New-Old Potential Field Data in the Alaska OCS*

Mike Unger[1]

Search and Discovery Article #30646 (2019)**
Posted January 6, 2020

*Adapted from oral presentation given at AAPG 2019 Annual Convention & Exhibition, San Antonio, Texas, May 19-22, 2019
 DOI:10.1306/30646Unger2019

[1]BOEM - Department of the Interior, Anchorage, Alaska (michael.unger@boem.gov)

Abstract

More than 15MM gravity and magnetic data points were collected in Alaska between 1960 and 1996. These potential field data were collected by public agencies, academic groups, and industry in multiple areas during multiple campaigns. Multiple permittees collected marine gravity, marine magnetic, aeromagnetic, and/or aerogravity data (collectively, potential field data) in nearly 100 permits across all 15 Alaska Outer Continental Shelf (OCS) planning areas. After collection, much of the data acquired by industry in the OCS under permits were selected by BOEM (previously the MMS and USGS - Conservation Division). Much of the public data were released by the USGS, and the academic data are available from various sources. However, the data collected by industry under the OCS permitting process and held by BOEM has not previously been assembled into a complete dataset or made available publicly. The potential field data previously collected in the Alaska OCS were identified, collected, preprocessed, and loaded to a GIS system. This enabled comparison of adjacent data from different permits (surveys), highlighting different processing assumptions between surveys, as well as varying interpretation methodologies. Data fields varied greatly for each permit, with some datasets having only limited values (i.e. only Bouguer corrected density values) while others were nearly complete, with original field data, Eötvös corrected, Free Air, and Bouguer values. Processing assumptions applied to the data also vary significantly between permit datasets; wherever possible, raw (field) data were used to integrate each permit dataset into the greater, regional dataset. An iterative process was applied to organizing and preprocessing the data, using learnings from permit data supplied by the same permitee in a similar timeframe to attempt to reconstruct as much information as possible. These data were then merged to minimize misties between permit datasets and create a regional OCS dataset. This OCS dataset was then integrated with the public on-shore potential field datasets to create an Alaska-wide, regional set of gravity, magnetic, and aeromagnetic data. Under federal regulation (30 CFR 551.14), such data are available for release 25 years after issuance of the permit authorizing their collection. This regional integration of potential field data from multiple permits will provide a framework for further exploration and scientific study in the Alaska OCS and the Arctic.

BOEM

Bureau of Ocean Energy Management

New-Old Potential Field Data in the Alaska OCS

2019 AAPG Annual Convention and Exposition

Mike Unger | 2019 AAPG ACE San Antonio TX | 22 May, 2019

Who is BOEM?

- **Agency of the Department of the Interior**
- **Manage the Outer Continental Shelf (OCS)**
  - Oil and Gas
  - Renewable Energy
  - Mineral Resources
- **Ensure environmental and economic E&P**
  - Responsible Stewardship
  - Science-Informed Decisions
  - Integrity and Ethics

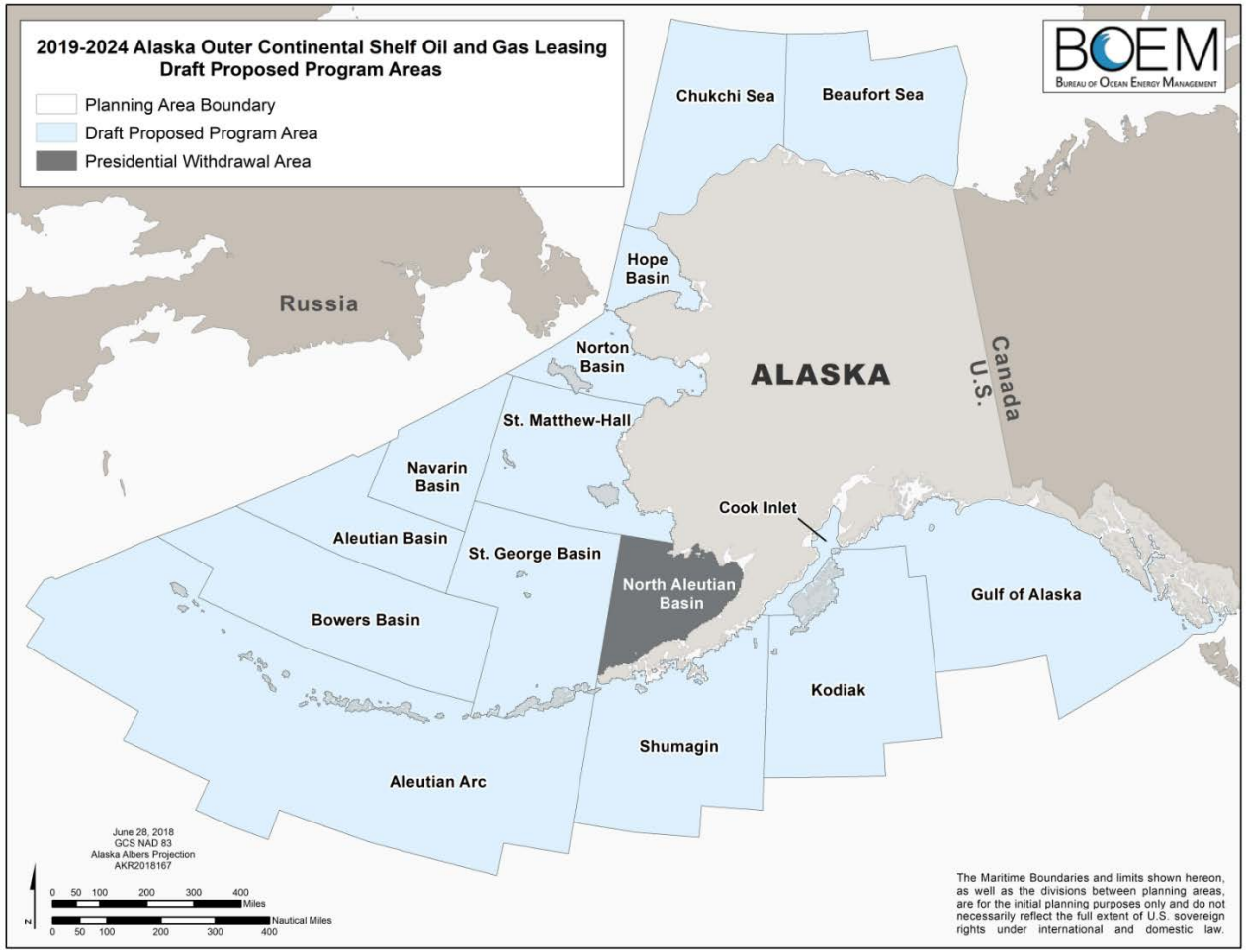
BOEM Alaska

We oversee

- Lease Management
- Exploration Plans
- Environmental Science
- Environmental Analysis
- Resource Evaluation

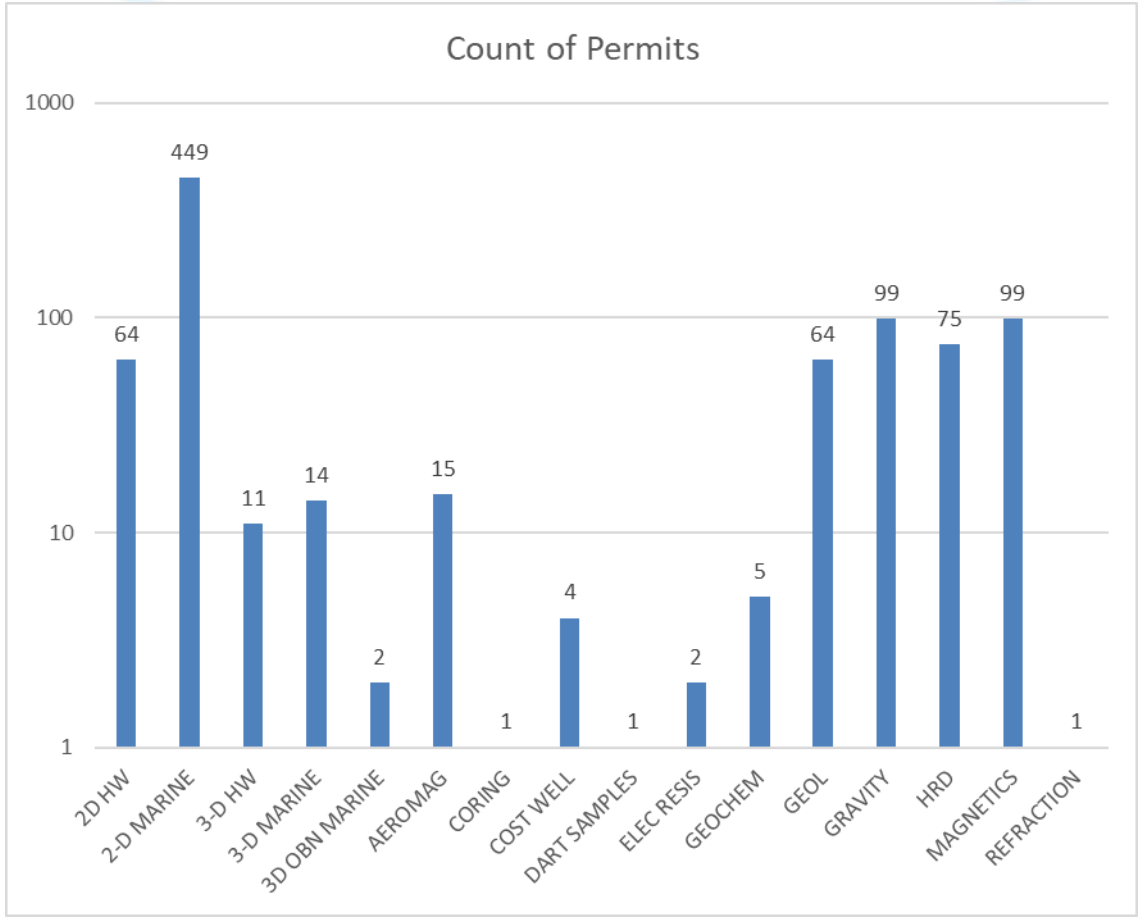
More than 1B acres in 15 separate planning areas

