benefit from basic information at least in the form of a fact sheet with a hazard map to keep them in safer zones. Informative fact sheets would also tell visitors about the local area as well as important locations like shelters, emergency phones and other vital emergency instructions. It remains a priority that visitors to active volcanic and geothermal environments must have sufficient advance information in preparation for their trip and they should be at least mentally prepared for unexpected hazards of various types if their destination is a currently classed active volcano. To make volcano tourism as safe as possible, there is an urgent need to look at risk prevention which should start at the beginning of the journey with adequate information for all potential visitors and suitable training for operators and guides.

Conclusion

Despite the fact that volcano and geothermal tourism has an underlying potential for unexpected disasters on

volcanoes currently classed as active, visitor numbers are on the rise, partly due to increased ease of access and budget air fares, as well as improved infrastructure at many destinations. The demand for tourism in unique environments such as active volcanic and geothermal areas is based on the growing interest in natural areas combined with experiencing adventure to gain knowledge about unique landforms.

The volcano tourism sector provides a significant contribution to local economies, which has resulted in increased marketing and promotion of ‘holidays on a volcano’. It is therefore advisable that tourist organisations, tour operators, local authorities and scientists should join forces to make this type of tourism as safe as possible. Tour guides would preferably all be trained as volcanologists with a background in disaster management who can assess potential dangers correctly, as tourism operators do not always have the ability to take the right steps in case of emergency. Although individual destinations like national parks, geoparks or world heritage areas may have their own safety measures in place, there is still a lot of room for improvement, especially regarding language barriers, which can pose a significant risk factor if warnings are not fully understood. Many regions close to active volcanoes have risk management strategies for the local population or for scientists working on volcanoes, but the temporary visitors are rarely included (Erfurt-Cooper 2009, 2010).

The future of tourism in currently active volcanic areas and geothermal environments depends on the recognition of the necessary safeguards and precautions, which need to be universally understandable and made available in advance to every tourist in potentially dangerous environments (Erfurt-Cooper 2007, 2008, 2009, 2010) because many volcano tourists rely on their personal judgement when they assess the potential risk of visiting such active volcanoes. The common lack of basic knowledge of potential volcanic hazards as well as particular conditions of mountain environments can lead to costly rescue situations, causing unnecessary danger to all involved.



Fig. 4 Signs located within the Shikotsu-Toya National Park Mt. Usu, which is a popular visitor attraction despite the fact that this volcano erupted only 10 years ago. Photo source: Patricia Erfurt-Cooper

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