Text to Accompany:

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COAL RESOURCE OCCURRENCE AND COAL DEVELOPMENT POTENTIAL MAPS OF THE ROUND BOTTOM QUADRANGLE, MOFFAT COUNTY, COLORADO

(Report includes 6 plates)

Prepared for

UNITED STATES DEPARTMENT OF THE INTERIOR

GEOLOGICAL SURVEY

by

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This report has not been edited for conformity with U.S. Geological Survey editorial standards or stratigraphic nomenclature.

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INTRODUCTION

Purpose

This text is to be used in conjunction with Coal Resource Occurrence and Coal Development Potential Maps of the Round Bottom quadrangle, Moffat County, Colorado. This report was compiled to support the land planning work of the Bureau of Land Management (BLM) and to provide a systematic coal resource inventory of Federal coal lands in Known Recoverable Coal Resource Areas (KRCRA's) in the western United States. This investigation was undertaken by Dames & Moore, Denver, Colorado, at the request of the U.S. Geological Survey under contract number 14-08-0001-15789. The resource information gathered for this report is in response to the Federal Coal Leasing Amendments Act of 1976 (P.L. 94-377). Published and unpublished public information available through August, 1978, was used as the data base for this study. No new drilling or field mapping was performed as a part of this study, nor was any confidential data used.

Location

The Round Bottom quadrangle is located in southeastern Moffat County in northwestern Colorado, approximately 7 miles (11 km) southwest of Craig via Colorado Highway 13 (also known as Colorado Highway 789) and 35 miles (56 km) north-northeast of Meeker via Colorado Highway 13. With the exception of several scattered ranches, the quadrangle is unpopulated.

Accessibility

Colorado Highway 13 crosses through the southeastern part of the quadrangle and joins U.S. Highway 40 west of Craig. U.S. Highway 40 crosses east-west approximately 1 mile (1.6 km) north of the quadrangle. An improved light-duty road crosses southwesterly through the central part of the quadrangle. The remainder of the quadrangle is accessible by a number of unimproved dirt roads and trails.

Railway service for the Round Bottom quadrangle is provided by the Denver and Rio Grande Western Railroad from Denver to the railhead at Craig. The railroad is the major transportation route for coal shipped east from northwestern Colorado (U.S. Bureau of Land Management, 1977).

Physiography

The Round Bottom quadrangle lies in the southern part of the Wyoming Basin physiographic province, as defined by Howard and Williams (1972). The quadrangle is approximately 52 miles (84 km) west of the Continental Divide.

The landscape in the southern third of the quadrangle is dominated by moderate to steep slopes and narrow valleys. This area includes the Williams Fork Mountains in the southeastern part of the quadrangle and Iles Mountain on the south-central edge of the quadrangle. The northern two thirds of the quadrangle, generally northwest of the Yampa River, is characterized by broad slopes, wide valleys, and low hills. Two large areas along the Yampa River, Round Bottom and Big Bottom, are relatively flat. Bell Rock is located in the north-central part of the quadrangle.

Altitudes range from 7,440 feet (2,268 m) on Iles Mountain to less than 6,080 feet (1,853 m) along the Yampa River in the southwestern part of the quadrangle.

The Round Bottom quadrangle is drained by the Yampa River and Williams Fork through a series of intermittent creeks and their tributaries, which flow mainly in response to snowmelt in the spring. The Yampa River flows southwesterly from the northeastern to the southwestern edge of the quadrangle. The Williams Fork flows north-northwestward from the southeastern corner of the quadrangle and joins the Yampa River in the east-central part of the quadrangle.

Climate and Vegetation

The climate of northwestern Colorado is semiarid. Clear, sunny days prevail in the Round Bottom quadrangle area, with daily temperatures typically varying from 0° to 35°F (-18° to 2°C) in January and from 42° to 80° F (6° to 27° C) in July. Annual precipitation in the area averages 14 inches (36 cm). Snowfall during the winter months accounts for the major part of the precipitation in the area; however, rainfall from thundershowers during the summer months also contributes to the total. Winds are generally from the west, averaging approximately 3 miles per hour (5 km per hour), but wind directions and velocities tend to vary greatly depending on the local terrain (U.S. Bureau of Land Management, 1977).

The predominant vegetation in the Round Bottom area is sagebrush, but much of the flatter land in the northern half of the quadrangle is utilized as cropland. Vegetation on Iles Mountain and the Williams Fork Mountains is dominated by pinyon, juniper, and mountain shrubs, which include serviceberry, Gambel oak, and rabbitbrush (U.S. Bureau of Land Management, 1977).

Land Status

The Round Bottom quadrangle lies in the southwestern part of the Yampa Known Recoverable Coal Resource Area (KRCRA). Most of the quadrangle, approximately 92 percent, lies within the KRCRA and the Federal government owns the coal rights for approximately three fourths of that area. Four active coal leases are located in the east-central part of the quadrangle as shown on plate 2.

GENERAL GEOLOGY

Previous Work

The first geologic description of the general area in which the Round Bottom quadrangle is located was included by Emmons (1877) as part of a survey of the Fortieth Parallel. The decision to build a railroad into the region stimulated several investigations of coal between 1886 and 1905, including papers by Hewett (1889), Hills (1893), and Storrs (1902). Fenneman and Gale (1906) conduted geologic studies of the Yampa Coal Field and included a description of the geology and coal occurrence in the Round Bottom quadrangle in their report. Hancock (1925) reported on the Axial and Monument Butte 15-minute quadrangles, which includes the entire Round Bottom quadrangle, and is the most comprehensive work on the area. Tweto (1976) compiled a generalized regional geologic map which also includes this quadrangle. A report by Johnson (1978) included geophysical logs of coal test holes drilled by the U.S. Geological Survey in the Round Bottom quadrangle during 1977.

Stratigraphy

Rock formations cropping out in the Round Bottom quadrangle range in age from Late Cretaceous to Miocene, and include the coal-bearing Iles and Williams Fork Formations of the Mesaverde Group.

The Mancos Shale of Late Cretaceous age occurs in the subsurface of the Round Bottom quadrangle. It is composed of a thick sequence of gray to dark-gray shale with a number of tan silty thin-bedded ridge-forming sandstones interbedded with sandy shale and shale in the upper 1,000 feet (305 m) of the formation (Hancock, 1925; Bass and others, 1955).

The Mesaverde Group of Late Cretaceous age conformably overlies the Mancos Shale and contains two formations, the Iles and the Williams Fork.

The Iles Formation ranges from approximately 1,320 to 1,500 feet (402 to 457 m) in thickness where measured in oil and gas wells drilled in the quadrangle and crops out in the southeastern part of the quadrangle (Hancock, 1925). The basal "rim rock" sandstone (Hancock, 1925; Konishi, 1959) ranges from approximately 25 to 65 feet (8 to 20 m) thick and consists of tan to brown massive sandstone. Overlying the "rim rock" sandstone is approximately 1,205 to 1,385 feet (367 to 422 m) of light-colored thin-bedded sandstone, interbedded with gray sandy shale and coal. The coal beds found in this sequence, designated as the Lower Coal

Group, were first described by Fenneman and Gale (1906). The overlying Trout Creek Sandstone Member consists of approximately 50 to 85 feet (15 to 26 m) of white, fine-grained, thick-bedded to massive cliff-forming sandstone. The top of the Trout Creek Sandstone Member forms the contact between the Iles Formation and the conformably overlying Williams Fork Formation (Hancock, 1925; Bass and others, 1955).

The Williams Fork Formation crops out in the southern half and through the north-central part of the quadrangle (Hancock, 1925). The formation is divided into three units: a lower coal-bearing unit, the Twentymile Sandstone Member, and an upper coal-bearing unit (Bass and others, 1955).

The lower coal-bearing unit of the Williams Fork Formation extends from the top of the Trout Creek Sandstone Member of the Iles Formation to the base of the Twentymile Sandstone Member. It ranges in thickness from approximately 840 to 1,020 feet (256 to 311 m) where measured in the oil and gas wells drilled in the quadrangle and consists of thin-bedded sandstone, dark-gray to black sandy shale, carbonaceous shale, and lenticular coal beds (Hancock, 1925; Bass and others, 1955). Fenneman and Gale (1906) have designated the coal in this lower unit as the Middle Coal Group.

The Twentymile Sandstone Member ranges from approximately 95 to 100 feet (29 to 30 m) thick where measured in the oil and gas wells and is, characteristically, a white fine-grained massive sandstone (Hancock, 1925; Bass and others, 1955).

The upper coal-bearing unit of the Williams Fork Formation overlies the the Twentymile Sandstone Member. Information is not available on the thickness of this unit in the Round Bottom quadrangle; however, in the Easton Gulch quadrangle to the east it is estimated to be about 820 feet (250 m) thick. It is composed of interbedded dark-gray shale, massive white sandstone, sandy shale, and coal beds (Bass and others, 1955). The coal beds in this upper unit, between the top of the Twentymile Sandstone

Member and the base of the Lewis Shale, form the Upper Coal Group (Fenneman and Gale, 1906).

The Lewis Shale of Late Cretaceous age conformably overlies the Williams Fork Formation and crops out in the northwestern and northeastern parts of the quadrangle along the axes of the Round Bottom and Big Bottom synclines. It consists of dark-gray shale interbedded with a few thin beds of sandstone (Hancock, 1925). The total thickness of the Lewis Shale is unknown in this quadrangle, but it ranges in thickness from 2,140 to 2,220 feet (652 to 677 m) where measured in the oil and gas wells in the Craig quadrangle to the northeast.

The Miocene-age Browns Park Formation rests unconformably on the Williams Fork Formation and Lewis Shale on the north-central edge of the quadrangle. It is composed of fluvial siltstone, claystone, conglomerate, and loosely consolidated eolian tuffaceous sandstone, becoming more conglomeratic toward the base (Hancock, 1925; Tweto, 1976).

Holocene deposits of alluvium cover the stream valleys of the Yampa River and the Williams Fork.

The Cretaceous formations exposed in the Round Bottom quadrangle accumulated close to the western edge of a Late Cretaceous epeirogenic seaway which covered part of the western interior of North America. Several transgressive-regressive cycles caused the deposition of a series of offshore-marine, shallow-marine, marginal-marine, and non-marine sediments in the Round Bottom quadrangle area (Ryer, 1977).

The Mancos Shale was deposited in an offshore marine environment which existed east of the shifting strand line. Deposition of the Mancos Shale in the quadrangle area ended with the eastward migration of the shoreline, and the subsequent deposition of the Iles Formation (Konishi, 1959; Kucera, 1959).

The interbedded sandstone, shale, and coal of the Mesaverde Group were deposited as a result of minor changes in the position of the shoreline. Near-shore marine, littoral, brackish tidal, brackish and fresh water supratidal, and fluvial environments existed during the deposition of the Iles and Williams Fork Formations. The major sandstones of the Iles and Williams Fork Formations were deposited in shallow marine and near-shore environments. The lenticular coal beds of the Lower, Middle, and Upper Coal Groups were generally deposited in environments associated with fluvial systems, such as back-levee and coastal plain swamps, interchannel basin areas, and abandoned channels (Konishi, 1959; Kucera, 1959).

Deposition of the Lewis Shale marked a landward movement of the sea. The marine sediments of the Lewis Shale were deposited in water depths ranging from a few tens of feet to several hundred feet until a regional uplift west of the Yampa Basin area caused a regression of the sea and ended the deposition of the Lewis Shale in the area (Kucera, 1959).

The Miocene-age Browns Park Formation was deposited in the Round Bottom quadrangle after a long period of non-deposition and erosion. The coarse conglomeratic nature of the base of the Browns Park Formation and the fine wind-blown tuffaceous sands of the upper part of the formation suggest that it was deposited during a time when the climate of the region was changing from one of relatively high rainfall to one of semiaridity, such as is found in the region today (Carey, 1955).

Structure

The Yampa KRCRA lies in the southern extension of the Washakie/Sand Wash structural basin of south-central Wyoming. The basin is bordered on the east by the Park Range, approximately 50 miles (80 km) east of the Round Bottom quadrangle, and on the southwest by the Axial Basin anticline, approximately 4 miles (6 km) southwest of the quadrangle (Hancock, 1925; Tweto, 1976).

A series of anticlines and synclines, generally trending northwest, cross the Round Bottom quadrangle. The Big Bottom syncline lies in the northeast corner of the quadrangle. It trends from east-west on the eastern side of the quadrangle, to north-south on the northern edge of the quadrangle. The southern part of the Bell Rock dome lies on the north-central edge of the quadrangle. This dome is part of the north-northwest-trending Williams Fork anticline which crosses through the central and southeastern parts of the quadrangle. The Round Bottom syncline, paralleling the Williams Fork anticline, crosses the western half of the quadrangle (Hancock, 1925).

Three major faults cut the Cretaceous-age rocks in the northern quarter of the Round Bottom quadrangle and are shown on plate 1 (Hancock, 1925; Bergin, 1959; and Tweto, 1976). Two of the faults in the northwestern part of the quadrangle strike northwest, while the easternmost fault along the northern edge of the quadrangle strikes east-west. Numerous other faults have been postulated by the Utah Construction and Mining Company in reports describing several inactive coal prospecting permits (U.S. Geological Survey, 1962). These faults lie in the central part of the quadrangle, but they are not shown on plate 1 because their inferred existence could not be substantiated.

COAL GEOLOGY

Numerous coal beds of the Lower, Middle, and Upper Coal Groups have been identified in the Round Bottom quadrangle. The Lower Coal Group includes all coal beds in the Iles Formation below the Trout Creek Sandstone Member. None of the Lower Coal Group coal beds are known to exceed Reserve Base thickness (5 feet or 1.5 meters) in this quadrangle. The Middle Coal Group includes the coal beds in the lower coal-bearing zone of the Williams Fork Formation between the Trout Creek Sandstone Member of the Iles Formation and the Twentymile Sandstone Member of the Williams Fork Formation. The Upper Coal Group includes the coal beds in the upper Williams Fork Formation above the Twentymile Sandstone Member.

In general, the Middle and Upper Coal Groups contain numerous coal beds that are usually thin, lenticular, and of limited areal extent, and only about 15 percent of the coal beds exceeding Reserve Base thickness can be correlated between outcrops and/or drill holes. Additional investigation would certainly increase this percentage. The remaining 85 percent of the coal beds were identified at one location only and have been treated as isolated data points (see Isolated Data Points section of this report). None of the coal beds are formally named, but where coal beds exceed Reserve Base thickness they have been given bracketed numbers for identification purposes.

Dotted lines shown on some of the derivative maps represent a limit of confidence beyond which isopach, structure contour, overburden isopach, and areal distribution and identified resources maps are not drawn because of insufficient data, even where it is believed that the coal beds may continue to be greater than Reserve Base thickness beyond the dotted lines.

Chemical analyses of coal.--Analyses of the coals in this area are listed in table 1 and include samples from the Middle and Upper Coal Groups. In general, chemical analyses indicate that the coals in the Middle Coal Group are high-volatile C bituminous and the coals in the Upper Coal Group probably range from subbituminous A to high-volatile C bituminous in rank on a moist, mineral-matter-free basis according to ASTM Standard Specification D 388-77 (American Society for Testing and Materials, 1977).

Middle Coal Group

Sixty-six coal beds exceeding Reserve Base thickness in the Middle Coal Group have been identified throughout the quadrangle. Of these, only 12 coal beds were isopached; the remaining 54 coal beds, including seven located on non-Federal land, were treated as isolated data points.

The isopach maps of the 12 Middle Coal Group coal beds identified in outcrops or drill holes in this quadrangle are shown in figures 4, 8, 12, 16, 19, 22, 26, 29, 33, 36, 39, and 42. (All figures are attached to the end of this report). All of the coal beds occur in the north-central part of the quadrangle and lie on the axis of the north-northwest-trending Williams Fork anticline. Two northwest-striking faults also cut the coal beds in this area. One fault cuts across the axis of the anticline while the other lies approximately one mile (1.6 km) north of the anticline. The coal beds range in thickness from 3.0 to 20.0 feet (0.9 to 6.1 m). Rock partings, ranging from 2.0 to 5.0 feet (0.6 to 1.5 m) thick, occur locally. All of the coal beds, except the MG[5] (i.e., Middle Coal Group, coal bed [5]) and the MG[10] coal beds, have been identified in the Pine Ridge quadrangle to the north where the coal beds have the same designation.

Another Middle Group coal bed, the MG[209], has been projected into the west-central edge of the quadrangle based on measurements made in the adjacent Horse Gulch quadrangle where the coal bed ranges from 8.5 to 12.0 feet (2.6 to 3.7 m) in thickness. In sec. 32, T. 6 N., R. 92 W., of this quadrangle, the coal bed is believed to range from 8 to 11 feet (2.4 to 3.4 m) in thickness (figure 44).

Upper Coal Group

Sixty-eight coal beds exceeding Reserve Base thickness have been identified in the Upper Coal Group, and only four of these were isopached. Of the remaining 64 coal beds, six are located on non-Federal land and 58 are located on lands for which the Federal government owns the coal rights. All of the non-isopached coal beds are treated as isolated data points.

The isopach maps of the four Upper Coal Group coal beds identified in this quadrangle are shown in figures 48, 52, 55, and 59. These coal beds were identified in the north-central part of the quadrangle. They lie on the north-northwest-trending Williams Fork anticline and are cut by two northwest-trending faults parallel to the fold axis. These coal beds are thin and lenticular, ranging in thickness from 4.0 to 12.0 feet (1.2 to 3.7 m). Rock partings were not reported in any of the coal beds. All four coal beds extend northward into the Pine Ridge quadrangle and have the same designation in that quadrangle.

Two other Upper Coal Group coal beds have not been identified in the Round Bottom quadrangle, but are believed to extend into the west-central edge of the quadrangle based on drill-hole data extrapolated from adjacent the Horse Gulch quadrangle. The UG[247] coal bed ranges from 9.0 to 9.5 feet (2.7 to 2.9 m) in thickness in the Horse Gulch quadrangle and is believed to be as much as 9 feet (2.7 m) thick where projected into sec. 32, T. 6 N., R. 92 W., of this quadrangle. The UG[251] coal bed ranges in thickness from 2.3 to 10.5 feet (0.7 to 3.2 m) where measured in the Horse Gulch quadrangle, and it is inferred to range from 5 to 7 feet (1.5 to 2.1 m) in thickness where projected into secs. 29 and 32, T. 6 N., R. 92 W.

Undifferentiated Williams Fork Coal Beds

Two coal beds greater than Reserve Base thickness, the Williams Fork [90] and [142], cannot be located in the stratigraphic section with enough accuracy to place the coal beds in either the Middle or Upper Coal Groups. Since each of these coal beds were encountered at only one location, they are treated as isolated data points.

Isolated Data Points

In instances where single or isolated measurements of coal beds thicker than 5.0 feet (1.5 m) are encountered, the standard criteria for construction of isopach, structure contour, mining ratio, and overburden isopach maps are not available. The lack of data concerning these beds limits the extent to which they can be reasonably projected in any direction and usually precludes correlations with other, better known beds. For this reason, isolated data point maps are included on a separate plate for non-isopached coal beds (plate 4). Because of the extreme lenticularity of the coal beds in this quadrangle, it is assumed that these coal beds maintain their measured thickness for only 1,000 feet (305 m) in all directions from their points of measurement. Also, where the inferred limit of influence from the isolated data point is entirely within non-Federal land areas, an isolated data point map is not constructed for the coal bed.

COAL RESOURCES

Data from drill holes, mine measured sections, and outcrop measurements (Hancock, 1925; U.S. Geological Survey, 1962; and Johnson, 1978) were used to construct outcrop, isopach, and structure contour maps of the coal beds in the Round Bottom quadrangle. The source of each indexed data point shown on plate 1 is listed in table 4.

Coal resources for Federal land were calculated using data obtained from the coal isopach maps and the areal distribution and identified resources maps. The coal bed acreage (measured by planimeter), multiplied by the average thickness of the coal bed and by a conversion factor of 1,770 short tons of coal per acre-foot (13,018 metric tons per hectare-meter) for subbituminous coal, or 1,800 short tons of coal per acre-foot (13,238 metric tons per hectare-meter) for bituminous coal, yields the coal resources in short tons of coal for each coal bed. Coal beds thicker than 5 feet (1.5 m) that lie less than 3,000 feet (914 m) below the ground surface are included. These criteria differ somewhat from those stated in U.S. Geological Survey Bulletin 1450-B which call for a minimum thickness of 28 inches (70 cm) for bituminous coal and a maximum depth of 1,000 feet (305 m) for both subbituminous and bituminous coal.

Reserve Base and Reserve tonnages for the isopached coal beds are shown on the areal distribution and identified resources maps, and are rounded to the nearest 10,000 short tons (9,072 metric tons). Only Reserve Base tonnages (designated as inferred resources) are calculated for areas influenced by the isolated data points. Coal Reserve Base tonnages per Federal section are shown on plate 2 and total approximately 315.75 million short tons (286.45 million metric tons) for the entire quadrangle, including the tonnages for the isolated data points. Reserve Base tonnages in the various development potential categories for surface and subsurface mining methods are shown in tables 2 and 3.

Dames & Moore has not made any determination of economic recoverability for any of the coal beds described in this report.

COAL DEVELOPMENT POTENTIAL

Coal development potential areas are drawn to coincide with the boundaries of the smallest legal land subdivisions shown on plate 2. In sections or parts of sections where no land subdivisions have been surveyed by the BLM, approximate 40-acre (16-ha) parcels have been used to show the limits of the high, moderate, or low development potentials. A constraint imposed by the BLM specifies that the highest development potential affecting any part of a 40-acre (16-ha) lot, tract, or parcel be applied to that entire lot, tract, or parcel. For example, if 5 acres (2 ha) within a parcel meet criteria for a high development potential; 25 acres (10 ha), a moderate development potential; and 10 acres (4 ha), a low development potential; then the entire 40 acres (16 ha) are assigned a high development potential.

Development Potential for Surface Mining Methods

Areas where the coal beds of Reserve Base thickness are overlain by 200 feet (61 m) or less of overburden are considered to have potential for surface mining and are assigned a high, moderate, or low development potential based on the mining ratio (cubic yards of overburden per ton of recoverable coal). The formula used to calculate mining ratios for surface mining of coal is shown below:

$$MR = \frac{t_o\ (cf)}{t_c\ (rf)}$$

where MR = mining ratio

t_o = thickness of overburden in feet

t_c = thickness of coal in feet

rf = recovery factor (85 percent for this quadrangle)

cf = conversion factor to yield MR value in terms of cubic yards of overburden per short tons of recoverable coal:
0.911 for subbituminous coal
0.896 for bituminous coal

Note: To convert mining ratio to cubic meters of overburden per metric ton of recoverable coal, multiply MR by 0.8428.

Areas of high, moderate, and low development potential for surface mining methods are defined as areas underlain by coal beds having respective mining-ratio values of 0 to 10, 10 to 15, and greater than 15. These mining ratio values for each development potential category are based on economic and technological criteria and were provided by the U.S. Geological Survey.

Areas where the coal data is absent or extremely limited between the 200-foot (61-m) overburden line and the outcrop are assigned unknown development potential for surface mining methods. This applies to areas where coal beds 5 feet (1.5 m) or more thick are not known, but may occur, and to those areas influenced by isolated data points. Limited knowledge pertaining to the areal distribution, thickness, depth, and attitude of the coal beds prevents accurate evaluation of development potential in the high, moderate, and low categories. The areas influenced by isolated data points in this quadrangle total approximately 24.68 million short tons (22.39 million metric tons) of coal available for surface mining.

The coal development potential for surface mining methods is shown on plate 5. All of the Federal land areas having a known development potential for surface mining are rated low. The remaining Federal lands within the KRCRA boundary are classified as having unknown development potential for surface mining methods.

Development Potential for Subsurface and In-Situ Mining Methods

Areas considered to have a development potential for conventional subsurface mining methods include those areas where coal beds of Reserve Base thickness are between 200 and 3,000 feet (61 and 914 m) below the ground surface which have dips of 15° or less. Unfaulted coal beds lying between 200 and 3,000 feet (61 and 914 m) below the ground surface, dipping greater than 15°, are considered to have development potential for in-situ mining methods.

Areas of high, moderate, and low development potential for conventional subsurface mining are defined as areas underlain by coal beds of Reserve Base thickness at depths ranging from 200 to 1,000 feet (61 to 305 m), 1,000 to 2,000 feet (305 to 610 m), and 2,000 to 3,000 feet (610 to 914 m) below the ground surface, respectively.

Areas where the coal data is absent or extremely limited between 200 and 3,000 feet (61 and 914 m) below the ground surface are assigned unknown development potentials. This applies to areas where coal beds of Reserve Base thickness are not known, but may occur, and to those areas influenced by isolated data points. The areas influenced by isolated data points in this quadrangle contain approximately 81.22 million short tons (73.68 million metric tons) of coal available for conventional subsurface mining.

The coal development potential for conventional subsurface mining methods is shown on plate 6. Of the Federal land areas having a known development potential for conventional subsurface mining methods, 74 percent are rated high and 26 percent is rated moderate. The remaining Federal lands within the KRCRA boundary are classified as having unknown development potential for conventional subsurface mining methods.

Based on criteria provided by the U.S. Geological Survey, coal beds of Reserve Base thickness dipping between 15° and 35°, regardless of tonnage, have low development potential for in-situ mining methods. Coal lying between the 200-foot (61-m) overburden isopach and the outcrop is not included in total coal tonnages available because it is needed for cover and containment in the in-situ process.

All of the Federal lands where the dip of the coal beds exceeds 15° are rated low for in-situ development potential because faults are present and only approximately 2.73 million short tons (2.48 million metric tons) of coal distributed through six different coal beds are believed to be available for in-situ mining. The remaining Federal lands within the proposed KRCRA boundary are classified as having unknown development potential for in-situ mining methods.

Table 1. -- Chemical analyses of coals in the Round Bottom quadrangle, Moffat County, Colorado.

Location	COAL BED NAME	Form of Analysis	Proximate				Ultimate					Heating Value	
			Moisture	Volatile Matter	Fixed Carbon	Ash	Sulfur	Hydrogen	Carbon	Nitrogen	Oxygen	Calories	Btu/Lb
NW¼ sec. 6, T. 5 N., R. 91 W., Wise Mine (George and others, 1937)	Middle Coal Group	A	13.3	33.5	45.8	7.4	0.5	-	-	-	-	-	10,510
		C	-	38.6	52.9	8.5	0.6	-	-	-	-	-	12,110
SW¼ SE¼ sec. 31, T. 6 N., R. 91 W., Ratcliff Mine (George and others, 1937)	Middle Coal Group	A	13.5	35.5	47.8	3.5	0.3	-	-	-	-	-	11,010
		C	-	41.0	55.3	3.7	0.4	-	-	-	-	-	12,720
Sec. 31, T. 6 N., R. 91 W., Wisehill #5 (Eagle #5) Mine (Dawson and Murray, 1978)	Upper Coal Group	A	16.0	-	-	5.8	0.5	-	-	-	-	-	10,600
NW¼ SW¼ sec. 29, T. 6 N., R. 91 W., Haubrich Mine (George and others, 1937)	Upper Coal Group	A	17.8	30.4	48.0	3.8	0.5	-	-	-	-	-	10,340
		C	-	37.0	58.4	4.6	0.6	-	-	-	-	-	12,570

Form of Analysis: A, as received
C, moisture free

Note: To convert Btu/pound to kilojoules/kilogram, multiply by 2.326

Table 2. -- Coal Reserve Base data for surface mining methods for Federal coal lands (in short tons) in the Round Bottom quadrangle, Moffat County, Colorado.

Coal Bed or Zone	High Development Potential	Moderate Development Potential	Low Development Potential	Unknown Development Potential	Total
UG {10}	-	-	270,000	-	270,000
Isolated Data Points	-	-	-	24,680,000	24,680,000
Totals	-	-	270,000	24,680,000	24,950,000

NOTE: To convert short tons to metric tons, multiply by 0.9072.

Table 3. -- Coal Reserve Base data for subsurface mining methods for Federal coal lands (in short tons) in the Round Bottom quadrangle, Moffat County, Colorado.

Coal Bed or Zone	High Development Potential	Moderate Development Potential	Low Development Potential	Unknown Development Potential	Total
UG {251}	3,320,000	40,000	-	-	3,360,000
UG {247}	1,470,000	-	-	-	1,470,000
UG {10}	12,140,000	140,000	-	-	12,280,000
UG {9}	4,590,000	280,000	-	-	4,870,000
UG {4}	1,150,000	1,770,000	-	-	2,920,000
UG {3}	670,000	1,200,000	-	-	1,870,000
MG {209}	-	2,190,000	-	-	2,190,000
MG {15}	1,420,000	710,000	-	-	2,130,000
MG {14}	40,000	3,290,000	-	860,000*	4,190,000
MG {13}	5,400,000	34,760,000	-	50,000*	40,210,000
MG {12}	360,000	6,590,000	-	-	6,950,000
MG {11}	60,000	25,360,000	920,000	-	26,340,000
MG {10}	-	1,010,000	-	-	1,010,000
MG {8}	-	39,330,000	2,580,000	-	41,910,000
MG {7}	-	3,620,000	230,000	-	3,850,000
MG {6}	-	5,400,000	1,510,000	490,000*	7,400,000
MG {5}	-	11,540,000	110,000	160,000*	11,810,000
MG {2}	-	19,040,000	6,630,000	820,000*	26,490,000
MG {1}	-	5,310,000	2,670,000	350,000*	8,330,000
Isolated Data Points	-	-	-	81,220,000	81,220,000
Totals	30,620,000	161,580,000	14,650,000	83,950,000	290,800,000

NOTE: To convert short tons to metric tons, multiply by 0.9072.

*Tonnages for coal beds dipping greater than 15 degrees.

Table 4. -- Sources of data used on plate 1

Plate 1 Index Number	Source	Data Base
1	Johnson, E. A., 1978, U.S. Geological Survey Open-File Report 78-229	Drill hole No. E-1-RdB
2	Hancock, E. T., 1925, U.S. Geological Survey Bulletin 757, pl. 11 and 18	Measured Section Nos. 315-319
3		Measured Section Nos. 311 and 313-314
4		Measured Section No. 328
5		Measured Section Nos. 325, 327, and 330
6		Measured Section Nos. 321, 324, 326, and 329
7		Measured Section Nos. 322-323
8	U.S. Geological Survey, 1962, Inactive Coal Prospecting Permit No. Colorado 066623, Utah Construction and Mining Company	Drill hole No. S-26
9	Hancock, E. T., 1925, U.S. Geological Survey Bullein 757, pl. 10 and 18	Measured Section Nos. 418-419
10	U.S. Geological Survey, 1962, Inactive Coal Prospecting Permit No. Colorado 066623, Utah Construction and Mining Company	Drill hole No. S-25
11		Drill hole No. S-7
12		Drill hole No. S-22

Table 4. -- Continued

Plate 1 Index Number	Source	Data Base
13	U.S. Geological Survey, 1962, Inactive Coal Prospecting Permit No. Colorado 066623, Utah Construction and Mining Company	Drill hole No. S-9
14	↓	Drill hole No. S-12
15	U.S. Geological Survey, 1962, Inacative Coal Prospecting Permit No. Colorado 066620, Utah Construction and Mining Company	Drill hole No. S-6
16	Hancock, E. T., 1925, U.S. Geological Survey Bulletin 757, pl. 10 and 18	Measured Section Nos. 414-416
17	U.S. Geological Survey, 1962, Inactive Coal Prospecting Permit No. Colorado 066620, Utah Construction and Mining Company	Drill hole No. S-8
18	Johnson, E. A., 1978, U.S. Geological Survey Open-File Report 78-229	Drill hole No. E-2-RdB
19	U.S. Geological Survey, 1962, Inactive Coal Prospecting Permit No. Colorado 066620, Utah Construction and Mining Company	Drill hole No. S-11
20	↓	Drill hole No. S-3
21	↓	Drill hole No. S-4
22	↓	Drill hole No. S-2
23	↓	Drill hole No. S-5
24	Johnson, E. A., 1978, U.S. Geological Survey Open-File Report 78-229	Drill hole No. E-3-RdB
25	U.S. Geological Survey, 1962, Inactive Coal Prospecting Permit No. Colorado 066620, Utah Construction and Mining Company	Drill hole No. S-13

Table 4. -- Continued

Plate 1 Index Number	Source	Data Base
26	Johnson, E. A., 1978, U.S. Geological Survey Open-File Report 78-229	Drill hole No. E-4-RdB
27	↓	Drill hole No. E-5-RdB
28	Hancock, E. T., 1925, U.S. Geological Survey Bulletin 757, pl. 10 and 18	Measured Section No. 413
29	↓	Measured Section Nos. 410-412 and 425
30	Johnson, E. A., 1978, U.S. Geological Survey Open-File Report 78-229	Drill hole No. E-6-RdB
31	↓	Drill hole No. E-7-RdB
32	Trend Exploration, Limited	Oil/gas well No. 1 Bilsing
33	Hancock, E. T., 1925, U.S. Geological Survey Bulletin 757, pl. 7 and 18, p. 60	Measured Section Nos. 454, 458, 460-461, 464-465, 467-468
34	Hancock, E. T., 1925, U.S. Geological Survey Bulletin 757, pl. 7 and 18	Measured Section No. 463
35	↓	Measured Section Nos. 443-444
36	↓	Measured Section Nos. 446 and 448
37	↓	Measured Section Nos. 445, 451, 455, and 457
38	Continental Oil Co.	Oil/gas well No. 1 R.F. Robertson
39	McCulloch Oil Co. of California	Oil/gas well No. 1 Robertson
40	Hancock, E. T., 1925, U.S. Geological Survey Bulletin 757, pl. 8 and 18, and p. 68	Measured Section Nos. 556, 558, and 559

Table 4. -- Continued

Plate 1 Index Number	Source	Data Base
41	Johnson, E. A., 1978, U.S. Geological Survey Open-File Report 78-229	Drill hole No. E-8-RdB
42	↓	Drill hole No. E-9-RdB
43	↓	Drill hole No. E-10-RdB
44	↓	Drill hole No. E-11-RdB
45	Hancock, E. T., 1925, U.S. Geological Survey Bulletin 757, pl. 8 and 18	Measured Section No. 547
46	U.S. Geological Survey, 1962, Inactive Coal Prospecting Permit No. Colorado 066621, Utah Construction and Mining Company	Drill hole No. S-15
47	↓	Drill hole No. S-14
48	↓	Drill hole No. S-16
49	Johnson, E. A., 1978, U.S. Geological Survey Open-File Report 78-229	Drill hole No. E-12-RdB
50	U.S. Geological Survey, 1962, Inactive Coal Prospecting Permit Nos. Colorado 066621, Utah Construction and Mining Company	Drill hole No. S-17
51	↓	Drill hole No. S-21
52	↓	Drill hole No. S-20
53	Hancock, E. T., 1925, U.S. Geological Survey Bulletin 757, pl. 8 and 18	Measured Section Nos. 530-532
54	U.S. Geological Survey, 1962, Inactive Coal Prospecting Permit No. Colorado 066621, Utah Construction and Mining Company	Drill hole No. S-19

Page 4 of 5

Table 4. -- Continued

Plate 1 Index Number	Source	Data Base
55	U.S. Geological Survey, 1962, Inactive Coal Prospecting Permit Nos. Colorado 066621,Utah Construction and Mining Company	Drill hole No. S-18
56	Hancock, E. T., 1925, U.S. Geological Survey Bulletin 757, pl. 8 and 18	Measured Section Nos. 533-534, 537, 539-540, 542, 545, and 546
57	Hancock, E. T., 1925, U.S. Geological Survey Bulletin 757, pl. 8	Measured Section No. 554
58	Johnson, E. A., 1978, U.S. Geological Survey Open-File Report 78-229	Drill hole No. E-13-RdB
59	Hancock, E. T., 1925, U.S. Geological Survey Bulletin 757, pl. 8 and 18	Measured Section Nos. 552-553
60	Johnson, E. A., 1978, U.S. Geological Survey Open-File Report 78-229	Drill hole No. E-14-RdB
61	Hancock, E. T., 1925, U.S. Geological Survey Bulletin 757, pl. 8 and 19	Measured Section No. 521
62	↓	Measured Section No. 522
63	Johnson, E. A., 1978, U.S. Geological Survey Open-File Report 78-229	Drill hole No. E-15-RdB
64	↓	Drill hole No. E-17-RdB
65	↓	Drill hole No. E-18-RdB
66	Superior Oil Co.	Oil/gas well No. 13-36 Greeley
67	Hancock, E. T., 1925, U.S. Geological Survey Bulletin 757, pl. 11 and 19	Measured Section No. 328
68	Hyland Oil and Gas Corp.	Oil/gas well No. 1 Ansley

REFERENCES

American Society for Testing and Materials, 1977, Standard specification for classification of coals by rank, in Gaseous fuels; coal and coke; atmospheric analysis: ASTM Standard Specification D 388-77, pt. 26, p. 214-218.

