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PRELIMINARY CARBONATE LITHOFACIES MAPS AND POSSIBLE DOLOMITE POROSITY TRENDS, MISSISSIPPIAN-PENNSYLVANIAN LISBURNE GROUP, NORTH SLOPE ALASKA

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Preliminary carbonate lithofacies maps and possible dolomite porosity trends, Mississippian-Pennsylvanian Lisburne Group, North Slope Alaska

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Carbonate porosity within the Mississippian-Pennsylvanian age Lisburne Group is probably extensively developed in the subsurface of the North Slope. The Lisburne Group may prove to be one of the more significant reservoir zones in the region and should not be overlooked in any exploration program. Isopach maps for the total Lisburne Group and other upper Paleozoic and Mesozoic rocks, North Slope, can be found in Brosge and Tailleur (1969).

This preliminary study is based on 29 measured sections of the Lisburne Group (fig. 1, sec. 1-25). The outcrops are from near Cape Lisburne$^{(1)}$ in the west to Egaksrak River$^{(29)}$ in northeastern Alaska and are used as the basic building blocks for the carbonate facies maps and the one cross section.

The construction of the carbonate facies maps are based upon, 1) arbitrary palinspastic reconstruction of the sections (fig. 1), 2) the assumption in Early Mississippian time of a low-lying, somewhat peneplained cratonic shelf to the north of the Brooks Range, and 3) the development during Mississippian time of a marine transgression onto this shelf.

The carbonate sections studied in the Brooks Range were divided into the Osage, Meramec, Chester, Morrow, and Atoka series by foraminiferal and coral faunal assemblages. The carbonate rocks of each section within these biostratigraphic time units were interpreted as to facies and environment of deposition by the criteria established by Ball (1967), Deffeyes, Lucia, and Weyl (1965), Illings, Wells, and Taylor (1965), Shinn, Ginsburg, and Lloyd (1965), Murray and Lucia (1967), Roehl (1967), McDaniel and Pray (1969), and Wilson (1967, 1969).

The facies observed in the outcrop section were then projected into the subsurface north of the Brooks Range to produce the theoretical carbonate models shown in figures 2 through 6.

The carbonate sections in the Lisburne Hills (sec. 1-3) are considered to have a minimum translation of 10 miles from the west or northwest. These thick sections, 3,000 to 3,500 ft, are shallow open marine carbonates with some dolomites.

The sections in the DeLong Mountains (sec. 4-6) are believed to have moved a minimum of 70 miles on low-angle northward thrusts (Snelson and Tailleur, 1968). They were deposited in an open marine environment on a subsiding shelf on which carbonate deposition and subsidence were near equilibrium (Armstrong and Dutro, 1969, p. 704).

The interpretation of the palinspastic adjustment of the sections 7-11 from Mt. Bupto to Killik River in the central Brooks Range is critical to the configuration of the lithofacies maps. These sections are extensively dolomitized and have thick units of intertidal and supratidal sedimentary structures; i.e., algal mats, birdseye structures, etc. (Armstrong, ~~196_~~ in press). If these sections have not moved a great distance from the site of their deposition (as shown in fig. 1), then they indicate a broad region of shallow water carbonate deposition over an area of slow subsidence. These sections combined with the basement Topagruk test-well south of Barrow may indicate a north-south plunging high. This is indicated on figure 1 as the Mead Arch.

The sections at Skimo Creek[12], Anivik Lake[13], Shainin Lake[14], and Itkillik Lake[15] have moved northward less than 25 miles with a minimum displacement of 5-8 miles (Porter, 1966, p. 977). The carbonates in all these sections were deposited in shallow open marine environments.

The sections east of Itkillik Lake (15-19) are believed to have only a few miles of horizontal displacement. The sections in northeastern Alaska (20-29) are believed to be autochthonous. The latter sections (fig. 7) show evidence in the Mississippian part of the section of having been deposited in shallow low energy, poor circulation, marine water, whereas the overlying Pennsylvanian carbonates were deposited in part in high energy shoaling water environments (Armstrong, Mamet, and Dutro, ~~196_~~ in press).

A cross section of part of the Lisburne Group carbonate basin can be reconstructed from the central Brooks Range at Itkillik Lake[14] to the northeastern Brooks Range at Egaksrak River by correlation of the outcrop sections.

