Geomorphological and sedimentary evidence for a marine environment in Ellsworth Mountains – West Antarctica

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Introduction and Methods

Past fluctuations of the West Antarctic Ice Sheet (WAIS) are of fundamental concern for the possibility of WAIS collapse in the future and a consequent rise in global sea level (Hein et al., 2016).The WAIS volume has undergone fluctuations since the Quaternary, from expansion events, with ice covering local mountains and valleys, to the retraction events with exposure of subglacial topography.

There is evidence for the sensivity of the WAIS to climate variations during the last glacial cycle, especially in its peripheral areas. Marine biological studies suggest the disappearance of a substantial part of ice sheet during the interglacials, creating an open seaway between the Pacific and the Atlantic sectors (Barnes and Hillenbrand, 2010; Strugnel *et al*., 2012). Hein *et al.* (2016) suggests the continuous presence of an ice sheet in southern Ellsworth Mountains uplands for 1.4 Ma, while the sectors near the grounding line have experienced loss of marine-based portions during some interglacials throughout the Pleistocene.

Objective – This work presents new geomorphological and sedimentary evidence for the marine environment in Elephant Head valley (Union glacier area) in the southern part of the Ellsworth Mountains (79º49,298'S / 83º20,426' – Figure 1).

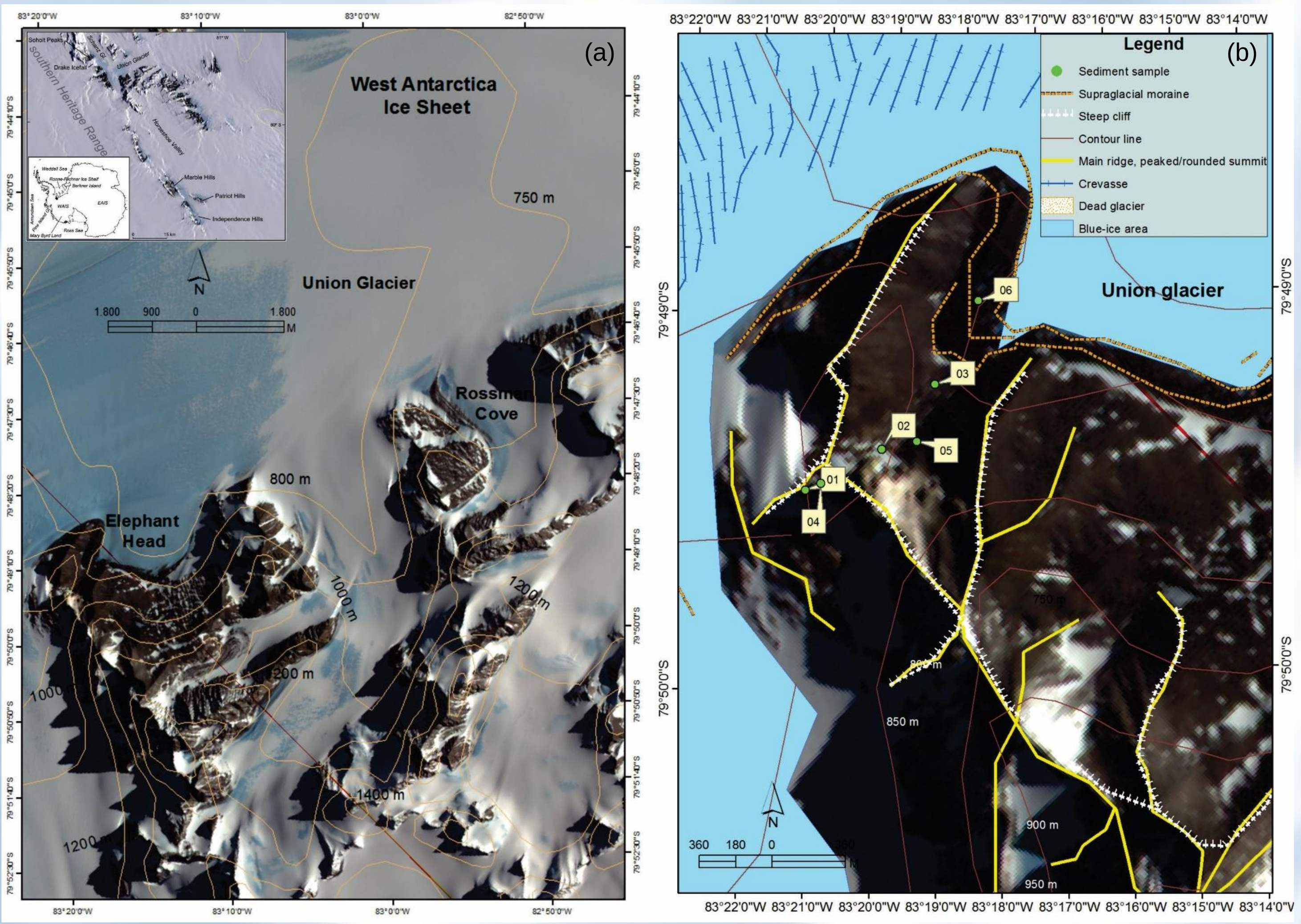
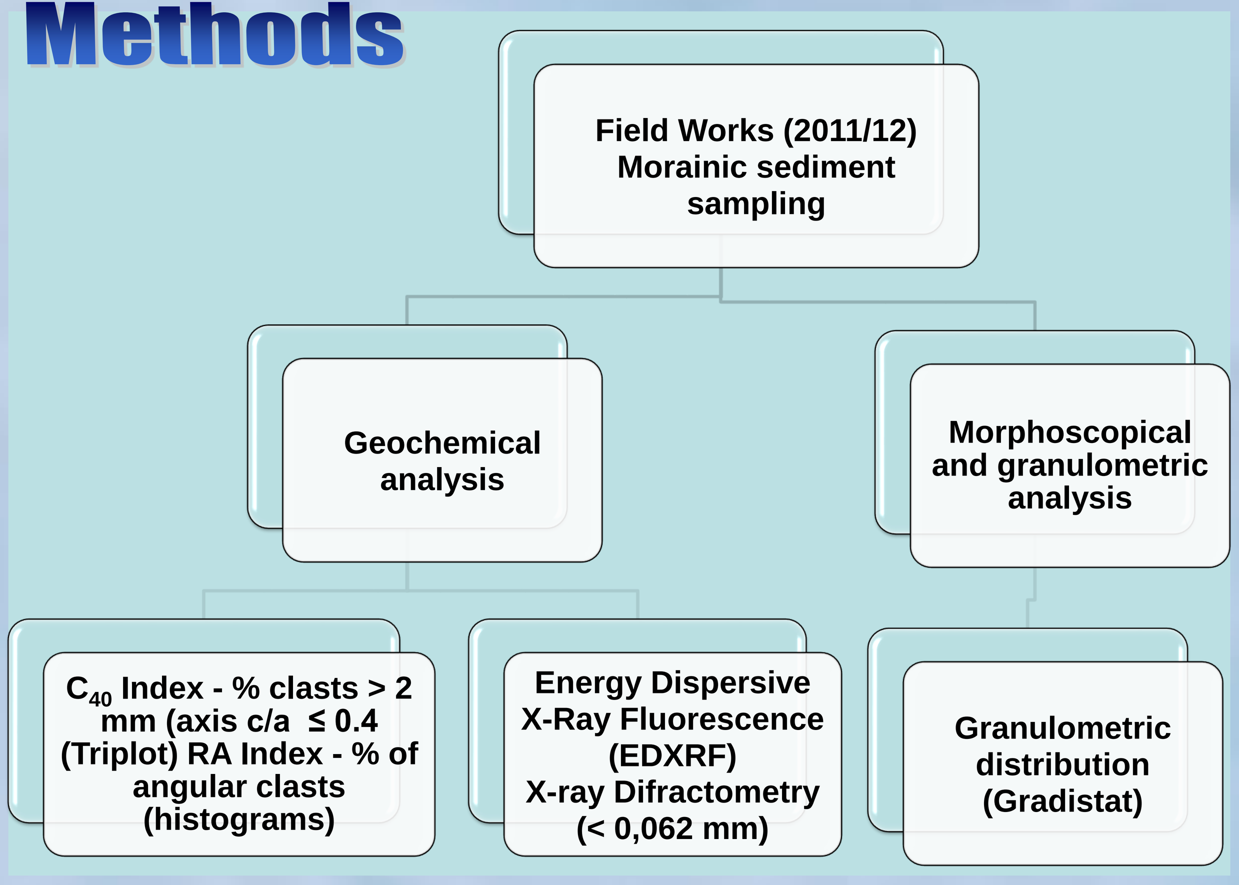


Figure 1: Location map of Ellsworth Mountains: (a) Elephant Head Valley; (b) Geomorphological map based on ASTER imagery (2010).

