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GEOLOGY OF TUMBLEDOWN MOUNTAIN

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INTRODUCTION

Tumbledown Mountain is a steep-sided, west-projecting spur of Beach Mountain, 11 km north-northwest of Van Horn, Texas (fig. 1). An account of its geology seems worthwhile, as the locality will be visited during the New Mexico Geological Society Field Conference. Moreover, its excellent rock exposures epitomize many of the earlier geological events in the Van Horn area.

This account is based on observations that I made half a century ago, between 1933 and 1939 (King and Flawn, 1953; King, 1965), and I have made only brief visits there since then. I am aware that more recent work has been done in the area, including prospecting for talc. Nevertheless, I doubt that this later work materially changes the conclusions that I reached during my earlier survey.

PREVIOUS OBSERVATIONS

The region was first investigated by W. H. von Streeruwitz for the Texas Geological Survey between 1888 and 1892 (von Streeruwitz, 1890, 1891, 1892, 1893). He divided the rocks of the southern Sierra Diablo region into a red "Diablo sandstone," which he believed to be of Devonian age, and an overlying mass of limestone which he assigned to the Carboniferous, on the basis of fossil determinations by C. D. Walcott.

More complications were discerned afterwards by E. T. Dumble

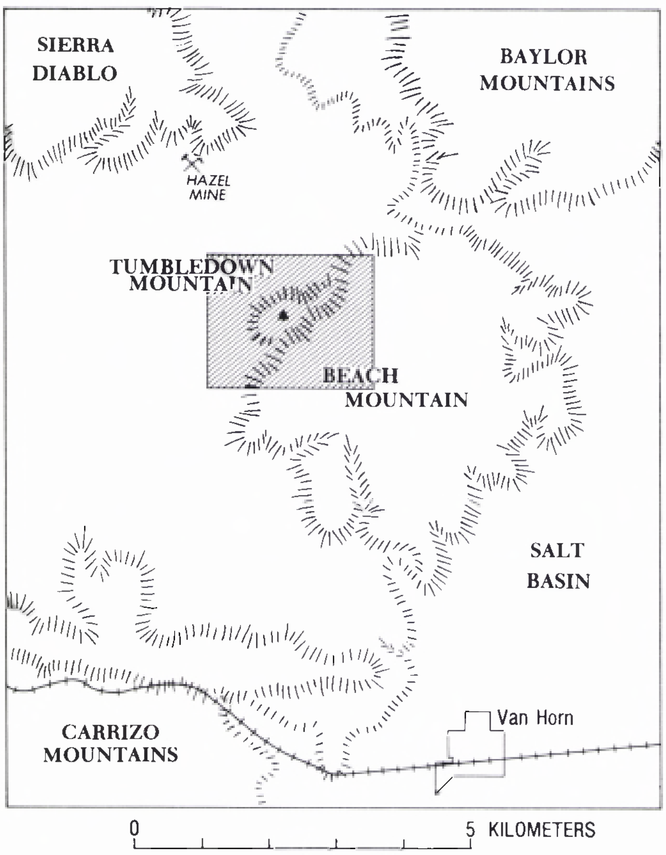

Figure 1. Index map of Van Horn area, showing location of Tumbledown Mountain.

(Dumble, 1902), the former director of the Texas survey. On Tumbledown Mountain he observed that the red sandstones, which he called the "Hazel," were overlain by "Texan marble," considered to be of "Algonkian" age, followed by sandstone, lava and shale. In nearby areas he found a sequence of "brown" sandstones and grits, which passed upward into gray and yellow sandstone containing worm tubes, or *Scolithus*, and he considered all these sandstones to be of "Potsdam" (Cambrian) age. The sandstones were followed by sands and limes of "Silurian" (i.e., Ordovician) age. Significantly, he observed that the top of the Algonkian sequence on Tumbledown Mountain was overlain directly by the Silurian, with the Potsdam missing.

The area was visited a little later by G. B. Richardson (1904), during a general reconnaissance of northern Trans-Pecos Texas. He named Dumble's brown Potsdam sandstones the "Van Horn" and his overlying Silurian limestones the "El Paso." On Tumbledown Mountain he found that the Precambrian rocks were steeply folded into "an almost complete quaquaversal syncline," which was "separated from the Ordovician rocks to the east by a normal fault striking north and south, with an upthrow on the west." He did not mention Dumble's observation of "Silurian" lying directly on the Precambrian at the top of the mountain. He remarked that "this area demands detailed study."

