Appendix B – Region 19

Country and regional profiles of volcanic hazard and risk:

Antarctica

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This download comprises the profiles for Region 19: Antarctica only. For the full report and all regions see Appendix B Full Download. Page numbers reflect position in the full report. The following countries are profiled here:

Brown, S.K., Sparks, R.S.J., Mee, K., Vye-Brown, C., Ilyinskaya, E., Jenkins, S.F., and Loughlin, S.C. (2015) Country and regional profiles of volcanic hazard and risk. In: S.C. Loughlin, R.S.J. Sparks, S.K. Brown, S.F. Jenkins & C. Vye-Brown (eds) *Global Volcanic Hazards and Risk,* Cambridge: Cambridge University Press.

Region 19: Antarctica

Description

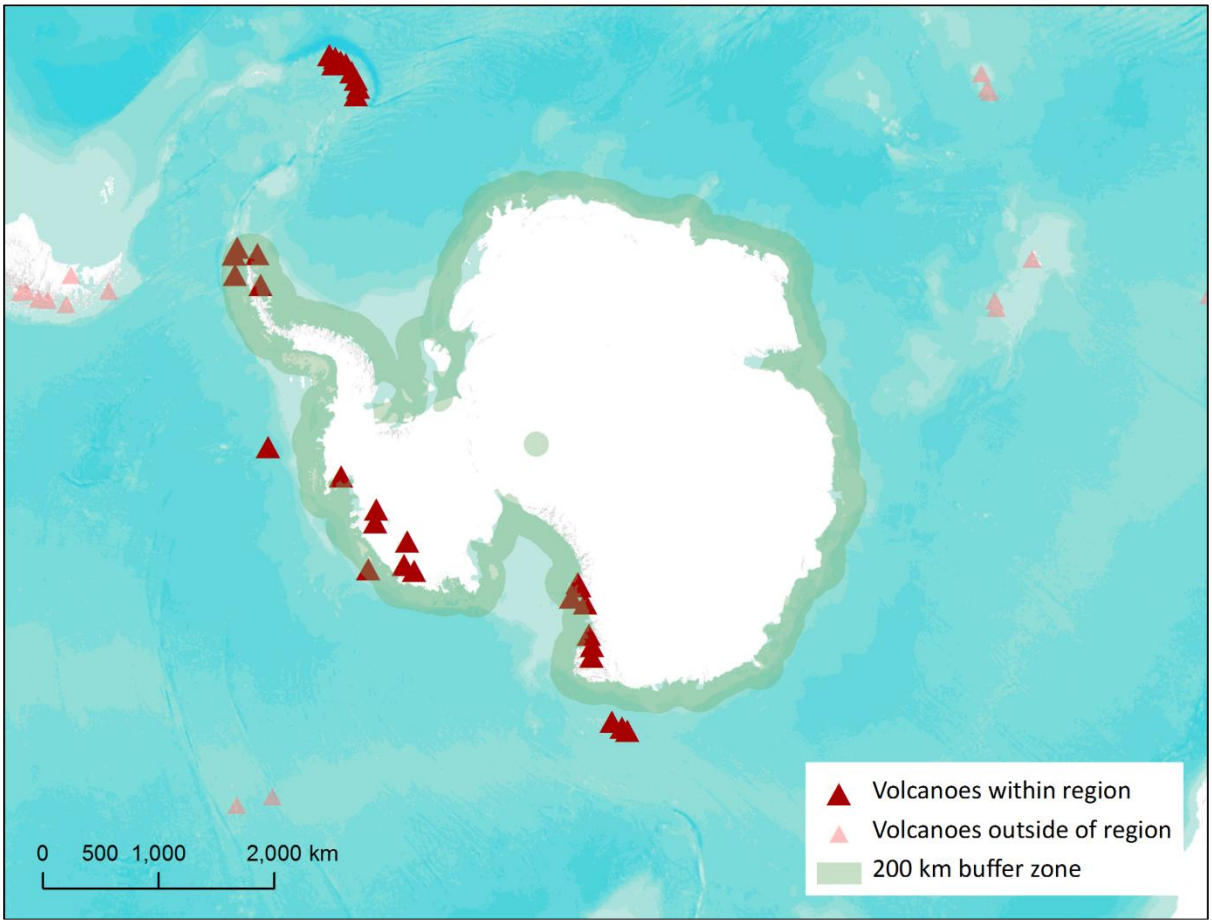

Figure 19.1 The distribution of Holocene volcanoes through the Antarctica region. A zone extending 200 km beyond the region's borders shows other volcanoes whose eruptions may directly affect Antarctica.

Thirty-two Holocene volcanoes are located in Antarctica. Half of these volcanoes have no confirmed eruptions recorded during the Holocene, and therefore the activity state is uncertain. A further volcano, Mount Rittmann, is not included in this count as the most recent activity here was dated in the Pleistocene, however this is geothermally active as discussed in Herbold et al. (2014). The region includes the South Sandwich Islands (a British Overseas Territory) and other island groups adjacent to Antarctica. Note that the volcanoes included and discussed here are described as country "Antarctica" and "UK" in VOTW4.0. Many of these volcanoes are related to rift and extension in the West Antarctic Rift System. Holocene volcanoes on the Antarctic continent except those on the northern tip of the Antarctic Peninsula are located in the West Antarctic Rift System. Those in the South Sandwich Islands are related to subduction processes. The range of tectonic settings here results in a range of compositions and volcano morphologies.

Eighty confirmed Holocene eruptions of VEI 0 - 4 are recorded in Antarctica, indicating mild activity to large explosive events, with small VEI 0 events with associated lava flows dominating the record.

