The Bronze Age in Southern Africa.

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IN view of the impetus which has been given to the metallurgical analysis of ancient copper and bronze objects by the initial investigations of Prof. John Sebelien of Aas, Norway (*NATURE*, Jan. 10, 1924), and the practical activity of the British Association Research Committee which has resulted in the important interim report embodying the recent investigations of Prof. C. H. Desch (*NATURE*, Dec. 8, 1928), it is ardently to be hoped that funds will not be lacking for following up Prof. Bernard W. Holman's suggestions (*NATURE*, Dec. 29, 1928) concerning the further collection and publication of data about the ancient mining industry and the products thereof which are available in southern Africa.

It has been the uniform experience of those who have investigated the ancient mining industry in South Africa that the work has been on so gigantic a scale as to preclude any belief that the products of the industry were consumed by a local population. Beginning with the investigations of Mr. T. G. Trevor, at that time Inspector of Mines for the Union Government, and now holding a similar post for the Rhodesian Government, several important papers by Woodburn and Baumann and others have been published in the *Journal of the Chemical, Metallurgical, and Mining Society of South Africa* which established not only the above-mentioned conclusion but also the further important deduction that the early copper-, tin-, micaceous iron- and ochre-getters had the same sort of industrial implements as the ancient gold-getters of Rhodesia and the north-eastern Transvaal.

On similar lines of reasoning it was possible for me (*NATURE*, June 21, 1924), by gathering together information from these and other sources, as well as by my personal investigations, to put forward the thesis that the enormous ancient mining district from Katanga and Broken Hill to Pretoria, and from the Kalahari to the eastern coast, formed a single cultural unit.

In the *South African Geographical Journal* of that year I developed the same view in an article on "The Ancient Mining Industry in South Africa," and in *NATURE*, Mar. 21, 1925, p. 425, was enabled, through the remarkable researches of Bro. Otto, to demonstrate some of the objective proofs that are to be discovered in Bushman cave shelter paintings in the Cape Province, Natal, and Rhodesia of alien intruders wearing headgear of Babylonian and Phrygian appearance.

The great age of at least one of the mines was demonstrated by me in "The Rooiberg Cranium" (*S.A. Journal of Science*, vol. 21, 1924), when I pointed out the existence of a stalagmite fifteen feet high and eight feet thick, in its narrowest part, extending from the roof to the floor, thirty to forty feet from the entrance and in such a position as to render practically certain its formation since the period of occupation by the miners.

It was, therefore, with considerable confidence that I boldly suggested in my article on "Nickel in

Ancient Bronzes" (1924), that, as Sebelien had failed to find nickel-carrying ores in the sites of ancient mines in the Arabian and Mediterranean areas, the probable source of the nickel-contaminated copper and tin for the ancient Near East was southern Africa.

At that time, although it was known that there was ample evidence of smelting operations in the Rooiberg area, and a piece of bronze slag had been discovered which had provided in the hands of Mr. Schoch the analysis revealing about 3.0 per cent of nickel which has now proved of such significance, there was no conclusive proof that bronze had been intentionally fabricated at Rooiberg.

This important corroboration of the view advanced by me was forthcoming at the Pretoria meeting of the South African Association (1926), when Dr. Percy A. Wagner (*S.A. Journal of Science*, 1926) revealed the amazing discovery of Mr. Gordon of "no fewer than thirty distinct furnaces on the farm Blaauwbank, No. 433, and alongside of some of them . . . small separate stacks of hand-cobbed tin and copper ore . . . also accumulations of nodular aluminous surface limestone and hand-cobbed iron evidently used as a flux. In the furnaces themselves were found 'slugs' and 'frills' of bronze, many of them still embedded in an iron-rich slag. The largest slug weighs 31.3 grammes."

"Here, then," as Dr. Wagner stated, "is definite proof for the first time that these ancient metallurgists had deliberately set out to make bronze, and that they were thus evidently acquainted with the properties and uses of that important alloy."

The reason for the admixture of nickel with the ores at Blaauwbank by the bronze makers was also proposed by Dr. Wagner, who pointed out that on the farm "there is, in addition to important tin and copper deposits, a nickel lode carrying at the outcrop big masses of apple-green 'nickel-bloom' or anabergite. This bears a remote resemblance to malachite, and it is probable that the ancient miners, who could not fail to have noticed this outcrop, mistook it for that mineral and thus introduced nickel into their bronze." The objects demonstrated by Dr. Wagner are now in the Social Anthropology Museum of the University of the Witwatersrand.

Irrespective of any other question, there has, therefore, been established by incontrovertible evidence the existence in South Africa of a definite Bronze Age period. Such a phase of South African prehistory has not hitherto been recognised by antiquarians, and naturally enough since the bronze objects which in other lands symbolise the existence of such a period have not been found here, but rather only the raw materials of mines, furnaces, and dumps which must have contributed to the blatant bronze cultures of more advanced cultural centres.

