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Early Cretaceous High Arctic Magmatism and the Oceanic Anoxic Event 1a

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The High Arctic Large Igneous Province (HALIP) comprises Early and Late Cretaceous igneous deposits extending from the Canadian Arctic Archipelago in the west to the east Siberian Island in the east. It also includes anomalously thick igneous crust in the Canada Basin. We have mapped out the distribution of HALIP volcanic extrusive and intrusive rocks in the Barents Sea based on field work and borehole data in Svalbard and extensive geophysical data in the offshore areas. The volcanic extrusive and intrusive rocks in the Barents Sea Large Igneous Province (BLIP) are present in a 700 000 km2 large region extending across the northern and eastern Barents Sea. The igneous complex is dominated by a large sill complex intruded into organic-rich Jurassic to Permian age sequences in the East Barents Basin, on Svalbard and on Franz Josef Land. Geochemical data suggest that the tholeiitic igneous rocks were likely formed during a short-lived melting event. New geochronology data (U/Pb on zircons) suggest that the igneous event occurred in the Early Aptian or Barremian. Marine and terrestrial Cretaceous shales and sandstones of the Carolinefjellet, Helvetiafjellet, and Rurikfjellet formations have recently been cored in four boreholes on Svalbard (the Longyearbyen CO_2 Laboratory). We have completed a comprehensive analytical program of samples from the boreholes, including geochronology (Ar/Ar and zircon U/Pb), biostratigraphy (palynology), and geochemistry (ICP-MS, RockEval, TOC). In the boreholes, the Barremian-early Aptian Helvetiafjellet Formation is overlaid by early Aptian sapropel-rich shales of the Carolinefjellet Formation. Carbon isotope data reveal a negative excursion in this anoxic interval, most likely representing the Oceanic Anoxic Event 1a (OAE1a). The geochronology data suggest that the intrusive BLIP volcanism occurred at the tim e of the early Aptian OAE1a. We propose that the link between the BLIP and the OAE1a is a massive release of thermogenic methane from contact aureoles of thermally altered sediments surrounding the hot sill intrusions in the BLIP. We estimate that about 9000 Gt of carbon was potentially degassed from the contact aureoles in the East Barents Basin. A rapid release of isotopically light metamorphic greenhouse gases to the atmosphere is therefore a possible trigger for the OAE1a and the associated negative carbon isotope excursion. Subsequent lava degassing from the HALIP or the Ontong Java Plateau may have caused the subsequent increase in isotopically heavy carbon.