Surface studies of Lisburne Group sections in the BrooksRange suggest the possibility of extensive areas in the north slope subsurface of intertidal to supratidal carbonate development. These possible trends are shown on figures 3, 4, and 5.

These facies possibly intimately associated with cyclic sebkha environments would result in the deposition of penecontemporary dolomites that are composed of 10-50 micron dolomite rhombs with associated intercrystalline porosity.

Also the sebkha environment can produce hypersaline brines (Deffeyes, Lucia, and Weyl, 1965) which can, by downward migration, dolomitize marine limestone and produce excellent vuggy porosity.

Both types of dolomite porosity are seen in the central Brooks Range (Armstrong, in press ~~196-~~) and in the Mississippian part of the section in the Sadlerochit and Franklin Mountains of northeastern Alaska (fig. 7).

The writer believes the Lisburne Group carbonates in the subsurface of the north slope are an extremely attractive drilling target over a wide region. Studies in the Brooks Range indicate intertidal-supratidal carbonates with their associated dolomite porosity can be expected in the subsurface of the North Slope. The Lisburne Group has a regional dip to the south and thins to the north. It is underlain by marine, organic-rich shales of the Mississippian Kayak Shale and is overlain by marine shales of Permian, Triassic, and Jurassic age. These shales are believed capable of generating oil which would migrate updip and into the porous zones within the Lisburne Group carbonates.

Intercrystalline and vuggy porosity in the carbonates of the Lisburne Group may prove to contain large quantities of oil in the subsurface whenever it is associated with favorable structure or stratigraphic traps.

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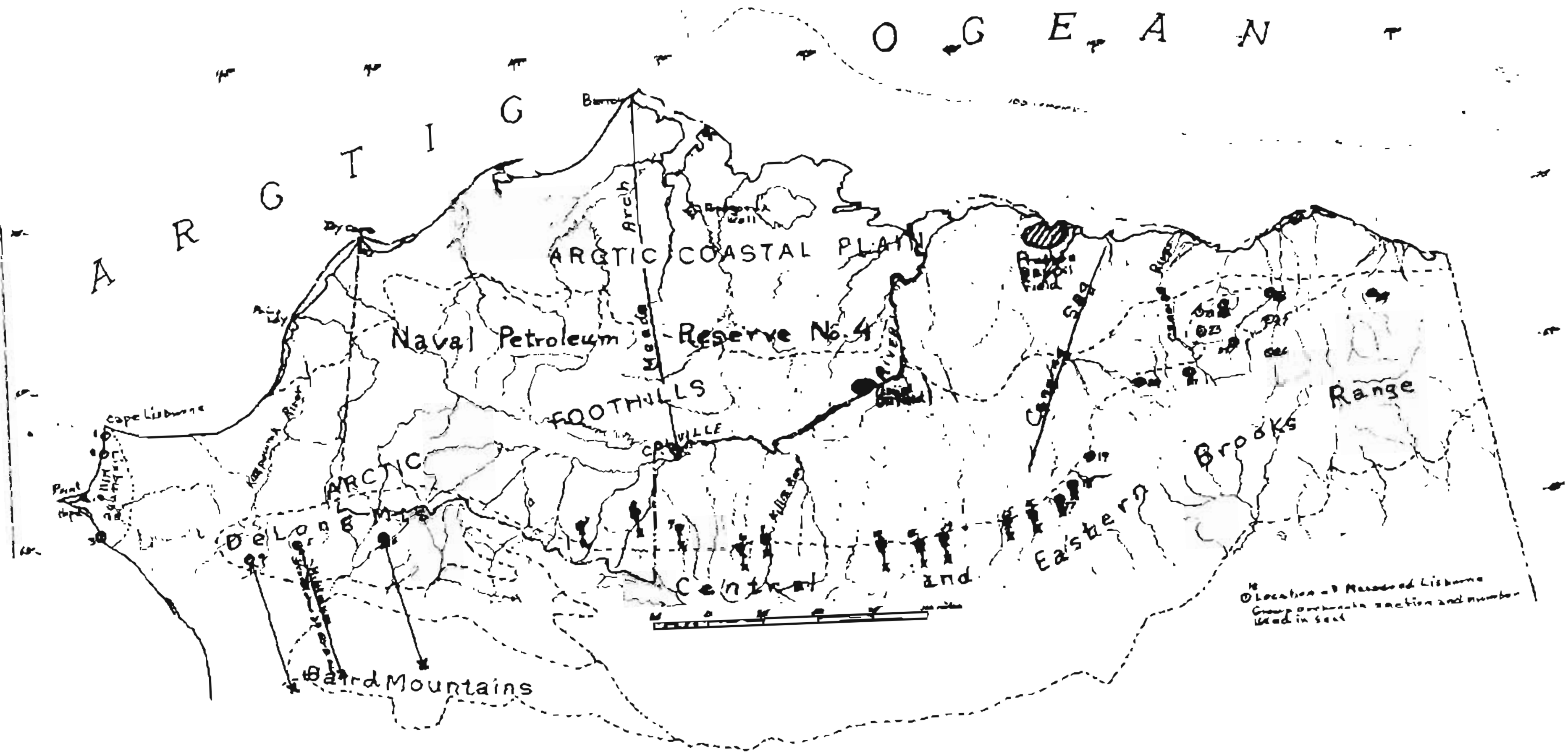

