

UNITED STATES DEPARTMENT OF THE INTERIOR  
GEOLOGICAL SURVEY

THERMAL MATURATION VALUES (CONODONT COLOR ALTERATION INDICES) FOR  
PALEOZOIC AND TRIASSIC ROCKS, CHANDLER LAKE, DE LONG MOUNTAINS,  
HOWARD PASS, KILLIK RIVER, MISHEGUK MOUNTAIN,  
AND POINT HOPE QUADRANGLES,  
NORTHWEST ALASKA, AND SUBSURFACE NPRA

By

Anita G. Harris, Inyo F. Ellersieck, Charles F. Mayfield,  
and Irvin L. Tailleux

Open-File Report  
83-505

This report is preliminary and has not  
been reviewed for conformity with U.S.  
Geological Survey editorial standards  
and stratigraphic nomenclature

1983

## INTRODUCTION

Conodonts are apatitic marine microfossils that can be relatively easily and rapidly recovered from carbonate and metacarbonate rocks of Cambrian through Triassic age. They are valuable biochronologic indices throughout most of their geologic range and, since 1977, have also become important indices of organic metamorphism (Epstein and others, 1977; Harris, 1979). Conodonts visibly change color between 50° and 500°C and are therefore useful thermal indices for assessing hydrocarbon and mineralization potential. Several papers describe the origin, calibration, and geologic applications of conodont color alteration, particularly as related to hydrocarbon exploration (Epstein and others, 1977; Harris and others, 1978; Harris, 1979; Harris and others, 1980; Harris and others, 1981). It is only necessary to repeat here that conodont color alteration is time and temperature dependent and results chiefly from either burial metamorphism or heat associated with intrusive igneous activity. Less commonly, conodont color alteration can also result from contact with warm saline solutions that can produce oxidation of organic materials and corrosion of minerals.

Color alteration index (CAI) values have been correlated with temperature via laboratory experiments, bore holes and other geothermometers. This correlation is given below; the temperature ranges represent heating durations of 500 million to 1 million years (lower temperature is the 500 m.y. value).

| CAI | Temperature range, °C |
|-----|-----------------------|
| 1   | 50-80                 |
| 1.5 | 50-90                 |
| 2   | 60-140                |
| 3   | 110-200               |
| 4   | 190-300               |
| 5   | 300-400               |
| 6   | 350-450               |
| 7   | 400-500               |
| 8   | 450-550               |

## PURPOSE

In the last several years, there has been increasing interest on the part of U.S. Geological Survey geologists mapping Paleozoic and Triassic terranes in Alaska to collect conodont samples for biostratigraphic control. Therefore, the conodont samples for which CAI values are given in this report were not collected specifically for organic maturation studies, but for biostratigraphic and structural interpretations. As a result, the distribution of CAI points is not related to any strategy for thermal maturation assessment.

We are releasing our CAI values for part of the northwest Brooks Range and the subsurface National Petroleum Reserve in Alaska, at this time, because this area is of current interest to hydrocarbon explorationists. As a result we have had inquiries

from industry concerning any available organic maturation data.

All samples were collected by U.S. Geological Survey geologists, mostly by S. Curtis, I.F. Ellersieck, C.F. Mayfield, and I.L. Tailleux in the course of field mapping related to exploration of the NPRA (Curtis and others, 1982; Ellersieck and others, 1982; Mayfield and others, 1982). A.G. Harris is solely responsible for the conodont age and thermal evaluations.

