does not seem impossible that a gas so active and so easily stored might be exploded with air in a pneumatic gun to give an additional impulse to the projectile.

The laboratory experiments which have been described may perhaps serve as a guide in some directions to manufacturers, but they cannot settle the commercial details upon which the success of the new enterprise depends. Much further study and tests upon a larger scale, with the improvements suggested by prolonged trial, can alone decide whether the new illuminant is destined to supplant older industries built up slowly and surely by the persistent efforts of hard-working and skillful men.

J. M. Crafts.
Massachusetts Institute of Technology.

NOTES ON THE CERRILLOS COAL FIELD.*

During August, 1895, the writer revisited the Placer, or Cerrillos, coal field of New Mexico, which is about 25 miles south from Santa Fé. The field is small, apparently a detached portion of the Laramie area extending far southward within the Rio Grande region.

The district of especial interest is a strip lying south from Cerrillos and Waldo, stations on the Santa Fé railroad. It is less than two miles wide and reaches southward to a little more than five miles from the railroad; but evidently all of the workable coal beds are shown, and the transition from bituminous to anthracite is exhibited very satisfactorily. The mines are on Coal cañon, which extends from the Placer, or Ortiz mountains, at the south, to Waldo, at the north, somewhat more than six miles.

The Ortiz mountains are largely trachytic; from them there extend northward two plates, each one about 200 feet thick, which lie between Laramie beds and follow their dip very closely. The upper plate covers the area east from Coal cañon and is now the surface rock, the overlying beds having been removed. It extends northward to somewhat less than two miles south of Waldo, terminating abruptly at the lower end of Madrid, where are the offices of the Cerrillos Coal Company. The lower plate, about 400 feet feet below the upper, does not come to the surface on Coal cañon, but it was pierced in a boring on the mesa immediately west and it crops in an arroyo within a few rods further west. Several dikes extend upwards from this plate, one, very large, seen west from Coal cañon, which must have been connected with the upper plate, as it rises very high above the mesa; a second, seen in Coal cañon, not more than 10 or 12 feet wide does not reach the upper plate; a third, very narrow, found in the same cañon at a mile and a half above Madrid, passes distinctly into the upper plate. Prof. Kemp examined the specimens from several exposures and recognized the close relation in composition throughout.

The stratified rocks within this strip belong to the Laramic and the exposed section is somewhat more than 1,000 feet thick. They resemble those of the same age in the Trinidad coal field, but shale is present in greater proportion. Limestone is apparently wholly absent and the sandstones are unusually non-fossiliferous. The coal beds are numerous, but most of them are very thin and several are not persistent in all of the sections.

The only coal beds of interest here are those in the interval between the trachyte plates; they are

White Ash coal bed	2′6″ to 7′
Interval	70′
Coking coal bed	1′ to 2′6″
Interval	80′
Cook-White coal bed	3′
Interval about	150′
Waldo coal bed	4′

*Abstract of paper read before N. Y. Academy of Sciences, January 20, 1896.

The *White Ash bed* is not more than 15 feet below the upper plate and the *Waldo bed*, as found in the bore hole, not more than 10 feet above the lower plate of trachyte.

The *White Ash* has been mined at many pits along Coal cañon for a distance of nearly three miles, beginning at about a mile and a half from Waldo. It is the important bed of the region and the only one now mined. Four pits, two of which are now in operation, show the bed. At the old Boyle mine, about a mile and a half above Madrid, the coal is a hard, dry anthracite, slipped and jointed throughout; some portions closely resemble the graphitoid anthracite of Rhode Island.

The Lucas mine at Madrid was idle when visited, but work had been stopped for only a short time. The southerly levels of this mine yield an anthracite of excellent quality, equal in appearance and composition to the average anthracite of Pennsylvania; but a rapid change is shown in the northerly levels. Jointing becomes annoying at a little distance from the slope, and the coal is wasted in the breaker; within 350 feet evidences of great pressure and disturbance accumulate, and the coal is laminated like that from some Vespertine mines of southwest Virginia, with the polished surfaces, often curved, frequently not more than one-fourth of an inch apart. This, however, is still anthracite, and work was stopped in these northerly levels only because of great waste in breaking.

The Cunningham mine, at the lower end of Madrid, entered a tender coal at the crop; the slope was pushed 1,100 feet, but no anthracite was found. The coal burns with flame.