Although few large explosive eruptions are recorded in the Holocene, there is a record of VEI ≥4 eruptions in the Pleistocene, with the largest recorded Quaternary eruption occurring at 1.7 Ma with the M7 Eltanin eruption of Young Island. This latter eruption is uncertain, having initially been identified through tephra studies by Huang et al., (1975) as a single large rhyolitic eruption from the Balleny Islands, then proposed as as product from the North Island, New Zealand by Kyle and Seward (1984) and later identified as several eruptive events from the Antarctica region by Shane and Froggatt (1992). Shane and Froggatt (1992) identified seven rhyolitic tephra zones between 2 and >0.06 Ma, and suggested stratovolcanoes in Marie Byrd Land as the likely sources. Fifty-two of these Holocene eruptions are recorded in historical times (since 1500 AD), however over 90% of these have in fact been recorded since 1800 AD, due to an increase in exploration and visual observations.

No permanent population resides in Antarctica, with only a transitory population of workers (mainly researchers), which grows to its maximum of a few thousand in the summer months. Due to this low population no eruptions have reported fatalities and the volcanoes are all low risk, however the hazard is still poorly understood at many of Antarctica's volcanoes.

Mount Erebus has long-term lava lake activity with occasional explosions and larger Strombolian activity. This activity, ongoing since at least 1972, has led to the establishment of the Mount Erebus Volcano Observatory (MEVO) with research undertaken primarily by the New Mexico Institute of Mining and Technology. Seismic and gas monitoring is undertaken and GPS and tiltmeters are used to investigate the deformation of the volcano. Although there is no permanent population here, the US base of McMurdo and the New Zealand Scott Base are located within 40 km of Erebus.

The Observatory Volcanologico Decepcion (OVD) was established by the Argentine Antarctic Institute, University of Buenos Aires and Higher Council for Scientific Research (CSIC), Spain, to study and monitor Deception volcano. Ground monitoring activities take place in the summer of each year, when seismic, gas, deformation and additional monitoring is undertaken. Monitoring and research is undertaken gain a better understanding of activity here and to provide forecasts of activity. No permanent population resides here, but significant numbers of scientists and tourists visit.

