

Gold mineralization in Scotland: a rough guide for goldpanners

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Introduction

Over the past 20 years recreational gold panning has enjoyed its most popular period. Amateur prospectors have contributed significantly to our knowledge of gold occurrences, and often they use some geological features to guide their prospecting. However gold occurs in a variety of geological environments, and an understanding of these could assist the choice of sampling site. The purpose of this poster is to briefly describe these different styles of gold mineralization and to relate them to well known panning localities. The reasons for some well known compositional characteristics of gold from some localities can be explained in terms of their origins.

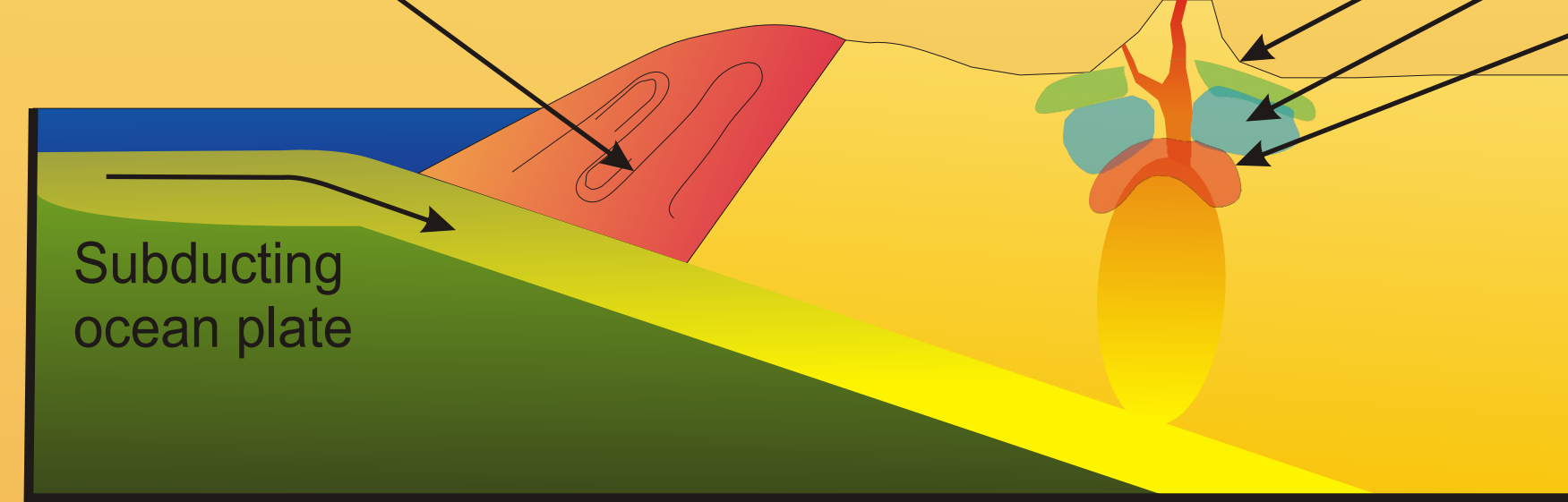
Origin of Gold Mineralization in Scotland

With the exception of the small gold occurrences on Shetland, all gold in Scotland was formed by a hydrothermal (literally hot water) process. Hydrothermal gold mineralization requires the pre-existing low gold concentrations in a rock to be leached by a solution in which gold is soluble, and for those solutions to be focussed in a small volume before changes in the chemical environment cause the gold to precipitate. This series of events occurs in a variety of different geological environments, each of which generates a different **style** of gold mineralization. The most important geological settings are shown in the diagram below.

