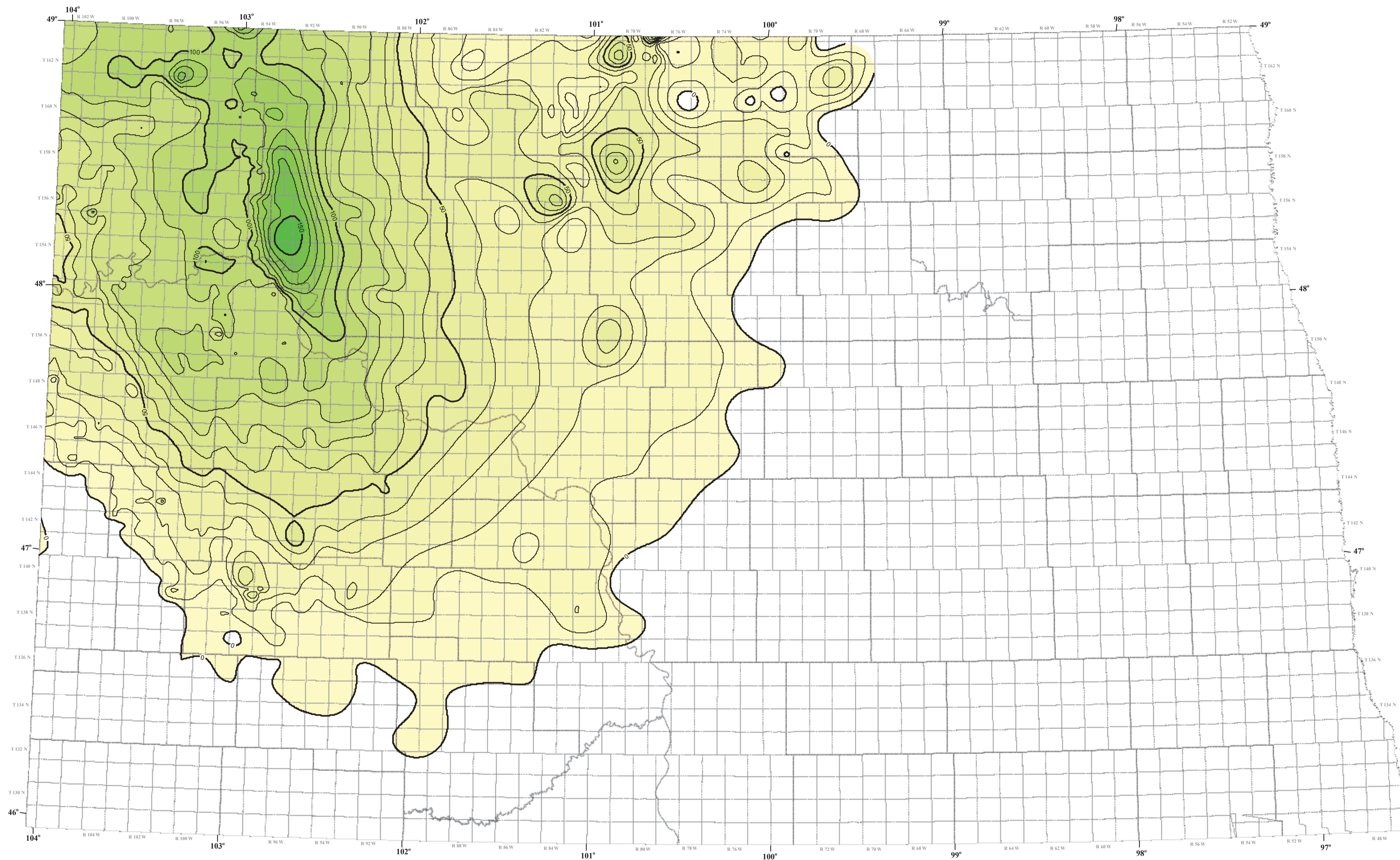


# Isopach of the Bakken Formation

Julie A. LeFever



## INTRODUCTION

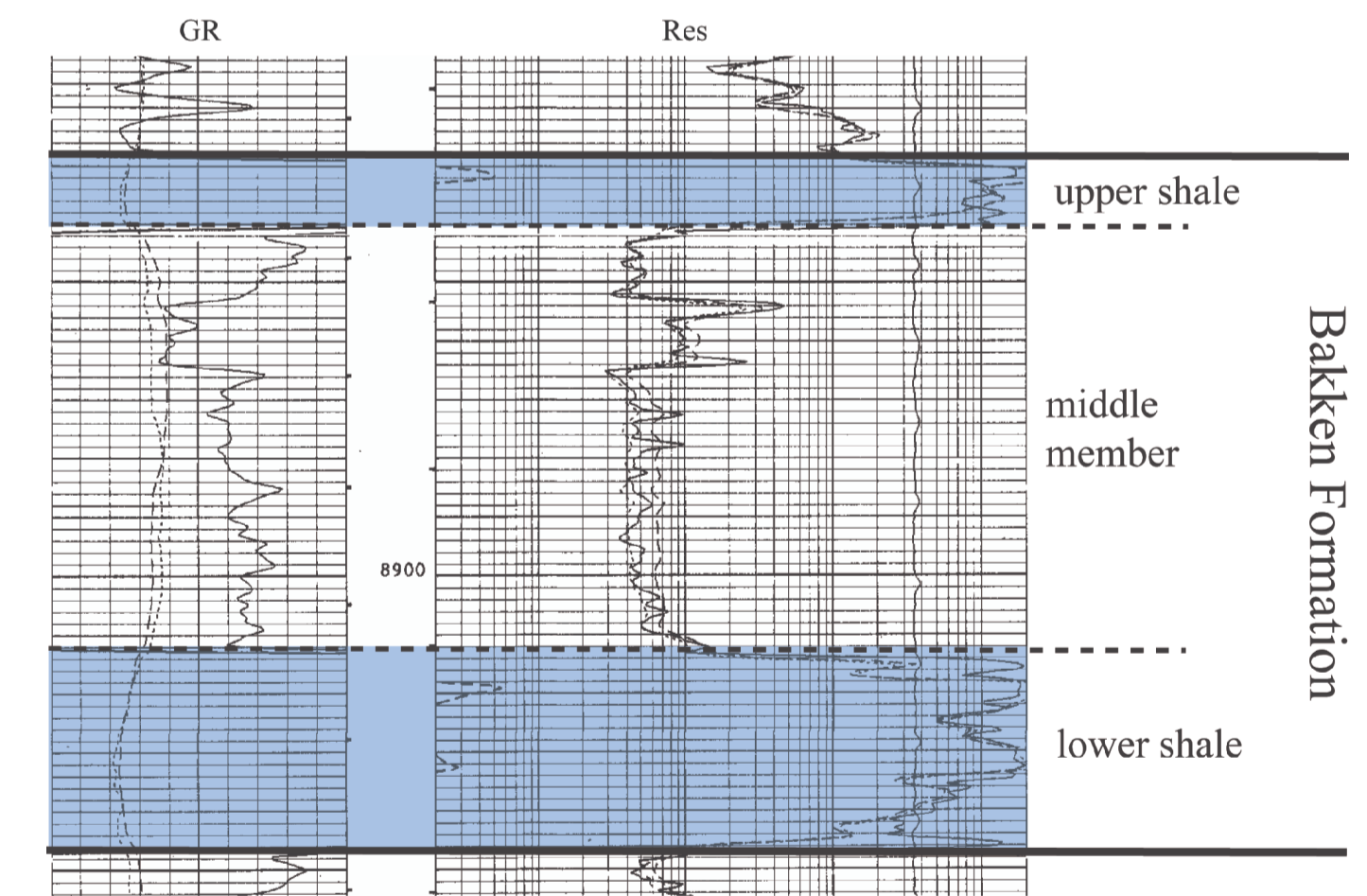
A series of five regional maps have been constructed for the Bakken Formation including an overall isopach of the Bakken Formation, individual isopachs for each of the three members, and a structure map on the top of the formation. These maps are based on 4,260 data points scattered throughout the North Dakota side of the Williston basin.

