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Possible Origin of High-Amplitude Reflection Packages (HARPs) in the Canada Basin, Arctic Ocean

Nina Lebedeva-Ivanova (1), Deborah Hutchinson (2), John Shimeld (3), Deping Chian (4), Patrick Hart (5), Ruth Jackson (3), Richard Saltus (6), and David Mosher (3)

(1) Woods Hole Oceanographic Institution, Woods Hole, MA, USA (nina@whoi.edu), (2) U.S. Geological Survey, Woods Hole, MA, USA, (3) Geological Survey of Canada (Atlantic), Natural Resources Canada, Dartmouth, Nova Scotia, Canada, (4) Chian Consulting Incorporated, Dartmouth, Nova Scotia, Canada, (5) U.S. Geological Survey, Menlo Park, CA, USA, (6) U.S. Geological Survey, Denver, CO, USA

The Canada Basin (CB) of the Arctic Ocean is a semi-enclosed ocean basin surrounded by the Alaskan and Canadian margins to the south and east, the Alpha-Mendeleev Large Igneous Province (AMLIP) to the north and the subsided continental Chukchi Borderland (ChB) to the west. During 2007-2011, US-Canada expeditions collected ∼15,000 km multichannel seismic data and sonobuoy reflection and refraction seismic data with average spacing of ∼80 km mostly over the CB and AMLIP.

High-amplitude reflective packages (HARPs) underlie the mostly flat-lying sediments of CB. Although HARPs are discontinuous in the central CB, they become more continuous toward ChB and AMLIP. HARPs are often the most reflective events in the seismic section, exceeding even the seafloor reflection. Only rarely are reflections seen beneath HARPs. Where best developed, HARPs are ∼100-300 ms TWTT, consisting of several high-amplitude wavelets with a pronounced narrow frequency band within the limits of ∼10-30 Hz. This character of HARPs is consistent with patterns produced by constructive interference of thin beds (Widess, 1973). Forward modeling of sonobuoy data, synthetic tests, and frequency analysis of the tuning effect suggest that HARPs are composed of a series of alternating high- and low-velocity layers. The high-velocity layers are ∼100-200 m thick with P-velocities of ∼3.5-4.5 km/s. The low-velocity layers are about half as thick with velocities of ∼2-3 km/s. A broad range of possible interpretations of rock composition exists from these velocities, e.g. sandstone and interbedded shale (Prince Patrick Island, Harrison and Brent, 2005); or tholeiitic basalts flows and sediments (Voring volcanic margin, Olanke and Eldholm, 1994); or sills and sediments (Newfoundland margin, Peron-Pinvidic et all, 2010).

HARP can be associated with several origins. In the central and southern CB, where oceanic spreading is interpreted, HARPs are discontinuous among high-relief, but otherwise low-amplitude reflections interpreted to be large basement blocks. These discontinuous HARPs, associated with basement, are presumed synchronous with the seafloor spreading event that opened CB. Further north, near AMLIP, HARPs are more continuous over 10s of km, suggesting an origin associated with magmatism of AMLIP. In several areas in northern CB, HARPs have a shingled, en-echelon character, suggestive of sills intruding younger (i.e. post-rift) sediments. These relations suggest that HARPs are associated with basalts (flows and sills) interbedded with or separated by thinner sediment layers. Although the deep sediments and basement of CB are unsampled, seismic stratigraphic relationships suggest HARPs are of at least two ages: one associated with rifting/seafloor spreading (∼125 Ma?) and a younger one associated with a post-rift magmatic pulse on AMLIP (∼90-80 Ma?).