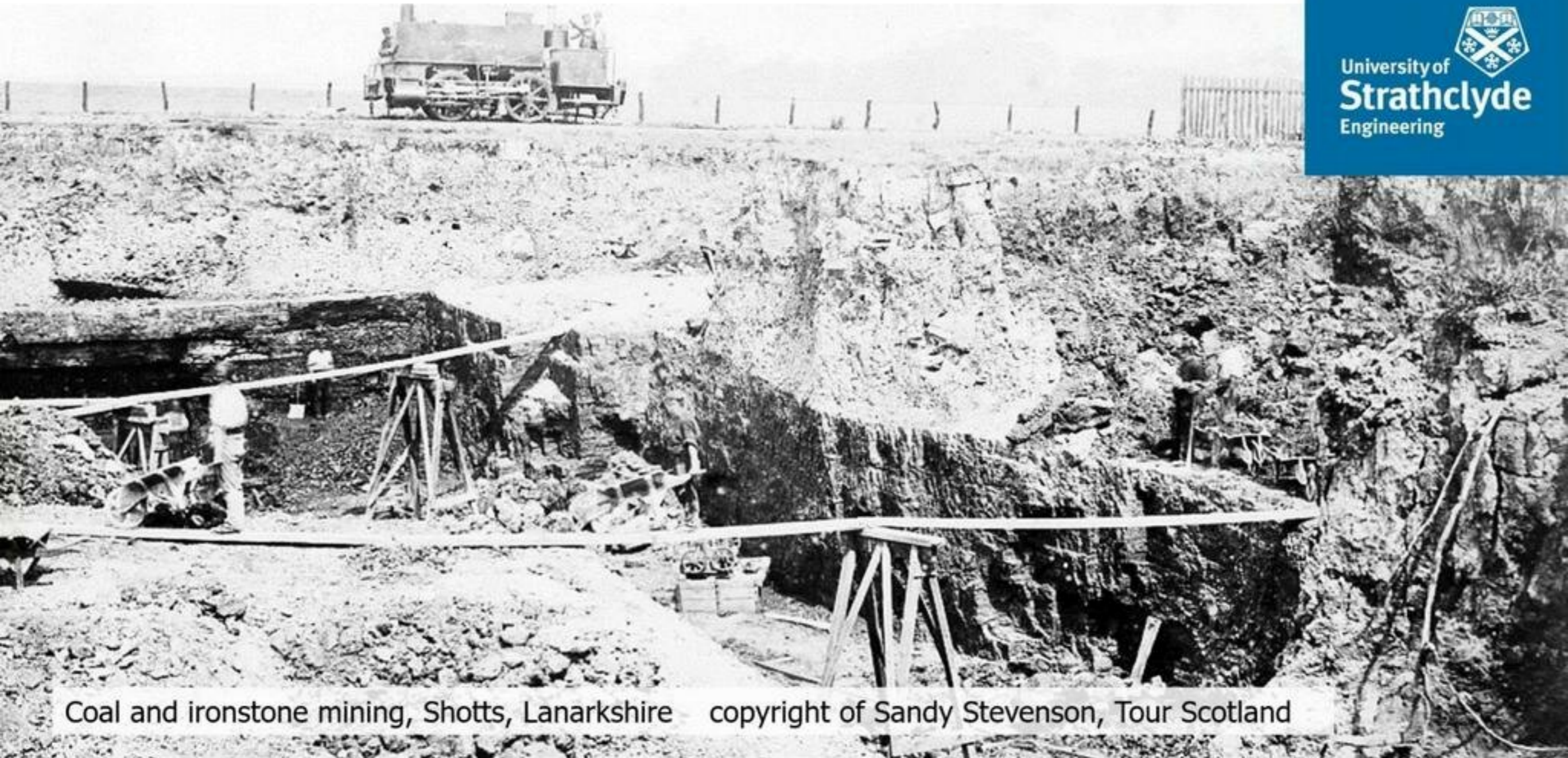


Presentation outline



Coal and ironstone mining, Shotts, Lanarkshire copyright of Sandy Stevenson, Tour Scotland

Presentation outline

- Overview
- Coal, limestone, clay, and ironstone mining
- Geotechnical impacts
- Burning bings
- Historical metal mining in Scotland
- Environmental impacts

The impact of mining on land condition

Geotechnical Impacts

- Subsidence
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- Groundwater flow
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- Fault reactivation
- Waste material, e.g. bings

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- Ground gas potential
- Impacts to ground water
- Acid rock drainage
- Impacts to surface water
- Soil contamination

Other considerations

- “ If you dig a hole in the ground, someone will use it to dump waste”
- Protected species; e.g. bats
- SSSI and Scheduled Ancient Monuments



Coal Mining

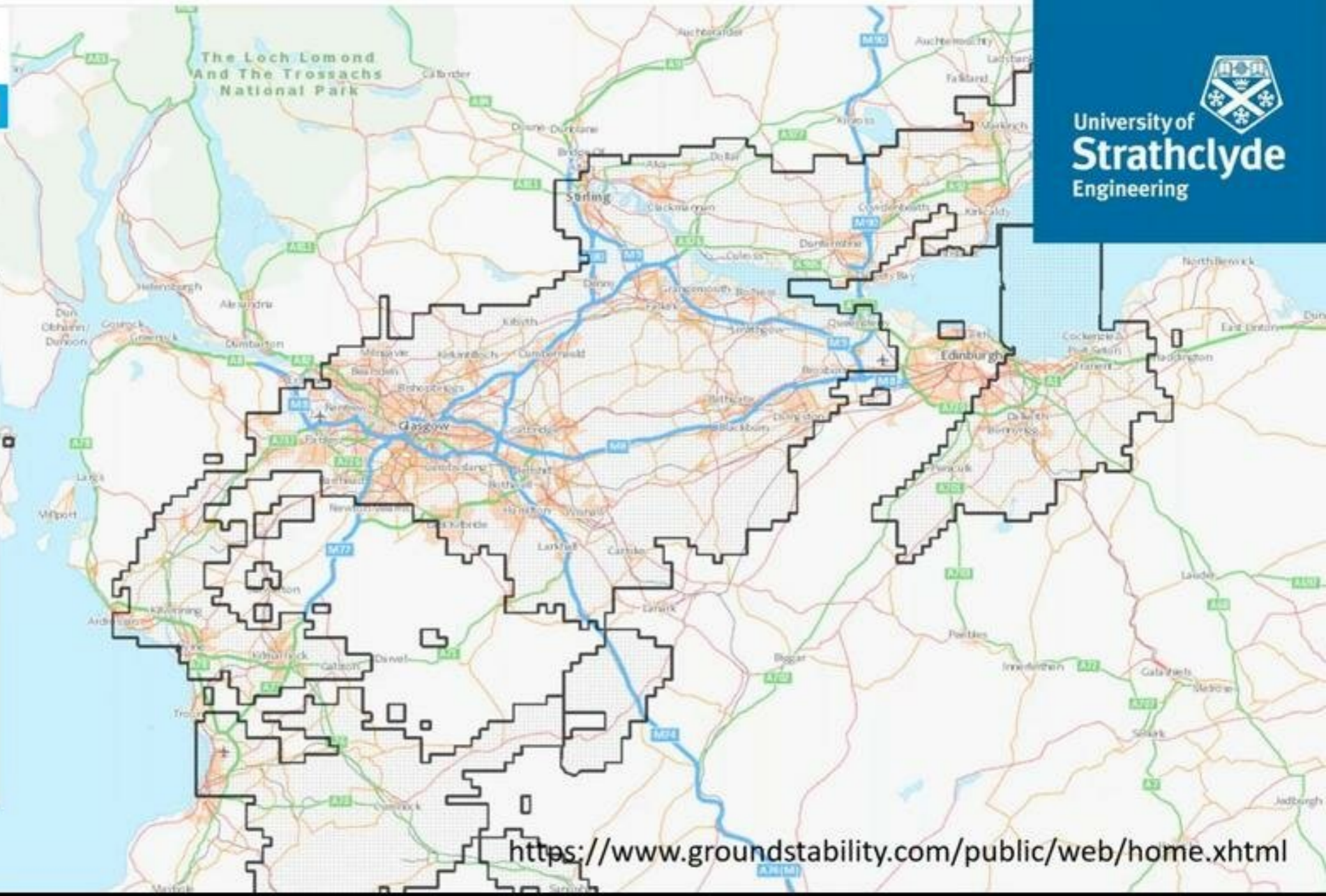
Enviro All-in-One
Residential search report

Specimen Address, Specimen Town

Summary of risks identified

| | | |
|--|---|--|
|  | Known coal or gas-bearing strata within the property area | Further action |
|  | The property may have potential for natural or man-made ground subsidence | Identified |
|  | The property could be investigated further as potentially contaminated land | Action Required |
|  | The property is considered to have a risk of flooding | High |
|  | The property lies within a Radon affected area | Identified |
|  | Identified | Full assessments for these risks are available in other Groundsure searches including the Groundsure Bricks T in 3 report. Contact Groundsure or your search provider for further details. |
|  | Identified | |
|  | Identified | |

