GEOLOGY OF THE EKALAKA AREA, SOUTHEASTERN MONTANA

FACULTY

Edward S. Belt, Amherst College
Edward C. Beutner, Franklin & Marshall College
Walter Coppinger, Trinity University

STUDENTS

Russell H. Abell, Amherst College
Christene L. Albanese, Smith College
Ian H. D. Clark, Amherst College
Barret S. Cole, Amherst College
Cheryl Kallweit, Trinity University
Beth C. Lambert, Carleton College
Kristin Moyle, Beloit College
Jamie L. Robertson, Whitman College
Srabani Roy, Beloit College

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John A. Diemer, University of North Carolina at Charlotte
Tekla Harms, Amherst College
Carl Mendelson, Beloit College

SLUMP STRUCTURES BELOW A MAJOR UNCONFORMITY WITHIN THE PALEOCENE TONGUE RIVER MEMBER and the Miocene unconformably above the Paleocene, southeastern Montana

Edward S. **Belt**, Dept. Geology, Amherst College, Amherst, MA 01002
Edward C. **Beutner**, Dept. Geol., F & M College, Lancaster, PA 17604
Walter **Coppinger**, Geol. Dept., Trinity Univ., San Antonio, TX 78212

Introduction

The main objectives of the SE/MT project were to determine the origin of slump structures found below a Paleocene unconformity within the Tongue River Member of the Fort Union Formation near Ekalaka, Montana (Figure 1). These relationships were discovered by Susan Vuke Foster (Montana Bureau of Mines and Geology) and Ed Belt in the summer of 1991, and they formed the basis of the 1992 SE/MT field project.

Seven students concentrated on the Paleocene aspect of the project. Two other students studied the Arikaree Formation (Miocene), which unconformably overlies the Fort Union Formation. Because more than one student tackled the same aspect of the strata, and because their individual study localities were separated, the Jan 1993 workshop was an important "sharing" of the whole team to discuss regional relationships.

Christene, Ian and Cheryl analysed the structural geometry of the slump blocks with the objective of determining the direction(s) of slump movement. Ian is summarizing the regional implications of all the data. Suggestions made by Tekla Harms during the Fall, and re-iterated by Don Wise at the workshop, spurred Ian to plot: the pole positions of faults that cut the slump blocks, the relationship of block size and magnitude of dip, and to plot the dip direction of the blocks. By these plots he can determine the stress axis, though not the precise direction. Work continues to identify likely candidates for the variation in stress directions plotted.

Barret and Russ concentrated on paleocurrent directions of cross-beds in fluvial sandstones, and the provenance of sand composition within those same channel deposits. Drawing heavily on the outcrop sections measured by Jamie, Beth, Cheryl, and Christene, Barret made a cross-section chart that showed how the important units correlated. Jamie and Beth's field project consisted of regional correlation of the stratigraphic units. They made valuable observations in places no one else had the time to visit.

Srabani ("Beanie") and Kristin studied the composition and burrow structures of the volcanogenic Arikaree Formation. They resolved some important issues about whether or not some facies of the Arikaree were Paleocene, and about whether or not the burrow structures were marine.

Results and Discussion

The Medicine Rocks Sandstone (Tongue River Member) directly overlies a regional unconformity. The basal part of this sandstone was dated by mammal teeth 20 years ago as late Torrejonian; strata in it 30 m higher in the section was dated as Tiffanian in age. The Ludlow Member underlies the unconformity, but in places an un-named fine-grained rippled sandstone unit occurs between the Ludlow and the Medicine Rocks Sandstone. This un-named sandstone was included in the Tongue River Member by previous workers (Bergantino, 1980). It is generally flat-lying, conformable above the Ludlow, and either of lacustrine or flood-basin lake origin. In certain regions and always above the Ludlow Member and below the Medicine Rocks Sandstone, this un-named sandstone is distorted by brittle-fracture slumping. See Figure 1 that accompanies the January workship report (this volume).

Coal beds at the top of the Ludlow Member have recently been dated by pollen as late Puercan and/or early Torrejonian in age (Doug Nichols, U. S. G. S., pers. communication, 1993). Thus the un-named sandstone and the slumping event likely occurred during the early and middle Torrejonian. The timing of this event seems to correspond with a mid-Torrejonian event of wide occurrence within the Bighorn basin (Hicks, 1993). Hicks argues that this event, in the Bighorn basin, was of tectonic, rather

than eustatic origin. His conclusion raises the issue as to whether the slumping event and the erosion that accompanied and followed it in our area was a consequence of tectonism or of global sea level change.

The mid-Torrejonian gap in the record studied by Hicks (1993) in the Bighorn basin was too far removed from sea level influence to have been controlled by the Cannonball Sea, which lay at that time 200 miles (320 km) to the east in western South and North Dakota, and separated by topographic uplifts such as the Bighorn mountains and possibly the Black Hills. However, the strata of the Ekalaka study area, although of fluvial and lacustrine origin were deposited less than 80 km to the west of the approximate edge of the Cannonball sea. Hence the slumping event could have resulted from a baselevel change due either to tectonism or eustacy.

Paleodrainage switching evidence 100 km to the northwest of the Ekalaka study area (Belt et al., 1992) suggests a slight rise of the Miles City arch, associated with the Black Hills, during mid-Torrejonian time. This is also consistent with a re-orientation of paleodrainages at that time in western North Dakota (Belt et al., 1984). Some of the regional hypotheses in those reports may be seriously challenged by the results from the KECK students of this project.

