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Rodger E. Denison

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PRE-BLISS (P€) ROCKS IN THE VAN HORN REGION, TRANS-PECOS TEXAS

RODGER E. DENISON
One Energy Square
4925 Greenville Avenue
Dallas, Texas 75206

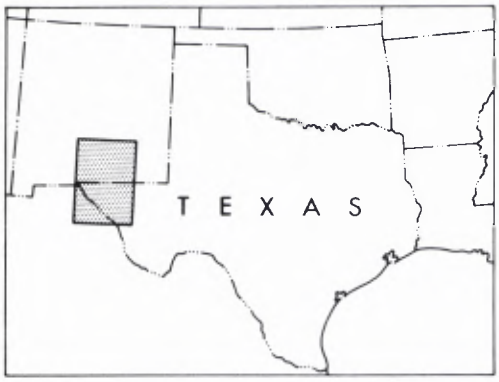
INTRODUCTION

The Precambrian rocks exposed around Van Horn are unique among the scattered exposures between the Rocky Mountains and the Appalachians.

King and Flawn (1953) provided the basis for most of our understanding of these rocks. Wasserburg and others (1962), Denison and Hetherington (1969), and Denison and others (1971) have provided a reconnaissance geochronologic framework that is requisite in understanding Precambrian activity. The relationship of these Precambrian rocks to those exposed in the general area and to those penetrated in the subsurface has been discussed by Denison and Hetherington (fig. 1).

FRAMEWORK

The area can be conveniently divided into rocks exposed north and south of the Streeruwitz fault. King (1965, p. 100) described the Streeruwitz thrust fault (fig. 2) as the major Precambrian structural feature "which forms a boundary between much-metamorphosed Carrizo Mountain Formation and its associated intrusive rocks to the south and the disturbed but little-metamorphosed Allamoore and Hazel Formations to the north."



INDEX MAP

EXPLANATION

950 M.Y. — FRANKLIN MTN. IGNEOUS ROCKS
950-1000 M.Y. — DEBACA TERRANE
1150 M.Y. — GRANITE AND SYENITE
~1250 M.Y. — CARRIZO MOUNTAIN GROUP
1350 M.Y. & OLDER — CHAVES GRANITIC TERRANE
o² — WELL REACHING BASEMENT SEE APPENDIX 2

