rupture takes place between the parent cells and the resulting daughter cells—the former still continue to absorb and assimilate various nitrogenous substances from the liquid.

It was long held that the only true theory in regard to fermentation was the one formulated by the distinguished Pasteur, which was, that:

“Alcoholic fermentation is a chemical action connected with the vegetable life of cells, which cells, in the absence of free oxygen, live by withdrawing the oxygen they require from certain carbohydrates, such, for example, as maltose or grape sugar.”

Quite recently, however (1897), it has been shown by Buchner—a good authority—that the actual process of fermentation, or, in other words, the decomposition of sugar into alcohol and carbonic acid gas, is independent of the vital action, being induced *outside the yeast cells by a functional product excreted during its growth*. This product has been eliminated by Buchner and called zymase; and it is to all intents and purposes an enzyme or diastase.

[To be concluded.]

Mining and Metallurgical Section.

Special Meeting held Wednesday, January 31, 1900.

THE OCCURRENCE OF FULLER'S EARTH IN THE UNITED STATES.

BY DR. DAVID T. DAY,
Chief of Division of Mineral Resources, U. S. Geological Survey.

Characteristics.—The only classification of clays which suggests itself by which definite place can be given to the variety called fuller's earth would be based upon the consideration of the relative proportion of total bases, such as alumina, iron, calcium, magnesia, alkalies and silica, together with the proportion of water in the sun-dried clay. Very frequently the clays which have a large proportion of total

bases and silica usually contain more than the average amount of water. For example, kaolin, containing from 40 to 50 per cent. of silica, and from 30 to 40 per cent. of total bases, will frequently contain from 10 to 15 per cent. of water in the sun-dried material. Where, however, the percentage of silica is very high, say 70 per cent., and the total percentage of bases less than 30, the percentage of water is usually quite low. Fuller's earth appears to be an interesting exception to this rule, as its chief chemical characteristic seems to be a high percentage of silica, which, though varying through a considerable range, frequently reaches 65 to 70 per cent., but with a total proportion of bases even as low as 20 per cent., and seldom higher than 28 per cent., while the percentage of water in the sun-dried material will range easily from 15 to 25 per cent. Approximately half of this water can be driven off by prolonged heating in a water-bath; the remainder is only to be driven off at a much higher temperature. These clays usually stick to the tongue more than other clays. When placed in water they show no plasticity, but fall apart in gelatinous flakes.

Such clays have been used for very many years even in this country for extracting from newly-made cloth the oil used to render the wool pliable in weaving. From this fulling process the clay has taken its name.

Silliman refers* to a deposit near the town of Kent on the Housatonic River, in Connecticut. He states that: "A fuller's earth is a clay usually soapy in its feel, very absorbent of grease and oily matters; fine in its texture, so as to present no parts that shall be large and harsh enough to injure cloth or wool, mechanically, by rubbing; it should fall to powder easily in water, so as to diffuse itself through that fluid, and easily mix with it and with the stuffs to which it is applied. The fuller's earth of Hampshire, England, so much celebrated, is of a greenish-yellow, tolerably firm, crumbles easily in water, receives a polish from the finger nail, and is *very powerfully detergent*. This is, after

* *American Journal of Science*, first series, I, 2, 217.

all, the important criterion by which to distinguish fuller's earth: if it removes grease with avidity, crumbles easily in water so as to diffuse itself readily, and yet is not so coarse as to wear the fiber, it is fuller's earth. The subject is of some practical importance to this country on account of its woollen manufactures, which, although checked for the present, must eventually rise and prevail. While they are of small extent it may be better to use soap, but in very large establishments fuller's earth from its cheapness (provided it can be abundantly obtained) is very desirable.

"With respect to the existence of fuller's earth in the clay of the Kent iron bed it appears very probable, and some of the specimens appear very like the Hampshire earth, but experiments alone can decide."

This visit of Silliman was in 1820. William Thompson* found clay in a fullonica excavated at Pompeii, which was pointed out to him as the soap which the ancient inhabitants used. This was used not only by the washers and dyers, but frequently in the ordinary houses. In composition it has the general characteristics of fuller's earth.

One of the first uses for the white kaolin at Woodbridge, N. J., was for this same purpose of fulling cloth in the absence of real fuller's earth, as shown by note on page 1 of the Report on the Clay Deposits of New Jersey, Geological Survey of New Jersey, in 1878.

But the name fuller's earth has usually designated the material obtained in Surrey, England. This has been the chief source of supply for English cloth manufacturers and for export. Various attempts have been made by mineralogists to find in fuller's earth some definite mineral substance which could be referred to as distinctive and which could be found in all varieties. Thus, Dana speaks of it as being in part kaolin and partly the hydrous silicate smectite, but this has been of little value in the identification of other specimens. Even to-day the name fuller's earth is applied to any form of clay which has the characteristics

* Reports of the British Association for the Advancement of Science, **49**, 321.

mentioned above, and is capable of absorbing liquids in considerable quantity, and particularly when it will act like bone-black in taking out the coloring matter from certain oils.

