TUFA-TRAVERTINE DEPOSITS AT BLACK MOUNTAIN, SOUTH WALES

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On the Bath Geological Society fieldtrip, in July 2015, to the Black Mountain, north of Brynamman, South Wales, spectacular tufa-travertine deposits were seen. Although tufa is commonly developed in areas of limestone in Britain, where there are springs and streams, these near the old quarries at Penwyllt quarry (Grid reference SN 735 189) are beautifully developed and very special.

Figure 2. A stream with water a cm or 2 deep flowing over a crystalline crust with tiny terracettes.

Located in the Upper Swansea Valley, Penwyllt is a former quarrying village where quicklime and silica bricks were produced from the early 19th Century. Until the 1940s, there were five working limestone quarries in the area, but the closure of the ironworks at Ystradgynlais reduced the demand for lime as a flux in iron production and in 1959 the lime kilns finally closed. The disused kilns were backfilled with lime spoil to make them safe and since then small streamlets have developed running down the hillside to the north. Calcareous deposits are forming within these streams and the marshy ground close by (Figures 1, 2 and 3).

Within the streams there are abundant crystalline crusts as well as deposits of pisoids, coated grains formed of calcite. The sheets of calcite extend for several metres across and down the streams, where water flows over the surface periodically. A feature of these crusts is the development of terraces on the surfaces, called ghours (Figure 4), reflecting the flow of water with tiny wavelets during the precipitation of carbonate. These crusts are identical to those forming in modern travertine deposits, where the water has come from a hot spring. They are famously well-known from Pumukkale in Turkey, and Tuscany; much of Rome is constructed of travertine, and this material is also used extensively as a floor tile (including my study!!). On a small-scale, similar travertine is forming at the Roman Bath in Bath where the water emerges from the Sacred Pool at the Great Drain.

Figure 1 :View to old quarries at Penwyllt, Black Mountain, with a stream, emerging from old spoil tips, with extensive calcite precipitates.

The pisoids reach 3 cm in diameter and form extensive gravel carpets (Figures 5 and 6, page 34). Internally they have an irregular to finely laminated structure (Figure 7, page 35), arising from the seasonal/annual microbial growth and occasional agitation and rolling

Figure 3. Small stream with crystalline crust and

Figure 4. Terracettes (ghours) in the crystal-line crust at

Figure 5. Abundant pisoids up to 3 cm diameter formed within a stream draining from the old lime-slaking site, Penwyllt.

of the pisoid during calcite precipitation. Where forming in very shallow pools of water, pisoids may become stationary and flat tops may then develop on the pisoids where they reach the water surface to create a crystalline crust (Figure 8 overleaf).

These carbonate precipitates are the result of both inorganic and organic processes. Degassing of CO_2 from the water as a result of the turbulence in the stream water is a major cause of precipitation. Also the photosynthetic activity of microbes (chiefly cyanobacteria) also removes CO_2 from the water and so induces calcite precipitation.

Figure 6. Pisoids - mostly precipitated by microbial activity.

Figure 7. Pisoids – internal structure, the result of microbial activity.

Figure 8. Flat surfaces developing on the tops of pisoids where stationary to create a more extensive crystalline crust in a quiet area of a hyperalkaline stream.

The waters from which calcite precipitation is taking place at Penwyllt are extremely alkaline (pH up to 12) and rich in HCO_3 and Ca^{2+} (Andrews et al. 1997). The calcite precipitates have been analysed for their stable isotopic composition and values for $\delta^{18}O$ are as negative as -14 ‰ and for $\delta^{13}C$ as negative as -21 ‰. The very negative values of the calcite are attributed to isotopic fractionation effects caused by the hyperalkalinity of the stream waters, which are derived from the dissolution of waste lime spoil coming from the kilns.

Reference: Andrews, J.E., Gare, S.G. & Dennis, P.F. (1997) Unusual isotopic phenomena in Welsh quarry water and carbonate crusts. Terra Nova 9, 67-70.