DEPARTMENT OF THE INTERIOR
UNITED STATES GEOLOGICAL SURVEY

MISCELLANEOUS INVESTIGATIONS SERIES
MAP I-1249 (SHEET 1 OF 2)

INTRODUCTION

These maps show conodont color alteration indices (CAI) which are a measure of organic and mineral metamorphism (Epstein and others, 1977). Conodonts are microscopic (generally 0.1–1 mm in size) apatitic hard parts of an extinct group of marine animals that are common to abundant in rocks of Ordovician through Triassic age. Conodonts have become an important group of index fossils because they evolved and spread rapidly throughout most of their geologic range and are relatively easy to concentrate from a variety of marine rocks. Conodonts contain trace amounts of organic matter that undergo visible changes in color from pale yellow to brown to black with increasing temperature as a result of a carbon-fixing process. Above 400°C, conodont elements change from black to gray to opaque white, and finally to crystal clear as a result of carbon loss, release of water of crystallization, and recrystallization. Thus, conodonts are a valuable index of metamorphism because they occur in rock types and within age and thermal ranges where other organic and mineral metamorphic indices may be absent.

The maps provide a rapid means for assessing oil and gas potential as well as identification of areas of high heat flow where some types of mineralization might be possible in rocks of Ordovician through Triassic age. Similar maps have been published for the Appalachian basin (Harris and others, 1978). All of our data, a total of 848 localities are chiefly from outcrop samples in the Great Basin and adjacent Colorado Plateaus. Many localities represent several collections within a measured section or within an area too small to show at the compilation scale. Thus, many of the CAI values represent the range of values in numerous samples. We estimate that over 5,000 samples, collected in the past 25 years, were indexed for this study.

The distribution of data points, representing almost all available conodont collections in the Great Basin, strongly reflects location of U.S. Geological Survey field studies and conodont biostratigraphic studies of university, federal, and state survey geologists. Many of our points lie in tectonically disturbed belts, in areas of mineralization, and at localities where relatively complete stratigraphic sequences are readily accessible and therefore have an unavoidable sampling bias. We have sampled only in western Box Elder, Tooele, and Juab Counties, Utah, and eastern Elko and White Pine Counties, Nevada, specifically to augment the geographic distribution of available conodont collections. Although these maps represent our initial compilation of CAI values for part of the Great Basin, we feel it is appropriate to present our data without further delay because of the present hydrocarbon, geothermal, and ongoing mineral exploration activity in this area. In addition, several hundred collections from Arizona, Colorado, New Mexico, West Texas, and Washington have been indexed. These data points, however, are too widespread over a vast area of diverse geologic terrane, so we hesitate to present a preliminary compilation at this time.

MAP COMPILATION

In order to facilitate geologic interpretation, our maps are on the same base and at the same scale as "The geologic map of the United States" (King and Beikman, 1974). The tectonic features shown on the maps provide an interpretative and very generalized framework for the complicated geologic setting of the Great Basin area. All patterned areas are preliminary and are shown with indefinite boundaries because our data generally are widely scattered within discontinuous and (or) disrupted areas of Paleozoic and Triassic rocks. The pattern formed by these rocks is the result of multiple episodes of thrusting, block faulting, igneous activity, and post-Triassic deposition and erosion. Patterned areas were extrapolated beyond the data points using: 1) "The geologic map of the United States" (King and Beikman, 1974); 2) Isopach and lithofacies maps of Triassic and Paleozoic Systems of the Great Basin (Ross, 1977; Poole and others, 1977; Poole and Sandberg, 1977; McKee, Crosby, and others, 1975; Stevens, 1977; McKee and others, 1959; Q. C. Hebrew and H. D. Harris, consultants, and General Crude Oil Company, unpub. data); and 3) CAI values from super- and subjacent systems—projecting low CAI values (1–2) from older rocks into overlying systems and projecting high CAI values (>4.5) from younger rocks into underlying systems in areas having a continuous stratigraphic sequence, not in overthrust belts.

In many areas we have extended map patterns between ranges with equivalent CAI values in order to maintain cartographic continuity. Obviously the CAI values shown across basin areas do not necessarily characterize the thermal maturity of the Paleozoic and Triassic rocks beneath basin fillings, some of which are known to exceed 3,000 m in thickness,(Amoco USA Jiggs no. 1 well and Pan Am USA Franklin no. 1 well, Elko Co., Nev., Amoco Production Co., unpub. data). Similarly, any of the mapped CAI areas may have smaller areas of higher or lower CAI values within them because of geologic complexities, broad distribution of data points, and cartographic constraints. Where appropriate, patterned areas extend beyond the present limit of erosion of a geologic system. Finally, wherever possible, we avoided extrapolation of patterns into areas of exceedingly complex structure.

