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# Clevedon Shore, Avon

[ST 402 719]

## Introduction

At Clevedon, adjacent to the pier (see (Figure 6.10)), a mineralized fault and the associated country rocks contain a primary barite-sulphide assemblage and a variety of secondary minerals. The geological setting and mineralogy of the mineralized fault has been studied and described by Starkey (1984, 1986), and an ore mineral paragenesis was given by Ixer (1986) (see (Figure 6.11)), and by Ixer *et al.* (1993). As well as the assemblage of primary and secondary sulphides, an interesting suite of secondary alteration minerals (including phosgenite, beudantite and cotunnite) can be studied.

## Description

The coast at Clevedon exposes a section through the Portishead Formation of Devonian age and the overlying Carboniferous Lower Limestone Shale Group, this being on the south-east side of the Clevedon–Portishead Anticline. At the north end of the beach the formations are faulted against the Triassic Dolomitic Conglomerate. A mineralized E–W-trending fault and fault plane is marked by a prominent low cliff-face running out to sea. This face exhibits traces of barite mineralization with minor amounts of galena, and green and yellow secondary copper and lead minerals. The fault can be traced across the promenade and road to a small mineralized exposure in the bank close to the public conveniences.

On the beach close to the cliff-face and west of the Pier Head are many large boulders of the Dolomitic Conglomerate (up to 1 m across) carrying prominently banded barite. The boulders appear to be derived by erosion along the fault. At various states of the tide many small barite pebbles (up to 10 cm across) are exposed within the beach mud, and where mineralized these show a higher degree of secondary alteration.

The vein filling is predominantly pale-cream to pink, banded barite. Some cavities contain barite of 'cockscomb' habit. Bands of chalcopyrite crystals intergrown with tennantite and sphalerite are found in the barite. Galena occurs as euhedral crystal sections and irregular masses up to 5 cm across, and carries minute tetrahedrite inclusions along grain boundaries. It is surrounded sequentially by partial or complete rims of pyrite and marcasite, a second generation of chalcopyrite and tennantite, and later inclusion-free, dark sphalerite and minor enargite. Alteration has led to the formation of idaite and covellite accompanied by native Cu and a native As-Ag alloy (Ixer, 1986). The development of botryoidal galena and colloform pyrite may also be secondary. A number of yellow, green, brown and colourless secondary minerals include beudantite, brochantite, phosgenite, cerussite and anglesite (Starkey, 1984, 1986; Bridges, 2003).

## Interpretation

Vein-style mineralization at Clevedon cross-cuts limestone breccias (Triassic Dolomitic Conglomerate). The mineralization at Clevedon belongs to the widespread but minor lead-zinc-copper mineralization of the Bristol area (Alabaster, 1989), and has many features in common with the mineralization of the Mendip Orefield, which is considered to be Mississippi Valley-type mineralization. The major mineralogy in all cases is of galena-sphalerite-barite accompanied by minor amounts of chalcopyrite, pyrite, marcasite and bornite.

At Clevedon pale-cream to pink barite, in strongly developed rhythmic bands, is the most abundant hydrothermal mineral in the vein assemblage. Chemical analyses show it to have very high strontium contents (10.7–11.6 wt% Sr). High Sr values in the barite can be equated with the mineralization recently recorded from Chipping Sodbury (Rankin, pers. comm.). The very high values of Sr in the barite are remarkable, but probably reflect the fact that the Bristol area constitutes one of the world's classic celestine orefields. Minor amounts of lead, copper, and zinc sulphides and

sulphosalts are present within the barite as rare, small disseminations. Detailed studies of the mineralogy and mineral chemistry presented by Ixer *et al.* (1993) have provided a paragenesis for the primary mineral assemblage within a single barite band.

In decreasing order of abundance the main opaque minerals are galena, chalcopyrite and sphalerite, which are accompanied by minor amounts of tennantite, pyrite, marcasite and hematite, while trace amounts of bornite and enargite are also present. Alteration of the primary sulphides to secondary digenite and covellite is widespread. An Idaite-like mineral accompanies chalcopyrite, and some tennantite shows features suggesting it is an alteration product of chalcopyrite.

Galena is the earliest phase to crystallize in the polymetallic sulphide bands, where it occurs as small euhedral to subhedral crystals. They tend to be free of primary inclusions, and are commonly enclosed within sulphide and sulphosalt rims. Galena at Clevedon is similar to that from the general Mendip Orefield in being optically free of sulphosalt inclusions, and the silver content (although low) may be as solid solution within the galena.

