

CHAPTER 1

AN INTRODUCTION TO 2014 FIELD STUDIES IN WESTERN COOK INLET, ALASKAMarwan A. Wartes¹, editor**INTRODUCTION**

Resource assessments of the Cook Inlet region in south-central Alaska indicate that significant hydrocarbons likely remain to be discovered in the basin (BOEM, 2011; Stanley and others, 2011). The Alaska Division of Geological & Geophysical Surveys is leading a multi-agency collaborative effort to acquire new geologic data relevant to the petroleum system in Cook Inlet. This type of information is critical to improving the understanding of the basin's evolution and provides new constraints on exploration models.

The Cook Inlet program has resulted in a number of publications to date, most notably a milestone synthesis of the framework geology of the basin, published as a book chapter by the American Association of Petroleum Geologists (LePain and others, 2013). Earlier noteworthy reports stemming from this program include a series of papers on the geology of reservoir analogs exposed in the Kachemak Bay area (LePain, 2009). Investigations along the western margin of Cook Inlet have also produced vital new information on the migration of oil within the basin, including the discovery of several new examples of oil-stained Cretaceous and Jurassic outcrops (LePain and others, 2012; Stanley and others, 2013a; Wartes and others, 2013a; Wartes and Herriott 2014a, 2014b). Petrologic work on newly collected samples has dramatically increased the available data on the reservoir quality of various units around the basin (Helmold and others, 2013). In addition to field geologic studies, the program has also integrated oil and gas well and seismic data to produce an important new map of the depth of the basal Tertiary unconformity in the Cook Inlet subsurface (Shellenbaum and others, 2010).

To provide timely results from ongoing studies, the program has produced an annual series of short reports highlighting noteworthy aspects of the previous year's field studies (Gillis, 2013, 2014). This volume includes preliminary summaries of topical studies undertaken during the 2014 field season in western Cook Inlet. Much of this new information will contribute to a planned geologic mapping effort north of Chinitna Bay in summer 2015 (Gillis and others, 2014).

2014 FIELD STUDIES

This volume includes two papers detailing important aspects of the structural geology of western Cook Inlet. The first examines the complex kinematics of the Bruin Bay fault system, which marks the western boundary between the magmatic arc and the forearc basin (Detterman and Reed, 1980; fig. 1-1). This study examines a key locality at Ursus Head (fig. 1), and builds on prior work reported in Gillis and others (2013b) and Betka and Gillis (2014). The second structural geology paper summarizes new data on the nature of fractures in western Cook Inlet. Due to relatively low bulk porosity and permeability of Mesozoic rocks, fractures may prove to be a key factor controlling a number of potential exploration plays (Detterman and Hartsock, 1966; Blasko, 1976; Gillis and others, 2013a).

- The superposition of strike-slip and reverse-slip faults in the Bruin Bay fault system, Ursus Head, lower Cook Inlet (chapter 2)
- Preliminary investigation of fracture populations in Mesozoic strata of the Cook Inlet forearc basin: Iniskin Peninsula and Lake Clark National Park, Alaska (chapter 3)

The third chapter in this volume summarizes new field data from the volcanic and volcanoclastic rocks that comprise much of the hanging wall of the Bruin Bay fault (fig. 1-1). This report builds on preliminary discussions provided in Bull (2014), and will contribute significantly to criteria used in geologic mapping.

- Preliminary observations: Continued facies analysis of the Lower Jurassic Talkeetna Formation, north Chinitna Bay, Alaska (chapter 4)

The Middle Jurassic Tuxedni Group is the primary source of Cook Inlet oil (Magoon and Anders, 1992) and has been an important target of stratigraphic studies during the Cook Inlet program (LePain and others, 2013; Stanley and others, 2013b). The following three chapters provide new information on the sedimentology and reservoir quality of these rocks.