## ISOPACH OF THE BAKKEN FORMATION

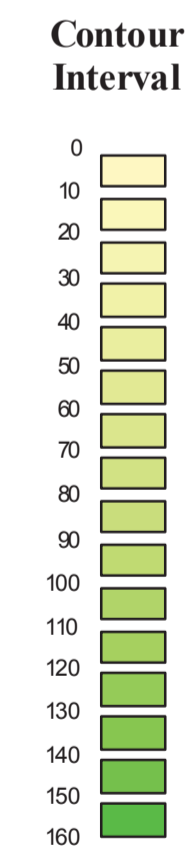
The Bakken Formation is present only in the subsurface of the Williston basin and extends over approximately two-thirds of the State of North Dakota (see Map). The formation consists of three members, two black, fissile shales separated by a mixed sequence of siliciclastics and carbonates (see Typical Log). The formation overlies the Three Forks Formation (Devonian) and is overlain by the Lodgepole Formation (Mississippian).

The formation attains a maximum thickness of 160 ft (49 m) and has a well-defined depocenter just east of the Nesson Anticline (western Mountrail County). A smaller north-south trending sub-basin occurs on the eastern edge of the Bakken in Bottineau and McHenry counties. Anomalous formation thicknesses also occur in the area of the Lodgepole Dickinson mounds in Stark County. The southeastern extension of the formation is probably due in part to a shift in the depositional shoreline related to movement along the Heart River and Antelope fault zones.

SENW Sec. 11, T.160N., R.95W  
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 #17 Watterud "A"

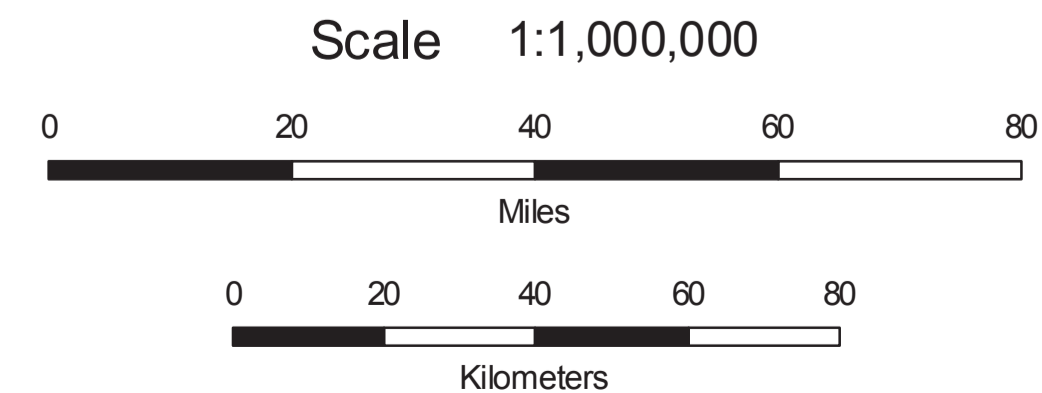


Typical Log

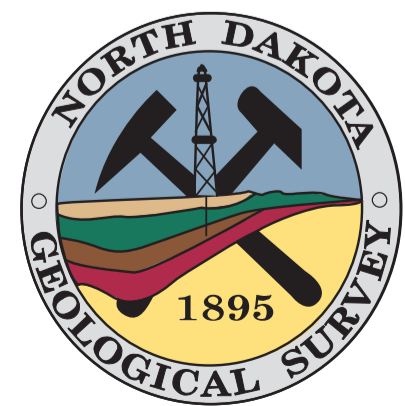
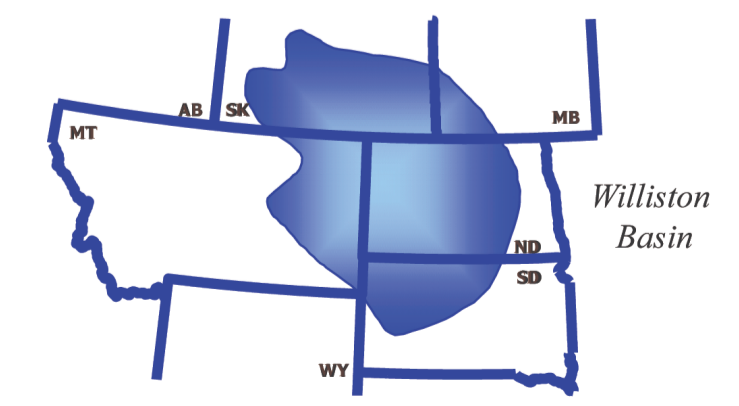
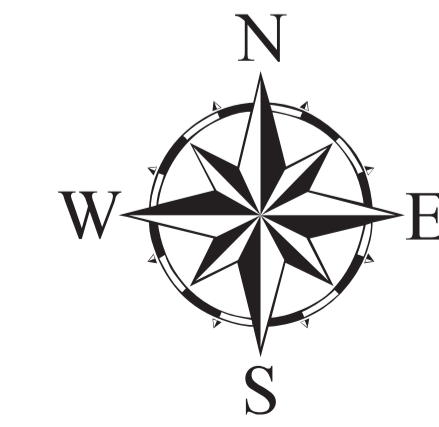


## Explanation

- Thickness of the Bakken Formation (in feet)
- Township Boundaries
- County Boundaries



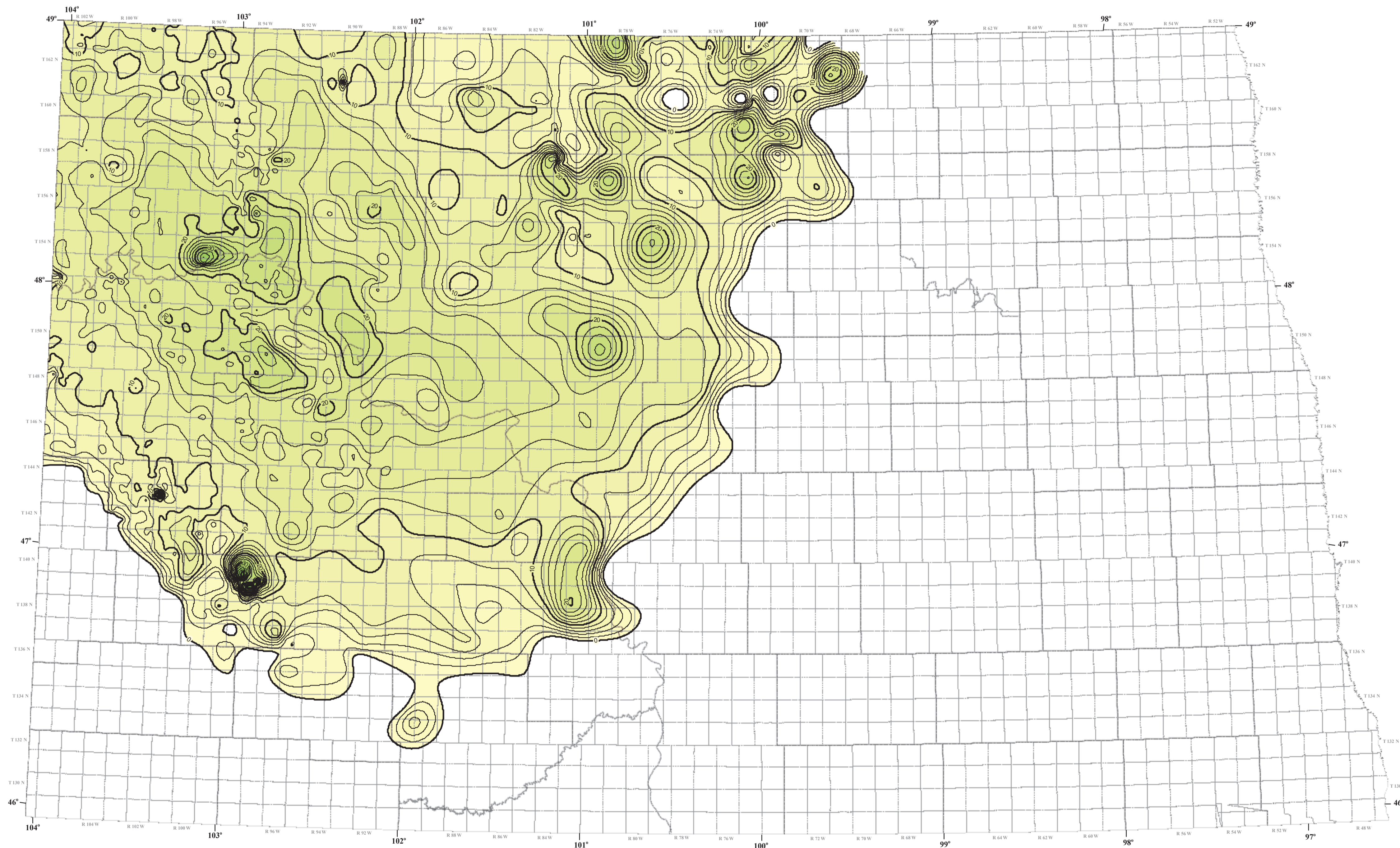
North American Datum 1927 Lambert Conformal Conic