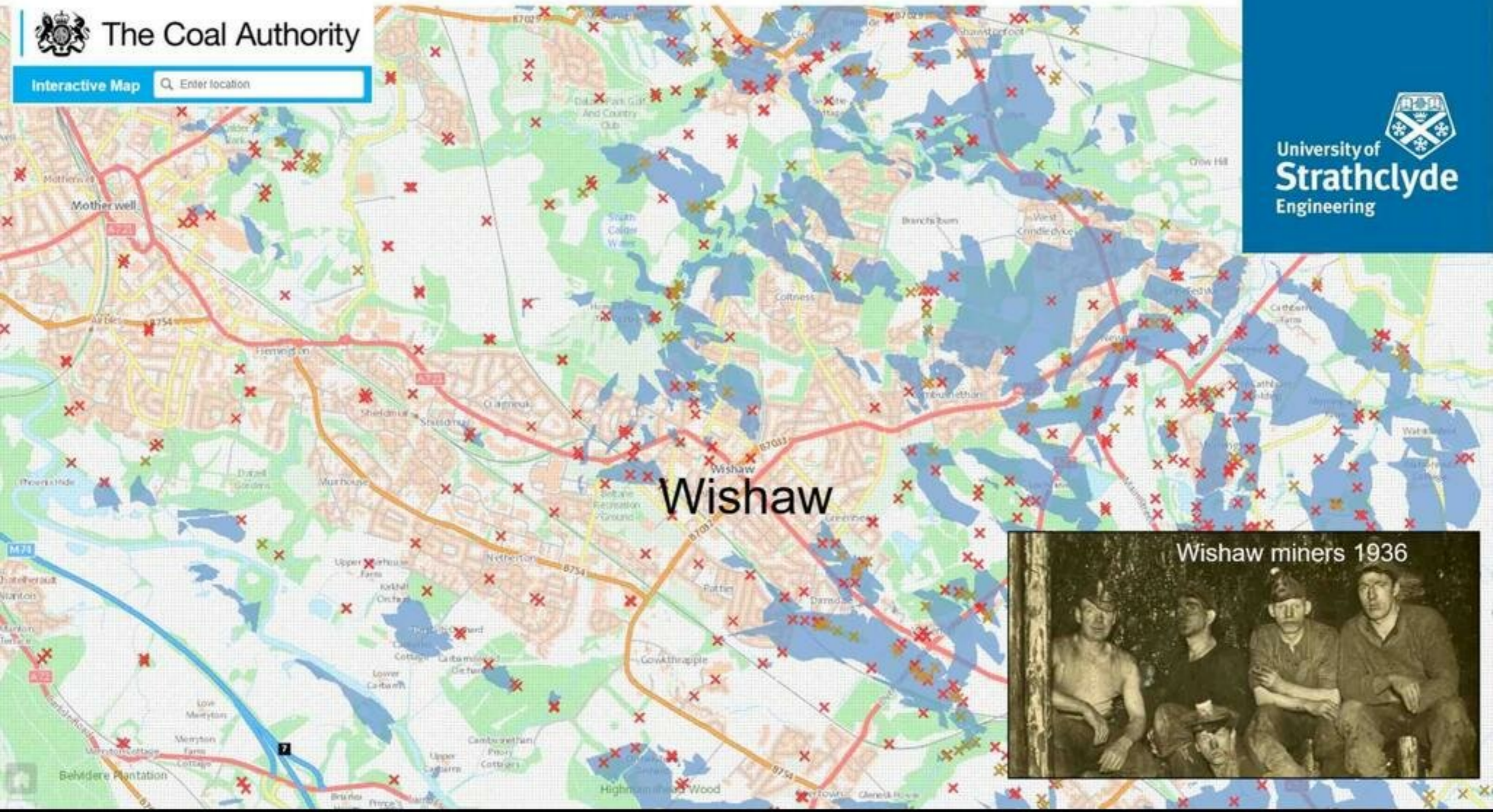
It is important to be fully informed of all risks associated with a property before completing your purchase. Please read all the information in this report carefully.





The Coal Authority

Interactive Map



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Strathclyde
Engineering



Wishaw miners 1936

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Sinkhole in Midlothian above Roslin Colliery, 2019, STV News

Subsidence

- Shallow workings
- Shafts and adits
- Air holes
- Void Migration

27th October 2012

Half of Glasgow homes at risk from disused mines

By Judy Harrold



WEDNACE: Homeowners in Jordanhill have been asked to pay £3000 toward filling in an old mine, a roofstone from which is held by historian Brian Walker above. STV/STV News. The secret behind the story yesterday.

Glasgow Herald, 2012

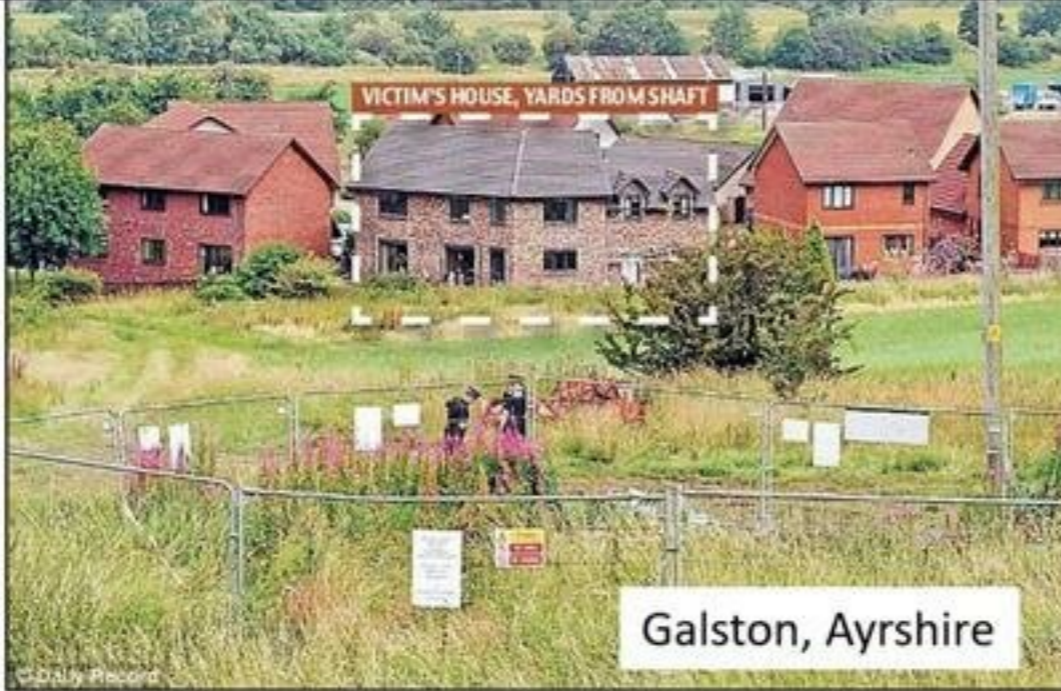
HALF of Scotland's largest city is affected by disused mine workings that have been left over from its industrial past, say geologists.

A survey commissioned by Glasgow City Council, which has embarked on a major project to fill in the disused shafts, has mapped out the extent to which areas of the city are undermined.

