

ALASKA GEOLOGY

Newsletter of the
Alaska Geological Society



No Offset, No Significant Slip to Recent Times, and the Large Translation Mobilists: Three Different Perspectives on the Cenozoic History of Horizontal Slip Along the Denali Fault System

Jeff Benowitz

University of Alaska, Geophysical Institute, Fairbanks, AK

jbenowitz@alaska.edu

The Denali Fault System, at over ~800 km in length, is one of the major intra-continental strike-slip faults in the world and presents a significant seismic hazard to the state of Alaska and the Yukon Territory of Canada. Given the Denali Fault System's prominence as a geographic trench and feature clearly visible from space and as a tectono-lithospheric boundary, and given the highest mountain range in North America parallels its trace, it is surprising the published literature provides conflicting constraints on the Cenozoic horizontal displacement history along the different segments of this structure.

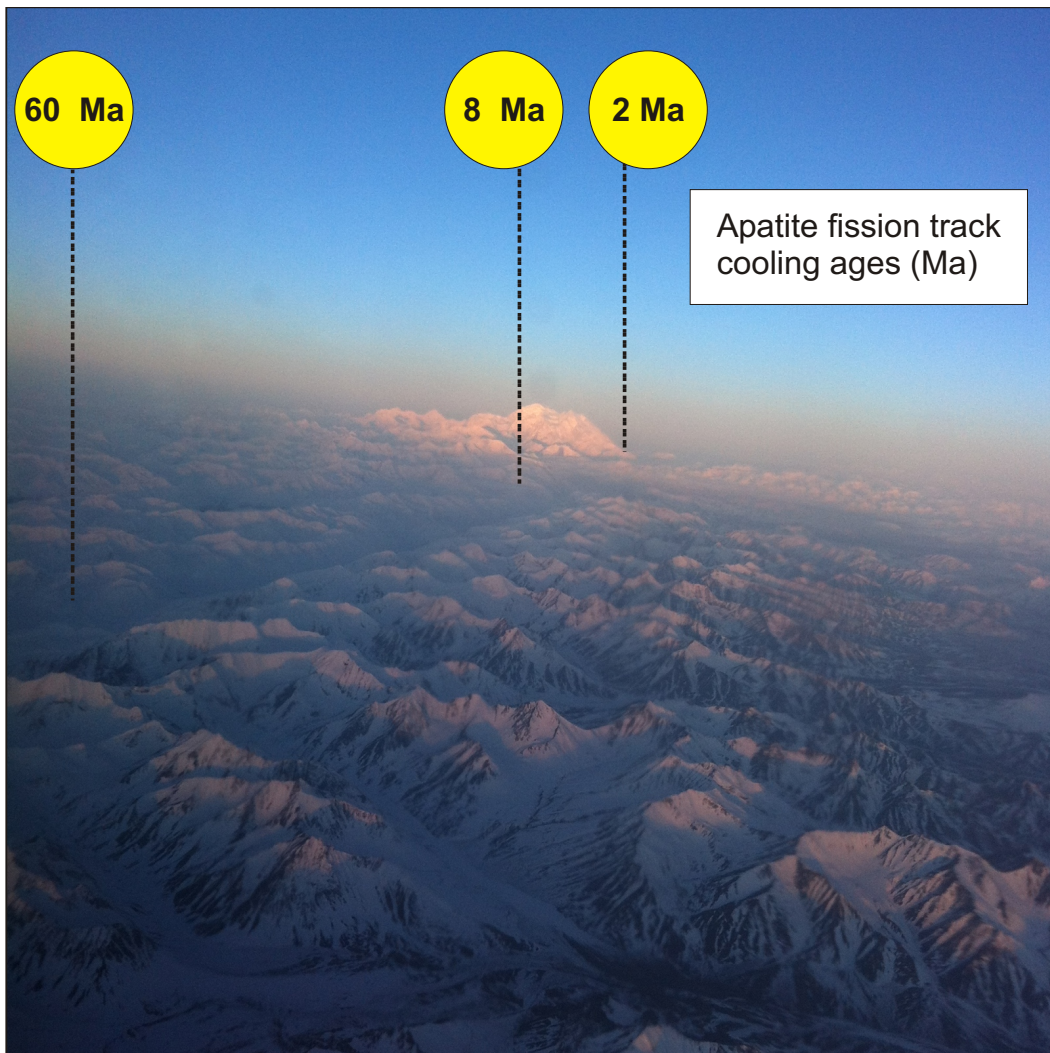
In this talk I will first review the many segments of the Denali Fault System and three different Denali Fault System displacement perspectives: A) Essentially no Cenozoic horizontal displacement has occurred, B) Horizontal displacements rates of ~10 mm/yr along the Denali Fault have only been occurring from approximately the Holocene to present, and C) Cenozoic horizontal displacement along the Denali Fault System has totaled around 400 km.

I will present new published piercing point and other geologic slip constraints from along the Totschunda Fault, Broxon Gulch Fault, and the segmented main Denali Fault from collaborators and myself. I will document that the initiation of many segments of the Denali Fault System are far older (ex. The Totschunda Fault is a Cretaceous structure) than previously considered. I will also make the case that ~400 km is a minimum horizontal total displacement along the Denali Fault System since ~57 Ma, and that Neogene slip rates mimic Holocene slip rates along many segments of the fault.

AGS Luncheon

Date & Time: Tuesday, February 20, 11:30 am – 1:00 pm
Program: No offset, no significant slip to recent times, and the large translation mobilists: Three different perspectives on the Cenozoic history of horizontal slip along the Denali fault system
Speaker: Jeff Benowitz, University of Alaska, Geophysical Institute, Fairbanks, AK
Place: BP Energy Center, 1014 Energy Court, Anchorage, AK
Reservations: Make your reservation before noon **Friday, February 16, 2018**
Cost: Seminar is free (catered lunches are no longer available)
Fell free to bring your own brown-bag lunch

For more information call (907) 854-2363 or visit the AGS website: <http://www.alaskageology.org>



The Denali Fault trench, low topography, a “track” of apatite fission track ages and the Mount McKinley restraining bend: Thermochronology and topographic evidence of a long-term history of rapid horizontal slip-with a vertical component along the Denali Fault system.

About the Speaker:

Jeff Apple Benowitz received a family photo postcard and a map of vast Alaska from Governor Jay Hammond as part of a 5th grade pen-pal writing project. When Jeff turned 19, he hitch-hiked to Alaska from his New York upbringing to a place where most mountains are named simply after their elevation. He spent his 20’s and 30’s writing climbing adventure stories about the Alaska Range. 26 years since originally sticking his thumb out, he is currently employed as the director of the University of Alaska Geophysical Institute Geochronology Facility. Jeff now finds himself coaxing stories out of the rocks of Alaska that tell tales of where the mountains he calls home originate. He has studied the Brooks Range, Wrangell Mountains, Talkeetna Mountains, White Mountains, and of course the Alaska Range.

From the President’s Desk:

Greetings everyone. The days are already starting to get noticeably longer so I’m already looking forward the onset of spring, even though it is a ways off yet. I just hope the usual impatience doesn’t set in too soon. Don’t take me wrong, I’m actually enjoying this winter, now that it has finally arrived.

The AGS board is still looking for the President-Elect/President for the 2018-19 season yet. Ideally the president elect will have enough time this year to get up to speed with the society business before their term starts in June. Time is drawing short. If anyone is interested in volunteering for a challenge, please contact me or anyone on the board as soon as possible.

Keith Torrance has already started planning the spring tech conference which will be held on Friday, April 20th at UAA. Calls for abstracts will be coming out shortly. If you’ve got a paper to present, please look into it.

Hope to see you all at the next luncheon meeting on February 20th where Jeff Benowitz will be talking about the Denali Fault system. It should be a great talk.

Regards ~Larry Ljsmithak@gmail.com



Alaska's Oil & Gas Consultants

- ◆ *Geoscience*
- ◆ *Engineering*
- ◆ *Operations*
- ◆ *Project Management*

From the North Slope to Cook Inlet, PRA's professional and highly skilled consultants know and understand the regional geology, the unique operating conditions, and the regulatory environment, having managed exploration and development projects across Alaska since 1997.

3601 C Street, Suite 1424
Anchorage, AK 99503

907-272-1232

www.petroak.com
info@petroak.com

THE SIX SISTERS WELL TREND: GATEWAY INTO THE DEVELOPMENT AND UNDERSTANDING OF THE PETROLEUM SYSTEMS ALONG THE NORTHWEST MARGIN OF ANWR

Robert B. Blodgett¹ and Stephen C. Sutherlin²

¹Blodgett & Associates, LLC , 2821 Kingfisher Drive, Anchorage, Alaska 99502,
RobertBBlodgett@gmail.com

²Strategic Action Associates, P.O. Box 112546, Anchorage, Alaska 99511,
stevepna@hotmail.com

INTRODUCTION

The U.S. Department of the Interior has ordered updated assessments of oil and gas resources on Alaska's North Slope, notably the 1002 Area of the Arctic National Wildlife Refuge (ANWR). While the central North Slope has been explored extensively, relatively little is known about the eastern frontier in the vicinity of ANWR. Much that is known about ANWR is tightly held, although the area is believed to be resource rich.

