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TECTONIC MAP OF NORTHERN COLORADO AND NORTHEASTERN UTAH, SHOWING THE DISTRIBUTION OF URANIUM DEPOSITS

By Frank W. Osterwald and Basil G. Dean

Trace Elements Memorandum Report 949

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GEOLOGICAL SURVEY

TECTONIC MAP OF NORTHERN COLORADO AND NORTHEASTERN UTAH SHOWING THE DISTRIBUTION OF URANIUM DEPOSITS*

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Frank W. Osterwald and Basil G. Dean

August 1956

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TECTONIC MAP OF NORTHERN COLORADO AND NORTHEASTERN UTAH

by

Frank W. Osterwald and Basil G. Dean

FOREWORD TO TECTONIC MAP OF CORDILLERAN FORELAND

The Cordilleran Foreland (King, 1951, p. 58-62; Horberg, et al., 1949, p. 192-194) forms a broad north-south belt, parallel to and east of the Cordilleran geanticline (fig. 1), in which the predominant geologic structure is a series of anticlinal mountains and broad asymmetric basins that contrast sharply with the folds and overthrusts related to the Cordilleran geanticline. The mountains of the Foreland are bordered by flexures, and by high-angle normal and reverse faults. Many structures are completely or partly covered by nearly flat-lying sedimentary rocks of Tertiary age. Most of the eastern margin of the Foreland is beneath the Tertiary rocks of the Great Plains and has not been defined.

A tectonic map of most of the Cordilleran Foreland (fig. 2) is being compiled as an aid to study the geologic setting of uranium deposits within the region, and to determine what relationships may exist between the distribution of uranium deposits and the regional tectonic pattern (Osterwald, 1955). The map will show the distribution of faults, uranium deposits, areas of volcanic activity, and crest lines and troughs of folds. Outcrop areas of Precambrian and post-Eocene rocks will be shown to designate the relative age of structures. Where possible, the Precambrian rocks will be subdivided into structural types so that their influence on younger deformations

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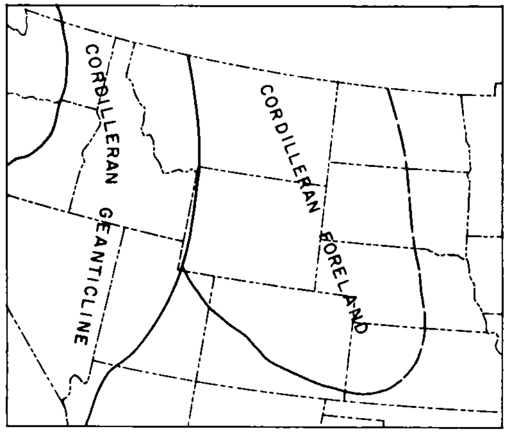

FIGURE 1. –INDEX MAP OF WESTERN UNITED STATES SHOWING GENERALIZED LOCATIONS OF CORDILLERAN FORELAND AND CORDILLERAN GEANTICLINE

