THE DEPARTMENTS OF GEOGRAPHY.

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THE sub-division of any portion of science must be largely empirical, and in accordance rather with practical convenience than with natural planes of cleavage. Thus we are accustomed to such phrases as mathematical geography, physical geography, astronomical geography, ancient geography, political geography, and the like, although it would be very difficult to piece together the fragments which pass under these names so as to make up a coherent geography. In endeavoring to sub-divide the content of geography in such a way as to bring out the natural interrelations of its parts and their logical sequence, for purposes of exhaustive study, it has occurred to me to represent the whole metaphorically by a pyramid of several courses of masonry differing in material and finish but each supported by those below and supporting those above. Thus the fundamental course would be mathematical geography, constructed of great blocks hewn from the quarries of the only absolute science, accurately squared and fitted. It includes all that has to do with exact measurement of space and time and motion, the form and dimensions of the earth, its motions and the construction of maps. Upon this base is reared the second tier, physical geography, the material for which, less homogeneous and perfect than the foregoing, comes from quarries scattered over the realms of many sciences, from chemistry, physics and the different departments of geology, from meteorology and the science of the oceans. It is concerned with all these phenomena which depend on differences of substance, structure and state, and accounts for the origin of surface features and of scenery, the interactions of lithosphere, hydrosphere and atmosphere and the effect on each of solar energy. Next in order and less regular in structure, dependent on physical geography as physical is on mathematical, I place bio-geography, wherein the influence of life is taken into account. This serves to explain how vital processes of plant and animal affect the structure of the earth, and how the lifeless features of the globe regulate the distribution of vegetation and of animals. Arising directly from this floor, but as yet only imperfectly put together, is the course of anthropo-geography, the elucidation of the action of mankind as an animal species upon the globe. The unit of consideration is mankind as a whole; the variety of races, conditions of life and density of population are the features taken into account, and the interaction between man and nature has to be studied in its widest aspects. The changes in the relation of different tribes to their habitat belong to this zone, and these changes are the basis of historical geography, which gives origin to the next tier of our pyramid, in which the influence of races of men on the earth finds a place. This may be termed, for lack of a better name, political geography; its units are uncertain and transitory, for the hold of nations on regions is subject to continual change. But political geography is stability itself compared with the rough pile of commercial geography which caps if it does not crown the edifice. Here it is no longer the racial or national view-point which determines the conditions, but the individual greedy of gain or struggling for life. The distribution of natural resources is the fundamental condition, and the national frontier has rarely much in common with the political.

But here a further simile must be brought in. This cap of the pyramid plays the part of a keystone as well, and binds the whole structure together. As rain filtering through a mass of brick or stonework dissolves the mortar of the upper parts, and redeposits it in the lower courses, so the stream of self-interest permeates the whole structure of geography, and its results are felt throughout. Commercial motives consolidate national life, accentuate racial differences, redistribute animals and plants, modify physical conditions, start investigations into the nature of the earth, and even invade the solid groundwork of mathematics with the practical counsels of common-sense.

There are many people, but there were more, who deny to the sphere of geography anything beyond the measuring of distances and the mapping of distributions. The legitimate scope of the science, however, includes very much more, and the simile which I have sketched may help some students to understand and some teachers to apply the principles of geography.

THE AGE OF THE IRON ORES OF EAST TEXAS.[1]

BY WILLIAM KENNEDY, AUSTIN, TEXAS.

EXTENSIVE deposits of brown iron ore, or limonite, occur throughout east Texas, from the State line westward to the Brazos River, and covering a roughly irregular triangular area, having its base resting upon the Sulphur Fork of the Red River across the northern side of Cass County and extending westward until the apex touches the Brazos.

Regarding the age of these deposits considerable confusion appears to have arisen. In the Tenth Census Professor Pumpelly assigns them to the Quaternary. Why this age was given to these ores is not stated. They simply appear among the Quaternary deposits in the Texas section shown on plate VIII., of the fifteenth volume, and no mention is made anywhere in the text of any authority for so placing them. As the only Texas ore of which any notice is taken in this volume is that found in Marion County, and then worked in the Kelleyville furnace, it may be presumed that, as that ore is of the nodular variety and corresponds very closely in physical appearance and approximately in chemical composition to the ores found in Mississippi by Dr. Hilgard and described by him as belonging to his Orange Sand formation, and consequently of Quaternary age, Professor Pumpelly considered the Marion County ores to have the same origin and date, and so placed them in the Quaternary when making his section.