Now that Congress has moved to open ANWR for further evaluation and exploration, geologists are preparing to gain a deeper understanding of this large, potentially productive geologic onshore basin on the shore of the Beaufort Sea.

The Stinson #1 well, drilled in 1989 by ARCO (now ConocoPhillips), is the closest well to the 1002 Area, some 3.5 miles offshore its northwest border. (Fig. 1) The well's cores and associated 2-D seismic data suggest it could be a major gateway to understanding and developing the northwestern border region of the ANWR 1002 Area.

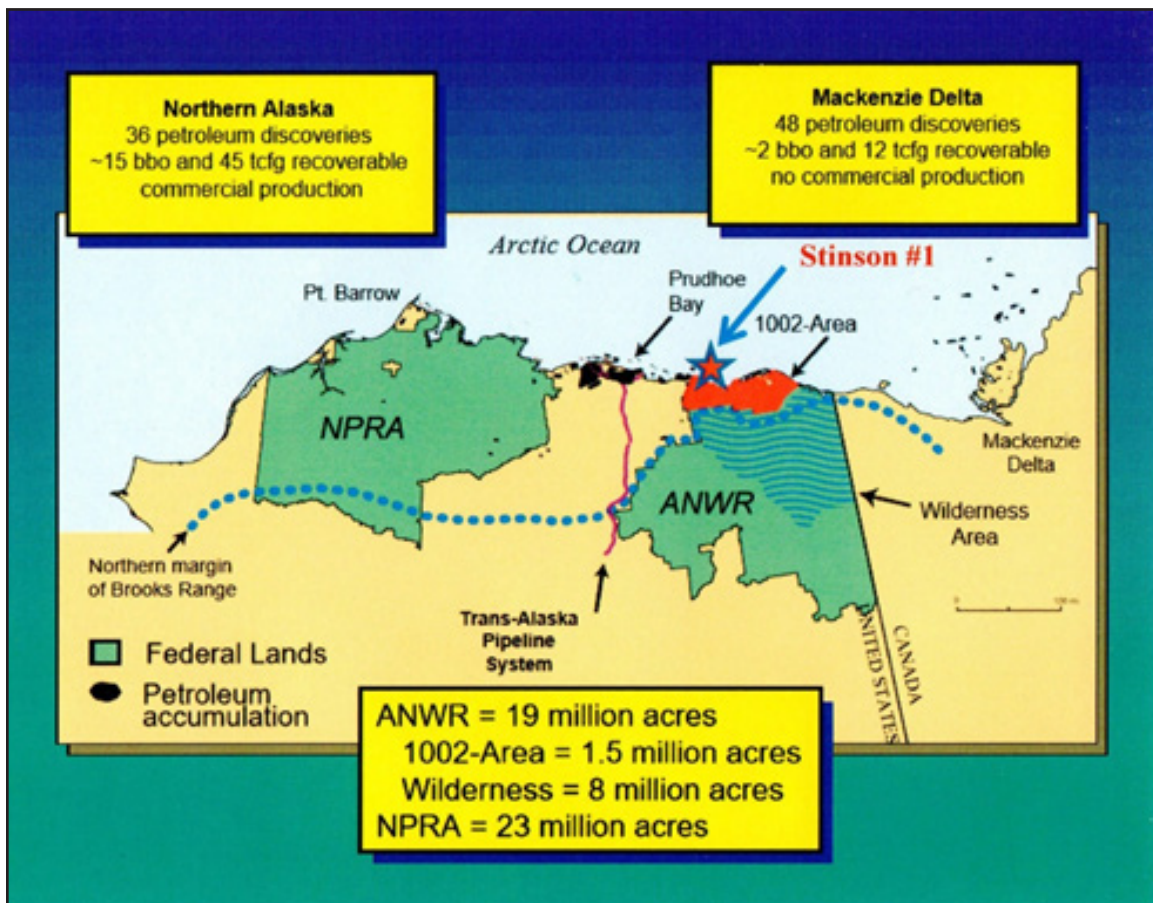


Figure 1. Map of northern Alaska and nearby parts of Canada showing locations of the Arctic National Wildlife Refuge (ANWR), the 1002 assessment area, the National Petroleum Reserve - Alaska (NPRA), and the Stinson #1 well. Modified from Bird (1998).

“THE SIX SISTERS”

Our study presented here focuses on a six well trend (termed here as “The Six Sisters”) that borders the NW edge of ANWR (Figs. 2 and 3), just offshore of the Point Thomson Unit in adjacent, shallow waters of the Beaufort Sea. These wells are situated atop and along the upper flanks of a WNW-ESE trending anticlinal structure, dipping to the east, that some have identified as the eastern terminus of the Barrow Arch. The trend starts at its eastern terminus with the Stinson #1 well, then is followed to the west by the Alaska State A #1, the Alaska State D #1, the Alaska State F #1, the Alaska Island #1, continuing through to the Challenge Island #1 on the western end. The trend is characterized by two primary petroleum plays, one in basal strata of the Tertiary age Canning Formation and the other in immediately underlying Paleozoic basement rocks, recognized here to be primarily (if not entirely) of Cambrian age. Excellent oil recovery has been noted in the easternmost of the two wells (Stinson #1 and Alaska State A #1). Lesser hydrocarbon shows have been noted further to the west in the remaining wells. Some minor Lower Cretaceous strata have been noted as well in the western three wells (Alaska State F #1, Alaska Island #1, and Challenge Island #1).

Much of the data presented here is derived from internal industry reports [some available now on the Web: Brizzolara (2009); Dunn (2010), Gross (no date given, 2012, 2015), Gross and Brizzolara (2012), and Waters and Kruwell (2010)] as well as the Alaska Oil & Gas Conservation Commission well history files.

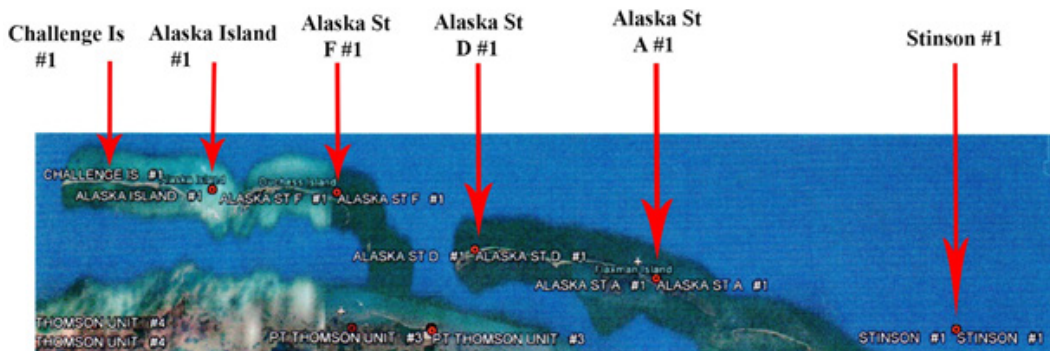


Figure 2. The “Six Sisters” wells are characterized by a highly distinctive stratigraphic succession of a basement consisting of early Cambrian orthoquartzite, dolostone, and shale (no formation names established at this time) overlain unconformably by Paleocene-Eocene clastic strata of the Canning Formation. Excellent oil shows and recovered oil are present in the fractured Cambrian basement as well as the early Tertiary clastics. This east-west line of exploratory wells encountered carbonate-rich, dominantly Cambrian age “basement” lithologies. The line starts at its eastern terminus with the Stinson #1 well, then is followed to the west by the Alaska State A #1, the Alaska State D #1, the Alaska State F #1, the Alaska Island #1, continuing through to the Challenge Island #1 on the western end.