- 47°N to 75°N (3,100 km)
- 130°W to 167°E (4,200 km)

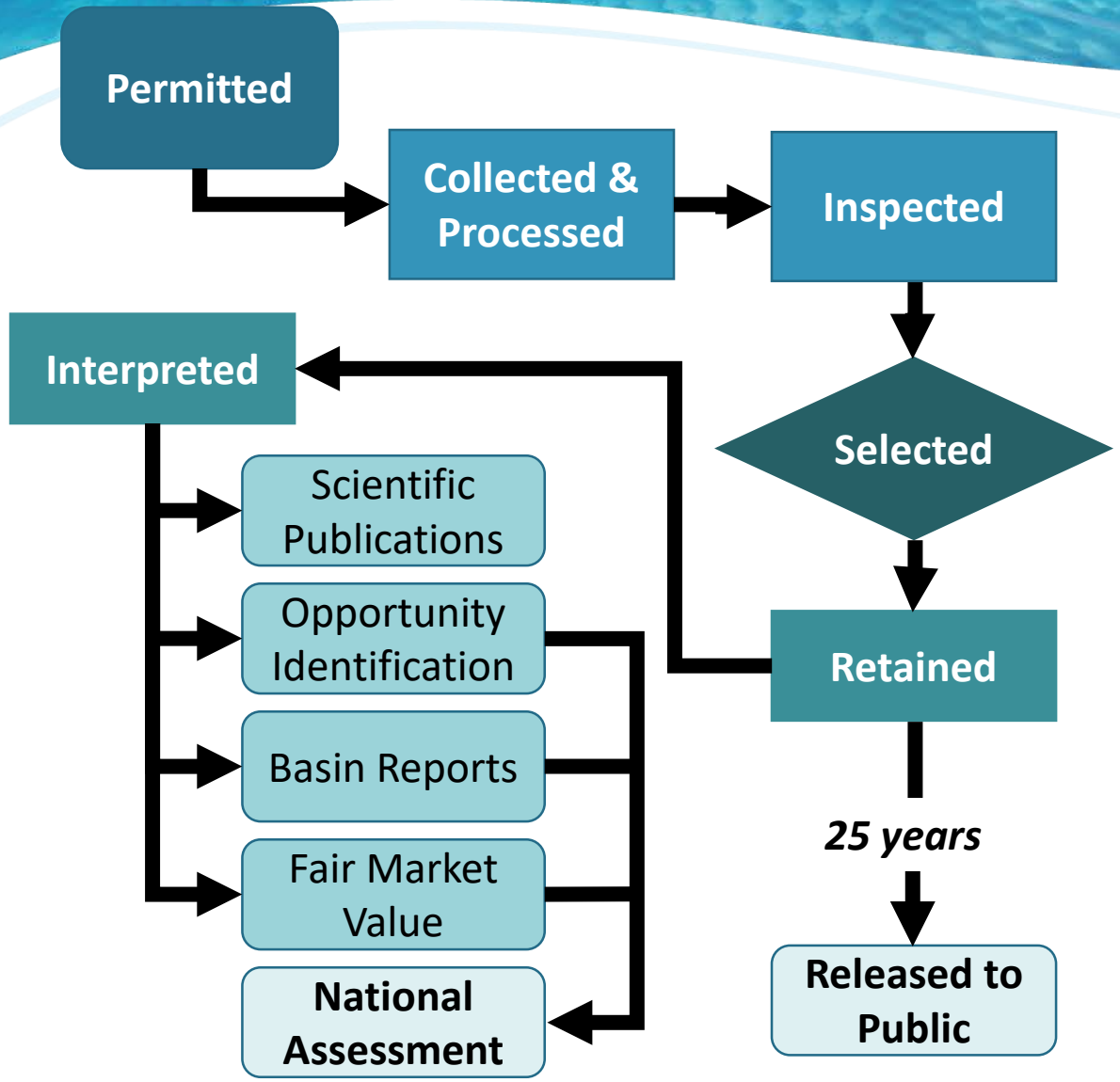


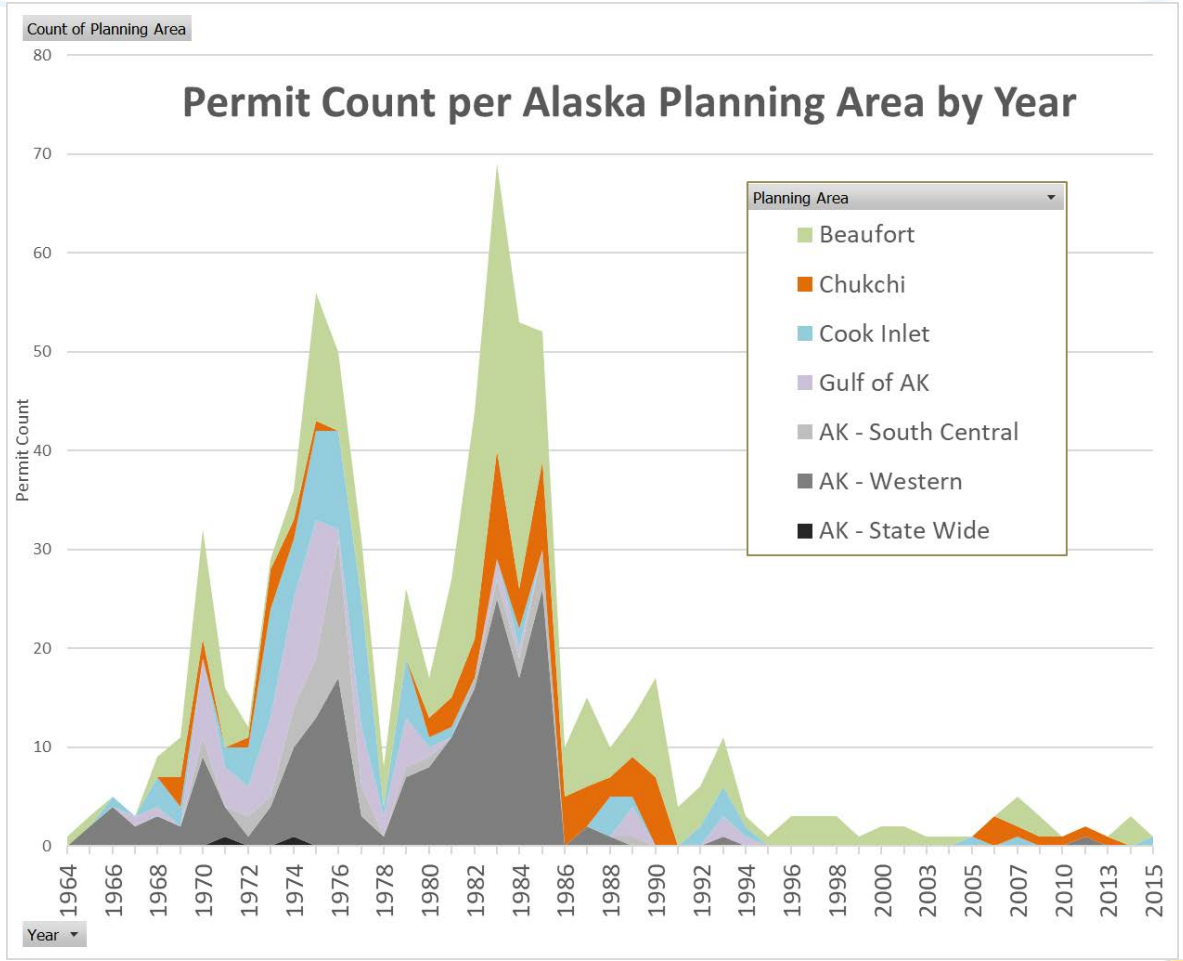
BOEM AK Resource Evaluation

- **Responsible for**
  - Regulating the collection of geological & geophysical data
  - Assessing Resource potential
  - Ensuring Fair Market Value
- **Since 1964**
  - 716 permits
  - 906 data types



