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The information contained in this circular was gathered by a unit of the WPA Statewide Mineralogical Survey of Texas, a project sponsored by the University of Texas, Bureau of Economic Geology. The purpose of this survey is to assemble information concerning mineral resources and to gather other geological data and make them available to the public. With this information in the hands of the public, it is reasonable to suppose that industries of value to the State may be developed. The following report is based on work done in Val Verde County by a Unit of Work Project No. 49040.

THE OCCURRENCE OF MANGANESE ON THE INGRAM-HOWE RANCH, WITH NOTES ON OTHER AREAS ALONG PECOS RIVER, VAL VERDE COUNTY, TEXAS*

by Lincoln E. Warren

INTRODUCTION

This report deals essentially with the occurrence of manganese on the Ingram-Howe ranch 3 miles north of Shumla where several test pits were dug and the manganese sampled for analyses. Included also are brief descriptions of the occurrence of manganese on the Babb and Mills ranches along Pecos River. The purpose of this investigation was to locate manganese deposits, determine their mode of occurrence, tonnage, and whether or not the deposits could be mined on a commercial basis.

Previous investigations of manganese in the Shumla area were made during World War I and prior to that war by several local prospectors, who dug many test pits. A report on the manganese at Shumla and Feely was made by Roberts and Nash[1] in 1918. Much of the preliminary work, such as the supervision of the digging and sampling of 15 test pits on the Ingram ranch, was done by Mr. George H. Shafer, Assistant Project Supervisor, Work Project No. 18927. The writer wishes to express his appreciation to Mr. John Ingram and to the other property owners who were very cooperative in aiding this investigation. The writer is indebted to Dr. V. E. Barnes for his many helpful suggestions, and thanks are also due to Mr. William N. McAnulty, State Supervisor, Statewide Mineral Resources Survey.

GEOLOGY AND PHYSIOGRAPHY

The relief in the Ingram-Howe area taken from the bottom of Pecos Canyon to the U.S. Engineers Triangulation Station approximately 3 miles to the north is about 500 feet. Away from Pecos River the hills are rounded, and the surrounding country looks almost level. However, the area is a greatly dissected one, with deep precipitous walled canyons that can be crossed only at selected places. The manganese area lies within a 5-mile wide bend of Pecos River and drains on three sides directly into the river. The divide is about 1½ miles south of the north part of the bend, and the canyons are steeper here than to the south, producing a rugged terrain. The south sloping part of the area is relatively flat for about three-fourths mile, followed by shallow "draws" which deepen quickly into deep straight canyons, reaching depths of 80 to 90 feet near Pecos River. The vertical walls which form Pecos Canyon are as much as 300 feet above water level at many places.

The rocks which outcrop in this area include formations in the Comanche and Gulf Series of the Cretaceous. The following is a list of formations present:

Quaternary	Recent	"Low" gravels	
	Pleistocene?	"High" gravels	
Cretaceous	Gulf series	Boquillas flags	
	Comanche series	Buda limestone	
		Del Rio clay	
		Georgetown limestone	Devils River limestone
		Edwards limestone	Devils River limestone

Because of the close similarity in lithologic character of the Georgetown and Edwards formation, these were grouped together by Udden[2] in 1907 under the name Devils River limestone. For the purpose of this report, these two formations will be referred to as the Devils River limestone because of lack of time for detailed study.

*Assistance in the preparation of these materials was furnished by the personnel of Work Projects administration Official Project No. 265-1-66-214.

[1]Roberts, J. R., and Nash, J. P., The Geology of Val Verde County: Univ. Texas Bull. 1803, pp. 23-43, 1918.

[2]Udden, J. A., Report on a geological survey of the land belonging to the New York and Texas Land Company, Ltd., in the upper Rio Grande embayment in Texas: Augustana Libr. Pub. No. 6, pp. 56-60, 1907.

Devils River limestone. — The Devils River limestone is a massive, hard, compact, weathering to a bluish-gray limestone. It contains the casts of many fossils; the most common types observed were rudistids and gastropods. It forms the precipitous bluff of Pecos Canyon and Rio Grande Canyon.

Following is a detailed section measured by Roberts[3] in the gorge of Pecos River in the bend north of Shumla:

"In the gorge of the Pecos River, in the bend north of Shumla, the uppermost beds of this formation are exposed, and they are conformably capped by the Buda, which is included in the following vertical section taken from the west wall and numbered from the bottom up."

