Durham County Council

Killhope Museum
Creative Science Programme

Key Stage 1 & Key Stage 2

"A zest for life combined with a will to experiment"

Materials Maze

Science Detectives Discover Killhope

Resources for Teachers

SMA
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Materials Maze

Teachers Resource Pack
Killhope Museum Creative Science Programme

Contents

Killhope Lead Mine
Background Information

The 18th Century Boom

Over 200 years ago the Killhope valley experienced a mining boom. New people moved into the area. Shafts, levels, 'hushes' and 'dead heaps' were scattered far and wide over the hillsides. Many of the scars of mining are hidden beneath the trees, but the landscape must have looked devastated. Nearly all the houses you can see in the valley were built during the boom times of the second half of the 18th century. The houses were not huddled together in a village, but scattered over the south-facing hillside. Each family was surrounded by land they could farm to add to the small income they got from the mines.

At Killhope the 'W B Lead' company worked the mines. This was a family business owned by the wealthy Blackett family (later through marriage the Beaumont family). The company leased the mining rights and most of the land in the valley from the Bishop of Durham. This meant that many miners had their bosses as landlords. With a tight grip on employment prospects the Blackett family was a powerful influence on the lives of the workers and their families.

Park Level Mine

Until 150 years ago the area that is now Killhope Lead Mining Museum was field, open moorland and fell. In the 1850s a new mine was started. First, a tunnel was dug to reach the lead veins upstream, then the mineshop was built, and by the 1870s the Killhope Lead Mine was one of the most productive in the whole country. W B Lead's company supplied about one-quarter of the lead mined in England. They had a prestige product that sold at premium prices on the London market. Killhope's second boom had arrived.

W B Lead built the big wheel and buildings near it, to power and house brand new ore crushing and separating machinery. This plant, known as Park Level Mill, started production in 1878.

Shortly after this the price of lead fell by half, undercut by foreign competition. The Weardale Lead Company took over Killhope and prospered, but the mine was almost worked out. The last ore was brought out in 1910.

In some places in Weardale fluorspar mining took over from lead mining and saved many jobs but this did not happen in Killhope. Machinery was sold. Stone was sold off for building. Timber and metal were scavenged. Sheep were the new inhabitants.

A new beginning

In the 1950s the Forestry Commission bought the land of the Killhope valley. The 'Weardale Forest' was planted as an experiment - the highest plantation in England. By chance, the Killhope water wheel had been left in its original location. In 1968 Durham County Council took a lease on Park Level Mill, its wheel and buildings, to develop as a picnic site. Then in the mid 1980s the County Council bought the site and adjacent woodland.

Materials Maze - Materials & their Properties

Teachers Resource Pack
Killhope Museum Creative Science Programme

National Curriculum Science KS1 and KS2

The **Materials Maze – Materials and their Properties -** is part of the Creative Science Programme developed for Killhope Lead Mining Museum and Durham County Council.

The **Materials Maze** teachers' resources offer a range of possible pre and post-visit activities linked to the focus of on-site activities that pupils will be involved in at Killhope supported by the expert team of Information Assistants. These cross-curricular activities are in no way comprehensive and neither are they meant to be. But they do provide a selection of activities that will support pupils in preparing for their visit, and ideas for follow up work.

As you will be aware, for the value of the visit to have the maximum impact good preparation is essential. Good preparation also gives children the confidence to allow their imaginations to work, giving full reign to their thinking skills in making connections and creating their own tests and experiments; and gain an understanding of the scientific principles they will see applied in the context of a 'real life' situation – Killhope – a nineteenth century lead mine in the North Pennines, County Durham.

All the activities in the **Materials Maze**, both on and off site are centred on the requirements of the national curriculum **Sc3 Materials and their Properties, KS1 and KS2.** They focus on the science principles and concepts that can be best explored at Killhope Lead Mining Museum.

Each of the four sections is designed to embrace key concepts in **Sc3 Materials and their Properties**. Used together they build up a comprehensive understanding of the nature of different materials, where they come from, what they are used for and why.

KS1 Searching for Clues: a 'Materials' Experience
(Grouping Materials)

KS2 Gathering Evidence: Fitness for Purpose
(Grouping and Classifying Materials)

KS1&2 Investigating Change: a Testing Time
(Changing Materials)

KS2 Finding the Process: Solving the Problem
(Separating Mixtures and Materials)

Note: *Searching for Clues* is designed for KS1 but can be adapted to KS2 pupils.

The other Killhope Creative Science Teachers Resource Packs for KS1 and KS2 are

Overground, Underground Sound
Forces & Motion
Revealing Rocks and Soils

The last pack – **Revealing Rocks and Soils** – can be used as an independent pack or in association with the **Materials Maze** as part of **Sc3 Materials and their Properties**.

Materials and their Properties in Context
Visiting Killhope Lead Mining Museum

'A safe and stimulating environment for learning'

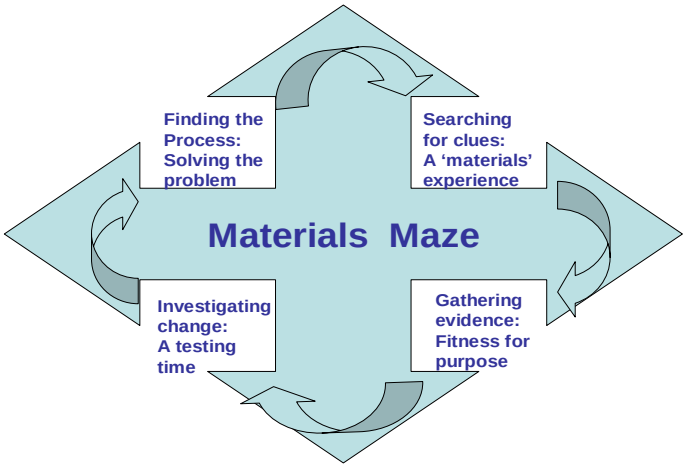
At Killhope Lead Mine in Upper Weardale in the 19th century questions (and answers) about materials and their properties were fundamental to establishing and running a successful lead mining business and for personal survival in the isolated location and harsh climate of Pennine Hills.