## REFERENCES CITED

- Curtis, S.M., Ellersieck, Inyo, Mayfield, C.F., and TAILLEUR, I.L., 1982, Reconnaissance geologic map of southwestern Misheguk Mountain quadrangle, Alaska: U.S. Geological Survey Open-File Report 82-611, scale 1:63,360.
- Ellersieck, Inyo, Curtis, S.M., Mayfield, C.F., and TAILLEUR, I.L., 1982, Reconnaissance geologic map of south-central Misheguk Mountain quadrangle, Alaska: U.S. Geological Survey Open-File Report 82-612, scale 1:63,360.
- Epstein, A. G., Epstein, J. B., and Harris, L. D., 1977, Conodont color alteration--an index to organic metamorphism: U.S. Geological Survey Professional Paper 995, 27 p.
- Harris, A.G., 1979, Conodont color alteration, an organo-mineral metamorphic index, and its application to Appalachian basin geology, in Scholle, P.A., and Schluger, P.R., eds., Aspects of diagenesis: Society of Economic Paleontologists and Mineralogists Special Publication No. 26, p. 3-16.
- Harris, A.G., Harris L.D., and Epstein, J.B., 1978, Oil and gas data from Paleozoic rocks in the Appalachian basin: maps for assessing hydrocarbon potential and thermal maturity (conodont color alteration isograds and overburden isopachs): U.S. Geological Survey, Miscellaneous Investigations Series I-917-E, scale 1:2,500,000, 4 sheets.
- Harris, A.G., Wardlaw, B.R., Rust, C.C., and Merrill, G.K., 1980, Maps for assessing thermal maturity (conodont color alteration index maps) in Ordovician through Triassic rocks in Nevada and Utah and adjacent parts of Idaho and California: U.S. Geological Survey Miscellaneous Investigations Series I-1249, scale 1:2,500,000, 2 sheets.
- Harris, L.D., Harris, A.G., de Witt, Wallace, Jr., and Bayer, K.C., 1981, Evaluation of the southern Eastern Overthrust belt beneath the Blue Ridge-Piedmont thrust: American Association of Petroleum Geologists Bulletin, v. 65, no. 11 p. 2497-2505.
- Mayfield, C.F., Curtis, S.M., Ellersieck, I.F., and TAILLEUR, I.L., 1982, Reconnaissance geologic map of the southeastern part of the Misheguk Mountain quadrangle, Alaska: U.S. Geological Survey Open-File Report 82-613, scale 1:63,360.

## EXPLANATION OF TABLE NOTATIONS

(Samples are listed alphabetically by quadrangle name, then chronologically by decreasing geologic age, and lastly by increasing latitude.)

|                              |   |
|------------------------------|---|
| *                            | Subsurface sample   |
| Devonian (U)                 | Conodonts indicate a Late Devonian age  |
| Devonian (M-U)               | Conodonts indicate a Middle through Late Devonian age                                     |
| Devonian (M/U)               | Conodonts indicate a short interval across the Middle-Late Devonian boundary              |
| Devonian-Mississippian       | Conodonts merely indicate a Devonian through Mississippian age                            |
| Devonian-Mississippian (U-L) | Conodonts indicate a Late Devonian through Early Mississippian age                        |
| Devonian/Mississippian (U/L) | Conodonts indicate a short interval across the Late Devonian-Early Mississippian boundary |
| CAI                          | Conodont color alteration index   |

Table 1.--Conodont-based age and thermal maturation values for part of the northwest Brooks Range and the subsurface NPRA.

| QUADRANGLE<br>(1:250,000) | LATITUDE/LONGITUDE | SYSTEM        | (SERIES) | CAI   | FIELD NO.   |
|---------------------------|--------------------|---------------|----------|-------|-------------|
| CHANDLER LAKE             | 68°00.1'/152°17.0' | Dev.-Miss.    | (M-L)    | 5.5   | 75ATr14.1   |
| "                         | 68°00.0'/152°49.7' | Mississippian | (L)      | 5     | 75ATr15.2   |
| "                         | 68°22.6'/152°50.8' | Mississippian | (L)      | 5.5-6 | 80My01.1    |
| "                         | 68°18.0'/151°50.2' | Mississippian | (U)      | 2     | 75Tr1.2     |
| "                         | 68°18.0'/151°53.8' | Mississippian | (U)      | 1.5   | 80My10-7-10 |
| "                         | 68°18.2'/151°50.3' | Mississippian | (U)      | 1.5-2 | 80My07c     |
| "                         | 68°22.3'/151°52.7' | Mississippian | (U)      | 2     | 75Tr11:0-15 |

