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

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Radar Ice Sounding and Aeromagnetic Surveys reported over the West Antarctic Ice Sheet WAIS have been interpreted as evidence of subglacial eruptions. Several active volcanoes have shown evidence of eruption through the WAIS and several other active volcanoes are present beneath the WAIS (e.g. Corr et al., 2009; Blankenship et al., 1993) reported from radar ice sounding and aeromagnetic data (Behrendt et al., 1995; 2004). Aeromagnetic profiles (>10,000 km) acquired in the early 1960s over the West Antarctic Ice Sheet (WAIS) combined with coincident aeromagnetic and radar ice sounding in 1978-79 indicated numerous high-amplitude, shallow-source, magnetic anomalies over a very extensive area of the volcanically active West Antarctic rift system interpreted as caused by subglacial volcanic rocks. These early aerogeophysical surveys defined this area as >500,000 km^2. Five-kilometer spaced coincident aeromagnetic and radar ice sounding surveys since 1990 provide three dimensional characterization of the magnetic field and bed topography beneath the ice sheet. These 5-50-km width, semicircular magnetic anomalies range from 100->1000 nT as observed ~1 km over the 2-3 km thick ice have been interpreted as evidence of subglacial eruptions. Behrendt et al, (2005, 2008) interpreted these anomalies as indicating >1000 "volcanic centers." requiring high remanent normal (and at least 10% reversed) magnetizations in the present field direction. These data have shown that >80% of the anomaly sources at the bed of the WAIS, have been modified by the moving ice into which they were injected, requiring a younger age than the WAIS (about 25 Ma). Although exposed volcanoes surrounding the WAIS extend in age to ~34 m.y., Mt Erebus, (<1 Ma) Mt. Melbourne, (<0.26 Ma), and Mt. Takahae (<0.1 Ma) are examples of exposed active volcanoes in the WAIS area. However, the great volume of volcanic centers is buried beneath the WAIS. If only a very small percentage of these >1000 volcanic, magnetic-anomaly sources are active today, or in the recent past, in the drainage area of the WAIS, subglacial volcanism may still have a significant effect on the dynamics of the WAIS. Interpreted active subglacial volcanism is revealed by aerogeophysical data reported by Blankenship et al., (1993, Mt. Casertz), and Corr and Vaughan, (2008, near Hudson Mts.), who raised the question of possible volcanic effects on the regime of the WAIS. Wingham et al. (2009) reported an average rate of volume loss from 2.6 to 10.1 km^3 /yr from 1995 to 2006 for the Pine Island Glacier in the vicinity of the active subglacial volcano near the Hudson Mts. Probably wet-based areas of the WAIS would be the most likely to be impacted. Here I discuss these geophysical data over the WAIS, and conclude that even if there is a very low probability, future effects on the stability of the WAIS and associated sea-level rise should not be ignored, as changes observed in the past 20 years resulting from global warming, could be accelerated by subglacial volcanism.