4C Background Information about Lead

Lead in the Earth

Lead is present throughout the earth's crust, but in very small quantities. In terms of abundance it is the 38th most common element in the crust, and on average a rock sample will contain only about 12 parts per million of lead – just 12 grams of lead in every ton of the rocks in the earth's crust.

In spite of the apparent scarcity of lead normally present, much has been mined and about 2.8 million tons of lead are used each year. Clearly, if large quantities can be found, then there must be some natural means by which lead can become concentrated in certain parts of the earth's crust, as at Snailbeach.

Normal processes of erosion on rocks will simply remove the lead, along with other minerals, from mountains, and the resulting deposits will come to rest in the beds of rivers, or of the sea. Some lead is dissolved and carried in solution by rainwater, but this has not resulted in any great concentration of lead in sea water. Lead compounds are eventually deposited with other sediments on the sea bed, and remain dispersed in minute quantities throughout the rock.

The immediate question is therefore about the way in which lead becomes concentrated in sufficient quantities to be worked commercially. At Snailbeach the lead is found in a vein which cuts across the Mytton Flags; sandstones and siltstones of Lower Ordovician age, that is to say, in rocks deposited some 470 million years ago. Over more than 150 million years thick sediments came to rest in a rapidly deepening ocean trench. Rocks of similar age are found in Wales, the Lake District and Scotland, where the sediments include volcanic deposits.

The presence of volcanic deposits shows that the rocks at depth were being heated to the point where they would melt. Some molten magma would emerge at the surface from volcanoes, but much would eventually recrystallise underground to form granites. As the magma cooled deep in the earth under great pressure, crystals would begin to form. Silica, which has a very high melting temperature, would be present in most of the first crystals to appear – quartz, feldspar and mica. When most of the magma had solidified as granite some elements would be concentrated in the remaining fluid. They would include metals which have a low melting point, such as lead, silver, mercury, antimony, tin and copper.

Earth movements, associated both with mountain building, and with the shrinking of the granite as it solidified, opened up fissures in the overlying rock which the remaining fluid could penetrate. At Snailbeach the lead combined with sulphur to crystallise as the mineral Galena (PbS), and it was associated with Calcite (Calcium Carbonate, $CaCO_3$) Barytes (Barium Sulphate, $BaSo_4$)and Fluorite (Calcium Fluoride, $Ca F_2$).

The result was a very distinctive set of minerals filling a vein in the grey sandstones and shales. The white Calcite, Barytes and Fluorite would attract attention immediately, and then the grey metallic crystalline Galena would be discovered.

Identifying the minerals at Snailbeach

Distinguishing minerals in the field can be quite difficult. This is because the most obvious feature we use to recognise most things, colour, can be affected by impurities in a mineral. Calcite, Fluorite and Baryte found at Snailbeach may all be present as white minerals. Galena, in the white veins, is completely different. It is a dull grey metallic looking mineral, and if crystal shapes are visible they are very clearly cubic.

Galena, as lead ore, is also much denser than the other minerals. Barytes, known to lead miners as 'heavy spar', is also appreciably denser than Fluorspar or Calcite, which have about the same density as ordinary rock forming minerals.

Weak acids, such as vinegar, will react with Calcite. A drop of vinegar will fizz as it reacts with Calcite, but will not react with Fluorite or Barite.

Another identifying characteristic is hardness. A hard material will scratch a softer one. But often the softer material will leave a streak on the harder one, so this test must be used with care. On Moh's scale of hardness a fingernail has a hardness of 2. So a fingernail will scratch lead, which has a hardness of 1.5. Rubbing a fingernail against a harder material will leave a trace of fragments of the nail behind. Calcite and Fluorite at Snailbeach may both be white, but Fluorite is harder.

Close inspection may reveal the crystalline structure of minerals. Fluorite has cubic crystals like those of salt. By contrast the crystals of Calcite are clearly not bounded by right angles or formed of equilateral pyramids. Light passing through Calcite crystals is bent sharply, and light may be reflected with a rainbow sheen from surfaces.

MINERAL	HARDNESS	DENSITY	FORMULA	MELTING POINT (degrees centigrade at normal pressure)
Quartz (sand grains, Silica)	7	2.65	SiO_2	1830
Calcite (Calcium Carbonate)	3	2.7	$CaCO_3$	1612
Fluorite (Calcium Fluoride)	4	3.2	CaF_2	1360
Barytes (Barium Sulphate)	3	4.5	$BaSO_4$	1600
Galena (Lead Sulphide)	2.5	7.6	PbS	1114
Lead	1.5	11.3	Pb	327