OUR ASTRONOMICAL COLUMN.

THE NATURE OF SUN-SPOTS.—A useful summary of our knowledge of the phenomena presented by sun-spots is given by the Rev. A. L. Cortie in *Science Progress* for October. A spot is regarded as an up-rush of metallic vapours, which become cooled by rapid expansion, so that the spot appears dark by contrast with the bright solar surface. The umbra is considered to rise above the level of the photosphere, while the penumbra is built up by dark radial streams flowing from the umbra and seeking a level slightly lower than that of the photosphere. In round spots the penumbra is a shallow, saucer-like cavity, the lowest portion being due to the falling-in of the photospheric clouds caused by the initial uprush. This falling-in and heaping together of the photospheric clouds to fill the partial void produced by the ejection of the umbral vapours would account for the bright border which is generally seen to separate the umbra and penumbra. At a high level above the spot are the hydrogen flocculi, the rotation of which gives rise to the appearance of the solar vortices. Friction of the gyrating gases and vapours is considered competent to generate electric currents, and the accompanying magnetic fields which produce the Zeeman effects in the spectra of spots. Father Cortie considers it doubtful whether the umbra and penumbra of the spots themselves share this gyratory motion.

SOLAR PROMINENCES IN 1915.—An account of the observations of solar prominences made at Catania during 1915 has recently been given by Prof. Ricco, in continuation of the admirable series commenced by him in 1880 (*Mem. Soc. Spett. Italiani,* July–August, 1917). The number of days of observation was 168, and the total number of prominences exceeding 15″ in height was 1264, giving a mean daily frequency of 7·5. The activity in the northern hemisphere was the greater, the respective numbers being 677 and 587. The prominences were distributed almost symmetrically in the two hemispheres, few or none appearing in the polar and equatorial regions, while there were well-defined maxima in the zones ±30°–35° and ±50°–55°. Twenty-four of the prominences exceeded 100″ in height, and one observed on May 5 reached 286″. The mean latitude of all the prominences was 38·65°, which was rather lower than for the preceding year. There was a marked increase of activity as compared with 1914.

A COMMERCIAL IRON OF UNUSUAL PURITY.

FOR some time past the Shelton Iron, Steel, and Coal Co., of Stoke-on-Trent, has been manufacturing a commercial iron of unusual purity in the basic open-hearth furnace. This iron is guaranteed to be 99·84 per cent. pure, and has been placed on the market under the trade name "Armco Iron." It differs from wrought-iron in that it has been melted and cast, and thus contains much less slag, and from mild steel in that its carbon content is so low that no pearlite is present. It has been found, however, to possess a peculiar property which militates against its practical usefulness, viz. the property of a characteristic red-shortness, or brittleness, when subjected to mechanical treatment between certain limits of temperature. The reason for this peculiar behaviour, which is not shared by other forms of commercial iron and mild steel of high quality, has been investigated by Messrs. Brooke and Hunting, and their preliminary results were communicated in an interesting note to the recent meeting of the Iron and Steel Institute.

Very early in the history of the process it was found that this brittleness always appeared between certain fixed limits of temperature, which they place at from 900°–800° C.; that on heating the iron to well above Ac3, and allowing it to cool, brittleness appeared, first at about 900° C., and disappeared sharply at about 800° C.; and that above and below these temperatures the metal possessed an unusually high degree of ductility and malleability. In fact, they comment on its similarity when cold to copper in respect of malleability, thus emphasising also its resemblance to the electrolytic iron investigated in 1913 by Stead and Carpenter.