Figure 1 Index map of arctic Alaska showing location of Measured stratigraphic sections (circled); probable amount of minimum translation (Thrusting) and original site of deposition (X). The Meade Arch is believed to be an area of lesser subsidence and thinner carbonate cover and the Canning Sag an area of thicker carbonate accumulation during Lisburne Group time. Physiographic division of Arctic Alaska from Wahrhaftig (1965, pl. 1).

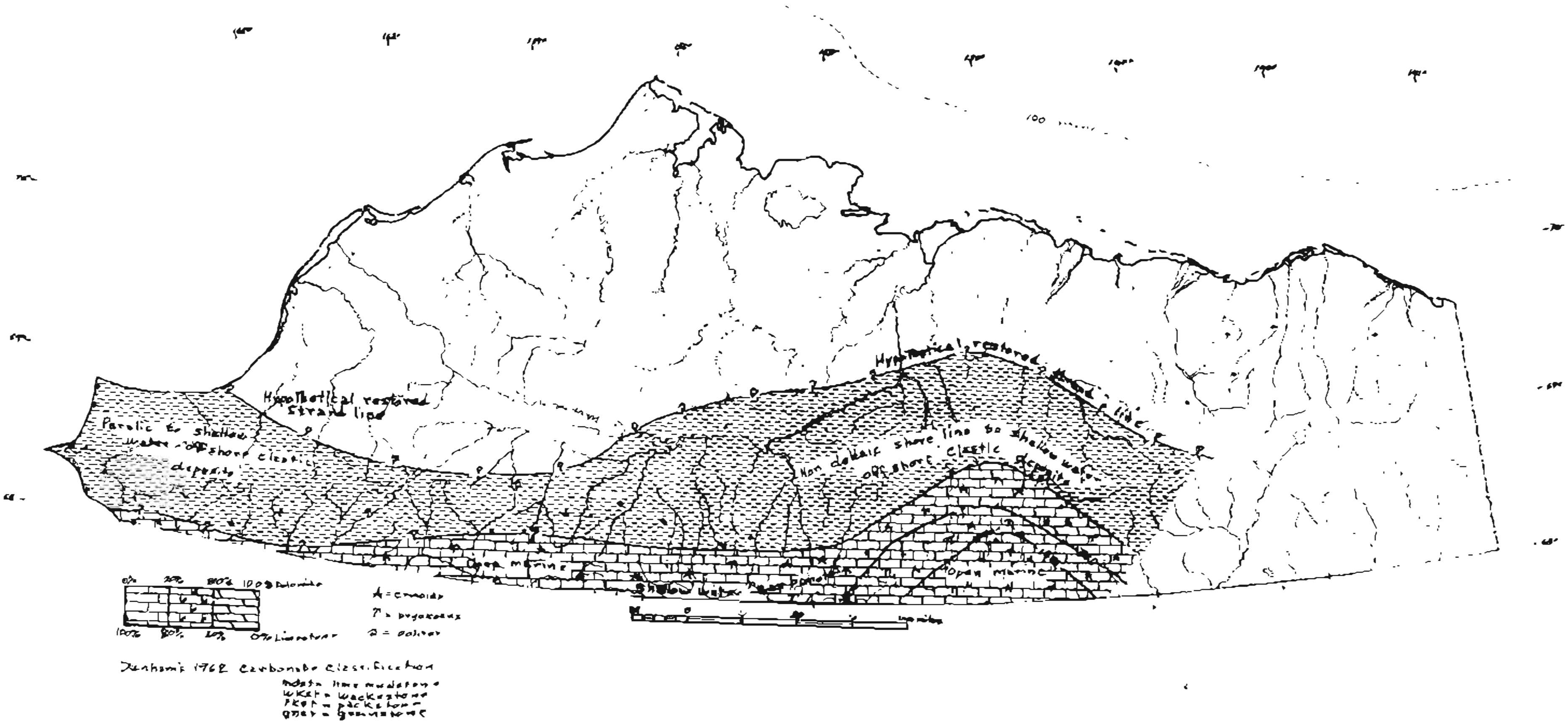

Figure 2.- Preliminary palinspastic and carbonate facies map of arctic Alaska at the end of Osage Time

