

What happened to the volcanic debris erupted beneath the WAIS?

*John C. Behrendt, David Morse, and Donald D. Blankenship
INSTAAR, University of Colorado
U.S. Geological Survey, Denver
UTIG, University of Texas, Austin*

Aeromagnetic and radar ice sounding results from the 1991-1997 Central West Antarctica (CWA) aerogeophysical survey over part of the West Antarctic Ice Sheet (WAIS) and subglacial area of the volcanically active West Antarctic rift system have enabled detailed examination of specific anomaly sources. These anomalies, previously interpreted as caused by late Cenozoic subglacial volcanic centers, are compared (Behrendt et al., 2004) to newly available glacial bed-elevation data from the radar ice sounding compilation of the entire area of the aeromagnetic survey to test this hypothesis in detail. We examined about 1000 shallow source magnetic anomalies for bedrock topographic expression. More than 400 steep-gradient, shallow-source, magnetic anomalies observed over the WAIS in the CWA survey area have associated bed topography directly beneath them, of approximately the same width as the anomalies, and which are interpreted as the tops of the sources of these anomalies. The magnetic anomalies examined range in amplitude from 40 to >1000 nT which is very high considering 1 km flight elevation above the WAIS surface and 2-3-km ice thickness. The great bulk of the anomaly sources at the base of the ice have low bed relief (80% <200m), which we interpret as indication of removal of volcanic edifices comprising hyaloclastite, pillow breccia, and other volcanic debris injected into the moving ice during eruption. The sources must be >1-2 km (as shown by models) with very high magnetizations. About 18 of the anomalies, half concentrated in the area of the WAIS divide, have high elevation topography and high bed relief, up to 1600 m. There are no high bed relief (>600 m) magnetic anomaly sources that do not have high elevation topography. All of these high-topography magnetic sources would be above sea level after ice removal and glacial rebound. Because of their form similar to exposed volcano's in the WAIS area with edifices primarily comprising sub-aerially erupted volcanic flows, which have resisted glacial erosion, we infer that these high topographic volcanic sources are also subaerially erupted volcanoes. A number of anomaly sources are very shallow beneath the very smooth glacial bed in the area of rapidly moving Ice Stream D (Bindshadler Ice Stream), which probably comprises unconsolidated sediment, and yet have no observable bed relief. A few of the very shallow source "volcanic" anomalies overlie the ice shelf just downstream of the grounding line of Ice Stream D, suggesting a causal relationship, if the volcanism is recent. Two core holes (Elston and Bressler, 1986; Barrett, 1989) in the McMurdo area near Ross Island beneath the continental shelf show a range of ages of late Cenozoic volcanic material in the sedimentary section from Pleistocene to mid Oligocene. Because Erebus Volcanic Province (Kyle, 1990) exposures are all much younger than the oldest volcanic detritus in these core holes (e.g. Mt. Terror on Ross Island at <15 Ma and Mt. Morning at <19 Ma are the oldest K/Ar ages reported in this group), this detritus must have been carried in from more distant areas. The late Cenozoic volcanism has been active in the WAIS area since >30 Ma, the WAIS since >10 Ma, but the oldest ice which presently comprises the WAIS is likely only 100-200 Ka at most. Therefore, if the glacial removal of subglacially erupted volcanic edifices has been active throughout the existence of the WAIS in the area of the inferred volcanic centers we might not expect to see much volcanic detritus in the few core holes into the WAIS. Little or none has been reported. Nonetheless, we might expect recovery of more volcanic material within or at the base of the ice as more coring into the WAIS at inferred volcanic centers or immediately downstream of these is done in the future, if volcanism has been active upstream during the period of present ice deposition.