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RECENT HIGH GRADE URANIFEROUS LIGNITE
DISCOVERIES IN HARDING COUNTY, SOUTH
DAKOTA

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2

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<u>CONTENTS</u>	<u>Page</u>
ABSTRACT	4
INTRODUCTION.	4
History	
Location	
Purpose and Scope	
STRATIGRAPHY	
Upper Cretaceous.	6
Hell Creek Formation	
Tertiary	6
Fort Union Formation	
Ludlow member	
Cannonball Marine member	
Tongue River member	
White River Group.	7
Chadron Formation	
Brule Formation	
Arikaree Formation	
Quaternary	8
STRUCTURE	8
LOCALITIES	
North Cave Hills	9
South Cave Hills	10
Slim Buttes.	10
Short Pine Hills	11
URANIUM MINERALS	11
SUGGESTIONS AND PROSPECTING	12
REFERENCES	13

ILLUSTRATIONS

Figure 1 Geologic Map of Harding County, South Dakota	5
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RECENT HIGH GRADE URANIFEROUS LIGNITE DISCOVERIES
IN HARDING COUNTY, SOUTH DAKOTA

ABSTRACT

The first known deposits of commercial grade uraniferous lignites have been discovered in Harding County, South Dakota. Significant tonnage of this material is found in the Cave Hills and Slim Buttes area. Trial lots of lignitic ore, assaying as high as 0.86% U_3O_8 , have been shipped to the ore buying station at Edgemont. The deposits are in both the Ludlow and Tongue River members of the Fort Union formation which crops out over a large part of Harding and Perkins Counties. Most of the uranium concentrated in the lignite exists as a urano-organic compound or complex. Meta-autunite has been identified and other minerals may be present.

Yellow carnotite-type minerals have been found in sandstones of the Chadron formation and the Ludlow member of the Fort Union formation in the Slim Buttes area and in rocks which are thought to be part of the Arikaree formation in the West Short Pine Hills.

A major part of both Harding County and Perkins County is considered favorable for prospecting.

INTRODUCTION

History

The presence of uranium-bearing lignites in Harding County, South Dakota has been recognized for several years but no deposits sufficiently high in uranium content to be of commercial interest were known until recently. In August of 1954 a thin bed of ore-grade lignite was discovered in the North Cave Hills area. This discovery started intense prospecting activity and ore-grade deposits have since been found in several localities in Harding County.

Location

Harding County (fig. 1) is located in the extreme northwest corner of South Dakota. It is served by U.S. 85, a north-south, paved, all-weather highway. Buffalo, the county seat, is the largest town in the area. Railroad facilities are available at Belle Fourche, South Dakota, 75 miles to the south, and at Bowman, North Dakota, 50 miles to the north.

Purpose and Scope

The purpose of this report is to provide a general description, both geographically and geologically, of the areas in Harding County,

EXPLANATION

	Arikaree formation	} MIO-OCENE
	White River group	
	Tongue River member	
	Cannonball member	} PALEO-OCENE
	Ludlow member	
	Hell Creek formation	} CRETACEOUS
	Fox Hills sandstone	
	Pierre shale	

Geology after D. E. Winchester et al.

0 5 10 MILES
SCALE

INDEX MAP OF SOUTH DAKOTA

GEOLOGIC MAP OF HARDING COUNTY SOUTH DAKOTA

FIGURE 1

South Dakota in which commercial uranium deposits are known to exist. It is hoped that this information may be useful in the discovery and development of additional areas. No attempt is made herein to postulate theories of origin or control of deposition.

STRATIGRAPHY

The rocks exposed in the central and northern portion of Harding County range in age from Late Cretaceous to Recent and most are of continental origin. An unconformity at the base of the Oligocene rocks and another at the base of the Miocene rocks indicate at least two major interruptions in the sequence of sedimentation. These unconformities are best observed in the Slim Buttes area.

The lignitic ore deposits are found in both the Tongue River and Ludlow members of the Fort Union formation. Radioactive material occurs in thin, impure lignites, lignite ash, clinker, and a gray, well indurated mudstone. A carnotite deposit in the Chadron formation of Oligocene age in the southern part of the Slim Buttes area has been described in detail by Gill and Moore (1954) and is not discussed in this report.