| QUADRANGLE<br>(1:250,000) | LATITUDE/LONGITUDE | SYSTEM        | (SERIES) | CAI   | FIELD NO. |
|---------------------------|--------------------|---------------|----------|-------|-----------|
| DE LONG MTNS.             | 68°08.1'/163°41.5' | Devonian      | (M)      | 3     | 79MD171A  |
| "                         | 68°05.7'/163°36.3' | Devonian      | (U)      | 3     | 79MD86C   |
| "                         | 68°06.0'/163°36.3' | Devonian      | (U)      | 2.5-3 | 79MD86B   |
| "                         | 68°10.6'/163°24.6' | Devonian      | (U)      | 3     | 79MD115E  |
| "                         | 68°10.7'/163°24.4' | Devonian      | (U)      | 3     | 79MD115F  |
| "                         | 68°18.9'/162°08.8' | Devonian      | (U)      | 3     | 79CX60A   |
| "                         | 68°08.7'/163°38.6' | Dev.-Miss.    | (M-L)    | 2.5-3 | 79CX127G  |
| "                         | 68°10.3'/163°26.2' | Dev.-Miss.    | (M-L)    | 3-4   | 79MD116B  |
| "                         | 68°10.6'/163°34.5' | Dev.-Miss.    | (M-L)    | 3     | 79EK180C  |
| "                         | 68°20.3'/162°18.2' | Dev.-Miss.    | (M-L)    | 3     | 79MD47    |
| "                         | 68°08.2'/162°30.8' | Dev.-Miss.    | (U-L)    | 3     | 79EK274A  |
| "                         | 68°12.9'/163°04.7' | Dev.-Miss.    | (U-L)    | 2.5-3 | 79EK196F  |
| "                         | 68°07.8'/163°33.1' | Dev.-Miss.    | (U-U)    | 3-4   | 79CX227   |
| "                         | 68°08.8'/163°05.2' | Dev.-Miss.    | (U-U)    | 3-4   | 79EK166   |
| "                         | 68°06.1'/163°34.3' | Mississippian | (L)      | 3     | 79EK175C  |
| "                         | 68°07.8'/163°43.2' | Mississippian | (L)      | 2.5-3 | 79MD171D  |
| "                         | 68°08.3'/163°25.8' | Mississippian | (L)      | 2.5-3 | 79Tr144   |
| "                         | 68°14.5'/164°03.7' | Mississippian | (L)      | 2     | 63Tr243B  |
| "                         | 68°21.3'/162°02.4' | Mississippian | (L)      | 3     | 79MD44C   |
| "                         | 68°21.4'/162°56.5' | Mississippian | (L)      | 2.5-3 | 79EK184B  |

| QUADRANGLE<br>(1:250,000) | LATITUDE/LONGITUDE | SYSTEM           | (SERIES) | CAI   | FIELD NO.  |
|---------------------------|--------------------|------------------|----------|-------|------------|
| DE LONG MTNS.             | 68°00.3'/163°16.3' | Mississippian    | (U)      | 2.5   | 79Tr142    |
| "                         | 68°03.5'/163°08.2' | Mississippian    | (U)      | 2.5-3 | 79EK15R2   |
| "                         | 68°18.3'/163°19.5' | Mississippian    | (U)      | 3     | 79MD146D   |
| "                         | 68°06.3'/164°06.3' | Mississippian    |          | 1.5-2 | 79MD180    |
| "                         | 68°21.6'/162°56.0' | Mississippian    |          | 2-3   | 79Tr74E    |
| "                         | 68°22.0'/163°22.3' | Mississippian    |          | 2.5-3 | 79EK189C   |
| "                         | 68°07.9'/163°38.7' | Pennsylvanian    | (L)      | 2.5-3 | 79CX125H1  |
| "                         | 68°18.0'/163°10.2' | Triassic         | (L)      | 2     | 79EK264B   |
| "                         | 68°24.4'/163°31.8' | Triassic         | (L)      | 2     | 79MD107C   |
| "                         | 68°08.8'/163°05.2' | Dev.-Permian     |          | 3-4   | 79CX119A   |
| "                         | 68°01.5'/162°45.0' | Silurian-Permian |          | 3     | 79CX198E   |
| "                         | 68°04.8'/163°04.8' | Silurian-Permian |          | 3.5   | 78W38782   |
| "                         | 68°06.0'/163°15.5' | Silurian-Permian |          | 3-4   | 79CX22E    |
| "                         | 68°07.5'/163°43.5' | Silurian-Permian |          | 2-3   | 79MD171E   |
| "                         | 68°07.7'/163°33.0' | Silurian-Permian |          | 3-4   | 79MD84D    |
| "                         | 68°08.5'/162°29.5' | Silurian-Permian |          | 3     | 79MD164-29 |
| "                         | 68°09.4'/162°48.0' | Silurian-Permian |          | 2.5-3 | 79EK163    |
| "                         | 68°10.8'/162°20.0' | Silurian-Permian |          | 3     | 79EK2B     |
| "                         | 68°12.5'/163°04'   | Silurian-Permian |          | 2.5   | 79EK196J   |
| "                         | 68°15.8'/163°09.8' | Silurian-Permian |          | 3     | 79CX214A   |



| QUADRANGLE<br>(1:250,000) | LATITUDE/LONGITUDE | SYSTEM           | (SERIES) | CAI   | FIELD NO.   |
|---------------------------|--------------------|------------------|----------|-------|-------------|
| DE LONG MTNS.             | 68°16.0'/163°07.2' | Silurian-Permian |          | 2-3   | 79EK262C    |
| "                         | 68°22.3'/163°22.0' | Silurian-Permian |          | 3     | 79EK189C    |
| "                         | 68°22.7'/162°28.7' | Silurian-Permian |          | 3     | 79MD181-62  |
| "                         | 68°12.2'/163°07.7' | Ord.-Permian     |          | 3     | 79MD110G    |
| "                         | 68°22.7'/162°28.7' | Ord.-Permian     |          | 2.5-3 | 79MD181-132 |

