U.S. DEPARTMENT OF THE INTERIOR

GEOLOGICAL SURVEY

# PRELIMINARY REPORT ON MAJOR AND MINOR ELEMENTS IN CORES FROM THE TRIASSIC SHUBLIK FORMATION, JURASSIC AND CRETACEOUS KINGAK SHALE, AND CRETACEOUS PEBBLE SHALE UNIT, HUE SHALE, AND TOROK FORMATION, NORTH SLOPE, ALASKA

by

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Open-File Report 95–236



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1995

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## INTRODUCTION

This report provides preliminary inorganic geochemical data for a set of 33 core samples from 8 wells in the North Slope of Alaska (Table 1, Figure 1). These samples were analyzed as a reconnaissance study of the distribution of trace elements in petroleum source-rocks and shales in the region. Formations sampled include the Triassic Shublik Formation, Jurassic and Cretaceous Kingak Shale, and Cretaceous pebble shale unit, Hue Shale, and Torok Formation. These analyses supplement and expand on earlier inorganic geochemical analyses by Brosgé and Tailleur (1988). Organic geochemical analyses and thermal maturity measurements for most of the wells analyzed in this study may be found in the reports by Magoon and Bird (1988), Claypool and Magoon (1988), Magoon and others (1988), and Bayliss and Magoon (1988).

## REGIONAL STRATIGRAPHY AND SAMPLE SELECTION

The North Slope of Alaska is a foreland basin formed in Mesozoic and Cenozoic time in response to crustal loading by the Brooks Range, an orogenic belt produced by collision of the continental Arctic Alaska plate with an island arc (Figure 2). The foreland basin developed on an older passive margin sequence composed of Mississippian to Cretaceous clastic and carbonate rocks. A schematic cross section (Figure 3) shows the characteristic structural and stratigraphical relations. The stratigraphic nomenclature and ages of these rocks are summarized in figure 4. The paleogeography during formation of the passive margin consisted of a land mass to the north and the open ocean to the south in present-day coordinates. Land and sea relations were reversed during foreland basin development with the orogenic ancestral Brooks Range highlands in the south and the marine basin to the north. Marine shale having the requisite organic carbon richness and type to be classified as petroleum source rocks have been identified in previous studies as occurring in both passive margin rocks (Triassic Shublik Formation, Jurassic and Cretaceous Kingak Shale, and Cretaceous pebble shale unit) and foreland basin rocks (Hue Shale and Torok Formation).

Regional reconstruction indicates that during deposition of the Shublik Formation, the Kingak Shale, and, to some extent, the pebble shale unit sedimentary facies were oriented in a west-northwest to east-southeast trend, with the shoreline to the north of the modern coastline. Figure 5 summarizes the paleogeography and sedimentary facies for the Shublik Formation. In contrast to these passive margin facies trends, regional reconstructions show

that foreland basin trends were distinctly different. Lithofacies and seismic reflection data show that the foreland basin was filled primarily from southwest to northeast. The Hue Shale (previously reported as the gamma-ray zone of the pebble shale unit by Bird, 1988) is interpreted as the most distal, most slowly deposited, and probably the deepest marine of the foreland basin deposits. The overlying Torok Formation is interpreted as a less distal and more rapidly deposited unit composed of marine shale and turbidite sandstone.

Average organic carbon abundance in the Shublik Formation increases with increasing distance from the paleoshoreline, from a mean of about 1% in the Drew Point No. 1 well to a mean of about 3% in the Inigok No. 1 well (Magoon and Bird, 1987, 1988). Organic carbon abundance follows a similar pattern in the Kingak Shale, increasing from a mean of about 1% in the Drew Point No. 1 well to about 2% in the Inigok No. 1 well and about 3% in the Seabee No. 1 well (Magoon and Bird, 1987, 1988). The samples reported here were selected to represent, insofar as possible, a transect more or less perpendicular to the paleogeographic shoreline trend of the passive margin facies.

## SAMPLE PREPARATION

Samples were selected from cores stored at U.S. Geological Survey repositories in Menlo Park, California (Table 1). From a piece of core weighing several hundred grams, two matching subsamples of 10-20 g were cut with a free-flowing water saw for (1) major and minor element chemistry, and (2) organic carbon analysis (not reported here). The remainder of each sample piece was retained for subsequent petrographic and other petrologic studies.

## ANALYTICAL METHODS AND REPRODUCIBILITY

The samples were analyzed by a multi-extraction, multi-element major and trace element package (ME3) by XRAL Laboratories in Don Mills, Ontario, Canada. Techniques included X-ray fluorescence spectrometry (XRF), instrumental neutron activation analysis (NAA), and inductively coupled plasma spectrometry (ICP). The 33 North Slope samples were analyzed as a part of one batch, consisting of a total of 60 samples, including 8 duplicate analyses of samples and 2 duplicate analyses of system standards. For each element, the technique used and detection limit is given in Table 2.

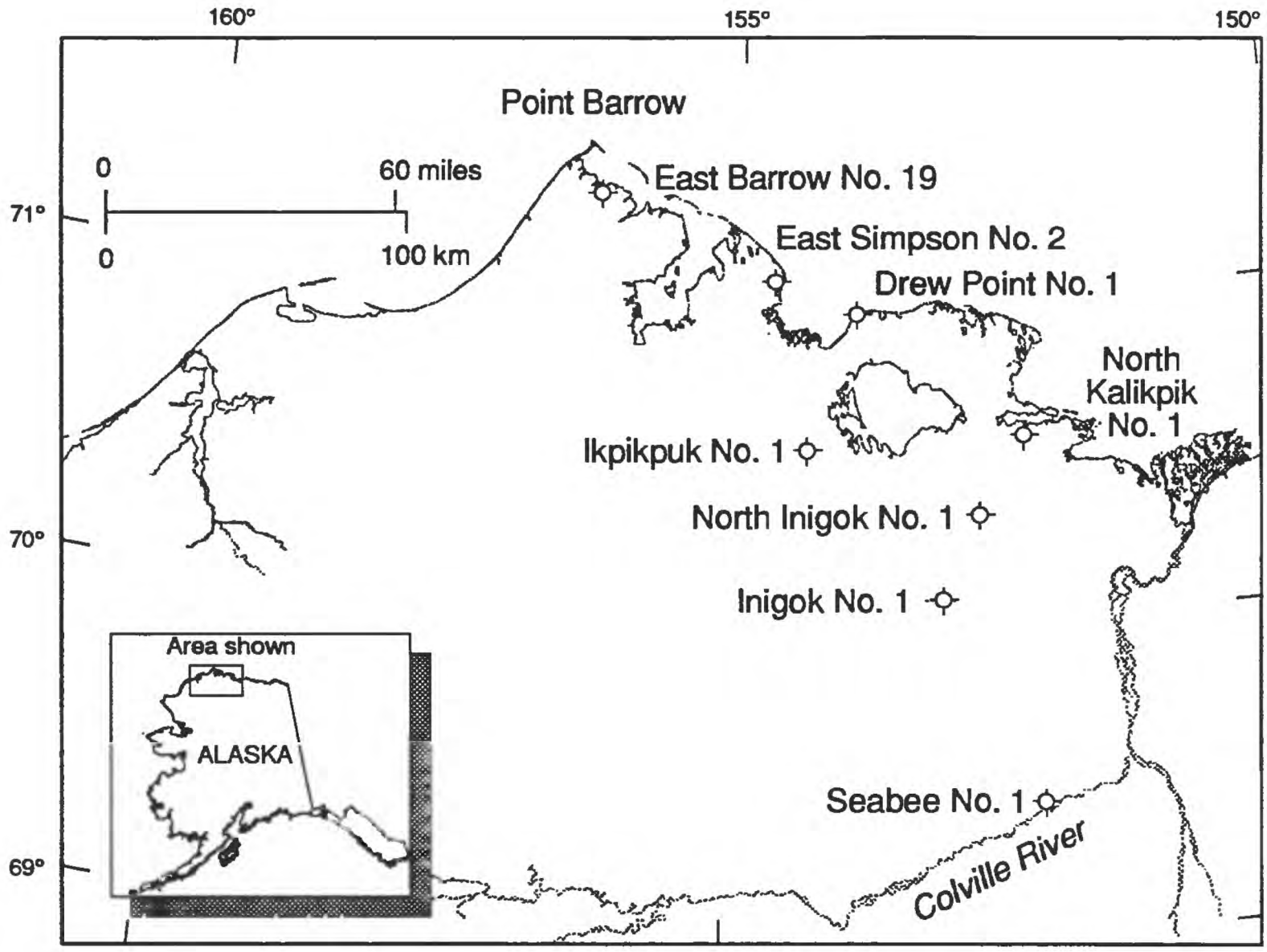



Figure 1. Index map of part of the North Slope of Alaska showing locations of wells sampled.

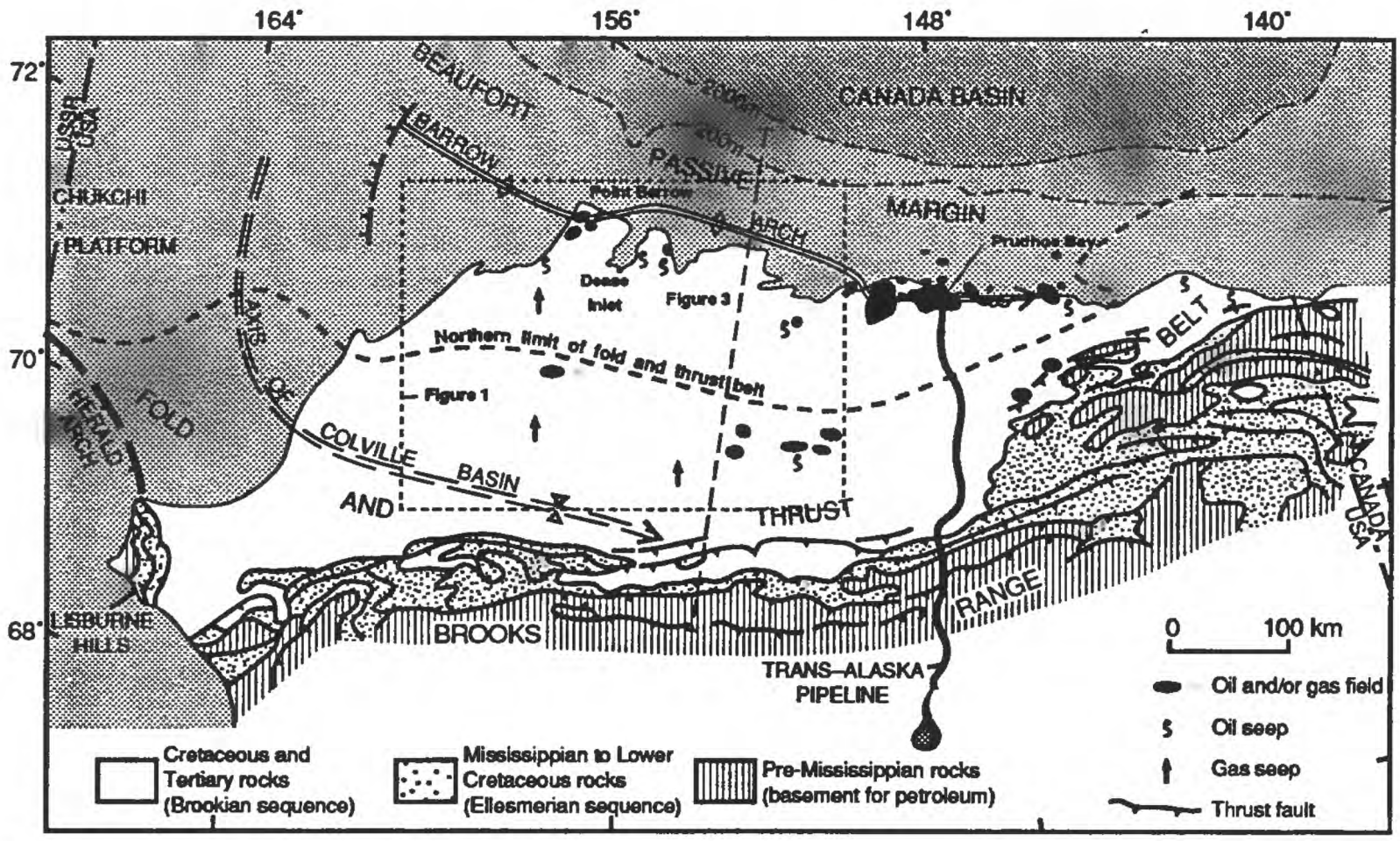



Figure 2. Generalized geologic map of the North Slope, showing locations of oil and gas fields, hydrocarbon seepages, major tectonic elements, and cross section (Figure 3). Modified from Bird (1991) and Bird and Molenaar (1992).