The White Ash mine, about half a mile north from the Lucas, is the important pit. At one time trains might be seen coming from its slope made up of cars carrying, some of them anthracite, others the tender semi-bituminous, and others still the rich bituminous coal which has given this mine its reputation. The bituminous coal, containing 39 per cent. of volatile combustible, is obtained from the northerly levels, but the southerly levels yield for the most part what is called tender coal. The latter is dull, very tender, and much of it has an almost cone-in-cone structure. It is reached in the southerly levels at varying distances from the slope. The passage from bituminous into anthracite through this tender coal is shown in the sixth level southerly where tender coal was reached at 125 feet from the slope and anthracite at 450 feet. The passage is gradual. The anthracite makes its appearance at the bottom and thickens gradually, crushed coal being replaced by laminated and that by the harder almost homogeneous coal, the change being completed within 50 feet.

The *Coking bed* was worked some years ago at about two miles above Madrid, where its coal was coked in ricks.

The *Cook-White* is no longer mined, but it has been opened at many places along Coal cañon, and the changes in character of the coal are clearly shown. Above Madrid fragments on the old dumps show that the coal is anthracitic; a pit at the lower end of Madrid, almost midway between the Cunningham and White Ash mines, shows a tender coal which bears some resemblance to that from Pocahontas, in Virginia; analysis shows that it contains about 30 per cent. of volatile, which is about what should be expected, if its changes are similar to those of the *White Ash*.

The *Waldo bed* is not reached in the upper part of Coal cañon, but it has been mined extensively further down. The only interest it has here is its existence in the bore hole west from Coal cañon, where it is not more than 10 feet above the lower plate of trachyte and shows no evidence of any metamorphism whatever.

Long ago Newberry, and afterwards Stevenson, regarded the coal as metamorphosed by heat from a great dike of eruptive rock following the northerly side of the Placer (now Ortiz) mountain. This, which then was but a suggestion, is sufficiently clear as an explanation now. As the center of eruption was in the Ortiz mountains the metamorphism should be most notable near those mountains. That is distinctly the condition, for, at the most southerly point showing the *White Ash bed* well, the anthracite is very hard; but the change is less toward the north until normal coal is reached in the White Ash mine below Madrid. The gradation is equally clear in the *Cook-White bed*; but the small bed between the main seams appears to contradict the hypothesis, as it is decidedly bituminous at half a mile above the pit, where the *White Ash bed* yields the hardest anthracite observed. This condition is easily explained by the fact that the small bed is not continuous, being broken by clay seams several feet wide, which sometimes cut out all of the coal; these seams would prevent the passage of heat from one portion to another.

The conditions at several localities show that mere proximity to the mass of eruptive rock was insufficient to produce change. The lower plate of trachyte is but 10 feet below the *Waldo coal bed* in the bore-hole west from Coal cañon, but, though 200 feet thick, it had no appreciable effect upon the coal. The interval between the *White Ash bed* and the upper plate of trachyte shows insignificant variations along Coal cañon, and it must be approximately the same in the newer parts of the White Ash mine; yet in the Lucas mine and at all localities south from it the coal is anthracitic; whereas at all points north from it to the border of eruptive rock one finds only transition coal. It seems clear that direct contact is necessary to produce change.

Prof. J. F. Kemp describes the eruptive rock as a trachyte closely allied to andesyte. Its outflow then was early, possibly at the time of the Laramide elevation, when great outpourings of andesyte occurred in Colorado, Utah, Wyoming and Montana. The coal was completely formed prior to this elevation, prior to any disturbance, there being not only no evidence of pulpiness, but every evidence that the coal was thoroughly hard. It was crushed into minute fragments, slicken-sided, like the Utica shales of Franklin county, Pa., or laminated and rolled into leaves, like the Vespertine coals of southwestern Virginia. The process of conversation was complete before disturbance not merely in the lowest beds, but also in the *White Ash bed*, at nearly 900 feet above the bottom of the Laramie.

JOHN J. STEVENSON.

THE RÖNTGEN PHENOMENA.

A FEW EARLY RESULTS OBTAINED AT THE UNIVERSITY OF PENNSYLVANIA.

THE first attempt here to repeat Röntgen's experiments was made on Wednesday, January 22d, but without success, owing to the impression obtained from early accounts of experiments abroad that two induction coils were necessary. As a matter of fact, one coil giving a four-inch spark through air is quite powerful enough to produce most of the results that have yet been obtained. The average current through the primary is about three amperes with an E. M. F. of twelve volts. Our tube is a beautiful large pear-shaped one, admirably adapted for the purpose. It is about 27 cm. long, and 11 cm. in diameter at the largest end.

Fig. 1 shows the result of a test to demonstrate the possible reflection or refraction of the X-rays when incident upon two very large and white diamonds set in a ring. The gems were placed within a purse with some coins. Certain features of the cutting