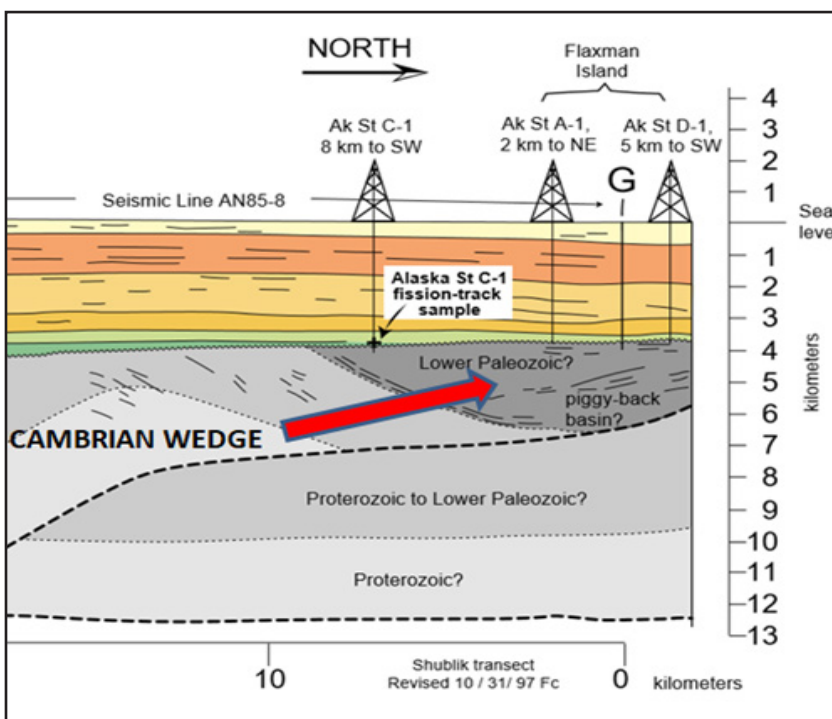


Figure 3. Balanced cross section of northern part of transect shown in Cole et al. (1998, Plate 1) in the western part of the ANWR near its northwest corner. Relative position of Alaska State A #1 and D #1 wells (both part of the Six Sisters complex) indicated. Stinson #1 well is in same relative position but situated to the east by approximately 7.5 miles. The dark gray area we have labeled here as the oil-rich Cambrian wedge corresponds to their Lower Paleozoic? basin. Cross-section based on Seismic Line AN85-8.

TERTIARY (EARLY CENOZOIC; LATE PALEOCENE & EARLY EOCENE PLAY)

This play consists of late Paleocene and early Eocene turbidite channel and lobe sandstones encased within marine slope and deep basin mudstone (Bird, 1998). A DST test in the Alaska State A #1 well flowed a spectacular 2,507 BOPD in strata of late Paleocene strata in the interval between 12,565-12,635 feet (Jamison et al., 1980). A DST test on the Alaska State F #1 well flowed 137 BOPD from the Canning Formation.

“CAMBRIAN WEDGE” (EARLY PALEOZOIC PLAY)

This play consists of a westward thinning wedge of Cambrian age orthoquartzites, clastic and carbonate (mostly dolostone) rocks that form the basement of “The Six Sisters” wells. These strata are stratigraphically equivalent to the lower part of the Nanook Limestone (see Blodgett et al., 1986). Several distinctive new units of formation rank need to be established within this wedge, including an upper orthoquartzite unit recognized only in the Stinson #1 well (pinching out laterally to the west along the Barrow Arch). This orthoquartzite is highly fractured and contains significant amounts of oil in the fractures (Fig. 4). Where fracturing is absent, the orthoquartzite is typically highly cemented (Fig. 5). Underlying strata include an interval of clastics (shales, sandstones) and limestone, well represented in the Stinson #1, Alaska St. A #1 and Alaska Island #1 wells. The lowermost interval in the Stinson #1 well consists of a massive dolostone unit. Maximal thickness attained in the Cambrian wedge in the Stinson #1 well is 374 m (1,226 ft). The Alaska State A #1 well to the west attained a thickness of 392 m (1,286 ft) in the Cambrian wedge, but lacks the orthoquartzite unit which forms the upper part of the Stinson #1 well.



Figure 4. A. Probable Cambrian age orthoquartzite core from the Stinson #1 well showing highly fractured character and oil staining. B. Light brown oil (~37 API) from open-hole test at 14863'-15194' (corresponding to the top of the Cambrian orthoquartzite and basal few feet of the overlying Tertiary Canning Formation).

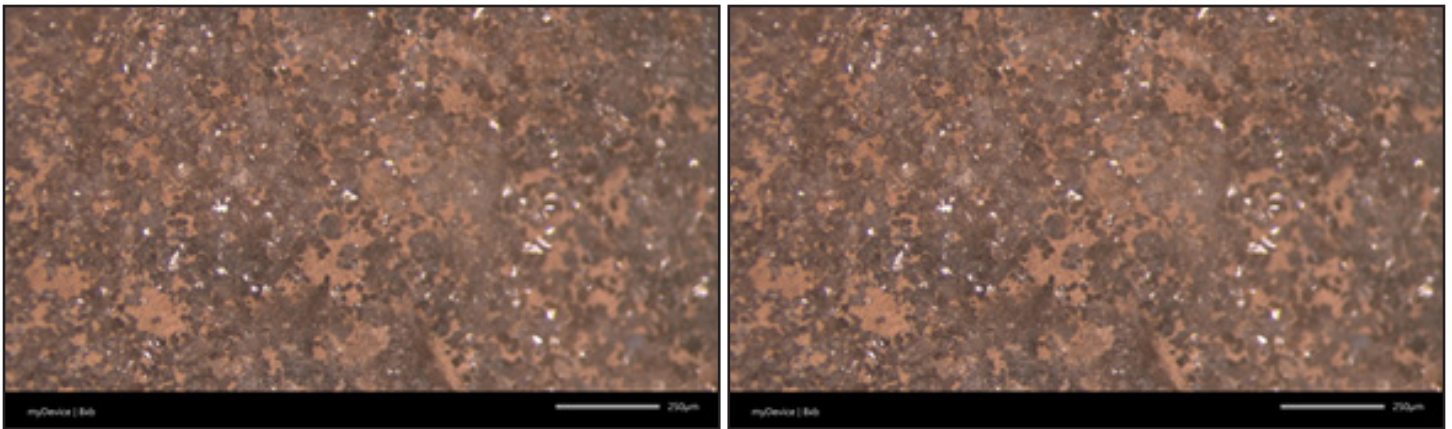


Figure 5. Core chips from Core #4, upper orthoquartzite interval, Stinson #1 well. Both show the typical highly cemented character of the host rock where it has not been intensely fractured. Scale bar 250 μm .

In the Stinson #1 well an open hole test flowed 430 BOPD with a predicted flow rates from 750 to 800 BOPD under clean hole conditions in the interval 14,863-15,194 feet, primarily within the fractured upper orthoquartzite. Two DST tests on the Cambrian basement in the Alaska State F #1 flowed condensate at rates of 152 and 284 barrels of condensate/day, respectively (Nelson et al., 1999).

The mixed clastic and carbonate interval has yielded a SSF fauna (Small Shelly Fauna) (see Fig. 6), indicative of a Tommotian (earliest Early Cambrian) age [see Betts et al., 2015; Bhatt, 1989 ; Gubanov and Peel, 1999; and Missarzhevsky, 1969]. Other fossils present in this interval include calcareous algae (notably the genus *Epiphyton* – see Fig. 7), and the trace fossil *Planolites* (Fig. 8). The overlying thick orthoquartzite is unfossiliferous, but presumed to be of probable early Cambrian age based on its proximity to the lower strata package, similarities between the orthoquartzites in both interval, and regional stratigraphic considerations. A lower shale interval is recognized in the Alaska State A #1 well (not present in the Stinson #1 well) is also unfossiliferous, hence it is undated, but may prove to be as old as of late Proterozoic age. The abundance of hydrocarbons in this play makes it the oldest identified potential oil reservoir in Alaska (the next oldest being the Mississippian age Kekiktuk Formation of the North Slope). Shows of hydrocarbons are noted in the lowermost basement strata of the Stinson #1 well, evidenced by the presence of minor bitumen pore fillings in the lowermost dolostones. Significant hydrocarbon shows also observed in the basement of the Alaska State #1 well with zones of dense bitumens seen in thin section (Fig.9).

The early Cambrian succession is unnamed stratigraphically but is probably equivalent to the basal Nanook Formation exposed to the south in the Sadlerochit and Shublik Mountains (Blodgett et al., 1986). Several distinctive, discrete lithostratigraphic intervals suggest that at least three formation-rank units can be recognized with further study. The top of the Stinson #1 well consists of 122 m (400 ft) of pure orthoquartzite, and this unit is not seen in the other wells, as it has been erosionally removed from beneath the unconformity with the Tertiary beds. Paleocurrent and dipmeter data indicate that the sands of the orthoquartzite unit are derived from the north, suggesting a northerly cratonal source area providing highly mature quartz sands.

