Subglacial volcanism beneath the West Antarctic Ice Sheet in the West Antarctic Rift System, from aeromagnetic and radar ice sounding - Thiel Subglacial Volcano as possible source of the ash layer in the WAISCORE

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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 volcanic eruptions over a very extensive area (>500,000 km^2!) of the volcanically active West Antarctic rift system interpreted as caused by subglacial volcanic rocks. Several active volcanoes have shown evidence of eruption through the WAIS and several other active volcanoes are present beneath the WAIS reported from radar and aeromagnetic data. 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. Comparison of a carefully selected subset of ~400 of the >1000 high-amplitude anomalies in the CWA survey having topographic expression at the glacier bed, showed >80% had less than 200-m relief. About 18 high-amplitude subglacial magnetic sources also have high topography and bed relief (>600 m) interpreted as subaerially erupted volcanic peaks when the WAIS was absent, whose competent lava flows protected their edifices from erosion. All of these would have high elevation above sea-level, were the ice removed and glacial rebound to have occurred. Nine of these subaerially erupted volcanoes are concentrated in the WAIS divide area.

Behrendt et al., 1998 interpreted a circular ring of positive magnetic anomalies (Fig. 1a) overlying the WAIS divide as caused by a volcanic caldera. The area is characterized by high elevation bed topography (Fig.1b). The negative regional magnetic anomaly surrounding the caldera anomalies was interpreted as the result of a shallow Curie isotherm. High heat flow inferred from temperature logging in the WAISCORE (G. Clow 2012, personal communication; Conway, 2011) and a prominent volcanic ash layer in the core (Dunbar, 2011) are consistent with the magnetic data. A prominent subaerially-erupted subglacial volcano, here named Mt Thiel, about 100 km distant to the NE, at approximately 78^o 25’ S, 111^o 20’ W, may be the source of the ash layer. This peak is characterized by a ~400-nT positive magnetic anomaly which Behrendt el, 2004, modeled as having apparent susceptibility contrasts of .034 and .15 SI (Fig. 2). From its appearance (and the moat surrounding it), Mt. Thiel has subsided somewhat since initial eruption as is the case for Mt. Erebus and the Hawaiian Island chain. I suggest that Mt Thiel, about 100 km distance from the WAISCORE, may be the source of the ash layer. The present rapid changes in the WAIS resulting from global warming could be accelerated by subglacial volcanism. These results are discussed in Behrendt et al., 2012; Figs. are from this paper.

References

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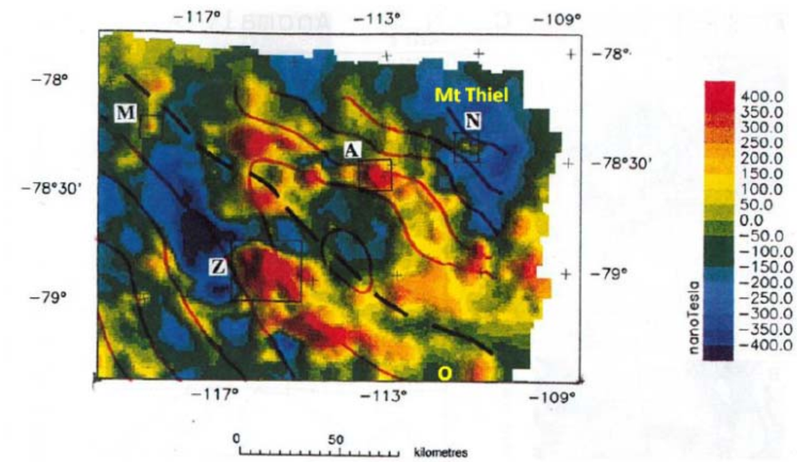

Fig. 1 (a) Shaded relief aeromagnetic anomaly map and bed maps of WAIS divide area from Behrendt et al., 2012. Circular group of anomalies define the interpreted caldera. Anomalies N, M, and N (Mt. Thiel) are modeled as shown in that paper. Anomaly A is modeled as shown in Behrendt et al., 2002. Location of WAISCORE is indicated by "o". WAIS divide (dashed black line) and 50-m snow surface contours are indicated; the dome elevation is 1800 m. Anomaly N overlies the subaerially erupted volcano Mt Thiel.