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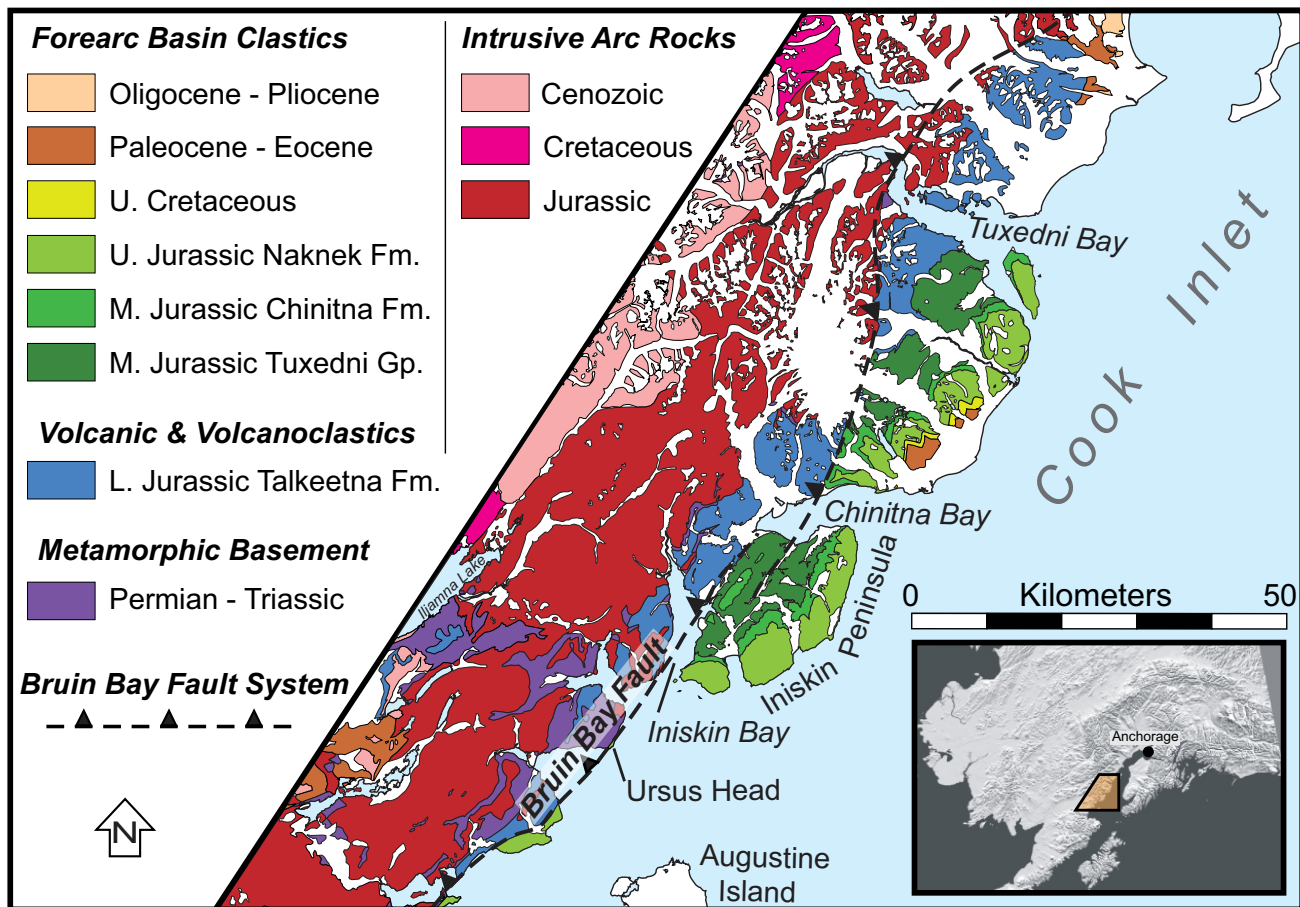


Figure 1-1. Simplified geologic map of western Cook Inlet, modified from compilation by Wilson and others (2009).

- Stratigraphic reconnaissance of the Middle Jurassic Red Glacier Formation, Tuxedni Group, at Red Glacier, Cook Inlet, Alaska (chapter 5)
- Storm-influenced deltaic deposits of the Middle Jurassic Gaikema Sandstone in a measured section on the northern Iniskin Peninsula, Cook Inlet basin, Alaska (chapter 6)
- Petrology and reservoir quality of Gaikema Sandstones: Initial impressions (chapter 7)

The final two chapters discuss ongoing stratigraphic studies of the Upper Jurassic Naknek Formation, building on prior stratigraphic work reported in Wartes and others (2013b) and Herriott and Wartes (2014). Although available data indicate reservoir quality in this unit will be challenging (Helmold and others, 2013), it is locally oil-stained (Stanley and others, 2013a) and may represent an important unconventional tight oil/gas play.

