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LETTER TO THE EDITOR

Will the development of the Grassy Mountain Coal Project adversely affect one of the top agricultural food production areas on the continent?

Normally when I write or speak of selenium, it is in regard to cattle supplementation as a result of deficiencies in many areas of the province. The announcement of the potential development of an open pit coal mine on Grassy Mountain, at the headwaters of the Oldman River with additional potential impacts to the tributaries as well as the Crowsnest and South Saskatchewan Rivers, has me concerned and thus now writing about potential toxicity of selenium to both animals and humans.

Selenium is a required nutrient for all living organisms. There is a narrow range with selenium between what is essential and what is toxic. In humans the range of toxicity is less than 1 mg selenium per day. Thankfully, as nutritionists, we rarely deal with selenium toxicities. Once an animal is selenium toxic, it is usually fatal.

Early symptoms of selenium deficiency versus toxicity are very much alike, which makes diagnosis difficult. Without a history of selenium intakes, a tissue sample of the animal must be taken and analyzed to determine if the animal is deficient or, in fact, poisoned by selenium. Cattle and other ruminants have the greatest tolerance to selenium toxicity. Less tolerant in descending order are monogastrics such as pigs and horses, followed by birds, reptiles and finally least tolerant, invertebrates and fish. As an intolerant species, signs of selenium toxicity in fish are an early indicator that there is a potentially toxic level selenium in the environment, so it is important to ensure fish are monitored downstream of development.

The daily upper recommended limit of selenium intake for humans, as recommended by the WHO, is 400 nanograms per day. At twice that level, 800 nanograms/day, selenium intake may start to become toxic. Levels of toxicity will be affected by the form (organic vs inorganic) of selenium.

The availability of selenium depends on its form. The two most common forms of inorganic selenium are selenite and selenate. Selenate is extremely soluble and mobile which allows it to be taken up by plants. Selenite is not as soluble therefore is not taken up by plants. Inorganic selenate, when taken up, is converted into organic forms of selenium by the plant. These organic forms are ten to 100 times more bioavailable than inorganic selenate when consumed or absorbed by other living organisms, such as cows and humans.

Conversion of inorganic selenate to organic forms of selenium by plants has been used to remove selenium from contaminated areas. The plants containing high levels of organic selenium decay and the selenium is then converted into gaseous forms such as hydrogen selenide (SeH2). These gases are then released into the atmosphere, thus resulting in decreased levels of selenium in previously contaminated areas.

In this case however, this process cannot be used in the downstream prime agricultural area. Here, irrigation is essential. Crops are used for livestock feed and/or human food consumption and are not permitted to decay. The more bioavailable organic form of selenium remains in these crop plants, moves up the food chain and accumulates in increasing levels in both tissue and waste material (fecal). Two things happen through the transformation from inorganic to organic selenium forms:

1. This increased concentration can quickly result in toxic levels of selenium in animals and humans consuming the farmed products from the watershed. These agricultural products become unsaleable and could result in a huge economic loss for southern Alberta and Canada.
2. Now let's talk manure. Crops containing high levels of organic selenium are harvested then fed to animals at nearby intensive livestock operations. Results from studies in North Carolina showed that manure from animals with high selenium intake will produce manure that has 10 to 50 times the level of selenium that is in the feed. When the manure from the intensive operation is applied to cropland, the high organic selenium runs off into the river causing concentrations 100 times more bioavailable than the original selenate which came from the mining operations. Not only would the water downstream of the intensive livestock operations have more concentrated selenium levels, but because the selenium is in organic form, it is more bioavailable and therefore more toxic.

Remember there are also the inorganic selenium forms to consider. Water sourced from the river for irrigation will contain higher levels of inorganic selenium and the consequences can be described by the Kesterson Effect. As river water is applied to crops, some of it evaporates from the soil, leaving the selenium to become concentrated as selenium salts. Over time these salts contribute to the salinity of the soil (salinity is already an issue for irrigation districts). When a high moisture event occurs (natural or man-made), selenium salts will leach back into the river system downstream. The result will be an even higher concentration of inorganic selenium in water downstream. This Kesterson effect is documented as the cause of selenium toxicities in the San Joaquin Valley in California.

