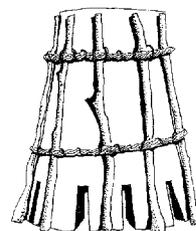


Iron Technology

Teachers' Guide



This resource complements the pupils' study of the modern day blast furnace. It discusses some world developments in iron technology, focussing on a comparison between the older technology of Tanzania, and more recent technology in Scotland. It could be used with pupils as homework or for revision purposes.

Though a visit to the historical sites in Tanzania is not practical, a visit to the Bonawe site, in Argyll, is to be recommended. Information on the Bonawe site is available from Historic Scotland.

The resource helps to reinforce the following learning outcomes from Chemistry S-Grade, Topic 11 - Metals:

6. state that ores are naturally-occurring compounds of metals (G)
8. explain that the extract of a metal from its ore is an example of reduction (C)
12. state that iron is produced from iron ore in the blast furnace (G)
13. state the two key reactions which take place in the blast furnace:
production of carbon monoxide
reduction of iron oxide (G)

References used in preparing this resource -

"Blacks in Science", ed. Ivan Van Sertima, Transaction, 1994.

"Complex Iron Smelting and Prehistoric Culture in Tanzania", P. Schmidt and D.H. Avery, Science, Vol. 201, pages 1085-1089, 22/9/78.

"Learning Technology, Science and Social Justice : an integrated approach for 3 - 13 year olds" by John Siraj-Blachford, Education Now, 1996.

"Inorganic Chemistry, Part B", Mzumbe Book Project, Tanzania.

"Iron Smelting", Third World Science Project.

"Technology in World Civilisation", by Arnold Pacey, Basil Blackwell, 1990.

"Bonawe Ironworks - information for teachers", available from Historic Scotland, Longmore House, Salsbury Place, Edinburgh, EH9 1SH.

With thanks to Historic Scotland for the illustration of the Bonawe Ironworks.

1.

Process	Bahaya	Bonawe	Modern Day
Formula of Iron Ore	Fe_3O_4	Fe_2O_3	Fe_2O_3
Source of Carbon	charcoal	charcoal	coke
Temperature of the Furnace	1800°C	1600°C	1800°C
Preheated Air	yes	no	yes

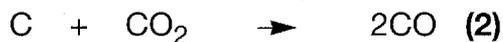
(5)

b) Similarities - both the Bahaya furnace and the modern day furnace have preheated air and operate at similar temperatures.

Differences - the ore used is different, and the source of carbon is different. (2)

2. a) Limestone, a source of carbon, and iron ore. Limestone is missing from the Bahaya furnace. (2)

b)



(ii) Fe_2O_3 is reduced and CO is oxidised. (1)

d) (i) Calcium carbonate, and CaCO_3 . (2)

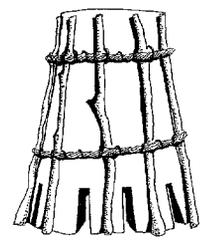
(ii) About 118Kg (259.84 pounds), for every ton of iron. (2)

3. a) An alloy is a mixture of metals, or metals and non-metals. (1)

b) Carbon and iron. (2)

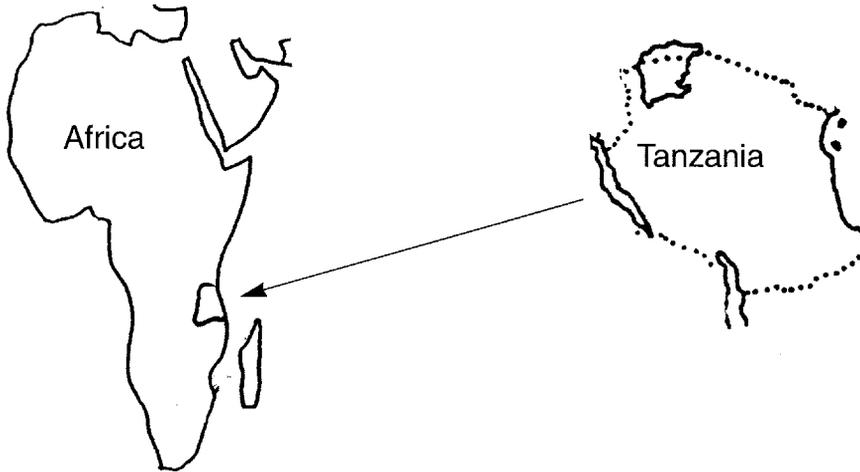
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Pupils' Worksheet



