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COAL RESOURCE OCCURRENCE AND COAL DEVELOPMENT POTENTIAL MAPS OF THE SOUTHEAST QUARTER OF THE KEMMERER 15-MINUTE QUADRANGLE, LINCOLN COUNTY, WYOMING

[Report includes 9 plates]

Prepared for

UNITED STATES DEPARTMENT OF THE INTERIOR

GEOLOGICAL SURVEY

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INTRODUCTION

Purpose

This text is to be used in conjunction with Coal Resource Occurrence (CRO) and Coal Development Potential (CDP) Maps of the southeast quarter of the Kemmerer 15-minute quadrangle, Lincoln County, Wyoming. This report was compiled to support the land planning work of the Bureau of Land Management (BLM) 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 14-08-0001-17104. The resource information gathered for this report is in response to the Federal Coal Leasing Amendments Act of 1975 (P.L. 94-377). Published and unpublished public information available through March, 1979, was used as the data base for this study. No new drilling or field mapping was performed, nor was any confidential data used.

Location

In this report, the term "quadrangle" refers only to the southeast quarter of the Kemmerer 15-minute quadrangle which is located in southern Lincoln County, Wyoming, approximately 9 airline miles (14 km) west of the town Opal and 17 airline miles (27 km) east of the town of Sage, Wyoming. The towns of Kemmerer, Diamondville, and Frontier are located in the eastern half of the quadrangle.

Accessibility

U.S. Highway 189 crosses north-south through the eastern half of the quadrangle connecting the town of Kemmerer with Interstate Highway 80 approximately 35 miles (56 km) to the southwest. U.S. Highway 30N crosses east-west through the central part of the quadrangle connecting the town of Kemmerer with Sage to the west and Opal to the east. Wyoming Highway 223 extends northwesterly from the town of Frontier to the Bridger-Teton National Forest. Numerous unimproved dirt roads and trails provide access through the remainder of the quadrangle (Wyoming State Highway Commission, 1978).

The Oregon Short Line Railroad, a branch of the Union Pacific Railroad, passes through the town of Kemmerer and is a major shipping route connecting Pocatello, Idaho with the Union Pacific Railroad main east-west line at Granger, Wyoming. A spur line runs south from Moyer, a station on the railroad, to service the Elkol, Sorensen, and Skull Point strip mines, and the power plant at the town of Elkol (U.S. Bureau of Land Management, 1978).

Physiography

The southeast quarter of the Kemmerer 15-minute quadrangle lies on the eastern edge of the Wyoming Overthrust Belt. The landscape within the quadrangle is characterized by north-trending ridges and valleys. Oyster Ridge, extending north-south along the eastern edge of the quadrangle, rises approximately 800 to 1,000 feet (244 to 305 m) above the Hams Fork valley. Altitudes in the quadrangle range from approximately 6,840 feet (2,085 m) along the southern edge of the quadrangle to 8,017 feet (2,444 m) at the summit of Quealy Peak on Oyster Ridge near the northeastern corner of the quadrangle.

Hams Fork, a tributary of the Green River southeast of the quadrangle, flows southeasterly through the quadrangle. A tributary, Willow Creek, drains the northeastern corner of the quadrangle and joins Hams Fork north of Frontier, Wyoming. The south-central part of the quadrangle is drained by the North Fork of Little Muddy Creek, also a tributary of the Green River. The Colorado River-Great Basin Divide crosses north-south along the western edge of the quadrangle. Streams west of the divide flow into the Bear River west of the quadrangle. Streams in the area, with the exception of Hams Fork which flows year-round, are intermittent and flow mainly in response to snowmelt in the spring (U.S. Bureau of Land Management, 1971 and 1978).

Climate and Vegetation

The climate of southwestern Wyoming is semiarid, characterized by low precipitation, rapid evaporation, and large daily temperature variations. Summers are usually dry and mild, and winters are cold. The

average annual precipitation is approximately 10 inches (25 cm) and is fairly evenly distributed throughout the year (Wyoming Natural Resources Board, 1966).

The average annual temperature of the area is 39° F (4° C). The temperature during January averages 17° F (-8° C) and typically ranges from 4° F (-16° C) to 30° F (-1° C). During July, the average temperature is 62° F (17° C), and the temperature typically ranges from 43° F (6° C) to 82° F (28° C) (Wyoming Natural Resources Board, 1966; U.S. Bureau of Land Management, 1978).

Winds are usually from the west and west-southwest with an average velocity of approximately 12 miles per hour (19 km per hr) (U.S. Bureau of Land Management, 1978).

Principal types of vegetation in the quadrangle include sagebrush, winterfat, rabbitbrush, greasewood, saltbush, serviceberry, mountain mahogany, grasses, willow, and cottonwood (U.S. Bureau of Land Management, 1978).

Land Status

The southeast quarter of the Kemmerer 15-minute quadrangle lies within the northern part of the Kemmerer Known Recoverable Coal Resource Area (KRCRA). Only the southeast corner of the quadrangle, approximately one tenth of the quadrangle's total area, lies outside the KRCRA boundary. The Federal government owns the coal rights for approximately two thirds of the land within the KRCRA boundary. One active coal lease is present within the KRCRA boundary and is shown on plate 2.

GENERAL GEOLOGY

Previous Work

Veatch (1907) mapped the geology and economic resources of a large part of Lincoln and Uinta counties in southwestern Wyoming including this quadrangle. Schultz (1914) described the geology and coal resources in the northern part of the Kemmerer coal field. Toenges and others (1945)

published lithologic logs of coal test holes drilled in the Willow Creek coal bed in the same area. Hunter (1950) gave detailed descriptions of coal beds in the Kemmerer area. Cobban and Reeside described the stratigraphy of the coal-bearing Frontier Formation in the Kemmerer area in 1952. Hale (1960) described the stratigraphy of the Frontier Formation in southwestern Wyoming and Utah. Oriel and Tracey (1970) described the stratigraphy of the Evanston and Wasatch Formations present in the Kemmerer area. Smith and others included the southeast quarter of the Kemmerer 15-minute quadrangle in their investigation of the strippable coal reserves of Wyoming in 1972. Glass (1975) reported coal analyses and measured sections of Adaville Formation coals from the Elkol and Sorensen mines located in the southeast quarter of the Kemmerer 15-minute quadrangle and adjacent quadrangles. The geology of the Kemmerer and Sage 15-minute quadrangles was mapped by Rubey and others (1975). Roehler and others (1977) described the geology and coal resources of the Hams Fork coal region including the Kemmerer coal field. Myers (1977) conducted a detailed study of the stratigraphy of the Frontier Formation in the Kemmerer area. Alvord (1977) reported on coal analyses and geophysical logs of coal test holes drilled in 1977 by the U.S. Geological Survey in the southeast quarter of the Kemmerer 15-minute quadrangle. Glass (1977) described the coal-bearing formations and coal beds present in the Hams Fork coal region.

Stratigraphy

The formations exposed in the southeast quarter of the Kemmerer 15-minute quadrangle range in age from Early Cretaceous to Eocene. The Frontier Formation, trending north-south along the eastern edge of the quadrangle, and the Adaville Formation which trends north-south along the western edge of the quadrangle contain minable coal.

The Aspen Shale of Early Cretaceous age crops out in the southeastern corner of the quadrangle. It consists of light- to dark-gray siltstone and claystone, gray quartzitic sandstone, and numerous porcelanite (silicified volcanic ash) beds. The porcelanite beds in the lower part of the Aspen Shale form silver-gray ridges and hogbacks that are

barren of vegetation. The Aspen Shale is approximately 825 to 1,025 feet (251 to 312 m) thick and is non-coal-bearing (Rubey and others, 1975).

The Frontier Formation of Late Cretaceous age crops out along the eastern edge of the quadrangle where it conformably overlies the Aspen Shale. Rubey and others (1975) mapped this formation as three informal units (not shown on plate 3). The lower unit is composed of thin white and brown sandstone beds (which are less resistant to erosion than the rest of the formation), tan siltstone, dark-gray claystone, thin beds of gray, pink and white porcelanite, and the Spring Valley coal zone. The lower unit is approximately 1,000 feet (305 m) thick, thinning to the south. The middle unit of the formation, approximately 675 feet (206 m) thick, consists of tan sandstone, dark shaly claystone, and the Willow Creek coal zone, capped by the prominent hogback-forming Oyster Ridge Sandstone Member. The Oyster Ridge Sandstone Member consists of approximately 130 feet (40 m) of white to light-gray, thick-bedded resistant sandstone. The upper unit of the formation consists of hog back-forming tan sandstone containing abundant large fossil oyster shells, lignitic claystone, and the Kemmerer coal zone (including the Main Kemmerer or Kemmerer No. 1 coal bed). The upper unit ranges in thickness from 450 to 600 feet (137 to 183 m), thickening to the north (Rubey and others, 1975).

The Hilliard Shale of Late Cretaceous age conformably overlies the Frontier Formation and crops out in a wide band running north-south through the central part of the quadrangle. It is composed of a thick sequence of dark-gray, gray, and tan fissile marine claystone; light- to medium-gray, partly argillaceous and partly lignitic sandy siltstone; white to dark-gray, thin-bedded, very fine grained to gritty sandstone; and white to gray bentonite. The Shurtliff Member, approximately 150 to 550 feet (46 to 168 m) thick, divides the Hilliard Shale in half with its prominent sandstone ledges. The Hilliard Shale is approximately 6,150 feet (1,875 m) thick (Rubey and others, 1975).

Cropping out along the western edge of the quadrangle, the Adaville Formation of Late Cretaceous age lies conformably on the Hilliard

Shale. The Adaville Formation consists of interbedded gray sandstone, siltstone, carbonaceous clay, and the Adaville coal zone which may contain up to 32 subbituminous coal beds (Glass, 1977). The sandstone, which weathers to yellow and brown, is calcareous, fine- to coarse-grained, thin-bedded to massive, and is partly conglomeratic in the upper part of the formation. The Lazeart Sandstone Member is a prominent ledge- and cliff-forming unit at the base of the Adaville Formation and is composed of light-gray to white, fine- to coarse-grained sandstone. The member is approximately 400 feet (122 m) thick near the southern end of the quadrangle and thins northward, pinching out in sec. 4, T. 21 N., R. 116 W. Numerous coal beds, including the extensively mined Adaville No. 1 coal bed, are present in the lower 1,200 feet (366 m) of the formation. Because of the number and thickness of coal beds in the Adaville Foramtion it is believed to be one of the most important coal-bearing formations in the country (Hunter, 1950). The Adaville Formation is approximately 2,900 feet (884 m) thick (Rubey and others, 1975).

The Evanston Formation lies unconformably on the Adaville Formation, cropping out along the western edge of the quadrangle. The main body of the Evanston Formation is underlain by the Hams Fork Conglomerate Member of latest Cretaceous age and consists of up to 1,000 feet (305 m) of boulder-conglomerate beds, gray to brown cross-bedded sandstone and gray mudstone. The main body of the Evanston Formation, which is of Paleocene age, consists of gray siltstone, red mudstone, carbonaceous claystone, lignite, thin coal beds, and dark brown concretionary ironstone. It may be more than 1,000 feet (305 m) thick locally (Oriel and Tracey, 1970; Rubey and others, 1975).

The main body of the Wasatch Formation of Eocene age unconformably overlies the Evanston Formation and crops out along the northwestern border of the quadrangle. This formation includes red, maroon, yellow, and gray variegated mudstone; yellow, brown, and gray, fine- to coarse-grained sandstone; and stream-channel conglomerate beds containing pebbles and boulders of quartzite, chert, and limestone (Oriel and Tracey, 1970; Rubey and others, 1975).

Holocene and Pleistocene deposits of gravel cover the stream valleys of Hams Fork and Willow Creek and terrace-gravel remnants cap hills bordering the Hams Fork valley (Rubey and others, 1975).

The Upper Cretaceous formations in the southeast quarter of the Kemmerer 15-minute quadrangle indicate the transgressons and regressions of a broad, shallow north-south seaway that extended across central North America. Sediments accumulated near the western edge of the Cretaceous sea and reflect the location of the shoreline (Weimer, 1960 and 1961).

Deposition of the Aspen Shale marked a westward or landward movement of the sea. According to Hale (1960), the marine shales, siltstones and sandstones of the Aspen Shale were deposited in water depths up to 120 feet (37 m)

The Frontier Formation sediments were deposited during two major transgressions and regressions of the sea. The coal beds in the upper and lower parts of the formation were deposited in coastal swamps during periods when the sea retreated eastward. The Oyster Ridge Sandstone Member is a littoral or beach deposit marking the retreat of the Cretaceous sea from the area (Hale, 1960; Myers, 1977; Roehler and others, 1977).

The marine sequence of shales, claystones and sandstones of the Hilliard Shale were deposited during a transgression of the Cretaceous sea and indicate the fluctuations of the shoreline (Roehler and others, 1977).

The Lazeart Sandstone Member at the base of the Adaville Formation is a beach deposit marking a transition from the marine deposition of the Hilliard Shale to the continental coastal plain deposition of the Adaville Formation. The sediments of the Adaville Formation were deposited in flood plains and swamps along the coastal plain (Roehler and others, 1977).

After the final withdrawal of the Cretaceous sea, thick sections of detrital material, eroded from older deposits to the west, were deposited by large streams as the conglomerates of the Hams Fork Conglomerate Member of the Evanston Formation. Environments of deposition for the main body of the Evanston Formation included streams, marshes, and, probably, ponds (Oriel and Tracey, 1970).

The main body of the Wasatch Formation is composed of continental sediments. The bright-colored mudstones were probably deposited on a flood plain and then cut by stream channels now filled with well-sorted conglomerate (Oriel and Tracey, 1970).

Structure

The southeast quarter of the Kemmerer 15-minute quadrangle is located on the southeastern edge of the structurally complex Wyoming Overthrust Belt. Folded Paleozoic and Mesozoic rocks are thrust eastward over folded older-Cretaceous rocks with younger Cretaceous and Tertiary rocks resting unconformably on top of the older rocks. Coal-bearing strata crop out in eroded limbs of folds as long narrow belts bounded on the west by major thrust faults (Roehler and others, 1977).

The coal-bearing beds in the southeast quarter of the Kemmerer 15-minute quadrangle crop out on the eastern limb of the Lazeart syncline, an asymmetrical fold whose axis crosses the northwestern corner of the quadrangle. Strata dip to the west from less than 10° to nearly 40° (Rubey and others, 1975).

The Quealy fault, a high-angle normal fault with the downthrown side to the north, extends northeasterly through secs. 1 and 12, T. 21 N., R. 116 W., sec. 6, T. 21 N., R. 115 W., and secs. 30 and 31, T. 22 N., R. 115 W. (Rubey and others, 1975).

COAL GEOLOGY

In this quadrangle, both the Frontier and Adaville Formations contain coal. The Frontier Formation has three coal zones: the Spring

Valley, the Willow Creek, and the Kemmerer. Coal beds in the Adaville Formation are separated from the upper Kemmerer coal zone by approximately 6,900 feet (2,103 m) of thick shales, sandstones and siltstones.

Chemical analyses of coal.--Analyses of coal from the Adaville, Kemmerer, Willow Creek, and Spring Valley coal zones are included in table 1. In general, coals in the Spring Valley and Kemmerer coal zones rank as high-volatile B bituminous, Willow Creek coal ranks as high-volatile A bituminous, and coal from the Adaville No. 1 coal bed ranks as subbituminous A. Coal from other Adaville coal beds are either subbituminous B or C (Glass, 1975). These coals have been ranked on a moist, mineral-matter-free basis according to ASTM Standard Specification D 388-77 (American Society for Testing and Materials, 1977).

Frontier Formation Coal Zones

The Frontier Formation and its associated coal zones are exposed in a belt trending in a north-south direction along the eastern boundary of the quadrangle. Coals in the Frontier Formation have been traced for a distance of more than 60 miles (97 km) in the Kemmerer coal field (Glass, 1977). In this quadrangle, the Kemmerer coal zone is the most significant of the Frontier Formation coal zones. The coals crop out along the eastern limb of the Lazeart syncline where dips average 18° to the west (Rubey and others, 1975).

Spring Valley Coal Zone

The Spring Valley coal zone is, stratigraphically, the lowest coal zone in the Frontier Formation. Although the Spring Valley coal zone was mapped by Veatch (1907) in this quadrangle, neither drill-hole data nor measured sections of coal beds in the zone are available.

Willow Creek Coal Zone

The Willow Creek coal zone lies stratigraphically above and is separated from the Spring Valley coal zone by approximately 600 to 800 feet (183 to 244 m) of sandstone, siltstone, and claystone (Hunter,

1950). The zone crops out in the southeast and northeast corners of the quadrangle. Several coal beds, including the Willow Creek (No. 5) or Middle Willow Creek, are identified in drill holes and measured sections in this zone, but none are of Reserve Base thickness (5 feet or 1.5 meters) at more than one point of measurement. The Willow Creek (No. 5) coal bed was mined in the northeast and southeast quarters of the Kemmerer 15-minute quadrangle in the early 1900's (Hunter, 1950).

Kemmerer Coal Zone

The Kemmerer coal zone overlies the Willow Creek coal zone and is separated from it by approximately 600 feet (183 m) of sandstone and claystone. The Oyster Ridge Sandstone Member of the Frontier Formation is a prominent sandstone bed located between the Kemmerer and Willow Creek coal zones, and is often expressed as a distinctive ridge where it crops out. The beds dip to the west at approximately 18° (Rubey and others, 1975).

The Main Kemmerer coal bed, or Cumberland Seam, is the only coal bed greater than Reserve Base thickness in the Frontier Formation in this quadrangle. The name "Main Kemmerer" is used by Veatch (1907) and the name "Cumberland Seam" is used by the Rocky Mountain Energy Company (RMEC) in the quadrangles to the south. The Main Kemmerer coal bed was mined extensively in the Kemmerer coal field around the turn of the century. In this quadrangle, the maximum recorded thickness of the coal bed is 20 feet (6.1 m) where measured in the Frontier No. 1 Mine in sec. 12, T. 21 N., R. 116 W. (Schultz, 1914). This measurement was not shown on the derivative maps because the coal has since been mined. Data indicate that the Main Kemmerer coal bed thickens and thins locally and, in some areas, pinches out altogether. For example, the coal bed is 14 feet (4.3 m) thick in sec. 12. T. 21 N., R. 116 W., but is absent in a drill hole 4,400 feet (1,341 m) to the northwest in sec. 1, T. 21 N., R. 116 W. A thin shale parting frequently occurs in this coal bed, having a maximum recorded thickness of 2.5 feet (0.8 m) in sec. 24, T. 21 N., R. 116 W. In the adjacent Elkol quadrangle to the south, the Main Kemmerer coal bed attains a maximum thickness of 20.3 feet (6.2 m), but is thin in

most areas. In the northeast quarter of the Kemmerer 15-minute quadrangle to the north, the Main Kemmerer coal bed has a maximum reported thickness of 8 feet (2.4 m).

Adaville Formation Coal Zone

The Adaville Formation crops out along the western edge of the quadrangle and the coal beds dip to the west at an average of 18°. Extensive strip mining in the Elkol and Sorenson mines has removed much of the Adaville coal in the southwestern corner of the quadrangle. Seventeen Adaville coal beds were mapped in this quadrangle and are shown in figures 1 through 52. (All figures are included at the end of this report.) Bed names for the Adaville No. 1 through the Adaville No. 6 coal beds and their riders are those used by Glass (1975). The Adaville [7] through Adaville [13] coal beds are given bracketed numbers for identification purposes in this quadrangle only. Adaville coal beds vary dramatically in thickness and character, and according to Glass (1977), all the coal beds thicken, thin, split, and coalesce over very short distances. For this reason, correlation of individual coal beds is difficult without continuous control. The dotted lines on maps of the Adaville coal beds represent a limit of confidence beyond which isopach, structure contour, overburden and mining ratio, and areal distribution and identified resources maps are not drawn because of insufficient data. Two minor coal beds, the Adaville No. 1 Upper Rider and the Adaville No. 2 Upper Rider, are greater than Reserve Base thickness in one or more drill holes but have not been mapped because of their extreme lenticularity and limited areal extent. Also, these two coal beds do not occur on Federal land where they are more than 5.0 feet (1.5 m) thick.

Adaville No. 1 Coal Bed

The Adaville No. 1 coal bed is the thickest and most persistent coal bed in the Adaville Formation and is normally found directly overlying the Lazeart Sandstone Member (Glass, 1977). In the quadrangle, the Adaville No. 1 coal bed has a maximum recorded thickness of 88.1 feet (26.9 m), with no partings, where measured in sec. 20, T. 21 N., R. 116 W. The coal bed splits to the north. In the northern part of sec. 17, T. 21 N., R. 116 W., the upper bench of the Adaville No. 1 coal

bed is 37 feet (11.3 m) thick and is separated from the lower bench by 18.5 feet (5.6 m) of rock. The lower bench has a cumulative coal thickness of 13 feet (4.0 m) at this location. Farther north, the Adaville No. 1 coal bed moves up in section away from the Lazeart Sandstone member, and the upper and lower benches thin to 5 feet (1.5 m) or less. The Adaville No. 1 coal bed eventually loses its identity to the north (Hunter, 1950). In the Elkol quadrangle to the south, the Adaville No. 1 coal bed is generally over 30 feet (9.1 m) thick and does not contain partings.

Adaville No. 3 Coal Bed

The Adaville No. 3 coal bed is located approximately 300 feet (91 m) stratigraphically above the Adaville No. 1 coal bed. It has a maximum recorded thickness of 59 feet (18.0 m), with no partings where measured in sec. 17, T. 21 N., R. 116 W., but thins to the north and south. In sec. 5, T. 21 N., R. 116 W., the Adaville No. 3 coal bed is 15 feet (4.6 m) thick. To the south, in the Sorensen Mine in sec. 20, T. 21 N., R. 116 W., the Adaville No. 3 coal bed is 33.6 feet (10.2 m) thick. It has not been traced into the Elkol quadrangle.

COAL RESOURCES

Information from coal test holes provided by Veatch (1907), the U.S. Geological Survey (1935), RMEC (no date), Alvord (1977), and surface mapping and measured sections by Veatch (1907), Schultz (1914), the U.S. Geological Survey (1935), Glass (1975), Rubey and others (1975), and RMEC (no date) were used to construct outcrop, isopach, and structure contour maps of the coal beds in this quadrangle. The source of each indexed data point shown on plate 1 is listed in table 4.

Coal resources were calculated using data obtained from the coal isopach maps. The coal bed acreage (measured by planimeter) multiplied by the average isopached 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 for each isopached 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 used in calculating Reserve Base and Reserve tonnages as stated in U.S. Geological Survey Bulletin 1450-B, which calls 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 Main Kemmerer and the Adaville coal beds are rounded to the nearest 10,000 short tons (9,072 metric tons). Coal Reserve Base tonnages per Federal section are shown on plate 2 and total approximately 11.97 million short tons (10.86 million metric tons) for the entire quadrangle. Reserve Base tonnages in the various development potential categories for surface and in-situ 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 so as 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 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.

Unknown development potentials have been assigned to those areas where coal data is absent or extremely limited. Even though these areas may contain coal thicker than 5 feet (1.5 m), 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, or low categories.

The coal development potential for surface mining methods is shown on plate 8. Of the Federal land areas having known development potential, 100 percent are rated high. The remaining Federal lands within the KRCRA boundary in this quadrangle are classified as having unknown development potential for surface mining methods.

Development Potential for Subsurface and In-Situ Mining Methods

Areas where the coal beds of Reserve Base thickness lie between 200 feet (61 m) and 3,000 feet (914 m) below the ground surface, having dips of 15° or less, are usually considered to have development potential for conventional subsurface mining methods. In this quadrangle, all known coal beds of Reserve Base thickness have dips greater than 15°. Therefore, all Federal lands have been rated as having unknown development potential for conventional subsurface mining methods.

Coal beds lying between 200 feet (61 m) and 3,000 feet (914 m) below the ground surface, dipping greater than 15°, are considered to have a development potential for in-situ mining methods. Based on criteria provided by the U.S. Geological Survey, coal beds of Reserve Base thickness dipping between 35° and 90° with a minimum Reserve Base of 70 million short tons (63.5 million metric tons) of subbituminous coal or 50 million short tons (45.4 million metric tons) of bituminous coal have a moderate potential for in-situ development. Coal beds dipping from 15° to 35°, regardless of tonnage, and coal beds dipping from 35° to 90° with less than 50 million short tons (45.4 million metric tons) of coal have a low development potential for in-situ mining methods. Coal lying between the 200-foot (61-m) overburden line and the outcrop are not included in the total coal tonnages available because they are needed for cover and containment in the in-situ process.

Areas classified as having development potential for in-situ mining methods are shown on plate 9. Since the dips of the coal beds in these areas exceed 15° and the total Reserve Base tonnage is only 8.27 million short tons (7.50 million metric tons), all of the Federal land areas having a known development potential have been rated low for in-situ mining methods. The remaining Federal land areas within the KRCRA boundary that have not already been leased for coal mining are classified as having unknown development potential.

Table 1. Chemical analyses of coals in the southeast quarter of the Kemmerer 15-minute quadrangle, Lincoln County, Wyoming

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, SW¼, sec. 3, T. 20 N., R. 117 W. (Sorenson Mine - Glass, 1975)	Adaville No. 10	A	20.5	33.0	39.6	6.9	0.9	-	-	-	-	-	9,410
		C	0.0	41.5	49.8	8.7	1.2	-	-	-	-	-	11,840
SE¼, NE¼, sec. 19, T. 21 N., R. 116 W. (Sorenson Mine - Glass, 1975)	Adaville No. 5	A	17.5	35.1	43.7	3.7	0.4	-	-	-	-	-	10,180
		C	0.0	42.5	53.0	4.5	0.4	-	-	-	-	-	12,330
SE¼, sec. 17, T. 21 N., R. 116 W. (Alvord, 1977)	Adaville No. 2A (2LR)	A	19.5	28.2	34.3	18.0	0.7	-	-	-	-	-	8,004
		C	0.0	35.0	42.7	22.3	0.8	-	-	-	-	-	9,938
SE¼, sec. 17, T. 21 N., R. 116 W. (Alvord, 1977)	Adaville No. 1A (1LR)	A	18.5	27.5	31.6	22.4	0.5	-	-	-	-	-	7,695
		C	0.0	33.7	38.8	27.5	0.6	-	-	-	-	-	9,444
NE¼, NW¼, sec. 25, T. 21 N., R. 116 W. (Diamondville Mine- U.S. Bur. of Mines, 1931)	Main Kemmerer	A	5.1	40.5	49.8	4.6	0.5	-	-	-	-	-	12,960
		C	0.0	42.7	52.4	4.9	0.5	-	-	-	-	-	13,660
SW¼, NW¼, sec. 19, T. 22 N., R. 115 W. (Willow Creek Prospect - U.S. Bur. of Mines 1931)	Willow Creek	A	4.0	36.2	55.0	4.8	0.8	-	-	-	-	-	13,500
		C	0.0	37.7	57.3	5.0	0.8	-	-	-	-	-	14,060
Sec. 32, T. 20 N., R. 116 W. (Sneddon No. 1 Mine - U.S. Bur. of Mines, 1931)	Spring Valley	A	6.7	33.5	42.3	17.5	0.7	-	-	-	-	-	10,870
		C	0.0	35.9	45.4	18.7	0.7	-	-	-	-	-	11,650

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 southeast quarter of the Kemmerer 15-minute quadrangle, Lincoln County, Wyoming.

Coal Bed or Zone	High Development Potential	Moderate Development Potential	Low Development Potential	Unknown Development Potential	Total
Adaville-{13}	670,000	30,000	0	0	700,000
Adaville-{12}	0	0	30,000	0	30,000
Adaville-{11}	30,000	60,000	0	0	90,000
Adaville-{10}	70,000	0	0	0	70,000
Adaville-{9}	0	0	0	0	0
Adaville-{8}	0	0	0	0	0
Adaville-{7}	140,000	0	0	0	140,000
Adaville-6	40,000	20,000	0	0	60,000
Adaville-5	20,000	10,000	10,000	0	40,000
Adaville-4	20,000	0	0	0	20,000
Adaville-3	50,000	10,000	0	0	60,000
Adaville-2 L. Rider	80,000	0	0	0	80,000
Adaville-2	290,000	0	0	0	290,000
Adaville-1 L. Rider	50,000	40,000	60,000	0	150,000
Adaville-1	1,970,000	0	0	0	1,970,000
Main Kemmerer	0	0	0	0	0
Totals	3,430,000	170,000	100,000	0	3,700,000

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

Table 3. -- Coal Reserve Base data for in-situ mining methods for Federal coal lands (in short tons) in the southeast quarter of the Kemmerer 15-minute quadrangle, Lincoln County, Wyoming.