REGIONAL STRUCTURE

Ordovician, Silurian, and Devonian eugeosynclinal rocks are present west of the leading edge of the Roberts Mountains thrust system which climaxed the Antler orogeny. Emplacement occurred in latest Devonian or earliest Mississippian time. In Nevada and Idaho, Devonian and older rocks were moved eastward more than 100 km on the upper plate of the low-angle Roberts Mountains thrust (Poole and others, 1977). These allochthonous rocks now abut, or rest in thrust contact on, autochthonous or parautochthonous Devonian and older transitional and miogeosynclinal strata exposed in erosional windows. The approximate leading edge of the Roberts Mountains thrust system, shown on the maps, was plotted by F. G. Poole (written commun., 1979).

Upper Paleozoic eugeosynclinal rocks are present west of the leading edge of the Golconda thrust system which climaxed the Sonoma orogeny. Emplacement occurred early in Triassic time (Speed, 1979). In Nevada, upper Paleozoic rocks were moved more than 50 km on the upper plate of the low-angle Golconda thrust. These allochthonous rocks now abut, or rest in thrust contact on, autochthonous or parautochthonous Permian and older rocks. The approximate leading edge of the Golconda thrust system, shown on the maps, was extended and modified by Wardlaw from the interpretation of Speed (1979).

Jurassic and older rocks are present west of the leading edge of the Sevier thrust system which climaxed the Sevier orogeny (Armstrong, 1968b). Emplacement occurred in Cretaceous time. In California, Nevada, Utah, and Idaho, pre-Cretaceous rocks moved eastward 50 to 100 km on low-angle thrusts of the Sevier thrust system and now abut, or rest in thrust contact on, cratonic Paleozoic and Mesozoic strata, which occupy the eastern part of the report area. The mapped and inferred traces of the major overthrusts in the system, shown on the maps was interpreted by F. G. Poole (written commun., 1979) who based the correlation of major local segments of the thrust system on studies by Crittenden (1959, 1961), Armstrong (1968b), and Poole and others (1967, 1977).

Several mapped and inferred strike-slip fault zones, active in Mesozoic and Cenozoic time, have brought together Paleozoic and lower Mesozoic rocks of different thicknesses and lithofacies. The strike-slip faults shown on the maps were plotted and interpreted by F. G. Poole (written commun., 1979). Sources of data include: Snake River fault (Poole and others, 1977); Wells and Dry Creek faults (Thorman and Ketner, 1979); Tybo and Warm Springs faults (Ekren and others, 1976; F. G. Poole, unpub. data); Furnace Creek, Death Valley, Garlock, Stewart Valley, and Las Vegas faults (Stewart and others, 1968; Poole and others, 1967 and 1977).

REGIONALLY METAMORPHOSED PALEOZOIC ROCKS

Relatively large areas of low- to high-grade metamorphosed Paleozoic rocks occur in this part of the Great Basin (Armstrong and Hansen, 1966; Crittenden and others, 1978); most of these metamorphic terranes that are known to involve post-Cambrian strata are shown on the maps (ruled pattern). Some nonmetamorphosed Paleozoic rocks also occur within these terranes. In general, these terranes have not been sampled for conodonts, but the distribution of regionally metamorphosed areas should be considered when using and interpreting the conodont color alteration index maps. The metamorphic terranes shown are: 1) Northwestern Box Elder County, Utah, and southern Cassia County, Idaho (Raft River, Grouse Creek, and Albion Ranges), where Pennsylvanian and older rocks are metamorphosed (Armstrong, 1968a; Compton and others, 1977); 2) Parts of Blaine and Custer Counties, Idaho (Pioneer Mountains), where Ordovician and older rocks are metamorphosed to medium grade (Dover and others, 1976); 3) South-central Elko County, Nevada (Pequop Mountains, Wood Hills, and Ruby Mountains), where Devonian and older rocks are metamorphosed and migmatized (Thorman, 1970; Howard, 1971); and 4) Southeastern San Bernardino and northeastern Riverside Counties, California (New York, Old Woman, Maria, and Riverside Mountains), where all Paleozoic and some Mesozoic rocks are metamorphosed (Hamilton, 1964; Stone and Howard, 1979).

GENERAL INTERPRETATION

The Great Basin is one of the most difficult terranes in which to assess thermal metamorphic patterns in Paleozoic and Triassic rocks. Original burial metamorphic patterns are disrupted by thrust and block faulting, masked by post-Triassic sedimentary and igneous rocks, and overprinted by post-Triassic thermal events related to igneous activity. Nevertheless, these maps show broad regional thermal patterns for the systems of the Paleozoic Erathem and the Triassic System. This is partly because conodonts are chronologic as well as metamorphic indices and provide an invaluable tool for unraveling the tectonic as well as thermal history of complex geologic areas.