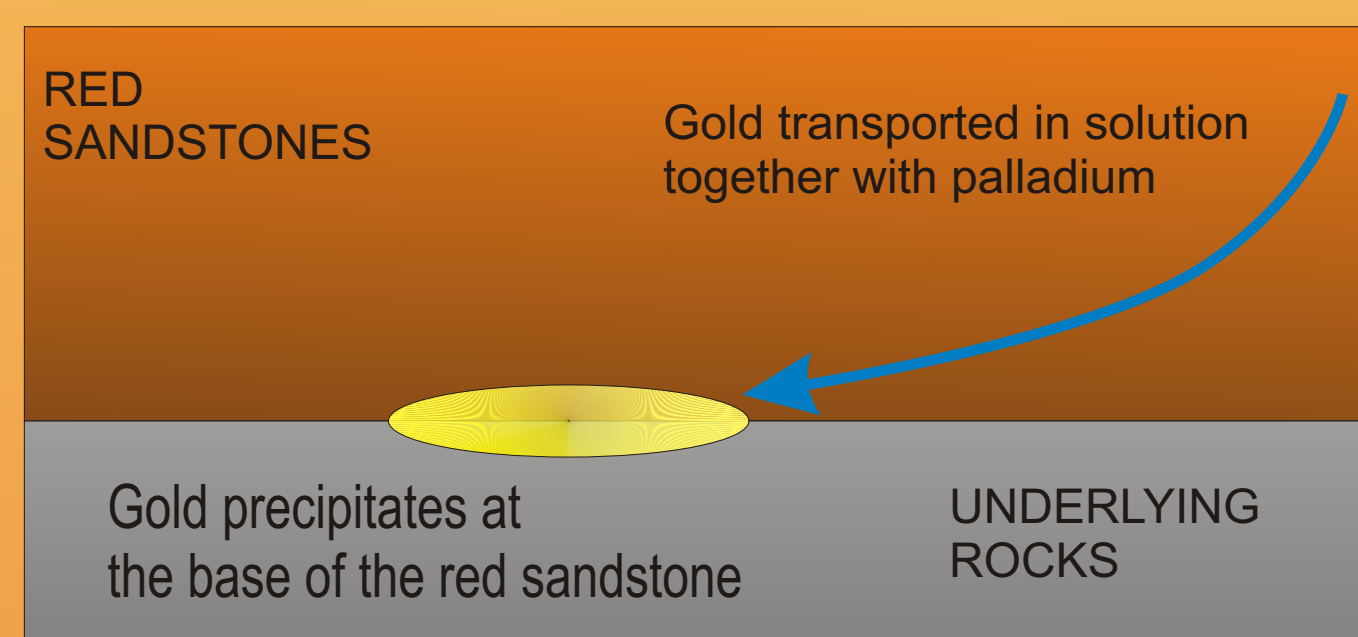
Orogenic gold is formed during metamorphic changes usually associated with subduction of the oceanic plate. The mineralization is formed much deeper than that associated with volcanism

Low sulphidation epithermal
High sulphidation epithermal
and
Porphyry

gold mineralization are associated with volcanic activity. They are emplaced at relatively shallow depths. Epithermal mineralization is generally in the form of veins, but porphyry mineralization is usually diffuse.



A further, rare but interesting type of gold occurs in several areas of Scotland where red sandstones contact underlying rocks. This gold type is the same as occurs at Hope's Nose in Devon, and was found in Scotland by the British Geological Survey, who identified similar geological environments in sedimentary basins of Permian age.



Within the red sandstone, solutions rich in sodium chloride are very oxidizing (because of the haematite in the rocks) and are capable of dissolving both gold and palladium. When these solutions encounter the underlying (less oxidising) rocks, gold and palladium precipitate. The gold is usually very fine grained, but can exhibit spectacular crystalline forms. This gold type is probably more widespread than currently realised - but unlikely to make you rich!

Studying Geology at Leeds University

The Geological Sciences BSc degree at the University of Leeds is the only University course in the UK to offer a course on gold mineralization in the UK as part of its undergraduate teaching. From 2009 this degree will offer a 'minerals' stream, so that students can choose from a portfolio of courses designed to prepare them for a career as exploration geologists. For further information about studying Geological Sciences at Leeds see www.see.leeds.ac.uk

