



Encouragement Award

Science Writing Year 11-12

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Lead Mining in Broken Hill

How has lead mining affected Broken Hill and what is being done to reduce the Risks?

Australia has one of the greatest lead mining industries worldwide with a major mine located in Broken Hill. Scientists however have discovered that lead mining is negatively affecting the mental and physical development of children living in these mining towns (Taylor, 2015). Lead is also seeping into soil and waterways, meaning that the chances of people being exposed to lead without even realising are significantly high. Fortunately, the 3.8 billion-dollar industry has decreased by 7.5% in the last five years and is continuing to decrease (Ibis World, 2020). Despite this, Lead is still very prevalent in the atmosphere and damage done by lead poisoning is irreversible.

Relevant Science

Lead can be found in many forms. Elemental lead (Pb) is a bluish-grey metal that is very soft and ductile (Royal Society of Chemistry, 2021). It is also highly malleable as it has delocalised electrons, allowing lead atoms to easily slide past one another (HowStuffWorks, 2009). Lead is usually found as Galena (PbS), which is the lead ore mineral. Other ore minerals of lead include cerussite (PbCO₃) and anglesite (PbSO₄) (Government of South Australia, 2021).

Lead is extracted by a three-stage process. The lead ore (galena) and zinc ore (sphalerite) are separated from other minerals by being crushed and mixed using a frothing agent and water.

Afterward, a soluble depressant chemical is added which separates the galena and sphalerite. The galena is then roasted in oxygen-enriched air, which converts the sulfide to lead(II) oxide. This process can be expressed as, $2\text{PbS} + 3\text{O}_2 \rightarrow 2\text{PbO} + 2\text{SO}_2$. The sulfur dioxide is then removed to make sulfuric acid.

The lead(II) oxide is mixed with limestone and coke in a blast furnace to form molten lead. The coke is mainly carbon and produces carbon monoxide and carbon dioxide that act as reducing agents. This can be expressed as, $\text{PbO} + \text{C} \rightarrow \text{Pb} + \text{CO}$ or $\text{PbO} + \text{CO} \rightarrow \text{Pb} + \text{CO}_2$ (Better Health Channel, 2020). This lead is referred to as bullion lead as it is still not entirely pure. The lead is then refined by heating slightly above its melting point and stirring with an air blast (The Essential Chemistry, 2021). Lead is so dangerous due to its ability to mimic calcium, as both minerals form ions with a charge of 2+ (Fighting with Food, n.d).

Calcium is vital to body as it promotes bone density to prevent osteoporosis. It also stimulates the release of neurotransmitters in the brain (Better Health Channel, 2020). When lead is absorbed into the bloodstream instead of calcium, it disturbs the communication between neurons by either sending false information or blocking the release of neurotransmitters entirely (see figure 1). Children are more severely harmed by the exposure to lead as their bodies require more calcium.

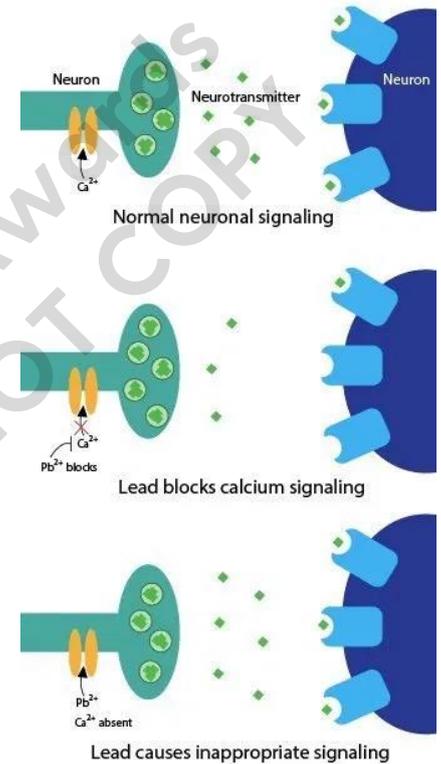


Figure 1 Lead can interfere with the neurotransmission process (Lyon, 2016)

Interaction between science and society

Due to lead's convenient properties, it is present in a variety of common goods. 80% of lead is used in lead-acid batteries (The Essential Chemistry, 2021) in which 90% is recycled (Science Direct, 2020). Other uses include lead foil, plumbing, solder, sound proofing, ammunition, glass that blocks harmful radiation and ultraviolet protection in PVC plastics

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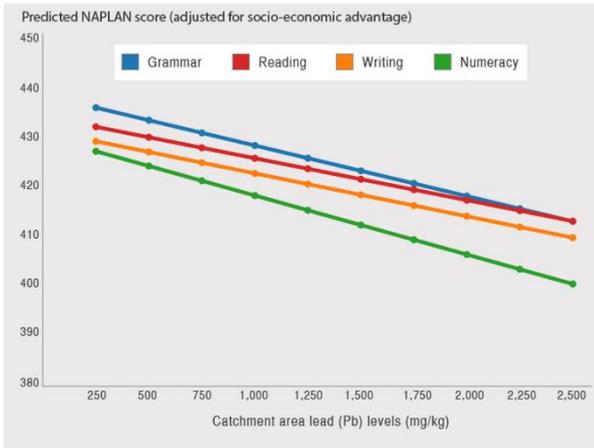


Figure 2 predicted NAPLAN scores for children in Broken Hill purely dependent on the lead levels. (Taylor, 2015).