0 155 310 MILES

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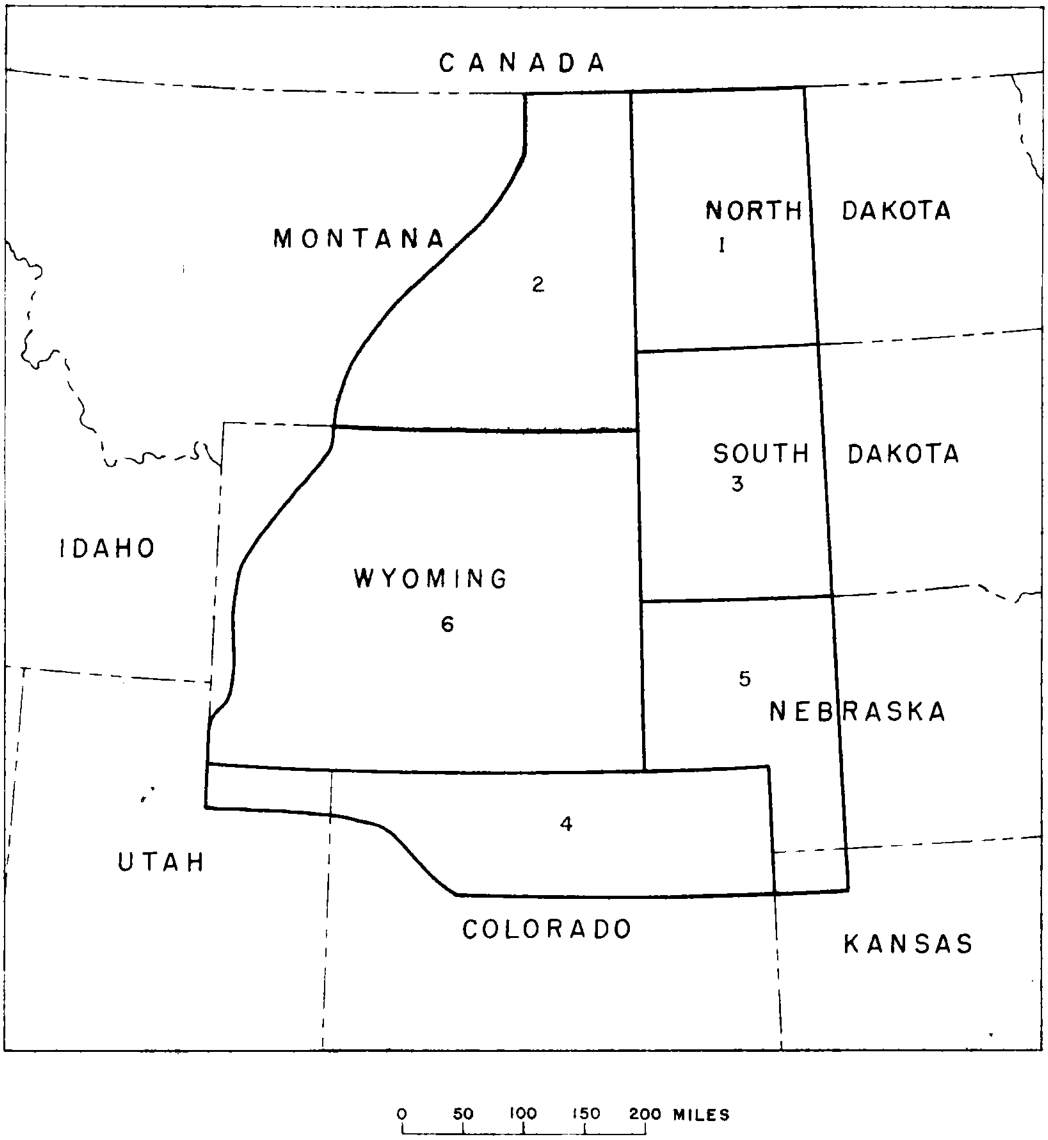

FIGURE 2—. INDEX MAP OUTLINING THE TECTONIC MAP OF MOST OF THE CORDILLERAN FORELAND

NUMBERS IDENTIFY THE INDIVIDUAL MAPS

1. – Western North Dakota
2. – Eastern Montana
3. – Western South Dakota
4. – Northern Colorado – Utah
5. – Western Nebraska – Kansas
6. – Wyoming, east of overthrust belt

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may be inferred. The relationship between the distribution of uranium deposits and the regional tectonic pattern might designate new areas favorable for the discovery of uranium deposits in the Cordilleran Foreland as well as in other areas with similar tectonic history.

INTRODUCTION

The compilation of the tectonic map of northern Colorado and northeastern Utah (area 4, fig. 2) was done by the U. S. Geological Survey on behalf of the Division of Raw Materials of the U. S. Atomic Energy Commission. Structures shown on the map have been obtained from published geologic maps, and from unpublished data supplied by government agencies, private companies, and independent geologists. Particular acknowledgment is given to H. F. Murray of the University of Colorado, who supplied an unpublished structure contour map of the Denver Basin. W. H. Bradley, W. R. Hansen, D. M. Kinney, E. J. McKay, R. T. Chew, and P. K. Sims of the U. S. Geological Survey supplied unpublished data. The tectonic map of northern Colorado and northeastern Utah is only a progress report; any suggestions for corrections or additions will be appreciated.