The 2008 Galston Mine Incident

The Scottish Government
response to the HM Fire Service
Inspectorate Report

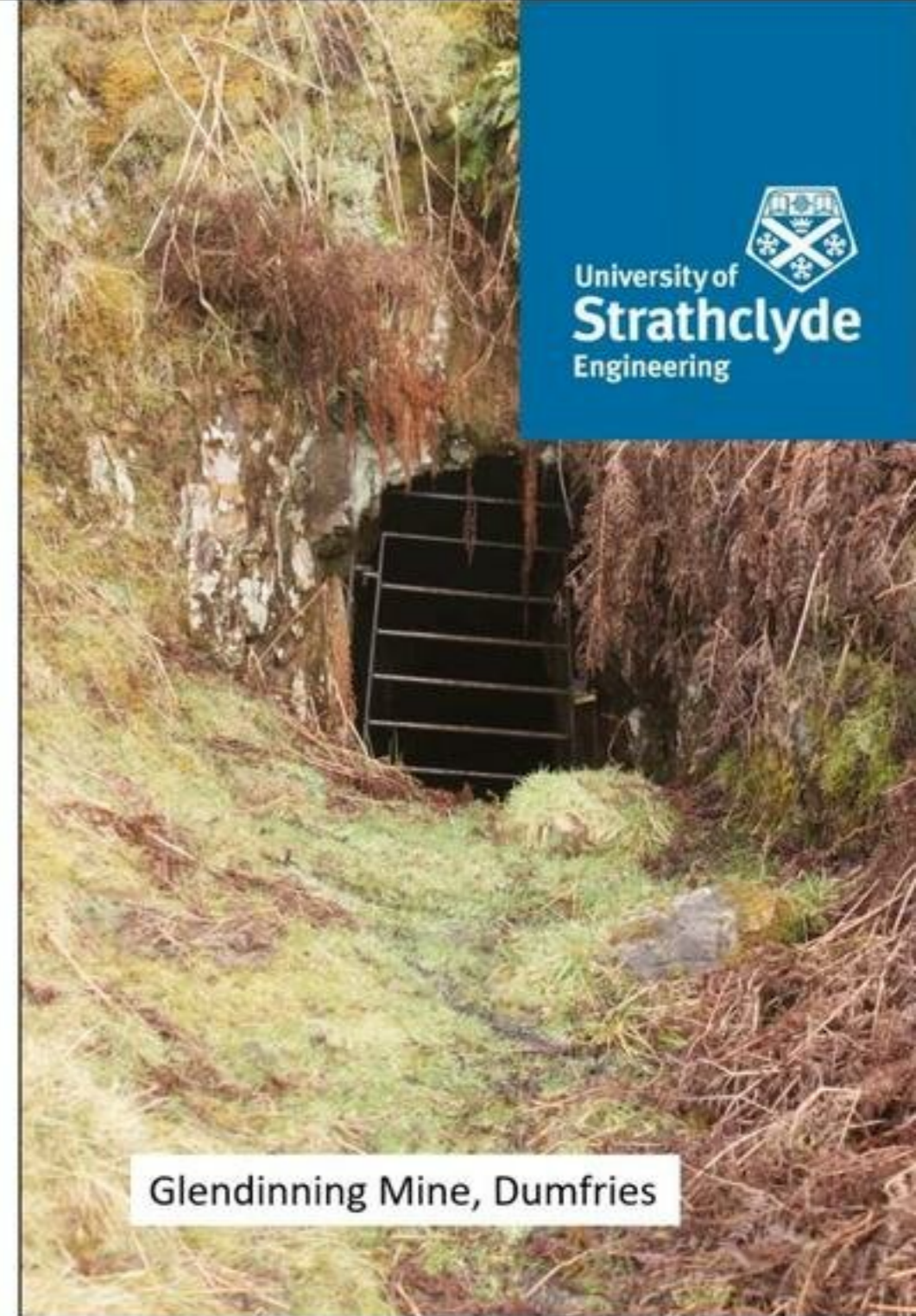
October 2012



Galston, Ayrshire



Derbyshire



Glendinning Mine, Dumfries

300m mineshaft – Scorrier, Cornwall, 2016

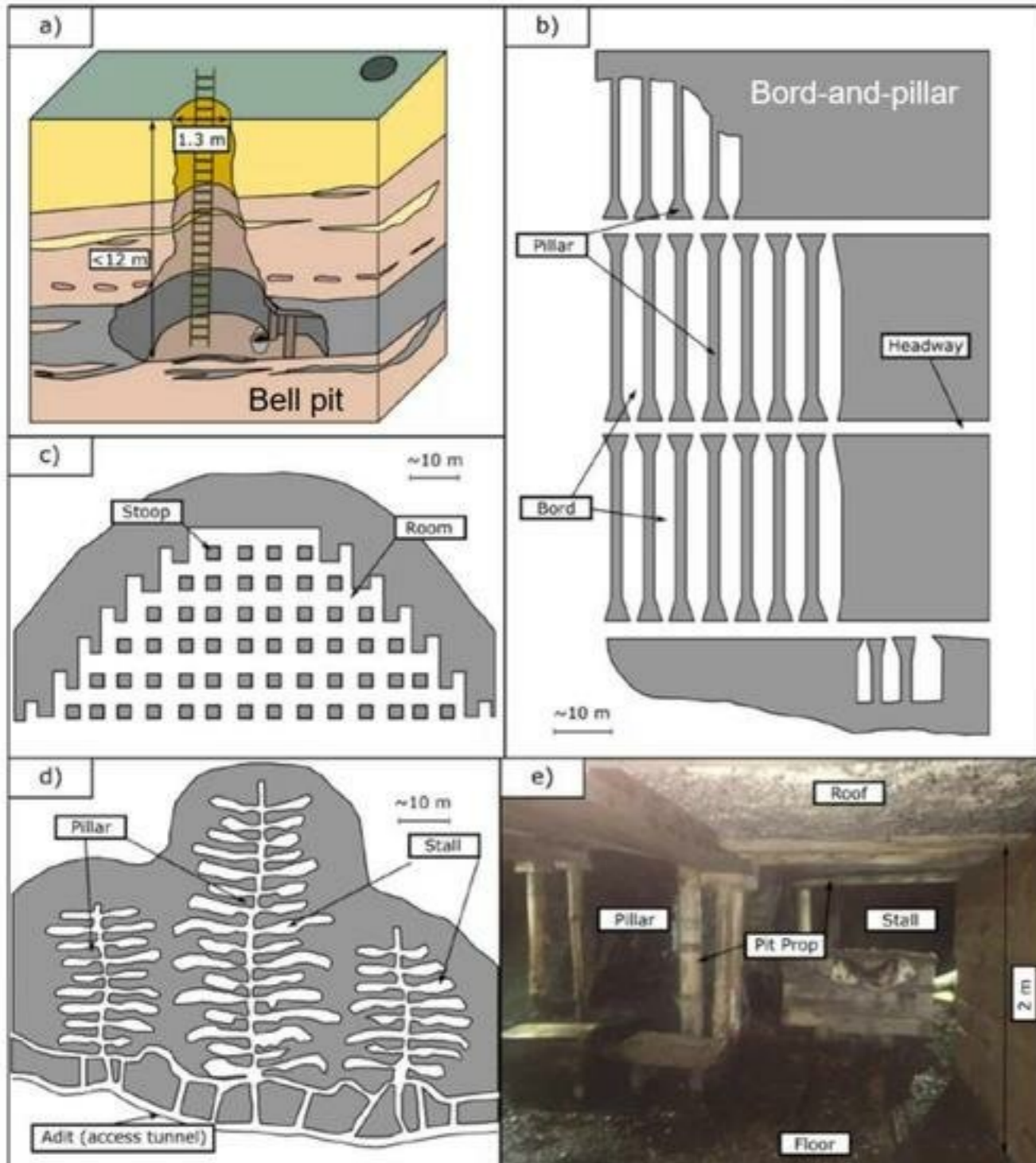




Major subsidence through chalk mine crown hole collapse, Field Road, Reading, Berkshire (photo credit: Clive Edmonds).

Void Migration





Typical UK shallow mining methods. (b) to (d) plan view pillar and stall mining methods to show regional variations in terminology and layout. (b, c and d redrawn from Bruyn and Bell (1999) a) bell pit, b) Bord-and-pillar workings, Newcastle upon Tyne (17th Century), c) Stoop and room workings, Scotland (17th Century), d) Pillar and stall workings, South Wales (17th Century), e) Photograph of pillar and stall workings, Beamish open air museum.



Contents lists available at ScienceDirect

Geothermics

journal homepage: www.elsevier.com/locate/geothermics



Collapse processes in abandoned pillar and stall coal mines: Implications for shallow mine geothermal energy

Billy J. Andrews^{a,*}, Zoë A. Cumberpatch^b, Zoe K. Shipton^a, Richard Lord^a

^a Department of Civil and Environmental Engineering, University of Strathclyde, Glasgow, G11XJ, United Kingdom

^b Department of Earth and Environmental Sciences, University of Manchester, Manchester, M13 9QQ, United Kingdom



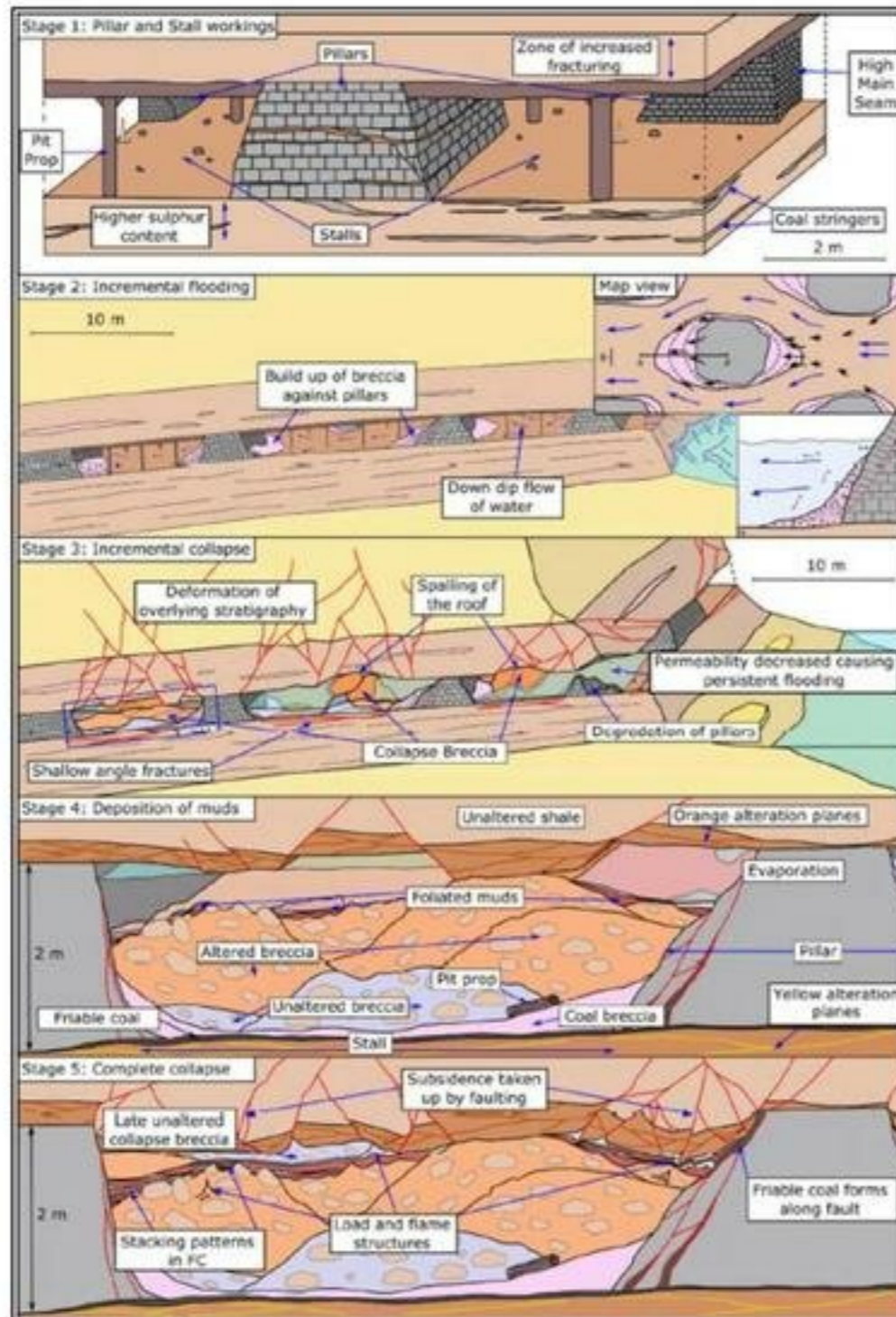
19th century stoop and room workings - Stony Heap Mine



https://www.aditnow.co.uk/Album/Photographs-Of-Stoney-Heap_5400/

Conceptual evolutionary model of the collapse of pillar and stall mine workings, based on Whitley Bay Northumberland

