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Preface

Volcanology of Erebus volcano, Antarctica

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> "Erebus not only commands a view of incomparable grandeur and interest, but is in itself one of the fairest and most majestic sights that Earth can show." (David in Shackleton, 1908).

In January 1841 Captain James Clark Ross sailed with his 2 diminutive ships *Erebus* and *Terror* into what is now known as the southern Ross Sea. On 28 January 1841, he noted:

> "…some land which had been in sight since the preceding noon…. we called the "High Island;" it proved to be a mountain twelve thousand four hundred feet of elevation…. emitting flame and smoke in great profusion… as we drew nearer, its true character became manifest. The discovery of an active volcano in so high a southern latitude cannot but be esteemed a circumstance of high geological importance and interest, and contribute to throw some further light on the physical construction of our globe. I named it "Mount Erebus"…" (Ross, 1847).

And so Erebus volcano was discovered, named and shown to be active.

Erebus is a large stratovolcano 3794 m high above sea level with a subaerial volume of ~2000 km^3 (Esser et al., 2004). It is sited on thinned (18 km) crust in the Terror rift near the western boundary of the West Antarctic rift system (Behrendt, 1999). Along with its subsidiary volcanoes, Erebus forms the bulk of Ross Island. The volcano dominates the site of the US McMurdo Station and the New Zealand Scott Base that host a wide range of Antarctic science operations.

Erebus is the most active volcano in Antarctica and possesses a unique anorthoclase phonolite geochemistry among the Earth's active volcanoes. It is also unique in hosting a persistent convecting lake of magma in its summit crater (Kyle et al., 1992). This lake, while a long-lived feature, is also the site of Strombolian explosions that cluster in time intervals of several months (Aster et al., 2003). The sustained low-level "open vent" activity makes the volcano an excellent laboratory to study the dynamics of both effusive and explosive eruptions and to investigate the sometimes abrupt transitions in behaviour. Despite its remoteness, three decades of volcanological research have now been chalked up at Erebus thanks in large part to outstanding support from the Office of Polar Programs of the National Science Foundation.

This Special Issue on the "Volcanology of Erebus volcano, Antarctica" has the aim of showcasing a wide-ranging selection of the most recent scientific research on the volcano, but it also marks and commemorates two notable events. The first is the 100th anniversary of the first ascent of the volcano and the second is the International Polar Year (IPY 2007–2008), which is still underway at the time of writing.

Our first knowledge of the geology of Erebus was gleaned during the "heroic era" of exploration of Antarctica during the early 1900's. Four separate expeditions lead by Ernest Shackleton and Robert Scott built bases at the foot of Erebus, and geologists collected and mapped the volcanic rocks in the vicinity of these encampments. It was in March 1908 that the first party (belonging to Shackleton's 1907–9 "Nimrod" British Antarctic Expedition) climbed Erebus and glimpsed the steaming summit crater (Fig. 1). They included the geologists: T.W. Edgeworth David (University of Sydney) and Douglas Mawson (University of Adelaide), their assistant Sir Philip Brocklehurst (who lost a few toes in the undertaking), Alistair Mackay (surgeon), Jameson Adams (meteorologist) and Eric Marshall (cartographer). All but Brocklehurst (who turned 21 on the ascent) reached the crater rim on 10 March 1908, and in David's words:

> "We stood on the verge of a vast abyss and at first could see neither to the bottom nor across it on account of the huge mass of steam filling the crater and soaring aloft in a column 500 to 1000 ft high. After a continuous loud hissing sound, lasting for some minutes, there would come from below a big dull boom, and immediately great globular masses of steam would rush upwards to swell the volume of the snow-white cloud which ever sways over the crater. This phenomenon recurred at intervals during the whole of our stay at the crater. Meanwhile, the air around us was extremely redolent of burning sulphur. Presently a pleasant northerly breeze fanned away the steam cloud, and at once the whole crater stood revealed to us in all its vast extent and depth." (Shackleton, 1909).

