# Geology and Source Rock Potential of the Lower Cretaceous Pebble Shale Unit, Northeastern Alaska

van der Kolk, Dolores A.[*1]; Whalen, Michael T.[1]; Wartes, Marwan A.[3]; Newberry, Rainer J.[2]; McCarthy, Paul [2]
(1) Jackson School of Geosciences, UT Austin, Austin, TX.
(2) Department of Geology & Geophysics, University of Alaska, Fairbanks, AK.
(3) Energy Division, Alaska's Division of Geological & Geophysical Surveys, Fairbanks, AK.

An organic-rich, marine mudstone informally known as the pebble shale unit (Kalubik Formation) was deposited during the Early Cretaceous in northern Alaska. The pebble shale unit is widely regarded as a hydrocarbon seal for the Ellesmerian petroleum system and an important hydrocarbon source rock on the North Slope. Deposition of the pebble shale unit occurred during later stages of rifting that led to the opening of the Canada Basin during the Barremian and early(?) Aptian. The pebble shale unit lies above the discontinuous, shallow marine Kemik Sandstone and stratigraphically below a radioactive shale known as the highly radioactive zone (HRZ) within the Hue Shale. A high-resolution study of surface exposures was conducted along the west side of the Canning River, an unnamed tributary east of the Katakturuk River, and Marsh Creek. Measured stratigraphic sections were enhanced with gamma-ray analyses in order to correlate outcrops with well logs. Samples were collected for biostratigraphy, petrography, mineralogy, X-ray Fluorescence, total organic carbon (TOC), Rock Eval II, and vitrinite reflectance.

The pebble shale unit-HRZ contact is exposed along the Canning River where, except for a subtle facies change, the transition can only be recognized with a gamma-ray spectrometer in the field. The pebble shale unit and lower HRZ have very distinct geochemical signatures. The pebble shale unit is anomalously low in U relative to *average black shale.* Compared to *average shale,* the pebble shale unit is enriched in Ba, As, Zn, Cr, Y, and Pb though is depleted in Co, Cu, Ni, Mo, and S. The pebble shale unit is within the average for V, U, and Se in average shale. HRZ mudstones stand out geochemically because they are enriched in metals, especially when compared to the pebble shale unit, which is so poor in trace metals relative to average shale compositions. The high radioactivity in the HRZ is caused by elevated concentrations of U as measured with a spectral gamma-ray spectrometer and confirmed with XRF results.

Facies analysis of the pebble shale unit reveals hemipelagites that alternate with sediment gravity flows, interpreted as dilute fine-grained turbidites. Consideration of grain size and facies suggests exposures along the Canning River were deposited basinward of the two localities north of the Sadlerochit Mountains. As implied by its name, a primary lithologic characteristic of the pebble shale unit is the occurrence of isolated, rounded, and frosted quartz sand grains as well as granules, pebbles, and cobbles floating in laminated mudstone (sometimes <1-mm). This out-sized detritus is generally interpreted as ice-rafted material. During reconnaissance, silicified glendonites were discovered in the pebble shale unit, suggesting near freezing temperatures and offering further evidence that this important stratigraphic interval was deposited in a cold water, high-latitude setting.

TOC and Rock Eval analyses indicate that pebble shale unit has good to excellent source-rock quantity (2-6 wt. %TOC), but poor source-rock quality (Hydrogen Index [HI] <50mg Hydrocarbon [HC]/g TOC) resulting from thermal overmaturity (1.28 to 1.79 %Ro). The source-rock potential of the pebble shale unit assessed in this study is consistent with previous data indicating that the pebble shale unit originally had good source-rock potential; however, because of advanced thermal maturity of the study area, the parameters that correspond to source-rock quality indicate considerable degradation.