# Isopach of the Upper Bakken Shale

Julie A. LeFever

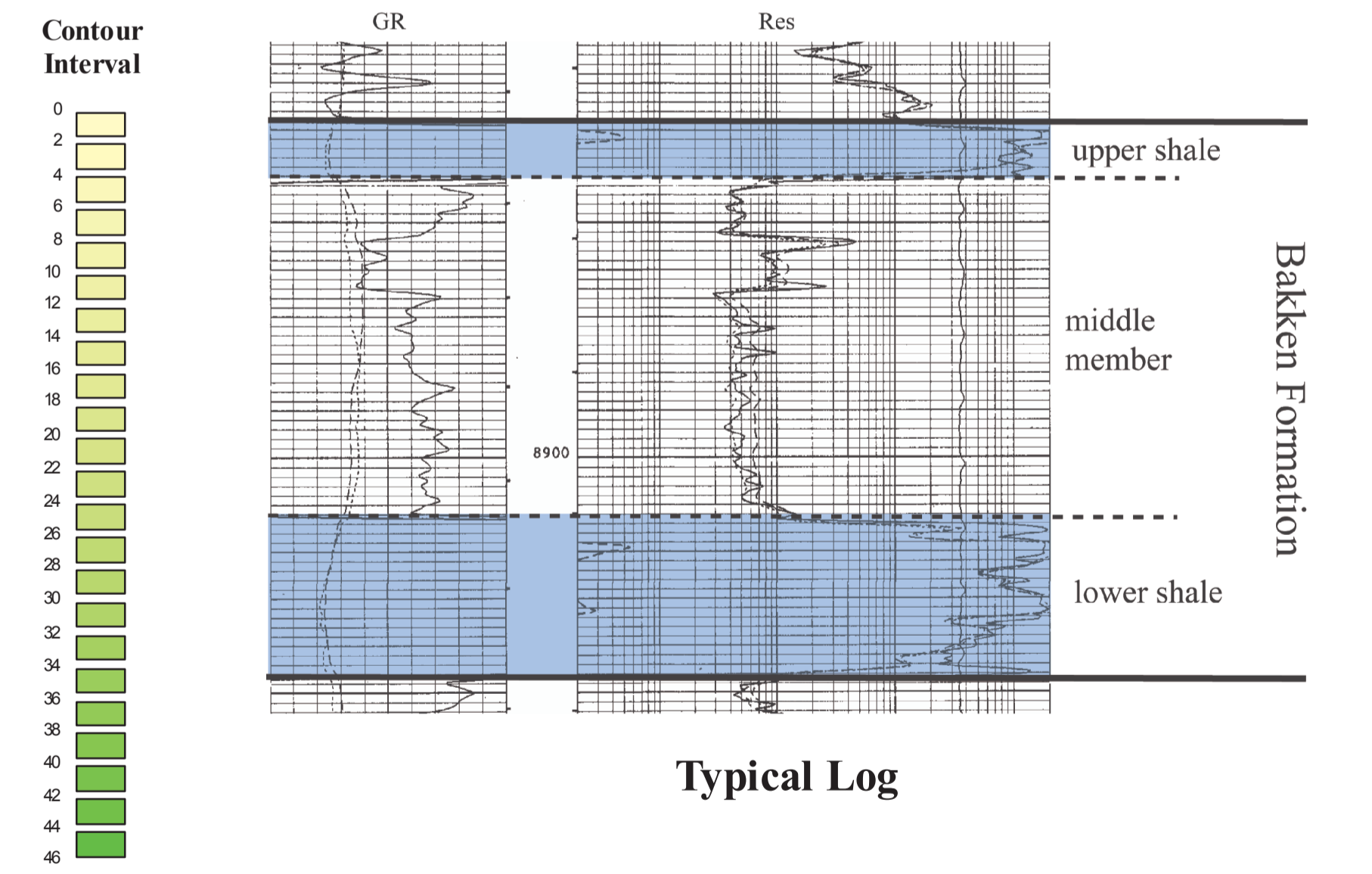


## ISOPACH OF THE UPPER BAKKEN SHALE

The maximum extent of the Bakken seas is represented by the upper Bakken shale. This shale attains a maximum thickness of 23 ft (7 m) within a broad, poorly defined depocenter situated along the eastern side of McKenzie and Dunn counties (see Map). In the vicinity of the Dickinson Lodgepole mounds however, the upper shale reaches a local maximum thickness of 58 ft (18 m). The Bottineau County sub-basin is readily apparent on the upper shale map by its irregular distribution of isolated thick sections that are probably related to Prairie salt tectonics.

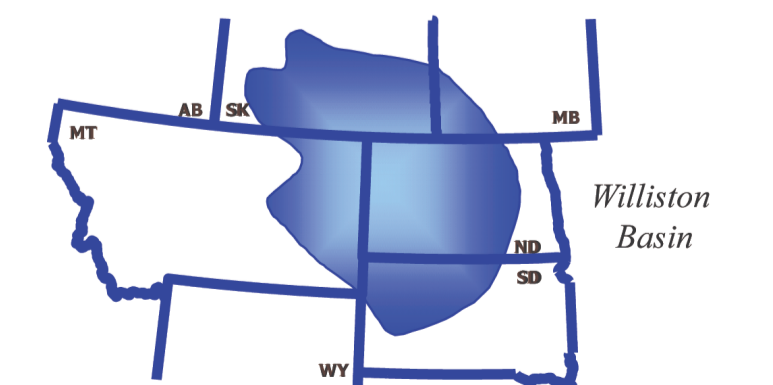
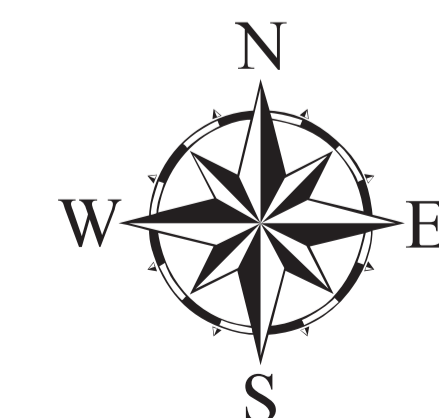
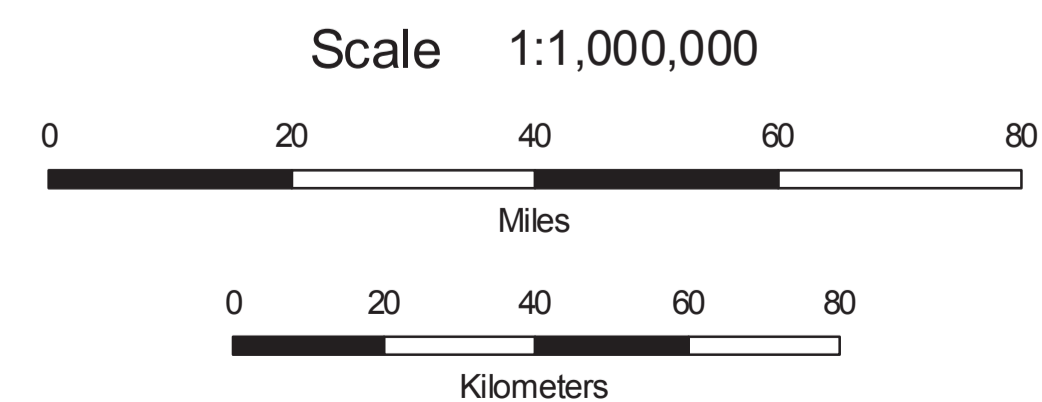
The upper Bakken shale is laminated to massive with poorly-sorted beds of silt-sized material. The upper shale is organic rich and consists of minor amounts of clay, silt, and dolomitic grains. However, it lacks the crystalline limestone and siltstone that is frequently found in the lower shale. Sedimentary structures within the upper shale range from thinly laminated beds to massive, poorly-sorted beds of silt-sized material. A lag rich in conodonts, fish bones, teeth and phosphatic particles is often found along the basal contact of the member.