Over 100 years later, Killhope is no longer a working lead mine but is a museum run by Durham County Council. The purpose of Killhope Museum is to care for and display buildings, refurbished industrial equipment and show life above and below ground in a nineteenth century lead mine in the North Pennines. Current features of the museum include: tours of the mine, refurbished working water wheel, displays in the miners' living accommodation, blacksmith's shop, and mineral displays, washing floor, jigger house, woodland areas, museum display areas and café, shop and toilet facilities.

Killhope Lead Mining Museum provides a safe and stimulating environment for educational visits.

Educational visits to Killhope have a very good reputation. Visiting teachers and pupils particularly value the involvement of trained staff from the museum during every visit, and the focus on hands on and participatory activities. This approach to site-based learning was commended recently in *The Guardian*'s Education supplement. The newspaper reported that Killhope is "an inventive and vibrant museum with an excellent tour and educational package…..the Museum prides itself on being a worksheet -free zone: pupils are encouraged to 'do' rather than observe….."

The *Killhope Creative Science Programme* builds on the established reputation of Killhope Lead Mining Museum for 'hands on' and participatory activities, making full use of the expertise of the trained staff team. The Killhope Museum site and collection of buildings, machinery and artifacts in their original setting within the landscape of the North Pennine hills offer a unique opportunity to explore innovatory approaches to science education at KS1 and KS2 and Materials and their Properties in context.



Creative Science at Killhope

Inspiring learning through Creative Science

The concept of creative science is an exciting new approach to engaging pupils in learning about science supported by QCA. Creativity allows for greater flexibility in terms of learning opportunities. Thinking creatively means that science can be inspiring. Once the traditional boundaries between arts and science are broken the creative arts can also be a rich source of inspiration for science learning.

Other boundaries are crossed too. Links can be made to real life situations beyond the home/ school environment. Undertaking interesting, new scientific experiments relevant to a particular place and industrial practices enables pupils to gain a better understanding of scientific principles, their application and usefulness.

Science Detectives

Detectives need to be equipped with a range of special qualities and some special equipment. Discuss with the class what these special qualities are and what equipment would be helpful in looking at different materials in detail.

Explain that when the class arrives at Killhope, they will be divided into several groups. Each group will explore and undertake experiments around the site. When the class gets back to school one of the tasks will be for each group to report back to others in the class on their observations, the evidence they have found, the tests and experiments they have carried out and their experiences.

It is up to individual teachers how far they pursue the 'science detective' idea. Digital cameras, video cameras and voice recorders would be useful for recording purposes.

Pupils will need to understand the importance of

- Close observation and examination of clues
- Gathering and sifting through evidence, then sorting it into different categories
- Carrying out investigations and tests
- Using different methods to solve a problem

Subject links and cross-curricular learning

Across all four Killhope Creative Science Teachers Resource Packs art, drama and dance are used when appropriate as innovative approaches to experiential learning in primary science alongside 'hands-on', interactive practical sessions at the Museum.

Cross-curricular learning is encouraged, in particular the use of ICT and literacy.

In turn pupils of primary school age are inspired to explore experiment and gain an understanding of the need to understand and apply scientific principles in a 'real life' situation – lead mining at Killhope in the nineteenth century.

Materials Maze: Creative Science Learning Activities

The **Materials Maze** Teachers' Resource Pack is divided into four sections that each includes Pre-visit, and Post-visit Follow up Activities. There is a logical development from one section to the next linked closely to the national curriculum Science.

Section 1: KS1 Searching for Clues: a 'Materials' Experience (Grouping Materials)

Section 2: KS2 Gathering Evidence: Fitness for Purpose (Grouping and Classifying Materials)

Section 3: KS1& KS2 Investigating Change: a Testing Time (Changing Materials)

Section 4: KS2 Finding the Process: Solving the Problem (Separating Mixtures and Materials)

However, many of these activities are also designed for a flexible approach. You may choose to do more preparation or more follow up. You may choose to take a strong science focus supported by the creative work or you may choose to integrate 'arts/ science' learning.

How you decide to approach using the **Materials Maze Teachers Resources** will depend on how you want to include the on-site learning at Killhope within your curriculum planning, schemes of work and the timing of the visit to Killhope.

Section 1:

KS1 Searching for Clues: a 'Materials' Experience (Grouping Materials)

Pre-visit Activities

1a KS1 Activity: A Classroom Collection

Make a collection of objects of different materials linked to

The Seaside – sand, shells, stones, plastic bucket and spade, cotton towel, nylon/ lycra swimming costume, shorts, tee shirt, paper plates, straw hat, sunglasses, rubber flip flops, camera etc

Cooking and Entertaining at home – aluminium/ stainless steel frying pan or saucepan, wooden spoon, plastic microwave dish, china plate, glass, paper napkins, spoon, tea, sugar, tin of cola, slippers, tee shirt, trousers/ skirt, music player etc

Shopping and Take Aways – mobile phone, coat, leather bag, plastic bags, shoes, MacDonald's - paper cup, box, spoon, straw – sweets, chocolate

***Visiting Killhope Museum**

- in summer – sandals, shorts, sunhat, tee shirt, coke can, sweets, trees, leaves, grass, stones, water; birds, flowers, 'galena' (lead ore)

– in winter – hat, scarf, gloves, coat, jumper, Wellington boots, trainers, football, stainless steel flask, chocolate, trees, twigs, leaves, water, stones, mud, 'galena' (lead ore).

***** '*Visiting Killhope Museum in Summer and Winter' is a pre-visit activity that can be extended further into a post-visit activity using the Killhope Materials Loan Box***.** *This will include galena – lead ore.*

Explore the objects in the collection in different ways

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1. Through the senses. What does it feel like? Does it smell? Can you see anything special – colour, shape? What noise does it make? Can you eat it?

