

Appendix A: Measured sections, in Furer, L.C., Fehlmann, R.H., Taylor, A.M., Self, G.W., and Amoco Oil Co., Data compilation of the 1971 field party, southeast Brooks Range and Fort Yukon, Alaska; Vol 1

Furer, L.C., and Amoco Oil Co.

GMC DATA REPORT 464A

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Field Descriptions:

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Angry Bee Creek 1971 (Lower Hunt Fork - Smoke Creek Member)

Amoco measured and collected an incomplete 580-foot thick section of the Lower Hunt Fork (Devonian, Dlf unit of the U.S.G.S.) at Angry Bee Creek. Neither formation contact was exposed. The section consists of three units. The basal 70-foot unit is stromatoporoid and coral rich, fetid, argillaceous limestone with scattered thin interbeds of dark shale. The shales are most abundant at the base of this unit which grades vertically into a cleaner limestone. The middle 240-foot unit is dark, fissile, iron-rich shale with minor mudstone layers at its base. Its upper 35 feet contains small, fossiliferous incipient carbonate buildups which grade upward from nodules through lenses and layers into massive reefoid coral and stromatoporoid boundstones. Only the lower part of the 250-foot thick upper boundstone unit was accessible.

The depositional environment grades upward from back reef-lagoonal shales and argillaceous carbonates to clean reef core carbonate boundstones. This sequence indicates a shallow nearshore or shelf edge marine environment and a transgressing sea.

An additional 550 feet of section above the 1971 section was measured in 1972.

Above the massive 250-300 foot stromatoporoidal boundstone discussed above is an additional 270 feet of massive stromatoporoidal wackestone and mudstone. Overlying this unit is 230 feet of thick bedded stromatoporoidal wackestone that contains zones of abundant corals. The sequence is Middle Frasnian.

Biederman Bluff Section

The Biederman Bluff Section was measured to determine carbonization of palynomorphs and source rock quality of indurated shales in structurally complex areas (i.e., faulting). Samples were taken near and away from faults.

The outcrops are in bluffs along the Yukon River with very steep precipitous slopes. The rocks are very fresh, hard and difficult to sample. Section measurement is difficult owing to sheer cliffs along the water's edge. A portion of the eastern edge of the outcrop was selected to measure as it contains several small faults suitable for the purpose described above.

Lithologies are thinly interbedded indurated black shales and hard silicified sandy siltstones. The shales are black, indurated and thinly fissile. Siltstones are light tan, 3" to 21" in thickness, sandy, have sharp bottom contacts and sharp (ripple marked) to gradational upper contacts. Internally, the siltstones exhibit pronounced penecontemporaneous deformation (flame structuring and convolute bedding) as well as ripple cross-lamina, all of which indicate that the section is right-side-up.

The rocks are of deep marine origin and exhibit the following characteristics:

1. Lack of fossils.
2. Penecontemporaneous deformation known to occur in deep water.
3. Cyclic deposition.
4. Reducing environment (marcasite concretions).

Deacon Rock Section

This section was sampled at fair to good exposures on the north side of the Porcupine River from the first good exposure east of Deacon Rock (about one mile) eastward nearly to the first north tributary of the river.

This cannot be considered a measured section because many times the dip could not be determined, and in places the river follows the strike of the rock section. Also, other structural complications may be involved, thus from top to bottom on the log the sample intervals represent distance from west to east along the bank of the river. Where possible, true stratigraphic thickness is recorded.

Very interesting carbonate rocks are present in the top 1200 feet of this section. The uppermost 500 feet of carbonate contains a high-energy depositional environment in the middle and is over- and underlain by low-energy depositional environments as determined by grain sizes of bioclastic materials and types of fossils present.

	0	dolomitic ls. (wkst.?)
Low-energy	100	
	200	wkst.
		wkst. conglomeratic with colonial and tetra-
High-energy		pkst. corals in growth position and abundant
	340	grst. crinoid columnals.
		grst. (crinoidal)
Low-energy	380	
	500	wkst. with few corals, crinoids

The middle zone is conglomeratic and contains colonial and tetracorals in growth position as well as fragments of crinoid columnals in a micrite matrix. The zone is high-energy and may be reefoid (such as a "patch reef"). Similar conglomeratic patch reefs (but with different faunal assemblages) may be observed in the Pleistocene Key Largo Limestone of the Florida Keys.