The next investigator was Mr. Lawrence C. Johnson, an Assistant on the United States Geological Survey. Mr. Johnson had been assigned to make an examination of the iron ores of northern Louisiana in 1885, and in 1886 his instructions were modified and extended so as to enable him to examine the east Texas deposits. This investigator appears to have been the first to recognize the existence of two divisions among the ores. These he separated, assigning the name of *nodular* ore to the one variety, and by the term *lacustrine* designated the other. This latter class he again divided into "laminated" and "buff crumbly" ores, according to their texture and physical appearance.

While dividing the ores into these two great divisions, he at the same time placed them in different ages and under entirely different conditions. The nodular ore, Mr. Johnson considered as belonging to the lignitic Tertiary, and we find him, after describing the ores of Marion County, saying: "All this portion of the iron field, including Upshur, Camp, Morris, Marion and Cass Counties, is assigned to the great Lignitic of the Geological Column." (Iron Ores of Northern Louisiana and Eastern Texas, Ex. Doc. 195, first session, Fiftieth Congress, p. 34.)

[1]Read before the Texas Academy of Science, Dec. 16, 1893.

The laminated ore, or, as he described it, the lacustrine ore, Mr. Johnson appears to place in the Quaternary, as, after describing the conditions and modes of formation and deposition of such ores, he says: "Such deposits were produced at various stages of the Quaternary history of the regions under consideration, and some of them possibly during the Tertiary, and now that the strata are exposed to erosion, the hard insoluble limonites resist it more successfully than the unconsolidated sediments in which they occur; the softer rocks are therefore swept away, and the iron deposits remain upon elevated plateaus or buttes."

Mr. Johnson also appears to have recognized the existence of the extensive deposits of conglomerate ores, but of these it is unnecessary to speak. They belong to every age, from the Eocene Tertiary to the present. In point of fact, many of them are still forming.

In 1888 the Geological Survey of Texas was established and the east Texas division assigned to Dr. Penrose. This area included the whole of the ore regions examined by Johnson. In his views regarding the age of the ore deposits, as shown in his "Preliminary Report on the Gulf Tertiary of Texas," Dr. Penrose appears to agree with Johnson as to the age of the nodular ores being lignitic Tertiary, but the whole of the laminated ores he places, and rightly so, in the glauconitic or Claiborne Tertiary. In a recent report on the iron ores of Arkansas Dr. Penrose again refers to the east Texas ores as follows: "In eastern Texas, where the geologic position of the Tertiary iron ores is more easily defined than in Arkansas, two principal divisions of the Eocene contain noticeable quantities of ore; the lower one is the great series of sands and clays, which forms the central part of the Eocene (the Timberbelt or Sabine River beds of the Texas section); the upper one is the Claiborne glauconite that overlies these beds." In this report Dr. Penrose compares the Arkansas ores to the Texas nodular ores and places both in the lignitic (Report on Iron Ores, Geological Survey of Arkansas, Vol. I. of 1892, pp. 105–6).

Numerous and careful examinations of these ore deposits throughout a great portion of east Texas and particularly in Cass, Marion, Morris, Upshur and Harrison Counties, the regions in which the nodular ores are most extensively developed, have convinced me that these nodular ores do not belong to the lignitic stage of the Eocene, but rather that they are of the same age as, or probably a little newer than, or derived from, the laminated ores, which, according to Mr. G. D. Harris's determination of the fauna, are of lower Claiborne age.

Without entering into any discussion as to the geological conditions of the ore regions, it may only be necessary to say that the lignitic and glauconitic divisions are both represented in the regions occupied by the nodular ores. The characteristic features of each are so distinctly marked that there is nowhere the least difficulty in separating or distinguishing the one from the other. The uppermost number of the lignitic stage is a series of thinly stratified or laminated white and red sands and sandy clays, the laminæ rarely exceeding half an inch in thickness and having, wherever exposed, a thin covering, or uppermost lamina, of silicious iron or ferruginous sandstone from a half to one inch in thickness. These sands have not always this ribbon-like banding but occasionally, through an intermixture of the colors, present a mottled appearance. This condition is usually confined to the vicinity of streams.

The lowermost deposits of the Marine stage of the Tertiary or glauconitic deposits are usually coarse greenish or brownish-yellow colored indurated sands or sandstones. Occasionally these deposits are dark brown and usually without fossils, although not unfossiliferous throughout, but wherever found the fossils exist only as casts and are chiefly *Cardita planicosta* and turretella. These deposits are, as a general thing, ferruginous and carry laminated iron ore in thin seams, not only interstratified with the beds of sand and sandstone, but often filling joints and fractures running in different directions through the beds. No ore of any economic value, however, is found associated with them. The base of these glauconitic sands and sandstones rests directly upon the uppermost white and red sands and clays of the lignitic and marks the limit below which no ore of any quantity or value has yet been found in any portion of east Texas.

