Geophysical evidence of Ice-Magma interactions beneath the West Antarctic Ice Sheet in the West Antarctic Rift System

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Rignot, et al., 2011
Late Cenozoic Volcanic Center, LeMasurier and Thomson, 1990

Active volcanic centers

West Antarctic Rift

Mt Erebus (0-1 Ma)

Mt Melbourne (≤ 0.26 Ma)

16-19 Ma

Takahe (≤ 0.75 Ka)

PIG

Thwaites

Hudson
Mt Melbourne (≤ 0.26 Ma)

Aeromagnetic anomaly superposed on enhanced Landsat image
Frequency of occurrence of short-wavelength, high-amplitude magnetic anomalies

PIG

Thwaites

SOAR

Ferraccioli et al, 2002
Luyendyk et al, 2003

UW, Behrendt, 1964

SPRI, Drewry, 1983
Mt CASERTZ

Magnetic anomalies

C.I. 10 nT
Surveyed in 1991

Magnetic Anomaly

Bed Topography

Mt CASERTZ

5 km

Magnetism

Topography

Bed

Mt CASERTZ

Surveyed in 1991
Victoria Land Basin, Ross Sea shelf

Magnetic anomalies

Seismic Reflection Section

Observed

Modeled

Modeled Magnetic Anomalies
Bed Topography
Bed topography
Subglacial Volcanic Centers

![Subglacial Volcanic Centers Diagram]

- Magnetic Anomaly, nT
- Bed Relief, m

- Subaerially Erupted Edifices
- Subglacially Erupted Edifices
Possible intrusions

Volcanic ridge(?)
(Tinto et al. 2010)

Thwaites

PIG

Gohl et al., 2008

- Ferraccioli, et. al, 2002
- Luyendyk et al., 2003
- Aeromagnetic surveys
Estimated Basal Melting

Tulaczyk and Hossainzadeh, 2011

Wright and Seigert, 2011
Vogel and Tulaczyk, 2006
Conclusions

The aeromagnetic method has proven the most useful geophysical tool for studying subglacial volcanic rocks since early surveys in the 1950s. The Central West Antarctica (CWA) aerogeophysical survey covering ~50,000 km² over the WAIS, consisting of 5-km orthogonal line spaced aeromagnetic, radar ice sounding and aerogravity measurements is a unique Antarctic data set.

These data indicate numerous high-amplitude (100->1000 nT), 5-50km width, shallow-source, magnetic anomalies over a very extensive area (>500,000 km²) mostly resulting from subglacial volcanic eruptions. I previously interpreted these anomalies in the CWA survey as ~1000 "volcanic centers" requiring high remanent normal magnetizations in the present field direction; >80% of these anomaly sources at the bed of the WAIS, appear modified by moving ice, requiring a younger age than the WAIS (~25 Ma).
Exposed volcanoes in the WR are <34 Ma, but at least four are active today. Most "volcanic centers" are buried beneath the WAIS; if a few of these are active today, subglacial volcanism may well have a significant effect on the WAIS regime.

Aerogeophysical data (Blankenship et al., 1993, Mt. CASERTZ; Corr and Vaughan, 2008, near Hudson Mts.) indicated active subglacial volcanoes and suggested volcanic effects on WAIS dynamics. Wingham et al. (2009) reported increasing volume loss from 2.6 to 10.1 km³/yr from 1995 to 2006 for the Pine Island Glacier. This may be partly from Hudson Mts subglacial-volcanism.

The present rapid changes in stability of the WAIS resulting from global warming, could be accelerated by subglacial volcanism.