2. Put together things that are the same or similar because….. they are hard, soft, flexible, transparent, light, heavy, rough, smooth etc

3. Put together things to do with food and eating; playing outside; keeping you warm etc

4. Label the things [made in different materials] that keep you warm, keep you dry, keep you cool, hold water, etc

5. Make links e.g. 'a towel is soft and flexible. It makes you dry because it absorbs the water. It is made of cotton'

6. Place the objects in groups according to what materials they are made of – metal, wood, plastic etc

Write a story including some of the objects in the collection. This could be fiction 'The towel that wouldn't bend' or fact 'Shopping with my Nan'

Fantasy Fashion Show – Different materials in the wrong places. Saucepan on head as a hat, shoes of paper etc

After the Visit - Killhope Fashion Show (19th century) – Clothes made of wool, cotton, leather and wooden clogs.
Killhope Loan Box will be helpful here

1b KS1 Activity:

What clothes do I wear?

What things do I need when I …….

The class is divided into 4 groups to explore the following themes:

- **Go to the seaside and sit on the beach?**
- **Invite friends round for a meal?**
- **Go shopping and eat food out?**
- **Go on a visit to Killhope in summer or winter?**

Discussion: each group talks about what clothes they like to wear and what things they need relating to their chosen theme.

Drawing: make either individual or group drawings of the things the pupils think they need and what they like to wear.

Difference: identify the different materials by describing them using the five senses.

Charts: fill in 4 separate charts with 4 different objects for each of the 4 themes. An example is given below.

Make a drawing and/ or a list of what makes each object special. For example, a scarf – warm, bendy, long, red and white, stretchy, rough, wool

Note:
These activities create an awareness of the experience of natural and man-made materials in readiness for working at Killhope.

Repeat both the above activities after a visit to Killhope Lead Mining Museum

- A Killhope Loan Box will be supportive in making a Killhope Classroom Collection

- Discuss what clothes you would wear - and why - working at Killhope Lead Mine at different times of the year
    - Outside on the Washing Floor
    - Inside the Mine Lodging Shop
    - In the Underground Mine

- Ask the children to make comparisons with what we might wear today to do the same jobs

1b Killhope Worksheet

What clothes do I wear?
What things do I need when I ……

When I go on a visit to Killhope Museum in winter I take

Wellington boots	A picnic box
A scarf	A hat

On-site Visit Activities

1c KS1 Activity: Finding Observing &Testing Materials

- **Discovery Session:** collection of different natural and man-made materials around the Killhope Museum site, including the woods

- **Senses as Search Tools:** using the senses describe the objects collected

- **Experiments:** test the properties of all the materials collected e.g. floating and sinking, waterproof or not, flexible or rigid, heavy or light (This can also be done at school)

- **Observation and Recording:** 'I Spy' on site again to see if the pupils can find the materials used in different ways in different places on the Killhope site – recording through drawing, filming or photography

- **Experiential Activities**: wearing clogs, dressing up in wool clothing, using china cups, iron tools and utensils and children's toys made of iron

- **Linked Creative Arts Activities:** create collages or sculptures using different materials. Describe what it feels like to wear woollen clothes, wooden shoes, to work outside in the warm sun of summer and the cold snow of winter – short poems etc. (These creative activities can also be done at school.)

Post-visit Activities

1d KS1 Activity: 'Touchy Feely' Boxes

You will need

Medium sized card board boxes with a circular hole at one end;

Flexible stocking cloth or rubber - to seal the hole so that no-one can see inside, but allow a small hand to feel inside the box

Paper to cover the boxes

Inside each box place one example of materials that the children encountered during the visit to Killhope Museum.

These boxes could include some of the following:

An iron pot/ tool (not with jagged edges)

A piece of rough woollen cloth

A wooden clog

A roofing stone/ slate

A piece of galena

Sheep's wool – (washed)

A mug

Straw/ heather

A 'fake' fur mouse

The class takes turns in feeling into the boxes and working out what the objects are and what they were used for at Killhope

1e KS1 Activity: Collages or Sculptures of Killhope

The inspiration of Killhope and the work on materials is combined in a large collage or sculpture.

Draw on

- shapes - large wheel
- trees and woodland
- stone walls
- hilly landscape
- miners lodgings

Cross reference to the work of the sculptor Antony Gormley

Section 2

KS2 Gathering Evidence: Fitness for purpose
(Grouping and Classifying Materials)

Pre-visit Activities
The knowledge and understanding contained within these activities will be re-enforced and put into an actual context on your visit to Killhope Lead Mining Museum.

Lead is heavy, water-resistant, does not float, and is non-magnetic, flexible, non-transparent and strong. (See the Section on 'Uses of Lead' for either pre-visit or post-visit activities)

2a KS2 Activity: Tests for Comparing the Properties of Different Materials

Equipment and Materials

A wet area containing a large work table (big enough for the class to observe action)
A fairly large fish tank or similar
A tray (which will hold a little water)
A jug to hold water
A set of weighing scales
A set of simple magnets

Collect together a selection of two different groups of materials – one natural and the other man-made, all of a similar handling size.

Wood
Natural Stone (Granite, Sandstone & if possible Chalk)
Metal (if possible – steel, cast iron, lead & copper pipe)
Rubber (sheet), Leather, wool (square), cotton (square)
Cardboard, Writing Paper, Tissue Paper
Plastic sheet (hard), Plastic sheet (flexible)
Glass

You will need to devise a **Properties Comparison Chart** (see example below) to record results for each of the different materials tested. Also make use of IT equipment, whiteboard, flipcharts or clipboards & pens.

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You will be carrying out the same fixed number of simple tests on all the materials collected.

Test Number 1
What is the weight of the material? Do you think it is **HEAVY or LIGHT** for its size?

Test Number 2
(Using the tray of water) If placed in water, does the material soak up water? Is it **ABSORBENT? or NON- ABSORBENT?** This test will take approximately 1 hour and the results can be gained by weighing the material before and after the soaking.

Test number 3
(Pouring water from the jug held over material in the fish tank) Does the material let water go through it? Is it **PERMEABLE or IMPERMEABLE (WATERPROOF)**?
N.B. With rocks in the ground note that being ABSORBENT is the same as being PERMEABLE.

Test number 4
(Using the fish tank full of water) When placed in the water, does the material **FLOAT or SINK**?