Mount Melbourne has been monitored by the Italian Antarctic Program in the past and the Korea Polar Research Institute plans to undertake monitoring here (P. Kyle, pers. comm. 2014).

See also:

Observatorio Volcanologico Decepcion: www.dna.gov.ar/CIENCIA/OVD/INDEX.HTM

Mount Erebus Volcano Observatory: erebus.nmt.edu/index.php/general-information

Herbold, C.W., McDonald, I.R., and Cary, S.C. (2014) Microbial Ecology of Geothermal Habitats in Antarctica. In: D.A. Cowan (ed*) Antarctic Terrestrial Microbiology*, Springer-Verlag, Berlin Heidelberg.

Huang, T.C., Watkins, N.D. and Shaw, D.M. (1975) Atmospherically transported volcanic glass in deep-sea sediments: volcanism in sub-Antarctic latitudes of the South Pacific during late Pliocene and Pleistocene time. *Geological Society of America Bulletin*, 86: 1305-1315.

Kyle, P.R. and Seward, D. (1984) Dispersed rhyolitic tephra from New Zealand in deep-sea sediments of the Southern Ocean. *Geology*, 12: 487-490.

Shane, P.R. and Froggatt, P.C. (1992) Composition of widespread volcanic glass in deep-sea sediments of the Southern Pacific Ocean: an Antarctic source inferred. *Bulletin of Volcanology,* 54: 595-601.

Volcano facts

Number of Holocene volcanoes	32
Number of Pleistocene volcanoes with M≥4 eruptions	3
Number of volcanoes generating pyroclastic flows	0
Number of volcanoes generating lahars	1
Number of volcanoes generating lava flows	4
Number of eruptions with fatalities	0
Number of fatalities attributed to eruptions	0
Tectonic settings	3 Rift zone, 20 Intra-plate, 9 Subduction zone
Largest recorded Pleistocene eruption	The M7 Eltanin eruption of Young Island at 1.7 Ma is the largest recorded Quaternary eruption in this region, however this event is uncertain with various authors attributing it to volcanic activity at other volcanoes and/or to multiple smaller eruptions: see Huang et al., (1975), Kyle and Seward (1984), and Shane and Froggatt (1992).
Largest recorded Holocene eruption	The largest Holocene eruption recorded in LaMEVE is the M4.7 eruption of the Hudson Mountains in 2160 BP.
Number of Holocene eruptions	80 confirmed Holocene eruptions.
Recorded Holocene VEI range	0 – 4 and unknown
Number of historically active volcanoes	12
Number of historical eruptions	52

Number of volcanoes	Primary volcano type	Dominant rock type
1	Caldera(s)	Basaltic (1)
16	Large cone(s)	Andesitic (4), Basaltic (10), Phonolitic (1), Trachytic/Andesitic (1)
9	Shield(s)	Basaltic (5), Phonolitic (1), Trachytic/Andesitic (3)
4	Small cone(s)	Andesitic (1), Basaltic (3)
2	Submarine	Rhyolitic (1), Unknown (1)

Table 19.1 The volcano types and dominant rock types of the volcanoes of this region according to VOTW4.0.

Eruption Frequency

VEI	Recurrence Interval (Years)
Small (< VEI 4)	3
Large (> VEI 3)	

Table 19.2 Average recurrence interval (years between eruptions) for small and large eruptions in Antarctica.

The eruption record indicates that on average small- to moderate- sized eruptions of VEI <4 occur in this region with an average recurrence interval (ARI) of about 3 years.

Eruption Size

Eruptions are recorded through Antarctica of VEI 0 to 4, representing a range of eruption styles from gentle effusive events, to explosive eruptions. VEI 0 and 2 events dominate the record, with about 80% of all Holocene eruptions classed as such. Fewer than 2% of eruptions here are explosive at VEI ≥4.