However, when Richardson returned to prepare the more detailed Van Horn folio (1914), he added few details to Tumbledown Mountain geology. Dumble's Hazel sandstone, Texan marble and associated Precambrian rocks were grouped together into a "Millican formation." He again mentioned their synclinal structure on Tumbledown Mountain (here called "Morris Peak," a name that has not survived) and reported that the Precambrian on the mountain "is in fault contact to the south and east with the Van Horn sandstone and El Paso limestone."

LATER OBSERVATIONS

I first climbed Tumbledown Mountain during a brief span of field work in the summer of 1933. The results of my climb startled me, and overturned many of my preconceived notions of the stratigraphy. I found that Tumbledown Mountain was, as previously reported, a synclinal mass of Precambrian limestone and other rocks (later called the Allamoore Formation). But I was surprised to discover that these were overlain directly by flat-lying Ordovician sandstones (later called the Bliss Sandstone) (fig. 2). (I was unaware, as was Richardson, that Dumble had made the same observation much earlier.) Where was the Van Horn Sandstone, which stood in bold cliffs and ledges to the northeast and southeast? I fancied that the Bliss Sandstone had overstepped across the Van Horn Sandstone to lie on a buried hill of Allamoore.

Field work during later seasons modified somewhat my first impressions. As worked out by me and my colleagues, the stratigraphic sequence near Tumbledown Mountain became as follows:

Ordovician

El Paso Limestone, forming main mass of Beach Mountain.

Bliss Sandstone, about 36 m thick, of early Early Ordovician age. Structural unconformity; block-faulting of Van Horn; erosion.