The various structures of the Foreland can be divided into three large classes to show the relation of uranium deposits to the structural pattern: (1) Large-scale structures include large mountain ranges, major basins, and fault zones, with structural relief as much as a few tens of thousands of feet; some are several hundred miles long. (2) Intermediate-scale structures are large folds and faults superimposed on large-scale structures; these have a structural relief of a few hundred feet and few exceed several tens of miles in length. (3) Small-scale structures are folds, faults, and joints of lesser size which, though not important in the localization of uranium districts, nevertheless may be very important controls of individual deposits.

GENERALIZED STRUCTURE OF NORTHERN COLORADO AND NORTHEASTERN UTAH

The predominant tectonic structures in northern Colorado and northeastern Utah trend northwest, northeast, and east-west to east-northeast; these trends probably originated during Precambrian time (Osterwald, 1955). Locally some units, as for example the Colorado Front Range and the Denver Basin, trend about north-south at an oblique angle to the trend of the other tectonic structures. Most of the structures, however, were accentuated, and received most of their present configuration during the Laramide Revolution. The present Colorado Front Range occupies the site of an older range that was topographically and structurally high during Pennsylvanian time. Within this general framework the tectonic map indicates four large areas containing geologic structures of different size, configuration, and trend: (1) the Uinta Mountains uplift, (2) the Sand Wash Basin-Axial

Basin (structure no. 1)/-White River uplift, (3) the Colorado

/Structure numbers in parentheses following tectonic structure names are keyed to the structure symbols on the tectonic map of Colorado and Utah.

Front Range-Park Range uplift with associated intermontane basins and subsidiary ranges, and (4) the Denver Basin.

Uinta Mountains uplift

The general trend of the Uinta Mountains uplift is indicated on the map by the approximate position of the crestline of the Uinta anticline (structure no. 22), by the trends of the faults bordering the uplift, and by the outcrop area of rocks of Precambrian age. Most of this uplift trends approximately east-west; the eastern end, however, trends northwest where the range is intersected by a series of northwest-trending structures. The Uinta anticline is unique, in that the crestal part is broad and gently folded, whereas the flanks are intensely folded and faulted.

Sand Wash Basin-Axial Basin-White River uplift

The Sand Wash Basin-Axial Basin-White River uplift is characterized by a series of long, northwest-trending folds and faults; locally the northwest-trending geologic structures are intersected by structures that trend approximately northeast. Some of the folds have a few thousands of feet of structural relief, but most are much smaller. Post-Miocene movement along some of the northwest-trending anticlines has produced superposed synclines in rocks of Miocene age, as well as zones of en-echelon anticlines, synclines, and small faults (Sears, 1924). Volcanic flows, dikes, sills, and plugs characterize the eastern part of the area, particularly the White River uplift and the eastern part of the Sand Wash Basin. Most of these volcanic rocks are of late Tertiary age, except for a few intrusives along the eastern margin of the Sand Wash Basin that are of early Tertiary age. Other intrusives that do not crop out probably are present in the Sand Wash Basin; an example is Slater dome (structure no. 67) (Wells, R.E., 1956, verbal communication).

Colorado Front Range-Park Range uplift

The Colorado Front Range-Park Range uplift consists of several mountain ranges that trend approximately north, and a few intervening large basins. Within these ranges and basins, the smaller tectonic structures trend northwest or northeast at angles oblique to the trend of the larger structures. Though there are many local variations, the trends of structures of Precambrian age shown on the map, such as foliation, folds, and trend of lithologic units, are approximately northwest, northeast, and east-west. In many local areas Tertiary structural trends diverge from Precambrian structural trends, but the general coincidence of the two patterns on a regional basis suggests that the later structures are controlled, at least in part, by the earlier ones (Lovering and Goddard, 1950, p. 57-59).

Most of the intermediate- and small-scale Tertiary faults within the uplift are high-angle normal or reverse types. The Williams Range thrust fault (structure no. 58) and a few other low-angle thrust faults are exceptions, and probably are caused by local compressive components of stress during deformation that was largely the result of differential vertical movements.