This newly emerging data suggest that the Cambrian strata of the northern offshore coastal area (in state waters) bordering the 1002 Area of ANWR may possibly be a major North Slope petroleum play in the future. Similar Vendian-early Cambrian rocks in Eastern Siberia provide the largest reserves of petroleum in that region [i.e., Chayandinskoe and Talakanskoye fields – see Matveev et al, 1989; Meyer and Freeman, 2006; Nakashima, 2004]. The strong similarities in gross Cambrian stratigraphy and fauna of the ANWR region with that of Eastern Siberia support the alternative hypothesis that the Arctic Alaska terrane originated by rifting away from the Siberian paleocontinent (Blodgett et al., 2002), rather than by counterclockwise rotation away from the Canadian Arctic Islands.

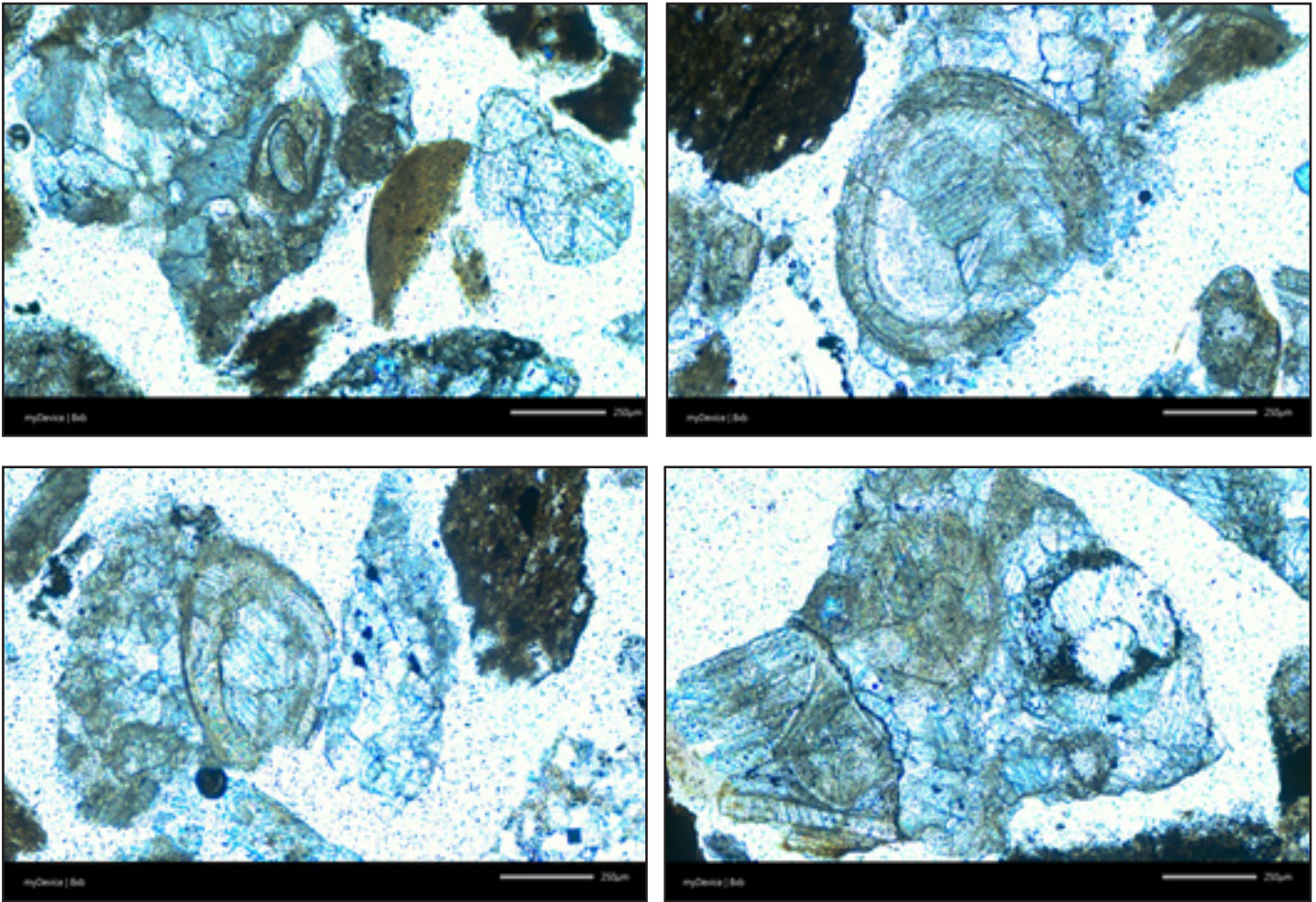


Figure 6. Alaska Island #1 well. Small shelly fauna (SSF) and coated grains, all from cuttings at 15030'-15060'. SSF fauna indicative of Tommotian (earliest Cambrian) age. Scale bar 250 µm.

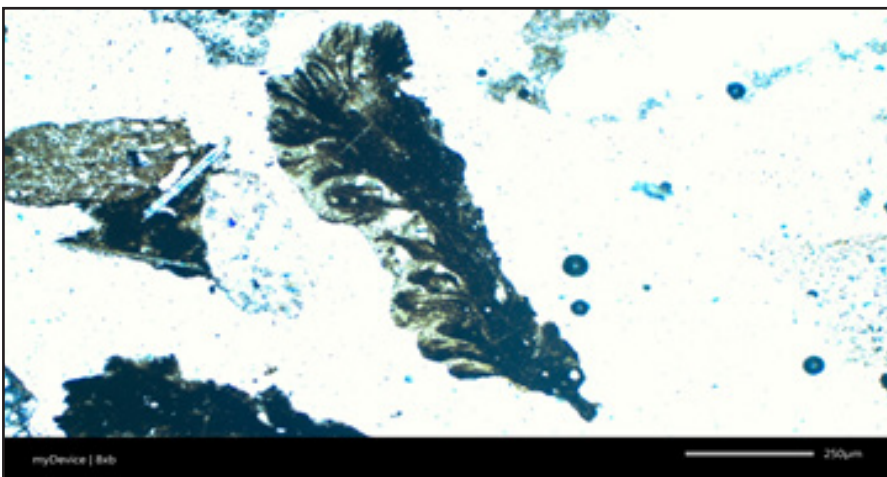


Figure 7. Alaska St A #1 well, 14170-14190', the alga *Epiphyton* sp. Scale bar 250 µm. *Epiphyton* is most commonly reported globally from Cambrian and Lower Ordovician strata.

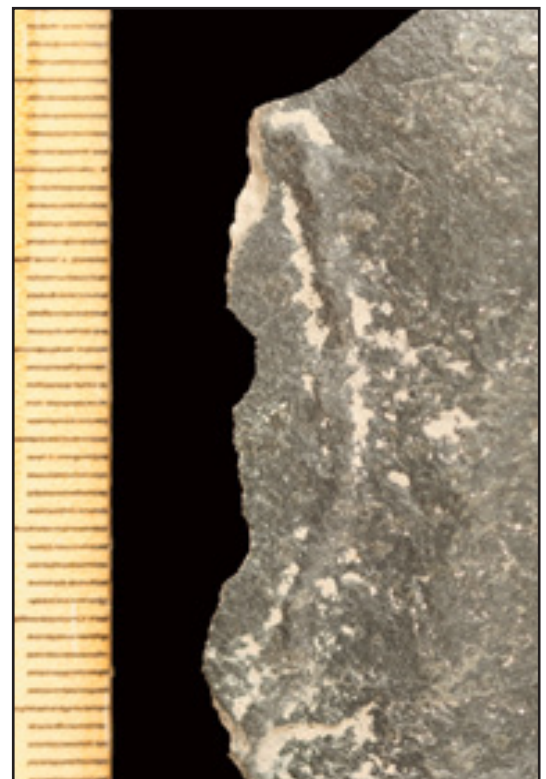


Figure 8. Trace fossil *Planolites* sp. from a core chip at 15101' in the Alaska Island #1 well. This well known trace fossil is not known below the Cambrian. The scale bar is marked in mm.

FRACTURING

Fracturing is common throughout the wedge, and may provide most of the reservoir potential for this interval. Figure 10 (from Waters and Kruwell, 2010) presents the results of an FMS image study of the upper part of the Cambrian basement complex in the Stinson #1 well. Several prospective fractured intervals are indicated.