Bass, N. W., Eby, J. B., and Campbell, M. R., 1955, Geology and mineral fuels of parts of Routt and Moffat Counties, Colorado: U.S. Geological Survey Bulletin 1027-D, p. 143-250.

Bergin, M. J., 1959, Preliminary geologic map of the Maybell-Lay area, Moffat County, Colorado: U.S. Geological Survey Open-File Report 59-7, scale 1:24,000.

Carey, B. D., Jr., 1955, A review of the Browns Park Formation, in Guidebook to the geology of northwest Colorado, Intermountain Association of Petroleum Geologists and Rocky Mountain Association of Geologists, 6th Annual Field Conference, 1955: p. 47-49.

Dawson, L. C., and Murray, D. K., 1978, Colorado coal directory and source book: Colorado Geological Survey Resource Series 3, p. 198.

Emmons, S. F., 1877, Valleys of the Upper Yampa and Little Snake Rivers, Section VIII, in Report of the geological exploration of the Fortieth Parallel, Vol. II, Descriptive geology: U.S. Army Engineer Department Professional Paper No. 18, p. 181-189.

Fenneman, N. M., and Gale, H. S., 1906, The Yampa coal field, Routt County, Colorado: U.S. Geological Survey Bulletin 297, 96 p.

George, R. D., Denny, E. H., Young, W. H., Snyder, N. H., Fieldner, A. C., Cooper, H. M., and Abernethy, R. F., 1937, Analyses of Colorado coals: U.S. Bureau of Mines Technical Paper 574, 327 p.

Hancock, E. T., 1925, Geology and coal resources of the Axial and Monument Butte quadrangles, Moffat County, Colorado: U.S. Geological Survey Bulletin 757, 134 p.

Hewett, G. C., 1889, The northwestern Colorado coal region: American Institute of Mining and Metallurgical Engineers Transactions, v. 17, p. 375-380.

Hills, R. C., 1893, Coal fields of Colorado, in Coal: U.S. Geological Survey, Mineral resources of the United States, calendar year 1892, p. 319-365.

References--Continued

Howard, A. D., and Williams, J. W., 1972, Physiography, in Mallory, W. W., ed., Geologic atlas of the Rocky Mountain region: Rocky Mountain Association of Geologists, p. 30.

Johnson, E. A., 1978, Geophysical logs for eighteen holes drilled during 1977 in the Round Bottom area, Yampa coal field, Moffat County, Colorado: U.S. Geological Survey Open-File Report 78-229.

Konishi, Kenji, 1959, Upper Cretaceous surface stratigraphy, Axial Basin and Williams Fork area, Moffat and Routt Counties, Colorado, in Washakie, Sand Wash, and Piceance Basins, Symposium on Cretaceous rocks of Colorado and adjacent areas, Rocky Mountain Association of Geologists Guidebook, 11th Annual Field Conference, 1959: p. 67-73.

Kucera, R. E., 1959, Cretaceous stratigraphy of the Yampa district, northwest Colorado, in Washakie, Sand Wash, and Piceance Basins, Symposium on Cretaceous rocks of Colorado and adjacent areas, Rocky Mountain Association of Geologists Guidebook, 11th Annual Field Conference, 1959: p. 37-45.

Ryer, T. A., 1977, Geology and coal resources of the Foidel Creek EMRIA site and surrounding area, Routt County, Colorado: U.S. Geological Survey Open-File Report 77-303, 31 p.

Storrs, L. S., 1902, The Rocky Mountain coal field: U.S. Geological Survey, 22nd Annual Report, pt. III, j, p. 415-471.

Tweto, Ogden, compiler, 1976, Geologic map of the Craig 1° x 2° quadrangle, northwest Colorado: U.S. Geological Survey Miscellaneous Investigations Series Map I-972, scale 1:250,000.

U.S. Bureau of Land Management, 1977, Description of the environment, chapter II, in Final environmental statement, northwest Colorado coal: p. II-1-II-125, and appendix B, foldout 9.

U.S. Bureau of Mines and U.S. Geological Survey, 1976, Coal resource classification system of the U.S. Bureau of Mines and U.S. Geological Survey: U.S. Geological Survey Bulletin 1450-B, 7 p.

U.S. Geological Survey, 1962, Inactive Coal Prospecting Permit Nos. Colorado 066620, 066621, and 066623, Utah Construction and Mining Company.

EXPLANATION

5

6

ISOPACHS - Showing thickness of coal, in feet. Long dashed where inferred.

5500

5600

STRUCTURE CONTOURS - Drawn on top of coal bed. Solid where vertical accuracy within 40 feet; long dashed where vertical accuracy possibly not within 40 feet. Contour interval 100 feet (31 m). Datum is mean sea level.

5056 o
6.0

DRILL HOLE - Showing altitude of top of coal bed, and thickness of coal, in feet.

10.0/2.0 o

INTERBEDDED COAL AND ROCK - Showing total coal thickness/total rock thickness.

COAL BED SYMBOLS AND NAMES - Coal beds identified by bracketed numbers are not formally named, but are numbered for identification purposes in this quadrangle only.

TRACE OF FAULT - Bar and ball on downthrown side. Dashed where inferred or approximately located.

15°

SUBSURFACE MINING LIMIT - Showing areas where dips of coal beds are greater than 15° and subsurface mining by conventional methods is not considered feasible. Reserve Base tonnages are calculated beyond limit; Reserve tonnages are not. Arrow points toward area where dips are greater than 15°.

ANTICLINE - Showing subsurface trace of axial plane.

To convert feet to meters, multiply feet by 0.3048.

FIGURE 1. — Explanation for isopach and structure contour map.

EXPLANATION

2000

OVERBURDEN ISOPACHS - Showing thickness of overburden, in feet, from surface to top of coal bed. Isopach interval 100 feet (31 m) over strippable coal and 200 feet (61 m) beyond the stripping-limit line.

1446 o

DRILL HOLE - Showing thickness of overburden, in feet, from surface to top of coal bed.

COAL BED SYMBOLS AND NAMES - Coal beds identified by bracketed numbers are not formally named, but are numbered for identification purposes in this quadrangle only.

TRACE OF FAULT - Bar and ball on down-thrown side. Dashed where inferred or approximately located.

To convert feet to meters, multiply feet by 0.3048.

FIGURE 2. — Explanation for overburden isopach map.

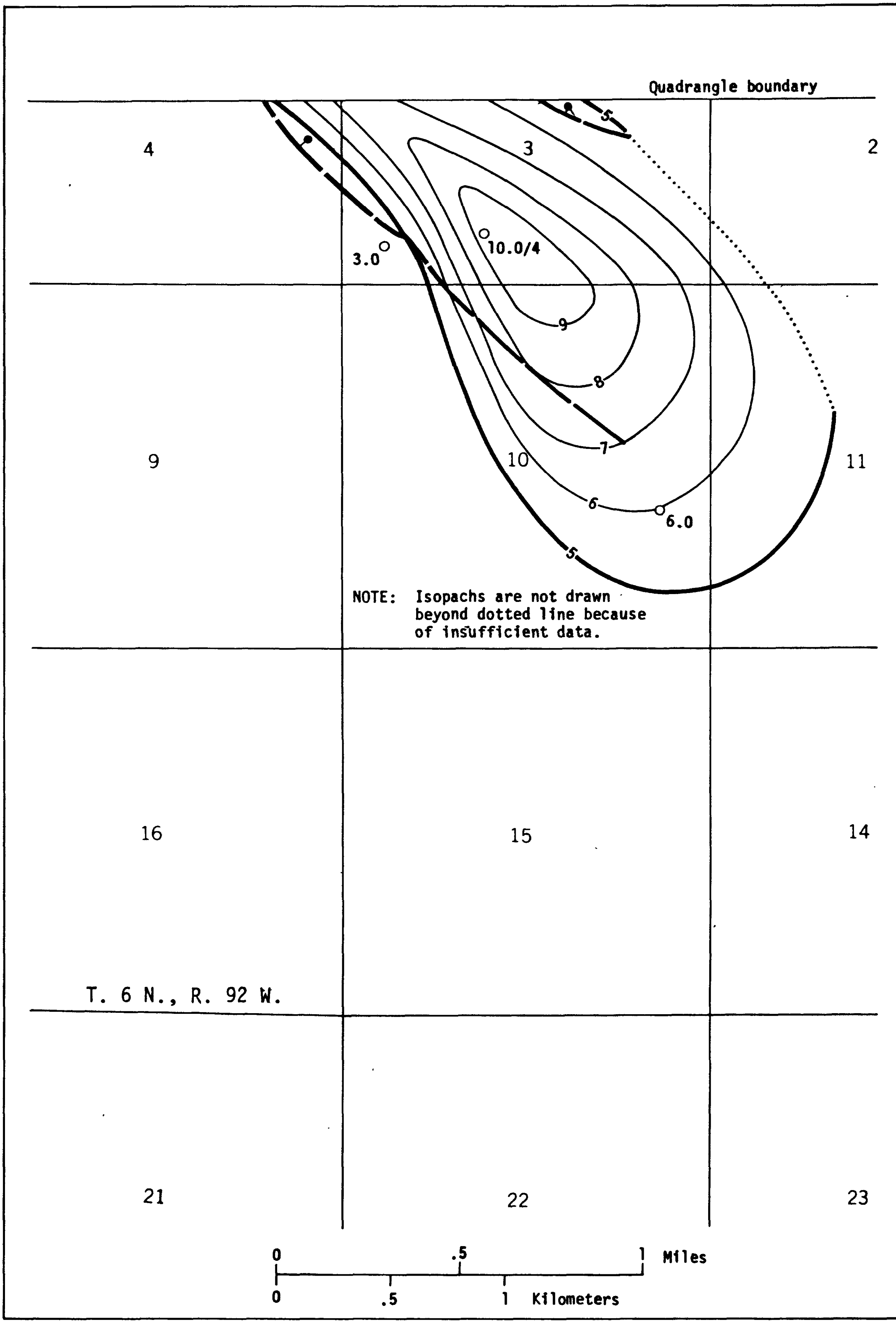

FIGURE 4. — Isopach map of the Middle Coal Group, coal bed [1].

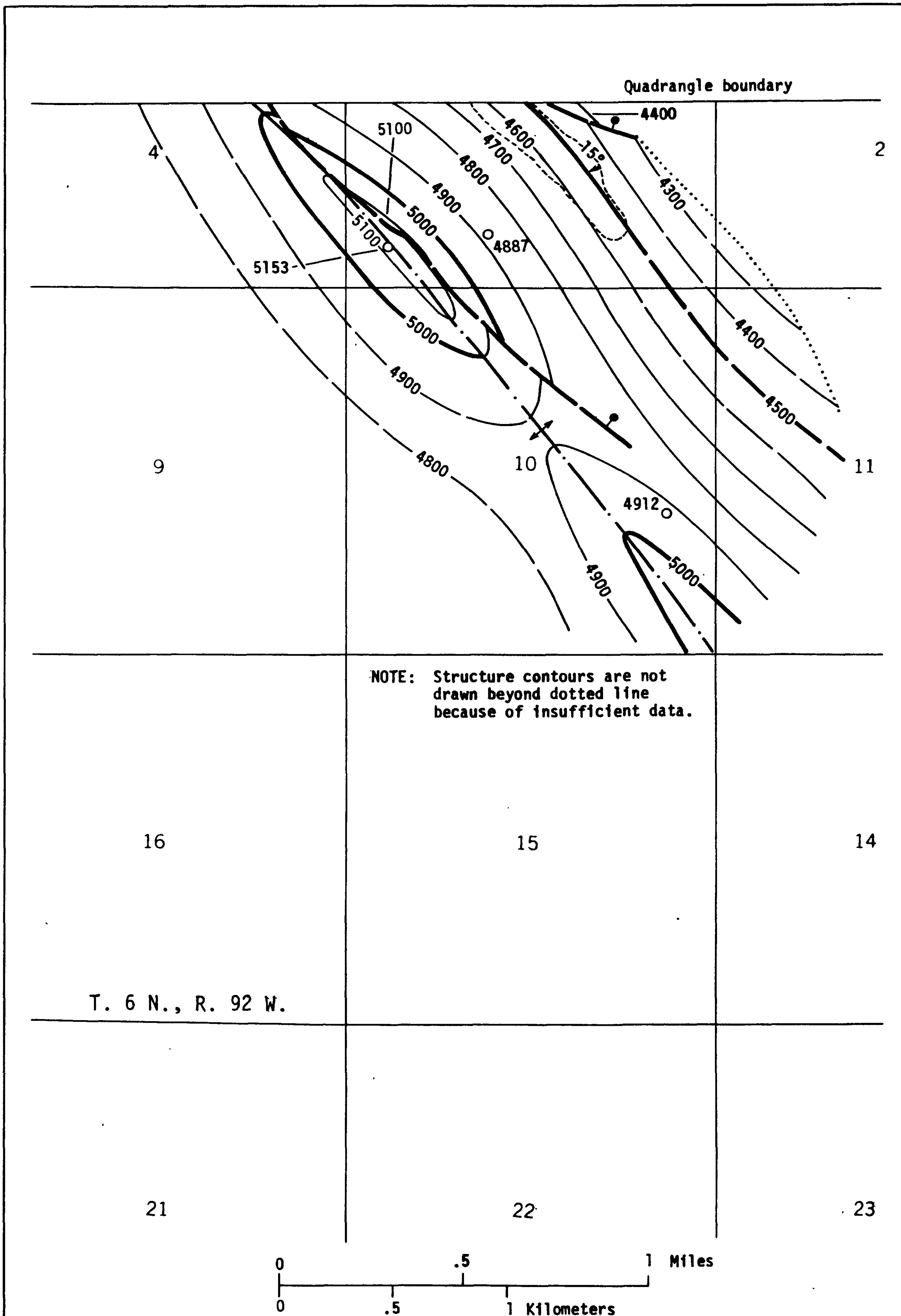

FIGURE 5. — Structure contour map of the Middle Coal Group, coal bed [1].

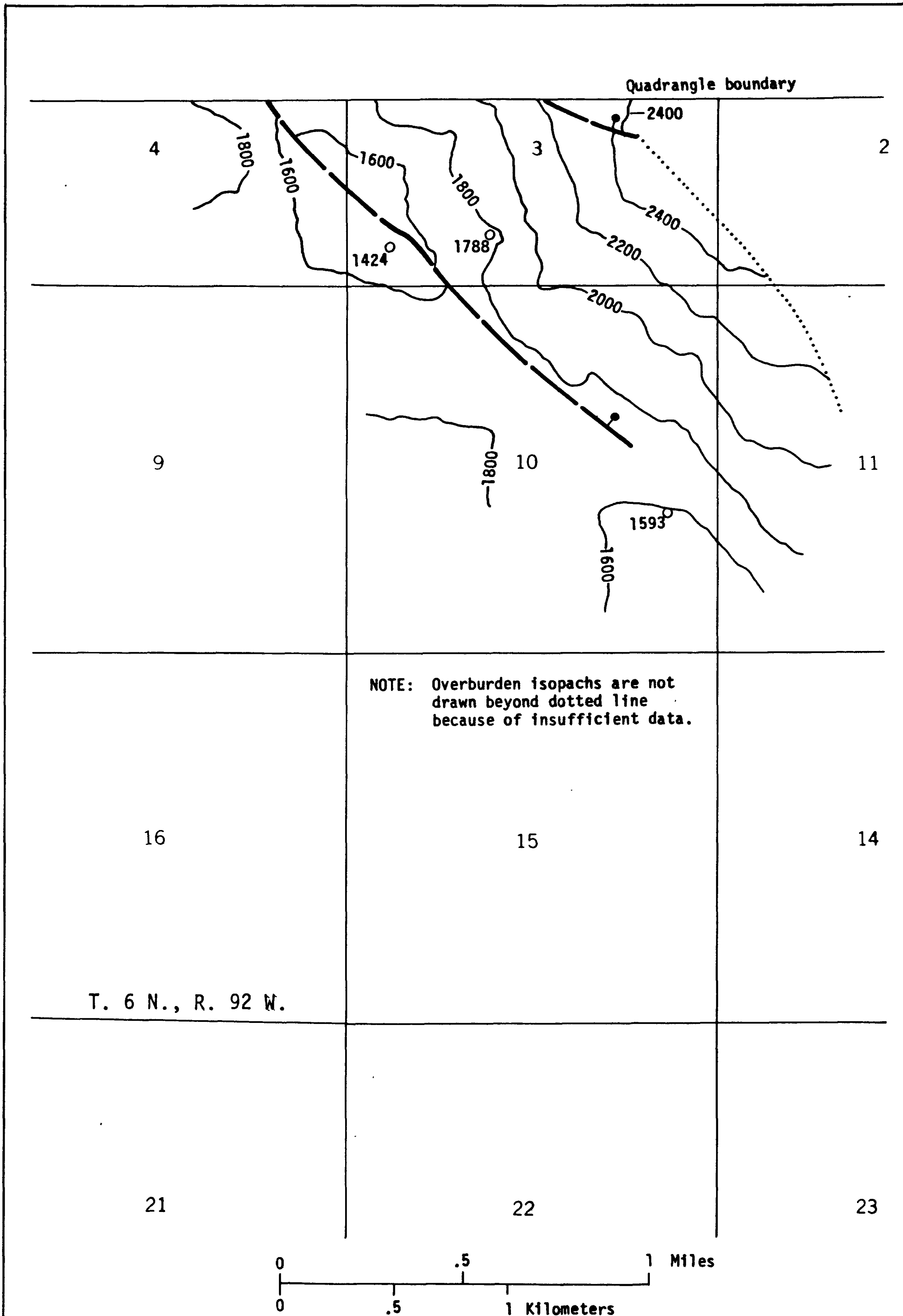

FIGURE 6. — Overburden isopach map of the Middle Coal Group, coal bed [1].

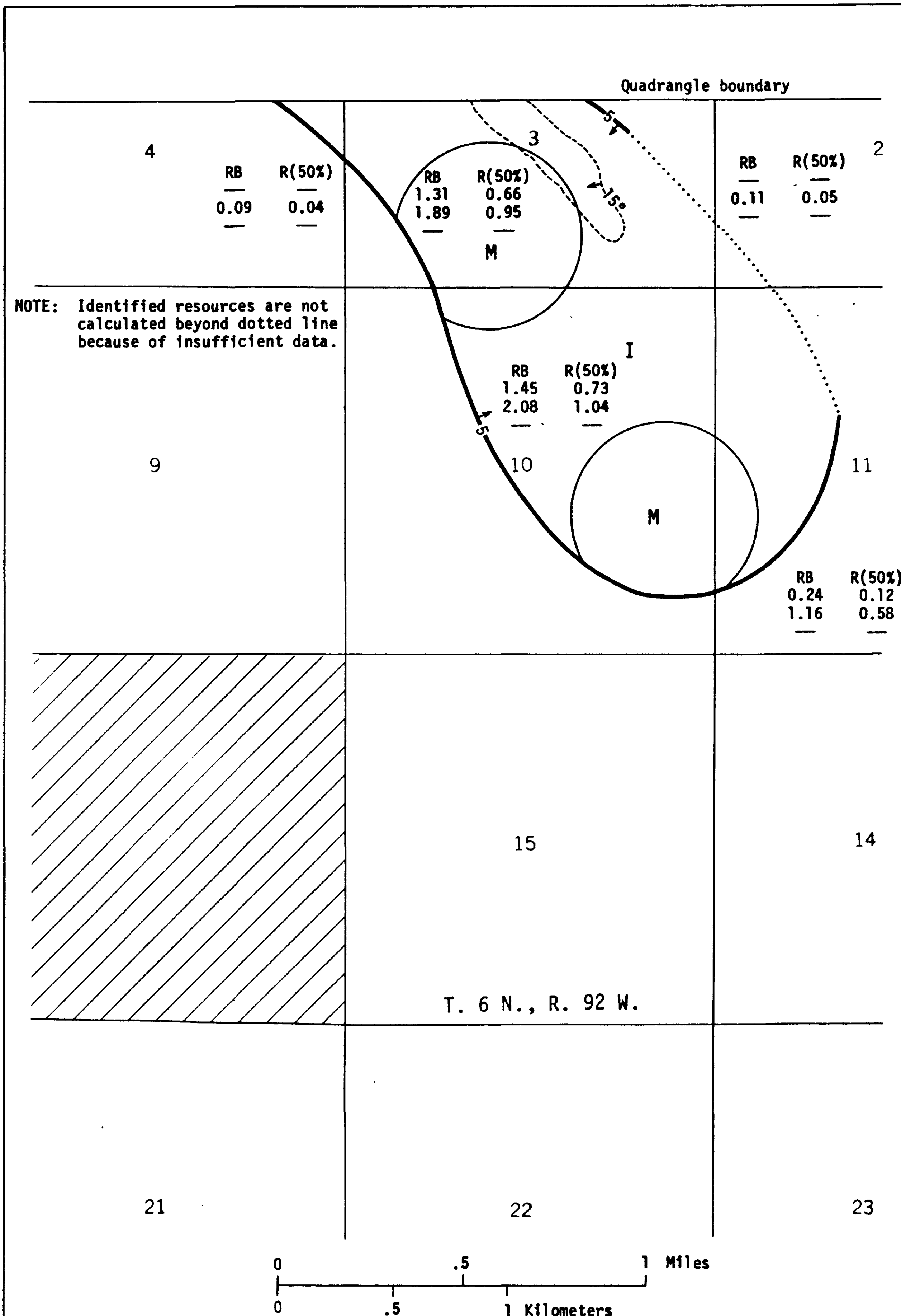

FIGURE 7. — Areal distribution and identified resources map of the Middle Coal Group, coal bed [1].

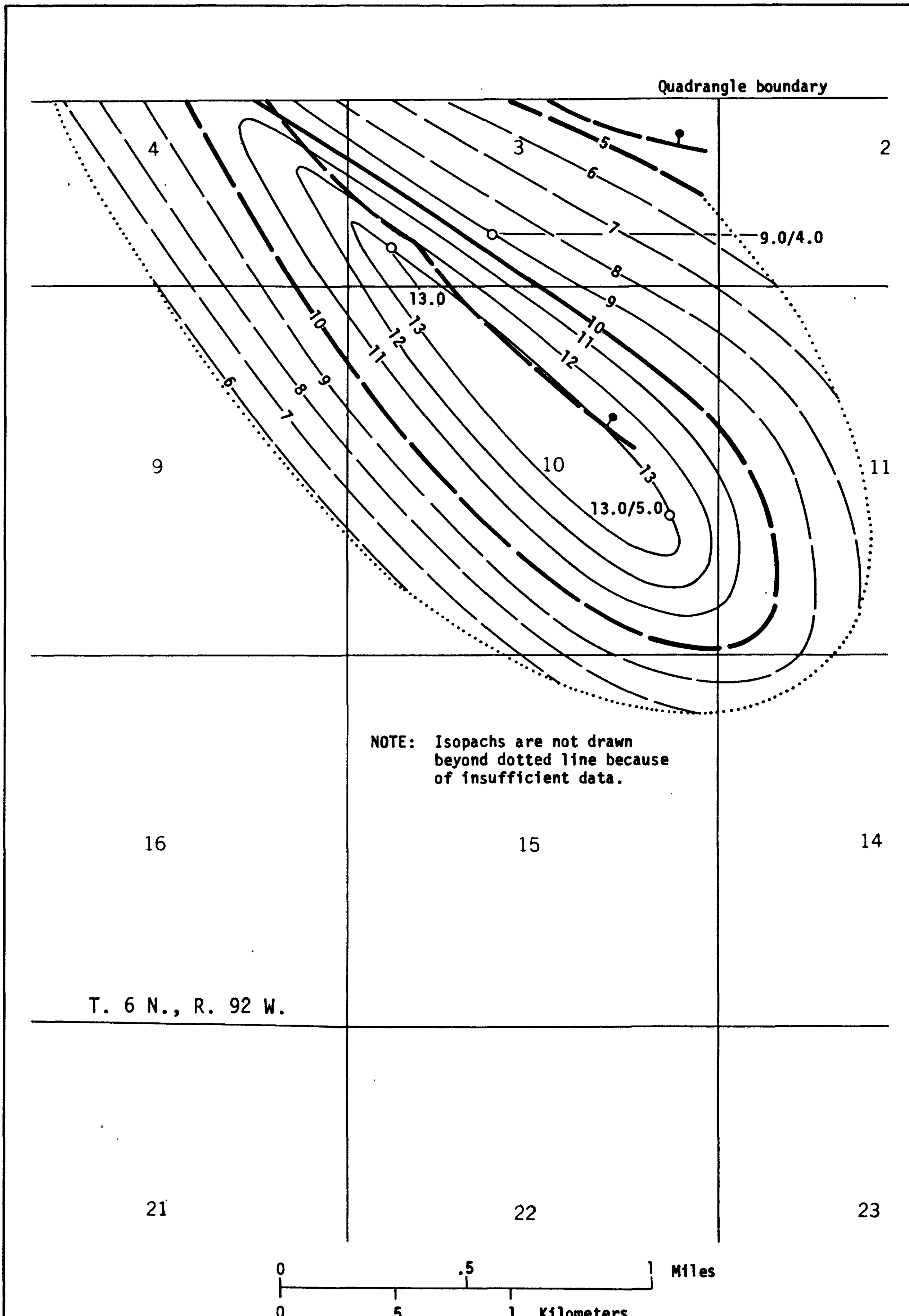

FIGURE 8. — Isopach map of the Middle Coal Group, coal bed [2].

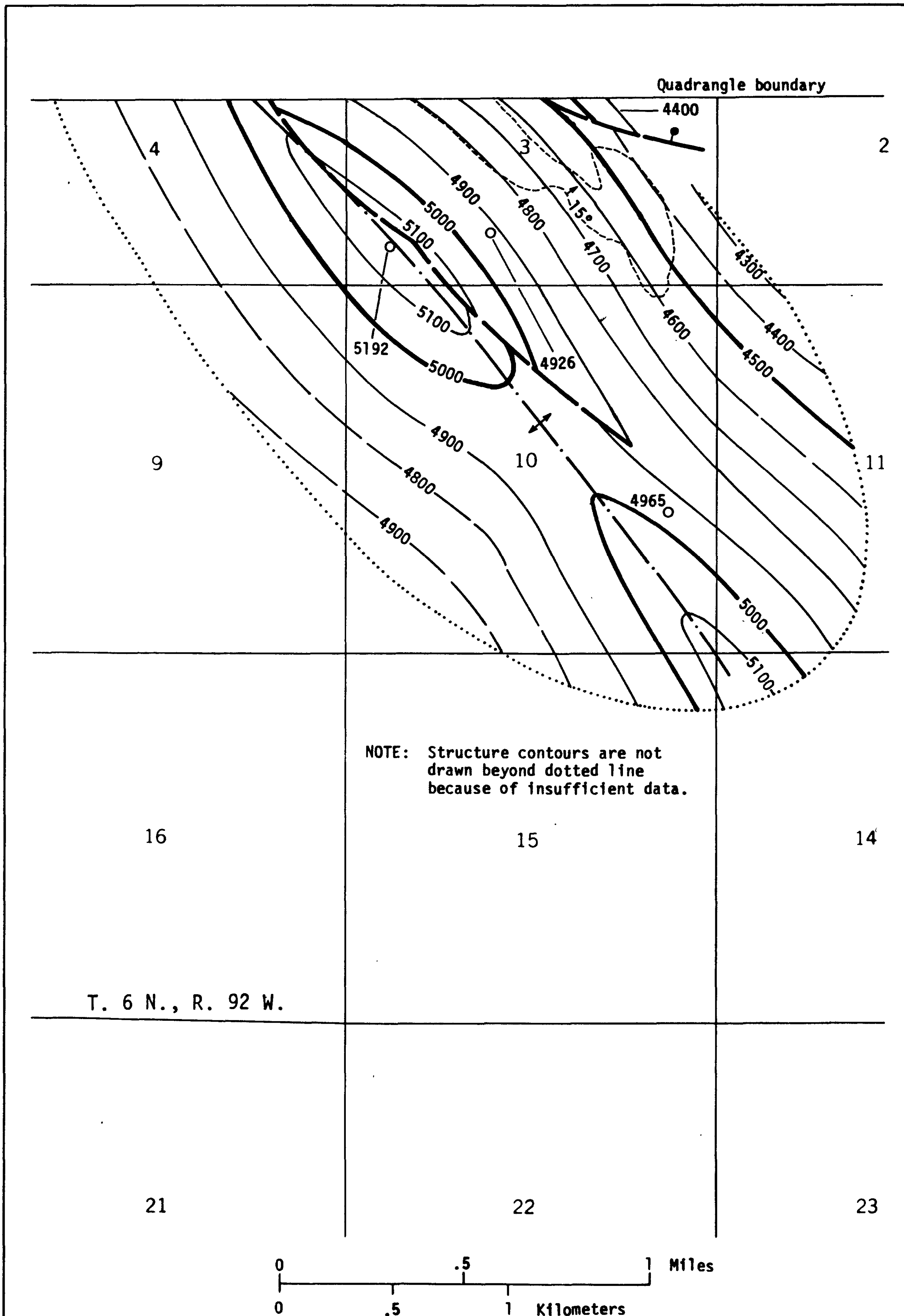

FIGURE 9. — Structure contour map of the Middle Coal Group, coal bed [2].

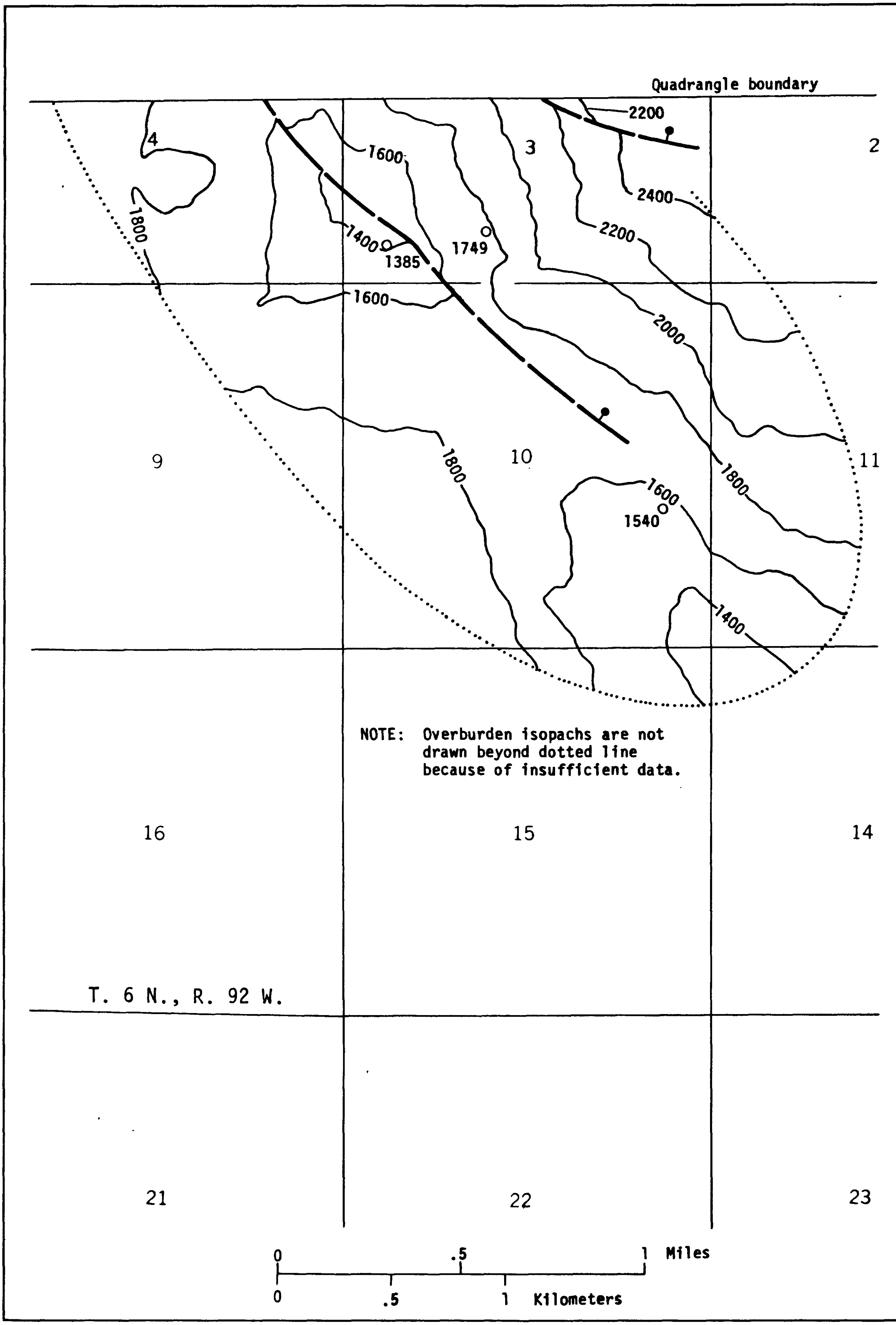

FIGURE 10. — Overburden isopach map of the Middle Coal Group, coal bed [2].

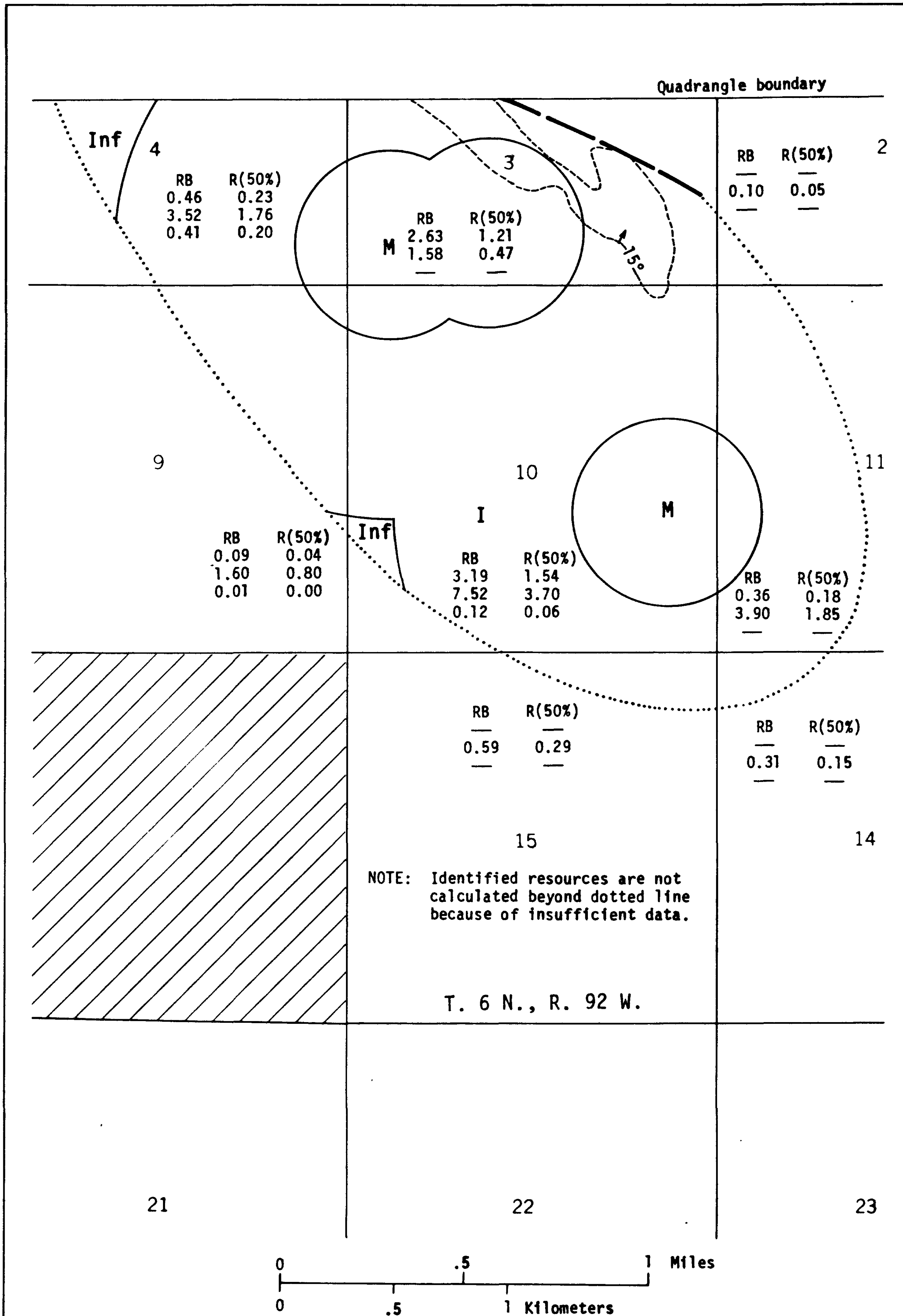

FIGURE 11. — Areal distribution and identified resources map of the Middle Coal Group, coal bed [2].