These maps are useful for delineating broad hydrocarbon and mineral exploration objectives in untested areas, especially for preliminary assessments. The thermal intervals shown on these maps generally correspond to the thermal window for commercial oil (CAI 1–2) and gas (CAI 1–4.5) production and the thermal cutoff for most hydrocarbon production (CAI >4.5). Because thermal maturity can be related to depth of burial, areas of high CAI values become increasingly larger, and areas of low CAI values become increasingly smaller on the map of each older geologic system. Thus, many of the limits of our thermal intervals should not be geographically coincident on each map. This generalization, however, does not apply to overthrust belts. Near the leading edge of overthrust belts, thermal patterns are extremely complex. For example, locally in central Nevada, near the leading edge of the Roberts Mountains thrust system, more thermally mature Ordovician eugeosynclinal rocks have been thrust eastward over less thermally mature Ordovician shelf carbonate rocks. In other areas in central Nevada, however, the reverse may be true (Poole and Desborough, 1979). Later tectonic events as well as erosion have combined to produce a complex mosaic of thermally diverse plates, klippen, and windows; the same is true of Silurian and Devonian rocks in this area. Similar structural complexities occur in other areas.

In general, Ordovician through Triassic rocks west of 117°30′ W. longitude and most Ordovician through Pennsylvanian rocks north of 41°30′ N. latitude and west of 113° W. longitude have CAI values >4.5. CAI values of >4.5 also occur in all Paleozoic rocks in a large area north of the Snake River Plain, Idaho. These high values north of the Snake River Plain are undoubtedly influenced by the extensive Mesozoic through Quaternary igneous activity in that area. Another area of high thermal maturity in Pennsylvanian through Ordovician rocks is centered in northern Utah County, Utah, and coincides with a late Paleozoic depocenter, the Oquirrh basin. Our CAI data suggest all of the above areas are not favorable targets for hydrocarbon exploration. Ordovician through Devonian rocks in east-central Nevada and Millard County, Utah, have regionally moderate to low CAI values. The same is true for Mississippian through Triassic rocks but the areal extent of low CAI values is greater for these systems. This terrane should provide a variety of hydrocarbon exploration targets. It is interesting to note that the only two producing fields in Nevada, the Eagle Springs and Trap Spring fields, are within this terrane. The hydrocarbons are in Tertiary welded tuffs and lacustrine carbonate reservoir rocks, some of which may have a multiple origin that include both Paleozoic and Tertiary source beds (Claypool and others, 1979; French and Freeman, 1979).

INTERPRETATION BY SYSTEM

The individual CAI maps are discussed in the same order in which they were compiled, in reverse stratigraphic succession. Interpretation of the CAI map for any Ordovician through Triassic System is dependent upon the composite effect of the depositional and tectonic patterns in each overlying geologic system as well as younger igneous events.

Our data are largely from the Basin Ranges and thus our interpretations apply to the ranges directly but can be applied with modification to the intervening basins. In the area of the Great Basin with which we deal, these ranges are composed chiefly of Archean and Proterozoic through Triassic rocks and the post-Triassic igneous rocks that intrude and overlie them. As a result, interpretation of any individual CAI map is enhanced by a knowledge of the location of major igneous intrusions and should be made with overburden isopach maps of the systems of the Paleozoic Erathem and the Triassic System. For example, the best interpretation of the Devonian CAI map requires data on Triassic, Permian, Pennsylvanian, Mississippian, and Devonian depositional and tectonic patterns as well as post-Silurian igneous events.

CAI MAP OF THE TRIASSIC SYSTEM

Most areas of Triassic rock east of the Golconda thrust have low CAI values, chiefly less then 2. Areas of higher CAI values within this terrane are generally associated with igneous activity, such as the area of moderate to high CAI values in the vicinity of the Dolly Varden Mountains in southeast Elko County, Nev. These mountains are cored by a Cretaceous granitic stock. Moreover, on this map and on the CAI maps for the underlying systems of the Paleozoic Erathem, a large area of moderate to high CAI values is delineated by, and is probably related to, the large igneous intrusions of the Dolly Varden Mountains, Silver Island Range, Newfoundland Range, Gold Hill Mining District, Deep Creek Range, and the Kern Mountains, near the northern Utah-Nevada border area. This same thermal high has been outlined previously in Permian rocks by Wardlaw and others (in press). Another anomalous area of moderate CAI values in Triassic rocks occurs adjacent to the Mineral Mountains granitic pluton in central eastern Beaver County, Utah.

West of the leading edge of the Golconda thrust, as well as immediately southeast of it (near the Tonopah mining district), CAI values are generally greater than 4. In this area, Triassic rocks are represented by thick eugeosynclinal deposits.

CAI MAP OF THE PERMIAN SYSTEM

The Permian rocks of east-central Nevada, southern Utah, and the eastern thrust belt of northeasternmost Utah and southeastern Idaho generally have CAI values of 2.5 or less. Within this terrane are local areas of moderate to high CAI values that are related to igneous activity, in particular the high to moderate CAI areas in west Tooele and southwest Box Elder Counties, Utah, and southeast Elko County, Nevada, which also occur on and were discussed for the map of the Triassic System. The very large area of low CAI values in northeast Nye County and White Pine County, Nevada, coincides with a positive area of relatively thin accumulation from Permian through Triassic time and with the southern part of a Permian depocenter, the Ely basin. The thickness of Permian rocks within this part of the depocenter, however, is still within the range for low CAI values.