Methods



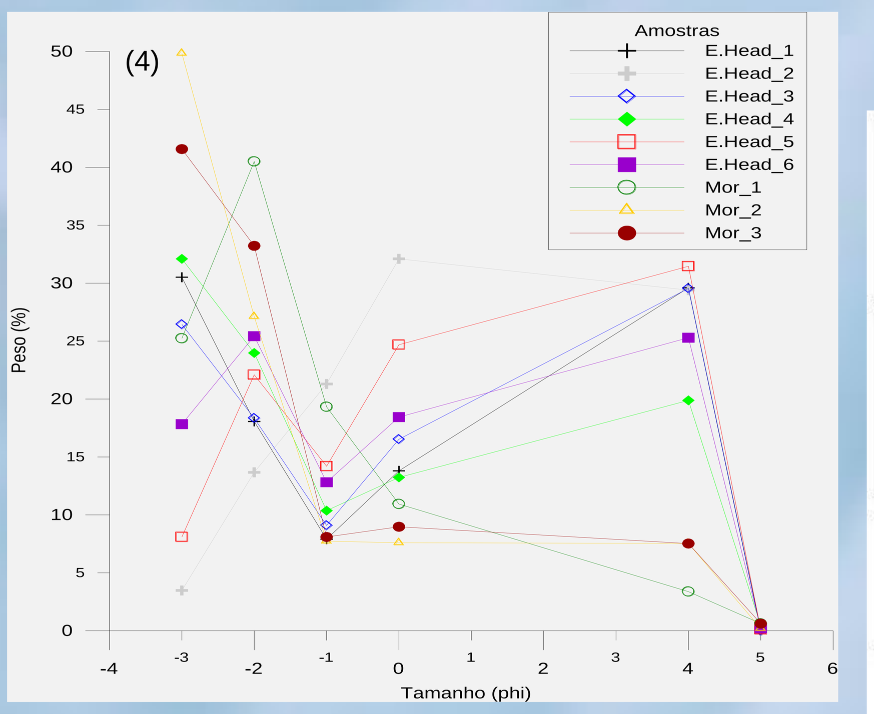


Figure 4: Plot of grain size data from morainic sediments.

MORPHOLOGICAL AND GEOCHEMICAL ANALYSIS

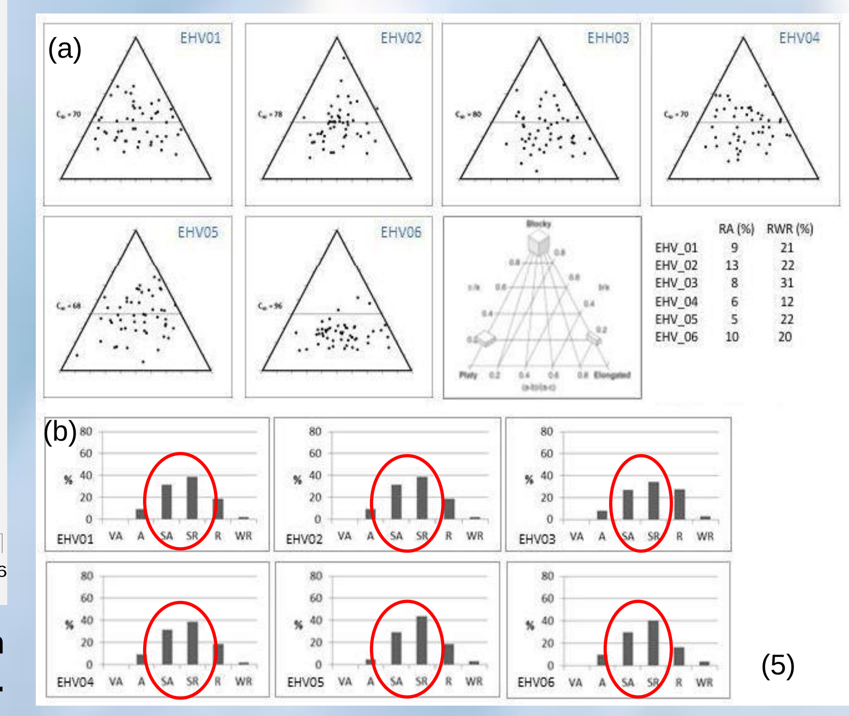


Figure 5: Clast morphological data. (a) Ternary diagrams (clast shape); (b) Histograms (roundness), C_{40} index (percentage of clasts with *c:a* ratio of ≤ 0.4), RA index (percentage of very angular clasts), and RWR index (percentage of well-rounded and rounded clasts).

Results and Discussions

GEOMORPHOLOGICAL FEATURES

- Marine-derived deposits occur in association with the glacial and periglacial deposits; such sediments are characterized by grey straight-crested ripples on sandstone, and asymmetric ripples within quartzite immediately overlying grey sandstone with flat-crested ripples (Figure 2). Discontinuous sandstone blocks cover the ground of the valley slopes, between low rounded dome-like bodies of conglomerates and carbonate (Figures 3 and 4). The conglomerate blocks consist largely of medium to large pebbles, with some incrusted ripple marks.
- Predominance of gravel and sand, and reduced presence of fine material due to wind action and aridity conditions (Figure 5). The clasts are subangular and subrounded with high C_{40} index, inidcating low transport distance.