- Permeability of collapsed mine workings is degraded over time



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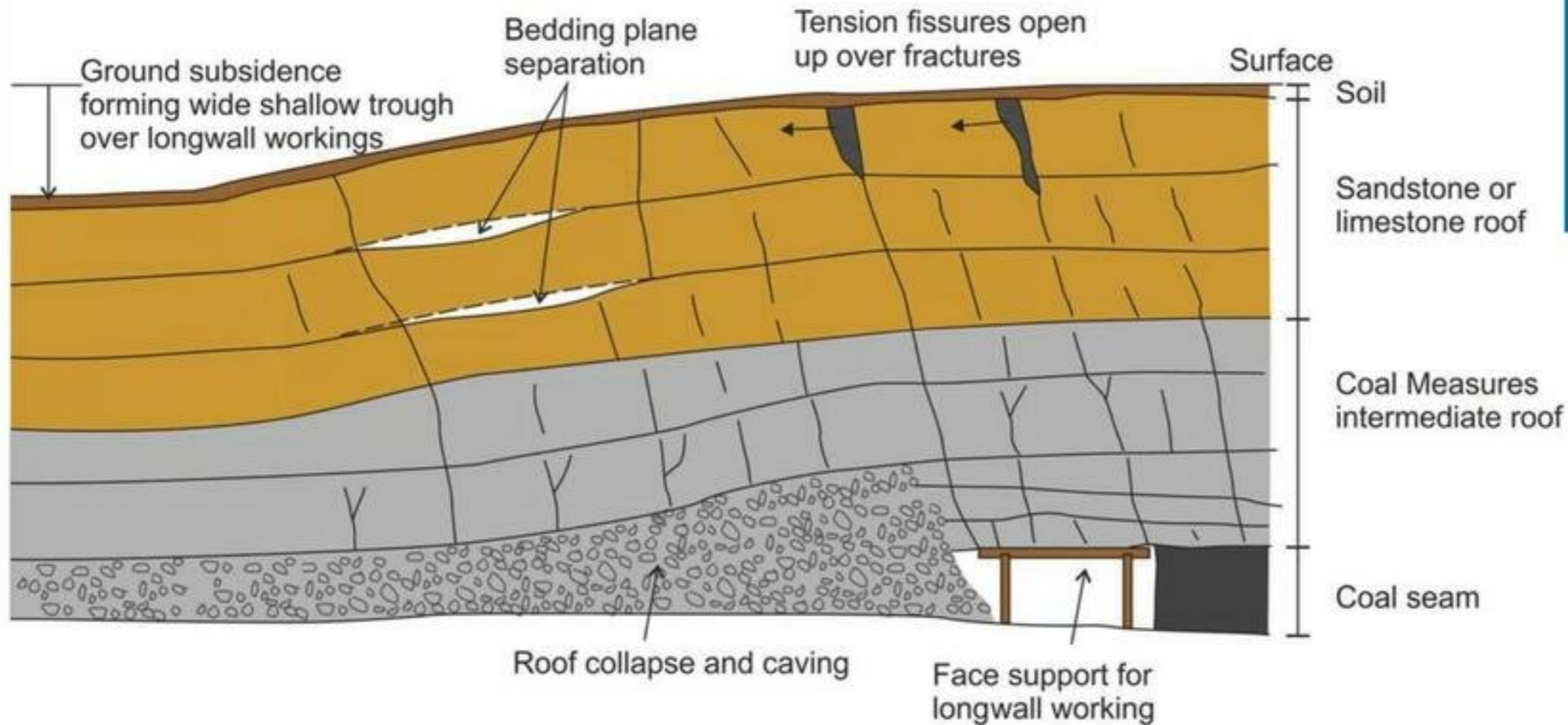


Longwall mining



Longwall mining machinery in a Colorado coal mine. Image credit: Peabody Energy, Inc.

Collapsing strata over longwall workings

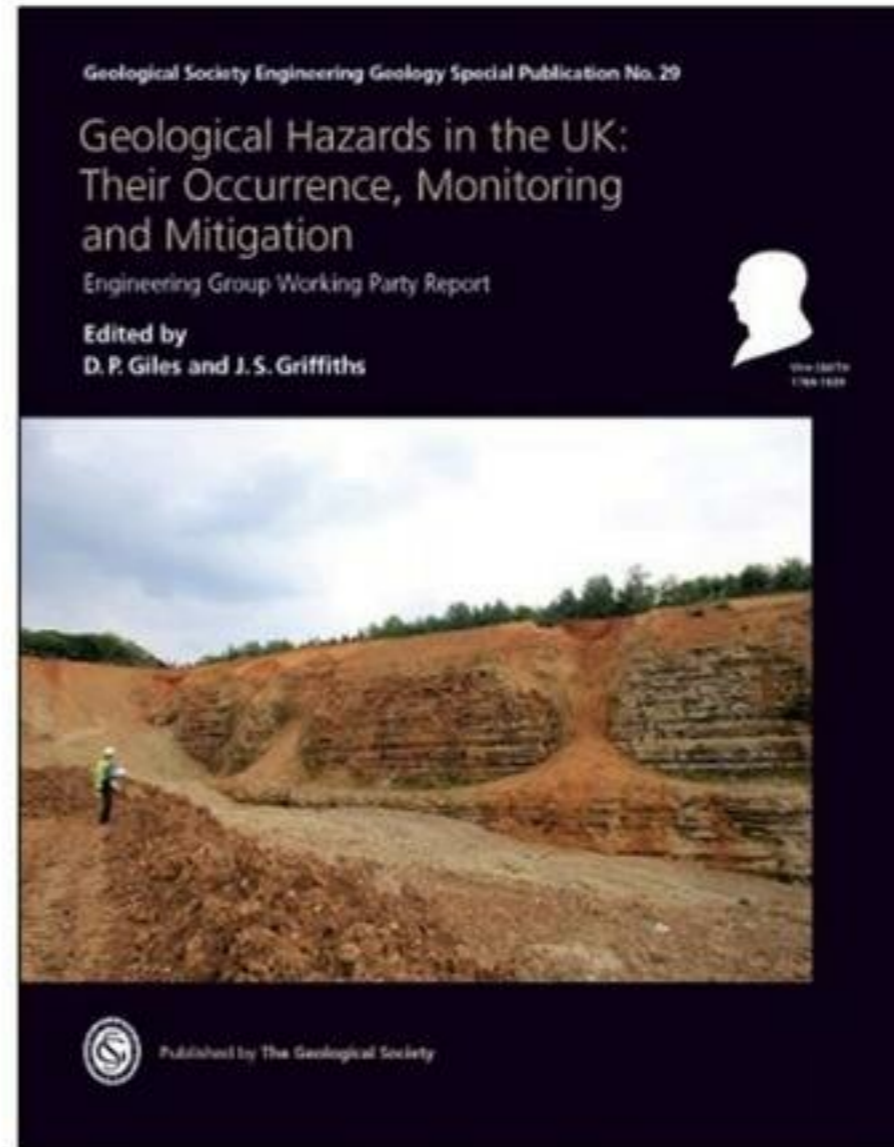
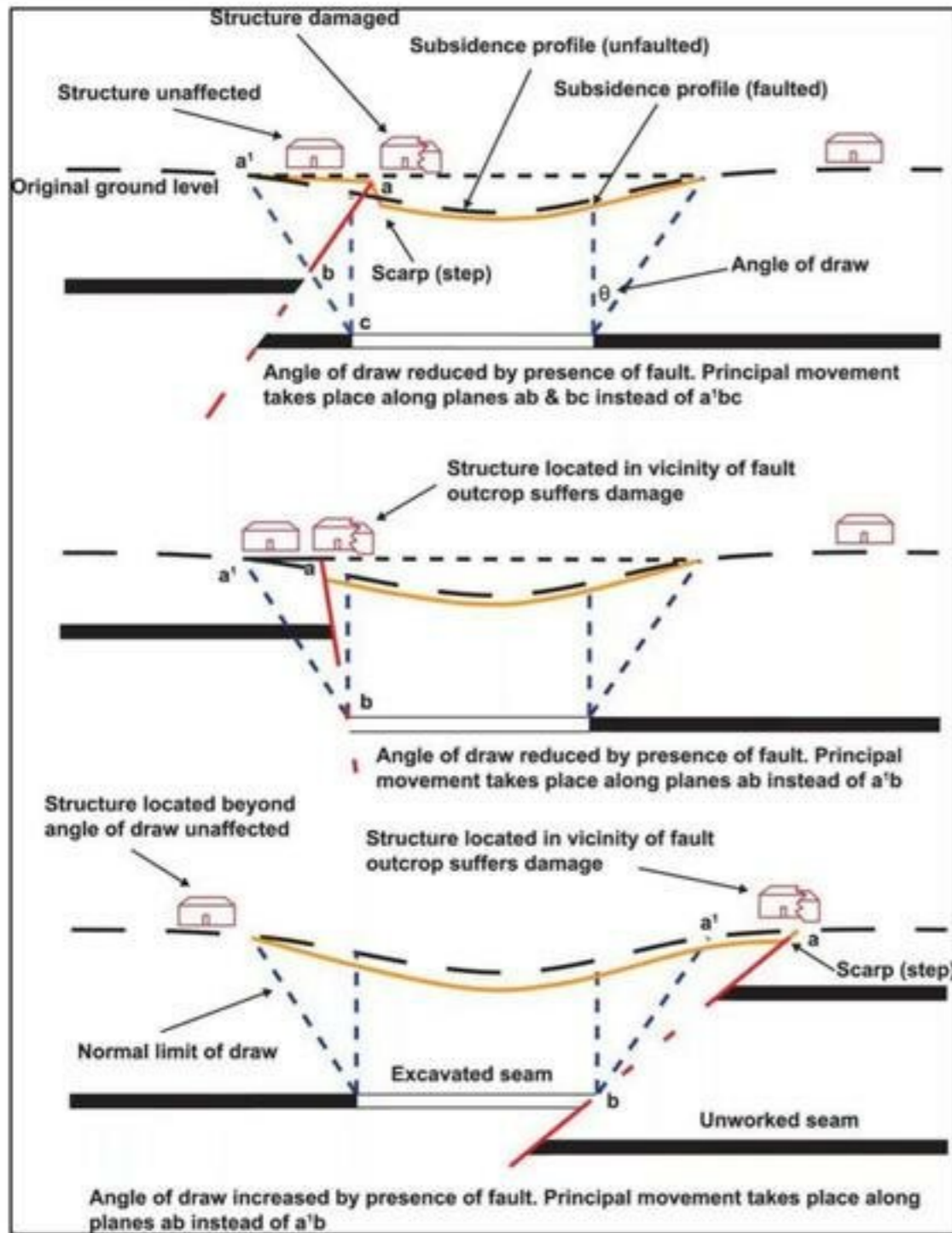


Five decades of settlement and subsidence, Clive Edmonds
Quarterly Journal of Engineering Geology and Hydrogeology, 51, 403-416, 23 October 2018,
<https://doi.org/10.1144/qjegh2018-089>



A tension fissure developed in sandstone cover rocks above mined Coal Measures at Mynydd James, Abertillery, South Wales. Reproduced by permission of Peter Brett Associates LLP.