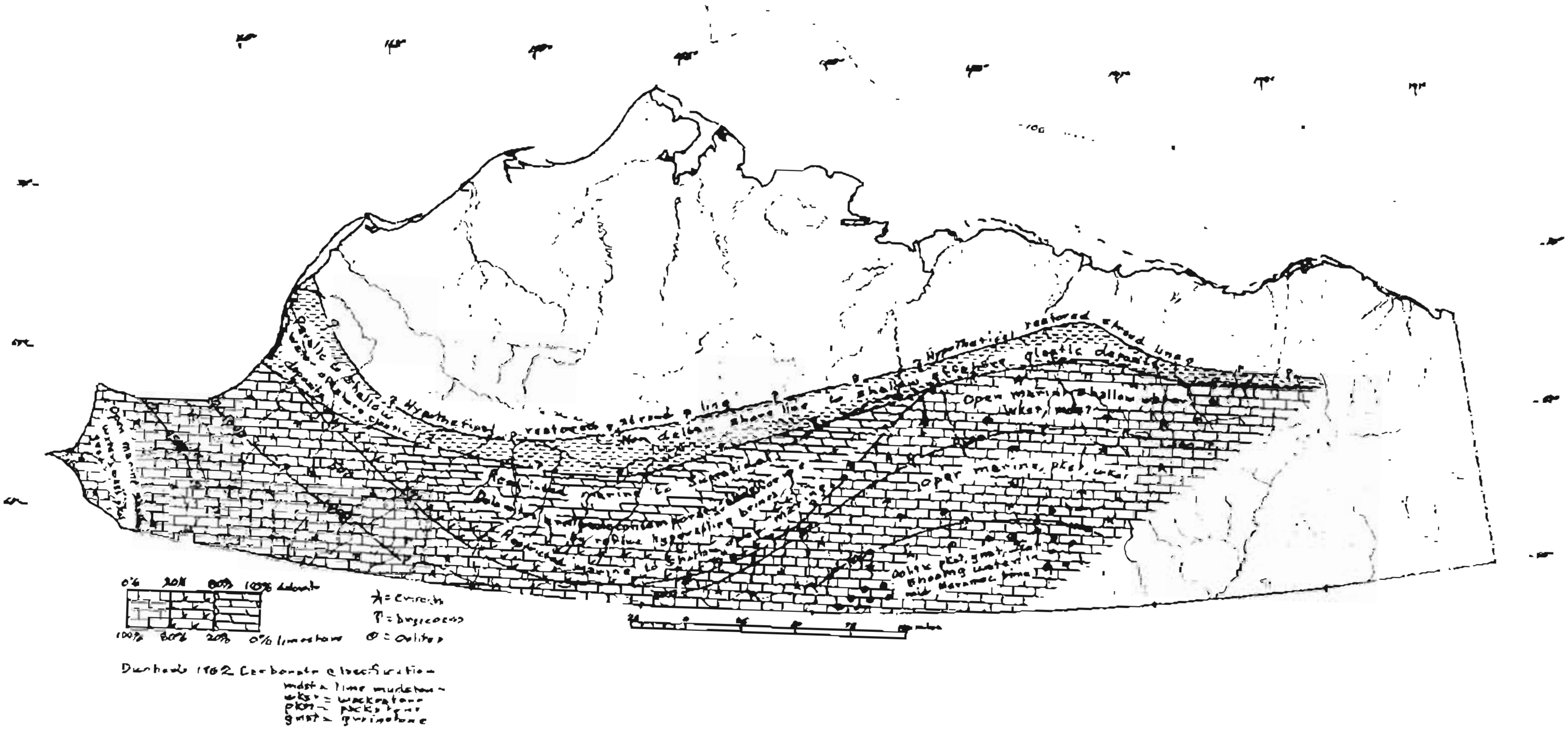

Figure 3.— Preliminary palinspastic and carbonate facies map of Arctic Alaska at the end of Meramec time