| QUADRANGLE<br>(1:250,000) | LATITUDE/LONGITUDE  | SYSTEM        | (SERIES) | CAI   | FIELD NO. |
|---------------------------|---|---------------|----------|-------|-----------|
| *HARRISON BAY             | 70°25'29"/151°43'52.5"<br>(South Harrison Bay test<br>well, 10,613-26') | Pennsylvanian | (L-M)    | 2     |           |
| * "                       | 70°49'56"/152°18'11"<br>(W.T. Foran test well<br>8,253-69')             | Pennsylvanian | (L-M)    | 1-1.5 |           |

| QUADRANGLE<br>(1:250,000) | LATITUDE/LONGITUDE | SYSTEM        | (SERIES) | CAI   | FIELD NO. |
|---------------------------|--------------------|---------------|----------|-------|-----------|
| HOWARD PASS               | 68°20.9'/158°15.8' | Silurian-Dev. |          | 1.5   | 78CX27A1  |
| "                         | 68°20.9'/158°15.7' | Devonian      | (U)      | 7     | 79ANS41C  |
| "                         | 68°24.2'/158°26.7' | Devonian      | (U)      | 2     | 79ANS25C  |
| "                         | 68°27.6'/156°34.6' | Devonian      | (U)      | 1-1.5 | 78Tr231   |
| "                         | 68°20.7'/158°16.5' | Dev.-Miss.    | (U-L)    | 3.5-4 | 78ANS205B |
| "                         | 68°19.4'/158°18.9' | Dev.-Triassic |          | 3     | 78AMM35D  |
| "                         | 68°19.3'/158°19.2' | Triassic      |          | 2     | 79ANS31B  |

| QUADRANGLE<br>(1:250,000) | LATITUDE/LONGITUDE  | SYSTEM        | (SERIES) | CAI   | FIELD NO. |
|---------------------------|---|---------------|----------|-------|-----------|
| *KILLIK RIVER             | 68°29'05.5"/155°41'35.5"<br>(Lisburne test well,<br>16,302-09') | U. Dev.-Miss. |          | 3.5   |           |
| "                         | 68°26.8'/155°52.5'  | Mississippian |          | 1.5-2 | 79EK296B  |
| "                         | 68°28.6'/155°42.2'  | Mississippian |          | 1.5   | 79Tr177F  |

| QUADRANGLE<br>(1:250,000) | LATITUDE/LONGITUDE | SYSTEM        | (SERIES) | CAI   | FIELD NO.  |
|---------------------------|--------------------|---------------|----------|-------|------------|
| MISHECUC MTN.             | 68°26.2'/160°57.3' | Devonian      | (M)      | 3     | 78MD160A   |
| "                         | 68°09.3'/161°41.0' | Devonian      | (M-U)    | 3     | 78Tr161B-C |
| "                         | 68°12.1'/160°10.7' | Devonian      | (M-U)    | 4     | 78Tr120A   |
| "                         | 68°09.2'/161°44.1' | Devonian      | (U)      | 1.5-2 | 78Tr157    |
| "                         | 68°19.5'/161°42.5' | Devonian      | (U)      | 2     | 78MD133    |
| "                         | 68°04.4'/161°52.6' | Dev.-Miss.    | (U-L)    | 1.5   | 78Tr155A   |
| "                         | 68°14.4'/159°51.9' | Dev./Miss.    | (U/L)    | 3     | 78MD87     |
| "                         | 68°24.5'/159°54.5' | Dev./Miss.    | (U/L)    | 3     | 78MD116A   |
| "                         | 68°10.2'/161°44.0' | Dev.-Miss.    | (M-L)    | 1.5   | 78MD128C   |
| "                         | 68°15.3'/161°33.8' | Dev.-Miss.    | (U-L)    | 2     | 78MD137R   |
| "                         | 68°34.1'/159°26.2' | Dev.-Miss.    | (U-L)    | 3     | 78Tr32A    |
| "                         | 68°10.4'/161°41.2' | U. Dev.-Miss. |          | 1.5-2 | 78MD129B   |
| "                         | 68°24.3'/161°34.4' | Mississippian | (L)      | 2.5-3 | 78EK123C   |
| "                         | 68°36.6'/159°13.0' | Mississippian | (U)      | 2     | 82Tr3B     |
| "                         | 68°37.1'/159°12.5' | Mississippian | (U)      | 2     | 82Tr4G     |
| "                         | 68°10.5'/161°41.1' | Mississippian |          | 1.5-2 | 78MD129A   |
| "                         | 68°11.4'/160°46.7' | Mississippian |          | 2.5-3 | 78EK116F   |
| "                         | 68°21.8'/161°44.8' | Mississippian |          | 2-3   | 78MD130B   |
| "                         | 68°37.2'/159°14.0' | Miss./Penn.   | (U/L)    | 2     | 82Tr2C-E   |
| "                         | 68°38.5'/159°17.3' | Miss./Penn.   | (U/L)    | 1.5   | 82Tr1A     |