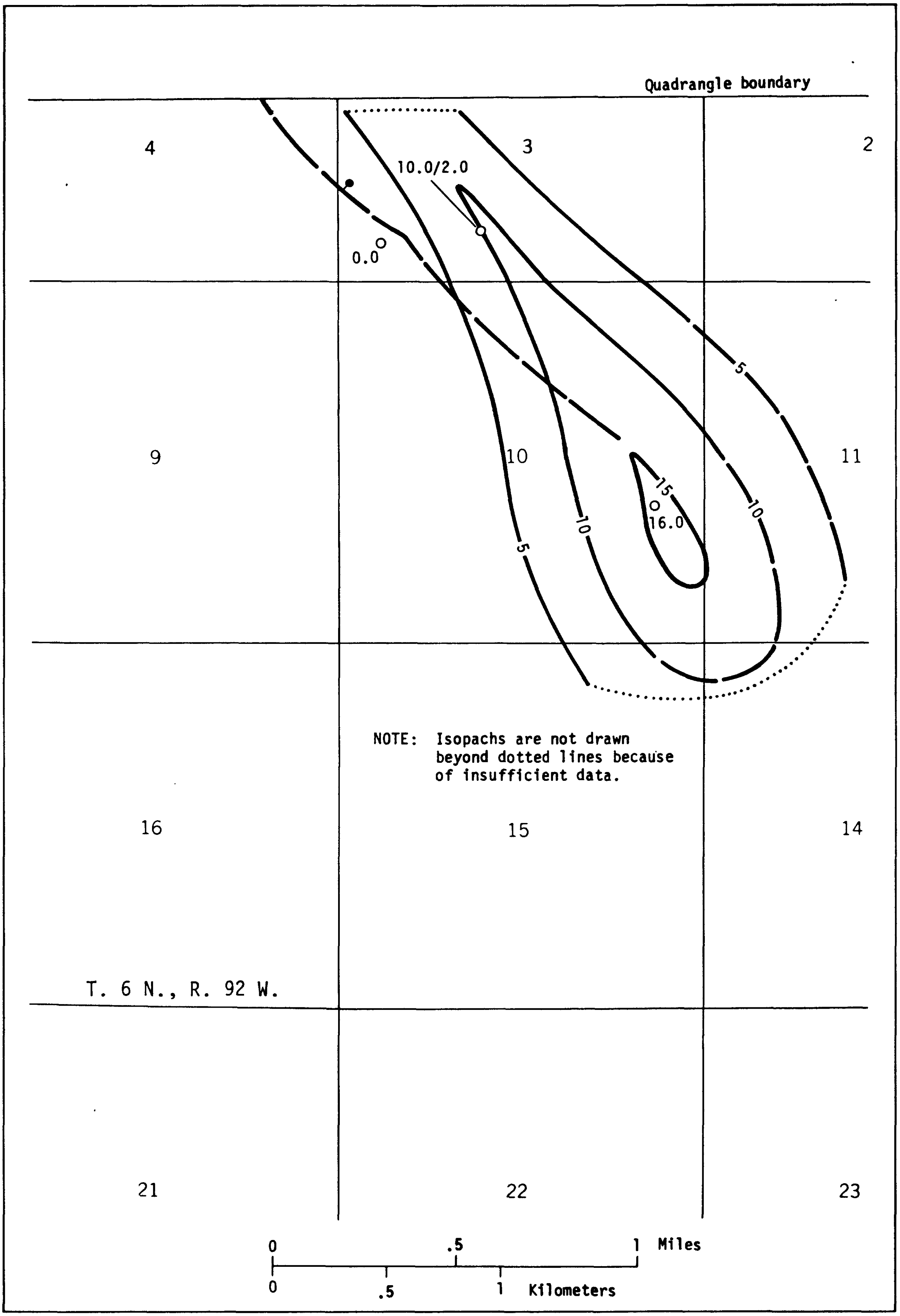

FIGURE 12. — Isopach map of the Middle Coal Group, coal bed [5].

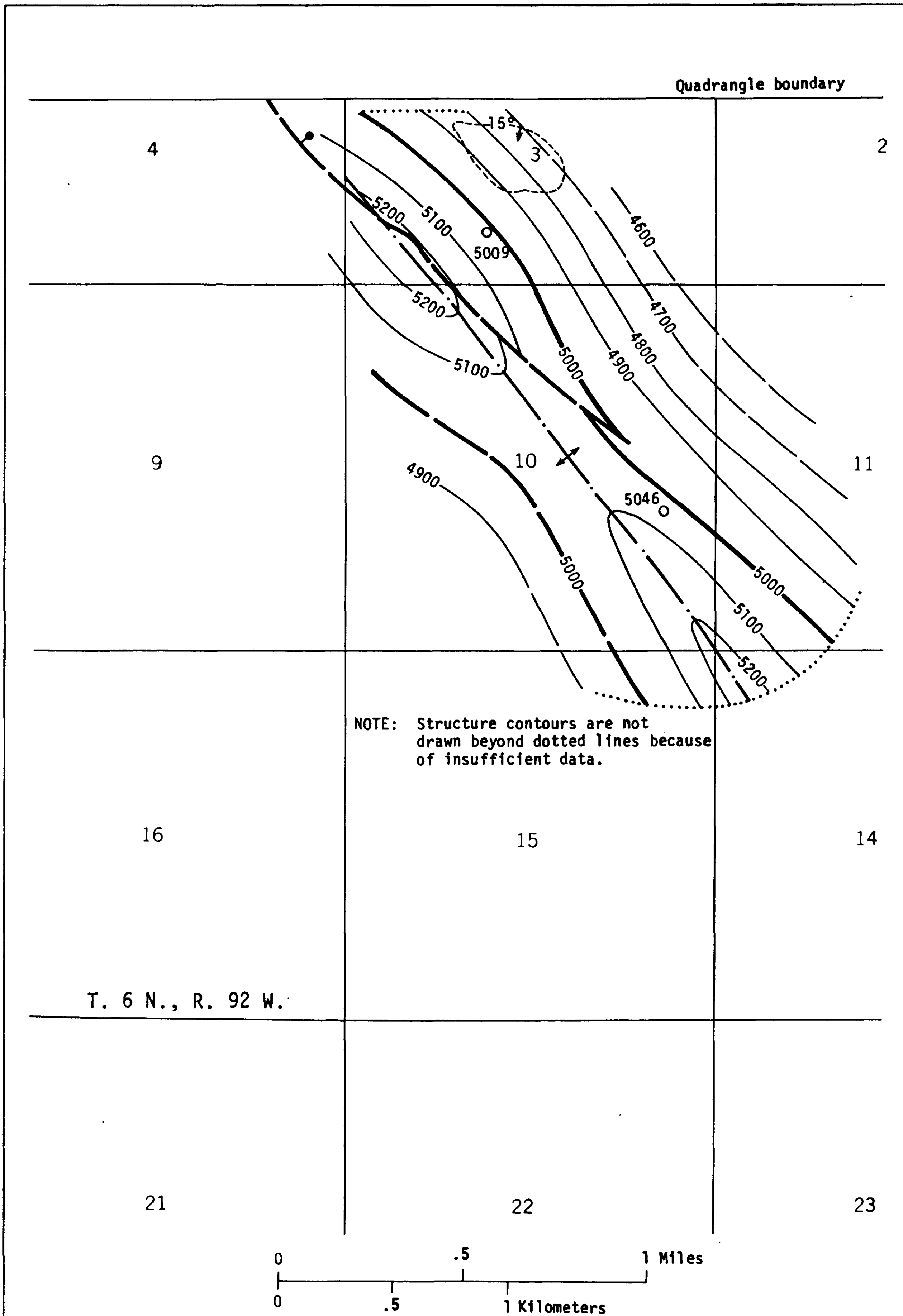

FIGURE 13. — Structure contour map of the Middle Coal Group, coal bed [5].

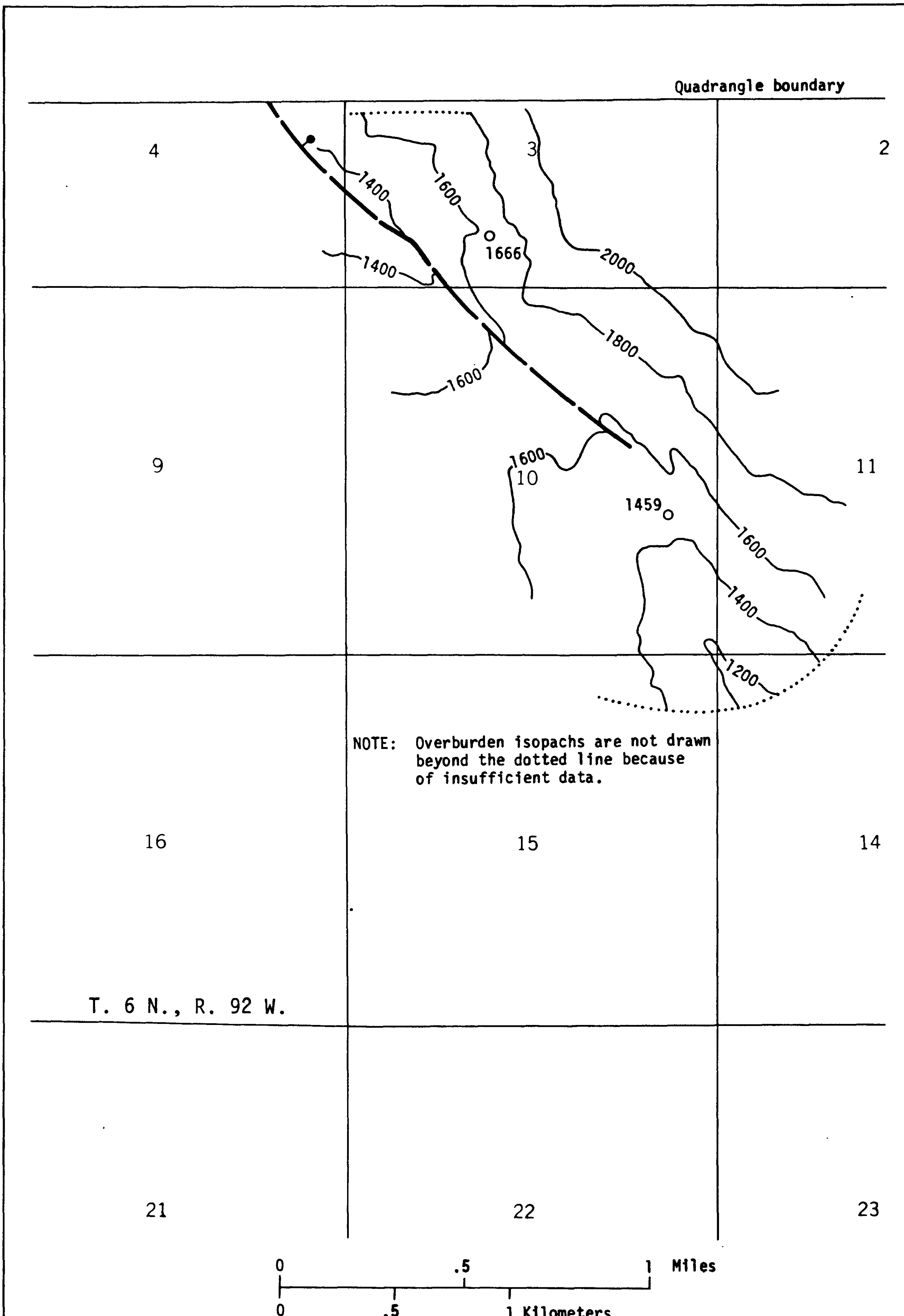

FIGURE 14. — Overburden isopach map of the Middle Coal Group, coal bed [5].

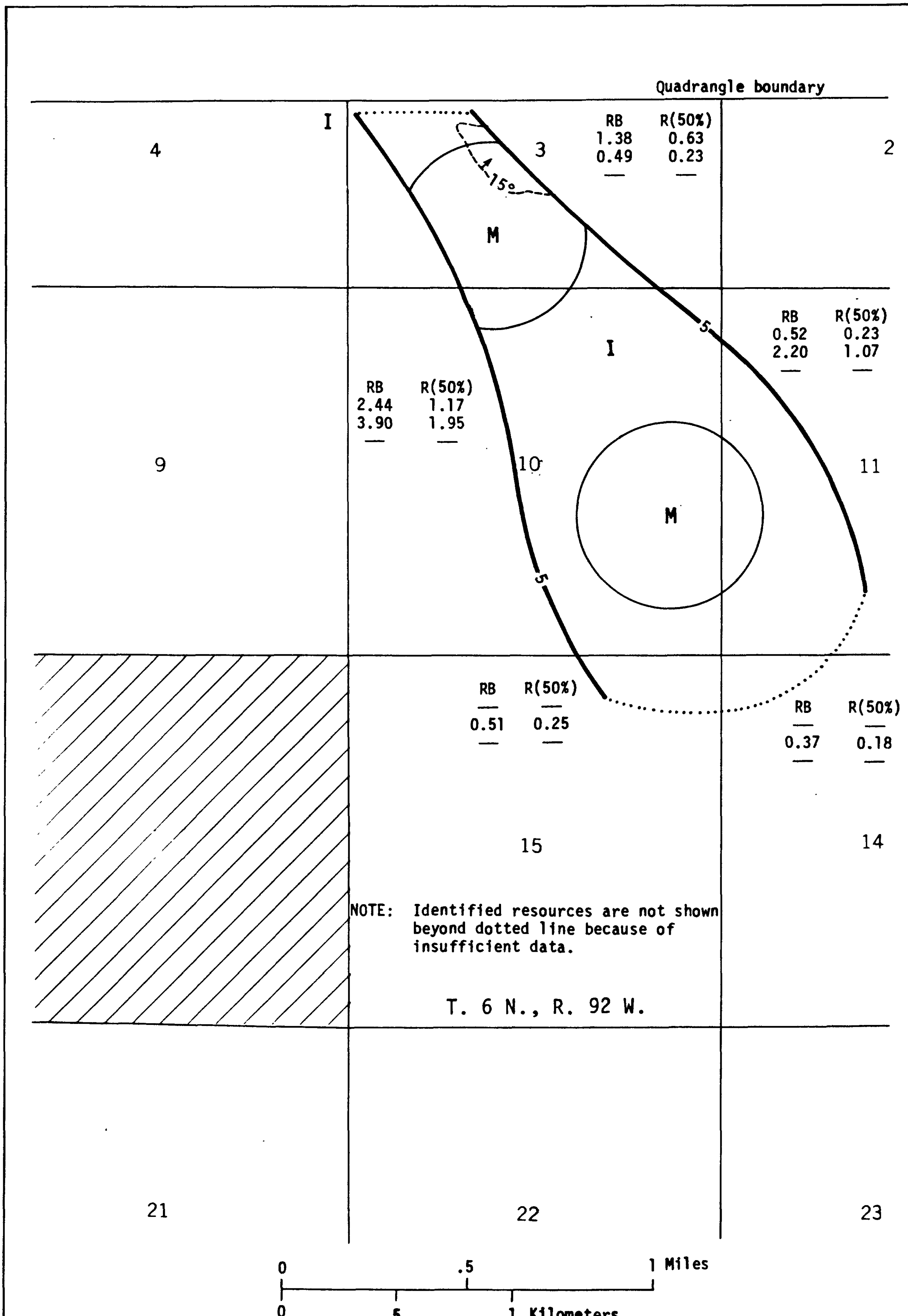

FIGURE 15. — Areal distribution and identified resources map of the Middle Coal Group, coal bed [5].

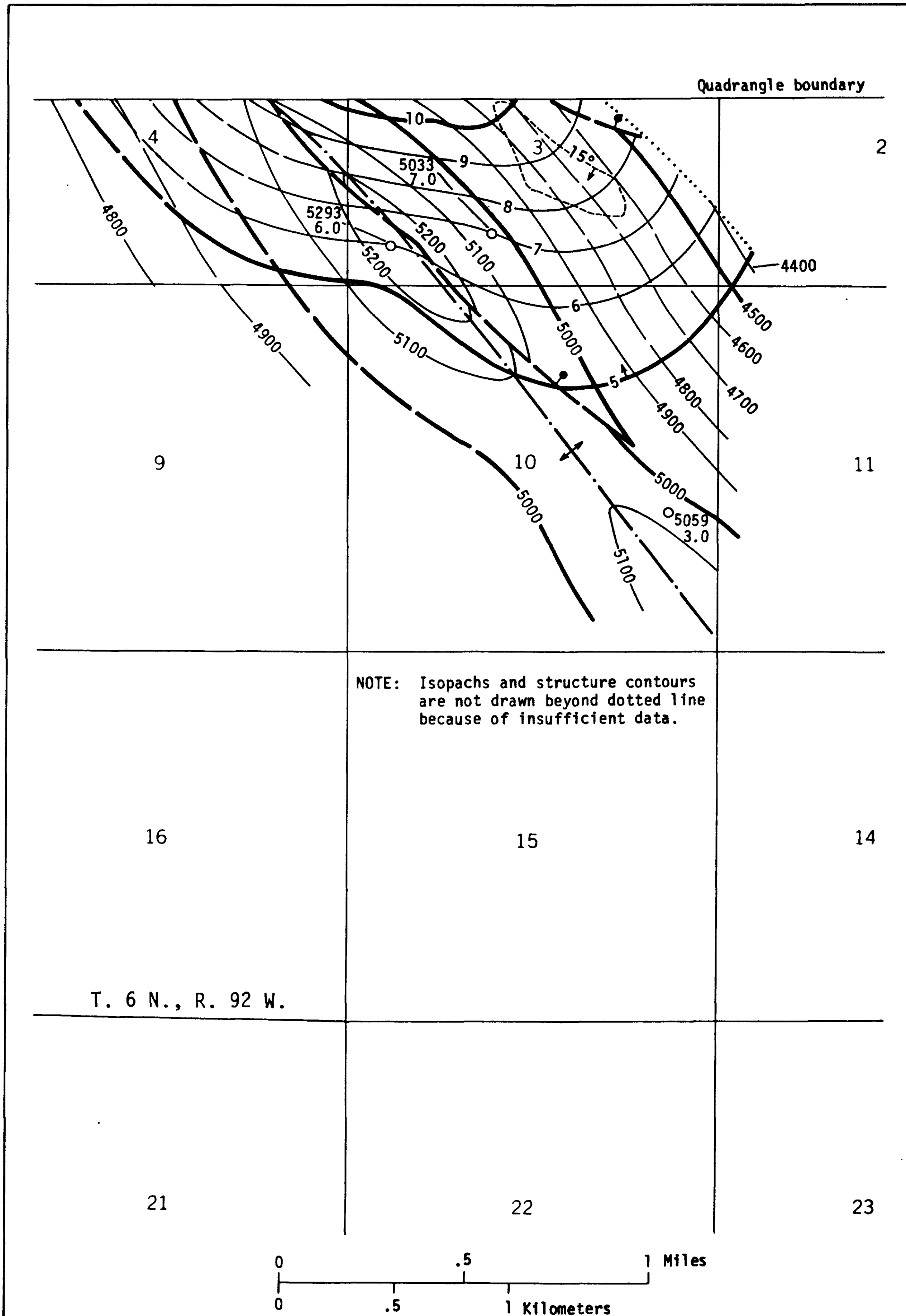

FIGURE 16. — Isopach and structure contour map of the Middle Coal Group, coal bed [6].

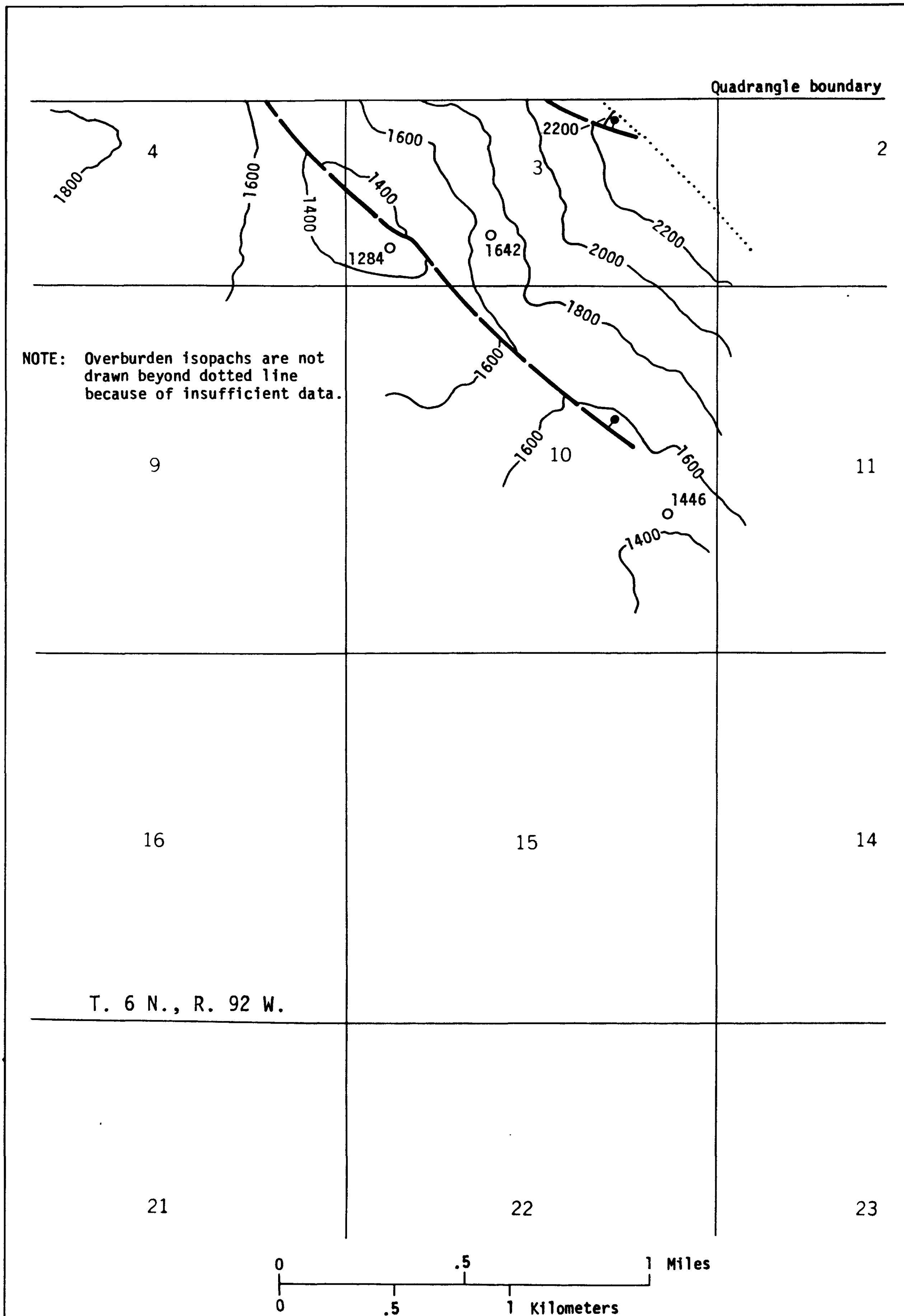

FIGURE 17. — Overburden isopach map of the Middle Coal Group, coal bed [6].

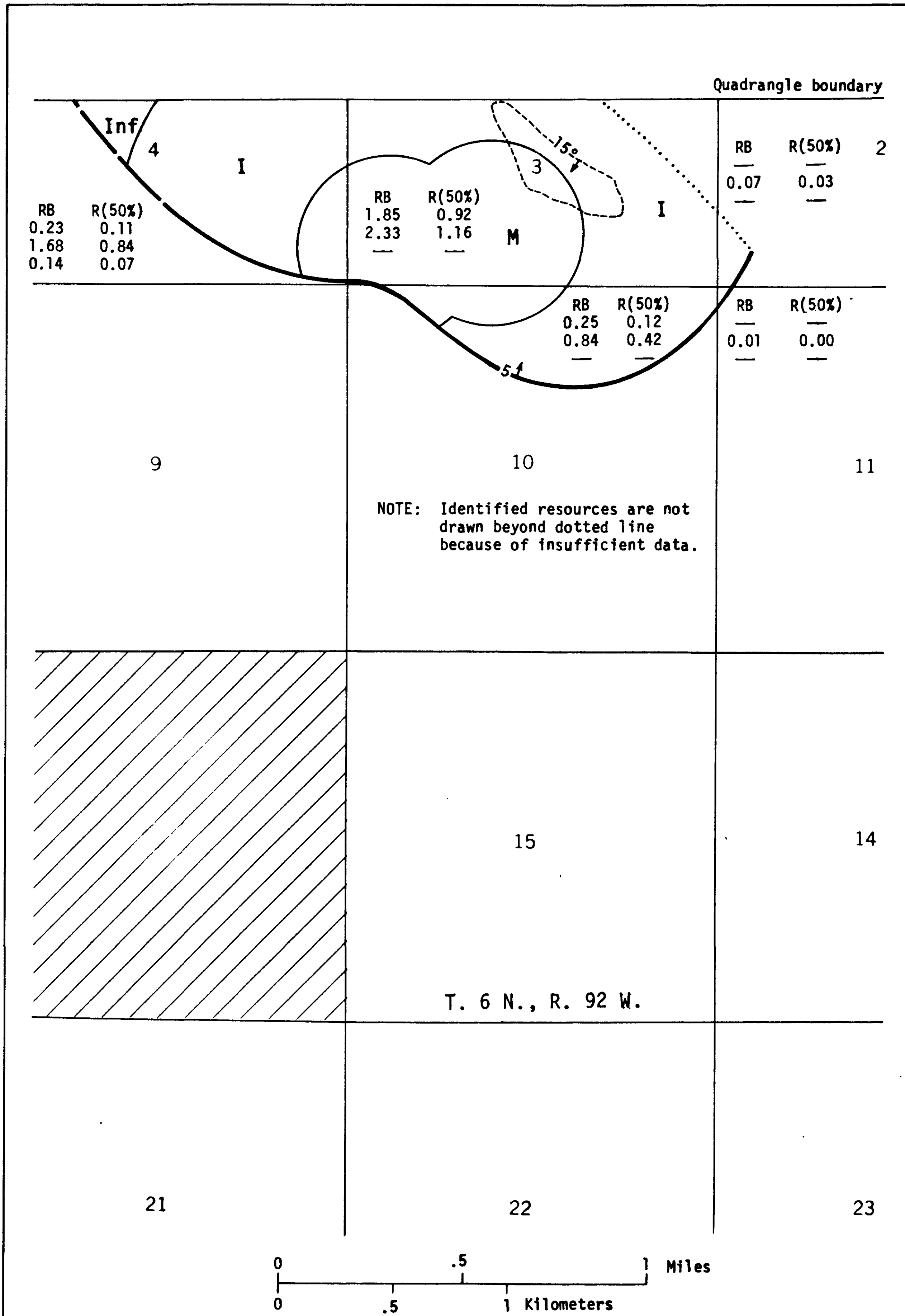

FIGURE 18. — Areal distribution and identified resources map of the Middle Coal Group, coal bed [6].

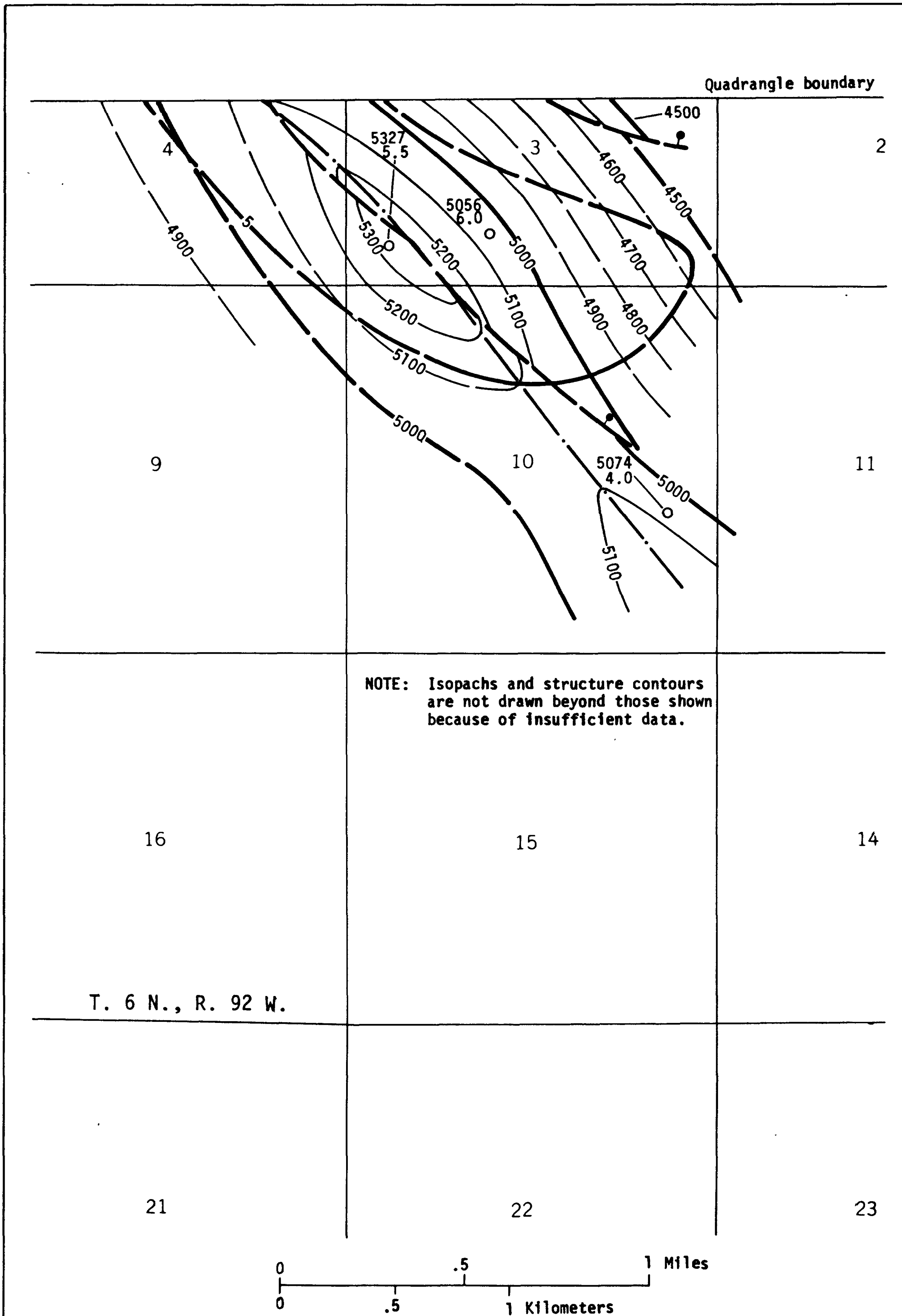

FIGURE 19. — Isopach and structure contour map of the Middle Coal Group, coal bed [7].

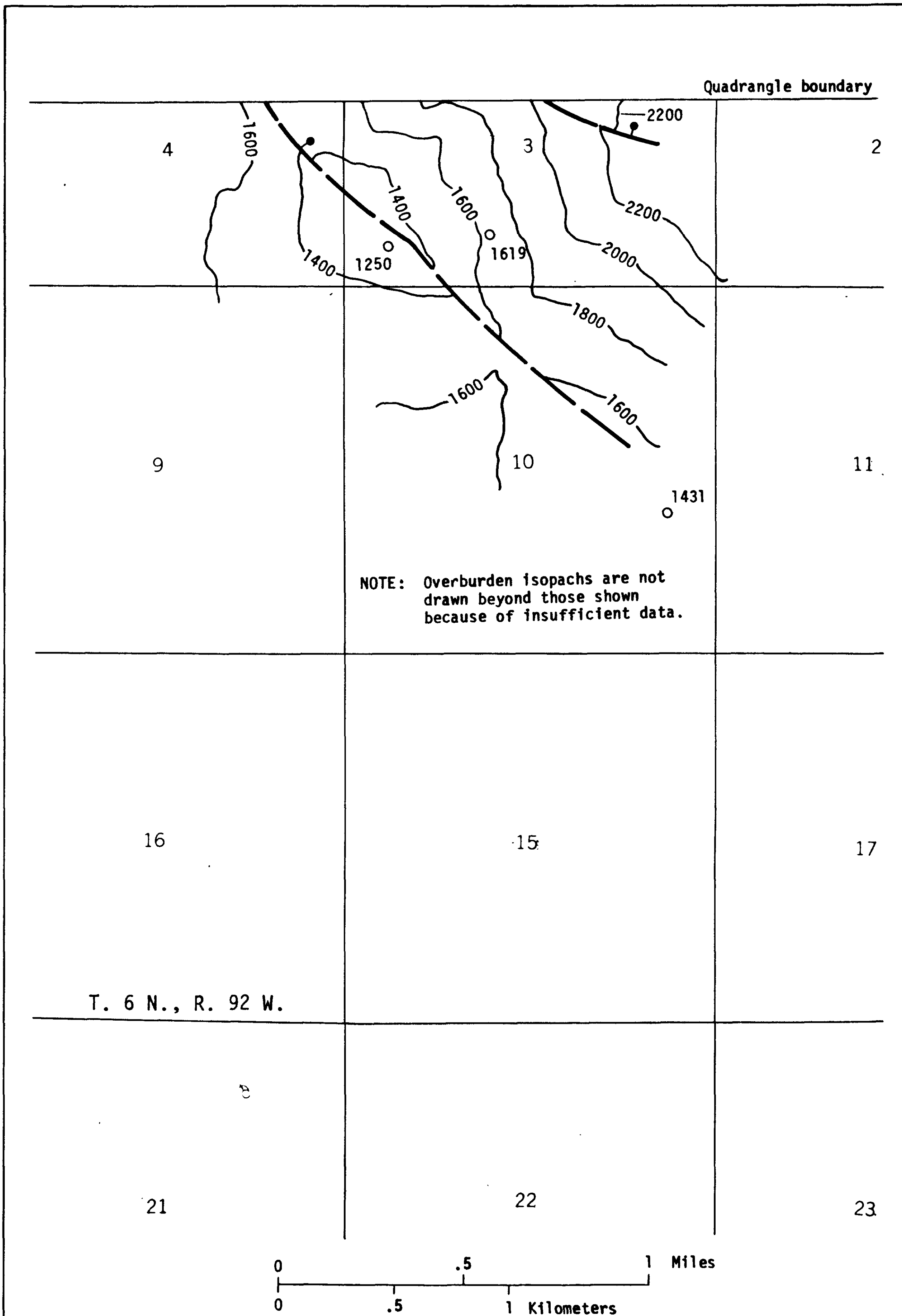

FIGURE 20. — Overburden isopach map of the Middle Coal Group, coal bed [7].