Coal Bed or Zone	Moderate Development Potential	Low Development Potential	Total
Adaville-{13}	0	1,380,000	1,380,000
Adaville-{12}	0	360,000	360,000
Adaville-{11}	0	1,480,000	1,480,000
Adaville-{10}	0	660,000	660,000
Adaville-{9}	0	240,000	240,000
Adaville-{8}	0	60,000	60,000
Adaville-{7}	0	1,030,000	1,030,000
Adaville-6	0	120,000	120,000
Adaville-5	0	160,000	160,000
Adaville-4	0	110,000	110,000
Adaville-3	0	240,000	240,000
Adaville-2 L. Rider	0	0	0
Adaville-2	0	0	0
Adaville-1 L. Rider	0	0	0
Adaville-1	0	310,000	310,000
Main Kemmerer	0	2,120,000	2,120,000
Totals	0	8,270,000	8,270,000

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

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

Plate 1 Index Number	Source	Data Base
1	U.S. Geological Survey, 1935, Inactive Coal Lease No. Evanston-08809	Drill hole No. 28
2		Drill hole No. 31
3		Drill hole No. 32
4		Drill hole No. 2
5		Drill hole No. 7
6	Rocky Mountain Energy Co., (no date), unpublished data	Drill hole No. 1-C
7		Drill hole No. 2-C
8		Drill hole No. 3-C
9		Drill hole No. 4-C
10		Drill hole No. 5-C
11		Drill hole No. 6-C
12		Drill hole No. 7-C
13		Drill hole No. 8-C
14		Drill hole No. 9-C
15		Drill hole No. 10-C
16		Drill hole No. 1-D
17		Drill hole No. 2-D
18		Drill hole No. 3-D
19		Drill hole No. 4-D
20		Drill hole No. 5-D offset

Table 4. -- Continued

Plate 1 Index Number	Source	Data Base
21	Rocky Mountain Energy Co., (no date), unpublished data	Drill hole No. 6-D
22	↓	Drill hole No. 14-A
23	↓	Drill hole No. 15-A
24	U.S. Geological Survey, 1935, Inactive Coal Lease No. Evanston-08809	Drill hole No. 1
25	↓	Mine Section
26	↓	Drill hole No. 3
27	Rocky Mountain Energy Co., (no date), unpublished data	Drill hole No. 1-A
28	↓	Drill hole No. 2-A
29	↓	Drill hole No. 3-A
30	↓	Drill hole No. 4-A
31	↓	Drill hole No. 5-A
32	↓	Drill hole No. 6-A
33	↓	Drill hole No. 7-A
34	↓	Drill hole No. 8-A
35	↓	Drill hole No. 9-A
36	↓	Drill hole No. 5-A
37	↓	Core hole "B"
38	↓	Core hole "A"
39	Alvord, 1977, U.S. Geological Survey Open-File Report 77-828	Drill hole No. T 98-1
40	↓	Drill hole No. T 98-2

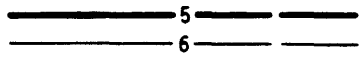
Table 4. -- Continued

Plate 1 Index Number	Source	Data Base
41	Alvord, 1977, U.S. Geological Survey Open-File Report 77-828	Drill hole No. T 98-3
42	Rocky Mountain Energy Co., (no date), unpublished data	Drill hole No. 1-B
43	↓	Drill hole No. 2-B
44	↓	Drill hole No. 3-B
45	↓	Drill hole No. 4-B
46	↓	Drill hole No. 5-B
47	Alvord, 1977, U.S. Geological Survey Open-File Report 77-828	Drill hole No. T 98-4
48	↓	Drill hole No. T 98-5
49	↓	Drill hole No. T 98-6
50	Rocky Mountain Energy Co., (no date), unpublished data	Drill hole No. 10-A
51	↓	Drill hole No. 11-A
52	↓	Drill hole No. 12-A
53	↓	Drill hole No. 13-A
54	Glass, 1975, Wyoming Geology Survey Report of Investigations No. 11	Measured Section No. 74-6
55	↓	Measured Section No. 74-13
56	↓	Measured Section No. 74-10 and 74-11
57	↓	Measured Section No. 74-19

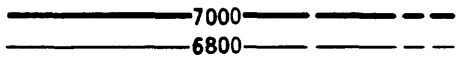
Table 4. -- Continued

Plate 1 Index Number	Source	Data Base
58	Glass, 1975, Wyoming Geology Survey Report of Investigations No. 11	Measured Section No. 74-16, 74-17, and 74-18
59	↓	Measured Section No. 74-14 and 74-15
60	↓	Measured Section No. 74-12
61	Veatch, 1907, U.S. Geological Survey Professional Paper 56, p. 120	Drill hole No. 16
62	↓	Mine Section No. 17
63	↓	Drill hole No. 18
64	↓	Measured Section No. 4
65	Schultz, 1914, U.S. Geological Survey Bulletin 543, p. 100	Measured Section E
66	↓	Measured Section F
67	↓	Measured Section G
68	U.S. Geological Survey, 1935, Inactive Coal Lease No. Evanston-08809	Measured Section
69	Schultz, 1914, U.S. Geological Survey Bulletin 543, p. 101	Measured Section L
70	↓	Measured Section N
71	U.S. Geological Survey, 1935, Inactive Coal Lease No. Evanston-08809	Drill hole No. 8

EXPLANATION



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



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; short dashed where projected through subsurface mine area. Contour interval 200 feet (61 m). Datum is mean sea level.

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

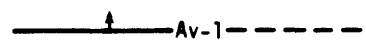
POINT OF MEASUREMENT - Showing altitude of top of coal bed, and thickness of coal, in feet. Altitudes not shown for underground mine measured sections. Includes all points of measurement other than drill holes.

44/10

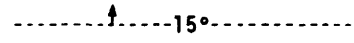
INTERBEDDED COAL AND ROCK - Showing total coal thickness/rock thickness.

Av-1 - Adaville No. 1
Av-1LR - Adaville No. 1 Lower Rider
Av-2 - Adaville No. 2
Av-2LR - Adaville No. 2 Lower Rider
Av-3 - Adaville No. 3
Av-4 - Adaville No. 4
Av-4R - Adaville No. 4 Rider
Av-5 - Adaville No. 5
Av-5R - Adaville No. 5 Rider
Av-6 - Adaville No. 6

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.

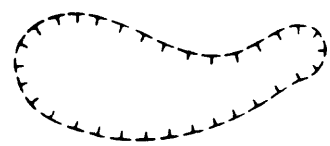


TRACE OF COAL BED OUTCROP - Showing symbol of name of coal bed as listed above. Arrow points toward coal-bearing area. Short dashed where inferred by present authors.



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°.

SUBSURFACE COAL MINE - Showing name of mine. Dashed where approximately located.



COAL STRIP MINE - Hachures point toward mined area. Dashed where approximately located.

To convert feet to meters, multiply feet by 0.3048.

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

EXPLANATION

200

OVERBURDEN ISOPACHS - Showing thickness of overburden, in feet, from surface to top of coal bed. Dashed where vertical accuracy possibly not within 40 feet. Isopach interval 200 feet (61 m).

o 185

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

10

MINING-RATIO CONTOUR - Number indicates cubic yards of overburden per ton of recoverable coal by surface mining methods. Contours shown only in areas underlain by coal of Reserve Base thickness within the stripping-limit (in this quadrangle, the 200-foot-overburden isopach). To convert mining ratio to cubic meters of overburden per metric ton of recoverable coal, multiply mining ratio by 0.8428.

Av-1 - Adaville No. 1
Av-1LR - Adaville No. 1 Lower Rider
Av-2 - Adaville No. 2
Av-2LR - Adaville No. 2 Lower Rider
Av-3 - Adaville No. 3
Av-4 - Adaville No. 4
Av-4R - Adaville No. 4 Rider
Av-5 - Adaville No. 5
Av-5R - Adaville No. 5 Rider
Av-6 - Adaville No. 6

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.

Av-1

TRACE OF COAL BED OUTCROP - Showing symbol of name of coal bed as listed above. Short dashed where inferred by present authors.

SUBSURFACE COAL MINE - Showing name of mine. Dashed where approximately located.

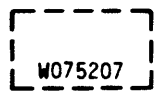
COAL STRIP MINE - Hachures point toward mined area. Dashed where approximately located.

To convert feet to meters, multiply feet by 0.3048.

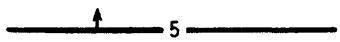
FIGURE 2. — Explanation for overburden isopach and mining ratio map.

EXPLANATION

NON-FEDERAL COAL LAND - Land for which the Federal Government does not own the coal rights.



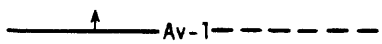
AREA OF COAL LEASE ON FEDERAL LAND - Showing coal lease number.



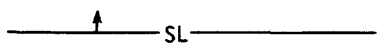
ISOPACH - Showing thickness of coal, in feet. Arrow points toward area where coal bed is 5 feet or more thick.

Av-1 - Adaville No. 1
Av-1LR - Adaville No. 1 Lower Rider
Av-2 - Adaville No. 2
Av-2LR - Adaville No. 2 Lower Rider
Av-3 - Adaville No. 3
Av-4 - Adaville No. 4
Av-4R - Adaville No. 4 Rider
Av-5 - Adaville No. 5
Av-5R - Adaville No. 5 Rider
Av-6 - Adaville No. 6

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 COAL BED OUTCROP - Showing symbol of name of coal bed as listed above. Arrow points toward coal-bearing area. Short dashed where inferred by present authors.



STRIPPING-LIMIT LINE - Boundary for surface mining (in this quadrangle, the 200-foot-overburden isopach). Arrow points toward the area suitable for surface mining where the recovery factor is 85 percent, and away from the area suitable for subsurface mining (down dip to the 3,000-foot-overburden isopach) where the recovery factor is 50 percent.

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°.

SUBSURFACE COAL MINE - Showing name of mine. Dashed where approximately located.

RB	R(85%)	RB	R(50%)	
1.91	1.62	0.31	—	(Measured)
—	—	—	—	(Indicated)
—	—	—	—	(Inferred)

IDENTIFIED COAL RESOURCES - Showing totals for Reserve Base (RB) and Reserves (R), in millions of short tons, for each section or part of section of non-leased Federal coal land, both within and beyond the stripping-limit line. Reserve (R) tonnage is calculated by multiplying the Reserve Base (RB) tonnage by the appropriate recovery factor. Dash indicates no resource in that category. Underground Reserves have been calculated for only that part of the Reserve Base that is suitable for underground mining, and do not include Reserves for areas where the dip of the coal bed exceeds 15°. Measured resources (M) extend 0.25 miles beyond the point of measurement. Indicated resources (I) are defined between 0.25 and 0.75 miles from the point of measurement. Inferred resources (Inf) extend from 0.75 to 3 miles from the point of measurement.

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

To convert feet to meters, multiply feet by 0.3048.

To convert miles to kilometers, multiply miles by 1.6093.

FIGURE 3. — Explanation for areal distribution and identified resources map.

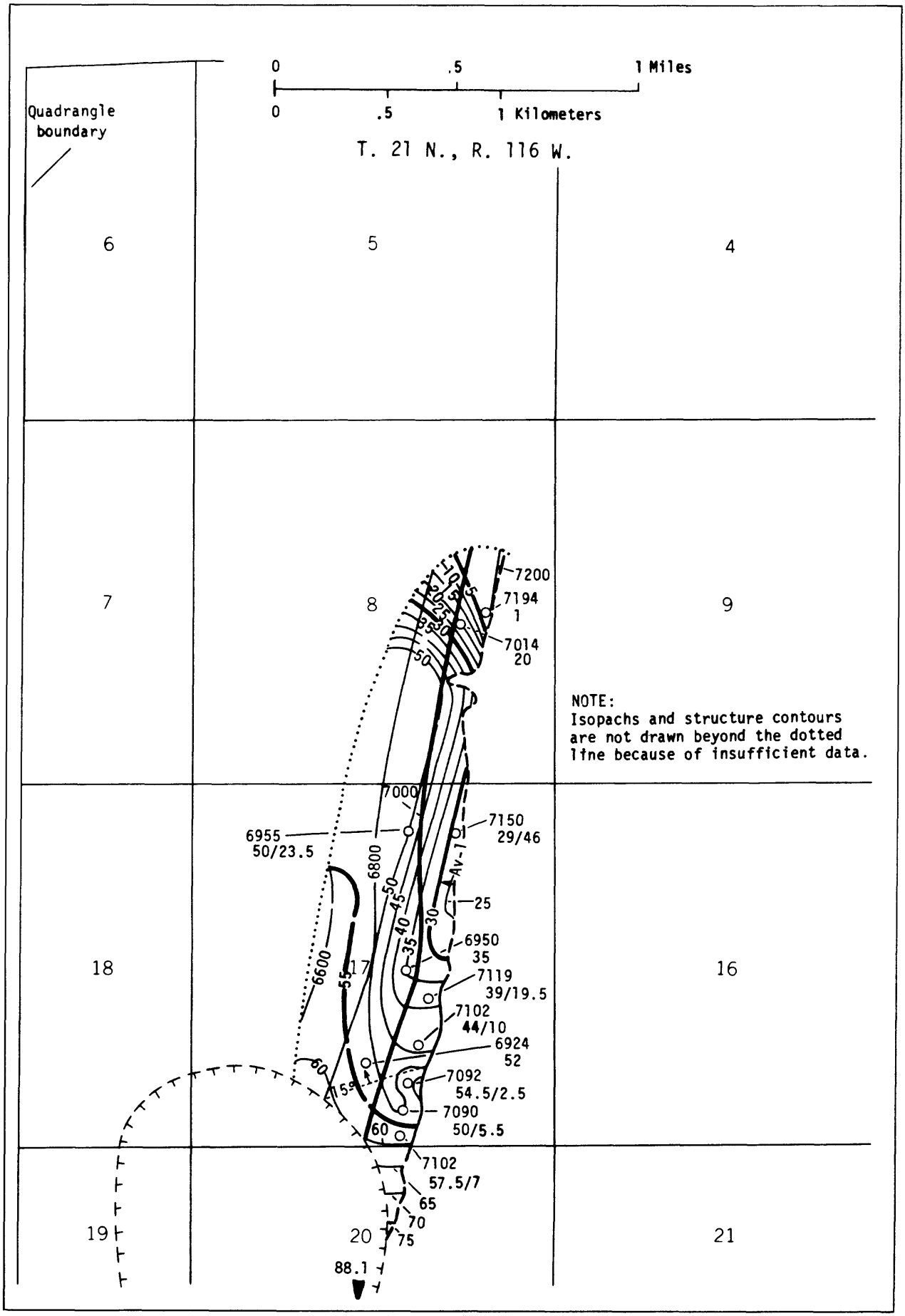


FIGURE 4. — Isopach and structure contour map of the Adaville No. 1 coal bed.

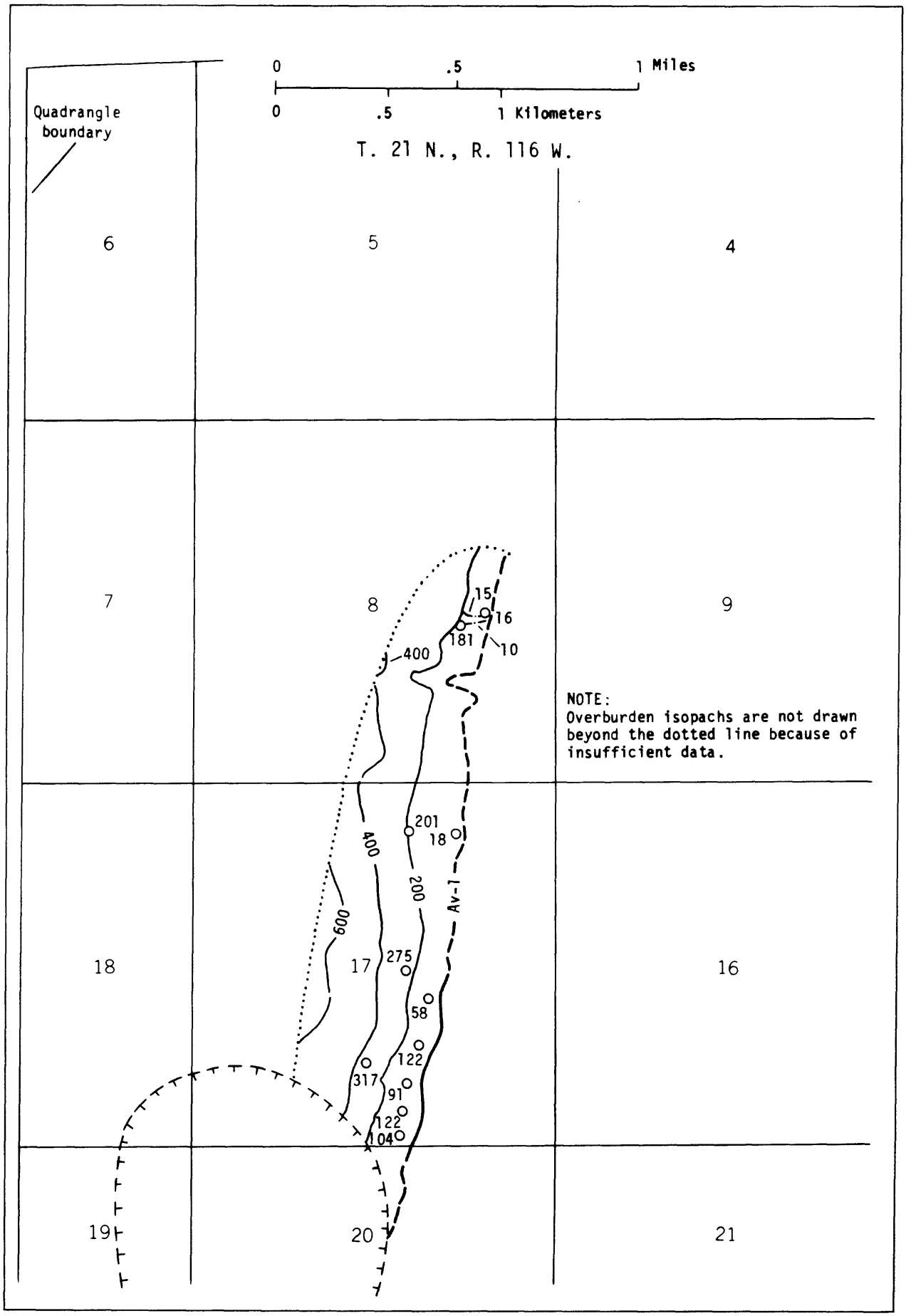


FIGURE 5. — Overburden isopach and mining ratio map of the Adaville No. 1 coal bed.

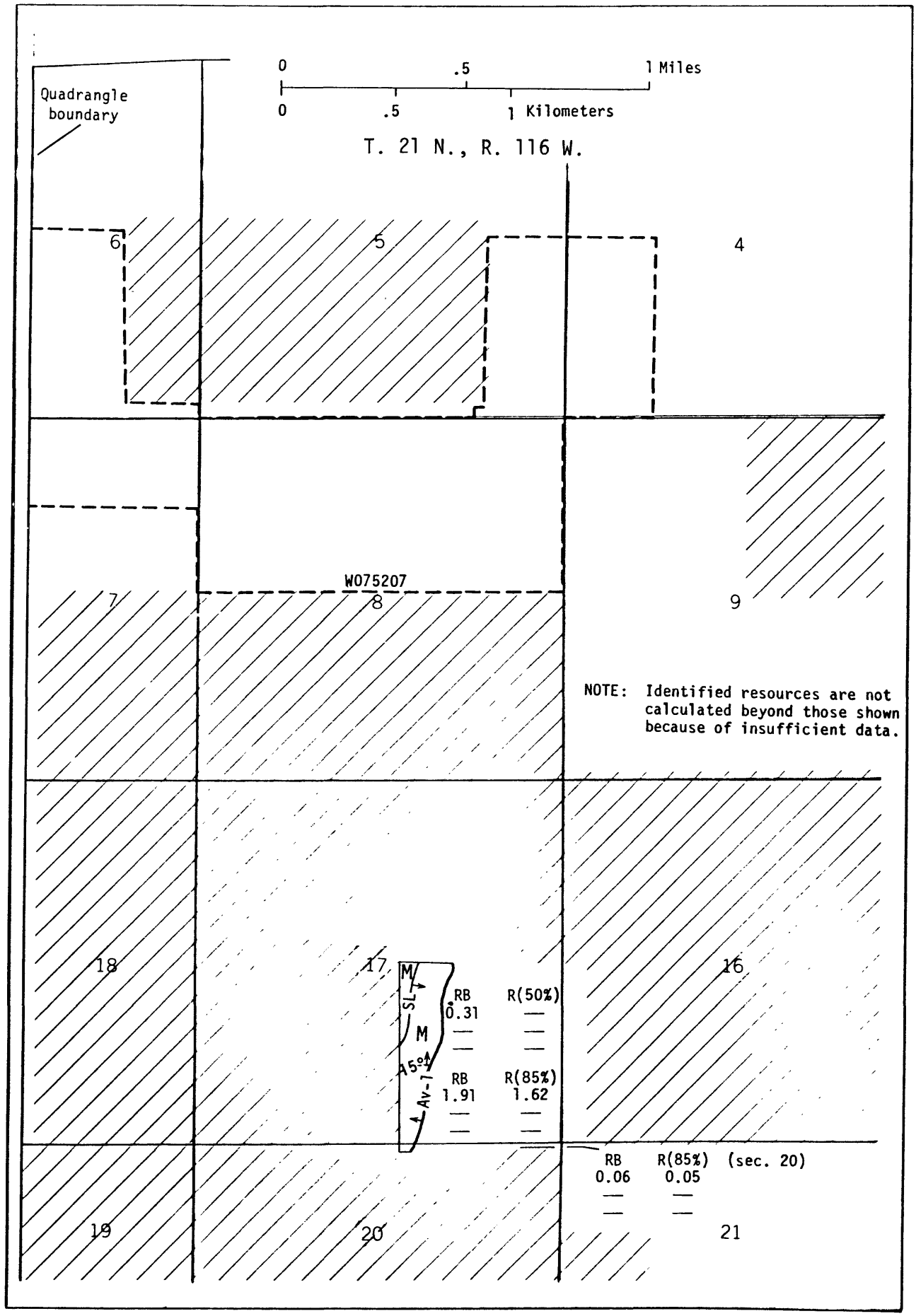


FIGURE 6. — Areal distribution and identified resources map of the Adaville No. 1 coal bed.

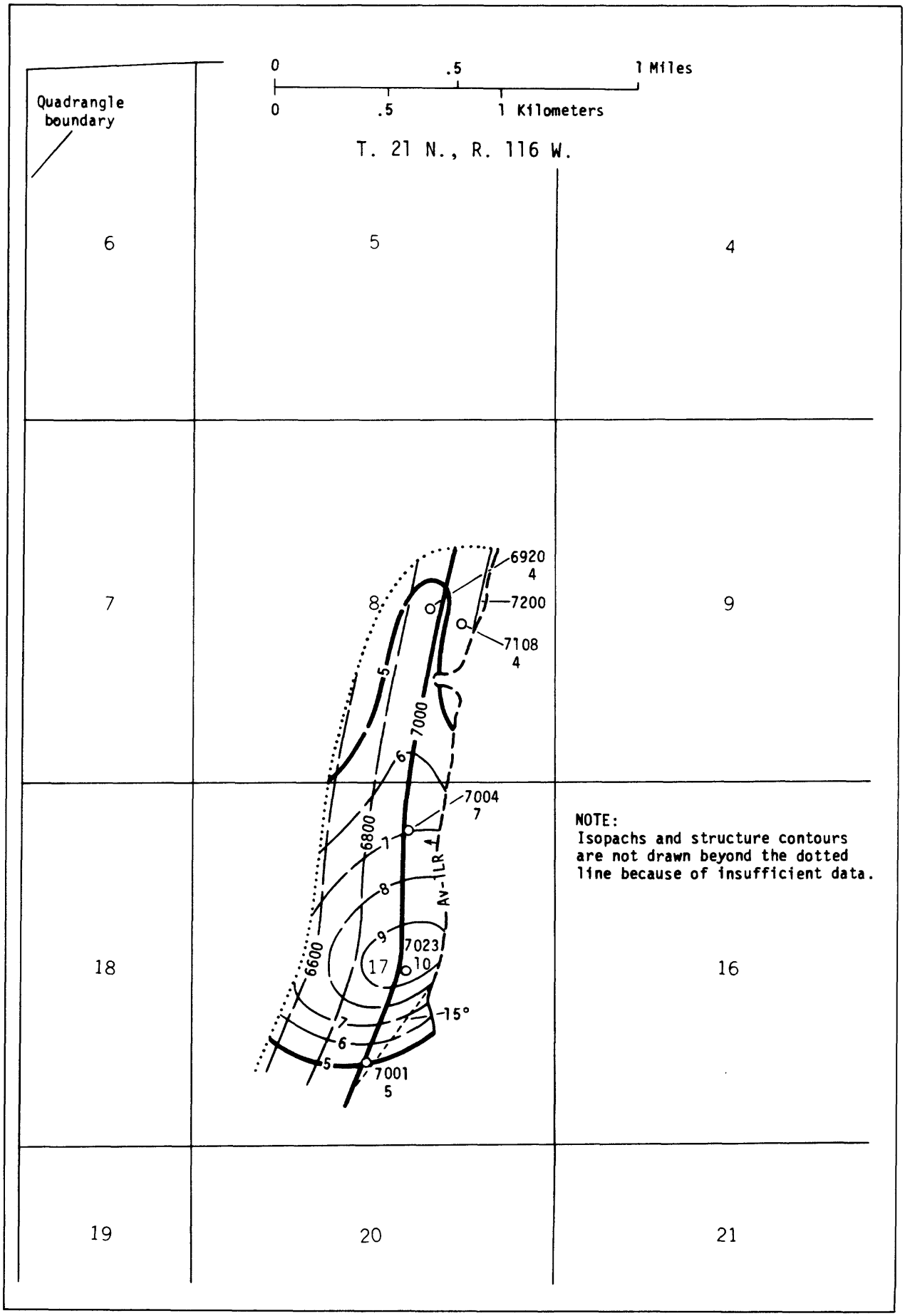


FIGURE 7. — Isopach and structure contour map of the Adaville No. 1 Lower Rider coal bed.

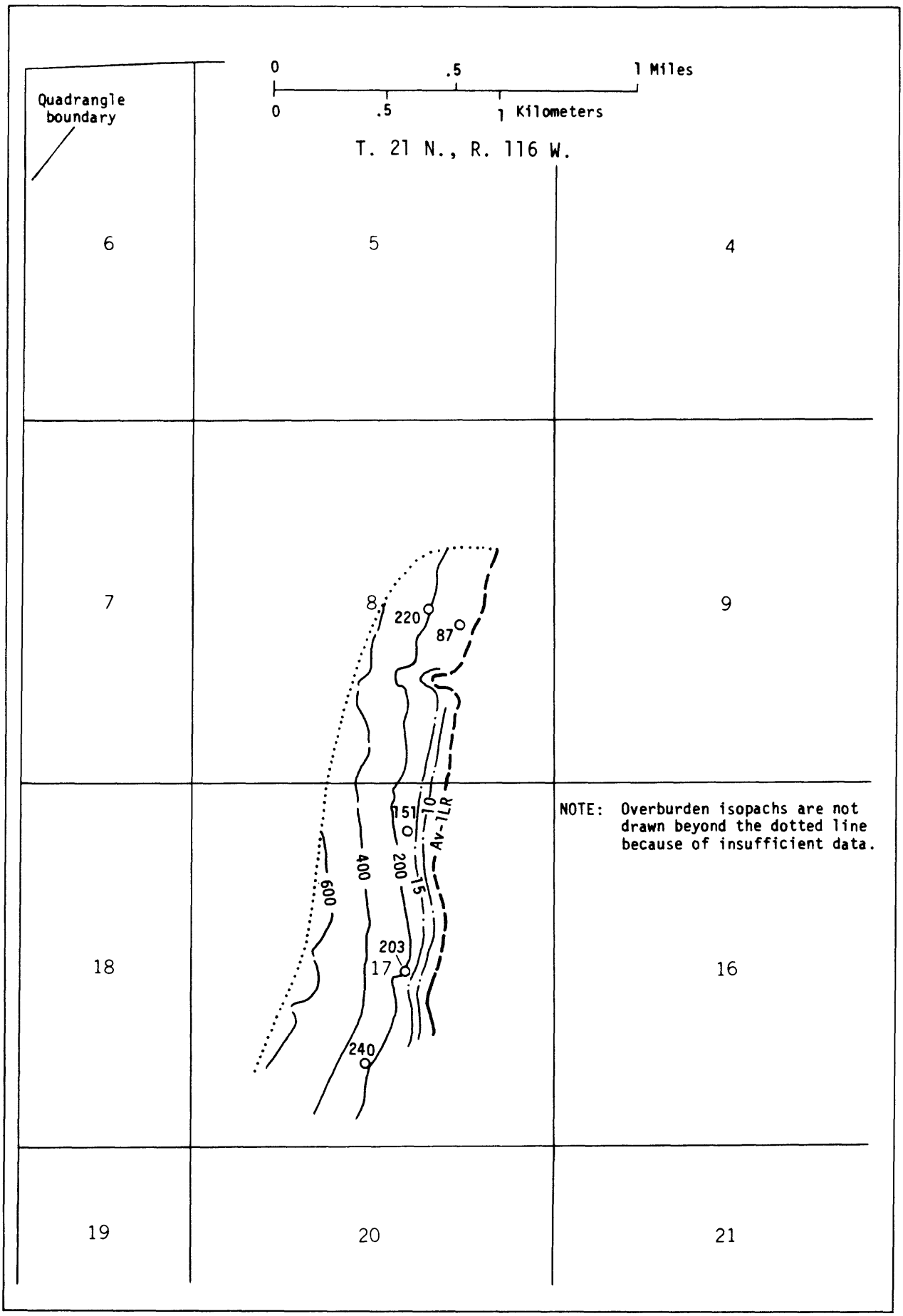


FIGURE 8. — Overburden isopach and mining ratio map of the Adaville No. 1 Lower Rider coal bed.