Figure 3: Dome of conglomerate in the central part of the valley, surrounded by blocks of sandstone. Rhodes Bluff peak is visible in the background.

Figure 4: Rounded domes of carbonate surrounded by sandstone and quartzite blocks, which spread over the surface, from the base of the slope.

Figure 2: Field photographs of asymmetric ripple marks covering symmetrical ripples on the sandstone surface.

- Extensive deposits of mixed sandstone, quartzite and limestone cover the valley floor and the base of the slopes (Figure 6).
- Highest peaks if carbonate / calcite in sediments deposits located amidst 800 and 900 m, except sample 6, in the supraglacial moraine and influenced by other processes, such as slopes activities (and 7).

Figure 6: Contents of the main groups of minerals and other particle.

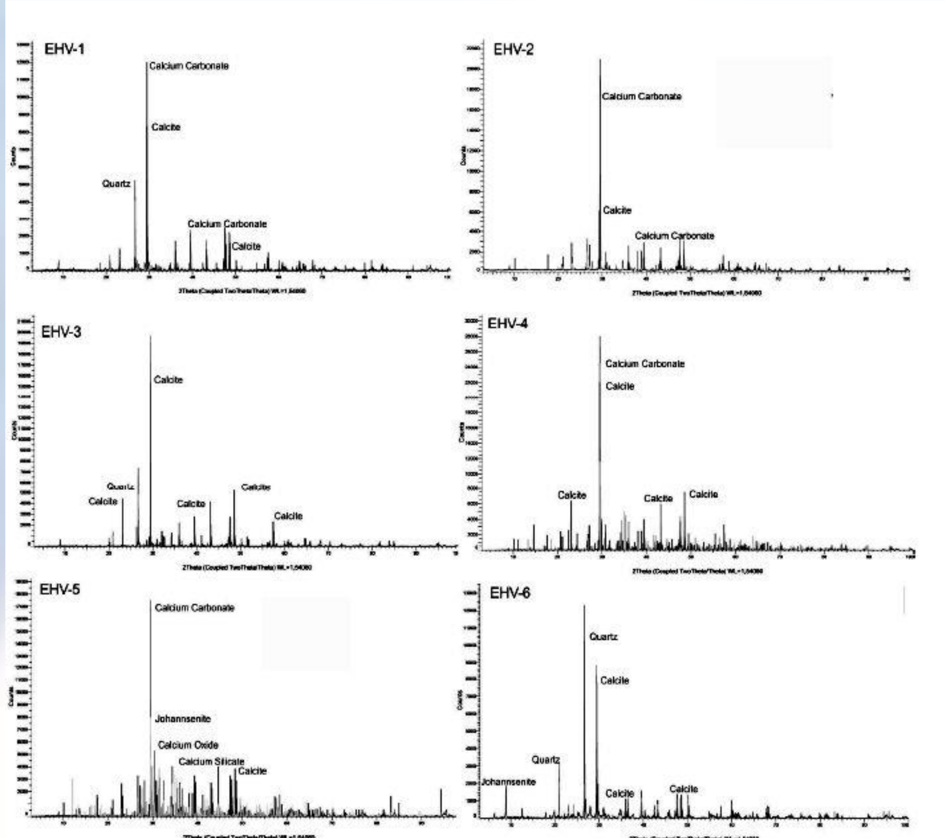


Figure 7: X-ray diffraction results of fine-grained sediments.

- Studies in the Patriot and Independence Hills (70 km south) suggest an intact ice sheet in the southern part of the Ellsworth Mountains between 1.4 and 3.5 Ma (Hein *et al*., 2016; Sugden *et al*., 2017).

- The carbonate components, the grain size and the morphometric features of the sediments collected in the morainic deposits indicate the valley as a main source area. In this case, since there was no infilling of the valley floor by the elevated sea waters, the sediments and geomorphic features may be the product of older marine conditions.

Conclusion

- The morainic deposits in the Elephant Head valley may be prior to the Pleistocene, remaining in the valley even with variations of the ice sheet. Sediments may be older than those dated so far in the region.
- The marine paleoenvironment was uplifted and later covered by glaciers.
- Other agents has contributed to sediment deposition in the valley by reducing the thickness of the ice sheet since the LGM.
- Glacial and aridity conditions have preserved the marine-derivated sediments.
- Definitive interpretation of deposits as pre-Pleistocene depends on the dating of sediments and rocky blocks.

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Support