The general assumption of the nodular ores belonging to the lignitic by both Johnson and Penrose appears to have arisen from the idea held by both that the regions in which these ores occur in greatest abundance are altogether occupied by the clays and sands of that series. While it is true that the deposits of the lignitic stage are extensively developed in Cass, Marion and Upshur, and in a more limited way in Morris and Harrison Counties, the marine stage is also represented, and widely spread, fragmentary deposits of altered greensand and glauconitic sandstones occur within the limits of these counties. These fragmentary deposits often cover several miles of territory, and their presence is always marked by the occurrence of nodular ore and a greater or less extent of laminated ore. This is usually in the form of very thin seams interstratified with the sands or occurs in a fragmentary condition scattered on the surface and mixed with the geodes of nodular ore.

In Cass County the brownish-yellow altered greensands occur in association with both nodular and laminated ore at the Berry Crawford mine about a mile north of Atlanta. Here the section shows the nodular overlying the laminated ore and the underlying altered greensand resting directly upon the uppermost deposits of the lignitic series. This ridge extends for several miles to the north and west, and the nodular ore is found buried in the grayish and brownish-yellow sand forming the summit and sides of the ridge and overlying the laminated ore and altered sands and sandstones. The same thing occurs in the neighborhood of Linden, where the nodular ore occupies its usual position among the yellow sands overlying the beds of laminated ore. At Cusseta, in the so-called Cusseta Mountain, we have the same laminated and nodular ores associated with altered greensand.

Throughout the northwestern portion of Cass and eastern portion of Morris Counties extensive deposits of laminated ore occur overlying pyritiferous greensand. A small quantity of nodular ore is found along the margin of this plateau and occasionally among the brown and yellow sands overlying the region.

South of Avinger Station in the same county, and extending across into Marion County, heavy deposits of yellow and brownish-yellow sands containing great quantities of nodular ore occur, and the whole of this field rests upon the thinly stratified deposits of the uppermost lignitic, whose bright red and white striped beds show beneath the ore deposits near Mr. Lockett's mill on the one side, and the cuttings along the Texas and Pacific Railway on the other, and throughout this area wherever stream channels have been cut deep enough.

Throughout Marion County the same sequence of beds follows. Two miles north of Jefferson the banded lignitic is found occupying a position beneath the laminated and nodular ores. In Harrison County it is the same thing. In this county the marine or glauconitic

Tertiary is if anything more pronounced than in the counties to the north. Heavy deposits of altered glauconitic sands, sandstones and laminated ores belonging to the marine or Claiborne stage of the Eocene form a ridge extending through the centre of the county from nearly five miles east of Marshall to beyond the western line of the county and for over a mile into Gregg, where it is separated from the same class of deposits lying further west, by the broad bottom lands of the Sabine River. These deposits are more or less fossiliferous, containing the characteristic fauna of the marine beds found farther south and west, and rest directly upon the uppermost lignitic, exposures of which may be seen near Willow Switch in Gregg and at many places north and east of Marshall, in Harrison. Laminated and nodular ores occur scattered everywhere throughout this region. The yellow sand with its contained nodules occurs capping many of the secondary portions of the ridge and lies intermingled with fragments of laminated ore or forms portions of the ore deposits that lie scattered along the sides and around the base of the ridge.

There is no use, however, to multiply instances in which the two varieties of ore lie associated and intermingled with each other. To merely recount the localities would be long and tedious and require a detailed account of the whole geology and geography of the country.

It must, however, be admitted that as a general rule the heavier deposits of nodular ore occupy positions lying at relatively lower levels than the heavy deposits of laminated ores, and it also appears to be a settled condition that while extensive deposits of nodular ore overlie these beds, by far the most extensive and valuable of these nodular deposits occupy positions between the isolated ridges, or what may be said to form the broken ends of the marine beds. This, however, is to be expected, if we are to assume that these geodes or nodules with their surrounding sands are the products, or the results of, erosion and consequent destruction of the glauconitic beds. That these glauconitic beds extended many miles farther north of the positions in which we now find the main bodies there can be no doubt. Not only the points already mentioned, but many others not nearly so prominent, still exist, bearing witness to this northward extension and the enormous erosion which has taken place in the past and is still going on.