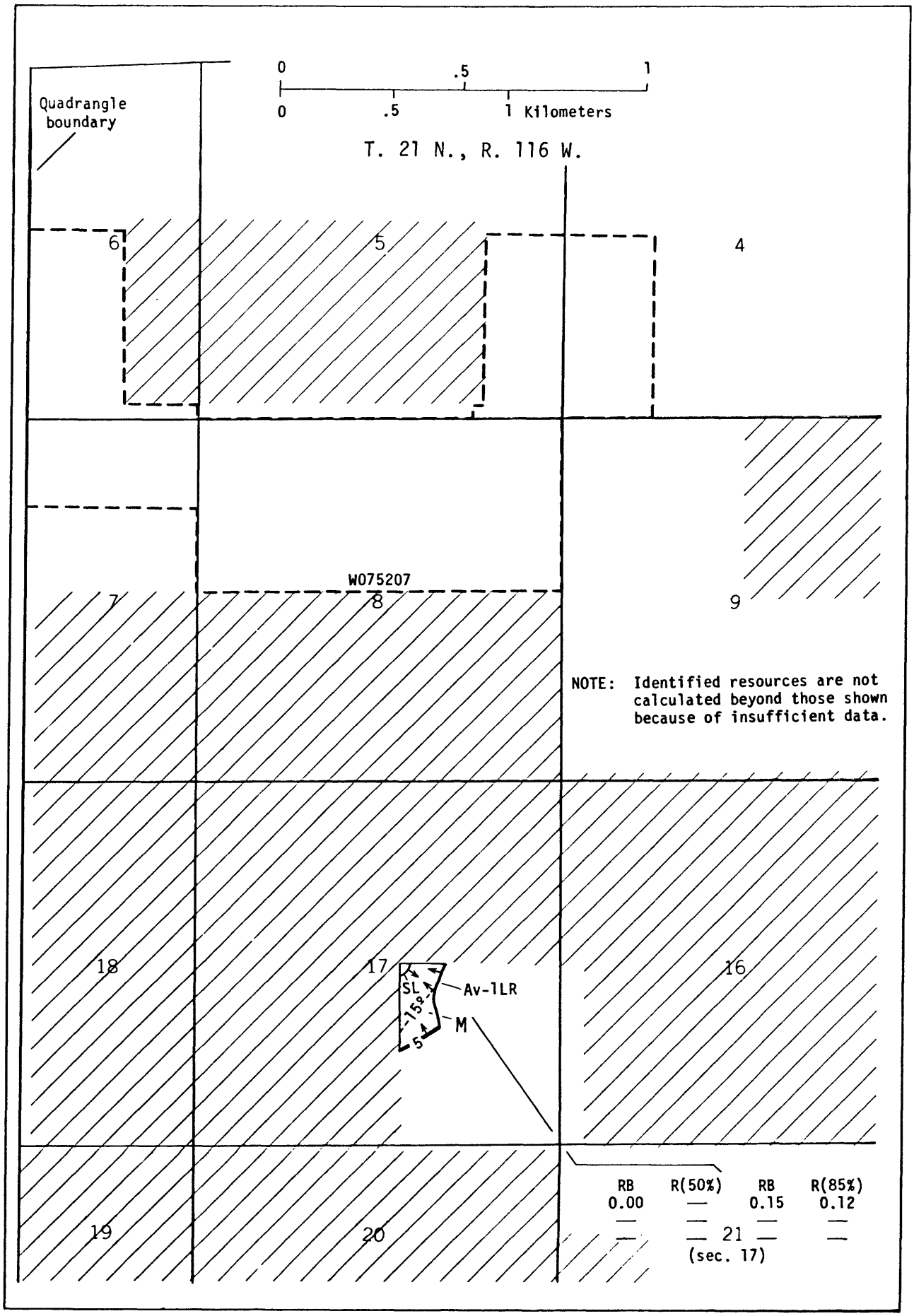


FIGURE 9. — Areal distribution and identified resources map of the Adaville No. 1 Lower Rider coal bed.

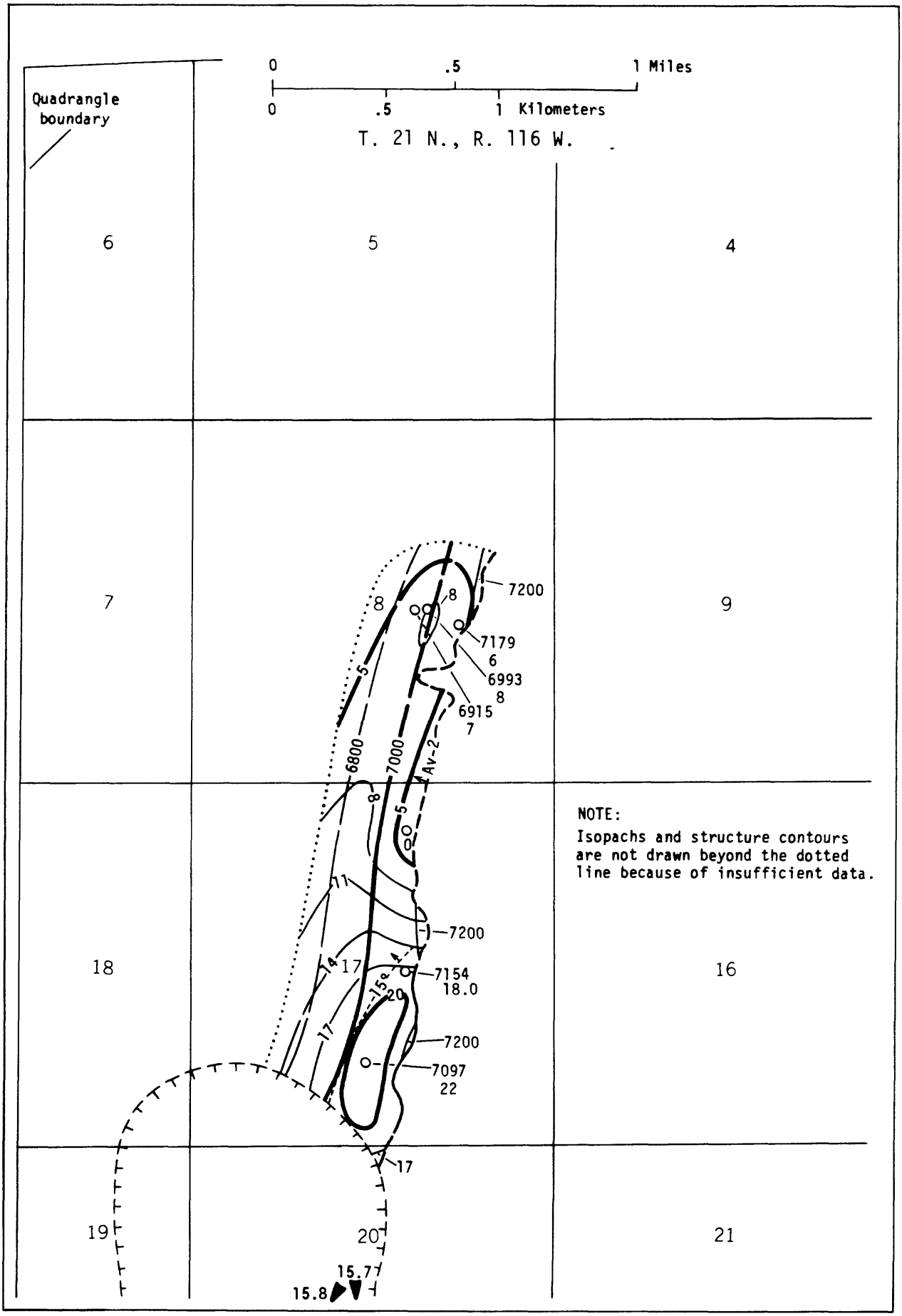


FIGURE 10. — Isopach and structure contour map of the Adaville No. 2 coal bed.

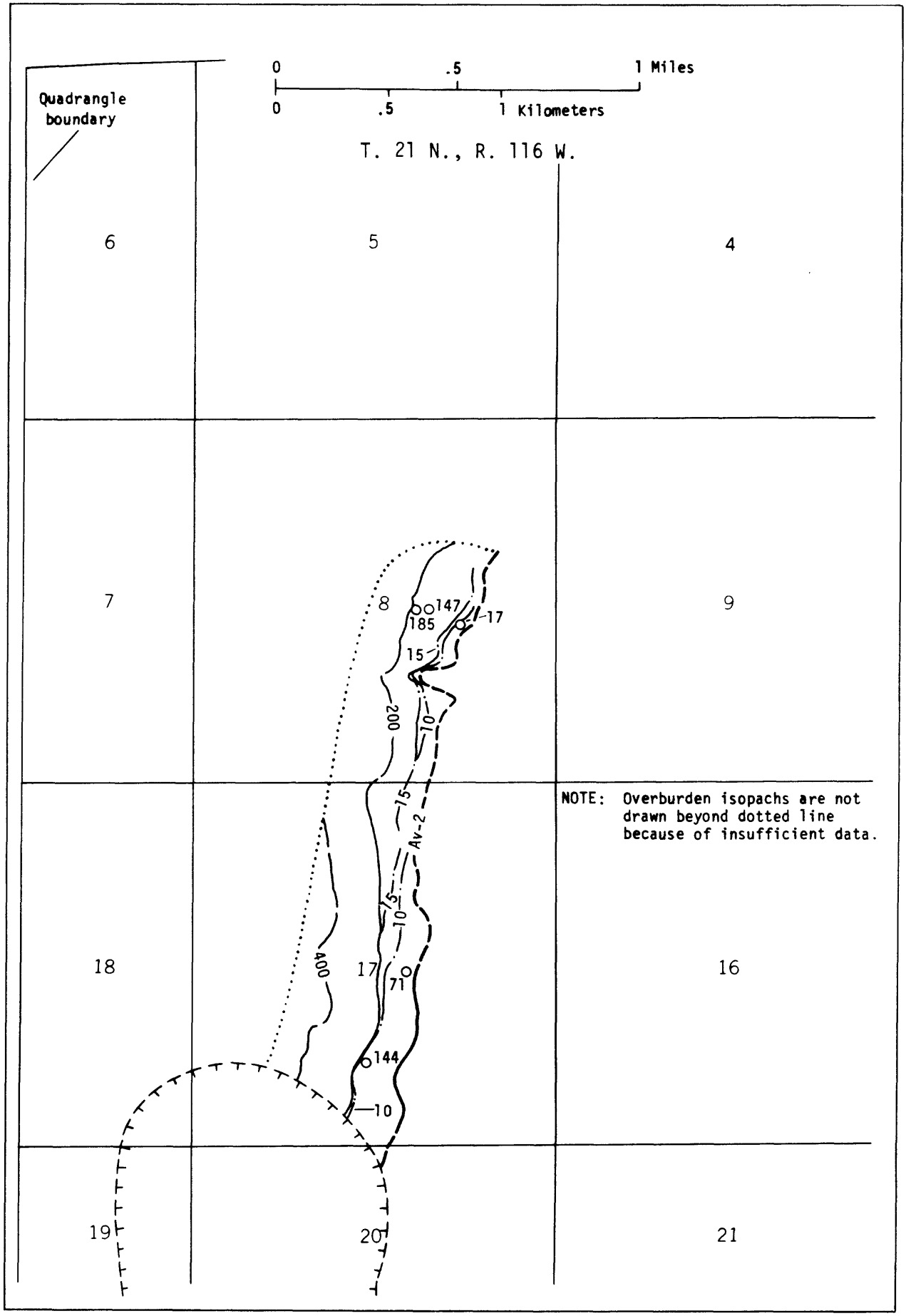


FIGURE 11. — Overburden isopach and mining ratio map of the Adaville No. 2 coal bed.

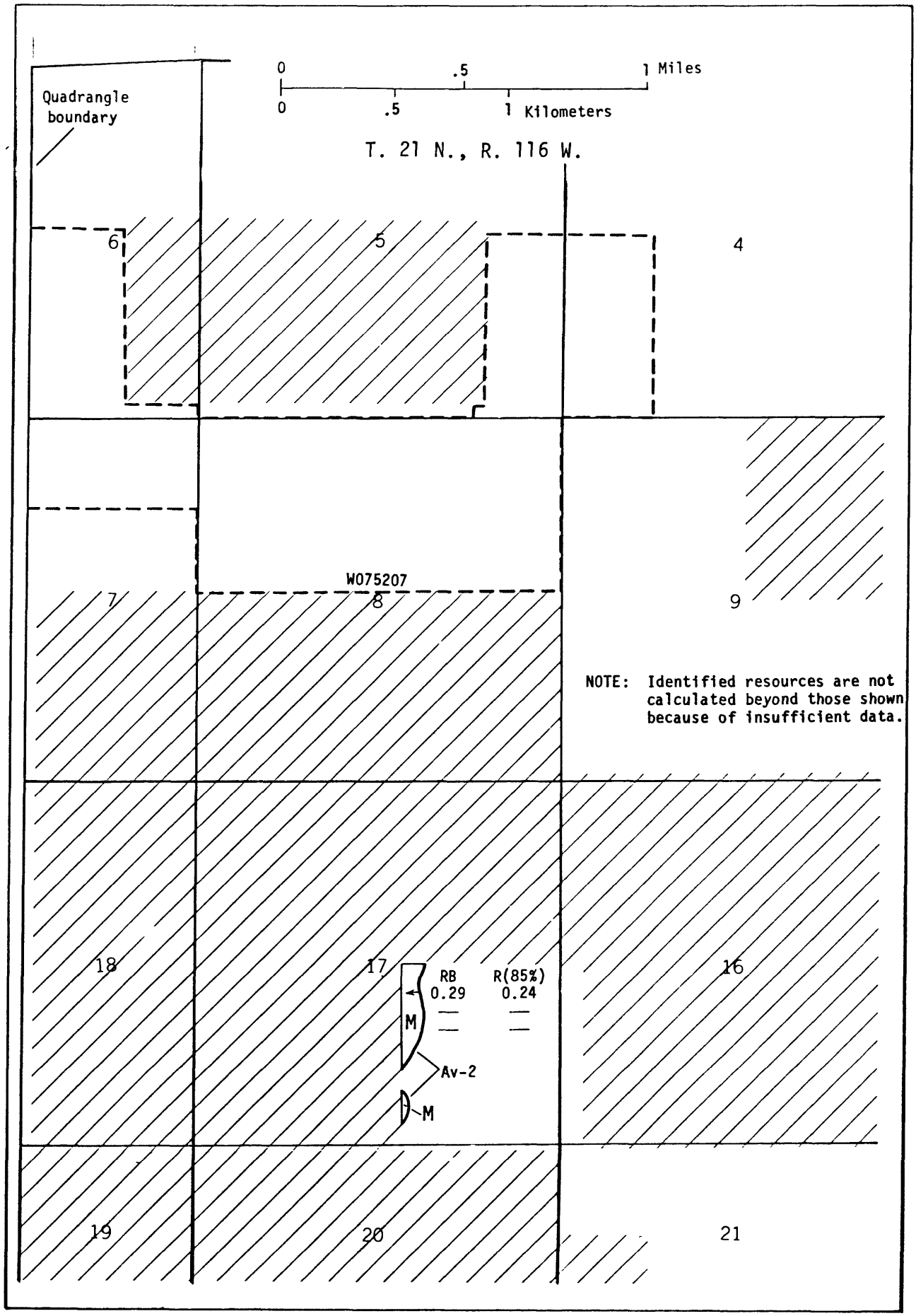


FIGURE 12. — Areal distribution and identified resources map of the Adaville No. 2 coal bed.

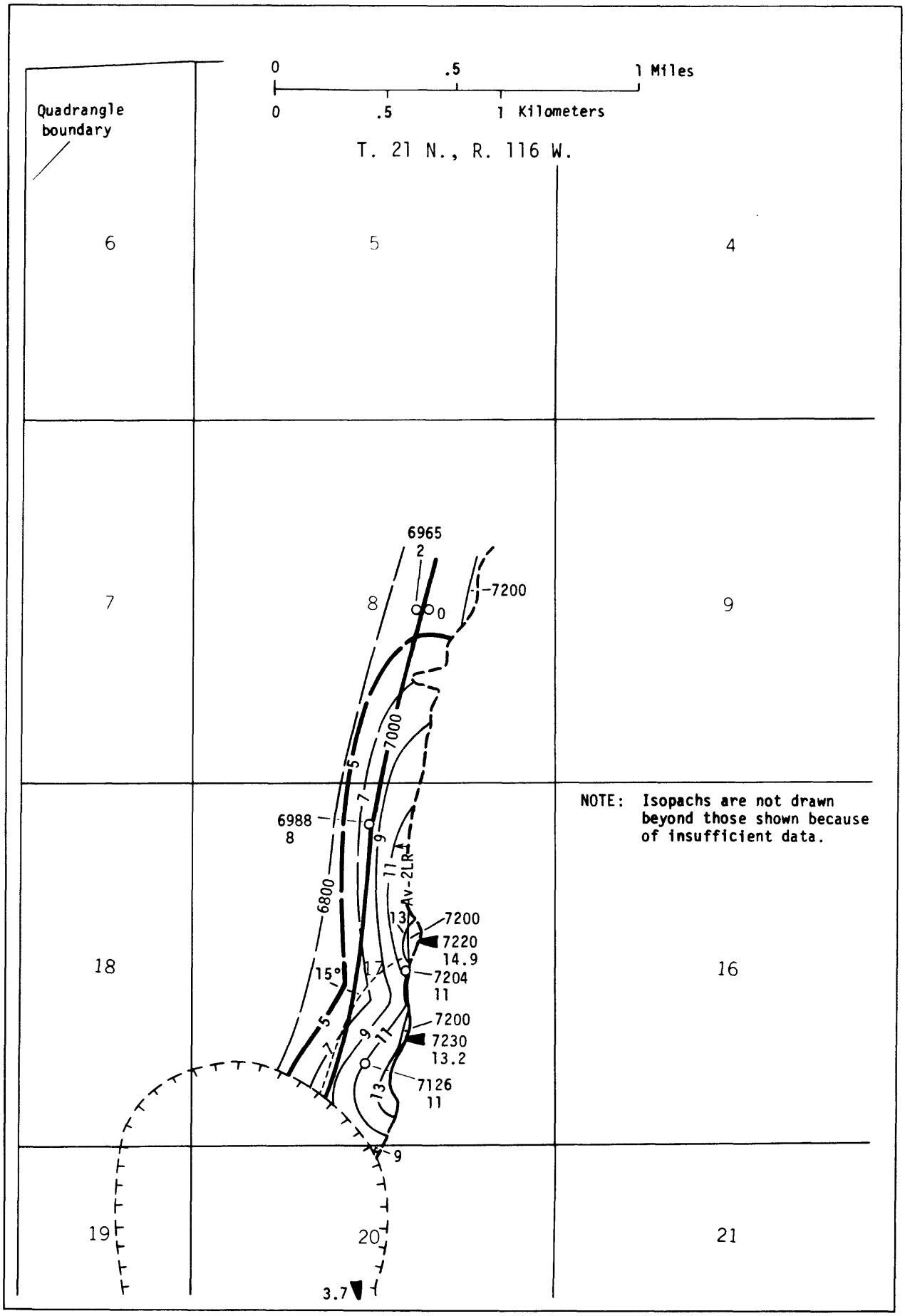


FIGURE 13. — Isopach and structure contour map of the Adaville No. 2 Lower Rider coal bed.

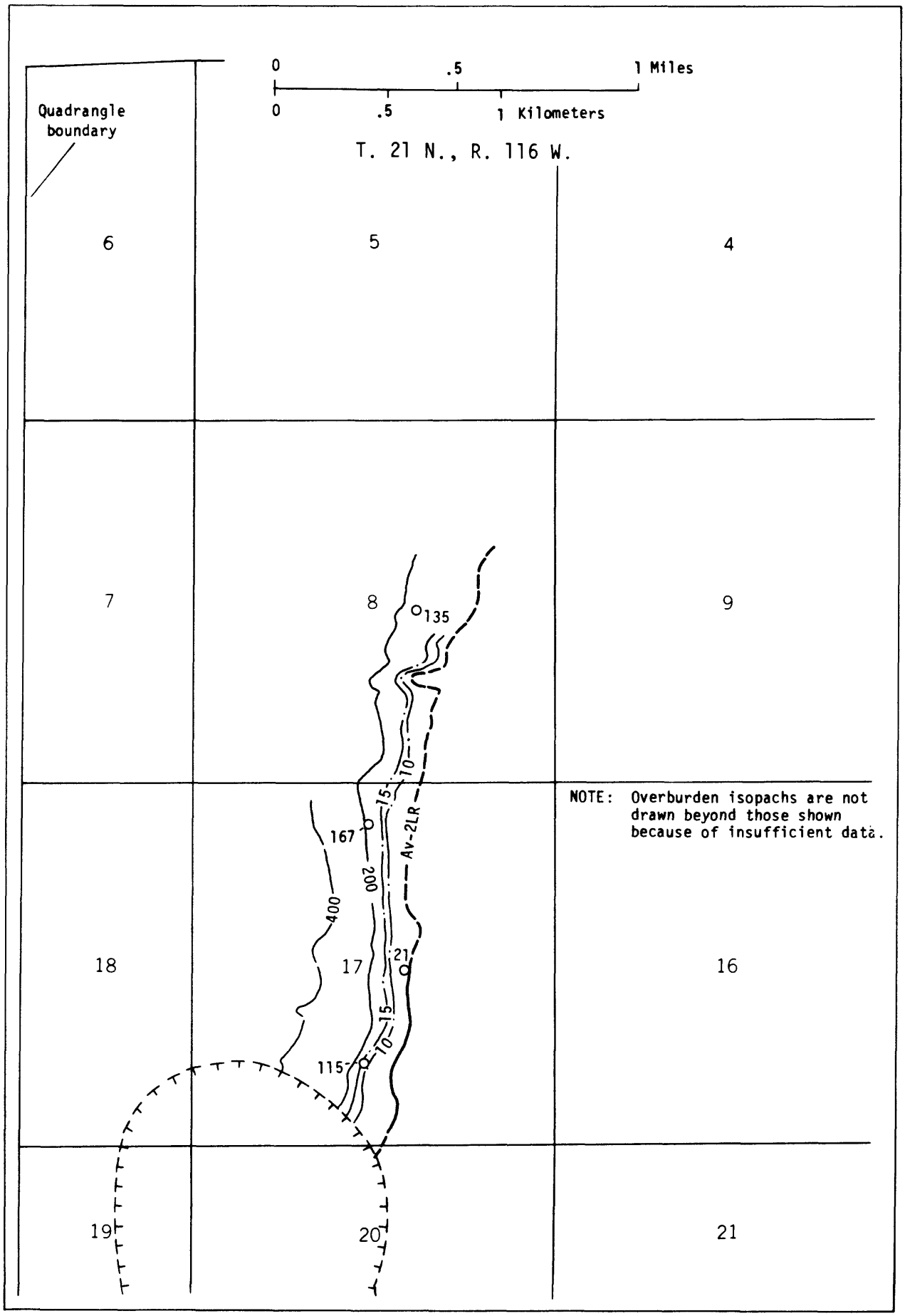


FIGURE 14. — Overburden isopach and mining ratio map of the Adaville No. 2 Lower Rider coal bed.

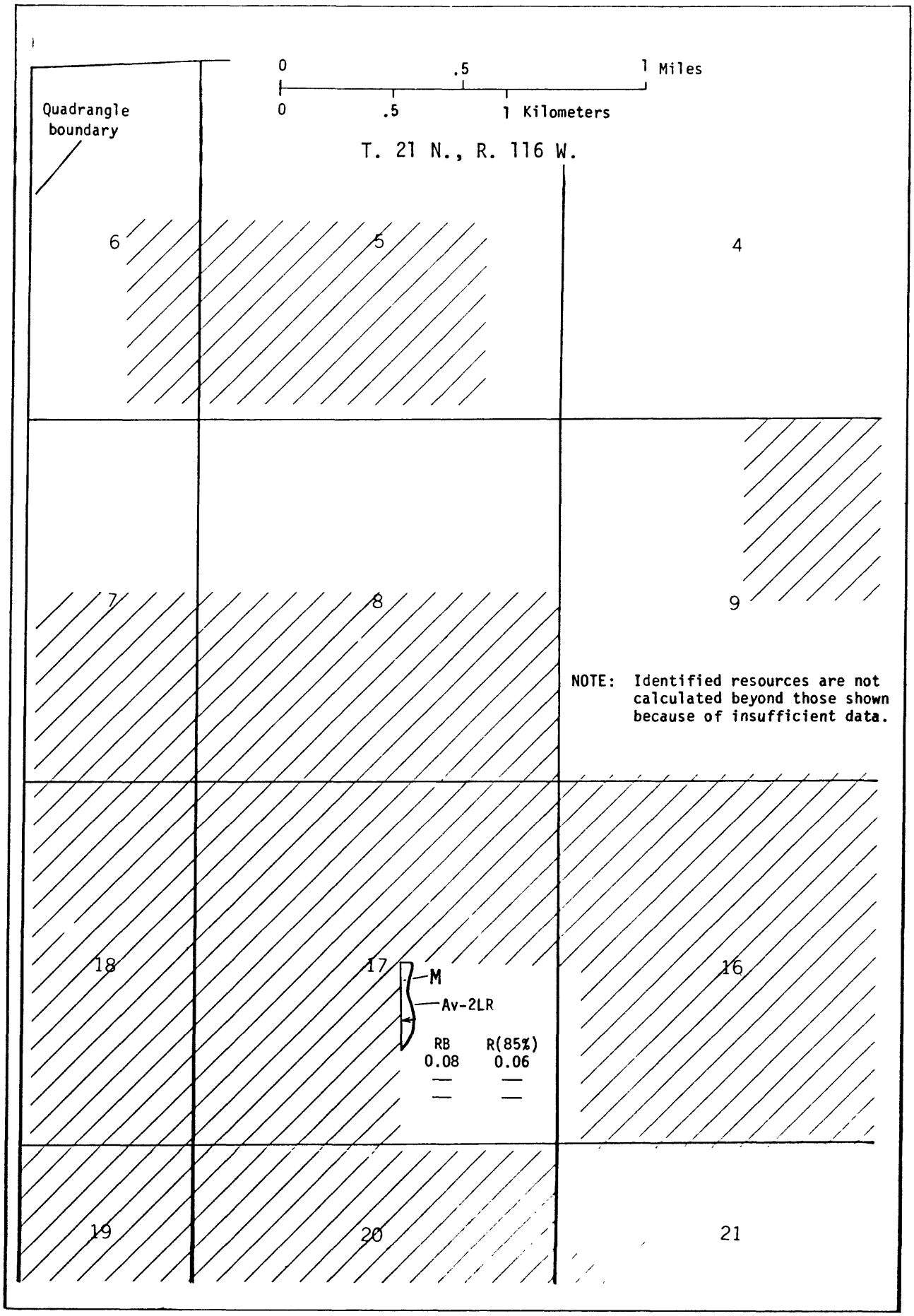


FIGURE 15. — Areal distribution and identified resources map of the Adaville No. 2 Lower Rider coal bed.