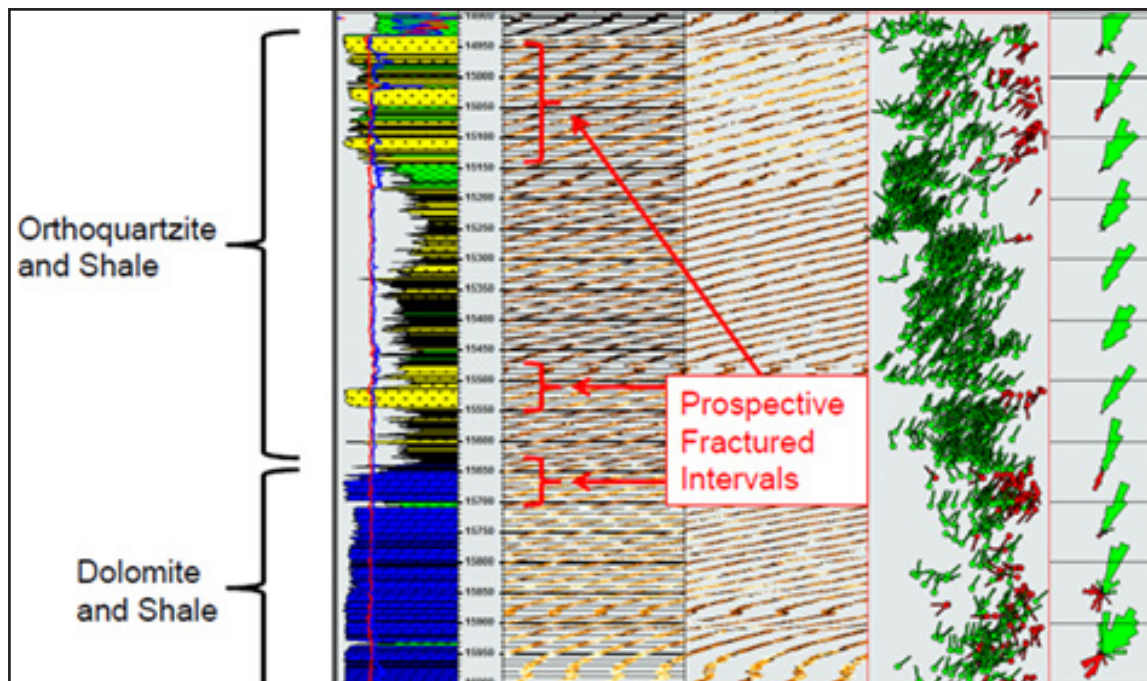


Figure 10. FMS image interpretation of the Stinson #1 below the Basal Tertiary Unconformity (BTU). Three dominant rock types: Orthoquartzite, Shale and Dolomite ~ 1200 feet evaluated. (from Waters and Kruwell, 2010).

SEISMIC ANALYSIS

2D seismic analysis by the late Dr. Robert Klipping suggests that the Cambrian Basement play at Stinson is quite large, some 18 miles long from east to west, located on the Barrow Arch and plunging to the southeast (see Gross, undated - video of David Gross interviewing Dr. Klipping)

A bounding high angle reverse fault near the south edge of the acreage alone would provide closure for the entire anticlinal trend.

“The two key anomalies which are involved in the acreage also have critical dip into that fault zone, so you really don’t need the fault but it’s there and it adds to the closure,” Klipping said.

The Stinson No. 1 well also had very good shows in the base Eocene sand which is present in the vast majority of the acreage. The Eocene layer extends south into ANWR.

The Stinson #1 well likely shares additional plays which the USGS identified in ANWR. Klipping said the Stinson seismic indicates other plays updip – not seen in the well – that match what the USGS said could be expected in the area.

ACKNOWLEDGMENTS

This study greatly benefitted from help provided by the staff (Kurt Johnson, Jean Riordan, Alexandra Busk, and Walter Zimmerman) of the Alaska Geologic Materials Center in Anchorage, Alaska. We also thank Don Brizzolara (Olympia, WA), Kay Cashman and Alan Bailey of Petroleum News (Anchorage, AK), Doug Waters (Anchorage, AK), Jim Winegarner (Anchorage, AK), Robert Morse (Seattle, WA), Samuel H. Cade (Dallas, TX) and Dan Donkel (Orlando, FL) for numerous long phone conversations on the Stinson #1 well. Other useful comments for our study were provided by Ken Bird (Menlo Park, CA), Gil Mull (Salt Lake City, UT), and Harry Jamison (Tucson, AZ).

REFERENCES

- Alaska State A-1 Well History (Well Permit 174-014), 249 p., available for downloading through Alaska Oil & Gas Conservation Commission at: <http://aogweb.state.ak.us/WebLink/PDF/j1a3usv4qeto4exkxtx0rz03/1/174-014.pdf>
- American Stratigraphic Company, 1978, Lithologic log for Alaska State A-1 well.
- Betts, M.J., Brock, G.A., Patterson, J.R., Jago, J.B., and Andrew, A.S., 2015, Intergrated shelly fossil. Biostratigraphy and chemostratigraphy: Applying a multi-proxy toolkit to correlating the Lower Cambrian of South Australia. Search and Discovery Article #30436.
- Bhatt, D.K., 1989, Small shelly fossils, Tommotian and Meishucucnian stages and the Precambrian-Cambrian boundary-Implications of the recent studies in the Himalayan sequences. *Journal of the Palaeontological Society of India*, v. 34, p. 55-68.
- Bird, K.J., 1998, Chapter AO – Assessment Overview, in *The Oil and Gas Resource Potential of the 1002 Area, Arctic National Wildlife Refuge, Alaska*, by ANWR Assessment Team, U.S. Geological Survey Open File Report 98-34, p. AO-1-AO-30, 21 figs., 4 tables.
- Blodgett, R.B., Clough, J. G., Dutro, J.T., Jr., Ormiston, A.R., Palmer, A.R., and Taylor, R.E., 1986, Age revisions for the Nanook Limestone and Katakaturuk Dolomite, northeastern Brooks Range, in Bartsch-Winkler, Susan, and Reed, K. M., eds., *Geologic studies in Alaska by the U.S. Geological Survey during 1985*. U.S. Geological Survey Circular 978, p. 5-10.
- Blodgett, R. B., Rohr, D. M., and Boucot, A. J., 2002, Paleozoic links among some Alaskan accreted terranes and Siberia based on megafossils, in Miller, E.L., Grantz, Art, and Klemperer, S.L., eds., *Tectonic Evolution of the Bering Shelf-Chukchi Sea-Arctic Margin and Adjacent Landmasses: Geological Society of America Special Paper 360*, p. 273-290.
- Brizzolara, D.W., 2009, Donkel/Cade North Slope, Alaska Properties Geologic Report. Unpublished report to Donkel Oil & Gas, LLC, 42 p.
- Cole, Frances, Bird, K.J., Mull, C.G., Wallace, W.K., Sassi, William, Murphy, J.M., and Lee, Myung, 1998, A balanced cross section and kinematic and thermal model across the northeastern Brooks Range Mountain Front, Arctic National Wildlife Refuge, Alaska, in *The Oil and Gas Resource Potential of the 1002 Area, Arctic National Wildlife Refuge, Alaska*, by ANWR Assessment Team, U.S. Geological Survey Open File Report 98-34, p. SM-1-SM-42, 16 figs., 1 plate, 1 table.
- Dunn, M.D., 2010, Donkel Oil & Gas Stinson Prospect Engineering Report, Development Plan Scenarios. Unpublished report to Donkel Oil & Gas, LLC, 20 p.
- Gross, D.T., no date given, "David Gross discusses the Geology around the Stinson project." Video presentation available at: <http://donkeloilalaska.com/video.html>
- Gross, D.T., 2012, North Point Thomson, off-shore, Western North Slope. Unpaginated document available at: http://donkeloilalaska.com/north_thomson.html
- Gross, D.T., 2015, The Stinson Project: A Program to Delineate and Develop the Penultimate Discovery in the North Slope's "String of Pearls" (Unpublished). PowerPoint Presentation, 31 slides.
- Gross, D.T., and Brizzolara, D.W., 2012, Stinson, East Point Thomson - Off-shore, Eastern North Slope. Unpaginated document available at: <http://donkeloilalaska.com/stinson.html>
- Gubanov, A.P., and Peel, J.S., 1999, Oelandiella, the earliest Cambrian helcionelloid mollusk from Siberia. *Palaeontology*, v. 42, pt. 2, p. 211-222.
- Jamison, H.C., Brockett, L.D., and McIntosh, R.A., 1980, Prudhoe Bay—A 10-year perspective, in Halbouty, M.T., ed., *Giant oil and gas fields of the decade 1968-1978*. American Association of Petroleum Geologists Memoir 30, p. 289-314.
- Matveev, V.D., Mikulenko, K.I., Sitnikov, V.S., Protopopov, Yu.Kh., Gudeev, R.B., and Shabalin, 1989, Novye predstavleniya o stroenii neftegazonosnykh territorii Yakutii, p. 4-17, in *Tektonika i neftegazonosnost Yakutii*. Sbornik nauchnykh trudov, Yakutsk.
- Meyer, R.F., and Freeman, P.A., 2006, Siberian Platform: Geology and Natural Bitumen Resources. U.S. Geological Survey Open-File Report 2006-1316, 18 p.
- Missarzhevsky, V.V., 1969, Description of hyolithids, gastropods, hyolithelminths, camenides and forms of obscure taxonomic position, in Rozanov, A.Yu., et al., *The Tommotian Stage and the Cambrian lower boundary problem*. Trudy Geologicheskii Institute, Nauka, Moscow, v. 206 [in Russian].
- Nakashima, Keishi, 2004, Petroleum potential in the East Siberian region. The Institute of Energy Economics, Japan (IEEJ), 27 p.
- Nelson, P.H., Kibler, J.E., and Giberson, C.P., 1999, Chapter WL (Well Data), in *The Oil and Gas Resource Potential of the 1002 Area, Arctic National Wildlife Refuge, Alaska*, by ANWR Assessment Team, U.S. Geological Survey Open File Report 98-34, p. WL1-WL26, 10 tables, 43 pls.
- Stinson #1 Well History (Well Permit 189-067), 581 p., available for downloading through Alaska Oil & Gas Conservation Commission at: <http://aogweb.state.ak.us/ WebLink/PDF/j1a3usv4qeto4exkxtx0rz03/2/189-067.pdf>
- Waters, D.L., and Kruwell, R.I., 2010, Stinson Image Analysis. Unpublished report to Donkel Oil & Gas, 43 p.