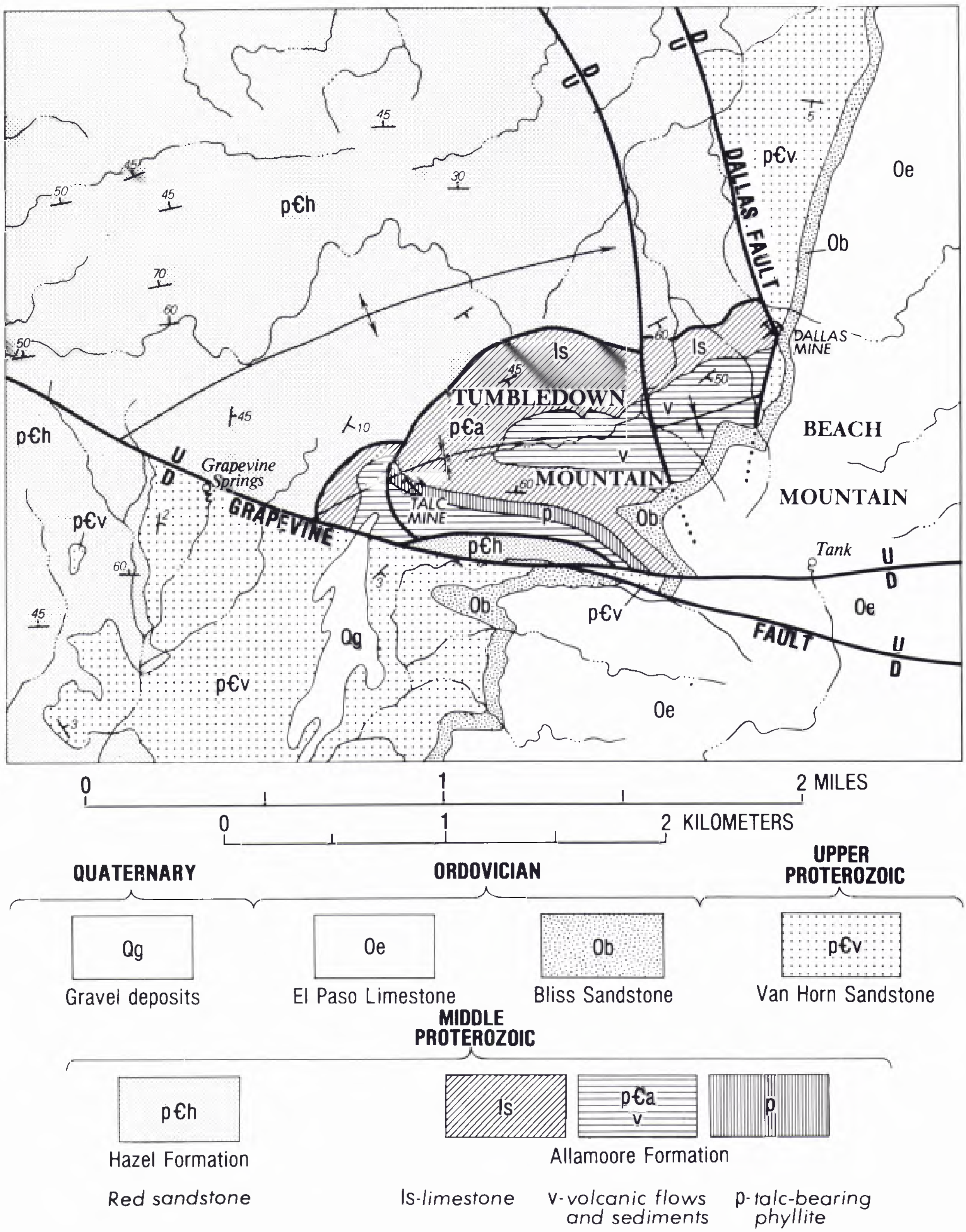

Figure 2. Geologic map of Tumbledown Mountain area.

Upper Proterozoic

Van Horn Sandstone. Massive coarse red sandstone, with layers of rounded cobbles of older rocks; thickness variable, due to erosion at the top.

Structural unconformity, with major orogeny, folding and thrusting.

Middle Proterozoic

Thrust which brings Allamoore Formation over Hazel Formation. Thrusting is generally from south to north.

Hazel Formation. Red sandstone, with layers of conglomerate containing clasts of Allamoore Formation.

Allamoore Formation. About 427 m exposed in synclinal remnant (fig. 3), with a 150-m thick limestone unit in lower part, underlain by greenstone lava and talc-bearing phyllite, and overlain by volcaniclastic sandstone, lava and sandy limestone.

The Allamoore Formation on Tumbledown Mountain has a clearly marked synclinal structure, with southward dips on the north flank of about 45°, and northward dips on the south flank of about 60°. The layers pursue regular courses around the syncline. Its limestones and other rocks are fresher and less altered than in other areas and are not marked by the crumpling and irregularity seen in most exposures of the formation. The Allamoore is infolded in the surrounding Hazel Formation, whose red sandstones are well exposed below it to the north and west.