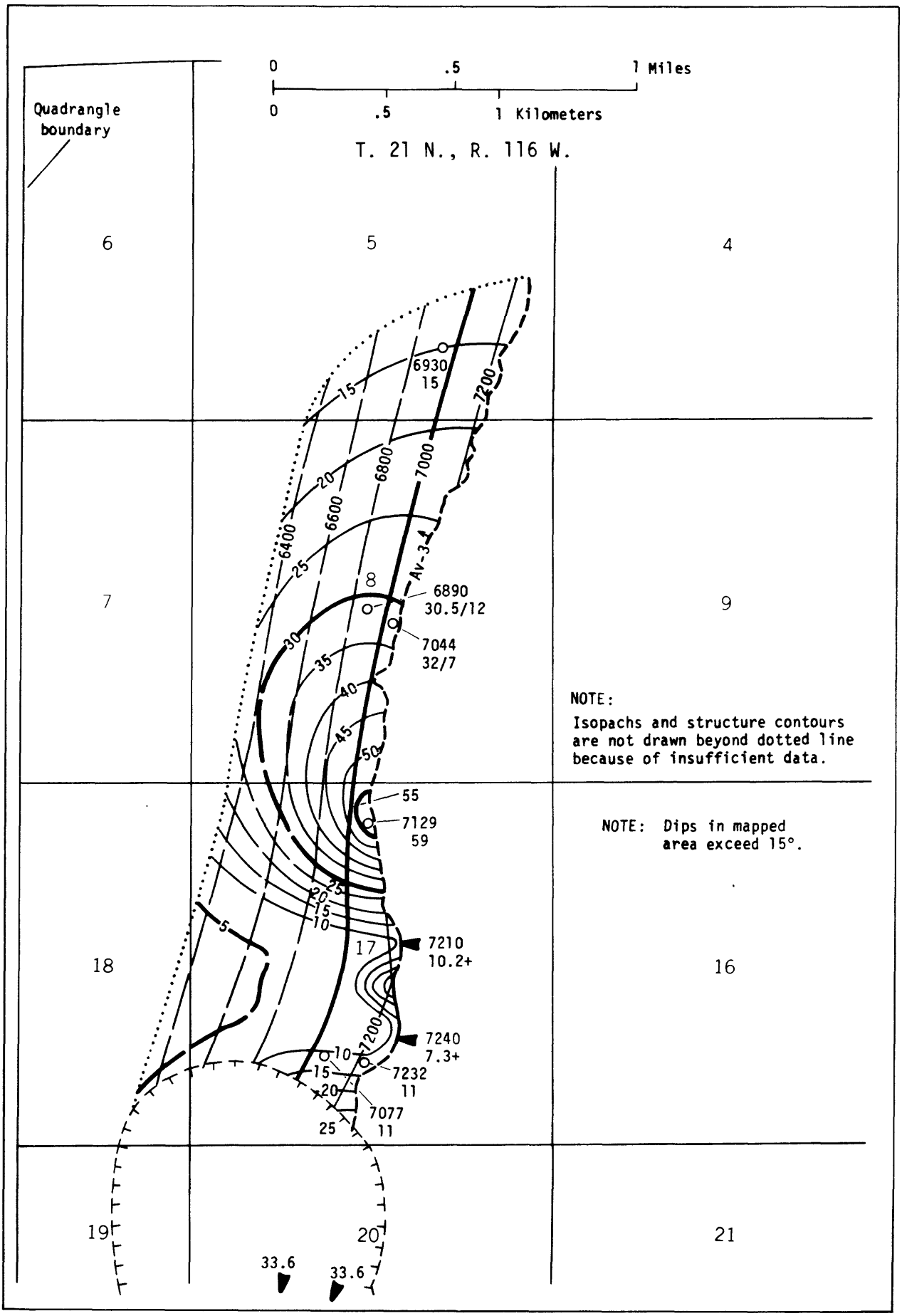


FIGURE 16. — Isopach and structure contour map of the Adaville No. 3 coal bed.

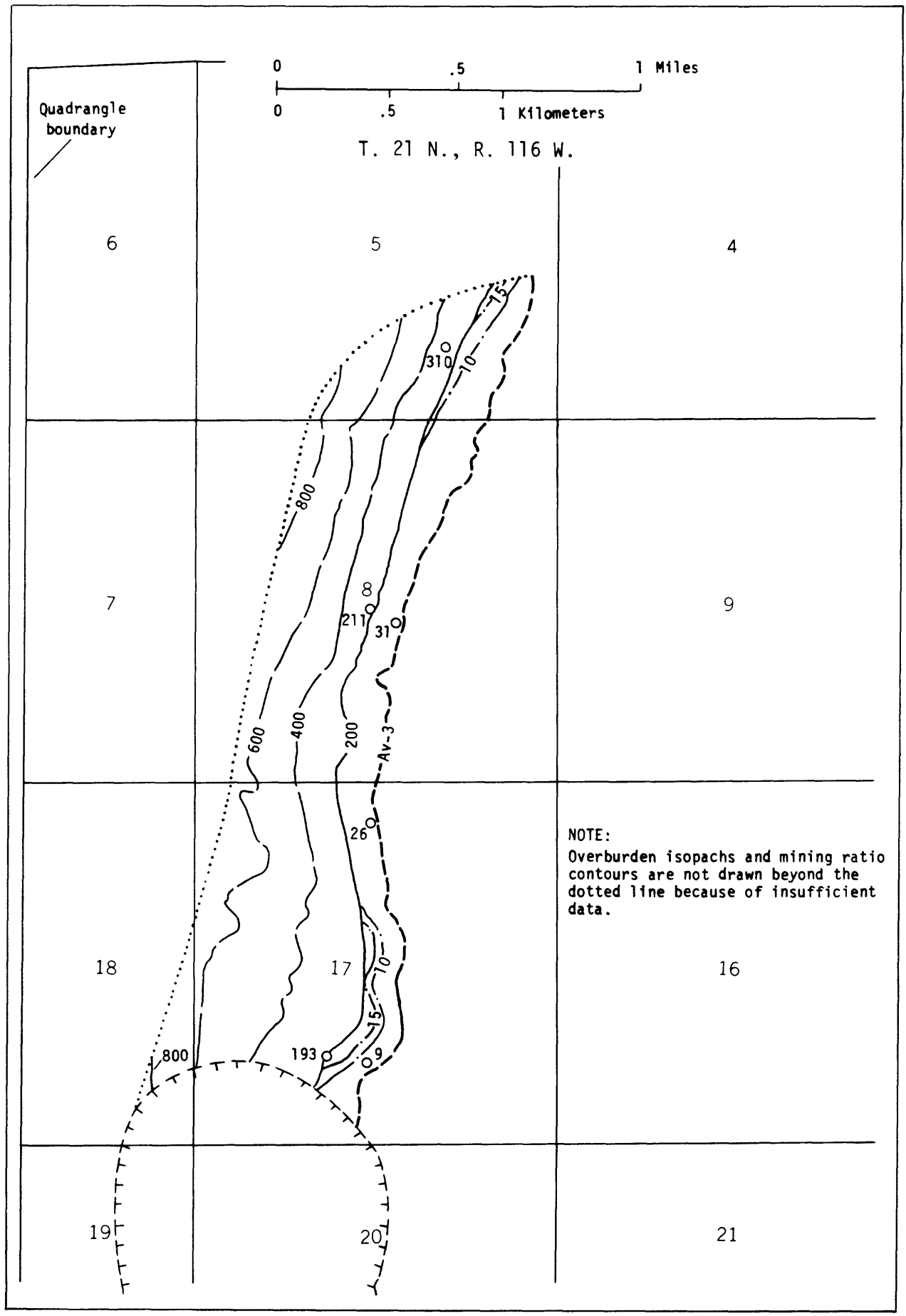


FIGURE 17. — Overburden isopach and mining ratio map of the Adaville No. 3 coal bed.

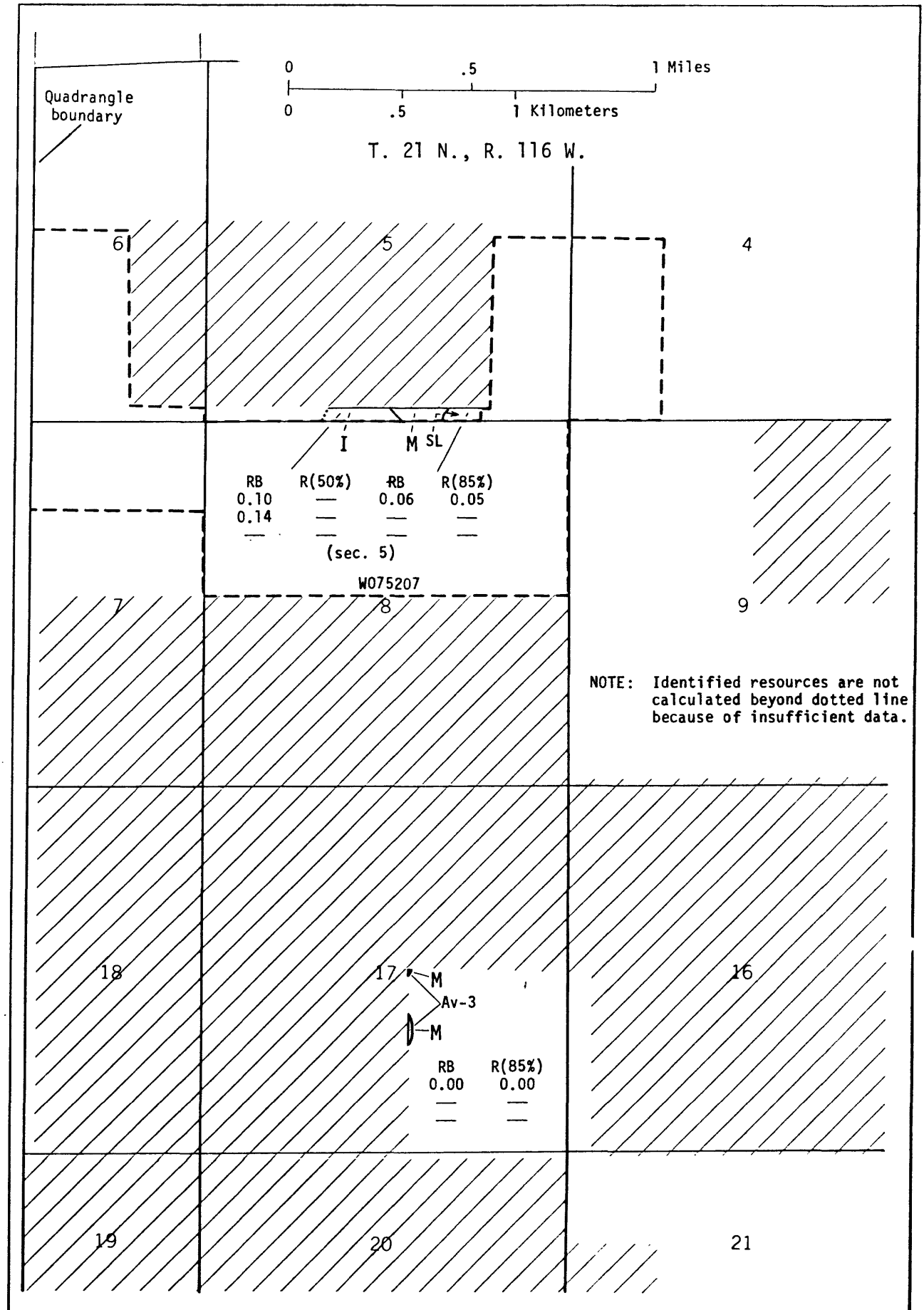


FIGURE 18. — Areal distribution and identified resources map of the Adaville No. 3 coal bed.

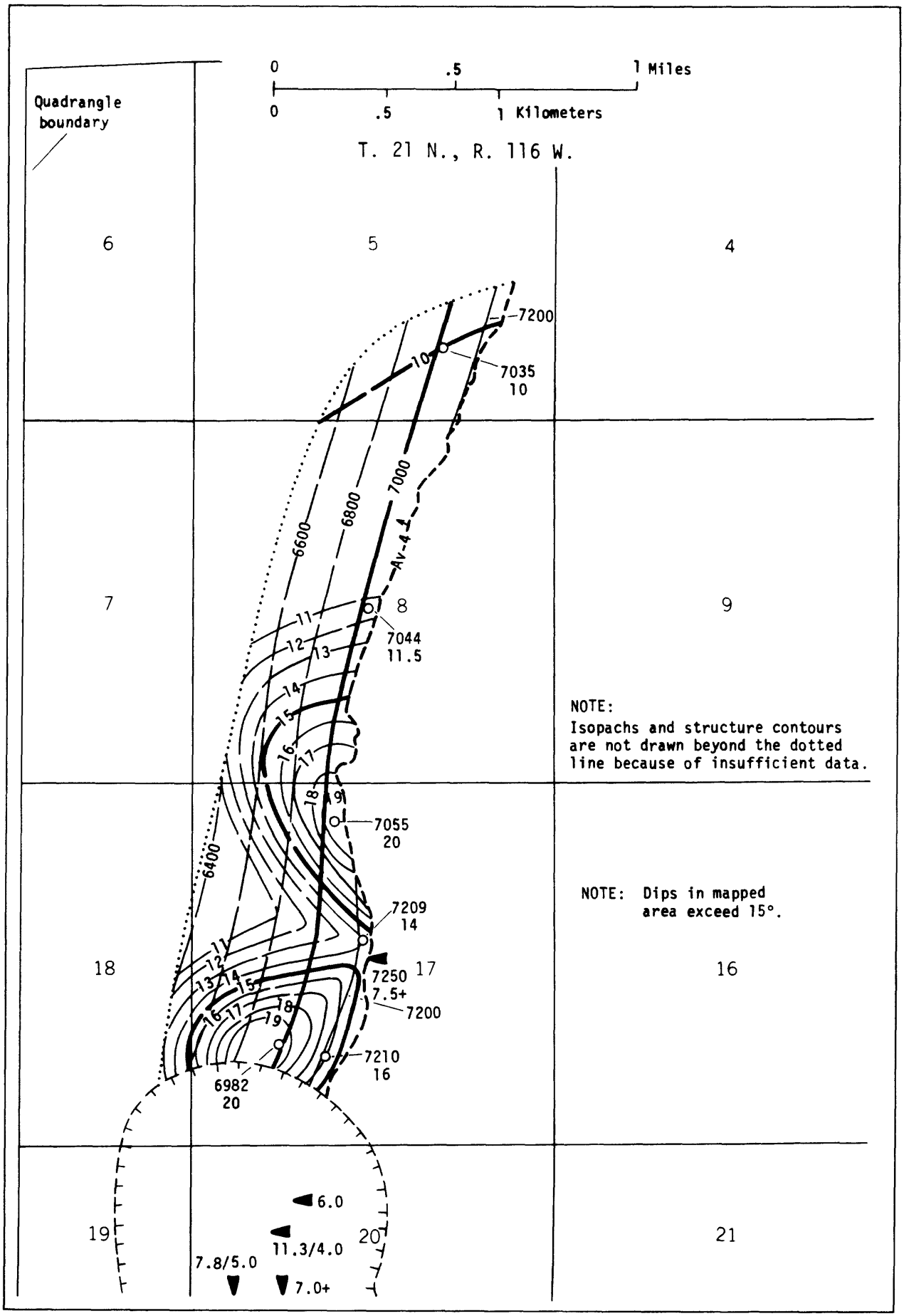


FIGURE 19. — Isopach and structure contour map of the Adaville No. 4 coal bed.

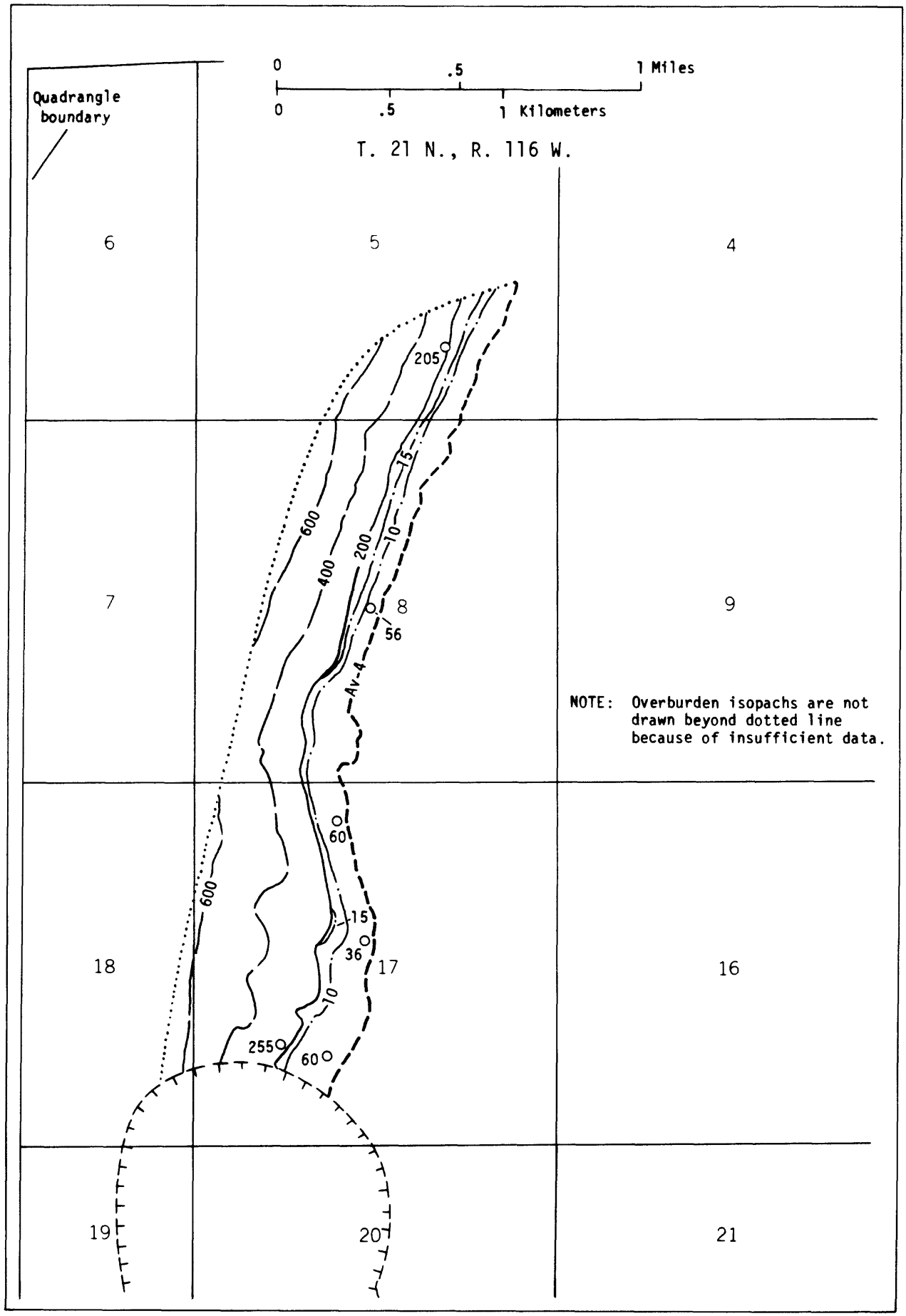


FIGURE 20. — Overburden isopach and mining ratio map of the Adaville No. 4 coal bed.

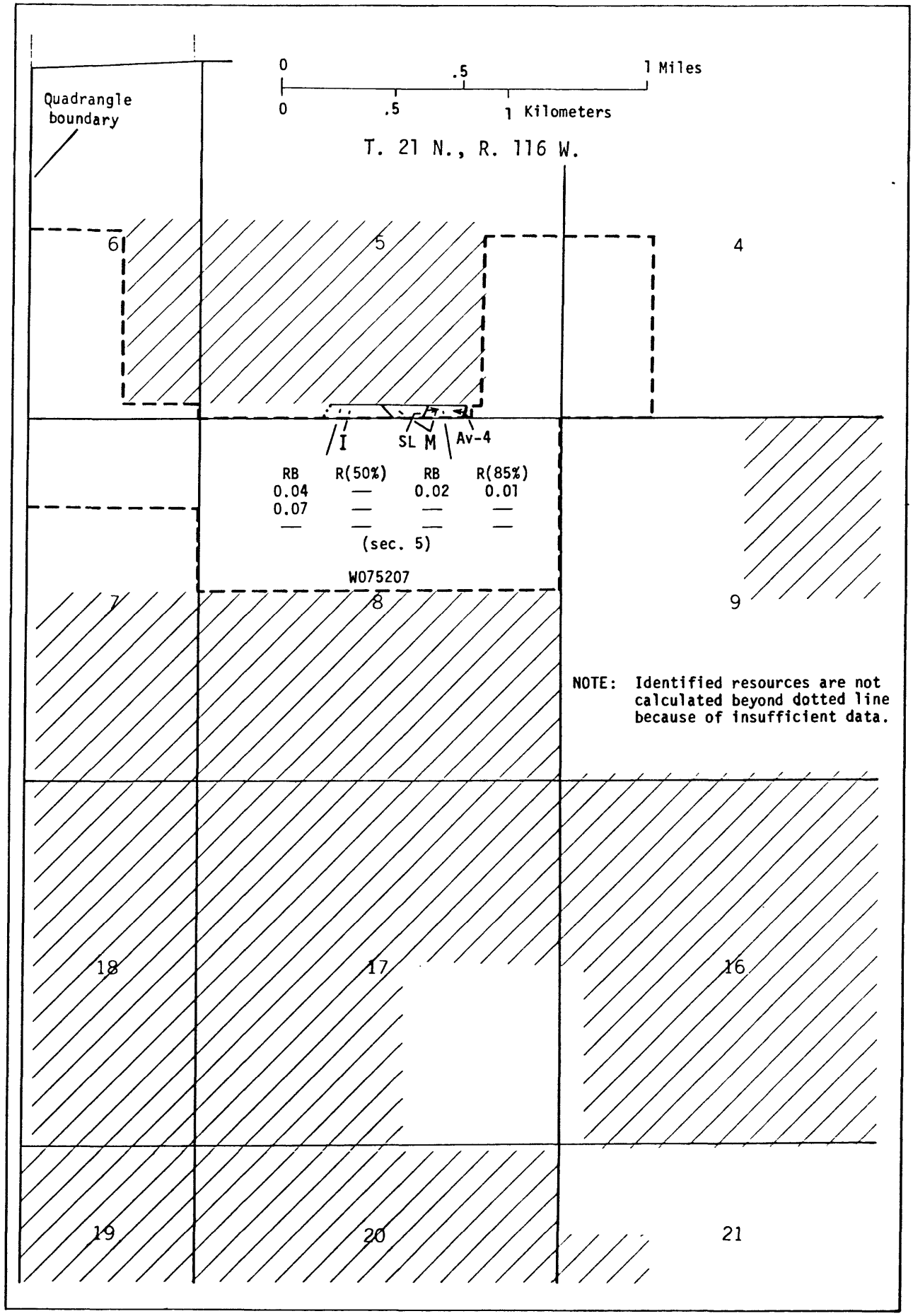


FIGURE 21. — Areal distribution and identified resources map of the Adaville No. 4 coal bed.

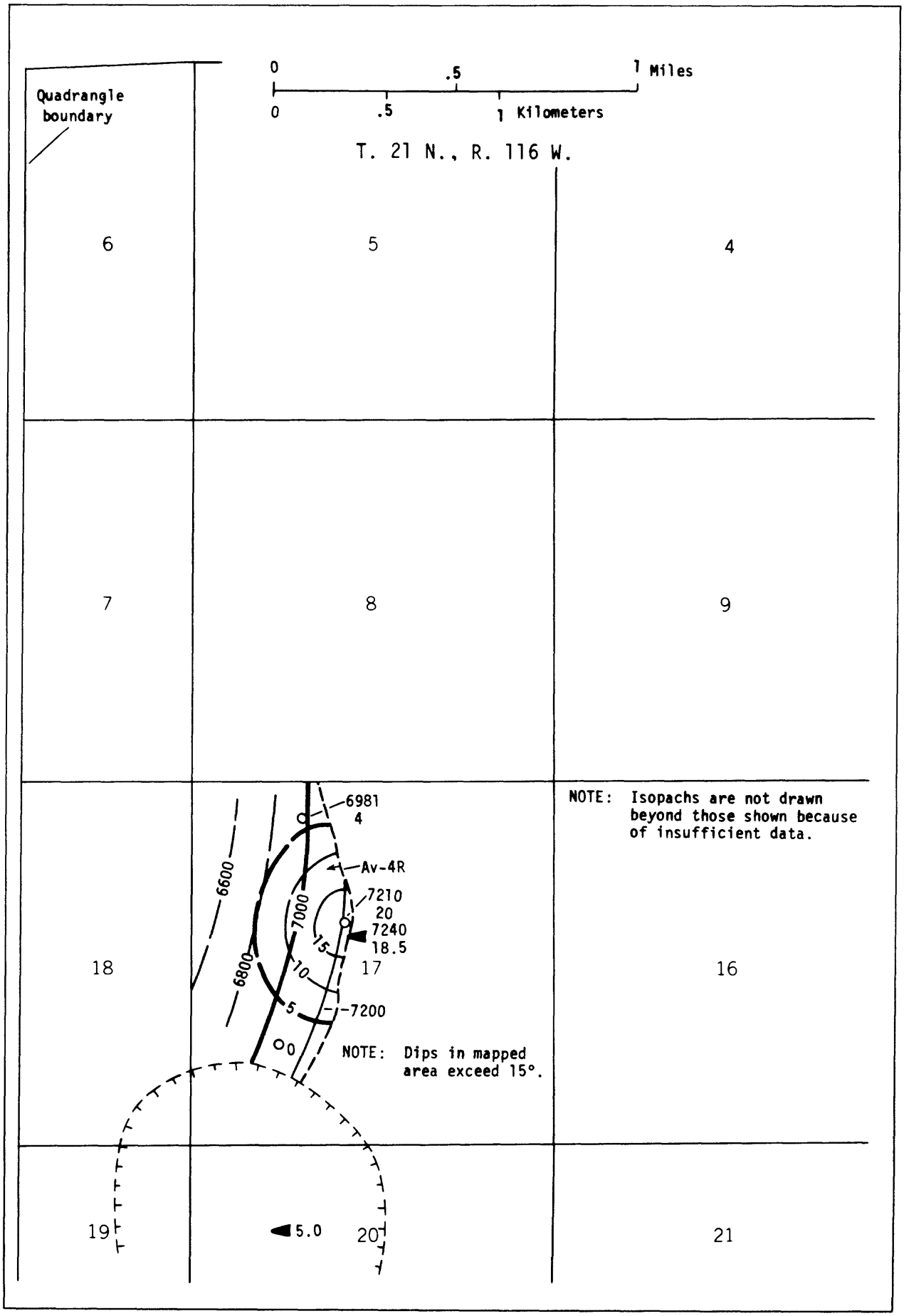


FIGURE 22. — Isopach and structure contour map of the Adaville No. 4 Rider coal bed.