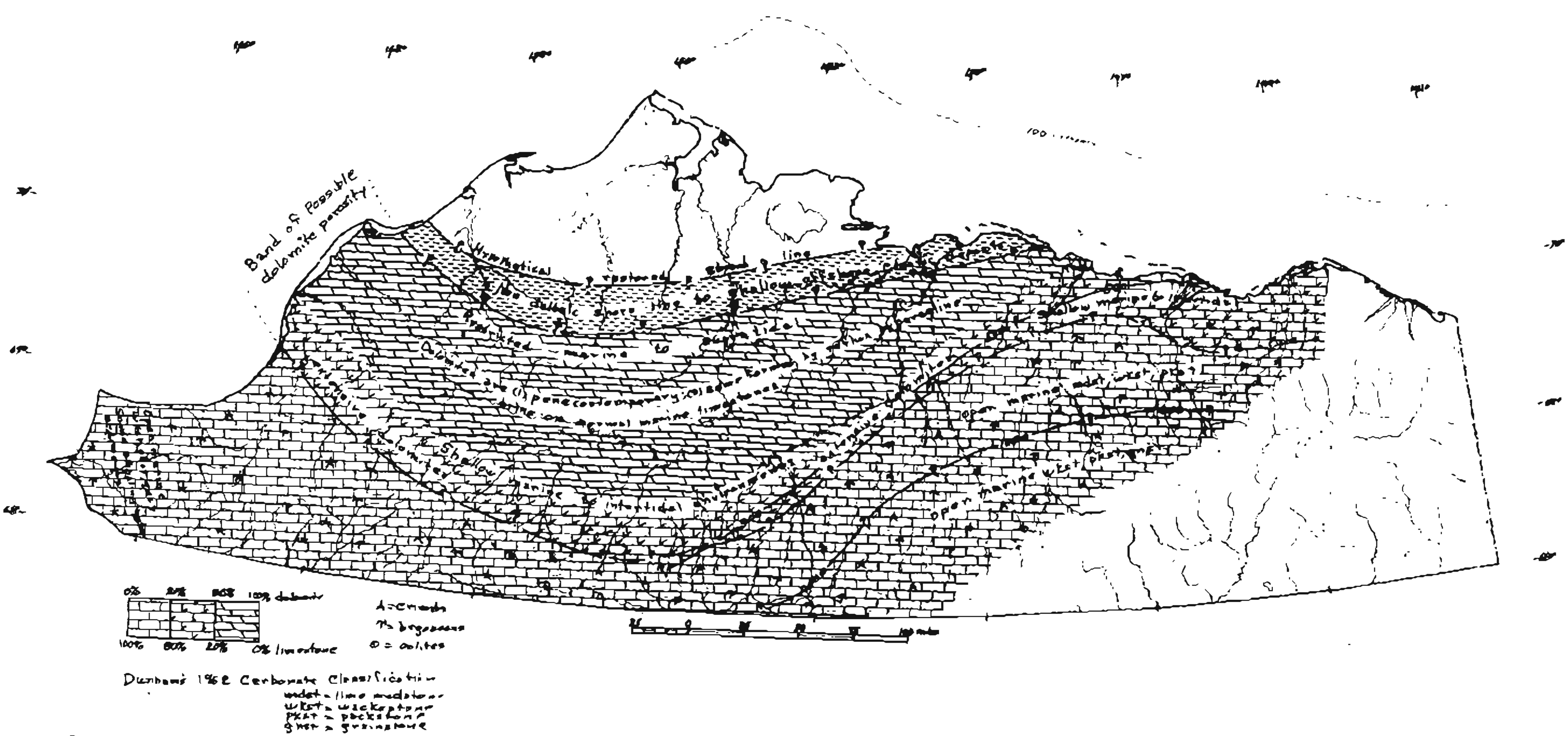

Figure 4.– Preliminary palinspastic and carbonate facies map for the lower half of Chester time, arctic Alaska (B. Mamet's 1968, Zones 16, 17)