Test number 5
Will your magnet stick to it? Is the material **MAGNETIC or NON-MAGNETIC?**

Test number 6
When held in two hands, can you bend the material? Is the material **FLEXIBLE or INFLEXIBLE?**

Test number 7
Can you see through it? Is it **TRANSPARENT or NON-TRANSPARENT?**

Test number 8
How strong is the material? Can you break it, snap it or rip it? **STRONG or WEAK?**

Discussion & Conclusions

Using your completed comparison chart, discuss and record the following:

- Where each different material comes from. Is it natural? If so, where is it found? Or is it man-made? If so how is it made?
- Each material will have a unique set of properties. Discuss each in turn and decide exactly what special properties are significant for each material.
- Investigate the inside of the classroom and the outside of the school buildings to find which material is used where? For example, wood for tables, glass for windows etc. Do your conclusions on the properties of each material match their apparent use around the school?
- Make a list of other possible exemplary uses for the materials which may not be evident in the school environment.

Example: Properties Comparison Chart

Material	Heavy		Absorbent		Waterproof		Float		Magnetic		Flexible		Transparent		Strong	
Result	Y	N	Y	N	Y	N	Y	N	Y	N	Y	N	Y	N	Y	N
Wood	X		X		X		X			X		X		X	X	
Granite	X			X		X		X		X		X		X	X	
Cotton		X	X			X		X		X	X			X		X
ETC.																

On-site Visit Activities

2b KS2 Activity: Gathering Evidence on the Use of Materials

- **Discovery Session**: Find and group selected materials with different properties into different categories for different uses, and describe their special characteristics.

  For example - permeable and impermeable; magnetic and non-magnetic; flexible and inflexible; transparent and opaque; waterproof and non waterproof.

- **Waterproof Building Materials and Their Uses**. Visit Mine Shop building. Look at what materials have been used on the outside to keep the building waterproof. (Stone, lead, wood, glass)

  Make a record by taking photographs.

- **Charting Old and New – Discussion** Compare and contrast the use of building materials on the old and new buildings on the Killhope site. What is the same and what is different?

  Record the information and take photographs in order to make charts at school.

- **Keeping warm, Keeping cool, Keeping dry - Discussion** Compare and contrast the clothing materials, shelters and living spaces of Killhope miners and boys with what we expect today.

  Record the information and take photographs.

- **Water, Water Everywhere But?** Gather evidence on how the special characteristics of water have been used to benefit the lead mining process. Find out when water was a help and when it was a hindrance.

  Make a video of all the places water is used (including the woods). Why it is used there, what it is used for. Don't forget the forge!

Post-visit Activities

2c KS2 Activity: Water – a Friend or an Enemy?

This activity is designed to reinforce the thinking; understanding and learning about the role of water at Killhope when it was an active lead mine. The activity then leads on to a consideration of the role of water around the world.

Water is an environmental issue. The post-visit creative session on exploring the relative value of water at Killhope is a catalyst for exploring the relative value of water around the world as either a 'Friend or an Enemy'.

Water, Galena and *Air* were essential materials in the lead mining process as you will have seen on your visit to Killhope. The significance of the different properties and different characteristics of these solids, liquids and gases was an important factor in the success of the lead mining process.

At Killhope one of the problems in the underground mine was providing sufficient air for the miners to breathe and to keep the candles alight. The advantages of galena being a solid – and a heavy solid – are evident both in the mine and on the washing floor (washing rake). It is not soluble in water. But the properties of water have both advantages and disadvantages at Killhope and elsewhere in the world – sometimes too much, sometimes too little but essential for living and working.

Killhope Lead Mine is a good example of the fitness for purpose of water but its nuisance value as well.

Solids, Liquids & Gases at Killhope

Water is a liquid material. *Galena* – lead ore – and the metal '*lead'* are solids. *Air* is a gas.

You may like to invite the class to plan an experiment grouping different materials into solids, liquids and gases to show how and why they were important at Killhope.

Key properties from the Killhope point of view:

- Solids are substances that retain their shape and do not flow.
- Liquids flow and take the shape of the container they are in.
- Gases also flow, but more easily than liquids: they fill the space available and often escape.

Other solid materials used in the lead mining process that you will have seen in action at Killhope are *wood*, *stone* and *iron.*

There were mine timbermen who used wood to make ladders, platforms and timber props to support side passages. Stonemasons created beautiful dry stone arch supports in the lead mines of the North Pennines and the work of Edward English can be seen at Killhope. Stone was cheaper and more readily available and more long lasting than wood in the wet environment of the mine. The iron tools such as 'jumpers' (long chisels for boring holes for gunpowder to blast out the rock in order to reach the veins of galena) – were made from iron ore mined in the nearby valleys of the North Pennines.

Water at Killhope

Water was in short supply at Killhope. A series of reservoirs was built on the hillside above Killhope to supply water for the Killhope lead mining activities. The problem was that on the surface where the separation processes of the lead ore – 'galena' – from the waste rock and other minerals took place, there was hardly ever enough water. Underground in the mine there was usually too much.

The reasons why this dual problem occurred is not a lack of rainfall, but the upland location and the porosity/ permeability of limestone and sandstone. The water disappeared either into the ground or downhill in streams such as Killhope Burn. Therefore, the huge quantity of rainfall that did fall had to be saved in clay-lined reservoirs and directed down hill to where it was needed by 'water races'. The one supplying Park Level Mill was 9 miles long.

Large quantities of water were needed both for the labour intensive, hand tool and semi-mechanised separation processes carried out on the Washing Floor and later for the fully mechanised separation processes of Park Level Mill.

Both processes relied on two simple characteristics of Galena.

- Galena has a high specific gravity: it is denser than the waste rock and other minerals found with it. Therefore it will always sink to the bottom of the mixture of materials.
- Galena does not dissolve in water.