Developments of the Industry in the United States.—For many years either soap or fuller's earth was used as a detergent in fulling cloth, but with the increased use of cotton-seed oil English fuller's earth came to be used to decolorize such vegetable oils and also lard oils. This increased the importation of fuller's earth very markedly, as shown in the table appended.

In 1893 good fuller's earth was discovered in the United States quite accidentally. At Quincy, Fla., an effort was made to burn brick from the clay found on the lands of the Owl Cigar Company; the effort was a failure, for fuller's earth when burned exfoliates instead of forming a coherent mass, suitable for bricks. An Alsatian cigarmaker employed by the company called attention to the close resemblance of this clay to the German fuller's earth. As a result, the material found sale and the industry was developed. This use quickly spread as a substitute for, though more expensive than bone-black, filtering various mineral oils, and it is principally for such purposes that the American earth is now used, the English earth being preferred for cotton-seed and lard oils. The development of the industry in this country was sufficient to develop a widespread interest in the search for fuller's earth, and thousands of samples were examined by the chemists of various consumers. Most of the clays examined proved worthless, yet enough good samples were obtained to show that the region to the west and north of Quincy contained many other available deposits if needed. The search extended over the United States, and deposits were soon found in Virginia, North Carolina, Georgia, at various places in Florida, Indian Territory, Nebraska, Colorado, New Mexico and South Dakota. A small industry has been developed in New York State, but, with this exception, the supply continues to come from the developed deposits at Quincy, Fla. The reason for this is the great variation in quality of the earth

from different deposits. That from North Carolina and Virginia is more or less sandy ; that from Georgia is almost identical with the Quincy earth, but is not more favorably located for shipment. All the other deposits are less accessible, except one near Tampa, which promises soon to be a large source of supply. Curiously enough, the material produced in Florida bears little outward resemblance to the earth which has long been imported from England.

The earth discovered in South Dakota is almost the exact duplicate of the English earth in every respect, and will no doubt become a valuable substitute for it.

Fragments of chert are common in beds of fuller's earth, and in Georgia fuller's earth passes almost indistinguishably into layers of chert, with nearly the same color and fracture. At Ballert Point, near Tampa, Fla., the fuller's earth contains many oyster shells, bits of coral, etc., all entirely changed to chalcedony. This leads to the suggestion, as to the origin of this earth, that it is probably ordinary clay which has received from interfiltering solutions an additional supply of silicic acid which has sometimes combined with the clay, and occasionally has been deposited as chert.

The conditions of occurrence of fuller's earth and the manner of preparing it for market are quite simple. In Florida it may be found outcropping at the foot of slopes around the edges of the swamps. The clays appear to occur in large, shallow basins in the swampy tracts characteristic of the region around Quincy, and many other parts of the State. Usually there will be 1 or 2 feet of surface soil, then 2 to 6 feet of mottled, plastic clay, then the fuller's earth in layers varying in thickness from 2 to 12 feet, then a layer of sand mixed with fuller's earth, which is usually persistent for a considerable depth below the deposit. Occasionally a second deposit of fuller's earth, bluish in color, will be found below the first, with a layer of sand intervening. Up to this time the very simplest methods have been used in preparing it. The overburden of sand and worthless plastic clay is removed and the wet fuller's earth chopped out in thin slices with mattocks and allowed to dry in the sun for several days. By this means the wet, greenish clay will lose

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Fuller's Earth.

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PRODUCTION OF FULLER'S EARTH IN THE UNITED STATES FROM 1895 TO 1898.

Year.	Quantity.	Value.
	<i>Short Tons.</i>	
1895	6,900	\$41,400
1896	9,872	59,360
1897	17,113	112,272
1898	14,860	106,500

IMPORTS OF FULLER'S EARTH FROM 1867 TO 1899.¹

YEAR.	ALL KINDS.		UNWROUGHT. ²		WROUGHT. ²	
	Quantity. Tons.	Value.	Quantity. Tons.	Value.	Quantity. Tons.	Value.
<i>Ending June 30th.</i>						
1867	280	\$3,113				
1868	211	2,522				
1869	324	3,587				
1870	239	2,619				
1871	290	3,383				
1872	274	3,358				
1873	251	2,978				
1874	277	3,440				
1875	300	3,694				
1876	246	3,097				
1877	400	4,460				
1878	335	4,095				
1879	361	4,269				
1880	578	6,925				
1881	268	3,207				
1882	908	11,444				
1883	1,241	14,309				
<i>Ending December 31st.</i>						
1897 ³	—	—	2,308	\$14,283	2,138	\$20,037
1898	—	—	2,038	15,921	6,315	55,123
1899 ⁴	—	—	2,639	17,147	5,243	37,525

¹ Not classified from 1883 to 1897.² Not classified separately until 1897.³ Latter half.⁴ Three-quarters of calendar year.

