event, with all its attendant circumstances, appeared so familiar to him that he was absolutely sure he had previously experienced the same impressions, surrounded by the same people or objects, with the same sky, weather, etc. If he ventured to undertake a new occupation of any kind whatever, he was certain he had done it before and under identical conditions. Sometimes the sensation would occur the same day, in the course of a few minutes or hours, sometimes it did not strike him until the day following, but it was always a distinct impression.

In this phenomenon of false memory, there is an anomaly of mental mechanism which escapes us, and which is difficult to comprehend in a healthy state. The person affected, no matter how acute an observer he might be, could only analyze the condition when he ceased to be deceived by it. From the examples given it would seem to me that the impression received is reproduced in the form of some image. To employ a physiological term, there is a repetition of the primative cerebral process. This is a very ordinary phenomenon. It occurs in every recollection which is not caused by the actual presence of the object. The only difficulty is to discover why this image which arises a minute, an hour or a day after the real condition, should appear to be a repetition of the latter. We may possibly admit that the mechanism of recollection acts in a distorted manner, for my part, however, the following explanation seems more explicit:

The image formed in this manner is very intense and partakes of the nature of an hallucination. It is, apparently, a reality, for nothing rectifies the illusion. Consequently, the real impression is forced back, as it were, and assumes the character of a recollection. It becomes realized in the past, erroneously if we consider the facts, objectively, properly, if we consider them subjectively. The hallucination, although very vivid, does not efface the actual impression, but as the latter is quite separate, and as the former is produced at a comparatively late period, the real occurrence appears to be a second experience. The hallucination assumes the place of the actual impression, it seems to be more recent, and this is really the case. Of course, to us who judge according to what we see externally, it is false to say that the impression was received twice. To the person afflicted, however, who determines solely as his consciousness may dictate, it is true that the impression was actually received twice.

To the support of this explanation, I would call attention to the fact that false memory is nearly always allied to some mental affection. The person mentioned by Pick suffered from a form of insanity. He was continually endeavoring to escape from people he supposed were his persecutors. Hallucinations in this instance would be perfectly natural. I do not, however, wish to assert that my theory is the only possible one. In regard to this isolated condition of false memory, much more numerous and concise observations than mine are probably required.

THE EXCAVATION OF THE GRAND CAÑON OF THE COLORADO RIVER.*

By Capt. C. E. Dutton, U. S. A. U. S. Geological Survey.

The Grand Cañon of the Colorado River is the longest, widest and deepest of the almost continuous chain of cañon valleys through which the upper half of that river flows. Its length is 218 miles, its width from 5 to 11 miles, and its depth from 4500 to 6000 feet. For convenience of discussion it may be arbitrarily divided into four divisions: 1st. The Kaibab division; 2d. The Kanab; 3d. The Uinkaret; 4th. The Sheavwits division. The upper or Kaibab division is the grandest, widest and most diversified, and a little deeper than the others

* Read before the A. A. A. S. Cincinnati, 1881.

The three others are simpler in form and much alike in their topographical features. Capt. Dutton first exhibited a view of the cañon in the Uinkaret division, showing its simplest and most typical form. It consists of an inner and an outer chasm, or a cañon within a cañon. The outer chasm is five to six miles wide, and is walled on either side with palisades 2000 feet high, of singularly noble and graceful profiles, which confront each other across a comparatively smooth plain. Within this plain is sunken the inner gorge, descending 3000 feet lower, and having a width a little greater than its depth. At the bottom of the inner gorge flows the Colorado River, a stream about as large as the Ohio between Pittsburg and Wheeling. The strata in which the chasm is cut are chiefly of carboniferous age. The summit of the outer cañon wall is very near the summit of that series. The chasm throughout the greater part of its extent cuts below the carboniferous and penetrates the Lower Silurian, and even the Archæan schists, revealing the fact that before the carboniferous was deposited the country had been extensively ravaged by an erosion which swept away heavy bodies of Silurian, and probably also of Devonian strata. The carboniferous now rests upon the beveled edges of the flexed older strata, and in many places rests upon the completely denuded Archæan.