	Thickness feet
11. A heavy-bedded, hard, dense, white limestone, containing a few flints at the base and fossil shells which are filled with calcite and are poorly preserved. This rock is remarkable in that it appears to be an almost pure calcium carbonate	60
10. A thin-bedded arenaceous limestone, alternating with two-inch seams of calcareous, brown clay	7
9. Hard, compact, gray limestone having many fossil shells very poorly preserved	3
8. A stratum of compact white limestone containing flints, and which is also cut diagonally from top to bottom with open fractures a few inches wide, and from 6 to 10 feet apart. The fissures are filled with honey-combed limestone fragments	18
7. A one-foot shelf of dense blue limestone projecting a few inches beyond the face of the bed below. This rock weathers smooth, though composed of small, blue-tinted calcite crystals surrounded by a hard, blue-black, limy matrix	1
6. A stratum of heavy-bedded, hard, yellow-white limestone, which has a sub-conchoidal fracture, and has specks of brown iron oxide and indistinct lines of stratification. The base is made up of an 8-inch stratum of a compactly consolidated conglomerate composed of flint nodules and a marly calcareous matrix, which imperceptibly merges into the bed above	19
5. A thick stratum of honey-combed, jointed, and weathered limestone that is easily distinguished by the caves within it. On a fresh surface, it is dark bluish-gray, and has well developed crystals of calcite. Some of the caverns extend into the wall for 6 or 8 feet and have their roofs 10 or 12 feet above their floors. Within the caverns on the walls, can be seen fine laminations in the limestone that cannot be observed on a fresh fracture. Flint nodules 6 to 8 inches in their longer dimensions are abundant in this bed	50
4. This stratum is like the lower 30 feet of number 5, without the large cavities of the latter, and with flint nodules in place in the exposed face	30
3. A zone of fractured or crushed rock	3
2. This bed is a limestone, on weathered surface of bluish-gray color, showing innumerable small cavities 1 to 1½ inches in surface extent, and penetrating the face from a quarter of an inch to 3 inches; honey-combed only at the surface. On a fresh fracture, the rock is seen to be a fine-grained, compact limestone, with a greenish tint, containing minute crystals of calcite and fossil imprints which are indistinct parts of large shells	25
1. A waterworn and weathered limestone, stained and coated with reddish-brown silt. Fresh surface shows small crystals of calcite imbedded in a matrix of bluish light gray, calcareous material, having many minute stains of brown iron oxide	3
	220

Del Rio Clay. — The Del Rio clay is missing west of Shumla. Approximately 5 miles southeast of Shumla the formation is 13 feet thick; 1½ miles southeast of Shumla, 4 feet thick; and at Shumla, 1 foot or less thick. On the Ingram-Howe ranch the Del Rio is missing and Buda limestone is resting directly upon Devils River limestone.

Buda limestone. — The Buda limestone is a hard, white, almost pure calcium carbonate limestone which breaks with a sub-conchoidal fracture. Where the Del Rio clay is absent, the Devils River limestone can be distinguished from the Buda limestone by the greater massiveness of the Devils River limestone and its darker color upon weathered surfaces. The Buda limestone weathers to a dirty white to a light buff; and in some places it is stained with iron oxide, while the Devils River limestone exhibits a dark bluish-gray surface.

Boquillas flags. — The Boquillas flags is the only formation of Upper Cretaceous age in this area. It consists of alternating beds of flaggy, white to brown limestones, and brownish to bluish-gray shales containing fragments of fish scales. The Boquillas flags rest uncomfortably upon the Buda limestone, and the contact is easily picked on the bases of the sharp break between the massive Buda and the flaggy limestones and shales of Boquillas. The Boquillas flags attain their greatest thickness in this area a few miles north and east of Langtry where they form high, conical hills having altitudes of as much as 250 or 300 feet.

"High" gravels of Pecos River are found on both sides of the river, in some places as high as 400 feet above the present stream level. The gravels are very characteristic in that they are composed of rounded, black cherts, light-colored cherts, various types of igneous rocks, and large boulders of river-scarred Cretaceous limestone. Some boulders which weigh as much as 200 pounds were found approximately 300 feet above the present stream level. This would indicate deposition by torrential flood waters. In some places the gravels are relatively thick and extensive, while in other localities only occasional rounded black chert pebbles remain.