(Government of South Australia, 2021). Lead was also used as tetramethyl lead which was used as an anti-knocking additive to fuel. This however has devastating effects on residents of lead mining towns like Broken Hill, particularly the children; due to their higher demand for calcium. *'The Conversation'* (2015) revealed that children in Broken Hill have considerably lower academic progression compared to the national average. More specifically, children residing closer to the lead mine within the town suffer more severely, as demonstrated in the predicted NAPLAN scores in figure 2. Due to years of lead mining in Broken Hill, lead is now widespread in dust, soil, dirt and rainwater tanks (NSW Government, 2021). Also, due to the dry climate, lead dust

spreads faster. 98% of exposure is from ingestion. This involves dirty hands, unwashed food and accumulated dust. The other 2% of exposure is from inhalation and absorption (NSW Government, 2021). The New South Wales government have also warned that lead exposure can be threatening for pregnant women as it can lead to decreased birth weight or miscarriage (NSW Government, 2021).

Potential Impacts

Many actions have been initiated in order to reduce lead exposure. The NSW Government launched a \$13 million program in February 2016 to 'address the issue of lead contamination among local children in Broken Hill' (Taylor, 2015). They have also created a website informing the public of the dangers involved with the mine as seen in figure 3. (NSW Government, 2021). Other laws have been established in order to reduce the concentration of lead in the atmosphere including banning the use of lead in paint pigments and tetramethyl lead in fuel (Taylor, 2015). There are also housekeeping practices that are recommended to reduce lead contamination, including, keeping homes dust-free, washing fresh produce as well as addressing any water damage quickly (EPA, 2020).

Despite Lead's threat to society, many limitations prevent lead mining from being abandoned completely. Mining is the third largest industry in Broken Hill, providing work for 10.9% of the population, in which 88% of jobs involve metal ore mining (idcommunity, 2019). Discontinuing this sector could cause serious unemployment issues. It will also negatively impact the local and national economy greatly (Ibis World, 2020). Replacing lead objects such as pipes is also impractical. Although pipes are now usually made of copper, replacing every lead pipe with copper pipes is an expensive process. This has been addressed by adding minerals to the water to form walls blocking the lead. However, this is not a secure strategy, particularly for drought-prone towns. (Yoshida, 2020). Lead is also usually mined with sphalerite (a zinc ore) which is a highly used metal (General Kinematics, 2020). In order to stop mining lead, zinc mining would become nearly impossible.

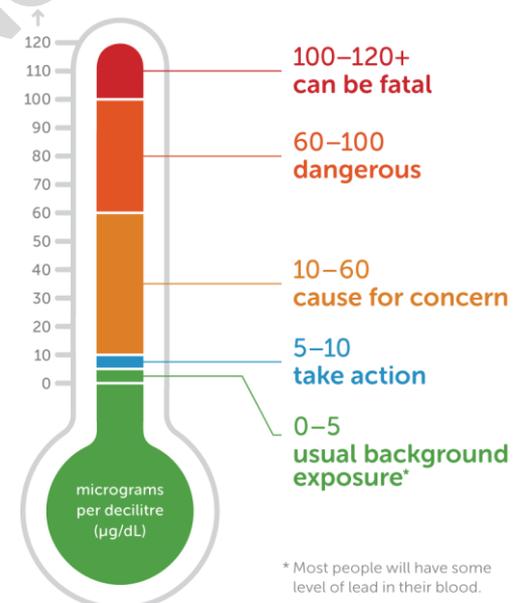


Figure 3 An indicator of different blood lead levels for Broken Hill residents (NSW Government, 2021)

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Lead mining is an essential material in the production of many objects due to its malleable and ductile properties. It still, however, poses a major threat to society, particularly the residents of lead mining towns. Due to lead's ability to mimic calcium, children are particularly affected. Children suffer with mental and physical development. Many solutions have been created to reduce the concentration of lead in the atmosphere; however, the threat of lead cannot be completely removed and those already affected are incurable. Lead is a useful yet dangerous metal that can be reduced, however, cannot be completely removed from mining towns.

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