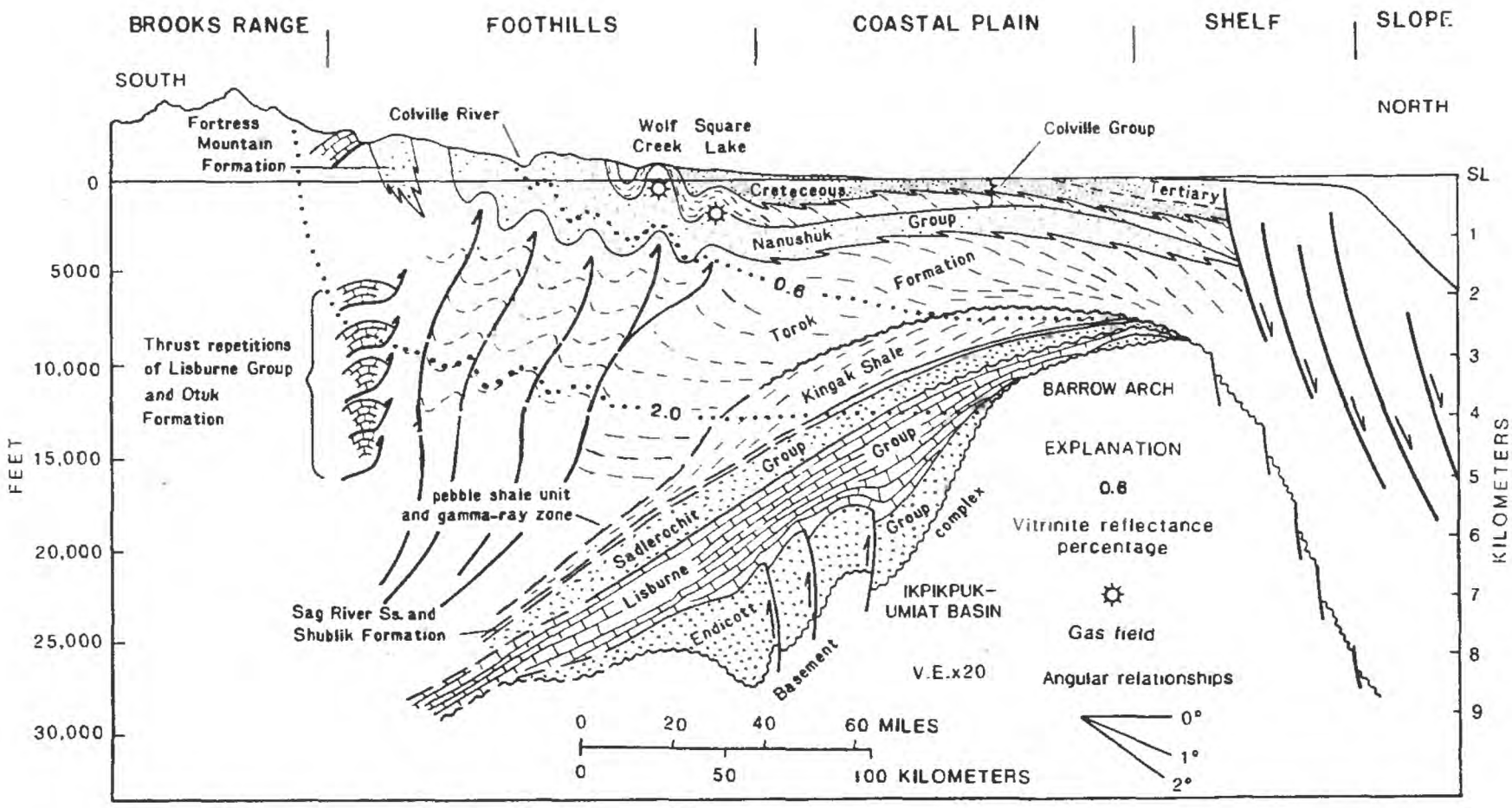
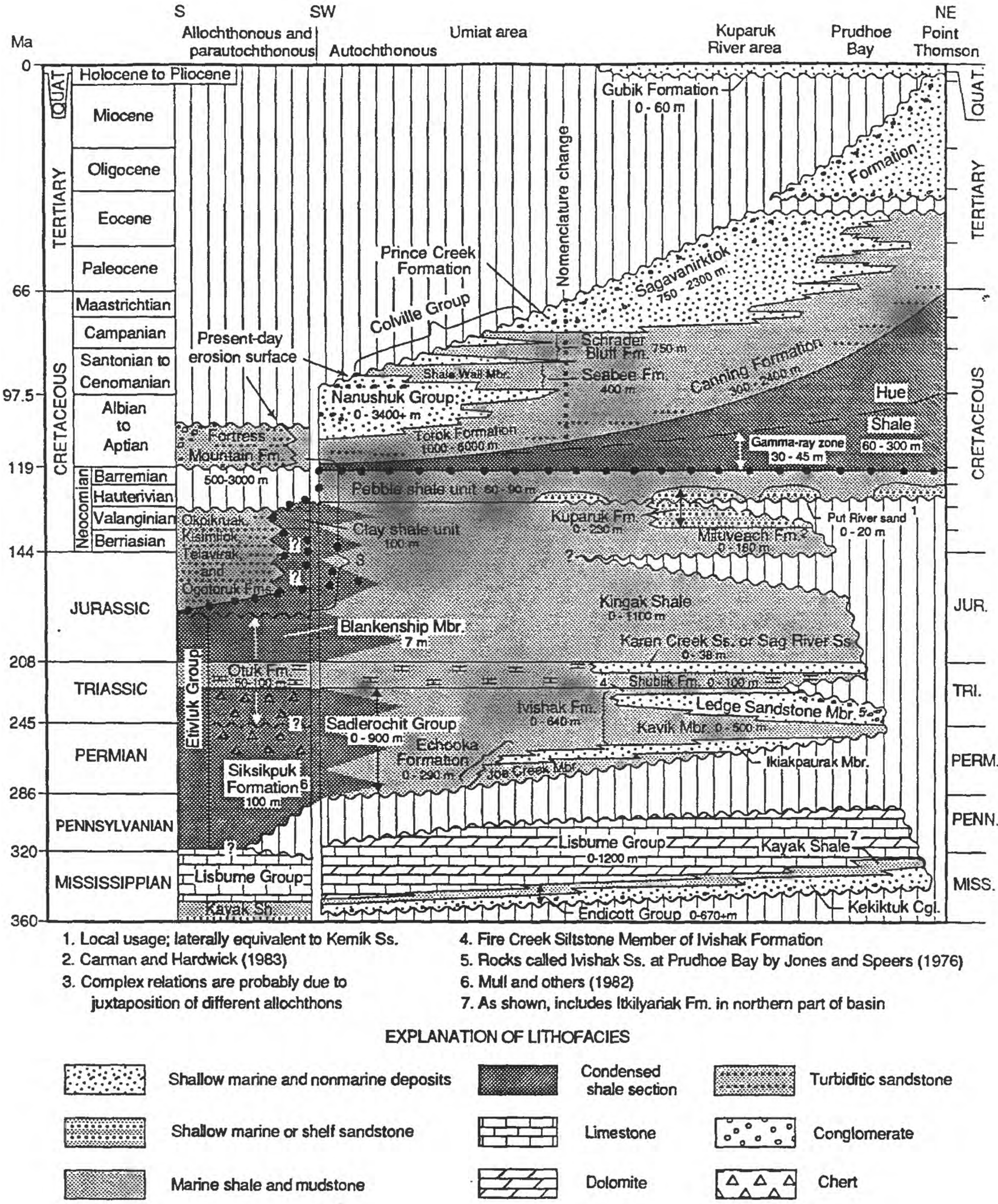



**FIGURE 3.** Schematic structural and stratigraphic cross section across the central North Slope (from Bird, 1987). Shaded zone between Torok Formation and Kingak Shale is the pebble shale unit and gamma-ray zone. See Figure 2 for location of section.




1. Local usage; laterally equivalent to Kemik Ss.
2. Carman and Hardwick (1983)
3. Complex relations are probably due to juxtaposition of different allochthons
4. Fire Creek Siltstone Member of Ivishak Formation
5. Rocks called Ivishak Ss. at Prudhoe Bay by Jones and Speers (1976)
6. Mull and others (1982)
7. As shown, includes Itkilyariak Fm. in northern part of basin

EXPLANATION OF LITHOFACIES

- Shallow marine and nonmarine deposits
- Shallow marine or shelf sandstone
- Marine shale and mudstone
- Condensed shale section
- Limestone
- Dolomite
- Turbiditic sandstone
- Conglomerate
- Chert

Figure 4. Chronostratigraphic chart of post-Devonian rocks across the North Slope basin. Heavy dotted line at top of pebble shale unit and extending down section into the Jurassic in allochthonous rocks separates Brookian sequence (foreland basin) rocks above from Ellesmerian sequence rocks (passive margin) below. Absolute time scale modified from Palmer (1983). Vertical time scale changes by a factor of 2 at 144 Ma.

