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.

by heating to 68°, then polarizing again, carefully noting the temperature. From these readings the percentage of cane sugar present is calculated from the following formula:

$$x = \frac{a - a'}{144 - \frac{t}{2}}$$

Here a=first reading of polariscope.
a'=second reading of polariscope.
t=temperature of observation.
x=percentage cane sugar required.

In connection with the polariscope readings I also made reductions both before and after inversion, and thus obtained valuable data in regard to the nature of the amylose present, as well as securing a check on the optical results.

Following is a scheme of an analysis which will illustrate the method of procedure:

Reduction. Took 10 g. in 1000 c.c. Of this, to reduce 10 c.c. Fehling's Solution, took 27.8 c.c.
Then 1000 : 27.8 = x : .05 (.05 g = sugar corresponding to 10 c.c. copper solution.)
Whence x = 1.8 g. = 18 per cent reducing matter.
Polarization. 26.048 g. in 100 c.c. gave........ 97°.8+
After inversion at 21° " .... 2°.6—

Difference, = ... 100°.4

$$100°.4 \div 144 - \frac{21}{2} = 75.2 = \text{per cent sucrose.}$$

Reduction after inversion.
For 10 c.c. copper solution took 5.35 c.c.
Then 1000 : 5.35 = x : .05.
x = 9.35 g. = ... 93.50 per cent.
Deduct 18 per cent due to amylose = .. 75.50 "
Due to invert sugar.................... "
Sucrose by polariscope................. 75.2 "
Amylose, water and ash by difference... 24 8 "

Following are the results of twelve examinations of mixed sugar:

No.	Per cent Reducing Matter.	Per cent Sucrose by Polariscope.	Amylose, Water, Ash, etc., by difference.
1	*29.70	*71.4	28.6
2	24.6	64.35	35.65
3	25.64	68.2	31.80
4	25.00	64.72	35.28
5	22.52	66.80	33.20
6	24.4	60.34	39.66
7	26.88	60.7	39.30
8	25.00	68.6	31.40
9	30.5	59.9	40.10
10	25.8	71.6	28.40
11	26.6	61.0	39 00
12	18.0	75.4	24.60

The analysis of mixed sugars is at this time a matter of great public interest. It is important that the public be not defrauded by purchasing sugars under false names. It is true that the manufacturers, as far as I know, do not sell the mixed sugars as *straight*, but when they pass into the hands of the retail dealers they are usually disposed of as if they were genuine. I do not anticipate that mixed sugars will jeopardize the public health. When well made they are certainly palatable and harmless. For boiling with fruits, etc., as in making preserves, they are quite as efficient as cane sugars. Nevertheless a "mixed sugar" should be bought, sold, and consumed as a mixed sugar, and thus all "winking" at fraud be prevented.

* One of these numbers is evidently incorrect. On looking over my notes I cannot find the mistake, and I have no more of the sugar with which to repeat the analysis. I think the error is in the per cent of reducing matter.—H. W. W.

COAL DUST AS AN ELEMENT OF DANGER IN MINING; SHOWN BY THE LATE EXPLOSION IN THE ALBION MINES IN NOVA SCOTIA.*

By H. C. Hovey.

My object, in this communication, is to lay before the public by permission of Mr. Edward Gilpin, Inspector of Mines for Nova Scotia, the results of his investigations into the part played by coal dust in spreading and augmenting the terrible explosion that took place in the Albion mines, near Stellarton, on the East river, N. S., on the 12th of November, 1880.

Explosions are frequent in the coal mines of England and Belgium. causing loss of many lives and the destruction of much property. But in our own country, as a rule, we are fortunately exempt from such calamities. On the other side of the Atlantic there are special causes leading to these explosions; the thinness of the seams, the depth of the workings, the gaseous nature of the coals most prized for their coke and illuminating power, all combining to render difficult the great problem of producing ventilating currents sufficiently powerful and searching to insure the safety of the workmen.

Within the last few years men of scientific and practical knowledge have studied into these disasters and their causes, hoping that some remedy might be found that could remove the dreadful uncertainty hanging over the lives of those who help to sustain the fabric of modern civilisation. It was discovered by a rigid inspection of all available accounts of explosions, that many of them had occurred in pits known to be, as a rule, not dangerous from explosive gas, or declared to be free from it shortly before the moment of the accident. Then the fact gradually became apparent that a seemingly innocuous constituent of the mines, namely, *coal dust*, played an important part in spreading and augmenting the blasts. It was as if the wadding of a gun was composed of an inflammable material which, on ignition of the charge, doubled its effect.

It is well-known that chemical action is often induced in heaps of slack, such as exist in thick coal workings, and that the heat evolved may be enough to cause ignition. The danger is increased when the broken coal is comminuted, and floats in the air, as in this form, under various conditions, it may undergo rapid oxidation. Galloway's experiments show that when the particles of dust are so fine as to pass through the gauze shield of a safety lamp, an explosion may be caused by their ignition. Bauerman states that, in the Franco-Belgian collieries, "several fatal explosions have been traced to the firing of coal dust from the flame of a shot, even in cases where no fire-damp was present in the workings."

A brief glance at the history of the Albion Mines will not be misplaced. The main seam, which has been continuously worked since 1807, attains the remarkable thickness of 37 feet 6 inches, and is a highly bituminous coal, well adapted for gas and coke-making. It contains several layers of iron stone up to one foot in thickness, but may be considered as an unbroken mass of coal.

The earliest workings, now known as "the Burnt Mines," furnished large quantities of coal, until they were abandoned in 1839 on account of fire, which blazed so fiercely from the shafts that the chains used in raising the coal tubs, were melted. A new opening, the Bye Pit, was worked till 1863, when a fire occurred from a shot lighting gas. This was extinguished; but a short time after the gas ignited at the boilers, which were within a few yards of the top of the pit. and the works had to be closed up. The Foster Pit was next opened, but in 1869 spontaneous combustion caused a fire, which necessitated its abandonment before it was fairly under way.

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