UNITED STATES DEPARTMENT OF THE INTERIOR

GEOLOGICAL SURVEY

REVISED AGE AND STRUCTURAL INTERPRETATIONS OF THE NUKA FORMATION AT NUKA RIDGE, NORTHWESTERN ALASKA

By

I. L. Tailleur, B. L. Mamet, and J. T. Dutro, Jr.

Open-file report

1972

Revised age and structural interpretations of the Nuka Formation at Nuka Ridge, northwestern Alaska

By I. L. Tailleur, B. L. Mamet, and J. T. Dutro, Jr.

Abstract

New collections of foraminifers and macrofossils from Nuka Ridge, the type area of the enigmatic Nuka Formation, demonstrate that the type Nuka Formation contains at least two, and probably several, thrust sheets instead of a single continuous stratigraphic sequence as originally described.

Paleontological evidence indicates the presence of a thrust-repeated sequence at Nuka Ridge consisting of Upper Mississippian (Meramec and younger) strata overlain by Permian beds which, in turn, are succeeded by Triassic(?) and Cretaceous rocks. Mississippian calcareous mudstone and limestone units are correlated with the Lisburne Group; microcline-bearing arkose units with Permian macrofossils and microfossils represent the Nuka Formation; units of chert are inferred to be of Permian and Triassic age; and wacke at the top of the sequence resembles unnamed wacke assigned to the Cretaceous elsewhere.

These new data and their interpretations indicate that the type section of the Nuka Formation is inadequate. The standard for the Nuka Formation is therefore referred to a newly measured section of the middle arkosic unit of the old section, and is considered to be Late Mississippian and Permian in age.

In 1963, the sequence of strata exposed on Nuka Ridge at the north edge of the eastern De Long Mountains was established as the type section for the Nuka Formation (Tailleur and Sable, 1963), a map unit in northern Alaska distinguished by arkosic rocks and extending from the west coast to the Anaktuvuk River in the central foothills. The 6,500-foot section at Nuka Ridge was subdivided into 13 members on the bases of rock type and stratigraphic succession (Column I, Fig. 1). Analysis of fossils available at that time indicated a Late Mississippian age for the lower part (Gordon, 1957) and a Permian age for the upper part. The base of member m was considered to be approximately the base of the Permian.

Additional work by several oil companies and the U.S. Geological Survey during the past 10 years and recent microfossil analysis by Mamet disclosed several age anomalies that implied structural complications in the sequence underlying Nuka Ridge. To help resolve some of these anomalies in a stratigraphic unit important in evaluating the petroleum potential of the region, systematic sampling and reexamination of the rocks at the southeast end of Nuka Ridge were undertaken in 1971. Conoco-Sun and Socal-Mobil companies provided helicopter transportation. Tailleur, assisted by J. R. LaVolpa, restudied the type section and two other sections in the field. Mamet analyzed dozens of thin-sectioned samples for microfossils. Dutro identified the macrofossils from 40 new collections made from intervals that had been poorly known previously, and he reevaluated the collections made earlier.

These new analyses indicate that the sequence is not a simple stratigraphic succession as had been interpreted. Rocks with a Late Mississippian fauna are structurally repeated at least twice. Macro- and

microfossil determinations indicate both that the arkosic subdivisions are partly Permian and partly Mississippian in age and that they are also structurally repeated. Preliminary results of this new work show that additional study is needed because biostratigraphic and physical-stratigraphic data do not completely agree.

A generalized map of Nuka Ridge (Fig. 2) shows the areal distribution of the rocks and the indicated structural and depositional discordances in the type area of the Nuka Formation.

Faunal data.-- New and revised faunal data are shown on Column II, Figure 1. Members f, h, l and o are of Late Mississippian age (almost all middle or upper Meramec correlatives) and are assigned to foraminiferal zone 14 (late Viséan) by Mamet (see Armstrong and others, 1970).

Members g, i and n have yielded no significant fossils.

Member j is of Late Mississippian (early Namurian-Chester) age on the basis of foraminifers assigned to zone 18 by Mamet.

Member k is unfossiliferous except for poorly preserved pectenids, collected by Sable in 1953, that may be Triassic in age (N. J. Silberling, written commun., 1972).

Member m is apparently of Permian age, on the basis of both macro- and microfossil evidence.