The region adjoining the chasm and for 40 to 60 miles on either side is a nearly level platform presenting the summit beds of the carboniferous system patched over here and there with fading remnants of the Permian. The strata is very nearly, but not quite horizontal. There is a slight dip to the northward rarely exceeding one degree, but as the general course of the river is along the strike, the edges of the strata disclosed in the Cañon walls are to all appearances rigorously horizontal.

From 40 to 60 miles north of the river are found the principal masses of the later formations, including the Permian, Trias, Jurassic, Cretaceous and Lower Eocene. These form a series of terraces rising successively like the steps of a gigantic stairway as we move northward. Each formation is terminated southwardly by a great cliff and the strata are nearly horizontal, collectively they have been named the Southern Terraces of the High Plateaus. The latest formation which was deposited in this region was the Lower Eocene.

To the geologist it is obvious that the formations of the Terraces now terminated by gigantic cliffs once extended further out towards the southward and formerly covered regions from which they have been denuded. Captain Dutton is confident that all these terrace formations once reached entirely across the Grand Cañon platform in full volume, and that their ancient shore line is found in Central Arizona. The thickness of the strata thus denuded was a little more than 10,000 feet on an average, and the area from which they have been swept away is more than 13,000 square miles. It is through the heart of this denuded region that the course of the Grand Cañon is laid. The denudation began probably at an epoch not far from Middle Eocene time, since at that epoch took place the final emergence of the region from a marine condition (through the brackish water and lacustrine stages) to the condition of *terra firma*.

It is apparent that the cutting and development of the present Grand Cañon is only a closing episode of a long history of erosion, extending from Middle Eocene time down to the present. Before the river could begin its attack upon the summit beds of the carboniferous which now form the crests of its upper walls, it had to cut through more than 10,000 feet of superior strata. This would alone indicate that the beginning of the present cañon cannot date far back in Tertiary time, and Capt. Dutton thinks that the evidence points strongly to the conclusion that its excavation in the carboniferous began in Pliocene time. This evidence is cumulative and not direct, but is derived from a comparison of many groups

of facts which are too numerous and complex to be summarized very briefly. One group of facts bearing upon the question of age is found in the comparative study of the lateral drainage channels and their gradual extinction by the progressive development of the arid climate of the region which took place in Pliocene time. Nearly all the ancient tributaries of the Grand Cañon appear to have dried up at the beginning of its excavation or very soon after, and the whole work shows the influences upon arid climate.

The Grand Cañon district has also been subject to a great amount of uplifting, amounting in the aggregate according to locality, to 16,000 to 19,000 feet. The present elevation of its surface above the sea is the difference between the amount of uplift and the thickness of strata removed, and is from 7,000 to 9,000 feet. This great elevation is considerably surpassed in some other portions of the West. Obviously, it has been an important factor or essential condition in the process of cañon cutting.

The peculiar forms of the drainage channels of the Plateau country, and of which the chasms of the Colorado are extreme developments, are ascribed to the operation of two groups of processes acting under abnormal conditions. It is customary to say that the rivers have cut their cañons. This is but a partial truth, for the rivers cut passages no wider than their water surfaces. The first group of processes is termed corrasion, the result of which is the continuous sinking of the bed of the stream by the grinding action of flowing water charged with sand. Many factors enter into this result, and their mutual relations are highly complex. But in a general way it may be said that a river with a rapid descent, carrying a notable quantity of sediment, but not enough to overload it or overtax its transporting power, will continuously corrade or grind down and deepen its channel. If it is overloaded, a portion of its sediment will be deposited and form a protective covering to the bed-rock. Under special conditions it will actually build up its bed. Most rivers, along their middle and lower courses have their general conditions so adjusted that there is little or no tendency either to build up or corrade. To this equilibrium of adjustment all rivers are tending, and most rivers have nearly or quite reached it. The Colorado is exceptional in this respect, and its tendency is to corrade. Its waters, though carrying great quantities of sediment, are still under-loaded, and could carry more if they could get it. This tendency to corrade may be ascribed to the fact that the country through which it flows has been gradually rising in altitude through Tertiary and probably also Quaternary time, and this elevation produces and maintains a rapid declivity in the stream-bed, which in turn imparts a high velocity, and consequently great transporting power to its waters.