Areas of moderate CAI values in eastern Tooele, Salt Lake, Wasatch, and Utah Counties, Utah, lie within the northwest-trending Oquirrh basin which contains 5,000 to 8,000 feet of Permian rocks alone. Thermally high areas in Cassia County, Idaho, and northeasternmost Elko County, Nevada, correspond to a north-trending Permian isopach high of 10,000 to 20,000+ feet in the Sublette basin. In this area, the moderate to high CAI values in eastern Cassia County, are probably related to thick Lower Permian deposits, whereas the moderate to high values in western Cassia County and northeasternmost Elko County, Nevada, are related to moderate thicknesses of both Lower and Upper Permian rocks which combine to produce a thick total Permian section.

The large area of moderate CAI values in southeast Elko County, Nevada, approximates the trend of the Early Permian Ferguson trough (Stevens, 1977) and the Late Permian southeast Elko County depocenter (Wardlaw and Collinson, 1978). This Permian depocenter (labeled Ely basin on the map) contains at least 6,000 feet of Permian rock as well as 1,000 or more feet of overlying Triassic.

A large area of very high CAI values in western Nevada lies chiefly west of the leading edge of the Golconda thrust and is probably linked to the thick eugeosynclinal deposits of the overlying Triassic System. In Humboldt and Pershing Counties, moreover, in the northern part of this CAI high, the Permian also contains thick eugeosynclinal accumulations. Still another area of high CAI values lies north of the Snake River Plain in Custer County, Idaho. At present, little is known about the Permian sequence in this area. However, this is an area of Mesozoic through Quaternary igneous activity and the high CAI values could be easily related to high heat flow.

CAI MAP OF THE PENNSYLVANIAN SYSTEM

The east-central Nevada area continues to have low to moderate CAI values in Pennsylvanian rocks. This is because the Pennsylvanian (McKee and others, 1975) as well as overlying younger systems are thin in this area. The area of moderate CAI values in northeast White Pine County, Nevada, and western Juab County, Utah, is unrelated to Pennsylvanian depositional patterns but does reflect the thick younger overburden as well as younger igneous activity.

The thermal high in parts of Wasatch, Utah, Juab, and Tooele Counties, Utah, on this and the CAI maps of older Paleozoic systems corresponds to thick accumulations of Pennsylvanian and Permian rocks in the Oquirrh basin (McKee and others, 1975). Similarly, moderate CAI values are associated with moderately thick Pennsylvanian and Permian deposits in the Paradox basin of east-central Utah and western Colorado. Low CAI values characterize the Pennsylvanian rocks bordering the Uinta uplift in Daggett, Duchesne, Summit, and Uintah Counties, Utah.

In the vicinity of the Las Vegas fault, Pennsylvanian CAI values are high as are CAI values in older Paleozoic rocks in this same area. This high does not appear to be related to overburden, which is relatively thin in this area.

Relatively thin shallow-water marine Pennsylvanian deposits that overlap the Roberts Mountains thrust system have low CAI values whereas most eugeosynclinal Pennsylvanian deposits west of the Golconda thrust system have very high values. The high CAI values in northern Elko County north of the Wells fault may represent eastward transport of this same eugeosynclinal sequence.

The high CAI values in Cassia County, Idaho, continue to reflect the thick Pennsylvanian and Permian accumulations of the Sublette basin and are near the Raft River area of post-Triassic metamorphism (Compton and others, 1977). The CAI high in Custer and Blaine Counties, Idaho, is probably the result of high heat flow and moderate to possibly thick Pennsylvanian and Permian overburden as well as thick accumulations of Mesozoic and Cenozoic volcanic rocks.

CAI MAP OF THE MISSISSIPPIAN SYSTEM

East-central Nevada, western Millard County and the Uinta uplift area, Utah, and the overthrust belt of southeastern Idaho and northeasternmost Utah contain the major areas of low to moderate CAI values. The largest area of moderate to low CAI values (moderate on the west and low on the east) is centered at the common border of Eureka, Nye, and White Pine Counties, Nevada. In this area, the eastward decrease in CAI mimics the Mississippian isopach trend (Poole and Sandberg, 1977, figs. 4 and 6). The return to moderate CAI values in eastern White Pine County is probably related to heat flow associated with the igneous intrusions in the Kern Mountains and adjacent areas. The CAI trend in western Millard County, Utah, apparently correlates with Mississippian as well as younger overburden trends.

The only two oil fields in Nevada are in Railroad Valley (northeastern Nye County) and within a large area of low CAI. The ranges bordering Railroad Valley contain some Paleozoic rocks that are at peak thermal levels for hydrocarbon generation (Poole and others, 1979). According to Claypool and others (1979), oil in the Trap Spring field had a Chainman Shale source (Mississippian) whereas oil in the Eagle Springs field probably had a Sheep Pass Formation source (Paleocene). Other workers (Poole and others, 1979) have suggested that the Chainman is the major source of the oil in Railroad Valley.

The high CAI values in eastern Tooele, Utah, and Wasatch Counties, Utah, conform to the superposition of Mississippian, Pennsylvanian, and Permian depocenters in that area. High CAI values in Custer and Butte Counties, Idaho, likewise conform to high overburden values related to a thick northwest-trending accumulation of Mississippian and younger Paleozoic deposits.

