Geophysical Research Abstracts
Vol. 16, EGU2014-8722, 2014
EGU General Assembly 2014

Geophysical glimpses into the Ferrigno Rift at the northwestern tip of the West Antarctic Rift System

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The West Antarctic Rift System (WARS) forms one of the largest continental rift systems on Earth. The WARS is of major significance as it forms the lithospheric cradle for the marine-based and potentially unstable West Antarctic Ice Sheet (WAIS). Seismic refraction, reflection, aeromagnetic, gravity and drilling in the Ross Sea have revealed most of what we know about its structure, tectonic and magmatic patterns and sedimentary basins. Aerogeophysical research and passive seismic networks have considerably extended our knowledge of the WARS and its influence on the overlying WAIS in the Siple Coast and Amundsen Sea Embayment (ASE) regions. The Bellingshausen Sea Embayment region has however remained largely unexplored, and hence the possible extent of the WARS in this sector has remained poorly constrained.

Here we use a combination of reconnaissance ground-based and airborne radar observations, airborne gravity, satellite gravity and aeromagnetic data to investigate the WARS in the Bellingshausen Sea Embayment, in the area of the Ferrigno Ice Stream (Bingham et al., 2012, Nature). This region is of high significance, as it one of the main sectors of the WAIS that is currently exhibiting rapid ice loss, thought to be driven primarily by oceanic warming. Assessing geological controls on subice topography and ice dynamics is therefore of prime importance in this part of the WAIS.

Ground-based and airborne radar image a subglacial basin beneath the Ferrigno Ice Stream that is up to 1.5 kilometres deep and that connects the ice-sheet interior to the Bellingshausen Sea margin. We interpret this basin as a narrow, glacially overdeepened rift basin that formed at the northwestern tip of the WARS. Satellite gravity data cannot resolve such a narrow rift basin but indicate that the crust beneath the region is likely thinned, lending support to the hypothesis that this area is indeed part of the WARS. Widely-spaced aeromagnetic data image a linear low along the inferred Ferrigno rift, but provide no evidence for high-amplitude aeromagnetic anomalies, typically associated with Cenozoic magmatism within the WARS. However, the reconnaissance character of these data, do not enable us to rule out the presence of magmatism within this part of the rift and cannot disclose the potential greater variability in subglacial geology either.

Bingham et al. (2012) proposed the glacially overdeepened Ferrigno rift basins provided major controls for a palaeo-ice stream on the adjacent continental shelf during glacial maxima. The palaeo-ice stream, in turn, eroded the ‘Belgica’ trough, which today routes warm open ocean water back to the ice front to potentially reinforce dynamic thinning. Dynamic thinning in the Bellingshausen Sea region appears to be steered back to the ice-sheet interior along the Ferrigno rift system. We conclude that detailed aerogeophysical studies of the inferred rift basins that cut across the WAIS margin in the Bellingshausen Sea sector are a high priority to: a) better comprehend the structure and the tectono-magmatic evolution of the WARS and; b) to test the hypothesis that these rifts play a key role in rapidly transmitting oceanic-driven change inland, potentially promoting accelerated ice-sheet instability.