Five decades of settlement and subsidence, Clive Edmonds
Quarterly Journal of Engineering Geology and Hydrogeology, 51, 403-416, 23 October 2018,
<https://doi.org/10.1144/qjegh2018-089>



The influence of faults on mining subsidence and the angle-of-draw. Donnelly (2020)

The impact of mining on land condition

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Ground Gas



Carbon dioxide ingress – Gorebridge,
Midlothian

- Methane and carbon dioxide from former coal workings
- Radon associated some with tin and gold mining
- BS 8576:2013
- Vapour barriers

Impacts to Surface Water Quality



Discharge from abandoned coal mine, Jackson Bridge, West Yorkshire in Feb 2014 and 6km downstream (photos by Environment Agency); the pollution was visible up to 60km downstream. Normally the river is orange for 5km but after heavy rainfall, there was a severe 'blowout'.



Coal bings; spontaneous combustion

Bogside bing, South Lanarkshire, 2011

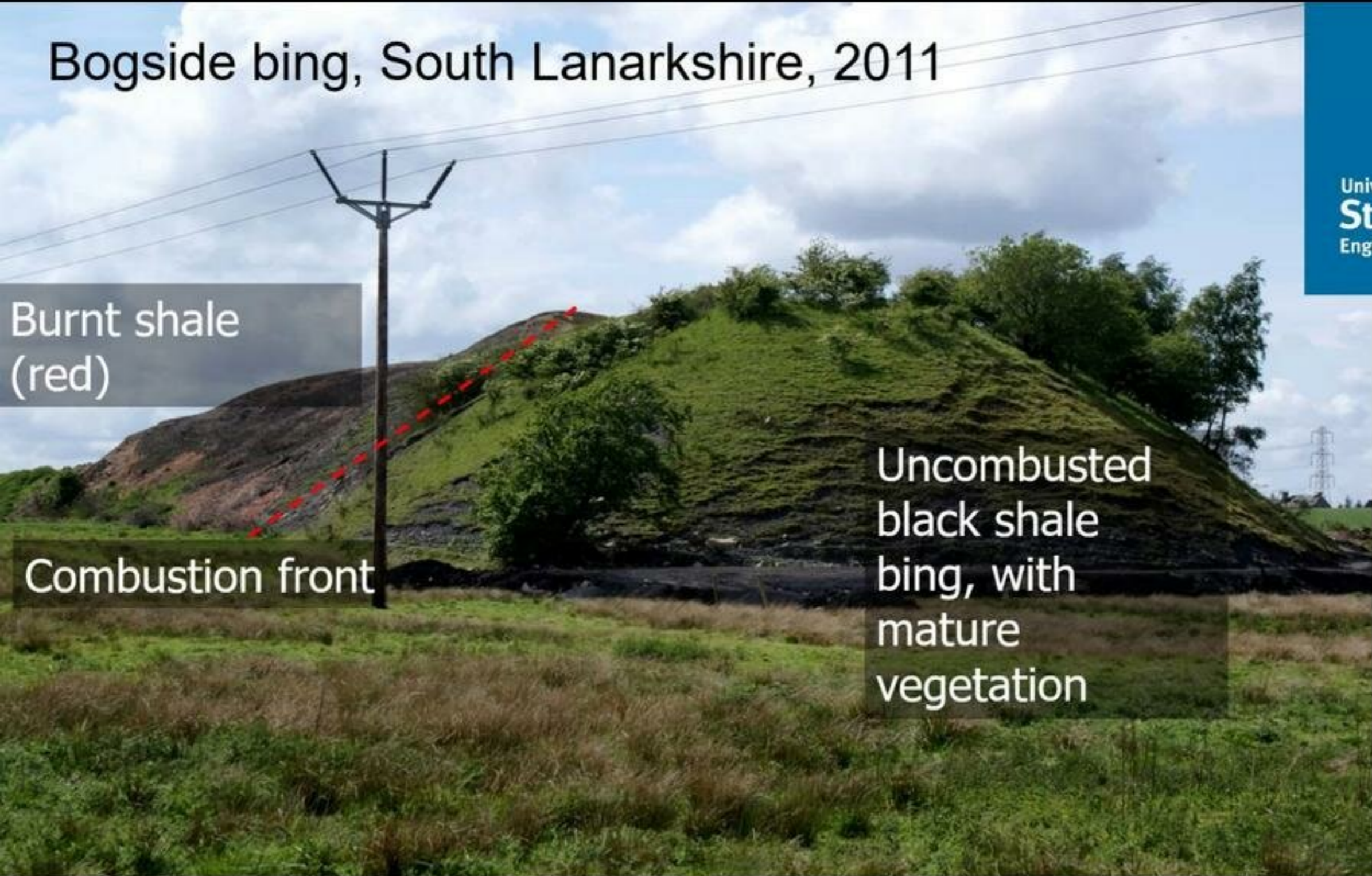


Bogside bing, South Lanarkshire, 2011

Burnt shale
(red)

Combustion front

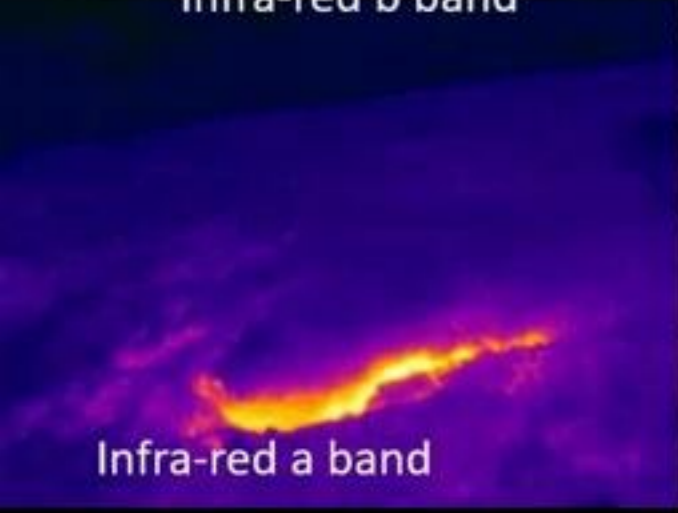
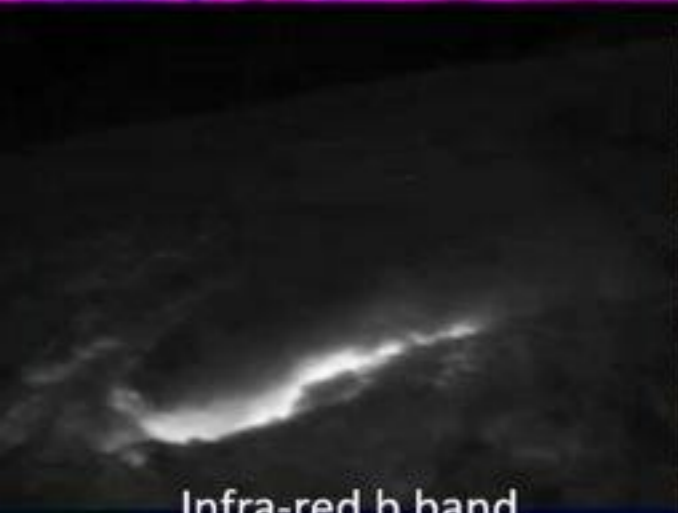
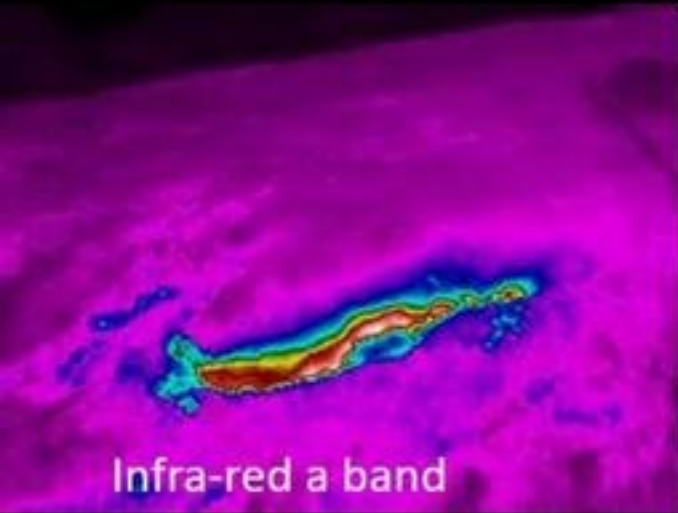
Uncombusted
black shale
bing, with
mature
vegetation



Pre-combustion—coal waste, with carbonaceous shales

| | Moisture | Carbon | Color |
|------|----------|--------|-------|
| BOG1 | 5.7% | 9.54% | Black |





COAL AND PEAT FIRES
A Global Perspective
VOLUME 2
PHOTOGRAPHS AND MULTIMEDIA TOURS
Edited by
GLENN B. STRACHER, ANUPMA PRAKASH,
ELLINA V. SOKOL