IPY 2007–2008 is a large scientific effort that is focused on the Arctic and the Antarctic (http://www.ipy.org/). It covers two full annual cycles from March 2007 to March 2009. It was organized through the International Council for Science and the World Meteorological Organization. This is the fourth Polar Year. The first was in 1882–3, the second from 1932 to 1933. The third Polar Year was part of the broader International Geophysical Year (IGY) of 1957–1958, in which many nations collaborated to exploit new technologies to understand the Earth. IGY was the

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Fig. 1. Photograph taken by Sir Douglas Mawson at the crater rim on 10 March 1908 during the first ascent of Mount Erebus. Measurements made by Mawson "made the depth 900 feet, and the greatest width about half a mile. There were evidently three well-like openings at the bottom of the caldron, and it was from these that the steam explosions proceeded". Steam is seen rising to the left in this image. Image nla.pic-vn3239568, National Library of Australia.

beginning of the modern era of scientific exploration of Antarctica. The Antarctic Treaty, which continues to govern operations by many nations in Antarctica, was an outgrowth of the IGY program.

IPY 2007–2008 was conceived as "an opportunity to demonstrate, follow, and get involved with, cutting edge science in real-time" (http://www.ipy.org). Although the on-going operation of the Mount Erebus Volcano Observatory (MEVO: http://erebus.nmt.edu/) is not funded as a special project under IPY, much of the sustained research fits within the overall framework of the IPY program, and it is appropriate to recognize the potential contribution that papers in this special issue will make to IPY. One of the themes being addressed by IPY is the present environmental state of the Polar Regions. Erebus is the largest point source of numerous gas and aerosol species to the Antarctic troposphere, some of which (including sulfur, halogen and nitrogen compounds) are of environmental significance (Radke, 1982; Zreda-Gostynska et al., 1997; Oppenheimer et al., 2005). Any account of the Antarctic environment should therefore consider Erebus as a potential atmospheric source.

It is also worth pointing out the role of Erebus and Antarctic research more generally in the development of surveillance methods capable of application in extreme environments. This extends not just to instrumentation but importantly to power and communication systems. One of the not inconsiderable achievements of the Mount Erebus Volcano Observatory has been to maintain year-round monitoring using low power, autonomous networks of seismometers and other sensors. This aspect of research in Antarctica paves the way for work in other extreme environments including deep space and planetary exploration.

The last collection of Erebus volcanology was published over a decade ago (Kyle, 1994). As much has been learnt about the volcano since then, we felt it was timely to collate the latest findings in a single volume, especially in view of the intense scientific interest in volcanic conduit processes and the environmental consequences of volcanism. In this Special Issue on "Volcanology of Erebus volcano, Antarctica" we have therefore edited a collection of 17 papers that describe aspects of the volcanology of this remarkable volcano. They span geological mapping using airborne lidar mapping (Csatho et al.) and fieldwork (Panter and Winter), tephrostratigraphy (Harpel et al.), geochronology (Kelly et al., a), geochemistry and isotope geology (Kelly et al. b, and Sims et al.), videography and seismology (Dibble et al., Aster et al), Doppler radar (Gerst et al) and acoustic (Jones et al., Johnson et al.) surveillance of explosions, thermal monitoring from the ground (Calkins et al.) and from space (Davies et al., Wright et al.), and gas geochemistry and flux measurement (Sweeney et al., Wardell et al., Oppenheimer and Kyle).

We hope the compilation will help bring further attention to the important insights Erebus provides into our understanding of volcanoes and magmatic systems, and to their environmental impacts. We hope, too, that it will stimulate ideas for future research on this and other volcanoes, and welcome feedback from readers.

This special issue owes much, naturally to the contributors, many of whom were graduate students at New Mexico Tech at one time or other, but also to the numerous colleagues who refereed manuscripts — Rick Aster, Jon Blundy, Fabrizzia Buongiorno, Alain Burgisser, Alan Cooper, Phillip Dawson, Nelia Dunbar, Ricky Herd, Mike James, Jeff Johnson, Philippe Jousset, Valerio Lombardo, Emanuele Marchetti, Larry Mastin, Kurt Panter, Maurizio Ripepe, Charlotte Rowe, Vincent Salters, Terry Spell, Andreas Stracke, Joachim Wassermann, Dave Williams, Ken Wohletz — and to the Elsevier team of Herman Engelen, Timothy Horscroft, and Lionel Wilson. We are very grateful indeed to all who participated in this project and indeed to all our colleagues and friends who have worked at or passed through Lower Erebus Hut. We especially thank the Office of Polar Programs, at the US National Science Foundation and especially our program manager Tom Wagner for his continued and wonderful support of the Mount Erebus Volcano Observatory over the years. For further information and links, please see the MEVO website: http://erebus.nmt.edu/. Over the last 8 years our field work at Erebus would have been impossible without the able support of the pilots of PHI, Inc helicopters and the U.S. Antarctic Program contractor Raytheon Polar Services Company.

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