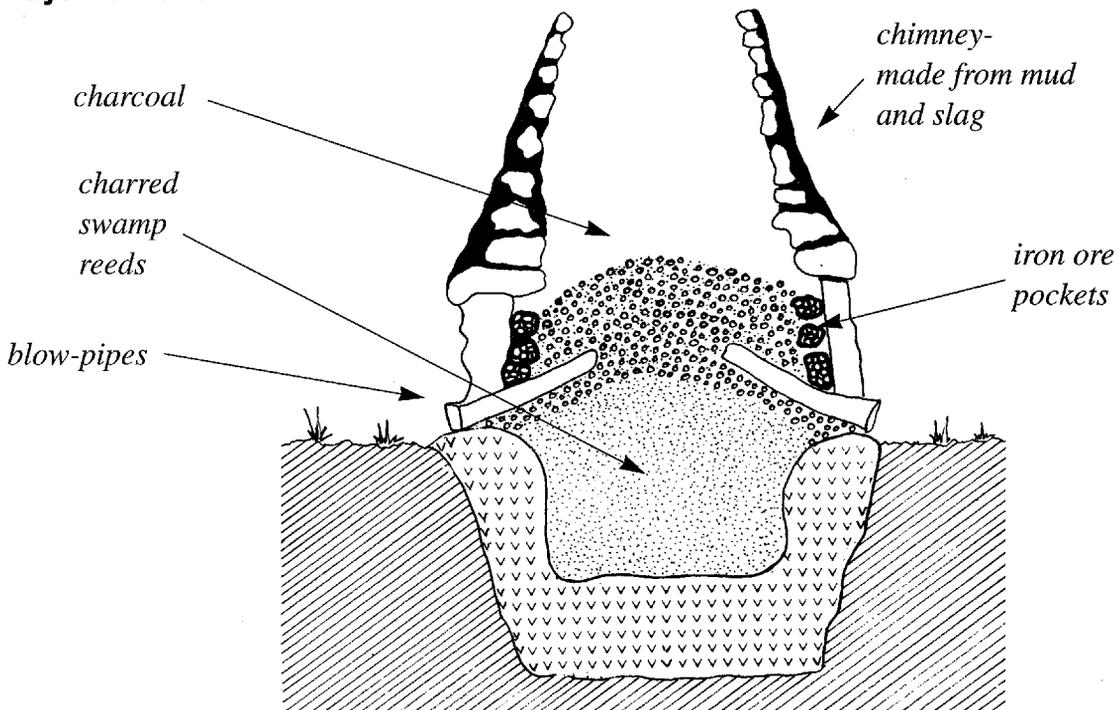
East African Iron Technology

Iron technology has a long history in Africa. Steel is an alloy of iron. A high quality carbon steel was produced by the Bahaya people nearly 2000 thousand years ago. The Bahaya people are from the north-west area of what is now Tanzania, in East Africa.

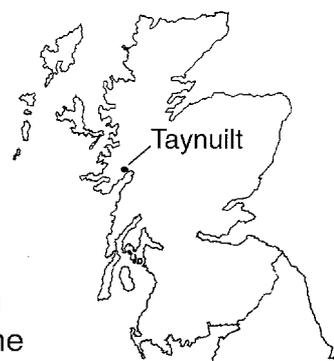


This quality of steel was not found in Europe until about the year 1800. The iron ore used by the Bahaya people had the formula Fe_3O_4 . This was added to the top of the furnace with charcoal, as the source of carbon. The air entered the furnace through blow-pipes at the bottom. In this way the air was preheated, which improved the yield and quality of the iron. The temperature reached in the furnace was $1800^{\circ}C$.