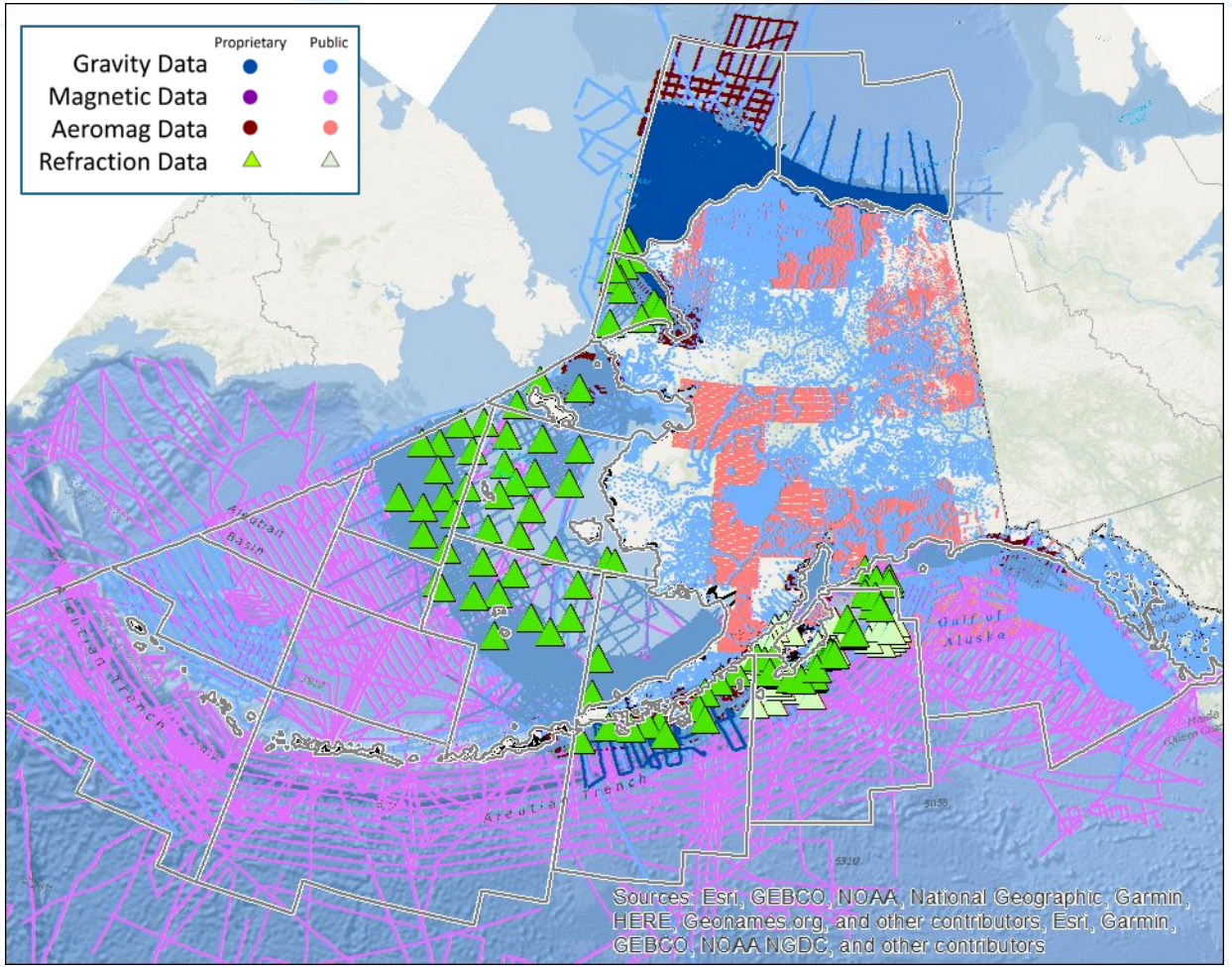
OCS Data Lifecycle





Gravity, Magnetic, Aeromagnetic and Refraction Data

- **Focus of this talk is the ‘Weird Data’**
  - **G**ravity, **M**agnetics, **A**eromagnetic and **R**efraction data (G-MAR)
- **Over the past 15 years, Alaska Region MMS/BOEM has released a series traditional 2D seismic datasets**
  - Now we are moving forward in releasing the G-MAR data
- **These data are key to generating new ideas in basin formation, basin structure, seismic imaging and tectonic models**



- **The metadata are organized by permit number**
  - Year, Permittee, Planning Area
- **Went through data stores**
  - Permit Files
  - Contract Files
  - Paper on Shelves
  - Disk Drives

to determine what data were Selected, and media type & location of data & metadata

BOEM AK Region - Acquired Gravity, Magnetic & Seismic Refraction data

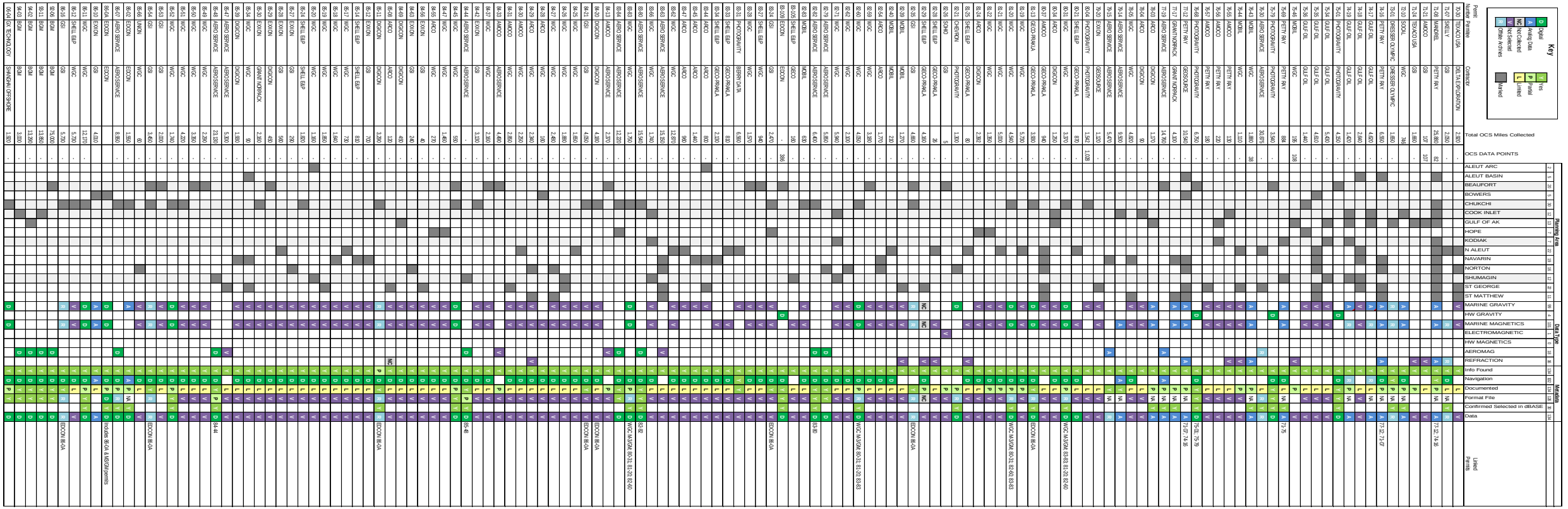
Key

D	Digital	Y	Yes
A	Analog Data	P	Partial
NC	Not Collected	L	Limited
V	Not Selected		
R	Offsite Archives		Marked

Permit Number	Permitee	Contractor	Total OCS Miles Collected	OCS DATA POINTS	Planning Area: ALEUT ARC (2)	ALEUT BASIN (5)	BEAUFORT (20)	BOWERS (5)	CHUKCHI (30)	COOK INLET (12)	GULF OF AK (13)	HOPE (7)	KODIAK (7)	N ALEUT (22)	NAVARIN (19)	NORTON (16)	SHUMAGIN (12)	ST GEORGE (22)	ST MATTHEW (11)	Data Type: MARINE GRAVITY (99)	HW GRAVITY (4)	MARINE MAGNETICS (101)	ELECTROMAGNETIC (1)	HW MAGNETICS (0)	AEROMAG (18)	REFRACTION (16)	Metadata: Info Found (134)	Navigation (102)	Documented (134)	Format File (126)	Confirmed Selected in dBASE (30)	Data (134)	Linked Permits
70-30	TEXACO USA	DELTA EXPLORATION	2,920	-																V		V					Y		L			V	
82-29	SHELL E&P	GECO-PRAKLA	4,160	-																NC		NC				V	Y	D	P	NC		V	
83-83	WGC	WGC	1,750	-																D		D					Y	D	P	R	Y	D	WGC M-3/GM; 80-31; 81-20; 82-60
85-51	WGC	WGC	4,220	-																V		V					Y	D	L	V		V	
85-52	WGC	WGC	1,740	-																D		D					Y	D	P	Y	Y	D	
94-03	BGM	BGM	3,000	-																					D		Y	D	Y	Y		D	

