Antarctic Science 5 (1): 105–106 (1993)

Short note
Preliminary lithofacies assessment and $^{40}Ar/^{39}Ar$ ages of Cenozoic volcanic sequences in eastern Marie Byrd Land

J.L. SMELLIE[1], W.C. MCINTOSH[2], J.A. GAMBLE[3], K.S. PANTER[2], P.R. KYLE[2] and N.W. DUNBAR[2]

[1]*British Antarctic Survey, Natural Environment Research Council, High Cross, Madingley Road, Cambridge CB3 0ET, UK*
[2]*Department of Geoscience, New Mexico Institute of Mining and Technology, Socorro, NM 87801, USA*
[3]*Victoria University, Department of Geology, PO Box 600, Wellington, New Zealand*

Accepted 1 December 1992

Introduction

Because of its remoteness, Marie Byrd Land is among the most inaccessible and least visited parts of Antarctica. However, it contains a very poorly studied, large Cenozoic alkaline volcanic province and an outstanding record of volcanism coeval with glaciation (LeMasurier & Thomson 1990). This short note describes the results of the second of two planned periods of fieldwork, which form part of the West Antarctic Volcano Exploration (WAVE) project. The background to WAVE and preliminary results of the 1989–1990 fieldwork are described in Smellie *et al.* (1990) and McIntosh *et al.* (1990). The studies described here took place between 2 November 1990 and 11 January 1991.

Mount Murphy

Early, reconnaissance studies suggested that Mount Murphy was a roughly circular, dissected basaltic to felsic shield volcano founded on a local "basement" of hydrothermally altered trachytic rocks (McIntosh *et al.* 1985, LeMasurier & Thomson 1990, Fig. 1). The main volcanic succession was interpreted as an 8 Ma-old edifice which grew up through an ice sheet. On the west side of Mount Murphy, a late parasitic cone (Sechrist Peak) was dated as 0.9 Ma, whereas Turtle Peak and Hedin Nunatak were dated as 14.7 and 20.4 Ma, respectively, and interpreted as small shield volcanoes formed prior to the main succession. Preliminary $^{40}Ar/^{39}Ar$ data ($[Ar/Ar^*]$) confirm that the main edifice of Mount Murphy is 8–9 Ma old, but indicate younger ages for Sechrist Peak (0.5 Ma) and Hedin Nunatak (6 Ma).

Within the volcanic sequences, there are a least three, major, structurally distinct associations (A–C) of dominantly hydroclastic lithofacies. Additional lithofacies (not further described here) consist of subaerially erupted lavas (mainly found above 1300 m), cinder and tuff cones. One of the cinder cones contains ultramafic nodules.

Lithofacies association A is formed of diverse sedimentary lithofacies, including massive-graded gravelly conglomerate, stratified gravelly sandstone, graded, laminated fine sandstone-mudstone, matrix-supported breccia, and isolated slump sheets and slurried beds. Most of the lithofacies are sandy-gravelly high-density turbidites, but the breccias represent sandy debris flows or density modified grain flows. The fine sandstone-mudstone beds are classical T_{ae} turbidites, possibly deposited from low-density residual flows derived from the high-density turbidity currents. The lithofacies are dominated by vesicular vitroclasts and they represent resedimented hyalotuffs originally formed during phreatomagmatic eruptions. Evidence for syn-sedimentary deformation is common and includes normal faulting, convolute stratification and partial fluidization. Large-scale, channel-like unconformities are ubiquitous and are interpreted as slope scars left following sector collapse of the growing volcanic piles. There is a strong similarity to subglacial tindar sequences (e.g. Jones 1969).

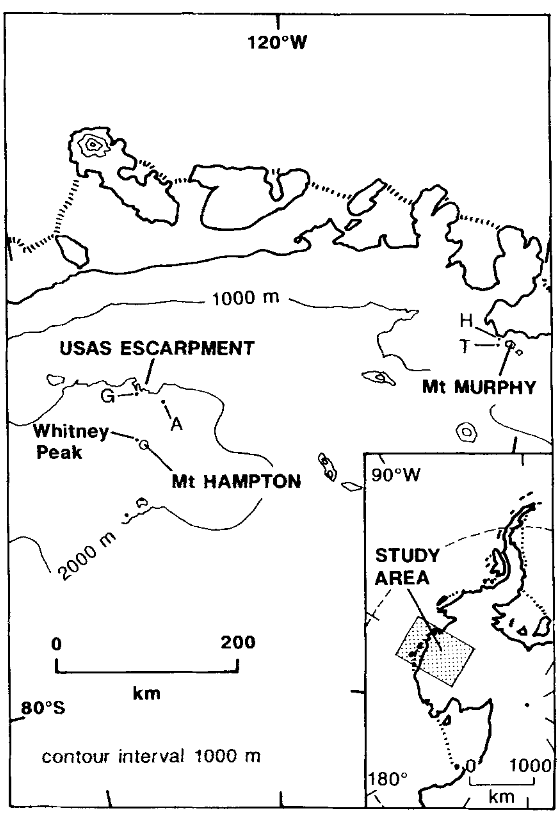

Fig. 1. Simplified map of eastern Marie Byrd Land, showing the location of the outcrops described in the text. A = Mt Aldaz; G = Mt Galla; H = Hedin Nunatak; T= Turtle Peak.

https://doi.org/10.1017/S0954102093000136 Published online by Cambridge University Press

Lithofacies association B mainly consists of planar-stratified hyaloclastite, in large-scale foreset units overlain by subhorizontal subaerial lava. Together, these two lithofacies comprise a hyaloclastite delta structural association. Additional subordinate lithofacies include massive hyaloclastite, graded-massive conglomerate and gravelly sandstone, sandy breccia, laminated fine to coarse sandstone, massive block-jointed lava, and pillow lava. Most of the sedimentary lithofacies are varieties of cohesionless debris flow deposits, but high-density turbidites are also rarely present. One sequence (nunatak SE of Turtle Peak) is capped by a degraded cinder cone formed of crudely planar stratified, palagonitised scoria. Multiple hyaloclastite delta sequences are very well exposed at Hedin Nunatak and Turtle Peak and a subglacial setting for the volcanism, analogous to tuyas (e.g. Jones 1969) is possible.