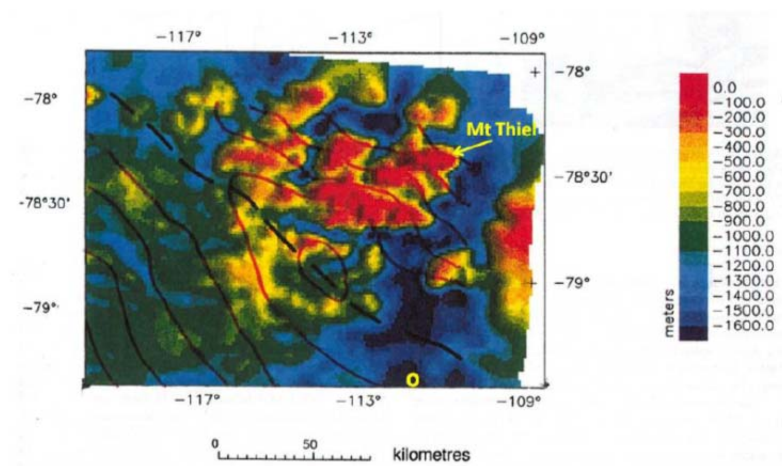

Fig. 1b. Shaded bed relief of WAIS divide area, from Behrendt et al., 2012. Note smoothed caldera rim. Detailed bed topography of Mt. Thiel (bed elevation ~440 m; bed relief ~1800 m) is shown in Fig. 2. Other features as in (a).

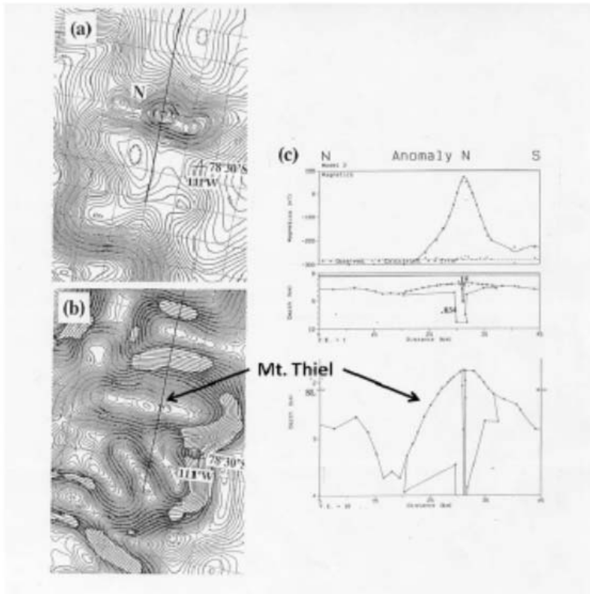

Fig. 2. Aeromagnetic (a) and bedrock elevation (b) maps of area of anomaly N (Mt. Thiel). Note the suggestion of a "moat" bordering the base of Mt.Thiel. (c) Theoretical 2 1/2 D model fit to aeromagnetic profile for anomaly N. Central body has strike length of 2.5 km to west and 2 km to east. Outside body has strike length of 8 km to west and east respectively. Note the surrounding magnetic "low" resulting from the inferred shallow Curie isotherm here and in Figs. 1a .Contour interval 10 nT. Grid survey lines are spaced at 5 km, and the long edges of the map trend true north. Location of modeled profile is indicated. (b) Bedrock elevation in area of anomaly N. Contour interval (CI) 20 m. Grid lines are the same as in (a). Location of modeled profile is shown. (c) Theoretical 2 1/2 D (two-and-one-half-dimensional, a special case of three-dimensional model in common usage) model fit to aeromagnetic profile for anomaly N. Apparent susceptibilities indicated in SI. VE= vertical exaggeration.