Some of the advantages and disadvantages of water at Killhope that you will have observed

Underground in the Mine:

- Water blasts directed down shafts in pipes pushed air into the spaces ahead and pulled air into the vacuum created behind them to help ventilate the mine
- Water helped to keep down the level of dust
- Horse levels acted as drains to prevent flooding
- An underground water wheel was used to drive a mechanical pump to clear the mine of unwanted water

Over-ground :

- Washing Floor (Washing Rake) processes
- Park Level Mill – wheel, jigger house, buddle house (where fine material was separated into waste and galena), slime pits etc
- The waste rock and soil 'deads' were carried away by the stream
- Water used at Killhope was used again 3 miles down the valley at Cowshill.

Water at Killhope in a global context

- During their visit to **KILLHOPE** your group of children will have seen or heard about **WATER** being used in a considerable number of different ways. Some of these ways are useful and indeed essential to the success of the industrial processes at the mine.

- Conversely, they will also have seen where water was definitely not useful and indeed hindered the work being done.

- This phenomenon can be seen all over the world. At different times in different situations water can be a friend or an enemy.

Creative Activity

This activity can be done over a number of days or weeks.

1. Discuss with the children what they remember about the many different ways they saw water being used at Killhope Lead Mine.

2. At the end of this first discussion, can the children identify anywhere else or any other situation they may have heard about, anywhere in the world, where either a positive or a negative situation is created by the same simple material – **WATER?**

3. Set the children a research task to find pictorial or written evidence from any source they wish e.g. News Bulletins, Magazines, Newspapers, (recorded) oral history or particular family experiences that shows water as the 'Hero' or the 'Villain' of the situation.

4. Create a Wall Mural using the evidence the children collected.

5. When the mural is finished, discuss the conclusions drawn from the evidence displayed.

2d KS2 Activity: The Photo Shoot

Build on the photographic evidence collected at Killhope and/or available in the ***Killhope Materials Loan Box***

- Ask the pupils to take photographs of each other dressed for warm, cold and wet weather. Make charts of the different materials with room to give short explanations of why they are used
- Make a photographic record of the exterior of the school building and buildings in neighbouring streets. Make charts of the different materials with room to give short explanations of why they are used
- Carry out the same processes with the photographic information gathered from the visit to Killhope
- Print out a wide range of photographs on the copying machine. Ask the children to use scissors to cut up the pictures and then paste them back together in a montage. (This can also be done using ICT if the equipment is available)
- This exercise should produce some curious results. A miner's woollen cap on a boy wearing jeans and a tee shirt or a girl wearing a sequin party top with a woollen skirt
- Will the differences be so marked in the buildings' montages? If not, why not?
- Invite pupils to come up with ideas for developing a photographic exhibition on Killhope. It could include examples of the different materials actually used at Killhope, set next to the pictures of the actual objects
- They might want to colour code their work, add poems, move on further to make abstract collages using different materials, creating a Killhope 'Water World' or 'Killhope Materials Landscape'
- Take the exhibition to Killhope or invite the Information Assistants to visit the school and discuss the results

Section 3

KS1 & KS2 Investigating Change: A Testing Time (Changing Materials)

Pre-visit Activities

The knowledge and understanding contained within these activities will be reinforced and contextualised on your forthcoming visit to Killhope Lead Mining Museum.

3a KS1 & KS2 Activity: Reversible and Irreversible States

During their visit to Killhope your pupils will

- Find out about the effects of reversible changes by exploring what happens as a result of condensation from a boiling pot of water in the miners' lodgings. (Experiment 1)

- Discover how, where and why candles are used and what issues arise for the miners as a result of the fact that burning candles is an irreversible process that needs oxygen from the air and forms new substances. (Experiment 2)

- Observe the effect of the environment on the physical state of different materials such as iron tools and machines, wooden tubs, lead roofing, stone tiles and glass windows. (Experiment 3)

Reversible and Irreversible States

Equipment and Materials

Experiment 1

- water condensing apparatus OR a transparent electric kettle
- heat proof gloves

Experiment 2

- basic Candle Making Kit
- saucer or base plate
- glass jar

Safety Note: Work with boiling water or molten wax should be a *teacher demonstration only*. In experiments 1 & 2 it important that the children watch from a safe distance and do not touch the condensing apparatus, kettle or candle wax while it is being heated or before it has cooled down completely.

Experiment 3

- A number of water proof containers (jam jars are perfect)

- A selection of different solid materials, small enough to be placed in your containers:
    - cast iron
    - copper tube
    - lead
    - untreated soft wood (pine)
    - untreated hard wood (oak)

You will need to devise a **Properties Comparison Chart** (see 2a for an example) to record results for each of the different materials you test.

Make use of IT equipment, whiteboard, flipcharts or clipboards & pens.

Reversible & Irreversible States
Experiment 1 – Condensing Water

EITHER

- Set up the glass condensing apparatus on your work table. The apparatus will arrive with all its assembly and operating instructions.

- Light the heat source beneath the water container and let the water begin to boil.

- The children will witness the effect of heat on water. They will observe the water change state from being a liquid into water vapour when it is being heated. Then when it is cooled back through the condensing tube they will observe a second change back into a liquid again.

OR

- Use a transparent electric kettle half filled with water placed one metre from a glass window.

- Turn on the switch and bring the water in the kettle to boiling point. Allow the kettle to boil for 2 minutes (switching the kettle on a number of times if the kettle has an automatic switch to switch itself off once the water has reached boiling point).

- The children will witness the effect of heat on water. They will observe how the water changes state from a liquid into water vapour when it is being heated and how when the water vapour meets a cold surface – the glass window – it condenses and changes back into a liquid again – water.

- Therefore, in this experiment, as with the previous one, the change to the material is **REVERSIBLE**.

Experiment 2 – Discoveries with a Candle

- There are two main questions for discussion, recording and answering at all points during the undertaking of this experiment. Do we still have all the original **MATERIALS** in whatever state? Is any change in state **REVERSIBLE**?

- The candle making kit will include various items. Each item or different material that comes in the kit will be independently in a stable state. Ask the children to note this. For example, the wick is a piece of string; the wax is either a block or a bag of granules.