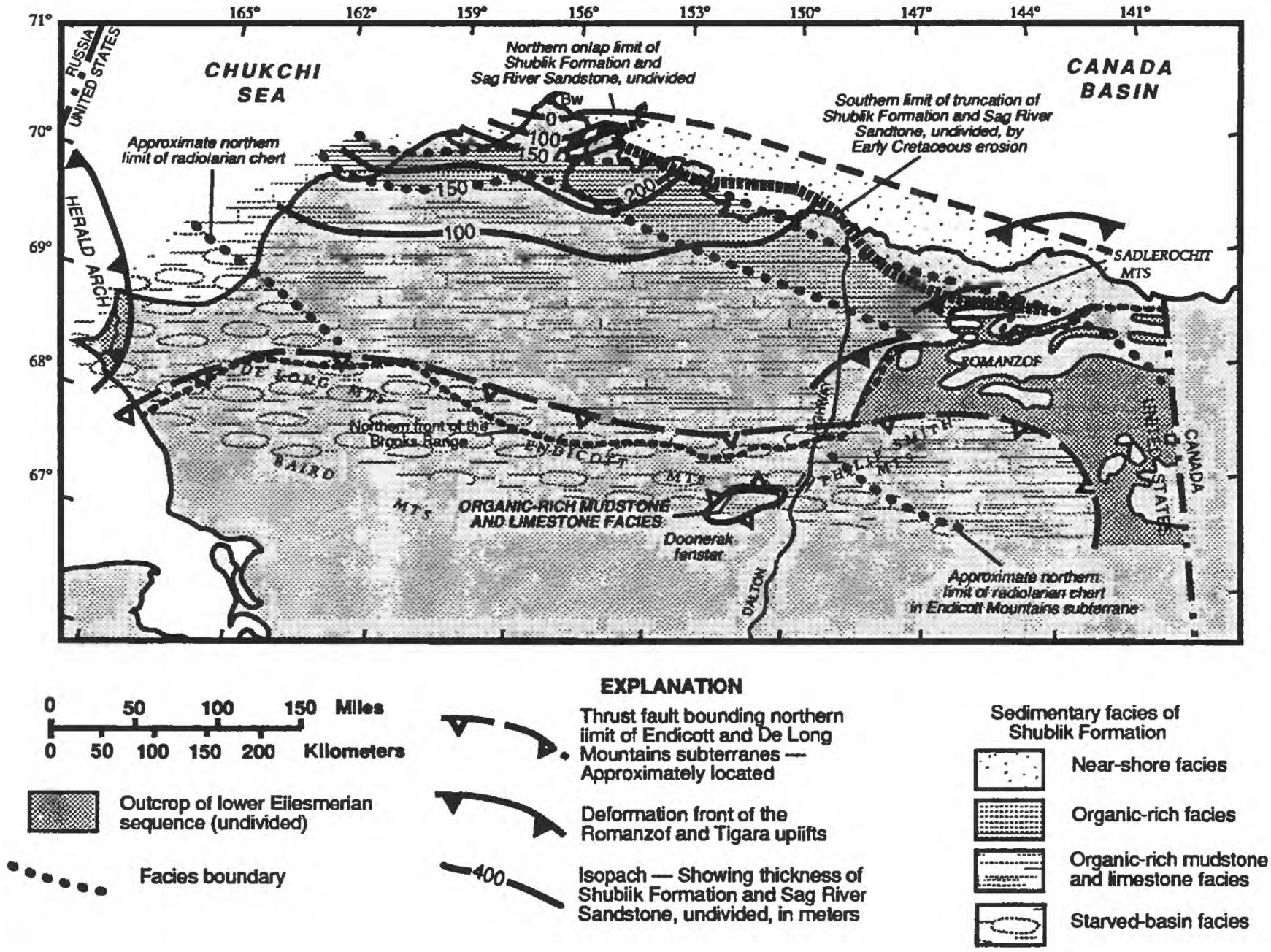



Figure 5. Facies distribution of the Shublik Formation and isopachs for the undivided Shublik Formation and Sag River Sandstone. From Moore and others (1992) based on summaries of Parrish (1987) and Hubbard and others (1987).

Methods and reproducibility of previously reported NAA analyses are detailed by Isaacs (1992), and reproducibility of XRF and ICP analyses by Piper and Isaacs (1995, in press). For previously reported samples analyzed using both NAA and ICP methods at XRAL Laboratories, common elements (Fe, Ca, Na, Co, Cr, Mo, Sc, and Zn) agreed better than ± 3% at one standard deviation. Intermethod comparison with XRF results at XRAL Laboratories and interlaboratory comparison of XRF and ICP results for the same samples at U.S. Geological Survey laboratories also showed excellent agreement for all elements except Ba. For Ba, different analytical methods (and for ICP, different chemical digestion procedures) yield significantly different results, probably because of incomplete extraction of Ba during chemical digestion (Piper and Isaacs, 1995, in press).

For the batch including the 33 North Slope samples reported here, duplicate analyses and a system standard duplicate analysis are given in Table 3. Relative standard deviations, grouped by abundance class, are shown in Table 4. For all major oxides and LOI, relative standard deviations are in the range 0.0–1.2%. For minor elements, relative standard deviations are in the range 0.0–3.2% for abundances greater than 100 times the detection limit, and 0.4–6% for abundances 10–100 times the detection limit. Only a few elements with mean abundances <10 times their detection limit have relative standard deviations exceeding 10% (Table 4).

## DATA TABLES

Table 5 gives abundances of major oxides and minor elements for the 33 North Slope core samples reported here. Listed first are major oxides ($SiO_2$, $Al_2O_3$, $Fe_2O_3$, MgO, CaO, $Na_2O$, $K_2O$, $TiO_2$, $P_2O_5$, MnO) and LOI (loss on ignition). Following in alphabetical order are minor elements (Ag, As, Au, B, Ba, Be, Br, Cd, Ce, Co, Cr, Cs, Cu, Eu, Ge, Hf, Ir, La, Lu, Mo, Nb, Nd, Ni, Pb, Rb, Sb, Sc, Se, Sm, Sr, Ta, Tb, Th, U, V, W, Y, Yb, Zn, Zr).

For samples analyzed in duplicate, only one of the two analyses is listed. For comparison of duplicate analyses, see Table 3.

## ACKNOWLEDGMENTS

We thank Lynda Bloom of XRAL Laboratories for discussions of analytical reproducibility, and Randy Koski and Les Magoon for reviewing preliminary versions of the report.

Table 1. Well identifications, sample depths, and stratigraphic units of core samples analyzed from the North Slope of Alaska.

| WELL | API Number | Sample Depth (ft) | Stratigraphic Unit |
|---|---|---|---|
| Seabee No. 1 | 50-287-20007 | 14589 | Kingak Shale |
| | | 14593.8 | Kingak Shale |
| | | 14599 | Kingak Shale |
| | | 14604 | Kingak Shale |
| Inigok No. 1 | 50-279-20003 | 8849.5-51.5 | Torok Formation |
| | | 8849.5 | Torok Formation |
| | | 9457.5 | Kingak Shale |
| | | 10299 | Kingak Shale |
| | | 12273.5 | Shublik Formation |
| | | 12275.5 | Shublik Formation |
| North Inigok No. 1 | 50-103-20017 | 10160 | Shublik Formation |
| | | 10165.3 | Shublik Formation |
| North Kalikpik No. 1 | 50-103-20011 | 7131.4 | Pebble shale unit |
| | | 7136 | Pebble shale unit |
| | | 7148.5 | Pebble shale unit |
| | | 7149.5 | Pebble shale unit |
| Ikpikpuk No. 1 | 50-279-20004 | 7369 | Hue Shale |
| | | 7372.3 | Hue Shale |
| | | 7376 | Hue Shale |
| | | 7491 | Kingak Shale |
| | | 7500 | Kingak Shale |
| | | 10277 | Shublik Formation |
| | | 10283 | Shublik Formation |
| | | 10288 | Shublik Formation |
| Drew Point No. 1 | 50-279-20002 | 6927 | Kingak Shale |
| | | 6941 | Kingak Shale |
| | | 7544 | Shublik Formation. |
| | | 7568.5 | Shublik Formation |
| East Simpson No. 2 | 50-279-20007 | 6344.3 | Hue Shale |
| | | 6354 | Hue Shale |
| | | 6367 | Hue Shale |
| South Barrow No. 19 | 50-023-20012 | 1354 | Hue Shale/Torok Formation |
| | | 1359.3 | Hue Shale/Torok Formation |

Table 2. Methods of analysis and detection limits. Methods are X-ray fluorescence spectrometry (XRF), inductively coupled plasma spectrometry (ICP), and neutron activation analysis (NAA).

| Oxide or element | Method | Detection limit |
|---|---|---|
| $SiO_2$ | XRF | 0.01% |
| $Al_2O_3$ | XRF | 0.01% |
| $Fe_2O_3$ | XRF | 0.01% |
| MgO | XRF | 0.01% |
| CaO | XRF | 0.01% |
| $Na_2O$ | XRF | 0.01% |
| $K_2O$ | XRF | 0.01% |
| $TiO_2$ | XRF | 0.01% |
| $P_2O_5$ | XRF | 0.01% |
| MnO | XRF | 0.01% |
| LOI | XRF | 0.01% |
| Ag | ICP | 0.1 ppm |
| As | NAA | 1 ppm |
| Au | NAA | 2 ppb |
| B | ICP | 10 ppm |
| Ba | XRF | 10 ppm |
| Be | ICP | 1 ppm |
| Br | NAA | 0.5 ppm |
| Cd | ICP | 1 ppm |
| Ce | NAA | 1 ppm |
| Co | NAA | 0.5 ppm |
| Cr | NAA | 0.5 ppm |
| Cs | NAA | 0.5 ppm |
| Cu | ICP | 0.5 ppm |
| Eu | NAA | 0.05 ppm |
| Ge | ICP | 10 ppm |
| Hf | NAA | 0.2 ppm |
| Ir | NAA | 5 ppb |

Table 2. continued

| Oxide or element | Method | Detection limit |
|---|---|---|
| La | NAA | 0.1 ppm |
| Lu | NAA | 0.01 ppm |
| Mo | NAA | 2 ppm |
| Nb | XRF | 10 ppm |
| Nd | NAA | 3 ppm |
| Ni | ICP | 1 ppm |
| Pb | ICP | 2 ppm |
| Rb | XRF | 10 ppm |
| Sb | NAA | 0.1 ppm |
| Sc | NAA | 0.01 ppm |
| Se | NAA | 1 ppm |
| Sm | NAA | 0.01 ppm |
| Sr | XRF | 10 ppm |
| Ta | NAA | 0.5 ppm |
| Tb | NAA | 0.1 ppm |
| Th | NAA | 0.2 ppm |
| U | NAA | 0.1 ppm |
| V | ICP | 2 ppm |
| W | NAA | 1 ppm |
| Y | XRF | 10 ppm |
| Yb | NAA | 0.05 ppm |
| Zn | ICP | 0.5 ppm |
| Zr | XRF | 10 ppm |

Table 3. Duplicate analyses of rocks and standards analyzed in the same batch with samples from the North Slope of Alaska reported here. The system standard is not included in sample averages.