Alaska Geological Society Scholarship Awards 2017



The following are recipients of AGS scholarship awards in 2017. Below are summaries of progress on their research projects.

Alaska Geological Society Scholarships:

Selva Marroquin, PhD, Virginia Polytechnic Institute and State University: Investigating the biogeochemical record of the Late Triassic-Early Jurassic from Alaska

Felix Ziwu, PhD, University of Texas El Paso: Using integrated geophysical methods to investigate the structure and tectonics of Cook Inlet Basin, Alaska

John Barefoot, MS, University of Alaska Fairbanks: Rock and age relationships of the Talkeetna forearc subduction complex in the Nelchina area, southern Alaska

Nathanial Bootes, MS, University of Cincinnati: Offshore sedimentary record of exhumation in SE Alaska using detrital zircon fission track analysis

Austin Carter, BS, University of Michigan: Chemical Constraints on Water-Balance Partitioning on Wolverine Glacier, AK

Molly Johnson, MS, Western Washington University: Correlation of wells for evaluating geothermal potential on Akutan Island

PSAAPG Matching Scholarships:

Veselina Yakimova, MS University of Alaska Fairbanks: Are there remnants of subduction fabrics along the Border Ranges Fault system?

Ibrahim Ilhan, PhD, University of Alaska Fairbanks: Chukchi Edges Project: Geophysical constraints on the tectonic development of the Amerasia Basin, Arctic Ocean

Patrick Terhune, MS, University of Alaska Fairbanks: Thermochronological constraints for vertical tectonics along the Castle Mountain Strike-Slip Fault System: Talkeetna Mountains, Alaska

Richter Scholarship:

Nathan Graham, PhD, University of Alaska Fairbanks: Linking Current Volcanic Activity to the Explosive 1929 Eruption of Mount Gareloi, Alaska through Petrology and Volatile Geochemistry

An Analysis of Changes in Stable Water Isotope Compositions in Firn Cores Drilled on the Wolverine Glacier, AK over the 2016 Melt Season

Austin Carter, University of Michigan

Analyzing changes in stable water isotope compositions ($\delta^{18}\text{O}$ and δD) of ice cores drilled in cold, dry environments like Antarctica have provided knowledge on historical global temperatures. However, our interpretation of past climate using coring methods is limited to dry firn and ice that is not subject to surface melt. This study hopes to expand these methods to alpine glaciers with wet firn by investigating how post-depositional processes like surface melting alter the isotopic composition of firn before it is preserved into an annual layer. The Wolverine Glacier located on the Kenai Peninsula of southcentral Alaska has been continuously studied by the U.S. Geological Survey since 1966. In the accumulation zone of the Wolverine Glacier, firn cores were drilled to depths of about 25+ meters every month throughout the 2016 melt season (May–September). Cores drilled in May, July, and September were sampled for $\delta^{18}\text{O}$ and δD measurements. Drilling and measuring stable water isotopic composition of wet firn on mountain glaciers at this depth and repetition has never been done before. This study will investigate how and why isotope compositions change within wet firn cores on sub-seasonal time scales in order to improve our understanding of how annual firn layers are preserved.

Using integrated geophysical methods to investigate the structural and tectonics of Cook Inlet Basin, Alaska: Investigating serpentinization within the Cook Inlet basin, Alaska, from the inversion of magnetic data

Felix Ziwu, University of Texas El Paso

Southcentral Alaska is a tectonically active region with an unusual subduction geometry. Cook Inlet basin (CIB) and the Kenai Peninsula, located in the southcentral Alaska, have a topographic transition from low to high lands, respectively. GPS observation indicates a topographic transition due to uplift of the Kenai Peninsula and a corresponding subsidence of CIB. Analysis of tectonic processes suggests that the subsidence is related to the formation of an unusually hydrated and serpentinized mantle wedge with lateral variations in heat flow due to a shallow-eastward subducting slab.

This research investigates the thickness and location of the serpentinized body using magnetic data to determine the Curie Point Depth (CPD) using 3D inversion methods. Seismic refraction models of the crust beneath the CIB will be used as a constraint for the CPD analysis. The CPD and seismic models will be compared to thermal models to best interpret the zone of serpentinization. CPD analysis from the 3D inversions shows that the top of serpentinized body is at ~2.5 km and the bottom at ~30 km. The crustal thickness within forearc region is greater than 20 km and this indicates that the magnetic anomaly is within the crustal rock of the North American plate. The models show the magnetic anomaly is not within the mantle wedge. Seismic models and thermal model of CIB will be used to further ascertain the possible rocks with the magnetic anomalies

Work in Progress

Developing temperature models from well log data to compare with curie depth temperature from magnetic anomalies. This approach will help identify if the curie depth is along the formation boundary or not.

Process seismic and gravity data to constraint the extent of this anomalous bodies.

Rock and age relationships of the Talkeetna forearc subduction complex in the Nelchina area, southern Alaska

John Barefoot, Elisabeth Nadin, and Rainer Newberry; University of Alaska Fairbanks

Subduction-zone processes are challenging to study because of the rarity of good exposures and the complexity of rock relationships within accretionary prisms. In south-central Alaska, a remarkably well-preserved exposure of subduction-related outcrops is located at the foot of Nelchina glacier. Here, the contact between crystalline basement of the Talkeetna volcanic arc and the mélangé of its related accretionary complex is exposed. This contact is known as the Border Ranges fault. A new zircon U-Pb age of an amphibolite from the Talkeetna arc mid-crustal basement near the fault is 188.9 ± 2.2 Ma, which coincides with previous dates from arc rocks. A new hornblende $^{40}\text{Ar}/^{39}\text{Ar}$ age from the same outcrop yields a plateau age of 181.1 ± 1.3 Ma, indicating uplift of this part of the arc. The mélangé south of the Border Ranges fault, known as the McHugh Complex, comprises generally deformed argillite, metavolcanic rocks, and chert, and in the Nelchina area it includes a roughly 100-m-diameter block of pillow lavas that are undeformed but altered. Detailed compositional data show that the pillow lava formed in an intraplate setting, indicating it is unrelated to Talkeetna arc volcanism. New whole-rock $^{40}\text{Ar}/^{39}\text{Ar}$ analyses of two pillow-lava samples yielded irregular plateaus with a general age of ca. 60 Ma. Dikes of dacitic composition crosscut the mélangé in the area and provide a new zircon U-Pb age of 53.0 ± 0.9 Ma, which coincides with ages of near-trench plutonism across southern Alaska. This plutonism has been ascribed to subduction of a spreading ridge that migrated eastward along the southern Alaska margin. These new ages constrain McHugh Complex formation and subsequent hydrothermal alteration to pre-55 Mya. We suggest that the pillow lava was originally part of a Triassic (or earlier) seamount that was scraped off in the subduction zone during Talkeetna arc accretion, and underwent extensive hydrothermal alteration that almost completely reset its age during the later ridge subduction event.