- Follow the instructions and make the candles. During the candle-making process the children will observe the wax melting when it is heated up. Wax **CHANGES ITS MATERIAL STATE** from a solid to a semi-liquid state when *indirect* heat is applied to it. The wick on the other hand will not change its state at this stage.

- When the candle-making process has been completed the wax will have re-formed into a **SOLID STATE,** a different shape from the beginning, but still the same material. The wick will be encased, but still in its original state.

- Place the candle on a saucer and light it. Observe it burning. The children will see the wick changing from its solid string state to another, it is literally 'going up in smoke'- **CHANGING STATE** from a solid to a vapour. The wax will also be melting again, but in a slightly different way to the first time.

- Now place the jam jar over the lighted candle. As the children watch the flame of the candle will eventually burn up all of the **OXYGEN** which is contained within the jam jar and candle will stop burning. Note that once again the wax will still be in a solid state.

- Carefully examine the wick and the jam jar. At this same point, it will be possible to see the material which started just as a string wick, now in **THREE DIFFERENT MATERIAL STATES** at the same time.

    1. The wick will be visible still as string just above the wax and inside the wax.

    2. The burnt end of the wick will be turned into a 'charred brittle' state. This change is **IRREVERSIBLE**. It is impossible to change the string back to its earlier 'flexible' solid state.

    3. The vapour produced as the wick burned will now be **CHANGED AGAIN** into a solid state as black dust in the top of the jam jar. This change is also **IRREVERSIBLE.** The black dust cannot be changed back into either the solid state of string or the state of vapour.

Experiment 3 – The Effect of Environment on The Physical State of Different Materials

This experiment can be done over a matter of weeks. The condition of the materials will need to be monitored and recorded at regular intervals.

- Record precisely the exact state of the different individual strips of wood and metal. Record their weight, surface condition, colour and strength and identify their visual state e.g. dull or bright and shiny.
- Place each strip of material in one of the containers and fill each one with water. Label them with a waterproof system and place them side by side, outside of the classroom in an exposed location.
- Leave them in this location. If possible each week, carefully monitor the state of each individual material and record any changes as they happen. The water level should also be topped up regularly so the containers do not dry out.
- After approximately one month, bring the containers into the class room. Carefully examine each material asking exactly the same questions as at the beginning of the process and record the findings. Some materials will have changed **IRREVERSIBLY**. But some will not have changed.
- Record this evidence in relation to a comparison of materials being 'fit for purpose'.

Discussions & Conclusions

Using your completed comparison chart, discuss and record the following:

- Was the testing fair and equal?
- What exactly happened to each material? Is any possible change REVERSIBLE?
- Has either type of wood taken on water – if so, is each still as strong as it was at the beginning?
- If these different types of wood were used outside for building houses and other things, which one would be the safest to use?
- Have any of the metals gone rusty? If so, which ones?
- If any of these metals were used inside buildings where water was being used, which ones would be the most practical?
- Investigate the inside of the class room and the outside of the school buildings to find which material is used where? For example, wood for tables, glass for windows etc. Do your conclusions on the properties of each material match their apparent use around the school?
- Make a list of other possible good uses for the materials which may not be evident in the school environment

On-site Visit Activities

3b KS1 & KS2 Activity: Investigating Change: A Testing Time

KS1 & KS2 During a visit to the Miners' Lodgings investigate

- What happened to the miners' lodgings when a large pot was full of boiling water? Was the effect beneficial? What happened to the water?
- What fuel was burnt on the fire? Where did it come from and how was it changed?
- What are the candles made of? How did they get new ones?
- What changes happen to straw, wool cloth, iron and wooden utensils when they get old?
- What makes the walls white?
- Why did miners hang joints of meat from the pig in the rafters?

KS2 During a visit to the underground mine investigate

- How the mineral veins are formed
- What is the water doing?
- What are the candles made of, how they change, and how they help test for good air?
- Where the air came from for the miners to breathe and how they knew that the air was getting thin
- Set up a test inside the mine to see if there is enough air to breathe

KS2 During a visit to the Washing Floor investigate

- What is found in some pieces of rock?
- What is the water doing?

KS2 During a visit to the Smithy investigate

- What was the job of the blacksmith?
- What heat source did he use?
- Why did he need water?
- What tools did he use?
- What happens to the properties of iron when it is heated to a high temperature?

Post-visit Activities

3c KS1 & KS2 Activity:
Watching an Imaginary Television Documentary 'How Killhope used to be'

Watching An Imaginary Television Documentary 'How Killhope Used To Be'

- Your class will have recently experienced a visit to Killhope Lead Mining Museum. Whilst on their visit they will have seen: The Underground Mine, The (outside) Washing Rake (Washing Floor), The Miners' Lodgings and the Smithy.

- They will have seen and experienced the Killhope mine workings in their present state. A state which reflects everything having had many years of very heavy use. Most things on view now are at least one hundred years old and what they look like now reflects that long hard history.

The Activity

- You are going to create with the children an imaginary Television Documentary about what Killhope may have looked like one hundred years ago when everything was a lot newer. Therefore using the children's imagination to describe what has materially changed from the point at which everything there was new.

- This activity is most successful with a complete confidence from you that a 'mimed' television actually exists. If you don't play the game, the children won't either.

- First, draw an imaginary television and as you are doing it, tell the children what you are doing as you do it. Describe the screen and all the controls.

- Choose any image you remember from Killhope.

- **You must look deeply into the imaginary screen** and, using what you saw on your recent visit as a point of reference, start to describe what you have seen recently and then compare it to a picture on your imaginary television of a bright new Killhope one hundred years ago. For example, "I can see inside the miners lodging house. Nowadays it is all dark and damp and dingy. One hundred years ago it was very different. I can see the walls are painted a bright white colour of new lime wash, the new glass in the window is clear and sparkling and the cooking pot on the fire is new, shining brightly and full of hot, clean, steaming water

etc.etc.etc…….

- Invite one child at a time to come and look into the television screen and tell the class what they can see. You may need to prompt them gently through questioning until they get going.

- You can use this activity to include every child in the class, gradually moving all around the different Killhope areas and expanding the imaginary images. If you keep it moving, the children will not get bored. You may ask questions whenever you like of any child's vision to amplify the specific image for the others listening and watching.