The following rock descriptions are given in the order of the oldest to the youngest rocks.

Upper Cretaceous

Hell Creek Formation

The Hell Creek formation occupies most of Harding County south and west of Slim Buttes, Cave Hills and Table Mountain (fig. 1). It is approximately 450 feet thick and is composed largely of somber colored sandy shales containing lenses of greenish-gray and yellow sandstone. It also contains large iron carbonate concretions which weather to limonite on the surface. A few thin lenticular beds of lignite are found in the upper portion of the formation.

The Hell Creek formation contains no known or reported deposits of radioactive material.

Tertiary

Fort Union Formation

Ludlow member

The Ludlow member of the Paleocene Fort Union formation is exposed in outliers and in belts around the base of the higher buttes and mesas. It is approximately 250 feet thick but thins to the south and east. It is composed of interbedded, buff to yellow,

fine-to-very-fine-grained, poorly cemented sandstone, carbonaceous shale, and lignite.

The lignite beds locally attain considerable thickness and some of them have been worked commercially for coal. Two thin lignite beds in the upper portion of the Ludlow member contain significant amounts of uranium locally. There has been production from these beds.

Cannonball Marine member

The Cannonball Marine member of the Fort Union formation is present only in a very narrow zone in northeastern Harding County. It is the same age as the rocks of the Ludlow member with which it interfingers. It is composed of yellowish-brown to dark gray, fine- to medium-grained sandstone, some shale, and lenses of bluish-gray limestone.

There are no known or reported deposits of radioactive material in this member.

Tongue River member

The Tongue River member of the Fort Union formation is present in Table Mountain, North and South Cave Hills and their associated outliers. It is 75 to 200 feet thick in this area. The two distinct cliffs of the North Cave Hills are formed by two massive sandstone units of the basal Tongue River member. The lower unit, which is the most prominent caprock in the buttes, is 75 to 100 feet thick, buff to brown in color, fine-grained to coarse in texture, and is massively bedded in this area. It is cemented by calcium carbonate and is locally cross-bedded. This unit, in the southern portion of the North Cave Hills, is overlain by approximately 20 feet of light-colored, soft, thin-bedded sandstone. The upper cliff-forming sandstone is buff to reddish-brown in color, coarse-grained, massive, cross-bedded, and contains sparse calcium carbonate. Its thickness varies from 30 to 135 feet.

In several localities in the North Cave Hills the lower massive sandstone is directly overlain by a lignite bed 6 to 18 inches thick, which has supplied the major portion of the uranium production from Harding County to date.

White River group

Chadron Formation

The basal portion of the White River group, which is Oligocene in age, is represented by the Chadron formation. The Chadron formation rests unconformably upon either the Ludlow member or the Hell Creek formation in the Slim Buttes and Short Pine Hills areas, and upon the Tongue River member in the Cave Hills area. The lower

portion of the formation consists of yellowish sandstone, siltstone, and some detrital lignite representing material reworked from the underlying Ludlow member. The upper part is composed of white, fine- to coarse-grained sandstone, gray bentonite, and some tuffaceous sandstone. Carnotite occurs as an efflorescent yellow coating on fracture surfaces in this portion of the Chadron formation at one locality in the south Slim Buttes area. This deposit has been described in detail by Gill and Moore (1954).

Brule Formation

The Brule formation, representing the upper portion of the White River group, is present only in fossil landslide blocks in the Slim Buttes area. Most of this formation was removed by erosion prior to deposition of the overlying Arikaree formation. The Brule formation is composed of flesh-colored, thin-bedded to massive, sandy clays and tuffaceous sandstone.

The formation contains no known or reported deposits of radioactive material.

Arikaree Formation

The Arikaree formation, which is Miocene in age, unconformably overlies the rocks of the White River group. This unit forms the cliffs in the Slim Buttes and Short Pine Hills areas. It is composed of tan to light gray to greenish-gray, very-fine-grained, thin-bedded to massive, tuffaceous sandstone. Conglomerate lenses, composed of reworked material from the Chadron and Brule formations, occur locally near the base.

