Evidence for thicker ice in interior West Antarctica

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Abundant evidence in the Transantarctic Mountains (Denton 1989a, 1989b, 1991, pp. 55–86, and 1992, pp. 403–432) as well as local data from nunataks of Marie Byrd Land (e.g., Doumani 1964, pp. 665–675; LeMasurier 1972, pp. 139–141) suggest that coastal interior portions of the west antarctic ice sheet were on the order of several hundred meters or more thicker during the Late Pleistocene glacial maximum than they are now. Furthermore, marine geologic data show the grounding line of this ice sheet to have advanced 1,150 kilometers (km) beyond its present position through the Ross Sea at this time (Anderson 1991, pp. 87–110). Although these and other data suggest an overall thicker west antarctic ice sheet, analysis of total gas content in the Byrd Station ice core has been interpreted to indicate that interior portions of the ice sheet were 200 meters (m) to 350 m lower than now about 18,000 years ago (Raynaud and Whillans 1979, pp. 289–291, 1982, pp. 269–273). Their major rationale for this interpretation is that lower temperatures at that time allowed lower total precipitation than present in interior portions of the ice sheet. During the 1994–1995 field season, we found evidence for a once thicker ice sheet on the flanks of Mount Waesche. Mount Waesche is the southernmost nunatak of the volcanic Executive Committee Range, about 350 km inland from the coast of West Antarctica (figure 1*A*).

The present general level of the ice sheet at Mount Waesche is approximately 2,000 m above sea level. Ice flows southward, around the volcano, controlled by a major dome of the west antarctic ice sheet centered on the northern nunatak of the range (figure 1*A*). The southern flank of Mount Waesche rises 1,200 m from the ice surface to the summit caldera and supports local glacier tongues. These terminate 2,400 m above sea level, 400 m above the surrounding ice sheet.

Ice-cored lateral moraines at the current ice-sheet elevation flank the southwest side of Mount Waesche (figures 1*B* and 2). The moraine ridges appear to be continuous with narrow bands of debris-rich ice extending southward as a tail from the nunatak. Above these on the western to southwestern volcano flank is a band of lateral moraine extending up to at least 80 m above the immediately adjacent ice-sheet surface (figures 1*B* and 2). The upper 20 to 30 m occurs as an undulating terrace of subdued relief that parallels the present ice-sheet surface as its level falls southward. Clasts rarely project more than a meter above the surface. Extending down to the present ice surface from this terraced segment, the moraine character varies but includes sharp-crested discontinuous ridges and flatter undulating surfaces. Clasts on this lower part of the moraine band rise up to 2 m above the surface. Clasts of the whole moraine are primarily fine grained