Member p has yielded microfossils assignable both to zone 17 (early Namurian-Chester) and to the post-Carboniferous, according to Mamet. Several collections of probable Permian brachiopods have also come from this member.

Field data.--New and revised physical stratigraphic observations are also shown on Column II. Newly measured thicknesses of members o and p are substantially less than the older measured section, principally because several small transverse faults duplicating the section were not recognized originally.

Scattered occurrences of arkosic and coarse clastic rocks within member k were found to represent a significant clastic zone just above the possible Triassic fossil locality near the middle of the member.

A cut bank just north of the type section consists of euxinic and calcareous deposits physically above, and possibly gradational with, the quartzitic arkose of member i. These beds were not originally described in the type section.

Member m thins substantially from the type section to the north flank of the ridge. The massive to thick-bedded arkose and quartzitic arkose that hold up the hogbacks on the nose appear to pinch out westward.

Hematitic rocks originally included with the chert in member n are actually an uppermost phase of member m. They occur at the top of a sedimentary sequence that grades from typically arkosic limestone, to hematitic calcareous arkose, to strongly cross-bedded hematitic arkose, and finally to fine-grained hematitic and cherty beds.

The discovery of wacke within the succession at Nuka Ridge is of fundamental importance. Instead of lying on the uppermost member of the succession as originally inferred (J? and member q, section B, Fig. 1), fine-grained wacke with cannonball concretions occurs between members n and o. Wacke and mudstone are exposed for more than 100 feet near the base of the interval between outcrops of members k and l in the type section, and rubble of wacke is conspicuous on stream banks adjoining slopes below member m on the north flank. Although the wackes do not contain the heavy

mafic minerals common in Lower Cretaceous detritus elsewhere (Patton and Tailleur, 1964), they physically resemble those assigned to the Lower Cretaceous.

Evidence that the succession at Nuka Ridge is allochthonous with respect to the sequence that discordantly surrounds it may be exposed on lower Sorepaw Creek. The upper part of a bank there is an outlier or klippen of chert (Fig. 2), and the lower part is deformed wacke indistinguishable from exposures upstream and downstream that seem to be part of the Lower Cretaceous Okpikruak Formation in the sequence wrapping around the southern end of the Nuka Ridge terrane. This may be only a local structural condition, however, as regional stratigraphic relations and aeromagnetic surveys of the area (U.S. Geological Survey, 1972) neither confirm nor contradict allochthonous relations.

Some of the physical and faunal data do not fit, as shown by the Column III, Figure 1. The arkoses imply sedimentary and provenance conditions unlikely to be recurring. Yet the absence of Pennsylvanian fossils, as is common in arctic late Paleozoic faunas, indicates a hiatus between Mississippian and Permian deposition. Member p seems to overlie member o gradationally; breaks representing unconformities within and at the base of member p, required by the fossil data, were not recognized in the field. Member i is close enough lithologically to members m and p to be their thrust-repeated correlative. However, the member is unfossiliferous and it seems to grade up into dark mudstone that does not succeed the other two arkosic members and it underlies the fine clastic beds of member j containing zone 18 foraminifers.

Probable thickness of section

The Upper Mississippian rocks are probably no thicker than 1,000 feet; member f is less than 750 feet thick, member h about 800 feet and possibly faulted, and member o is probably not more than 1,000 feet thick.

Permian rocks are only a few hundred feet thick on the southeast end of Nuka Ridge; member m is a maximum of 450 feet thick. Member p, although thicker, may be structurally complex and includes both Mississippian and Permian fossils. Section B, Column I, has not been restudied, so the thickness of Permian rocks in it has not been clearly defined.

Member k, about 600 feet thick, represents a maximum thickness for the Permian and Triassic cherts, but the arkosic zone near the middle suggests that the member may contain fault-repeated strata.

As a result of this reinterpretation, it seems probable that the total thickness of rocks spanning Mississippian to Triassic time is no more than 2,000 feet.

Conclusions

New data indicate that the succession at Nuka Ridge, originally designated the type section, consists of thrust-repeated stratigraphic units (Column III, Fig. 1) instead of the single stratigraphic sequence previously interpreted (Column I, Fig. 1). The type section of the Nuka Formation is therefore inadequate and no longer constrains the map unit to a definition that is atypical regionally (Dutro, written commun., 1953). In the type area, the Nuka Formation can be restricted, as it has been elsewhere, to coarse-grained, arkosic rocks containing microcline. Until inconsistencies are resolved by additional work, a section within the succession is designated a reference section for the formation.