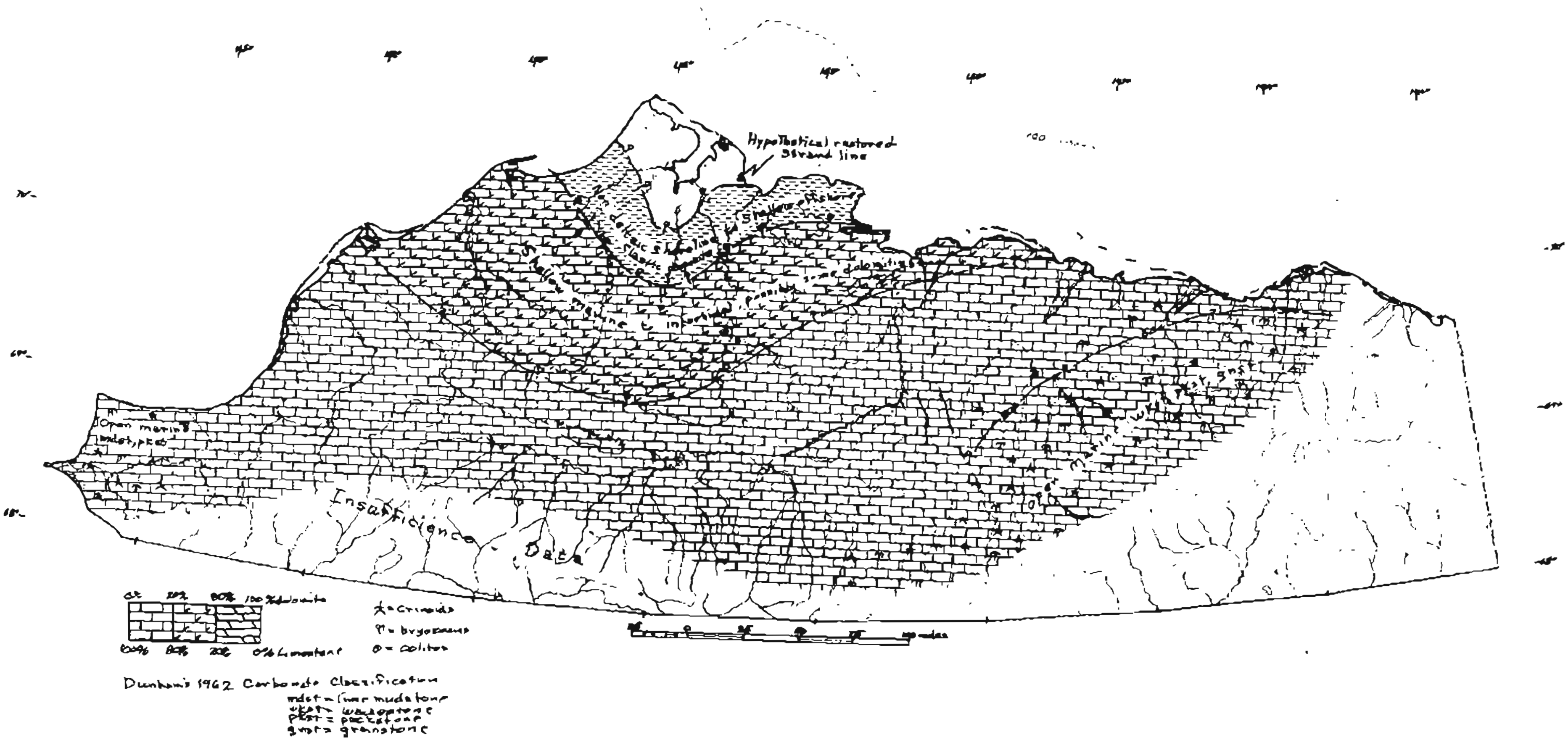

Figure 5.- Preliminary palinspastic and carbonate facies map for the upper half of Chester time, arctic Alaska (B. Mamet's 1968 zone 18, 19).