There are a number of sphalerite generations, one being part of the early mixed sulphide sub-assemblage found at the base of the barite bands, or sometimes as millimetre-wide rims to galena. Most sphalerite is pale-coloured and is the last major sulphide to form; it overgrows tennantite to fill the centre of vugs in galena. All generations of sphalerite tend to be inclusion-free.

Sphalerite tends to have low iron contents but is remarkably high in cadmium (analyses indicate up to 8.46 wt% Cd), this being a regional feature. The body colour is thought to be due to microscopic sulphosalt inclusions, and the opacity to copper content and incipient alteration.

Tetrahedrite-group minerals are generally rare in the Mendips. The sulphosalts, including tennantite, from Clevedon are notably silver-poor and tend to have similar arsenic: antimony ratios.

The presence of phosgenite and other secondary minerals were reported by Starkey (1984), and the intimate association of beudantite with oxidized tennantite-tetrahedrite and galena by Starkey (1986). At Clevedon, beudantite is locally common and seems to occur where tennantite (As-bearing) has undergone alteration in association with oxidizing pyrite-marcasite and galena.

Bridges (2003) more recently described the presence of cotunnite from a single pebble in mud on the foreshore at Clevedon. This represented only the second occurrence of cotunnite in the British Isles.

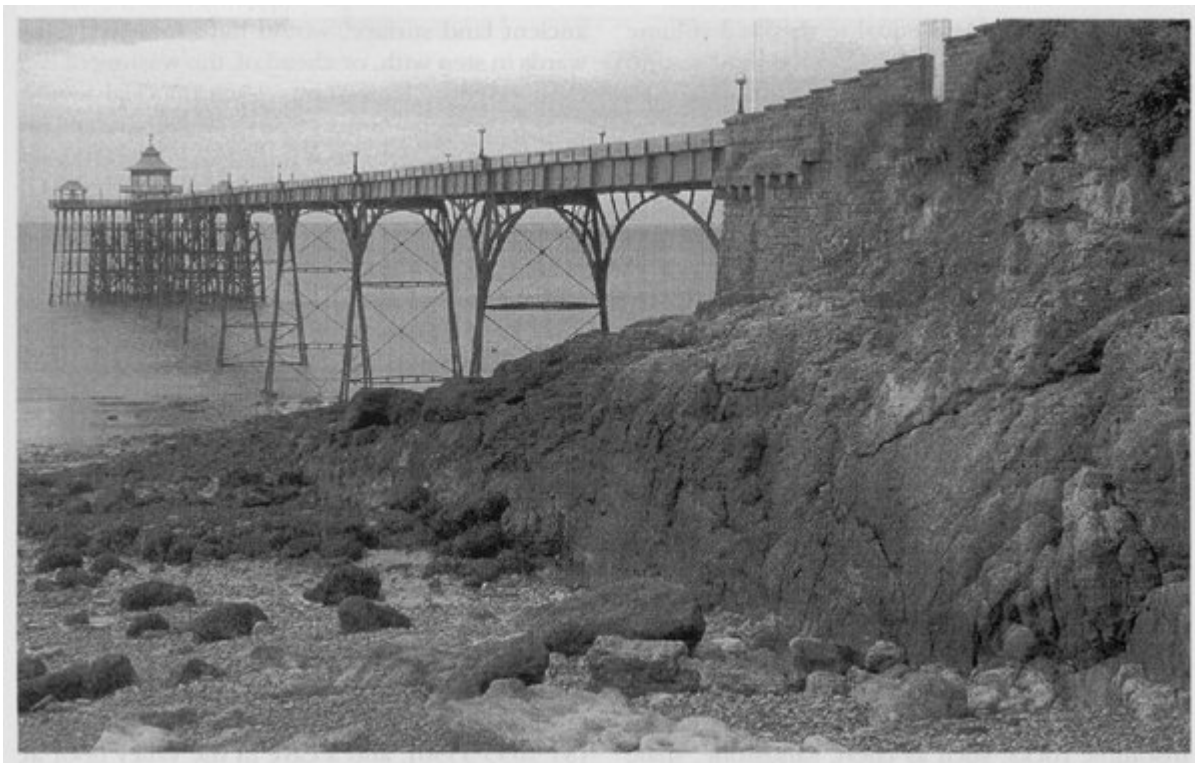
The lack of a comparable mineralogy and mineral chemistry from the Mendip Orefield makes it hard to assess the overall importance of the Clevedon mineralization. At the Clevedon Pier section upward-moving fluids of hydrothermal origin may represent a single event associated with late-stage Jurassic mineralization, or the complex mineralization may have formed from a small, localized feeder of mainstream mineralization through the fault system.