CAI MAP OF THE DEVONIAN SYSTEM

This map shows a major decrease in the area of low CAI values compared to the maps for younger systems. The areas of high CAI values are more extensive than but in the same general vicinity as those on the map for the Mississippian System. The thermally complex area between the Golconda thrust system and the leading edge of the Roberts Mountains thrust system represents the composite effects of different thermal levels in klippen, windows, and sheets within an imbricate thrust system as well as thermal highs related to post-Paleozoic igneous activity. East of the leading edge of the Roberts Mountains thrust system, in east-central Nevada and Millard County, Utah, Devonian rocks have low to moderate CAI values which reflect Devonian and younger isopach trends.

CAI MAP OF THE SILURIAN SYSTEM

We have the least number of data points for the Silurian System. In general the Silurian rocks we have sampled have high CAI values. Low to moderate CAI values occur immediately west of and at the leading edge of the Roberts Mountains thrust system in central Nevada and near the central Utah-Nevada border area. As in overlying systems, a CAI high associated with igneous activity occurs along the northern Utah-Nevada border area, mainly the western Tooele County, Utah.

CAI MAP OF THE ORDOVICIAN SYSTEM

Most Ordovician rocks have high CAI values that are related to the composite effects of Ordovician and younger depositional patterns as well as tectonic burial and igneous activity.

Ordovician rocks have moderate CAI values near the center of the Ordovician Ibex basin in Millard County, Utah, and southeast White Pine County, Nevada. This depocenter also overlaps the area of relatively thicker Silurian and Devonian deposition.

The same complex pattern of thermal values associated with the leading edge of the Roberts Mountains thrust system in Eureka, north-central Nye, and western Elko Counties, Nevada, seen on the Devonian CAI map persists on the Ordovician CAI map for the same reasons.

In the overthrust belt of southeast Idaho and northeasternmost Utah, Ordovician rocks have CAI values of 2 to 3½ and are well within peak levels of gas production. In general, stratigraphically higher Paleozoic and Triassic sequences in this area are at the same or lower thermal levels.

Ordovician rocks present fewer target areas for hydrocarbon exploration than Devonian and younger rocks.

ACKNOWLEDGMENTS

Most of the data points are from U.S. Geological Survey conodont collections. We gratefully acknowledge the cooperation of conodont workers and their institutions or companies across the United States who permitted us to index their conodont collections from the Great Basin. We particularly wish to thank specifically those whose large collections contributed substantially to the data base: F. H. Behnken, Augustana College, Rock Island, Ill.; D. L. Clark, Univ. Wisconsin; J. W. Collinson, Ohio State Univ.; R. L. Ethington, Univ. Missouri; Gilbert Klapper, Univ. Iowa; H. R. Lane and J. F. Basemann, Amoco Research Center, Tulsa, Okla.; J. F. Miller, Southwest Missouri Univ.; L. C. Mosher, Phillips Research Center, Bartlesville, Okla.; M. A. Murphy, Univ. California, Riverside.

Thanks are due M. P. Hunt, E. F. MacDonald, L. E. Savoy, and L. J. Vigil for their assistance in sample processing, indexing, map compilation, and drafting and for withstanding the harassment that accompanies the rapid accumulation of data.

The report was reviewed by K. A. Howard, K. B. Ketner, F. G. Poole, and M. E. Taylor. We appreciate their speed, thoroughness, and criticisms. Special thanks are due F. G. Poole for his contribution on regional structure and K. A. Howard for his contribution on regionally metamorphosed Paleozoic rocks; both their contributions are included in the text.