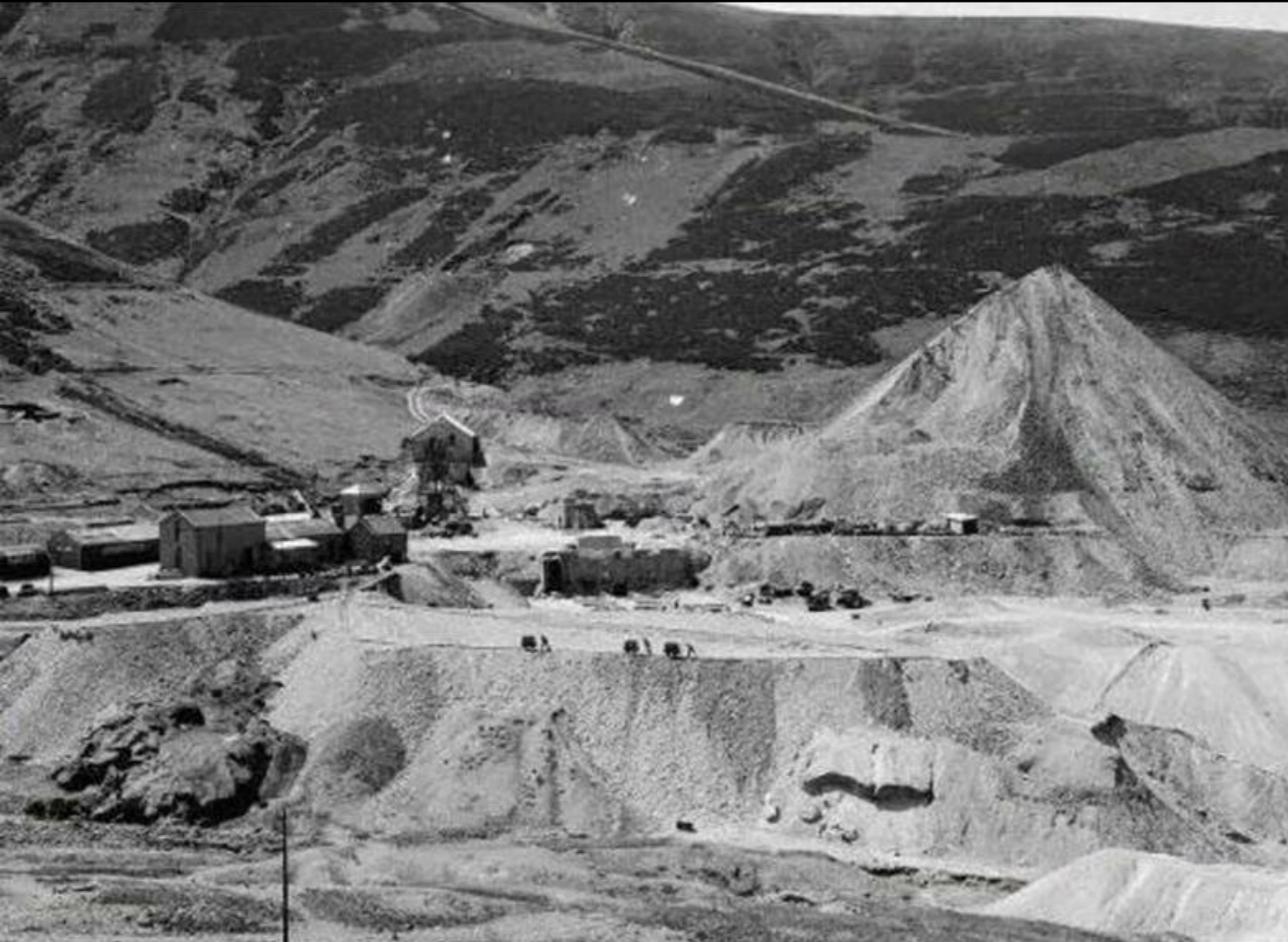
Southfield Bing, Lanarkshire, 2012





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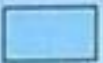





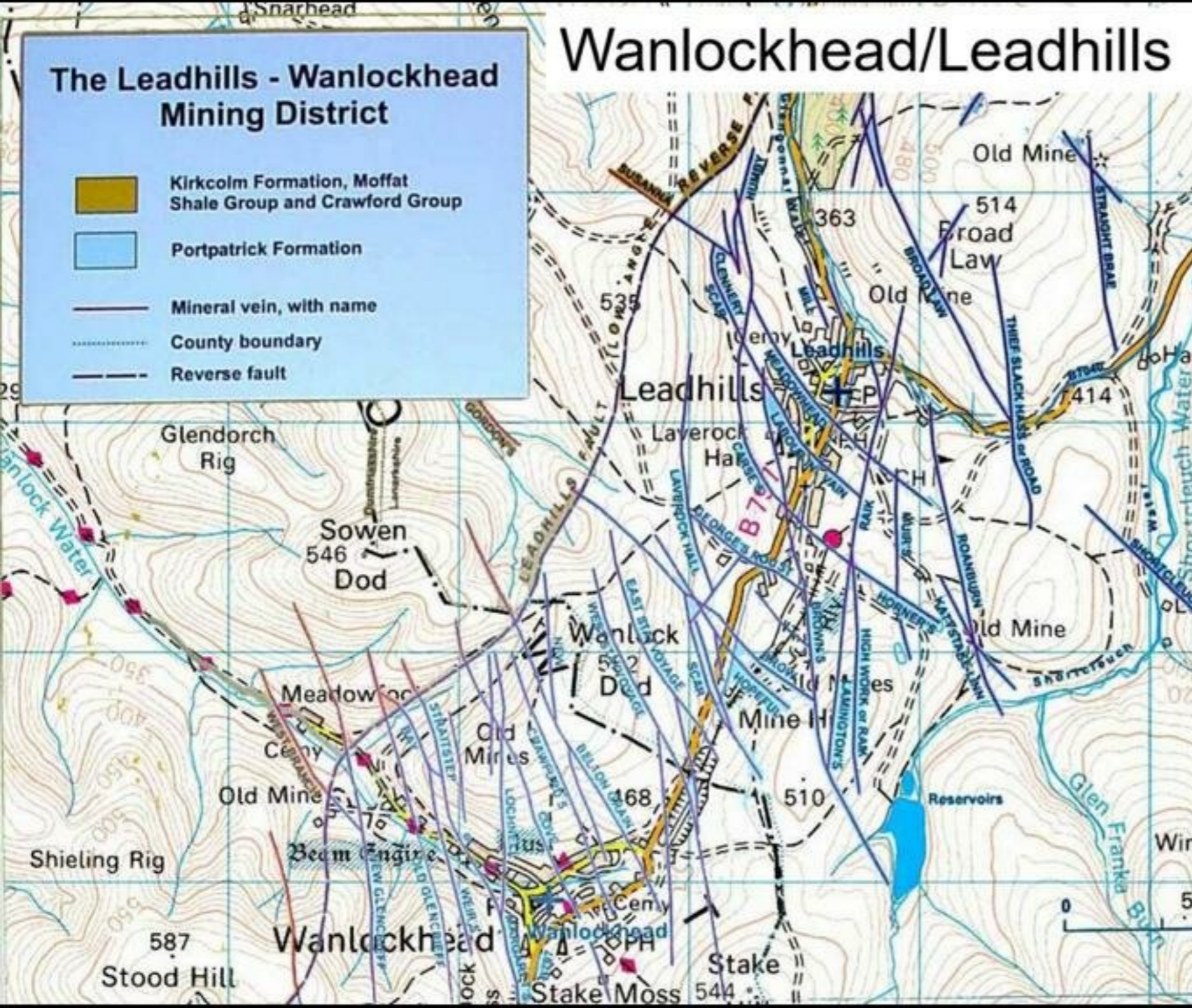


Historical Metal Mining in Scotland

Wanlockhead/Leadhills

The Leadhills - Wanlockhead Mining District

-  Kirkcolm Formation, Moffat Shale Group and Crawford Group
-  Portpatrick Formation
-  Mineral vein, with name
-  County boundary
-  Reverse fault



- Active from 1700 until 1958.
- Lead, zinc, & silver.
- Some alluvial gold.
- Hazardous levels of Pb, Zn, and Cd in tailing ponds that is impacting surface water

Wanlockhead, 1930s



Evaluating controls on potentially toxic element release in circum-neutral mine water: a case study from the abandoned Pb–Zn mines of Leadhills and Wanlockhead, South of Scotland, United Kingdom

[Uche O. Chukwura](#) & [Andrew S. Hursthouse](#)

Environmental Earth Sciences **79**, Article number: 363 (2020) | [Cite this article](#)

431 Accesses | 2 Altmetric | [Metrics](#)



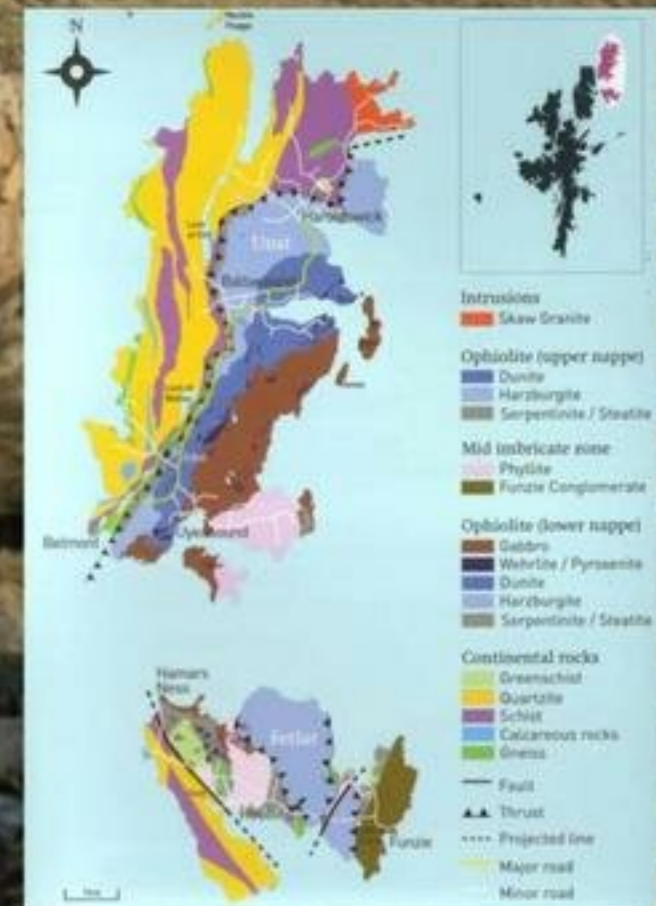
Middleshop Lead Mine – Strontian, Argyll



Chromite mining, Unst, Shetland

- Chromite was mined in Unst from 1824 until 1945
- A wedge of ophiolite (oceanic crust) of Ordovician age, with pillow lavas and ultramafic rocks. Chromite occurs as pods within dunites.
- PGE are enriched (Pt & Pd 100 ppm).
- Exploration drilling in 1980's by ESSO.