FIGURE 3

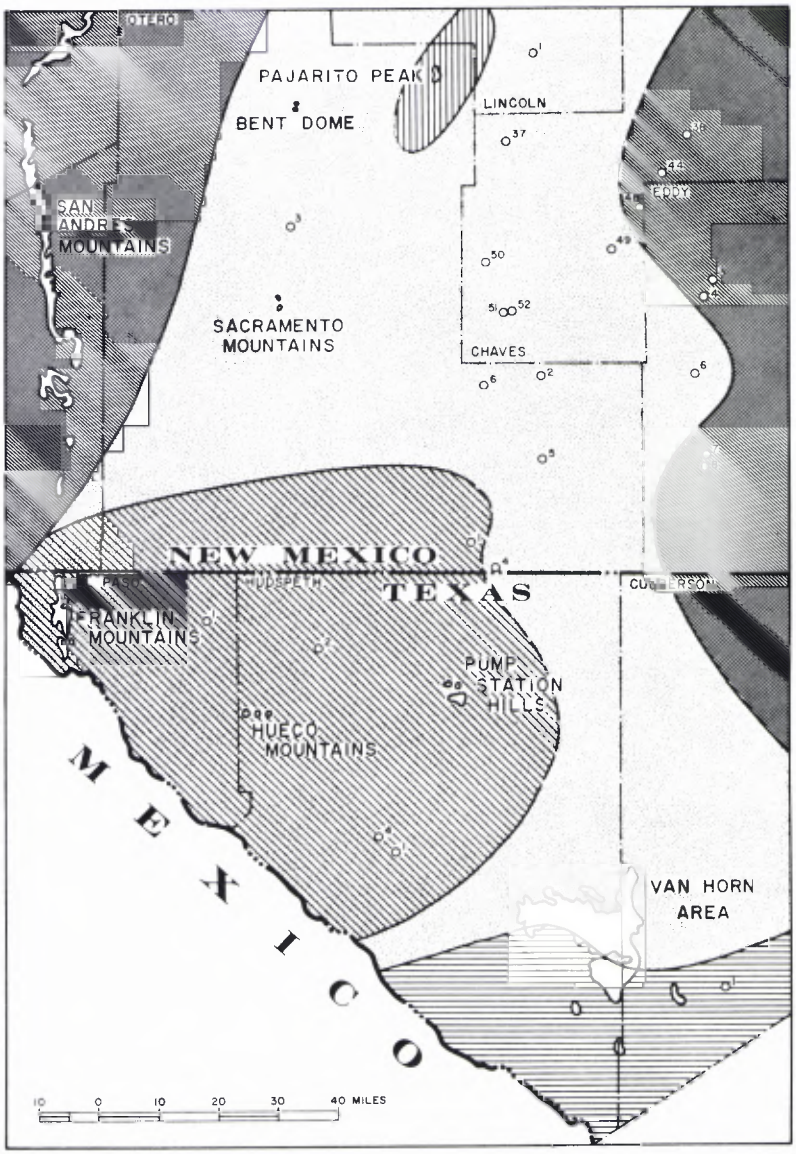


Figure 1. Basement geologic map of far West Texas and south-central New Mexico. Modified from Denison and Hetherington (1969).