- You may keep this activity going as long as you like, inviting the whole class, one by one, to look more carefully at what they can see. In fact you can encourage them to look and examine very detailed minutia within the imaginary image.

- After the exercise, discuss with the class the major changes in the different materials they will have imagined from being new one hundred years old, to what has happened to them over the years and if any of the changes could possibly be reversible.

3d KS1 & KS2 Activity: Pottery Forms
Fired Shapes at Killhope

Killhope is an exciting place with unusually shaped objects lying around the site, intriguing activities, woodland, wildlife, water and evocative machinery.

Pottery Forms

Following a discussion of what shapes the children have seen during their visit, use clay or other modeling materials to create a display of the shapes and forms of Killhope. (Note: you could use air drying clay)

- Discuss what happened when water was added to the dry clay
- Discuss what happened when the water evaporated from their shapes/ sculptures

Fired Shapes

If you have access to a pottery kiln to fire the work of the class (a local potter or secondary school might oblige), examine what changes have taken place before and after the firing:

- Discuss what has happened in the kiln
- Examine what effect the firing process has had on the clay and on the original shape – surface feel, size, shape of their creations etc
- Set up a fair test to decide whether the Pottery Forms and Fired Shapes of Killhope have been subjected to reversible or irreversible change processes during the firing
- Find out what lead glazed pottery looks like

Section 4
KS2 Finding the Process: Solving the Problem (Separating mixtures and materials)

Pre-visit Activities

4a KS2 Activity: Examining Different Ways Materials Separate

The knowledge and understanding contained within these activities will be reinforced and contextualised on your forthcoming visit to **Killhope Lead Mining Museum**.

The experiments suggested here are designed to provide a series of building blocks to aid your pupils' understanding of some of the different ways the separation of materials takes place. They are completely artificial in practice, but are a reflection of the actual principles of separation.

During their visit to Killhope Lead Mining Museum your pupils will examine the separation processes that were carried out by the men and boys employed by W B Lead's mining company applying one of these scientific principles in a successful commercial enterprise in the 19th Century.

On site the Killhope Information Assistants will lead an interactive session demonstrating the various ways by which the Galena – lead ore – was separated from the waste rock and other minerals.

The early methods demanded hard physical work. The rock and ore – 'bouse' - was broken up by hammers – 'buckers'. The broken mixture was then put into a sieve and shaken up and down in a tub of water.

The invention of the 'hotching tub' was a considerable improvement. This was a sieve suspended from a long pole acting as a lever which when pulled, jerked and agitated the sieve up and down in water full of small pieces of bouse. The heavier galena sank to the bottom. (Experiment 3)

Every small fragment and particle of galena was collected because lead was a valuable commodity.

The fine material left over from the 'hotching tub' process was separated on a 'Buddle' – a sloping board. Water playing over the 'fines' and washed off the waste, leaving the heavier lead ore behind.

Equipment and Materials

Experiments 1 & 2

1 x bag of long grain rice
1 x bag of cooking salt
1 x domestic flour sieve
1 x domestic coffee filter
2 x large bowls
1 x jug of water
1 x sheet of coloured cartridge paper

Experiment 3

A mineral water bottle with the label taken off
Some fish tank grit
Some builders sand
Some fragments of galena ore
A jug of water
A home made paper funnel

Experiment 1 – The Dry Separation of Materials

This experiment is to test the theory of sieving materials through a dry sieve

- Mix an equal amount of the rice and the salt in a bowl until they are completely mixed together.
- Hold the empty sieve over your empty bowl.
- Carefully pour the rice & salt mixture into the sieve.
- Gently shake the sieve from side to side.
- After a few minutes you will notice that all the salt should have fallen through the sieve into the bowl below and you will be only left with the rice which is now completely separated again.

Conclusion

The size of the mesh in the sieve will only allow the smaller particles of material to pass through. During the shaking, the smaller grains of salt will gradually work their way down through the rice, eventually falling to the bottom of the sieve. When they get there, they will fall through the fine mesh and into the bowl. This will only leave the larger grains of rice behind in the sieve.

Experiment 2 - Wet Separation of Materials

This experiment will show how some materials will dissolve in water to become, just for a short time, a liquid solution, helping the separation process.

- Mix an equal amount of the rice and the salt in a bowl
- Add a good amount of water to this mixture and mix well
- Hold an empty coffee filter over a bowl with the cartridge paper in the bottom of it
- Carefully pour the rice, salt and water mixture into the coffee filter
- Allow time for the mixture to drain through the filter onto the cartridge paper in the bowl below
- When all the liquid has drained out of the filter you will be left with just the rice again. Wet but separated
- If you carefully lift the cartridge paper out of the bowl, keeping it flat all the time and lay it flat on the table, as it dries you will see the salt re-appear on its surface. Once again completely separated from the rice and the water

Conclusion

The salt dissolved into the water and became a liquid mixture or 'salt-water solution'. This liquid was thin enough to pass through the coffee filter. The saltwater solution would then be soaked up by the paper. As the water evaporates away into the air it will just leave the salt drying on the paper, again completely separated.

Experiment 3 – Separation by Weight

This experiment will show how some materials can be separated not just by their own size, but mostly their own weight.

- Mix together in a bowl, a good amount of fish tank grit, some sand, some natural Galena - lead ore - fragments and an amount of water
- Roll up a piece of paper as a funnel and place it in the top of the water bottle
- Pour the mixture into the bottle through the funnel and fill it about three-quarters full
- Screw the top firmly on the bottle
- Shake the bottle up and down energetically for some minutes. This may take more than one person
- Place the bottle upright on the table and let the water settle and clear
- Notice how the GALENA fragments will be separated at the bottom of the bottle. The fish tank grit will be lying on top of it and the sand on top of that

Conclusion

The weight of each of the materials will dictate which one falls to the bottom of the mixture first when being shaken up. The heaviest material will fall or SEPARATE to the bottom first. GALENA is therefore the heaviest, followed by the FISH TANK GRIT and finally the sand on the top of the SEPARATED MIXTURE.