Horse-powered chromite ore crushing circle (restored)

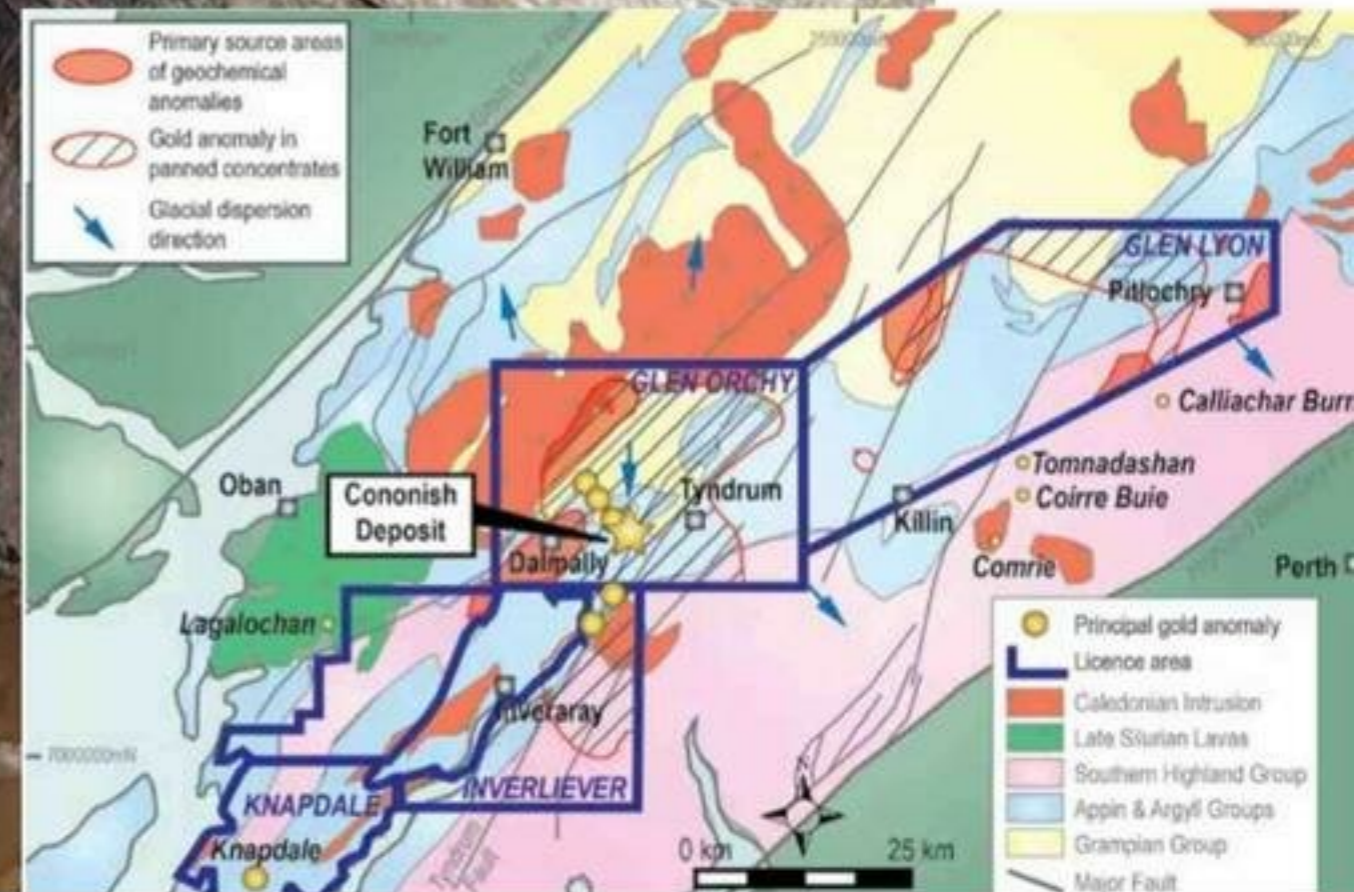


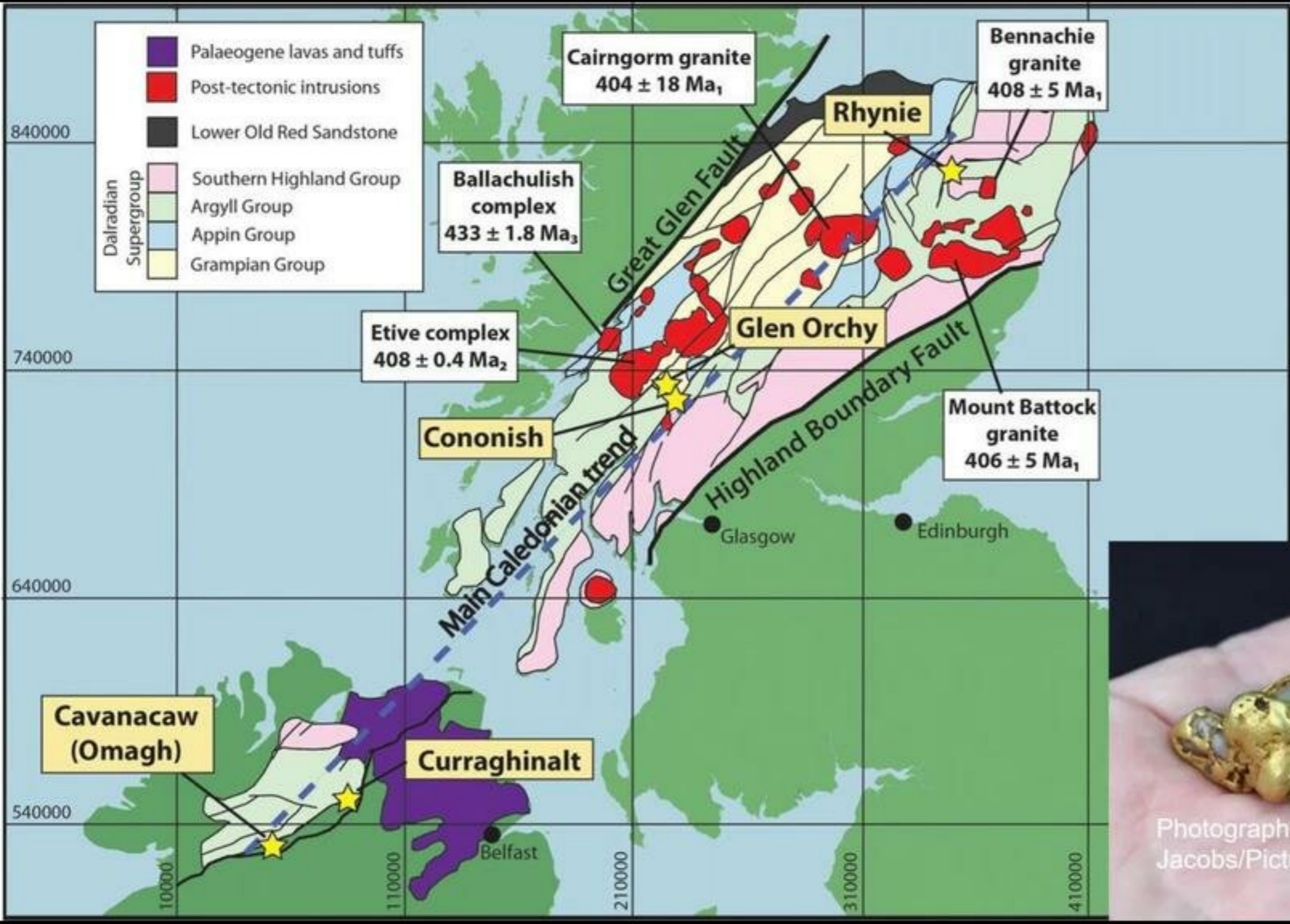
Raasay iron ore mine



- Lower Jurassic age
- Oolites are composed of siderite, chamosite, and goethite

Cononish gold project, Tyndrum







Former uranium mine, Viseau, Portugal

Surface Water Quality – metal mining

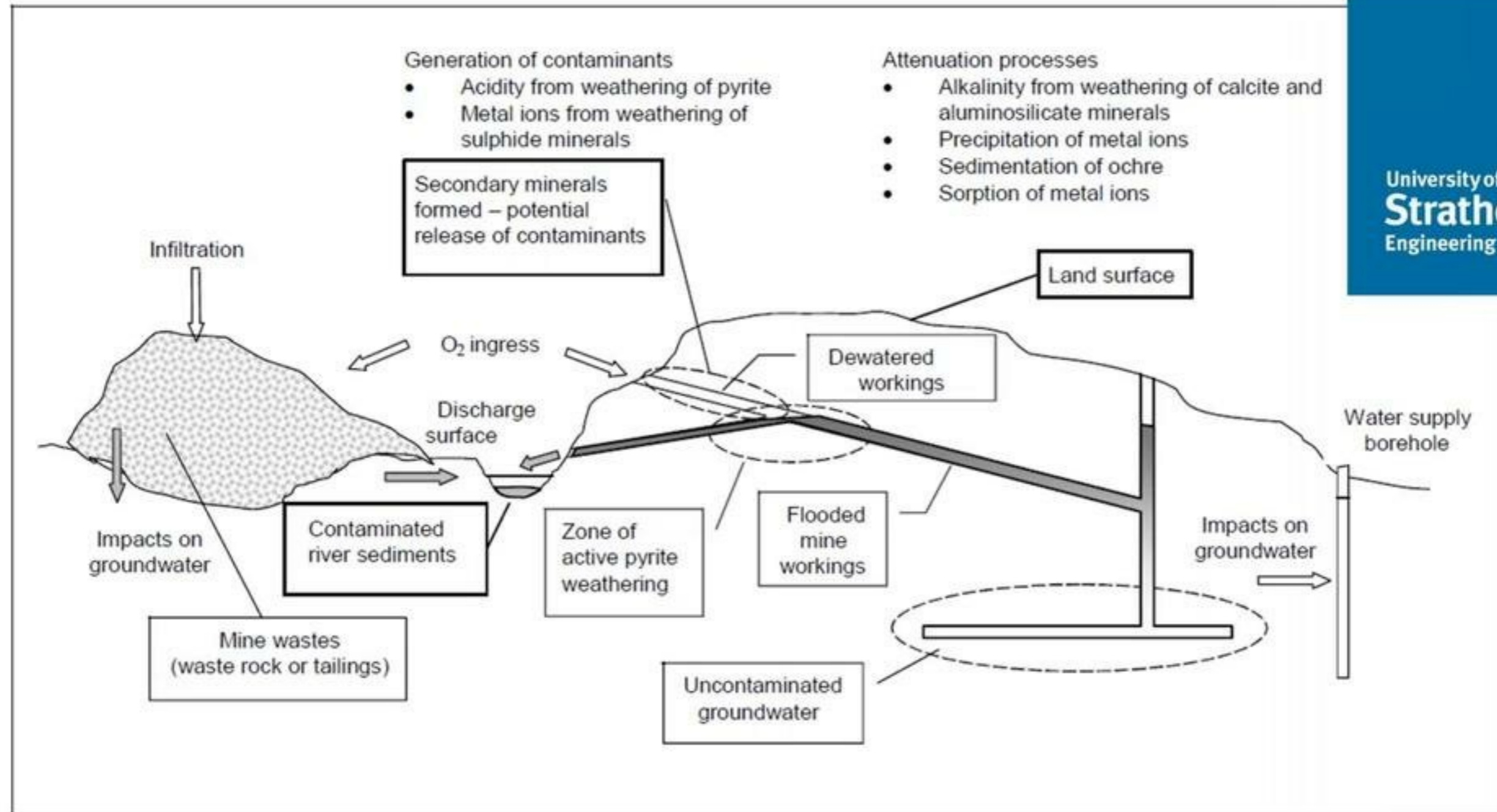


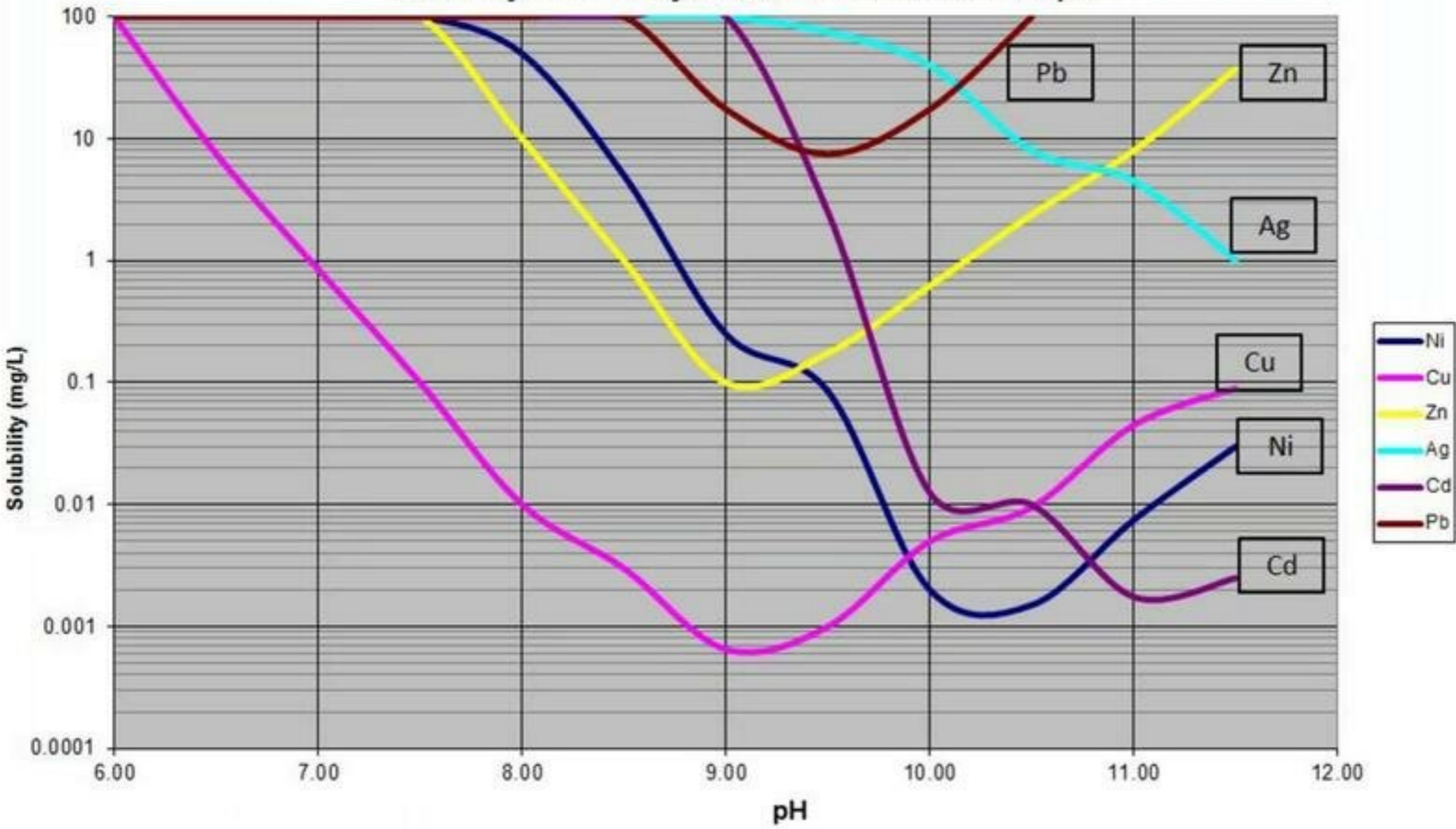
Figure 2.1: Sources and pathways of mine pollution (from Younger *et al.* 2002)

- Surface water impacted by groundwater discharge *and*
- Erosion of tailing material exacerbated by lack of vegetation

Central Wales Orefield – Pb, Zn, Ag, Cu



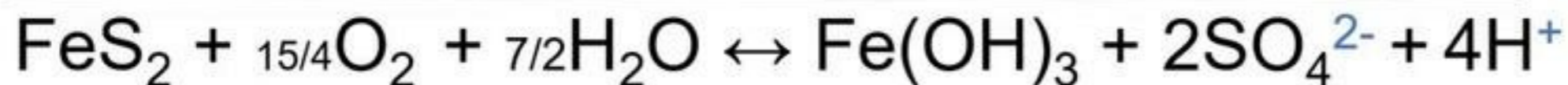
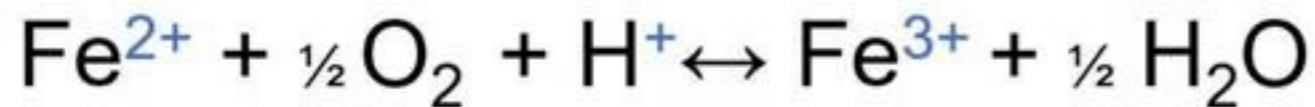
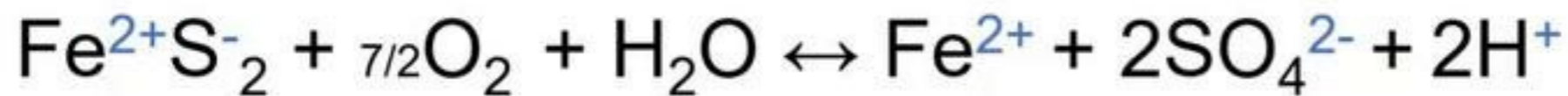
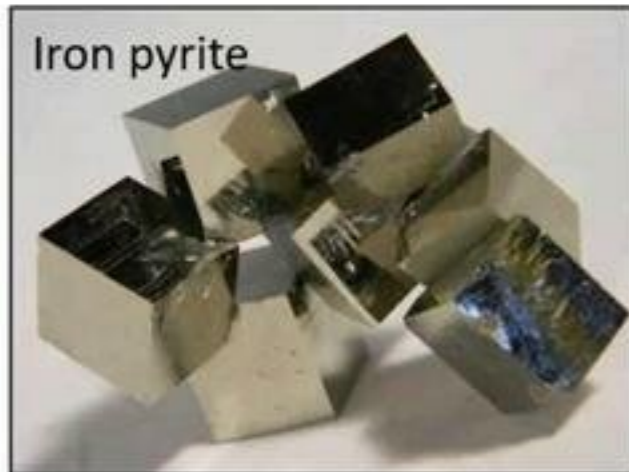
Solubility of Metal Hydroxides as a Function of pH



Acid Rock Drainage



Oxidation of Iron Sulfide (FeS₂)



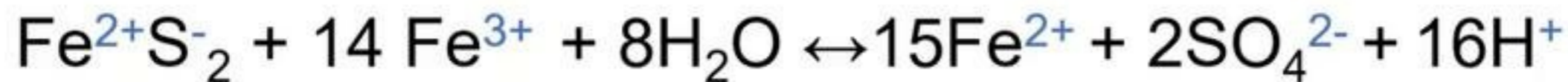
pyrite

ferric hydroxide

sulfuric acid

Oxidation of (FeS₂) in absence of O₂

The oxidation of pyrite can also take place in the absence of oxygen by the action of Fe³⁺ which serves as the electron acceptor:



The Fe³⁺ required for this reaction is provided by the oxidation of Fe²⁺ and by the dissolution of solid Fe(OH)₃

Artisanal gold mining - Colombia



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The impact of mining on land condition

