Circum-Arctic Lithosphere Evolution (CALE)

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1. Background

The geological evolution of the Arctic region is one of the last unknowns of our global plate tectonic system. The Arctic Ocean basins (Fig. 1), relatively inaccessible to direct sampling, are known mostly from 'remote' geophysical methods. Until recently, the Amerasia Basin at more than 3500 meters below sea level was virtually unexplored. Its age and spreading history is inferred from structural and stratigraphic relationships observed on the basin margins. These inferences have not been confirmed by observations within the basin itself, while on-shore the Arctic region comprises remote wilderness areas far from supporting infrastructure and consequently is mapped mostly at a reconnaissance scale. The lack of age control on units, structural fabrics, timing of fold and thrust belts, etc., makes it difficult to correlate geology from one region to another, to extrapolate geology from on-shore to off-shore, or to constrain the development of Arctic ocean basins using circum-Arctic geologic data. The CALE project was developed in order to adress some of these deficiencies.

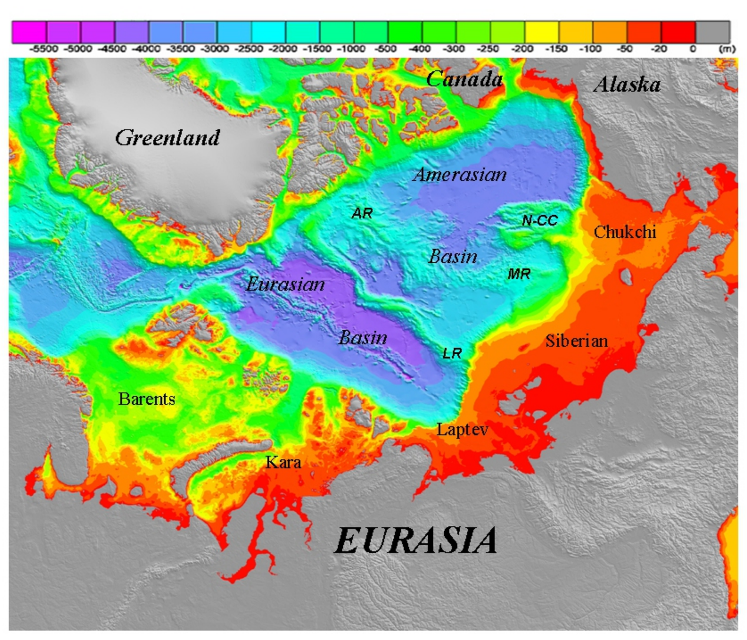

Figure 1. International Bathymetric Chart of the Arctic Ocean (Jakobsson et al., 2008). Colors indicate depth below sea-level in meters. AR, Alpha Ridge; LR, Lomonosov Ridge; MR, Mendeleev Ridge; N-CC, Northwind-Chukchi Cap.

2. The program

The CALE project ran for 5 years (2011-2015) and was intended to fully integrate on-shore geology with off-shore geophysics (Fig. 2) in order to provide us with the capacity to make significant advances in our understanding of the tectonic and lithosphere development of the Amerasia Basin. This would be achieved by i) increasing data coverage across the region, ii) providing direct links between on-shore geology and off-shore geophysics surrounding the Basin, and iii) obtaining physical samples from across the region (including obtaining new data sets, as well as reworking older data sets using more modern techniques).