Samples of a yellowish-green radioactive mineral, which may have been obtained from this formation, have been submitted by local prospectors.

Quaternary

The Quaternary system is represented in Harding County by Recent terrace and flood plain deposits along the principal streams. The materials in these deposits were derived from the older Cretaceous and Tertiary sediments.

STRUCTURE

The area is located at the southwestern margin of the Williston basin. A number of structures, including the Cedar Creek anticline which crosses the area of principal interest, have been determined by sub-surface work. These structures are not reflected in the Tertiary beds but the surface strata are characterized by very gentle dips to the northeast.

There are several local variations in dip. In the area of Riley Pass in North Cave Hills the presence of a shallow structural trough is suggested in the Tongue River strata which cap the mesa.

Only a few small faults have been recognized. Slumping of beds in the Slim Buttes area produces effects similar to faulting. These local structural failures occur in beds of both the Ludlow and the White River units and tend to complicate the geology.

LOCALITIES

The geographic limits of the various localities, all in Harding County, South Dakota, are shown in figure 1. A general discussion of each area follows.

North Cave Hills

The North Cave Hills are located in Townships 21 and 22 North, Range 5 East, only a few miles south of the North Dakota state line. The hills are readily accessible by automobile, and jeep trails traverse most of the area.

The hills are capped by a massive sandstone of the Tongue River member of the Fort Union formation, and the Ludlow member is exposed on the lower slopes. The ore-bearing lignite bed, which directly overlies the basal massive sandstone of the Tongue River member, crops out in an area extending a few miles to the northwest and southeast from Riley Pass. The depth of overburden varies from 0 to 80 feet. Local variations in the dip of the sediments occur in this area but their possible relation to ore deposition is not understood at present. Lignitic material from this bed comprises the bulk of the ore shipped from Harding County to date.

In the vicinity of Riley Pass, the ore-bearing bed is an impure lignite unit containing the major portion of the uranium in undetermined association with the carbonaceous material. A fluorescent uranium mineral, identified as meta-autunite, occurs locally as a thin coating on cleat faces or fracture surfaces. The meta-autunite appears to be present in the richest portions of the deposits. Assays of shipments from North Cave Hills range from 0.10% U_3O_8 to 0.86% U_3O_8 . Channel samples of the lignite assay as high as 1.5% U_3O_8 and one picked sample showed an equivalent uranium content of more than 8%. Disequilibrium is commonly in favor of the chemical assay.

In the North Cave Hills district, at least two thin lignite beds are present near the top of the Ludlow member of the Fort Union formation. An ore-grade sample was obtained from one of these beds in the northwestern portion of the area and both beds are considered possible ore-horizons. Ore-grade samples have also been reported from a lignite bed in Flint Butte, 3 miles east of the Cave Hills. This bed is believed to be part of the Ludlow member.

South Cave Hills

The South Cave Hills are located in Townships 20 and 21 North, Ranges 4 and 5 East, due north of Buffalo, South Dakota. The area is easily accessible by automobile.

The South Cave Hills and McKinzie Butte to the south are geologically similar to the North Cave Hills, with a cap of massive Tongue River sandstone underlain by the Ludlow member. Known occurrences of anomalous radioactivity in this area, at present, are confined to the stratigraphically highest lignite bed in the Ludlow member. In many places this bed has been burned and only the ash remains. High-grade samples have been reported from lignite ash in the northwest part of the area. Along the west side of the hills very high radioactivity is found in a gray, sandy, mudstone containing abundant black particles of unidentified material and some scattered pyrite crystals. The mudstone averages 2 feet in thickness and directly overlies a radioactive lignite bed.

Assays of a few trial shipments from the South Cave Hills range from 0.10% U_3O_8 to 0.21% U_3O_8 . Picked samples from this area have assayed as high as 3.45% U_3O_8 .

Anomalous radioactivity is found in lignite, lignite ash, mudstone, and red "clinker" at various places around the periphery of the South Cave Hills as well as at McKinzie and Rattlesnake Buttes lying to the south (fig. 1).