| QUADRANGLE<br>(1:250,000) | LATITUDE/LONGITUDE | SYSTEM           | (SERIES) | CAI   | FIELD NO. |
|---------------------------|--------------------|------------------|----------|-------|-----------|
| MISHEGUK MTN.             | 68°16.5'/161°58.8' | Miss.-Permian    | (U-L)    | 2-2.5 | 79Tr30D   |
| "                         | 68°28.1'/160°31.0' | U. Dev.-Permian  |          | 3     | 78EK73    |
| "                         | 68°30.8'/159°19.2' | Dev.-Permian     |          | 3     | 78EK16C   |
| "                         | 68°11.6'/160°12.6' | Silurian-Permian |          | 3     | 78TR121A  |
| "                         | 68°15.9'/161°28.8' | Silurian-Permian |          | 3     | 78MD186   |
| "                         | 68°20.3'/159°51.5' | Silurian-Permian |          | 3     | 78MD115E  |
| "                         | 68°27.0'/160°14.2' | M. Ord.-Permian  |          | 3     | 78EK79E   |

| QUADRANGLE<br>(1:250,000) | LATITUDE/LONGITUDE | SYSTEM      | (SERIES) | CAI   | FIELD NO. |
|---------------------------|--------------------|-------------|----------|-------|-----------|
| POINT HOPE                | 68°33.9'/166°14.0' | Silurian    | (L)      | 5     | 82Tr83B   |
| "                         | 68°49.2'/166°12.2' | Dev.-Miss.  | (U-U)    | 1.5-2 | 82Tr108B  |
| "                         | 68°08.4'/165°57.9' | Miss.       | (U)      | 2.5   | 82Tr105   |
| "                         | 68°41.6'/166°11.7' | Miss.       | (U)      | 1.5-2 | 82Tr95    |
| "                         | 68°43.5'/166°11.9' | Miss.       | (U)      | 1-1.5 | 82Tr96    |
| "                         | 68°44.5'/165°49.8' | Miss.       | (U)      | 1.5-2 | 82AKr26a  |
| "                         | 68°45.1'/166°11.8' | Miss.       | (U)      | 1.5-2 | 82Tr98A   |
| "                         | 68°45.3'/166°11.9' | Miss.       | (U)      | 1.5-2 | 82Tr98B   |
| "                         | 68°45.7'/166°11.8' | Miss.       | (U)      | 1.5-2 | 82ARr30   |
| "                         | 68°47.1'/166°11.3' | Miss.       | (U)      | 1.5-2 | 82Tr99    |
| "                         | 68°48.8'/166°12.0' | Miss.       | (U)      | 2-3   | 82Tr108A  |
| "                         | 68°49.7'/166°12.0' | Miss.       | (U)      | 1.5-2 | 82Tr109   |
| "                         | 68°50.1'/166°11.8' | Miss.       | (U)      | 2-2.5 | 82Tr110   |
| "                         | 68°46.8'/166°11.2' | Miss.-Penn. |          | 1.5-2 | 82Tr100   |
| "                         | 68°44.4'/166°11.7' | Ord.-Tr1.   |          | 1.5-2 | 82Tr97    |

| QUADRANGLE<br>(1:250,000) | LATITUDE/LONGITUDE   | SYSTEM        | (SERIES) | CAI   | FIELD NO. |
|---------------------------|--|---------------|----------|-------|-----------|
| *TESHEKPUK                | 70°00.3'/153°06'<br>(Ingok test well,<br>16,185-98')<br>(14,037-54') | Mississippian | (U)      | 3.5-4 |           |
| *                         | 70°55.2'/153°08.3'<br>(J.W. Dalton test well,<br>8317-41')           | Pennsylvanian | (L-M)    | 1.5   |           |
| *                         | 70°57.2'/155°21.4'<br>(T.W. Simpson well,<br>6464')                  | Triassic      | (M)      | 1.5   |           |
| *                         | 70°27.3'/154°19.9'<br>(IkpikpuK test well,<br>11,718-33')            | Permian       | (L/U)    | 2     |           |