- Preliminary facies analysis of the lower sandstone member of the Upper Jurassic Naknek Formation, northern Chinitna Bay, Alaska (chapter 8)
- Evidence of a submarine canyon in the Snug Harbor Siltstone and Pomeroy Arkose Members, Naknek Formation, south-central Alaska—Implications for the distribution of coarse-grained sediment in Upper Jurassic strata of Cook Inlet (chapter 9)

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REFERENCES CITED

- Betka, P.M., and Gillis, R.J., 2014, Preliminary characterization of brittle deformation on the Iniskin Peninsula—Implications for the kinematic history of the Bruin Bay fault system, lower Cook Inlet, Alaska: Alaska Division of Geological & Geophysical Surveys Preliminary Interpretive Report 2014-5, 14 p. doi:[10.14509/29130](https://doi.org/10.14509/29130)
- Blasko, D.P., 1976, Oil and gas exploration on the Iniskin Peninsula, Alaska: U.S. Bureau of Mines Open-File Report 76-69, 19 p.
- BOEM (Bureau of Ocean Energy Management), 2011, Assessment of undiscovered technically recoverable oil and gas resources of the nation's outer continental shelf, 2011: Bureau of Ocean Energy Management BOEM Fact Sheet RED-2011-01a, 8 p.
- Bull, K.F., 2014, Preliminary observations—A facies architecture study of the Lower Jurassic Talkeetna Formation, Iniskin Peninsula, Alaska, *in* Gillis, R.J., ed., Cook Inlet program 2013 field studies—Observations and preliminary interpretations from new 1:63,360-scale geologic mapping of the Iniskin Peninsula, lower Cook Inlet, Alaska: Alaska Division of Geological & Geophysical Surveys Preliminary Interpretive Report 2014-2-3, p. 13–16. doi:[10.14509/27308](https://doi.org/10.14509/27308)
- Detterman, R.L., and J.K. Hartsock, 1966, Geology of the Iniskin–Tuxedni Peninsula region, Alaska: U.S. Geological Survey Professional Paper 512, 78 p., 7 plates.
- Detterman, R.L., and B.L. Reed, 1980, Stratigraphy, structure, and economic geology of the Iliamna Quadrangle, Alaska: U.S. Geological Survey Bulletin 1368-B, 86 p., scale 1:250,000, 1 plate.
- Gillis, R.J., ed., 2013, Overview of 2012 field studies—Upper Alaska Peninsula and west side of lower Cook Inlet, Alaska: Alaska Division of Geological & Geophysical Surveys Preliminary Interpretive Report 2013-1, 48 p. doi:[10.14509/24824](https://doi.org/10.14509/24824)
- Gillis, R.J., ed., 2014, Cook Inlet program 2013 field studies—Observations and preliminary interpretations from new 1:63,360-scale geologic mapping of the Iniskin Peninsula, lower Cook Inlet, Alaska: Alaska Division of Geological & Geophysical Surveys Preliminary Interpretive Report 2014-2, 31 p. doi:[10.14509/27303](https://doi.org/10.14509/27303)
- Gillis, R.J., Maley, M.R., Frohman, R.A., and Peterson, C.S., 2013a, Fracture studies in Upper Cretaceous and Upper Jurassic strata on the upper Alaska Peninsula and lower Cook Inlet, *in* Gillis, R.J., ed., Overview of 2012 field studies—Upper Alaska Peninsula and west side of lower Cook Inlet, Alaska: Alaska Division of Geological & Geophysical Surveys Preliminary Interpretive Report 2013-1D, p. 13–17. doi:[10.14509/24847](https://doi.org/10.14509/24847)
- Gillis, R.J., Swenson, R.F., Wartes, M.A., and Frohman, R.A., 2013b, Reconnaissance investigations of the Bruin Bay fault system along the western margin of lower Cook Inlet and upper Alaska Peninsula, *in* Gillis, R.J., ed., Overview of 2012 field studies—Upper Alaska Peninsula and west side of lower Cook Inlet, Alaska: Alaska Division of Geological & Geophysical Surveys Preliminary Interpretive Report 2013-1G, p. 33–37. doi:[10.14509/24850](https://doi.org/10.14509/24850)
- Gillis, R.J., Wartes, M.A., Herriott, T.M., Bull, K.F., Decker, P.L., and Betka, P.M., 2014, Overview of new 1:63,360-scale geologic mapping of the Iniskin Peninsula, lower Cook Inlet, Alaska, *in* Gillis, R.J., ed., Cook Inlet program 2013 field studies—Observations and preliminary interpretations from new 1:63,360-scale geologic mapping of the Iniskin Peninsula, lower Cook Inlet, Alaska: Alaska Division of Geological & Geophysical Surveys Preliminary Interpretive Report 2014-2-1, p. 3–6. doi:[10.14509/27306](https://doi.org/10.14509/27306)
- Helmold, K.P., LePain, D.L., Wilson, M.D., and Peterson, C.S., 2013, Petrology and reservoir potential of Tertiary and Mesozoic sandstones, Cook Inlet, Alaska—A preliminary analysis of outcrop samples collected during 2007–2010 field seasons: Alaska Division of Geological & Geophysical Surveys Preliminary Interpretive Report 2013-5, 34 p. doi:[10.14509/25035](https://doi.org/10.14509/25035)
- Herriott, T.M., and Wartes, M.A., 2014, Geologic-mapping-based observations of the Middle Jurassic Chinitna Formation and Upper Jurassic Naknek Formation in the Tilted Hills, Iniskin Peninsula, Cook Inlet, Alaska: Alaska Division of Geological & Geophysical Surveys Preliminary Interpretive Report 2014-3, 23 p. doi:[10.14509/27305](https://doi.org/10.14509/27305)
- LePain, D.L., ed., 2009, Preliminary results of recent geologic investigations in the Homer–Kachemak Bay area, Cook Inlet basin—Progress during the 2006–2007 field season: Alaska Division of Geological & Geophysical Surveys Preliminary Interpretive Report 2009-8, 187 p. doi:[10.14509/20161](https://doi.org/10.14509/20161)