Slim Buttes

The Slim Buttes area covers part of Townships 16, 17, 18, and 19 North, Ranges 7 and 8 East in the southeast part of Harding County. Good state and county roads traverse part of the area but access to the northern end and the top of the Buttes is restricted to jeep trails.

The Slim Buttes are capped by the Arikaree formation lying unconformably upon rocks of the White River group. The latter unconformably overlies the Ludlow member, and the Tongue River member is absent in this area.

Carnotite-type minerals have been discovered in two localities in the Slim Buttes area. The first discovery was made in Cedar Canyon where the carnotite occurs as yellow coatings on fracture surfaces and as minor disseminations in fine-grained tuffaceous sandstones near the top of the Chadron formation. A yellow carnotite-type mineral was found in light brown, fine-grained sandstone and carbonaceous shale of the Ludlow member in an area east of Reva Gap. High-grade samples have been reported from this deposit. Radioactivity has also been discovered in lignite beds at three separate localities, one of which has produced several tons of ore assaying more than 0.30% U_3O_8 .

A core drilling program was carried out in the Slim Buttes area in 1951 and 1952 by the U. S. Geological Survey. Results of this program were later published in a series of U.S.G.S. reports, including Zeller, (1952 and 1953), and a Bureau of Mines report, Walker (1954).

Short Pine Hills

The Short Pine Hills occupy parts of Townships 16 and 17 North, Ranges 1, 2, and 3 East in southwestern Harding County. Good roads lead to the area but access within the hills is limited to jeep roads and trails.

The Short Pine Hills are capped by rocks of the Arikaree and White River formations with the Cretaceous Hell Creek formation exposed on the lower slopes and in the area surrounding the hills. No outcrops of the Ludlow member have been mapped in this area.

A yellow carnotite-type mineral has been found in the West Short Pine Hills. The mineral occurs as a thin, very spotty coating on small boulders of dense, very hard and siliceous, fine-grained sandstone included in a thin bed of soft clay. Abnormal radioactivity is also found in thin limestones and calcareous siltstones of the upper part of the Arikaree formation in this area. No radioactive lignite beds are known in the Short Pine Hills to date and no ore shipments have been made from this area.

URANIUM MINERALS

Visible uranium minerals are rare in the lignite; most of the uranium is believed to exist as a urano-organic compound or complex. All petrographic studies known to this writer have been done on the low-grade lignites and petrographic and mineralogic studies of the higher grade lignites have only recently been initiated.

Only two uranium minerals have been identified in the radioactive sandstones and lignites of Harding County, although further mineralogical work may prove the existence of others.

The greenish-yellow fluorescent mineral which is found in the Tongue River lignite bed in the North Cave Hills has been identified as meta-autunite. This mineral may also be present in the radioactive lignites of the Ludlow member, although fluorescence is seldom observed. Identity of the uranium mineral present in the radioactive mudstones of the Ludlow member is unknown at present.

The yellow uranium mineral which is found in the Chadron formation at Cedar Canyon has been identified as carnotite. A similar yellow mineral found at other places in the Slim Buttes area and also in the West Short Pine Hills may also be carnotite.

In many cases where radioactivity is detected in the lignites, and occasionally in the non-carbonaceous materials, there is no visible indication of mineralization. This is true even when the radioactivity is abnormally high.

SUGGESTIONS FOR PROSPECTING

Anomalous radioactivity has been found in most of the formations of Tertiary age that are exposed in Harding County. All contain potentially favorable host rocks. In prospecting, particular attention should be given to the thinner (0.5 to 2 feet) lignite beds of the Tongue River and Ludlow members, the gray to buff sandstones of the Ludlow member, and the light colored tuffaceous sandstones of the Chadron formation, particularly near the contact with the overlying Arikaree formation.

Prospecting in the Arikaree and Chadron formations will necessarily be confined to the Slim Buttes and Short Pine Hills area, and smaller erosional remnants to the east in Perkins County. Rocks of favorable members of the Fort Union formation extend in a broad belt eastward into Perkins County. It is possible that prospecting within this belt may lead to the discovery of additional deposits of radioactive material.

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