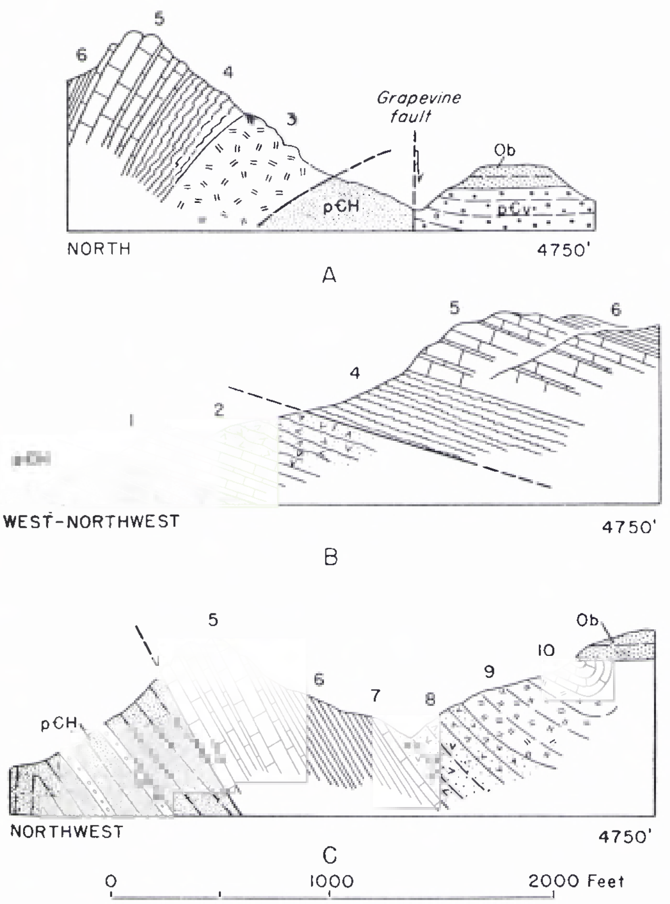

Figure 3. Profiles showing stratigraphic section on Tumbledown Mountain. A, On southern side of mountain; B, at west end of mountain; C, on north side of mountain. Numbers refer to units in Allamoore Formation (see text). p€h–Hazel Formation; p€v–Van Horn Sandstone; Ob– Bliss Sandstone.

Nevertheless, the Allamoore lies tectonically over the Hazel, and is a klippe which has been thrust over the Hazel. On the north flank of the mountain the main limestone unit of the Allamoore (unit 5, fig. 3) lies against the Hazel, but on the south flank lower units lie between (units 3 and 4, fig. 3), a talc-bearing phyllite (mined for talc) and a massive greenstone lava flow. At the west end of the mountain a lower slice of Allamoore 105 m thick (units 1 and 2, fig. 3) intervenes between the main mass on the mountain and the Hazel beneath. Moreover, the fine-grained red Hazel sandstone contains interbedded layers of conglomerate whose clasts are fragments derived from the Allamoore.

The Allamoore and Hazel Formations were strongly deformed, and this deformation preceded deposition of the Van Horn Sandstone, which lies with angular unconformity on the older rocks which are tilted at every angle. Their eroded surface is well displayed along the basal Van Horn contact southwest of Tumbledown Mountain and has a moderate topographic relief, with projecting hills of Hazel sandstone and intervening valleys filled by Van Horn Sandstone (fig. 4).

The Van Horn Sandstone is downfaulted against the Allamoore Formation along two nearly vertical faults, the Dallas fault on the east with northerly trend, and the Grapevine fault on the south with easterly trend (fig. 2). Both faults were displaced before Bliss time and were truncated by the Bliss Sandstone; the Dallas fault has not been displaced again, but the Grapevine fault was reactivated later, again with southward displacement. Next to the Dallas fault the Allamoore limestones have been mineralized with copper at the old Dallas Mine, but this mineralization probably occurred long after the fault displacement. Toward the west along the Grapevine fault, structures in the Hazel Formation are displaced left-laterally by about 800 m, but there is no evidence for lateral displacement where the fault extends through the Van Horn or the Ordovician formations, so that this displacement must have occurred earlier. Where the Grapevine fault crosses the Van Horn Sandstone it is followed by a line of springs; the most notable is Grapevine Spring.

There is an additional complication. During Late Pennsylvanian time the Sierra Diablo region was broadly folded, then deeply eroded before the Wolfcampian Hueco Limestone was laid down. Beach Mountain east of Tumbledown Mountain lay along the axis of a synclinal downfold, hence it preserves nearly 600 m of Ordovician sandstones and carbonate rocks (Bliss Sandstone, El Paso Limestone and Montoya Dolomite). But only 5 km to the northwest, the scarps north of the Hazel Mine consist of Hueco Limestone resting directly on the red sandstones of the Hazel Formation, and all the lower Paleozoic, as well as the Van Horn Sandstone, are missing as a result of pre-Hueco erosion. This area was on the crest of an anticlinal arch produced during Late Pennsylvanian deformation.

TECTONIC HISTORY

In summary, the following geologic and tectonic events have occurred in the Tumbledown Mountain area:

(1) Formation of the Allamoore and Hazel (Middle Proterozoic).
(2) Deformation of Allamoore and Hazel; northward thrusting of Allamoore over Hazel Formation.
(3) Left-lateral strike-slip displacement on Grapevine fault (age uncertain).
(4) Deposition of Van Horn Sandstone on deeply eroded surface of older rocks (Upper Proterozoic).

