The radiogenic isotope fingerprint of Wilkes Land - Adélie Coast Bottom Water in the Circum-Antarctic Ocean

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The Southern Ocean plays a crucial role in the present-day global ocean current system. The connection among the major ocean basins provided by the Antarctic Circumpolar Current (ACC) not only permits efficient global water-mass exchange between the Atlantic, Pacific and Indian oceans, but also dominates transport of heat, fresh water, and other propoerties that influence climate. Furthermore, the Southern Ocean is where the densest waters in the global thermohaline circulation system are formed, with production rates equal to, or even greater than, the production of North Atlantic Deep Water. While most monitoring studies have been focused on the Weddell Sea, it has become increasingly clear that bottom water is formed at many sites around Antarctica (e.g., Weddell Sea, Ross Sea, Enderby Land – Amery Shelf – Prydz Bay area, Wilkes Land – Adélie Coast area, Ross Sea). As these bottom waters are exported to the global ocean, the ability to trace their composition is of major interest for understanding global deep water circulation patterns.

Here we show that Wilkes Land – Adélie Coast Bottom Water, which is formed on the shelf of East Antarctica in the area east of Prydz Bay and west of the Ross Sea (90-150°E), has not only characteristic physical properties, but also carries a distinct radiogenic isotope signal that traces its dispersal. In the absence of direct seawater data, this conclusion has been reached by combining new and previously published results on Nd, Hf, and Pb isotopic compositions of surface scrapings of authigenic ferromanganese nodules from the Southern Ocean. Due to the proximity of the formation region of Wilkes Land - Adélie Coast Bottom Water to old, glacially weathered continental crust, bottom waters of the Australian-Antarctic Basin in the Indian Ocean sector have the lowest Hf and Nd isotopic compositions and the highest Pb isotopic compositions yet observed in the Southern Ocean. Thus radiogenic isotopes can provide valuable insights into formations and spreading of Antarctic Bottom Waters in the present and past ocean.