On the basis of characteristic fauna and lithology, the fine-grained clastic and calcareous members f, h, l, and o of the type section are correlative in time with the Alapah Limestone of the Lisburne Group and, in rock-type, mostly with the Lisburne Group but partly with the Kayak Shale (Bowsher and Dutro, 1957). In gross aspect, they represent the "black Lisburne" facies of informal usage (part of the Tupik Formation of Sable and Dutro, 1961) and can be mapped as Lisburne Group.

The chert members g, k, and n are of Permian and Triassic age. They correspond to but are not necessarily correlative with the Permian Siksikpuk (Patton, 1957) and Triassic Shublik Formations (Patton and Tailleur, 1964), respectively.

The arkosic lithology of members e, i, m, and most of p distinguishes them as Nuka Formation. Exposures measured in 1971 on hogbacks of member m north of Nose Creek ("A" within m on Fig. 2) are here designated the reference section for the Nuka Formation. Fossils of Permian age have been found in this section. Although arkosic rocks containing Mississippian fossils appear to be microscopically distinguishable from those with Permian fossils, they are indistinguishable in the field. Therefore, on the basis of the identifiable fossils in the map unit, the Nuka Formation is now considered to be Late Mississippian and Permian in age.

The information and interpretations reported here clarify to some extent the enigma of the Nuka Formation. More work is required, however, to provide an adequate grasp of the depositional and tectonic record uniquely displayed on Nuka Ridge.

References cited

Armstrong, A. K., Mamet, B. L., and Dutro, J. T., Jr., 1970, Foraminiferal zonation and carbonate facies of Carboniferous (Mississippian and Pennsylvanian) Lisburne Group, central and eastern Brooks Range, Arctic Alaska: Am. Assoc. Petroleum Geologists Bull., v. 54, no. 5, p. 687-698, 4 figs.

Bowsher, A. L., and Dutro, J. T., Jr., 1957, The Paleozoic section in Shainin Lake area, central Brooks Range, Alaska: U.S. Geol. Survey Prof. Paper 303-A, p. 1-39.

Gordon, Mackenzie, Jr., 1957, Mississippian cephalopods of northern and eastern Alaska: U.S. Geol. Survey Prof. Paper 283, 61 p., 6 pls.

Patton, W. W., Jr., 1957, A new upper Paleozoic formation, central Brooks Range, Alaska: U.S. Geol. Survey Prof. Paper 303-D, p. 40-45.

Patton, W. W., and Tailleur, I. L., 1964, Geology of the Killik-Itkillik Region, Alaska: U.S. Geol. Survey Prof. Paper 303-G, p. 409-500.

Sable, E. G., and Dutro, J. T., Jr., 1961, New Devonian and Mississippian formations in the De Long Mountains, northern Alaska: Am. Assoc. Petroleum Geologists Bull., v. 45, no. 5, p. 585-593.

Tailleur, I. L., and Sable, E. G., 1963, Nuka Formation of Late Mississippian to Late Permian age, new formation in northern Alaska: Am. Assoc. Petroleum Geologists Bull., v. 47, no. 4, p. 632-642, 3 figs.

U.S. Geological Survey, 1972, Aeromagnetic data from S. W. Naval Petroleum Reserve, Alaska: Open-file report, 4 sheets.