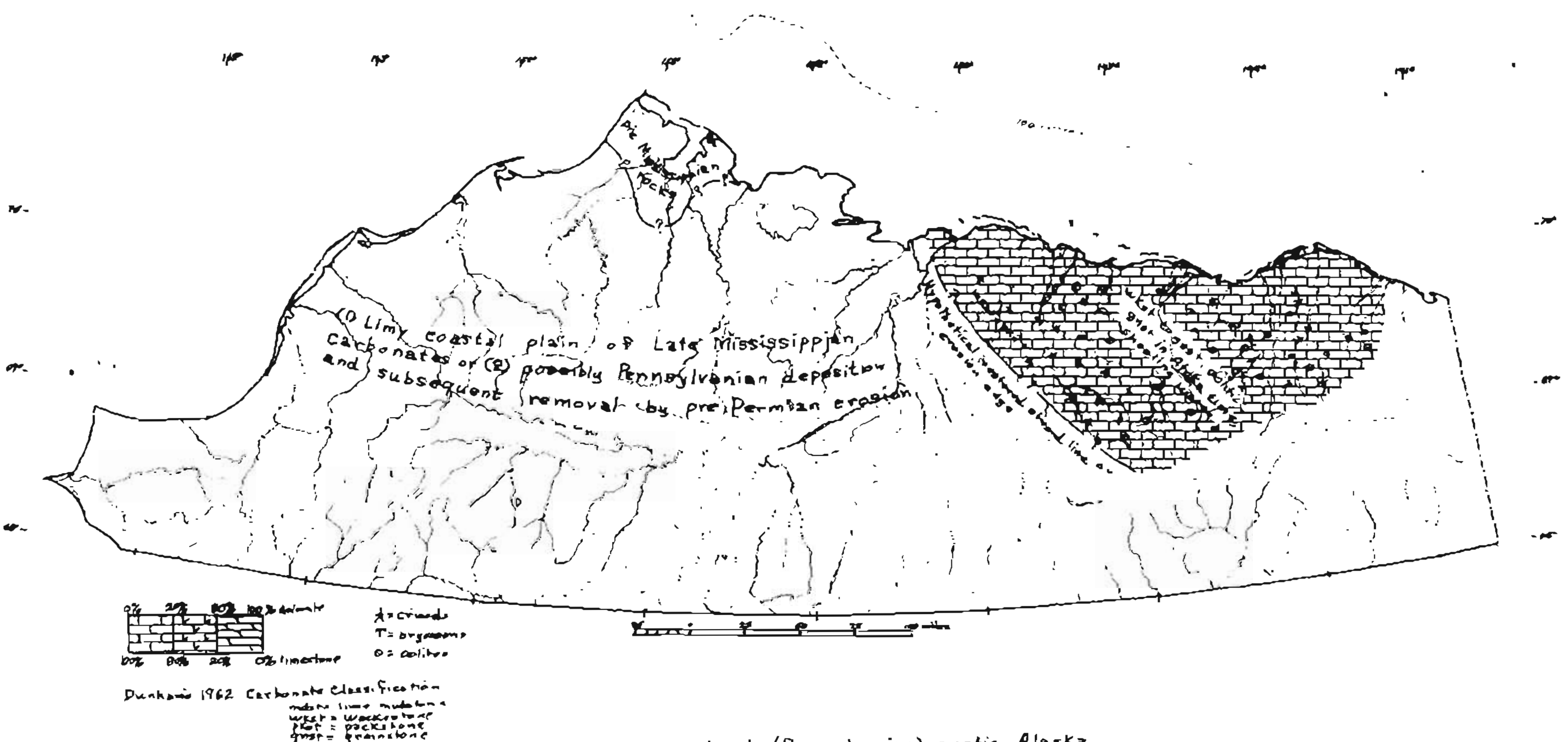

Figure 6.– Preliminary carbonate facies map for Morrow and Atoka age Carbonates (Pennsylvanian), arctic Alaska.