## Conclusions

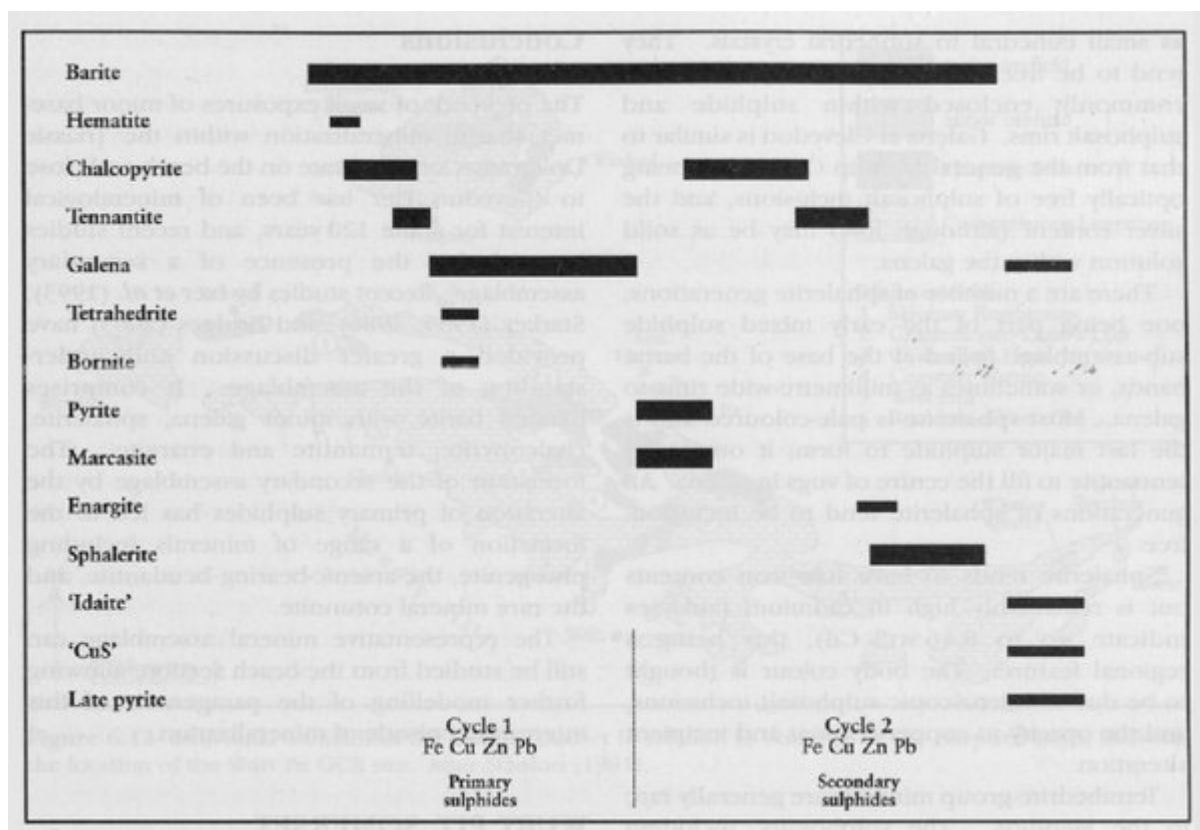
The presence of small exposures of minor base-metal-barite mineralization within the Triassic Dolomitic Conglomerate on the beach and close to Clevedon Pier has been of mineralogical interest for some 120 years, and recent studies have shown the presence of a secondary assemblage. Recent studies by Ixer *et al.* (1993), Starkey (1984, 1986), and Bridges (2003) have provided a greater discussion and understanding of the assemblage. It comprises banded barite with minor galena, sphalerite, chalcopyrite, tennantite and enargite. The formation of the secondary assemblage by the alteration of primary sulphides has led to the formation of a range of minerals including phosgenite, the arsenic-bearing beudantite, and the rare mineral cotunnite.

The representative mineral assemblage can still be studied from the beach section, allowing further modelling of the paragenesis of this interesting episode of mineralization.

## [References](#)



(Figure 6.10) Photo of Clevedon Pier at the Clevedon Shore GCR site. (Photo: Natural England.)



(Figure 6.11) Paragenesis of the mineralization at Clevedon Shore. After Ixer (1986).