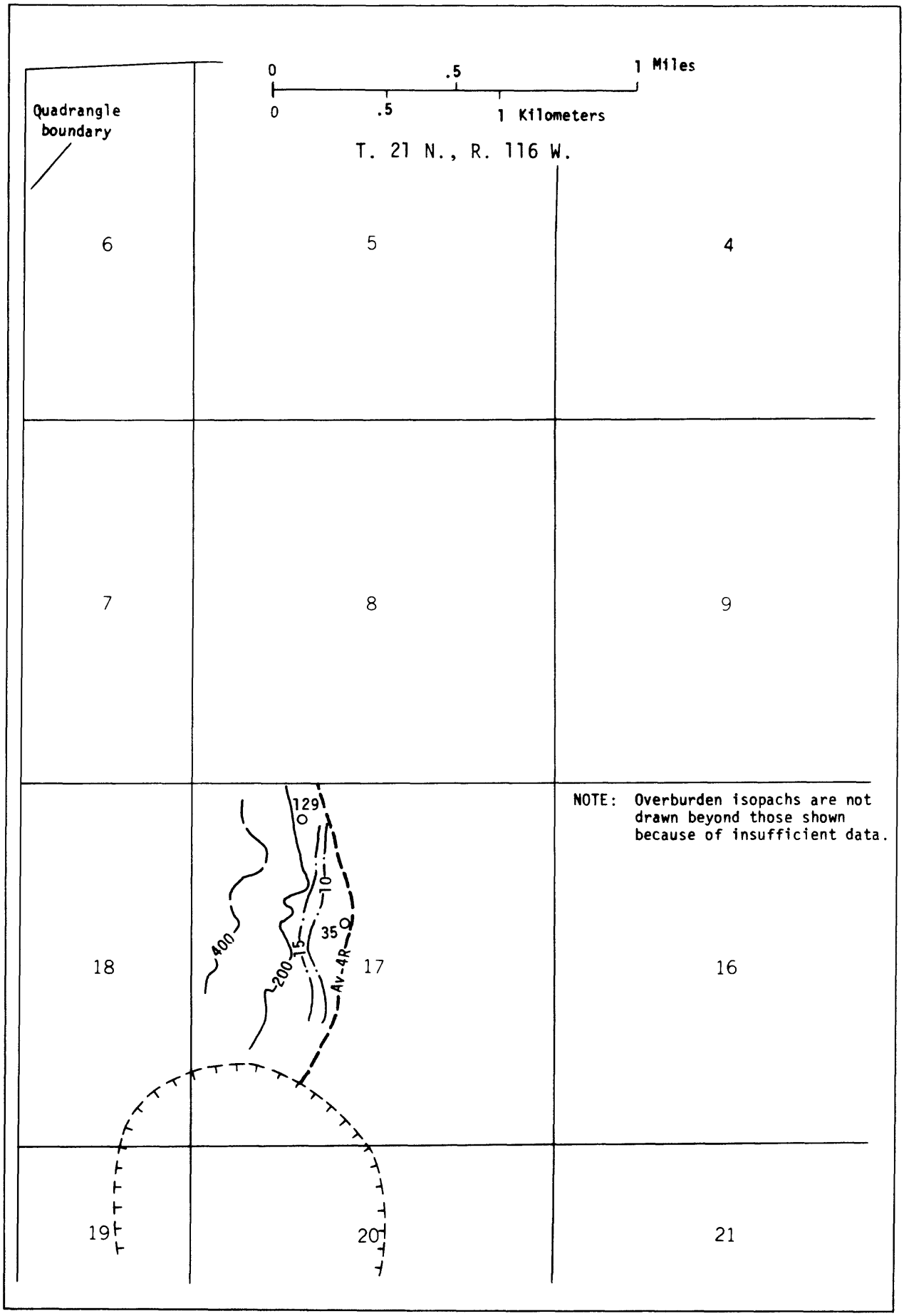


FIGURE 23. — Overburden isopach and mining ratio map of the Adaville No. 4 Rider coal bed.

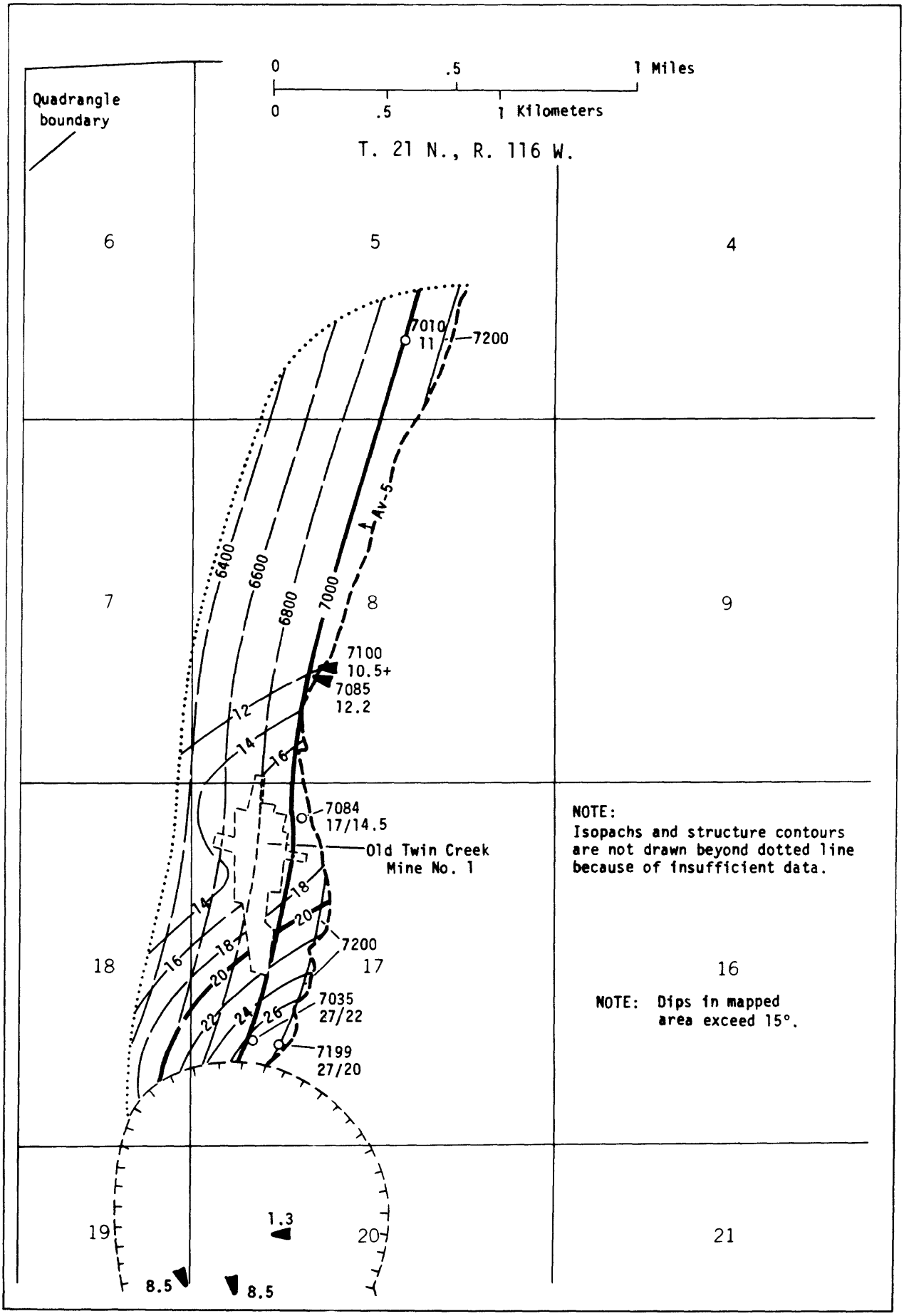


FIGURE 24. — Isopach and structure contour map of the Adaville No. 5 coal bed.

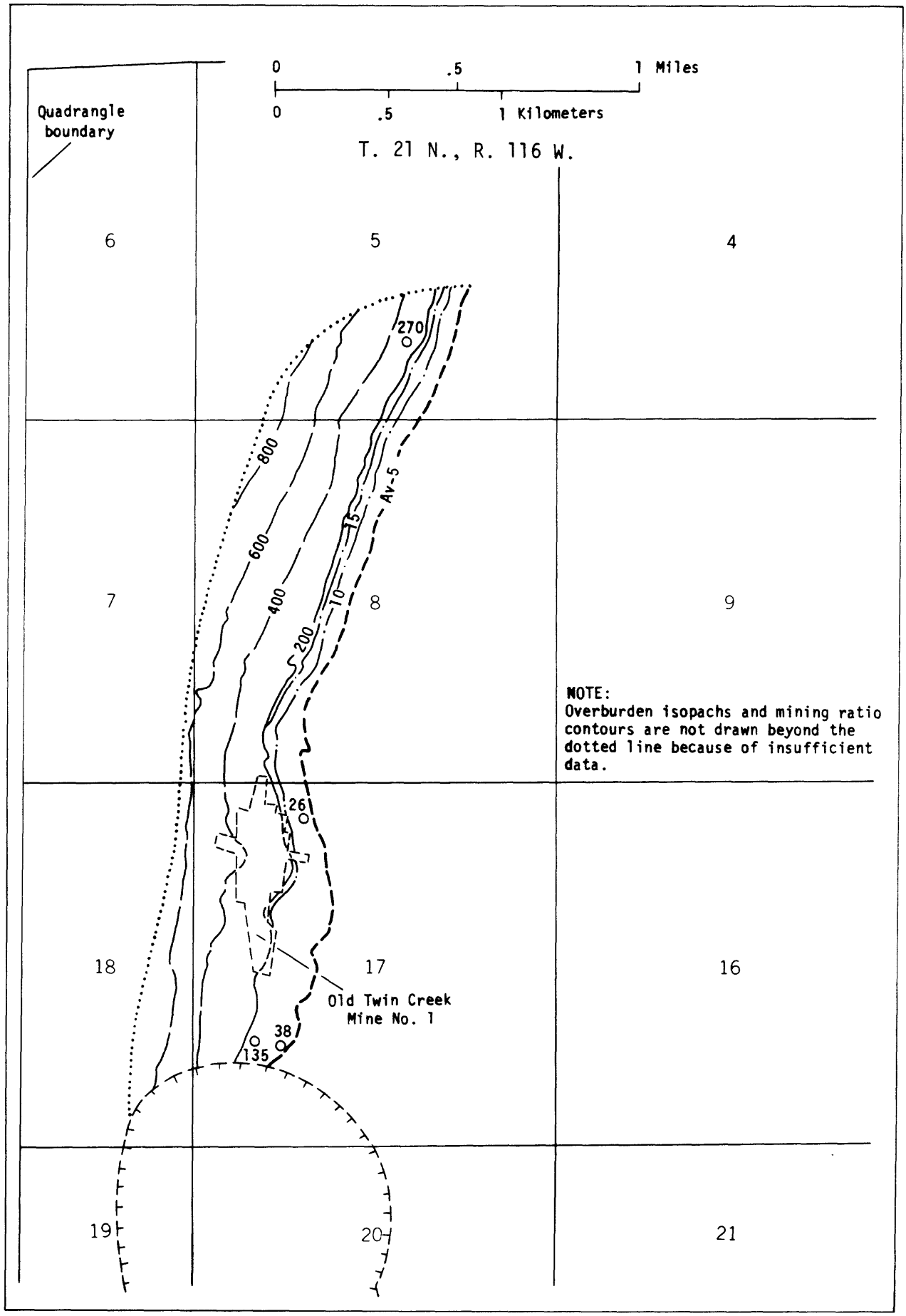


FIGURE 25. — Overburden isopach and mining ratio map of the Adaville No. 5 coal bed.

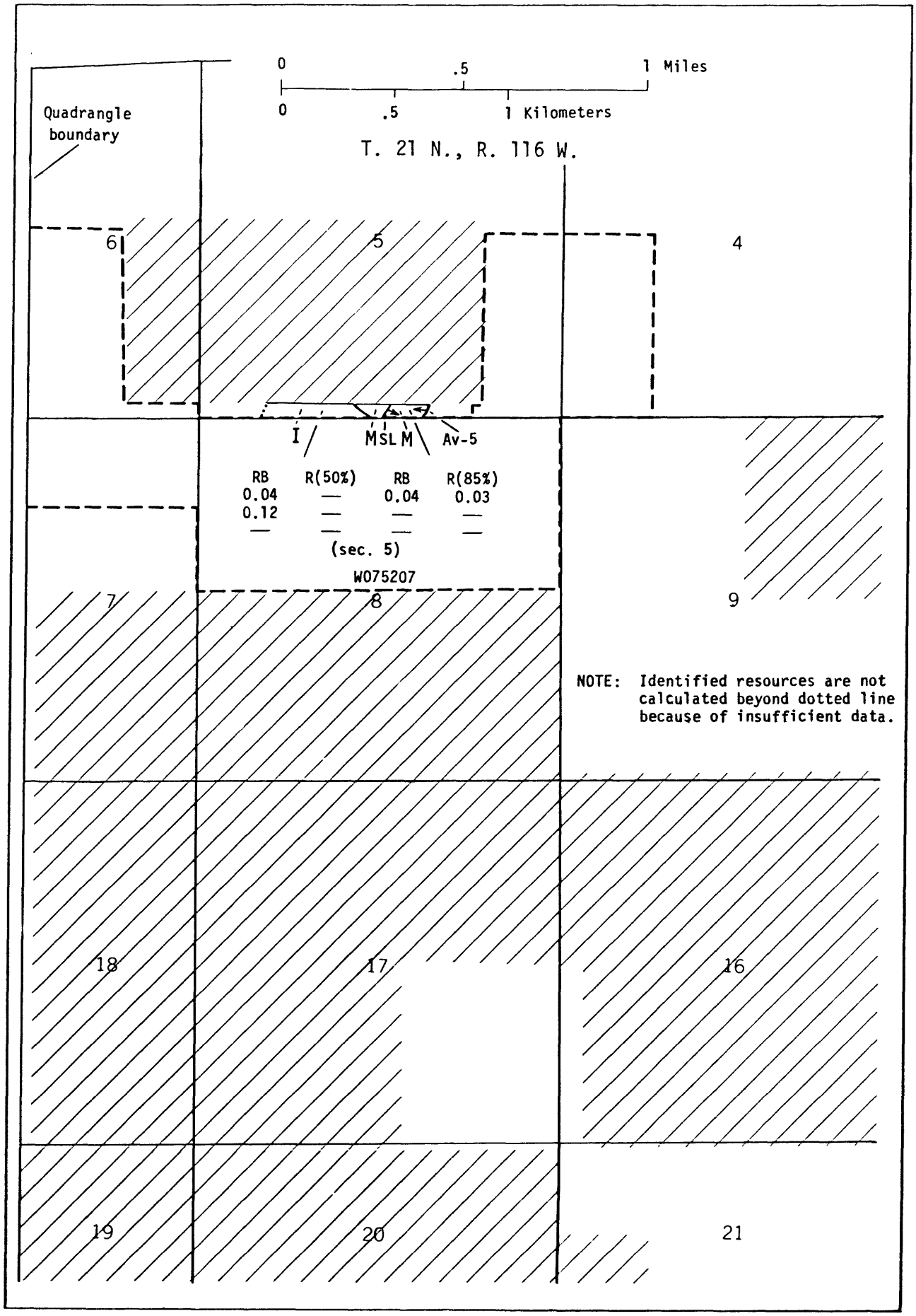


FIGURE 26. — Areal distribution and identified resources map of the Adaville No. 5 coal bed.

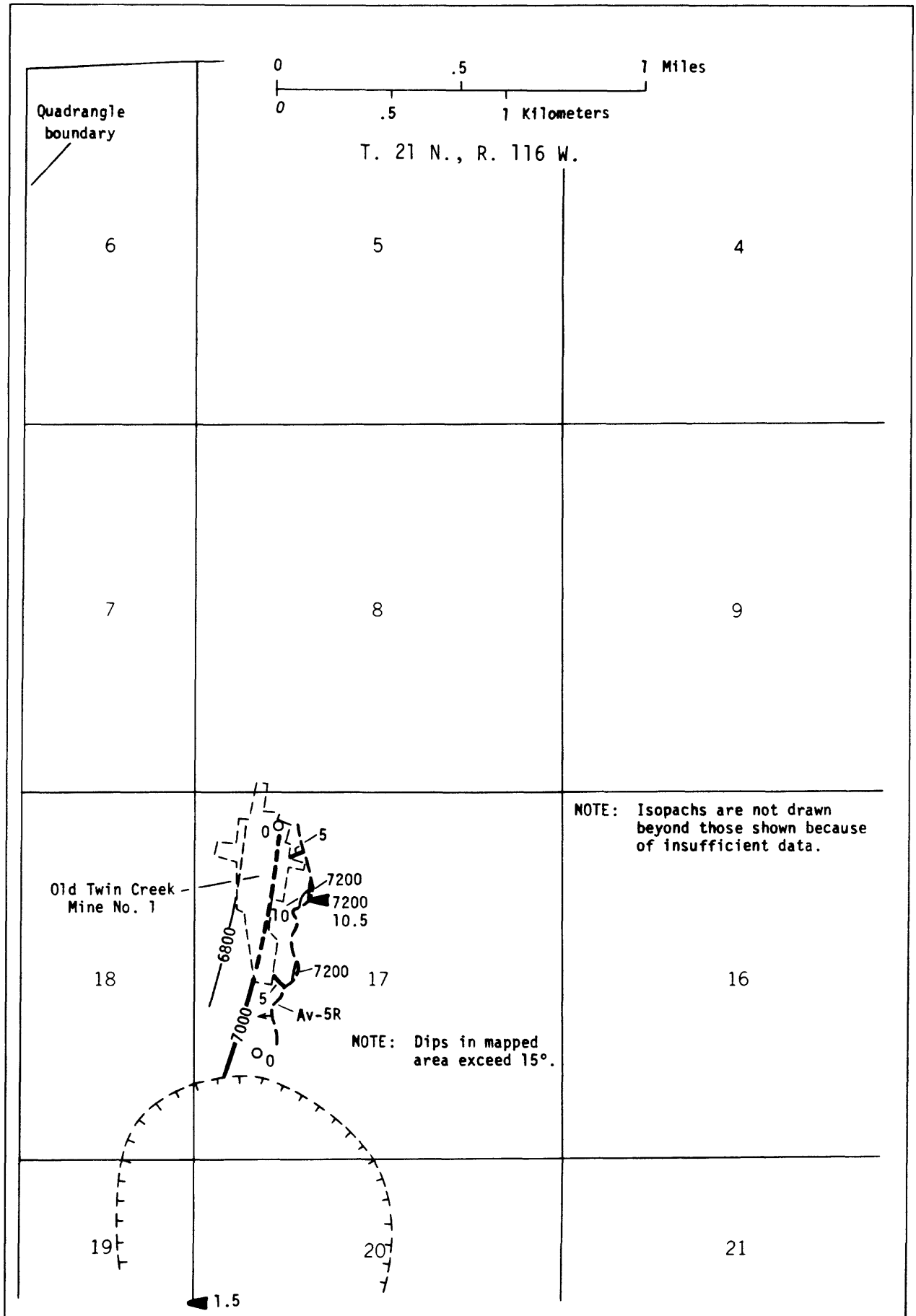


FIGURE 27. — Isopach and structure contour map of the Adaville No. 5 Rider coal bed.

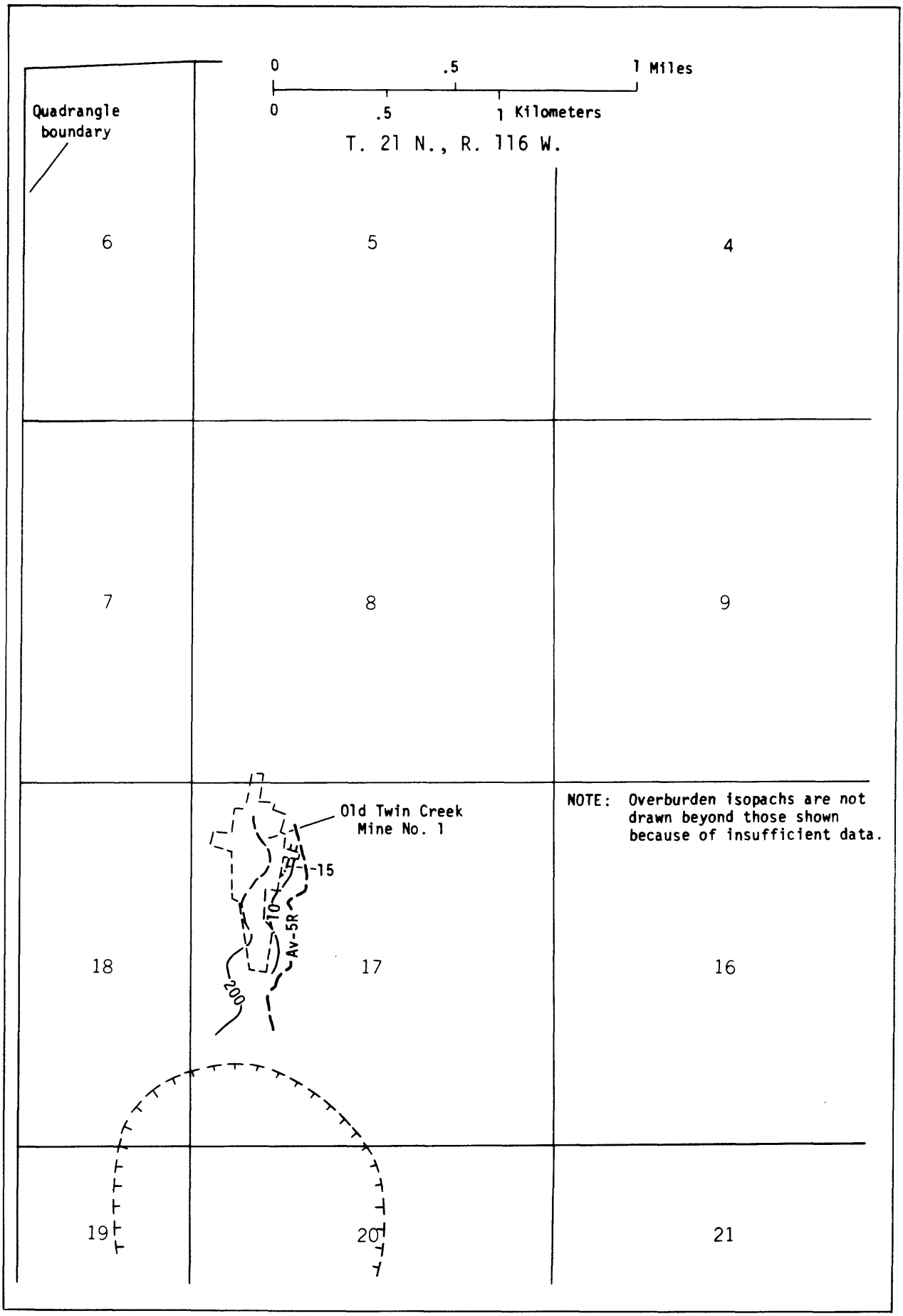


FIGURE 28. — Overburden isopach and mining ratio map of the Adaville No. 5 Rider coal bed.

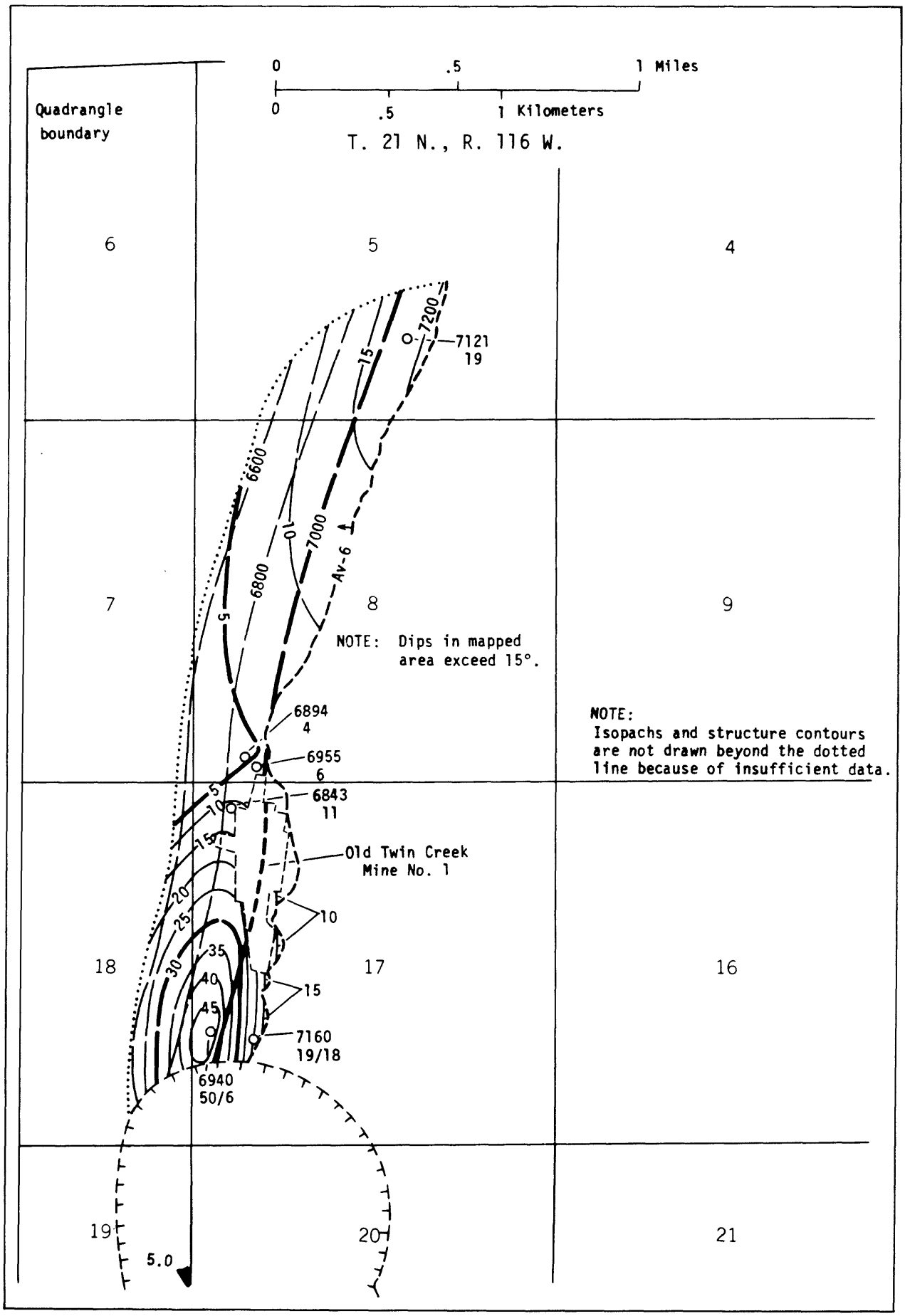


FIGURE 29. — Isopach and structure contour map of the Adaville No. 6 coal bed.

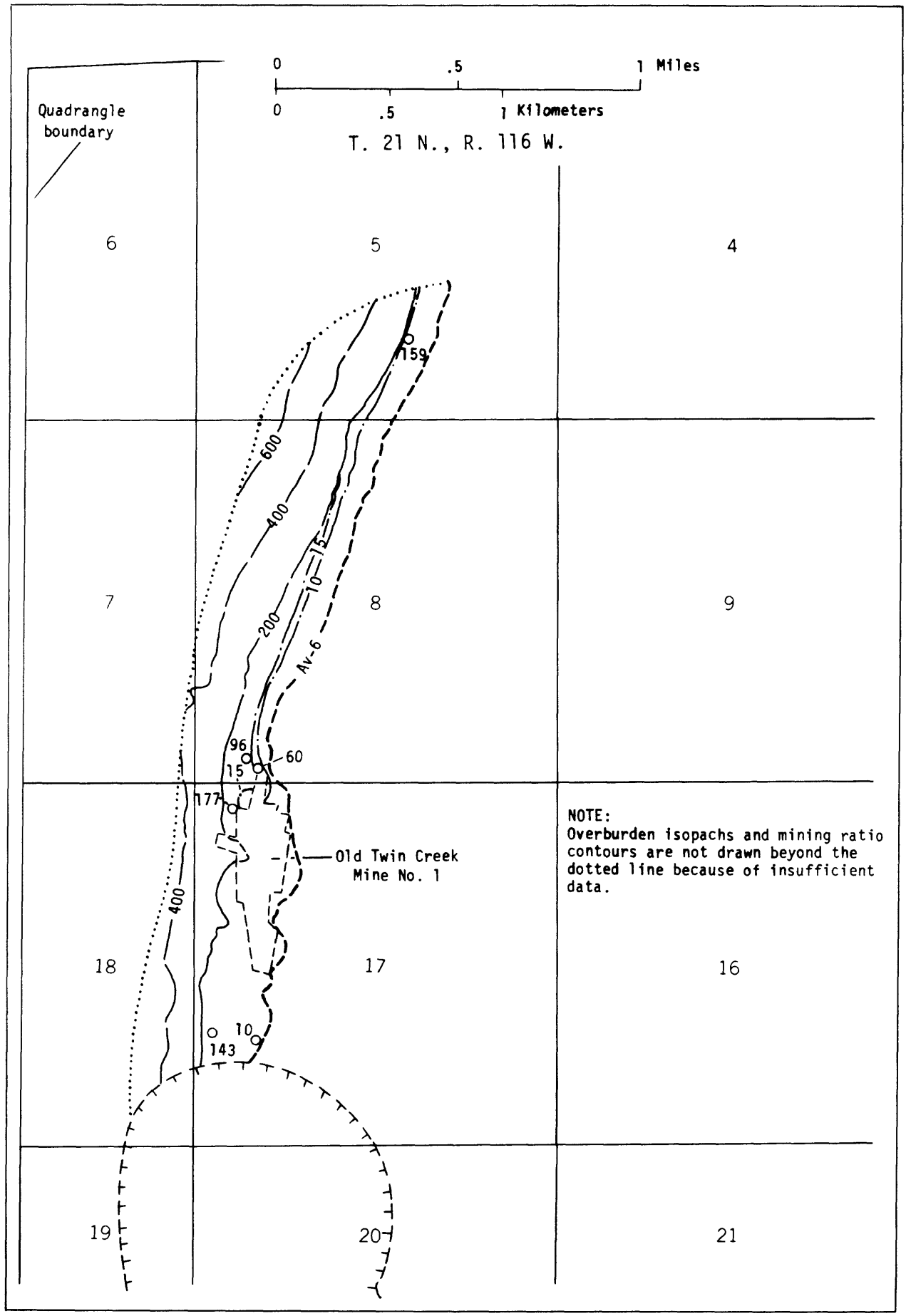


FIGURE 30. — Overburden isopach and mining ratio map of the Adaville No. 6 coal bed.