Folds within the mountainous region have up to a few thousands of feet of structural relief. Extensive Tertiary flows and a few bodies of intrusive rocks of early Tertiary age in the central part of the mountainous areas are shown on the tectonic map. A line of intrusives of early Tertiary age (Lovering and Goddard, 1950, p. 43), in the southern part of the mountainous area, marks the trend of the Front Range mineral belt. This line of stocks is parallel to other large-scale northeast-trending structures in the Cordilleran Foreland (Osterwald, 1955). Numerous northwest-trending high-angle faults, including many reverse faults with strong components of horizontal movement, are common along the eastern margin of the mountain area. The faults, and their related subsidiary fractures, provided openings along which many veins and dikes were emplaced. Folds along the mountain front are related to movements along these faults.

Denver Basin

The Denver Basin underlies most of eastern Colorado and adjacent parts of Wyoming, Nebraska, and Kansas; it is sometimes referred to as the Julesburg Basin. Within the area of the tectonic map of northern Colorado and northeastern Utah, the basin axis trends approximately north-south, but south of the map area the trend changes to southeast. Numerous small folds modify the structure of the Denver Basin throughout much of eastern Colorado. Although the trends of these folds vary, northwest and northeast trends are most common; some folds trend approximately east-west and a few almost north-south. The eastern margin of the Denver Basin, within the area shown on the tectonic map, is the northeastern extension of the Las Animas arch (structure no. 131). The trend of the Denver Basin trough is parallel to the trend of the mountain ranges west of Denver, Boulder, and Fort Collins, but is oblique to most of the structures within the Colorado Front Range-Park Range uplift, although a few structures in the mountain belt parallel the basin trough. Most of the small anticlines shown in the eastern part of Colorado have only a few tens of feet of structural relief.

RELATION OF URANIUM DEPOSITS TO STRUCTURES

Widely scattered uranium deposits or groups of deposits are distributed throughout northern Colorado and northeastern Utah. Most of the important deposits or groups of deposits are in three major tectonic units, namely, the Uinta Mountains uplift, the Sand Wash Basin-Axial Basin-White River uplift, and the Colorado Front Range-Park Range uplift. Within these major units, the uranium deposits form clusters or groups related to small- and intermediate-scale structures. In the Uinta Mountains uplift, deposits are distributed along the flanks of the uplift where there are abundant northwest-trending intermediate-scale folds and faults in en-echelon pattern. West of Craig, in Moffat County, Colorado, a group of deposits is spatially related to diverging northwest-trending and northeast-trending intermediate-scale faults and folds. In the northwestern part of the White River uplift in Rio Blanco County, Colorado, a group of deposits is spatially related to the crest of the large-scale Yellowjacket anticline (structure no. 68). In the eastern part of the Colorado Front Range-Park Range uplift, in Boulder, Clear Creek, and Jefferson Counties, Colorado, individual deposits or groups of deposits are spatially related to numerous prominent northwest-trending en-echelon intermediate-scale faults which are intersected by less prominent northeast-trending small- to intermediate-scale fractures.

A few widely scattered deposits or small groups of deposits cannot be clearly related to any individual small- to intermediate-scale structure. Many deposits are related to anticlinal crests, synclinal troughs, or to faults; others are spatially related to Tertiary dikes and intrusions.

Based on the relationships shown within the map area, and provided that good host rocks are available, a structural pattern should be favorable for the occurrence of uranium deposits if: (1) northwest-trending intermediate-scale structures are arranged en-echelon along the flanks of north- or east-trending large-scale structures, (2) northwest-trending intermediate-scale structures are associated with northeast-trending intermediate- to small-scale structures, or (3) simple large-scale structures are present.

Where deposits or groups of deposits are related to individual small- to intermediate-scale structures the structural pattern cannot be established except where the individual structure can be related to a framework of large-scale structures.