The authors then proceeded to carry out systematic experiments on specimens of the iron quenched from various temperatures. They determined the tensile properties, and examined its structure and the type of fracture. Most interesting and illuminating results were obtained with the photographic records. Quenched from temperatures above 1000° C., the structure was that of γ iron with "martensitic" markings. As the quenching temperature fell this appearance altered, and the "γ iron effect changed to a more definite ferrite form." The authors say that at about the Ar3 point a complete change occurred, the ferrite grains increased considerably in size, and at the junctions of many of the crystal boundaries a peculiar structure was observed which was "perfectly constant and always possessed the same characteristic . . . viz. a central structure more or less pearlitic and very clearly defined, surrounded by a space composed of ferrite, and the whole again surrounded by a definite boundary which connects up with adjacent crystal grains." This structure is clearly seen in the photographs published by the authors. They say that a very large number of experiments have been made, and that in every case this peculiar structure has appeared in exactly the same manner. On lowering the quenching temperature somewhat the structure gradually becomes less pronounced, and at just above 800° C. it ceases to exist. Below 800° C. it was never observed, and the structure was that of normal ferrite. The temperatures at which this material is precipitated and reabsorbed coincide so remarkably with the beginning and end of the zone of brittleness that a strong presumption has been established that herein lies the origin of the characteristic red-shortness of the iron. The authors suggest that it is a eutectoid, probably composed of iron carbide, phosphide, and sulphide, with possibly traces of manganese sulphide and ferrous oxide, and that it is thrown out of solution in a semi-liquid or plastic condition, causing the grains to be very loosely held together, and thus making the structure relatively weak. If the iron is quenched in the 900°–800° C. zone, no brittleness is observed in the static tests.

The authors have found that a sample of Swedish iron similar in purity to the above material also shows a brittle zone in the same temperature range, and that an iron containing carbon 0·06 per cent. and manganese 0·10 per cent. shows no brittleness when manufactured in the same way as "Armco" iron. At one stage of the investigation they were inclined to connect the appearance of the material with the existence of dissolved oxide, since in one set of experiments they found it difficult to reproduce the characteristic structure, and this coincided with a remarkable absence of spots of "oxide material." Samples of metal, however, taken from the bath, just before tapping, when it was known to be in a super-oxidised condition, gave only a normal amount of eutectoid structure. Again, when complete deoxidation was attempted it still appeared. There is no reason, therefore, for connecting it with the presence of an unusual amount of oxide, and the nature of the "eutectoid"

structure is still a matter of pure conjecture. It is to be hoped that the authors will investigate this aspect of the research, difficult though it will probably prove to be.

The authors entitled their paper "A Note on the Microstructure of Commercially Pure Iron between Ar3 and Ar2." Strictly speaking, this is not the case. Mr. P. Tucker, who took cooling and heating curves for them, found Ac3 at 888° C. and Ar3 at 874° C., and makes the significant statement that it was "practically impossible so far to determine the Ar2 point of this material even on the most delicate instruments." Now the new structural constituent is shown in the photographs at 899° C., *while the material was still in the γ range*—above Ar3. It does not appear, therefore, that the upper limit of brittleness coincides with the Ar3 change. Ar2 is normally found at about 765° C. in commercially pure irons. This is about 35° lower than the temperature at which the eutectoid structure disappeared. No iron has ever been found to give Ar2 at so high a temperature as 800° C., which is actually below that at which the new constituent vanishes. Neither, therefore, does the lower limit of brittleness coincide with the Ar2 change, assuming that it does exist, according to the evidence at present available.

H. C. H. CARPENTER.

RECENT RESEARCHES AT VESUVIUS.

PROF. ALESSANDRO MALLADRA, the successor of Mercalli at the Royal Vesuvian observatory, has published a number of papers, from 1912 onwards, on the volcanic manifestations and progressive changes in the great crater formed in 1906. It has been possible in recent years to descend, by hazardous paths, to the edge of the central funnel, 250 metres below the crater-edge, and valuable observations have been made on the gases emitted from the fumaroles. Prof. Malladra furnishes a well-illustrated summary of the conditions in 1914 in "Nel cratere del Vesuvio" (*Boll. reale Soc. Geografica*, 1914, p. 753). The gradual widening of the crater by the falling in of its cliffs is shown in plan in a paper, "Sulle modificazioni del Vesuvio dopo il 1906" (*ibid.*, p. 1237). The small aperture of 1900 is also here indicated, almost immediately over the pit that is now active. The volcano remained quiet, in a solfataric stage, for seven years after the enormous outburst of 1906; but a glowing funnel opened in the floor of the crater of explosion on July 5, 1913. Prof. Malladra was engaged in a hypsometrical survey on the cone a few hours after this outbreak ("Sui fenomeni consecutivi all' apertura della bocca 5 Luglio, 1913," *Rend. R. Accad. Sci. Fis. e Mat. di Napoli*, fasc. 11 and 12, 1914), and has recorded a true incandescence, accompanied by the emission of fresh scoriæ, specimens of which were collected on one of many later visits. The "yellow fumarole" in the crater gave a temperature-reading of 128° C. in 1911. In September, 1913, this had risen to 330°, and in October to 347°. During the collection of gases from this fumarole for analysis, water condensed, containing hydrochloric acid in the proportion of 9·21 grams per 100 c.c., and smelling strongly of sulphuretted hydrogen. The author points out that, following the arguments of Brun as to the possibility of the permeation of water into a heated mass from without, this water must be truly magmatic. He thus provides further evidence, in addition to that of Day and Shepherd, against Brun's main contention.