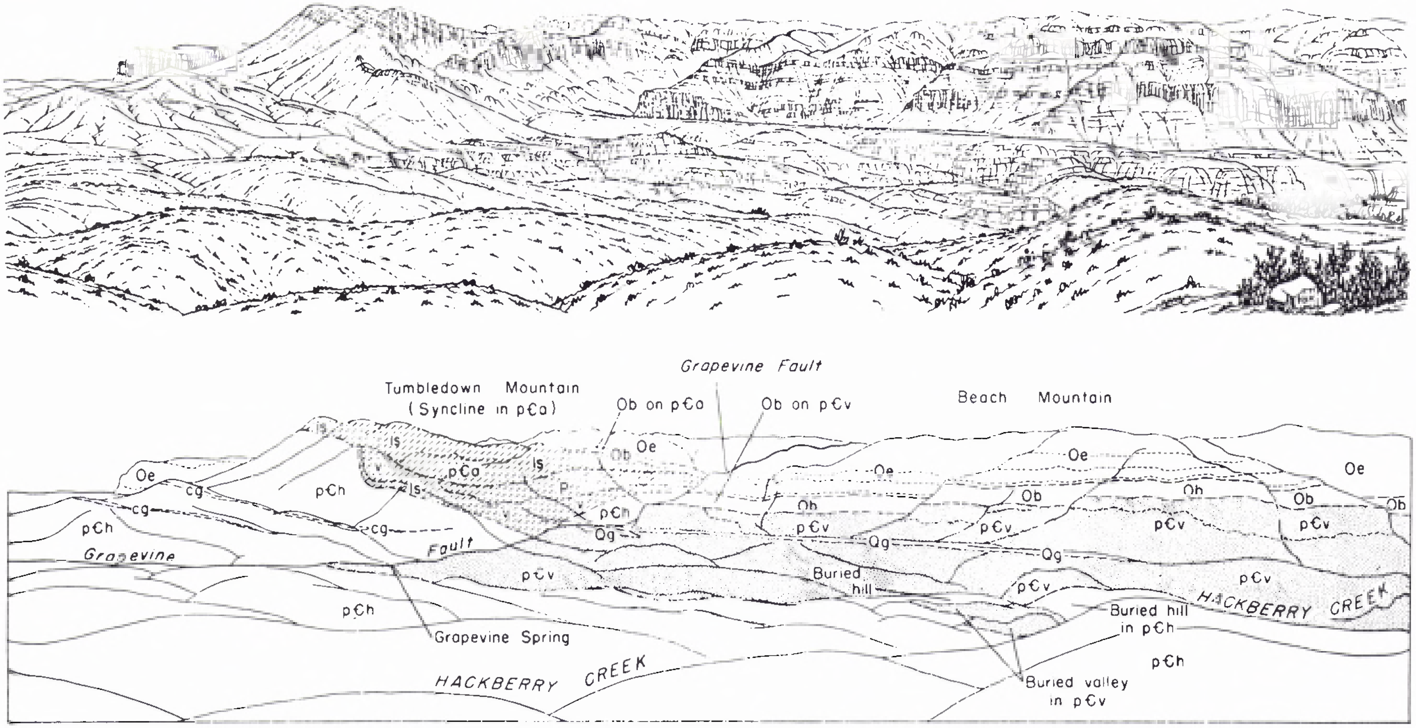

Figure 4. Panoramic view of Tumbledown Mountain, viewed northeastward from a hilltop near southwestern corner of area shown in Figure 2. Geologic features of panorama are summarized in diagram below. To south (right) are ledges of Van Horn and Bliss Sandstones and El Paso Limestone. To the north (left) beyond Grapevine fault is Allamoore Formation folded into a syncline on Tumbledown Mountain. In foreground are resurrected buried hills on pre-Van Horn erosion surface. p€a–Allamoore Formation, with units of limestone (ls), volcanics (v) and talc-bearing phyllite (p); p€h–Hazel Formation; Ob– Bliss Sandstone; Oe– El Paso Limestone; Qg– Quaternary gravel deposits.

(5) Block-faulting, and displacement on Dallas and Grapevine faults, followed by erosion.
(6) Deposition of Bliss Sandstone and younger Ordovician formations.
(7) Deformation during Late Pennsylvanian time.
(8) Deposition of Hueco Limestone on eroded surface of older rocks (Wolfcampian).
(9) Renewed displacement on Grapevine fault; mineralization along Dallas fault (Tertiary).

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