The widening of the cuts made by corrasion is the work of the second group of processes, viz., weathering. This is also a very complex action, and cannot be briefly summarized. To this action is due the remarkable sculpture of the cañon and cliff walls and all those surprising resemblances to architectural forms which are so abundantly displayed in the Plateau country, and most especially in the Grand Cañon.

The concluding portion of Captain Dutton's lecture was devoted to a description of the scenery in the Kaibab division of the cañon, which is declared by all who have seen it to be the most sublime and impressive spectacle in the world.

NEW OBSERVATORY.—A meteorological station is to be erected at Pavia, under the direction of Professor Cantoni. Investigations will be made at this station on the influence of heat, light, electricity, etc., on vegetation in general, and some cultivations in particular, and also the diurnal and annual variations of terrestrial magnetism.

MIXED SUGARS.*

BY PROFESSOR H. W. WILEY.

Mixed sugars are made of cane sugar and *amylose* (starch sugar.) Within a few years the mixed sugar industry has advanced from a small beginning to a business of considerable importance. It is difficult to get accurate data of the amounts of this sugar made. Manufacturers and dealers are extremely reticent on the whole subject, and often refuse to talk about it at all. I have, however, after considerable trouble, been able to get at the figures which will give at least an approximate estimate.

The principle centers of the grape sugar industry are Brooklyn and New York, Buffalo and Peoria. From a careful comparison of the data which I have been able to collect, I place the daily product of mixed sugars at the several factories at 1,500 barrels. This will be found not far from the truth. It is rather under than over the true number. It is thus seen that the mixing of sugars is a fact which is altogether too large to be laughed at. It must be remembered, too, that the manufacture is rapidly increasing, and is only limited now by the quantity of dry white amylose that can be made.

Amylose costs 3½ to 4 cents a pound by wholesale. Uuntil the price of corn became so high it was half a cent less than this. It is, therefore, a very profitable business to mix it with cane sugar and sell the whole for the same price which the cane sugar would fetch alone. I have here on the table specimens of these mixed sugars. Here are eleven samples made by the Manhattan Refinery, of New York, also six samples from the Atlantic Refinery, of Buffalo, and six samples from Henry Hobart, of New York. These sugars are sold retail under various names. Of these I may mention "New Process Sugar," "Niagara A B C," "Harlem B," "Excelsior C." and various others. To the eye these sugars look very much like straight cane sugars, and are generally pure and wholesome. They differ from the pure cane sugars in being less soluble in water and in being less sweet to the taste.

It has been estimated that amylose is two and a half times less sweet than sucrose; but this depends largely on the method of manufacture. Some samples of amylose will be found quite sweet, while others impart even a bitter taste.

In the manufacture of mixed sugars it is highly important that the amylose be dry. If hydrated amylose be used it is found almost impossible to pulverize it, and when ground it is pasty and sticky. Machines have been patented for obtaining finely granulated amylose from the well dried specimens. It is quite impracticable, however, to obtain amylose entirely dry, and it is capable of being worked very well when it still contains 8 to 10 per cent of water. This water is put in when sold at the same price as pure sucrose. In a commercial sense it is, therefore, not a disadvantage. The amylose which is used in mixing is generally made by high conversion under pressure. It, therefore, contains a high percentage of glucose, (dextrose) as compared with the maltose and dextrine present. It is, therefore, less sweet to the taste than the liquid amylose, where the percentage of maltose is larger.

Many schemes for the estimation of the different constituents of a mixed sugar have been proposed. For a discussion of the methods of analysis by reduction and fermentation, I refer to my paper read before this section last Saturday. I will content myself here with a brief outline of the method which I have employed. The water is estimated by heating two or three grammes in a flat platinum dish to 150° C. for two hours. The percentage of cane sugar I determine by Clerget's method. First get the total rotation in the polariscope then invert

* Read before the A. A. A. S., Cincinnati, 1881.