G-MAR Data Acquired

- **137 permits with Gravity, Magnetic, Aeromagnetic or Refraction data**

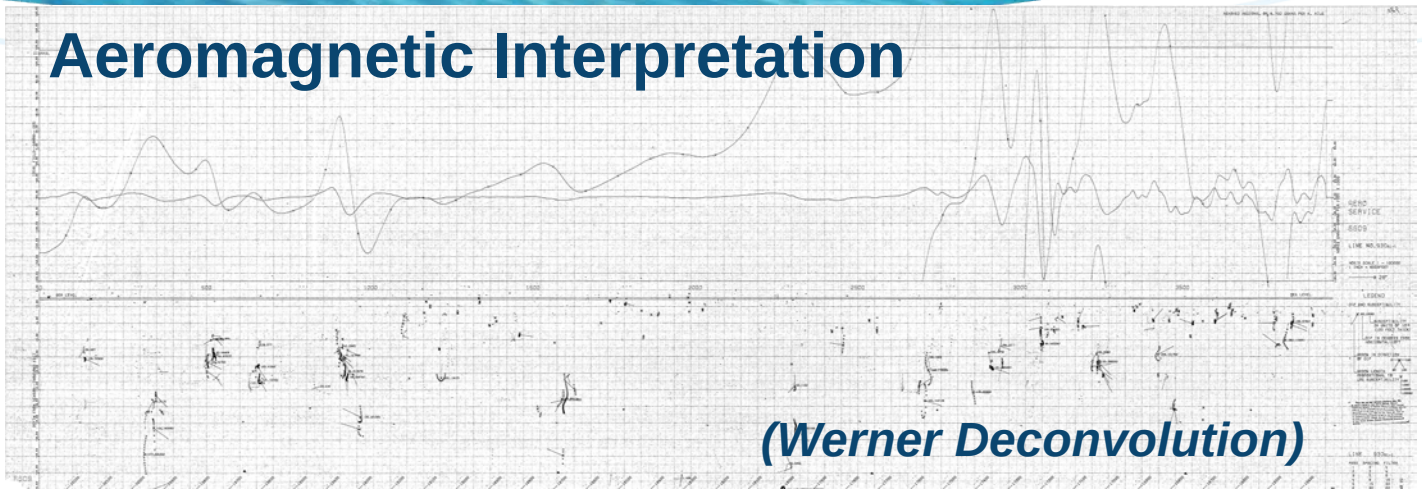


BOEM AK Region - Acquired Gravity, Magnetic & Seismic Refraction data

Types of data and Information

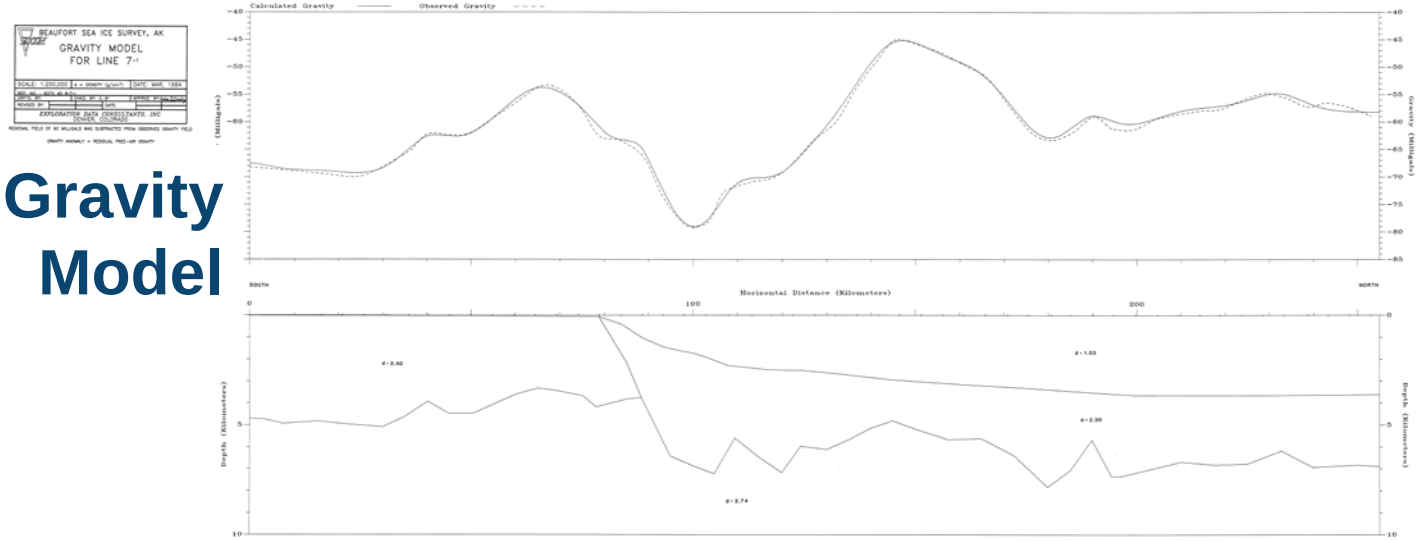
- Lots of analog data and information
- Many of these data have never been integrated
  - Lack of tools
  - Lack of staff

Aeromagnetic Interpretation

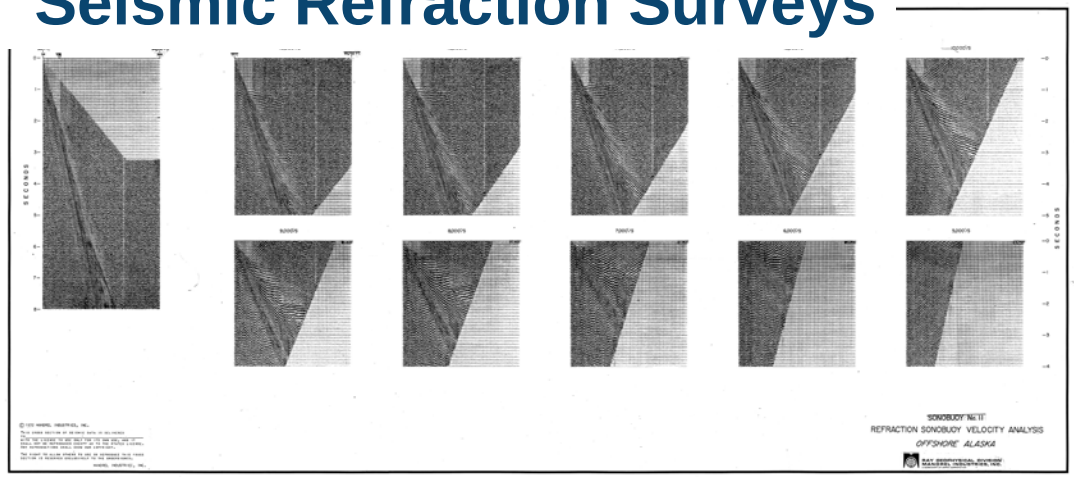


(Werner Deconvolution)

Gravity Model

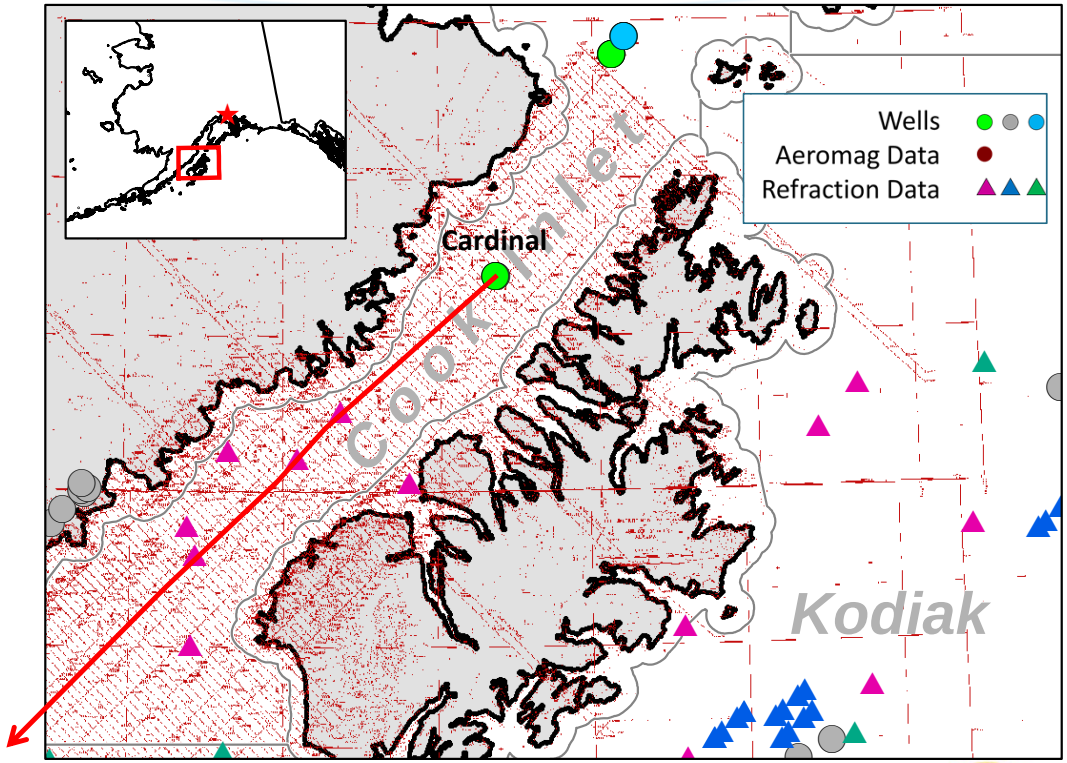


Seismic Refraction Surveys



Case Study Introduction – Lower Cook Inlet

- **Upper Cook Inlet**
  - Has been producing since 1950s
    - 1.3 BBO/7.5T FCG
  - Similar rocks in LCI
- **Dataset includes**
  - Aeromag (2D horizontal)
  - One well (1D high res)
  - Refraction Data (1D low res)
  - Poor quality 2D (2D vertical)
- **Want to analyze basin potential**
  - First-order structure
  - Kitchen presence
  - Reservoir quantity
    - Velocity as gross proxy for porosity