Chukchi Borderland | Crustal Complex of the Amerasia Basin, Arctic Ocean

Ibrahim Ilhan¹, Bernard J. Coakley¹ and David W. Houseknecht²

¹University of Alaska, Geophysical Institute, Fairbanks, AK 99775, USA

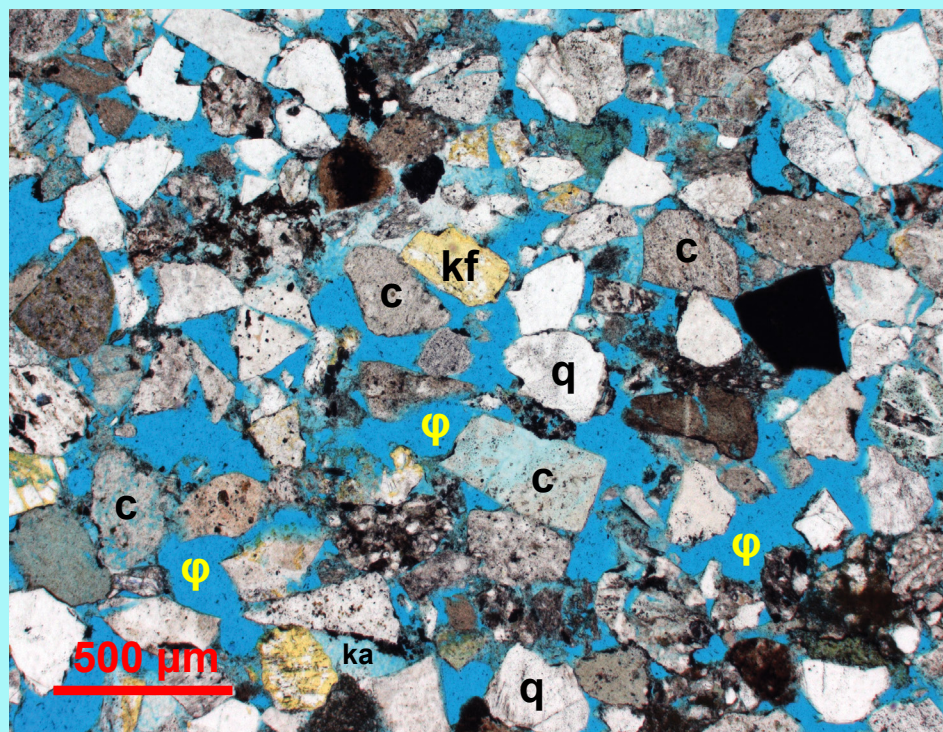
²U.S. Geological Survey, 956 National Center, Reston, VA20192, USA

In the Arctic Ocean, Chukchi Borderland separates the North Chukchi shelf and Toll deep basins to the west and Canada deep basin to the east. Existing plate reconstructions have attempted to restore this north-striking, fragments of the continental crust to all margins of the Amerasia Basin based on sparse geologic and geophysical measurements. Regional multi-channel seismic reflection and potential field geophysics, and geologic data indicate it is a high standing continental block, requiring special accommodation to create a restorable model of the formation of the Amerasia Basin.

The Borderland is composed of the Chukchi Plateau, Northwind Basin, and Northwind Ridge divided by mostly north striking normal faults. These offset the basement and bound a sequence of syn-tectonic sediments. Equivalent strata are, locally, uplifted, deformed and eroded. Seaward dipping reflectors (SDRs) are observed in the juncture between the North Chukchi, Toll basins, and southern Chukchi Plateau underlying a regional angular unconformity. This reveals that this rifted margin was associated with volcanism.

An inferred condensed section, which is believed to be Hauterivian–Aptian in age, synchronous with the composite pebble shale and gamma-ray zone of the Alaska North Slope forms the basal sediments in the North Chukchi Basin. Approximately 15 km of post-rift strata onlap the condensed section, SDRs and, in part, the wedge sequence on the Chukchi Plateau from west to east, thinning to the north. These post-Aptian sediments imply that the rifted margin subsided no later than the earliest Cretaceous, providing a plausible time constraint for the inferred pre-Cretaceous rifting in this region.

The recognition of SDRs and Hauterivian–Aptian condensed section, and continuity of the Early–Late Cretaceous post-rift strata along the margins of the Borderland, strike variations of the normal faults, absence of observable deformation along the Northwind Escarpment substantially constrain tectonic models proposed for tectonic development of the Amerasia Basin. Models that require significant relative motion between the Chukchi Shelf and Borderland since the Early Cretaceous are precluded by these observations.



My Pet Rock

Kenneth P. Helmold
Alaska Division of Oil & Gas

Medium-grained (0.27 mm) Nanushuk sandstone from the USGS Wainwright #1 Test Well. Rock framework consists largely of chert (c) and monocrystalline quartz (q) grains, with minor K-feldspar (kf) grains. Intergranular pores (ϕ) are common, with only local kaolinite (ka) cement. Reservoir quality is very good with measured porosity of 26.7% and Klinkenberg permeability of 753 md. Present burial depth is 1128 ft; maximum burial depth (Dmax) is 3890 ft.

For more information see:

<http://dggs.alaska.gov/pubs/id/29652>

Send me a photo of your pet rock at:

ken.helmold@alaska.gov

Linking Current Volcanic Activity to the Explosive 1929 Eruption of Mount Gareloi, Alaska through Petrology and Volatile Geochemistry

Nathan Graham, University of Alaska Fairbanks

The role of volatiles in volcanic systems is an intrinsic driving force behind violent explosive eruptions. Correlating current and past degassing of an active volcanic system can provide essential monitoring information for determining deviation from a “normal” degassing signature and can be linked with remote sensing and seismic monitoring data as a way to actively monitor volcanic systems and can provide potentially intrinsic information for attempts at forecasting violent volcanic eruptions. The proposed study will address key petrological and geochemical questions pertaining to the 1929 eruption of Mount Gareloi volcano in the Western Aleutians and approach the 1929 magmatic system as a proxy to better interpret current monitoring data (i.e. gas and seismic monitoring). We know essentially nothing about Gareloi volcano in terms of petrology and geochemistry but we do know that this system has the potential to erupt explosively as it did in 1929. Gareloi is a very gassy volcano, both currently and during its largest historic eruption in 1929. Due to recent work conducted by GEO-PRISMS there is current gas data available from active fumaroles at Gareloi as well as a suite of rock samples readily available from the 1929 eruptive products. Determining dissolved volatile concentrations for the most recent large eruption of Mount Gareloi and comparing to current degassing at this system may prove crucial for setting a baseline for evident periods of unrest at Gareloi as well as development of potentially new and useful volcanic monitoring techniques that may be applied to other volcanic systems with modern fumaroles activity. Funding graciously provided by the 2017 Don Richter memorial scholarship has allowed preliminary and focused EPMA analysis of mineral phases in the unusual 1929 trachyte and latite eruptive products using a microprobe housed at the Advanced Instrumentation Laboratory (AIL) at the University of Alaska Fairbanks. Thus far, this funding has provided geochemical data for major mineral phases in the 1929 eruptive products of Mount Gareloi resulting in a suite of compositional data for phenocrysts and microlites of olivine, augite, titanomagnetite, plagioclase, and a number of groundmass glass analyses. Information gleaned from these analyses suggest a complex source and cooling history for the 1929 magmatic system with evidence that the latite magma may have been hybridized from mixing between the resident and evolving trachyte magma with an injection of a more mafic magma into the system that likely catalyzed the 1929 eruption. Both olivine and plagioclase phenocrysts in the 1929 latite lavas seem to show two compositionally distinct populations, a relatively highly evolved nature, and zoned rim compositions suggesting multiple heating and cooling events. Further analytical work on Gareloi minerals will be focused on detailed analysis of phases that provide geothermometric and geobarometric information, such as diffusion of Fe and Ti in magnetite-ilmenite touching pairs to assess pre-eruptive storage temperatures as well as careful analysis of olivine hosted melt inclusions to model storage pressures (hence depths) of one or more of the magmas erupted from Mount Gareloi in 1929. Once a model for magma storage conditions of the 1929 magma chamber can be derived, then resulting dissolved volatile budgets can be linked to current degassing at Gareloi as an attempt to understand the current state of volcanic quiescence observed and monitored at this system.

