constituents of the superficial portions into those immediately beneath them may have caused the metamorphism of the superficial and the induration of the inferior portions.

I do not know of the existence of organic remains in any of the strata, with the exception of the anomalous worm-burrowings in the red and mottled clays, which were described by me in a paper read to the Geologists' Association, and which will be found in vol. 1 of the Proceedings, p. 161.

2nd. "On the Uneven Surface of the Chalk when covered by Boulder-clays and Gravel." By Mr. A. Bott, F.G.S.

Ordinary Meeting, December 6th, 1864.

E. Cresy, Esq., President, in the Chair.

A Paper was read by Mr. C. Tomlinson, F.C.S., entitled 'Two Days on the Chesil Bank,' in which he described a visit to that remarkable bank of shingle, the most extensive in Europe, extending, as it does, from Burton Cliff, near Bridport, to the Isle of Portland, a distance of nearly nineteen miles. Mr. Tomlinson did what few visitors to this part of our coast care to do: he walked the whole length of the Bank, which in the last ten miles has no other path than the loose shingle. He also collected (and exhibited) pebbles from different parts of the Bank, not only to illustrate their species, but also the remarkable and gradual increase in size, from blown sand, at Burton Cliff, to pebbles of the size of turnips, at the village of Chesil. Among the pebbles, those of rolled flint or of translucent quartz are most abundant: there were also pebbles of black fullers' earth, black Devonian Limestone, Old Red Sandstone, Porphyry with green and red spots, Lias with lines of carbonate of lime, forest-marble, and jasper. Parts of the Bank are broken into gulleys by the infiltration of water, and the subsequent hydrostatic pressure during heavy seas. A large map of the locality, and diagrams showing the dimensions of the Bank, as determined by Mr. Cooke, the Engineer of the Portland Breakwater, were exhibited. The questions then discussed by Mr. Tomlinson were—1. Where do the pebbles come from? 2. What

force transferred the pebbles from a distance? 3. What force retains them in their present position? 4. Why do the largest pebbles travel to the greatest distance? Mr. Coode's investigations were several times referred to, as well as those of Mr. Palmer and others, on moving shingle, and the importance to the Engineer of ascertaining the laws which govern it.

After the reading of the paper, a lively discussion followed, in which a large number of the Associates took part. The President summed up, and Mr. Tomlinson replied at some length. He recommended that one of the next Summer-trips of the Association should be to the Chesil Bank, and that in the meantime a Committee should be appointed to draw up instructions for the visitors as to what points require to be carefully examined before all the questions raised on the subject could be considered as settled.

Conversazione, January 24th, 1865.

A *Conversazione* was held on Tuesday, January 24th, in the rooms of the Association, at which about a hundred of the Members and their friends were present. A large number of interesting fossils were exhibited by Mr. Pickering, Mr. Evans, Mr. Bott, and Mr. Meijer, and a collection of minerals, from Germany, by Mr. G. E. Roberts, this latter being the chief centre of attraction to those present. It consisted of, perhaps, the finest collection of quartz, felspar, and lime crystals which has ever been exhibited in this country. Microscopes and objects were kindly lent and managed by Mr. Hislop, Mr. Leighton, and Mr. Ramsey. During the evening, Mr. Highley, F.G.S., exhibited by the aid of the oxyhydrogen light a series of micro-photographs, illustrative of geology and its allied sciences; and Mr. T. Boverton Redwood, read a paper "On the metal magnesium," and exhibited in great perfection the light produced by its combustion.

Coffee was served at ten o'clock, and the Members and their friends did not separate till eleven o'clock.

"On the Metal Magnesium." By Mr. T. BOVERTON REDWOOD.

THIS metal, which has of late attracted considerable attention on account of the brilliant light afforded by its combustion, is an

abundant element of the crust of the earth, but is never found in an uncombined or metallic state.

Combined with oxygen it constitutes the well-known alkaline earth, magnesia. Dolomite, or magnesian limestone, consists of a double carbonate of magnesia and lime. Steatite or soap-stone, meerschaum, of smoking celebrity, asbestos, and talc also all consist mainly of magnesia in combination with silica.

It is contained abundantly in sea-water, partly as sulphate of magnesia, but principally as chloride of magnesium. Sulphate of magnesia is also found in many mineral springs, such as those in the neighbourhood of Epsom, from which circumstance it has acquired the name of Epsom Salts; but although this well-known medicine was originally derived from Epsom waters, it is now principally prepared from magnesian limestone or dolomite in the following manner. The limestone is first burned, slaked, and washed with water to remove part of the lime which is associated with the magnesia in the mineral; it is then treated with sulphuric acid, and the sulphate of magnesia separated from the sulphate of lime by solution and recrystallisation.

From solution of sulphate of magnesia, carbonate of magnesia is prepared by precipitation with solution of carbonate of soda; and from the carbonate, chloride of magnesium is produced by dissolving the former in hydrochloric acid, adding some chloride of ammonium, evaporating the mixture to dryness, and fusing the residue at a red heat; under these circumstances the chloride of ammonium is volatilised and the chloride of magnesium remains in a fused state. This is the source from which metallic magnesium is now obtained.

Metals are usually reduced by heating one of their compounds to a high temperature in contact with carbon, but this method could not be adopted in the case of magnesium, for the high temperature necessary for the reduction would cause the metal to burn and recombine with oxygen as soon as produced.

Sir Humphry Davy, who has the credit of having first demonstrated the existence of magnesium as a chemical element, effected its separation from magnesia by means of electricity.