ANALYSES OF

	SiO ₂	Al ₂ O ₃	Fe ₂ O ₃	CaO	MgO	H ₂ O	Na ₂ O	K ₂ O
	P. C.	P. C.	P. C.	P. C.	P. C.	P. C.	P. C.	P. C.
Smectite from Cilly ¹	51'21	12'25	2'07	2'13	4'89	27'89	—	—
Fuller's earth from Reigate ²	53'00	10'00	9'75	'50	1'25	24'00	—	—
Malthite from Steindörfe ³	50'17	10'66	3'15	'25	—	35'83	—	—
Fuller's earth from England ⁴	44'00	11'00	10'00	5'00	2'00	—	5'00	—
Fuller's earth from England ⁵	44'00	23'06	2'00	4'08	2'00	24'95	—	—
Fuller's earth from England, No. 1 (blue earth)	52'81	6'92	3'76	7'40	2'27	14'27	—	'74
Fuller's earth from England, No. 2 (yellow earth)	59'37	11'82	6'27	6'17	2'09	13'19	—	'84
Fuller's earth from Gadsden County, Fla. ⁶	62'83	10'35	2'45	2'43	3'12	7'72	'20	'74
Fuller's earth from Decatur County, Ga. ⁶	67'46	10'08	2'49	3'14	4'09	5'61	—	—
Fuller's earth from Fairburn, S. D. ⁷	58'72	16'90	4'00	4'06	2'56	8'10	—	2'11
Fuller's earth from southeast of River Junction, Fla. ⁸	50'70	21'07	6'88	4'40	'30	9'60	—	—
Fuller's earth from between Mt. Pleasant and Norway, Fla. ⁹	58'30	10'63	6'72	1'71	3'15	9'05	—	—
Fuller's earth from near Norway, Fla. ¹⁰	54'60	10'99	6'61	6'00	3'00	10'30	—	—
Fuller's earth from Valen- tine, Neb.	47'37	7'08	3'89	32'19	1'19	—	Trace	93
Fuller's earth from Ocala, Fla. Fuller's earth from Fairburn, S. D.	36'73	27'78	3'21	'81	'64	At 110°, 7'38 Above 110°, 12'14 6'20	—	42
Fuller's earth from Fairburn, S. D.	68'23	14'93	3'15	2'93	'875	—	—	—
Fuller's earth from Custer, S. D.	55'45	18'58	3'82	3'40	3'50	8'80	—	—
Fuller's earth from Custer, S. D.	57'00	17'363	2'362	3'00	3'027	9'50	—	—
Fuller's earth from Custer, S. D.	63'50	14'97	4'48	2'40	2'882	—	7'20	1'116
Fuller's earth from Custer, S. D.	71'28	14'33	2'484	'33	1'199	4'30	—	—
Fuller's earth from Hermosa, S. D.	55'40	27'70	1'80	2'30	'703	—	'487	'589
Fuller's earth from Fairburn, S. D.	60'16	10'38	14'868	4'96	1'714	7'20	—	—
Fuller's earth from Fairburn, S. D. (dried)	56'18	23'23	1'26	5'88	3'29	11'45	—	—
Fuller's earth from Fairburn, S. D.	67'00	5'00	12'00	—	—	15'00	—	—
So-called "Glacialite," Enid, Oklahoma Ter.	50'36	33'38	3'31	—	—	12'05	—	88

¹ Pogg. Ann., 77, 591, 1849.² Klaproth, Beitr., 4, 338, 1807.³ Dana, System of Min., p. 695, 1893.⁴ Geikie, 1893, p. 133.⁵ Penny Encyclopedia, 11, Dr. Thompson, analyst.⁶ P. Fireman, analyst.

FULLER'S EARTH.