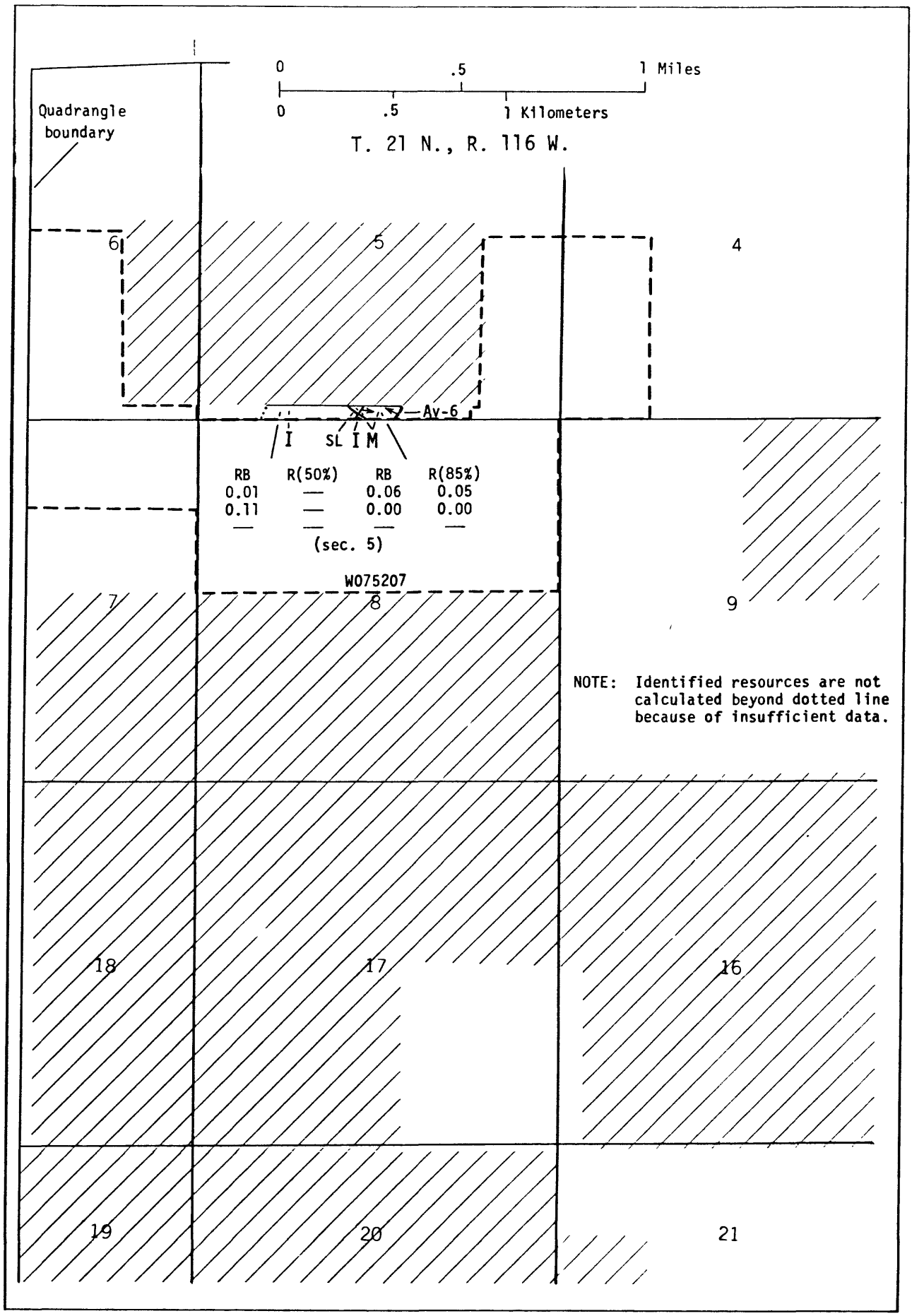


FIGURE 31. — Areal distribution and identified resources map of the Adaville No. 6 coal bed.

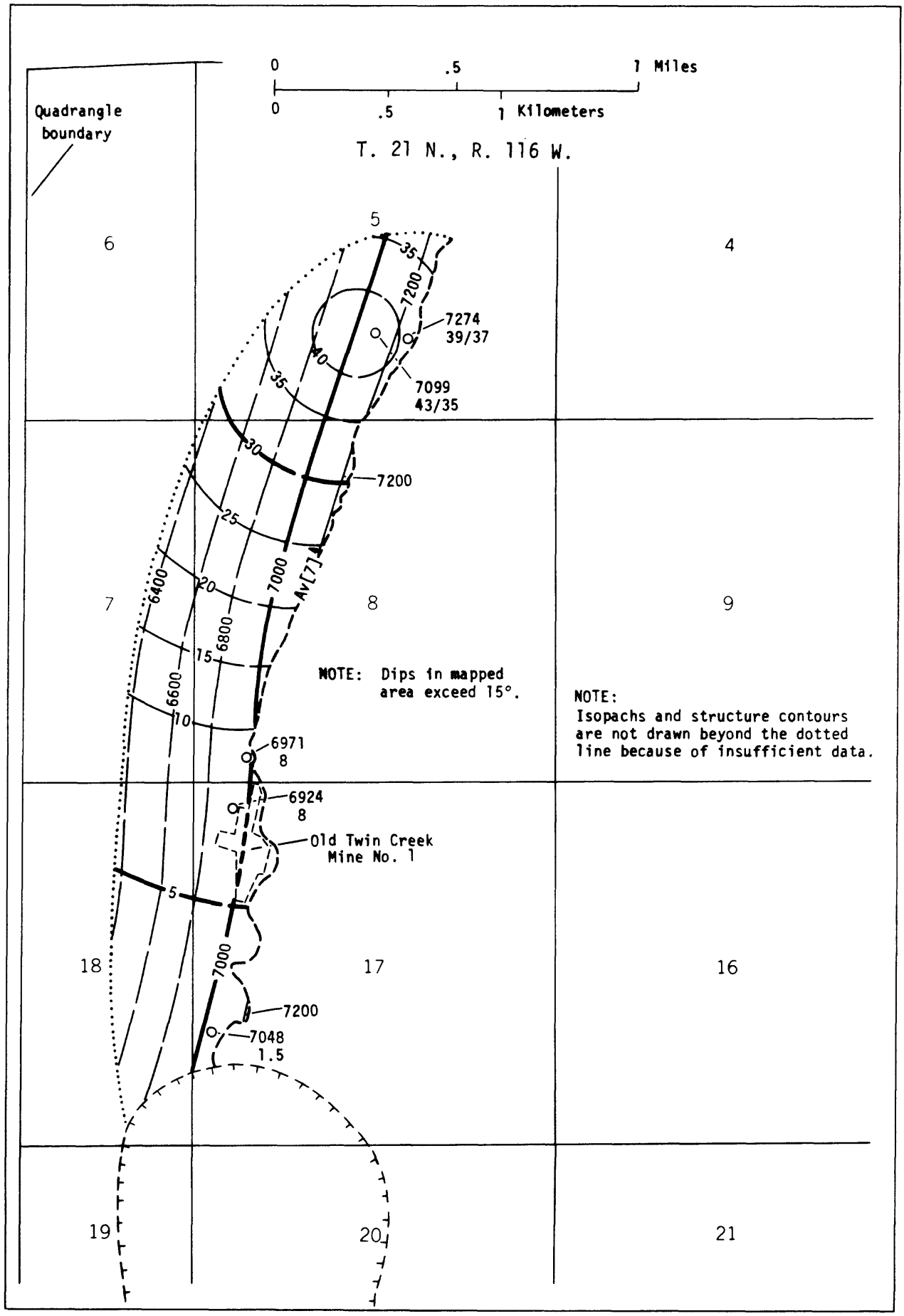


FIGURE 32. — Isopach and structure contour map of the Adaville [7] coal bed.

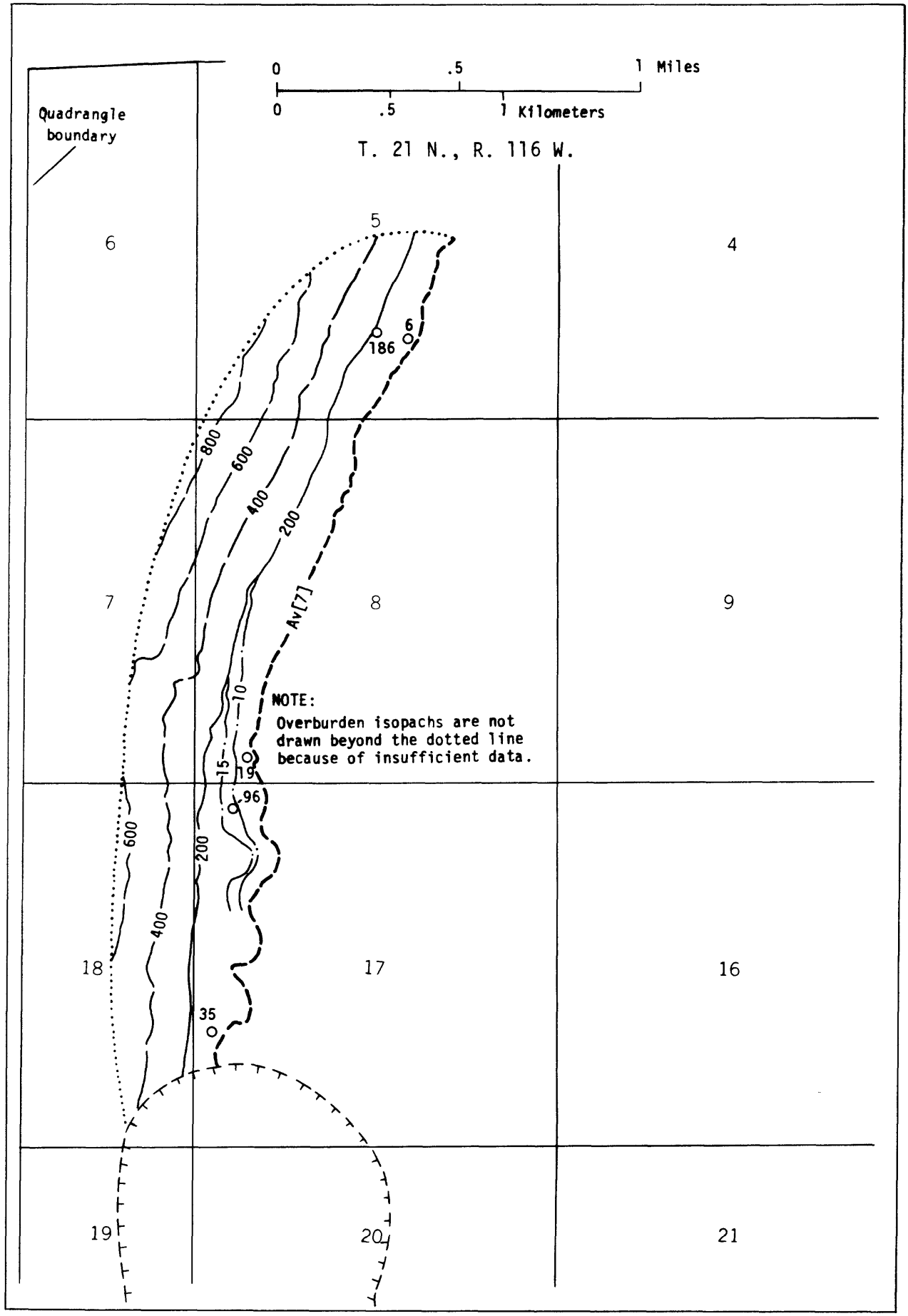


FIGURE 33. — Overburden isopach and mining ratio map of the Adaville [7] coal bed.

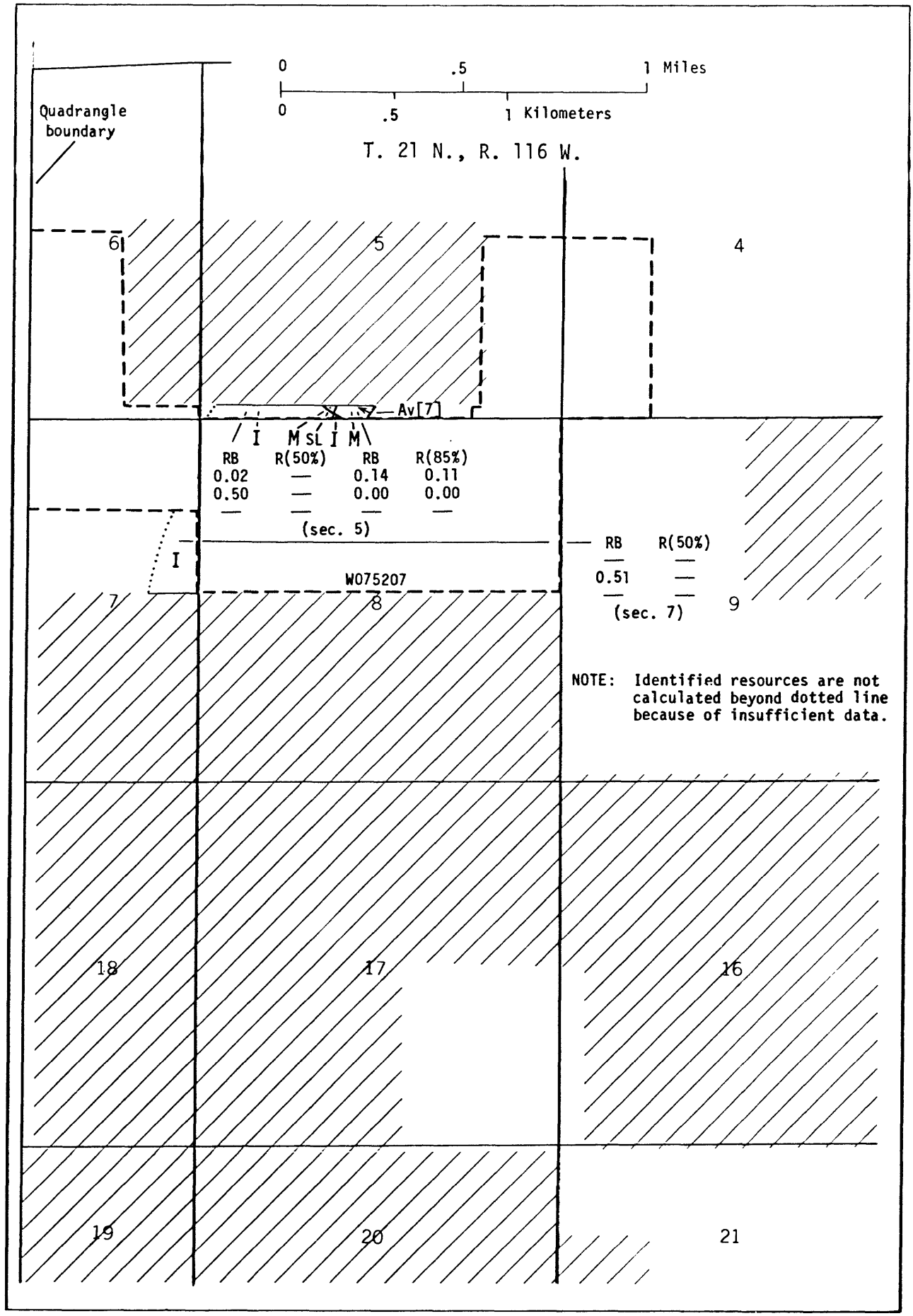


FIGURE 34. — Areal distribution and identified resources map of the Adaville [7] coal bed.

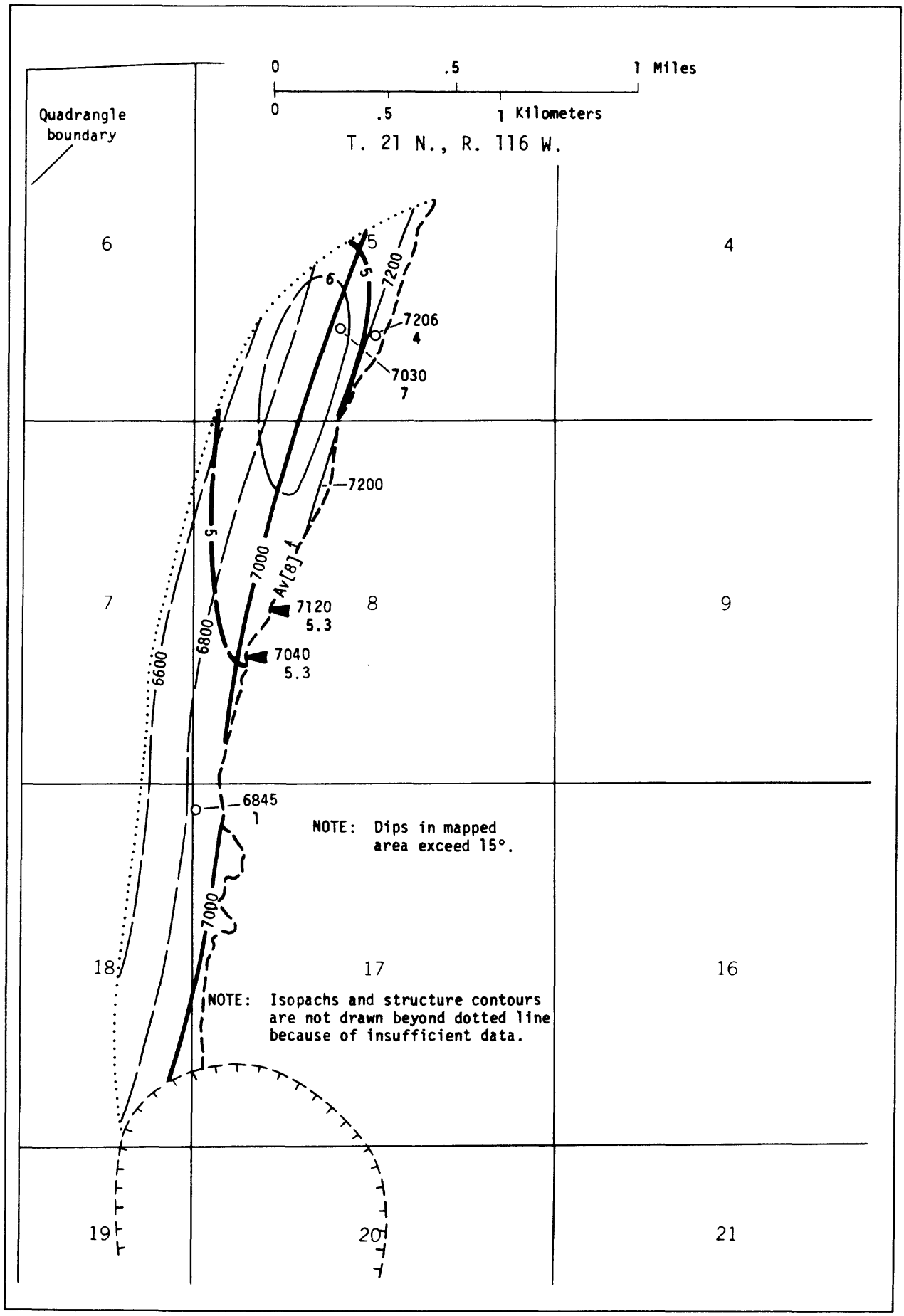


FIGURE 35. — Isopach and structure contour map of the Adaville [8] coal bed.

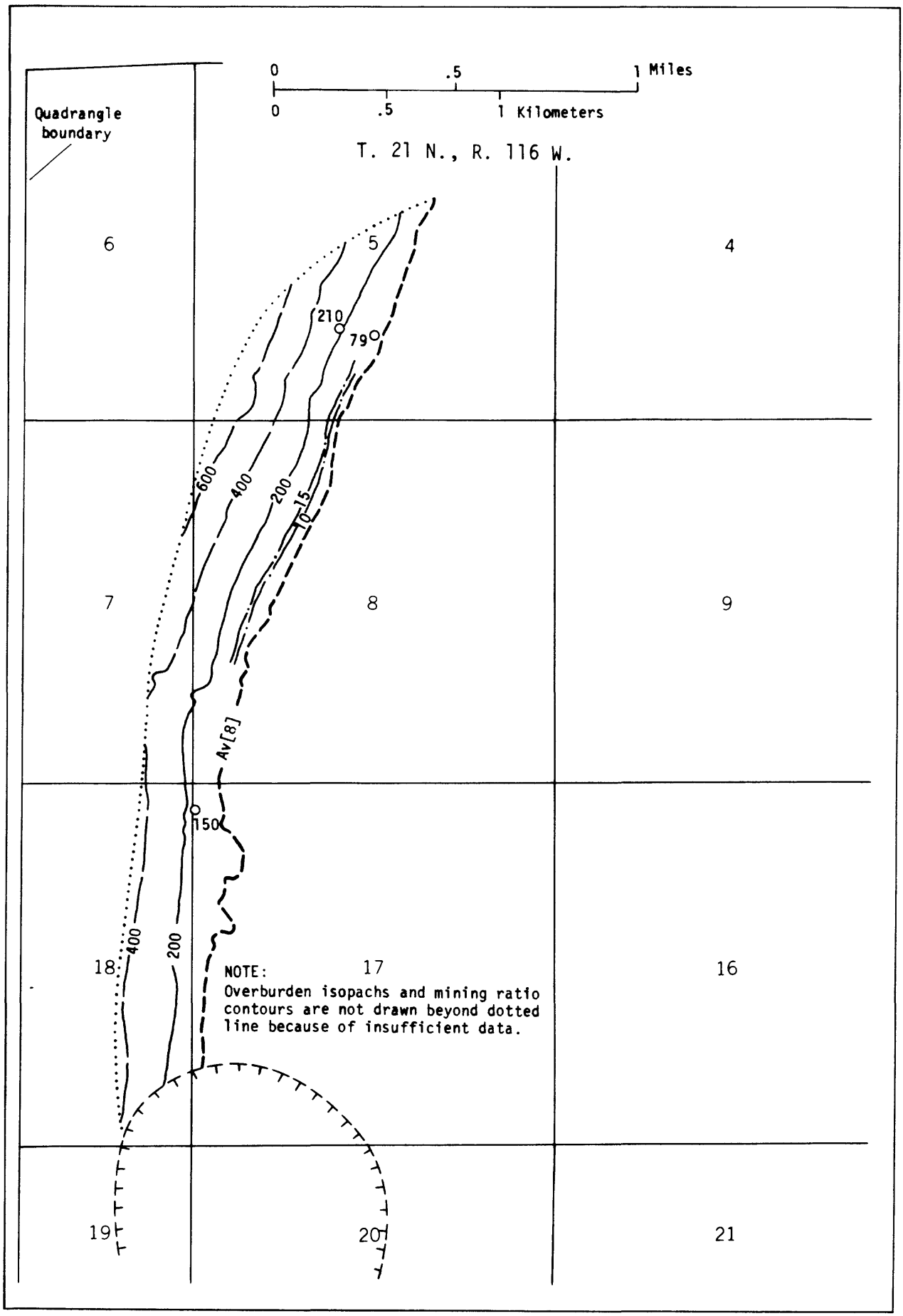


FIGURE 36. — Overburden isopach and mining ratio map of the Adaville [8] coal bed.

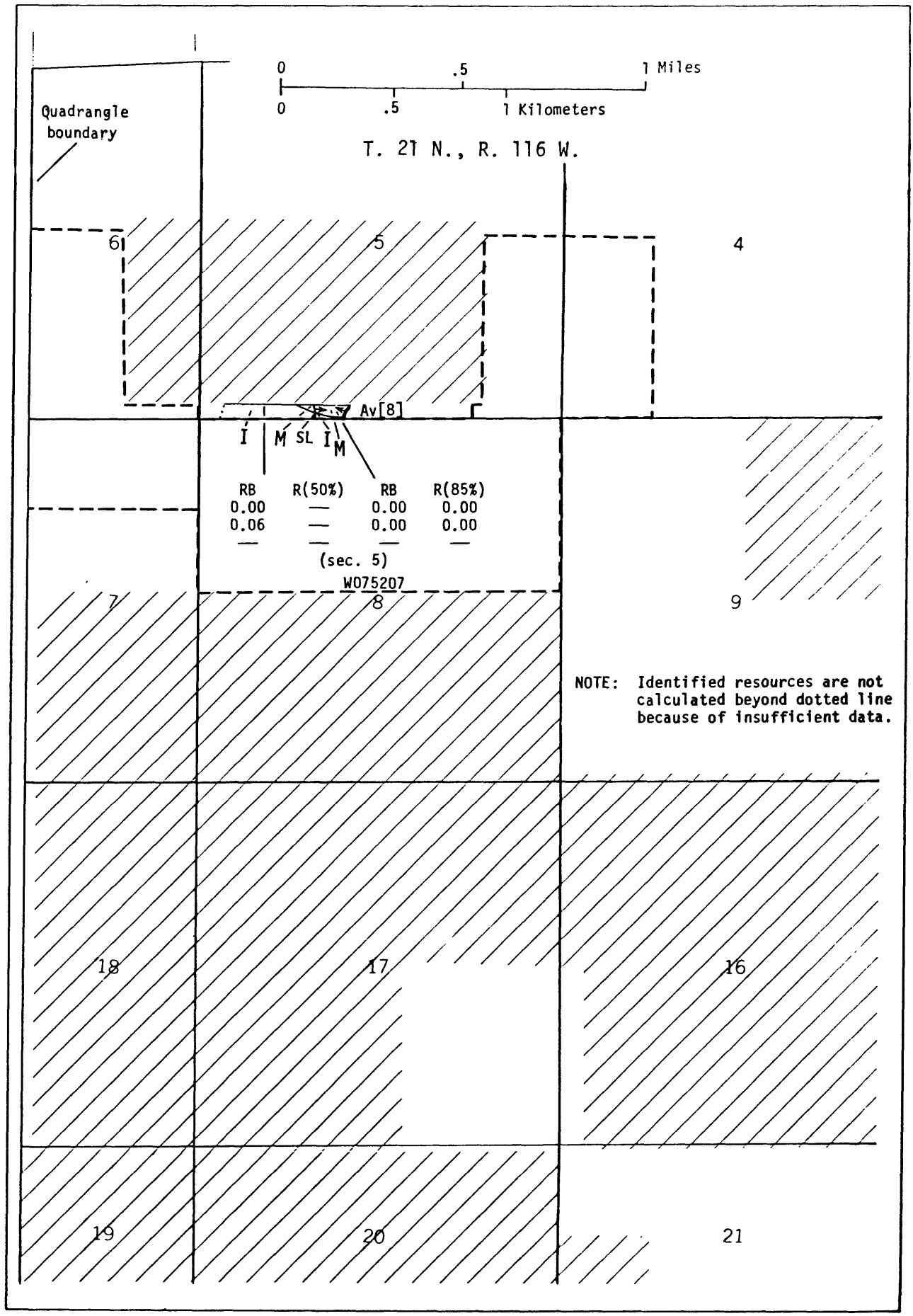


FIGURE 37. — Areal distribution and identified resources map of the Adaville [8] coal bed.