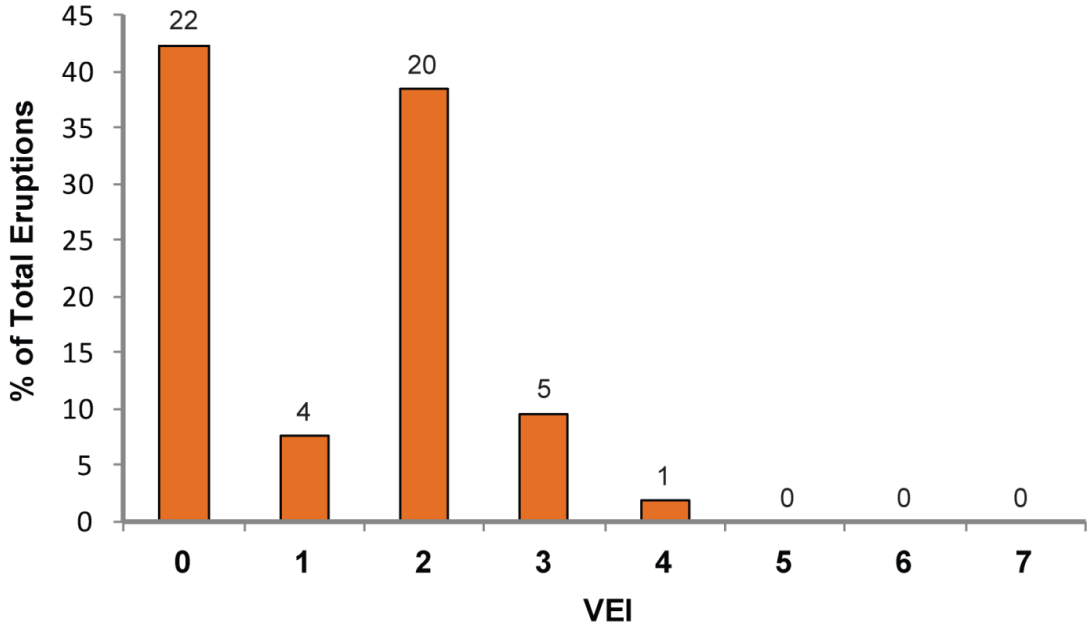

Figure 19.2 Percentage of eruptions in this region recorded at each VEI level; the number of eruptions is also shown. The percentage is of total eruptions with recorded VEI. A further 28 eruptions were recorded with unknown VEI.

Socio-Economic Facts

Total population (2011)	No permanent residents. 1,100 staff in research stations during the winter, 4000 in the summer, 1000 additional offshore workers[1].
Gross Domestic Product (GDP) per capita (2005 PPP $)	-
Gross National Income (GNI) per capita (2005 PPP $)	-
Human Development Index (HDI) (2012)	-

Population Exposure

Number (percentage) of people living within 10 km of a Holocene volcano	0 (0%)
Number (percentage) of people living within 30 km of a Holocene volcano	0 (0%)
Number (percentage) of people living within 100 km of a Holocene volcano	0 (0%)

Infrastructure Exposure

Number of airports within 100 km of a volcano	1
Number of ports within 100 km of a volcano	3
Total length of roads within 100 km of a volcano (km)	0
Total length of railroads within 100 km of a volcano (km)	0

The volcanoes of Antarctica are widespread. Three ports are located within 100 km of the volcanoes here, but otherwise, with no permanent population living on Antarctica, there is little infrastructure exposed to the volcanic threat. McMurdo Station, which is situated between Erebus and Mt. Morning, has seasonal runways with significant air traffic from October to March which could be impacted by ash eruptions.