COLORADO AND UTAH STRUCTURES

1. Axial Basin anticline
2. Danforth Hills anticline
3. Williams Fork anticline
4. Breeze anticline
5. Beaver Creek anticline
6. Iles dome
7. Powder Wash anticline
8. Hiawatha anticline
9. Dry Mountain anticline
10. Chimney Creek dome
11. Tow Creek anticline
12. Trull anticline
13. Sage Creek anticline
14. Fish Creek anticline
15. Pagoda anticline
16. Williams Park anticline
17. Seely anticline
18. Lookout Mountain arch
19. Uinta fault
20. Cross Mountain anticline
21. Elk Springs anticline
22. Uinta Mountain anticline
23. Yampa fault
24. Thornburg (Morapos) anticline
25. White River plateau
26. Wellington anticline
27. Fort Collins anticline
28. Douglas Lake anticline
29. Berthoud anticline
30. Black Hollow anticline
31. Parallel dome
32. Haystack Mountain anticline
33. Bellvue anticline
34. Clarks Lake anticline
35. Maxwell "dike"
36. Hoosier "dike"
37. Livingston "dike"
38. Rogers "dike"
39. Hurricane Hill "dike"
40. Junction Ranch "dike"
41. Blackhawk fault
42. Dory Hill fault
43. Floyd Hill fault
44. Valmont "dike"
45. Copeland "dike"
46. Stink Creek fault
47. Shell Creek fault
48. Laramie River syncline
49. Stuck Creek syncline
50. Bull Mountain syncline

51. North Middle Mountain fault
52. Green Ridge fault
53. Bull Mountain fault
54. Independence Mountain fault
55. North McCallum anticline
56. North Park syncline
57. East Pole Mountain fault
58. Williams Range thrust fault
59. Quartz Hill anticline
60. Granby anticline
61. Gore fault
62. Whiskey Creek fault zone
63. Spraddle Creek fault zone
64. Minturn - Grouse Creek fault zone
65. Round Bottom syncline
66. Dry Mountain anticline
67. Slater dome
68. Yellowjacket anticline
69. Poose Creek anticline
70. Crosho Lake anticline
71. Little Poose Creek anticline
72. Trout Creek anticline
73. Two Bar anticline
74. Haymower anticline
75. North Craig anticline
76. Bell Rock dome
77. Moffat dome
78. Shell Creek fault
79. King Solomon Creek fault
80. North Flank fault
81. Linwood nose
82. Henry's Fork fault
83. Clay Basin anticline
84. South Flank fault
85. Baker Spring nose
86. Island Park syncline
87. Glen anticline
88. McCoy (Rock Creek) fault and anticline
89. Burns syncline
90. Wolcott syncline
91. Squaw Creek fault
92. Coffin Mountain fault
93. Bruce Creek fault
94. Brush Creek fault
95. Lady Belle fault
96. Cabin Creek fault
97. Boetcher Ridge fault
98. Hill anticline
99. Sheep Mountain fault
100. Delanos fault
101. Delanos anticline
102. Byers Ridge fault

103. Never Summer thrust fault
104. Mt. Bross fault
105. Hot Sulphur Springs syncline
106. Louisville fault
107. Louisville anticline
108. Fireside fault
109. Harper fault
110. Fox fault
111. Boulder Creek anticline
112. Copper Spur anticline and fault
113. Yarmony monocline
114. Yarmony Mountain fault
115. Yarmony Park fault
116. Apex fault
117. Berthoud Pass fault
118. Coal Creek syncline
119. Ralston dike
120. Golden fault
121. Iron dike
122. Deep Creek fault zone
123. Coal Mine syncline
124. Dry Fork anticlinal nose
125. Ashley Creek anticlinal nose
126. Neal dome
127. Brush Creek anticlinal nose
128. Davis Spring anticlinal nose
129. Little Grizzly fault
130. Coalmont fault
131. Las Animas arch
132. Elk Mountain anticline
133. South McCallum anticline
134. East Lake Creek fault
135. Sand Creek - Boxelder Creek anticline

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DEPARTMENT OF THE INTERIOR
UNITED STATES GEOLOGICAL SURVEY

TRACE ELEMENTS MEMORANDUM
REPORT 949

Compiled by Arloa Shipman

FIGURE 3.– INDEX MAP OF NORTHERN COLORADO AND NORTHEASTERN UTAH, SHOWING SOURCES OF DATA

DEPARTMENT OF THE INTERIOR
UNITED STATES GEOLOGICAL SURVEY

PREPARED IN COOPERATION WITH
UNITED STATES ATOMIC ENERGY COMMISSION
DIVISION OF RAW MATERIALS

TRACE ELEMENTS MEMORANDUM
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FIGURE 4.– TECTONIC MAP OF NORTHERN COLORADO AND NORTHEASTERN UTAH.
SHOWING THE DISTRIBUTION OF URANIUM DEPOSITS.

10 0 10 20 30 Miles

Compiled by F. W. Osterwald and B. G. Dean
1955