water circulation has certainly modified to a slight extent the distribution of oil and gas in the Grey Bull and Torchlight fields and the waters in the Grass Creek field show admixture of non-saline waters, either of recent age or of post-Paleocene or post-Eocene age, with the saline waters of sedimentation.

In the Appalachian Basin, Mills and Wells have carried on extensive investigations of the oil-field waters. Their conclusions are not in accord with such a complete degree of "flushing" as postulated by Mr. Rich.

Another point which deserves emphasis is that the dilute or non-saline character of oil-field waters does not prove that they are the result of downward percolating ground water. Many of the sedimentary beds of our oil fields, including oil shales, show by their organic and lithologic character that they were deposited in brackish or non-saline waters under deltaic or coastal swamp conditions. It is therefore hardly reasonable to suppose that such water would even approximately correspond to the composition of sea water, although it is certainly interstitial water of sedimentation.

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SOME NOTES ON IRON-DEPOSITING BACTERIA.

The writers became interested in iron bacteria in 1920, and decided to carry on some investigations with reference to their possible activity in brackish and salt water. During the summer of 1920 collections were made in Iowa and along the Rio Grande in Texas, and in 1921 in the Maracaibo basin of Venezuela. Unforeseen circumstances have arisen which make the completion of the work impossible, at least in the near future, so that it has been decided best to publish the meager results obtained, in the hope that they may be of some benefit to those interested in the subject.

There is no need here to discuss the iron-depositing bacteria and their habits from the standpoint of the bacteriologist. Har-

der,¹ Ellis² and others have fully described them and their activities in fresh water. To date there is little mention in the literature of the action of these organisms in brackish or salt water. It is in view of this fact that this article is presented.

In all samples of water from which iron was being deposited in quantity these bacteria were found. Only two samples, however, were taken from brackish water. These were secured from old stream beds which act as overflow channels for the flood waters of the Rio Grande in its highest stages. In the Resaca del Rancho Viejo, six miles northwest of Brownsville, Texas, much iron was being deposited in brackish water. A sample taken from the bed of the Rio Colorado eight miles southwest of Harlingen, Texas, contained much iron from moderately brackish water. In the sample from the latter locality only *Cladothrix dichotoma* was found, but these were abundant. In the collection made near Brownsville the bacteria present were *Leptothrix ocracea*, *Spirophyllum ferrugineum*, *Siderocapsa* sp. cf. *treubii* and *major*, *Cladothrix dichotoma* and *Crenothrix polyspora*. *Siderocapsa* and *Crenothrix* were abundant at this locality. The threads of *Spirophyllum ferrugineum* were old and dead but all had a generous coating of ferric hydroxide and no doubt took an active part in the process of deposition. The other forms were present in large enough numbers to indicate that they too played an active part in the deposition.

The bacteria obtained from the Resaca del Rancho Viejo were kept alive for nine months by addition of ferric acetate, the water being made slightly acid to prevent too rapid precipitation of the acetate. The water was not freshened in any way, in fact it became more salty by evaporation from the container, which was closed only by cotton.

Attempts were made during the past winter to cultivate cultures of the five types of bacteria mentioned and to transform these fresh-water forms to salt-water forms. They were placed in four containers, one of distilled water and to the other three

¹ Harder, E. C., Prof. Paper No. 113, U. S. Geol. Surv., 1919.

² Ellis, David, "Iron Bacteria," Frederic A. Stokes Co., New York.

had been added one-fourth normal, one-half normal, and full normal amounts of oceanic salts as given by Clarke.¹ All cultures were started at the same time and ferric acetate was added. All samples precipitated iron, and no more dead threads were found in the saline water than in the fresh water at the end of one month. There was, however, a much greater development of new threads in the fresh water than in the brackish and salt water. The development of new threads decreased with the increase of the amount of salt. At the end of seven weeks a noticeable change was brought about in the reduction of live bacterial forms in all cultures, and later it proved that a certain fungus (species unknown) which had been present from the first had developed to such a stage that the bacteria were killed. Up to this time the forms transplanted into salty water apparently were becoming adjusted to saline conditions. The amount of iron deposited by them from the acetate was sufficient to denote quite active life. The destruction of the bacteria by this fungus happened at a time when the streams and springs in Iowa were frozen, and no new forms could be obtained in amounts sufficient to work with. Consequently, no more data were obtained regarding the adaptation of these bacteria.

It is thought that fresh-water forms of iron-depositing bacteria can be transformed into salt-water forms. If this be true, can it be that there are living today salt-water forms which are inaccessible to study that are depositing iron under marine conditions, and, if so, did this same type of bacteria materially aid in the deposition of our great sedimentary ore deposits? If these bacteria are transformable it would be logical to conclude that this transformation is being carried on today by types passing down streams to bodies of water containing a high percentage of salt.

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¹ "Data of Geochemistry," Bull. 695, U. S. Geol. Surv. p. 123, Analysis H.