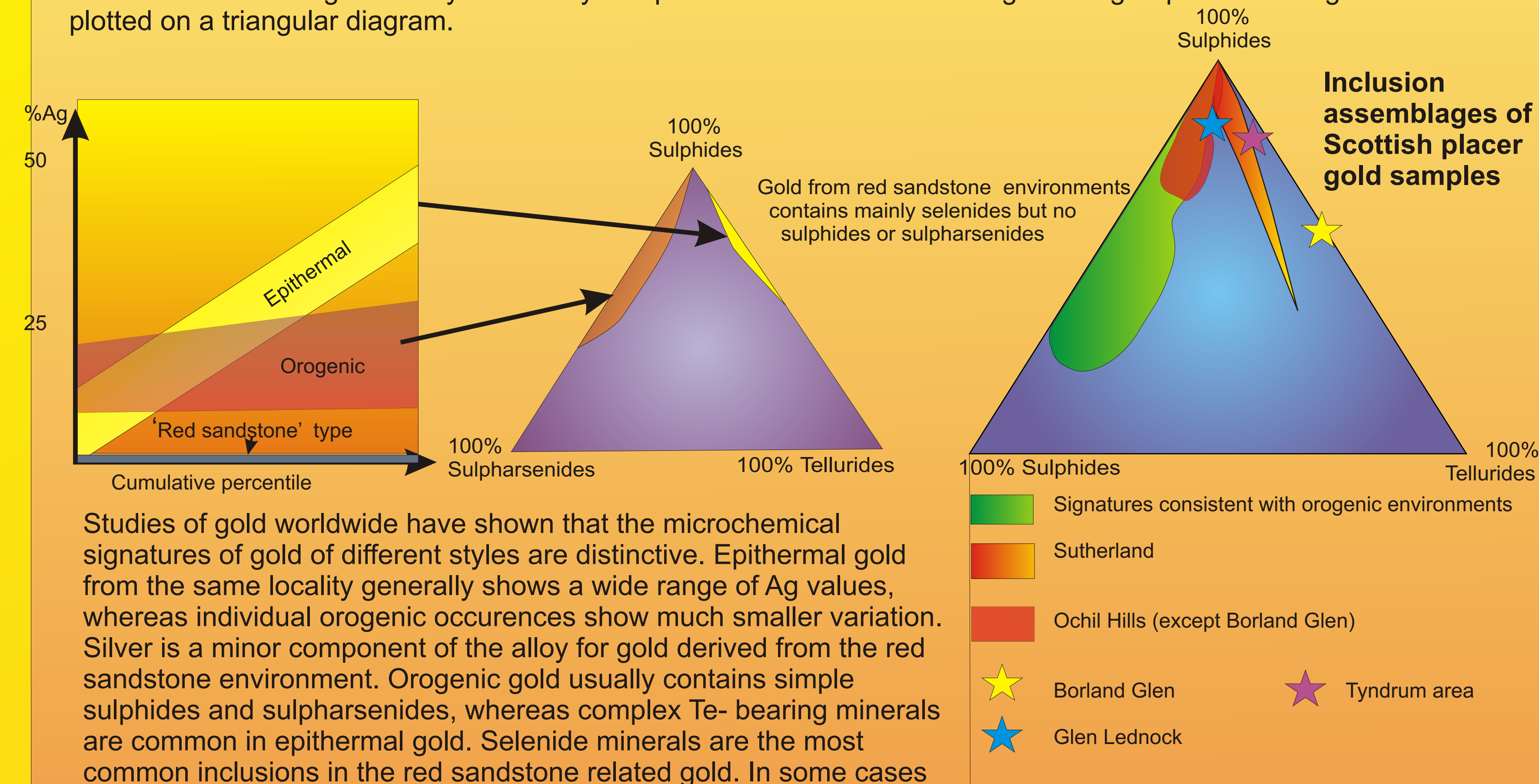
Many goldpanners have contributed to the work reported here over many years, but particular thanks are due to Anthony Crawshaw, Chris and Richard Deighton, Ben Fairgrieve, Mark Gregory, Colin Kimberley, John Krenc, and Vince Thurkettle

