

## Scottish antimony

R F Tylecote\*

Antimony is not a metal that is as familiar to us as lead, tin and copper; yet from the Middle Ages onwards it has been and still is a metal to be reckoned with. Today, it is mainly used for hardening lead and in this role it appears in batteries, type-metal and engine bearings, and in the form of a compound in matches and pigments. Historically, Scotland has been one of the main sources, if not the only one, in the British Isles. A mine and smelter were situated at Glendingning House, Westerkirk in Eskdale, and the technique used was described in the *Statistical Account of Scotland* in 1794 (vol 11, 525-7).

The ore used was probably jamesonite,  $Sb_6Pb_4FeS_{14}$ , which would be mined with a certain amount of waste rock or 'gangue'. This was first heated to 600°C in a perforated clay vessel in a furnace and the antimony sulphide allowed to liquate and be collected in a vessel below. The antimony sulphide,  $Sb_2S_3$ , was then heated in a crucible with scrap iron and an alkali flux at 1000°C to give metallic antimony, which melts at 630°C, and iron sulphide residue. The latter was discarded and the metal was refined with more flux to produce a slag.

An examination of this site in 1964<sup>1</sup> produced a number of slag blocks clearly related to this process. These blocks were c 28 cm in diameter by 10 cm thick and tapered slightly to give a bottom diameter of 25 cm. They weighed c 11 kg. Metallographic examination showed them to consist mainly of a silicate slag with randomly orientated lath-like crystals; this contained prills of grey cast-iron and stringers of impure antimony. The grey cast iron consisted of graphite and pearlite and had a hardness of 256 HV1 and the antimony stringers were quite brittle with another phase which was probably iron; they had a hardness of 108 HV1, whereas the hardness of pure antimony is between 30 and 60.

The composition of the slag and metal is given in the Table. The composition of the metal is 90-97.5% Sb, 2.5-4.3% As, and 0.0-5.5% Pb. It would appear that the flux was wood ash and that the iron had been well oxidized. The slag is a typical fayalite slag and resembles that from non-ferrous smelting generally and the iron bloomery process.

These slag blocks were connected with the second stage of the process and they confirm that iron was used as the reducing agent. Today, antimony is smelted in this country by roasting the

\* Institute of Archaeology, London

TABLE  
Electron Microprobe Analysis of Westerkirk Antimony and Slags

(1) <i>Antimony Metal</i>						
%	Spot A	Spot B	Spot C	Area 1	Area 2	
Sb	92.4	97.5	94.9	89.8	93.0	
Fe	0.3	0.0	0.0	1.4	0.0	
As	2.5	2.7	4.3	2.5	2.8	
P	0.3	0.3	0.2	0.3	0.2	
Si	0.2	0.2	0.2	0.2	0.3	
Pb	—	0.0	0.0	5.5	3.3	
(2) <i>Slag</i>						
%	1	2	3	4	5	Inclusion
SiO <sub>2</sub>	35.3	34.1	28.7	52.3	39.4	1.1
FeO	42.8	43.5	55.7	0.3	21.6	28.5
Al <sub>2</sub> O <sub>3</sub>	1.8	1.8	9.3	34.3	16.4	0.5
CaO	3.4	3.2	5.0	0.5	0.5	0.0
MgO	0.4	0.0	1.2	0.8	0.5	0.7
K <sub>2</sub> O	—	—	1.5	1.5	1.4	—
SO <sub>2</sub>	4.3	6.6	nd	0.2	0.4	14.4
P <sub>2</sub> O <sub>5</sub>	2.6	2.2	0.8	nd	2.3	—
Pb	3.2	nd	nd	nd	nd	1.4
Sb	3.2	2.0	nd	nd	nd	48.3
Zn	4.9	6.3	nd	nd	nd	0.5

nd=not detected

imported sulphide to the volatile oxide, Sb<sub>2</sub>O<sub>3</sub>, which is caught in filters leaving the gangue behind to form a slag. The composition of the slag is; 40% SiO<sub>2</sub>, 21% FeO, 18% CaO, 7% MgO, 7% Al<sub>2</sub>O<sub>3</sub> and 2-3% Sb. Most of the product is used in the form of oxides but metal is made in a small hearth furnace by the reduction of oxides with charcoal under a flux.

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#### NOTE

- This was made by C M Daniels of the University of Newcastle upon Tyne who was directing an excavation in the area.