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### Explanation

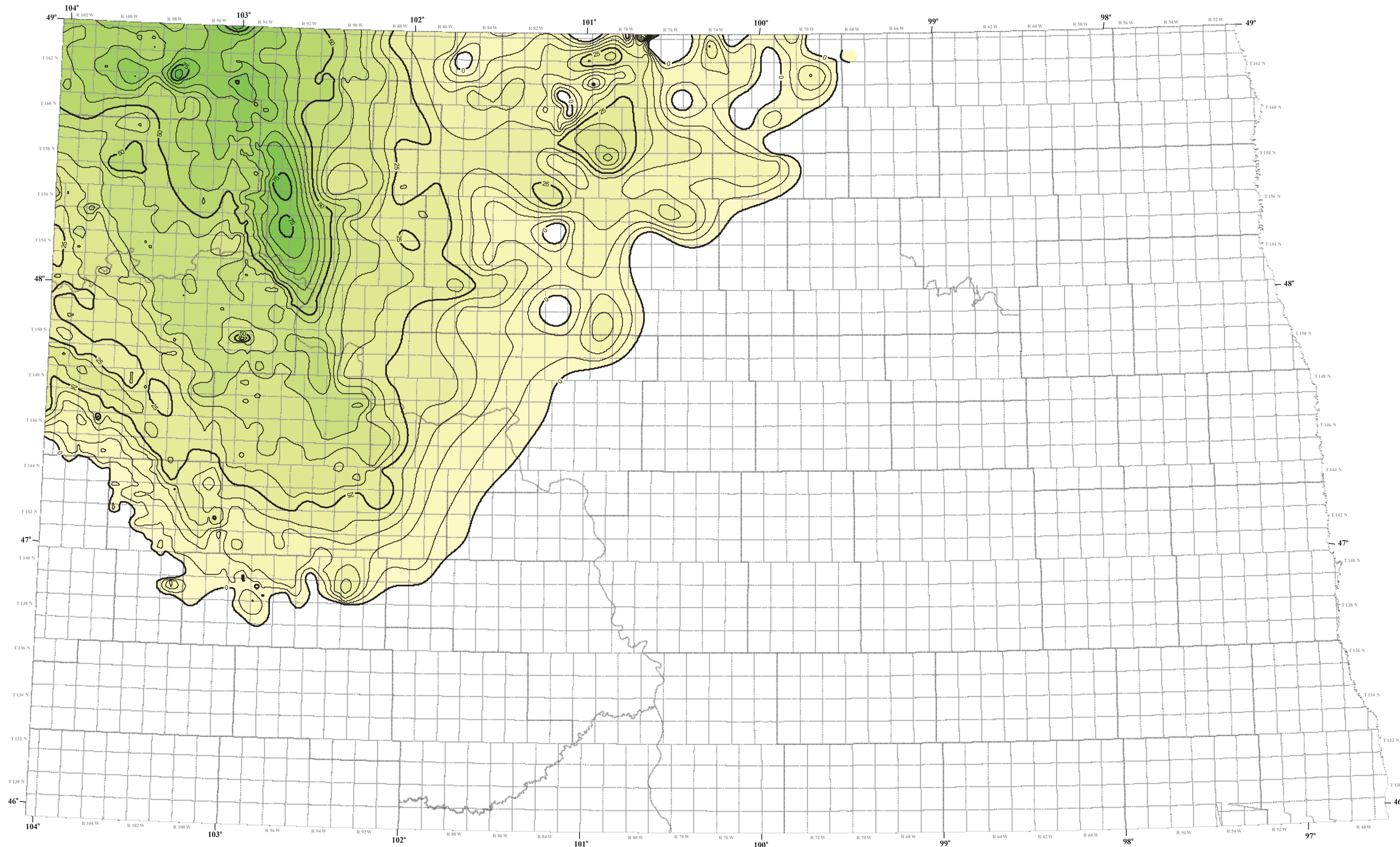
- Thickness of the Upper Bakken Shale (in feet)
- Township Boundaries
- County Boundaries





# Isopach of the Middle Bakken Member

Julie A. LeFever



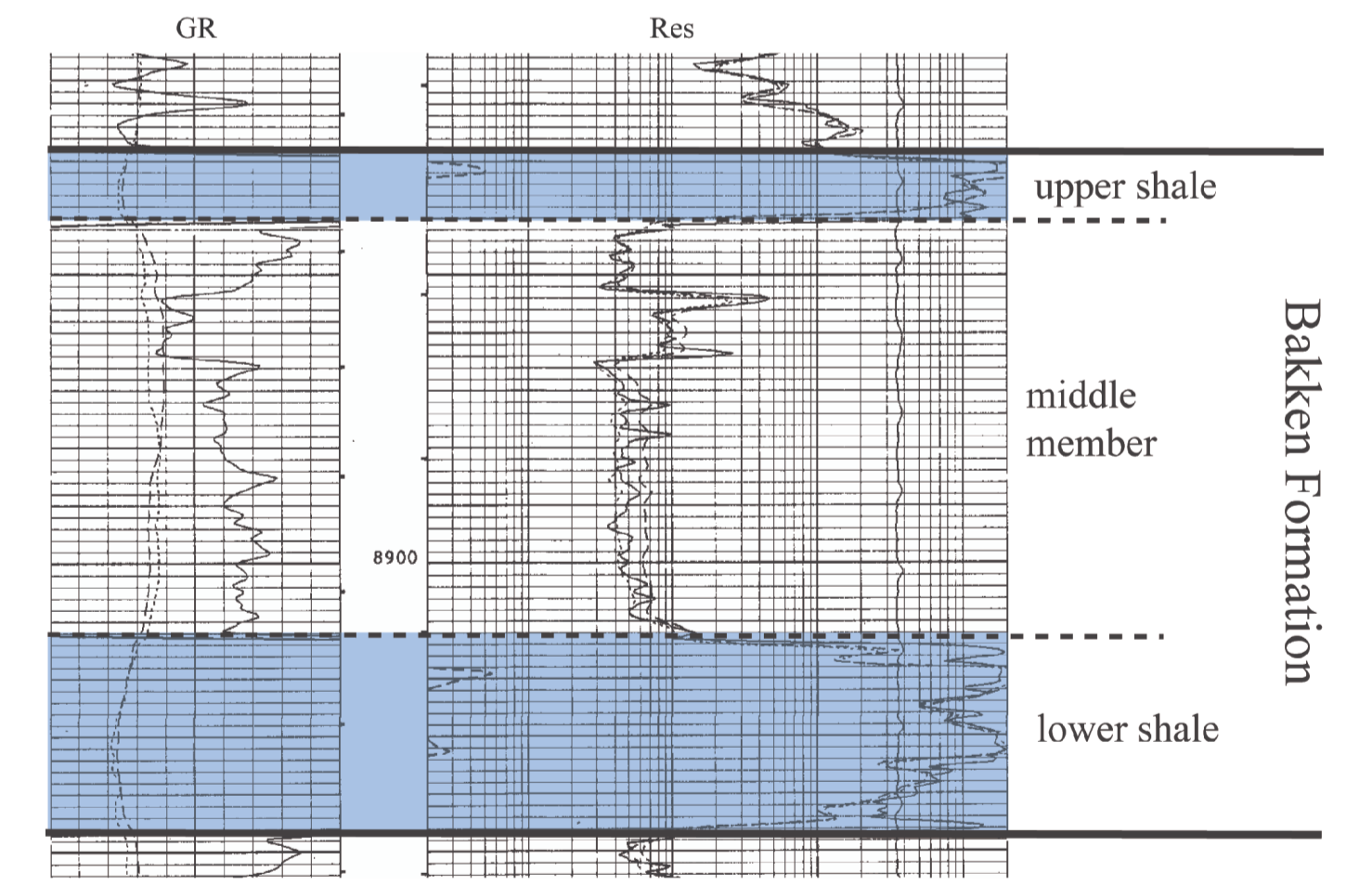
## ISOPACH OF THE MIDDLE BAKKEN MEMBER

The middle member of the Bakken Formation reaches a maximum thickness of 90 ft (27 m) with a well-defined, northwest-trending depocenter along the eastern side of the Nesson anticline (see Map). There are several notable features in the isopach of this member. The map shows a prominent thickness trend in southern McKenzie County that is continuous with the thickened middle Bakken that is productive in Richland County, Montana. The extension of the middle member to the southeast probably reflects a depositional response to movement along the Heart River and Antelope faults.