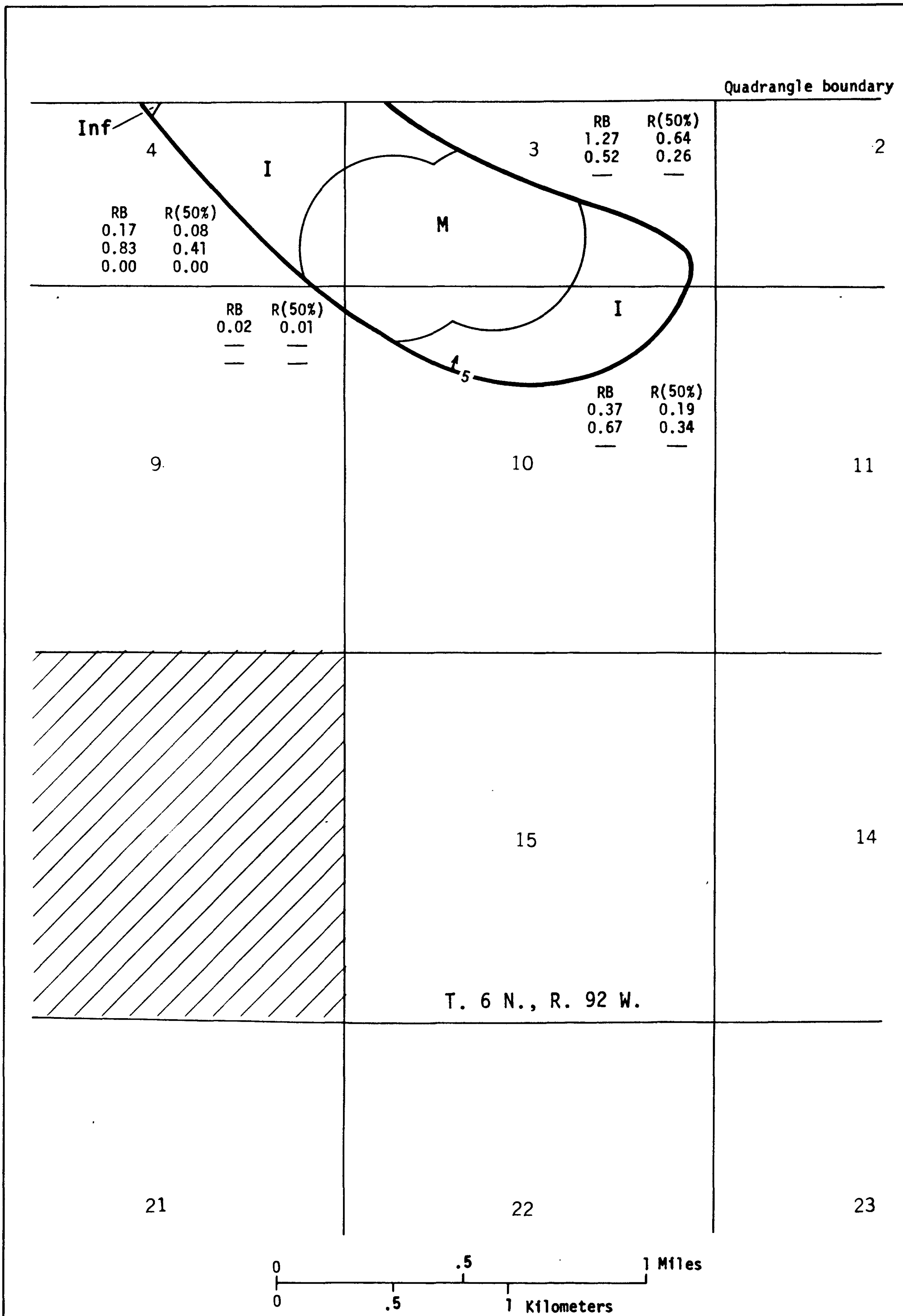

FIGURE 21. — Areal distribution and identified resources map of the Middle Coal Group, coal bed [7].

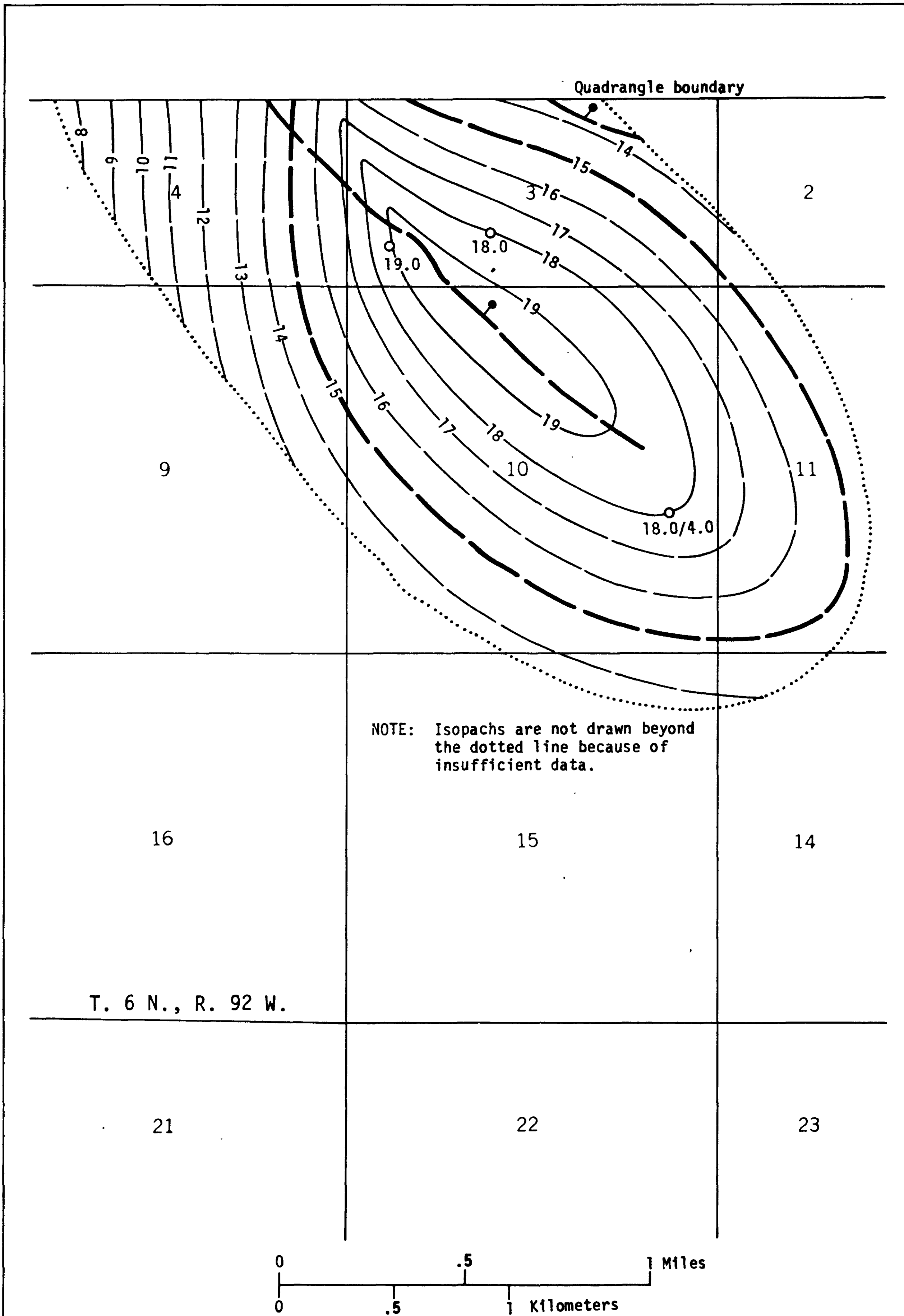

FIGURE 22. — Isopach map of the Middle Coal Group, coal bed [8].

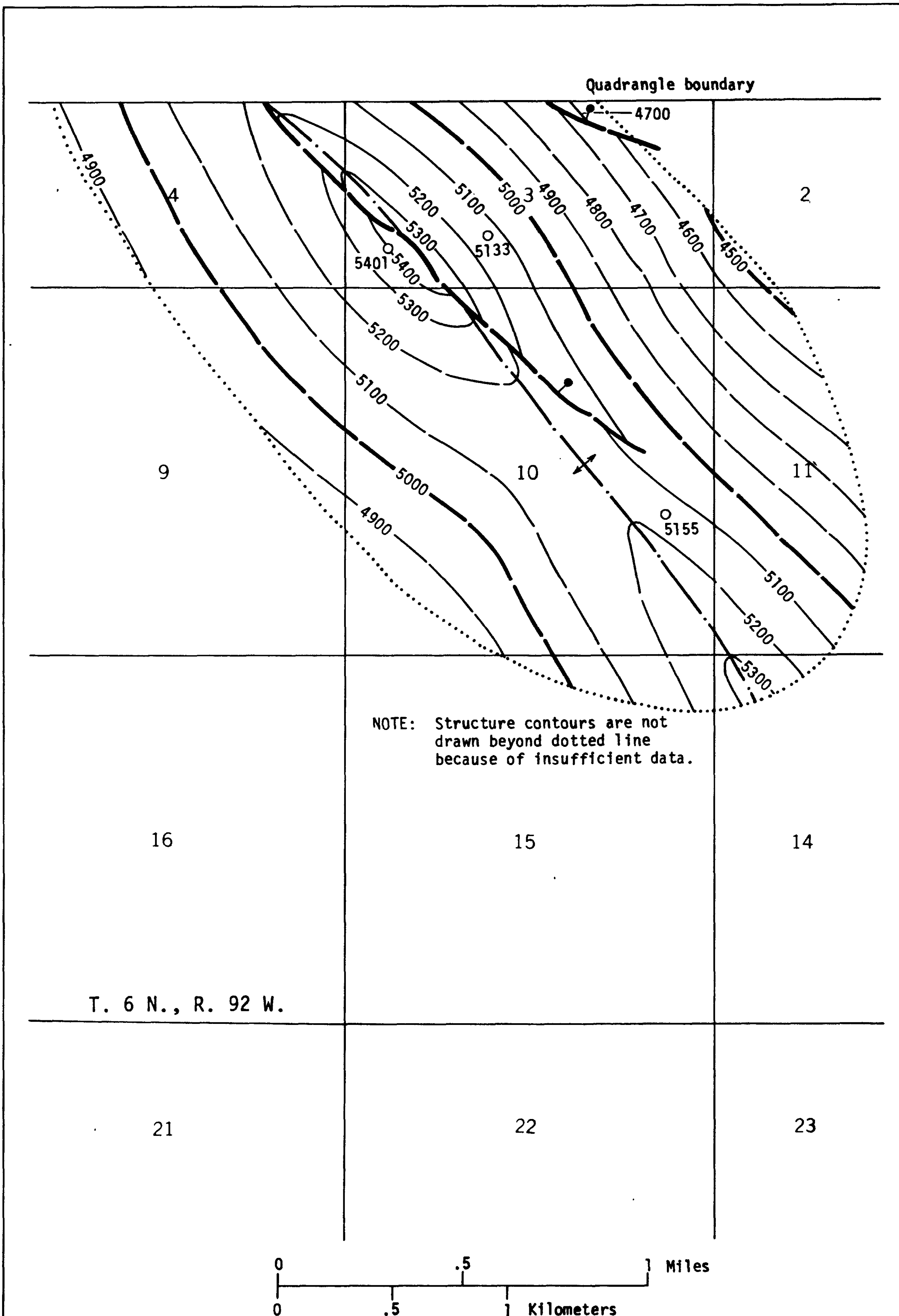

FIGURE 23. — Structure contour map of the Middle Coal Group, coal bed [8].

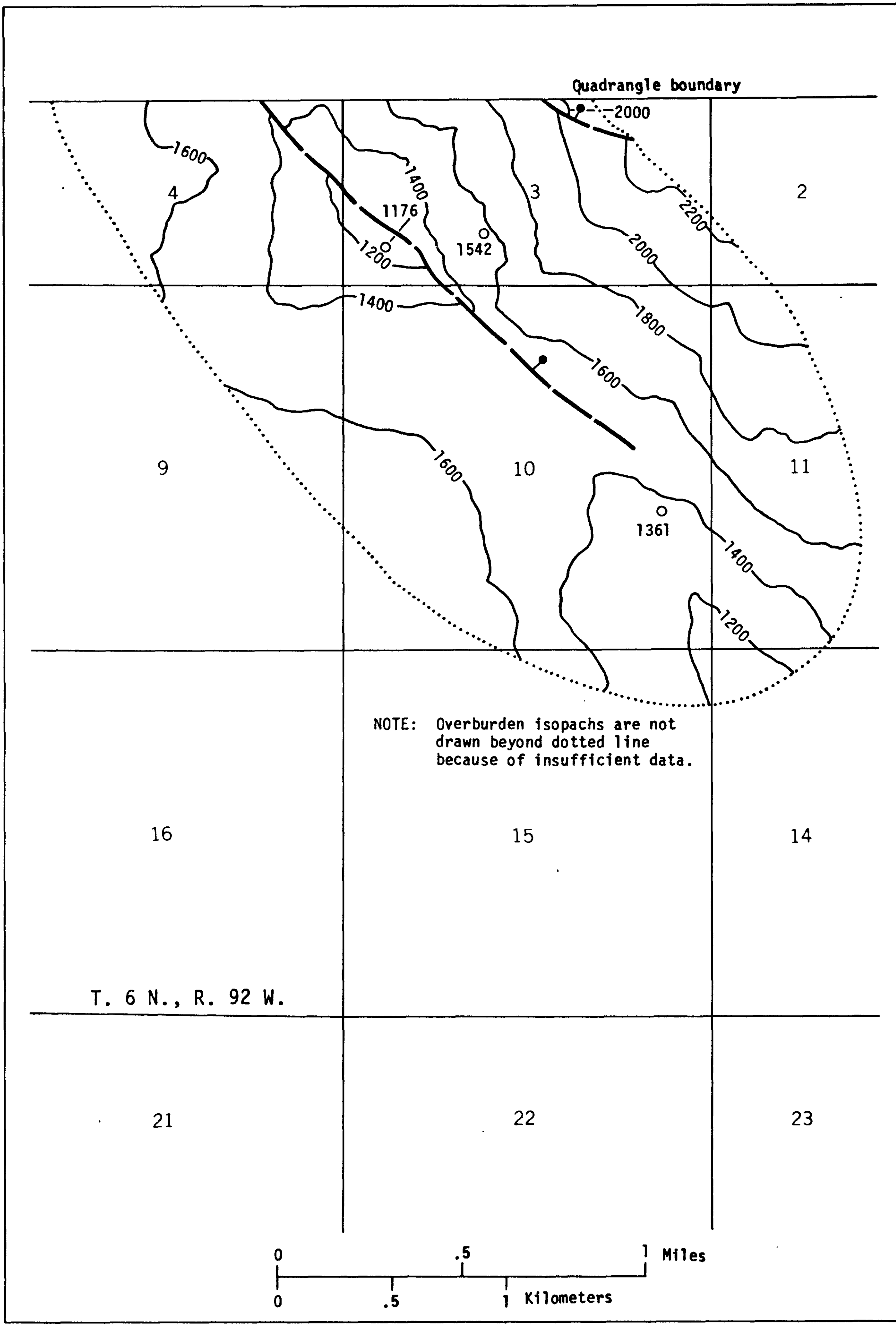

FIGURE 24. — Overburden isopach map of the Middle Coal Group, coal bed [8].

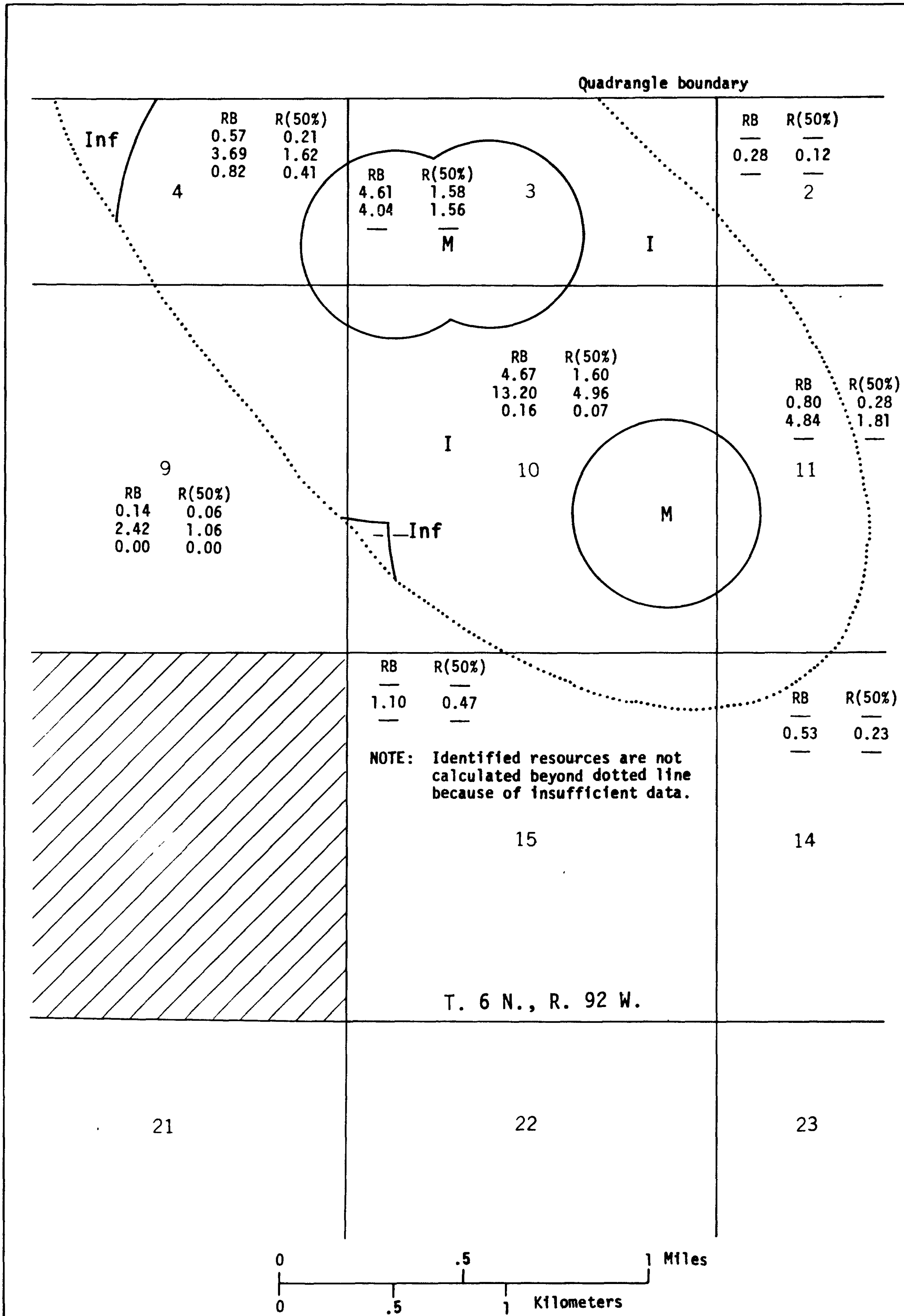

FIGURE 25. — Areal distribution and identified resources map of the Middle Coal Group, coal bed [8].

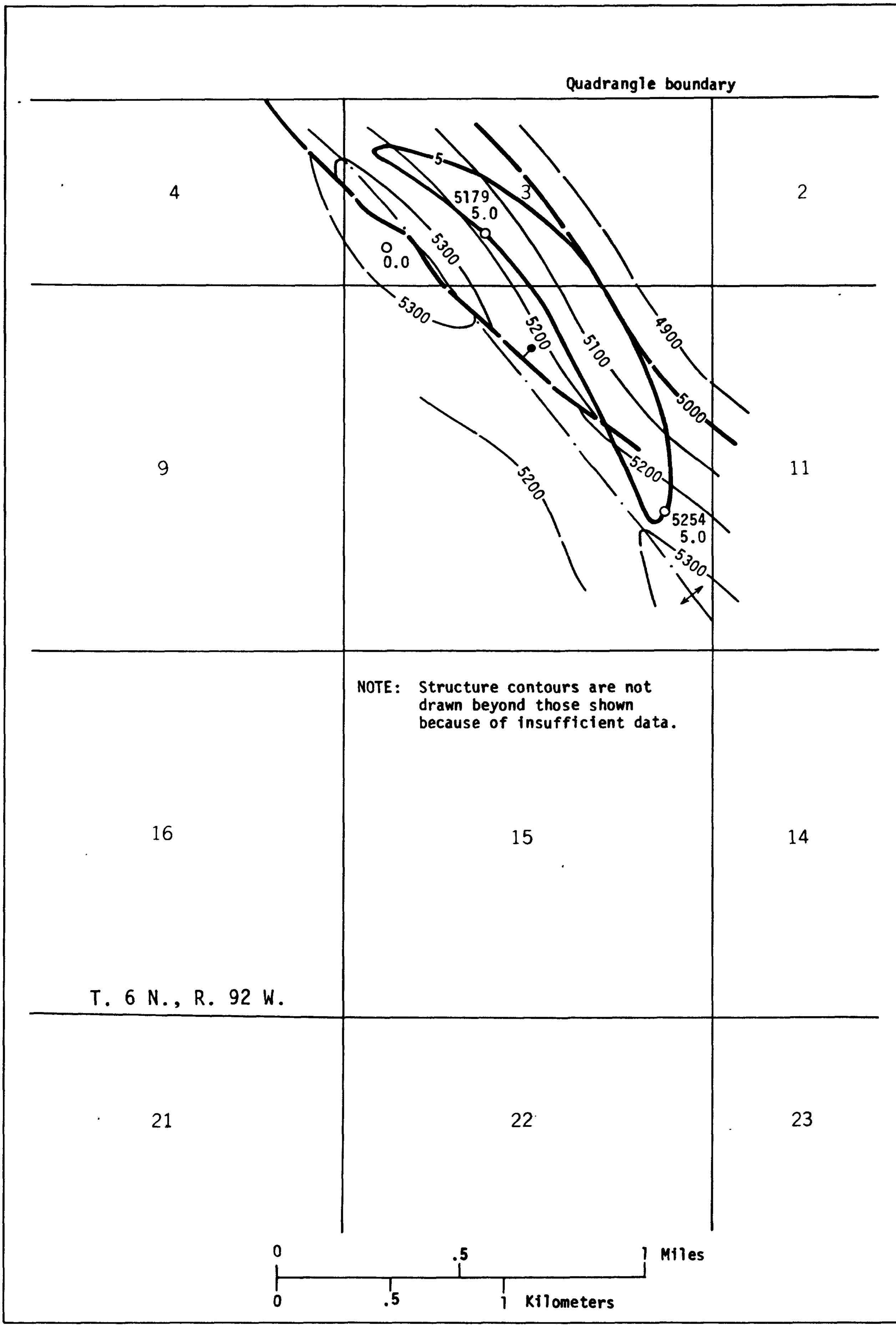

FIGURE 26. — Isopach and structure contour map of the Middle Coal Group, coal bed [10].

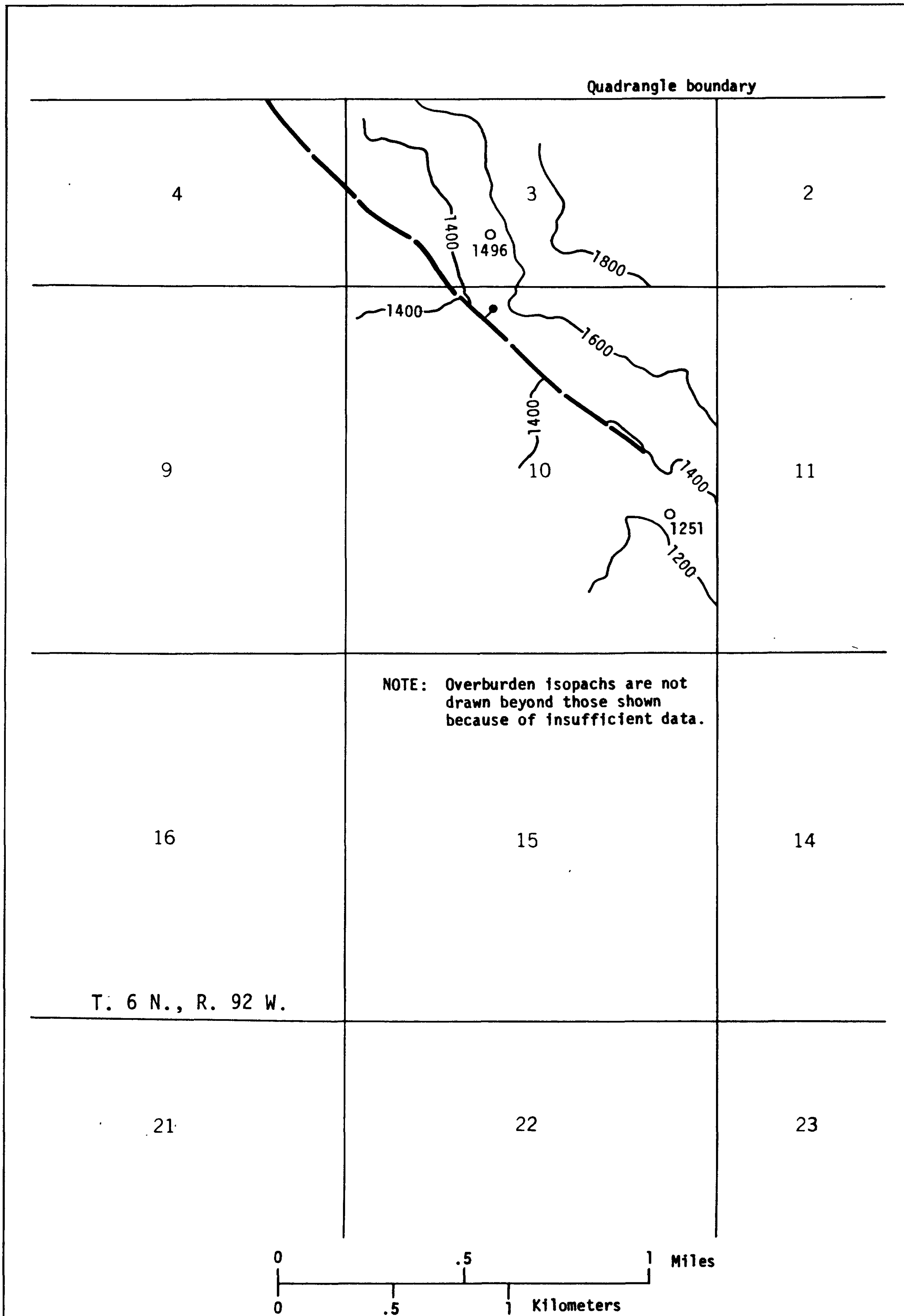

FIGURE 27. — Overburden isopach map of the Middle Coal Group, coal bed [10].

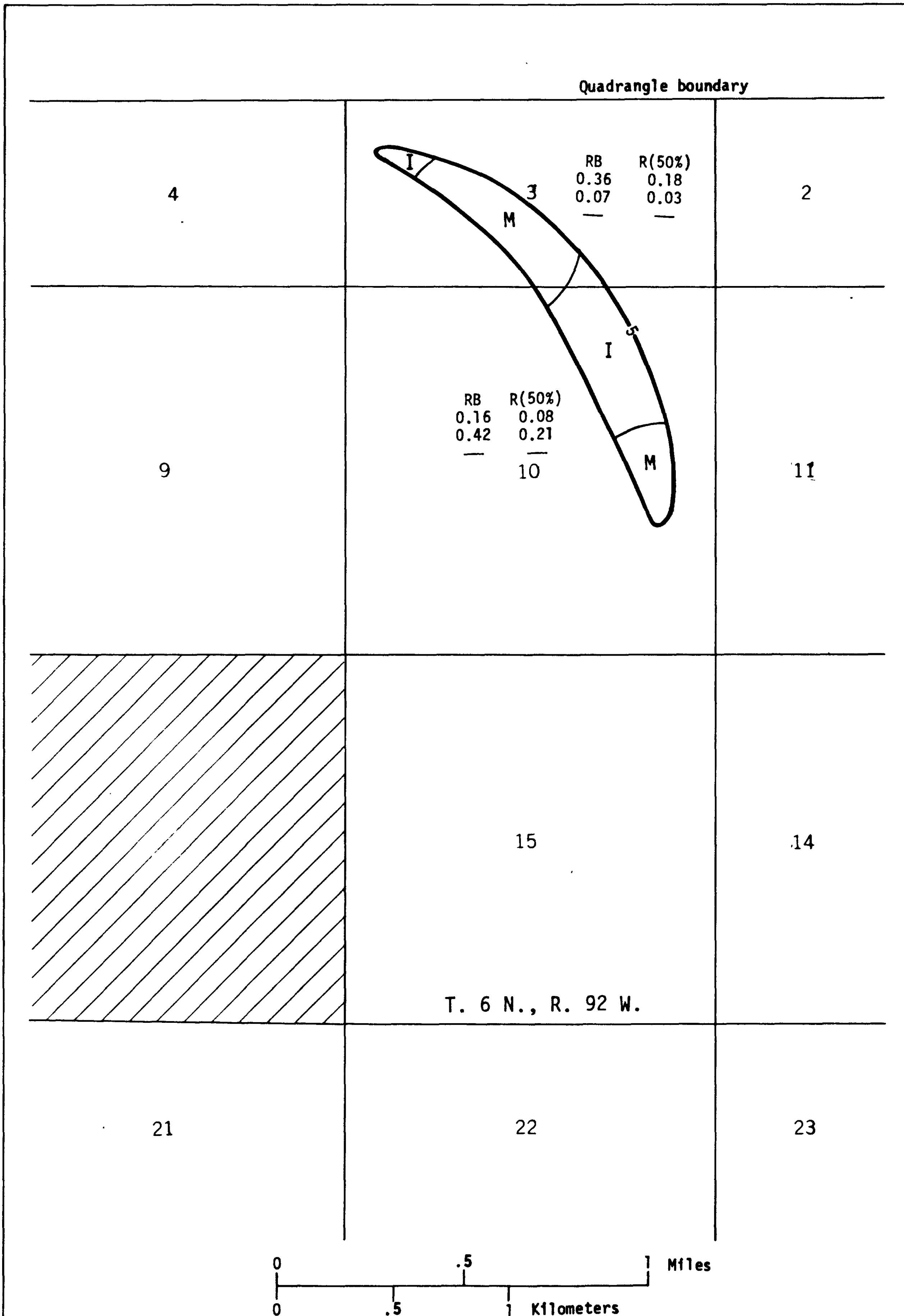

FIGURE 28. — Areal distribution and identified resources map of the Middle Coal Group, coal bed [10].

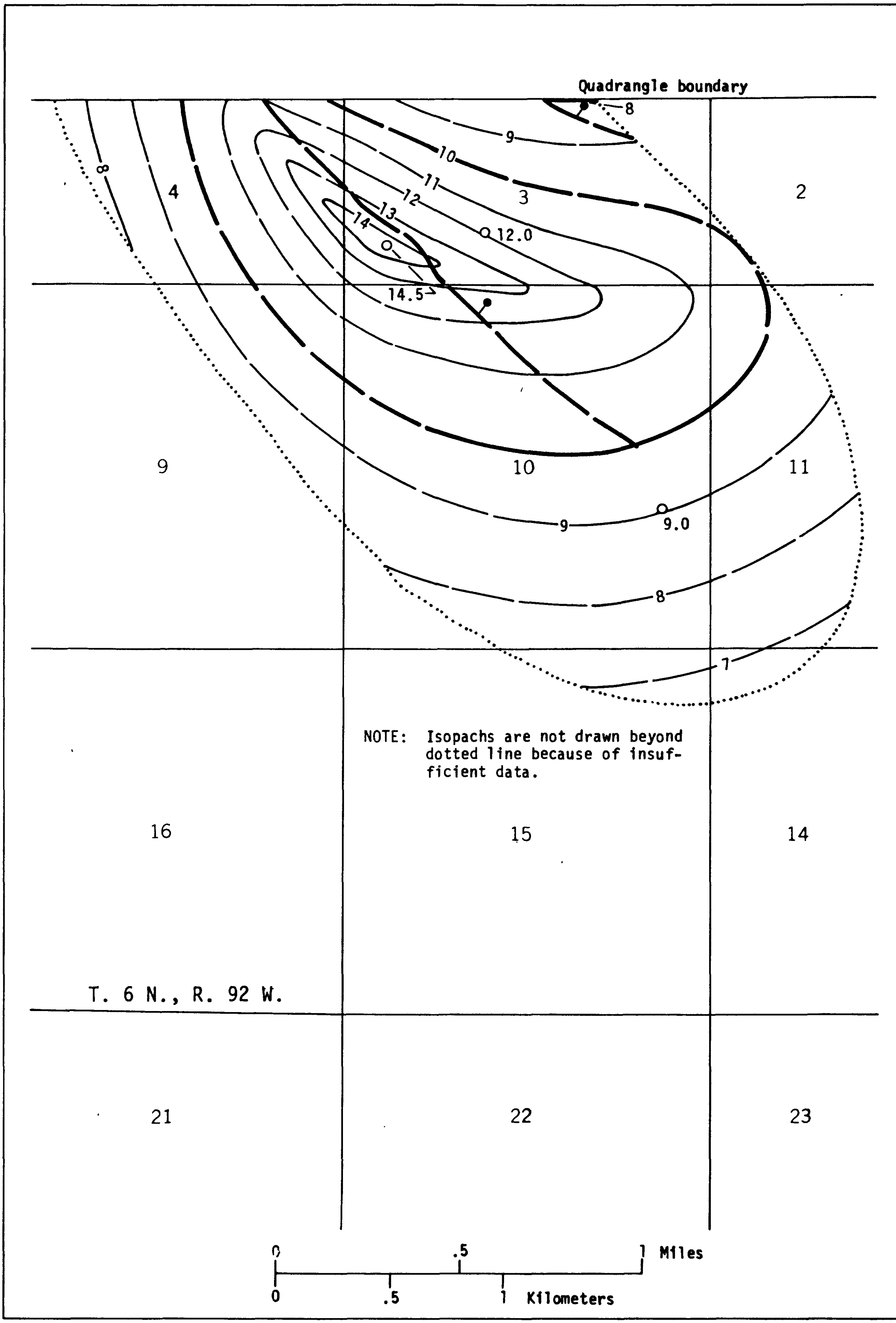

FIGURE 29. — Isopach map of the Middle Coal Group, coal bed [11].