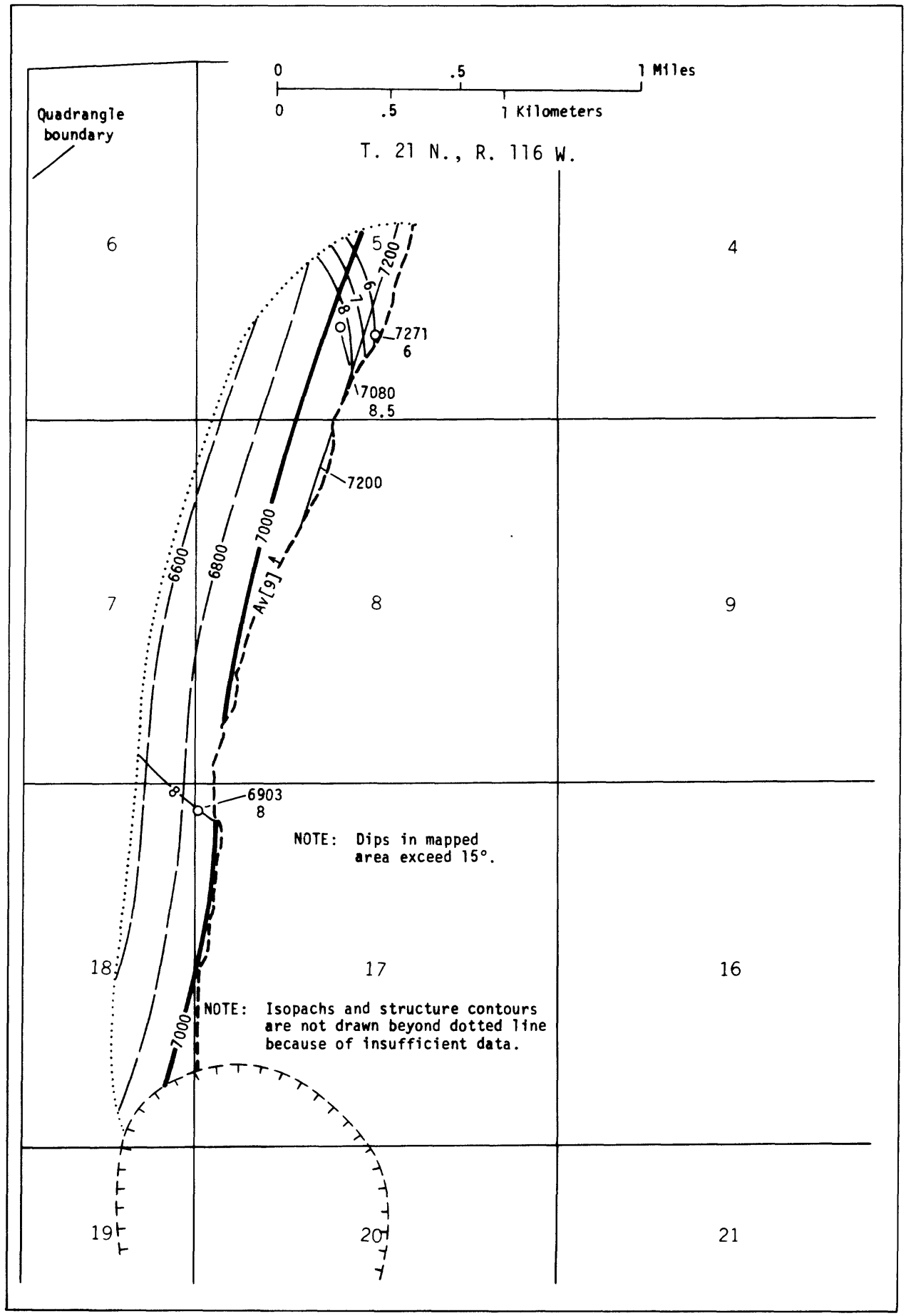


FIGURE 38. — Isopach and structure contour map of the Adaville [9] coal bed.

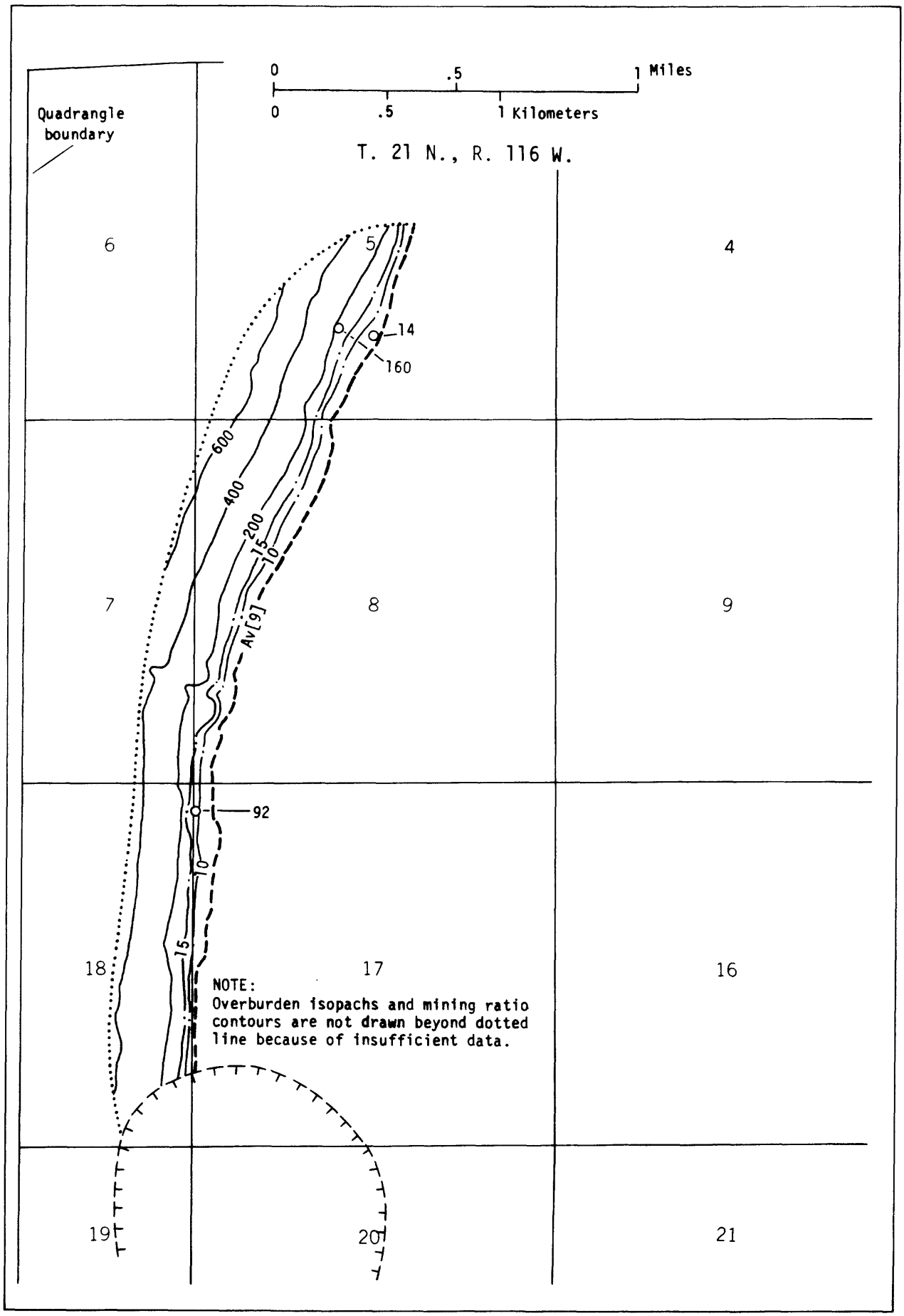


FIGURE 39. — Overburden isopach and mining ratio map of the Adaville [9] coal bed.

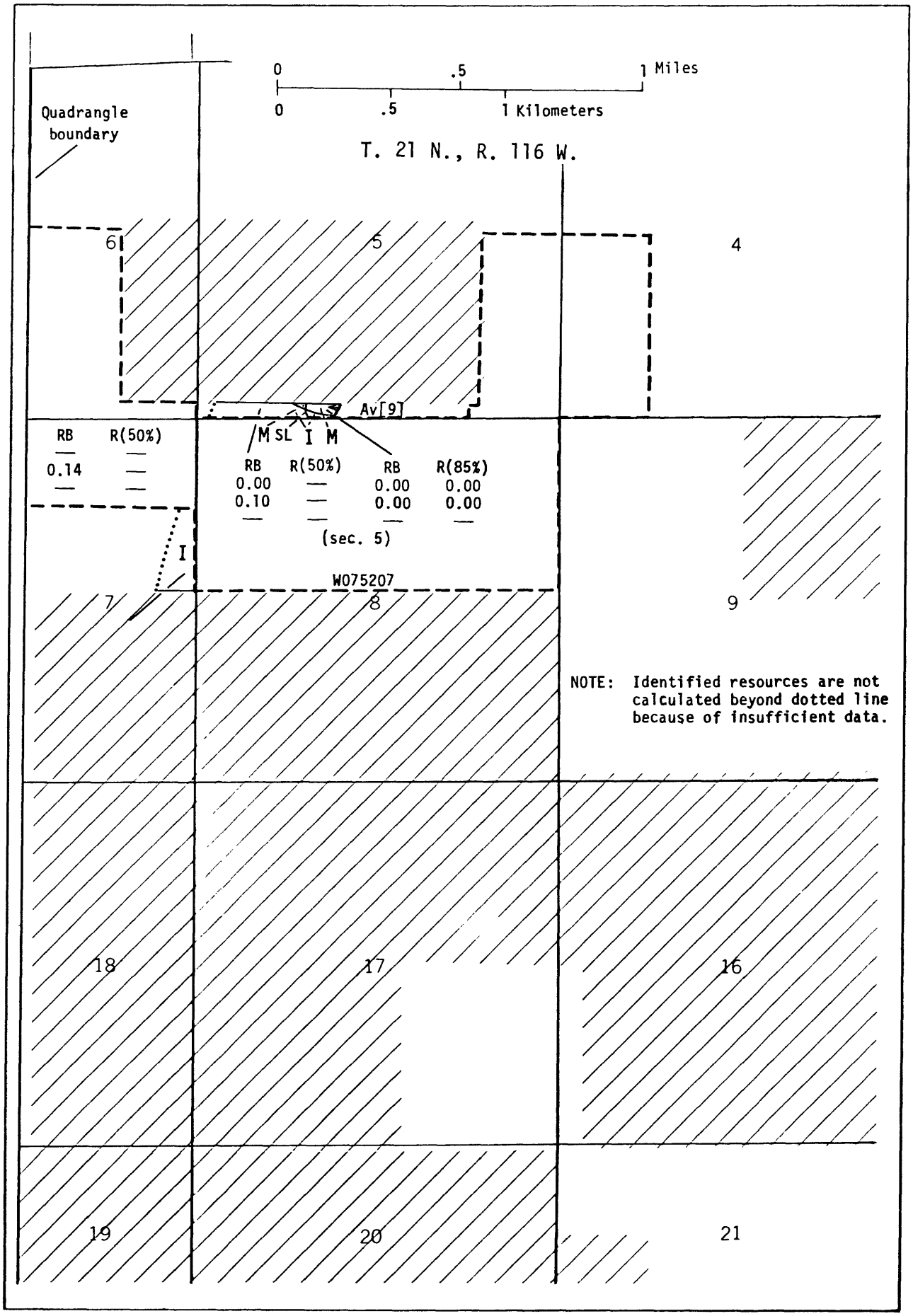


FIGURE 40. — Areal distribution and identified resources map of the Adaville [9] coal bed.

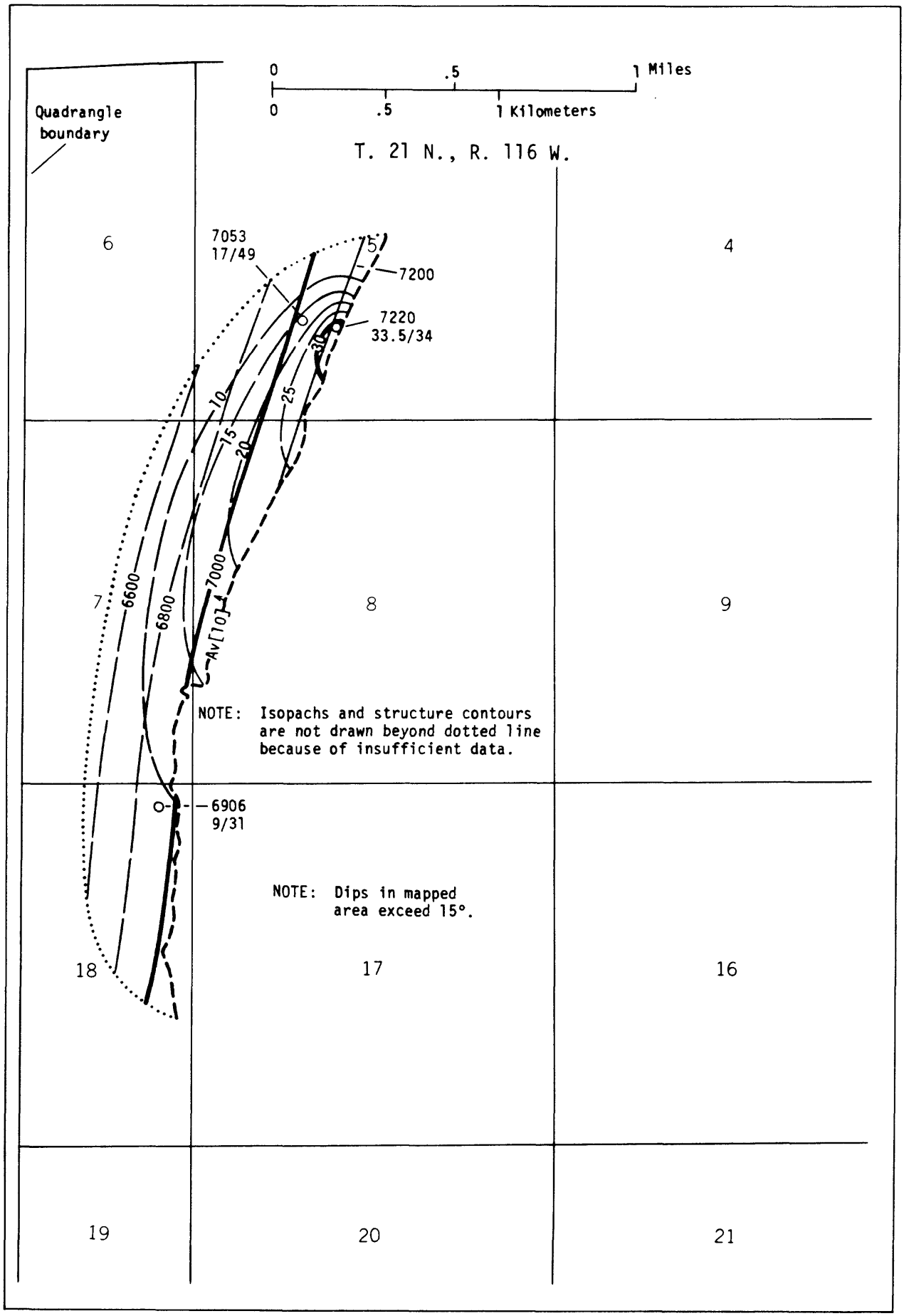


FIGURE 41. — Isopach and structure contour map of the Adaville [10] coal bed.

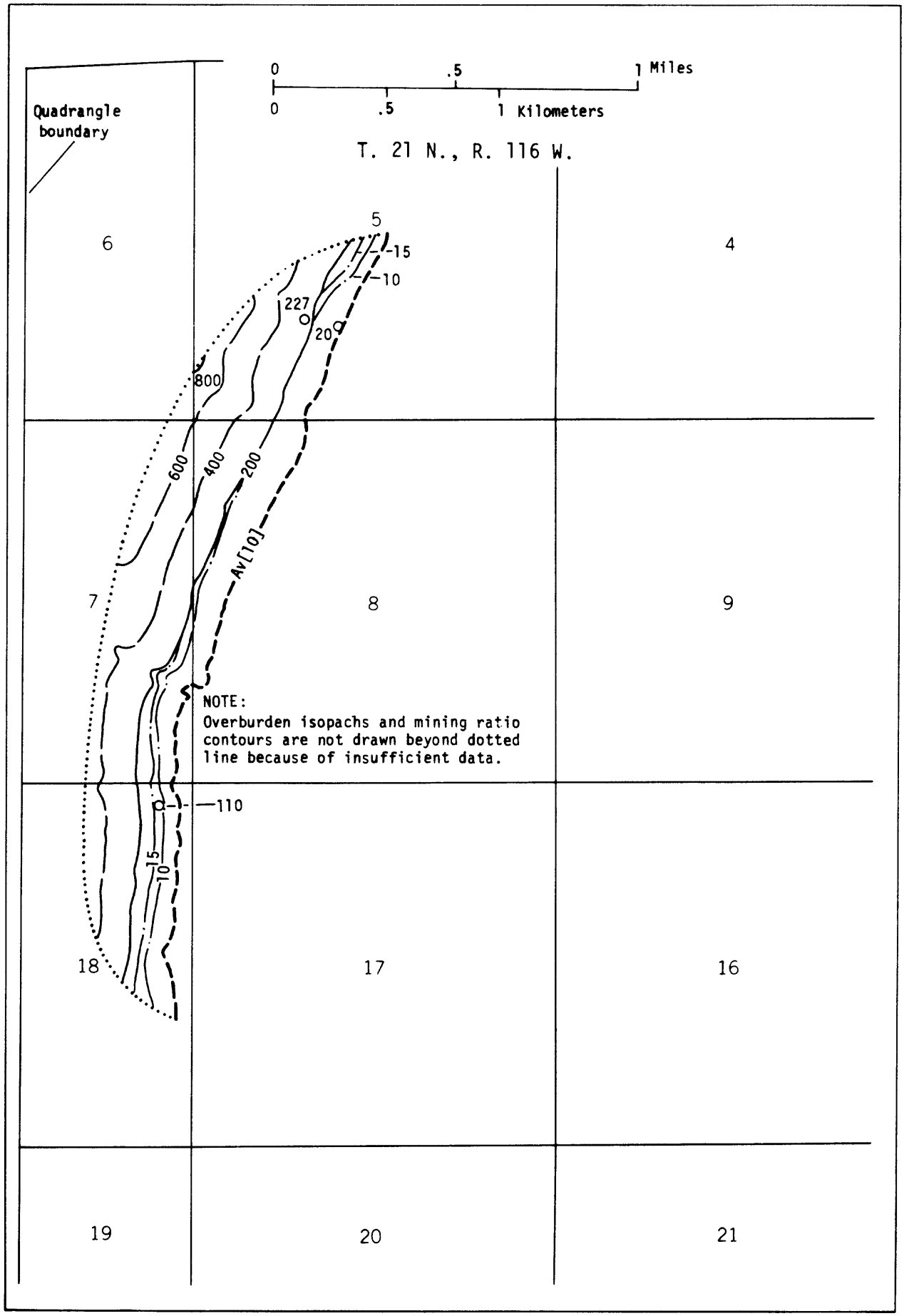


FIGURE 42. — Overburden isopach and mining ratio map of the Adaville [10] coal bed.

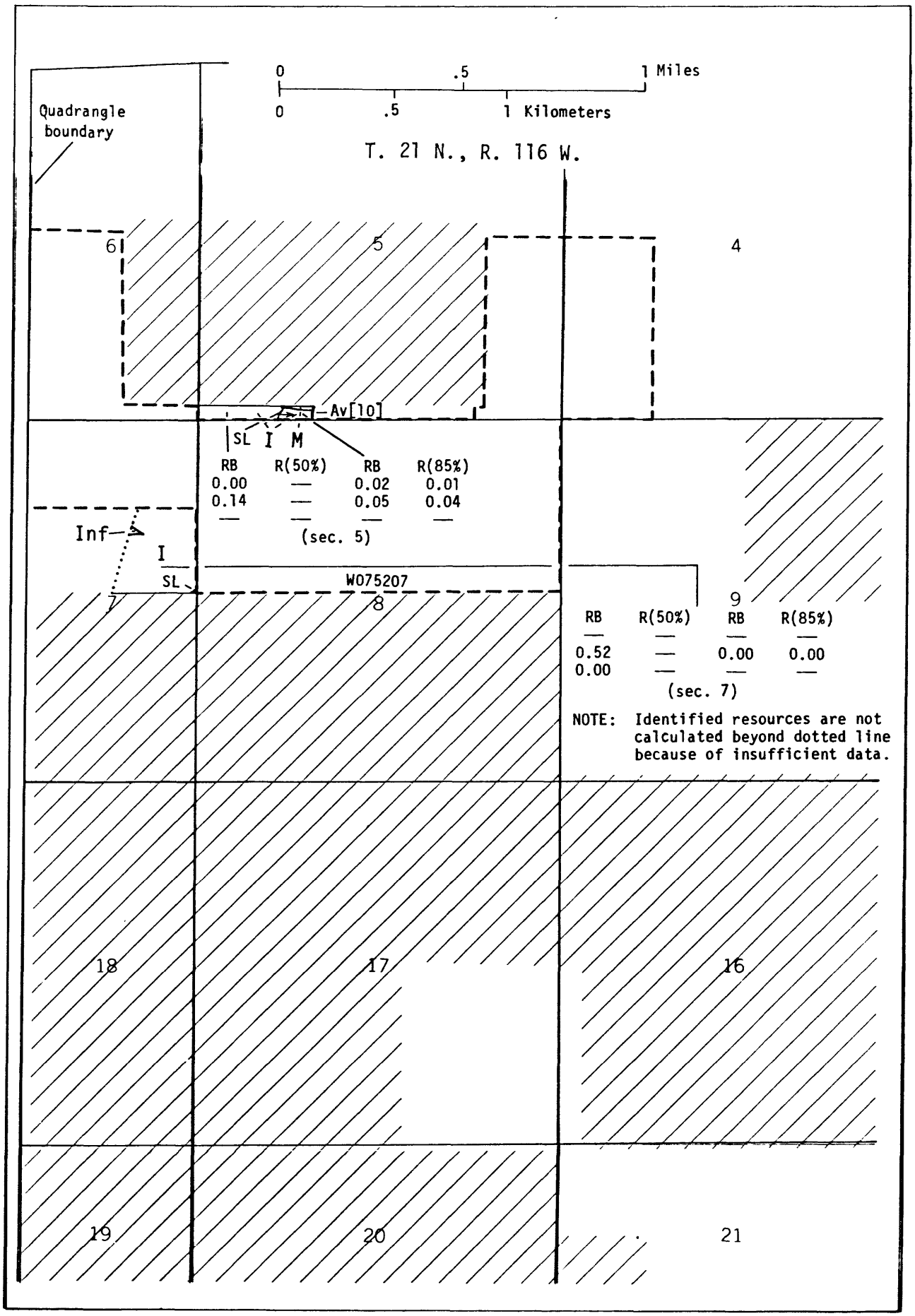


FIGURE 43. — Areal distribution and identified resources map of the Adaville [10] coal bed.

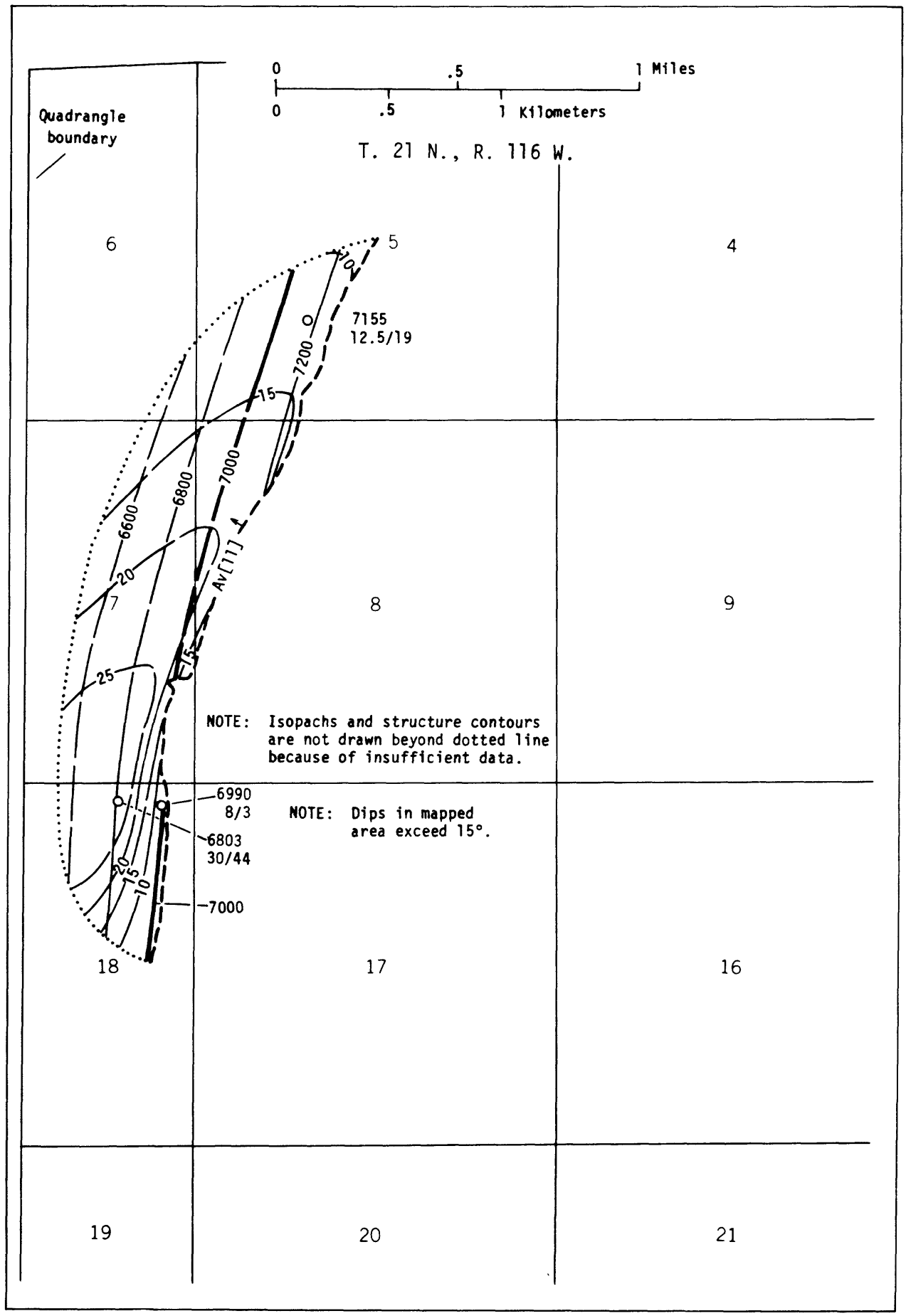


FIGURE 44. — Isopach and structure contour map of the Adaville [11] coal bed.

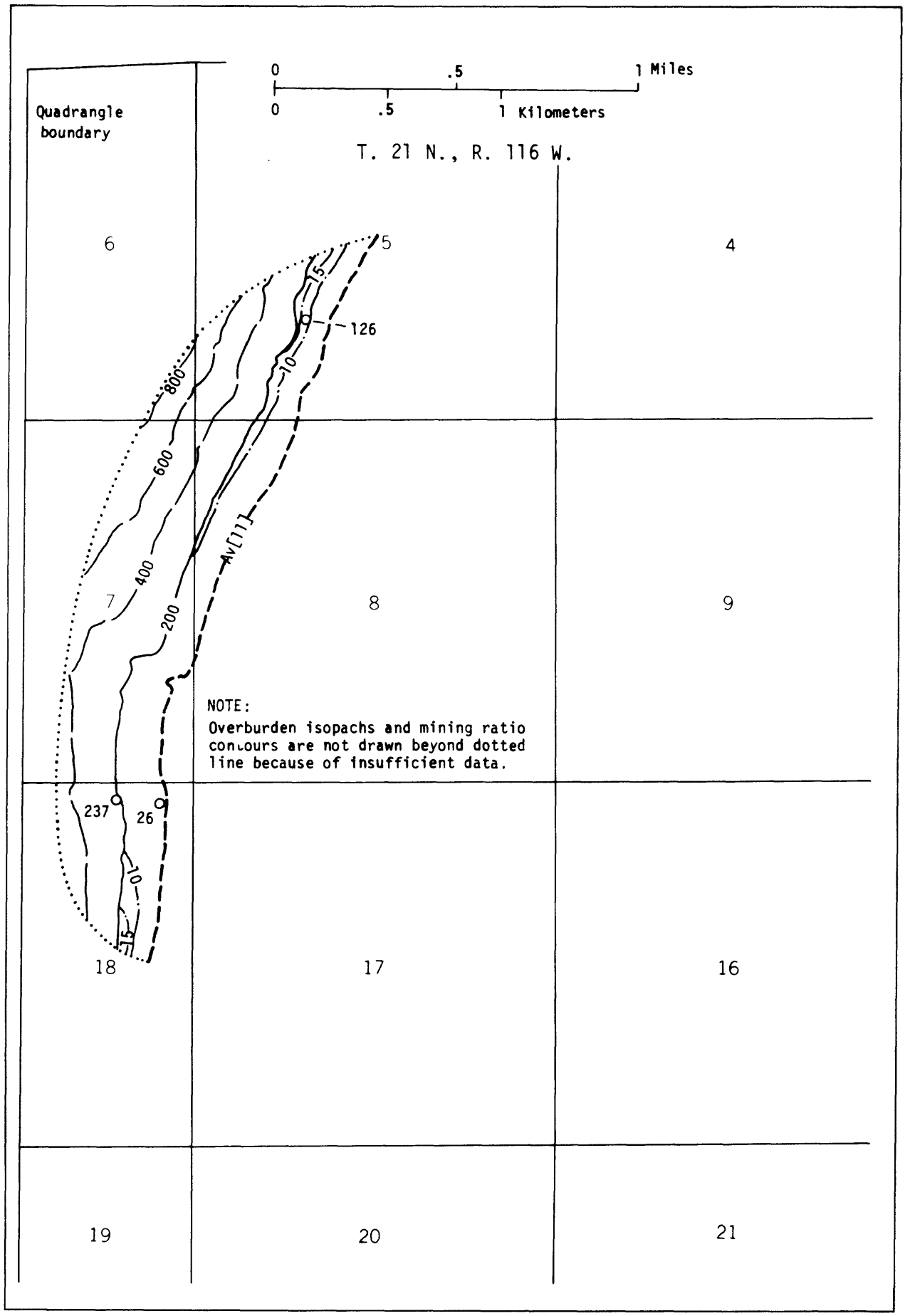


FIGURE 45. — Overburden isopach and mining ratio map of the Adaville [11] coal bed.