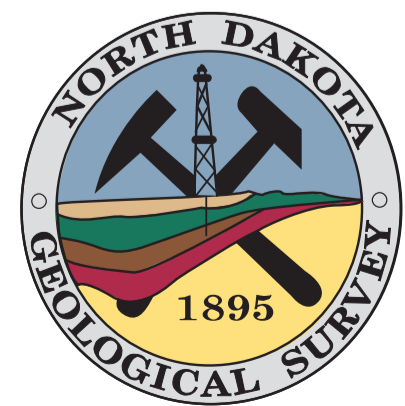
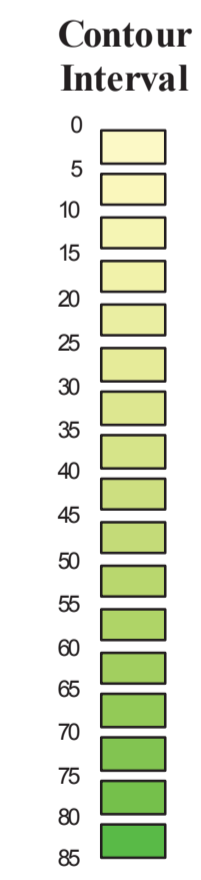
The middle member is usually easy to identify on wireline logs because of its relatively low gamma-ray response relative to the intense gamma-ray responses that come from the shales that lie above and below it (see Typical Log). However, when the lower shale is missing the middle member is difficult to distinguish from the underlying Three Forks Formation.

Vertically variable, the middle member consists of a mixture of siliciclastic and carbonate lithologies. These rock types range from calcareous siltstones to sandstones dominated by quartz with minor amounts of feldspar, dolostones, silty limestones, and occasionally oolitic limestone. The limestones are usually rich in quartz sand and silt. The siltstones and sandstones are massive to coarse-bedded with occasional trough or planar cross-bedding. There is some local soft sediment deformation and bioturbation. Fossils include brachiopods, pelmatozoan fragments, gastropods, and trace fossils. Mineral composition is variable across the basin, although quartz increases in a north-easterly direction. Sand size is also variable across the basin with the coarser-grained material occurring to the east side of the Nesson anticline.

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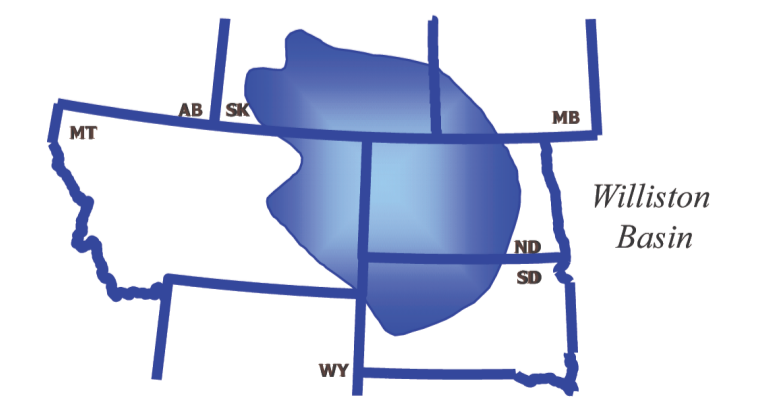
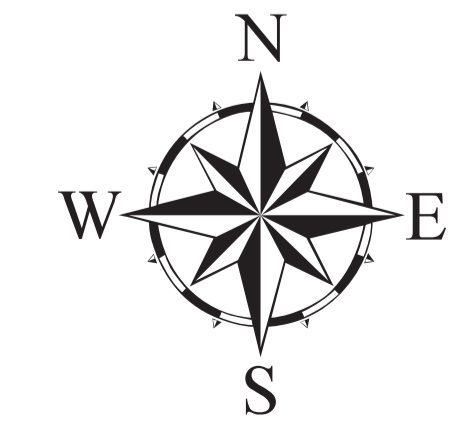
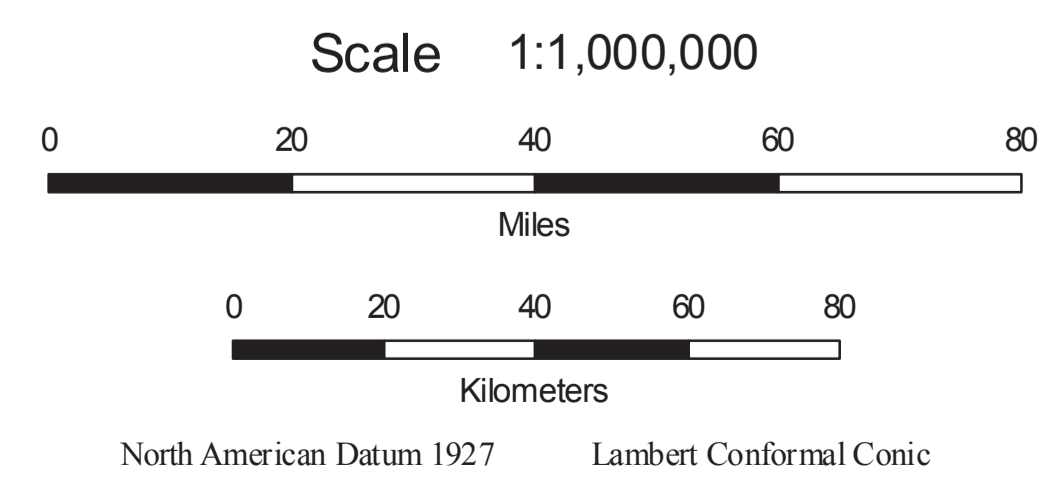