A review of the literature indicates that the top three sources of man-made selenium contamination worldwide in order of greatest to least are:
1. Mining
2. Irrigation
3. Feedlots

The Oldman River and South Saskatchewan watersheds already have large feedlots and supply irrigation. If additional pressures from a new coal mine were added to these watersheds, this area would be unique in the world as having all three top contributors to selenium contamination.

The proposed Grassy Mountain coal mine lies at the headwaters of the Oldman River, which flows into the South Saskatchewan downstream. As mentioned previously, fish are early indicators of selenium toxicity. Research shows that waste material from the open pit coal mines in the adjacent Elk Valley have been contaminating the Elk River with high levels of selenium to such an extent the local fish population is threatened. The Elk River watershed flows across the US Border and there are currently international conflicts over this contamination. Treatment of runoff water from the Elk River mines to remove selenium has not been successful despite the mining company spending $600 million dollars to try to resolve this problem.

The coal from Grassy Mountain is from the same geological coal formation as the Elk Valley. Therefore, one can assume the waste material from coal in Grassy Mountain would contain the same levels of selenium as the Elk Valley mines. If the selenium is not removed from the waste rock, there can be no guarantee it will not contaminate the watershed. At the point of writing, there is no mention of removing the selenium from the waste rock at the proposed Grassy Mountain Mine. Why is there no plan for this?

If contamination of the watershed occurs, a domino effect will happen downstream with increasing concentrations of selenium going back into the river. First, fish will start dying from the selenium contaminates. Secondly, due to the Kesterson Effect, there will be increased concentrations of inorganic selenium as it moves downstream. Thirdly, there will be increased concentrations of organic selenium from manure. The overall effect over time, has the potential to increase selenium levels to the point where the water in the river will be toxic to all living creatures.

The company proposing the mine for Grassy Mountain state they will have settling ponds to capture selenium but nowhere does it mention actual removal of this captured selenium. Is there a relationship to profitability? Other mining sites have shown that settling ponds on steep mountain sides have periodic catastrophic failures in times of heavy rainfall or runoff from high-snowfall winters. The silt contamination along with the selenium and other heavy metal contaminants would have severe deleterious effects on the watershed.

One solution to deal with the high selenium is dilution; remove all allocations and let the river water flow uninterrupted from the mine to Hudson Bay. If allocation is prohibited from the Oldman and South Saskatchewan Rivers, dilution would likely keep the waters within healthy limits.

The problem is, calling a halt to irrigation from the watersheds would result in the end of Taber Corn, french fries, greenhouses producing huge amounts of fresh vegetables, feedlot alley, thousands of jobs and millions of dollars. Economically this would be devastating to the tune of billions of dollars to southern Alberta and Canada. How would all that food be economically replaced?

From a purely academic point, Southern Alberta would be the only location in the world to have the top three causes of man-made selenium contamination of water in the same river system. It would be interesting to observe how high the selenium levels could get in Medicine Hat. Development of the Grassy Mountain Mine must consider the impacts of selenium in the waste. In my opinion, if selenium is not removed from mining waste, the potential impact to food supply, economics, and human health could be devastating. Removing selenium from the mine site is the only way to ensure that selenium does not go into the river. The other option is to not allow the Grassy Mountain mine to go ahead.

Respectfully submitted,
Lee Eddy

ABOUT THE AUTHOR
Lee Eddy graduated from the University of Alberta with a B.Sc. in agriculture majoring in Soil Science, Animal Science and Economics. He has spent his career working in animal nutrition, forming Blue Rock Minerals in 1998. Lee has been involved in significant nutrition research in the industry and the University of Alberta. Lee has both spoke on and published many articles about cattle nutrition and is incredibly knowledgeable in the field. He is always looking for a research project to help propel our industry into greater profitability.