[3]Roberts, J. R., and Nash, J. P., *op. cit.* pp. 13-14.

[4]Hewett, D. F., In Twenhofel, W. H., Treatise on Sedimentation, The Williams & Wilkins Company, p. 416-1926.

DESCRIPTION OF MANGANESE DEPOSITS

The Ingram-Howe manganese is located 12 miles by road east of Langtry and is reached by going east along the Del Rio highway for 1 mile, turning north under the Southern Pacific Railroad underpass, following a private ranch road 6 miles in a general northeast direction to the Ingram ranch headquarters, and continuing along a dim ranch road leading east-southeastward from the ranch house for approximately 5 miles. The first of a series of test pits is about one-fourth mile east of the deep canyon where the road ends.

The manganese deposit on the Walter Babb ranch is reached by following the Pandale road north from Lantry approximately 25 miles to the Walter Babb ranch house, which is located to the west and within sight of the road, and turning east along the private ranch road paralleling Pecos River for about 2 miles.

The manganese ore on the Ingram-Howe ranch occurs in shallow depressions and is intermingled with gravels, brecciated limestones, vegetable matter, and soil. The depressions are scattered over quite a large area along the southern portion of the bend of Pecos River already described. The manganese outcrops are easily recognized by the presence of manganese "float" and the general reddish yellow or brown color of the soil. The deposits are surficial and are not restriced to any one zone or bed. The manganese occurs in all of the formations present, icluding the Boquillas flags, Buda limestone, Devils River limestone, and as a cement in the "high" gravels. The amount of surface outcrop of manganese does not reflect the quantity beneath the surface. In one locality, manganese material was scattered over an area of approximately 2000 square feet, but test pits revealed that the manganese did not extend over 2 feet in depth and consisted of irregular lenses which appear to follow the present erosional surface.

The manganese on the Ingram-Howe ranch was deposited on an old erosional surface and is not related in any way to the structure of the underlying formations, as is indicated by: (1) the surficial character of the deposits, (2) their presence at the head of small "draws," or (3) their presence in shallow depressions on top of the low divides. All of these indicate that the surface at the time of deposition of the manganese was not greatly different from that in the divide area of the present.

Wad and pyrolusite are the manganese minerals of the small bodies which occur in a matrix of soil and debris. At no place was the manganese observed to replace the limestone bedrock. Small boulders of limestone intermixed with the manganese have not been altered or replaced by manganese.

Sinks in the Buda limestone into which Boquillas flags have slumped in every conceivable attitude are very common. A few small bodies of manganese overlap the margins of these sinks; however, neither the flags nor the adjacent bedrock are replaced by manganese, although in many cases they are greatly stained by iron oxide.

The Buda and Devils River limestones, even though being massive, are greatly jointed. Some joints have been enlarged by solution, and manganese occurs along some of them where they have been partially filled with clay, boulders, and other debris. The joints are in no definite system or pattern and are not traceable over great distances.

The manganese of the Walter Babb ranch 7 miles airline south of Pandale is mixed with sand and gravel between limestone ledges at the edge of Pecos River. The deposits are thin and occupy space between the beds scooped out by the river. They extend along the bluff for about one-fourth mile. The distance the manganese extends back under the ledges is unknown, but the exposed portion of the manganese suggests only a short distance. The manganese is of a poor grade. Manganese is also mixed with gravels of the flood plain which in its greatest width is about one-half mile. These gravels are as much as 50 feet in thickness. The manganese is disseminated through the flood plain deposits as a cementing agent. One hill of gravels 50 by 200 feet in size has a greater concentration of manganese than any other seen by the writer. The manganese is diseminated throughout the gravels, and in one shallow test pit manganese seems to be in a greater concentration than is required to fill the pore space of a gravel deposit. If this concentration exxtends to bedrock it will be about 10 feet thick.

In this locality manganese also occurs on high hills three-fourths mile to the south and approximately 300 feet above water level of Pecos River. The manganese is in shallow depressions on the Devils River limestone and resembles very much the occurrence on the Ingram-Howe ranch. The "high" gravels have almost been removed by erosion, with only occasional pebbles of black chert and igneous rock remaining.