Typical Log



### Explanation

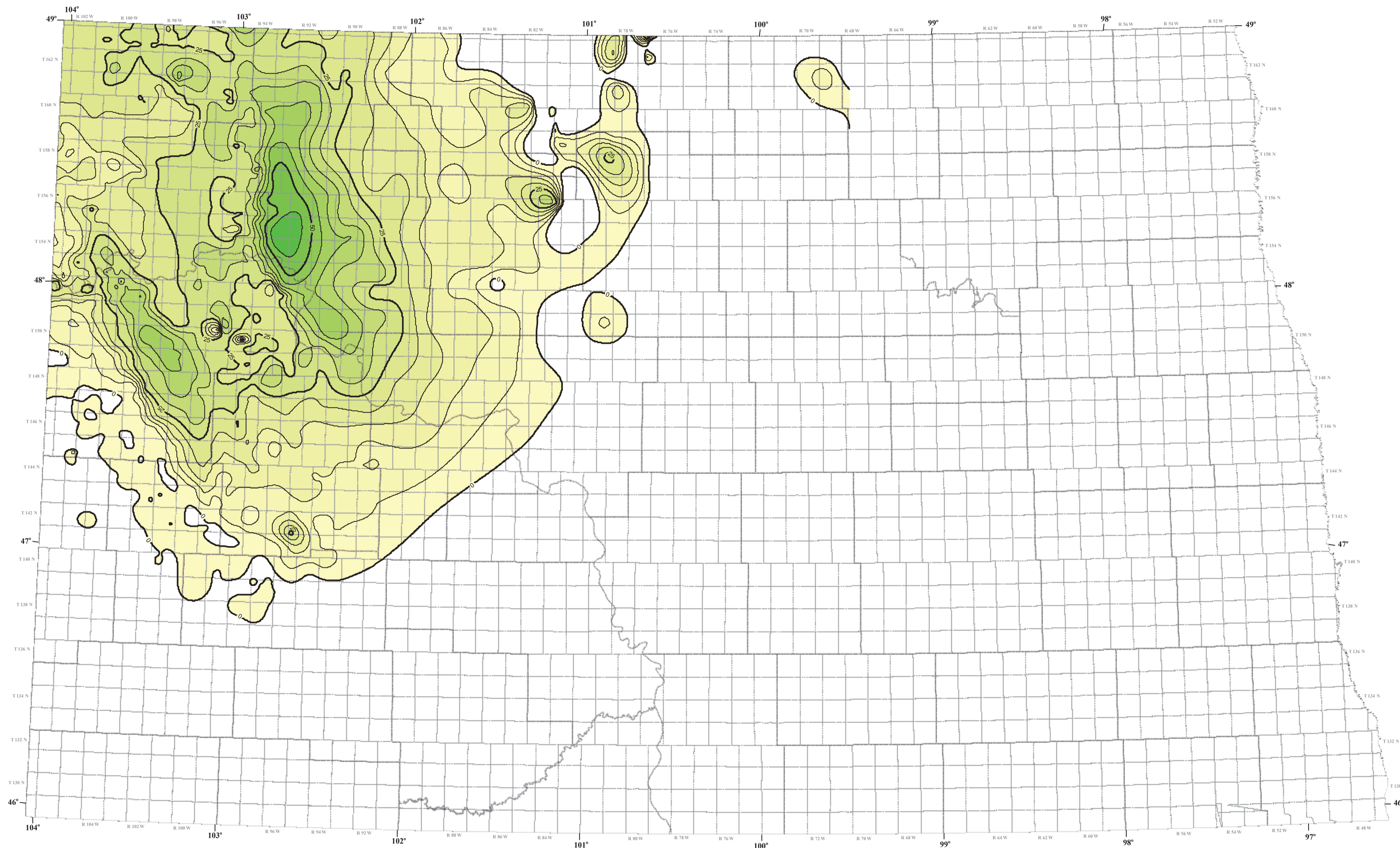
- Thickness of the Middle Bakken Member (in feet)
- Township Boundaries
- County Boundaries





# Isopach of the Lower Bakken Shale

Julie A. LeFever

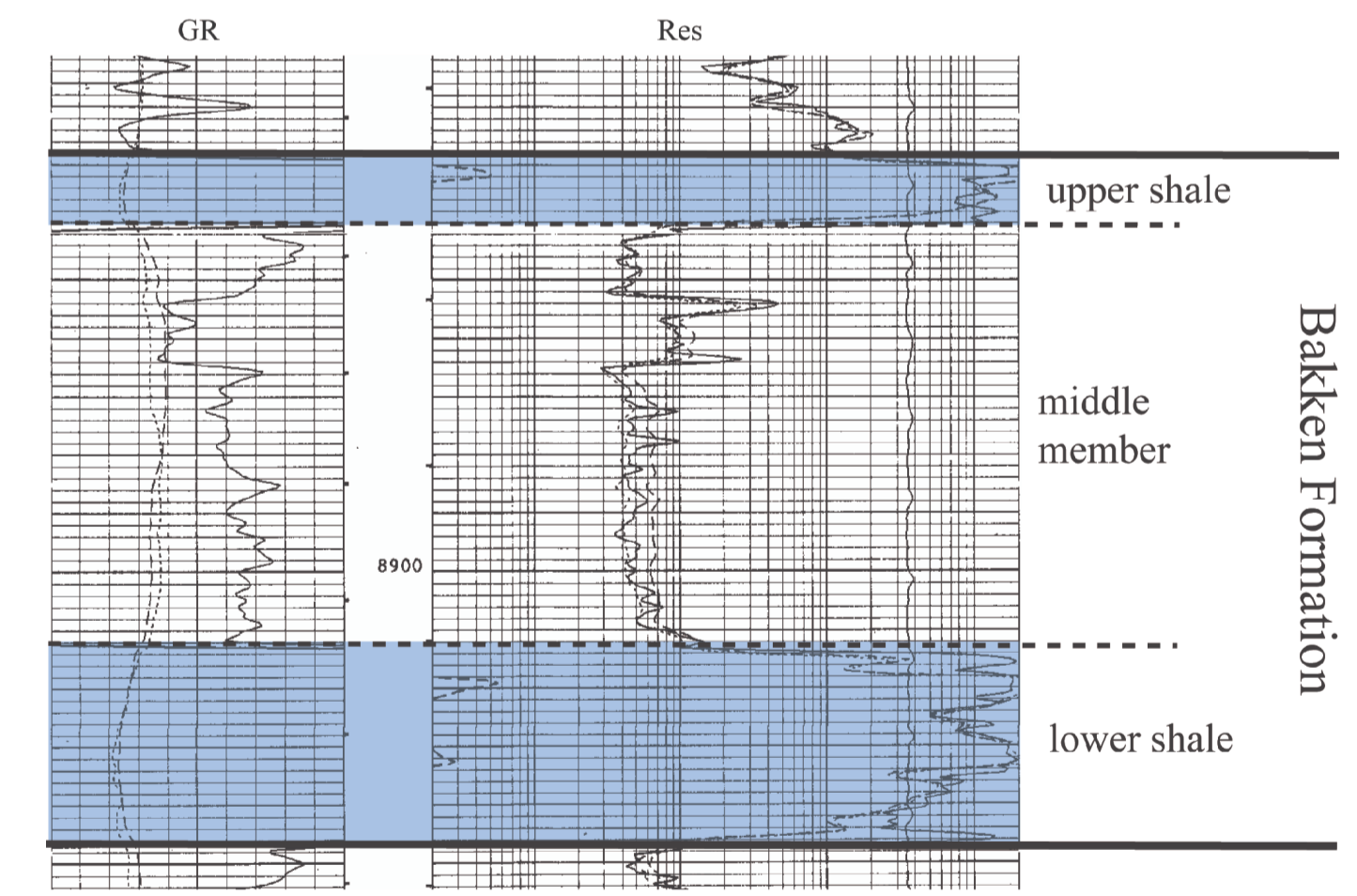


## ISOPACH OF THE LOWER BAKKEN SHALE

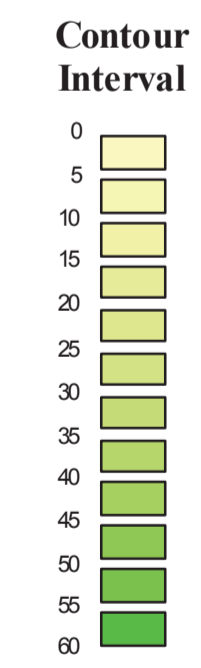
The lower shale member reaches a maximum thickness of 56 ft (17 m) with a well defined depocenter along the east flank of the Nesson anticline (see Map). A major thickness trend extends in a northwesterly direction across McKenzie County and appears correspond to the Heart River fault. The thickness change may be the response of the shale to Prairie salt tectonics. The sub-basin present in Bottineau and McHenry counties is not as significant in the isopach of the lower shale as it is in the upper members.

The shale is a dark brown to black, fissile, non-calcareous, organic-rich shale. Small amounts of finely laminated to massive siltstone, limestone, and sandstone are present towards the base of the shale. Where present, fractures are smooth and conchoidal, but can be irregular or blocky. Fractures are subparallel to bedding and are heavily oil stained. It is generally less organic than the upper shale. The organic matter appears to be distributed evenly throughout the member. Quartz is the dominant mineral with minor amounts of muscovite, illite and other clays. Pyrite is present in lenses, laminations, or is finely disseminated throughout. Fossils within the shale member include conodonts, algal spores, brachiopods, fish teeth, bones and scales. Localized changes in lithology include the development of siltstone or limestone beds near the base of the formation. Well developed lag deposits are also locally present along the base of the member.