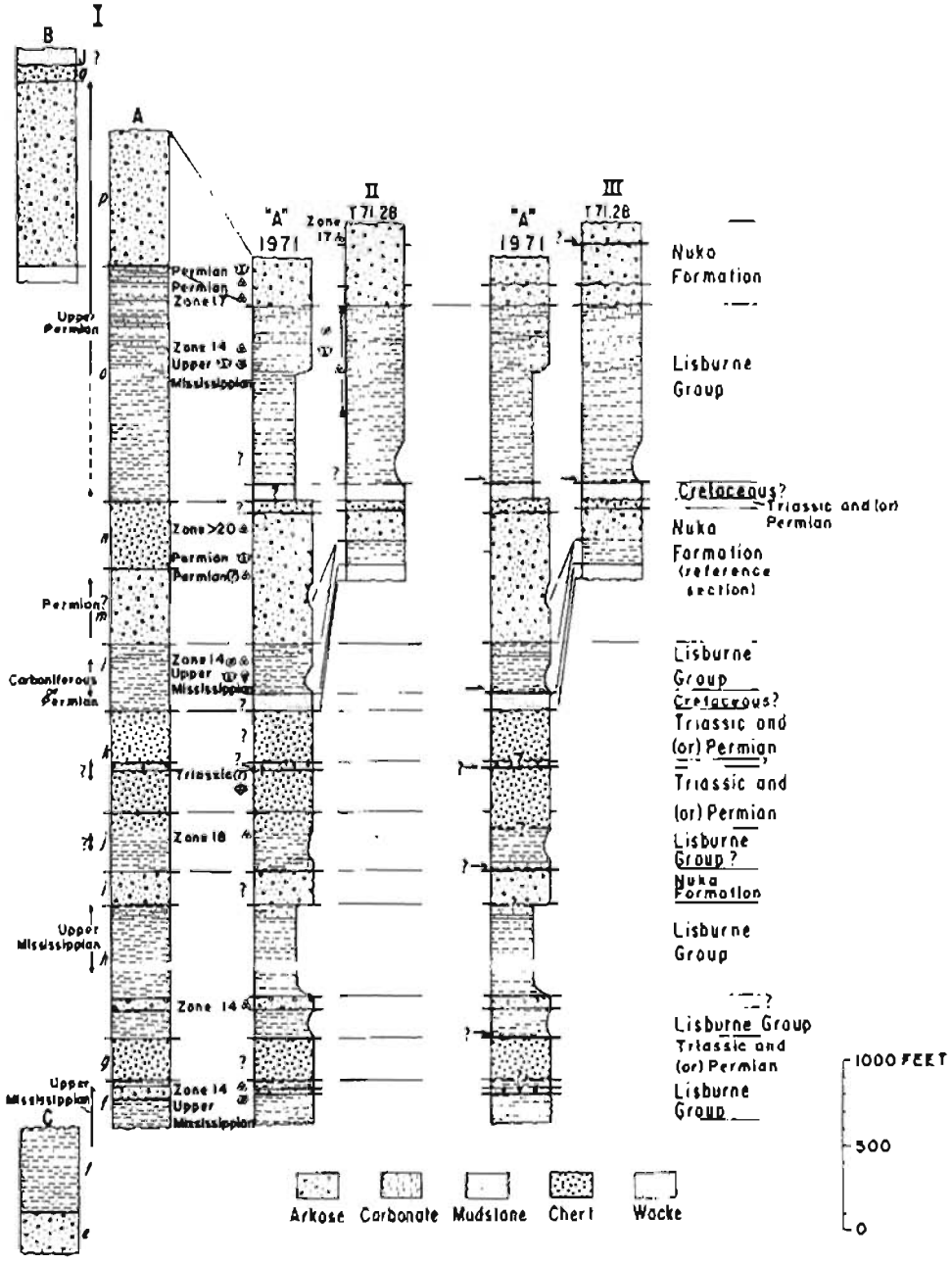

Figure 1.--Columnar sections at the southeast end of Nuka Ridge. Sections originally reported (Tailleur and Sable, 1963) are shown in Column I; section A was designated the type section for the Nuka Formation. Sections measured or reexamined in 1971 are shown in Column II; as plotted on figure 2, the line of section "A" coincides with the line for the lower part of section A but lies north of that line for the upper part; section T. 71.28 crosses the north flank of Nuka Ridge about 3 miles to the northwest. Tentative stratigraphic and structural interpretations--wavy lines for unconformity, arrow for flat thrust, and queried arrow for uncertain discordance--are shown in Column III, based on the foraminiferal zonation by Mamet and macrofaunal determination by Dutro. The new reference section for the Nuka Formation is the indicated arkosic unit near the middle of section "A".