Below this zone, corals and bioclastic fragments decrease in size and number with increasing distance, indicating lower water energies and greater accumulation of micrite mud. This zone may be farther seaward than the middle zone.

Above the middle zone are low-energy carbonates which are largely micrite, slightly dolomitic, with few fossils or bioclastic fragments. These rocks may be farther landward than the reefoid(?) zone.

Deacon Rock West Section

The Deacon Rock West Section is well-exposed along the north river bank. Attitude of the rocks is obscure, believed to be dipping about 30° west consistently. The section is plotted with samples located at horizontal distances but could be corrected to uniform dip.

Rocks are dolomitic limestones, nonfossiliferous, and range from sandy to clean micrite with stromatolites and laminar fenestrae with oolitically-coated pellets.

Absence of normal marine fauna, dolomitization, stromatolites, and oolitic pellets indicate shallow sub-tidal to supra-tidal with probable restricted circulation, probably back reef lagoon or bay.

Possible minor oil seep located near Deacon Rock.

Fossil Mountain Section

This section was measured at excellent exposures in a high saddle and slope just east of Fossil Triangulation Station.

A sequence of volcanic pebble conglomerates and agglomerates are exposed in the lower slopes to the southeast. These are probably in the core of an anticline.

The upper part of this sequence grades into a sandstone unit that contains scattered volcanic pebbles and is tuffaceous. The sandstone is fossiliferous and contains small lenses of biohermal limestone that contain corals in growth position. The sandstone is overlain by medium gray micritic limestone. The contact between the sandstone and limestone unit is abrupt, but there is no evidence of an unconformity.

This sequence probably represents a transgressive sequence developed along the shore of a subsiding volcanic island within a deep water basin similar to conditions in many South Pacific island areas today.

John Herbert Village Section

This section is composed principally of fine-grained calcareous dark shales and siltstones with subordinate amounts of limestone and sandstone. The rocks are exposed in the north bank of the Porcupine River and exposures are exceedingly good in view of the dominantly fine-grained nature of the sediments.

The black siltstones and shales exhibit an apparent cyclical depositional pattern of thin (1 foot) siltstones interbedded with thicker (1-4 feet) shales. Thin sandstones and limestones sporadically occur in the section. The thin sandstones largely are very poorly sorted with abundant brachiopods. The limestones are largely crinoidal packstones with large (4-5 inch) crinoid columnals. The black shales and siltstones contain very abundant tetracorals in growth position. The tetracorals do occur in the shales but seem to favor the siltstones as a growth medium.

Zoophycos, a trace fossil, is abundant in the silty zones. This marine trace fossil is indicative of a quiet, low-energy water environment, commonly interpreted to be "deeper marine" where current and wave actions are not strong.

The section presents problems in environmental interpretation, particularly in the prolific growth of tetracorals in black shales and siltstones. Observable depositional characteristics are summarized as follows:

<u>Color</u>	<u>Odor</u>	<u>Lithology</u>	<u>Organisms</u>	<u>Water Energy</u>	<u>Bedding</u>	<u>Shallow Marine</u>	<u>Deep Marine</u>
Black							X
	Fetid						X
		Sandstones (poorly sorted)				X	X
		Shales (black)					X
		Bioclastic limestones				X	
			Prolific corals, brachiopods, crinoids, etc.			X	
			<u>Zoophycos</u>				X
					Apparent cyclic siltstone: shale deposition		X

A similar environment is described by Ormiston and Lane (p. 7, Report No. M72-G-4) in the Michelle Formation. The environment is interpreted as requiring access to both shelf and basin and probably occurs at the basin-shelf interface, not too shallow and not too deep, where upwelling basin waters rich in nutrients occur. This explanation adequately explains the outcrop at John Herbert Village.

The shelf-basin interface could be shallow enough for abundant growth of organisms and deep enough for slow rates of basinally-influenced types of sedimentation (i.e., black shale, poorly-sorted sandstone).