| Sample ID | $SiO_2$ (%) | $Al_2O_3$ (%) | $Fe_2O_3$ (%) | MgO (%) | CaO (%) | $Na_2O$ (%) | $K_2O$ (%) |
|---|---|---|---|---|---|---|---|
| Seabee No.1 14,599 | | | | | | | |
| Run 1 | 55.2 | 16.1 | 8.21 | 1.70 | 1.04 | 0.63 | 2.39 |
| Run 2 | 55.2 | 16.1 | 8.24 | 1.69 | 1.05 | 0.70 | 2.40 |
| North Inigok No. 1 10,165.3 | | | | | | | |
| Run 1 | -- | -- | -- | -- | -- | -- | -- |
| Run 2 | -- | -- | -- | -- | -- | -- | -- |
| Ikpikpuk No. 1 7,369 | | | | | | | |
| Run 1 | 49.4 | 18.5 | 10.5 | 1.75 | 0.59 | 0.71 | 2.83 |
| Run 2 | 49.3 | 18.5 | 10.4 | 1.75 | 0.60 | 0.73 | 2.85 |
| East Simpson No. 2 6,344.3 | | | | | | | |
| Run 1 | -- | -- | -- | -- | -- | -- | -- |
| Run 2 | -- | -- | -- | -- | -- | -- | -- |
| East Simpson No. 2 6,354 | | | | | | | |
| Run 1 | 60.1 | 18.5 | 4.13 | 1.80 | 0.54 | 0.90 | 3.45 |
| Run 2 | 60.2 | 18.7 | 4.11 | 1.79 | 0.55 | 0.91 | 3.46 |
| Other sample #1 (TBP10613-55) | | | | | | | |
| Run 1 | -- | -- | -- | -- | -- | -- | -- |
| Run 2 | -- | -- | -- | -- | -- | -- | -- |
| Other sample #2 (TBP10613-435) | | | | | | | |
| Run 1 | 38.1 | 9.85 | 4.65 | 2.40 | 17.4 | 2.72 | 1.71 |
| Run 2 | 38.0 | 9.84 | 4.64 | 2.38 | 17.4 | 2.74 | 1.72 |
| Other sample #3 (TBB 26001-11) | | | | | | | |
| Run 1 | -- | -- | -- | -- | -- | -- | -- |
| Run 2 | -- | -- | -- | -- | -- | -- | -- |
| Other sample #4 (TBB 26022-1) | | | | | | | |
| Run 1 | -- | -- | -- | -- | -- | -- | -- |
| Run 2 | -- | -- | -- | -- | -- | -- | -- |
| System Standard (Sy-2) | | | | | | | |
| Run 1 | 60.1 | 11.9 | 6.21 | 2.69 | 7.99 | 4.19 | 4.32 |
| Run 2 | 59.6 | 11.9 | 6.22 | 2.70 | 7.95 | 4.19 | 4.32 |

| Sample averages | $SiO_2$ (%) | $Al_2O_3$ (%) | $Fe_2O_3$ (%) | MgO (%) | CaO (%) | $Na_2O$ (%) | $K_2O$ (%) |
|---|---|---|---|---|---|---|---|
| Number (N) | 4 | 4 | 4 | 4 | 4 | 4 | 4 |
| Standard deviation | 0.04 | 0.03 | 0.02 | 0.005 | 0.004 | 0.02 | 0.006 |
| Relative std. dev. | 0.1% | 0.2% | 0.3% | 0.3% | 0.1% | 1.2% | 0.2% |

Table 3. continued

| Sample ID | $TiO_2$ (%) | $P_2O_5$ (%) | MnO (%) | LOI (%) | Ag (ppm) | As (ppm) | Au (ppb) |
|---|---|---|---|---|---|---|---|
| Seabee No.1 14,599 | | | | | | | |
| Run 1 | 0.914 | 0.16 | 0.08 | 13.8 | --- | --- | --- |
| Run 2 | 0.910 | 0.16 | 0.08 | 13.8 | --- | --- | --- |
| North Inigok No. 1 10,165.3 | | | | | | | |
| Run 1 | -- | -- | -- | --- | 1.6 | 28 | 21 |
| Run 2 | -- | -- | -- | --- | 1.6 | 30 | 23 |
| Ikpikpuk No. 1 7,369 | | | | | | | |
| Run 1 | 0.935 | 0.12 | 0.02 | 15.1 | 0.9 | 35 | 5 |
| Run 2 | 0.926 | 0.12 | 0.02 | 15.1 | 0.9 | 34 | 3 |
| East Simpson No. 2 6,344.3 | | | | | | | |
| Run 1 | -- | -- | --- | --- | <0.1 | --- | --- |
| Run 2 | -- | -- | -- | --- | 0.3 | --- | --- |
| East Simpson No. 2 6,354 | | | | | | | |
| Run 1 | 0.905 | 0.19 | 0.02 | 9.65 | --- | --- | --- |
| Run 2 | 0.915 | 0.19 | 0.02 | 9.60 | --- | --- | --- |
| Other sample #1 (TBP10613-55) | | | | | | | |
| Run 1 | -- | -- | --- | --- | 1.3 | --- | --- |
| Run 2 | -- | -- | -- | --- | 1.5 | --- | --- |
| Other sample #2 (TBP10613-435) | | | | | | | |
| Run 1 | 0.510 | 0.39 | 0.04 | 22.5 | --- | --- | --- |
| Run 2 | 0.531 | 0.39 | 0.04 | 22.6 | --- | --- | --- |
| Other sample #3 (TBB 26001-11) | | | | | | | |
| Run 1 | -- | -- | | --- | 0.7 | --- | --- |
| Run 2 | -- | -- | | --- | 1.0 | --- | --- |
| Other sample #4 (TBB 26022-1) | | | | | | | |
| Run 1 | -- | -- | -- | --- | --- | <1 | <2 |
| Run 2 | -- | -- | -- | --- | --- | <1 | <2 |
| System Standard (Sy-2) | | | -- | | | | |
| Run 1 | 0.143 | 0.43 | 0.32 | 1.20 | 0.2 | --- | --- |
| Run 2 | 0.139 | 0.43 | 0.32 | 1.20 | <0.1 | --- | --- |

| Sample averages | $TiO_2$ (%) | $P_2O_5$ (%) | MnO (%) | LOI (%) | Ag (ppm) | As (ppm) | Au (ppb) |
|---|---|---|---|---|---|---|---|
| Number (N) | 4 | 4 | 4 | 4 | 4 | 2 | 2 |
| Standard deviation | 0.006 | 0.00 | 0.00 | 0.02 | 0.06 | 0.8 | 1.0 |
| Relative std. dev. | 0.7% | 0.0% | 0.0% | 0.1% | 5.3% | 1.6% | 4.2% |

Table 3. continued

| Sample ID | B (ppm) | Ba (ppm) | Be (ppm) | Br (ppm) | Cd (ppm) | Ce (ppm) | Co (ppm) |
|---|---|---|---|---|---|---|---|
| Seabee No.1 14,599 | | | | | | | |
| Run 1 | --- | 414 | --- | --- | --- | --- | --- |
| Run 2 | --- | 425 | --- | --- | --- | --- | --- |
| North Inigok No. 1 10,165.3 | | | | | | | |
| Run 1 | 130 | --- | 2 | 4.5 | 25 | 36 | 7.8 |
| Run 2 | 135 | --- | 2 | 5.0 | 22 | 35 | 8.1 |
| Ikpikpuk No. 1 7369 | | | | | | | |
| Run 1 | 190 | 765 | 2 | 3.8 | 6 | 90 | 16 |
| Run 2 | 205 | 745 | 4 | 3.4 | 6 | 91 | 15 |
| East Simpson No. 2 6,344.3 | | | | | | | |
| Run 1 | 182 | --- | 5 | --- | <1 | --- | --- |
| Run 2 | 198 | --- | 5 | --- | <1 | --- | --- |
| East Simpson No. 2 6,354 | | | | | | | |
| Run 1 | --- | 700 | --- | --- | --- | --- | --- |
| Run 2 | --- | 711 | --- | --- | --- | --- | --- |
| Other sample #1 (TBP10613-55) | | | | | | | |
| Run 1 | 86 | --- | <1 | --- | 1 | --- | --- |
| Run 2 | 95 | --- | 1 | --- | <1 | --- | --- |
| Other sample #2 (TBP10613-435) | | | | | | | |
| Run 1 | --- | 1350 | --- | --- | --- | --- | --- |
| Run 2 | --- | 1360 | --- | --- | --- | --- | --- |
| Other sample #3 (TBB 26001-11) | | | | | | | |
| Run 1 | 114 | --- | <1 | --- | <1 | --- | --- |
| Run 2 | 120 | --- | <1 | --- | <1 | --- | --- |
| Other sample #4 (TBB 26022-1) | | | | | | | |
| Run 1 | --- | --- | --- | 560 | --- | 28 | 24 |
| Run 2 | --- | --- | --- | 560 | --- | 29 | 20 |
| System Standard (Sy-2) | | | | | | | |
| Run 1 | 91 | 446 | 24 | --- | <1 | --- | --- |
| Run 2 | 103 | 425 | 25 | --- | <1 | --- | --- |

| Sample averages | B (ppm) | Ba (ppm) | Be (ppm) | Br (ppm) | Cd (ppm) | Ce (ppm) | Co (ppm) |
|---|---|---|---|---|---|---|---|
| Number (N) | 5 | 4 | 3 | 3 | 2 | 3 | 3 |
| Standard deviation | 4.5 | 6.5 | 0.3 | 0.1 | 0.8 | 0.4 | 0.7 |
| Relative std. dev. | 2.7% | 0.8% | 10% | 0.08% | 2.8% | 1.0% | 5.8% |

Table 3. continued

| Sample ID | Cr (ppm) | Cs (ppm) | Cu (ppm) | Eu (ppm) | Ge (ppm) | Hf (ppm) | Ir (ppb) |
|---|---|---|---|---|---|---|---|
| Seabee No.1 14,599 | | | | | | | |
| Run 1 | --- | --- | --- | --- | --- | --- | --- |
| Run 2 | --- | --- | --- | --- | --- | --- | --- |
| North Inigok No. 1 10,165.3 | | | | | | | |
| Run 1 | 200 | 5.5 | 82.9 | 0.55 | <10 | 4.4 | <5 |
| Run 2 | 210 | 5.8 | 79.0 | 0.65 | <10 | 4.5 | <5 |
| Ikpikpuk No. 1 7,369 | | | | | | | |
| Run 1 | 120 | 9.5 | 62.1 | 1.73 | <10 | 4.7 | <5 |
| Run 2 | 120 | 9.6 | 62.4 | 1.63 | <10 | 4.8 | <5 |
| East Simpson No. 2 6,344.3 | | | | | | | |
| Run 1 | --- | --- | 128 | --- | <10 | --- | --- |
| Run 2 | --- | --- | 136 | --- | <10 | --- | --- |
| East Simpson No. 2 6,354 | | | | | | | |
| Run 1 | --- | --- | --- | --- | --- | --- | --- |
| Run 2 | --- | --- | --- | --- | --- | --- | --- |
| Other sample #1 (TBP10613-55) | | | | | | | |
| Run 1 | --- | --- | 54.4 | --- | <10 | --- | --- |
| Run 2 | --- | --- | 51.9 | --- | <10 | --- | --- |
| Other sample #2 (TBP10613-435) | | | | | | | |
| Run 1 | --- | --- | --- | --- | --- | --- | --- |
| Run 2 | --- | --- | --- | --- | --- | --- | --- |
| Other sample #3 (TBB 26001-11) | | | | | | | |
| Run 1 | --- | --- | 57.4 | --- | <10 | --- | --- |
| Run 2 | --- | --- | 54.8 | --- | <10 | --- | --- |
| Other sample #4 (TBB 26022-1) | | | | | | | |
| Run 1 | 56 | 4.6 | --- | 0.66 | --- | 1.6 | <5 |
| Run 2 | 52 | 4.1 | --- | 0.65 | --- | 1.5 | <5 |
| System Standard (Sy-2) | | | | | | | |
| Run 1 | --- | --- | 4.0 | --- | <10 | --- | --- |
| Run 2 | --- | --- | 3.8 | --- | <10 | --- | --- |

| Sample averages | Cr (ppm) | Cs (ppm) | Cu (ppm) | Eu (ppm) | Ge (ppm) | Hf (ppm) | Ir (ppb) |
|---|---|---|---|---|---|---|---|
| Number (N) | 3 | 3 | 5 | 3 | --- | 3 | --- |
| Standard deviation | 1.8 | 0.1 | 1.5 | 0.03 | --- | 0.04 | --- |
| Relative std. dev. | 1.8% | 2.3% | 1.7% | 3.6% | --- | 1.4% | --- |