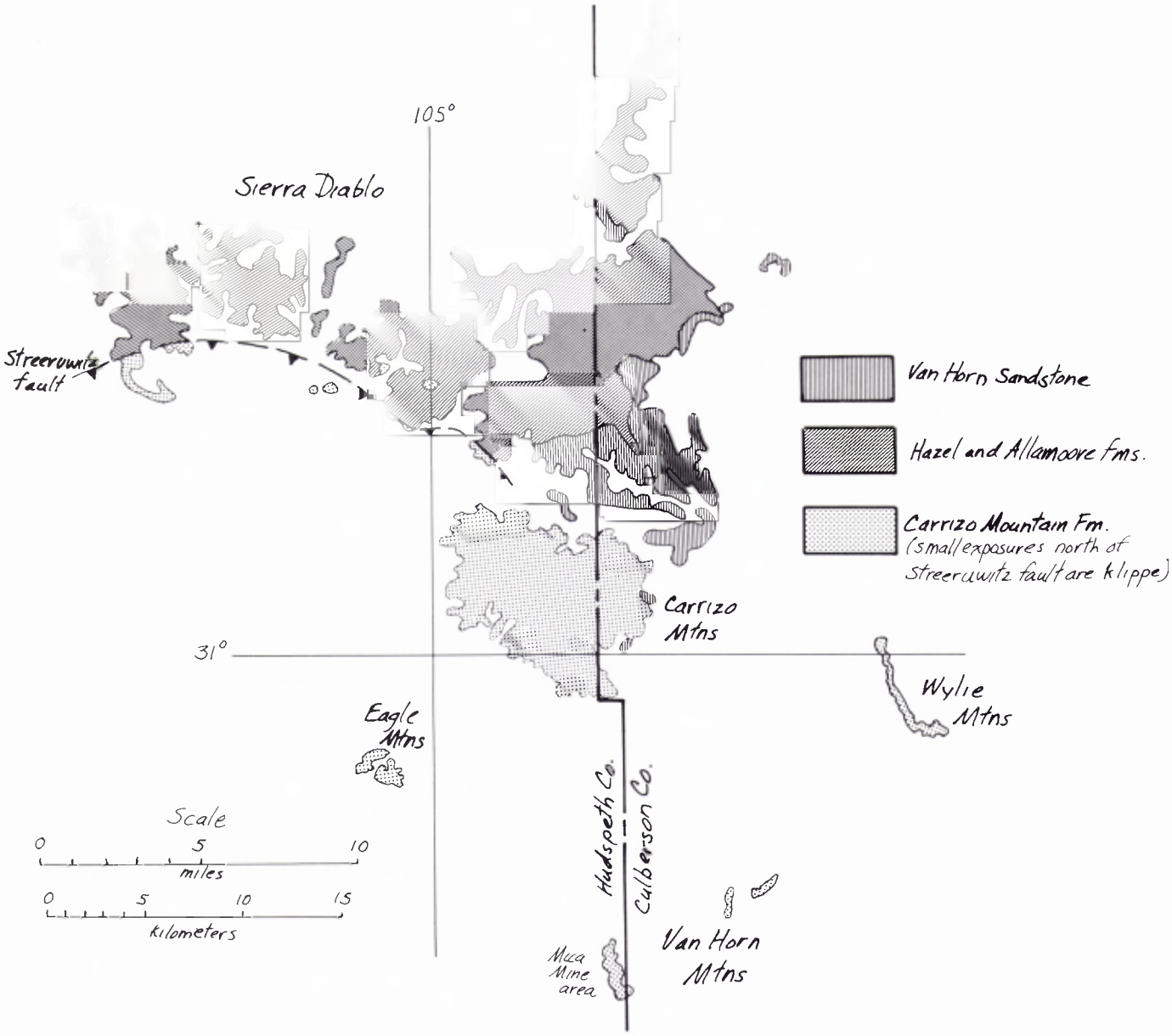


Figure 2. Generalized map of pre-Bliss rocks in the Van Horn area, largely from King and Flawn (1953).

South of the Streeruwitz Fault

The oldest rocks found south of the Streeruwitz fault are metamorphic rocks of the Carrizo Mountain Formation. Flawn (*in* King and Flawn, 1953) describes about 5800 m of metasedimentary rocks, which are intruded by numerous thin amphibolite sills and five large sill-like bodies of amphibolite with a combined thickness of 1750 m. Two metarhyolite sills have a combined thickness of 650 m.

The metasedimentary rocks are composed of quartzite, schist, phyllite, meta-arkose and marble. The foliation of these rocks is very closely coincident with the bedding where this can be observed. The rocks are intensely deformed, particularly near the Streeruwitz fault.

The metasedimentary rocks are overlain by metarhyolite. Flawn seems to favor an intrusive origin for these rocks and there is good field evidence for some of them being intrusive. There must, however, be a substantial portion of these metarhyolites that were extrusive. All the petrographic evidence that might demonstrate an extrusive origin, however, has been obliterated during shearing and metamorphism.

Amphibolites cut all other Precambrian rocks and are clearly the youngest of the metamorphic rocks.

The southernmost exposure of the Carrizo Mountain Formation is in the Van Horn Mountains (fig. 2). Flawn (*in* King and Flawn, 1953) reports extensive mica pegmatites, a higher metamorphic grade, and more complete recrystallization of metasedimentary rocks. Here the metamorphism is of medium grade (almandine-amphibolite facies). To the north, in the Carrizo Mountains, the metamorphic rocks are of a lower grade, probably middle or upper greenschist facies. The source for the heat and fluids causing the metamorphism is clearly to the south.

The age of deposition of the Carrizo Mountain rocks can be ap-

proximated by determining the age of the metarhyolites. If a substantial part of them is extrusive, then the age can be closely estimated. If they are all intrusive, then the determined age is a minimum for the time of deposition.

Denison and Hetherington (1969) obtained whole-rock Rb/Sr isochron ages on six samples of 1275 ± 67 million years (recalculated) but noted a considerable scatter in the data and were not confident that this was the time of formation. David Reynolds and Gene Scott of the University of Texas at Dallas recently used six whole-rock samples to obtain a Rb/Sr isochron age of 1220 ± 67 million years on the metarhyolites, with an initial ratio of 0.7029. The determinations are thus in agreement within error. The relatively large error on both isochrons is indicative of the analytical scatter. This is believed to be due to the isotopic system having been partly open during metamorphism. The Carrizo Mountain Group is, based on the available data, believed to have been deposited during a period about 1200 to 1300 m.y. ago. However, there remains considerable room for improvement in these age estimates.

