Mineral resources

Platinum in Scotland

Understanding the mineralisation processes

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Platinum is one of a group of six precious metals known as the platinum-group elements (PGE), which also includes palladium, rhodium, iridium, ruthenium and osmium. These elements have many important industrial applications, notably as key components in catalytic converters in car exhaust systems. Typical platinum and palladium concentrations in the Earth's crust are about three parts per billion (ppb), comparable with the abundance of gold. Economic deposits, where combined platinum and palladium contents exceed about 2000 ppb, are rare and production is dominated by South Africa and Russia.

In the 1980s, BGS exploration comprising geochemical and geophysical surveys, followed in some areas by drilling, led to the discovery of platinum-group elements mineralisation at several localities in Scotland, principally in Shetland, the East Grampians and in the Assynt district of north-west Scotland. Since 2000, increased demand for the platinum-group elements and concerns over security of supply have led to considerable renewed exploration and research activity worldwide. New BGS research, involving detailed mineralogical and geochemical studies, has been carried out in Scotland aimed at elucidating the processes responsible for platinum-group element mineralisation.

The Caledonian mafic–ultramafic intrusions of the East Grampians in north-east Scotland have long been considered prospective for platinum-group elements. BGS studies have identified discrete platinum-group minerals in magmatic copper–nickel deposits, with up to 500 ppb combined platinum and palladium, in the Knock intrusion, near Huntly, and at Arthrath, near Ellon.

Drilling for platinum in the Loch Borralan Complex, north-west Scotland.

A magmatic origin, subsequently modified by hydrothermal reworking in shear zones, is proposed for the mineralisation in these areas.

Platinum-group element mineralisation also occurs in the late Caledonian alkaline intrusions at Loch Ailsh and Loch Borralan on the north-western margin of the Scottish Caledonides. Enrichment, up to 878 ppb combined platinum and palladium, occurs over a distance of two kilometres along strike in the south-western marginal contact zone of the Loch Borralan intrusion. Two phases of mineralisation are evident: a magmatic phase comprising base-metal and platinum-group sulphides, and a more abundant, later phase with platinum-group tellurides and antimonides associated with brittle fracturing and veining, accompanied by baryte and carbonate. The genetic model for this mineralisation involves the redistribution of early-formed sulphides by low-temperature hydrothermal fluids.

High concentrations of platinum-group elements are found at several stratigraphical levels in the Shetland ophiolite complex on Unst. Platinum and palladium both exceed 100 parts per million at Cliff, close to the basal thrust of the ophiolite in a zone of talc–carbonate alteration. Lower grade platinum–palladium-dominant mineralisation has also been reported at higher levels in the complex. Elsewhere on Unst, platinum-group element mineralisation more typical of ophiolites, dominated by osmium, iridium and ruthenium, occurs in association with small chromite deposits. It is proposed that the high levels of palladium and platinum were produced by leaching of magmatic sulphides from large volumes of rock by basement-derived fluids.

Worldwide, most known platinum-group element deposits are thought to be products of high temperature, magmatic processes. The evidence from three areas in Scotland of platinum-group element remobilisation related to lower temperature hydrothermal processes is therefore of particular significance. If we can improve our understanding of how platinum-group element deposits were formed then we will be better able to predict the location of new sources of these rare metals, both in the UK and overseas.