Membership Note

Membership renewal is November 1

Annual dues are:

Full member - \$25

Student member - \$5

Lifetime membership - \$200



Alaska Geological Calendar of Events



Date	Time	Organization	Event	Location
Nov 9, 2017		GSA	Rada Khadjinova & Steve Wardlow, Fugro; Geo-intelligence for Resource Development and Permitting, http://www.geophysicalsofakalaska.org	BP Energy Center, Anchorage
Nov 15-16, 2017		RDC	38th Annual Alaska Resources Conference http://www.akrdc.org/conference	Dena'Ina Center, Anchorage
Nov 21, 2017	11:30 am	AGS	Tom Homza, Shell Exploration and Production, "A Geological Interpretation of the Chukchi Sea Petroleum Province: Offshore Alaska, USA"	BP Energy Center, Anchorage
Dec 13, 2018	1:00-4:30 pm	UAA/GMC	Marginal marine reservoirs core-outcrop workshop 2017	3651 Penland Pkwy Anchorage
Dec 14, 2017	11:30 am	AGS/GSA	Shuvajit (Jit) Bhattacharya, UAA, "Application of Predictive Data Analytics and Geostatistics for Multi-scale Shale Facies Modeling"	Glenn Olds Hall, USGS Anchorage
Jan 18, 2018	11:30 am	AGS	George Case, USGS, "The Alaska Resource Data File (ARDF): More than just a database"	BP Energy Center, Anchorage
Jan 22-26, 2018			Alaska Marine Science Symposium http://www.alaskamarinescience.org/agenda/	Hotel Captain Cook, Anchorage
Feb 12-16, 2018			Alaska Forum on the Environment http://www.akforum.org/afe/	Dena'Ina Center, Anchorage
Feb 13, 2018	6:00 pm	AEG	Eldon Gath; Earth Consultants International. AEG Distinguished Lecturer	Glacier Brewhouse, Anchorage
Feb 15, 2018		AAEP	Brown Bag Speaker Series http://www.akaep.org	BP Energy Center, Anchorage
Feb 15, 2018	4:30 - 8:00 pm	AAEP	Networking Social Hour and Annual Membership Meeting.	Glacier Brewhouse, Anchorage
Feb 20, 2018	11:30 am	AGS	Jeff Benowitz, UAF "Cenozoic off-set history of the Denali Fault system"	BP Energy Center, Anchorage
March 8, 2018	11:45 am	GSA	Keith Millis, SAExploration "Compressive seismic imaging"	TBA
March 15, 2018	11:45 am	AAEP	Brown Bag Speaker Series	BP Energy Center, Anchorage
March 20, 2018	11:30	AGS	Trystan Herriott, State of Alaska "Sequence-stratigraphic framework of the Middle Jurassic Chinitna Formation, Cook Inlet forearc basin, south-central Alaska".	BP Energy Center, Anchorage
March 26-31, 2018		AMA	Alaska Miners Association. Biennial Convention https://alma.memberclicks.net/2018-convention	Carlson Center Fairbanks
April 12, 2018		GSA	Carrie Laudon, Geophysical Insights	TBA
April 17, 2018		AAEP	Brown Bag Speaker Series	BP Energy Center, Anchorage
April 20, 2018	8:00 am - 4:00 pm	AGS	AGS Spring Technical Conference	UAA, Anchorage
April 24, 2018	11:30	AGS	Monthly luncheon meeting TBA	BP Energy Center, Anchorage
May 10, 2018	11:45	GSA	Dr. William Symes, Rice University 2018 SEG Distinguished Lecturer.	TBA
May 15, 2018	11:30	AGS	Erin Shea, University of Alaska, Anchorage	BP Energy Center, Anchorage
May 20-23, 2018		AAPG	AAPG Annual Convention & Exhibition	Salt Lake City, Utah

AMA: Alaska Miners Association; AGS: Alaska Geological Society; GSA: Geophysical Society of Alaska
 AAEP: Alaska Association of Environmental Professionals; SPE Society of Petroleum Engineers



Mark of Schlumberger. © 2015 Schlumberger. 15-1S-38913

Techlog

WELLBORE SOFTWARE
PLATFORM

Integrate Geoscience and Drilling Capitalize on Your Wellbore Data Investment

Only the Techlog* wellbore software platform brings all of your wellbore-centric data together for better decisions—from exploration to development. With its advanced acoustics, geomechanics, and complex lithology solver, the Techlog platform improves formation evaluation in every well. This advanced technology enhances characterization and increases understanding of drilling hazards—even in the most challenging reservoirs.

slb.com/Techlog

Schlumberger

ROCK SOLID EXPERIENCE



Core Lab
RESERVOIR OPTIMIZATION

www.corelab.com • 713-328-2748

© 2013 Core Laboratories. All rights reserved.

The Alaska Geological Society, Inc.
P.O. Box 101288

Anchorage AK 99510

On the web at: <http://www.alaskageology.org>

The Alaska Geological Society is an organization which seeks to promote interest in and understanding of Geology and the related Earth Sciences, and to provide a common organization for those individuals interested in geology and the related earth sciences.

This newsletter is the monthly (September-May) publication of the Alaska Geological Society, Inc. 300± newsletters delivered electronically per month.

Kenneth P. Helmold (Editor)

Alaska Geological Society, Inc.

P. O. Box 101288

Anchorage, AK 99510

e-mail: ken.helmold@alaska.gov

907-269-8673 (office)

MEMBERSHIP INFORMATION

AGS annual memberships expire November 1. The annual membership fee is \$25/year (\$5 for students). You may download a membership application from the AGS website and return it at a luncheon meeting, or mail it to the address above.

Contact membership coordinator Kirk Sherwood with changes or updates (e-mail: membership@alaskageology.org; phone: 907-334-5337)

All AGS publications are now available for on-line purchase on our website. Check to see the complete catalogue:

<http://www.alaskageology.org/publications.htm>

ADVERTISING RATES

Advertisements may be purchased at the following rates:

1/10 Page--\$190/9mo, \$75/1mo; size=1.8 x 3.5 inch

1/4 Page--\$375/9mo, \$95/1mo; size=4.5 x 3.5 or 2.2 x 7.5 inch

1/3 Page--\$470/9mo, \$105/1mo; size=7.0 x 3.5 or 3.0 x 7.5 inch

1/2 Page--\$655/9mo, \$125/1mo; size=9.0 x 3.5 or 4.5 x 7.5 inch

Full Page--\$1000/9mo, \$165/1mo; size=7.5 x 9.0 inch

1mo rate=(9mo rate/9)+\$50 (rounded up).

Contact Keith Torrance at 907-952-1288 for advertising information.

WELLSITE GEOSCIENCE SERVICES



When time is money, Wellsite Geoscience is money well spent.

Whether you're exploring a basin, producing a well or completing a shale play, time is money. That's why Weatherford Laboratories brings a suite of formation evaluation technologies right to the wellsite. Utilizing mud gas and cuttings, these technologies provide detailed data on gas composition, organic richness, mineralogy and chemostratigraphy in near real time. As a result, operators now have an invaluable tool to assist with sweet spot identification, wellbore positioning, completion design and hydraulic fracturing. We call it Science At the Wellsite. You'll call it money well spent.

SCIENCE AT THE WELLSITE™

www.weatherfordlabs.com

Formation Evaluation | Well Construction | Completion | Production

©2013 Weatherford. All rights reserved





Needs You

A volunteer is needed to serve as President-Elect. This person will serve on the AGS Board this year and become President next year.

Contact Larry Smith: Ljsmithak@gmail.com



2017 - 2018 Alaska Geological Society Board, Committees and Delegates

Title	Name	Phone	e-mail	Affiliation
President	Larry Smith	907-865-5803	Ljsmithak@gmail.com	Brook Range Petroleum
Past-President	Chad Hults	907-332-0740	chadcph@gmail.com	NPS
President-Elect				
Vice-President	Keith Torrance	907-952-1288	ktorrance@gci.net	
Treasurer	Holly Fair	907-269-8763	holly.fair@alaska.gov	AK DOG
Secretary	Dave Buthman	907-344-6001	dbuthman@hilcorp.com	Hilcorp
Director 16-2018	Laura Gregersen	907-375-8240	Laura.gregersen@alaska.gov	AK DOG
Director 16-2018	Karri Sicard	907-451-5040	karri.sicard@alaska.gov	AK DGGS
Director 16-2018	Steve Wright	907-855-2363	alaskageo@aol.com	Consultant
Director 17-2019	Jennifer Crews	907-263-4516	jennifer.r.crews@conocophillips.com	ConocoPhillips
Director 17-2019	Kirk Sherwood	907-334-5337	sherwook@mtaonline.net	
Director 17-2019	Monte Mabry	907-230-4488	monte.mabry@live.com	Hilcorp
AAPG Delegate	Ken Helmold	907-269-8673	ken.helmold@alaska.gov	AK DOG
PSAAPG AGS Representative	Ken Helmold	907-269-8673	ken.helmold@alaska.gov	AK DOG
Advertising	Keith Torrance	907-952-1288	ktorrance@gci.net	UMIAQ
Education/Science Fair	Jana DaSilva Lage	907-980-9368	jldasilva5@hotmail.com	APICC
Field Trips	Chad Hults	907-332-0740	chadcph@gmail.com	NPS
Bylaws	Sue Karl	907-441-801	smkarl107@gmail.com	
Memberships	Kirk Sherwood	907-334-5337	sherwook@mtaonline.net	
Newsletter Editor	Ken Helmold	907-269-8673	ken.helmold@alaska.gov	AK DOG
Publications	Mick Bradway		brad8450@yahoo.com	
Scholarship	Sue Karl	907-441-801	smkarl107@gmail.com	
Website	Jan Hazen		homesteadgraphics@gmail.com	Consultant
Fundraising	Jennifer Crews	907-263-4516	jennifer.r.crews@conocophillips.com	ConocoPhillips