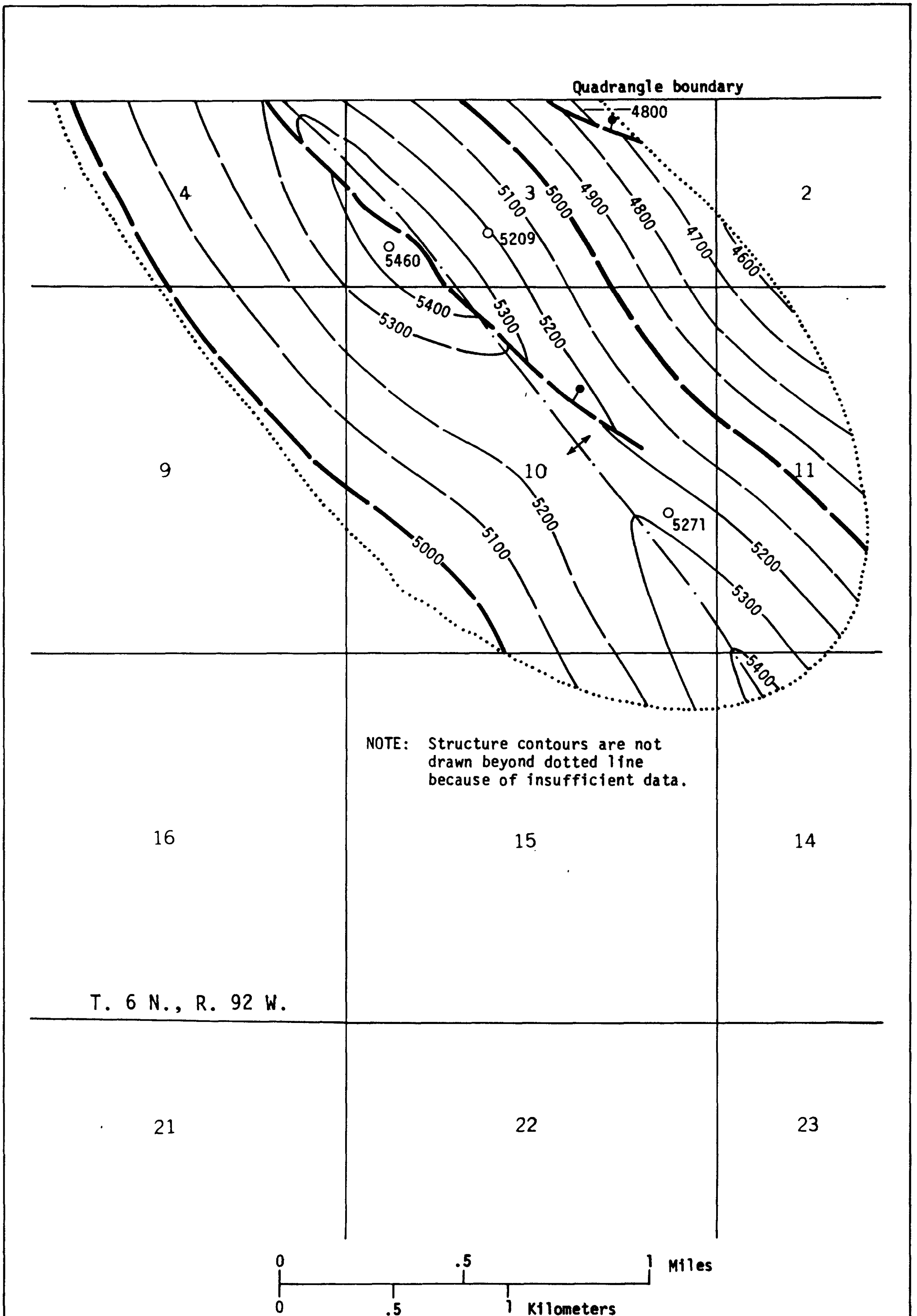

FIGURE 30. — Structure contour map of the Middle Coal Group, coal bed [11].

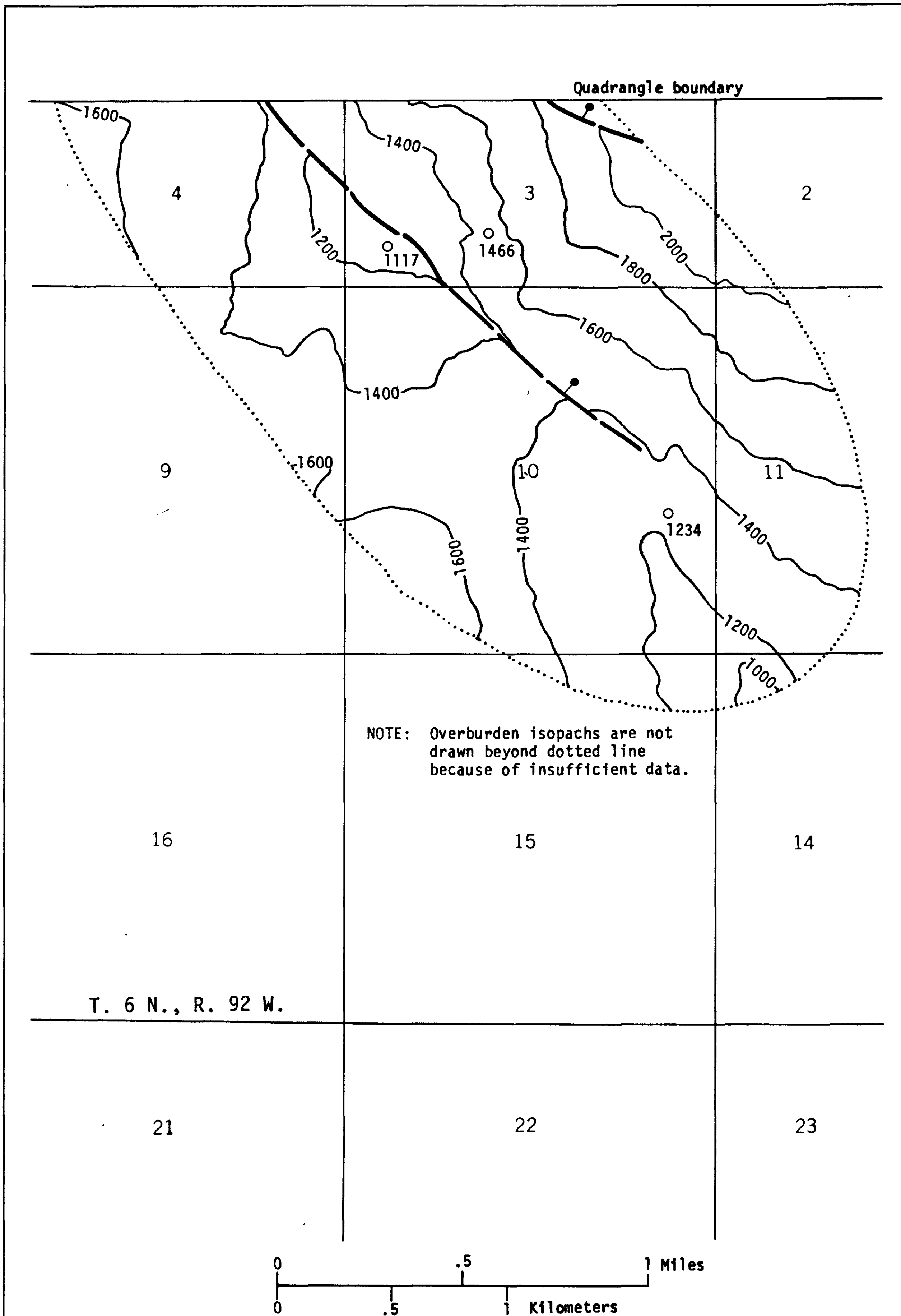

FIGURE 31. — Overburden isopach map of the Middle Coal Group, coal bed [11].

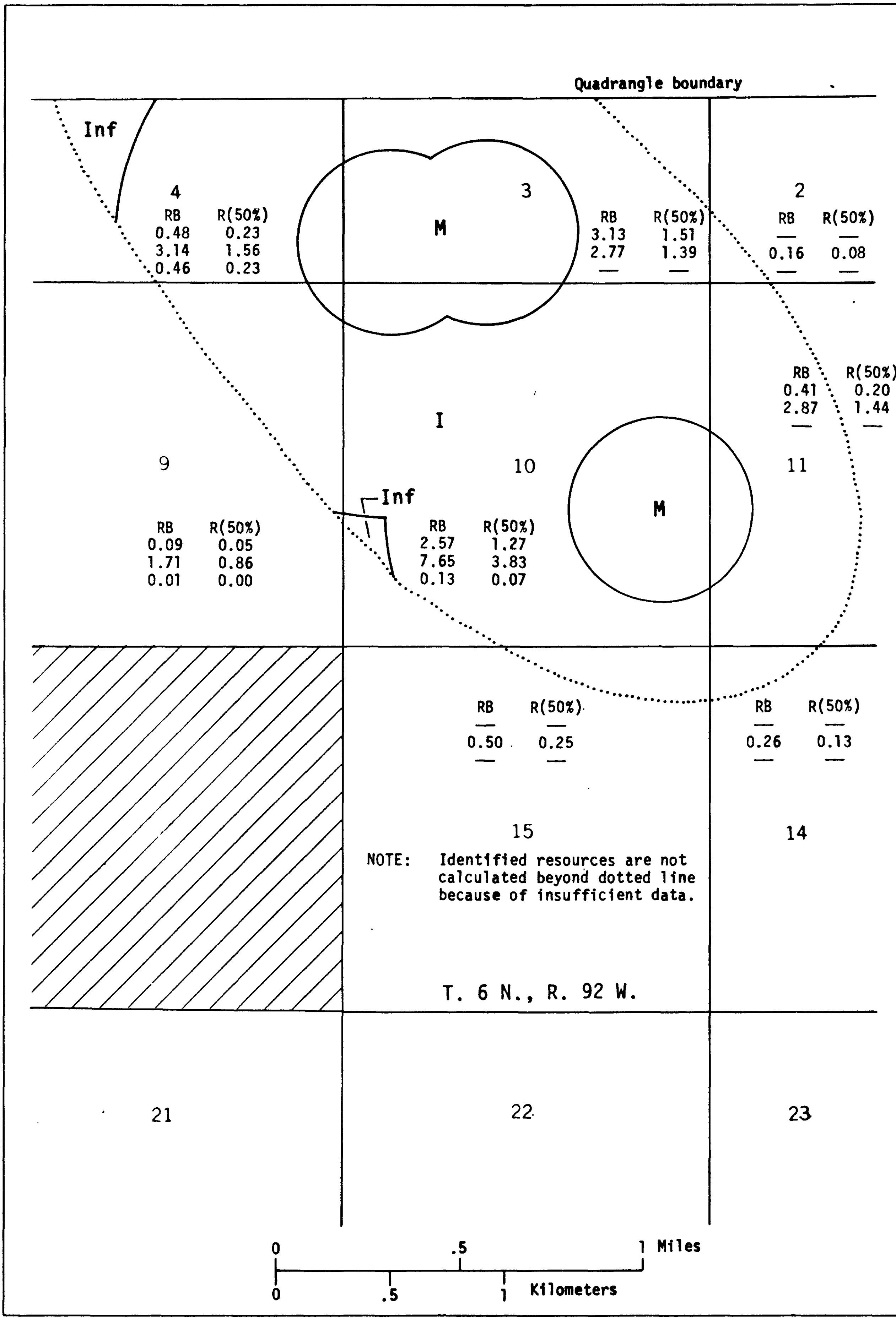

FIGURE 32. — Areal distribution and identified resources map of the Middle Coal Group, coal bed [11].

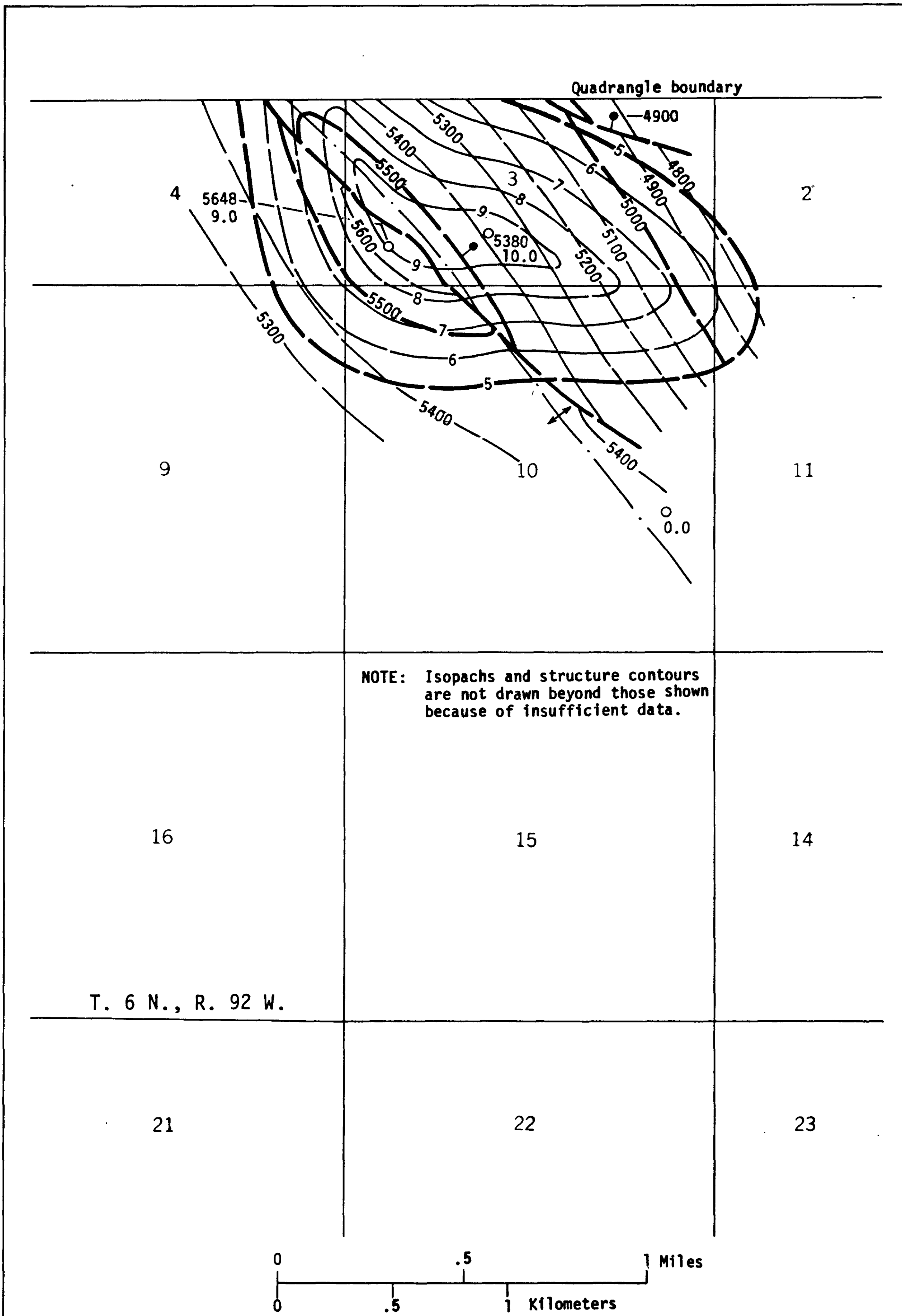

FIGURE 33. — Isopach and structure contour map of the Middle Coal Group, coal bed [12].

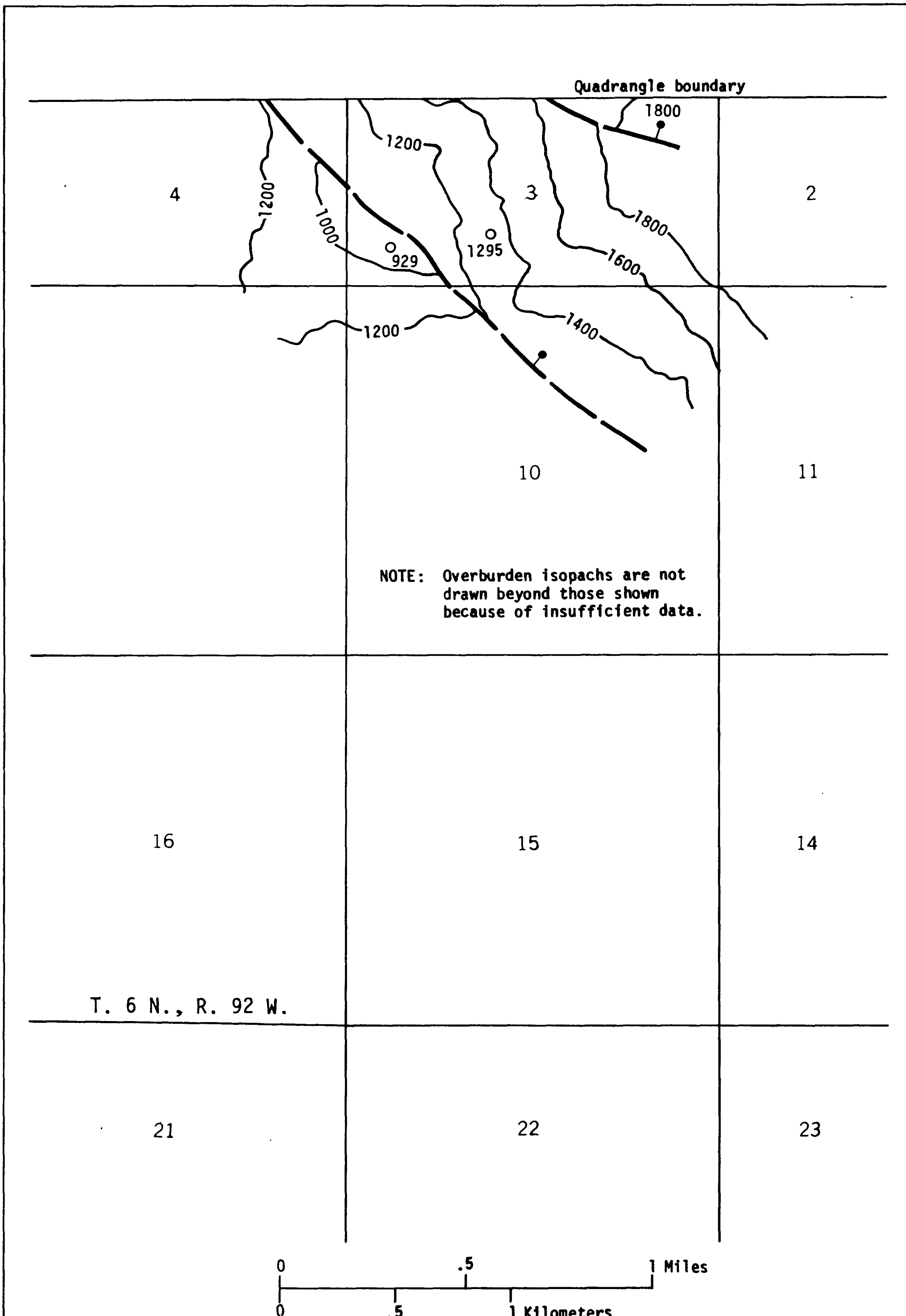

FIGURE 34. — Overburden isopach map of the Middle Coal Group, coal bed [12].

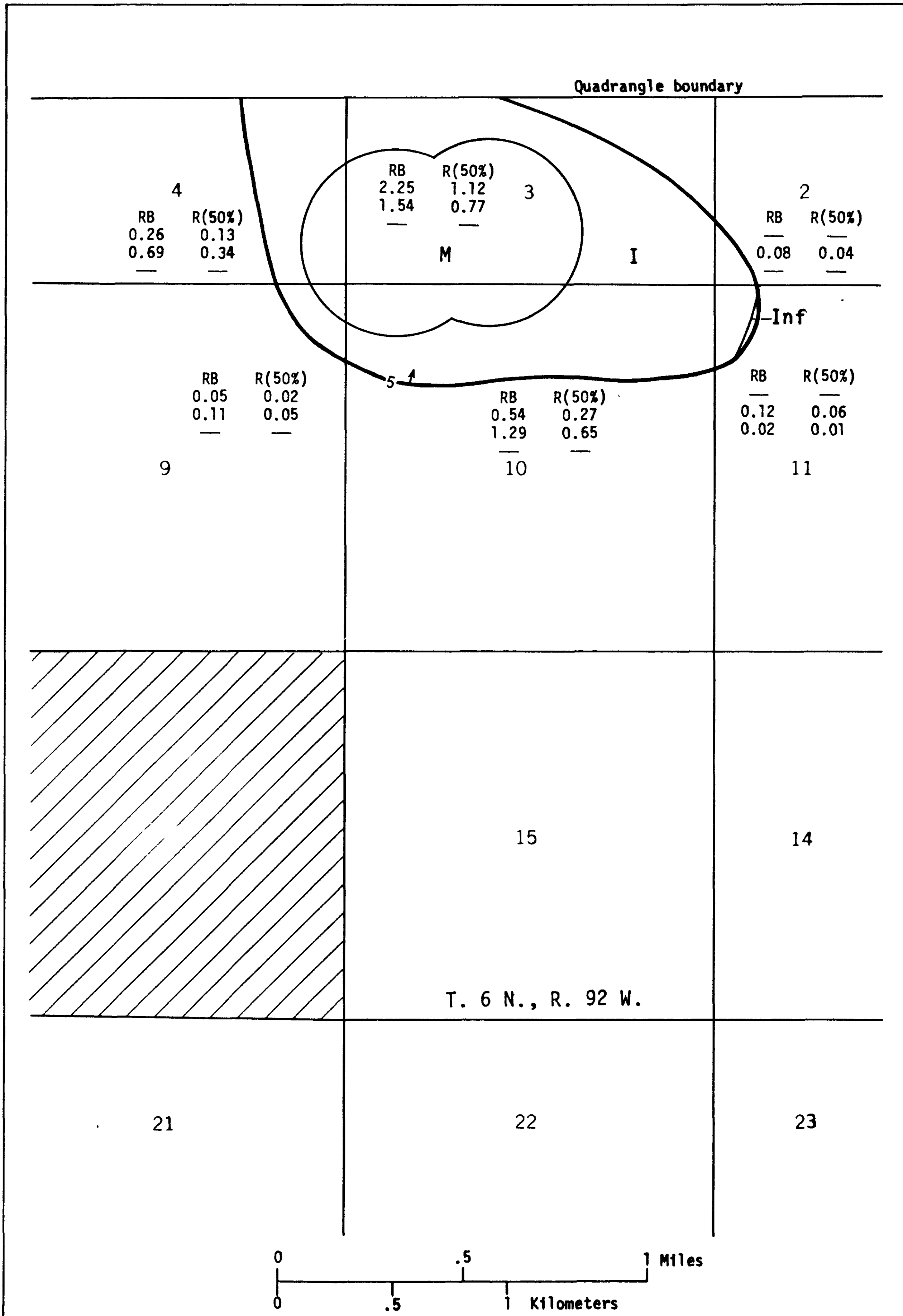

FIGURE 35. — Areal distribution and identified resources map of the Middle Coal Group, coal bed [12].

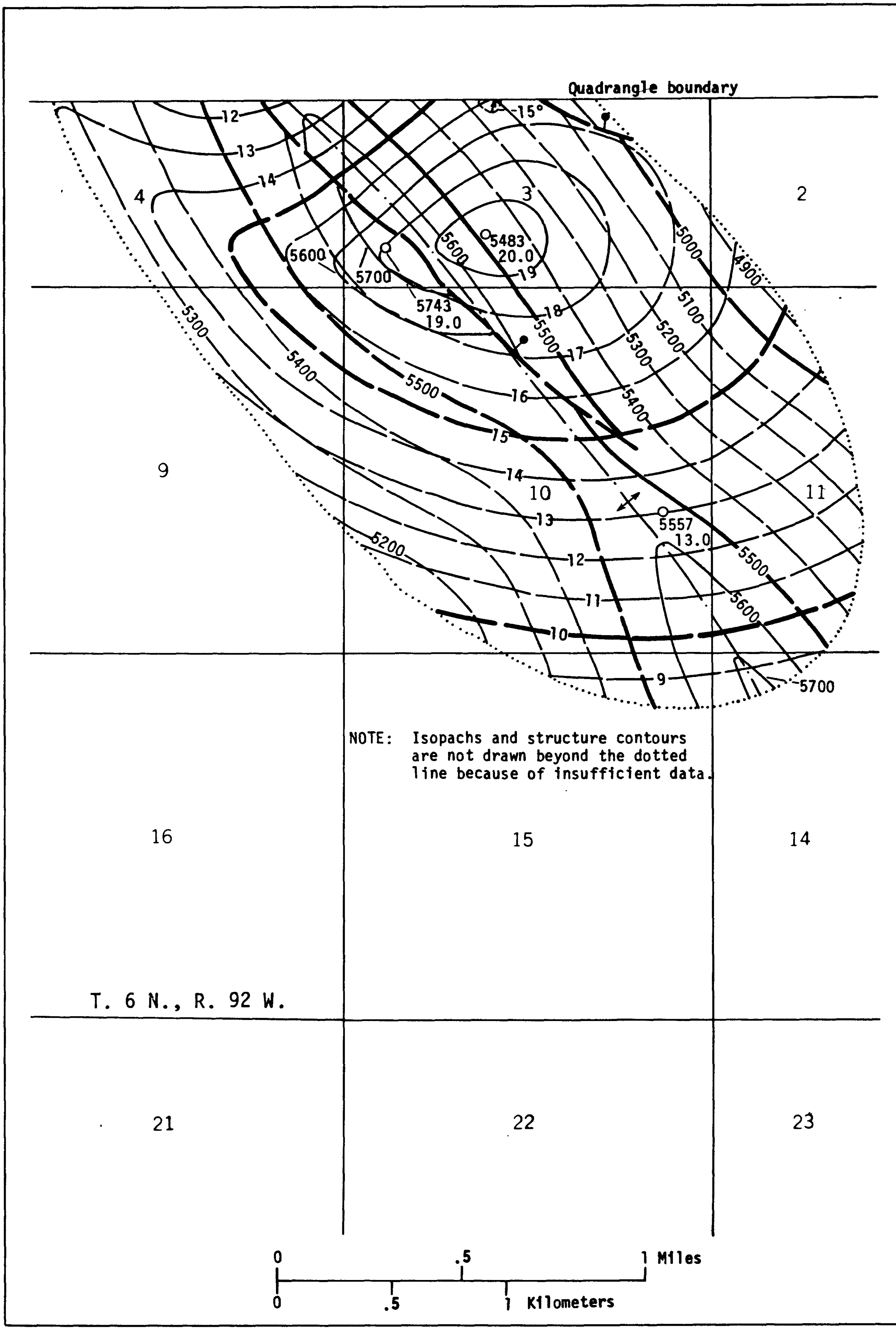

FIGURE 36. — Isopach and structure contour map of the Middle Coal Group, coal bed [13].

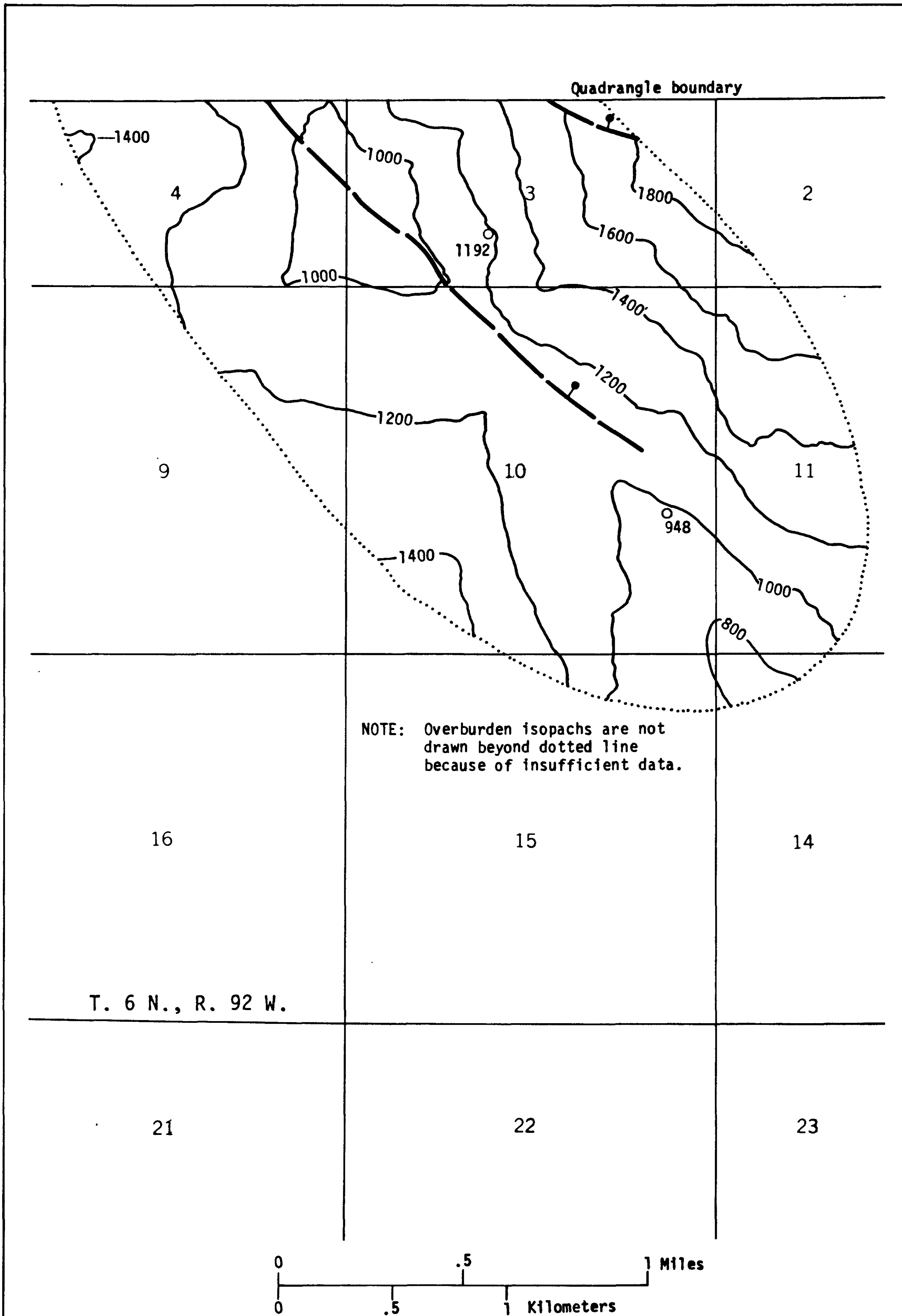

FIGURE 37. — Overburden isopach map of the Middle Coal Group, coal bed [13].

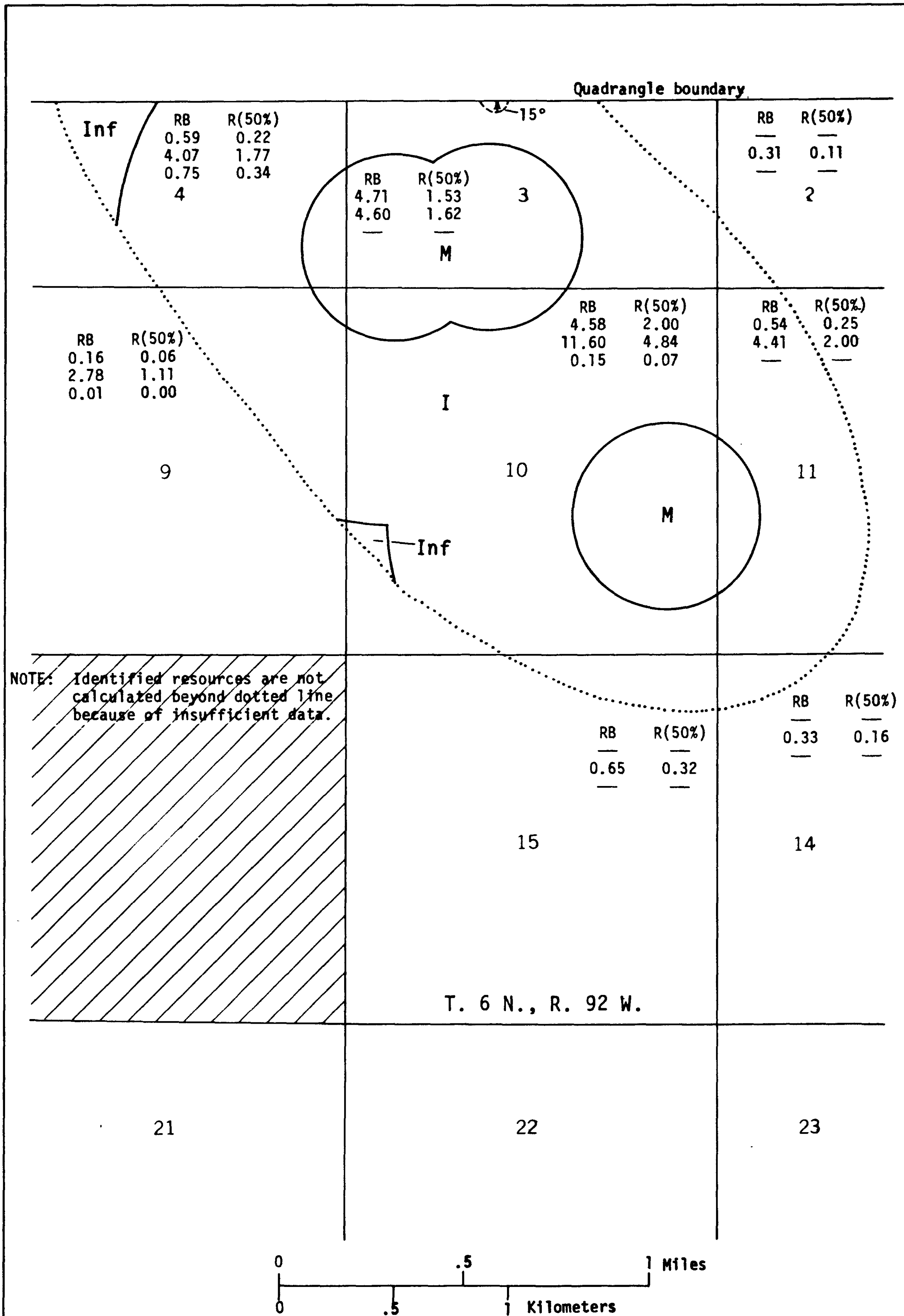

FIGURE 38. — Areal distribution and identified resources map of the Middle Coal Group, coal bed [13].

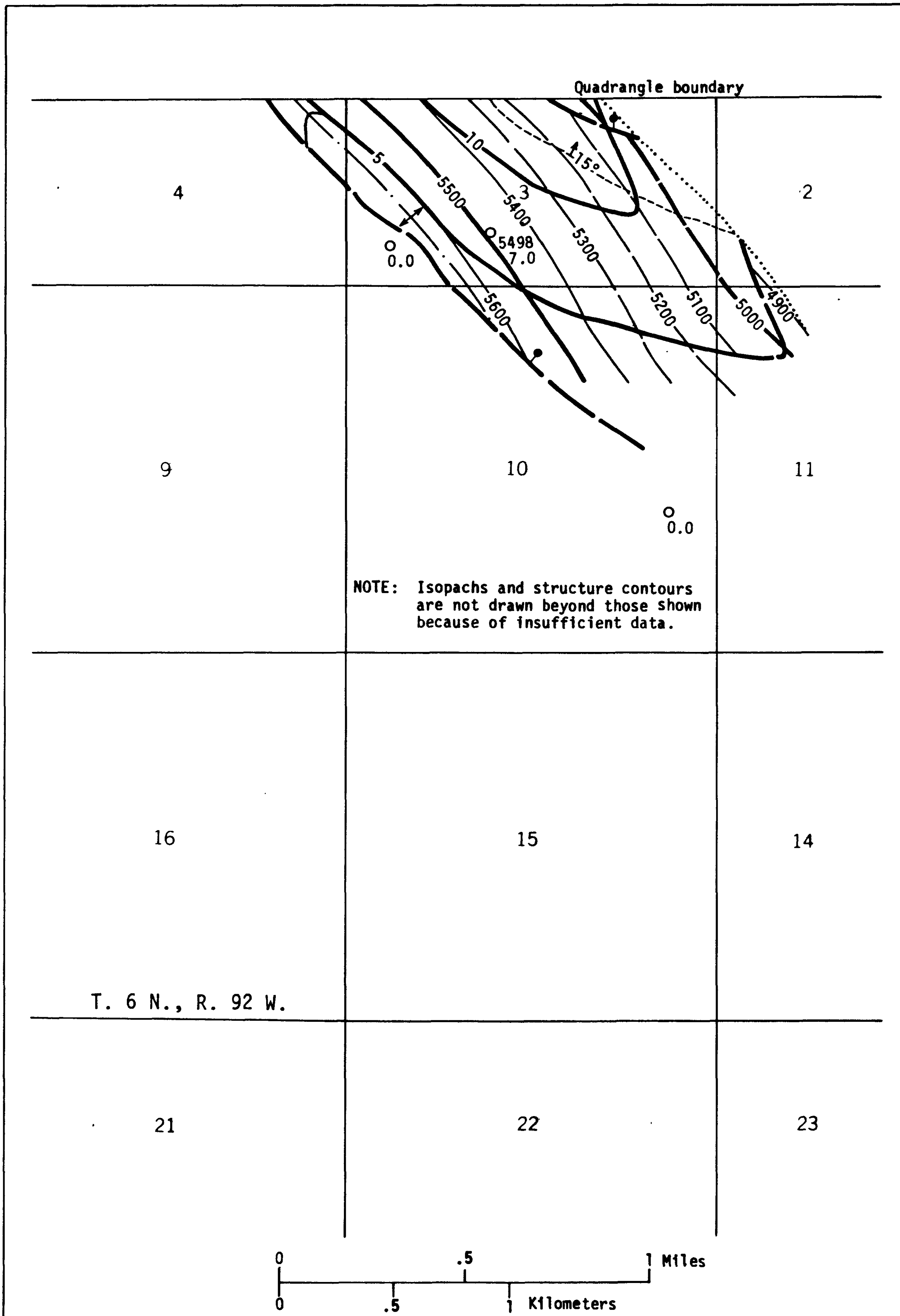

FIGURE 39. — Isopach and structure contour map of the Middle Coal Group, coal bed [14].