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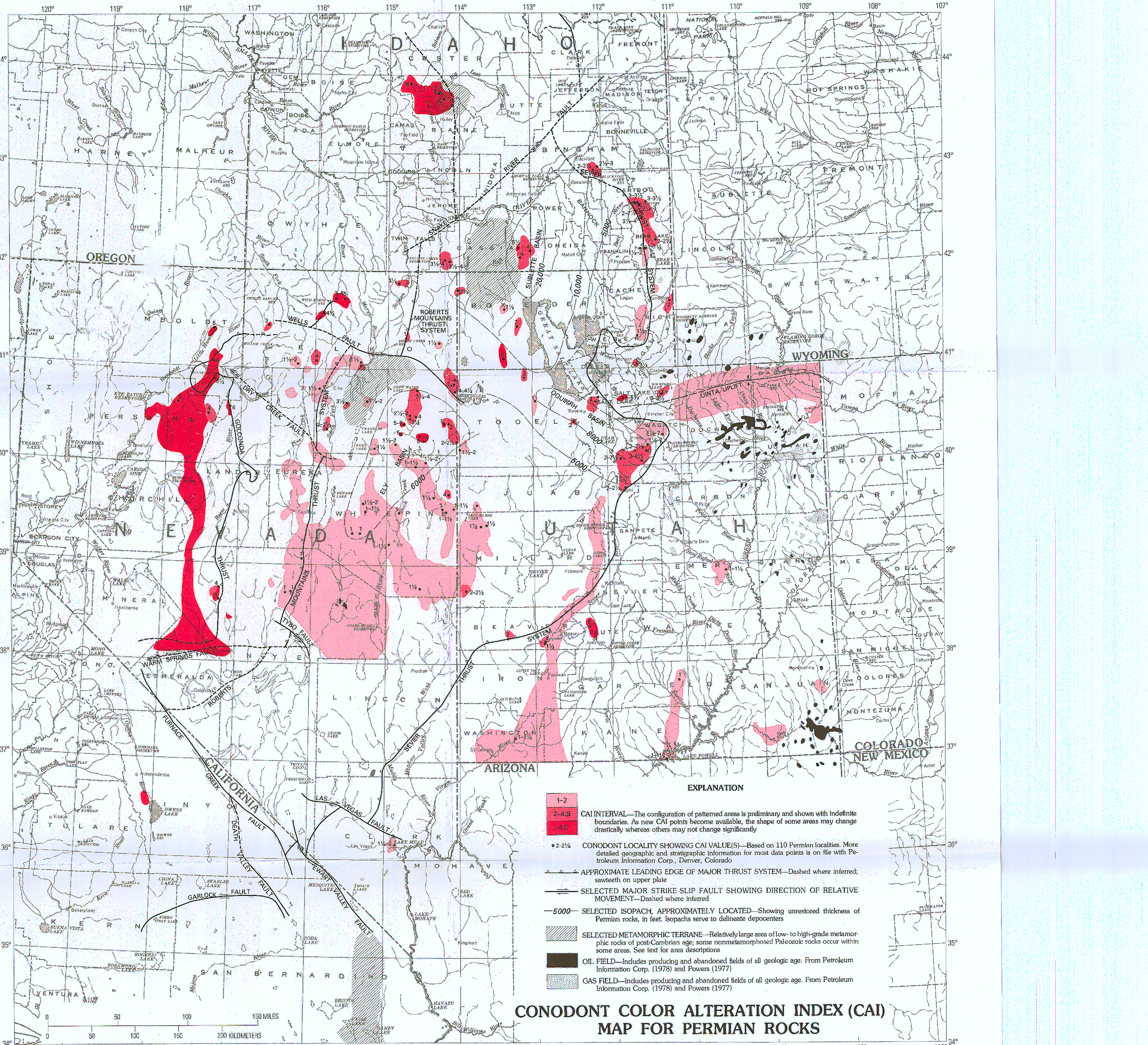
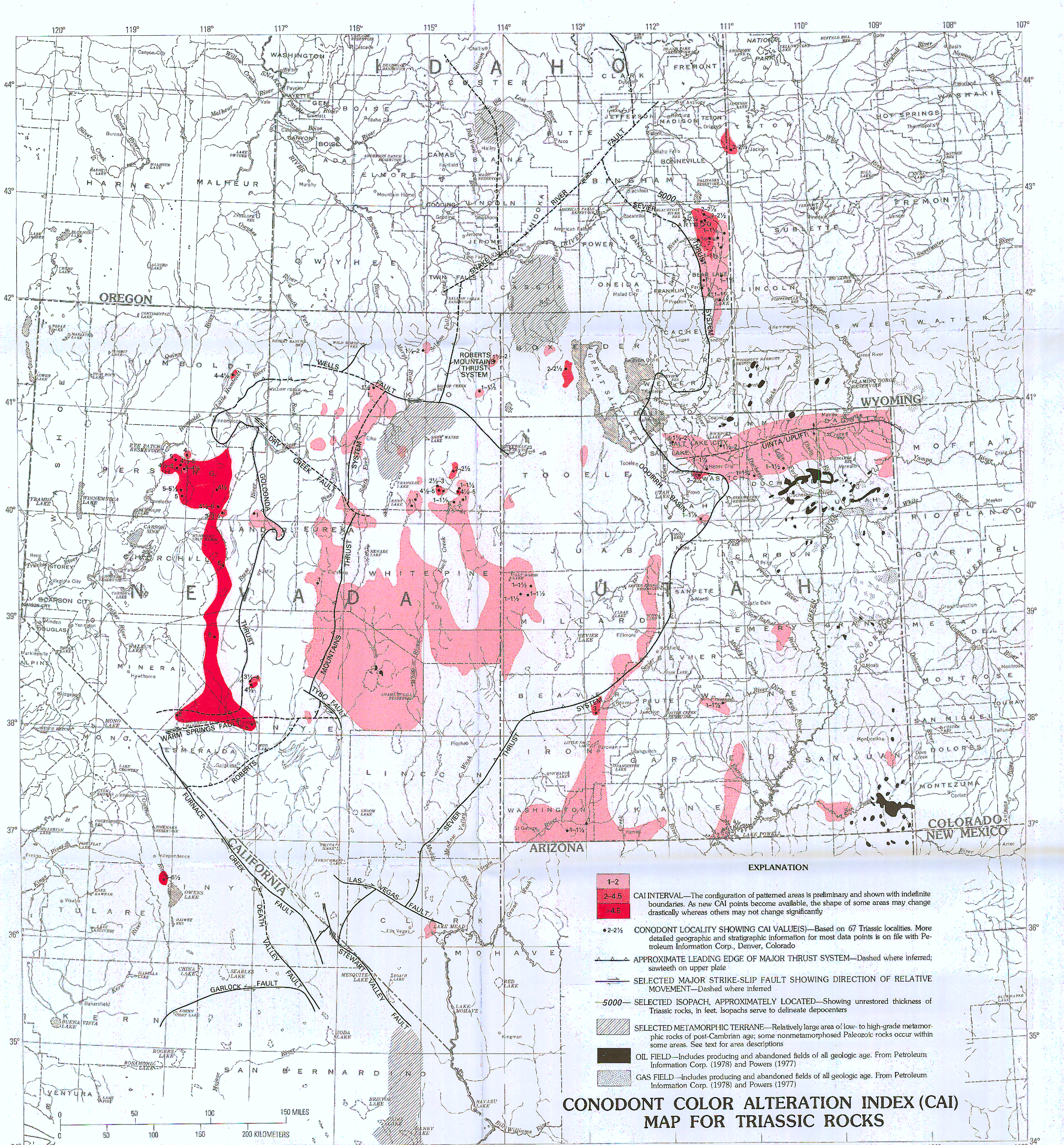
[2] Dept. Geology, College of Charleston, Charleston, S. C.