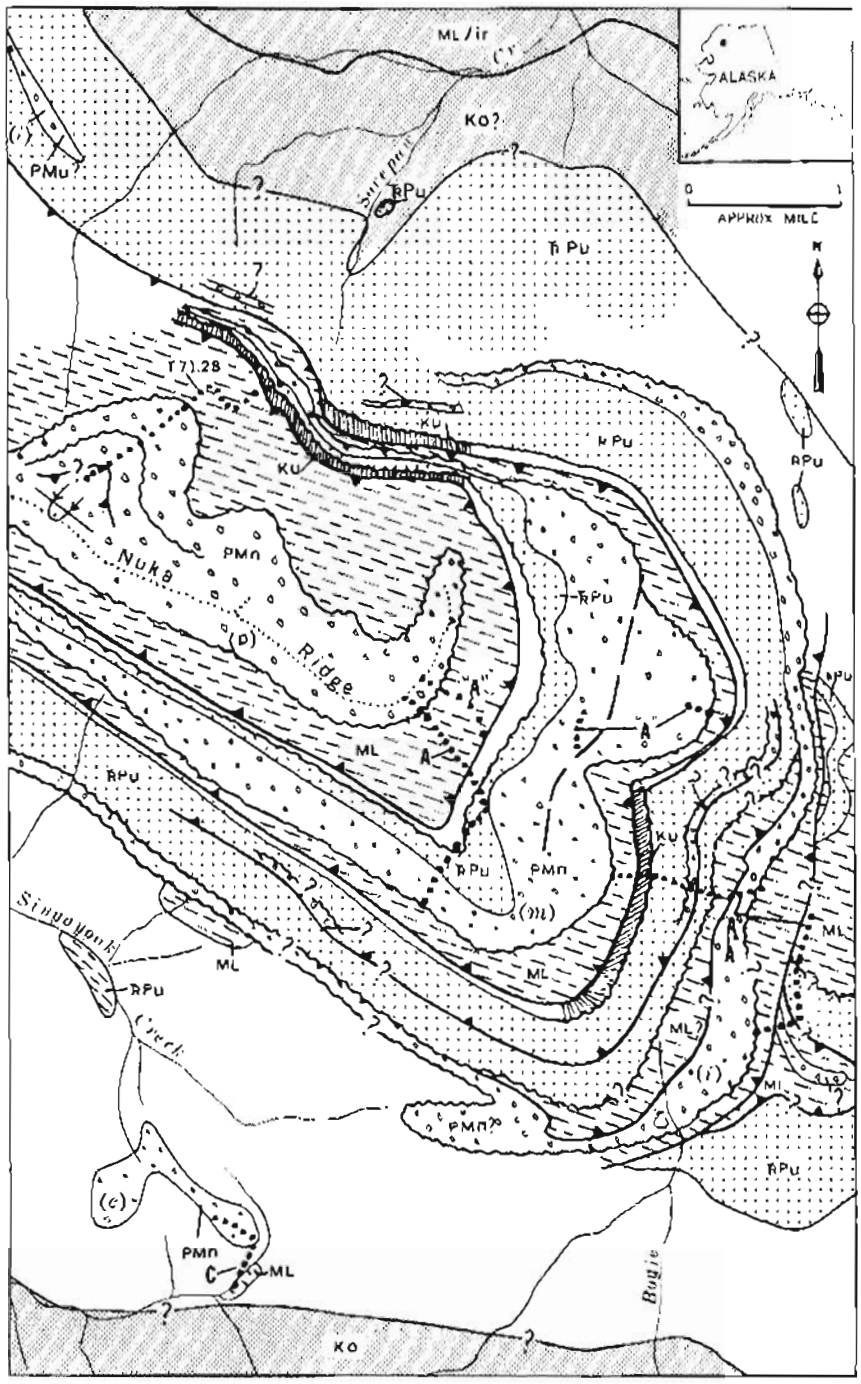

Figure 2.--Sketch map of reinterpreted structural and stratigraphic relations at southern end of Nuka Ridge syncline (from rectified twinplex photograph GS-TAL-18-110L). Heavy lines - faults, barbs on upper plate of flat thrust; wavy lines - unconformities; heavy dots - lines of sections shown in figure 1; Ku - undivided wacke and mudstone resembling lower Cretaceous rocks outside of area; RPu - Triassic and(or) Permian chert beds; PMn - Nuka Formation, characterized by arkosic rocks; Ml - Lisburne Group, fine-grained clastic and carbonate rocks; Ko, Ml/ir - Okpikruak Formation, Lower Cretaceous wacke and mudstone, and Lisburne Group, mafic sills, respectively; and (p), (m), (i) and (e) - arkosic members. The new reference section is composited from the two segments of section "A" within (m).