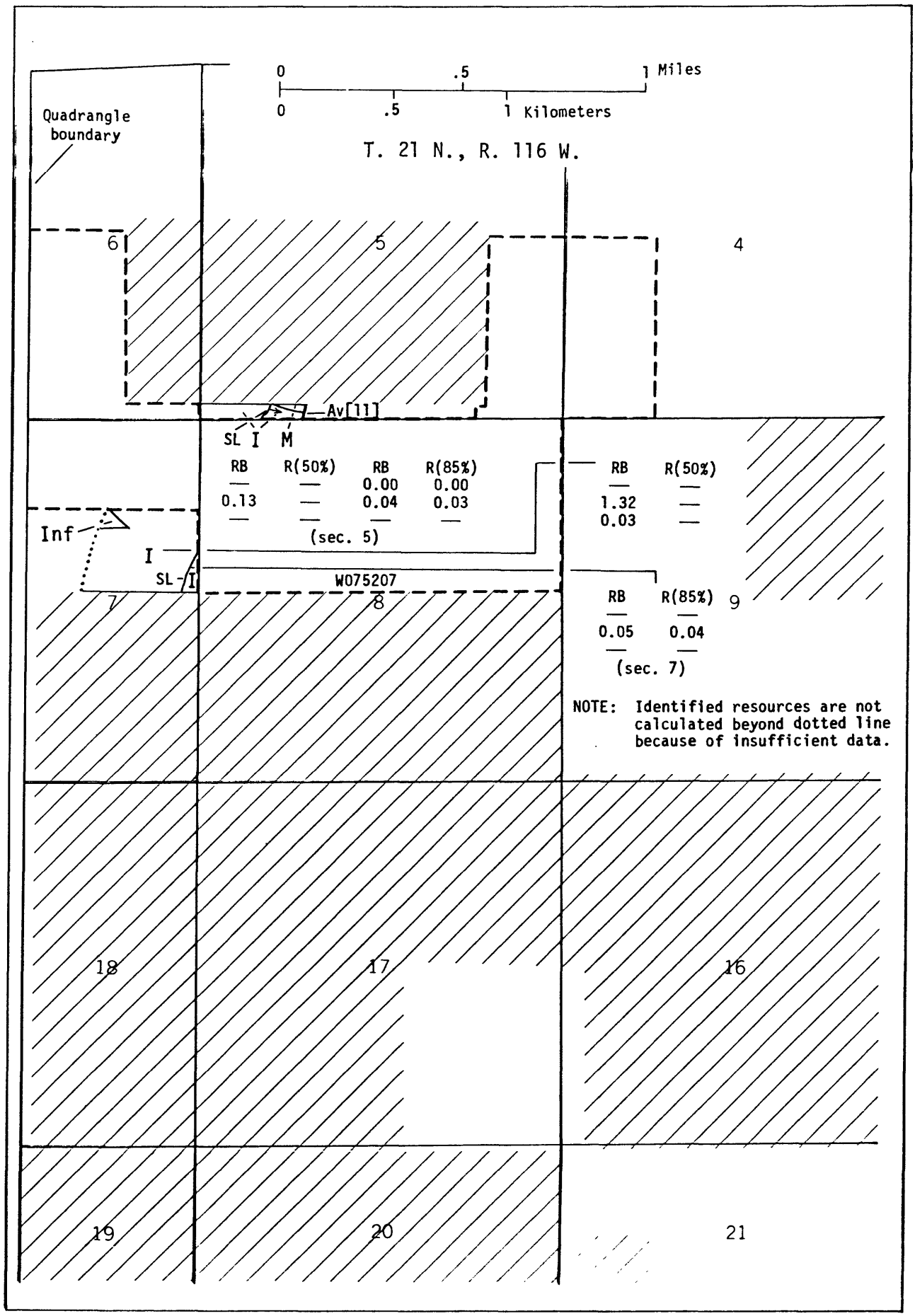


FIGURE 46. — Areal distribution and identified resources map of the Adaville [11] coal bed.

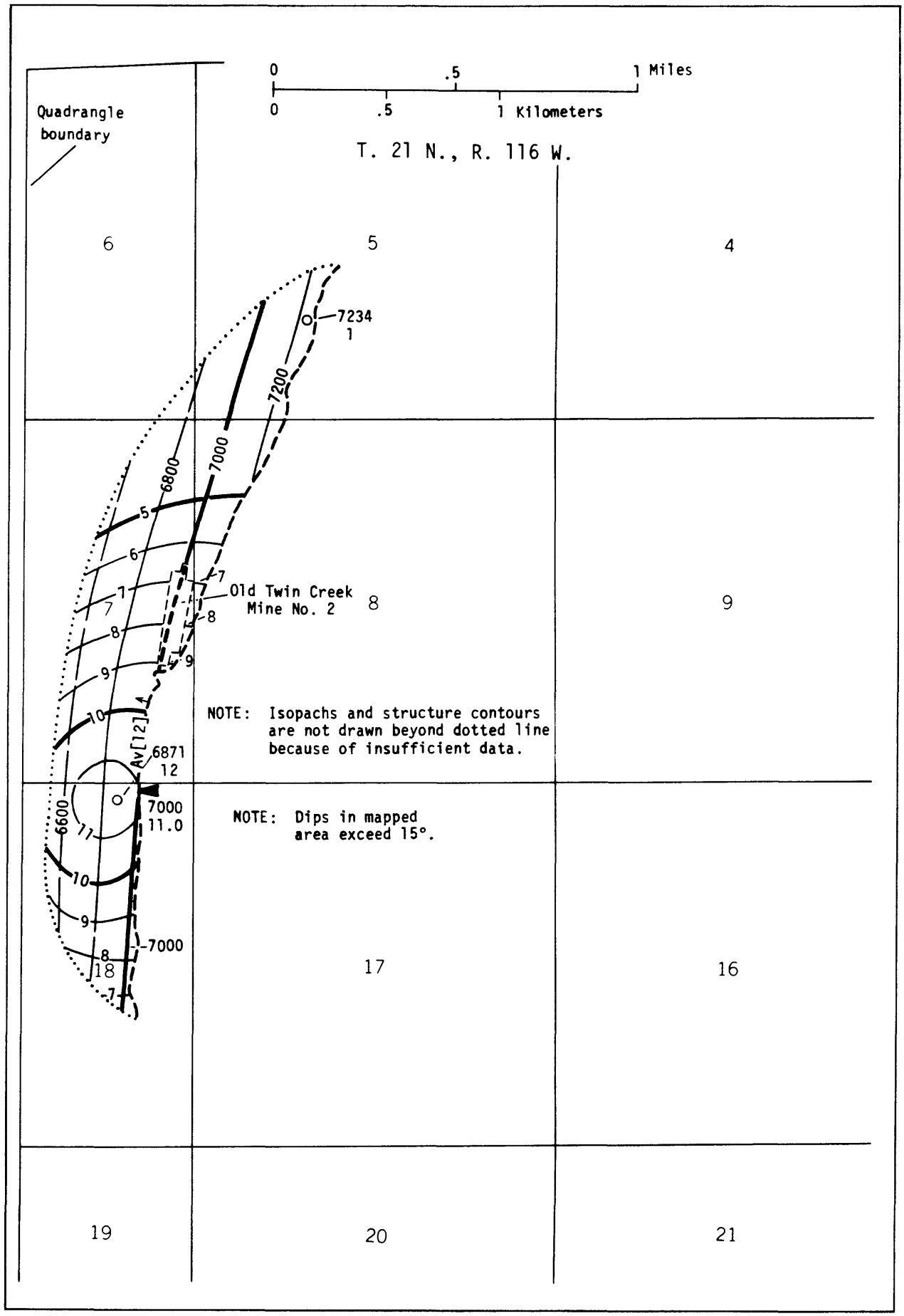


FIGURE 47. — Isopach and structure contour map of the Adaville [12] coal bed.

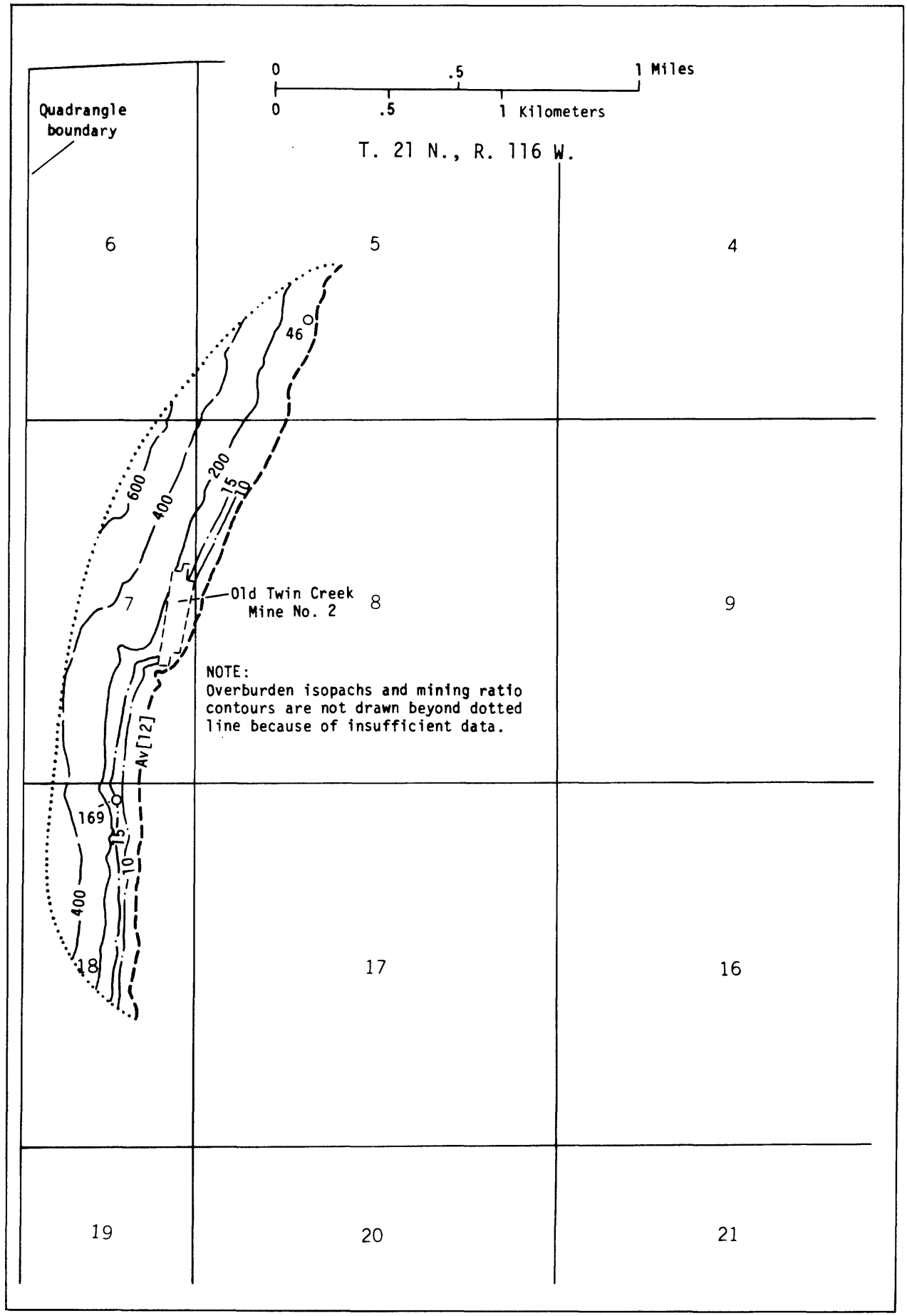


FIGURE 48. — Overburden isopach and mining ratio map of the Adaville [12] coal bed.

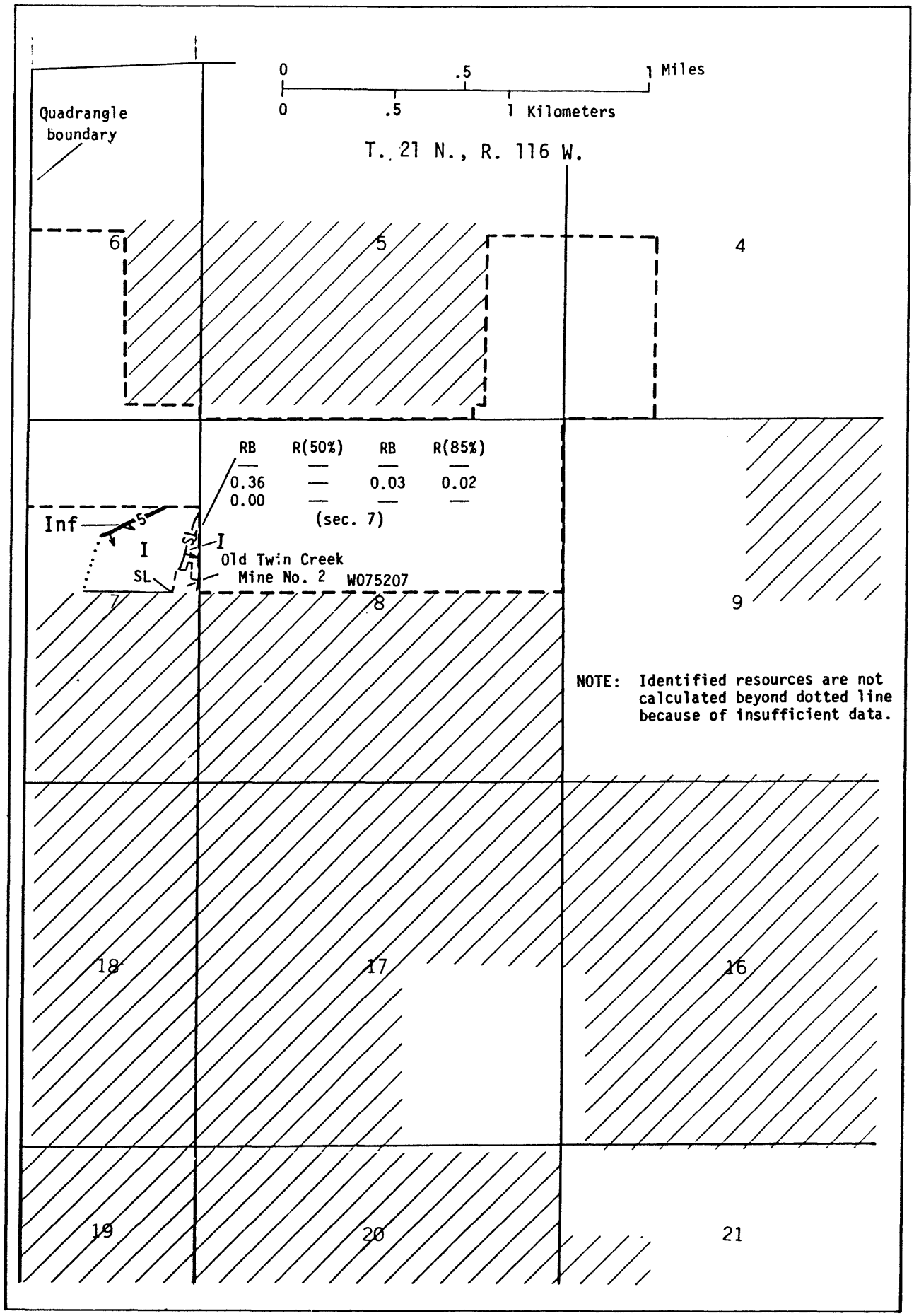


FIGURE 49. — Areal distribution and identified resources map of the Adaville [12] coal bed.

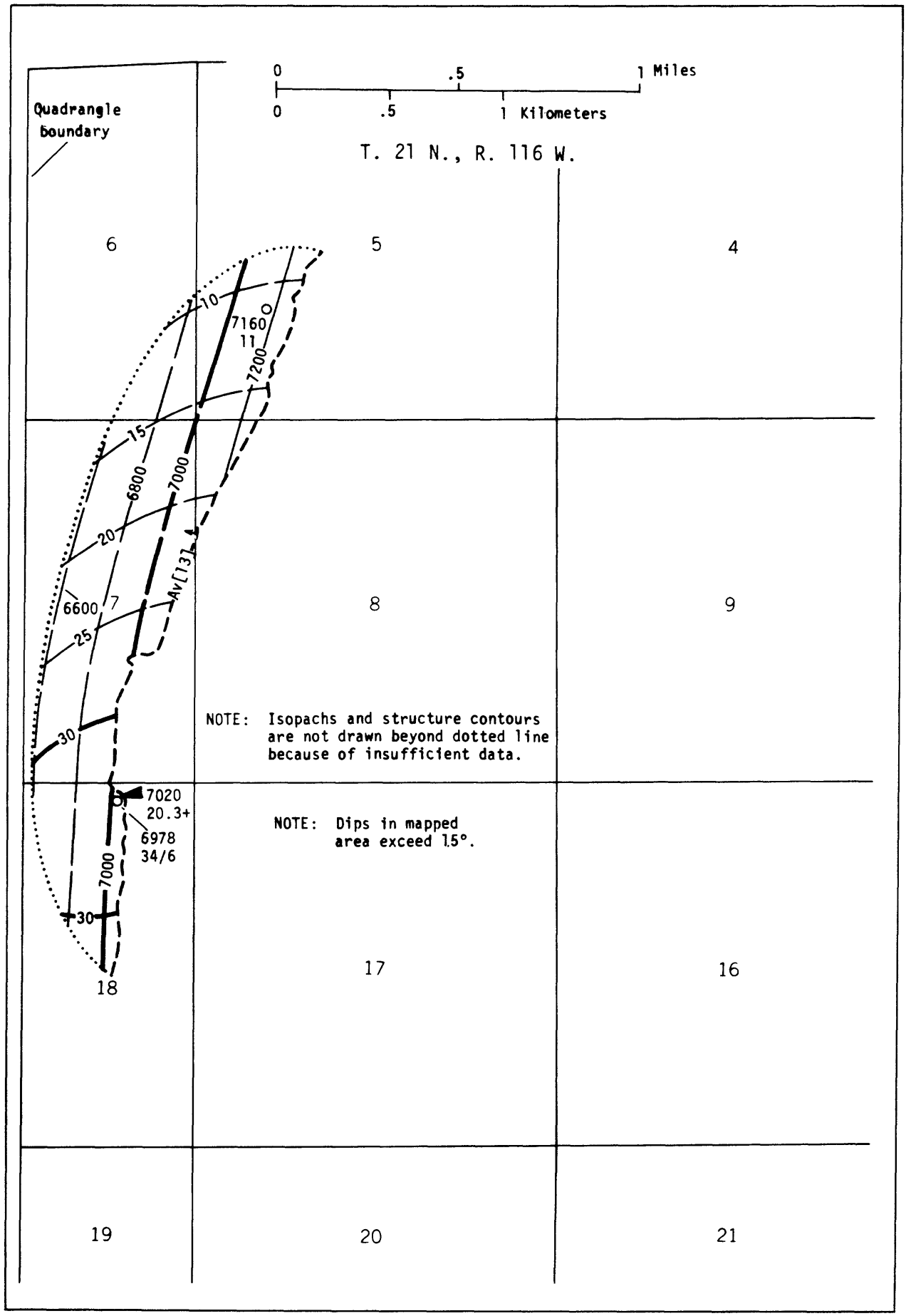


FIGURE 50. — Isopach and structure contour map of the Adaville [13] coal bed.

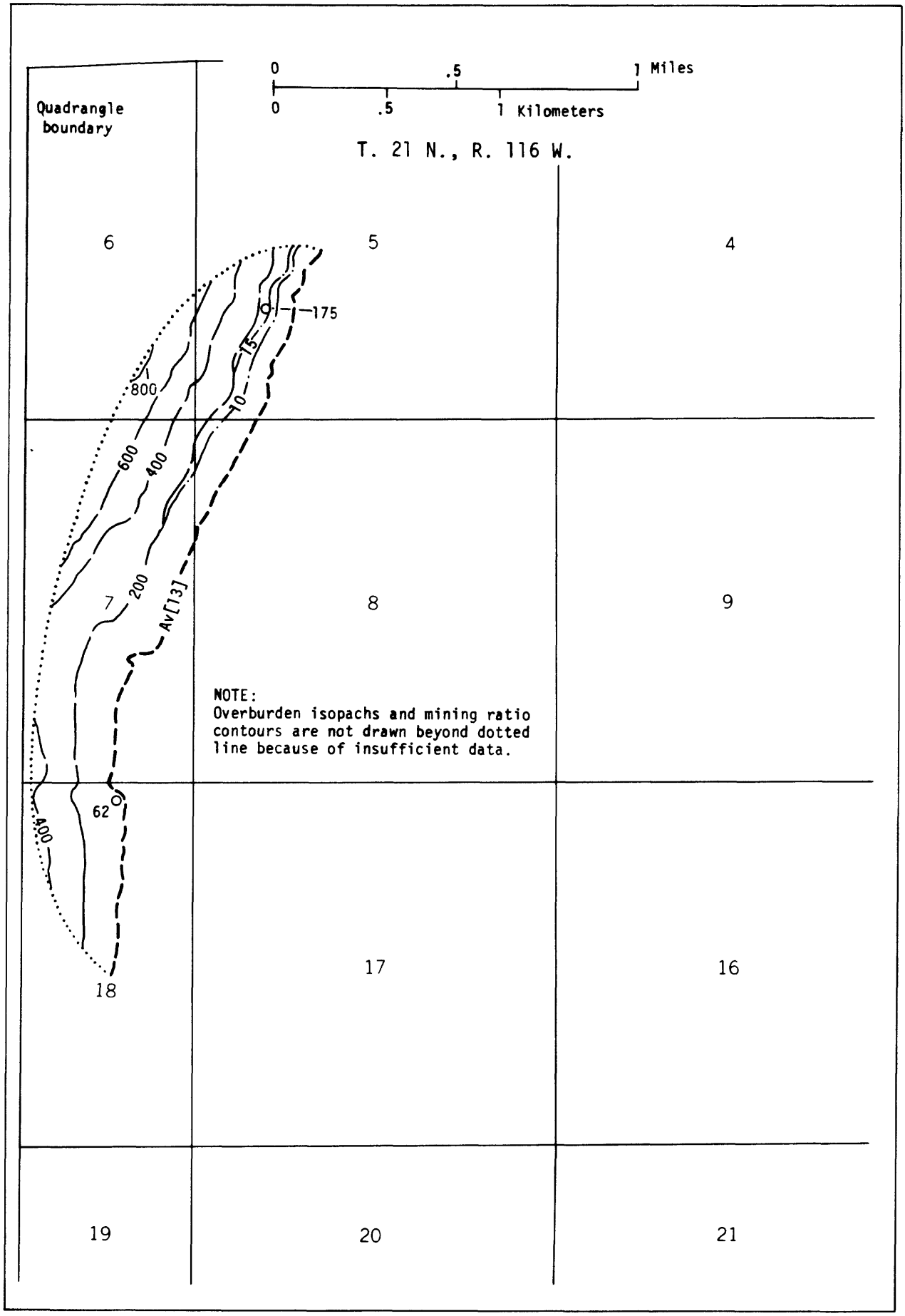


FIGURE 51. — Overburden isopach and mining ratio map of the Adaville [13] coal bed.

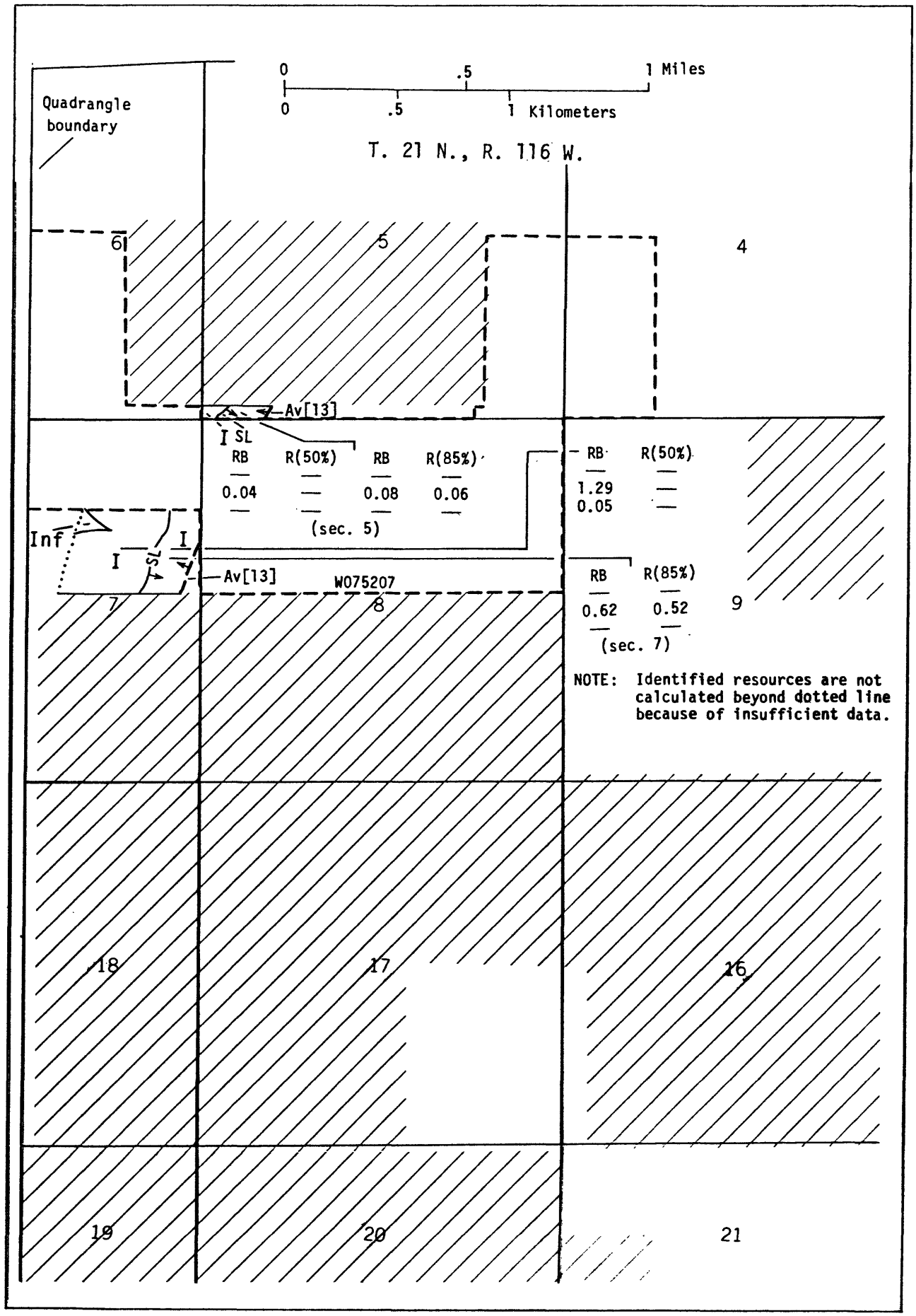


FIGURE 52. — Areal distribution and identified resources map of the Adaville [13] coal bed.

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