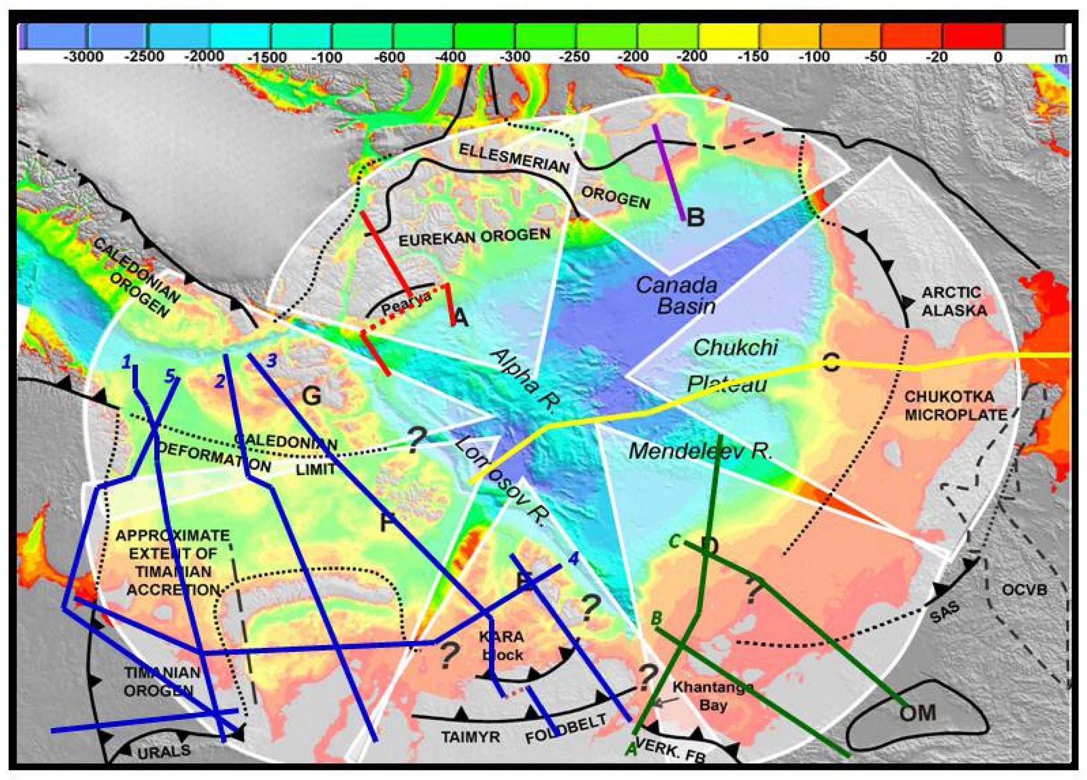

Figure 2. *CALE* swaths on an Eocene (c. 55 Ma) Arctic reconstruction (after Pease, 2011). The Eurasia Basin has not yet opened, Svalbard restores adjacent to N. Greenland. The white transparent regions represent the seven original regional teams of *CALE*. Important tectonic elements of the circum-Arctic region are shown. OCVB, Ohotsk-Chukotka Volcano-plutonic Belt; OM, Omolon Massif; SAS, South Anyui Suture.

Significant progress was made during the project. Numerous field campaigns were made to remote regions (e.g.- Wrangle Island, DeLong Islands, Ellesmere and Axel Heiberg, Brooks Range and Arctic Alaska), data and samples were collected (including marine geophysical data and dredge sample acquisition, e.g.- Chukchi Boarderlands, Mendeleev Ridge and Makarov-Povodnikov Basin, Barents Shelf). A large amount of new provenance, structural, thermochonological, geochemical and geophysical data was also generated. A review of Arctic lithosphere summarized our initial findings (Pease et al., 2014). More importantly, transects merging on-shore and off-shore geology (Fig. 2) were finalized and recently published (2017 online, 2018 hard copy).

These advances would allow us to test existing, and confidently formulate new, hypotheses related to:

The location of plate boundaries associated with the Amerasia Basin.
The mechanism(s) and timing of Canada Basin opening; the pre-drift setting of the Chukchi Borderland.
The tectonic processes that formed the Laptev, East Siberian, and Chukchi sea shelves.
The mechanism(s) and timing of ridge formation in the Amerasia Basin.
The structures connecting seafloor spreading along the Gakkel Ridge to continental extension on the Laptev Shelf.
The continuations of the pre-Eocene orogens in the Arctic.
The influence of these crustal-scale discontinuities on Arctic tectonic evolution; the nature, age, internal structure and stratigraphy of the main sedimentary basins.
The effect of tectonic evolution on the sedimentation history of the Arctic basins.

3. CALE teams

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4. Principal results

available at:
http://sp.lyellcollection.org/content/460/1

Greenland-Canada

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PIEPJOHN, K. & VON GOSEN, W.
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Alaska & Chukotka

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