Table 3. continued

| Sample ID | La (ppm) | Lu (ppm) | Mo (ppm) | Nb (ppm) | Nd (ppm) | Ni (ppm) | Pb (ppm) |
|---|---|---|---|---|---|---|---|
| Seabee No.1 14,599 | | | | | | | |
| Run 1 | --- | --- | --- | 28 | --- | --- | --- |
| Run 2 | --- | --- | --- | 28 | --- | --- | --- |
| North Inigok No. 1 10,165.3 | | | | | | | |
| Run 1 | 19.0 | 0.33 | 67 | --- | 14 | 126 | 8 |
| Run 2 | 19.2 | 0.34 | 70 | --- | 15 | 117 | 4 |
| Ikpikpuk No. 1 7,369 | | | | | | | |
| Run 1 | 45.7 | 0.46 | 16 | 18 | 40 | 78 | 13 |
| Run 2 | 45.5 | 0.46 | 18 | 17 | 40 | 80 | 15 |
| East Simpson No. 2 6,344.3 | | | | | | | |
| Run 1 | --- | --- | --- | --- | --- | 44 | 4 |
| Run 2 | --- | --- | --- | --- | --- | 48 | 2 |
| East Simpson No. 2 6,354 | | | | | | | |
| Run 1 | --- | --- | --- | 22 | --- | --- | --- |
| Run 2 | --- | --- | --- | 21 | --- | --- | --- |
| Other sample #1 (TBP10613-55) | | | | | | | |
| Run 1 | --- | --- | --- | --- | --- | 53 | <2 |
| Run 2 | --- | --- | --- | --- | --- | 52 | <2 |
| Other sample #2 (TBP10613-435) | | | | | | | |
| Run 1 | --- | --- | --- | <10 | --- | --- | --- |
| Run 2 | --- | --- | --- | <10 | --- | --- | --- |
| Other sample #3 (TBB 26001-11) | | | | | | | |
| Run1 | --- | --- | --- | --- | --- | 53 | <2 |
| Run 2 | --- | --- | --- | --- | --- | 52 | <2 |
| Other sample #4 (TBB 26022-1) | | | | | | | |
| Run 1 | 14.9 | 0.24 | <2 | --- | --- | --- | --- |
| Run 2 | 15.0 | 0.24 | <2 | --- | --- | --- | --- |
| System Standard (Sy-2) | | | | | | | |
| Run1 | --- | --- | --- | 27 | --- | 5 | 70 |
| Run 2 | --- | --- | --- | 27 | --- | 4 | 72 |

| Sample averages | La (ppm) | Lu (ppm) | Mo (ppm) | Nb (ppm) | Nd (ppm) | Ni (ppm) | Pb (ppm) |
|---|---|---|---|---|---|---|---|
| Number (N) | 3 | 3 | 2 | 3 | 2 | 5 | 3 |
| Standard deviation | 0.06 | 0.001 | 1.3 | 0.3 | 0.3 | 1.6 | 1.0 |
| Relative std. dev. | 0.3% | 0.5% | 1.6% | 1.5% | 0.7% | 2.0% | 17% |

Table 3. continued

| Sample ID | | Rb (ppm) | Sb (ppm) | Sc (ppm) | Se (ppm) | Sm (ppm) | Sr (ppm) | Ta (ppm) |
|---|---|---|---|---|---|---|---|---|
| Seabee No.1 | 14,599 | | | | | | | |
| Run 1 | | 92 | --- | --- | --- | --- | 186 | --- |
| Run 2 | | 93 | --- | --- | --- | --- | 190 | --- |
| North Inigok No. 1 | 10,165.3 | | | | | | | |
| Run 1 | | --- | 4.3 | 9.22 | 28 | 2.50 | --- | <0.5 |
| Run 2 | | --- | 4.5 | 9.46 | 29 | 2.54 | --- | <0.5 |
| Ikpikpuk No. 1 | 7,369 | | | | | | | |
| Run 1 | | 114 | 2.7 | 18.7 | 15 | 7.20 | 157 | 1.0 |
| Run 2 | | 108 | 2.7 | 18.1 | 16 | 7.22 | 159 | 0.9 |
| East Simpson No. 2 | 6,344.3 | | | | | | | |
| Run 1 | | --- | --- | --- | --- | --- | --- | --- |
| Run 2 | | --- | --- | --- | --- | --- | --- | --- |
| East Simpson No. 2 | 6,354 | | | | | | | |
| Run 1 | | 151 | --- | --- | --- | --- | 218 | --- |
| Run 2 | | 157 | --- | --- | --- | --- | 221 | --- |
| Other sample #1 (TBP10613-55) | | | | | | | | |
| Run 1 | | --- | --- | --- | --- | --- | --- | --- |
| Run 2 | | --- | --- | --- | --- | --- | --- | --- |
| Other sample #2 (TBP10613-435) | | | | | | | | |
| Run 1 | | 54 | --- | --- | --- | --- | 689 | --- |
| Run 2 | | 56 | --- | --- | --- | --- | 687 | --- |
| Other sample #3 (TBB 26001-11) | | | | | | | | |
| Run 1 | | --- | --- | --- | --- | --- | --- | --- |
| Run 2 | | --- | --- | --- | --- | --- | --- | --- |
| Other sample #4 (TBB 26022-1) | | | | | | | | |
| Run 1 | | --- | 1.6 | 6.68 | 8 | 2.42 | --- | <0.5 |
| Run 2 | | --- | 1.3 | 6.68 | 8 | 2.43 | --- | <0.5 |
| System Standard (Sy-2) | | | | | | | | |
| Run 1 | | 214 | --- | --- | --- | --- | 263 | --- |
| Run 2 | | 211 | --- | --- | --- | --- | 266 | --- |

| Sample averages | Rb (ppm) | Sb (ppm) | Sc (ppm) | Se (ppm) | Sm (ppm) | Sr (ppm) | Ta (ppm) |
|---|---|---|---|---|---|---|---|
| Number (N) | 4 | 3 | 3 | 3 | 3 | 4 | 1 |
| Standard deviation | 1.9 | 0.06 | 0.1 | 0.3 | 0.01 | 1.4 | 0.03 |
| Relative std. dev. | 1.8% | 2.9% | 1.2% | 1.9% | 0.3% | 0.4% | 5.3% |

Table 3. continued

| Sample ID | Tb (ppm) | Th (ppm) | U (ppm) | V (ppm) | W (ppm) | Y (ppm) | Yb (ppm) |
|---|---|---|---|---|---|---|---|
| Seabee No.1 14,599 | | | | | | | |
| Run 1 | --- | --- | --- | --- | --- | 30 | --- |
| Run 2 | --- | --- | --- | --- | --- | 29 | --- |
| North Inigok No. 1 10,165.3 | | | | | | | |
| Run 1 | 0.3 | 7.6 | 5.2 | 489 | 2 | --- | 2.04 |
| Run 2 | 0.3 | 7.9 | 5.4 | 430 | 1 | --- | 2.07 |
| Ikpikpuk No. 1 7,369 | | | | | | | |
| Run 1 | 0.9 | 13.0 | 5.4 | 302 | 2 | 35 | 3.16 |
| Run 2 | 0.8 | 13.0 | 5.2 | 310 | 3 | 31 | 3.15 |
| East Simpson No. 2 6,344.3 | | | | | | | |
| Run 1 | --- | --- | --- | 163 | --- | --- | --- |
| Run 2 | --- | --- | --- | 167 | --- | --- | --- |
| East Simpson No. 2 6,354 | | | | | | | |
| Run 1 | --- | --- | --- | --- | --- | 36 | --- |
| Run 2 | --- | --- | --- | --- | --- | 41 | --- |
| Other sample #1 (TBP10613-55) | | | | | | | |
| Run 1 | --- | --- | --- | 71 | --- | --- | --- |
| Run 2 | --- | --- | --- | 72 | --- | --- | --- |
| Other sample #2 (TBP10613-435) | | | | | | | |
| Run 1 | --- | --- | --- | --- | --- | 27 | --- |
| Run 2 | --- | --- | --- | --- | --- | 25 | --- |
| Other sample #3 (TBB 26001-11) | | | | | | | |
| Run 1 | --- | --- | --- | 57 | --- | --- | --- |
| Run 2 | --- | --- | --- | 57 | --- | --- | --- |
| Other sample #4 (TBB 26022-1) | | | | | | | |
| Run 1 | 0.3 | 4.2 | 2.6 | --- | <1 | --- | 1.34 |
| Run 2 | 0.3 | 3.9 | 2.9 | --- | <1 | --- | 1.33 |
| System Standard (Sy-2) | | | | | | | |
| Run 1 | --- | --- | --- | 49 | --- | 125 | --- |
| Run 2 | --- | --- | --- | 47 | --- | 125 | --- |

| Sample averages | Tb (ppm) | Th (ppm) | U (ppm) | V (ppm) | W (ppm) | Y (ppm) | Yb (ppm) |
|---|---|---|---|---|---|---|---|
| Number (N) | 3 | 3 | 3 | 5 | 2 | 4 | 3 |
| Standard deviation | 0.01 | 0.08 | 0.09 | 7.2 | 0.5 | 1.5 | 0.006 |
| Relative std. dev. | 3.4% | 1.2% | 2.6% | 3.2% | 18% | 4.7% | 0.4% |

Table 3. continued

| Sample ID | Zn (ppm) | Zr (ppm) |
|---|---|---|
| Seabee No.1 14,599 | | |
| Run 1 | --- | 240 |
| Run 2 | --- | 238 |
| North Inigok No. 1 10,165.3 | | |
| Run 1 | 745 | --- |
| Run 2 | 694 | --- |
| Ikpikpuk No. 1 7369 | | |
| Run 1 | 213 | 181 |
| Run 2 | 216 | 179 |
| East Simpson No. 2 6,344.3 | | |
| Run 1 | 179 | --- |
| Run 2 | 215 | --- |
| East Simpson No. 2 6,354 | | |
| Run 1 | --- | 181 |
| Run 2 | --- | 181 |
| Other sample #1 (TBP10613-55) | | |
| Run 1 | 117 | --- |
| Run 2 | 112 | --- |
| Other sample #2 (TBP10613-435) | | |
| Run 1 | --- | 108 |
| Run 2 | --- | 105 |
| Other sample #3 (TBB 26001-11) | | |
| Run 1 | 124 | --- |
| Run 2 | 121 | --- |
| Other sample #4 (TBB 26022-1) | | |
| Run 1 | --- | --- |
| Run 2 | --- | --- |
| System Standard (Sy-2) | | |
| Run 1 | 240 | 284 |
| Run 2 | 241 | 287 |

| Sample averages | Zn (ppm) | Zr (ppm) |
|---|---|---|
| Number (N) | 5 | 4 |
| Standard deviation | 9.5 | 0.9 |
| Relative std. dev. | 3.2% | 0.5% |