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- Protected species; e.g. bats
- Scheduled Ancient Monuments, SSSI



Cwmystwyth Mine

- Site of Special Scientific Interest (SSSI)
- Scheduled Ancient Monument

Summary: the impact of mining on land condition

| | Subsidence risk | Ground Gas | ARD potential | GW impacts | SW Impacts | Soil Contaminants | Other considerations |
|--------------------------|------------------------|--|----------------------|-------------------|--------------------------|--------------------------|------------------------------------|
| Coal | High | High CO ₂ , CH ₄ | Moderate | Severe | Moderate - severe | Fe, Se | Combustion |
| Clay | Moderate | | Low | Low | Low | - | Waste disposal in former pits |
| Iron ore | Moderate | | Moderate | Moderate | Moderate | F, As | |
| Limestone | Moderate | | Low | Low | Low | - | |
| Oil shale | Low | Low | Low | Moderate | High | PAHs | |
| Lead/zinc | Low | | High | Severe | Severe | Pb, Zn, Sb, As, Cd | |
| Gold, copper, tin | Low | Low (Rn) | Moderate | High | High | As, Cu, Zn, Sn | Hg, cyanide use in gold extraction |

Guidance



Abandoned mine workings manual



Abandoned mines and the water environment

Science project SC030136-41



Product code: SCH005086NZS-E-P

Treatment of Disused Lead Mine Shafts: A Guide to Good Practice



⏸ Pause sharing

Share something else ▾

Drawing Tools ▾