June 22, 1841.

The PRESIDENT in the Chair.

The following were balloted for and elected : Joseph Colthurst, as a Graduate ; Colonel George Ritso Jervis, B. E., Captain Henry Goodwyn, B. E., and William Lamb Arrowsmith, as Associates.

“ On the Construction and Use of Geological Models in connexion with Civil Engineering.” By Thomas Sopwith, F. G. S., M. Inst. C. E.

The author commences this paper with a review of the various methods adopted for the representation of objects required in carrying out the designs of engineers, architects, and mechanics—whether as the means whereby such designs are first studied, and afterwards matured—as guides for the resident superintendents and workmen—or for being preserved as records of what has been executed, and studies for those who may be engaged in similar undertakings.

He then proceeds to elucidate the advantages peculiarly possessed by models for demonstrating practical results in Geology and Mining, dividing the subject into six heads, as follows :

1. On the application of modelling to geological and mining purposes.
2. On the materials to be employed.
3. On the mode of construction.
4. On the scales to be employed.
5. On the objects to be represented.
6. On the use of geological models, and the connexion of the subject with civil engineering.

1. A large number of plans and sections is usually required to elucidate with clearness the geology of a district, and the nature and extent of mining operations ; and few departments of practical science admit of greater improvement than the art of delineating mining in connexion with geological features.

Much ingenuity has been exercised in representing the undulating surface of countries either by the process called “ relief-engraving,” (procédé Collas), or as in the Ordnance Maps of England and Wales,

Geological models.

Application of modelling to geology and mining.

and Mr. Greenough's recent edition of his Geological Map; but even in comparison with these a model affords a more correct idea. Hence models in relief are more peculiarly applicable in all cases where it is desirable to comprehend at once the relations of the several parts, and it is evidently still better adapted to explain the geological conditions; especially when it is required to show the relative position of various rocks, their inclination, thickness, extent, and the disturbances to which they have been subjected, which could only be understood by comparing together a number of drawings.

To those interested in mining, therefore, the easiest mode of conveying ideas is by modelling. This was illustrated by two models of the Forest of Dean, and by reference to Mr. Jordan's model of the Dolcoath mine, now in the Museum of Economic Geology.

Materials
for models.

2. The first material for forming a model which naturally occurs to the mind is clay, pins and wires being used to define the principal elevations. Plaster of Paris has occasionally been used, and is well adapted for solid forms, where the edges are not exposed to injury; but its brittleness and contraction in drying are objectionable. Papier Maché is a more elegant and durable material, but the expense of the requisite moulds prevents its general use. Coloured wax is adapted for small models not subject to be handled. Pottery appears to possess more requisites, but many corresponding disadvantages. Of all the materials which the author has employed, he found none so generally useful as well-seasoned wood, whether for the facility with which the requisite forms are attained, for durability, for portraying different strata by various-coloured woods, or for comparative economy.

Mode of
construction.

3. The mode of constructing geological models had been briefly alluded to by the author on a preceding occasion.* It is more fully described in the present communication, and was illustrated by complete models, and the detached parts for forming them purposely made on a large scale.

The plan of the district being divided by lines at given distances apart, into a certain number of squares, a series of thin slips of wood are made to intersect each other, corresponding to the lines so drawn—upon these slips the profile of the surface and the positions of the strata are delineated, when it is intended that the model when complete shall be dissected; the compartments are then filled in with wood, and carved down to the lines upon the slips; the several strata thus rest upon the subordinate beds, and can be detached in a mass or in compartments; these being geologically

* *Minutes of Proceedings*, Inst. C. E. 1840, p. 49.

coloured, convey an accurate idea of the relative positions of the strata, and display with the utmost clearness the mining operations in each. This system is applicable to any extent: and the operation of forming the model is so simple, that a skilful workman at once comprehends and executes unerringly the instructions given him by the engineer or surveyor, as the accuracy entirely depends upon the profile which is drawn upon the slips. The author considers lime-tree or plane to be the most suitable wood for the purpose; but in the construction of small models for showing peculiar geological features or disturbances of strata, he uses various coloured woods: as an illustration of which he showed a series of twelve models, which (with a printed description*) are now in the Museum of the Institution. These contain 579 pieces of wood, one of them consisting of 130 pieces. By fitting the parallel layers of wood together, and arranging them in conformity with sections of strata of the carboniferous limestones and coal measures of the north of England, he illustrates the formation of that district, and the nature of its dislocations, &c. better than can be done by any number of plans and sections.

4. Attention is drawn at some length to the proportion to be observed between the horizontal and vertical scales, and the relative merits of corresponding and dissimilar horizontal and vertical scales fully examined, illustrating the positions by two models of the Forest of Dean, in one of which the vertical is enlarged to three times that of the horizontal scale; while the other has the scales exactly alike. For the conventional purpose of giving an idea of a country such as would be formed by a general observer passing through it, the former model appeared best adapted; but in a scientific point of view the latter had a decided advantage, being based on geometrical truth, and conveying an exact knowledge of the real, but not of the apparent relations of the surfaces, and other objects represented.

5. Models had hitherto been chiefly used for conveying impressions of tracts of the surfaces of countries, or for displaying the minute tracery and proportions of buildings. The author's views have been more especially directed to introducing the construction of models for geological and mining purposes, for which he considers them peculiarly adapted.

The series of models now presented to the Institution, contains examples of various geological phenomena of regular stratification—interruption by slips, faults, and dykes—the effects of denudations in exposing to view the various strata—the deceptive appearance of the course of mineral veins on the surface—the intersection of veins

* Description of a series of Geological Models, &c. By Thos. Sopwith, F.G.S., &c. 12mo. Newcastle, 1841.

Scales to be employed.

Objects to be represented.

—and many other details which are intimately connected with practical mining.

Models
used in
civil en-
gineering.

6. The author then proceeds to describe his view of the uses of such models, and the connexion of the subject with civil engineering.

He considers that by them a practical knowledge of geology may be attained by the civil engineer, and that such knowledge is indispensable for his guidance in many of the works he is called upon to undertake in the exercise of his profession. It is to an engineer that the merit is justly due of having, by efficiently labouring to establish English geology on a firm basis, acquired the title of “Father of Geology,” which has been generally conceded to the late Mr. William Smith.

The avocations of the civil engineer peculiarly qualify him for an observant geologist; and being called upon to visit so many different districts, the remarks he might make would be replete with instruction. These observations might be illustrated more efficiently by models than by any other means; at the same time they might be made to answer another purpose—that of demonstrating to the owners of mineral property the advantage or the futility of commencing researches or mining speculations.

Plans do not admit of such certainty of definition as modelling, and no regular system of planning mining districts has yet been generally practised, by which the engineer can judge of the probable results of the operations which he is often called upon to direct. As a record of mining operations, models of this kind are pre-eminently valuable; the exact position not only of the mineral veins and the strata are clearly shown, but the quantities extracted are registered, and a guide for future proceedings is established. The author contends that it is a duty to secure, while it is in our power, such records of mining operations as may enable us and our successors really to exhaust whatever minerals can be worked with advantage.

Dr. Buck-
land.

Moulds for
plaster
casts.

As being in some degree connected with the subject under discussion, Dr. Buckland described a mode used by Sir John Robison, for obtaining moulds for plaster casts. The object, of which the mould was required, was immersed in a mixture of common glue, dissolved in brewers' sweet wort of about the consistency of thick cream, and allowed to remain until the mass became stiff; it was then released by cutting the mould open, when it would be found to resume its original form like Indian rubber: holes were made