- LePain, D.L., Lillis, P.G., Helmold, K.P., and Stanley, R.G., 2012, Migrated hydrocarbons in exposure of Maastrichtian nonmarine strata near Saddle Mountain, lower Cook Inlet, Alaska: Alaska Division of Geological & Geophysical Surveys Report of Investigation 2012-1, 13 p. doi:[10.14509/23943](https://doi.org/10.14509/23943)
- LePain, D.L., Stanley, R.G., Helmold, K.P., and Shellenbaum, D.P., 2013, Geologic framework and petroleum systems of Cook Inlet basin, south-central Alaska, *in* Stone, D.M., and Hite, D.M., eds., Oil and gas fields of the Cook Inlet basin, Alaska: American Association of Petroleum Geologists Memoir 104, p. 37–116.
- Magoon, L.B., and Anders, D.E., 1992, Oil-to-source-rock correlation using carbon-isotopic data and biological marker compounds, Cook Inlet—Alaska Peninsula, Alaska, *in* Moldowan, J.M., Albrecht, Pierre, and Philip, R.P., eds., Biological markers in sediments and petroleum: Englewood Cliffs, N.J., Prentice-Hall, p. 241–274.
- Shellenbaum, D.P., Gregersen, L.S., and Delaney, P.R., 2010, Top Mesozoic unconformity depth map of the Cook Inlet Basin, Alaska: Alaska Division of Geological & Geophysical Surveys Report of Investigation 2010-2, 1 sheet, scale 1:500,000. doi:[10.14509/21961](https://doi.org/10.14509/21961)
- Stanley, R.G., Charpentier, R.R., Cook, T.A., Houseknecht, D.W., Klett, T.R., Lewis, K.A., Lillis, P.G., Nelson, P.H., Phillips, J.D., Pollastro, R.M., Potter, C.J., Rouse, W.A., Saltus, R.W., Schenk, C.J., Shah, A.K., and Valin Z.C., 2011, Assessment of undiscovered oil and gas resources of the Cook Inlet region, south-central Alaska, 2011: U.S. Geological Survey Fact Sheet 2011-3068, 2 p. <http://pubs.usgs.gov/fs/2011/3068/>
- Stanley, R.G., Herriott, T.M., Helmold, K.P., Gillis, R.J., and Lillis, P.G., 2013a, Hydrocarbon-bearing sandstone in the Upper Jurassic Naknek Formation on the south shore of Kamishak Bay, *in* Gillis, R.J., ed., Overview of 2012 field studies—Upper Alaska Peninsula and west side of lower Cook Inlet, Alaska: Alaska Division of Geological & Geophysical Surveys Preliminary Interpretive Report 2013-1E, p. 19–23. doi:[10.14509/24848](https://doi.org/10.14509/24848)
- Stanley, R.G., Herriott, T.M., LePain, D.L., Helmold, K.P., and Peterson, C.S., 2013b, Reconnaissance studies of potential petroleum source rocks in the Middle Jurassic Tuxedni Group near Red Glacier, eastern slope of Iliamna Volcano, *in* Gillis, R.J., ed., Overview of 2012 field studies—Upper Alaska Peninsula and west side of lower Cook Inlet, Alaska: Alaska Division of Geological & Geophysical Surveys Preliminary Interpretive Report 2013-1B, p. 5–9. doi:[10.14509/24845](https://doi.org/10.14509/24845)