[1] www.cia.gov/library/publications/the-world-factbook/geos/ay.html

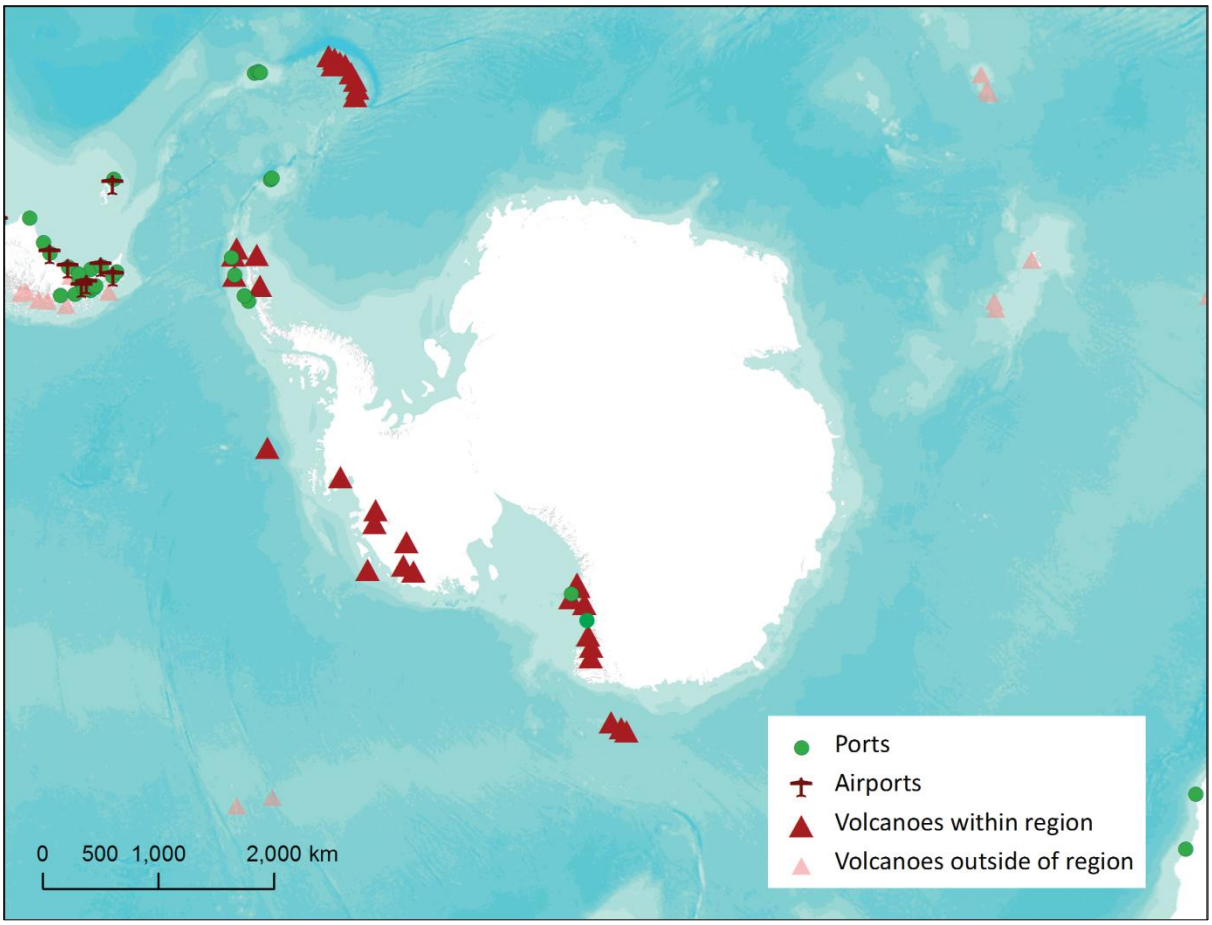

Figure 19.3 The location of Antarctica's volcanoes and ports.

Hazard, Uncertainty and Exposure Assessments

Of the 32 volcanoes in Antarctica, just four have assigned hazard levels: Deception Island, Erebus, Bristol Island and Michael. These volcanoes have a history of dominantly VEI 0 – 2 eruptions, frequently producing lava effusions and as such these are classed at Hazard Levels I and II.

