AGE AND ORIGIN OF HIMU VOLCANISM IN THE BALLENY ISLANDS: MELTING OF PLUME-DELIVERED DEEP MANTLE OR SHALLOW ASTHENOSPHERIC MANTLE? J.H. Berg[1], D. Weis[2], W.C. McIntosh[3], and B.I. Cameron[1], [1]Department of Geology, Northern Illinois University, DeKalb, IL 60115, USA (jon@geol.niu.edu), [2]Département des Sciences de la Terre et de L'Environnement, Université Libre de Bruxelles, B-1050 Brussels, Belgium, [3]Department of Earth and Environmental Sciences, New Mexico Institute of Mining and Technology, Socorro, NM 87801, USA.

The Balleny Islands form a 200-km-long linear chain of elongate islands in the Southern Ocean off the eastern Wilkes Land - northern Victoria Land coast of East Antarctica. To the north and on the opposite side of the Australian - Antarctic ridge, there is a long chain of seamounts that traverse the Tasman Sea floor of the Australian plate. These seamounts have been suggested by others to represent an earlier track of a Balleny plume. The Balleny magmas have erupted through oceanic crust that ranges in age from about 10 Ma to 20 Ma.

The Balleny Islands are dominated by primitive lavas and pyroclastics of alkali basalt and basanite composition, but a few of the lavas are highly fractionated phonolites or trachytes. Tholeiites have not been found. The ocean-island geochemical signature is strongly HIMU in terms of Sr and Nd isotopes and trace elements ($^{87}Sr/^{86}Sr$ = 0.7029 - 0.7031, $^{143}Nd/^{144}Nd$ = 0.5128 - 0.5130, Ba/Nb = 3 - 5, La/Nb = 0.6 - 0.7, Ba/La = 5 - 8, Rb/Nb = 0.4 - 0.6, Zr/Nb = 3 - 4.5, Th/Nb = 0.05 - 0.1), though not as extreme as St. Helena, Tubuai, and Mangaia in terms of Pb isotopes ($^{206}Pb/^{204}Pb$ = 19.6 - 20.1; $^{207}Pb/^{204}Pb$ = 15.6 - 15.7; $^{208}Pb/^{204}Pb$ = 39.4 - 40.1). The Balleny source has either had a shorter residence time in the mantle (ca. 750 Ma.) or a lower U/Pb ratio than the extreme HIMU sources. The HIMU signature supports a deep-seated, plume origin for the Balleny source. $^{40}Ar/^{39}Ar$ dating of Balleny rocks indicates an age range from 2.6 Ma to <10,000 years (activity was reported in 1839). The onset of volcanism on each island indicates a progression from south to north at a rate of about 7 cm/yr. This systematic age progression for a linear volcanic island chain is ironic on a tectonic plate that is essentially stationary.

Possible explanations for the origin of magmatism in the Balleny Islands include (1) leaky transform, (2) propagating fracture, and (3) laterally-moving hotspot. The leaky transform hypothesis is contradicted by the fact that the islands lie to the east of the Balleny Fractue Zone, the systematic age progression, and the seamount track in the Tasman Sea. A single propagating fracture is an unlikely explanation because although each island is very linear, their orientations are not parallel. A series of fractures that open first in the south and last in the north is possible. Extension related to the development of the fractures could have caused decompression of the shallow mantle, resulting in the Balleny magmatism. This would suggest that the HIMU source resides in the shallow mantle. Such a scenario cannot easily explain the seamount track in the Tasman Sea.

Interestingly, the 7 cm/yr northward progression of volcanism is similar to the northward movement of the mid-ocean ridge away from the Antarctic plate. If the Balleny Islands have resulted from a plume, the plume would have been jumped by the spreading ridge approximately 10 m.y. ago. If convective forces in the asthenosphere are stronger near the ridge and decrease away from the ridge, the lateral asthenospheric forces may have deflected the plume southward when the ridge was closer to the plume. As the ridge moved northward away from the plume, the plume could have rebounded to the north, leaving the northward progressing track of volcanism.