Shelikof Strait Refraction Data

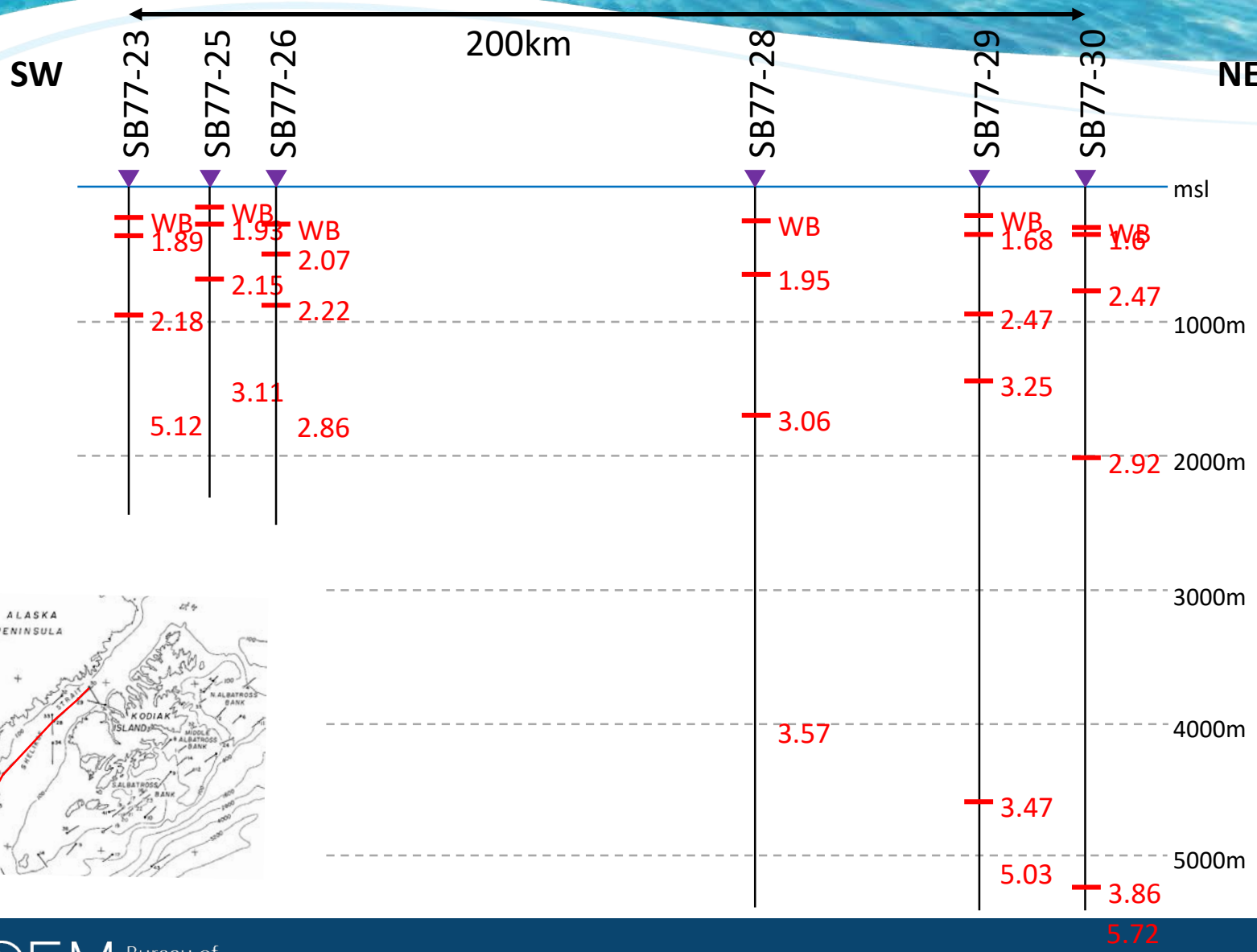
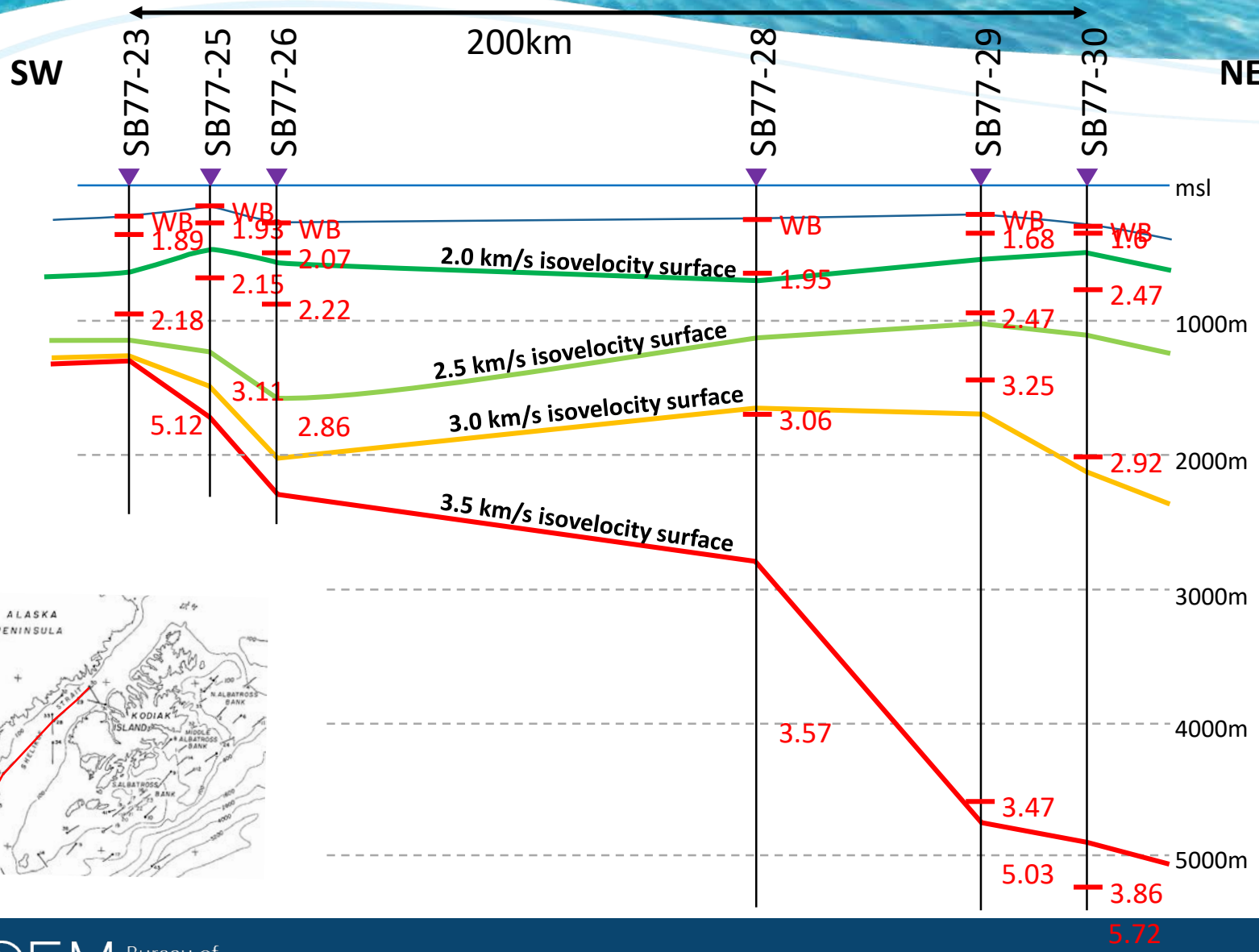


Table 1. (cont)