July Ninth Section

The July Ninth Section consists of 1860' of Lisburne carbonate and Kayak shale, overlain unconformably by Permian(?) siltstones. Lisburne comprises a monotonous sequence of interbedded shelf limestones and chert, with skeletal packstones and grainstones predominating. Crinoids, brachiopods, bryozoa and corals are the major fossil groups. Near the base, wackestones, mudstones and stromatolites(?) occur. The base of the Lisburne (at 1625') was picked based on the marked decrease of limestones and the first occurrence of red shale. The red shale was found only in float and in very minor amounts. It is possible that the base of the Lisburne is actually lower, either within the measured interval or stratigraphically below on the mountainside to the west across the stream valley.

Keenan Quartzite Section

This section was measured along the south banks of the Yukon River. Outcrops here are poor, largely covered by weathered talus, and in places very badly fractured and deeply weathered.

The lower part of the section is very poorly exposed and samples taken are assumed to be semi-in situ. Samples are black shale and sandstones with Monotis, one ammonite and Buchia.

The middle part is well-exposed massive quartzite with large Inoceramus imprints.

The upper part is fine-grained dark gray mudstones, very badly fractured and very deeply weathered. The mudstones contain oxidized marcasite concretions and questionable plant fragments.

The lower part of the section is marine, grading upward into a marginal marine sand facies, which in turn grades into a non-marine(?) fine-grained backshore facies, although the evidence for the last facies is weak and questionable. The upper mudstones could possibly be marine.

Mississippian on Neruokpuk Section (Photo 3)

This section was measured at good exposures on a high ledge a short distance north of the Total Eclipse Section.

At this section Mississippian plant bearing shales lie with angular unconformity on cherts and shales (Ordovician?) of the Neruokpuk Formation. There is a thin basal conglomeratic sandstone just above the unconformity. A short distance to the south (Total Eclipse Section) fossiliferous Devonian clastics are present between the Neruokpuk and the Mississippian shales.

Mouth Coleen River Section

Most of this section was measured at good exposures on the west bank of the Coleen River about 1-1/2 miles from its mouth. The top 180 feet of the section was measured a short distance downstream. The stratigraphic relationship of the two parts of the section is not clear. Dip suggests that the carbonates probably overlie the sandstones as shown. The same sequence and an underlying extension of it crops out on the east side of the Coleen River (Sta. 14 of 1971). Most of the sandstones in this section are very clean quartz sandstones which are very hard because of siliceous cement. Where the sandstones become silty or argillaceous, they weather friable. This suggests to me that they were never well cemented because they lacked the initial porosity to allow the degree of silicification that is found in the "clean" sandstones. One dark shale found in the same sequence on the east side of the river is soft and shows no metamorphic effects, thus the silicification is a result of interstitial fluid movement and not metamorphism. It is possible that these rocks could have good porosity in the subsurface of the Fort Yukon Basin. The age of this sequence is unknown, but may be Ordovician as at Amoco J. section.

Nelsen Bluff Section

Two short sections of carbonate were measured at Nelsen Bluff and along the river just south of the Bluff. Between the two outcrops are covered areas and poor outcrops of carbonate that were not examined.

At Nelsen Bluff 80 feet of very fossiliferous limestone is exposed. The limestone contains thin intervals of corraline and stromatoporoidal boundstone, suggesting that this is a near-reef facies. This sequence is time-equivalent to part of the Salmontrout Reef at the type section.

Just south of this outcrop 110 feet of crinoidal packstone-grainstone is exposed. This part of the section is time-equivalent to the upper part of the Salmontrout Limestone.

North Salmon Village Section

This section was measured at poor outcrops on a hillside on the northeast bank of the Black River three miles northwest of Salmon Village.

Many of the samples are from float that is thought to be nearly in place. The entire section is limestone that becomes slightly dolomitic and volitic near the top. At least the upper 500 feet of the section is open shelf carbonate. The faunal change at 510 feet is very similar to that which occurs at 200 feet in the Salmon Village Section (1971).

North Schwatka Mountain Section

This section was measured at good to excellent exposures on a high ridge 2-1/2 miles northeast of Mt. Schwatka. Sample 9090 is near the top of the ridge. The section below that sample was measured down a south facing back slope of the ridge and in a saddle on the back slope. The section above that sample was measured in a high saddle north of the ridge and out a northward extending spur of the ridge.