Manganese mixed with rock debris occurs on the Mills ranch about 3 miles west of Pandale. It is approximately 75 feet above the present level of Pecos River and is either associated with an old terrace or a fan-glomerate. The manganese is in a bed ranging up to 2 feet in thickness. The indurated gravels are dissected by drains from the high hills to the east. The manganese deposit is highly irregular in shape, and the lateral extent appears limited. Two carloads of manganese-bearing material have been shipped from this locality. Other occurrences of manganese were reported to the north, but the writer did not visit them.

One sample each from the Ingram-Howe and Mills areas, selected from what appeared to be the highest grade ore, were analyzed by Robert M. Wheeler, Project Technician assigned to Work Project No. 49040. The results are given below:

Sample	*MnO_2*	*$CaCO_3$*	*SiO_2*	*Al_2O_3*	*Fe_2O_3*
Ingram-Howe	42.92	43.33	3.92	4.78	.05
Mills	38.30	47.11	4.46	2.06	Trace

Small amounts of manganese have been reported near Feely. The writer did not visit this locality, and the following paragraph is taken from a report on the Feely manganese by Mr. George H. Shafer. "Both systematic and "hit and miss" methods have been applied to some extent in the past to locate deposits of manganese ore in the Feely area. In 1918 geologists dug several test pits over the area, but only small quantities were uncovered. In addition to these pits, others have since been dug by various individuals, some of whom live in the community. All efforts thus far in this vicinity have, however, resulted in finding only small quantities of manganese ore."

ORIGIN

Wad and pyrolusite are minerals of secondary origin, and the manner in which they occur in the Pecos River area, intermixed with sand, clay, gravels, vegetable matter, and soil in shallow depressions, disseminated through gravels, and in the joints of exposed limestone, indicates that these minerals are stream deposited. Since all the manganese deposits reported are in the drainage of either Pecos River or the Rio Grande, and all deposits are within a short distance of these rivers, it is believed that the manganese was deposited from the watrs of these rivers.

Manganese is carried in solution as a carbonate or as finely divided particles of undissolved oxides. The carbonate is easily precipitated by oxidation, generally as MnO_2 in the form of pyrolusite or wad.

D. F. Hewett[4] gives the following manganese cycle: "The manganese cycle is initiated with the decomposition and solution of the manganese minerals, is continued with the transport of the soluble salts, and ends with the deposition of the manganese minerals in the various environments..." He goes on to say, "Manganese is present in most streams as dissolved bicarbonate and as suspended oxides or undecomposed silicates."

The great lateral extent of the high gravels suggests that before Pecos River had cut so deeply through the underlying limestone, the water spread over a large and relatively flat flood plain at times of flood. This spreading facilitated greater oxidation of the manganese carbonates precipitating the manganese as oxides in the gravels. Subsequent leaching and erosion of the gravels has concentrated the manganese oxides in the shallow depressions and joints. Much manganese is disseminated through lower gravels which are little modified in thickness, such as the occurrence on the Walter Babb ranch.

Stanley O. Reichert[5] writes the following in regard to manganese in east Tennessee: "...many of the deposits, especially in the northeast corner of the State, appear to occur along remnants of terraces above the present valley floor. These benches are thought to be parts of the old valley floor formed during pauses in the process of denudation, between periods of active stream incision that followed intermittent uplift of the land." "...the occurrence of these manganese deposits bears a certain close genetic relationship to placer deposits in that they are areas of shallow or surficial mineralization located in relation to favorable topography; they are scattered over several different geologic formations ... but always located in favorable structural and physiographic basins or remnants of basins."

Near the mouth of Pecos River the "high gravels of Pecos River merge with the "high" gravels of the Rio Grande. The latter are composed of igneous rocks, cherts, and many boulders of Caballos novaculite (Devonian) from Brewster County. It is not improbable that the deposits south of Shumla and at Feely are the result of deposition from the waters of the Rio Grande.

COMMERCIAL ASPECTS OF THE MANGANESE DEPOSITS

The great irregularities of the manganese bodies and the varying admixture of clay, boulders, and gravels make it difficult to determine the tonnage or grade of material available. All types of ore present on the Ingram-Howe prospect, in the writer's opinion, will not exceed 2000 tons.

If the origin postulated is correct, diligent search in other areas along Pecos River should reveal other manganese deposits.

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[5]Reichert, S. O., Manganese resources of east Tennessee: Tennessee Div. Geol. Bull. 50, pp. 19-20, 1942.