Location	Profile	Velocity (km/sec) V_2	V_3	V_4	V_5	V_6	V_7	Water Depth (km)	Thickness (km) h_2	h_3	h_4	h_5	h_6	Lat N	Long W
N. Albatross Bank	77-3	2.00	2.80	3.80	..	..	..	0.07	0.81	1.15	..	..	..	57°54.5'	151°48.0'
"	77-4	1.73	2.33	2.97	5.20	..	..	0.07	0.21	0.31	0.94	..	..	58°01.9'	151°35.0'
"	77-6	1.94	2.32	3.89	..	..	..	0.06	0.27	1.08	..	..	..	57°37.3'	150°58.8'
M. Albatross Bank	77-7	2.25	2.68	3.30	..	..	..	0.09	0.88	0.71	..	..	..	57°09.8'	151°32.3'
"	77-8	1.99	4.19	5.31	..	..	..	0.10	0.26	1.39	..	..	..	57°20.2'	152°31.5'
Kiliuda Trough	77-9	1.97	2.46	4.28	4.85	..	..	0.14	0.67	0.44	0.93	..	..	56°57.5'	152°31.0'
S. Albatross Bank	77-10	1.99	2.47	3.07	3.35	..	..	0.05	0.04	0.23	1.65	..	..	56°24.8'	153°03.4'
Cont. Shelf	77-12	1.71	1.79	2.66	..	..	..	0.11	0.25	0.79	..	..	..	55°57.7'	153°44.5'
Cont. Shelf	77-14	2.04	2.18	2.80	5.01	..	..	0.02	0.30	0.78	1.08	..	..	55°55.5'	155°20.3'
Cont. Slope	77-16	1.80	2.40	2.56	3.18	..	..	0.33	0.29	0.39	1.27	..	..	55°36.4'	154°55.2'
Cont. Shelf	77-19	1.82	2.00	3.28	4.05	..	..	0.31	0.32	0.34	0.96	..	..	56°04.1'	154°32.8'
" "	77-22	1.69	2.02	4.72	6.23	..	..	0.20	0.11	0.62	2.52	..	..	55°32.6'	155°53.1'
Shelikof Strait	77-23	1.89	2.18	5.21	..	..	..	0.21	0.12	0.58	..	..	..	56°30.7'	156°20.2'
"	77-25	1.93	2.15	3.11	..	..	..	0.14	0.11	0.43	..	..	..	56°40.0'	156°21.0'
"	77-26	2.07	2.22	2.86	..	..	..	0.24	0.25	0.40	..	..	..	56°51.9'	156°11.1'
"	77-28	1.95	3.06	3.57	..	..	..	0.23	0.40	1.05	..	..	..	57°31.2'	155°08.6'
"	77-29	1.68	2.24	3.25	3.47	5.33	..	0.20	0.17	0.58	0.46	3.19	..	57°48.3'	154°36.5'
"	77-30	1.60	2.47	2.92	3.86	5.72	..	0.28	0.06	0.45	1.23	3.26	..	57°56.6'	154°22.9'
"	77-31	1.72	4.31	5.04	..	..	..	0.12	0.36	0.36	..	..	..	57°44.6'	154°00.1'
"	77-32	1.99	3.52	4.11	4.51	..	..	0.23	0.09	0.16	0.95	..	..	57°49.4'	154°59.0'
"	77-33	1.60	2.16	3.22	3.79	7.09	..	0.28	0.09	0.61	1.01	2.93	..	57°36.2'	155°11.5'
"	77-34	1.88	2.09	4.79	..	..	..	0.27	0.06	0.20	..	..	..	57°15.8'	155°09.2'
Cont. Shelf	77-38	2.37	3.00	4.29	4.86	..	..	0.11	0.36	0.78	2.37	..	..	56°12.2'	154°45.0'
S. Albatross Bank	77-41	3.55	4.73	..	..	..	..	0.07	0.67	..	..	..	..	56°27.5'	153°51.1'