The lower 600 feet of the section is a sequence of dark gray shales and thin interbedded dark limestones that overlie an andesite sill or flow. The volcanic body has baked the shales 300 feet above it. These are probably basinal shales.

The shale unit is overlain by 1000 feet of shallow water carbonates that contain numerous thick zones of stromatoporoidal boundstone. Several zones contain abundant corals and crinoids. Thin intervals between 2200-2500 feet on the measured section are layers of amphipora.

The top of the carbonate section terminates at an obvious fault. An additional 1500 feet of carbonate is exposed north of the fault. It appears to be a repeat section.

Both at the fault zone and at the top of the section there is poorly exposed reddish siltstone that is probably in normal stratigraphic sequence with the underlying carbonate.

Old John Lake Section

This section was measured at a good outcrop that is the same locality as that of Fehlmann (1971) - loc. 7060.

At this locality 100 feet of middle Devonian reefal boundstone is completely surrounded by Hunt Fork clastics of the same age. This outcrop is the easternmost exposure of Devonian reefal carbonate in the southeastern Brooks Range.

Only the top of the reefal mass is exposed at this locality.

Rock Slough Section

This section was measured at good exposures in the north bank of the Porcupine River area at the same location as Station 16 (1971).

Neither the upper nor lower contacts are exposed. The section is predominantly quartzitic quartz sandstone. The sandstone is interbedded with shale in the upper 120 feet of the section. The sandstones in the top of the section contain many large plant fragment impressions.

Total Eclipse Section (Photo 2)

This section was measured at good exposures in a saddle on the south slope of a high ridge just north of the headwaters of the Kongaguk River.

The high ridge is steeply dipping metasediments (Neruokpuk). About 250 feet of Devonian clastics form a dip slope on the south side of this ridge. The lower 100 feet of this unit is predominantly shale with thin interbeds of dirty sandstone. The interval contains abundant pelecypods and brachiopods and was deposited in a nearshore restricted environment. The lower contact is angular with the Neruokpuk.

The shale and sandstone unit grades upward into a massive clean quartzose sandstone that is at least 150 feet thick.

The upper contact is not easily observed; however, it projects into the stream valley where Kayak shale and sandstone crops out below Lisburne that forms a ridge on the south side of the stream valley.

Triassic Oil Section

This section is exposed in the southwest bank of the Yukon River only when the water is very low. The U.S. Geological Survey has reported (Brabb and Grant, 1971) that it was covered with silt when they visited the locality.

The upper 500 feet of this section is predominantly oil shale with a few dark limestone beds near the top and bottom of the section. There is some variation in the color and bedding of the shale. The entire 500 feet is Late Triassic. The shales have a strong petro-liferous odor, and sample bags turn brown from the oil content of the shales. Below the oil shales is a 400-foot covered interval that may be underlain by more oil shale or by Middle Permian shales and siltstones. The covered interval is underlain by 60 feet of fossiliferous Permian Tahkandit limestone.

Upper Wind River Section

This section was measured at well exposed outcrops on ridges northeast of an upper branch of the Wind River. The upper 200 feet was projected into the main part of the section from a ridge 1/4 mile northwest of where the section was measured.

The massive reef is 700 feet thick and is over- and underlain by very fine clastic rocks. A disconformity is present at the top of the stromatoporoidal reef. The reef is obviously enclosed within the fine clastics, and is younger than carbonates that have previously been assigned to the Skajit.

This unit is mappable and should be assigned as the Smoke Creek member of the Skajit in order to differentiate it from massive Skajit that is predominantly Middle Devonian and not encased in shale as is this member.

West Crazy Mountains Section

This section was measured at poor exposures on high ridges and slopes near the west end of the Crazy Mountains.

