Evaluation of the distribution and leaching potential of lead, cadmium, and zinc from the Cwmystwyth Mine (Fig. 1) has been undertaken along with surface grab samples in 2015. Metal concentrations and pH were evaluated respectively, in which a general weak association between these two factors was found. Using these two parameters, a factorial diagram was created to assess the type of drainage being produced at the Cym-y-Mynydd Mine, which indicated metal weathering-neutral mine drainage being generated. 

Drainage water from mine workings (Fig. 2), waste materials and surface generated some variations in terms of pH and metal concentration, with most samples showing elevated results but higher metals from water that flows through the mine (Fig. 3). 

In summary, the mine is heavily contaminating the Ystwyth catchment, with high levels of Pb, and controlled by zinc mobility and secondary phases. Cadmium geochemistry appears to be rather inconclusive. However, if more samples had been collected similar results could be expected. 

Neutral pH in the mine could be attributed to the lack of pyrite as evidenced by the XRD results, where only sample CS10 contained less than 1% pyrite. The majority of sulfides comprise, galena and sphalerite that are both non-acid generating. According to the XRD and Carbonate Rating test, buffering is coming from silicate minerals rather than calcite, such as Albite (NaAlSi3O8) and Muscovite (KAl2(AlSi3O10)(OH)2). Calcite minerals generate significantly more neutralisation potential than the other phases and therefore indicates that there is no neutralisation potential for the studied samples, as this is directly related to the abundance of non-carbonate minerals. This can be compared to a study by Jambor (2003) where it is stated that certain silicate minerals are known to buffer mine waters to a different pH in neutral pH. 

A site conceptual model of the Cwmystwyth Mine (Fig. 4) has been developed using literature research from desk study and field observations. The conceptual model aims to identify and highlight the environmental linkage for the studied transition metals, which are causing the River Ystwyth to be severely contaminated.

Using the results of the BS EN 12457 testwork, interpolated heat maps were derived to analyse the spatial distribution of the soluble metals that have potential to leach into the environment and cause serious harm (Fig. 5). These results portray the potential leachable nature of the metals from surface material. Cadmium and manganese show similar trends and are most notable in the area of Gill’s lower adit, Mn is in the south west of the map, and zinc is most notable in the sediments associated with high pH whilst arsenic shows a hot spot on the side of the Gill where pH is neutral and from other data low content is low. In the pH map of the River Ystwyth upstream and downstream from the mine, where soils to neutral waters can be observed (Fig. 6). This indicates most of the acidic waters are coming from the Nant Y Cadwyd which travels through the mine and waste dumps located closer to the Ystwyth river (Fig. 7). Magnesium analysis on water chemistry indicated that lead and zinc have an antagonistic relationship to pH whilst arsenic is positively correlated. Manganese and cadmium show a stronger relationship to alkalinity than pH.

In summary, the mine is heavily contaminating the Ystwyth catchment, with high levels of Pb, and controlled by zinc mobility and secondary phases. Cadmium geochemistry appears to be rather inconclusive. However, if more samples had been collected similar results could be expected.