Meanwhile, preliminary results from Barret Cole's project indicate that Ludlow (late Puercan to early Torrejonian age, based on Doug Nichol's pollen, written communic., 1993; see also Nichols and Brown, 1992) paleodrainages flowed northeast. This northeast trend was also found by Chris Goodrum (1983) in the Cave Hills district of South Dakota 80-100 km to the east of Ekalaka. Barret also found that the Medicine Rocks Sandstone (late Torrejonain and Tiffanian, based on mammal teeth) flowed southeast. This sandstone is fluvial and represents the major regressive phase of the Paleocene, accompanying and following the retreat of the Cannonball sea from the Western Interior. A southeast paleodrainage direction makes it less likely (though not impossible) that the Black Hills formed any sort of topographic high during late Torrejonian and Tiffanian time.

Russ Abell's project shows that there is a compositional difference, though minor, between the Medicine Rocks Sandstone and the fluvial sandstones of the upper Ludlow. This was predicted because the Medicine Rocks paleodrainage trend was shown by Cole to be SE and the Ludlow paleodrainage trend to be NE. These results have a bearing on the presence or absence of drainage blockage by the Bighorn Mountains to the southwest of the study area (see discussions in Connor, 1992 and Hansley and Brown, 1993), but bear no relationship with the Black Hills.

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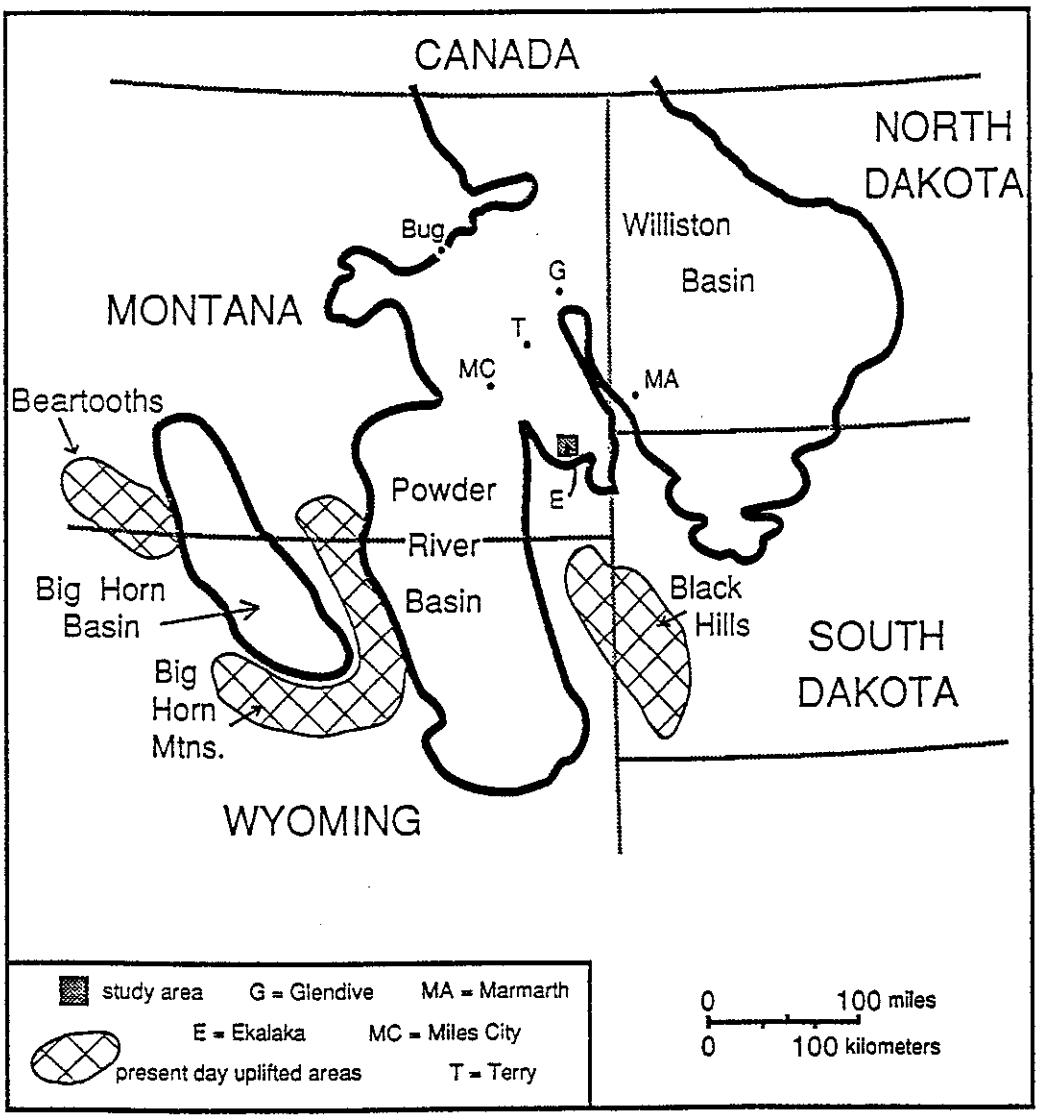

Figure 1. Map showing the location of the study area. The heavy line is the Cretaceous/Tertiary boundary with the Paleocene and younger strata lying within the Williston and Powder River basins. Note the position of the Big Horn and Black Hills basement-cored Laramide uplifts. One or both of these influenced the Paleocene sedimenation in the Ekalaka study area.