The carbonate at the base of the section is well exposed on an east-west trending limestone ridge near the south flank of the Crazy Mountains. It is crystallized and contains what may be "ghosts" of stromatoporoids. The limestone dips north and is overlain by 1300 feet of siltstone and shale that is sandy and calcareous in several intervals. The top 150 feet of this interval is interbedded limestone, chert and shale. The limestone contains stromatoporoids and is Devonian. The section above this unit is covered. Above the covered interval is 500 feet of sandstone that is probably in normal stratigraphic sequence with the underlying rocks. The sandstone is poorly sorted, quartzose and very hard. It does not have good reservoir potential.

West Wind River Section

This section was measured at excellent exposures in a high saddle (Photo 4) three miles west of Wind River. Only 160 feet of lower Lisburne is preserved here. The contact with the underlying Kayak is well exposed. The contact is conformable but rather abrupt.

The Lisburne is open shelf crinoidal pockstones-grainstones with thin zones of chert nodules and lenses. Only the lower few feet of the Lisburne has interbedded dark shale. The underlying few feet of Kayak shale contains fossiliferous limey concretions, but grades downward rapidly into dark gray fissile, nonfossiliferous shale.

The base of the Kayak was not observed. Of the 360 feet measured, the lower 250 feet of Kayak contains numerous thin fine-medium-grained quartz sandstones. One of these sandstones contains some poorly preserved plant fragments.

Windy Gap South Section

This section was measured at excellent exposures on the west slope and a westward extending ridge 1/2 mile south of Windy Gap in the White Mountains. The section includes the upper part of the Fossil Creek Volcanics and the Tolovana Limestone. Dip is not evident in the section, however faint bedding traces seen from the air suggest eastward dip within an overturned syncline. The stratigraphic sequence substantiates this idea.

The lower 350 feet of the section (Fossil Creek Volcanics) is basically volcanic pebble conglomerate and sandstone. This clastic sequence contains many lenticular limestone bodies that contain stromatoporoids and colonial corals in growth position. One volcanic pebble was trapped between stromatoporoid growth laminae. Obviously volcanic detrital material was being formed simultaneously with growth of corals and stromatoporoids.

The basal 250 feet of the overlying Tolovana Limestone is micrite that contain ostracods and birdseye structure, suggesting a shallow water restricted environment.

The overlying 500 feet of limestone is mainly micrite with interbeds of stromatoporoid boundstone and crinoidal-brachiopodal grainstone near the top.

The measured section above this point (1400 feet) is most likely a repeat section. It contains much evidence of shallow water restricted conditions, e.g., birdseye structure, algae and pellets. Intervals of grainstone are present, and one is oolitic. The boundary at 200 feet between the Tolovana and the Fossil Creek Volcanics is different than that to the east as shown at 2150 feet in the section. Volcanic flows rather than volcanic conglomerates are in contact with the Tolovana. However, to the north on strike along continuous outcrop the volcanic conglomerate again appears in contact with the Tolovana.

Woodchopper Limestone Section

The Woodchopper Limestone Section comprises approximately 150 feet of skeletal wackestones and packstones, with the lowermost outcrops at the river edge being extremely fossiliferous. Stromatopoids and crinoids predominate in the section.

Bedding is indistinct and generally parallel to the slope; therefore accuracy of the measured thickness is questionable. The relationship of the Woodchopper Limestone with the underlying volcanics (basalt) is uncertain. While the two units appear conformable, the relationship of these to other volcanics high on the outcrop was not studied. Therefore additional work is needed to evaluate the stratigraphic sequence.

Your Creek Section

This section was measured at fair to good exposures on a high ridge and slope on the east side of Your Creek.

The top 280 feet of the section is predominantly chert pebble conglomerate (Kanayut) that forms a massive ledge at the top of the ridge. The lower part of this unit contains interbedded quartz sandstones.

The Kanayut is underlain by 820 feet of interbedded shale and sandstone that has a thin fossiliferous limestone very near its top (Noatak). The sandstones in this section are fine-grained, silty, ripple marked and contain low angle cross bedding. They are probably marine sandstones.

The Noatak is underlain by at least 1300 feet of shale with a few thin sandstone interbeds (Hunt Fork).

Six miles northeast of this section the Hunt Fork contains numerous thin beds and lenses of back reef limestone (Frasnian) containing abundant corals, brachiopods, bryozoans and oncolites (~~Photo~~) which were not observed in this section.