Table 4. Relative standard deviations for duplicate analyses, grouped by mean abundance relative to the detection limit for each element. For CaO and Br, standard deviations for single samples with specially high abundances are listed separately. Data are detailed in Table 3.

| Element | 1-10X | 10-100X | 100-1,000X | 1,000-10,000X |
|---|---|---|---|---|
| $SiO_2$ | | | | 0.07% |
| $Al_2O_3$ | | | | 0.2% |
| $Fe_2O_3$ | | | 0.3% | |
| MgO | | | 0.3% | |
| CaO | | 0.7% | 0.0% | |
| $Na_2O$ | | | 1.2% | |
| $K_2O$ | | | 0.2% | |
| $TiO_2$ | | 0.7% | | |
| $P_2O_5$ | | 0.0% | | |
| MnO | 0.0% | | | |
| LOI | | | | 0.1% |
| Ag | | 5.3% | | |
| As | | 1.6% | | |
| Au | | 4.2% | | |
| B | | 2.7% | | |
| Ba | | 0.8% | | |
| Be | 10% | | | |
| Br | | 3.4% | 0.0% | |
| Cd | | 2.8% | | |
| Ce | | 1.0% | | |
| Co | | 5.8% | | |
| Cr | | | 1.8% | |
| Cs | | 2.3% | | |
| Cu | | | 1.7% | |
| Eu | | 3.6% | | |
| Hf | | 1.4% | | |
| La | | | 0.3% | |
| Lu | | 0.5% | | |
| Mo | | 1.6% | | |
| Nb | 1.5% | | | |
| Nd | | 0.7% | | |

Table 4. continued

| Element | 1-10X | 10-100X | 100-1,000X | 1,000-10,000X |
|---|---|---|---|---|
| Ni | | 2.0% | | |
| Pb | 17% | | | |
| Rb | | 1.8% | | |
| Sb | | 2.9% | | |
| Sc | | | 1.2% | |
| Se | | 1.9% | | |
| Sm | | | 0.3% | |
| Sr | | 0.4% | | |
| Ta | 5.3% | | | |
| Tb | 3.4% | | | |
| Th | | 1.2% | | |
| U | | 2.6% | | |
| V | | | 3.2% | |
| W | 18% | | | |
| Y | 4.7% | | | |
| Yb | | 0.4% | | |
| Zn | | | 3.2% | |
| Zr | | 0.5% | | |

Table 5. Abundances of major and minor elements for samples analyzed from the North Slope of Alaska.

| Well | Depth (ft) | $SiO_2$ (%) | $Al_2O_3$ (%) | $Fe_2O_3$ (%) | MgO (%) | CaO (%) | $Na_2O$ (%) | $K_2O$ (%) |
|---|---|---|---|---|---|---|---|---|
| Seabee No. 1 | 14589 | 56.8 | 18.5 | 5.01 | 1.24 | 0.80 | 0.74 | 2.52 |
| | 14593.8 | 52.2 | 19.3 | 5.31 | 1.09 | 0.94 | 0.78 | 2.75 |
| | 14599 | 55.2 | 16.1 | 8.21 | 1.70 | 1.04 | 0.63 | 2.39 |
| | 14604 | 55.8 | 17.2 | 6.66 | 1.50 | 1.14 | 0.67 | 2.54 |
| Inigok No. 1 | 8849.5-51.5 | 50.5 | 20.6 | 8.15 | 2.47 | 1.05 | 1.33 | 4.28 |
| | 8849.5 | 51.9 | 20.3 | 8.38 | 2.43 | 1.08 | 1.61 | 4.30 |
| | 9457.5 | 63.5 | 15.9 | 5.32 | 1.21 | 0.59 | 0.66 | 2.59 |
| | 10299 | 72.6 | 10.8 | 3.69 | 1.80 | 2.17 | 0.78 | 2.18 |
| | 12273.5 | 53.1 | 14.3 | 4.98 | 1.20 | 8.66 | 0.45 | 2.83 |
| | 12275.5 | 44.5 | 10.5 | 3.48 | 2.11 | 17.9 | 0.52 | 2.15 |
| No. Inigok No. 1 | 10160 | 33.8 | 7.34 | 2.42 | 1.75 | 27.7 | 0.39 | 1.21 |
| | 10165.3 | 47.2 | 10.3 | 4.86 | 1.85 | 16.2 | 0.55 | 1.70 |
| No. Kalikpik No. 1 | 7131.4 | 57.4 | 20.5 | 4.52 | 1.84 | 1.26 | 0.85 | 3.53 |
| | 7136 | 55.9 | 20.3 | 5.26 | 1.97 | 0.94 | 0.80 | 3.55 |
| | 7148.5 | 67.4 | 13.5 | 4.69 | 1.29 | 1.80 | 0.49 | 2.19 |
| | 7149.5 | 64.4 | 15.5 | 4.50 | 1.40 | 1.59 | 0.53 | 2.58 |
| Ikpikpuk No. 1 | 7369 | 49.4 | 18.5 | 10.5 | 1.75 | 0.59 | 0.71 | 2.83 |
| | 7372.3 | 54.0 | 20.4 | 7.34 | 1.79 | 0.60 | 0.86 | 3.39 |
| | 7376 | 55.2 | 18.9 | 7.20 | 1.93 | 0.62 | 0.82 | 3.11 |
| | 7491 | 62.3 | 16.7 | 4.69 | 1.36 | 0.80 | 0.70 | 2.68 |
| | 7500 | 63.6 | 16.2 | 4.46 | 1.30 | 0.74 | 0.67 | 2.49 |
| | 10277 | 24.9 | 4.43 | 1.59 | 1.45 | 34.5 | 0.50 | 0.69 |
| | 10283 | 20.5 | 4.20 | 2.06 | 1.82 | 36.4 | 0.43 | 0.64 |
| | 10288 | 20.1 | 4.12 | 1.29 | 1.07 | 38.3 | 0.50 | 0.67 |
| Drew Point No. 1 | 6927 | 56.3 | 18.7 | 8.03 | 1.91 | 0.99 | 0.59 | 3.22 |
| | 6941 | 60.4 | 20.3 | 4.02 | 1.70 | 0.65 | 0.57 | 3.68 |
| | 7544 | 64.4 | 9.96 | 3.61 | 1.30 | 7.86 | 0.48 | 2.09 |
| | 7568.5 | 79.5 | 4.81 | 2.32 | 1.25 | 4.93 | 0.22 | 0.86 |
| E. Simpson No. 2 | 6344.3 | 61.8 | 17.1 | 4.89 | 2.06 | 0.93 | 1.06 | 3.18 |
| | 6354 | 60.1 | 18.5 | 4.13 | 1.80 | 0.54 | 0.90 | 3.45 |
| | 6367 | 55.9 | 18.1 | 6.56 | 2.07 | 0.81 | 1.12 | 3.34 |
| So. Barrow No. 19 | 1354 | 44.3 | 13.9 | 8.82 | 1.51 | 1.42 | 1.29 | 2.33 |
| | 1359.3 | 37.6 | 14.3 | 11.1 | 1.59 | 0.79 | 1.10 | 2.47 |

Table 5. continued.

| Well | Depth (ft) | $TiO_2$ (%) | $P_2O_5$ (%) | MnO (%) | LOI (%) | Ag (ppm) | As (ppm) | Au (ppb) |
|---|---|---|---|---|---|---|---|---|
| Seabee No. 1 | 14589 | 1.00 | 0.17 | 0.05 | 13.6 | 0.1 | 7 | <2 |
| | 14593.8 | 1.03 | 0.15 | 0.03 | 16.4 | 0.4 | 88 | 5 |
| | 14599 | 0.914 | 0.16 | 0.08 | 13.8 | <0.1 | 3 | <2 |
| | 14604 | 0.934 | 0.15 | 0.06 | 13.8 | <0.1 | 6 | <2 |
| Inigok No. 1 | 8849.5-51.5 | 1.04 | 0.21 | 0.05 | 10.5 | <0.1 | 26 | <2 |
| | 8849.5 | 1.02 | 0.21 | 0.06 | 8.90 | 0.6 | 17 | <2 |
| | 9457.5 | 0.940 | 0.18 | 0.03 | 9.15 | 0.4 | 12 | <2 |
| | 10299 | 0.725 | 0.17 | 0.02 | 5.30 | 0.2 | 10 | <2 |
| | 12273.5 | 0.722 | 0.09 | <0.01 | 13.3 | 0.4 | 25 | 13 |
| | 12275.5 | 0.565 | 0.10 | <0.01 | 16.2 | 1.0 | 16 | 17 |
| No. Inigok No. 1 | 10160 | 0.409 | 4.16 | <0.01 | 19.9 | 0.3 | 13 | 8 |
| | 10165.3 | 0.630 | 0.09 | <0.01 | 15.5 | 1.6 | 28 | 21 |
| No. Kalikpik No. 1 | 7131.4 | 0.882 | 0.15 | <0.01 | 9.45 | 0.1 | 26 | <2 |
| | 7136 | 0.913 | 0.12 | 0.04 | 10.4 | <0.1 | 61 | 3 |
| | 7148.5 | 0.860 | 0.19 | 0.03 | 7.70 | <0.1 | 10 | <2 |
| | 7149.5 | 0.942 | 0.22 | 0.01 | 8.30 | <0.1 | 9 | 2 |
| Ikpikpuk No. 1 | 7369 | 0.935 | 0.12 | 0.02 | 15.1 | 0.9 | 35 | 5 |
| | 7372.3 | 0.963 | 0.20 | 0.03 | 10.6 | <0.1 | 16 | 5 |
| | 7376 | 0.932 | 0.12 | 0.03 | 11.3 | <0.1 | 22 | 3 |
| | 7491 | 1.01 | 0.21 | 0.04 | 9.65 | 0.5 | 10 | <2 |
| | 7500 | 0.961 | 0.17 | 0.03 | 9.60 | <0.1 | 3 | <2 |
| | 10277 | 0.251 | 5.65 | <0.01 | 24.8 | <0.1 | 9 | 10 |
| | 10283 | 0.219 | 5.19 | <0.01 | 26.6 | 0.2 | 13 | 5 |
| | 10288 | 0.231 | 2.91 | <0.01 | 29.4 | 0.7 | 12 | 9 |
| Drew Point No. 1 | 6927 | 1.04 | 0.16 | 0.06 | 9.15 | <0.1 | 75 | 6 |
| | 6941 | 1.19 | 0.12 | 0.02 | 7.35 | 0.3 | 11 | 8 |
| | 7544 | 0.686 | 0.89 | <0.01 | 9.00 | 0.4 | 16 | <2 |
| | 7568.5 | 0.434 | 1.43 | 0.01 | 4.20 | <0.1 | 13 | <2 |
| Ea. Simpson No. 2 | 6344.3 | 0.761 | 0.18 | 0.02 | 8.05 | <0.1 | 6 | 7 |
| | 6354 | 0.905 | 0.19 | 0.02 | 9.65 | 0.2 | 9 | 6 |
| | 6367 | 0.855 | 0.15 | 0.02 | 11.4 | 0.9 | 38 | 8 |
| So. Barrow No. 19 | 1354 | 0.777 | 0.36 | 0.03 | 25.7 | 0.4 | 150 | 4 |
| | 1359.3 | 0.750 | 0.26 | 0.03 | 30.3 | <0.1 | 110 | 8 |