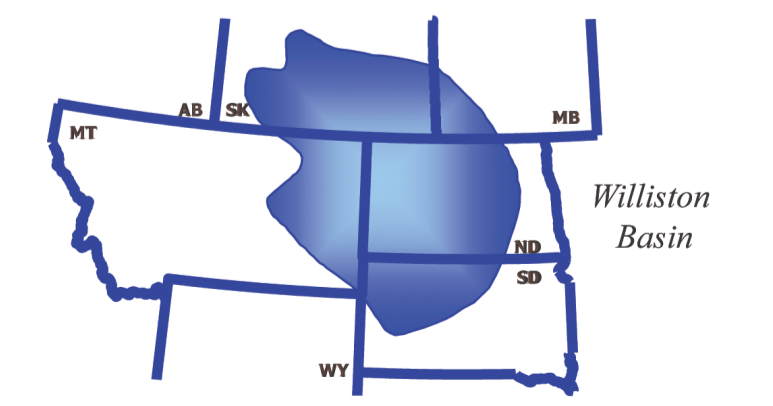
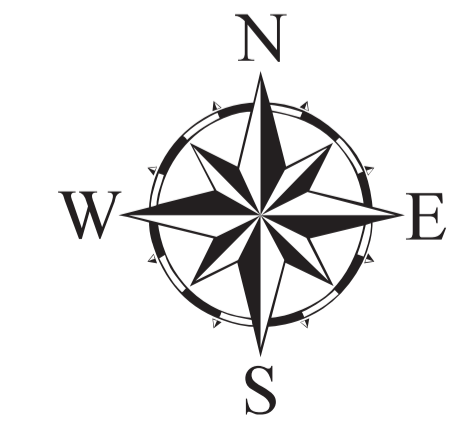
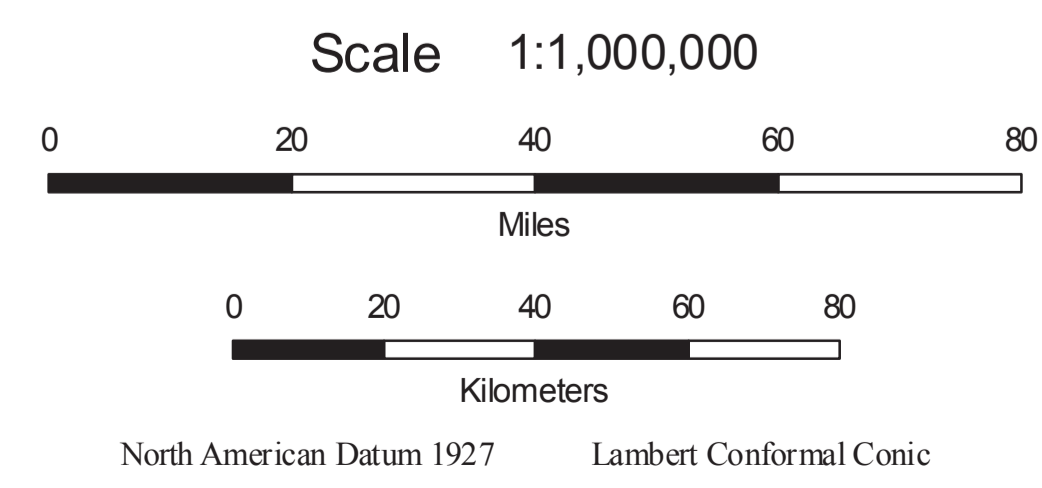
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 Conoco, Inc.  
 #17 Watterud "A"



Typical Log



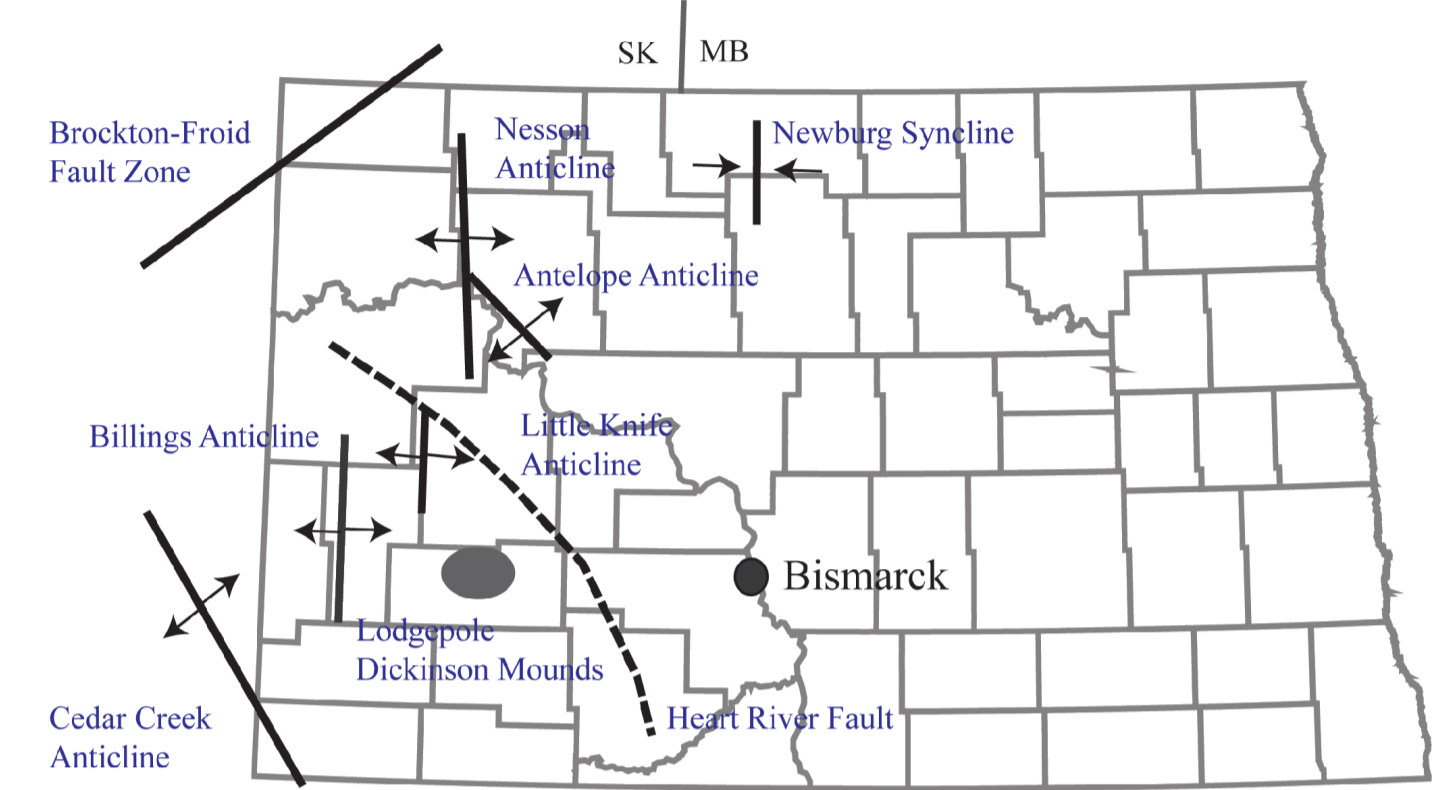
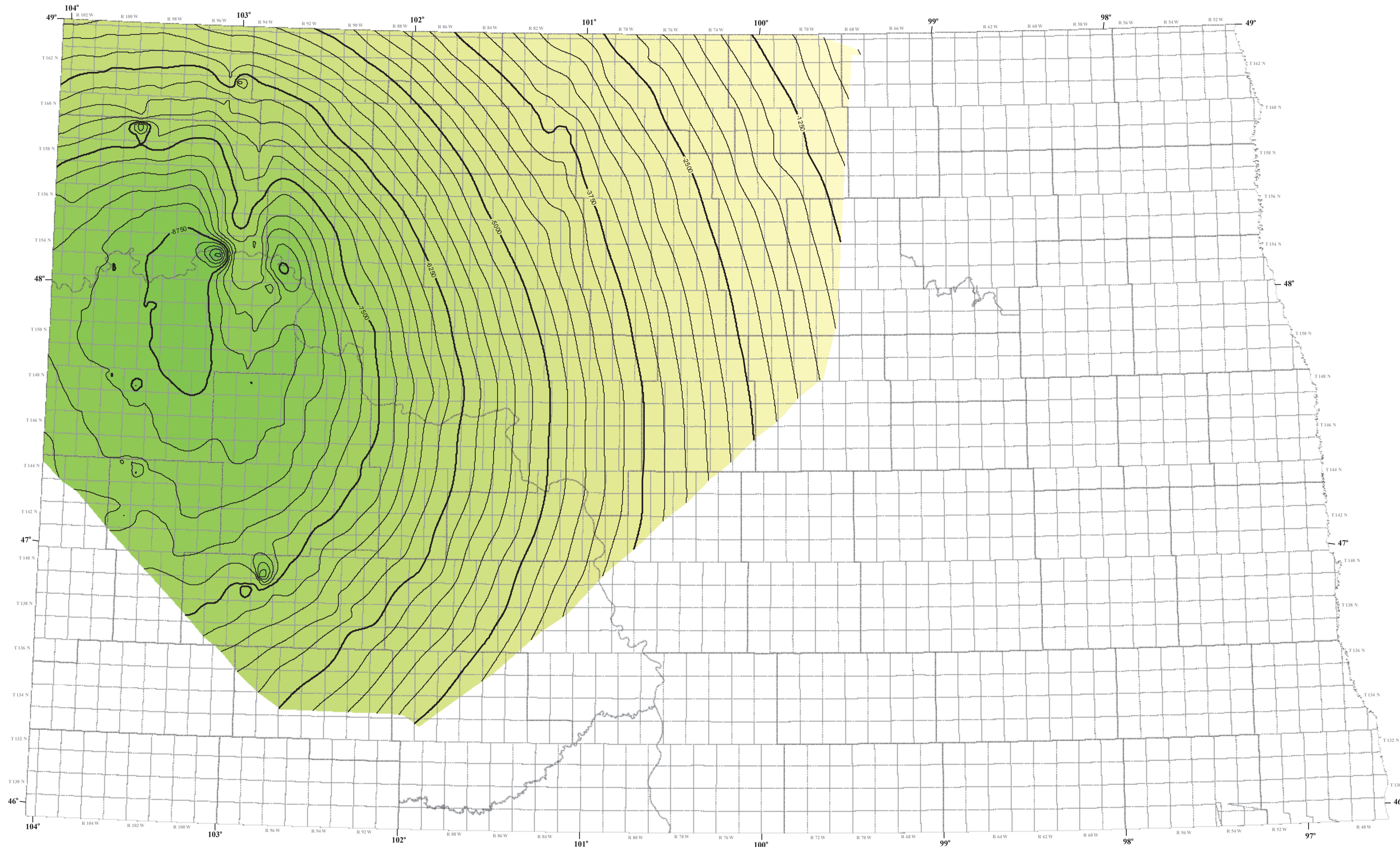
- Explanation**
- Thickness of the Lower Bakken Shale (in feet)
  - Township Boundaries
  - County Boundaries