A careful examination of one or two of the most prominent of these deposits of nodular ore and the yellow and brownish-yellow sand will, I think, be sufficient to show that these are both the results of the degradation of the beds now forming the ridges. Macroscopically, this sand is the same as the heavy deposits found covering many portions of the regions in Cherokee, Rusk and Anderson Counties, in which the laminated ores have their greatest development. The nodules of ore found among these sands do not occur promiscuously scattered over the face of the country, but usually occur in pockets or irregular deposits and at a noticeably higher elevation than the general level of the surrounding country.

In saying that none of these ore deposits occurs beneath the thinly stratified uppermost lignitic beds, I do not mean to affirm that no ore occurs within the lignitic series, but simply that none of the great deposits of nodular ore in east Texas which have hitherto been assigned to that series belongs to the lignitic. Small deposits of a nodular variety of ore as well as clay ironstone do occur at several places within the lignitic beds. These, however, lie at considerable depths and are found amongst the clays and sand of that series in well digging and other deep excavations. These are not all clay iron-stones nor carbonates, as has been asserted, and throughout the extensive areas of the eastern division of the State, in which the lignitic strata form the surface deposits, no ore of any kind has yet been found. The absence of these ores from the great lignitic areas of Limestone, Robertson, Smith, Harrison, Panola and other counties certainly appears remarkable if the nodular ores of Cass, Marion and others belong to these deposits.

While the question of the age of the nodular ores may form a subject for discussion, no such doubt or difficulty besets the age of the laminated ores of the region. These are altogether from top to bottom of Tertiary age and of the lower Claiborne or marine Eocene wherever found. These ores are connected with, and form an integral part of, the marine beds, and while the heaviest deposits are always, or nearly always, found at or near the surface, the same character of ore occurs at more than one horizon and lies interstratified with the glauconitic or greensand beds. Borings, as well as numerous natural sections, have demonstrated this fact,—and by the same methods it has also been shown that these lower beds are always much thinner than the upper, or surface deposits. Besides being thus stratigraphically constructed with the greensands, the ores themselves are also fossiliferous and carry the same fauna as that found in the greensand deposits. Numerous specimens gathered from deposits both overlying and underlying these ore deposits and from the ores themselves are to be seen in the cabinets of the Geological Survey of the State.

Just why these ores should assume the forms in which we now find them is somewhat difficult to say. It is quite likely that the laminated ores were deposited with the glauconitic deposits as bog iron, and part of them, particularly the interstratified deposits, have been derived from the destruction of the glauconite, and again from the destruction of these deposits, through a process of solution, infiltration and segregation, the nodular ores have been derived. Dr. Hilgard ascribes the formation of the nodular ore found in the Orange Sand in Mississippi to the solution of the iron contained in the sand and its leaching and sinking through that deposit and segregation at the base where the solution met with an obstruction to its descent in the impervious clays of the underlying lignitic beds. If this theory holds good for the Mississippi ores it certainly has everything in its favor so far as the Texas ores are concerned. There is at least one point in favor of such a theory everywhere throughout the Texas iron region. The waters found in nearly every spring and well in the country are highly charged with iron, many of them excessively so, and many of the streams crossing the ore-bearing ridges contain this impurity to such an extent that they are absolutely devoid of animal life. The waters of these streams are of a pale amber yellow color and excessively astringent taste.

Dr. Penrose's theory that these nodules are derived from nodules of clay iron-stone found in the underlying beds by oxidation—"When the carbonate has been completely oxidized the ore is either composed of concentric layers separated by cavities or is massive on the outside and hollow inside, forming geodes or iron pots. The clay or ochre often occurring in the geodes doubtless represents the residual product left after the oxidation of the impure carbonate"—does not appear to hold good in all cases. Many of the nodules found in the regions under consideration are not filled with residual ochre, but with coarse white and yellow sand, having exactly the same texture as that in which the nodules lie ; besides some of the nodules found on the ridge in Harrison County have their centres filled with silicious pebbly conglomerate, two conditions of existence which no known condition of carbonate of iron in the form of clay iron-stone could possibly create, even should we admit the existence of a sufficient quantity of that ore to form the vast deposits of iron as we now find them. The existence of the enormous quantities of carbonate of iron or clay iron-stone I am by no means inclined to admit. Whether the lignitic ever held such quantities I do not know, but certainly the beds as we now find them contain very little of this class of ore. The little they do contain is almost altogether a sulphide.

SORGHUM SUGAR.

BY T. BERRY SMITH, FAYETTE, MO.

It has been many years since the people in the central and northern parts of the United States began to cultivate sorghum for the purpose of obtaining molasses therefrom. The processes were such as could be employed by almost any farmer.

But it has been only a few years since experiments began for the purpose of extracting sugar from the sorghum cane.