- Wartes, M.A., and Herriott, T.M., 2014a, A new occurrence of oil-stained rocks within a small fault zone involving the Middle Jurassic Cynthia Falls Formation, Tuxedni Group, northern Iniskin Peninsula, *in* Gillis, R.J., ed., Cook Inlet program 2013 field studies—Observations and preliminary interpretations from new 1:63,360-scale geologic mapping of the Iniskin Peninsula, lower Cook Inlet, Alaska: Alaska Division of Geological & Geophysical Surveys Preliminary Interpretive Report 2014-2-5, p. 23–27. doi:[10.14509/27310](https://doi.org/10.14509/27310)
- Wartes, M.A., and Herriott, T.M., 2014b, Discovery of oil-stained sandstone within the Chinitna Formation, northern Iniskin Peninsula, *in* Gillis, R.J., ed., Cook Inlet program 2013 field studies—Observations and preliminary interpretations from new 1:63,360-scale geologic mapping of the Iniskin Peninsula, lower Cook Inlet, Alaska: Alaska Division of Geological & Geophysical Surveys Preliminary Interpretive Report 2014-2-6, p. 29–31. doi:[10.14509/27311](https://doi.org/10.14509/27311)
- Wartes, M.A., Decker, P.L., Stanley, R.G., Herriott, T.M., Helmold, K.P., and Gillis, R.J., 2013a, Preliminary stratigraphy and facies analysis of the Upper Cretaceous Kaguyak Formation, including a brief summary of newly discovered oil stain, upper Alaska Peninsula, *in* Gillis, R.J., ed., Overview of 2012 field studies—Upper Alaska Peninsula and west side of lower Cook Inlet, Alaska: Alaska Division of Geological & Geophysical Surveys Preliminary Interpretive Report 2013-1F, p. 25–32. doi:[10.14509/24849](https://doi.org/10.14509/24849)
- Wartes, M.A., Herriott, T.M., Helmold, K.P., and Gillis, R.J., 2013b, Preliminary stratigraphic interpretation of the Naknek Formation—Evidence for Late Jurassic activity on the Bruin Bay fault, Iniskin Peninsula, lower Cook Inlet, *in* Gillis, R.J., ed., Overview of 2012 field studies—Upper Alaska Peninsula and west side of lower Cook Inlet, Alaska: Alaska Division of Geological & Geophysical Surveys Preliminary Interpretive Report 2013-1H, p. 39–46. doi:[10.14509/24851](https://doi.org/10.14509/24851)
- Wilson, F.H., Hulst, C.P., Schmoll, H.R., Haeussler, P.J., Schmidt, J.M., Yehle, L. A., Labay, K.A., and Shew, N.B., 2009, Preliminary geologic map of the Cook Inlet region, Alaska, including parts of the Talkeetna, Talkeetna Mountains, Tyonek, Anchorage, Lake Clark, Kenai, Seward, Iliamna, Seldovia, Mount Katmai, and Afognak 1:250,000-scale quadrangles: U.S. Geological Survey Open-File Report 2009-1108. <http://pubs.usgs.gov/of/2009/1108/>