Shelikof Strait Isovelocity Model

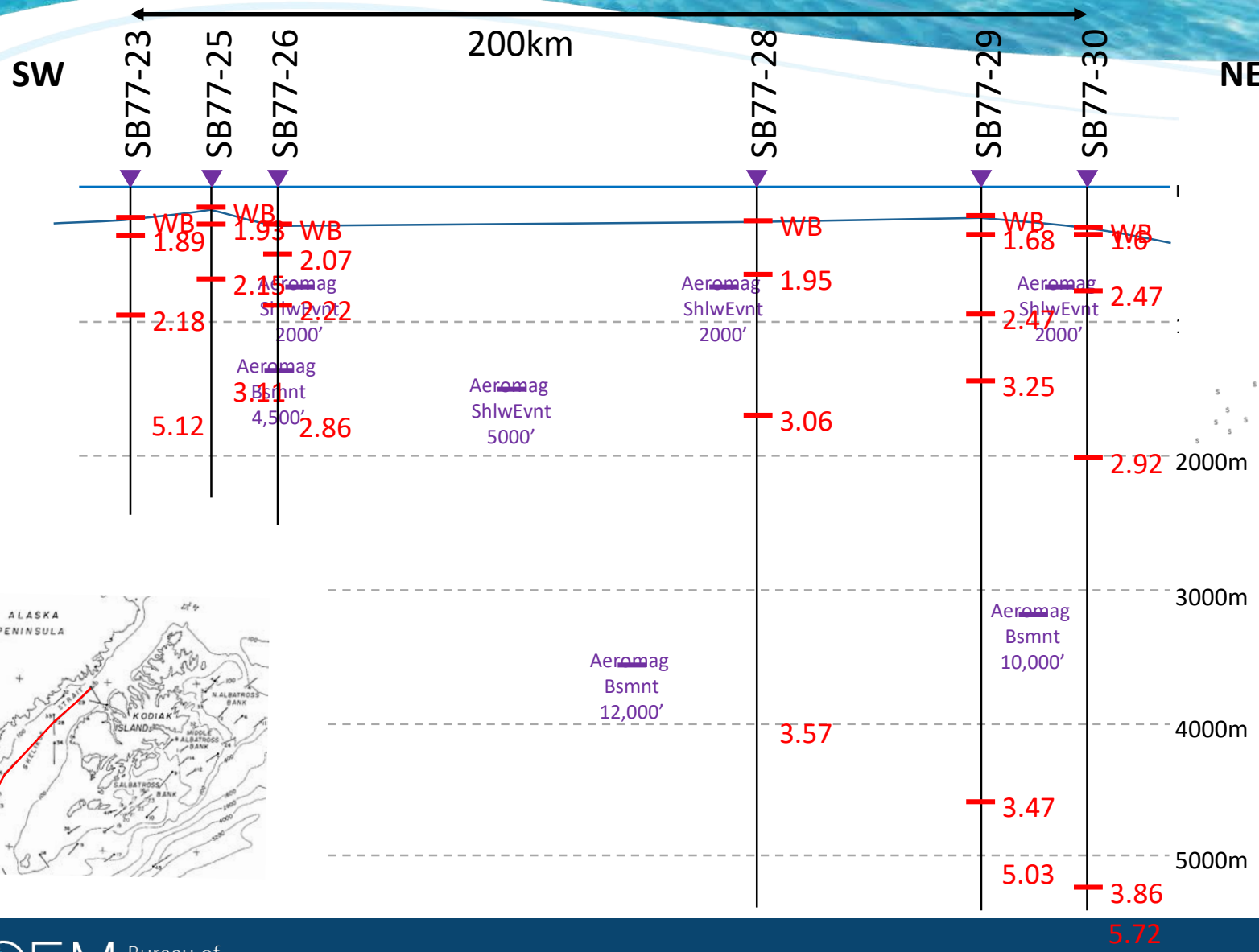


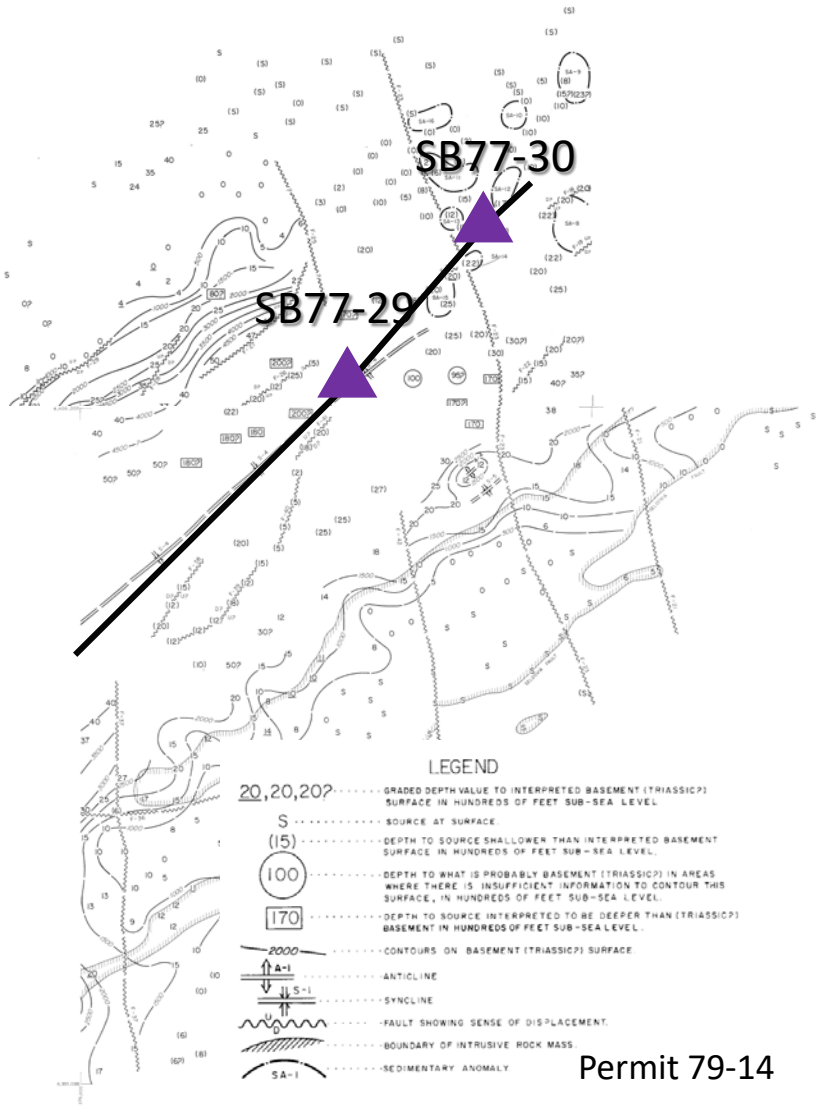
ft/s	m/s	Material Types		
5,000	1500	Water		
6,000	1800	Clastics (Sandstone & Shale)		
7,000	2100			
8,000	2400			
9,000	2700		Carbonates	
10,000	3000			
11,000	3400			
12,000	3700			
13,000	4000			
14,000	4300			
15,000	4600			
16,000	4900			
17,000	5200			
18,000	5500	Granite	Serpent-inite	Upper Crust
19,000	5800			
20,000	6100			
21,000	6400		Gabro	Middle Crust
22,000	6700			
23,000	7000			
24,000	7300		Ultamafic	Lower Crust
25,000	7600			
26,000	7900			Mantle
27,000	8200			

(Sediments)

