Ancient Chemosynthetic Life in the Canadian Arctic: Distribution, Biota and Stable Isotopic Signatures of Carbonate Mounds Formed by Cretaceous Methane Seeps

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Introduction

In recent years, modern chemosynthetic communities associated with hydrocarbon seeps have been discovered worldwide in various geotectonic settings, at a range of water depths (Campbell, 2006). Modern seeps are characterized by high carbonate precipitation and unique dense populations of heterotrophic biota reliant on chemosynthetic bacteria for energy. Similar to their modern counterparts, ancients seep communities are preserved in the rock record as mounds of carbonate rocks, teeming with marine fossils, including tubeworms, bivalves and ammonites. In 1989 the first ancient (Early Cretaceous) seep communities were discovered in the Canadian High Arctic (Beauchamp *et al*., 1989). This year, over 100 additional ancient methane seep mounds were discovered in the same region. The focus of this study is to characterize the spatial distribution, seep biota and stable isotopic signatures (δC^{13}, δO^{18} and δS^{34}) of these features.

Theory and Methods

Fieldwork carried out on Ellef Ringnes Island in July 2010 led to the discovery of nearly 100 new ancient chemosynthetic carbonate mounds, making the island the world's most prolific preservation of ancient methane seep communities. GIS systems are used to locate discovered sites, which were then sampled to conduct paleontological, petrological, and isotopic studies to define the environmental conditions and nature and diversity of ecosystems at the sites.

The newly discovered methane seep mounds are confined to a single stratigraphic horizon within the Christopher Shale, located near the top of the Invincible Point Group (Embry, 1985). The seep mounds partially encircle multiple evaporite Domes on Ellef Ringnes Island including Hoodoo Dome, Dumbells Dome, Helicopter Dome and Isachsen Dome (Fig.1).

Fossils collected from the seep mounds, provide dates that support the previous interpreted Albian (Early Cretaceous) age. More specifically, Late Early Albian, in some part of the upper or middle *Beudanticeras affine* regional Zone (Poulton, 2010).

The fossils described above are contained in isotopically-light authigenic carbonates, that are composed of up to seven unique carbonate phases. Beauchamp et al. (1992) reported early diagenetic carbonates to be extremely depleted in C^{13}, having δC^{13} values for micrite between -37‰ to -43‰, botryoidal calcite -36‰ to -50‰, splayed calcite -36‰ to -50‰, and yellow calcite from -35‰ to -42‰. Late diagenetic cements have δC^{13} values between -8‰ to -25‰. All of these isotopic compositions vary greatly that from of normal marine Albian fossils, the δC^{13} of which range between +1‰ to +4‰ (Beauchamp, 1992). Currently, new and more extensive isotope analyses of the δC^{13}, δO^{18} and δS^{34} values of the carbonates are underway and will be presented in May 2011.

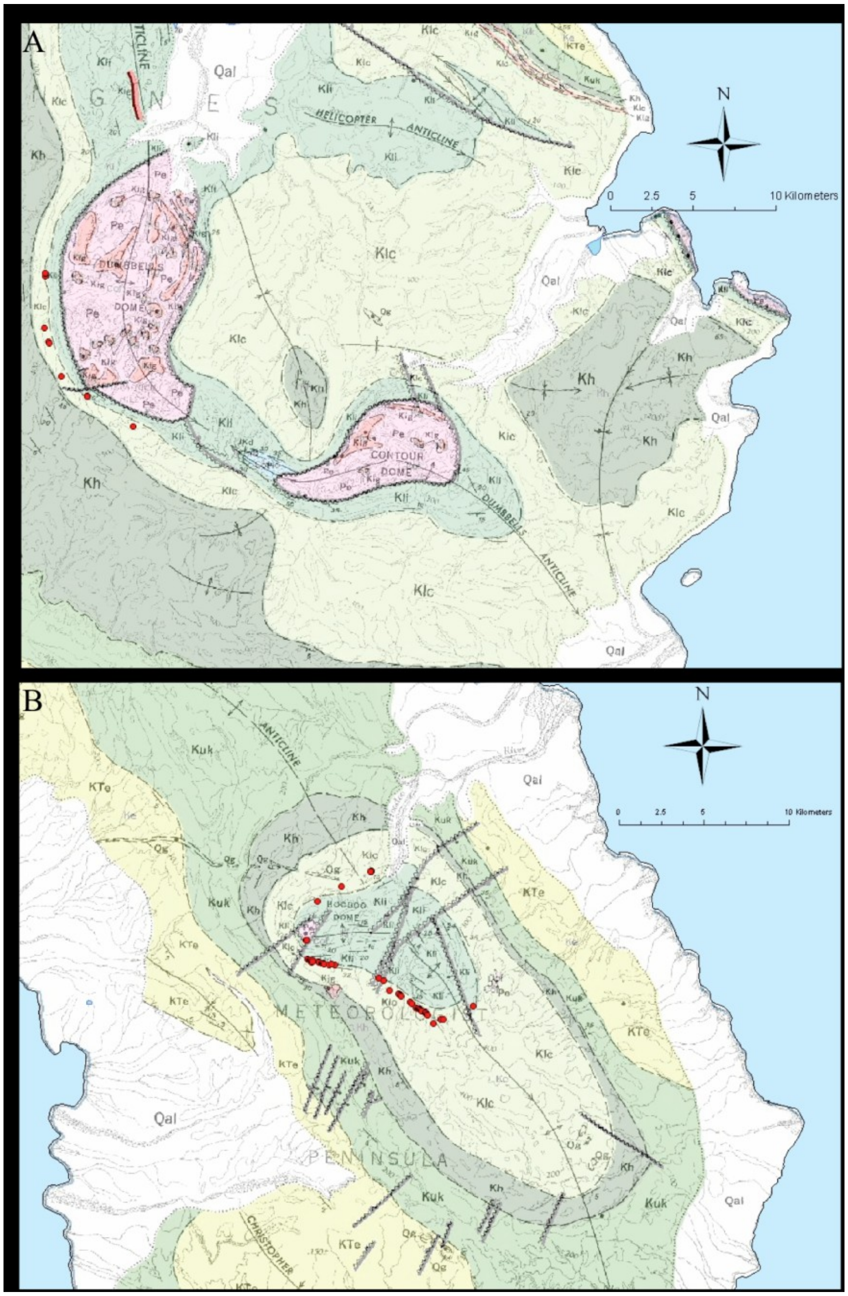

Figure 1. **A.** Map of east-central Ellef Ringnes Island, showing Dumbells, Contour and Helicopter Dome. Red octagons indicate seep mound occurrences. **B.** Map of southern Ellef Ringnes Island, showing Hoodoo Dome. Red octagons indicated seep mound occurrences. LEGEND: Pink(Pe)= Evaporite, Green(Kli)= Ishachsen Fm., Yellow(Klc)= Christopher Fm., Green(Kh)= Hassel Fm.

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