EXPLANATION

1–2 2–4.5 >4.5	CAI INTERVAL—The configuration of patterned areas is preliminary and shown with indefinite boundaries. As new CAI points become available, the shape of some areas may change drastically whereas others may not change significantly
• 2–2½	CONODONT LOCALITY SHOWING CAI VALUE(S)—Based on 110 Permian localities. More detailed geographic and stratigraphic information for most data points is on file with Petroleum Information Corp., Denver, Colorado
△—△—△	APPROXIMATE LEADING EDGE OF MAJOR THRUST SYSTEM—Dashed where inferred; sawteeth on upper plate
⇄	SELECTED MAJOR STRIKE-SLIP FAULT SHOWING DIRECTION OF RELATIVE MOVEMENT—Dashed where inferred
—5000—	SELECTED ISOPACH, APPROXIMATELY LOCATED—Showing unrestored thickness of Permian rocks, in feet. Isopachs serve to delineate depocenters
▨	SELECTED METAMORPHIC TERRANE—Relatively large area of low- to high-grade metamorphic rocks of post-Cambrian age; some nonmetamorphosed Paleozoic rocks occur within some areas. See text for area descriptions
■	OIL FIELD—Includes producing and abandoned fields of all geologic age. From Petroleum Information Corp. (1978) and Powers (1977)
░	GAS FIELD—Includes producing and abandoned fields of all geologic age. From Petroleum Information Corp. (1978) and Powers (1977)