The first appropriation made by Congress for large experiments in sorghum sugar making was during the last days of the session of 1884. Since that time, so far as we know, annual appropriations have been made and untiring efforts put forth to improve both the cane and the processes of sugar making; and the advances made in each line have been steady and encouraging.

It is our purpose to treat mainly of the applications of scientific principles, as made in the government experiments in Kansas and elsewhere.

Let us suppose the cane has been grown under the ordinary circumstances and is ready to be harvested. The usual course is then to strip and top the cane, cut it and haul it to the mill (who that has heard its creaking, can ever forget it?), there crush it and collect the juice, and then evaporate it to molasses by boiling in open pans, certain simple processes being employed to clarify the syrup more or less.

By such methods are obtained the molasses which we have all eaten and of which we can not mistake the peculiar flavor.

A brief analysis of the subject will show us that the main steps are:

1. Separation of the juice from the cane.
2. Separation of the sweets from the juice.

If we would manufacture sugar there must be a third step, viz.:

3. Separation of sugar from the molasses.

Let us treat these separately:

I.—Extraction of Juice.

Old Method: Expressing it by passing the cane between rollers.

New Method: Extraction by soaking in heated water, the process being termed diffusion.

The *topped* cane is delivered to the factory by the farmer. There it is cut into short lengths by a cutting machine, after which a fan blows away the boots, blades and trash, and then the short pieces are delivered to a shredding machine, which tears the cane into as small bits as possible.

This pulp is delivered to the diffusion battery, which is arranged in various ways, but the principle of which may be stated thus:

If hot water be poured over one jar of pulp it will soak out a certain amount of the sugar content. If this sweetened water be withdrawn and poured over a second jar of pulp, it will become still more sweet; and by passing it in like manner over a number of jars of pulp, it will finally become as rich in extracts as the original juice of the cane was, *i. e.*, it may be called cane juice.

Now in order to extract all the sweets, the first jar of pulp must be subjected to portion after portion of hot water, until there will be left in the pulp very little besides woody fibre. And so with the second jar and so with all the jars of pulp.

One can readily see that the jars or cells could be so connected that the hot water entering at No. 1 would be forced in succession through a sufficient number to attain the desired strength, and thus the process be rendered continuous. Such an arrangement is termed a diffusion battery.

If the subject has been made plain so far, we are now ready to take up the second great step.

II.—Extraction of Sweets.

Old Method: Simple evaporation in open kettles or pans, with constant skimming to remove the "scum" formed by heat.

New Method: (1) Neutralization of acids by lime; (2) Removal of surplus lime by carbonic acid gas (carbonatation); (3) Heating and skimming; (4) Settling; (5) Evaporation of clear juice under reduced pressure and temperature.

The *diffusion* juice is placed in large tanks and milk of lime added until an alkaline reaction is shown. The purpose of this is to counteract the effect of any acids that may be present. At this point in our paper it will be necessary to digress a little and introduce a small amount of chemistry.

There are in the vegetable world many products which are composed of charcoal and water, the only difference in chemical constitution being in the proportions of charcoal and water employed.

Let us look at the accompanying table:

Wood	= 6 parts carbon and	5 parts water	($C_6H_{10}O_5$)
Starch	= 6 " "	5 " "	($C_6H_{10}O_5$)
Grape Sug'r	= 6 " "	6 " "	($C_6H_{12}O_6$)
Cane Sugar	= 12 " "	11 " "	($C_{12}H_{22}O_{11}$)

Now if we take wood, starch or cane sugar and boil them in water with acids, they will be converted into grape sugar. It is in this way that tons and tons of starch are annually changed into syrup and sugar for household and other purposes. Almost all of the clear thick syrups used on our tables at the present day are glucose or grape sugar syrups. Such syrup is inferior to cane sugar syrup in the matter of sweetness, three pounds of cane sugar being equal to five ponds of grape sugar in this respect. You can plainly see, then, that the effect of the acids present in the diffusion juice would be to diminish the sweetness of the syrup produced by simply evaporating without their removal. Their removal is rendered easy by the use of lime, which neutralizes them by uniting with them to form insoluble compounds which settle to the bottom. Now as lime will combine with sugar also to form sucrates, it is necessary to remove any surplus lime that may be present, and this is done by blowing through the juices a stream of carbonic acid gas, which may be inexpensively obtained from the smoke stacks of the furnaces. This part of the process is known as carbonatation.

After neutralization and carbonatation, the juice is raised to the boiling point, the scum formed by heat is removed in the usual way, and then the clarified liquid is left in large tanks to settle. From these it is drawn off and is ready for concentration by evaporation. This is not accomplished in open pans because in an