SO ₂ .	CO ₂ .	P ₂ O ₅ .	FeO.	TiO ₂ .	NaCl.	MnO.	Moisture.	Volatile Matter.	Organic Matter. ⁿ	Moisture in Air-Dried Sample.	Calculated to Water-Free Material (dried)
P. C.	P. C.	P. C.	P. C.	P. C.	P. C.	P. C.	P. C.	P. C.	P. C.	P. C.	P. C.
-	-	-	-	-	-	-	-	-	-	-	-
-	-	-	-	-	-	-	-	-	-	-	-
-	-	-	-	-	-	-	-	-	-	-	-
-	-	-	-	-	-	-	-	-	-	-	-
-	-	-	-	-	-	-	-	-	-	-	-
05	-	'27	-	-	'05	-	-	-	-	-	-
07	-	'14	-	-	'14	-	-	-	-	-	-
-	-	-	-	-	-	-	6'41	-	-	-	-
-	-	-	-	-	-	-	6'28	-	-	-	-
-	-	-	-	-	-	-	2'30	-	-	-	-
-	-	-	-	-	-	-	7'90	-	-	-	-
-	-	-	-	-	-	-	9'55	-	-	-	-
-	-	-	-	-	-	-	7'45	-	-	-	-
20	17'73	'21	-	-	-	-	-	-	-	2'53	110° C.
-	-	5'54	-	1'27	-	-	-	•	3'61	-	-
-	-	-	-	-	-	-	-	-	-	-	-
-	-	-	-	-	-	Trace	-	5'35	-	-	-
-	-	-	-	-	-	Trace	-	5'85	-	-	-
-	-	-	-	-	-	-	-	{ CO ₂ & Vol. 10'70 }	-	-	-
-	-	-	-	-	-	Loss	-	{ Alk. und. }	-	-	-
-	-	-	-	-	-	13'00	-	-	-	-	-
-	-	-	-	-	-	-	-	-	-	-	-
-	-	-	-	-	-	-	-	-	-	-	-
-	-	-	-	-	-	{ Org. Trace }	-	TiO ₂ Trace	-	-	-

⁷ E. J. Riederer, analyst.

* Standard Oil Company's property. E. J. Riederer, analyst.

⁹ Howell property. E. J. Riederer, analyst.

11 The organic material was the

¹¹ The organic matter is based on the assumption of Wolff that humus contains 58 per cent. carbon, the latter being directly determined.

perhaps 50 per cent. of its weight, turn to a creamy white color and become very brittle and easily split into thin layers. It then contains 15 per cent. of its weight of water, which can only be driven off above the boiling point. Lately artificial dryers have been introduced and an arrangement for grinding the earth to the requisite fineness. The process of levigating the earth, which is quite common in Surrey, England, is not used in this country at all. This Florida earth, ground to 60 mesh and finer, is used almost entirely as a substitute for bone-black in filtering mineral lubricating oils, although its use has extended to some extent for the lightening of the color of cotton-seed oil. But for this latter purpose the practice is still universal of using English fuller's earth which has been taken out by the ordinary method and then washed in long, narrow troughs, very much like hydraulic sluice boxes, allowing quite a large percentage of the material to settle out as sand and displace the lighter material which goes off into the settling tanks, in which it is finally dried and sold in the resulting lump form. The English earth has not proved any more suitable for the refining of mineral oils than has the American earth for use in vegetable oils. The common practice with the mineral oils is to dry the earth carefully after it has been ground to 60 mesh, and fill it into long cylinders, through which the crude black mineral oils are allowed to percolate very slowly. As a result the oil which comes out first is perfectly water-white in color and markedly thinner than that which follows. The oil is allowed to continue percolating through the fuller's earth until the color reaches a certain maximum shade, when the process is stopped, to be continued with a new portion of earth. The oil is recovered from the spent earth.

With the vegetable oils the process is radically different. The oil is heated to beyond the boiling point of water, in large tanks, to which from 5 per cent. to 10 per cent. of its weight of fuller's earth is then added, and the mixture vigorously stirred for twenty minutes and then filtered off through bag filters. The coloring matter remains with the earth, leaving oil of a very pale straw color, provided the

original cotton-seed oil had been sufficiently well refined by the ordinary process to admit of this, and provided the operation had been conducted with sufficient care. Perhaps the most remarkable feature of this filtration by fuller's earth is the different rate of speed at which oils of different density, in such a mixture of oils as is found in an ordinary crude petroleum, will percolate through, with the result that the first oil which makes its appearance is not only very much lighter in color, but markedly lower in specific gravity. In fact, by this process separations can be made which are quite comparable with the results of fractional distillation. There is no question but that a method is here suggested for the scientific investigation of petroleum which chemists will not be slow to utilize, and, while it is slower and not so sharp in the fractions yielded, it is perfectly evident that the oil undergoes little change due to the process of separation itself, as is almost always found to be the case in fractional distillation.

Stated Meeting, held Wednesday, December 13, 1899.

THE TILLY FOSTER MINE.

BY EDWARD K. LANDIS.

This celebrated mine is situated in Putnam County, N. Y., about 52 miles north of New York City and 2 miles west of Brewster, where the Harlem and New York and New England Railroads cross each other. Brewster is also the northern terminus of the New York City & Northern R. R., since absorbed by the Harlem. This latter railroad runs through the mine property, so that the shipping facilities are exceptionally good.

HISTORY.

In 1697, William III granted Adolph Philipse a tract of land, now Putnam County, N. Y. At his death it came to his nephew, Frederick, and in 1754 Frederick's three surviv-