The second conclusion that is warranted from the facts is that the "ancient mining period" in South Africa dates back to the Bronze Age, seeing that the

methods of exploitation of the copper, tin, gold, and iron fields are culturally uniform. It can scarcely be that the whole industry was of one age: its very immensity demonstrates that it must have had several phases. The remote antiquity of at least one phase cannot, however, be questioned.

It is of the utmost importance that the Bantu peoples when first discovered did not belong to a 'bronze' but to an 'iron' culture, and there is no evidence to show that they evolved through a bronze phase to the iron phase. We are forced to conclude that the highly intricate metallurgical processes of bronze-making demonstrated by the deposits at Blaauwbank betray the actual presence there at a remote age of skilled and intelligent craftsmen from a superior cultural area. Seeing that the deposits are half-way across the continent, some estimate may also be arrived at concerning the lengthy period of South Africa's exploitation by that superior race utilising the bronze.

To the physical anthropologist who has lived in South Africa and had the opportunity of seeing and dissecting representatives of practically every tribe in the south-eastern end of the continent, there is concrete evidence in the thousands of negroid inhabitants with straight, aquiline, and hooked

noses, elevated nasal bridges, reduced lip fullness, and lack of prognathism, to demonstrate beyond cavil the flood of Semitic and other Caucasian blood which flows in the veins of the Bantu peoples; just as the presence, in a more reduced proportion, of Mongoloid eye-folds, slit-like eyes, and high cheek bones of the "Snese Hottentoten" of the Eastern Province and the Bantu tribes of the eastern coast generally reveals past, but probably more recent and less widespread, contacts with the Far East.

With regard to the actual date of the Bronze Age in South Africa, it seems clear that being provoked by one or more alien races who were interested in raw bronze and being absolutely dependent upon that alien interest (as the lack of a typical and separate local bronze industry, such as those of Europe, demonstrates), there can be little question that the South African Bronze Age synchronises with the Bronze Ages of the nearest ancient cultures, namely, those of Egypt and Sumeria. The importance to South African prehistoric chronology of the further prosecution of this absorbing piece of detective work in metallurgy and the exact chronological establishment of the different ancient mining phases can scarcely be overrated.

Fifty Years of Marine Refrigeration.

THE important subject of refrigeration on ship-board has recently been dealt with in three papers by Mr. A. Greenfield, Mr. G. W. Daniels, and Mr. H. J. Ward, read respectively to the Institution of Marine Engineers, the British Association of Refrigeration, and the Institution of Mechanical Engineers.

One of the earliest contributions to a technical society on this subject was the lecture of Alexander Kirk to the Institution of Civil Engineers in 1884, while two years later J. B. Lightfoot read a paper to the Institution of Mechanical Engineers on refrigerating and ice-making machinery. Associated with the production of artificial cold were the experiments and inventions of Cullen, Leslie, Carré, Gorrie, Tellier, the Bells, Coleman, Linde, Haslam, and others. To Gorrie, an American doctor, we owe the first machine which caused compressed and cooled air to expand in working a piston in a cylinder, his patent being taken out on Aug. 22, 1850. Five years later, Gorrie died at Apalachicola, Florida, and there are memorials to him in that city and in the Statuary Hall of the Capitol, Washington, D.C. It was not, however, until about twenty years later that the matter was taken up seriously, and refrigeration on shipboard may be said to have come in definitely with the voyage of s.s. *Strathleven* in 1879, just fifty years ago. The *Strathleven* was fitted with a Bell Coleman cold-air machine, and brought home a small cargo of frozen meat from Australia. As Mr. Ward said, that marked the economic beginning of the industry. The Bell Coleman patents were then acquired by the late Sir Alfred Haslam; one of his first machines was fitted in the liner *Orient* in 1881, and in 1889 some 2,000,000 carcasses of beef and mutton were

brought to England, most of them in ships having Haslam's machines. Compressed air machines then began to be replaced by machines using other gases, and to-day about 80 per cent of refrigerated cargo ships use carbon dioxide and 18 per cent ammonia; the advantages and disadvantages of which were touched upon by both Mr. Ward and Mr. Greenfield.

Nearly every writer on refrigeration acknowledges the great debt this branch of engineering owes to the scientific investigator, and frequent reference is made to the well-known standard treatise, "The Mechanical Production of Cold," by Sir Alfred Ewing. Refrigeration in all its aspects is almost entirely the outcome of research, and the various investigations now being made by the Food Investigation Board, at the Low Temperature Research Station at Cambridge, and at the National Physical Laboratory, are of great value to the industry.

Fish, meat, cheese, butter, apples, oranges, bananas all require different treatment, and the refrigerating engineer is faced with many problems. Mr. Greenfield's review of the arrangement of a large refrigerated cargo ship is of especial interest. With a sectional profile of such a ship, he gave particulars of the mechanical appliances and piping. The ship he described has 54 independent insulated cargo spaces of a total capacity of 560,900 cubic feet cooled by 37 miles of brine-cooling pipe divided into numerous circuits. The temperatures used vary from 10° to 20° F. for fish and butter, to 34° to 40° F. used for vegetables and fruit. Frozen meat is kept between 16° to 24° F., and chilled meat at 29° or 30° F.

Fruit was first brought to Great Britain from the