Lithofacies association C forms a repetitive succession > 700 m thick below Sechrist Peak. It contains multiple, moulded, polished and/or striated "pavements", each of which is overlain successively by massive, grey, polymict diamictite, stratified sandstone and conglomerate, heterogeneous massive hyaloclastite and lava, and finally, welded fall breccia (not always present). The diamictite resembles tillite, whereas the stratified sediments are formed of monomict, vesicular vitroclasts and are phreatomagmatic hyalotuffs resedimented by traction currents. There is a striking resemblance to valley-confined subglacial sequences in Alexander Island, Antarctic Peninsula (Smellie *et al.* in press). However, the eruptions at Mount Murphy were more extensive and were probably subaerially exposed in the closing stages of effusive phases.

USAS Escarpment

Planar and dune-form, tephritic surge tuffs dominate a small outcrop 10 km ESE of Mount Galla (28.2 Ma: LeMasurier & Thomson 1990), whereas the 150 m thick sequence at Mount Aldaz (19.4 Ma [Ar/Ar*]) comprises a sequence of hawaiite lavas, monomict lithic breccias and scoria resting unconformably on a gently sloping dioritic "basement". The Mount Aldaz sequence also contains palagonitised strombolian and phreatomagmatic (surge) tephra. The eruptive settings for these two sequences are uncertain.

Mount Hampton

Despite its age, the Miocene (11–12 Ma [Ar/Ar*]) Mount Hampton stratovolcano is virtually undissected. Only the upper 700 m of the volcano extends above the surrounding ice sheet and the 6 km wide caldera is filled by ice. Thus, only the final effusive phases are exposed for study. These comprise widespread, thin (<20 m) phonolite lavas of pre-caldera age, and several younger basanite cinder cones with abundant ultramafic nodules. One distinctive lava is anorthoclase megaphyric, containing c. 50% anorthoclase phenocrysts up to 4 cm long. Blocks of near-*in situ* stratified diamictite (tillite?) are locally abundant and may represent the youngest stratum on the volcano.

Whitney Peak is another Miocene (13.2 Ma [Ar/Ar*]) stratovolcano with a broad (5 km) ice-filled caldera cross-cut by the Mount Hampton volcano. Like Mount Hampton, there are no good cross-sectional exposures and the NW outer slopes are draped by thin (6–12 m) foliated trachyte lavas. Two, younger, hawaiite and benmoreite cinder cones are also present, one of which is dissected by the caldera and contains abundant upper crustal xenoliths.

Conclusions

Although only subaerial volcanism is recorded in the Mount Hampton and Whitney Peak volcanoes, the history of hydrovolcanism preserved at Mount Murphy appears to indicate interaction between the volcanism and fluctuating former ice sheets (or possibly sea-level) in a far more complex manner than was formerly recognized. Our field studies indicate that the volcaniclastic lithofacies at Mount Murphy were dominated by gravity-driven processes, which delivered and redistributed coarse sediment down the steep flanks of the volcano. By our interpretation, the outcrops at Hedin Nunatak, Turtle Peak and the un-named nunatak near Turtle Peak are probably near-vent accumulations representing small satellite centres independent from the Mount Murphy shield.

Acknowledgements

This work was supported by the British Antarctic Survey, National Science Foundation grant DPP-8816342, and the New Zealand University Grants Committee. Thanks are also due to W. Atkinson and P. Rose for assistance in the field, and to the U.S. Navy VXE-6 squadron. $^{40}Ar/^{39}Ar$ dating was performed in cooperation with Mick Kunk at the USGS Geochronology Laboratory in Reston, Virginia.

References

Jones, J.G. 1969. Intraglacial volcanoes of the Laugarvatn region, south-west Iceland - I. *Journal of the Geological Society of London*, **124**, 197–211.

LeMasurier, W.E. & Thomson, J.W. 1990. *eds.* Volcanoes of the Antarctic plate and southern oceans. *Antarctic Research Series*, **48**, 1–487.

McIntosh, W.C., LeMasurier, W.E., Ellerman, P.J. & Dunbar, N.W. 1985. A re-interpretation of glacio-volcanic interaction at Mt. Takahe, and Mt. Murphy, Marie Byrd Land, Antarctica. *Antarctic Journal of the United States*, **20**, (5), 7-59.

McIntosh, W.C., Panter, K.S., Smellie, J.L. & Gamble, J.A. 1990. Austral summer 1989–90 at the Executive Committee Range, Marie Byrd Land, Antarctica. *Antarctic Journal of the United States*, **25**(5), 5-7.

Smellie, J.L., McIntosh, W.C., Gamble, J.A. & Panter, K.T. 1990. Preliminary stratigraphy of volcanoes in the Executive Committee Range, central Marie Byrd Land. *Antarctic Science*, **2**, 353-354.

Smellie, J.L., Hole, M.J. & Nell, P.A.R. In press. Late Miocene valley-confined subglacial volcanism in northern Alexander Island, Antarctic Peninsula. *Bulletin of Volcanology*.