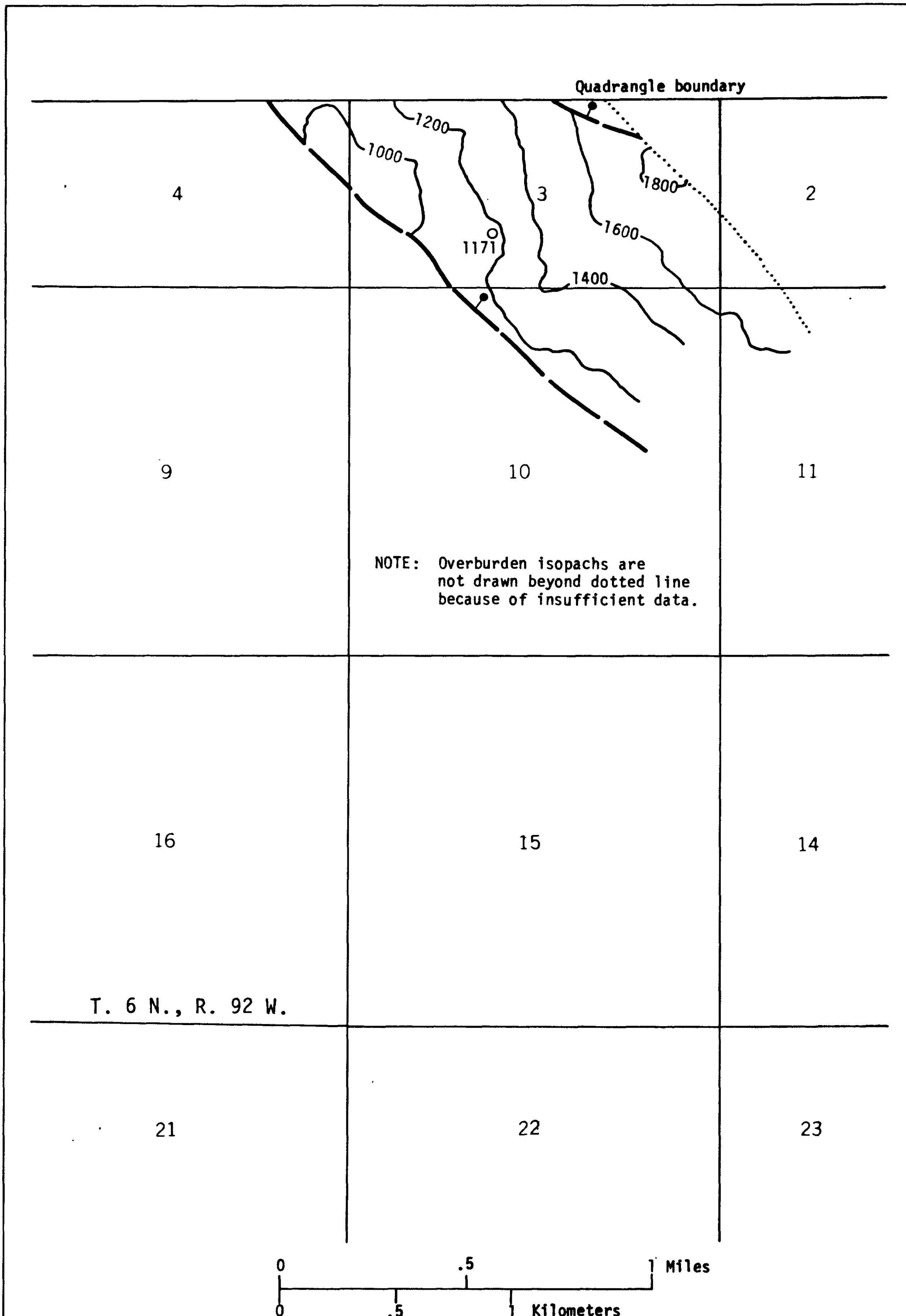

FIGURE 40. — Overburden isopach map of the Middle Coal Group, coal bed [14].

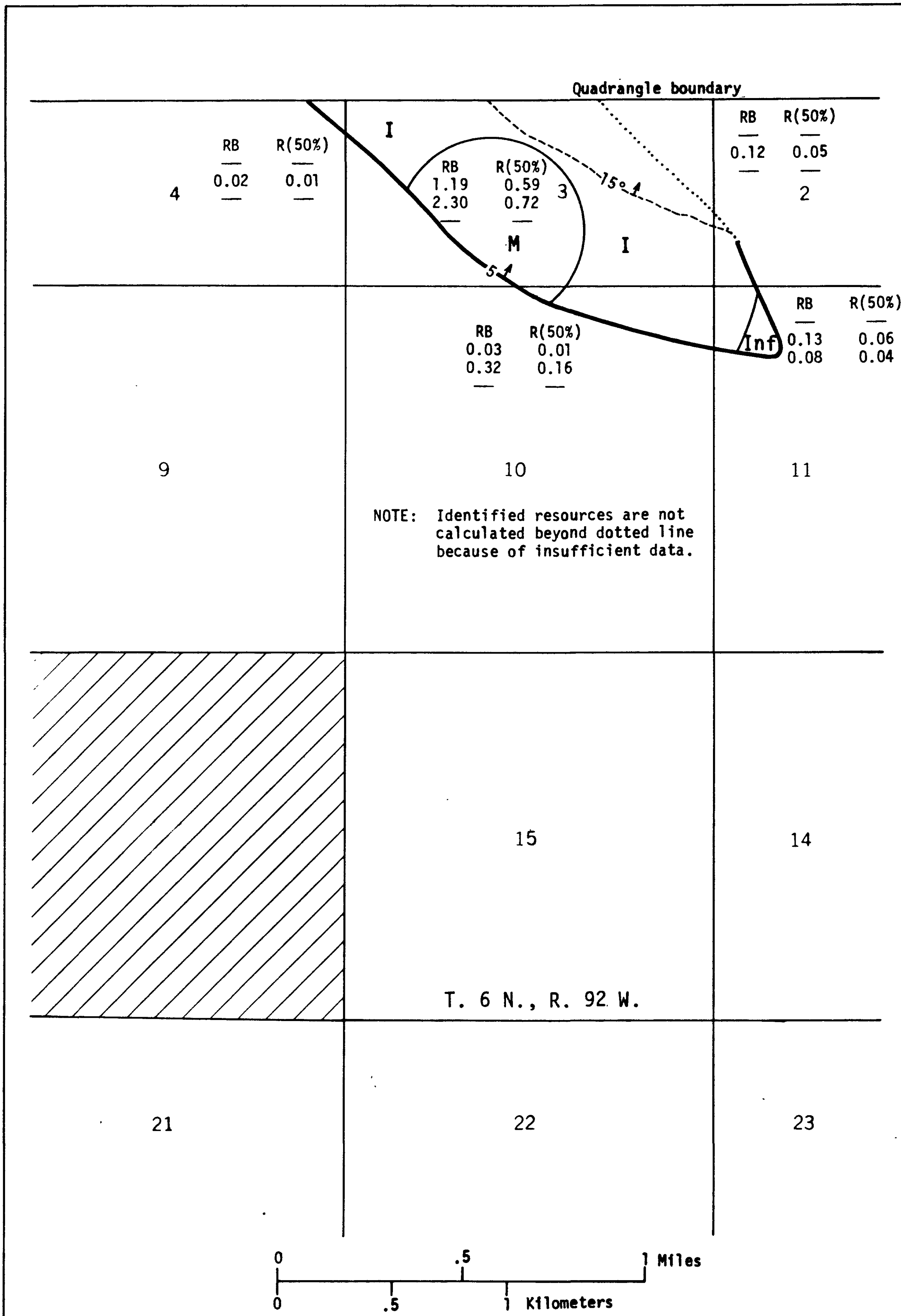

FIGURE 41. — Areal distribution and identified resources map of the Middle Coal Group, coal bed [14].

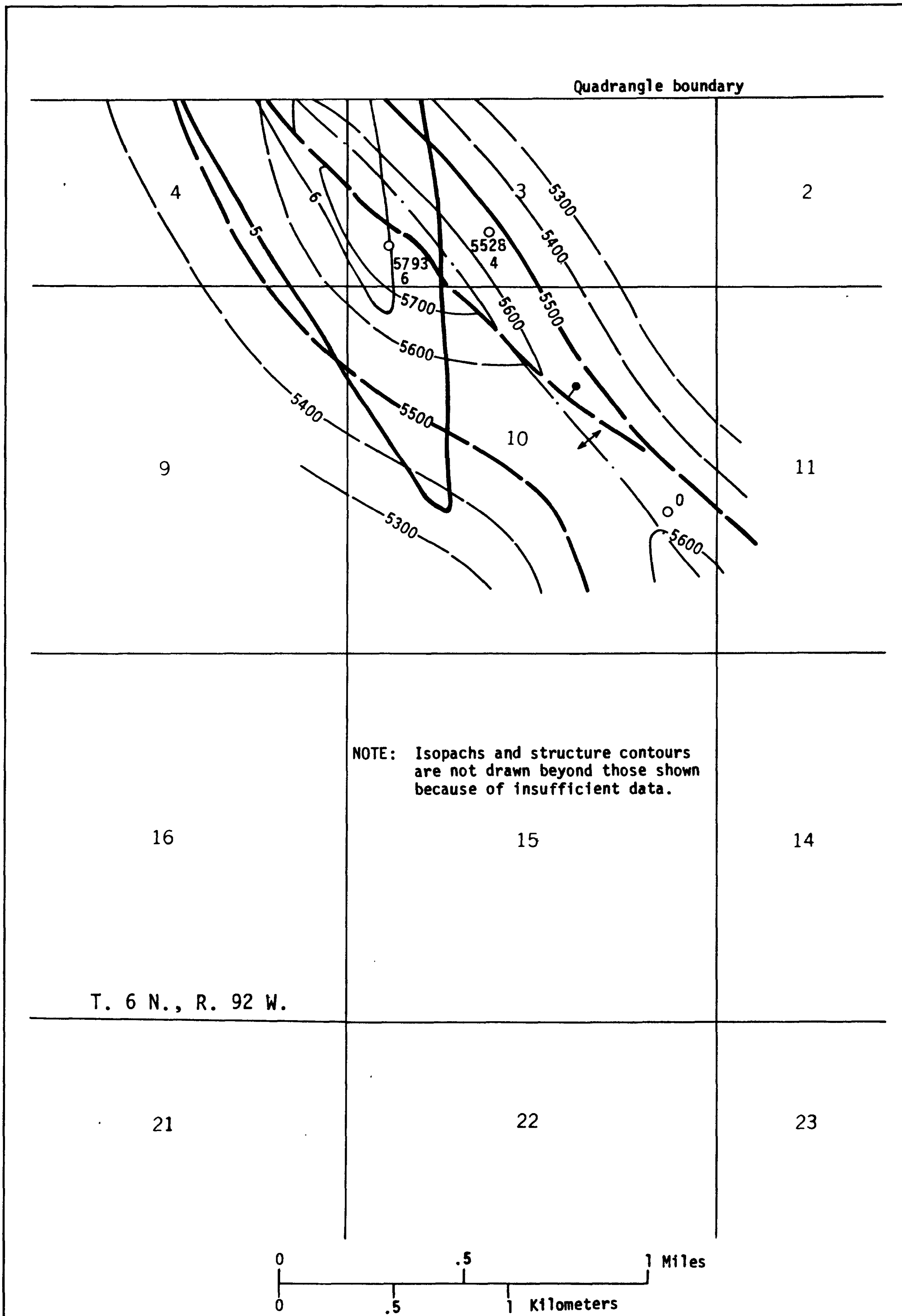

FIGURE 42. — Isopach and structure contour map of the Middle Coal Group, coal bed [15].

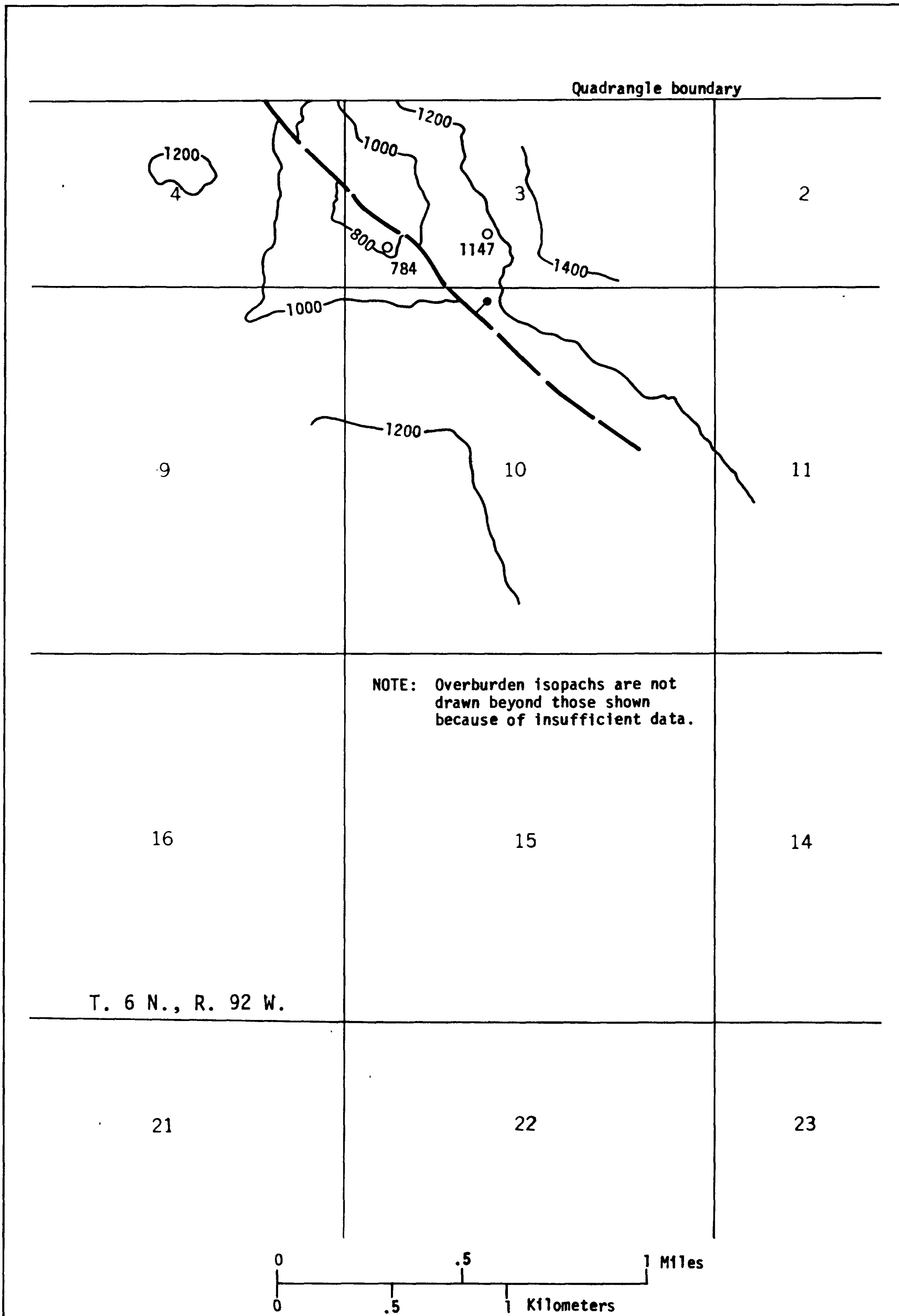

FIGURE 43. — Overburden isopach map of the Middle Coal Group, coal bed [15].

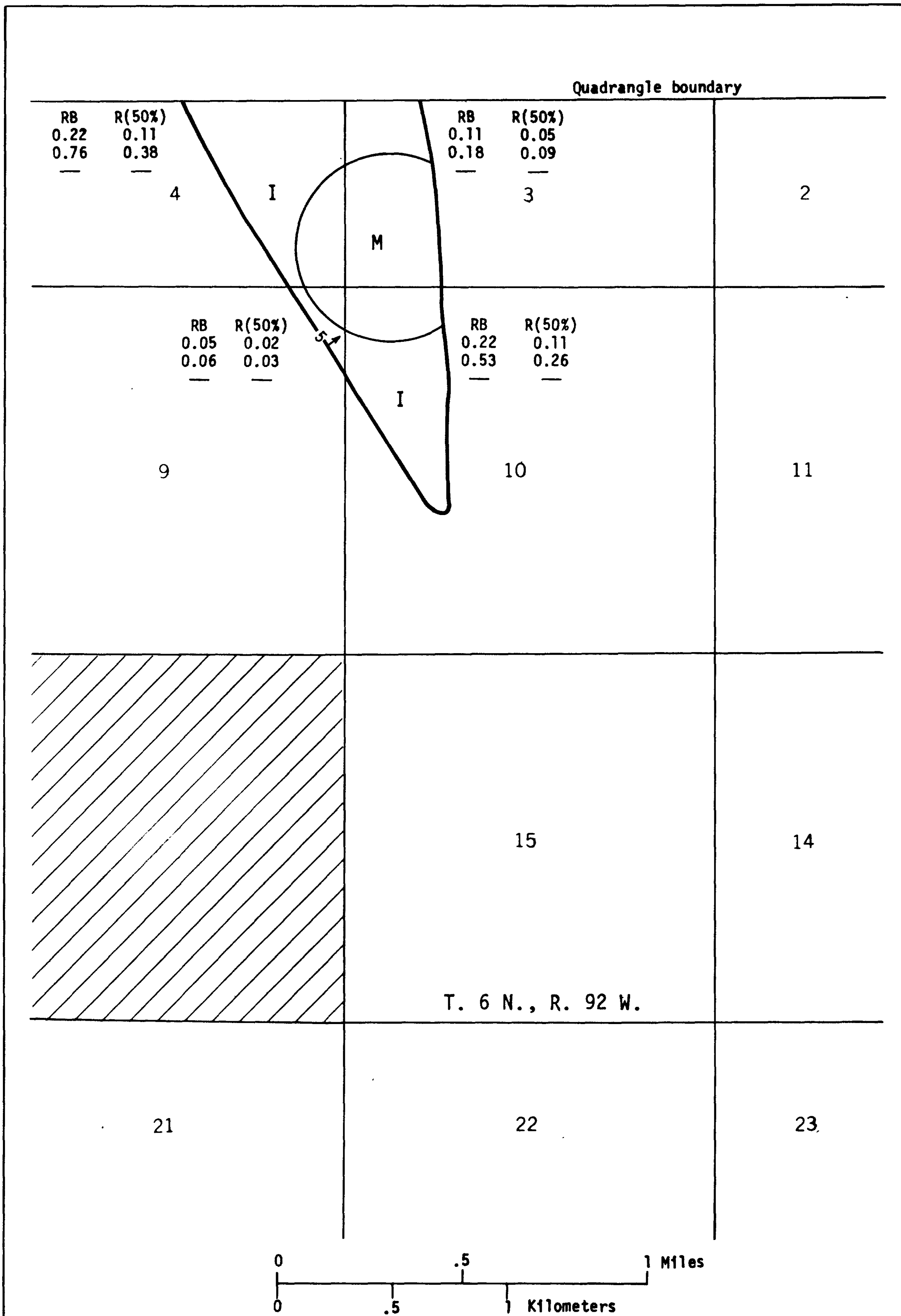

FIGURE 44. — Areal distribution and identified resources map of the Middle Coal Group, coal bed [15].

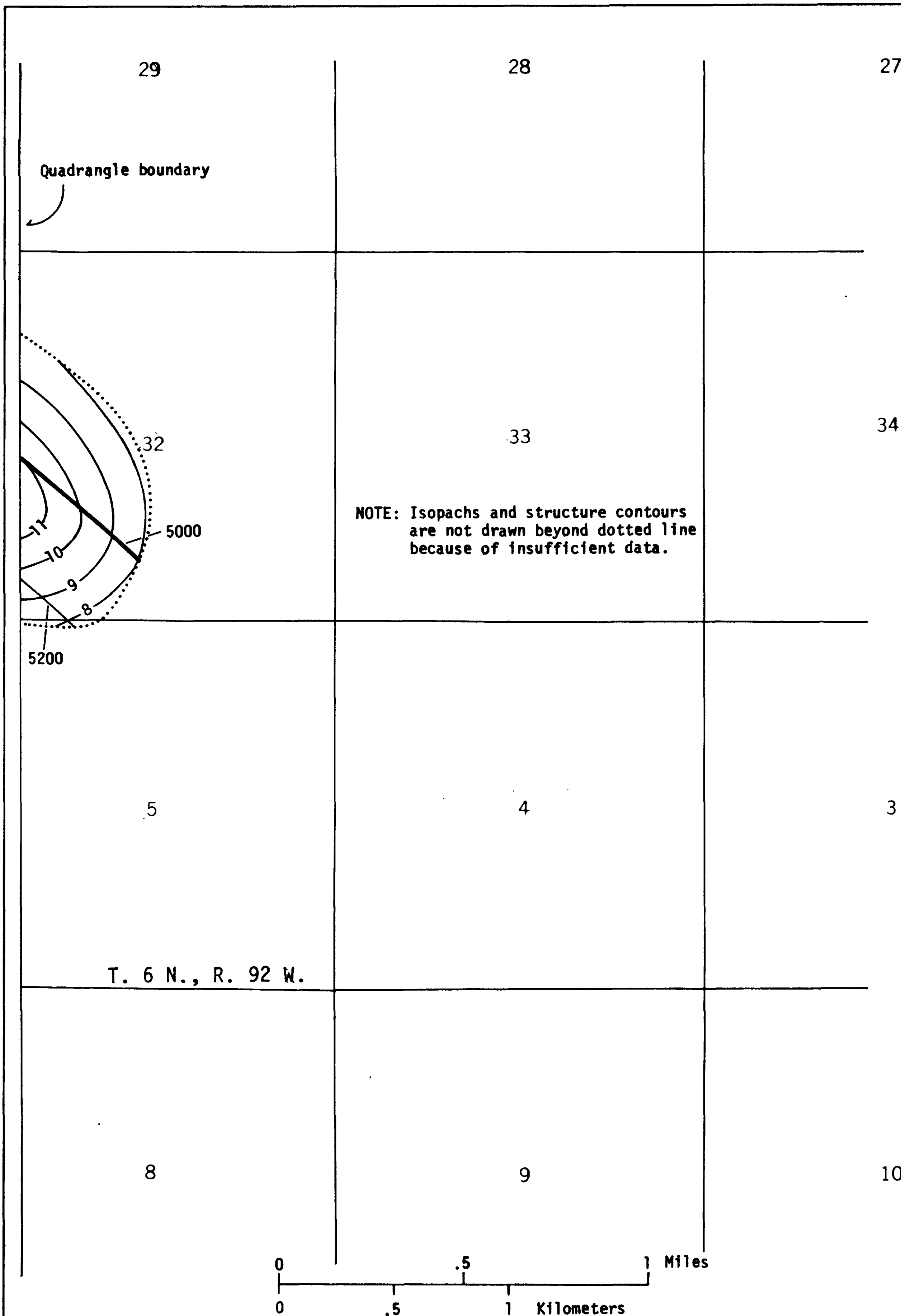

FIGURE 45. — Isopach and structure contour map of the Middle Coal Group, coal bed [209].

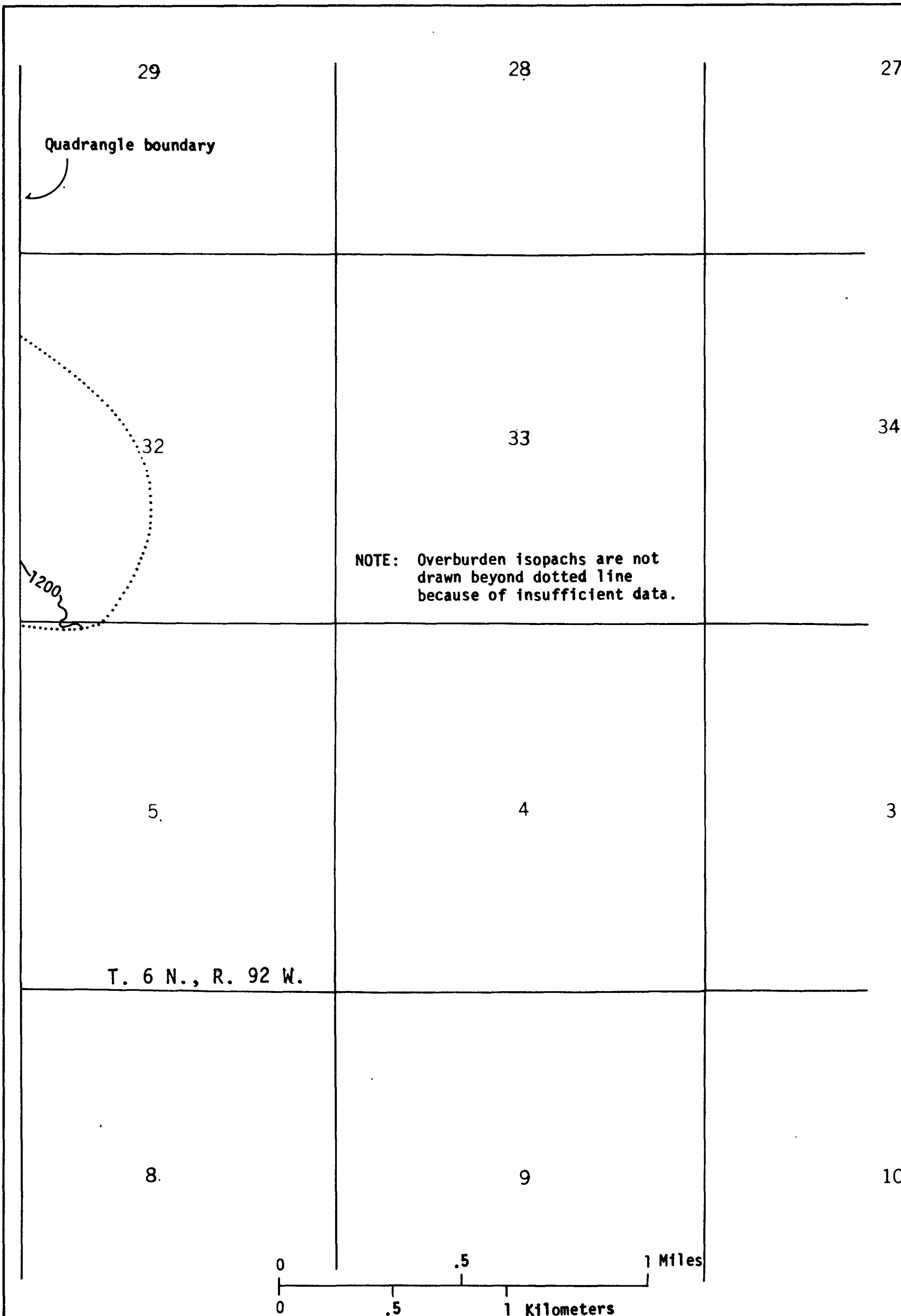

FIGURE 46. — Overburden isopach map of the Middle Coal Group, coal bed [209].

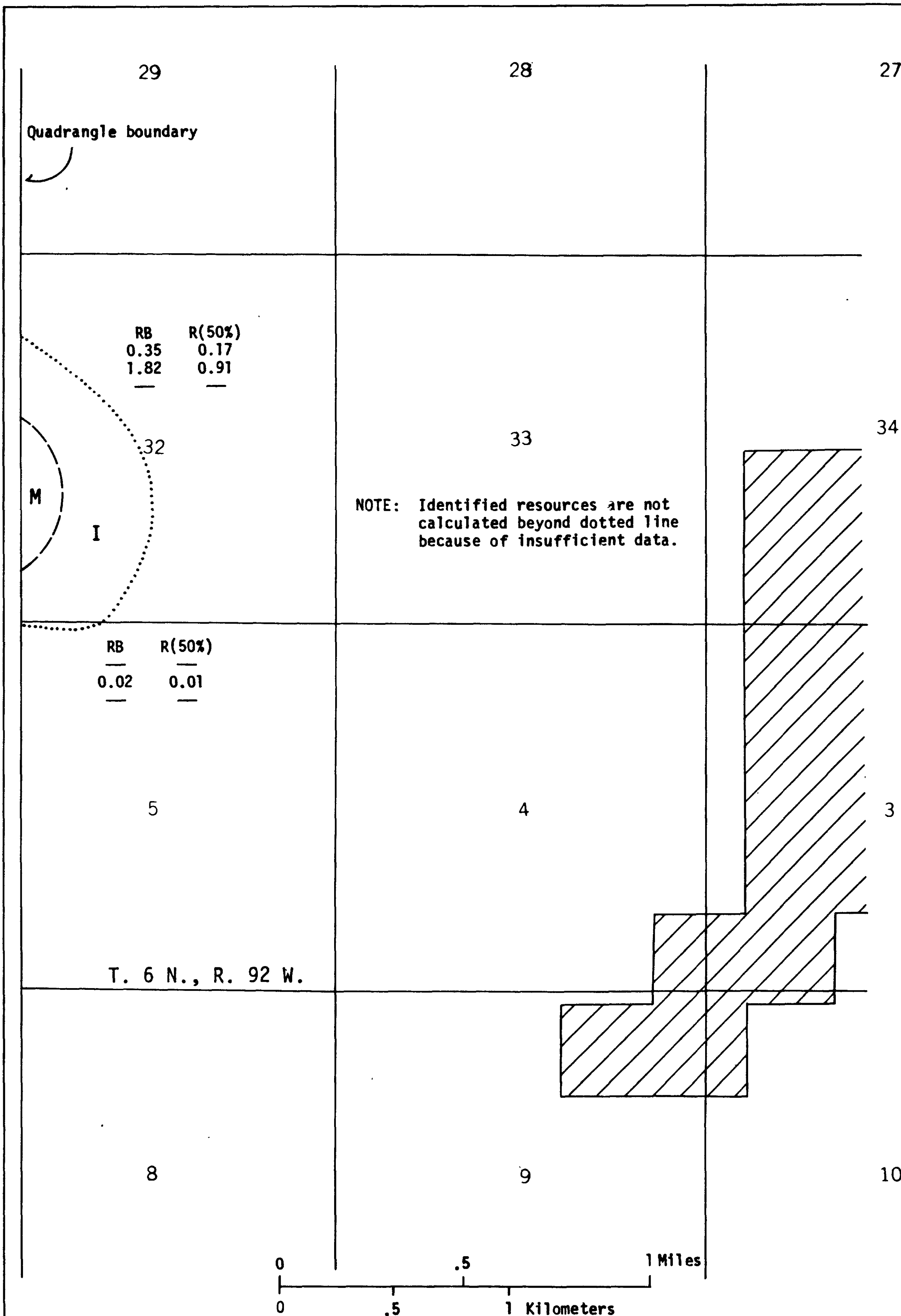

FIGURE 47. — Areal distribution and identified resources map of the Middle Coal Group, coal bed [209].

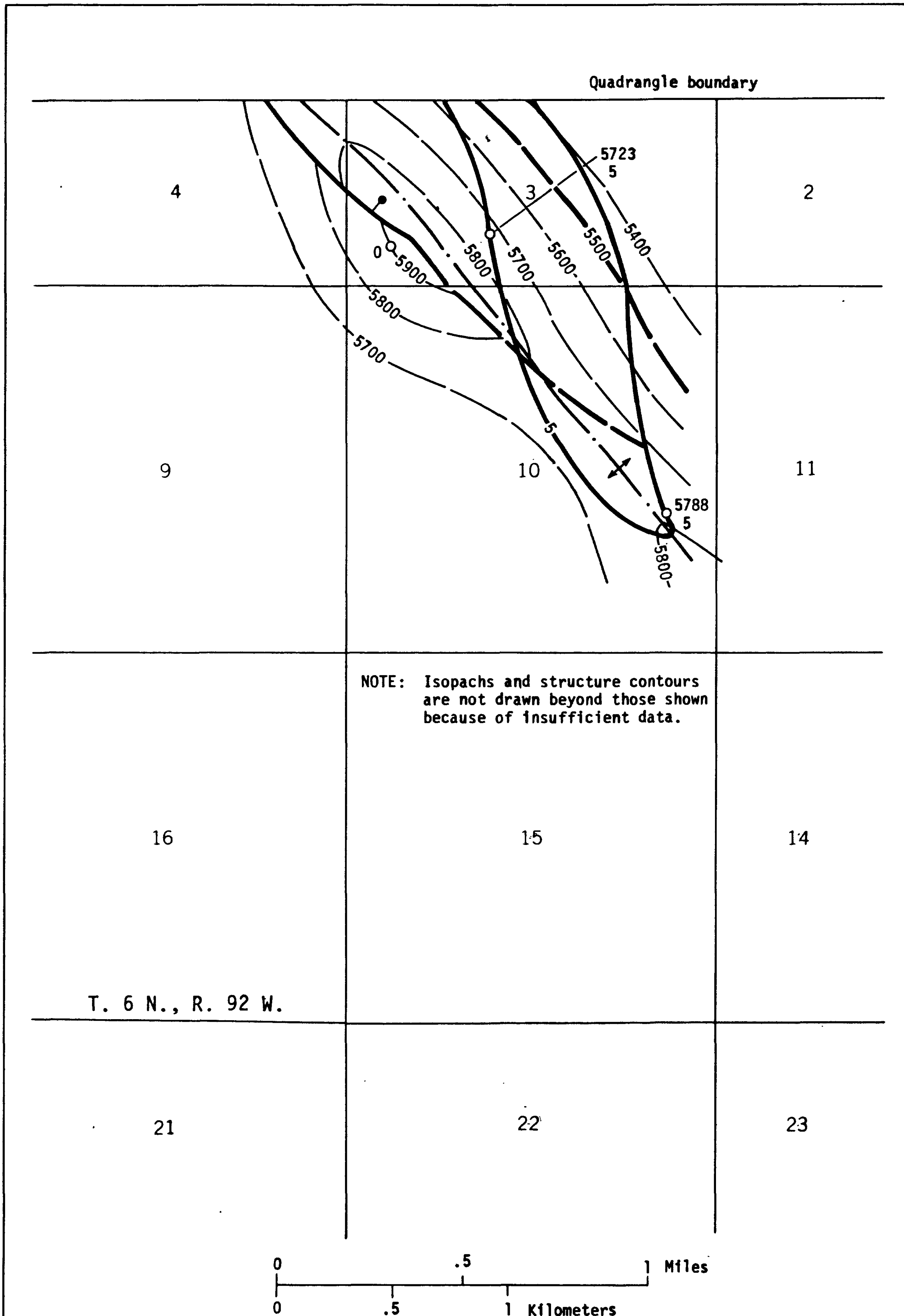

FIGURE 48. — Isopach and structure contour map of the Upper Coal Group, coal bed [3].