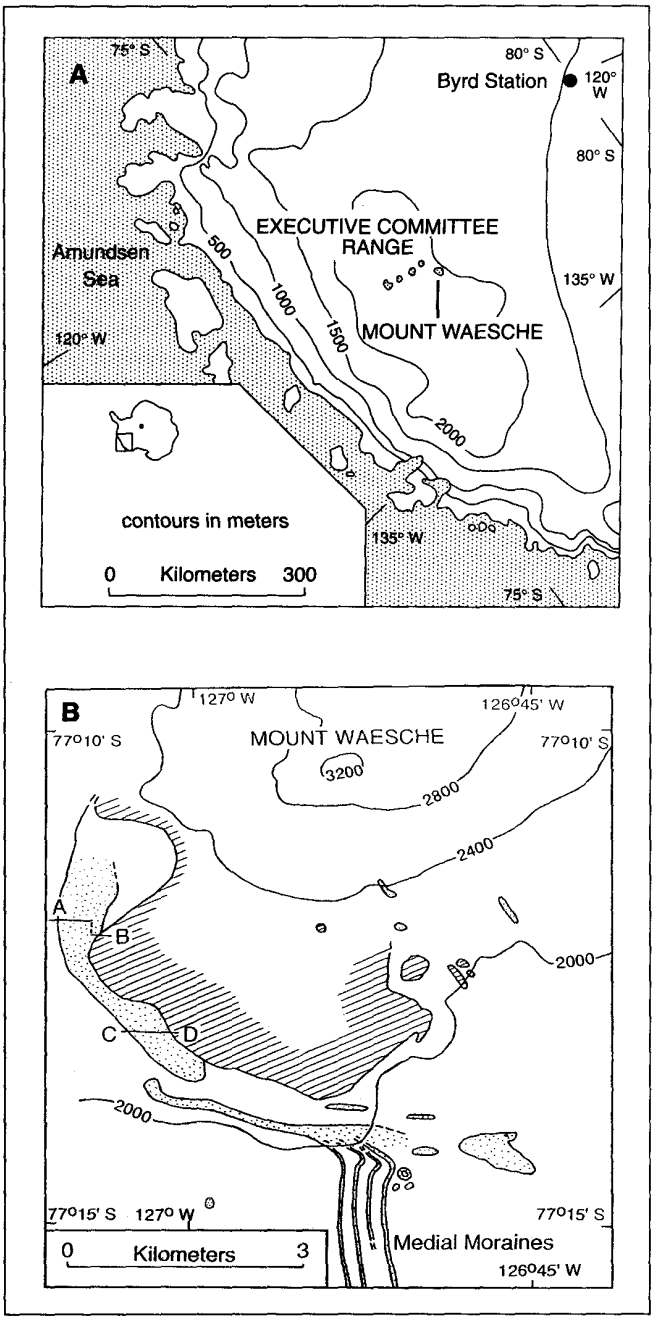

Figure 1. *A.* Index map of Antarctica and section of Marie Byrd Land showing the Executive Committee Range and surrounding ice dome in contours (Drewry 1983). *B.* A field geological sketch map of the southwestern flank of Mount Waesche showing the distribution of ice-sheet moraines (dotted) and bedrock (hatched).

Figure 2. Photograph looking west across the lateral moraine band and the ice-sheet surface beyond on the southwestern flank of Mount Waesche. Note snowmobile for scale on the right foreground.

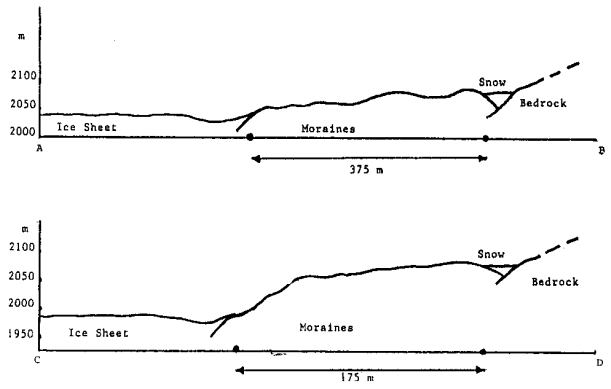

Figure 3. Measured transects A-B and C-D (figure 1*B*) across the lateral moraine band on the southwestern flank of Mount Waesche along which samples were collected for cosmogenic surface exposure dating.

and of basaltic composition with some gabbro/diorite clasts; this is consistent with reports of previous bedrock studies (e.g., LeMasurier 1990, pp. 147–163). No clastic sedimentary rocks nor quartz-rich igneous rocks were observed. Figure 3 shows two measured transects across the moraine band along which surface samples were collected for cosmogenic exposure dating.

The observed lateral moraines clearly indicate an ice-sheet surface that was higher than present at Mount Waesche. This may indicate that the west antarctic ice sheet as a whole was thicker at interior sites in the past. We have no ages for the moraines at this writing. Samples collected along the transect for cosmogenic surface exposure age analysis may provide some control. We suggest that at least some segments of the whole major lateral moraine band may be a product of the last glacial maximum.

A reconnaissance trip to Mount Sidley volcano, 25 km northeast of Mount Waesche, revealed some clear relationships between local glacier and ice-sheet flow. Further investigation of these and other morainal relationships we observed there may supplement those from Mount Waesche. Our observations of elevated ice-sheet moraines at Mount Waesche suggest that similar investigations at other nunataks of interior West Antarctica may be fruitful.

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