Prof. Malladra illustrates ("I Gas vulcanici e la Vegetazione," *Boll. Soc. Sismologica Ital.*, vol. xviii.) the acid gases of Vesuvius rolling in a dense cloud down the mountain slope. They deposit on the leaves and branches of the trees a white dust consisting of chlorides and sulphates of iron and the alkalies; and these anhydrous or slightly hydrated gases are easily recognisable to the experienced eye from the ordinary masses of water vapour. Like the descending clouds that brought death to Saint-Pierre and Morne Rouge, they consist of very finely divided solid matter and gas, and resemble the smoke of a conflagration. The caustic effect produces brown spots and decay in leaves, and experiments are in progress in the planting of bare parts of the Vesuvian slopes with Euonymus and with a bamboo, appropriately known as *Arundo Plinii*, which flourishes fairly upon Stromboli. Both these, it is hoped, will resist the acid emanations.

An investigation of the rainfall on Vesuvius, and of the distribution of snow on the variously heated areas near the vent ("La pioggia sul Vesuvio, 1863–1913," *ibid.*, vol. xviii.), contains an interesting passage on the snow-accumulations formed by the freezing of the vapour of the fumaroles. G. A. J. C.

FUEL RESEARCH.[1]

IN its first report[2] the Board stated that it had in view two main lines of research: first, a survey and classification of the coal seams in the various mining districts by means of chemical and physical tests in the laboratory, and, secondly, an investigation of the practical problems which must be solved if any large proportion of the raw coal at present burned in its natural state is to be replaced by the various forms of fuel obtainable from coal by carbonisation and gasification processes.

When the previous report was written it was believed that the survey and classification of coal seams might be proceeded with in advance of the second line of inquiry; but further consideration has shown that from the practical point of view the two lines are so thoroughly interdependent that they can be most satisfactorily dealt with side by side. This view will be further developed after the position and prospects with regard to the second line of inquiry have been more fully explained.

In preparation for the organisation of the first line, however, an experimental study of standard methods for the examination of samples of coal in the laboratory has been made. Hitherto in the systematic examination of coals in the laboratory there has been no generally accepted low-temperature carbonisation test. In the survey and classification of coals for the purposes of the present inquiries a test of this kind is practically indispensable. Certain existing tests are designed to ascertain the suitability of coal for gas- or coke-making, but as both these methods of carbonisation are carried out at temperatures above 900° C. they give little or no direct information as to the behaviour of the coal when carbonised at 500° to 600° C.

As a result of experimental work carried out for the Board in the fuel laboratory of the Imperial College of Science and Technology, a test has now been elaborated which by direct weighing and measurement gives the yields of gas, oil, water, and carbonaceous residue which result from carbonisation at any definite temperature. The apparatus is simple and is so arranged that the progress of the distillation can be watched from start to finish. The products can be weighed or measured with reasonable accuracy, and any or all of them can, if desired, be submitted to further examination.

[1] Report (slightly abridged) of the Fuel Research Board on its Scheme of Research and on the Establishment of a Fuel Research Station. (Published for the Department of Scientific and Industrial Research by H.M Stationery Office.) Price 2*d.* net.

[2] This report was not published.