The absence of extensive eruption records at the remaining volcanoes prevents hazard assessment without large uncertainties, and these are therefore unclassified. Of these, 16 have no confirmed Holocene eruptions. Eight unclassified volcanoes have records of historical eruptions, five of which have had eruptions since 1900: Penguin Island, Thule Islands, Montagu Island, Candlemas Island and Protector Shoal. Four unclassified volcanoes have experienced unrest above background levels since 1900.

With no permanent population in Antarctica, all volcanoes are classed as PEI 1, which therefore would categorise these as Risk Level I, regardless of the Hazard Level.

CLASSIFIED	**Hazard III**							
	Hazard II	Deception Island						
	Hazard I	Erebus; Bristol Island; Michael						
UNCLASSIFIED	**U – HHR**	Buckle Island; **Melbourne**; **Penguin Island; Thule Islands**; **Montagu Island**; **Candlemas Island**; Zavodovski; **Protector Shoal**						
	U- HR	Pleiades, The; Berlin; Takahe; Hudson Mountains						
	U-NHHR	Young Island; Sturge Island; Unnamed; Unnamed; Morning, Mount; Royal Society Range; **Andrus**; Waesche; Siple; Toney Mountain; Peter I Island; Bridgeman Island; Paulet; **Seal Nunataks Group**; Hodson; **Leskov Island**						
		PEI 1	**PEI 2**	**PEI 3**	**PEI 4**	**PEI 5**	**PEI 6**	**PEI 7**

*Table 19.3 Identity of Antarctica's volcanoes in each Hazard-PEI group. Those volcanoes with a sufficient record for determining a hazard score are deemed 'Classified' (top). Those without sufficient data are 'Unclassified' (bottom). The unclassified volcanoes are divided into groups: U-NHHR is Unclassified No Historic or Holocene Record: that is there are no confirmed eruptions recorded in the Holocene. U-HR is Unclassified with Holocene Record: that is there are confirmed eruptions recorded during the Holocene, but no historical (post-1500) events. U-HHR is Unclassified with Historic and Holocene record. The unclassified volcanoes in **bold** have experienced unrest or eruptions since 1900 AD, and those in red have records of at least one Holocene VEI ≥4 eruption.*

Population Exposure Index

Number of Volcanoes	Population Exposure Index
0	7
0	6
0	5
0	4
0	3
0	2
32	1

Table 19.4 The number of volcanoes in Antarctica classed in each PEI category.

Volcano	Population Exposure Index	Risk Level
Bristol Island	1	I
Deception Island	1	I
Erebus	1	I
Michael	1	I

Table 19.5 Classified Volcanoes of Antarctica ordered by descending Population Exposure Index (PEI). Risk levels determined through the combination of the Hazard Level and PEI are given.

Risk Levels for Classified volcanoes

Number of Volcanoes	Risk Level
0	III
0	II
4	I
28	Unclassified

Table 19.6 The number of volcanoes in the Antarctica region classified at each Risk Level.