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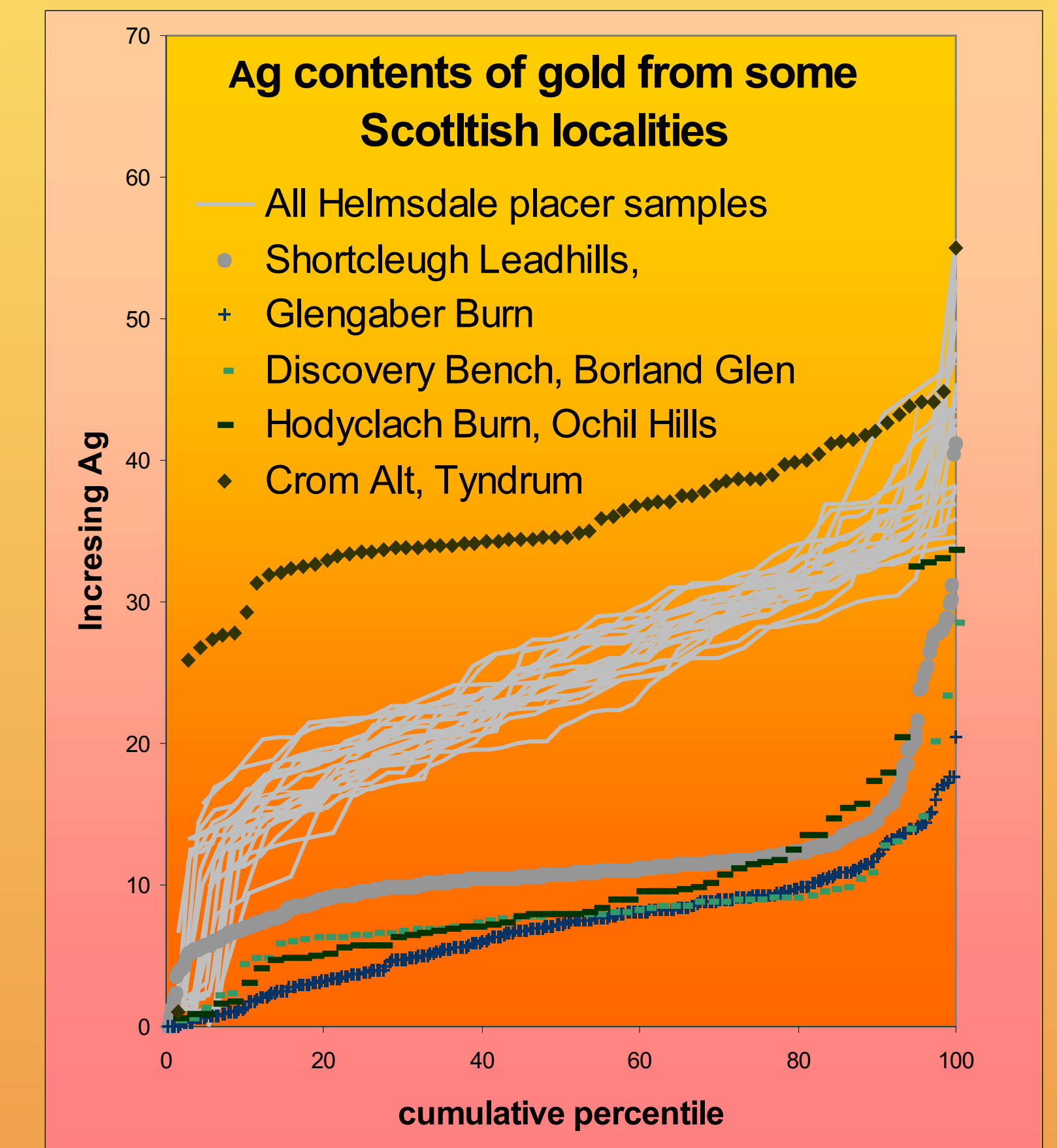
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Research at Leeds University: Linking placer gold to style of mineralization

Studies of placer gold at Leeds University have built upon a method originally developed by the British Geological Survey (BGS). The technique draws upon two sources of information: the composition of the gold alloy (i.e the % silver (Ag), Copper, (Cu) or mercury, (Hg)) and the suite of inclusions of other minerals that are revealed by polishing. Each style of gold mineralization described in panel 2 exhibits a distinctive signature in terms of these characteristics and so by studying placer gold we can speculate on the original style of mineralization. This approach studies populations of placer gold grains so that the variation in composition can be established. Sample populations are compared using plots of the type shown below, in which each grain is expressed as a percentile (100/no of grains) and plotted cumulatively against increasing Ag. In this way populations of different numbers of grains may be directly compared. The inclusions in the gold are grouped according to the mineral classes of sulphides, sulpharsenides and tellurides, and plotted on a triangular diagram.