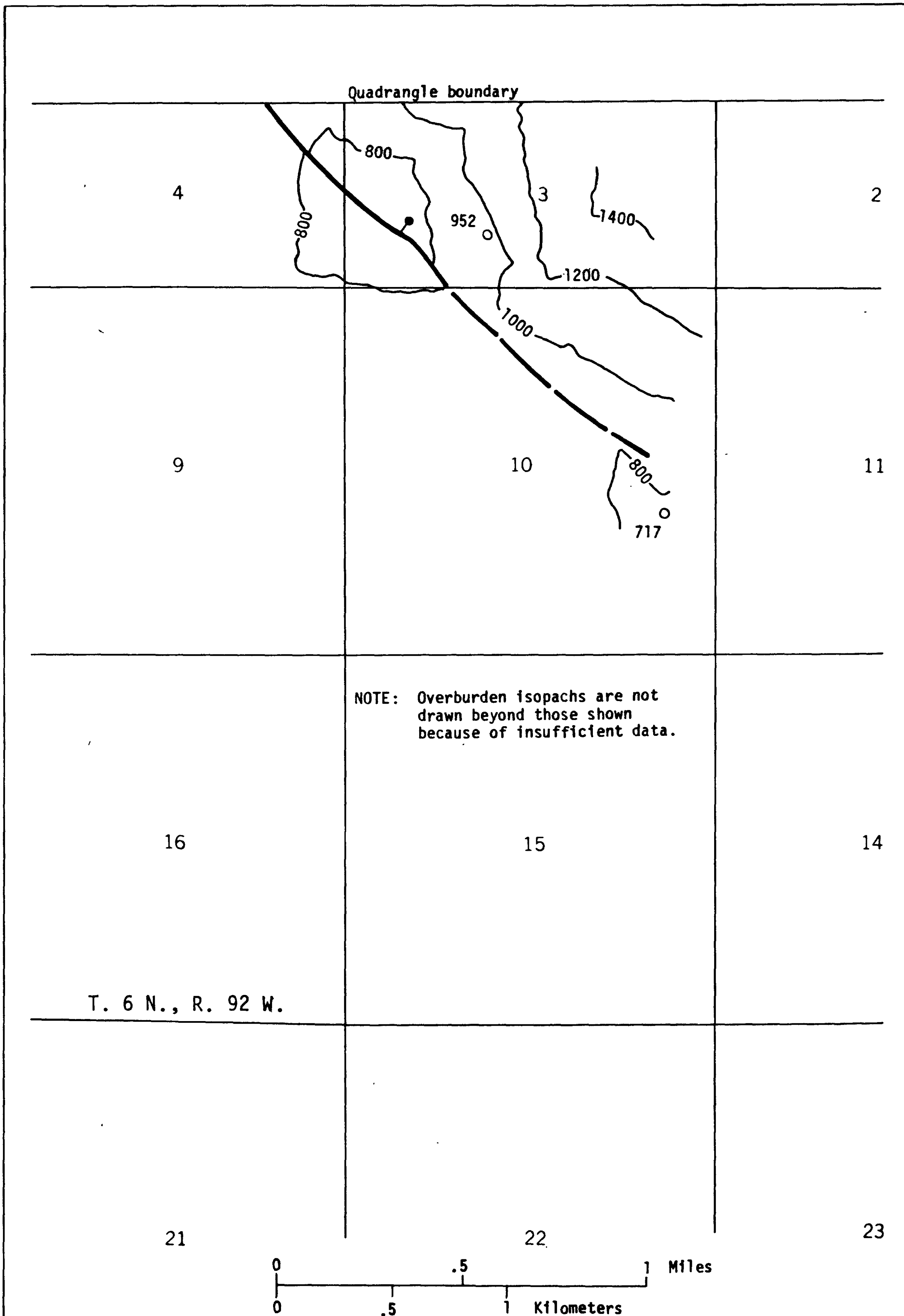

FIGURE 49. — Overburden isopach map of the Upper Coal Group, coal bed [3].

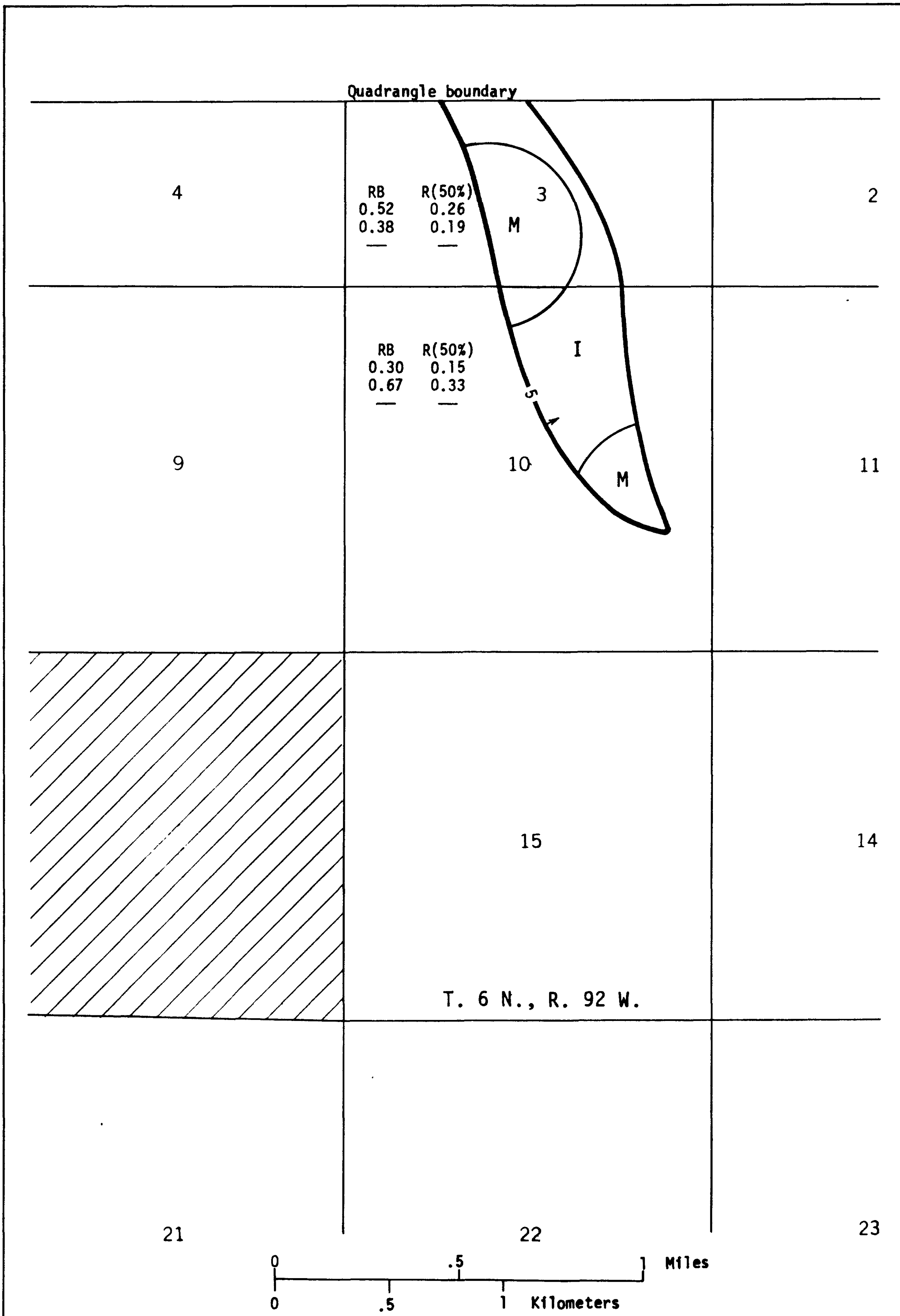

FIGURE 50. — Areal distribution and identified resources map of the Upper Coal Group, coal bed [3].

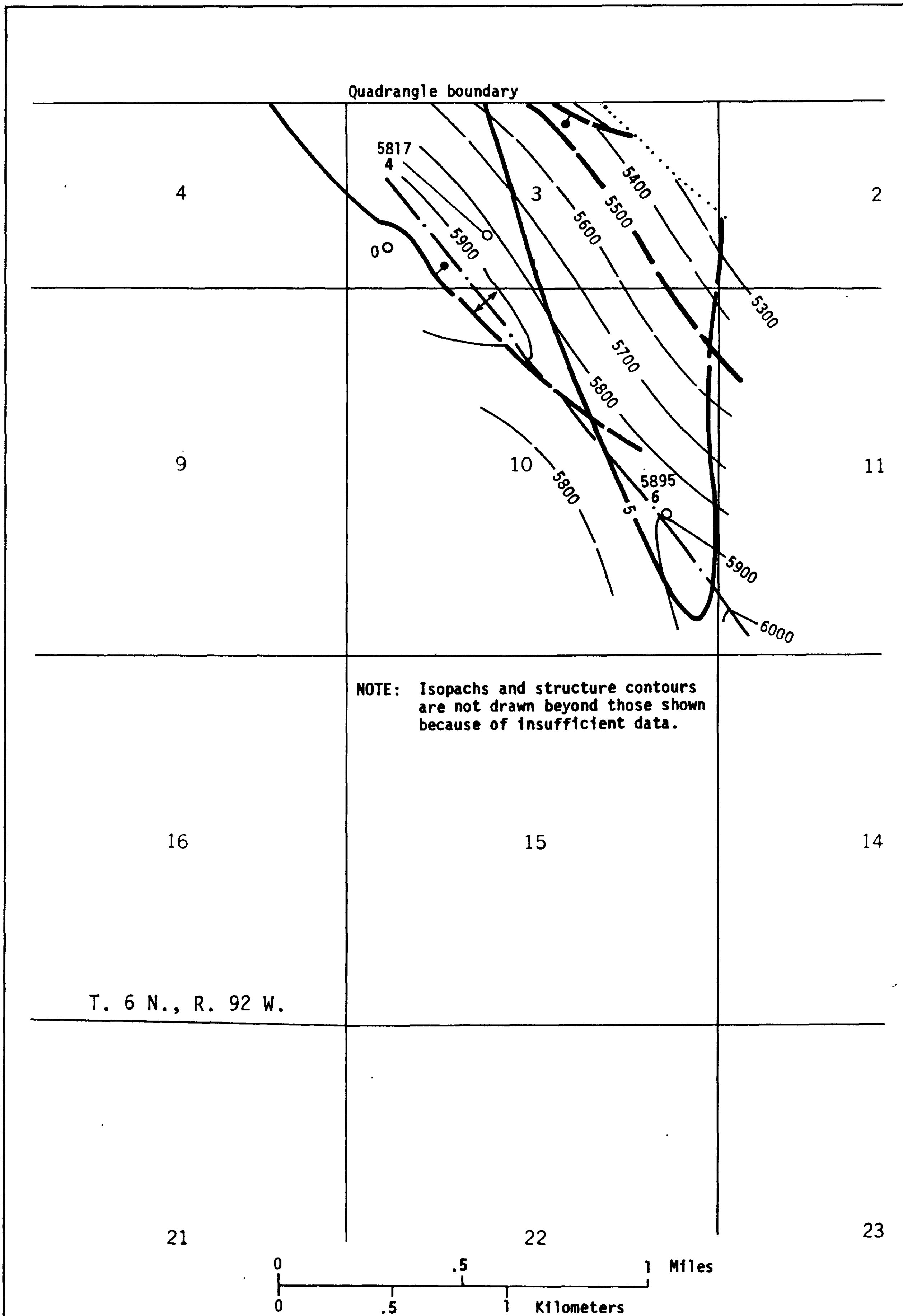

FIGURE 51. — Isopach and structure contour map of the Upper Coal Group, coal bed [4].

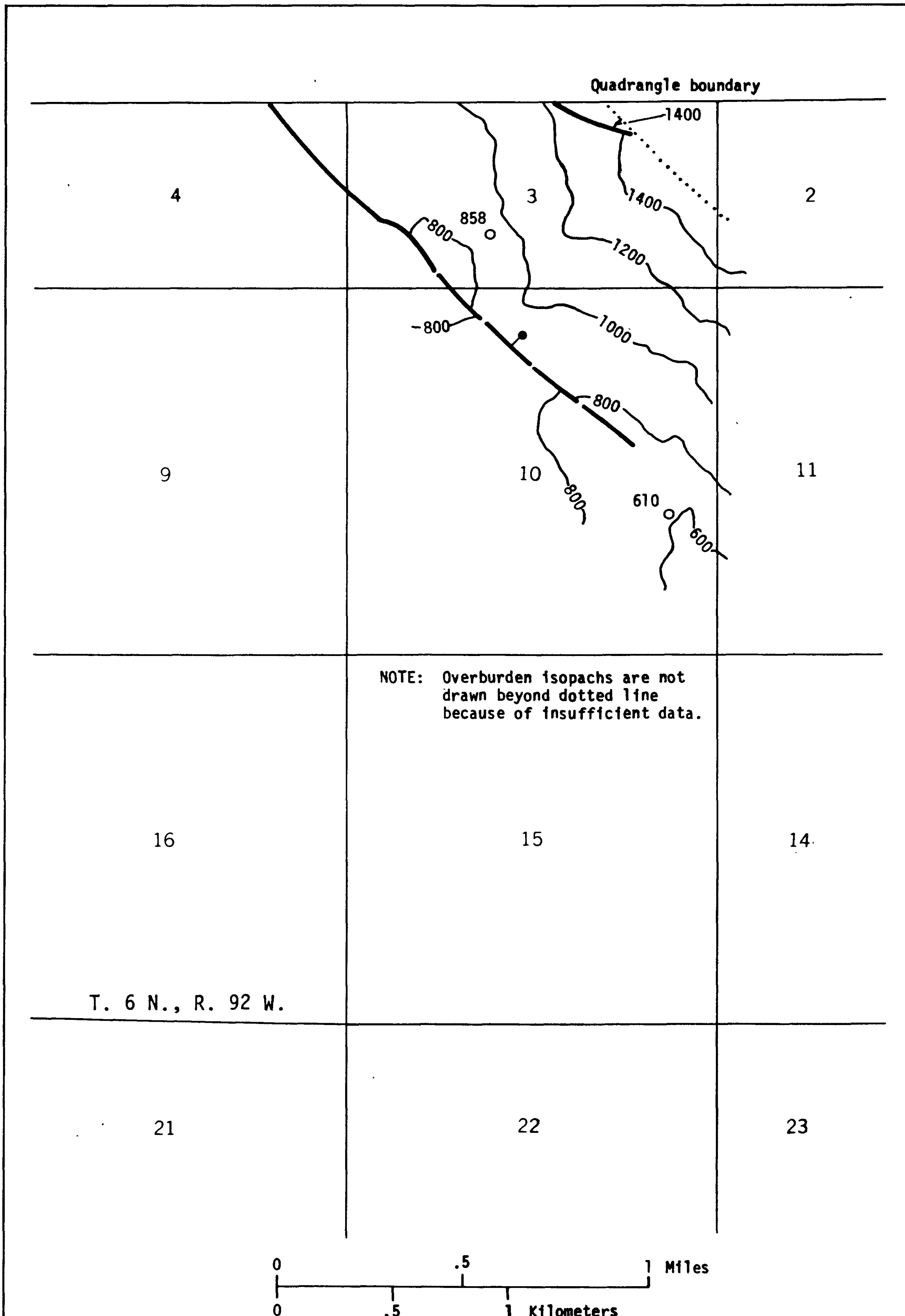

FIGURE 52. — Overburden isopach map of the Upper Coal Group, coal bed [4].

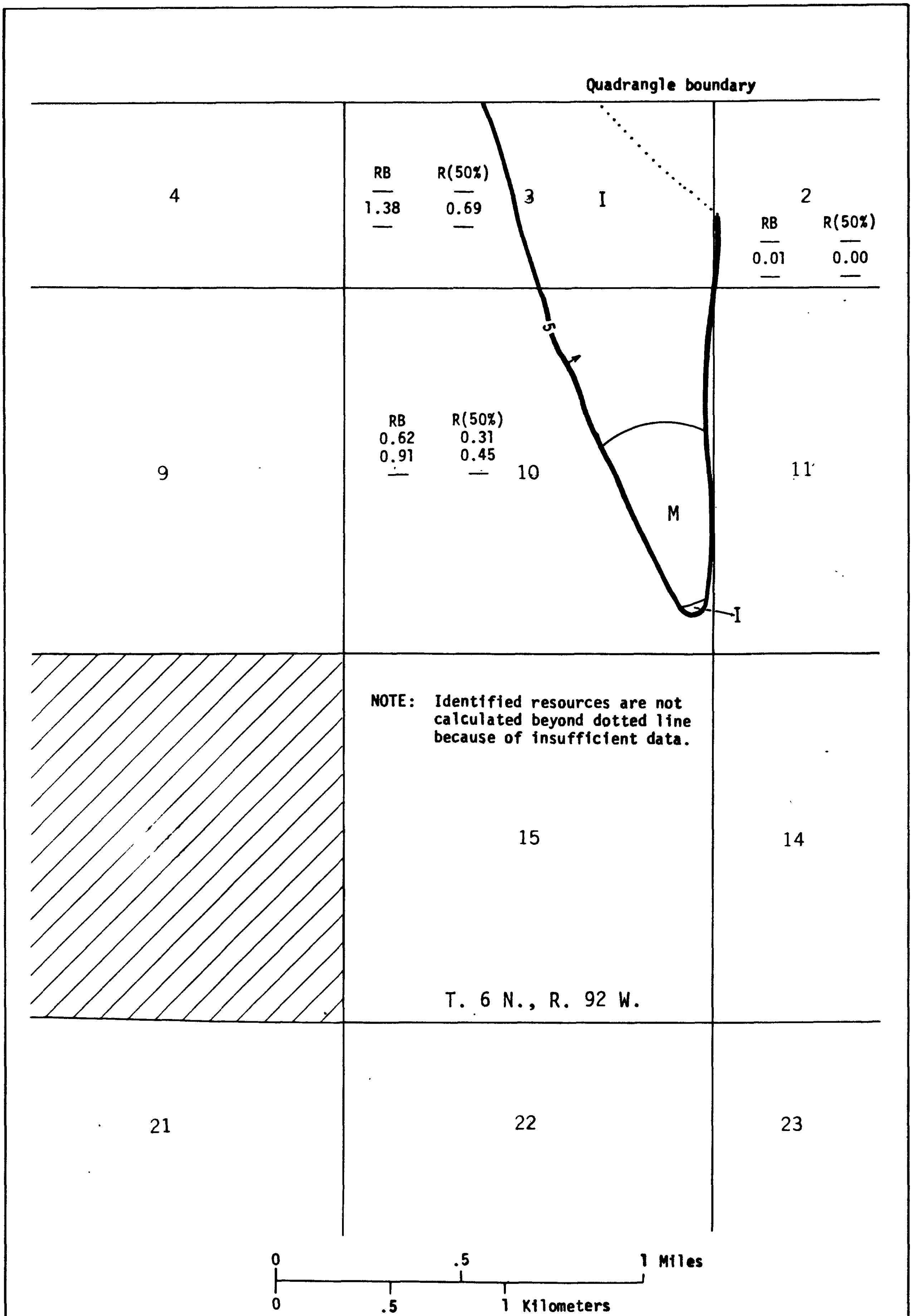

FIGURE 53. — Areal distribution and identified resources map of the Upper Coal Group, coal bed [4].

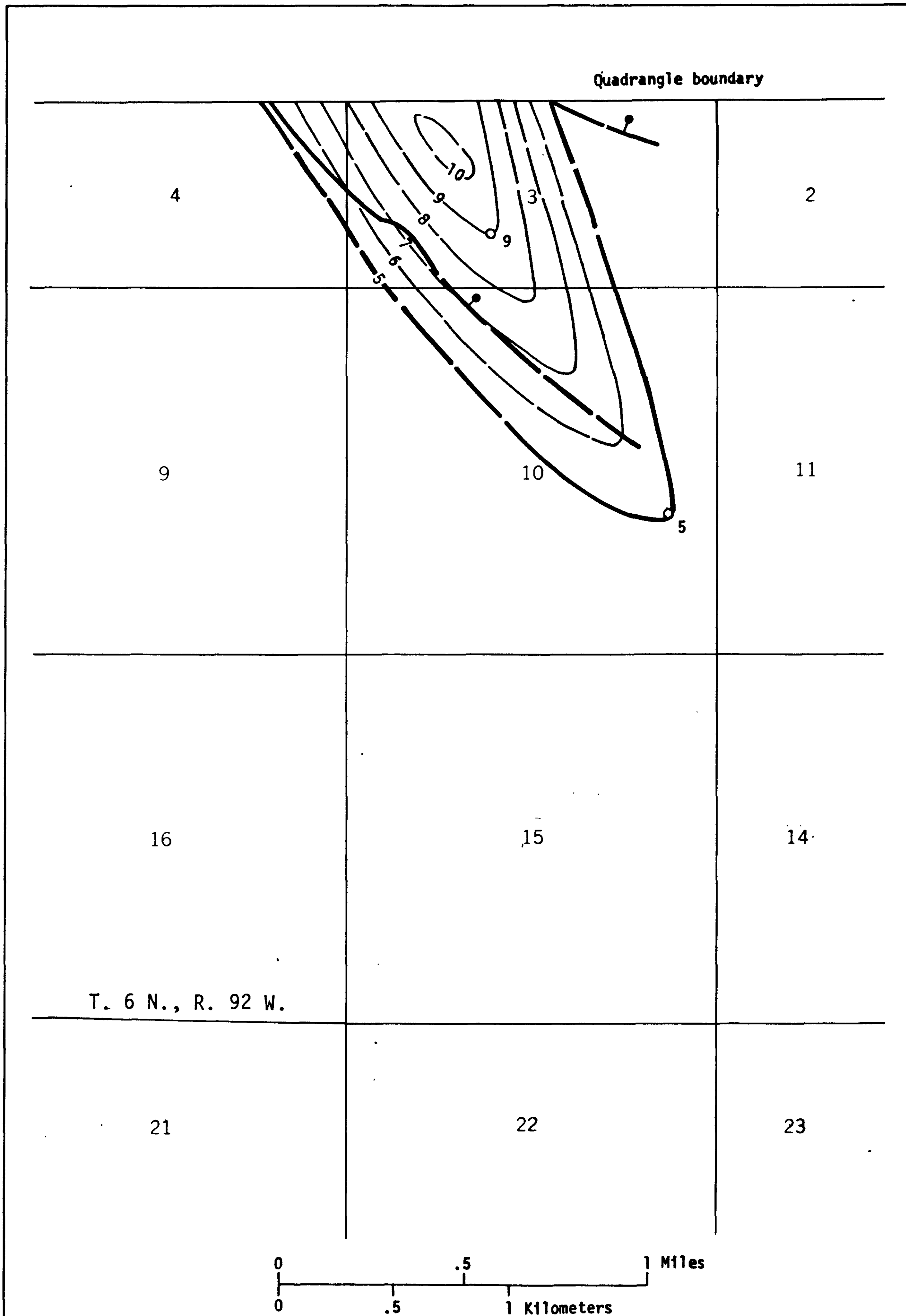

FIGURE 54. — Isopach map of the Upper Coal Group, coal bed [9].

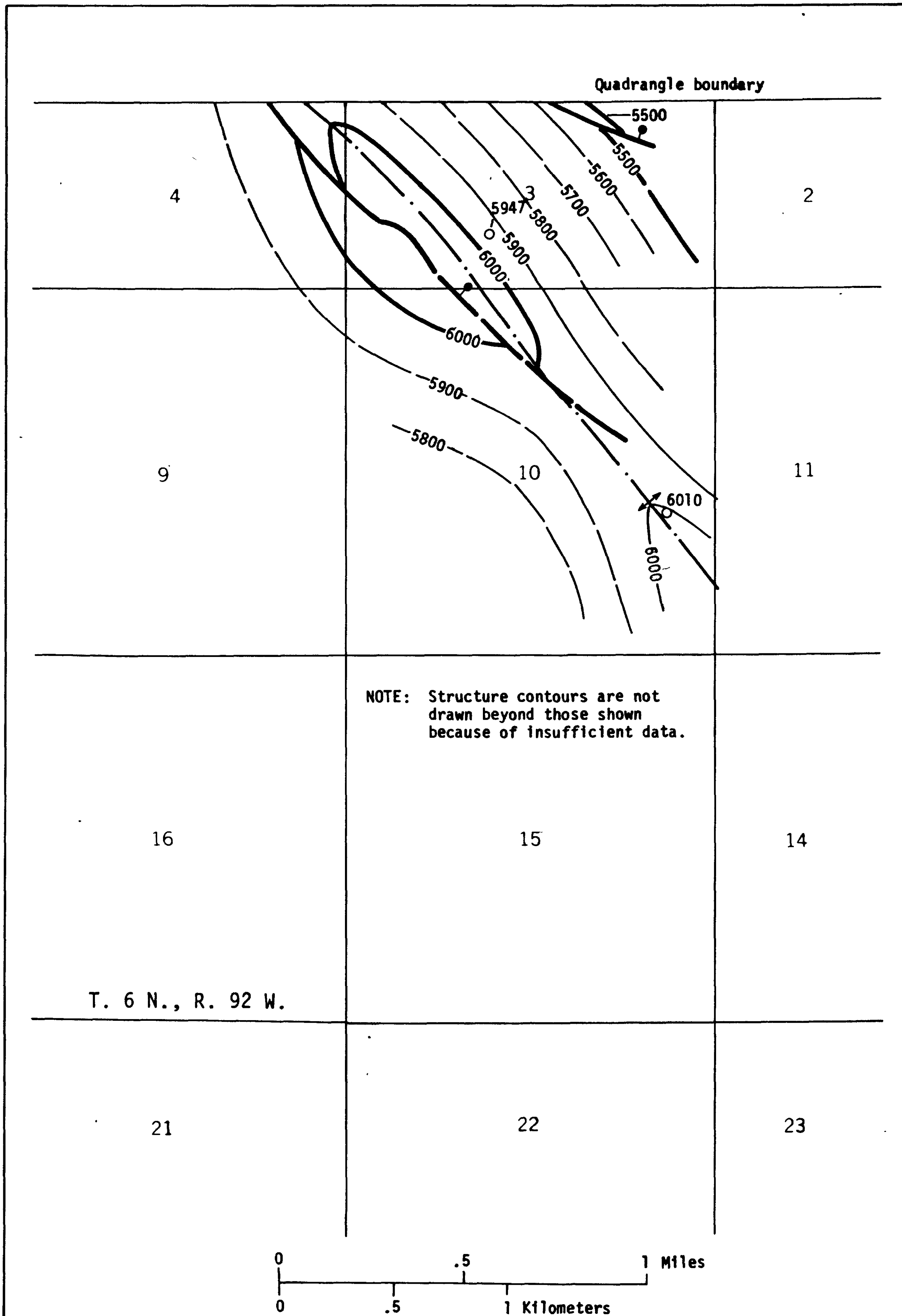

FIGURE 55. — Structure contour map of the Upper Coal Group, coal bed [9].

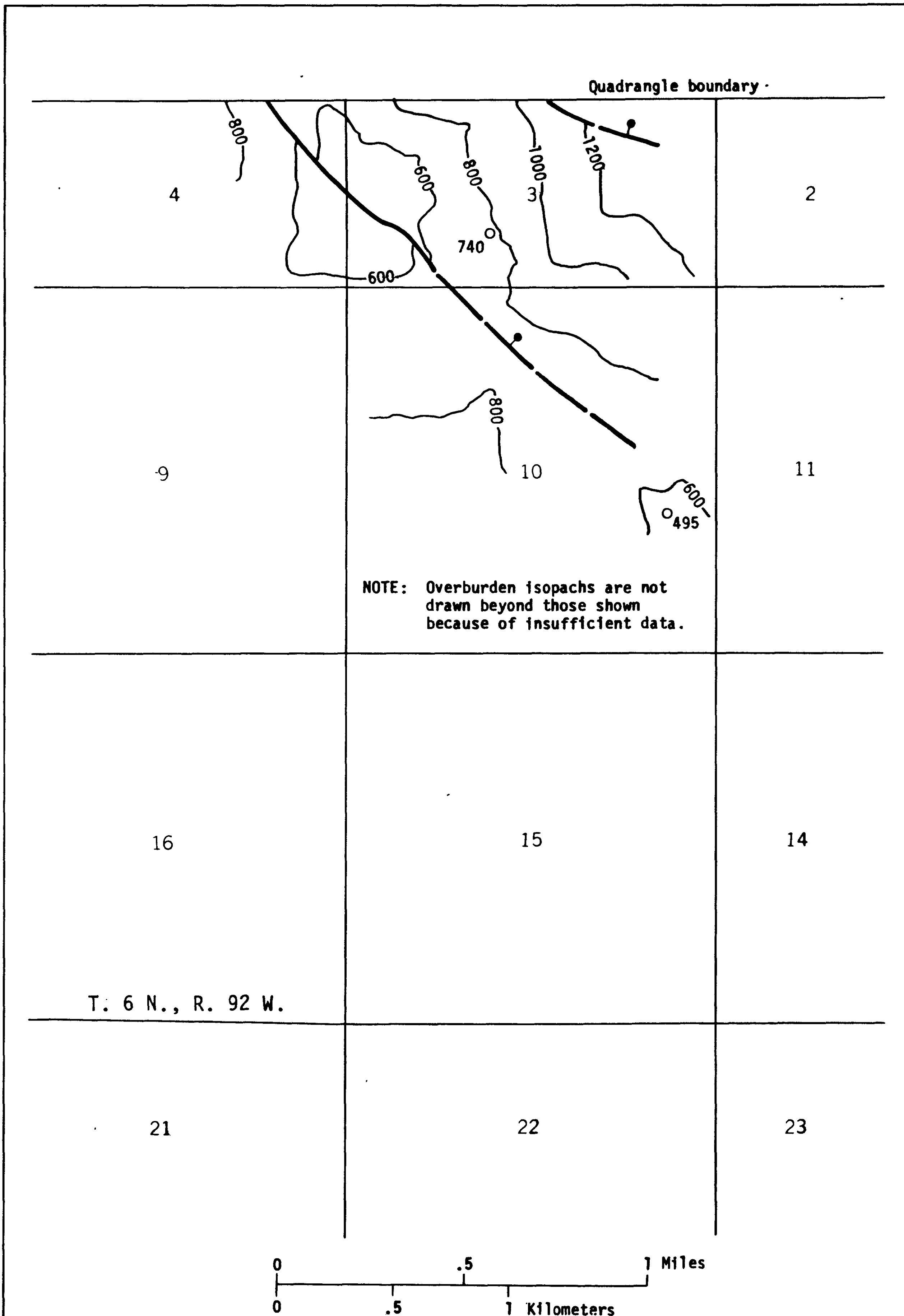

FIGURE 56. — Overburden isopach map of the Upper Coal Group, coal bed [9].

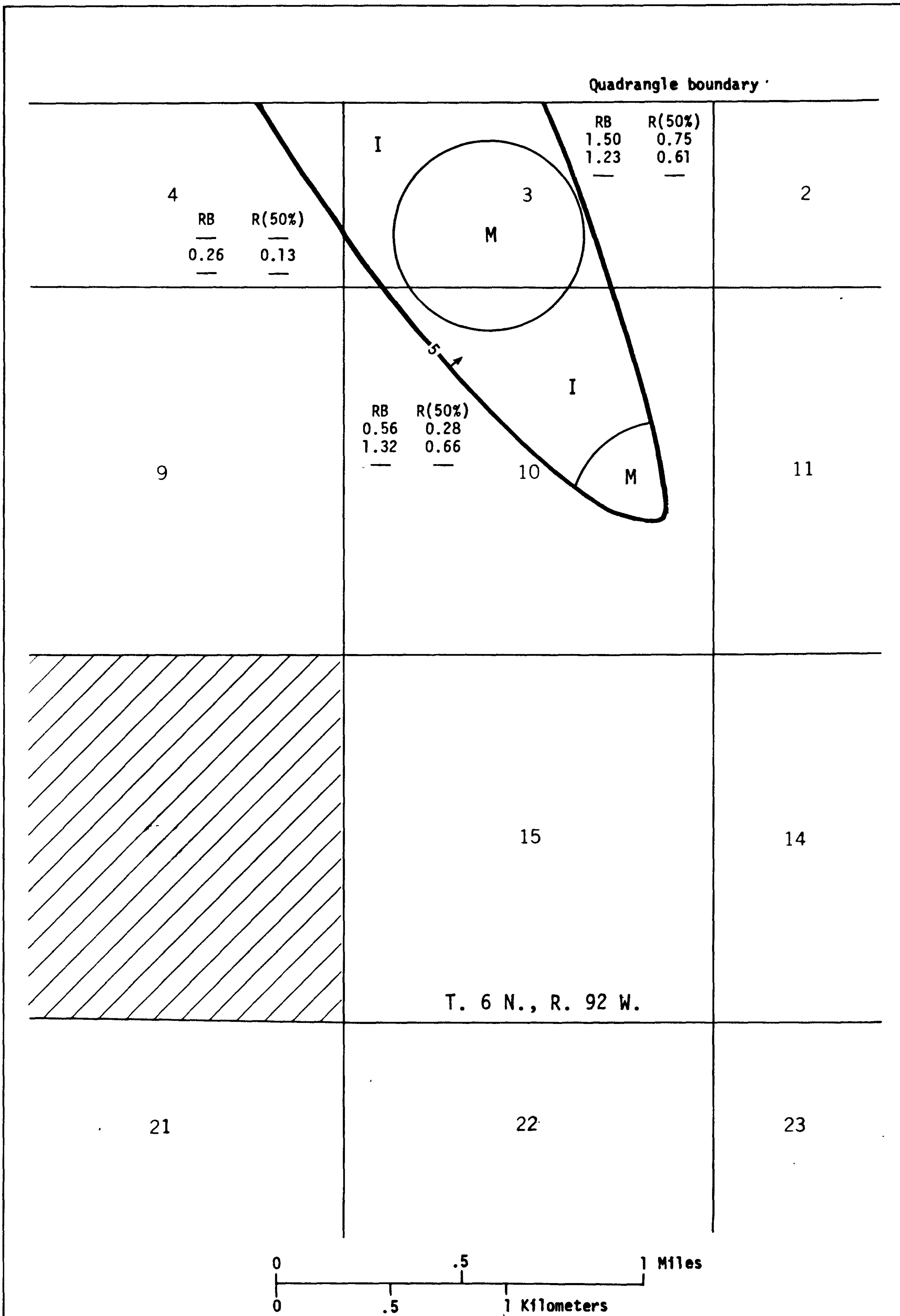

FIGURE 57. — Areal distribution and identified resources map of the Upper Coal Group, coal bed [9].

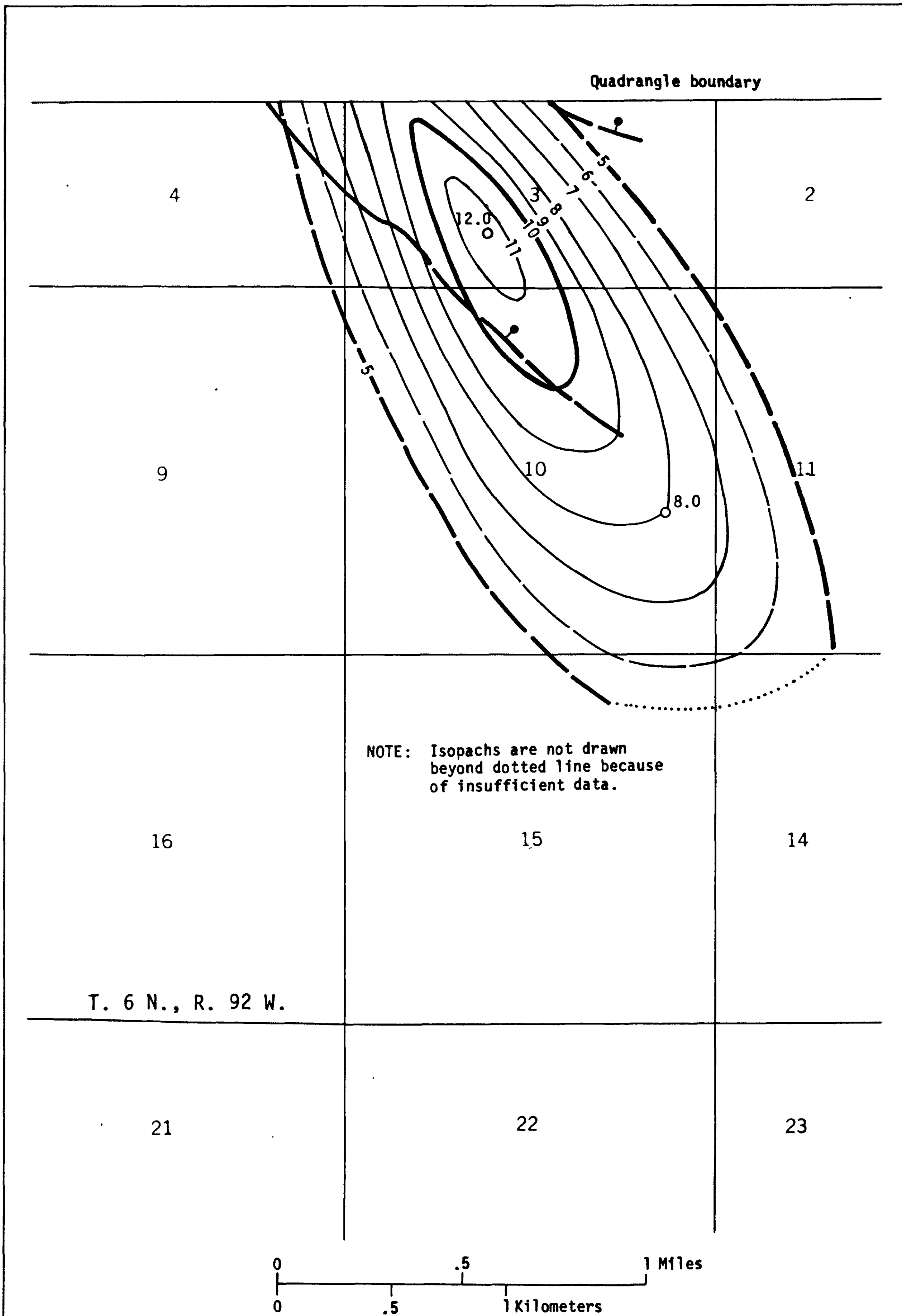

FIGURE 58. — Isopach map of the Upper Coal Group, coal bed [10].