On-site Visit Activities

4b KS2 Activity: Finding the Process: Solving the Problem (Separating mixtures and materials)

Lead ore – GALENA - is contained within the rocks at Killhope

- Only when the **Galena** is separated from the rock and smelted (heated to a high temperature) does it become lead
- The process of lead smelting was not carried out at Killhope
- The **Galena** was carried first by pack horses, later by horse and cart and still later on chronologically by traction engine across the hills to the Allenheads, Allendale or Rookhope smelt mills

At Killhope how to extract and separate the 'Galena' from the rock was always the problem to solve

- Across the Killhope Museum site evidence can be found of different ways of doing this. Each process was different but the aims and objectives were the same.
- There was continuous innovation and development in the use of manual, mechanical and water powered processes to separate the galena from the unwanted rock in order to ensure that the extraction and separation process became ever more efficient and cost effective.
- Explore the differences between the different extraction and separation processes. With the help of your **Killhope Information Assistant** you can
    - Start with the earliest - the shallow pits and their horse driven machinery
    - Go next to - the water-based hushing process. Then to the underground mine
    - Next you can visit the Washing Floor and Park Level Mill where large scale operations to separate the galena from the waste rock and other minerals took place
- Investigate what actually happened to the rock and ore from the point at which the horses pulled the tubs of rock and ore out of the mine and was separated on the Washing Floor and at Park Level Mill
- Make records on site to chart and correlate each stage of the manual process on the Washing Floor to the equivalent stage of the mechanical process at Park Level Mill. What was the water doing in each case?

The Killhope Information Assistants will help the pupils in the class to identify the various activities involved in the two large-scale separation processes that were used at Killhope - the Washing Floor and Park Level Mill. They will then invite each child (or small group) to describe the activities involved in each process to the rest of the group in the logical sequence in which they were performed in practice on site. *This will provide the basis for post-visit activities.*

Post-visit Activities

4c KS2 Activity: What Killhope is Really Good at!

What Killhope Is Really Good At!
Dramatised Narrative on the Killhope GALENA Separation Processes

Preparation

- On your recent visit to Killhope Lead Mining Museum your class will have been shown and explored the different historical processes involved in extracting a mixture of GALENA (lead ore) and rock from underground
- Alongside these methods of extraction, you will have been shown two main large-scale methods of separating the valuable GALENA (lead ore) from the worthless rock
- The earlier of these two processes was done out in the open air and entirely manually on the Washing Rake (Washing Floor) by many people using hand tools, hand operated machinery and their own 'muscle power' to separate the GALENA from the rock
- The later of these two processes carried out at Park Level Mill used water power to drive the mechanical devices which replaced some of the separation tasks traditionally done by manual labour
- As a conclusion to this particular section of your visit, some of your children were asked to describe to each other exactly what was going on in the different parts of each process. For example, manually raking the piles of rock and GALENA to separate them over the washing board – the Buddle

What Killhope Is Really Good At!
Dramatised Narrative on the Killhope GALENA Separation Processes

The Creative Activity

1. Discuss and re-cap with the whole class what they can remember about the two GALENA separation processes. Get them to identify, in as much detail as they can, how the Killhope Information Assistant described each part of each separation process as they happened. Start from the point when the tubs loaded with rock and ore were brought out of the mine.

2. Ask the group to decide which of the two separation processes they found the most interesting - the manual or the mechanical?

3. Divide the class into smaller groups.

4. Give each small group one part of the preferred separation process to focus on. Then one person from each small group should be chosen as the Narrator for the action.

5. Give these groups about ten minutes to discuss their part of the process and how they as a group would re-enact it with a narration. *In doing this, they need not necessarily be people who undertake the tasks; they can also creatively portray mechanical devices with attendant sounds.* Do not let the class forget the essence of what they are doing. They are re-enacting the separation process of the valuable GALENA (lead ore) from the worthless rock (deads).

6. Let each group show the others what individual scenarios they have created.

7. Put all the individual scenarios together in sequence and run it as a '*Dramatised Narrative on the Separation Process of Valuable GALENA (lead ore) from the Worthless Rock'.*

8. You may wish to present the whole dramatic narrative to another class in your school which has not yet been on a visit to Killhope Lead Mining Museum

4d Facts and Questions about Lead

- Lead is toxic (poisonous)
- Lead is the softest of all common metals
- Lead is one of the first metals to have been used by humans
- Ancient lead pipes have been discovered in Egypt dating to the time of the Pharaohs, who also used lead in the glazes on their pottery
- Lead has the highest recycling rate of all industrial metals in the world. It is easily re-melted and refined. In the USA about 80% of all lead is used in car lead-acid batteries, and more than 95% of these batteries are recycled
- The benefits of lead sheet are considerable: it is rugged, flexible and long lasting and is attractive to look at
- Lead is indispensable to many industries today because of its
    - Mass
    - Malleability
    - Low melting point
    - Corrosion resistance
    - Electrical properties
    - Long life
- Lead plays a vital role in space exploration, energy conservation and telecommunications.
- Lead is used as a radiation shield
- Lead weights are used by underwater divers
- In the 19th Century lead was used for plumbing inside the house and building materials – roofs, chimney flashing, rainwater pipes, cladding; in paint – red and white lead , glass and pottery glazes
- Lead paint is banned for use today because of its toxic properties. In Tyneside during the 1860s 12,000 tons of red and white lead and paint were sold each year. Red lead (lead oxide) was the standard paint for protecting iron work. White lead (lead carbonate) was the basis of most other paints
- Cable sheathing. Because of its excellent proven corrosion resistance when in contact with a wide range of industrial and marine environments, soils and chemicals, lead was one of the first materials to be used to provide an impervious sheath on electric cables

Questions and Issues to Explore

1. Is lead an environmentally friendly product?

2. Discuss the changes to the landscape as a result of lead mining.

3. Discuss the issues relating to the recycling of products that contain lead.

4. Find out more about lead in space exploration.

5. Find out what materials have replaced lead in the home.

6. Why is lead still used today when it is poisonous?

7. Where is lead mined today?