Data from USGS OFR 78-0368, interpretation by Unger

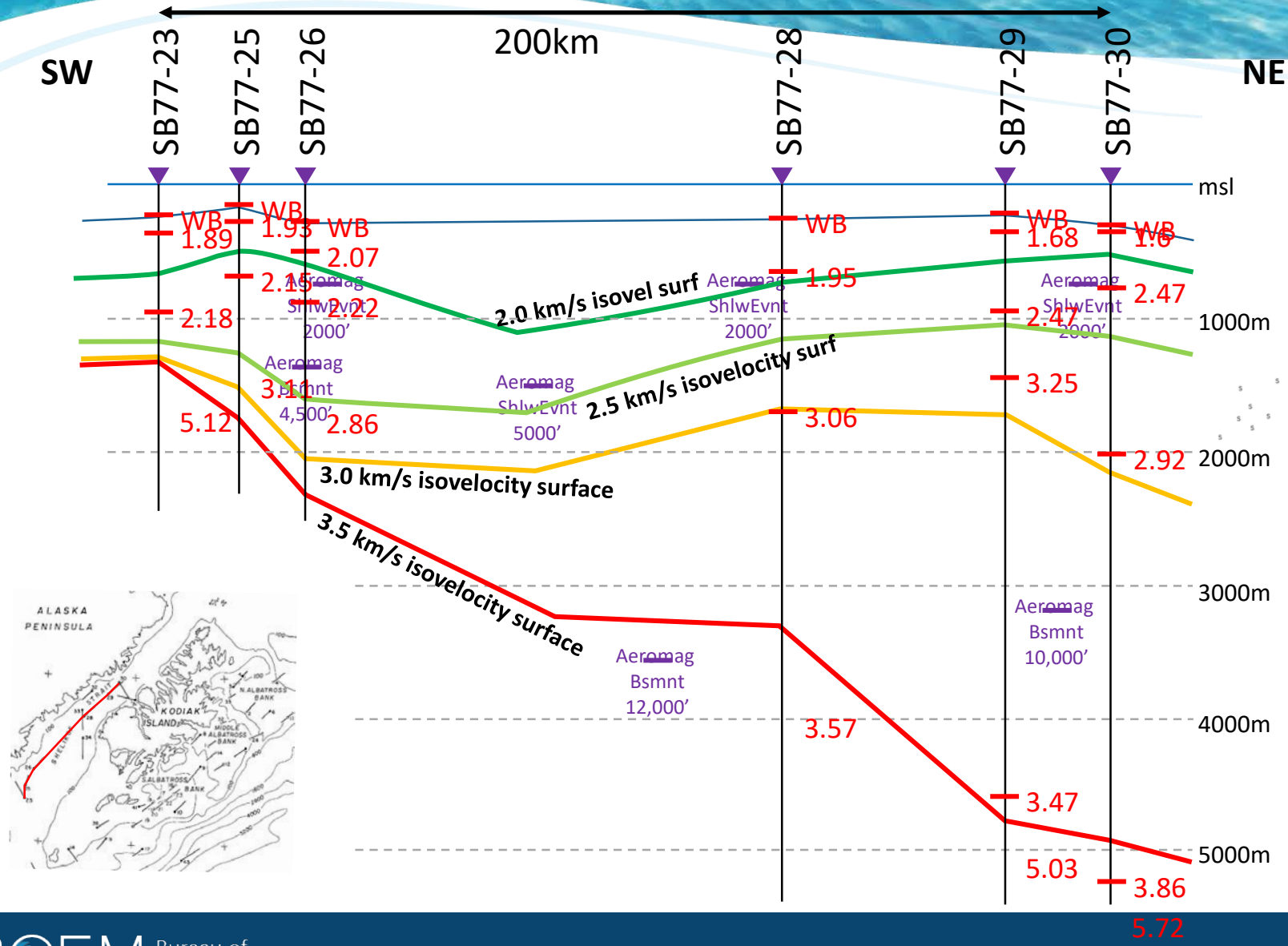
Aeromag Integration

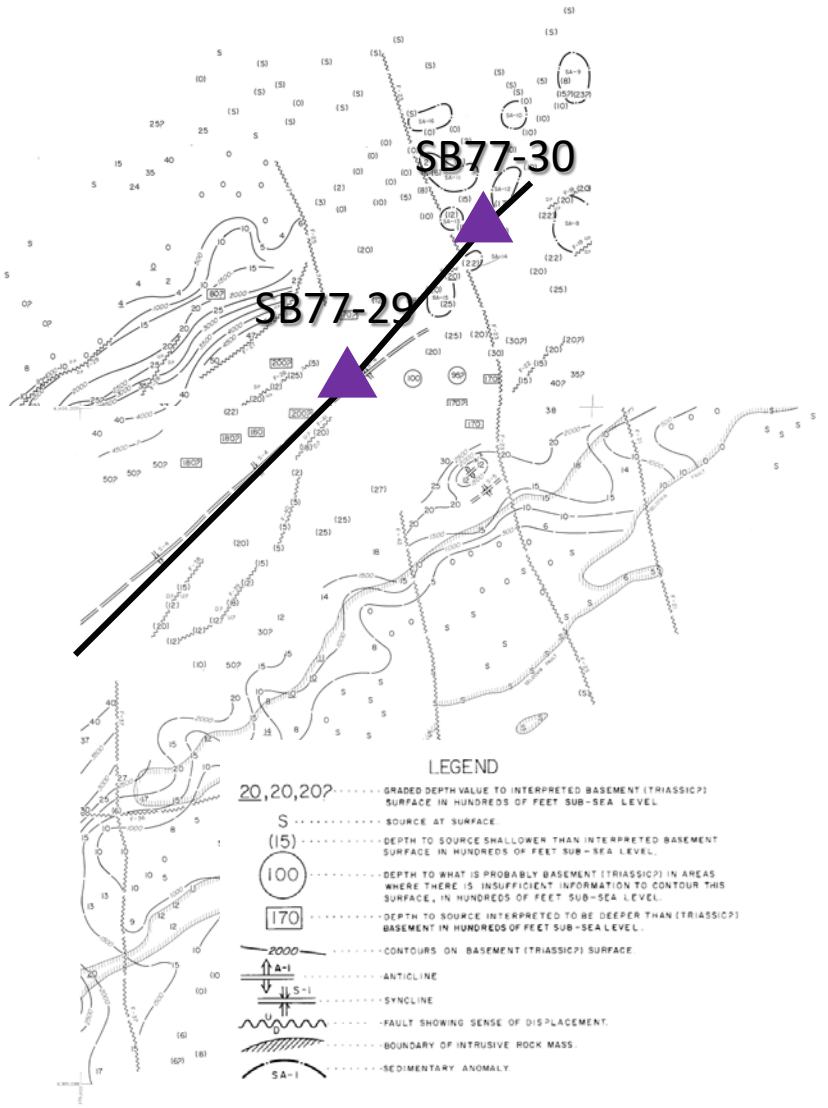




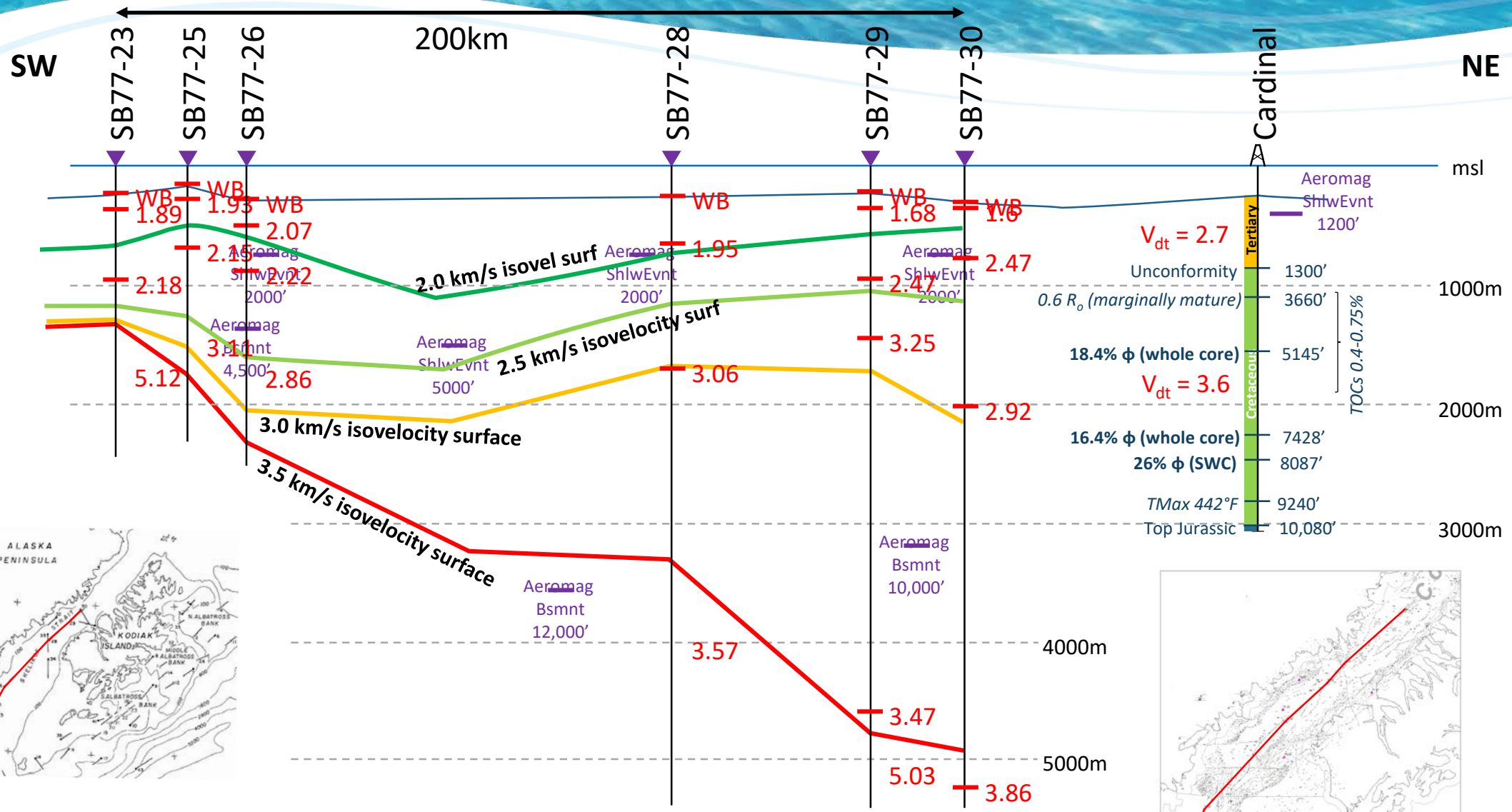
Permit 79-14

Aeromag Integration

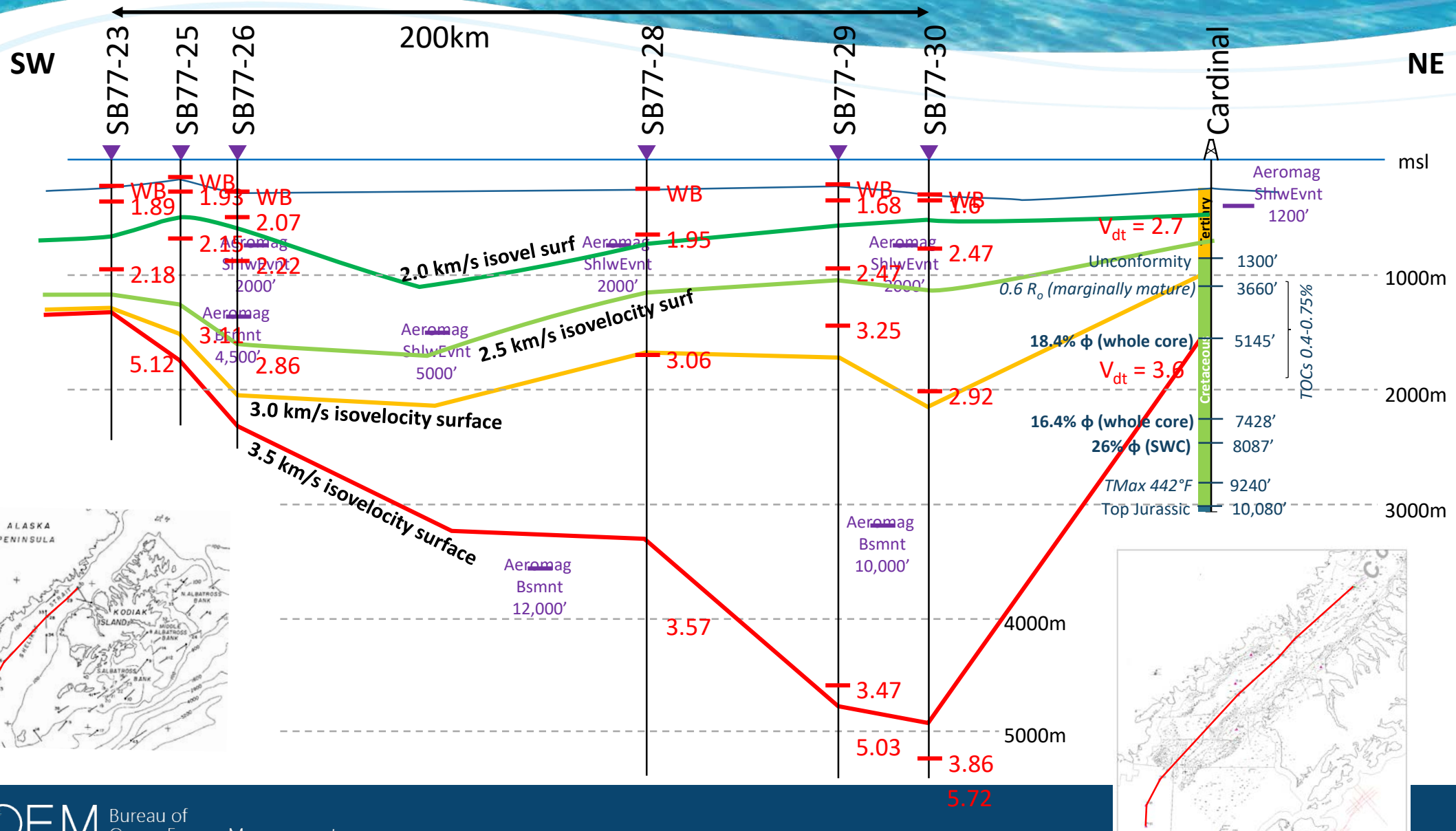




Well Integration



Well Integration



Next Steps

- **Focus on specific areas to develop workflows**
  - **Cook Inlet**
  - Beaufort
  - Chukchi
- **Basin scale integration**
  - Container shape
  - Fill attributes
    - Density
    - Magnetic Field
    - Velocity
- **Crustal-scale integration**
  - Crustal structure
    - Density
    - Velocity
    - Magnetic field
  - Tectonic models
  - Heat flow (crustal material)

Conclusions

- **Significant quantities of G-MAR data collected and selected**
- **Many of these data have not been recently examined or integrated**
- **These data can be applied to develop new ideas and opportunities**
  - Basin Formation
  - Basin Infill
  - Petroleum System analysis

Data Type		Digital		Analog		In Archive		Not Selected	
	Total	Ct	%	Ct	%	Ct	%	Ct	%
MARINE GRAVITY	109	11	10%	12	11%	5	5%	70	64%
HW GRAVITY	4	4	100%						
MARINE MAGNETICS	112	10	9%	10	9%	8	7%	72	64%

Data Type		Digital		Analog		In Archive		Not Selected	
	Total	Ct	%	Ct	%	Ct	%	Ct	%
ELECTROMAGNETIC	1							1	100%
AEROMAG	19	11	58%	2	11%	1	5%	4	21%
REFRACTION	16			4	25%	1	6%	10	63%

Looking for partners to work with these data…

BOEM

Bureau of Ocean Energy Management

BOEM.gov

Mike Unger | michael.unger@boem.gov | (907) 334-5286