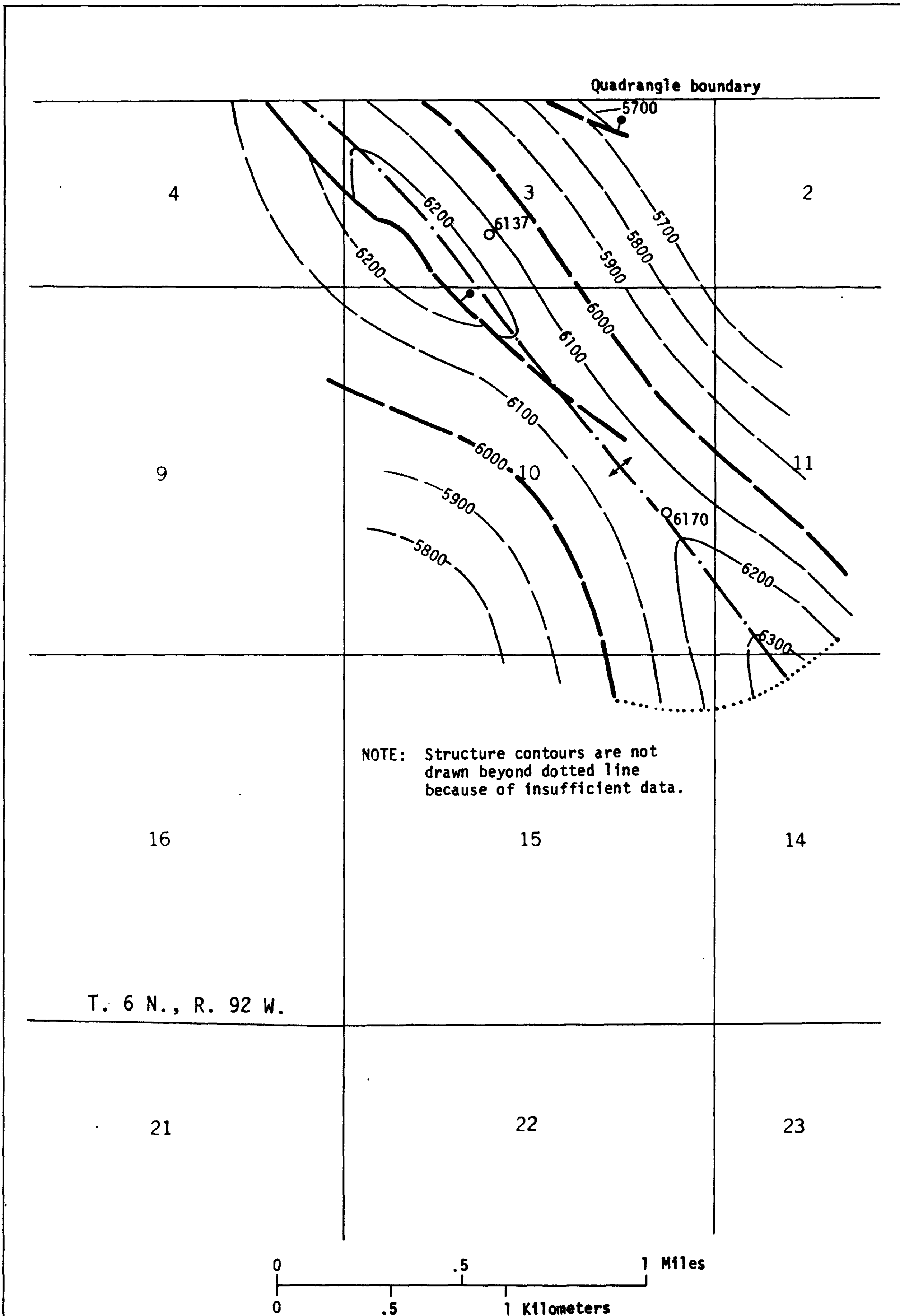

FIGURE 59. — Structure contour map of the Upper Coal Group, coal bed [10].

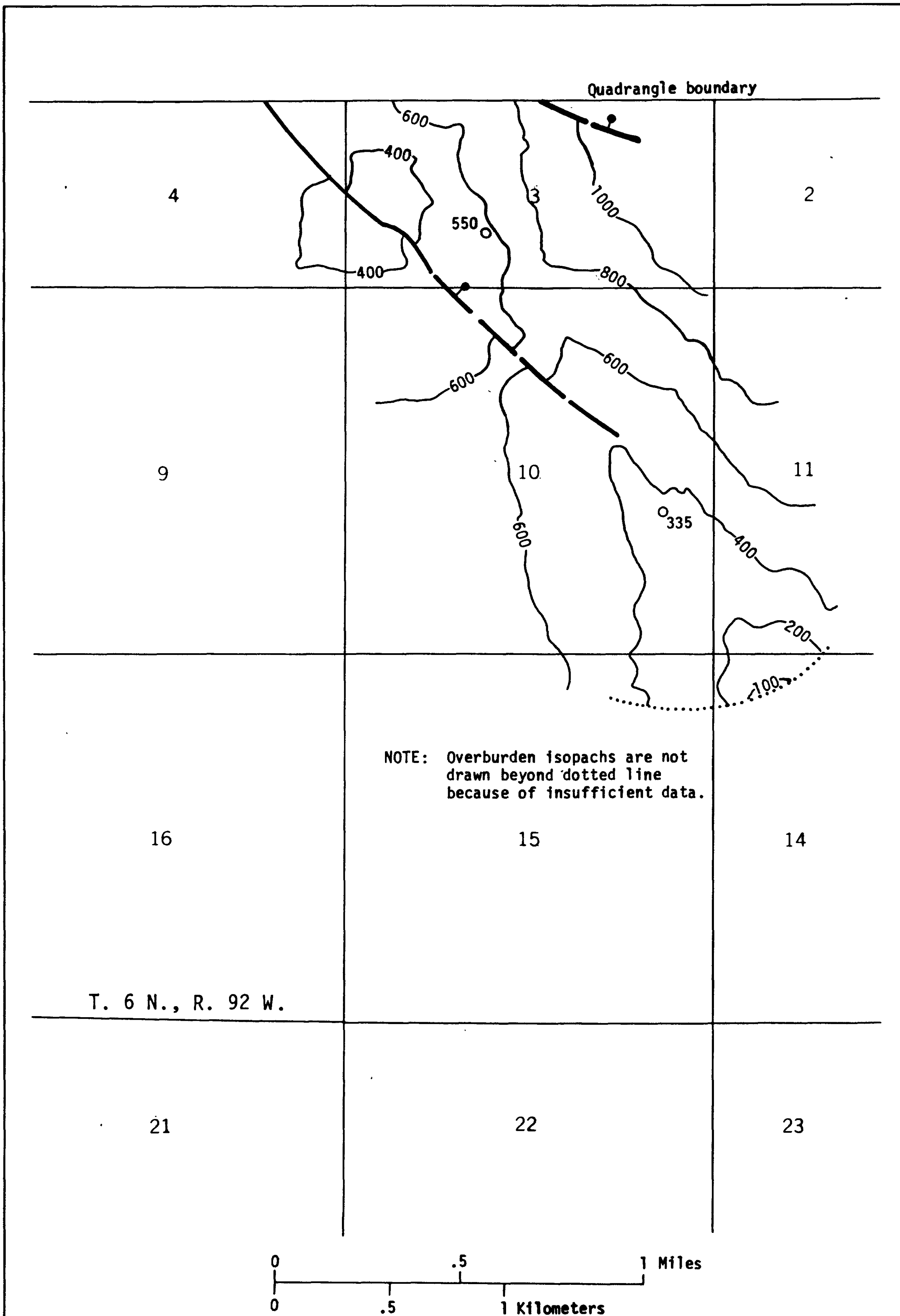

FIGURE 60. — Overburden isopach map of the Upper Coal Group, coal bed [10].

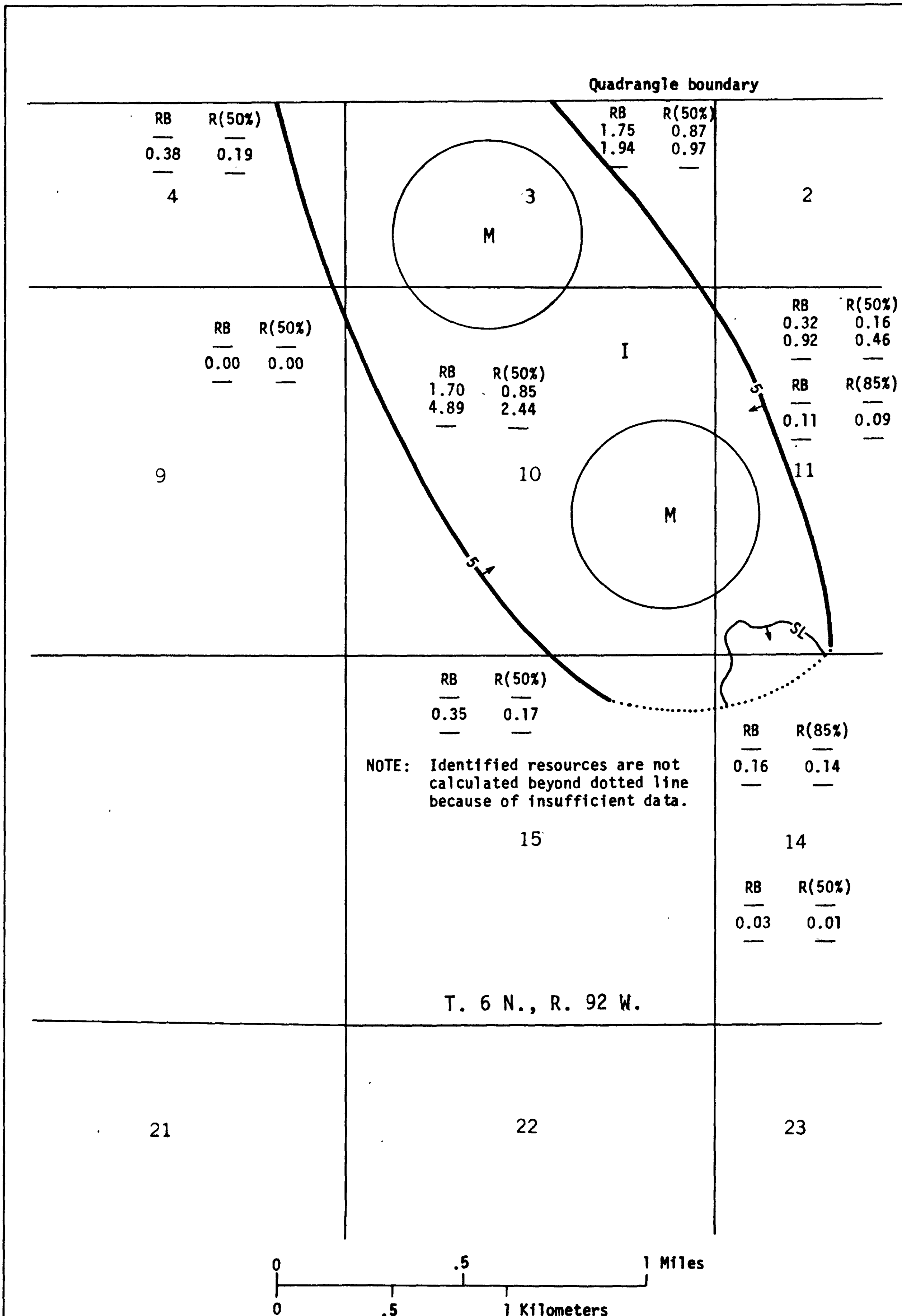

FIGURE 61. — Areal distribution and identified resources map of the Upper Coal Group, coal bed [10].

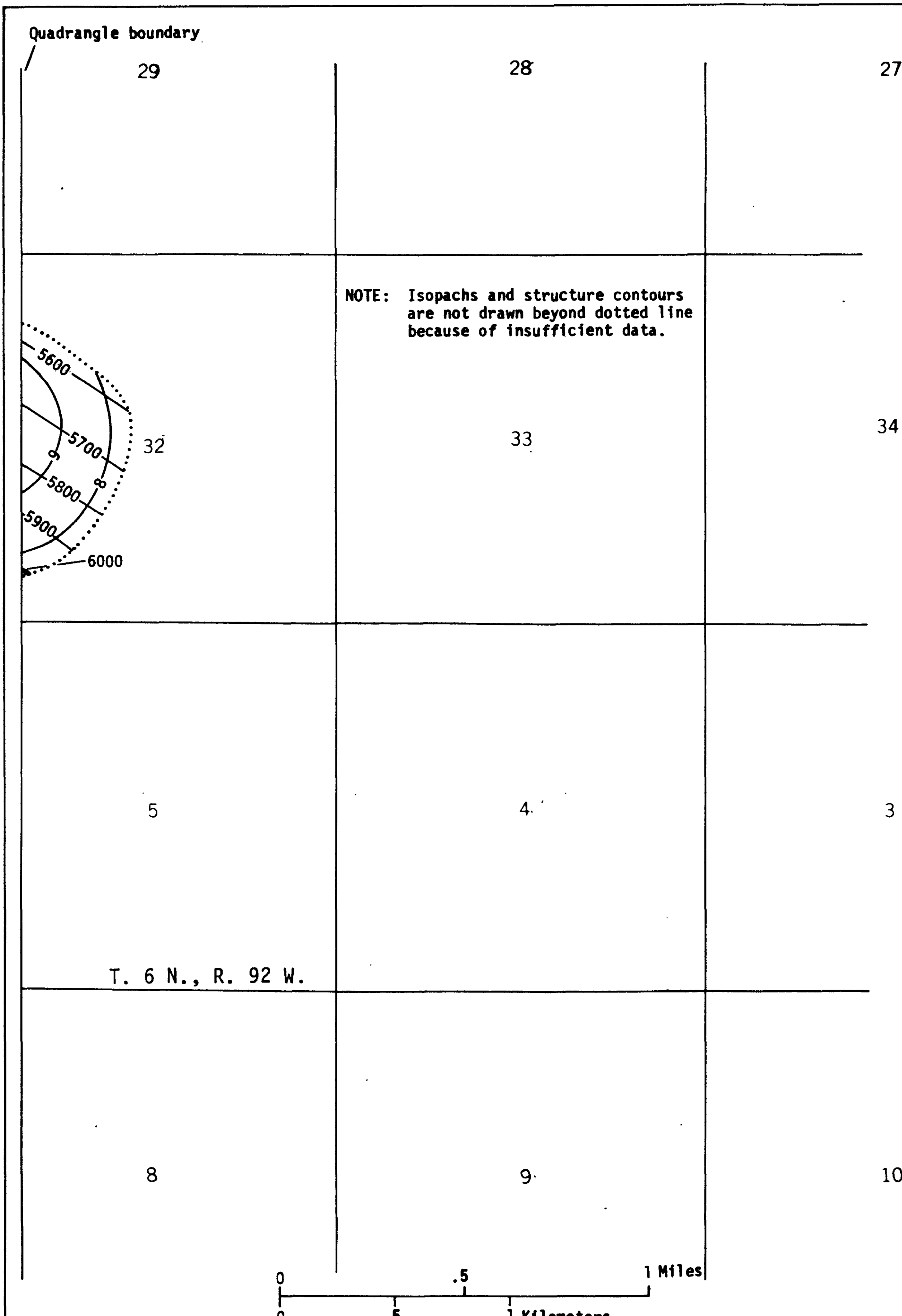

FIGURE 62. — Isopach and structure contour map of the Upper Coal Group, coal bed [247].

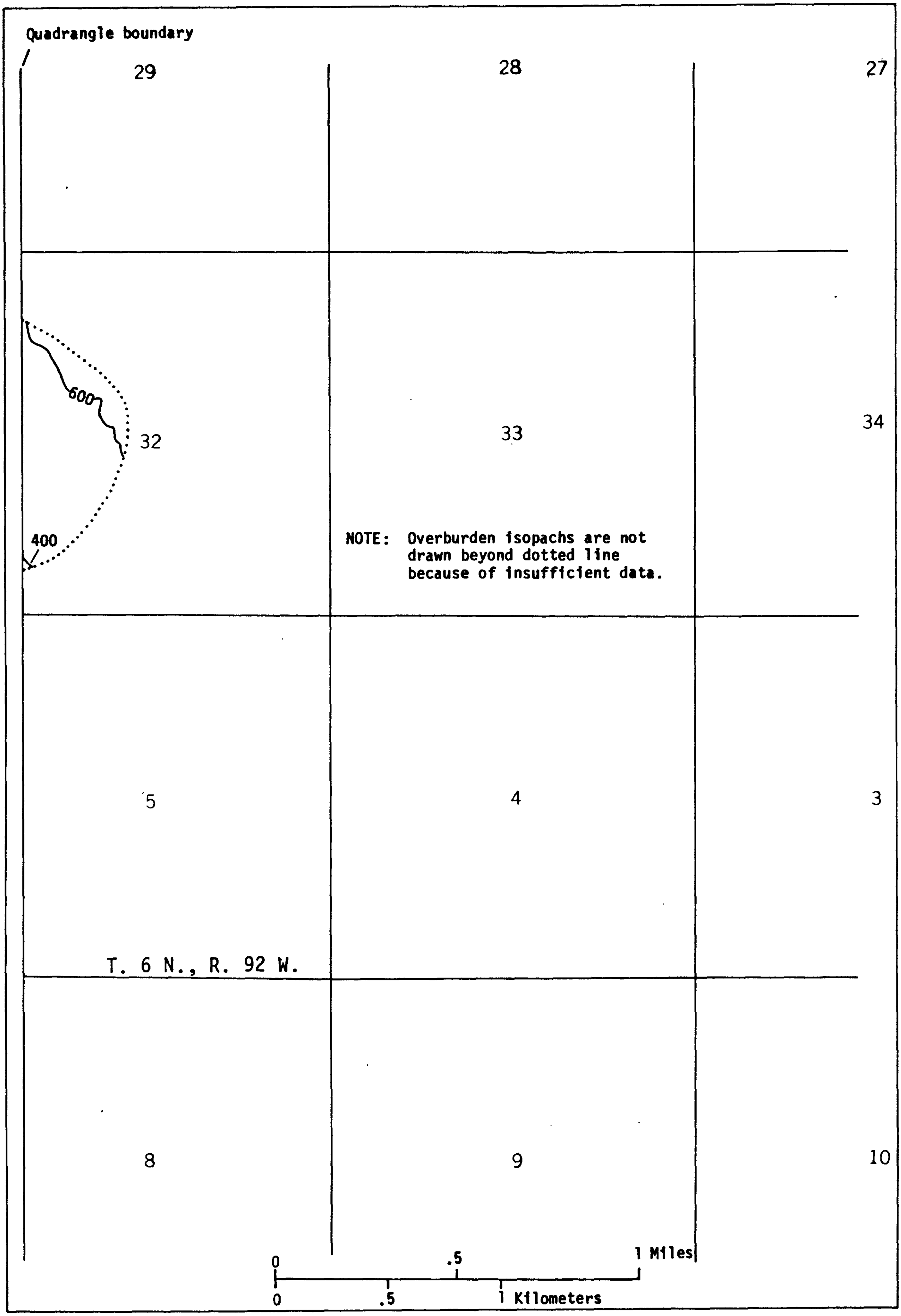

FIGURE 63. — Overburden isopach map of the Upper Coal Group, coal bed [247].

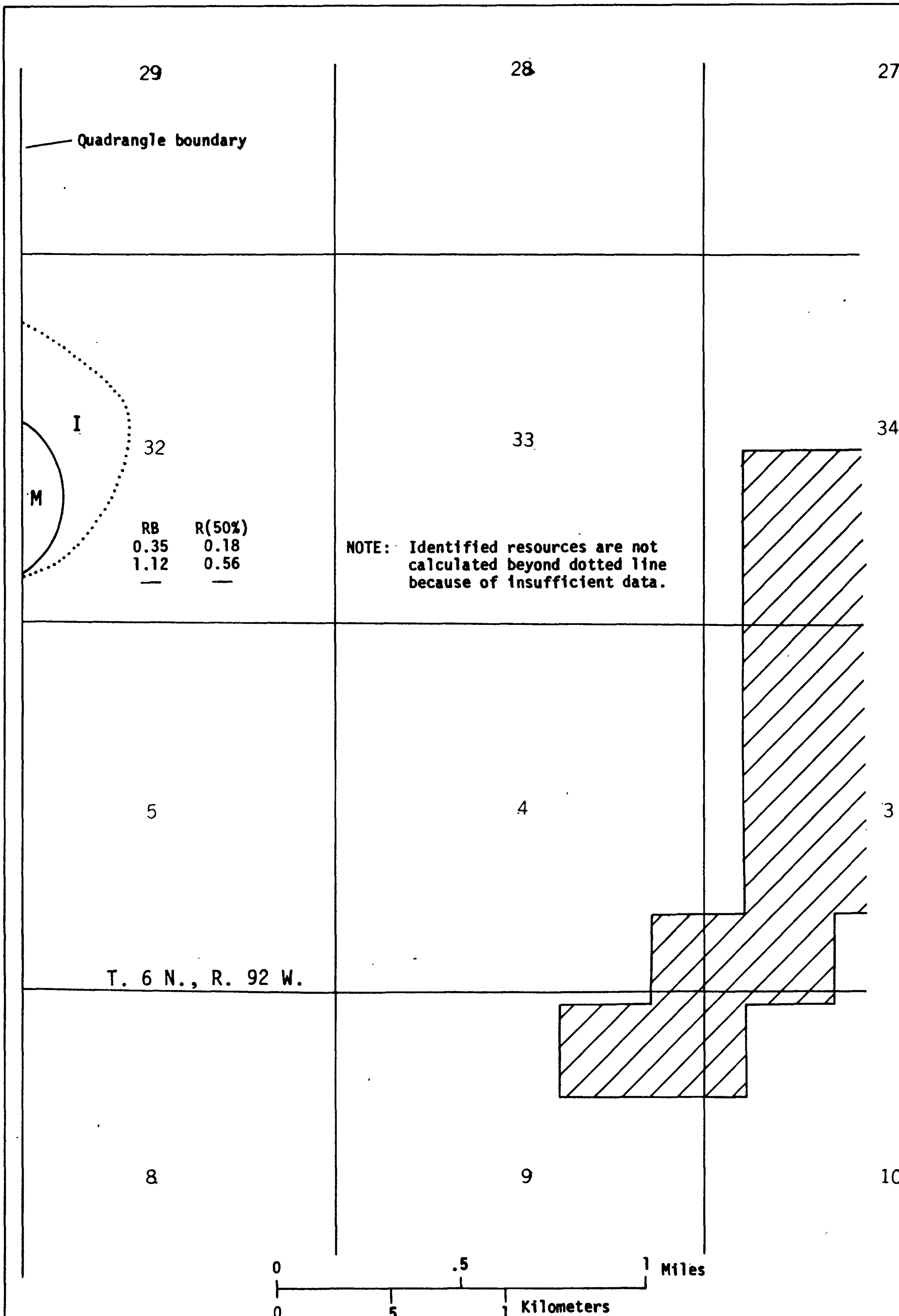

FIGURE 64. — Areal distribution and identified resources map of the Upper Coal Group, coal bed [247].

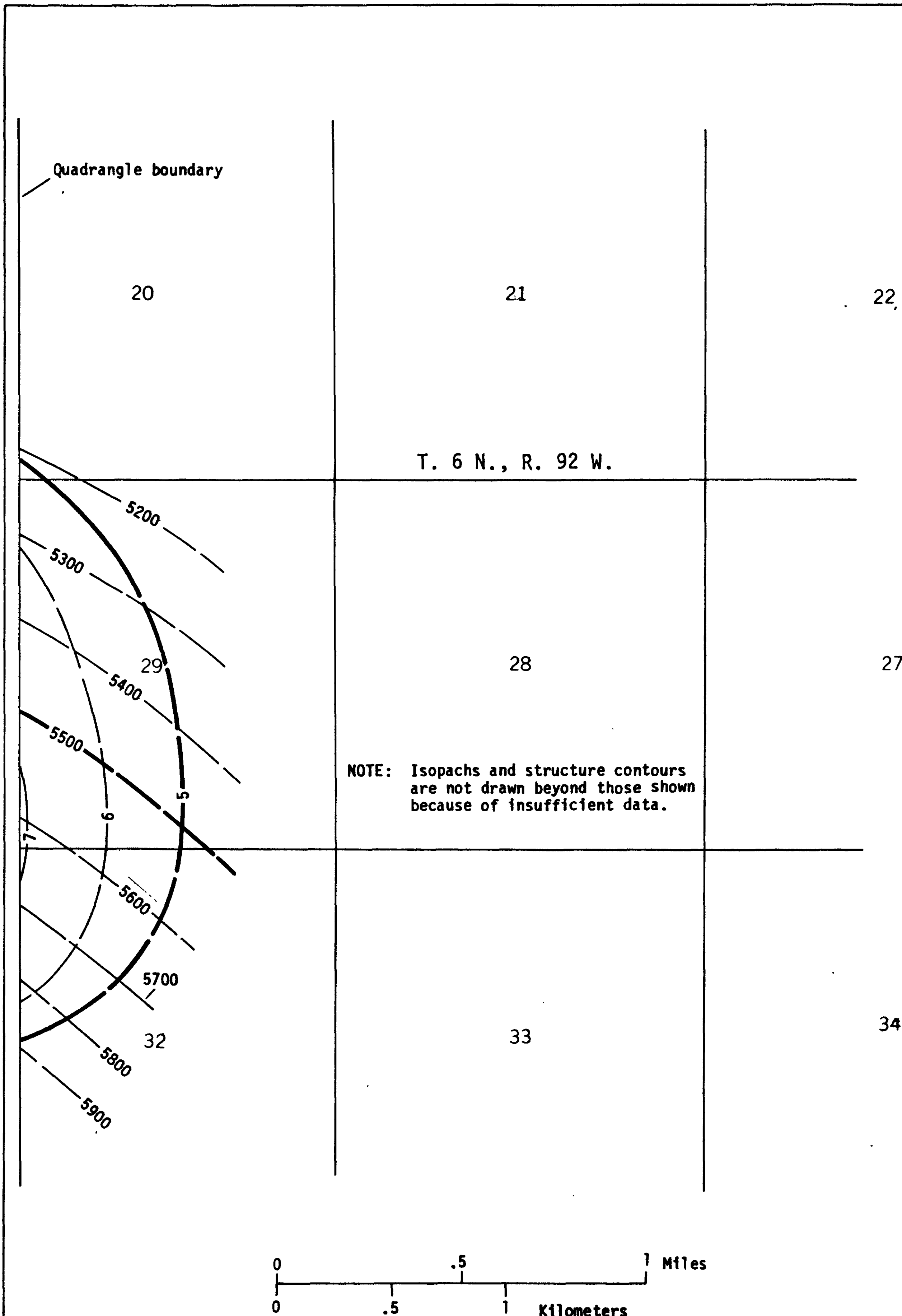

FIGURE 65. — Isopach and structure contour map of the Upper Coal Group, coal bed [251].

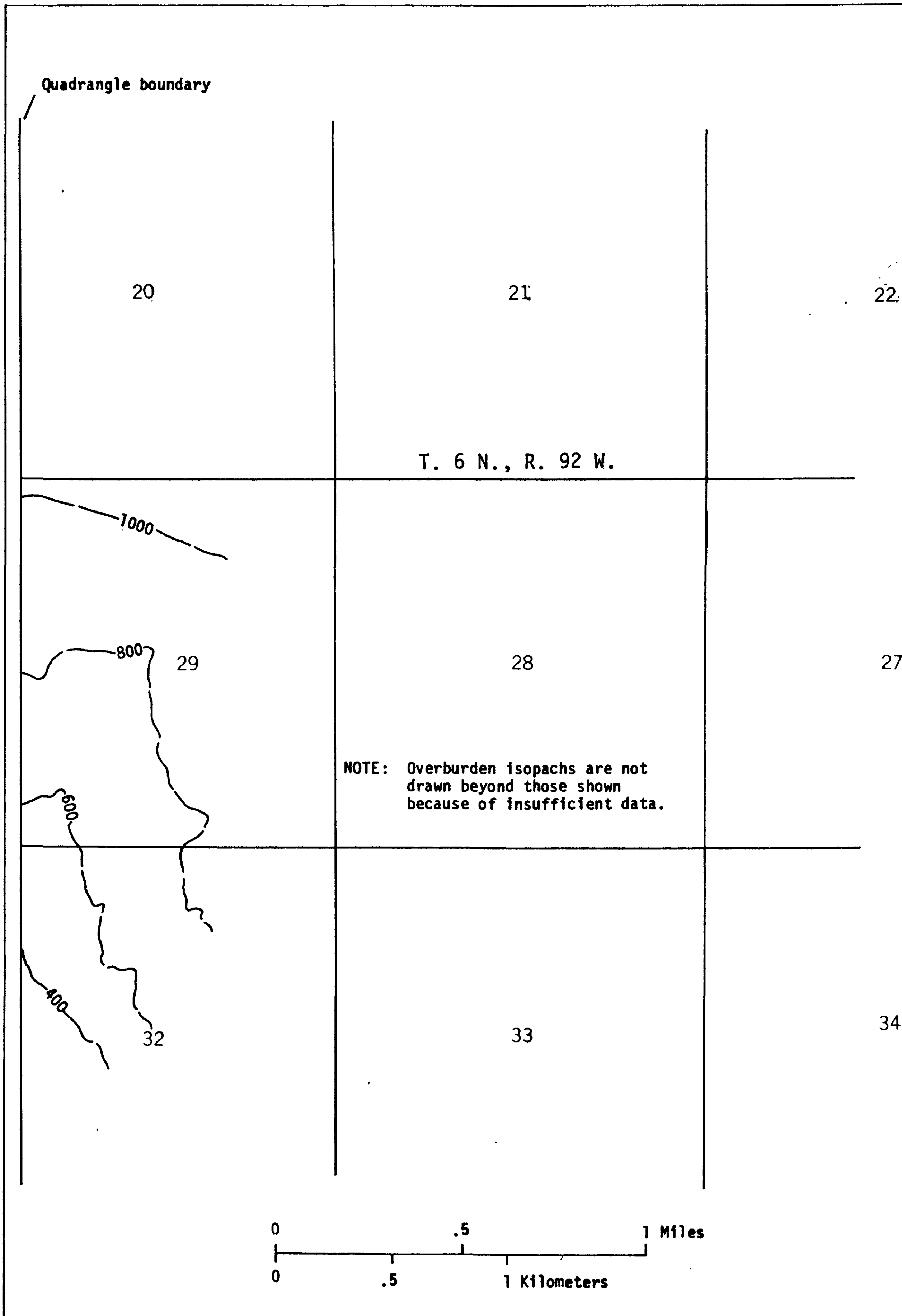

FIGURE 66. — Overburden isopach map of the Upper Coal Group, coal bed [251].

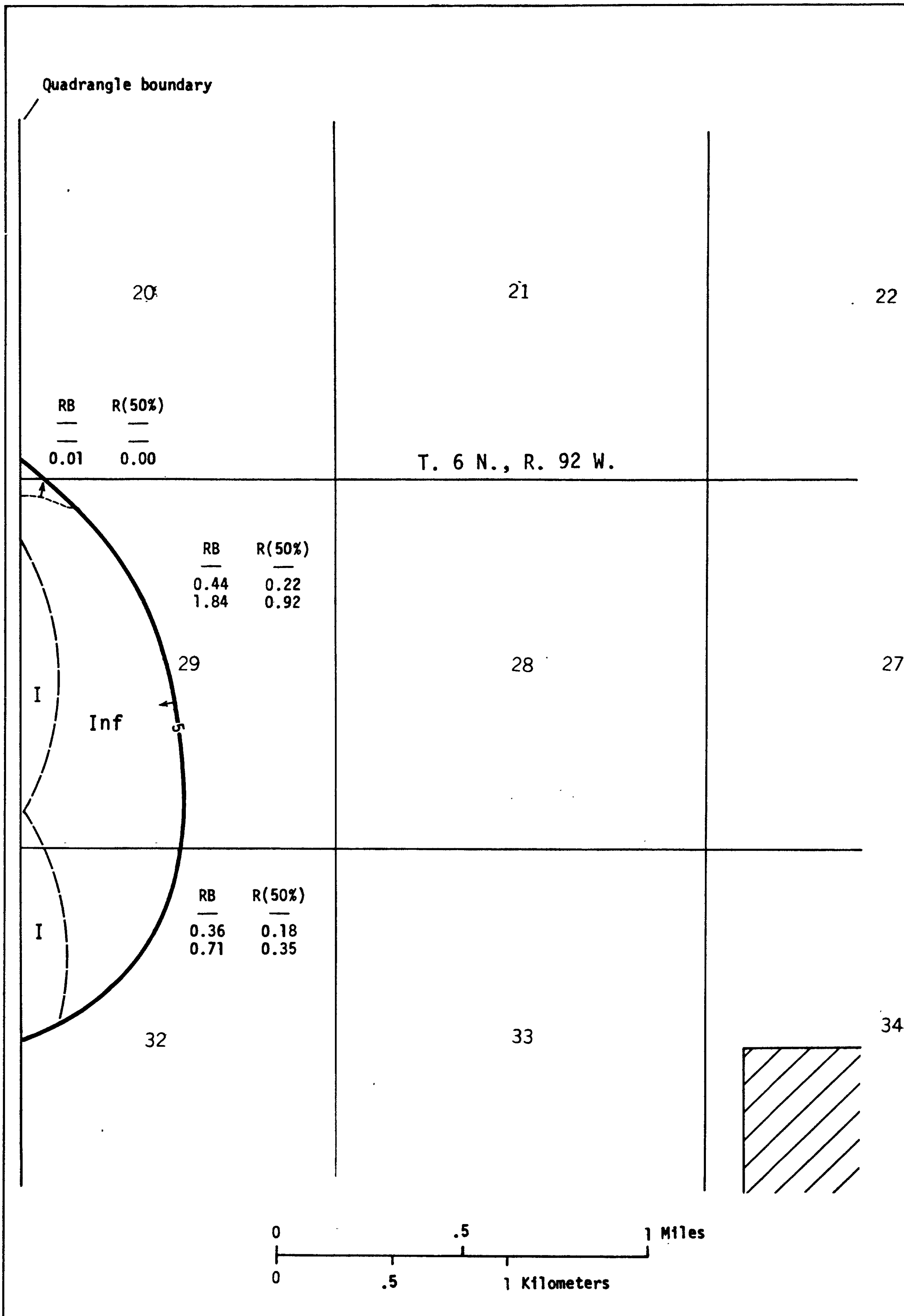

FIGURE 67. — Areal distribution and identified resources map of the Upper Coal Group, coal bed [251].