off in the demand for fish pastes, and at the end of the 1949–50 season it cancelled the arrangement. Since that season no further fish from the Bristol Channel swing-net fishery has been used by it for manufacturing purposes.

Even when the arrangement was in full operation, however, the fishermen frequently took larger quantities of fish than the factory could deal with, and the surplus was then sold to a local firm of poultry-food manufacturers. Nevertheless, at the height of most seasons this additional outlet was not able to absorb all the fish caught and the remainder was sold to a firm engaged in boiling pig-swill. The poultry-food manufacturers continued taking supplies until the season 1950–51, when their demand decreased and finally stopped. The remaining outlet, the firm boiling pig-swill, has always been able to take as much as the fishermen wished to dispose of but at very small prices.

Owing to the cessation of demand from the fish-paste factory and the poultry-food manufacturers, the effort put into the fishery in the season 1950–51 was much less than usual; such catches as were made were small and disappointing so that the season was counted a complete failure by the fishermen. The season just past, 1951–52, has also been a complete failure. The few nets put out at the beginning of the season caught practically nothing and the full fleets were not fished at all. A net was set at the beginning of October and was kept fishing on and off until into January; but on no occasion were more than about 10 lb. of sprats landed. The fishermen reported that it was the worst season ever known, and that they are at a loss to understand the reason for it.

The life of the industry thus lasted just ten years, and although the undertaking was never great it helped to eke out food supplies and to vary the monotonous diet of war-time; it was also a valuable source of income to enterprising fishermen. The factories are now able to obtain their raw materials from sources less liable to seasonal fluctuation, materials which, being partly manufactured, need less work done upon them. The ranks of the skilled fishermen are not being filled by younger men; the long, irregular hours of work for uncertain returns are very unattractive in times of full employment when easy work can be obtained by all. The old hands are discouraged by the failure of recent seasons and the lack of demand for their catches, and young men will not consider such hard work. Thus, high freight charges, and the frustration of enterprise by permits and regulations, combined with two very bad seasons, seem to have completed the extinction of this interesting local industry.

THE ORIGIN OF ASTRONOMY

THE George Darwin Lecture of the Royal Astronomical Society was given on April 13, 1951, at Burlington House, London, by Prof. Antonie Pannekoek, professor of astronomy in the University of Amsterdam, on the occasion of the award to him of the Society's Gold Medal for his work in astrophysics and on the structure of the galactic universe. Prof. Pannekoek's lecture, which has now been published*, was on "The Origin of Astronomy".

Starting with primitive astronomy, he said that he believed that the origin of this was not due to the beauty of the silent heavens but to utilitarian motives. He agrees with Schiaparelli that economic necessities were at the root of man's astronomical as well as of his physical and chemical knowledge. Among such necessities there was the need for finding direction by land and sea, and history affords many instances of man using the celestial luminaries to guide him. Even so-called backward races like the Polynesians were well acquainted with the stars, and they steered their vessels by means of the rising and setting of the heavenly bodies. Of even greater importance than for navigation was the application of astronomy for time reckoning, and so crude forms of almanacs came into existence which enabled farmers to regulate their work according to seasonal life-periods of animals and plants; to-day primitive peoples are able to observe solar phenomena, such as the solstices, by noticing the times of extreme rising and setting at points of the horizon marked with stones. The helical rising of certain stars, indicating the time for sowing, just as the helical rising of Sirius in June foretold to the ancient Egyptians the flooding of the Nile, is still used by backward races even if they have come into contact with the white man. The use of the moon as the measure of time among many ancient races is well known, and the sacred books of some of these allege that the moon was created for this very purpose. Although a certain amount of astronomical knowledge characterized prehistoric man, this knowledge was frequently in the hands of old people or priests; but it would be a misnomer to call it astronomical science. Science, in the real sense of the word, arose when man entered into the stage of civilization, and the transition from barbarism to civilization was marked by the invention of script.

About five thousand years ago the first civilizations arose in the fertile plains of Egypt, Mesopotamia, India and China, and in time a strong State power grew up to defend the inhabitants against warlike tribes who found only meagre living in their surrounding mountains and deserts. Thus arose an army to protect the farmers, and beside the military power stood the civil officials; with the appearance of these ruling classes with their wealth and luxury new needs gave rise to developments of refined arts and spiritual culture. In these circumstances the conditions were present for the introduction and spreading of script. The effect of the new conditions on astronomy was far-reaching, because the use of script added enormously to the powers of the priests to whom were entrusted the regulation of time as well as many other important State responsibilities. Ancient inscriptions show the leading part that the priesthood took in settling by means of the heavenly bodies the times of sowing and reaping. Naturally, the work for utilitarian purposes did not end there, and so a number of constellations were recorded and also the brightest of the planets; later astrology arose, though at first it was largely limited to the significance of celestial phenomena for national events—unlike this superstition at present when it is the cult of the individuals who may be more numerous than many astronomers suspect. How did these ancient peoples, Babylonians, Egyptians, Assyrians, etc., without knowing much about scientific aims, build up a scientific theory?