On the 6th of October, 1807, Davy commenced a series of experiments, remarkable for the results obtained, which ended in the discovery, amongst other metals, of magnesium.

He placed a small piece of potash or soda upon a platinum plate connected with the negative pole of a powerful galvanic battery, and brought into contact with it a platinum wire connected with the positive pole.

Under these circumstances the alkali became decomposed, effervescence occurred, and globules having a high metallic lustre were obtained. These globules were found to consist of the metallic base of the alkali; potash yielding the metal which is now called potassium, and soda yielding sodium. The metals were also obtained by treating, as above, either of the alkalies, previously mixed with oxide of mercury, but in this case the product consisted of a crystalline amalgam.

On substituting lime, magnesia, or any one of the alkaline earths for the potash or soda, amalgams of the metals calcium, magnesium, &c., were formed, though in much smaller quantity than in the preceding case; but when metallic mercury was used instead of its oxide, the amalgams were produced with facility.

It now only remained, theoretically, to heat the amalgams in a tube, for the mercury to be driven off, leaving the metals in a pure state, but practically it was found impossible to separate the whole of the mercury, and it was not until the year 1829 that pure magnesium was produced by Bussy, although its existence had been previously demonstrated. The method adopted by this chemist consisted in decomposing chloride of magnesium with metallic potassium. The metal thus produced was in the form of a grey powder, which could be fused into globules.

Bunsen prepares magnesium by the electrolytic decomposition of chloride of magnesium.

The salt is fused in a porcelain crucible divided by a vertical diaphragm which extends half way down the crucible, while carbon points (electrodes) connected with the ends of a galvanic battery, are introduced, one on each side of the diaphragm, through two openings in the lid of the crucible.

The negative electrode is notched to receive the reduced magnesium, which lodges in the cavities, and is collected there, while the chlorine escapes at the positive electrode.

Deville, of Paris, whose name is so intimately associated with

the practical processes by which the metal aluminum is produced on a manufacturing scale, together with Caron obtain the metal as follows:—9,000 grains of pure chloride of magnesium are mixed with 1,500 grains of fused chloride of sodium, and 1,500 of pure fluoride of calcium, both in fine powder; 1,500 grains of sodium in small fragments are carefully mingled with the powder, and the whole is thrown into a clay crucible at a full red heat, and it is then instantly covered.

When the mixture has become tranquil, the cover is removed, and the fused mass is stirred with an iron rod in order to render it homogeneous throughout, and to obtain a clear surface upon the liquid. Globules of magnesium are then distinctly visible. The crucible is allowed to cool partially, and the metallic particles are united by means of an iron rod; the melted mass is then poured upon a shovel, and the magnesium, amounting to about 675 grains, is separated from the clay. Magnesium is at present manufactured by a process lately patented by Mr. Sonstadt, which is similar to the one just described; the principal difference consisting in the employment of an iron instead of a clay crucible. Magnesium presents the appearance of a brilliant, silver-white metal, which is somewhat brittle at ordinary temperatures, but malleable at a heat below redness. It fuses and distils about as easily as zinc. It is little oxidisable at ordinary temperatures, even in moist air, but when heated to redness it takes fire, burning with an extremely brilliant white light, and producing magnesia. Its sp. gr. is 1.743 (not quite twice as heavy as water) and its hardness is equal to calc-spar.

For purposes of combustion it is forced into wire by pressing it in a heated steel press, having a fine opening at the bottom. The wire thus produced is sometimes flattened into ribbon. It can be burnt, either as wire, or in the state of ribbon by holding it, at an angle of 45°, in a spirit-lamp flame, but a preferable method consists in the use of a lamp such as was employed by the writer in exhibiting the light produced by the combustion of the metal. This apparatus * consists of a small metallic box, containing

* Made by Mr. Solomon, of 22, Red Lion Square.

two india-rubber-covered rollers, which are turned by clockwork. On pushing one end of a piece of wire or ribbon through an aperture provided at the back of the box, it comes into contact with the revolving rollers, is drawn in, and pushed forward through a tube terminating in front of a concave mirror, where it is burnt. On the top of the lamp are two fan arms in connection with the clockwork, and by turning these so as to expose more or less resistance to the air, the speed at which the wire is delivered can be easily regulated. The mirror is sometimes provided with a glass front, and a chimney to carry off the magnesia produced by the combustion, which additions are indispensable if the apparatus is used in a current of air. In lighting the lamp, it is only necessary to apply the flame of a lighted taper to the wire as it issues from the tube in front of the mirror. Provided that the rate of delivery of the wire is properly adjusted, it will continue burning until the supply is exhausted or the clockwork ceases to revolve.

In 1859 Professors Bunsen and Roscoe determined that a burning magnesium wire of the thickness of 0.297 millimetre evolves, according to their measurement, as much light as 74 stearine candles, of which five go to the pound. If this light lasted one minute, 0.987 metre of wire, weighing 0.120 gramme would be burnt. In order to produce a light equal to 74 candles, burning for ten hours, whereby about twenty pounds of stearine is consumed, 72.2 grammes of magnesium would be required. The same chemists also found the light to be extremely rich in chemically active rays, due partly to the incandescent vapour of magnesium, and partly to the intensely heated magnesia formed by the combustion. The intensity of the light produced, its richness in violet and ultra-violet rays, upon which the chemical action of light depends, and the facility with which it is produced, suggested its application to photography. This application has proved perfectly successful, and the magnesium-light is now used for taking photographic pictures, at night, in foggy weather, or in places where the direct light of the sun cannot be obtained.