Bahaya Furnace



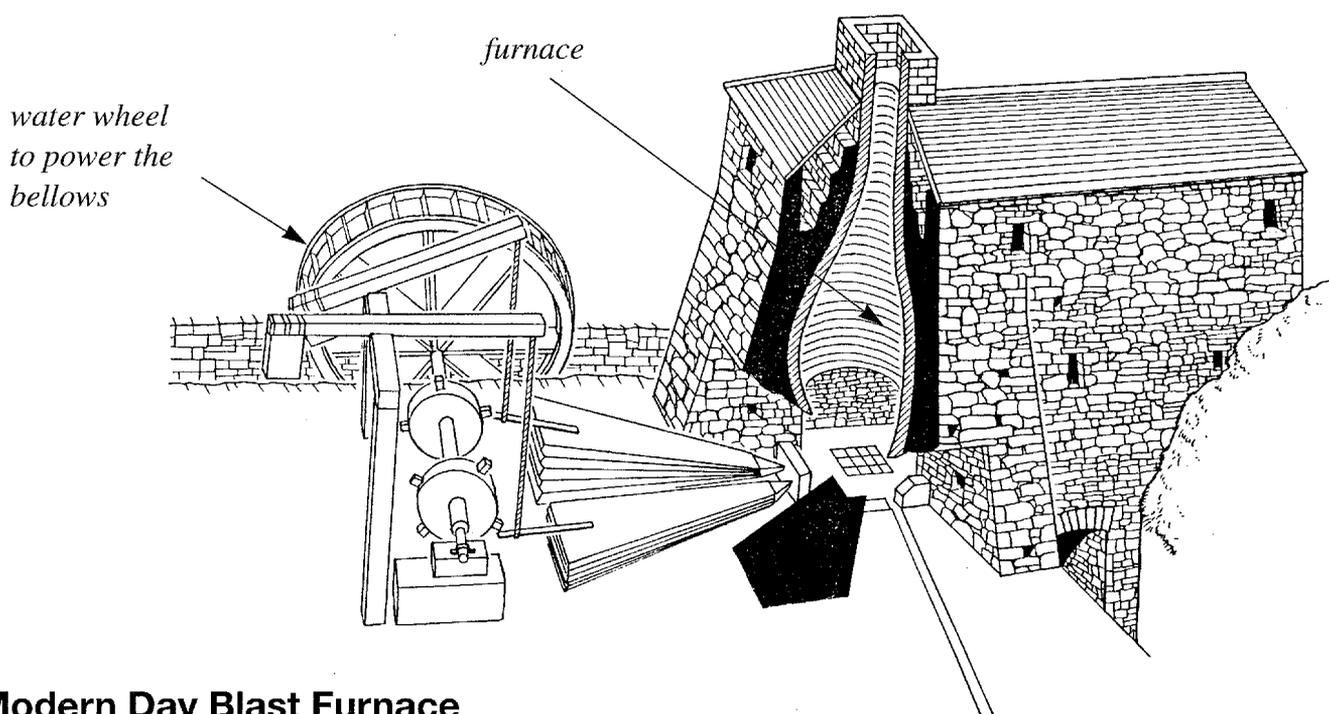
1752-1876 Bonawe Iron Furnace, Taynuilt, Argyll



The Bonawe Furnace was the longest functioning blast furnace in the Scottish Highlands.

The iron ore (iron (III) oxide) for the furnace was shipped from other parts of Scotland and from Furness in England. Limestone and charcoal were also needed for the furnace. The limestone was mined on the Island of Lismore and the charcoal came from the nearby forests. All the ingredients were added to the top of the furnace. The air entered at the bottom. The air was not preheated so the temperatures reached in the Bonawe furnace were lower than the temperatures in the Bahaya furnace.

Bonawe Furnace



Modern Day Blast Furnace

Modern day blast furnaces operate throughout the world. The ore used in British furnaces is iron (III) oxide. Coke has replaced charcoal, as the source of carbon. Coke is formed from coal. The procedures in a modern furnace are very similar to the older technology. Preheating of the air in the modern blast furnace ensures high temperatures of about 1800°C are reached in the furnace.

Questions

1. a) After reading a little about the history of iron extraction in the passage, complete the table below. **(5)**

Process	Bahaya	Bonawe	Modern Day
Formula of Iron Ore	Fe ₃ O ₄		
Source of Carbon			
Temperature of the Furnace		1600°C	
Preheated Air		no	

b) From the table, describe the similarities and differences between the Bahaya furnace and the modern day blast furnace. **(2)**

2. a) What are the 3 substances required for a modern blast furnace? Which one is missing from the the Bahaya furnace? **(2)**
- b) Carbon monoxide is the reducing agent for the extraction of iron from its ore in a modern furnace. It is formed by the reaction of the coke (carbon) and carbon dioxide. Write a balanced equation for the production of carbon monoxide. **(2)**
- c) When the carbon monoxide reacts with the iron (III) oxide in a blast furnace, iron and carbon dioxide are formed
- (i) Write a balanced equation for this reaction? **(2)**
- (ii) Which substance is reduced, and which one is oxidised in this reaction? **(1)**
- d) Limestone is added to the furnace to remove silica impurities in the ore.
- (i) What is the chemical name and formula of limestone? **(1)**
- (ii) In the Bonawe furnace 224 pounds (about 102 kg) of limestone had to be added to the furnace for every ton of iron collected.
- For every ton of iron collected how much slag (calcium silicate) will be collected? **(2)**
- The equation for the reaction is shown below :
- $$\text{CaCO}_3 + \text{SiO}_2 \longrightarrow \text{CaSiO}_3 + \text{CO}_2$$
3. a) What is an alloy? **(1)**
- b) Which are the two main elements present in the alloy called steel? **(2)**
4. Try and find out how coke and charcoal are made.