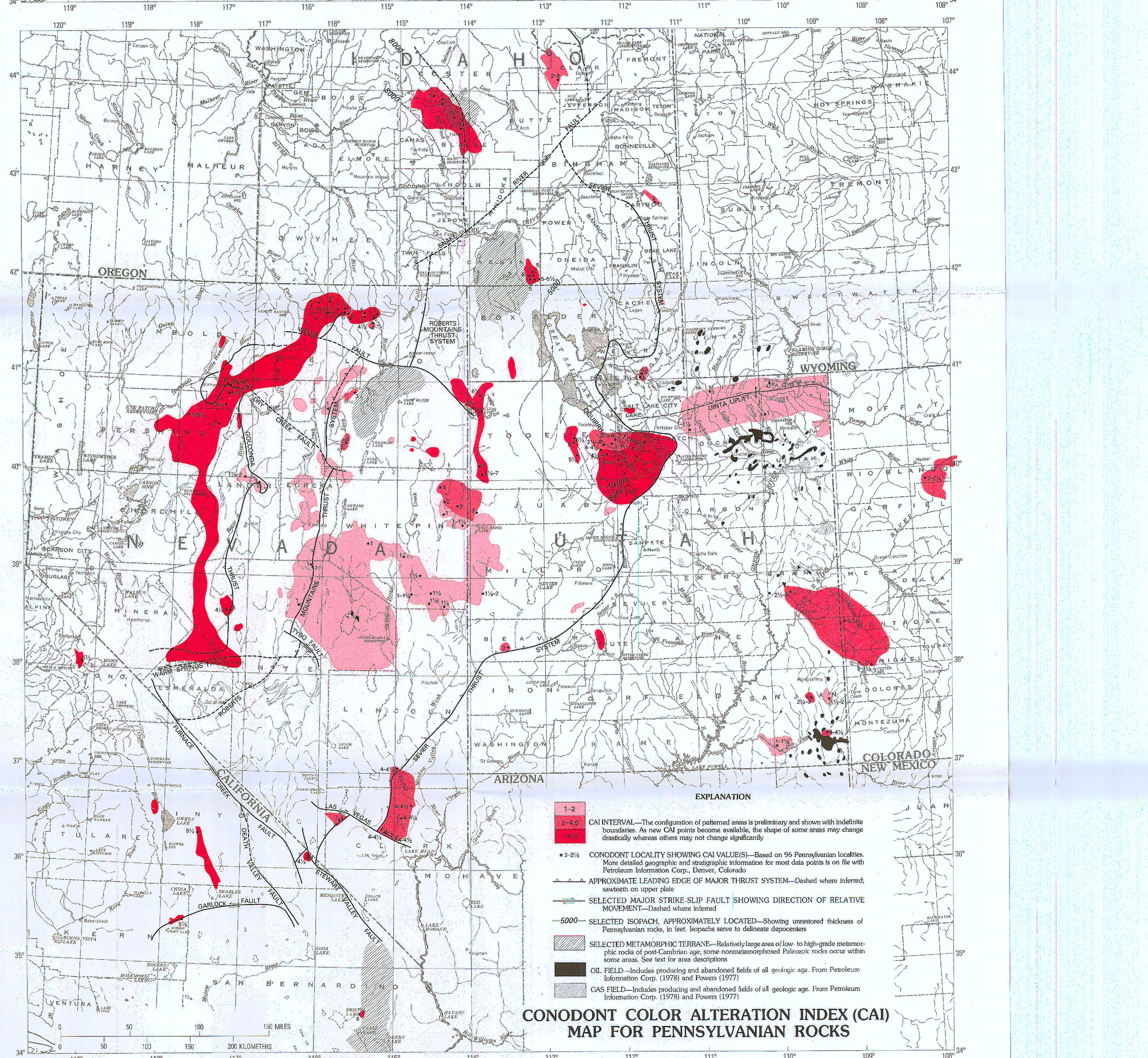
CONODONT COLOR ALTERATION INDEX (CAI) MAP FOR PERMIAN ROCKS



EXPLANATION

1–2 2–4.5 >4.5	CAI INTERVAL—The configuration of patterned areas is preliminary and shown with indefinite boundaries. As new CAI points become available, the shape of some areas may change drastically whereas others may not change significantly
• 2–2½	CONODONT LOCALITY SHOWING CAI VALUE(S)—Based on 67 Triassic localities. More detailed geographic and stratigraphic information for most data points is on file with Petroleum Information Corp., Denver, Colorado
△—△—△	APPROXIMATE LEADING EDGE OF MAJOR THRUST SYSTEM—Dashed where inferred; sawteeth on upper plate
⇄	SELECTED MAJOR STRIKE-SLIP FAULT SHOWING DIRECTION OF RELATIVE MOVEMENT—Dashed where inferred
—5000—	SELECTED ISOPACH, APPROXIMATELY LOCATED—Showing unrestored thickness of Triassic rocks, in feet. Isopachs serve to delineate depocenters
▨	SELECTED METAMORPHIC TERRANE—Relatively large area of low- to high-grade metamorphic rocks of post-Cambrian age; some nonmetamorphosed Paleozoic rocks occur within some areas. See text for area descriptions
■	OIL FIELD—Includes producing and abandoned fields of all geologic age. From Petroleum Information Corp. (1978) and Powers (1977)
░	GAS FIELD—Includes producing and abandoned fields of all geologic age. From Petroleum Information Corp. (1978) and Powers (1977)

CONODONT COLOR ALTERATION INDEX (CAI) MAP FOR TRIASSIC ROCKS



EXPLANATION

1–2 2–4.5 >4.5	CAI INTERVAL—The configuration of patterned areas is preliminary and shown with indefinite boundaries. As new CAI points become available, the shape of some areas may change drastically whereas others may not change significantly
• 2–2½	CONODONT LOCALITY SHOWING CAI VALUE(S)—Based on 96 Pennsylvanian localities. More detailed geographic and stratigraphic information for most data points is on file with Petroleum Information Corp., Denver, Colorado
△—△—△	APPROXIMATE LEADING EDGE OF MAJOR THRUST SYSTEM—Dashed where inferred; sawteeth on upper plate
⇄	SELECTED MAJOR STRIKE-SLIP FAULT SHOWING DIRECTION OF RELATIVE MOVEMENT—Dashed where inferred
—5000—	SELECTED ISOPACH, APPROXIMATELY LOCATED—Showing unrestored thickness of Pennsylvanian rocks, in feet. Isopachs serve to delineate depocenters
▨	SELECTED METAMORPHIC TERRANE—Relatively large area of low- to high-grade metamorphic rocks of post-Cambrian age; some nonmetamorphosed Paleozoic rocks occur within some areas. See text for area descriptions
■	OIL FIELD—Includes producing and abandoned fields of all geologic age. From Petroleum Information Corp. (1978) and Powers (1977)
░	GAS FIELD—Includes producing and abandoned fields of all geologic age. From Petroleum Information Corp. (1978) and Powers (1977)

CONODONT COLOR ALTERATION INDEX (CAI) MAP FOR PENNSYLVANIAN ROCKS

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

By

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1980

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