The age of metamorphism and shearing has been determined primarily from K/Ar dates on minerals formed during the metamorphism. The ages (Wasserburg and others, 1962; Denison and others, 1971) were obtained on muscovite, biotite and hornblende from the Carrizo Mountain Formation amphibolites and from a mica pegmatite.

The most consistent of these ages falls within the range 975 to 1025 m.y. There is no apparent systematic difference between the mica and the hornblende ages. Micas yield the youngest and oldest ages reported by Wasserburg and others (1962). The best estimate for the time of metamorphism is 1000 ± 25 m.y. ago.

North of the Streeruwitz Fault

Three major units crop out north of the Streeruwitz fault—the Allamoore and Hazel Formations and the Van Horn Sandstone. They differ considerably from the rocks exposed south of the fault.

The oldest unit is the Allamoore Formation. It is described as a sequence of marble, chert, phyllite and interbedded volcanic and volcaniclastic rocks that is "probably as much as several thousand feet thick" (King, 1965, p. 23). Nyberg and Schopf (1979) have described well-preserved fossils in the cherty layers associated with stromatolitic dolostones. They suggest a shallow subtidal or intertidal environment of deposition. The volcanic rocks are amygdular basalts and diabases interpreted as flows and sills. The rocks have undergone intense deformation and low-rank metamorphism near the Streeruwitz fault. The talc within the Allamoore, generated during the metamorphism of siliceous dolomites, has been exploited in numerous mines (see Edwards, this volume).

Overlying the Allamoore is the Hazel Formation. This unit is composed of sandstone and conglomerate and is estimated to be at least 1500 m thick near the Streeruwitz fault and about 686 m thick to the north. The conglomerate is derived mostly from rocks of the Allamoore Formation—chiefly the carbonate rocks. In some places the conglomerate also contains boulders of granite and rhyolite porphyry, unlike those exposed south of the fault. The Hazel Formation is less deformed and metamorphosed than is the underlying Allamoore Formation, in part because it is exposed farther from the belt of strong deformation associated with the Streeruwitz fault and in part because it is more massive and competent than the Allamoore.

VAN HORN SANDSTONE

The Van Horn Sandstone rests unconformably on highly dissected rocks of the Hazel and Allamoore Formations (King and Flawn 1953). It has been considered Precambrian, Cambrian and Early Ordovician in age. The time of deposition was after the deformation affecting the Hazel and Allamoore Formations and prior to the transgression of Ordovician seas that deposited the Bliss Sandstone.

Whereas the age of the Van Horn Sandstone cannot be strictly determined, geologic reasoning would suggest that it is probably Late Precambrian. The rugged topography on which the Van Horn was deposited most likely developed soon after the uplift and extensive erosion that followed the 1000-m.y. b.p. regional metamorphism and deformation. The Bliss was deposited over the entire area but has been removed by pre-Wolfcamp erosion except in the north, where it overlies the Van Horn and, very locally, the Allamoore. The Bliss, where the contact with underlying rocks is exposed, was deposited on a flat, relatively featureless surface. This would suggest that the Van Horn was deposited closer to the time of Precambrian deformation, when the surface was rugged, than to the time of Ordovician transgression, when the surface was peneplaned. The unconformity at the top of the Van Horn and the relatively restricted occurrence of the unit also support a Precambrian rather than an earliest Phanerozoic age.

McGowen and Groat (1971) have described the Van Horn Sandstone as having been deposited in an alluvial fan system. The northern highland source was composed of rhyolite, granite, metamorphic and sedimentary rocks. The sediment ranges from silt to boulders and was transported through canyons by fast-flowing mountain streams. Southward of these canyons the sediment was transported by less confined braided streams. As much as 365 m is exposed.

The granite and rhyolite found in the Van Horn is believed to have been derived from an igneous terrane now exposed to the north and west in the Pump Station Hills and in the Hueco and Franklin Mountains. This province has an age near 1000 m.y. (Denison and Hetherington, 1969). The Van Horn Sandstone is unique; nowhere in Texas, New Mexico or Oklahoma is an analogous unit found. It was evidently the product of rather special, local conditions of deposition and preservation.