As Prof. Pannekoek shows, this was made possible for astronomy by the occurrence of simple and striking periodicities in the celestial phenomena, and among such phenomena lunar eclipses played a prominent part as their prediction is comparatively

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simple. It is fairly certain that various regularities in the movements of the planets were also perceived and resulted in expectations, and ancient Assyrian inscriptions testify to a fairly advanced knowledge of planetary periods. A remarkable change in outlook took place when warring little countries were absorbed in the Persian Empire, because the old astrological omens of lucky for Akkad and unlucky for Elam lost all significance. Then astronomers were no longer ignorant earthlings deciphering from the sky messages for the times, and as a consequence the study of the stars and planets became more precise. Some of the scanty inscriptions of the following centuries of rule by the Persian and the Seleucid kings show that a greatly increased knowledge of the periods of revolution of the planets existed, and ephemerides have been found for different years, up to the beginning of the Christian era. Babylonian astronomy attained a more perfect form of theoretical knowledge in the last century B.C., of which various examples are given, and it presents an admirable system of theoretical knowledge, though it is entirely devoid of any physical interpretation. Even the planets were not solid bodies moving in their orbits but mere luminaries wandering along the firmament with unravelled regularity. The cause of this restricted character was due to the priests, whose astronomical work was service to the gods. A further step was necessary if structural theory is regarded as an essential characteristic of theoretical science, and this step was taken by the Greeks.

The Greeks cannot be said to have been great astronomers if we are to judge them from the amount of their observations and detailed knowledge of the heavenly bodies; but, on the other hand, they developed a geometrical way of thinking as an excellent system of demonstrable truths, and this was fit to become the basis of a future higher state of astronomy. The determination of the relative distances of the sun and moon by Aristarchus affords an example of their attitude towards the heavenly world, dealing with its orbs as objects of geometry. In consequence of the conquests of Alexander the Great and the mergence of the Greek and Oriental world which introduced the Hellenistic era, the Greeks gained access to the observational results of the Babylonians. As a result, it was now possible to fill in their geometrical world scheme by exact data on periods and inequalities, and the outcome was the theory of epicycles in which, Prof. Pannekoek believes, we may be said to have reached our goal—true astronomical science. "There is," he says, "a conception of science which considers only the latest truth as real, true science. It sees the epicycle theory as a primitive erroneous system, to be superseded 1,700 years later by the true world system." Regarding it from the historical point of view, the epicycle theory represents correctly the relative motions of the planets in their circular orbits, only the original assumptions as to the zero point of the motions requiring subsequent corrections. "It is scientific theory in the strictest sense of the word, systematization of observational facts in a world structure suited to the computation and prediction of future events." The study of the history of science—not only of astronomy shows how important is this stage in the growth of knowledge; though conditioned by the social development of the time, yet as the outcome of observation and thought throughout the centuries, it becomes the starting-point of later progress towards modern science. This affords an explanation of the fact that at a comparatively early time astronomy was able to rise to the high rank of a science when knowledge in other realms of natural phenomena had not risen above the stage of technical experience.

GEOLOGICAL ASPECTS OF CLAY MINERALOGY

A MEETING of the Clay Minerals Group of the Mineralogical Society, held in the apartments of the Geological Society of London, Burlington House, London, W.1, on November 2, 1951, was devoted to a discussion on geological aspects of clay mineralogy. Dr. G. Nagelschmidt (Sheffield) occupied the chair at both morning and afternoon sessions.

Prof. P. G. H. Boswell (Imperial College of Science and Technology, London), in the introductory paper (read in his absence by S. E. Coomber), reviewed the contributions made by clay mineralogists to the study of the diagenesis of sediments. Progress towards the assessment of the character of the clay mineral assemblages in some of the major stratigraphical divisions was summarized, and differences between the results obtained by various workers noted. After discussing the problem of shale formation, Prof. Boswell concluded by outlining some problems, the solution of which awaits more intensive application of clay-mineralogical techniques to geological research. In the discussion, general agreement as to the many problems awaiting solution was expressed, and the contributions which can be made by clay mineralogists were emphasized.

In a systematic petrographic study of the argillaceous rocks associated with the principal sedimentary facies[1], M. Georges Millot (Nancy) has found that kaolinitic minerals are characteristic of the lacustrine or fluviolacustrine continental facies deposited under acid, leaching conditions; that illite is characteristic of the saline lagoonal and basic continental facies, although attapulgite and montmorillonite appear under calcareous conditions; and that the mineralogical composition of the marine facies is very mixed, in accordance with its origin, but, generally, a mixture of micaceous minerals (mainly illite) with kaolinite predominates. Statistical information on the variation of clay mineralogy with medium, with potash content, with *p*H, etc., was given by frequency curves and, in summarizing his results, M. Millot directed attention to the problems which have still to be solved. Dr. H. Greene (Rothamsted Experimental Station), in the ensuing discussion, gave an example in agreement with M. Millot's observation of anomalous formation where conditions of deposition are only broadly defined, while Dr. E. W. Russell (University of Oxford) suggested that montmorillonite might be found in soils derived from the Lower Chalk, but not in those from the Upper. The abundance of kaolinite in the acid continental facies was commented upon by Prof. J. H. Taylor (King's College, London), who suggested that, in view of the work of Grim *et al.* on recent sediments[2], the absence of montmorillonite from ancient deposits might be due to its disappearance at some post-depositional stage. The conversion of montmorillonite into illite solely by pressure was queried by Dr. D. M. C. MacEwan (Rothamsted Experimental Station), while, in the same connexion, the effect of drying on potassium montmorillonite[3] was referred to by Dr. Nagelschmidt.