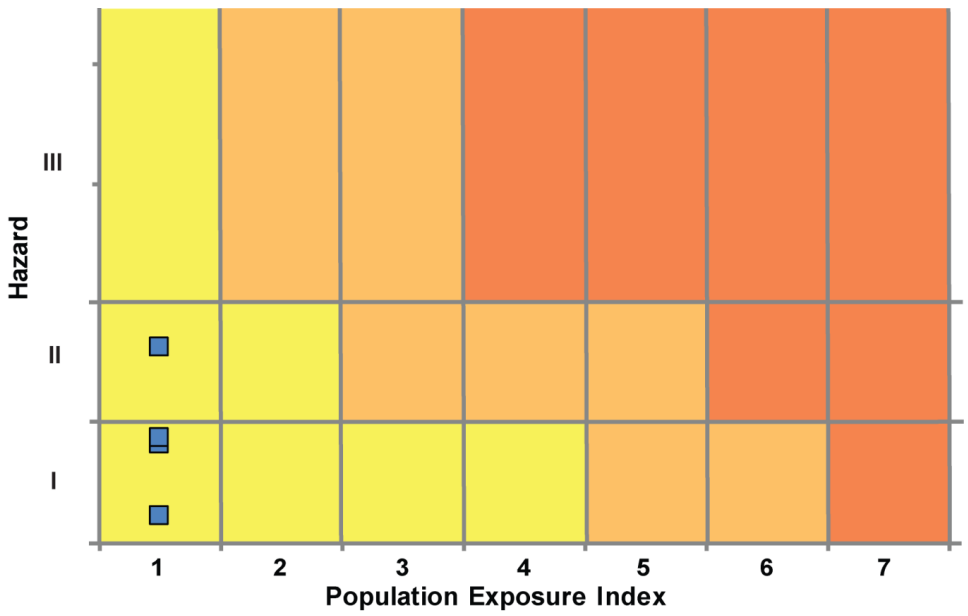

Figure 19.4 (previous page) Distribution of the classified volcanoes of Antarctica across Hazard and Population Exposure Index levels. The warming of the background colours illustrates increasing Risk levels from Risk Level I - III.

National Capacity for Coping with Volcanic Risk

Four Risk Level I volcanoes in Antarctica have records of historic activity. Of these Erebus and Deception have regular dedicated ground-based monitoring, including the use of seismic networks, gas and deformation monitoring. These systems are operated by the Mount Erebus Volcano Observatory and Observatory Volcanológico Deception. A further eight unclassified volcanoes (with no local populations) have historical records of activity but no current monitoring.

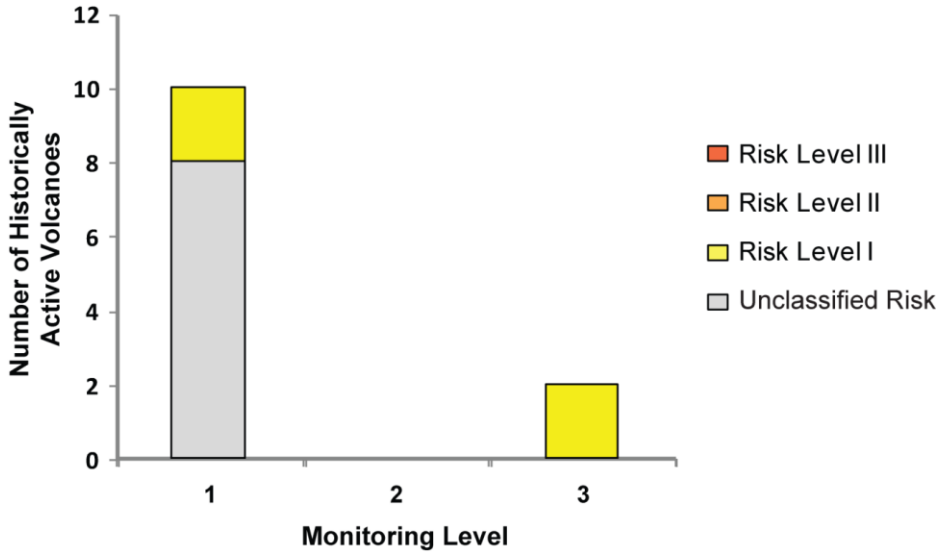

Figure 19.5 The monitoring and risk levels of the historically active volcanoes in Antarctica. Monitoring Level 1 indicates no known dedicated ground-based monitoring; Monitoring Level 2 indicates that some ground-based monitoring systems are in place including ≤3 seismic stations; Monitoring Level 3 indicates the presence of a dedicated ground-based monitoring network, including ≥4 seismometers.