PRECAMBRIAN HISTORY

Deposition of the Carrizo Mountain Formation is the earliest recorded event in the Precambrian. The depositional site, the source for the clastic sediments and the depositional substrate for these rocks cannot be directly determined. The Chaves granitic basement terrane found in the subsurface to the north yields ages of 1350 m.y. and older and is probably a reasonable choice. Based on isotopic ages from the rhyolitic rocks associated with the Carrizo Mountain, the most likely time of deposition is in the range 1200 to 1300 m.y. b.p.

The Hazel and Allamoore Formations were deposited at a later time. In the Franklin Mountains units believed equivalent (the Castner Marble and Llanoria Quartzite) are apparently conformably overlain by rhyolite flows yielding ages of about 1000 m.y. (Denison and Hetherington, 1969). This would indicate deposition just prior to extrusion of the rhyolite. It is suggested that the Hazel and Allamoore were probably deposited between 1000 and 1100 m.y. ago. There is no direct evidence for the rocks on which the units were deposited but the older Chaves granitic terrane seems a likely candidate. The rhyolite boulders in the Hazel could have been derived from those associated with either the Carrizo Mountain Formation or the Panhandle Volcanic Terrane (Flawn, 1956).

About 1000 million years ago the area to the south underwent

intense deformation and metamorphism. That episode moved the rocks of the Carrizo Mountain Formation northward over the Hazel and Allamoore Formations along the Streeruwitz thrust fault. The underlying Hazel and Allamoore rocks are deformed and metamorphosed near the thrust contact but these effects fade rapidly northward away from the Streeruwitz fault. The presence of relatively undeformed mica pegmatites that yield 1000-m.y. ages and a higher metamorphic grade for Carrizo Mountain rocks in the Van Horn Mountains indicate that the source of heat and fluids associated with the metamorphism was to the south.

The metamorphism and deformation was followed by a period of erosion. A large amount of rock has been removed to reveal the present level of exposure. Although estimates vary on the depth at which regional metamorphism of this type takes place, it seems unavoidable that more than five km of overlying cover has to have been removed.

On this eroded and dissected surface the Van Horn Sandstone was deposited by an alluvial fan system with a source mainly to the north. The time of deposition is most likely Precambrian but is definitely after extensive erosion following the 1000-m.y. b.p. metamorphism and prior to the transgression of the Ordovician seas that deposited the Bliss Sandstone.

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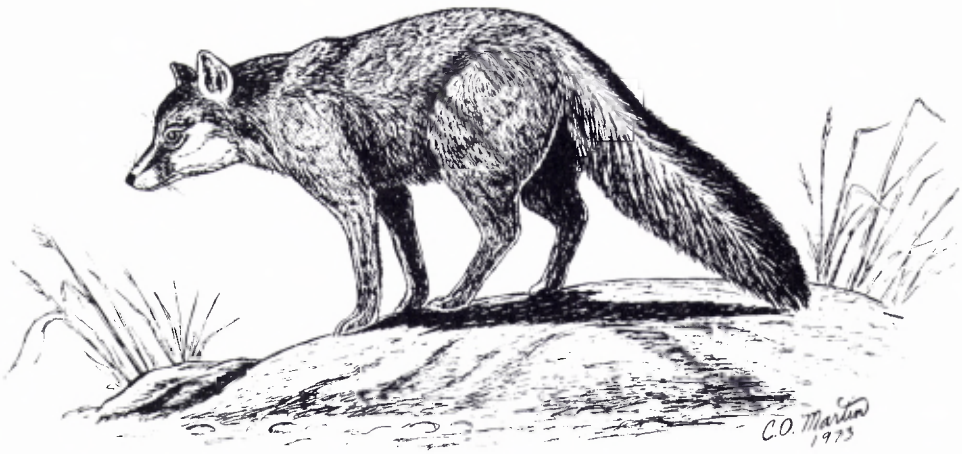

Gray fox, *Urocyon cinereoargenteus*.