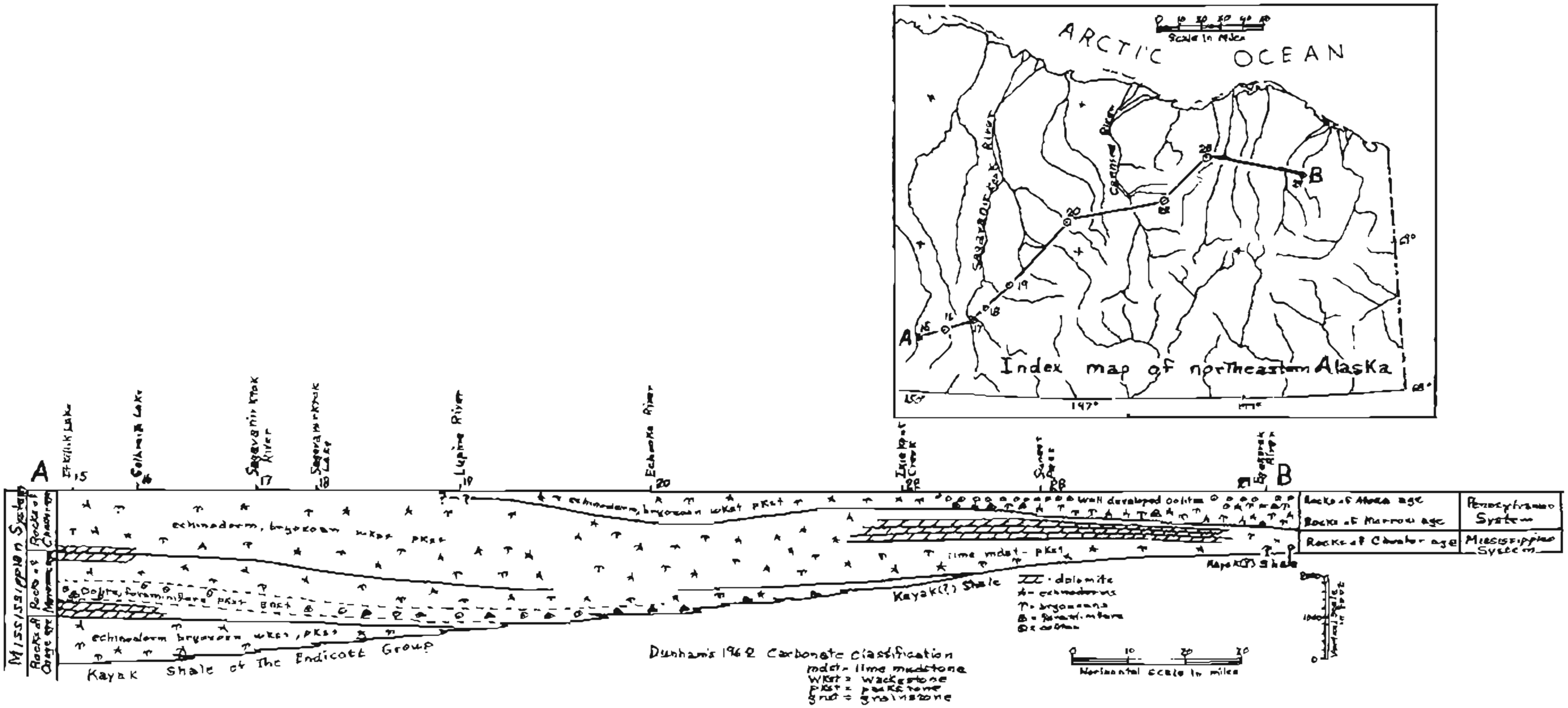

Figure 7 - Schematic cross section of the Lisburne Group carbonates, facies and biostratigraphic time lines at the end of Atoka; Pennsylvanian time from Itkillik Lake to Egaksrak River, Brook Range.