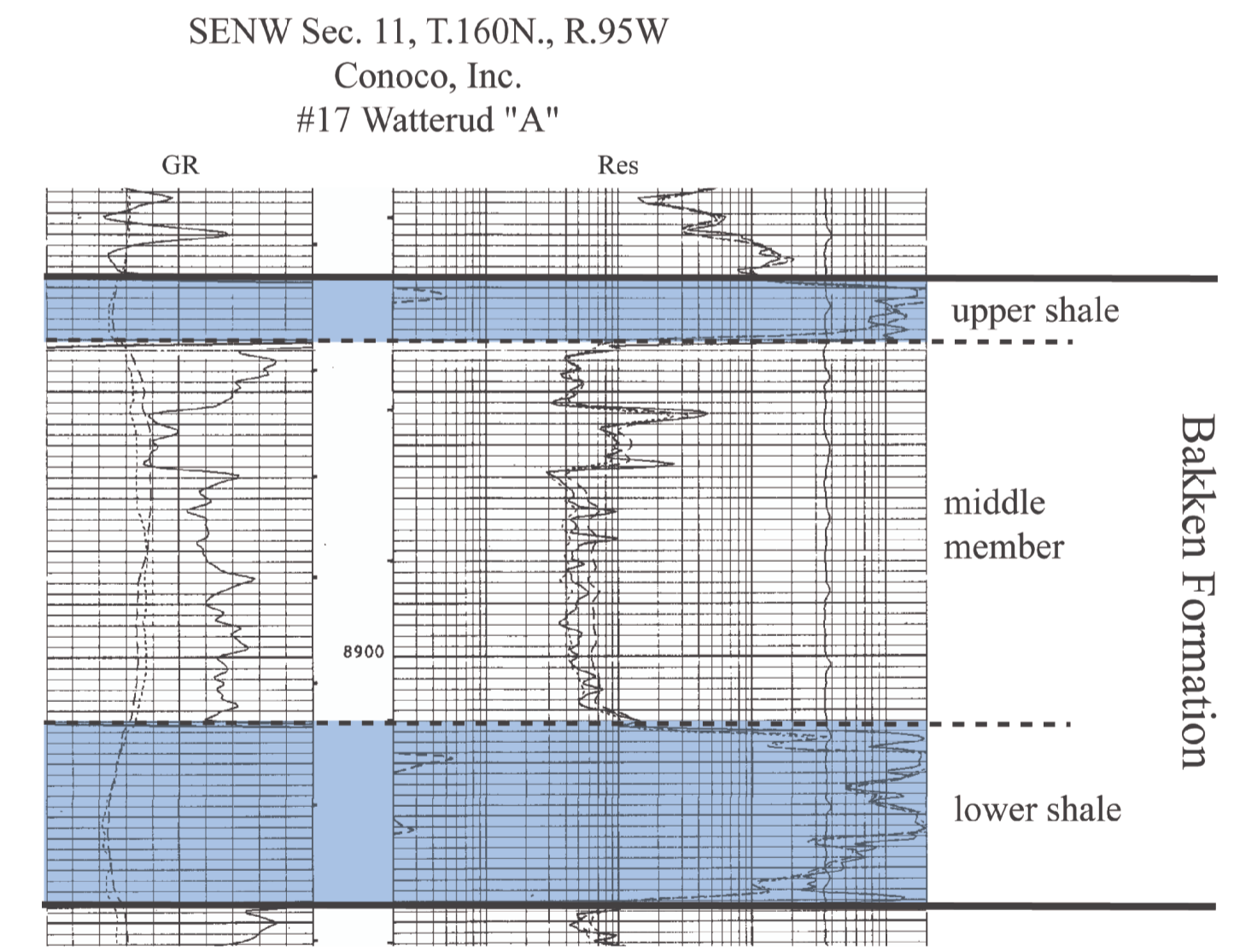
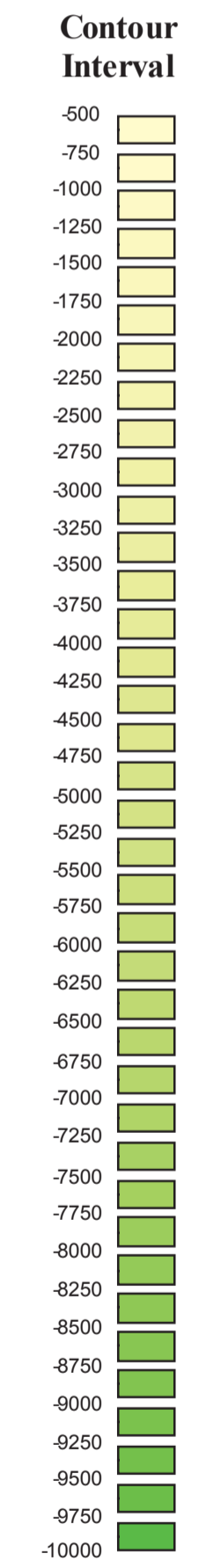


# Structure on the Top of the Bakken Formation

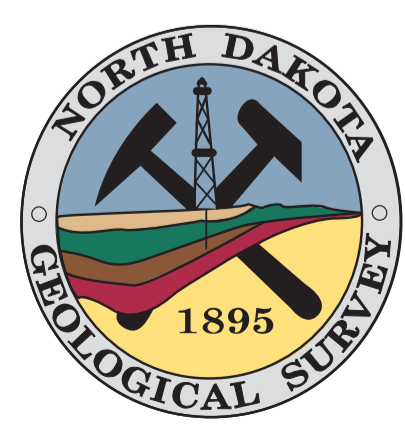
Julie A. LeFever



Index Map



Typical Log



### Explanation

- Top of Bakken Formation (in feet below sea level)
- Township Boundaries
- County Boundaries