Table 5. continued

| Well | Depth (ft) | B (ppm) | Ba (ppm) | Be (ppm) | Br (ppm) | Cd (ppm) | Ce (ppm) | Co (ppm) |
|---|---|---|---|---|---|---|---|---|
| Seabee No. 1 | 14589 | 190 | 401 | 2 | 3.9 | <1 | 95 | 9.9 |
| | 14593.8 | 191 | 597 | 2 | 5.1 | <1 | 86 | 45 |
| | 14599 | 179 | 414 | 2 | 4.1 | <1 | 93 | 11 |
| | 14604 | 178 | 429 | 4 | 3.9 | <1 | 90 | 13 |
| Inigok No. 1 | 8849.5-51.5 | 193 | 921 | 4 | 4.9 | <1 | 93 | 22 |
| | 8849.5 | 183 | 895 | 3 | 5.2 | <1 | 91 | 19 |
| | 9457.5 | 170 | 504 | 2 | 4.3 | <1 | 87 | 17 |
| | 10299 | 132 | 364 | 1 | 4.7 | <1 | 65 | 10 |
| | 12273.5 | 194 | 1220 | 1 | 4.9 | 3 | 55 | 7.7 |
| | 12275.5 | 137 | 1160 | 1 | 3.5 | 2 | 46 | 7.2 |
| No. Inigok No. 1 | 10160 | 87 | 1340 | <1 | 4.2 | 7 | 41 | 4.5 |
| | 10165.3 | 130 | 906 | 2 | 4.5 | 25 | 36 | 7.8 |
| No. Kalikpik No. 1 | 7131.4 | 232 | 1050 | 2 | 4.0 | <1 | 107 | 14 |
| | 7136 | 227 | 1120 | 3 | 4.4 | <1 | 108 | 30 |
| | 7148.5 | 154 | 701 | 2 | 2.4 | <1 | 64 | 11 |
| | 7149.5 | 187 | 790 | 2 | 2.4 | <1 | 70 | 12 |
| Ikpikpuk No. 1 | 7369 | 190 | 765 | 2 | 3.8 | 6 | 90 | 16 |
| | 7372.3 | 241 | 824 | 3 | 3.8 | <1 | 115 | 16 |
| | 7376 | 224 | 861 | 3 | 3.9 | <1 | 112 | 18 |
| | 7491 | 190 | 549 | 2 | 3.9 | <1 | 105 | 12 |
| | 7500 | 181 | 566 | 4 | 3.6 | <1 | 98 | 7.7 |
| | 10277 | 61 | 455 | <1 | 3.5 | 3 | 54 | 3.0 |
| | 10283 | 59 | 867 | <1 | 3.1 | <1 | 23 | 3.2 |
| | 10288 | 49 | 487 | <1 | 3.5 | 4 | 30 | 3.2 |
| Drew Point No. 1 | 6927 | 247 | 935 | 3 | 3.1 | <1 | 99 | 20 |
| | 6941 | 257 | 898 | 2 | 3.7 | <1 | 103 | 16 |
| | 7544 | 184 | 408 | 1 | 2.6 | <1 | 78 | 7.9 |
| | 7568.5 | 99 | 293 | <1 | 2.0 | <1 | 63 | 4.1 |
| Ea. Simpson No. 2 | 6344.3 | 182 | 742 | 5 | 3.1 | <1 | 180 | 11 |
| | 6354 | 205 | 700 | 3 | 2.9 | <1 | 102 | 13 |
| | 6367 | 188 | 747 | 3 | 3.0 | 5 | 78 | 19 |
| So. Barrow No. 19 | 1354 | 142 | 684 | 2 | 5.0 | 1 | 73 | 35 |
| | 1359.3 | 155 | 636 | 3 | 5.6 | 4 | 67 | 44 |

Table 5. continued

| Well | Depth (ft) | Cr (ppm) | Cs (ppm) | Cu (ppm) | Eu (ppm) | Ge (ppm) | Hf (ppm) | Ir (ppb) |
|---|---|---|---|---|---|---|---|---|
| Seabee No. 1 | 14589 | 110 | 7.8 | 21.6 | 1.33 | <10 | 6.9 | <5 |
| | 14593.8 | 110 | 9.5 | 34.7 | 1.13 | <10 | 5.9 | <5 |
| | 14599 | 100 | 7.4 | 19.9 | 1.19 | <10 | 7.1 | <5 |
| | 14604 | 100 | 7.2 | 21.5 | 1.26 | <10 | 6.9 | <5 |
| Inigok No. 1 | 8849.5-51.5 | 120 | 14.1 | 55.4 | 1.49 | <10 | 5.1 | <5 |
| | 8849.5 | 120 | 12.8 | 47.1 | 1.29 | <10 | 4.9 | <5 |
| | 9457.5 | 88 | 7.5 | 20.2 | 1.30 | <10 | 8.2 | <5 |
| | 10299 | 74 | 5.9 | 15.7 | 1.01 | <10 | 9.9 | <5 |
| | 12273.5 | 140 | 7.1 | 73.4 | 0.94 | <10 | 3.9 | <5 |
| | 12275.5 | 150 | 5.9 | 92.2 | 0.58 | <10 | 4.0 | <5 |
| No. Inigok No. 1 | 10160 | 160 | 4.7 | 55.9 | 1.36 | <10 | 3.3 | <5 |
| | 10165.3 | 200 | 5.5 | 82.9 | 0.55 | <10 | 4.4 | <5 |
| No. Kalikpik No. 1 | 7131.4 | 100 | 11.4 | 37.1 | 1.60 | <10 | 4.9 | <5 |
| | 7136 | 110 | 11.4 | 34.4 | 1.58 | <10 | 5.2 | <5 |
| | 7148.5 | 90 | 8.3 | 18.3 | 1.00 | <10 | 8.2 | <5 |
| | 7149.5 | 96 | 10.5 | 19.7 | 1.01 | <10 | 7.9 | <5 |
| Ikpikpuk No. 1 | 7369 | 120 | 9.5 | 62.1 | 1.73 | <10 | 4.7 | <5 |
| | 7372.3 | 120 | 11.2 | 52.4 | 2.46 | <10 | 4.9 | <5 |
| | 7376 | 100 | 10.3 | 44.4 | 1.84 | <10 | 6.0 | <5 |
| | 7491 | 96 | 7.6 | 16.4 | 1.29 | <10 | 8.0 | <5 |
| | 7500 | 94 | 7.4 | 15.9 | 1.18 | <10 | 8.6 | <5 |
| | 10277 | 110 | 2.3 | 53.7 | 2.11 | <10 | 1.9 | <5 |
| | 10283 | 110 | 2.4 | 37.9 | 0.99 | <10 | 1.5 | <5 |
| | 10288 | 140 | 2.1 | 78.4 | 1.66 | <10 | 2.1 | <5 |
| Drew Point No. 1 | 6927 | 120 | 8.9 | 37.3 | 1.60 | <10 | 5.6 | <5 |
| | 6941 | 130 | 7.6 | 47.9 | 1.34 | <10 | 8.0 | <5 |
| | 7544 | 130 | 16.8 | 24.2 | 1.67 | <10 | 8.0 | <5 |
| | 7568.5 | 88 | 4.9 | 6.7 | 1.67 | <10 | 13 | <5 |
| Ea. Simpson No. 2 | 6344.3 | 98 | 13.1 | 128 | 1.84 | <10 | 6.6 | <5 |
| | 6354 | 120 | 11.9 | 115 | 1.98 | <10 | 5.0 | <5 |
| | 6367 | 120 | 13.5 | 80.9 | 1.48 | <10 | 4.1 | <5 |
| So. Barrow No. 19 | 1354 | 84 | 6.1 | 65.0 | 1.82 | <10 | 3.9 | <5 |
| | 1359.3 | 88 | 9.0 | 83.0 | 1.35 | <10 | 3.5 | <5 |

Table 5. continued

| Well | Depth (ft) | La (ppm) | Lu (ppm) | Mo (ppm) | Nb (ppm) | Nd (ppm) | Ni (ppm) | Pb (ppm) |
|---|---|---|---|---|---|---|---|---|
| Seabee No. 1 | 14589 | 50.0 | 0.46 | <2 | 30 | 39 | 30 | <2 |
| | 14593.8 | 46.9 | 0.37 | <2 | 30 | 32 | 106 | 53 |
| | 14599 | 47.9 | 0.43 | 3 | 28 | 39 | 32 | <2 |
| | 14604 | 47.2 | 0.44 | <2 | 28 | 36 | 32 | 3 |
| Inigok No. 1 | 8849.5-51.5 | 49.0 | 0.49 | 7 | 17 | 38 | 57 | 7 |
| | 8849.5 | 47.8 | 0.49 | 3 | 15 | 38 | 49 | 8 |
| | 9457.5 | 45.8 | 0.40 | <2 | 28 | 34 | 35 | 8 |
| | 10299 | 32.9 | 0.43 | <2 | 16 | 27 | 20 | 6 |
| | 12273.5 | 31.0 | 0.33 | 41 | <10 | 24 | 84 | 5 |
| | 12275.5 | 25.6 | 0.31 | 36 | <10 | 19 | 87 | <2 |
| No. Inigok No. 1 | 10160 | 36.2 | 0.64 | 17 | 19 | 30 | 84 | 3 |
| | 10165.3 | 19.0 | 0.33 | 67 | 17 | 14 | 126 | 8 |
| No. Kalikpik No. 1 | 7131.4 | 54.3 | 0.45 | 2 | 21 | 43 | 34 | 9 |
| | 7136 | 55.4 | 0.50 | 2 | 24 | 46 | 49 | 18 |
| | 7148.5 | 33.7 | 0.41 | <2 | 13 | 26 | 39 | 9 |
| | 7149.5 | 37.9 | 0.46 | <2 | 50 | 28 | 35 | 4 |
| Ikpikpuk No. 1 | 7369 | 45.7 | 0.46 | 16 | 18 | 40 | 78 | 13 |
| | 7372.3 | 56.1 | 0.50 | <2 | 21 | 49 | 52 | 11 |
| | 7376 | 52.2 | 0.49 | <2 | 19 | 44 | 49 | 15 |
| | 7491 | 56.2 | 0.45 | <2 | 36 | 42 | 21 | <2 |
| | 7500 | 52.0 | 0.43 | <2 | 36 | 40 | 17 | <2 |
| | 10277 | 56.3 | 0.88 | 21 | 14 | 49 | 67 | <2 |
| | 10283 | 24.3 | 0.44 | 5 | <10 | 21 | 60 | <2 |
| | 10288 | 33.7 | 0.46 | 26 | <10 | 33 | 106 | 2 |
| Drew Point No. 1 | 6927 | 52.9 | 0.57 | 3 | 17 | 43 | 50 | 16 |
| | 6941 | 56.6 | 0.51 | 2 | 20 | 41 | 45 | 32 |
| | 7544 | 44.5 | 0.51 | 10 | 12 | 40 | 40 | <2 |
| | 7568.5 | 38.7 | 0.53 | <2 | 10 | 36 | 12 | 5 |
| Ea. Simpson No. 2 | 6344.3 | 96.3 | 0.55 | 3 | 24 | 68 | 44 | 4 |
| | 6354 | 52.5 | 0.53 | <2 | 22 | 46 | 41 | 4 |
| | 6367 | 39.7 | 0.42 | 31 | 17 | 34 | 98 | 6 |
| So. Barrow No. 19 | 1354 | 36.1 | 0.49 | 51 | 12 | 36 | 77 | 3 |
| | 1359.3 | 34.6 | 0.42 | 48 | 10 | 30 | 117 | 14 |