Studies of gold worldwide have shown that the microchemical signatures of gold of different styles are distinctive. Epithermal gold from the same locality generally shows a wide range of Ag values, whereas individual orogenic occurrences show much smaller variation. Silver is a minor component of the alloy for gold derived from the red sandstone environment. Orogenic gold usually contains simple sulphides and sulpharsenides, whereas complex Te-bearing minerals are common in epithermal gold. Selenide minerals are the most common inclusions in the red sandstone related gold. In some cases individual mineral species are diagnostic of a particular origin, e.g molybdenite inclusions in porphyry gold from Glen Lednock.



Some important panning localities

The styles of gold mineralization indicated by placer gold grain compositions are consistent with local geology. In the southern uplands, orogenic gold predominates with some contributions from the red sandstone type at the margins of Permian basins. Further north, gold mineralization is often a consequence of igneous intrusions or volcanic activity (e.g epithermal gold in the Ochil Hills and porphyry mineralization at Glen Lednock). The Hg-rich signatures of placer gold from some other localities are more difficult to interpret.



Several high grade gold - quartz veins were discovered at **Calliacher Burn**, and the subsequent discovery of placer gold in the **Moness River** (1) put Aberfeldy firmly on the gold panners map. The Moness gold is not derived from the veins upstream, but gold from both localities shows a silver and Hg - rich signature.
The Crom Alt Burn, Tyndrum (2) has been a favourite panning locality. In common with other local placer gold it shows a very high Ag content. The range of inclusion minerals suggests an igneous association for the mineralization.
The Glengaber Burn (3) was the richest locality within a larger auriferous area. Gold from Glengaber shows a slightly different signature from the smaller, less abundant gold in the surrounding drainage.
Leadhills- Wanlockhead (4) is a historically important gold locality and an estimated 30,000 oz of gold were recovered in the 16th Century, (on the basis of returns from the Scottish Mint). The gold signature of 11% Ag and a simple inclusion suite of sulphide and sulpharsenide minerals suggests orogenic gold, which is consistent with the setting within metamorphosed sediments.

Key to map:

- Pre Cambrian: Lewisian/Torridonian
- Pre Cambrian: Moine
- Pre Cambrian: Dalradian
- Cambrian to Devonian Intrusions
- Ordovician/Silurian
- Devonian
- Devonian Volcanics
- Carboniferous
- Carboniferous Volcanics
- Permian/Triassic



Sketch Geology Map of Scotland

The Sutherland Goldfield(5) is the most famous panning area in Scotland, and yet despite various searches the source of the gold remains elusive. The range of silver contents within every sample from Kildonan, Suisgill, Kinbrace and Torrish Burns is very high, but only samples from the major sites of historical gold production at Suisgill (5) and Kildonan contain bismuth bearing minerals as inclusions. This correlation between composition and abundance suggests a very local origin for the placer gold. The overall signature suggests a low sulphidation epithermal source. Kildonan is close to the palaeocontact between the Silurian and overlying Devonian. In northern Scotland Devonian rocks host several epithermal systems (e.g. the fossil hot springs at Rhyynie) so the presence of Au-bearing mineralization within Devonian strata at Kildonan is possible. Previous commercial exploration has focussed searches for structurally controlled orogenic gold mineralization in the Silurian, but this model may be incorrect.

The collection of gold from the **Angus Glens** (6) bought recently by the National Museum of Scotland shows that rich (if localised) gold mineralization is present in the metamorphosed sediments of this area. An orogenic type source may be inferred both from the geological setting and microchemical signature of the gold.

The Ochil Hills were a popular destination for panners in the 1990s. There were several excellent locations but the most productive, Borland Glen (7), yielded gold with a distinctive telluride signature in the inclusion suite. This area is within Devonian volcanic rocks and the gold shows the characteristics of the low sulphidation epithermal style, although a second, Cu - rich type suggests pervasive porphyry mineralization.

The Lammermuir Hills (8) has been recognised as a placer gold area for the last 20 years. The signature of the gold shows that both orogenic and red sandstone type gold are present.



Key to photographs: 1: Placer gold to 0.5g, Moness R. 2: Placer gold to 0.6g, Crom Alt. 3: Placer gold to 0.8g, Glengaber Burn. 4: Nuggets to 1.4g, Shortcleugh, Leadhills. 5 Placer gold to 0.5g Suisgill Burn. 6: Crystalline wire gold, (2mm max length) Borland Glen. 7: Scanning Electron micrograph of crystalline gold from the Lammermuir Hills. All images copyright Rob Chapman