Stratigraphic Characterization of Lower Cretaceous to Paleocene Formations of the Brookian Sequence, Alaskan North Slope Foothills, Using a Combined Chemostratigraphic and Sequence Stratigraphic Approach

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The Cretaceous- to Paleocene- age sediments of the Brooks Range foothills of the Alaskan North Slope are an east- and northeast- prograding, non-marine to deepwater foreland basin clastic wedge represented lithostratigraphically in the study area by the Torok, Seabee, Canning, Schrader Bluff, Prince Creek, and Sagavanirktok formations. These units each contain proven hydrocarbon reservoirs along the Barrow arch, but in the foothills are still considered frontier exploration targets. There are few well penetrations, biostratigraphic resolution is poor, outcrops are discontinuous, there is local structural complexity, the clastic sequences are lithologically non-unique through time, and true stratigraphic markers are rare, making the development of a reliable regional stratigraphy difficult. Here, we use chemostratigraphy, integrated with sequence stratigraphy, to refine the stratigraphic framework for this frontier region. The efficacy of this approach is shown by the ability to place Cretaceous-age units from Grizzly-1 and Heavenly-1 exploration wells, which are located tens of kilometers to the northwest of the primary study area, into the scheme adopted in the Brooks Range foothills.

Chemostratigraphic analysis was carried out on 145 composited cuttings samples from four widely spaced exploration wells (Echooka 1, Susie 1, Lupine 1 and Aufeis 1), and a suite of 240 outcrop samples. Rock chips from each cuttings sample were carefully selected for analysis, using gamma ray data to determine the most representative lithology from each cutting interval. Whole-rock inorganic geochemical analyses were carried out on all samples using inductively coupled plasma - optical emission spectrometry (ICP-OES) and inductively coupled plasma - mass spectrometry (ICP-MS) analyses to quantify the concentrations of 50 elements.

Changes through in time in values of key element and element ratios, including but not restricted to, K2O/Al2O3, K2O/Rb, Cr/Al2O3 and Zr/Cr and U (ppm) enable geochemical differentiation of lithostratigraphic units, definition of finer scale stratigraphic units and integration into a sequence stratigraphic model. The geochemical variables used to characterize the formations reflect changes in sediment provenance, extrabasinal volcanism, clay mineral species, and paleo-redox conditions through time and lateral facies changes. The most robust and systematic trends identified to date are expressed in well cuttings from mid-Cretaceous strata.