Table 5. continued

| Well | Depth (ft) | Rb (ppm) | Sb (ppm) | Sc (ppm) | Se (ppm) | Sm (ppm) | Sr (ppm) | Ta (ppm) |
|---|---|---|---|---|---|---|---|---|
| Seabee No. 1 | 14589 | 114 | 0.6 | 13.5 | <1 | 6.52 | 212 | 1.9 |
| | 14593.8 | 122 | 1.8 | 11.3 | <1 | 5.34 | 203 | 1.7 |
| | 14599 | 92 | 0.4 | 15.0 | <1 | 6.92 | 186 | 1.5 |
| | 14604 | 100 | 0.5 | 14.9 | <1 | 6.27 | 186 | 1.8 |
| Inigok No. 1 | 8849.5-51.5 | 166 | 2.0 | 21.5 | 1 | 6.80 | 162 | 0.7 |
| | 8849.5 | 164 | 2.0 | 19.8 | <1 | 6.48 | 156 | 0.9 |
| | 9457.5 | 108 | 0.6 | 12.3 | <1 | 5.97 | 165 | 1.8 |
| | 10299 | 86 | 0.6 | 10.0 | <1 | 5.04 | 114 | 0.6 |
| | 12273.5 | 116 | 2.2 | 14.8 | 10 | 4.27 | 246 | 0.5 |
| | 12275.5 | 90 | 1.3 | 12.2 | 10 | 3.11 | 413 | <0.5 |
| No. Inigok No. 1 | 10160 | 72 | 2.2 | 9.91 | 10 | 5.81 | 584 | <0.5 |
| | 10165.3 | 107 | 4.3 | 9.22 | 28 | 2.50 | 352 | <0.5 |
| No. Kalikpik No. 1 | 7131.4 | 157 | 1.0 | 18.5 | <1 | 7.85 | 206 | 1.2 |
| | 7136 | 157 | 1.8 | 18.6 | <1 | 8.32 | 200 | 1.7 |
| | 7148.5 | 106 | 0.7 | 11.1 | <1 | 4.65 | 144 | 0.7 |
| | 7149.5 | 127 | 0.8 | 13.0 | <1 | 4.99 | 148 | 0.9 |
| Ikpikpuk No. 1 | 7369 | 114 | 2.7 | 18.7 | 15 | 7.20 | 157 | 1.0 |
| | 7372.3 | 143 | 2.7 | 21.3 | 5 | 9.78 | 198 | 1.2 |
| | 7376 | 137 | 1.3 | 19.2 | <1 | 8.12 | 195 | 1.2 |
| | 7491 | 114 | 0.5 | 12.9 | <1 | 7.01 | 235 | 2.0 |
| | 7500 | 110 | 0.4 | 12.0 | <1 | 6.45 | 226 | 2.3 |
| | 10277 | 43 | 3.1 | 10.2 | 15 | 9.74 | 813 | <0.5 |
| | 10283 | 34 | 1.3 | 7.11 | 7 | 4.17 | 733 | <0.5 |
| | 10288 | 32 | 2.1 | 9.53 | 10 | 7.06 | 783 | <0.5 |
| Drew Point No. 1 | 6927 | 125 | 1.9 | 20.7 | <1 | 8.12 | 198 | 1.3 |
| | 6941 | 123 | 1.9 | 17.0 | <1 | 6.87 | 203 | 0.8 |
| | 7544 | 106 | 0.9 | 11.7 | 2 | 7.74 | 236 | 0.7 |
| | 7568.5 | 37 | 0.4 | 7.46 | <1 | 7.33 | 162 | <0.5 |
| Ea. Simpson No. 2 | 6344.3 | 141 | 1.3 | 19.1 | <1 | 11.2 | 268 | 0.9 |
| | 6354 | 151 | 1.1 | 22.1 | 5 | 8.53 | 218 | 1.0 |
| | 6367 | 146 | 3.8 | 21.7 | 11 | 6.55 | 193 | 0.8 |
| So. Barrow No. 19 | 1354 | 99 | 3.0 | 16.5 | 9 | 7.17 | 153 | 0.6 |
| | 1359.3 | 104 | 2.6 | 17.2 | 15 | 5.93 | 130 | <0.5 |

Table 5. continued

| Well | Depth (ft) | Tb (ppm) | Th (ppm) | U (ppm) | V (ppm) | W (ppm) | Y (ppm) | Yb (ppm) |
|---|---|---|---|---|---|---|---|---|
| Seabee No. 1 | 14589 | 0.7 | 12 | 3.1 | 154 | <1 | 34 | 2.95 |
| | 14593.8 | 0.5 | 12 | 3.0 | 132 | <1 | 24 | 2.35 |
| | 14599 | 0.8 | 12 | 3.7 | 136 | 3 | 30 | 2.91 |
| | 14604 | 0.7 | 12 | 2.9 | 140 | 2 | 29 | 2.90 |
| Inigok No. 1 | 8849.5-51.5 | 0.8 | 14 | 4.7 | 261 | 3 | 29 | 3.29 |
| | 8849.5 | 0.6 | 13 | 3.7 | 227 | 2 | 27 | 3.30 |
| | 9457.5 | 0.7 | 11 | 3.2 | 119 | 2 | 34 | 2.83 |
| | 10299 | 0.6 | 9.9 | 2.6 | 94 | 2 | 30 | 2.73 |
| | 12273.5 | 0.6 | 9.0 | 6.6 | 283 | 2 | 24 | 2.20 |
| | 12275.5 | 0.3 | 7.3 | 6.0 | 210 | <1 | 24 | 1.87 |
| No. Inigok No. 1 | 10160 | 0.7 | 6.4 | 22.8 | 204 | <1 | 82 | 3.92 |
| | 10165.3 | 0.3 | 7.6 | 5.2 | 489 | 2 | 33 | 2.04 |
| No. Kalikpik No. 1 | 7131.4 | 0.9 | 16 | 4.4 | 270 | 2 | 33 | 3.11 |
| | 7136 | 0.9 | 14 | 4.7 | 327 | 2 | 35 | 3.44 |
| | 7148.5 | 0.6 | 9.6 | 3.4 | 136 | 2 | 28 | 2.63 |
| | 7149.5 | 0.6 | 11 | 3.5 | 166 | 2 | 32 | 2.91 |
| Ikpikpuk No. 1 | 7369 | 0.9 | 13 | 5.4 | 302 | 2 | 35 | 3.16 |
| | 7372.3 | 1.2 | 16 | 6.0 | 336 | 2 | 43 | 3.57 |
| | 7376 | 1.0 | 14 | 4.5 | 277 | 2 | 34 | 3.41 |
| | 7491 | 0.8 | 13 | 4.0 | 138 | 2 | 33 | 3.02 |
| | 7500 | 0.7 | 13 | 3.5 | 129 | 2 | 36 | 2.87 |
| | 10277 | 1.6 | 4.2 | 34.3 | 237 | 1 | 137 | 5.92 |
| | 10283 | 0.6 | 3.1 | 13.3 | 74 | <1 | 52 | 2.76 |
| | 10288 | 1.1 | 3.8 | 26.5 | 186 | 1 | 63 | 3.19 |
| Drew Point No. 1 | 6927 | 0.9 | 14 | 4.0 | 216 | 1 | 40 | 3.79 |
| | 6941 | 0.6 | 15 | 4.8 | 195 | 2 | 28 | 3.30 |
| | 7544 | 1.0 | 11 | 4.5 | 108 | 2 | 60 | 3.51 |
| | 7568.5 | 1.0 | 9.5 | 3.5 | 68 | 1 | 54 | 3.38 |
| Ea. Simpson No. 2 | 6344.3 | 1.0 | 16 | 9.9 | 163 | 5 | 44 | 3.74 |
| | 6354 | 1.1 | 13 | 5.5 | 290 | 3 | 36 | 3.63 |
| | 6367 | 0.8 | 12 | 11.2 | 430 | 2 | 29 | 2.84 |
| So. Barrow No. 19 | 1354 | 1.1 | 8.5 | 17.3 | 295 | 1 | 49 | 3.44 |
| | 1359.3 | 0.6 | 9.2 | 15.1 | 492 | 1 | 33 | 2.67 |

Table 5. continued

| Well | Depth (ft) | Zn (ppm) | Zr (ppm) |
|---|---|---|---|
| Seabee No. 1 | 14589 | 93.0 | 229 |
| | 14593.8 | 109 | 195 |
| | 14599 | 92.0 | 240 |
| | 14604 | 107 | 230 |
| Inigok No. 1 | 8849.5-51.5 | 114 | 182 |
| | 8849.5 | 106 | 186 |
| | 9457.5 | 86.1 | 273 |
| | 10299 | 66.9 | 335 |
| | 12273.5 | 125 | 142 |
| | 12275.5 | 99.0 | 142 |
| No. Inigok No. 1 | 10160 | 275 | 138 |
| | 10165.3 | 745 | 160 |
| No. Kalikpik No. 1 | 7131.4 | 170 | 179 |
| | 7136 | 93.2 | 186 |
| | 7148.5 | 111 | 289 |
| | 7149.5 | 109 | 258 |
| Ikpikpuk No. 1 | 7369 | 213 | 181 |
| | 7372.3 | 142 | 174 |
| | 7376 | 135 | 210 |
| | 7491 | 96.8 | 277 |
| | 7500 | 90.6 | 293 |
| | 10277 | 110 | 97 |
| | 10283 | 118 | 69 |
| | 10288 | 223 | 90 |
| Drew Point No. 1 | 6927 | 88.6 | 201 |
| | 6941 | 202 | 242 |
| | 7544 | 127 | 270 |
| | 7568.5 | 48.7 | 431 |
| Ea. Simpson No. 2 | 6344.3 | 179 | 259 |
| | 6354 | 113 | 181 |
| | 6367 | 364 | 161 |
| So. Barrow No. 19 | 1354 | 178 | 161 |
| | 1359.3 | 294 | 142 |

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